

HP 3000 Computer System



SITE PLANNING AND PREPARATION GUIDE



HEWLETT
PACKARD

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LIST OF EFFECTIVE PAGES

The List of Effective Pages gives the date of the current edition and of any pages changed in updates to that edition. Within the manual, any page changed since the last edition is indicated by printing the date the changes were made on the bottom of the page. Changes are marked with a vertical bar in the margin. If an update is incorporated when an edition is reprinted, these bars are removed but the dates remain.

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This manual contains site preparation information for HP 3000 Computer Systems, and is part of the Site Preparation Set, part number 30000-60029. The set consists of:

HP 3000 Computer Systems Site Planning and Preparation Guide, part no. 30000-90206

HP 3000 Computer Systems Site Planning Workbook, part no. 30000-90207

HP Computer Supplies, part no. 5953-2450

Adequate and proper site preparation is vital to the extended reliability of your computer system. It is your responsibility, as the customer, to ensure that facility conditions are maintained in accordance with the specifications set forth in this document. This will allow Hewlett-Packard to provide support services in accordance with the "Customer Support Services Agreement".

You should carefully study and become familiar with the contents of this manual before starting the site planning and preparation process.

Your HP Representatives are available for consultation regarding the objectives, courses of action, and progress of installation. However, where recommendations are needed for electrical, environmental, air conditioning, and construction, you should retain the services of a consultant for that particular area of concern.

References are made to certain associations and standards in this manual. These references apply only to the United States (and in some cases, Canada). Since it is impossible to provide equivalent references for each locality, you must determine what your equivalent authority is, especially for safety codes.

1-1. INTRODUCTION

This section provides a brief discussion of the events in the site planning phase. Initially, your HP representative will be available to answer questions regarding the contents of this document and explain Hewlett-Packard's specifications. More detailed information for site preparation is contained in the subsequent sections.

1-2. INITIAL PLANNING

All factors related to proper site preparation should be considered at the time the order for your system has been placed and confirmed. Items to be considered are:

- Selection of the Site Coordinator
- Identification of Site Planning Team
- Site Selection and Size
- Equipment Location
- Construction Requirements and Schedules
- Safety Precautions / Regulations / Requirements
- Scheduling Contractors
- Ordering Data Communications Equipment and Providing for Installation
- Order Consumables
- Review Checklists and Complete as Applicable
- Schedule Training for Users
- Verify System Installation
- Delivery Schedules and Receipt

1-3. Site Coordinator

You should designate a site coordinator who will interface with contractors, Hewlett-Packard representatives, facilities personnel, and any consultants to ensure the timely completion of site preparation and acceptance of the computer system upon delivery. The site coordinator may be the system manager or data processing department manager and will be responsible for schedules and construction efforts, and will be the primary liaison with Hewlett-Packard representatives.

1-4. Site Planning Team

It may be desirable to establish a site planning team under the direction of the Site Coordinator. Members of the team should include contractors for electrical installation, site construction contractor, and air conditioning specialists. Also, Hewlett-Packard representatives will participate in meetings for planning purposes. The function of a site planning team is to determine site location, size, construction requirements (including electrical and environmental factors), review local codes and insurance carrier requirements, and schedule all events related to site completion.

1-5. Site Selection

Site selection is determined after a review of local building, electrical, fire, and other safety codes. In particular, environmental conditions must be considered. Existing sites that are to be expanded must be reviewed for size adequacy along with power and environmental requirements. However, new sites require a review of the entire building with regard to power source, environment, system accessibility by users, and space limitations. The key to a successful installation and long-term reliability of your new HP 3000 computer system is through effective and thorough site preparation.

1-6. Construction Requirements

In the planning phase, requirements for construction are determined and the types of contractors or specialists who are needed to perform the tasks. After consulting with these people a schedule of events should be prepared by the Site Coordinator and all events monitored for progress and completion.

1-7. Safety Precautions

When safety precautions are reviewed, emphasis should be exercised on all matters concerning personnel and equipment. Careful scrutiny of all codes may avert reconstruction costs at a later date because of oversights in planning and implementation. Careful study will eliminate inadvertant introduction of potential hazards. Your insurance carrier and local building inspectors can competently advise you on these matters.

1-8. Equipment Location

When planning equipment location, ensure that adequate working space is available for personnel and that all equipment is readily accessible. Use the materials in the Site Preparation Workbook to prepare a site floor plan. (See figure 1-1 for an example site floor plan.)

1-9. Data Communications and Remote Support Considerations

In addition to the equipment furnished for your system by HP, you must provide for the ordering and installation of:

- Modems
- Telephone equipment
- Equipment supplied by companies other than HP.

Remember that communications systems at your site are not part of the computer and must be considered separately for power, space, electrical, interface cable lengths, and cooling requirements. It is your responsibility to learn these requirements from the equipment vendors and to arrange for equipment installation.

Remote support significantly enhances hardware and software support through the use of an electronic data link established between your system and the local Hewlett-Packard Service Office. To be eligible for credit on hardware and/or software charges under this program, you must meet the following requirements:

NOTE

The following applies to the U.S.A. only. For other countries, refer to local authorities for the appropriate guidelines.

Site Planning

- An HP-approved modem must be connected to a direct data telephone line (not part of a PBX system) and installed on the remote console port of the eligible system. (Eligible systems are specified in the Remote Support Program data sheet.)

HP-approved modems are:

Hewlett-Packard 35016A
Racal-Vadic VA3451S
Bell 212A

- The modem must be connected to the system and the direct data telephone line at all times. Access to the equipment must be available when required by HP, although authorization from the system operator may have to be obtained.
- A separate telephone line must be located near the system console for voice communications.

The direct data line must have the following specifications when ordering from the telephone company:

- If using the HP 35016A or VA3451S, specify:
 - a. RJ36X telephone connector jack
 - b. RJ45S programmable data jack
 - c. RTC exclusion key telephone handset, either a RTC503 rotary dial with options A2, B3, C6, and D7, or a RTC2503 touch tone with options A2, B3, C5, and D7.

NOTE

Prior to connecting any device to the switched telephone network, FCC regulations (U.S.A. only) specify that you must provide the telephone company with the name of the manufacturer, equipment model numbers, FCC registration numbers, and ringer equivalence numbers of the devices to be used.

The data required by the FCC is listed as follows:

	HP 35016A	VA3451S
	-----	-----
Manufacturer	Racal-Vadic	Racal-Vadic
Model	35016A	VA3451S
FCC Registration No.	AJ496M-67213-DM-N	
Ringer Equivalence	0.9B	0.9B

If using the Bell 212A Data Set, specify:

Bell 212A Data Set with telephone handset and options A2 (T, Y, R), B3, C& (ZE, A, Q, W, interface speed indication out), D8 (YG, YJ, YP, YL, YR), E10 (YF).

1-10. Ordering Consumable Supplies

A catalog of consumable supplies available from HP is included at the end of this manual. Place your order promptly for all necessary supplies.

1-11. Schedule Training

Identify and enroll personnel who are expected to be HP 3000 users in the appropriate classes. Contact your HP Representative for a schedule of classes.

1-12. Checklists

The Site Planning Workbook accompanies this document. It contains the checklists and worksheets that are to be used during site preparation. Review these lists and complete each as planning and work progresses.

- SYSTEM CONFIGURATION TABLE

The system components table lists the processors and peripherals.

- SITE COORDINATOR PLANNING CHECKLIST

This checklist is used by the site coordinator to monitor all tasks that are to be performed.

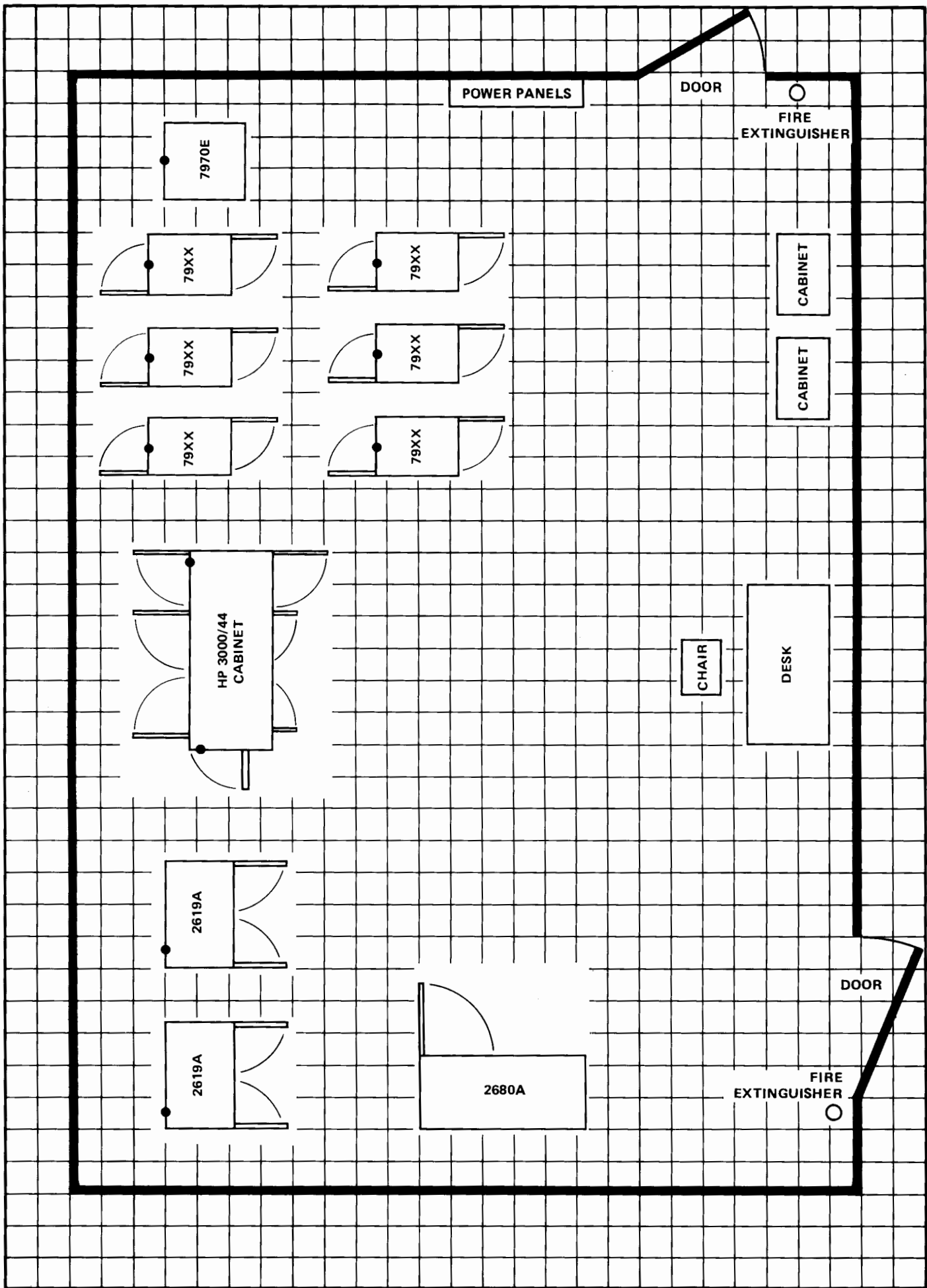


Figure 1-1. Example Site Floor Plan

- CONSTRUCTION PLANNING CHECKLIST

The construction planning checklist is used by the construction specialist as a guide as to the tasks that are to be performed.

- AIR CONDITIONING PLANNING CHECKLIST

This checklist aids the air conditioning specialist in planning and accomplishing the installation of the air conditioning system. It also includes a section for computing total heat dissipation which helps in determining the size and type of air conditioning system and air quality that is needed.

- ELECTRICAL PLANNING CHECKLIST

This checklist allows the electrical specialist to plan and record the electrical installation tasks necessary for the site. It also has a separate section for recording the power consumption of the computer system lines and the utility power lines.

- SITE VERIFICATION CHECKLIST

This checklist is filled out at the time site preparation is complete. Site verification is performed by the HP Customer Engineer the results of the verification are recorded on this checklist. The purpose of site verification is to ensure that the site is ready for installation.

- FLOOR PLAN KIT

The floor plan kit consists of a scaled-grid mylar sheet and adhesive-backed sheets on which component plan-views are printed. These sheets are to be used for laying out the equipment in the computer room or site.

1-13. System Delivery

The system is sold F.O.B. origin, therefore, you must choose the type of carrier for hauling and delivery. There are three shipping methods from which you may choose. You should contact your HP sales representative as early as possible to indicate the appropriate shipping method of your choice:

- Electronic Padded Van
- Air Consolidation Program (used for all International shipments)

Site Planning

● Common Carrier

For all shipments, HP selects the carrier of your choice for conveyance. The three methods are described as follows:

Type	Advantages	Disadvantages
Electronic Padded Van	Carrier will place the computer system on site at the exact location designated by the customer. No crate required. Least susceptible to shipping damage. Short shipping time.	Cost slightly higher than Air Consolidation Program
Air Consolidation Program (Used for all International shipments)	Fastest shipping method	System is delivered to customer dock but not the actual installation site. Customer must uncrate the system.
Common Carrier	Lowest cost to customer	Longer shipping time than other methods. Most susceptible to shipping damage. System is delivered to customer dock but not to actual installation site.

1-14. Providing Insurance Coverage

It is your responsibility to provide insurance for the system and all components thereof. Be sure to obtain adequate coverage to be in effect at the time the system and components are loaded onto the carriers, and to be terminated after the equipment is positioned at the installation site.

You are responsible for moving the system from your receiving area to the installation site. Therefore, be sure that you have insurance coverage during this move since accidental damage is your responsibility.

1-15. Receiving the System

The system will be delivered to the address on the "SHIP TO" portion of the system order. The processor unit will be shipped from Computer Systems Division. Peripherals will be shipped from the respective manufacturing divisions, as part of the general consolidated shipping plan. Circumstances beyond anyones control can

affect the delivery schedules of the system components, therefore, allow approximately a two-week time frame for receipt of the system components after you been notified of the shipments. If a component fails to arrive after this period, contact your Hewlett-Packard sales representative to locate the missing component.

Upon receipt of the system, check the carrier's bill of lading against the boxes, crates, cabinets, and other items received. Inspect all packages for damage, such as crushed corners, dents, scratches, breakage, or stains from liquids. If any signs of damage is discovered, have the carrier's representative present when you unpack the item. If the item is damaged, file a written claim with the carrier's representative and notify the HP Customer Engineer.

A Master Packing List is attached to one carton of each shipment. This is the only list provided. Before moving the equipment to its final location, and before unpacking items, check the Packing List against all items received. Report any missing items to your Hewlett-Packard representative.

Hewlett-Packard will replace missing or damaged parts without waiting for settlement of claims. Items shipped to replace missing or damaged parts will be billed to you and you have the responsibility of collecting all settlements from the carrier. Therefore, it is important not to release the carrier until the shipment is verified to be on hand and in good condition.

1-16. Moving the Equipment

The system components are shipped in various containers from the manufacturing facilities. Refer to the system specifications to determine size and weight before attempting to move any unit.

Move all items to the location planned for their installation, using the proper moving equipment and taking all the precautions noted below. If the site does not have the proper moving equipment or those handling the equipment do not know the proper techniques, obtain the services of a firm experienced in moving heavy electronic equipment.

CAUTION

Do not use a forklift to move cabinets unless no other alternative exists. A relatively offset center of gravity and point of balance could cause a cabinet to tip in any direction, possibly causing serious injury to personnel or damage to the equipment. If you must use a forklift, move only one cabinet at a time by placing the unit on a forklift pallet and then lifting the pallet.

Some units are equipped with casters while other units are not. In either case, the units may be moved over short distances providing that extreme care is taken to avoid tipping or jarring the units. Push slowly, being careful to avoid jamming casters or cabinet feet on debris or in seams or cracks in the floor.

CAUTION

Do not connect the system to the power source until all units are safely installed. This minimizes the danger of someone accidentally turning the system on.

Ensure that elevators, hallways, and doors are large enough to accomodate the units and moving equipment.

1-17. System Installation

When the site is completed and the shipments have been verified to be in good order, your HP Customer Engineer then assumes the responsibility for installing the system and ensuring that it is operating according to factory specifications. The installation will be performed at a mutually agreed upon time.

PHYSICAL SITE CONSIDERATIONS

SECTION

II



2-1. INTRODUCTION

This section provides information regarding the physical requirements of the installation site. In addition to the contents herein, be sure to check building, fire, and electrical codes for local requirements which may be more stringent in one area than another.

2-2. SITE AND EQUIPMENT LOCATION

Preparing your site may involve modifying an existing site or the construction of a new facility. In either case, maintain close liaison with the person who is coordinating site preparations. If questions arise or you need assistance, check with the Site Coordinator at once.

You may desire to establish the site with future expansion in mind so that equipment can be added with minimal disruption to the existing system. Be sure to allow at least approximately three feet (one meter) at the front and rear of the equipment for servicing purposes.

Fundamental safeguards for the computer system includes a location, building, and room design that will eliminate outside sources of potential damage. These sources include combustible construction, combustible or hazardous areas adjacent to the computer room, and exposure to nearby structures that pose a potential hazardous situation.

2-3. Partitions

Metal and glass partitions are acceptable for the computer room when the adjacent areas are noncombustible or has light combustible loading with sprinkler protection. Consideration should be given to unfavorable exposure from outside the the building, glare from sunlight, and forced entry. Generally, blank masonry walls or an equivalent structure will solve this problem.

2-4. Security

Computer room security can be an important factor even where classified work is not involved. Because of the potential damage to equipment or programming resulting from ignorance, carelessness, vandalism, or deliberate forced entry, and the delay and expense that could result, it is important that existing practices of building security be extended and improved to provide adequate protection for the computer area.

Safeguards such as tamperproof keylock door controls and electrically taped glass doors and windows can be tied into a comprehensive alarm system. If desired, this system could also be supplemented by a closed-circuit television monitoring unit.

2-5. Basements

Basement areas should not be used for computer installations or record storage. However, if a basement area is unavoidable, precautions should be taken to assure surface water drainage is away from the building and any ground level openings are made watertight. In multistory buildings, the floor above the computer site and related storage areas should be made watertight.

2-6. Maintenance Area

In larger installations, a maintenance area may be useful to optimize system availability. In these cases, the area should be within or adjacent to the computer room. A maintenance area is needed for spare parts and necessary supplies. The environmental requirements for this area are the same as that for the overall system. A small area where a cabinet can be placed for storage purposes will generally suffice.

2-7. STORAGE FACILITIES

Whenever possible, locate your operating records, permanent records, and operating supplies in separate cutoff areas having no other occupancy. These rooms or cutoff areas reduce the amount of combustibles in the immediate area of the computer system. Furthermore, the rooms or cutoff areas should be made fire resistant to the extent of exposure, but generally not less than a one-hour rating. Additionally, access doors should be self-closing.

Two types of supplies are generally used in or with computer systems; paper supplies and magnetic storage media. The paper supplies may include line printer paper, punched cards, and paper tape. The magnetic storage media includes magnetic tape and disc packs. Both types are used for record storage which can cause a shutdown of operations if destroyed or lost. It is therefore a

major consideration that proper storage is provided for these items. Paper supplies are more combustible than magnetic media even though the temperature at which damage occurs to paper is higher than magnetic media. Because fire is a major concern in the loss of stored data, these two types of supplies should be stored separately.

2-8. Paper Storage

One leading manufacturer recommends that line printer paper be stored at 75 degrees F (24 degrees C) with the relative humidity maintained at 45 percent. Recommended operating ranges include temperatures from 60 degrees F to 85 degrees F (15 degrees C to 30 degrees C) and the relative humidity from 40 to 60 percent. Containers are available that are designed to limit interior temperature to 350 degrees F (177 degrees C), in case of a fire, for one, two or four hours. This is generally considered adequate for paper supplies. However, before using paper that has been subjected to extreme temperatures, it should be stabilized at the recommended temperature range.

2-9. Magnetic Media Storage

Containers for magnetic tape should be able to limit the interior temperature to 150 degrees F (66 degrees C) in emergency situations, such as a fire. However since magnetic media tends to degrade at high temperatures in long-term storage, the permanent storage facility must not exceed 80 degrees F (27 degrees C). Also, the relative humidity should be maintained from 40 to 60 percent.

NOTE

Maintain the storage area temperatures close to that of the computer room. Magnetic tape, disc packs, and printer paper must be at the same temperature as the computer room for at least 24 hours prior to use.

NOTE

In the storage area and in the computer room, racks or hangers must be made available to store magnetic tape vertically.

2-10. DATA PROTECTION

Safeguards should be taken to protect vital data such as business records or other information that are either very expensive or impossible to duplicate. Adequate duplicate copies of vital data should be stored well away from the computer area, normally in a fireproof storage vault. In many cases, a regular updating program may be necessary to maintain the value of such duplicate data storage.

