# Generic Site Preparation Guide

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## Revision History

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# 1 General Site Preparation Guidelines

This guide contains recommendations and best practices to consider for improving site efficiency and tolerance before the installation or operation of an HP high-end or mid-range server system. This general information is intended for different server models and vendor sites around the world and is not a substitute for recommendations or requirements from the manufacturer or vendor of a specific product.

**NOTE:** Refer to the specific server *service guide* for the guidelines required to support the specific server.

The following information provides general principles and practices to consider before the installation or operation of the system. These guidelines apply to all of the customer environments an HP product is likely to be installed in:

- Controlled computer room
- Controlled office
- Uncontrolled office/home
- Light industrial
- Mobile/portable

However, the implementation of these guidelines will change from customer to customer and from one environment to another.

## Electrical Factors

### Synopsis

#### AC Electrical Distribution System

HP recommends using an electrical distribution system that might exceed your normal electrical guidelines. This recommendation is based on experiences with HP customers who have a low occurrence of unexpected interruptions. As your system availability needs increase, these recommendations become more important.

Recommended electrical distribution hardware includes receptacles, AC wiring, conduits, and breakers that are sized for maximum-rated loads, rather than for typical loads. Between the receptacle and nearest X0 bond and the transformers, do not exceed 75 feet (22.86 m) because connection points can become loose over time and subject to loading problems.

HP recommends sourcing a higher input voltage to the stepdown transformer within 75 feet (22.86 m). For example, if 480-volt current is available in the building, ensure that distribution transformers in the server room are 480/208-volt stepdown. In an optimum electrical distribution system:

- Electrical infrastructure is rated for maximum load.
- The distance from a receptacle to power source X0 is less than 75 feet (22.86 m).
- There are no daisy-chained receptacles, hot, neutral, or ground wires.
- The system is sourced from higher distribution voltages.

#### AC Power Quality Devices

HP products have a wide range of voltage tolerances. In general, approximately 10 percent of the nominal voltage is sufficient for the marked electrical rated voltage. The best operating margin is in the middle of this range. Your business needs will dictate the business risk you can withstand. Although utility-fed AC power is usually error free, your particular building or area might be subject to local problems.

HP recommends the use of uninterruptible power supplies (UPSs), backup generators, auto transfer devices, floor-mounted distribution transformers (less than 75-foot distances), and other alternatives for critical systems and applications demanding high availability. To ensure sufficient power quality, keep in mind:

- The best voltage operating margin is in the middle of the distribution range.
- Higher availability equipment should have UPS sourcing and dedicated breakers.
- A few large UPSs provide more protection than numerous smaller cabinet UPSs.

## UPS Recommendations

HP recommends the use of online versus offline UPSs for the highest availability environment. HP does not recommend the practice of sourcing a cabinet UPS from a room UPS. This practice can increase costs without providing more system availability. Indeed, this practice can introduce more system downtime than just a room-level or system-level UPS. UPSs that are more compatible with present-day technology generally use pulse width modulation (PWM) and have ratings that are appropriate for a nonlinear load.

## Power Consumption

Safety and regulatory labels on computer equipment list the ratings for maximum power consumption conditions. Even though you will not normally reach maximum conditions, HP recommends sizing all electrical distribution infrastructure to meet maximum conditions. It is best to rate up rather than down. For example, if the marked electrical voltage is 15 amperes (A) on a server, depending on your local electrical code, the electrical infrastructure should include 20-ampere receptacles, 20-ampere sized wiring, and 20-ampere breakers. Undersizing the wiring might save costs in the beginning, but it will cause problems as infrastructure grows. Average-sized wiring can be used with power quality devices, such as UPSs, but not with the electrical infrastructure.

In determining the power requirements:

- Size electrical infrastructure for maximum rated consumption.
- Size air conditioning and UPSs with typical ratings, but realize that overloading might take place with additional growth of the infrastructure.

**NOTE:** HP recommends that cooling be planned for maximum rated power output of the room and that there is a growth plan for the cooling infrastructure.

## Grounding Systems

**WARNING!** Follow electrical code when connecting equipment AC power ground wire to the AC distribution point. Failure to properly ground the equipment or the floor can lead to shock hazard.

HP computer hardware has been tested only on systems where protective earth is integral to the electrical distribution system. This grounding is crucial for personnel safety and for maximum equipment availability and use. Observe the following precautions:

- Neutral and ground wires have specific uses. Do not interchange them.
- Do not use conduit grounds in place of a separate grounding conductor to each receptacle.
- Size ground wires to be equal to the power source wires.
- Do not daisy chain phase, neutral, and ground wires.
- If the system is on raised flooring, use a 2-foot x 2-foot (61-cm x 61-cm) grounding grid.

## Comprehensive Discussion

**IMPORTANT:** Electrical practices and suggestions in this guide are based on North American practices. For regions and areas outside North America, local electrical codes take precedence over North American electrical codes.

For example, the recommendation that the Protective Earth (PE) conductor be green with a yellow stripe, is a European Union (EU) directive. North American local electrical inspectors will accept a ground wire if the color is green with a yellow stripe.

Local authority has jurisdiction (LAHJ) and should make the final decision regarding adherence to region-specific or area-specific electrical codes and guidelines.

Proper design and installation of a server power distribution system requires specialized skills. Those responsible for this task must have a thorough knowledge of appropriate electrical codes and the limitations of the power systems for computer and data processing equipment.

In general, a well-designed power distribution system exceeds the requirements of most electrical codes. A good design, when coupled with proper installation practices, produces the most trouble-free operation.

A detailed discussion of power distribution system design and installation is beyond the scope of this guide. However, electrical factors relating to power distribution system design and installation must be considered during the site preparation process.

The following electrical factors are discussed in this section:

- Computer room safety
- Power consumption
- Electrical load requirements (circuit breaker sizing)
- Power quality
- Distribution hardware
- System installation guidelines

## Computer Room Safety

**WARNING!** The safety of personnel must be paramount in consideration of performing the following recommendations. Failure to comply can create life-threatening scenarios.

Inside the computer room, fire protection and adequate lighting (for equipment servicing) are important safety considerations. Federal and local safety codes govern computer installations.

### Fire Protection

The National Fire Protection Association's Standard for the Protection of Electronic Computer Data Processing Equipment, NFPA 75, contains information on safety monitoring equipment for computer rooms.

Most computer room installations are equipped with the following fire protection devices:

- Smoke detectors
- Fire and temperature alarms
- Fire extinguishing system
- Air Handling (Plenum) space that is segmented from the remainder of the building

Additional safety devices are:

- Circuit breakers
- An emergency power cutoff switch located at the computer room exit door
- Devices specific to the geographic location (such as earthquake protection)

### Fire Suppression

Though fires in computer rooms are rare, they are a critical safety and business consideration. HP recommends the use of gaseous agents as primary fire control, with water as a backup system. Gaseous agents include $CO_2$, and