The evaluation of the records is the customer responsibility with regard to safeguarding computer operations. The amount of protection is directly related to the importance of records in the system and reestablishment of operations after a fire. The following classifications of records are based on recommendations of NFPA Standards 232 and 75 (in countries other than the U.S.A., refer to the equivalent documents concerning data protection). Records should be assigned to one of these categories to ensure adequate protection where necessary.

- Class 1 (vital) - These are irreplaceable records, record data which does not have the same value as the original, records needed to recover money promptly or records needed to avoid delay of products, sales or services. These records need to be stored in a fire-resistant vault, in safes, or areas afforded maximum fire protection.
- Class 2 (important) - These records are reproduced only at a considerable expense and labor, after a long delay. These records should be protected as Class 1 records, or stored in a fire resistant file storage room. If the building were completely burned out, These records may not be protected as well as Class 1 records.
- Class 3 (useful) - The loss of these records might cause some inconvenience, but could be readily replaced. They should be housed in closed steel containers, where they are not exposed to combustibles.
- Class 4 (nonessential) - These records are not valuable enough to warrant special protection and should be destroyed to reduce fire hazard if any undue accumulation occurs.

2-11. THE SITE FLOOR

The computer room floor must support the total weight of the system, as well as the localized weight at each caster or foot. The most common method of preparing a floor for a computer room or area is to construct a raised floor over the building floor.

This spreads the weight more evenly and provides an area through which interconnecting cables can be run conveniently and unobtrusively.

2-12. Floor Strength

Part of the information you will need in order to estimate floor requirements will be provided by the Site Coordinator in the form of a System Configuration Table and the Site Floor Plan. The System Configuration Table lists all equipment to be installed. The Site Floor Plan depicts the system layout, accessories, and support equipment.

To determine the necessary floor strength, consider the following items:

- Total weight of the system (refer to the System Configuration Table).
- Weight of the support equipment (includes desks, cabinets, chairs, tables, etc.).
- Approximate weight of operating personnel (live loading).
- Weight of moving equipment (live loads presented by forklifts and other equipment moving devices).
- Distributed and concentrated loads. You may need to distinguish between a distributed load (the overall weight that theoretically could collapse the floor) and the concentrated load (the weight at a bearing point, such as a leg or caster, that might result in penetration of the flooring material).

Floors of office buildings are usually rated at 50 pounds per square foot (244 kilograms per square meter) with an additional allowance of 20 pounds per square foot (98 kilograms per square meter) for partitions. If a large system is anticipated, floors must be able to support 100 pounds per square foot (488 kilograms per square meter). Any questions regarding the adequacy of floor construction should be evaluated by a qualified structural engineer.

Finally, determine that all floors, stairs, and elevators which might be used when the system is moved to its destination can support both the system and the moving equipment.

2-13. Raised Floors

Small systems with few peripherals do not require raised floors, and even larger systems can be installed without it. However, for most systems a raised floor is desirable because of the following advantages:

Physical Site Considerations

- Relatively unrestricted cable routing beneath the floor.
- Eliminates the need for covering exposed cables.
- Allows equipment layout to be changed more readily.
- Enhances the appearance of the computer area.

The most common type of raised flooring used in computer rooms is the pedestal type. (See figure 2-1.) The pedestal type is desirable because it allows cable routing in any direction, minimizing cable lengths and increasing layout flexibility. In addition, the space under the raised floor is often used for air ducting.

Raised floors are usually tile-covered panels supported by a grid system of either pedestals or pedestal support stringers, which provide lateral stability. The raised floor must be able to support a load of 100 pounds per square foot (488 kilograms per square meter). The preferred height for raised floors is 12 inches (30 centimeters), but should not be less than 4.5 inches (11 centimeters) in any circumstance.

The floors should be constructed of essentially noncombustible materials. Acceptable materials include concrete, steel, aluminum, and metal-clad plywood on noncombustible supports. If a raised floor is to be installed over a combustible main floor, the main floor should be flameproofed with an airtight hard sheet rock or equivalent. Openings into the space under the raised floors should be covered or screened to keep out combustible debris. Also, provide drainage in the main floor beneath the raised floor.

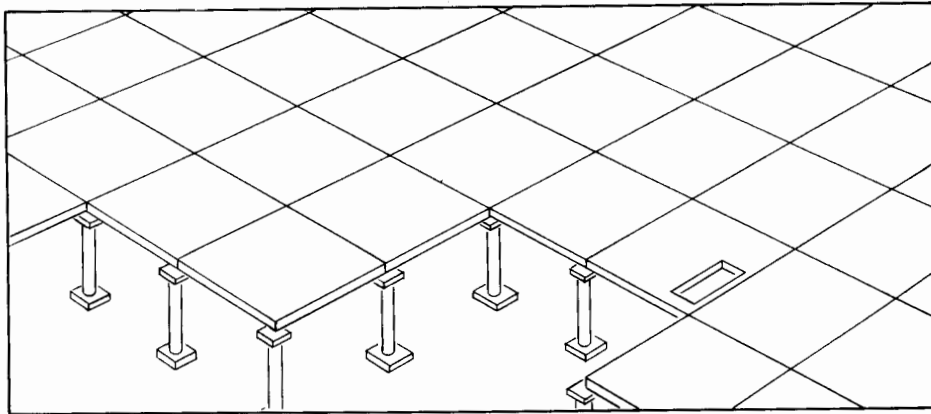
NOTE

If raised floors are used, ensure that all floor panels are grounded have a common ground so that a difference in potential does not exist between panels.

2-14. Floor Covering

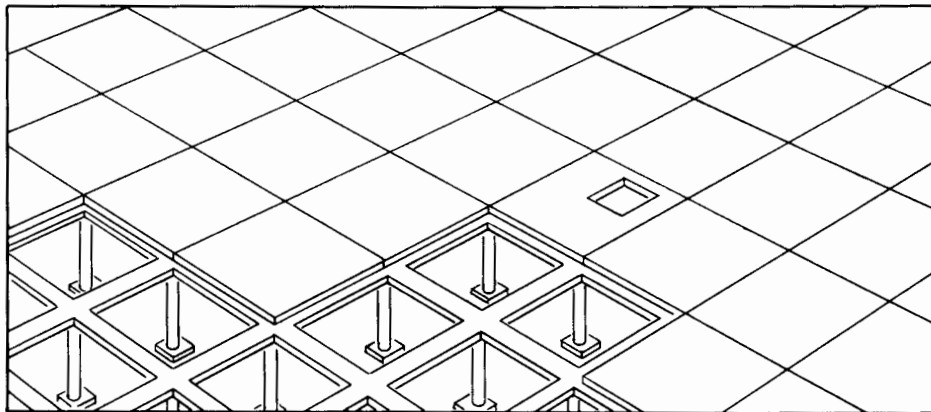
When planning a computer room floor, consider such factors as surface resistivity, ease of maintenance, durability, appearance, and cost. Floors should resist scuffing, gouging, marking and staining.

Free-Access Floor:
Pedestal Supported Panels
Panels Removable
Cutouts in Panels



NOTE: A RAISED FLOOR-PANEL LIFTER SHOULD
BE MADE READILY AVAILABLE IN THE
COMPUTER ROOM AT A CONVENIENT LOCATION.

Free-Access Floor:
Subframing Supported Panels
Panels Removable
Cutouts in Panels



047011-02

Figure 2-1. Examples of Raised Floors

Physical Site Considerations

Asphalt tiles should not be used since they easily chip with wear and produce dust that can cause equipment breakdowns. Usually vinyl tile is preferred because of its attractiveness, strength, and maintainability. High-pressure laminated fiber-resin floor surface tiles are the most desirable. These tiles are very hard and only require occasional mopping to maintain a good appearance. They are highly resistant to scratches, burns, and dents. (Refer to Section VI for cleaning techniques.)

Sealer and wax should be applied by experienced floor treatment specialists. Sealer should be applied as soon as possible after the floor has been laid, except for linoleum, which should be left for a week or so until the oils settle. A polyurethane sealer should be used for linoleum, wood, and cork. For other materials, a water emulsion sealer is more suitable.

Wax is necessary to form a durable yet replaceable coating over the sealer, but should be applied sparingly, and only to traffic routes as necessary. Other areas may simply be machine-buffed.

Standard wax should not be used as a protective coating for floors in computer areas because it tends to increase surface resistance. This can result in the formation of a dielectric that allows static electricity to build up on personnel and furniture. Tile floors should, however, be finished frequently with a "polymer" mixture which includes microscopic metal flakes.

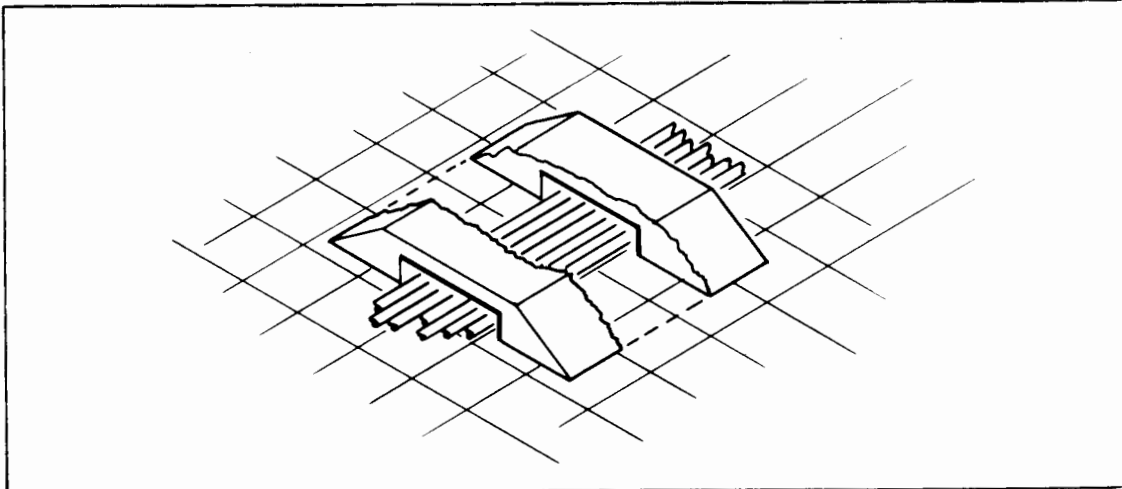
Experience shows that computer systems are susceptible to static discharges resulting from buildup in carpeting. It is not uncommon to observe static buildup in excess of 15 kilovolts. While the processors are designed to withstand discharges of up to 12 kilovolts, disc drives and terminals are susceptible to problems at levels of 1.5 kilovolts and higher. Static discharges in excess of specified maximum levels can and do cause system failures, such as loss of data.

IMPORTANT

Hewlett-Packard strongly discourages the use of carpeting, including antistatic varieties. However, if a system is to be installed in an area that is carpeted, remove the carpeting to ensure that it is not used within a 20-foot (6-meter) radius of the system area. For small rooms approaching these dimensions, remove all carpeting. A static discharge mat should be used at the door entries if the computer area entry is less than 20 feet away from carpeting.

2-15. Cable Ramps

A method of routing cables without the use of a raised floor is shown in figure 2-2. The cable ramp above the floor is less expensive than a raised floor, but does not provide the same cabling flexibility and may also constitute a safety hazard.



147011-03

Figure 2-2. Example of Cable Ramp

2-16. FURNITURE

Furniture can provide a source of static discharge. Ensure that chair upholstery consists of materials that resist static build-up. Cloth-covered chairs are less susceptible to static buildup than plastic-covered chairs. Casters and ball bearings should be made of conductive materials or be lubricated with graphite or other conductive substances.

2-17. DUST-PRODUCING EQUIPMENT

Avoid using equipment in the computer room that generate excessive amounts of dust. Equipment in this category include paper bursters and collators. Install these types of equipment in areas outside the computer room.

2-18. FIRE SAFETY

When considering the various aspects of fire safety, the insurance carrier should be consulted for suggestions and recommendations as to the adequacy of existing or proposed fire control systems. Also, if a new site is to be built or an existing structure modified, be sure to consult local building codes for fire prevention and protection.

2-19. Fire Prevention

The best method to prevent fire is to construct the site enclosure with noncombustible materials. If an existing structure is being modified, add noncombustible false ceilings and cover the floors with fire-resistant material. The normal fire rating for a site is one hour. This is the time that a ceiling or wall can remain structurally sound when subjected to fire.

Fire prevention precautions can also be exercised inside the computer room. These precautions include:

- Use noncombustible office furniture and furnishings.
- Use flame retardant interconnecting data cables
- Provide nonflammable cleaning agents. If solvents must be used, the flash point should be greater than 100 degrees F (37.8 degrees C).
- Limit records, paper supplies, spare tape, and disc packs or other combustibles in the computer room to the working minimum needed for current or daily requirements. Store all other materials in proper noncombustible containers or separate storage rooms.

2-20. Fire Warning Systems

Various fire warning systems are available that detect overheating of computer equipment before either fire or smoke becomes apparent. In the United States, systems that are designed especially for computer sites are listed in the National Fire Protection Association (NFPA) Handbook. To obtain a copy of the handbook, write to:

National Fire Protection Association
470 Atlantic Avenue
Boston, Massachusetts 02110

NOTE

In geographic locations outside the United States, consult your local regulations regarding fire protection.

For high-valued or important installations, provide an approved automatic smoke-actuated fire alarm system in the computer room, under any raised floors, in the air-conditioning system return air duct, and in rooms or areas containing numerous wires and cables. The location of detectors should be based on air flow and other physical arrangements. For spot-type detectors, a spacing of about one detector for every 250 sq ft may be used as a guide,

subject to modification depending upon the actual conditions which exist.

2-21. Fire Control

Studies of fire losses and surveys of the amounts of combustibles in computer systems, and especially in the neighboring areas, show that automatic sprinklers afford the most practical protection for computer installations. Automatic sprinklers will localize a fire originating either inside or outside the computer units and constitute the most effective safeguard against major damage. However, important damage can still result if the fire involves the interior of an unusually valuable or important unit. For such units, sprinkler protection can be effectively supplemented by automatic halogenated gas or carbon dioxide protection. In many instances, portable extinguishers are used as adequate supplements to sprinkler systems.

The selection of adequate fire control systems will depend upon local building codes, insurance regulations, and other influencing factors such as costs and serviceability of the systems. It may be necessary to supplement existing or proposed systems with an additional gaseous system, or to include portable extinguishers in the computer room.

- **HALOGENATED GAS SYSTEMS**

Halogenated gas chemically reacts directly to the burning combustibles and temperature of the fire to produce an extinguishing agent. This type of system is most effective against electrical fires and least damaging to the equipment. A concentration of five percent Halon 1301 produces extinguishing effects in approximately 10 seconds.

- **CARBON DIOXIDE FLOODING SYSTEMS**

Carbon dioxide (CO₂) is also a gaseous substance, but is not an extinguishing agent in itself. The extinguishing effects result from the displacement of oxygen in the combustible area. This effect generally takes place in approximately one minute after discharge, depending upon the volume to be flooded. The most commonly used portable extinguishers are of the CO₂ type.

- **SPRINKLER SYSTEMS**

The types of water-sprinkling systems that are generally used which are not subject to accidental discharge. These are:

Physical Site Considerations

- The pre-action sprinkler system.
- The high-temperature sprinkler head system.
- Automatic sprinkler head system

In the pre-action system, a heat-sensing valve turns on the main water supply to the sprinkler system when the temperature in the computer area exceeds a specified value. Since a heat-sensing device is not located in each sprinkler head, accidental discharge caused by damage to a single head is avoided.

In the high-temperature sprinkler head configuration, all sprinkler heads are fitted with temperature-sensing devices. This type is better than the standard fusible links because the high-temperature device is immune to slight increases in temperature.

The automatic sprinkler head system, similar to the high-temperature device, will turn off when the temperature falls below a specified level, thus reducing water damage.

2-22. ACOUSTICS

Acoustical treatment of the computer room is desirable to provide for more efficient and comfortable operation. Proper acoustic design of the computer room may require the services of a acoustical specialist.

The total noise level is affected by all noise sources in the room, the physical arrangement of the noise sources, and the acoustical characteristics of the room surfaces. The noise level can be reduced by proper spacing and orientation of mechanical equipment and providing sufficient space around these units. The farther apart these units are, the lower the overall room noise will be.

Consider placing the quieter electronics units between the mechanical units. Also, an effective method of noise reduction is to place mechanical units at an angle to aisles or open work areas.

Air conditioning blowers and other external noise sources, if improperly installed, can contribute substantially to the overall noise level. Ducts may transmit noise to and from other rooms. This can be reduced by acoustical treatment of the ducts.

Ceilings and walls should be made of sound absorptive materials. In addition, the walls should be constructed from the structural floor to structural ceiling, and be properly sealed. Doors should also have a good seal. Ensure that any acoustic materials used are of the non-flaking variety to prevent added dust particles from accumulating.

Avoid the use of drapery because of possible static buildup and dust abatement problems.

Acceptable sound pressure levels are stated for two operating environments; the office-oriented installation and the computer-room environment. For the office environment, the sound pressure level generally should not exceed 55 dbA. The computer room sound pressure level generally should not exceed 65 dbA, excluding printers. If printers present an undesirable noise level, noise suppression covers may be necessary. These covers are available through Hewlett-Packard for certain models and must be fabricated for others.

2-23. ILLUMINATION

To properly light the computer area, plan to:

- Maintain an average of 50 to 75 foot-candles of total illumination as measured 30 inches (91.4 centimeters) above the floor. Ensure that lighting is uniform throughout the computer room to provide adequate lighting at the rear of the cabinets.
- Avoid installing lights that produce excessive reflections on system indicators.
- Never use direct sunlight for illumination.
- Plan to use circuits separate from the system equipment power source for the lighting.
- Provide for emergency lighting.
- Comply with all local electrical codes.

NOTE

Dimmer switches should not be used in computer areas because of their tendency to generate noise and heat.

ENVIRONMENTAL CONSIDERATIONS

SECTION

III

3-1. AIR CONDITIONING

Prior to receiving your system, suitable air conditioning must be installed. Before selecting the air conditioning, system heat dissipation and operating environment must be considered.

3-2. Calculating Heat Dissipation

To provide your site with adequate air conditioning, follow these steps:

- Estimate the total heat dissipation by the system, accessories, lights, and personnel at the site. Record this information on the air conditioning planning checklist in the site planning workbook. (Refer to the temperature specifications for recommended operating conditions.)
- Take into consideration the humidity factors as given in the humidity specifications.
- Plan the location and installation of air conditioning equipment in compliance with local codes and regulations.
- Maintain positive air pressure within the computer room or area. This causes airflow away from the system, minimizing contamination by dirt or dust. Cleaned air should be brought into the room. In some local and national areas, safety codes dictate what the air volume exchange rate should be. Refer to your local codes for this information.

To calculate the total heat dissipated in the computer room, use the following guidelines and record the resulting data on the air conditioning planning checklist.

- Using the air conditioning planning checklist located in the site planning workbook, determine the total amount of heat dissipated by your system (total configuration).
- Consider the heat dissipated by special interface equipment (supplied by other vendors) as well as that produced by auxiliary equipment such as keypunches and electric typewriters. Consult vendor data sheets for this information.

Environmental Considerations

- Estimate the heat produced by the lights used to illuminate the facility.
- Calculate the heat dissipated by operating personnel working within the facility, using the values given in the air conditioning planning checklist.
- Allow for heat dissipation by equipment to be added during future expansion.
- Calculate the heat dissipated by any other elements not considered above. This includes rate of heat transfer through walls, windows, and ceilings plus the effects of climate. The air conditioning planning checklist provides guideline values for estimating heat dissipation through walls, windows, etc.
- Calculate the total heat dissipation for the site by adding the values recorded in the air conditioning planning checklist. For 60-Hz systems, heat dissipation is given in BTU/hr, and is given in kilocalories for 50-Hz systems. The values given in BTU/hr and kilocalories do not necessarily correlate, since 50-Hz systems generally consume more power than 60-Hz systems. Therefore, do not convert BTU/hr to kilocalories to determine heat dissipation.

3-3. Selecting Air Conditioning Equipment

There are two air distribution methods commonly used. One method uses the space under the raised floor as a plenum chamber, forcing air up through floor openings into the room. The second arrangement uses the space above the ceiling as a plenum chamber, and air is drawn down into the room. A third arrangement, but less commonly used, includes an air conditioning unit built into a separate compartment, from which cooling air is circulated directly through sections of the computer and into the main room.

NOTE

Avoid ducting air directly into disc drives. This will exert too much pressure within the drive and cause the heads to lift away from the discs, thereby causing data errors or loss of data.

An HP 3000 Computer System should be operated in an environment in which temperature and humidity are maintained within the recommended ranges specified in this manual. Also, the environment should be contaminant-free to the extent specified. The effects of climate should be carefully considered when selecting the air conditioning system.

3-4. Effects of Climate

You must consider the effects of outside temperature, humidity, vibration, altitude, airborne contaminants, and other characteristics of the region. For instance:

- At higher altitudes, the efficiency of a cooling fan decreases because of air density. Consider maintaining the site enclosure at a lower temperature to compensate for the reduced air density at the equipment air intake vents.
- Consider after-hours conditions, during which time the air conditioning may be shut off, and the possible effects on the system because of temperature and humidity variations. This condition generally occurs in installations where the heating and air conditioning are central to the entire building.
- In locations where extreme temperature and humidity prevail, consider the effects of such conditions on the system when main power is shut down. For example, in northern regions, consider the effects of night-time temperatures during winter when system power is shut off.
- Seasonal temperature and humidity variations must be considered, especially when a non-dedicated air conditioner is used. In the late spring, it is not uncommon to experience a slow but constant temperature increase because the air conditioning system has not been turned on for summer use. Be sure that provisions are made to monitor the temperature and humidity during cold-to-hot and hot-to-cold seasonal transitions. However, the air conditioning should never be shut down in the computer room, except for emergency situations.
- At coastal installations, the site may require special air conditioners, dehumidifiers, and other items to compensate for high humidity or corrosive salt air.

Environmental Considerations

- In locations where airborne contaminants are of a high density per volume, filtering may be required in the ducts. Since any filters in the ducting present a restriction to airflow and adds a load to the air conditioning unit, the size of the installation may be affected. Many locations experience corrosive contaminants that eventually destroy the electronic circuitry. In these instances, special filtering or air conditioning configurations may be required, such as positive pressure rooms fed by air through activated charcoal or metallic filtering techniques. (Refer to the paragraphs on airborne contaminants.)
- To maintain the recommended conditions in the computer room, the air conditioning system should be on at all times.

3-5. Emergency Considerations

To further protect the air conditioning and computer systems:

- Plan to control power to the air conditioning system with push-button switches that can shut the air conditioning system down in case of emergencies. In addition, consider thermostatically-controlled cutoff switches where the sensors are installed in the conditioned air ducts, and the switch cuts off power to the air conditioner.
- Consider installing a temperature-humidity recorder at the site for monitoring the air conditioning equipment for possible malfunctions.

3-6. Planning Equipment Installation

In your locality, city and county codes and regulations may exist covering the use of air conditioning devices in general and as applied to computer sites in particular. You are responsible for ensuring that your plans comply with these codes before the computer system is delivered.

As you plan for the location and installation of the air conditioning equipment, refer to the Site Floor Plan for computer system equipment locations. Then:

- Provide adequate space for the air conditioning system. Generally, the size of a typical system dictates housing the equipment in a separate room.
- Locate the return air ducts above the computer system output ducts, and the cold air ducts near the computer system intake ports. Ensure that the cold air ducts are suitably located so that they are not affected by other equipment at the site.

- Do not use window-type air conditioners to cool the area because the on-off cycling of such units can cause them to exhaust high-humidity air.
- Locate all thermostats away from the primary points of heat flow from the mainframe and accessory equipment cabinets.
- Make sure the on-off cycling is set for a narrow temperature range (recommended range) to avoid wide temperature and humidity swings. When operating the system over wide ranges in relatively short periods of time, the development of corrosion products is accelerated. This shortens the life of the computer system.
- Locate all humidistats away from ducts and heat exhausting equipment.

When your plans are complete, sketch the locations of the air conditioning unit and the air ducts with reference to equipment shown on the Site Floor Plan. As you complete the planning of temperature and humidity control facilities, check off the items on the planning checklists. Answer all questions so that the HP Customer Engineer will have the information available if problems arise. After installation, the Site Coordinator inspects the site and verifies that all temperature and humidity requirements have been met.



3-7. SYSTEM SPECIFICATIONS

The remainder of this section deals with environmental specifications relating to reliable system operation. While all factors are somewhat interrelated, temperature and humidity are closely related since both are under direct control of the air conditioning system. In addition, the rates of corrosion product development are directly influenced by temperature and humidity. To illustrate this, figures 3-1 and 3-2 are psychrometric charts that show the relationship between temperature, absolute humidity, and relative humidity in both English and metric units.

3-8. Temperature Range

There are two temperature ranges that are considered, the recommended range and the maximum-minimum range. The optimum range is within the minimum and maximum values and means that this is the range in which the system will most reliably operate. High temperatures increase the rate of deterioration of virtually every material. Therefore, continued operation outside the specified ranges will cause loss of data, system failures, and lead to shortened equipment life. An example of lost data could be blown volume labels.

Environmental Considerations

The minimum and maximum values are provided as a temporary safety margin in the event a malfunction occurs in the air conditioning system. The maximum time that the computer system should operate outside the recommended temperature range but within the maximum and minimum range is 48 hours. This time allows abnormal environmental situations to be corrected and still operate the system. If abnormal conditions continue to exist, shut the computer system down immediately to prevent possible system breakdown.

Experience has shown that the failure rate increases rapidly outside the recommended range. Therefore, to safeguard against the likelihood of unnecessary failures, it is imperative that the most ideal operating conditions be maintained.

Operating Temperatures: Recommended = 20 to 25.5 degrees C
(68 to 78 degrees F)

Maximum = 30 degrees C (86 degrees F)
(48 hours maximum)

Minimum = 15 degrees C (55.4 degrees F)
(48 hours maximum)

Rate of temperature Change: 5.5 degrees C/hr (10 degrees F/hr)
maximum

Instantaneous rate of change: 0.167 degree F/min.
(0.09 degree C/min.)

3-9. Relative Humidity

The recommended relative humidity range is the range over which the system will reliably operate over long periods of time. The maximum and minimum values provide a safety margin for a short periods of time to allow for correcting an abnormal condition. This time period is 48 hours. If the abnormal condition persists for any longer, the system should be shut down immediately. Continued operation outside the recommended range beyond 48 hours, and any operation outside the maximum and minimum values will result in poorer reliability.

High absolute humidity (dew point) causes moisture to form in the in the equipment and on paper and plastic media. Moisture absorption can cause dimension and handling changes in paper and plastic media (line printer paper, cards, paper tape, magnetic tape, etc.). High humidity, and rapid and wide humidity swings also allow corrosion products to develop more rapidly, thereby decreasing the operating life of electronic equipment.

Low humidity allows the buildup of static electricity which, if discharged through the system components will cause data errors and equipment failures.

Relative Humidity: Recommended = 40 to 60 percent,
no condensation

Maximum = 80 percent (48 hours, maximum)

Minimum = 30 percent (48 hours, maximum)

3-10. Vibration

Vibration can cause slow degradation of mechanical parts and, when severe, can cause data errors in disc drives; hence it should be avoided or controlled. Also, mechanical connections such as PCA connectors, cable connectors, and processor backplane wiring may be affected. The best preventive measure is to build the site away from vibration-generating sources, such as heavy industrial machinery (stamp mills, etc.). Care in handling the system components will also avoid problems resulting from sudden shock.

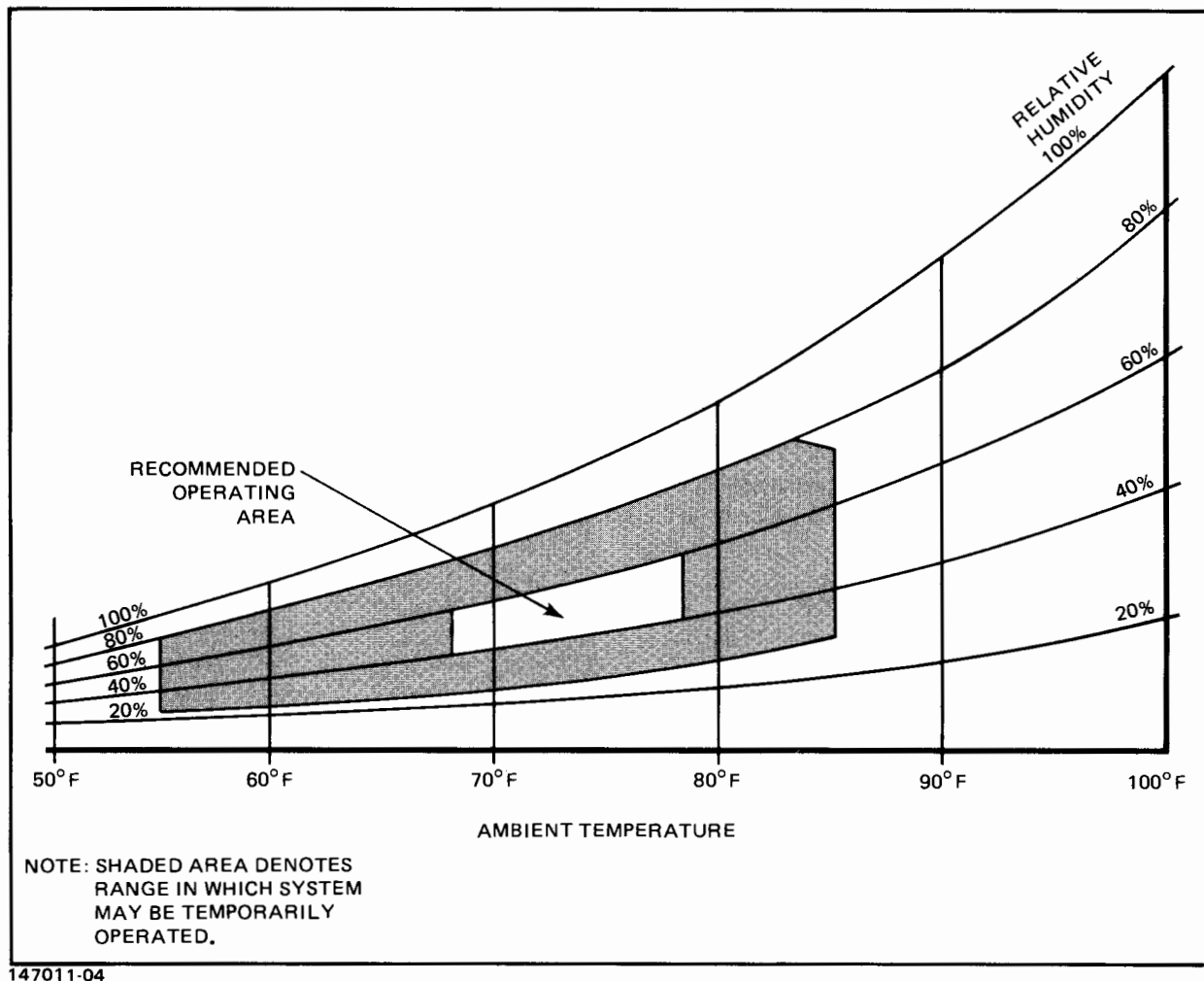


Figure 3-1. Psychrometric Chart (English Units)

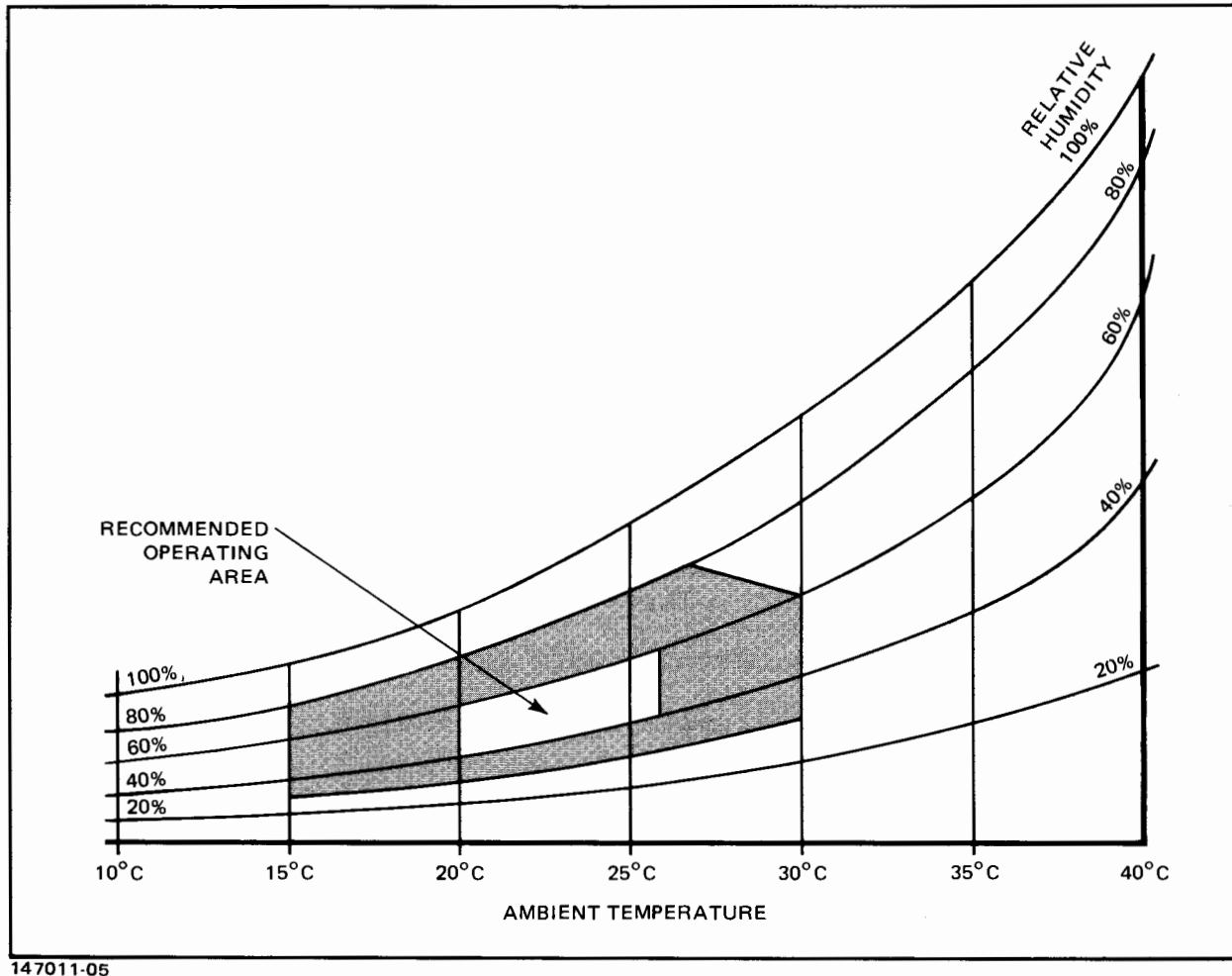


Figure 3-2. Psychrometric Chart (Metric Units)

3-11. Altitude

Altitude must be considered for two conditions, operating and non-operating. In the operating environment, the lack of adequate air density at extremely high altitudes may be insufficient to allow disc drive heads to lift off the disc surfaces and thereby cause a disc failure. In the non-operating environment, two problems arise. One problem results from the excessive pressure present that can collapse hermetically-sealed components and the second problem is the rapidly changing temperatures, which leads to condensation inside the system cabinets.

Operating Altitude - Sea level to 15,000 ft (4600m)

Non-operating Altitude - Sea level to 50,000 ft (15,300m)

CAUTION

Two peripheral devices cannot be operated at these maximum altitudes. If your system includes either or both devices, then the altitude limitations for the system that of the device. These devices are:

HP 7976A Magnetic Tape Drive

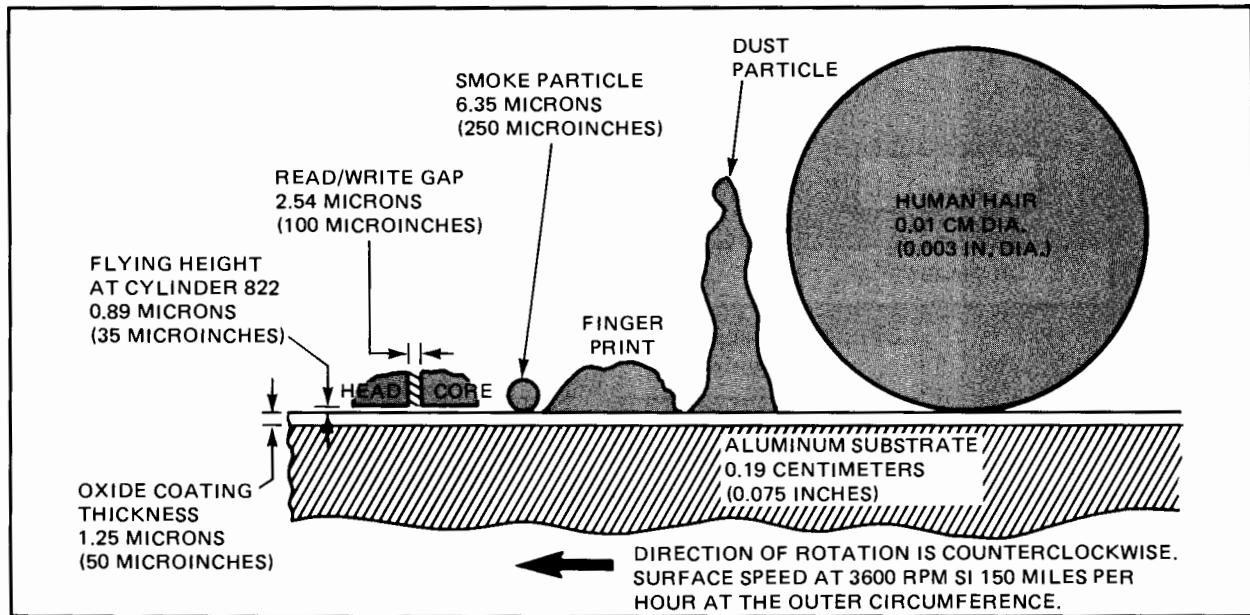
Operating altitude = 6500 ft (1981m)

HP 2680A Page Printer

Operating altitude = 8250 ft (2500m)

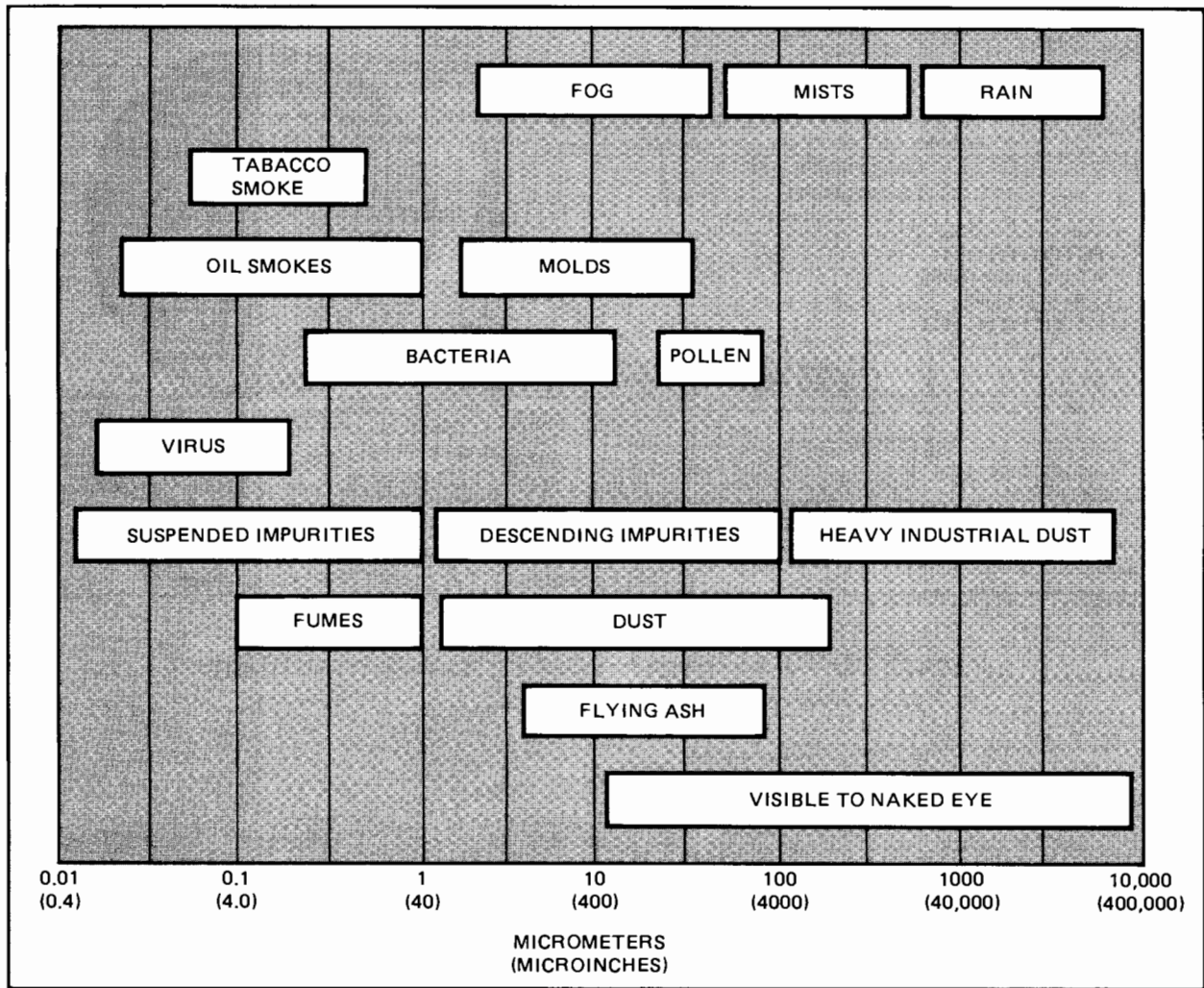
3-12. AIRBORNE CONTAMINANTS

Atmospheric dust is a complex mixture of smokes, mists, fumes, dry granular particles, and fibers. The components of any mixture may consist of soot and smoke, silica, clay, organic materials, and metallic fragments. A sample may also include living organisms such as mold spores and bacteria. These components vary with locality, season of the year, direction and strength of the wind, and proximity of dust sources. Size of the particles also varies with differing conditions. Figure 3-3 shows size ranges of typically encountered airborne particles and figure 3-4 shows the relationship between some particles and the gap between the flying heads and oxide coating on a disc.



147011-07

Figure 3-3. Sizes of Common Air Contaminants



147011-06

Figure 3-4. Contaminant Sizes Relative to Disc/Head Spacing

3-13. Hard Contaminants

Hard contaminants consist primarily of dust particles which are of various physical compositions. These particles present a clear hazard to disc drives if introduced into the operating environment. In some instances, the particles are conductive and can short circuit wiring in any of the system components when an excessive amount accumulates. Also, film-forming particles and residues cause connector problems. The maximum density of dust particles that will permit long-term reliable operation is:

45,000 particles (0.5 microns or larger)/ cu. ft.

3-14. Corrosive Contaminants

Corrosion is a complex form of materials deterioration and is generally defined as the destruction of material by chemical or electrochemical reaction with its environment. Some effects of corrosion in computer systems are the destruction of magnetic surfaces on discs and tape, deterioration of plastics used in the equipment, and general degradation of conformal coatings on printed circuit assemblies (PCAs). Also, corrosion buildup on metals, particularly metal connector contacts such as copper, nickel, and silver, eventually destroy electronic circuitry. Many common problems can be avoided by isolating the computer system from contaminant-producing machinery. Examples of this type are office copiers, milling machines, and equipment that produces corrosive vapors or particulants. However, in areas where the atmosphere contains large amounts of various corrosive contaminants, more drastic measures must be taken to ensure clean air in the computer room.

Most environments are corrosive to some degree. Examples are air and moisture; fresh, distilled, or salt water; urban and industrial atmospheres; steam and other gases such as chlorine, ammonia, hydrogen sulfide, sulfur dioxide, and fuel gases; mineral acids such as hydrochloric, sulfuric, and nitric. In general, inorganic materials are more corrosive than organic. For example, corrosion in the petroleum industry is due more to sodium chloride, sulfur, hydrochloric and sulfuric acids, and water than oil, naphtha, or gasoline.

Modern chemical process industries utilize higher temperatures and pressures, making possible new processes to obtain better yields, greater speeds, or lower costs of production. However, these higher temperatures and pressures unfortunately involve more severe corrosive environments.

Corrosive environments such as that found in steel, acid, and paper manufacturing industries usually preclude the use of filtered ambient air for forced convection cooling. Corrosives generally cannot be filtered out by normal filtration methods, and the techniques that must be used are complex and costly. In these cases, the computer system must be enclosed in a highly controlled environment.

Although the term "environment" as used here refers only to atmospheric contaminants, there is a strong link between corrosion rates and temperature and humidity conditions. Many corrosion processes (film thickness buildup, etc.) accelerate rapidly at high humidities and temperatures. This means that corrosive environments that possess high temperatures and humidities should be of particular concern.

3-15. Corrosives

- Chlorine. Compounds of chlorine are highly destructive to most metals, particularly nickel. When combined with sulfur compounds, these two elements form the most destructive corrosives, not only to metals, but to many plastics.
- Hydrogen Sulfide. Hydrogen sulfide is a rapid corrosive agent, particularly to copper and silver. Hydrogen sulfide is a common atmospheric contaminant found near oil fields, sulfur springs, and marshy areas, and occasionally is emitted from industrial or sewage treatment activities.
- Sulfur Dioxide. Sulfur dioxide is one of the more common contaminant gases. In combination with water, it forms sulfuric acid mist, an active and rapidly corrosive compound. It is known to produce molecular separation in polymers, and to cause spots microfilm materials. This acid is found in industrial environments and causes deterioration in electronic circuits.
- Total Hydrocarbons. Hydrocarbon vapors are known to be corrosive to precious metal contacts used in computer equipment. A typical example is the contacts on PCAs, which employ gold in many instances.
- Oxides of Nitrogen. Oxides of nitrogen cause nitrate stress cracking in electrical contacts, and the absorbed gases react to form nitric acid on component surfaces. Also, small amounts of nitrogen oxide cause deterioration in polymers.

- Total Oxidants. The presence of oxidizing gases in the atmosphere, particularly ozone, is known to be potentially harmful to any organic material. The damaging effects most often encountered are the cross linking of elastomers, the cracking of stressed rubber, and the oxidation of silver.
- Ammonia. In sufficient concentrations, ammonia has been found to cause cracking of stressed brass, decrease insulation resistance, and increase loss factor in certain insulators.

3-16. Filtration

Since airborne contaminants exist in all localities to some degree, attention must be given to filters in the air conditioning system. No one type of filter will solve all needs, therefore, air samples should be obtained and analyzed to determine which type(s) should be employed. Four factors should be considered for filter selection:

- The degree of air cleanliness required
- Disposal of the dirt after it is removed from the air
- Amount and type of dust in the air to be filtered.
- Corrosive oxidants or gases



These factors affect initial costs, operating costs, and the extent of maintenance that will be required. The long-term reliable operation of the computer system should be taken into account when considering operating costs and maintenance.

Three common types of filters are used for air filtering:

- Dry-Type Surface Filters - These types of filters are made of fiber mats of varying thicknesses, fiber sizes, and densities. Bonded glass fiber, cellulose fibers, wool fibers, and synthetics are commonly used for the filter medium. This category of filter varies greatly in particle removal efficiency. If this type is to be used, be sure to consult vendor data to obtain the level of desired efficiency.
- Electronic Air Cleaner - Electronic air cleaners use electrostatic precipitation principles to collect particles. Various types are available and are very efficient in cleaning air that contains chargeable particles. For example, petroleum or petroleum derivatives, metallic substances, and most dust particles are readily cleaned from the air. However, some plas-

Environmental Considerations

tic-type materials cannot be charged and therefore are not removed. Also, electronic air cleaners have little or no effect on certain toxic and corrosive gases, such as chlorine gas.

Since electronic air cleaners use ionizing principles, care must be excersized in the installing location of these devices. A static charge is present and if these devices are installed in the computer room ducts, they may contribute to static buildup within the room and cause loss of data through a resulting discharge. Also, high-voltage devices are capable of producing ozone, which is toxic and corrosive. Be sure to consult the manufacturer of these devices to ensure that ozone oxidants are not of the level to be hazardous to equipment and personnel.

- Activated Charcoal Filters - This type of filter is very effective for almost all contaminants, including gases such as the various sulfur compounds. To maintain maximum efficiency with this type of filter, the charcoal must not be allowed to saturate with agents that are to be removed from the air. Consult vendor data to detemine maintenance frequency for the agent to be removed.
- Metallic filters - Metallic filters are available from consulting vendors for use in extreme environments. These filters are particularly efficient for use in filtering chlorine compounds.

All types of filters have saturation points, at which time they must be replaced or cleaned. If the filters are allowed to collect matter beyond their holding capacity, the excess matter will be blown into the computer room, thereby defeating the purpose of filtering. The resulting effects will then cause poorer system reliabilty, loss of data, and sometimes present a hazard to operating personnel.

If the filters are not properly maintained at the vendor-recommended intervals, the air conditioning equipment can be harmed, as well as the computer system. For example, when fibrous filters are clogged, a back pressure is built up in the ducting and causes reduced life of the blowers. In addition, particles will be forced through the filter into the computer room. In electronic air cleaners, excessive buildup of particulate matter will flake off and be introduced into the computer room. Charcoal filters produce hazardous effects to the equipment and personnel if allowed to operate beyond saturation, especially when toxic and corrosive gases are involved. Charcoal absorbs gas until saturation, then will "burp" high concentrations of that gas into the computer room. Also, if the charcoal becomes clogged with hard particulants, the effect upon air blowers is the same as that for fibrous filters.

4-1. INTRODUCTION

Electromagnetic compatibility (EMC) is generally defined as an environment in which a computer system can operate and not produce an interference to other equipment and also not be affected by external sources of interference.

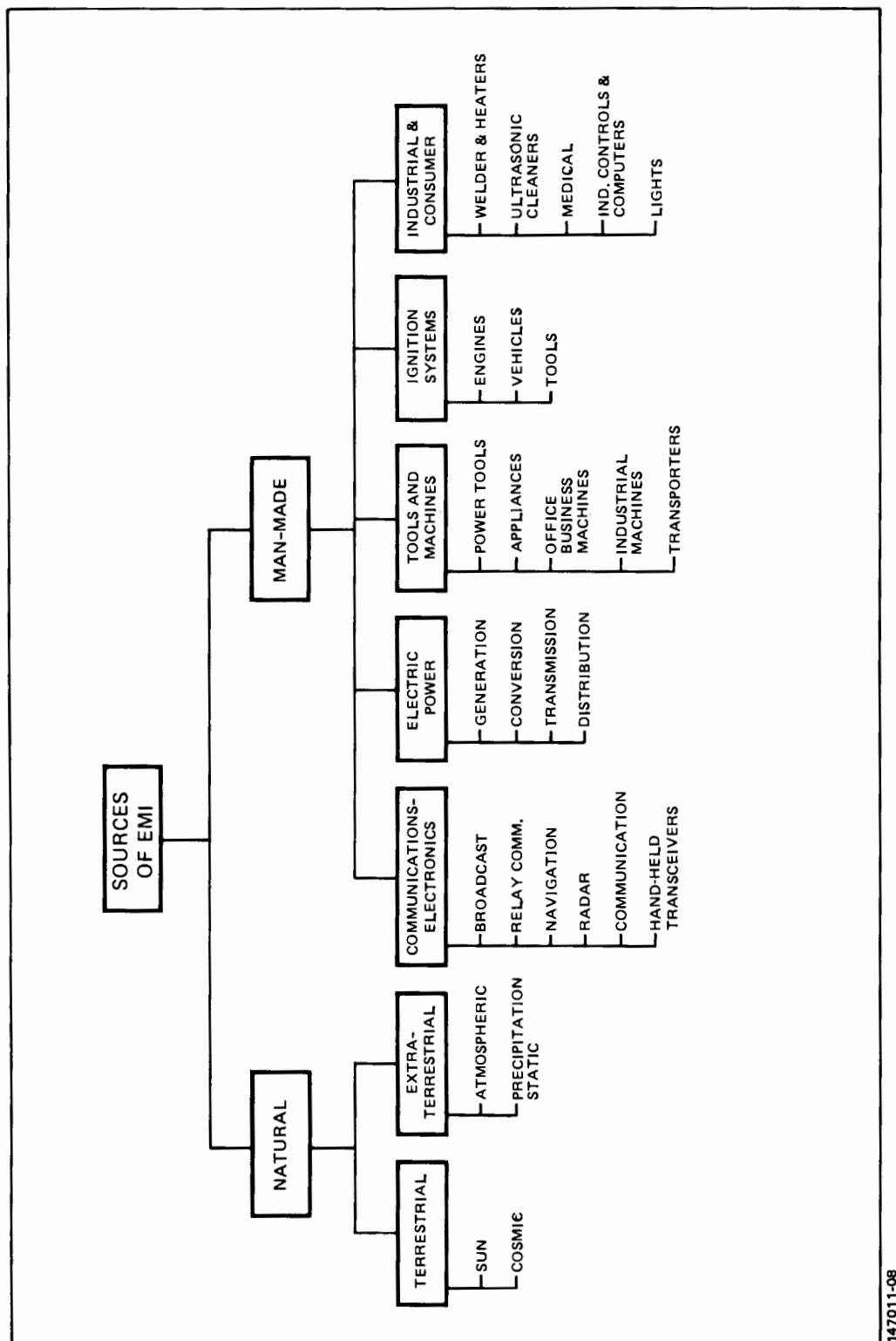
The satisfactory operation of the computer system requires that the environment be controlled to minimize the effects of external electromagnetic interference (EMI). This section describes the types of EMI in the environment and the potential hazards to the equipment, common sources of EMI, and some solutions to potential problems that may arise.

4-2. ELECTROMAGNETIC COMPATIBILITY CONSIDERATIONS

The two categories of interference that are considered are emissions originating in the computer system that may interfere with other equipment, and external sources of interference to which the computer system may be susceptible. Figure 4-1 provides examples and external sources of interference that may affect the computer.

Emissions that may be radiated or conducted from the computer should be considered only to the extent that sensitive receiving equipment should not be placed extremely close to the computer, or use the same dedicated power line. Since HP computer systems are designed to meet the standards of various regulatory agencies, this is normally not a problem. In addition, proper site construction further reduces the possibility of interference by the computer. Some components that may contain magnetic material, such as magnets in some disc drives, present a field that may interfere with highly sensitive compasses or gyro systems normally installed in aircraft or ships. In this case, the main concern is that shipping containers are appropriately marked to inform the carrier (particularly air freight) about shipping constraints. However, this type of equipment is designed to operate compatibly with the other components of the system.

Interferences to which the computer system may be susceptible include electrostatic discharge (ESD), Power line transients (conducted interference), radiated interference, magnetic interference, and lightning. These types of interference are common sources of problems when the levels exceed specified values, contained hereinafter.



147011-08

Figure 4-1. Sources of Electromagnetic Interference

4-3. Susceptibility to Electrostatic Discharge

Electrostatic discharge results from static charge buildup on nonconductive surfaces as contact between two surfaces is broken. This action can cause a failure in the system if the static discharges to ground through one of the system components. Charges of up to 20 kilovolts may be discharged through the system, and circuits in the discharge path can fail. Two of the most common causes of static buildup in the computer room are the use of carpeting and extremely low humidity.

Low humidity, which contributes to the cause of ESD, can be controlled within the specified limits simply by installing humidifiers. Your air conditioning contractor can determine the need and type at the time of room design.

Terminals that are located in other areas of the building may be operating in an environment with high static buildup potential. Since terminals are highly susceptible to static, it may be necessary to place the terminals on antistatic mats.

The HP 3000 computer systems are susceptible to discharge levels greater than 1.5 kilovolts.

4-4. Susceptibility to Power Line Transients

Power line transients, or conducted interference, is any undesired electromagnetic energy that is propagated along a conductor. The conductors that are most affected are the power lines to the computer system. Some sources of interference are pulse-controlled clocks, elevator motors (or any motor that frequently starts and stops), vending machines, fluorescent lights, or any other noise-producing machinery.

Power line transients may originate nearby and be of short, fast duration, or they may originate as distantly as the regional power substation and constitute wide voltage variations or frequency deviations. Also, power drop-out may occur. Sudden power surges in excess of the specified levels will also cause system failures. The effects of transients are the same as that which may occur from the various type of emissions. The susceptibility of the computer system to these transients are specified as follows:

Transient Specification: $\pm 100V$ for up to 200 μs duration. (See figures 4-2 and 4-3.)

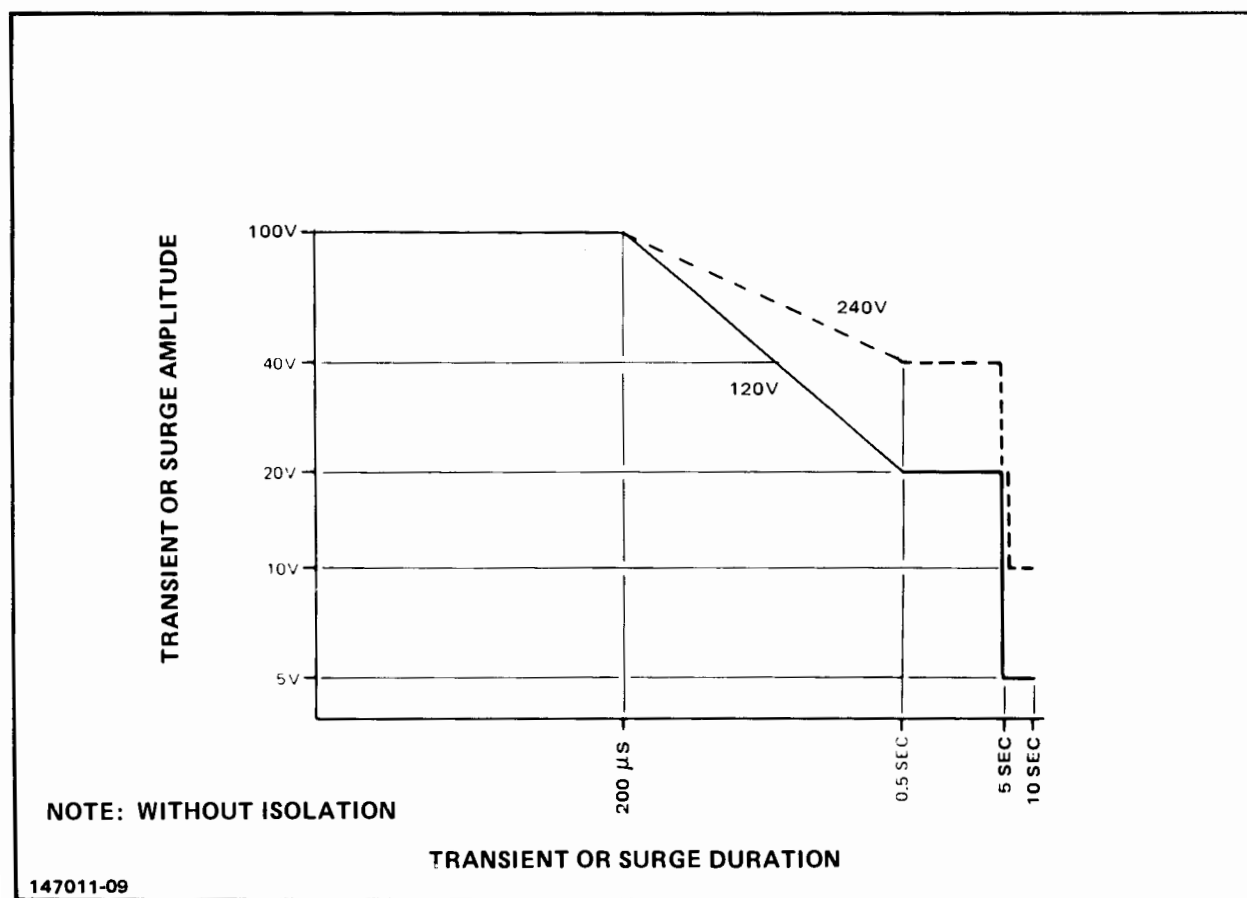


Figure 4-2. Allowable Transient and Surge Voltage Amplitudes That May Exist on the AC Power Line

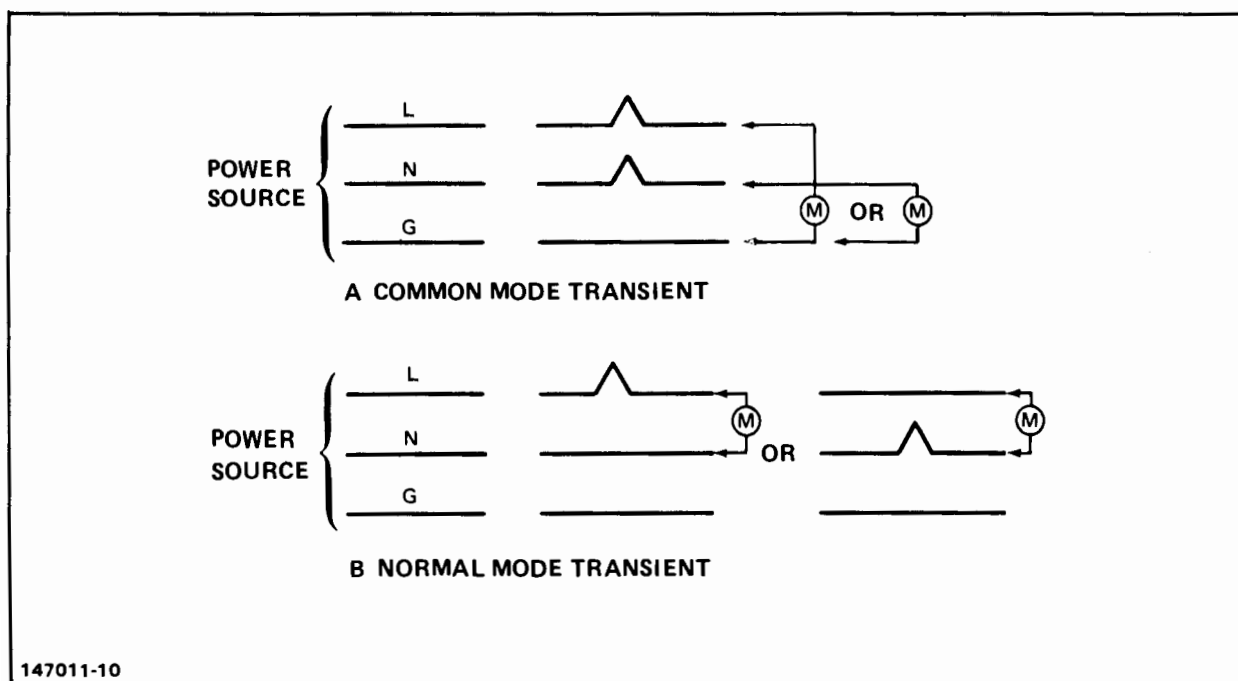


Figure 4-3. How Common and Normal Mode Transients are Monitored

4-5. Susceptibility to Radiated Interference

Radiated interference causes a variety of problems in computer systems. In locations where moderate levels of radiation are present, read/write errors can occur at a rate dependent upon intensity and duration of the interference. At extremely high levels, radiation may be hazardous to operating personnel and destructive to equipment components. The most common sources of radiation are airports which have communications and radar installations, high power transmissions such as radio stations, and freeways where a certain amount of radiation is generated by moving vehicles. Hand-held transceivers (i.e., walkie-talkies) produce the same effect as radio stations when used in or near computer equipment and should therefore be prohibited from the areas in which computer equipment is installed. Additionally, microwave links are sometimes aimed from adjacent buildings. This will present trouble for the computer system if it is installed in the transmission path.

HP 3000 Computer Systems are designed to withstand levels of radiation up 0.5 volt/meter over a frequency range of 14kHz to 1 GHz.

Because hand-held transceivers are commonly used within many buildings, warning signs should be posted around the the computer room. These signs will serve to alert personnel not to use these devices in or near the computer system. An example of this type of sign would be:

WARNING

Do not operate transmitting devices in this area.

4-6. Shielding. It is desirable to suppress the interference-generating devices at the source. This is not always practical, either mechanically or economically. In such cases, shielding must be used effectively to reduce radiated interference on power lines, data cables, or other external sources. The shielding of equipment and cabling enclosures serves as a barrier to external interference.

CAUTION

The following are some of the precautions that can be taken to reduce the effects of these emissions:

- Ground window screens and other large metal surfaces.
- Ensure that proper grounding exists for the computer system.

4-7. Susceptibility to Magnetic Field Interference

Magnetic field interference should be considered for two conditions, the operating environment and the non-operating environment. In the operating environment, this interference may be encountered when magnetic field-producing equipment is located in an adjacent room and the separating wall does not afford adequate shielding. Excessively strong magnetic fields may cause data stored on discs or tapes to be scrambled. Also, tapes and discs that are not properly stored when not in use can be similarly affected.

In the non-operating environment, a situation that might occur would be the transporting of magnetic materials through strong fields and have stored data altered. This condition may be avoided by packing magnetic tapes and discs in metal transit cases when transporting, and then storing in appropriate cabinets or rooms.

The disc drives can withstand magnetic field interference of 50 Oersteds, as measured at the top of the disc drive.

4-8. LIGHTNING PROTECTION

Two aspects of lightning protection must be considered, direct strikes and indirect strikes. Protection against these two aspects involve somewhat different techniques, even though they are interrelated.

The first aspect to consider is the protection against direct strikes, since not only equipment protection is involved, but human safety and structural integrity are also important factors. The National Fire Protection Association's Lightning Protection Code (NFPA Standard 78) specifies practical safeguarding of per-

sonnel and property from hazards arising from exposure to lightning. In addition, local safety and fire codes may provide additional or more stringent requirements.

The primary objective of lightning protection is to prevent lightning or resulting damaging effects from entering the building. This may not always be possible to achieve on an absolute basis, however, if the structural protection is properly installed, destructive results can be prevented. The NFPA Standard 78 clearly illustrates methods of installing lightning protection systems for various types of structures and soils. By following the recommendations set forth in this standard, it can be assured that lightning discharges will be conducted harmlessly from the point of contact into ground. Hewlett-Packard does not recommend any particular method but does recommend adhering to published standards, regulations, and codes.

While the structure can be adequately protected against destructive lightning entry, power lines and signals cables, which are highly susceptible to lightning effects, cannot be protected in the same manner. Power lines must be protected in accordance with local regulations. Data cables are virtually impossible to protect against direct or very strong indirect discharges and, therefore, should never be exposed.

The second consideration for lightning protection is that of indirect strikes. This is more common and, while not having visible effects upon the structure, will almost always produce voltage transients on power and signal lines. Transients resulting from lightning are unpredictable in frequency and time of occurrence, magnitude, and location. Therefore, protection for the computer system must be considered in terms of isolation, separate from that of the structural protection.

Hewlett-Packard specifies transient voltage levels to which the computer system is designed to withstand in normal, controlled environments. The controlled environment is that in which the facility is constructed in accordance with data presented in this document. This means that normal precautions, such as proper grounding systems, cable terminations, etc., have been considered and implemented.

Transients on power lines are generally resolved by adding some form of isolation device at the power entry panel, and subsequent locations in the service voltage lines, as required.

Transients on signal lines are typically much faster and of higher magnitudes than that experienced on power lines, primarily because of the difference in impedance levels and the nature of termination. Impulsive transients of this type, with rise times of less than 50 nanoseconds are the most damaging to digital circuitry. In order to benefit the most out of implementing transient suppression devices for data communication circuitry, the devices should be capable of guarding against 10 kV impulsive

Electromagnetic Compatibility

transients as well as 6 kV transients on longer duration (1 to 100 microseconds). Hewlett-Packard has installed devices that meet these goals on all data communications circuits in the HP 3000 Computer Systems. This is considered to be adequate in locations where lightning activity is moderate to mild. Also, this protection is still adequate in areas of high activity if the facility has been given proper attention.

In areas where lightning problems become severe, additional protection may be required. Since the effects of lightning cannot be accurately predicted, optional protection is available that can be added to the extent that local conditions dictate.

Hewlett-Packard offers the following devices for maximizing protection against lightning-induced transients for power lines and data cables. For power lines inside the facility, the following is specified:

- An isolation transformer with the capability of suppressing transients up to 120 dB.

The number of these, and how they are to be configured in AC power distribution system, is dependent upon local conditions.

EIA Specification RS-232-C states that the maximum withstand voltage for data communications cables to be +25 volts. The nominal operating voltage shall be no greater than 15 volts nor less than 5 volts in magnitude. The capacitance of the receiving end shall not be greater than 2500 pF, and the load shall not be inductive. With these constraints in mind, the following protection is recommended:

- Installation of a transient voltage suppression device with a breakdown voltage of 18 volts at 25 degrees C. This device has a breakdown voltage range of 15.8 volts at 0 degrees C to 20.6 volts at 70 degrees C. The capacitance of this device will range up to 2000 pF, depending upon bias conditions.

These devices must be installed on the data-in, data-out, and signal ground lines in RS-232-C applications. Also, the devices should be installed at both ends of the data communications cables. Methods for implementing the use of these devices are as follows:

- Install HP-manufactured data communications cables that include these features and which are available from the factory.
- Fabricate "black boxes" through which each data cable is routed and the proper lines are connected to these devices. Precautions must be taken to ensure that subsequent terminal installations are also connected to the devices in the same manner.

All devices connected to the data lines must be terminated on the outside of each unit to ensure that transients are not introduced into the unit enclosures. Further precautions should be taken to minimize lightning-induced transients. These are:

- Ensure that each unit in the system is properly earth-grounded.
- Route data communications cables away from power lines and other possible sources of transients.
- Run data communications cables through shielded conduit that is properly earth-grounded.

Do not route data communications cables outside the building, between buildings, or through any other exposed conditions.

4-9. POWER LINE TREATMENT DEVICES

Power lines feeding computer facilities act as pick-up antennas for various forms of electromagnetic interference. Also, the voltages on these lines are affected by transients, power outages, and brownout conditions. These power line disturbances can lead to degraded system performance. In areas where these conditions are extreme, power line protection must be employed to ensure reliable system operation. Depending upon a particular need, one of the following power line treatment devices may be required for the system:

- Isolation transformer
- Line regulator
- Line conditioner
- Motor generator
- Uninterruptable power source (UPS)
- Combinations of the above

4-10. Isolation Transformer

The isolation transformer is designed to eliminate transients on the incoming AC power line. This device provides common-mode noise suppression only. It is useful in situations where transients are of moderate levels and common-mode noise suppression is the primary concern. However, the isolation transformer does not regulate the line voltage, therefore provides no protection against voltage variations.

When isolation transformers are required to be installed, the following isolation transformer specifications are required for an acceptable level of reliable system operation of the HP 3000 computer systems:

- a. 0.001 pF coupling capacitance
- b. Greater than 140 dB common mode noise attenuation
- c. Underwriter Laboratories listed

4-11. Line Regulators

Line regulators provide auto regulation by switching turns in or out. This is a good device for regulating the output voltage, even in deep brownouts.

4-12. Line Conditioners

Line conditioners provide high protection against common- and normal-mode transients. Also, this device regulates the output voltage through moderate sags and surges (approximately 20 percent).

4-13. Motor Generators

Motor generators reject all external noise and regulates the output voltage through sags, surges, brownouts, and momentary dropouts. To protect against blackout conditions, the motor generator set would have to be equipped with a diesel-motor drive.

4-14. Uninterruptable Power Source (UPS)

The UPS is used in critical applications where uninterruptable power is a necessity. The greatest degree of power regulation and power line isolation is provided by the UPS system. Because it is a source of AC power that is not affected by fluctuations in commercial power, an UPS system guards against even momentary voltage disturbances. Since the UPS contains battery backup, blackout control is afforded, the duration of which is dependent upon

the size of the battery bank. Usually this battery bank has a typical maximum of 60 minutes. If longer durations are required, it may be necessary to back up the UPS system with a diesel generator.

NOTE

When an UPS is to be installed, some type of line treatment device must be installed on the output side.

4-15. Summary of Power Line Treatment Devices

The previously described devices provide varying degrees of protection, beginning with the isolation transformer which provides the least, and progressing to the UPS which provides the most protection. Selection of any of these devices depend on local conditions and must be determined after a power survey has been performed, or from some other statistical knowledge. Some HP 3000 systems include isolation transformers which are adequate for many geographical applications. However, conditions may exist in certain areas that dictate the use of additional line treatment equipment.

The devices described are the more commonly used power line treatment devices. Other types are available and may be utilized where conditions warrant. Table 4-1 lists the devices and their associated features, including advantages and disadvantages. In any case, the device must conform to all local safety requirements. If used, a safety ground is required on all units connected to the secondary of the isolation device.

The line treatment devices are positioned after the branch circuit panel and the peripheral power panel. (Refer to Section V.) These installations are valid for all devices except motor generators and UPS. The latter two must be installed before the branch circuit panel.

Table 4-1. Features of AC Line Treatment Devices

	VOLTAGE VARIATION PROTECTION	NORMAL MODE TRANSIENT PROTECTION (DIFFERENTIAL)	COMMON MODE TRANSIENT PROTECTION	PROTECTION FROM LINE FREQUENCY VARIATION (+/- 3%)	LINE DISTORTION PROTECTION	GREEN WIRE HI POT LEAKAGE	ADDITIONAL COMMENTS	
							POSITIVE	NEGATIVE
ISOLATION TRANS. UNSHIELDED	○ NONE ● CAN BE MANUALLY SET BY JUMPERING WINDINGS	○ VERY LITTLE	○ SOME, AT LOW FREQUENCY ○ CAPACITIVE COUPLING MAY PASS MOST HIGH FREQUENCY SIGNALS	○ NO PROTECTION	○ NO PROTECTION ○ WILL ADD DISTORTION 1-2%	● FULL PROTECTION	● READILY AVAILABLE FROM VENDORS IN MANY SIZES ● EFFICIENT POWER CONVERSION	○ HEAVY: 5KVA ≈ 100 POUNDS
SUPER ISOLATION TRANS.	○ NONE ● CAN BE MANUALLY SET BY JUMPERING WINDINGS	○ VERY LITTLE	● HIGH PROTECTION 120dB BECOMES FUNCTION OF WIRING LAYOUT	○ NO PROTECTION	○ NO PROTECTION ○ WILL ADD DISTORTION 1-2%	● FULL PROTECTION	● READILY AVAILABLE FROM SEVERAL VENDORS ● EFFICIENT POWER CONVERSION	○ HEAVY: 5KVA ≈ 100 POUNDS ○ APPLICATION INVOLVES TOTAL APPROACH TO PROPER AC/DC SYSTEM LAYOUT TECHNIQUES
LINE CONDITIONER, SCR SWITCHED TAPS	● AUTO REGULATION BY SWITCHING ADD'L TURNS IN/OUT ● $V_{IN} +13\% - 25\%$ ● $V_{OUT} \pm 7\%$	● $> 55dB @ 100 kHz$	● HIGH PROTECTION 120dB BECOMES FUNCTION OF WIRING LAYOUT	○ NO PROTECTION	○ NO PROTECTION ○ WILL ADD DISTORTION 1-2%	● FULL PROTECTION	● AVAILABLE FROM SEVERAL VENDORS ● EFFICIENT ($> 90\%$) POWER CONVERSION	○ HEAVY: 5KVA ≈ 100 POUNDS ○ APPLICATION IS PART OF TOTAL APPROACH
LINE CONDITIONER, FERRORESONANT	● AUTO REGULATION BY CORE SATURATION AND RESONANT CAPACITOR, SINE WAVE OUTPUT ● $V_{IN} +8\% - 20\%$ ● $V_{OUT} \pm 2\%$	● HIGH PROTECTION DUE TO SATURATED CORE: 120dB 1kHz - 1MHz	● HIGH PROTECTION CMRR BECOMES FUNCTION OF AC WIRING LAYOUT 120dB 1K - 1KHz	○ NO PROTECTION ○ DEVICE IS VERY SENSITIVE TO LINE FREQ. $\pm 1\%$	● HIGH PROTECTION ● REMOVES DISTORTION FROM LINE TO BELOW 5%	● FULL PROTECTION	● AVAILABLE FROM SEVERAL VENDORS	○ HEAVY: 1.5KVA ≈ 100 POUNDS ○ 70-80% EFFICIENCY (MAY REQUIRE A FAN)
PASSIVE FILTER	○ NO PROTECTION	● HIGH PROTECTION, FUNCTION OF DESIGN	● HIGH PROTECTION, BECOMES FUNCTION OF WIRING LAYOUT	○ NO PROTECTION	○ NONE ○ ADDS DISTORTION AS SERIES INDUCTORS SATURATE	○ ADDS LEAKAGE FROM RFI STANDPOINT MAY FAIL. SPECIAL COMPONENTS REQUIRED	● AVAILABLE FROM SEVERAL VENDORS, CAN BE CUSTOMIZED, USER CAN DESIGN HIS OWN	○ NEW OR CUSTOM DESIGNS CAN TAKE MONTHS FOR AGENCY APPROVAL
MOTOR GENERATOR	● HIGH PROTECTION OVER WIDE RANGE ● "RIDES THROUGH" BLACKOUTS OF < 3 SECONDS	● HIGH PROTECTION	● HIGH PROTECTION	● PASSES THRU ALL VARIATIONS THAT ARE > 3 SECONDS IN DURATION. EXTREME VARIATION(?) CAUSES MALFUNCTION	● COMPLETE ISOLATION FROM AC LINE ● DISTORTION IS GENERATOR OUTPUT % OF FULL LOAD	○ SEPARATE ISSUE FROM COMPUTER CHARACTERISTICS, SINCE IS EXTERNAL TO MAINFRAME	● LARGE POWER CAPABILITY	○ BIG APPLICATIONS ONLY 15KVA AND UP ○ NOISY, MUST BE REMOTED ○ REQUIRES PM ○ USUALLY REQUIRES A SITE PREP SUBCONTRACTOR FOR AN EFFECTIVE INSTALLATION
UNINTERRUPTIBLE POWER SOURCE	● COMPLETE ISOLATION, SUBJECT TO STAYING POWER OF BATTERIES OR FUEL IN ENGINE	● HIGH PROTECTION	● HIGH PROTECTION	● COMPLETE ISOLATION	● COMPLETE ISOLATION FROM AC LINE ● DISTORTION IS FUNCTION OF OUTPUT AMPLIFIER % OF FULL LOAD	○ SEPARATE ISSUE FROM COMPUTER CHARACTERISTICS, SINCE IS EXTERNAL TO MAINFRAME	● AVAILABLE FROM SEVERAL VENDORS ● SIZES AVAILABLE FOR ALL APPLICATIONS	○ ENGINE POWERED IS NOISY ○ CELL POWERED TYPE CHEMICAL HAZARD ○ SITE PREP SUBCONTRACTOR RECOMMENDED ○ REQUIRES PM

NOTE: (●) REPRESENTS POSITIVE FEATURE, (○) REPRESENTS NEGATIVE FEATURE
047011-19

ELECTRICAL REQUIREMENTS

SECTION

V

5-1. INTRODUCTION

Reliable computer system operation depends upon an adequate source of AC power that is stable and free from disturbances. A qualified electrician must provide this source of power to the computer system and ensure that the voltage measured at the computer input is within the specified tolerance and that fluctuations and disturbances are within tolerable operating specifications. In addition to a dedicated power line for the computer system, separate power is required for such items as lighting, air conditioning, etc.

Other factors that must be considered when planning and installing electrical system include isolated grounding, lightning protection, and power line treatment devices. Also electrical safety provisions must meet local code requirements.

5-2. DETERMINING POWER REQUIREMENTS

When determining power requirements for the computer site, the total current required for the system must be calculated. Future growth requirements should also be considered at this time. Use the System Components Table for power data and record the data on the Power Requirements Form. The table and form are contained in the Site Planning Workbook.

After calculating the power requirements for the computer system, establish the power needs for lighting, air conditioning, auxiliary equipment, and other non-computer equipment. These items must be on a separate power line.

5-3. SERVICE VOLTAGE

Voltages that are available in each geographic area determine which service voltage configuration that is to be installed for an HP 3000 Computer System. Consult with your HP Customer Engineer to ascertain your system requirements. The electrical contractor can then prepare the site.

5-4. Power Quality

In some geographic areas, available power that is to be used for the computer system may experience excessive voltage sags, surges, transients, outages, or other conditions that are unacceptable for reliable computer operation. Therefore, a power quality survey should be conducted. The results of the survey should be analyzed to determine the need for line treatment devices and what type. After the system is installed, a power line disturbance monitor should be connected to the dedicated system power to monitor the actual power conditions.

5-5. Voltage Limits

The line-to-line, steady-state voltage tolerances when the equipment is operating must be maintained within plus 6 percent or minus 10 percent of the rated voltage, measured at the receptacle. The voltage limits and power fail thresholds are given as follows:

- a. Overvoltage Limits: 100 VAC configuration = 106 VAC
120 VAC configuration = 127 VAC
208 VAC configuration = 220 VAC
220 VAC configuration = 233 VAC
240 VAC configuration = 254 VAC
- b. Undervoltage Limits: 100 VAC configuration = 90 VAC
120 VAC configuration = 108 VAC
208 VAC configuration = 187 VAC
220 VAC configuration = 198 VAC
240 VAC configuration = 216 VAC
- c. Power Fail Thresholds: 100 VAC configuration = 90 VAC
120 VAC configuration = 108 VAC
208 VAC configuration = 187 VAC
220 VAC configuration = 198 VAC
240 VAC configuration = 216 VAC

5-6. Frequency Limits

The line frequency must be maintained at 60 or 50 (+/-2%), as measured at the input to the system.

5-7. Harmonic Content

At all sites, the maximum harmonic content of the computer system feeder must not exceed 5 percent as measured at the input to the system with the system running. This is measured with a distortion analyzer.

5-8. Line-To-Line Imbalance

At the power distribution panel, from which individual circuits run to the computer and its peripherals, the current in any phase must not deviate by more than 20 percent from any other phase. This assures voltage uniformity to be within 5 percent between all phases in a multi-phase source.

5-9. Phase Angle Imbalance



The maximum phase angle imbalance between phases in a multiphase source should not deviate more than 5 percent from the 120 degree or 180 degree relationship, as observed with an oscilloscope at the branch circuit panel.

5-10. POWER DISTRIBUTION

When the power and its quality has been observed, the power distribution system can be constructed. Figures 5-1 and 5-2 depict the two basic voltage configurations that are used with the various HP 3000 computer systems. These configurations are shown for the distribution to the computer system components ONLY. Power for convenience outlets, lighting, and other non-computer use should be on separately wired circuits.

5-11. Power Panels

The panel(s) should be in an unobstructed, well-lighted area in the computer room. The individual branch circuits on the panel(s) should be protected by suitable circuit breakers properly rated according to manufacturer's specifications and applicable codes. Each circuit breaker should be labeled to identify the branch circuit it controls. Breaker ratings will be determined by each load and local electrical code requirements.

5-12. Wiring

Wiring from the main service entry to the branch service panel, and from the branch circuit panel to receptacles or the peripheral power panel must be considered separately. Wiring from the main service entry to the branch circuit panel may involve the use of aluminum wire rather than the preferred copper wire. If this is the case, then the connectors at the branch circuit panel breakers MUST be composed of an aluminum-copper alloy, which are usually marked: AL/CU. If aluminum wire is secured to the panel with a copper connector, the aluminum wire will eventually shrink and result in loose connections. When this occurs, a voltage drop across the connection will be present. Heat will be dissipated, causing a potential fire hazard. Also, the voltage drop may be large enough to adversely affect the computer system.

Wiring between the branch circuit panel and receptacles or peripheral power panel MUST be copper. All receptacles, connectors, and wiring associated with the computer system are made of copper and, therefore, should not be attached to aluminum conductors or connectors.

As a general rule-of-thumb, wire size should be increased one size for every 100 feet from source to load. Following this up-sizing rule should achieve an optimum condition of 1 volt RMS ground-to-neutral, maximum.

5-13. Receptacles and Connectors

When receptacles are used to connect system components to AC power, the receptacles must include an isolated ground connection that is insulated from the receptacle box. Some peripherals may be connected to outlets on the processor, however, because of the limited availability of these receptacles, other receptacles must be routed from the peripheral power panel. It is important to ensure that the separate receptacles include an isolated ground connection. When installing the receptacles, ensure that each receptacle has its own neutral if the source power is multiphase. Using the same neutral for more than one circuit will cause heat problems which results in fire hazard and voltage loss. Figure 5-3 depicts a typical receptacle that includes an isolated ground. Figure 5-4 provides a selection guide for isolated ground receptacles for various voltage ratings and includes the National Electrical Manufacturers Association (NEMA) identification number. The NEMA configurations apply specifically to North America. Use local equivalents where standards differ.

Peripheral power cords vary from country to country. While the connector to each peripheral is standard, the AC connector will not be standard. That which can not be ordered must be fabricated to meet the requirements of each country. Figure 5-5 depicts the available peripheral power cords.

5-14. Customer Convenience Outlets

Devices other than computer system units should be connected to receptacles that are separate from the computer power source. The source of power for these receptacles may be obtained from the branch circuit panel but be sure that it is connected to untreated power. This is to prevent devices such as vacuum cleaners from interfering with the computer units. Also, these receptacles should be clearly marked to avoid the inadvertent connecting of computer peripherals to convenience outlets.

Electrical Requirements

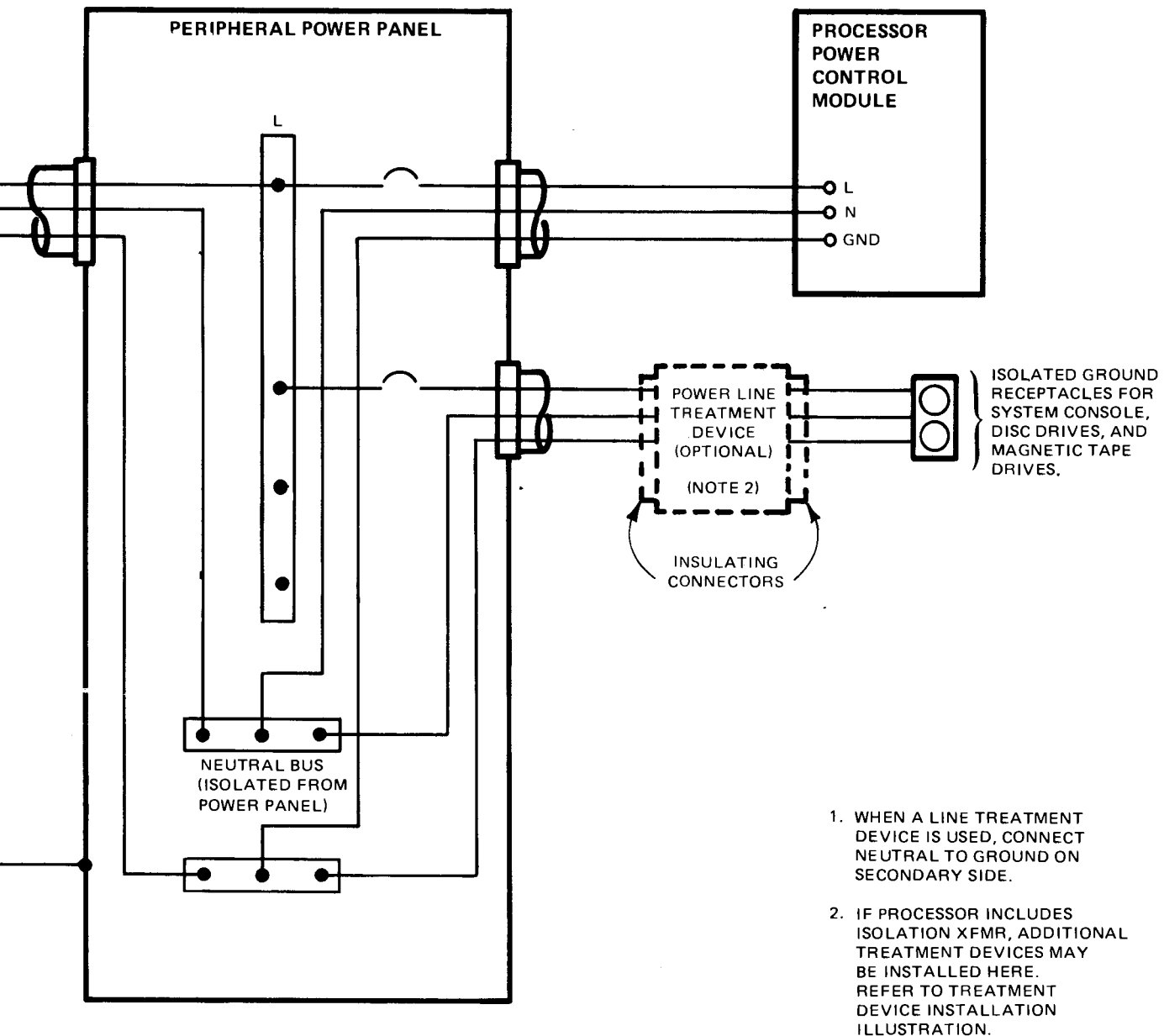
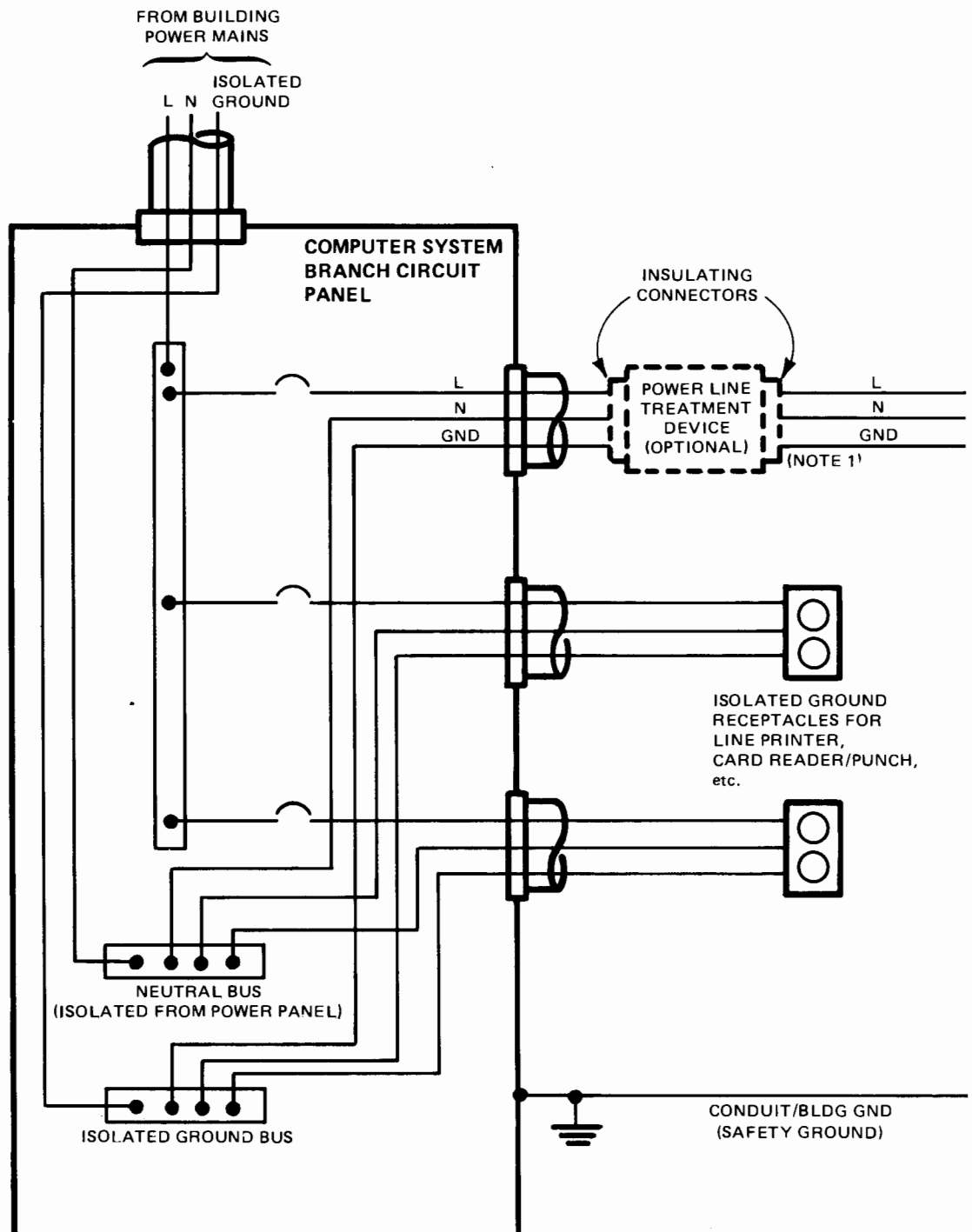


Figure 5-1. 100/120 VAC, Single Phase Power



Electrical Requirements

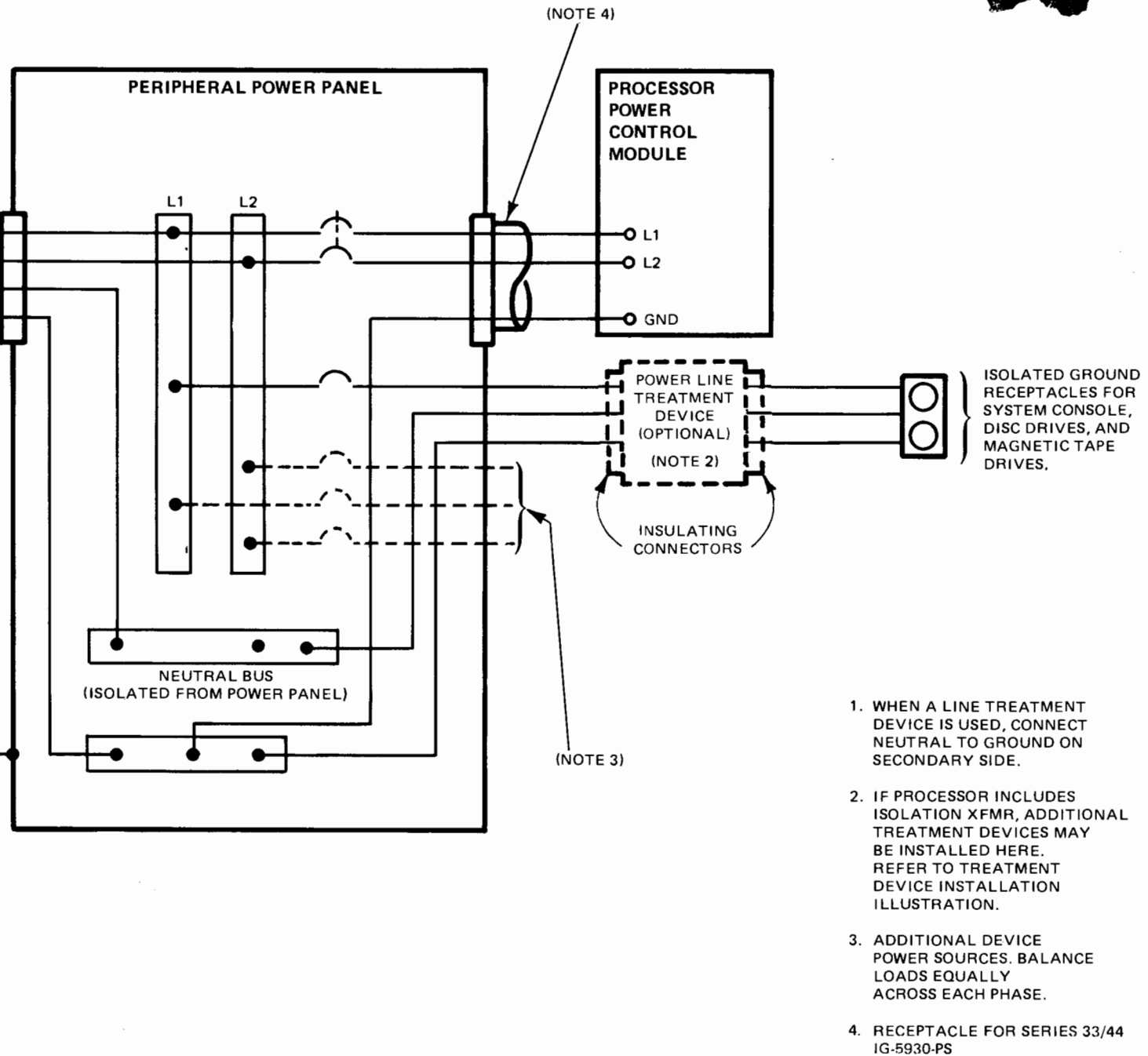
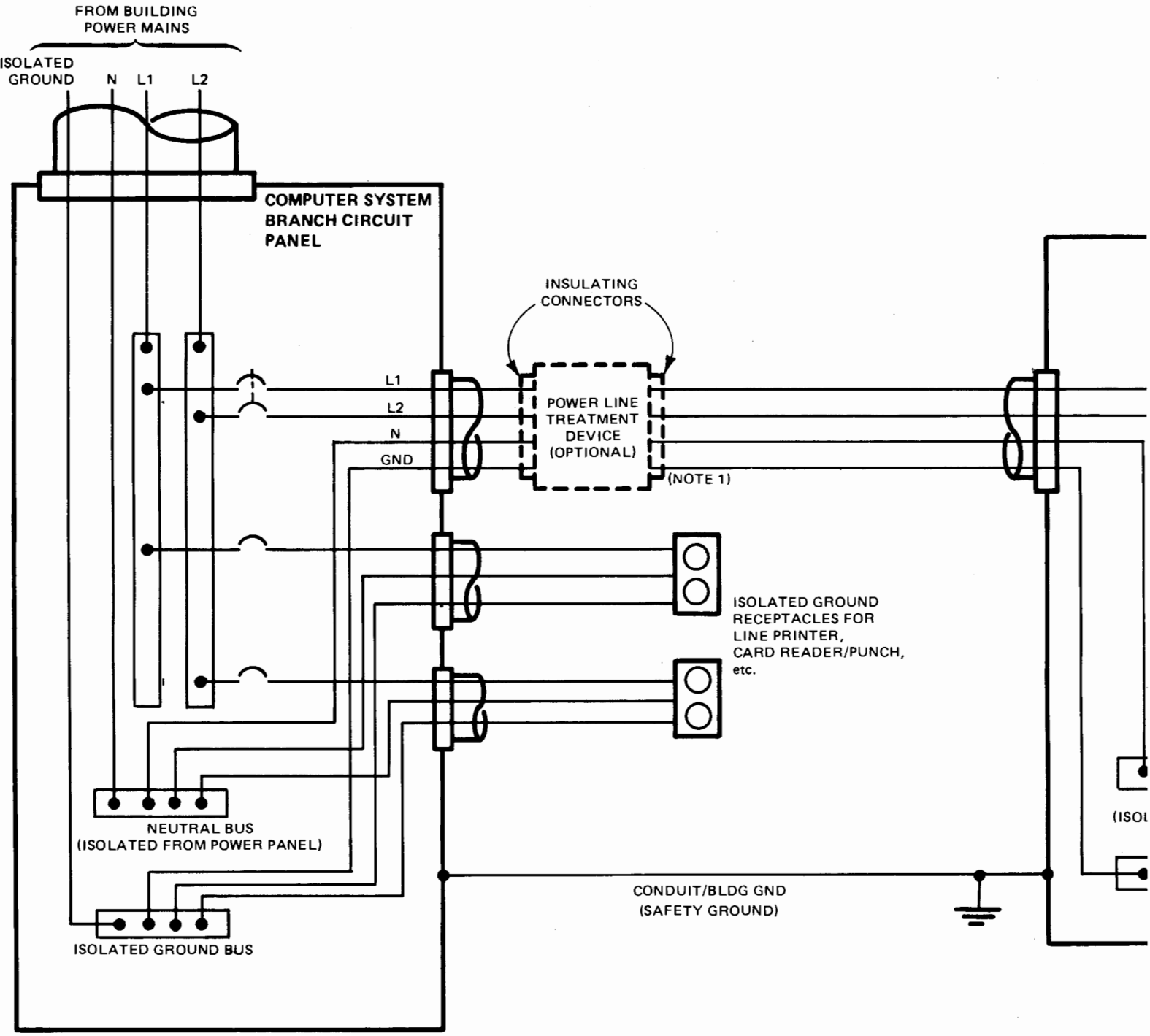


Figure 5-2. 208/240 VAC, Split Phase Power



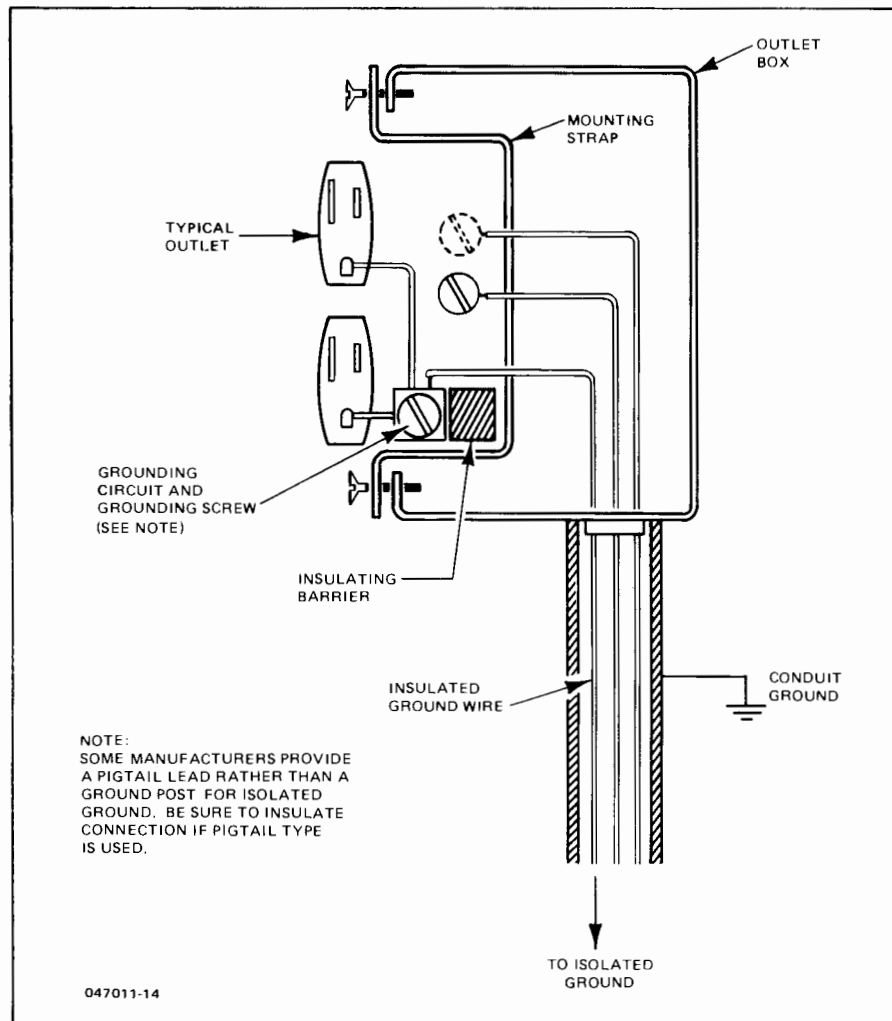


Figure 5-3. Typical Isolated Ground Receptacle

TWIST-LOCK

NEMA NO.	CONFIG.	RATING	DESCRIPTION	COLOR
L5-15R		15A 125V 15A 125V	2 Pole, 3 Wire, Duplex 2 Pole, 3 Wire, Single	Brown Orange
L6-15R		15A 250V	2 Pole, 3 Wire, Single	Orange
L7-15R		15A 277V	2 Pole, 3 Wire, Single	Brown
L5-20R		20A 125V	2 Pole, 3 Wire, Single	Black
L5-30R		30A 125V	2 Pole, 3 Wire, Single	Black
L14-20R		20A 125/250V	3 Pole, 4 Wire, Single	Black
L14-30R		30A 125/250V	3 Pole, 4 Wire, Single	Black
L21-20R		20A 3 ϕ WYE 120/208V	4 Pole, 5 Wire, Single	Black
L22-20R		20A 3 ϕ WYE 277/480V	4 Pole, 5 Wire, Single	Black
L23-20R		20A 3 ϕ WYE 347/600V	4 Pole, 5 Wire, Single	Black
L21-30R		30A 3 ϕ WYE 120/208V	4 Pole, 5 Wire, Single	Black

X = BLACK
 Y = RED
 Z = BLUE
 W = WHITE
 G = GREEN

STRAIGHT BLADE

NEMA NO.	CONFIG.	RATING	DESCRIPTION	COLOR
5-15R		15A 125V	2 Pole, 3 Wire, Duplex 2 Pole, 3 Wire, Single 2 Pole, 3 Wire, Single	Orange Orange Orange
5-20R		20A 125V	2 Pole, 3 Wire, Duplex 2 Pole, 3 Wire, Duplex	Orange Brown
6-15R		15A 250V	2 Pole, 3 Wire, Single	Orange

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Figure 5-4. Selection Guide For Isolated Ground Receptacles

Electrical Requirements

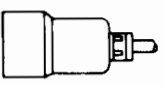
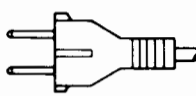
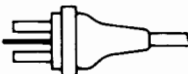
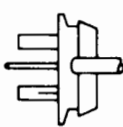
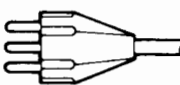
115 VAC	
MALE NEMA (MOLDED) BROWN OR BLACK (L) GREEN/YELLOW (E) LIGHT BLUE OR WHITE (N) 	FEMALE CEE BROWN OR BLACK GREEN/YELLOW LIGHT BLUE OR WHITE 
8120-2371 (2.3 m)	
230 VAC	
MALE CEE BROWN OR BLACK (L) GREEN/YELLOW (E) LIGHT BLUE OR WHITE (N) 	FEMALE CEE (L) BROWN OR BLACK (E) GREEN/YELLOW (N) LIGHT BLUE OR WHITE 
8120-1860 (1.5 m)	
NOTE: OTHER COUNTRIES SUCH AS CANADA, JAPAN (100 or 200 VOLTS), MEXICO, PHILIPPINES AND TAIWAN MAY USE SOME OF THE ABOVE SETS CONSULT YOUR NEAREST HP SALES OFFICE.	
E EARTH OR SAFETY GROUND N NEUTRAL OR IDENTIFIED CONDUCTOR L LINE OR ACTIVE CONDUCTOR	
EAST AND WEST EUROPE, SAUDI ARABIA, UNITED REPUBLIC OF EGYPT	
MALE SCHUKO LIGHT BLUE (N) GREEN/YELLOW (E) BROWN (L) 	FEMALE CEE (L) BROWN (E) GREEN/YELLOW (N) LIGHT BLUE 
NOTE: The light blue (N) and brown (L) wires to the MALE SCHUKO connector may be connected opposite to that shown.	
8120-2857 (2.0 m)	
AUSTRALIA, NEW ZEALAND	
LIGHT BLUE OR BLACK (N) GREEN/YELLOW (E) LIGHT BROWN OR RED (L) 	FEMALE CEE (L) LIGHT BROWN OR RED (E) GREEN/YELLOW (N) LIGHT BLUE OR BLACK 
8120-1369 (2.2 m)	
GREAT BRITAIN, CYPRUS, NIGERIA, RHODESIA, SINGAPORE	
LIGHT BLUE (N) GREEN/YELLOW (E) LIGHT BROWN (L) 	FEMALE CEE (L) LIGHT BROWN (E) GREEN/YELLOW (N) LIGHT BLUE 
8120-1351 (2.2 m)	
SWITZERLAND	
BLUE (N) GREEN/YELLOW (E) BROWN (L) 	FEMALE CEE (L) BROWN (E) GREEN/YELLOW (N) BLUE 
8120-2104 (2.0 m)	
DENMARK	
E L N 	FEMALE CEE E L N 
8120-2956	
NOTE: OTHER COUNTRIES USE MORE THAN ONE OF THE ABOVE POWER CORD CONFIGURATIONS FOR CORRECT POWER CORD SET IN YOUR AREA, CONSULT YOUR NEAREST HP SALES OFFICE	
E EARTH OR SAFETY GROUND N NEUTRAL OR IDENTIFIED CONDUCTOR L LINE OR ACTIVE CONDUCTOR	
147011-15	

Figure 5-5. HP Peripheral Cord Sets

5-15. GROUNDING

The primary consideration for grounding is personnel safety. This is required by the National Electrical Code (in the U.S.A.) and most other local, regional, and national codes. In addition, a noise-free ground (earth reference) must be installed so a common reference point exists for all system components.

5-16. Safety Ground

All codes generally require the use of a safety conductor for electrical equipment. The requirement, generally stated, is that each hot wire (phase) and return wire (neutral) from a power source to any equipment be accompanied by a safety conductor. The size of the safety conductor should be the same size as the hot wire. This same requirement applies for all power systems (i.e., split-phase delta, wye, etc.). Safety codes will generally require that the safety ground conductor be connected to any conductor surface that an operator can touch on the electrical equipment and that can be energized by an electrical fault. This wire, under normal operation, should not carry 50/60 cycle AC return current. If the hot (phase) wire accidentally shorts to the frame, the frame of the equipment would then become raised to some hazardous voltage. These safety shock hazards can be avoided by bonding the safety ground wire to the equipment chassis, thereby providing a very low impedance return path that will cause the circuit breaker to trip, or fuse to blow. The safety ground is provided internally with each product and the return path is completed when the unit is connected to a receptacle having a ground, or when an internal ground lug in the unit is connected to ground through a cord provided by the customer.

The safety ground should be properly terminated on the ground element at the main service entry. The safety ground impedance from any load back to the main service entrance must be less than one ohm.

5-17. Noise-Free Ground

Hewlett-Packard computer systems require the use of noise-free grounds for proper system operation. This ground is referred to as the isolated ground. In most cases, the safety ground is inadequate because ground medium may not be free from ground fault noise, RFI pickup, or may contain a steady current flow. Examples of unacceptable ground sources that are subject to noise are as follows:

- Conduit
- Roof building beams
- Horizontal building beams

- Sprinkler pipes (Connecting ground wires to sprinkler pipes violates most fire codes)
- Water pipes (May have PVC sections presently installed, or installed in future)
- Raised floor support pipes
- Gas pipes

These ground sources are subject to building noise from ground faults and pickup of RFI because of antenna action.

Acceptable ground sources may be of the following (Consult local electrical inspection authorities for an acceptable method in your area):

- Properly sized wire connected to the building mains or entrance ground point.
- Ground spike driven into moist earth and bonded to the entrance ground point.
- Vertical building beams in high rise structures
- Grounding nests or grid meshes but bonded to the entrance ground.
- Any approved service entrance ground.

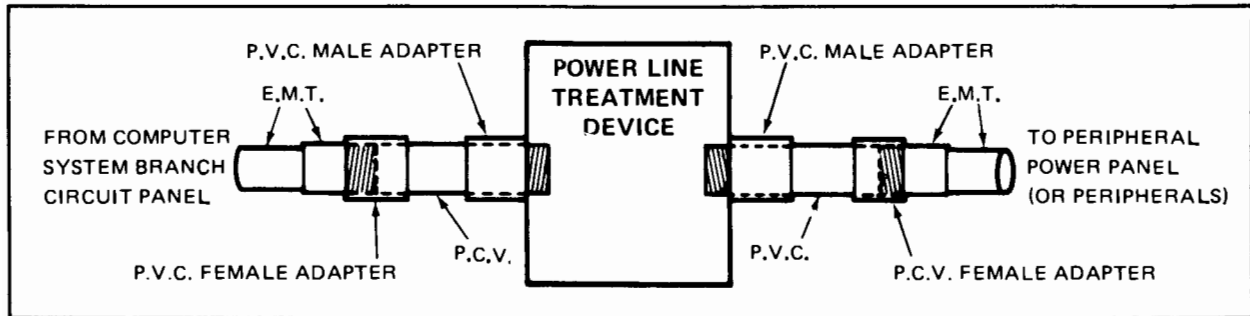
The isolated ground wire must be properly bonded to the ground source. This precludes the use of clamps bolted to a pipe or ground stake, or any other connecting method that result in a loose connection. The bond should be welded, brazed, or soldered to minimize possible IR drops at the ground connection. Any measurable resistance at a connection, plus the ground wire resistance may, if improperly installed, cause and unwanted potential to exist on the isolated ground.

When installing the isolated ground wire, the branch circuit panel should have a isolated ground bus, isolated from the power panel, from which the isolated ground is routed individually to each unit of the system. Where power panels are not available with integral isolated ground buses, a separate ground bus panel may have to be constructed. This separate bus panel then becomes the central distribution point for the dedicated ground.

Wire gauges must also be considered, since the distance from the ground element to the branch circuit panel may vary in distance from site to site. Refer to your local electrical inspection authority for applicable sizes.

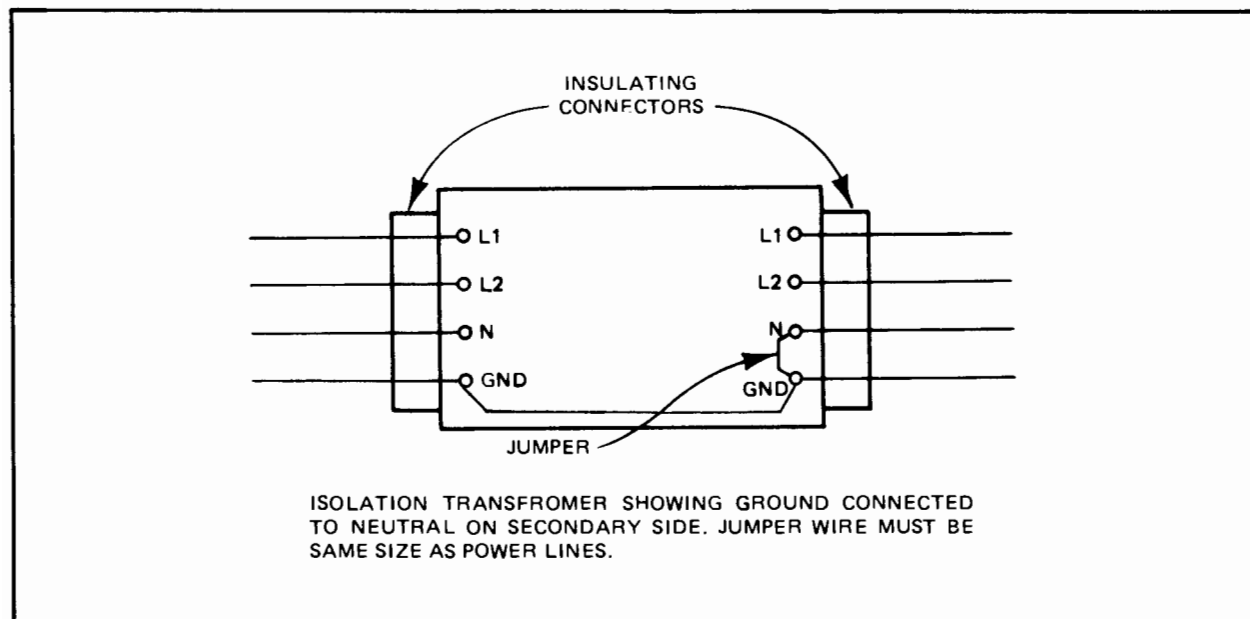
5-18. INSTALLING POWER LINE TREATMENT DEVICES

Install the power line treatment devices as indicated in figures 5-1 and 5-2, as appropriate. If power line treatment devices are installed, the devices are connected with insulated couplers as shown in figure 5-6. Also, some devices, such as isolation transformers, must have the neutral connected to ground on the secondary side as shown in figure 5-7. Check with local electrical inspection authorities to determine if this method is acceptable in your area.



147011-17

Figure 5-6. Power line Treatment Device Installation



147011-18

Figure 5-7. Isolation transformer Ground-to-Neutral Connection



6-1. INTRODUCTION

An essential key to continued reliable computer operation is proper facility maintenance. There is no substitute for cleanliness, neatness, and properly maintained power distribution and air conditioning systems. Cleanliness and neatness minimize dust and dirt accumulations. Properly maintained power to the system ensures constant and correct power to the computer and its peripherals. Also, periodic maintenance of the air conditioning system not only maintains the computer at the proper temperature and humidity levels, but adds to the longevity of the air conditioning system itself.

Periodic maintenance schedules should be initiated and performed on a regular basis. To determine the periodicity of each task described in this section, first ascertain the amount of traffic within the computer area to establish periodic cleaning, floor waxing, etc. Next, consult vendor data for air conditioning maintenance and filter cleaning or replacement schedules. Finally, ensure that the maintenance electrician checks the dedicated computer power regularly.

6-2. CLEANLINESS

The day-to-day operating practices will help keep the computer room clean and neat, and maintain a pleasant atmosphere in which to work. Establish the necessary procedures and ensure that operating personnel comply with these procedures. In addition, be sure that cleaning techniques are properly instituted and implemented.

6-3. Pre-Installation Cleaning

Before installing the computer system, ensure that the following steps have been taken to facilitate subsequent operating practices and cleaning:

- Ensure that all windows in the computer area are sealed.
- Select paints for walls and ceilings that will not flake or powder excessively.
- Use acoustical materials that do not attract and accumulate dust. Avoid sprayed-on acoustical ceilings and mineral-based dropped ceiling tiles because of inherent flaking characteristics.

Facility Maintenance

- Clean subfloor areas, including raceways and air-conditioning ducts and plenums, just before the computer system is installed.
- Place impregnated mats at each entrance to reduce the amount of dust tracked in from other areas.
- Avoid ordinary floor waxes and dry-bright finishes which tend to build up and subsequently fragment into particles.
- Prepare the cleaning schedule.

6-4. Operating Practices

To maintain the computer room cleanliness, the following practices should be observed:

- Prohibit smoking in the computer room and in the magnetic tape and disc storage areas.
- Do not stack materials on top of cabinets, disc drives, or any other equipment in the computer. In addition to restricting the flow of air through equipment, a potential hazard to personnel can be created.
- Keep magnetic tape and discs pack containers closed except when removing or replacing the contents.
- Provide a coat rack outside the computer room for outer garments.
- Minimize casual traffic in the computer area by restricting access to authorized personnel only.

6-5. Cleaning Techniques

The following techniques should be implemented for cleaning the computer area:

- Use water sparingly. If a mop is to be used, it should only be damp, never wet or dry. Antistatic lint-free dust cloths remove dust without stirring it up and without the electrical hazard water represents.

NOTE

If magnetic tape and disc drives are installed, do not sweep the area with a dry broom or mop.

- Use a vacuum cleaner with a nozzle that is not electrically conductive. The cleaner should be tightly sealed, filtered, and watertight.

NOTE

Do not connect vacuum cleaners or floor treatment equipment into the system power.

- Do not use steel wool to clean computer floors; the metal fibers can be a source of electrical problems if introduced into the equipment cabinets.
- Particular attention should be given to areas that are not readily cleaned. General discoloration that does not yield to a fresh application of emulsion polish and machine polishing indicates that dirt is caught in an excessive polish buildup. Remove and replace the polish; if the discoloration is still present, the sealer is probably broken or cracked, allowing dirt into the surfacing material. The floor covering must then be thoroughly cleaned and resealed.
- Apply polish sparingly, and only to traffic routes where necessary. Machine buff other areas. The polish should only fill in scratches not build up to a thick coating.
- Consult manufacturers of specific floor coverings regarding acceptable floor-cleaning procedures.

6-6. AIR CONDITIONING SYSTEM PREVENTIVE MAINTENANCE

Proper maintenance of the air conditioning system will prolong the life of the air conditioning system itself and, at the same time, assure the proper operating environment in the computer room. Since each system will differ between manufacturer and design, preventive maintenance will also differ from model to model. Be sure to consult the manufacturer of your system for their recommended maintenance schedules.

Various types of filters or filtering methods may be employed to prevent unwanted contaminants from entering the computer room. All filters have saturation points after which they are no longer effective. Consult your filter manufacturer for the necessary data on cleaning or replacement intervals. This is particularly important when filtering is required for corrosive contaminants. For example, when activated charcoal is employed to filter out corrosives, the saturation point becomes critical when reached. When charcoal saturates, it emits concentrated quantities of the unwanted gas into the computer room and thereby defeats the purpose filtering. For this reason, filters must be changed at the recommended intervals to prevent damage to the computer system. When corrosive contaminants are of major concern, ensure that data is obtained on each type of gas to be filtered and the fre-

quency of replacement for that particular gas category.

6-7. DEDICATED POWER MAINTENANCE

Normally, the dedicated power to the computer system requires little attention. However, the power source should be checked at least semi-annually to eliminate fire hazards and voltage loss because of loose connections. Schedule the maintenance electrician to perform the following checks and take remedial action, as necessary, on a regular basis.

NOTE

Fire safety codes, regulations, or ordinances may vary in differing areas. Consult your local authority for this information.

- Inspect all power panels and receptacle boxes for debris, such as bits of wiring, insulation, or combustibles. Remove any accumulations.
- Inspect all power panels and receptacle boxes for accumulations of dust, cobwebs, and other forms of dirt. Remove any accumulations.
- Check all mechanical wiring connections. Loose connections are a source of voltage loss and may also be a potential fire hazard because of the heat that may be generated. Tighten all connections.
- Inspect conduit for damage. If cuts, dents, or serious abrasions are evident, check the wiring inside the conduit. Repair or replace any damaged conduit or wiring.
- Replace damaged receptacles, ensuring that the isolated ground lead is properly connected.

PROCESSOR AND PERIPHERAL SPECIFICATIONS

APPENDIX

A

Appendix A contains the specifications for all HP 3000 computers and the peripheral equipment used in the systems. Typical information contained herein includes heat dissipation, current ratings (for voltages and frequency), weight, input voltage ranges, surge currents, and optional voltage ranges (where applicable). The appendix is divided into two parts, processor specifications, and peripheral specifications. After determining your system configuration (with potential expansion), refer to the tables to determine air conditioning requirements, electrical requirements, etc.

NOTE

Heat dissipation values are calculated from actual power measurements. True power is measured with equipment that takes into consideration the phase angle between voltage and current, the nonlinearity of both, and non-unity power factor. Any attempt to calculate heat dissipation using only the product of volts x amperes will produce incorrect results.

ELECTRICAL CHARACTERISTICS—PROCESSORS

MODEL NUMBER	EQUIPMENT	BTU/HR (KCAL/HR)	VOLTAGE (VAC) AND FREQUENCY	INPUT VOLTAGE RANGE (VAC)	MAXIMUM STEADY STATE CURRENT	SURGE CURRENT	MARKED ELECTRICAL RATINGS
HP 32435A	CPU BAY (SERIES III)	7500 (1890)	210 @ 60 Hz 220 @ 50 Hz	189-223 207-233	10A 10A	200A 200A	30A
P/O 32435A	I/O BAY (SERIES III)	1500 (378)	POWER IS OBTAINED FROM CPU BAY		2A	—	—
HP 30341A	HP-1B INTERFACE MODULE (SERIES III)	562 (142)	POWER IS OBTAINED FROM CPU BAY		0.75A 0.75A	—	—
HP 32430B	PROCESSOR MAINFRAME (SERIES 30)	1640 (459)	120 @ 60 Hz 220 @ 50 Hz	108-126 216-250	5.0A 2.6A	50A 50A	10A 5A
HP 32412C	PROCESSOR MAINFRAME (SERIES 33) ONE CARD CAGE	3350 (844)	210 @ 60 Hz 220 @ 50 Hz	189-223 207-233	6.3 6.1	100A 100A	25A —
HP 32412C WITH 30416C	PROCESSOR MAINFRAME (SERIES 33) TWO CARD CAGES	5300 (1335)	210 @ 60 Hz 220 @ 50 Hz	189-223 207-233	7.4A 7.1A	150A 150A	25A —
HP 32440A	PROCESSOR MAINFRAME (SERIES 44) ONE CARD CAGE	4370 (1200)	210 @ 60 Hz 220 @ 50 Hz	189-223 207-233	8.3A 8.1A	150A 150A	25A —
HP 32440A WITH HP 30087A	PROCESSOR MAINFRAME (SERIES 44) TWO CARD CAGES	7350 (1908)	210 @ 60 Hz 220 @ 50 Hz	189-223 207-233	13.1A 12.4A	150A 150A	25A —
HP 32445A	PROCESSOR MAINFRAME (SERIES 40)	3000 (756)	120 @ 50/60 Hz 220 @ 50/60 Hz	108-126 216-250	8.5A 4.5A	75A 75A —	10A 5A —

NOTE:

- CURRENT AND HEAT DISSIPATION VALUES ARE FOR PROCESSOR ONLY AND DO NOT INCLUDE PERIPHERALS CONNECTED TO PROCESSOR OUTLETS.
- HEAT DISSIPATION IS CALCULATED FROM MEASURED TRUE POWER FOR BOTH 60 Hz AND 50 Hz SYSTEMS. THE VALUES GIVEN IN BTU/HR APPLY TO 60 Hz SYSTEMS ONLY, AND THE VALUES GIVEN KCAL/HR APPLY TO 50 Hz SYSTEMS ONLY.

ELECTRICAL CHARACTERISTICS – DISC DRIVES

MODEL NUMBER	EQUIPMENT	BTU/HR (KCAL/HR)	VOLTAGE (VAC) AND FREQUENCY	INPUT VOLTAGE RANGE (VAC)	MAXIMUM STEADY STATE CURRENT	SURGE CURRENT	MARKED ELECTRICAL RATINGS
HP 7906S	DISC DRIVE (SLAVE)	1780 (440)	120 @ 60 Hz 220 @ 50 Hz	108-126 209-231	5.7A 3.2A	60A 60A	8A 4A
HP 7906M	DISC DRIVE (MASTER)	2526 (636)	120 @ 60 Hz 220 @ 50 Hz	108-126 209-231	8.0A 4.5A	60A 60A	8A 4A
HP 7920S	DISC DRIVE (SLAVE)	1621 (409)	120 @ 60 Hz 220 @ 50 Hz	108-126 209-231	5.1A 3.0A	60A 60A	8A 4A
HP 7920M	DISC DRIVE (MASTER)	2389 (602)	120 @ 60 Hz 220 @ 50 Hz	108-126 209-231	7.4A 4.3A	60A 60A	8A 4A
HP 7925S	DISC DRIVE (SLAVE)	1160 (292)	120 @ 60 Hz 220 @ 50 Hz	108-126 209-231	4.4A 2.2A	60A 60A	8A 4A
HP 7925M	DISC DRIVE (MASTER)	1928 (486)	120 @ 60 Hz 220 @ 50 Hz	108-126 209-231	6.7A 3.5A	60A 60A	8A 4A
HP 7935H	DISC DRIVE	5450 (1376)*	208 @ 60 Hz 220 @ 50 Hz	187.2-228.8 198-242	9.3A 9.0A	150 150	20A 20A
HP 9895A	FLEXIBLE DISC DRIVE	295 (74)	120 @ 60 Hz 220 @ 50 Hz	108-126 209-231	2.1A 0.88A	50A 50A	3.0A 1.5A
HP 7911/7912	DISC DRIVE	2593 (654)	120 @ 60 Hz 220 @ 50 Hz	108-126 198-231	4.7A 2.6A	60A 60A	7A 4A

*Includes drive and accessory outlets

ELECTRICAL CHARACTERISTICS – MAGNETIC TAPE DRIVES

MODEL NUMBER	EQUIPMENT	BTU/HR (KCAL/HR)	VOLTAGE (VAC) AND FREQUENCY	INPUT VOLTAGE RANGE (VAC)	MAXIMUM STEADY STATE CURRENT	SURGE CURRENT	MARKED ELECTRICAL RATINGS
HP 7970E	MAGNETIC TAPE DRIVE	580 (154)	115 @ 60 Hz 230 @ 50 Hz	103.5-126.5 207-253	2.0A 1.7A	50A 50A	4.0A 2.5A
HP 7970E OPT 426	MAGNETIC TAPE DRIVE	750 (198)	115 @ 60 Hz 230 @ 50 Hz	103.5-126.5 207-253	2.5A 1.4A	50A 50A	4.0A 2.5A
HP 7976A	MAGNETIC TAPE DRIVE	5100 (1285)	117 @ 60 Hz 220 @ 50 Hz	111.2-122.9 187-242	15.8A 8.2A		20A 10A

ELECTRICAL CHARACTERISTICS—TERMINALS

MODEL NUMBER	EQUIPMENT	BTU/HR (KCAL/HR)	VOLTAGE (VAC) AND FREQUENCY	INPUT VOLTAGE RANGE (VAC)	MAXIMUM STEADY STATE CURRENT	SURGE CURRENT	MARKED ELECTRICAL RATINGS
HP 2621A	CRT TERMINAL	140 (35)	120 @ 60 Hz 220 @ 50 Hz	90-126 198-231	0.43A 0.25A	10A 10A	0.8A 0.4A
HP 2621P	CRT TERMINAL WITH PRINTER	300 (75)	115 @ 60 Hz 230 @ 50 Hz	87-126 173-253	1.2A 0.6A	15A 15A	2.4A 1.2A
HP 2622A	CRT TERMINAL	255 (65)	110 @ 60 Hz 220 @ 50 Hz	99-115.5 198-231	0.65 0.35	3.2A 3.2A	2.0A 1.0A
HP 2622P	CRT TERMINAL WITH INTEGRAL PRINTER	578 (146)	115 @ 60 Hz 230 @ 50 Hz	103.5-120.8 207-241.5	1.5A 0.75A	20A 20A	5.0A 2.5A
HP 2624A	CRT TERMINAL	408 (103)	110 @ 60 Hz 220 @ 50 Hz	99-115.5 19-231	1.2A 0.6A	6.2A 6.2A	2.0A 1.0A
HP 2624P	CRT TERMINAL WITH INTEGRAL PRINTER	578 (146)	115 @ 60 Hz 230 @ 50 Hz	103.5-120.8 207-241.5	1.3A 0.7A	20A 20A	5.0A 2.5A
HP 2626A	CRT TERMINAL	255 (65)	120 @ 60 Hz 220 @ 50 Hz	114-126 209-231	0.8A 0.4A	2.0A 2.0A	2.0A 1.0A
HP 2626P	CRT TERMINAL WITH INTEGRAL PRINTER	408 (103)	115 @ 60 Hz 230 @ 50 Hz	109-120.8 218.5-241.5	1.7A 0.9A	20A 20A	5.0A 2.5A
HP 2640A/B	CRT TERMINAL	290 (73)	115 @ 60 Hz 230 @ 50 Hz	88.5-126.5 195-253	1.1A 0.6A	15A 15A	4.0A 2.0A
HP 2641A	CRT TERMINAL	290 (73)	115 @ 60 Hz 230 @ 50 Hz	88.5-126.5 195-253	1.2A 0.6A	15A 15A	4.0A 2.0A
HP 2642A	CRT TERMINAL	510 (129)	115 @ 50/60 Hz 230 @ 50 Hz	111.6-126.5 195.5-253			
HP 2644A	CRT TERMINAL	290 (73)	115 @ 60 Hz 230 @ 50 Hz	88.5-126.5 195-253	1.2A 0.6A	15A 15A	4.0A 2.0A
HP 2645A	CRT TERMINAL	348 (88)	115 @ 60 Hz 230 @ 50 Hz	88.5-126.5 195-253	1.3A 0.7A	15A 15A	4.0A 2.0A
HP 2647A	CRT TERMINAL	560 (140)	115 @ 60 Hz 230 @ 50 Hz	88.5-126.5 195-253	2.2A 1.1A	15A 15A	4.0A 2.0A
HP 2648A	CRT TERMINAL	440 (111)	115 @ 60 Hz 230 @ 50 Hz	88.5-126.5 195-253	1.7A 0.9A	15A 15A	4.0A 2.0A
HP 2649A	CRT TERMINAL	348 (88)	115 @ 60 Hz 230 @ 50 Hz	88.5-126.5 195-253	1.3A 0.7A	15A 15A	4.0A 2.0A



ELECTRICAL CHARACTERISTICS—PRINTERS

MODEL NUMBER	EQUIPMENT	BTU/HR (KCAL/HR)	VOLTAGE (VAC) AND FREQUENCY	INPUT VOLTAGE RANGE (VAC)	MAXIMUM STEADY STATE CURRENT	SURGE CURRENT	MARKED ELECTRICAL RATINGS
HP 2608A	LINE PRINTER	2900 (730)	120 @ 60 Hz 220 @ 50 Hz	108-126 198-231	10.5A 5.3A	15A 15A	12.5A 6.25A
HP 2613A	LINE PRINTER	1300 (328)	115 @ 60 Hz 220 @ 50 Hz	103.5-126.5 198-242	4.0A 2.5A	22.2A 22.2A	7.0A 3.5A
HP 2617A	LINE PRINTER	2030 (512)	115 @ 60 Hz 220 @ 50 Hz	103.5-126.5 198-242	6.3A 2.5A	22.2A 22.2A	7.0A 3.5A
HP 2618A	LINE PRINTER	4060 (1020)	115 @ 60 Hz 230 @ 50 Hz	103.5-126.5 207-253	12.9A 8.5A	52A 52A	20A 10A
HP 2619A	LINE PRINTER	4340 (1090)	115 @ 60 Hz 230 @ 50 Hz	103.5-126.5 207-253	12.5A 6.3A	— —	20A 10A
HP 2631B	LINE PRINTER	512 (126)	120 @ 60 Hz 220 @ 50 Hz	105-132 194-242	1.7A 0.9A	25A 25A	2.4A 1.2A
HP 2680A	PAGE PRINTER	13,650	208 @ 60 Hz 220 @ 50 Hz	187.2-218 209-231	24A 22A	35A 35A	30A 30A
HP 2635B	PRINTING TERMINAL	512 (142)	120 @ 60 Hz 220 @ 50 Hz	105-132 194-242	1.7A 1.0A	25A 25A	2.4A 1.2A

ELECTRICAL CHARACTERISTICS—PUNCHES AND READERS

MODEL NUMBER	EQUIPMENT	BTU/HR (KCAL/HR)	VOLTAGE (VAC) AND FREQUENCY	INPUT VOLTAGE RANGE (VAC)	MAXIMUM STEADY STATE CURRENT	SURGE CURRENT	MARKED ELECTRICAL RATINGS
HP 2748B	PAPER TAPE READER	683 (172)	115 v @ 60 Hz 230 v @ 50 Hz	103.5-126.5 207-253	2.5A 1.25A	3.5A 3.5A	2.5A 1.25A
HP 2893A	CARD READER	1230 (310)	115 v @ 60 Hz 230 v @ 50 Hz	103.5-126.5 207-253	4.0A 2.0A	20.6A 20.6A	5.4A 2.7A
HP 2893A WITH OPT 333	CARD READER WITH HP-IB INTERFACE	1230 (310)	115 v @ 60 Hz 230 v @ 50 Hz	103.5-126.5 207-253	4.0A 2.0A	20.6A 20.6A	5.4A 2.7A
HP 2894B	CARD READER/ PUNCH	1450 (365)	115 v @ 60 Hz 230 v @ 50 Hz	103.5-126.5 207-253	5.3A 2.6A	— —	7A 3.5A
HP 2895B	PAPER TAPE PUNCH	683 (172)	115 v @ 60 Hz 230 v @ 50 Hz	103.5-126.5 207-253	2.0A 1.0A	3.0A 3.0A	2.0A 1.0A
HP 7260 A	OPTICAL MARK READER	471 (119)	115 v @ 60 Hz 230 v @ 50 Hz	103.5-126.5 207-253	1.2A 0.6A	— —	1.2A 0.6A

PHYSICAL CHARACTERISTICS – PROCESSORS

MODEL NUMBER	EQUIPMENT	DIMENSIONS (UNCRATED)						WEIGHT (NET)	
		HEIGHT		WIDTH		DEPTH			
		IN.	CM	IN.	CM	IN.	CM	LB	KG
HP 30135A	CPU BAY (SERIES III)	64.5	163.8	21.0	53.3	31.5	80.0	475	216
HP 30235A	I/O BAY (SERIES III)	64.5	163.8	21.0	53.3	31.5	80.0	220	100
HP 30341A	HP-1B INTERFACE MODULE	64.5	163.8	21.0	53.3	31.5	80.0	---	---
HP 32430B	PROCESSOR MAINFRAME (SERIES 30)	40.0	101.2	24	61	22.5	57.0	190	86
HP 32412C	PROCESSOR MAINFRAME (SERIES 33) ONE CARD CAGE	28.5	72.4	72.25	183.5	31.25	79.4	240	109
HP 32412 WITH 30416C	PROCESSOR MAINFRAME (SERIES 33) TWO CARD CAGES	28.5	72.4	72.25	183.5	31.25	79.4	---	---
HP 32440A	PROCESSOR MAINFRAME (SERIES 44) ONE CARD CAGE	28.5	72.4	72.25	183.5	31.25	79.4	240	109
HP 32440A WITH HP 30087A	PROCESSOR MAINFRAME (SERIES 44) TWO CARD CAGES	28.5	72.4	72.25	183.5	31.25	79.4	---	---
HP 32445A	PROCESSOR MAINFRAME (SERIES 40)	40.0	101.6	24.0	61.0	22.4	56.9	190	86

PHYSICAL CHARACTERISTICS

MODEL NUMBER	EQUIPMENT	DIMENSIONS (UNCRATED)						WEIGHT (NET)	
		HEIGHT		WIDTH		DEPTH			
		IN.	CM	IN.	CM	IN.	CM	LB	KG
HP 2608A	LINE PRINTER	38.5	97.4	26.0	65.8	22.0	55.6	215	97
HP 2613A	LINE PRINTER	45.0	113.3	33.0	83.8	22.0	55.9	340	115
HP 2617A	LINE PRINTER	45.0	113.3	33.0	83.8	26.0	66.0	390	168
HP 2619A	LINE PRINTER	41.0	104.1	36.75	93.4	26.0	66.0	570	259
HP 2621A	CRT TERMINAL	18.0	45.7	14.5	36.8	23.0	58.4	35.5	16
HP 2621P	PRINTING CRT TERMINAL	18.0	45.7	14.5	36.8	23.0	58.4	39.5	18
HP 2622A	CRT TERMINAL	17.3	44.0	15.0	38.0	26.2	66.5	37	17
HP 2622P	PRINTING CRT TERMINAL	17.3	44.0	15.0	38.0	26.2	66.5	42	19
HP 2624A	CRT TERMINAL	17.3	44.0	15.0	38.0	26.2	66.5	37	17
HP 2624P	PRINTING CRT TERMINAL	17.3	44.0	15.0	38.0	26.2	66.5	42	19
HP 2626A	CRT TERMINAL	17.3	44.0	15.0	38.0	26.2	66.5	37	17
HP 2626P	PRINTING CRT TERMINAL	17.3	44.0	15.0	38.0	26.2	66.5	42	19
HP 2631B	LINE PRINTER	36.75	93.4	25.0	63.5	18.5	47.0	51	24
HP 2635A/B	PRINTING TERMINAL	36.75	93.4	25.0	63.5	18.5	47.0	56	26
HP 2640B	CRT TERMINAL	13.5	34.3	17.5	44.5	25.5	64.8	44	20
HP 2641A	CRT TERMINAL	13.5	34.3	17.5	44.5	25.5	64.8	44	20
HP 2644A	CRT TERMINAL	13.5	34.3	17.5	44.5	25.5	64.8	50	23
HP 2645A	CRT TERMINAL	13.5	34.3	17.5	44.5	25.5	64.8	50	23
HP 2647A/F	CRT TERMINAL	13.5	34.3	17.5	44.5	25.5	64.8	50	23
HP 2648A	CRT TERMINAL	13.5	34.3	17.5	44.5	25.5	64.8	50	23
HP 2649E	CRT TERMINAL	13.5	34.3	17.5	44.5	25.5	64.8	50	23
HP 2680A	PAGE PRINTER	48.0	122.0	64.0	162.6	27	68.6	875	375
HP 2748B	PAPER TAPE READER	7.0	17.8	17.0	43.2	16.0	40.6	42	19
HP 2893A	CARD READER	15.5	39.0	23.0	58.4	18.0	45.7	75	34
HP 2894A	CARD READER/PUNCH	40.0	102.0	42.0	107.0	27.0	69.0	260	118
HP 2895B	PAPER TAPE PUNCH	10.5	26.7	16.75	42.5	21.2	53.8	35	16
HP 7260A	OPTICAL MARK READER	--	--	--	--	--	--	54	25
HP 7906S	DISC DRIVE (SLAVE)	28.25	71.7	21.78	55.3	31.12	71.1	290	132
HP 7906M	DISC DRIVE (MASTER)	28.25	71.7	21.78	55.3	31.12	71.1	326	148
HP 7911P	DISC DRIVE	28.4	72.0	14.0	35.4	29.1	74.0	188	85

PHYSICAL CHARACTERISTICS (CONT.)

MODEL NUMBER	EQUIPMENT	DIMENSIONS (UNCRATED)						WEIGHT (NET)	
		HEIGHT		WIDTH		DEPTH			
		IN.	CM	IN.	CM	IN.	CM	LB	KG
HP 7920S	DISC DRIVE (SLAVE)	32.5	82.5	21.5	54.6	31.0	78.7	299	135
HP 7920M	DISC DRIVE (MASTER)	32.5	82.5	21.5	54.6	31.0	78.7	336	152
HP 7925S	DISC DRIVE (SLAVE)	32.5	82.5	21.5	54.6	31.0	78.7	304	138
HP 7925M	DISC DRIVE (MASTER)	32.5	82.5	21.5	54.6	31.0	78.7	334	155
HP 7935H	DISC DRIVE	32.5	82.5	21.7	55.2	32.8	83.4	340	154
HP 7970E	MAG TAPE	47.5	118.9	27.0	68.6	31.0	78.5	—	—
HP 7976	MAG TAPE	62.38	158.5	24.5	62.3	35.63	90.5	560	254
HP 9895A	FLEXIBLE DISC DRIVE	7.6	19.3	19.0	48.3	22.6	57.4	59	26.8

SYSTEM CABLES

APPENDIX

B

Appendix B contains a list of all system cabling. This list is to be used when planning site layout to determine how far away units can be placed from one another.

Most cables provided between the system and peripherals have a specified flammability rating. Determine where the cables are to be run (outdoors, in air plenums, in cable troughs, raceways, etc.) and if the cable is approved in that area.

Some jurisdictions require plastic coated cables to be in metal raceways and never in plenums or air handling areas. Check with your local electrical inspection authority.

Care must be taken where interconnecting data cables are to be run. Improper or near noisy conductors, motors, fluorescent lights, etc. may cause radiated or magnetic coupling onto the data lines. If this occurs, loss of data may result.

SIGNAL CABLES

MODEL NUMBER	EQUIPMENT	STANDARD LENGTH		MAXIMUM LENGTH	
		FEET	METERS	FEET	METERS
HP 2608A	LINE PRINTER	*	*	500	152.4
HP 2613A	LINE PRINTER	50	15.2	500	152.4
HP 2617A	LINE PRINTER	50	15.2	500	152.4
HP 2618A	LINE PRINTER	50	15.2	500	152.4
HP 2619A	LINE PRINTER	50	15.2	500	152.4
HP 2621P	PRINTING TERMINAL	5/15/50	1.5/4.5/15.2	100	30.4
HP 2631A	LINE PRINTER	*	*	500	152.4
HP 2635A	PRINTING TERMINAL	12.5	3.8	100	30.4
HP 2621A	CRT TERMINAL	5/15/50	1.5/4.5/15.2	100	30.4
HP 2640A/B	CRT TERMINAL	5/15	1.5/4.5	100	30.4
HP 2641A	CRT TERMINAL	5/15	1.5/4.5	100	30.4
HP 2644A	CRT TERMINAL	5/15/50	1.5/4.5/15.2	100	30.4
HP 2645A	CRT TERMINAL	5/15/50	1.5/4.5/15.2	100	30.4
HP 2647A	CRT TERMINAL	5/15/50	1.5/4.5/15.2	100	30.4
HP 2648A	CRT TERMINAL	5/15/50	1.5/4.5/15.2	100	30.4
HP 2649A	CRT TERMINAL	5/15/50	1.5/4.5/15.2	100	30.4
HP 7906S/M	DISC DRIVE	10/18**	3/5.5**	18/75	5.5/23
HP 7920S/M	DISC DRIVE	10/18**	3/5.5**	18/75	5.5/23
HP 7925S/M	DISC DRIVE	10/18**	3/5.5**	18/75	5.5/23
	MAGNETIC TAPE	20	6.1	20	6.1
HP 7970E	MAGNETIC TAPE	20	6.1	20	6.1
HP 2748B	PAPER TAPE READER	18	5.5	50	15.2
HP 2893A	CARD READER	25	7.6	500	152.4
HP 2894A	CARD READER/PUNCH	50	15.2	50	15.2
HP 2895A	PAPER TAPE PUNCH	15	4.5	15	4.5
HP 7260A	OPTICAL MARK READER	7.5	2.3	7.5	2.3

*See HP-IB cabling schemes for cable lengths.

**Cable lengths apply to slave drives only. For master drives, see HP-IB cabling schemes.

al HP-IB Cabling Schemes

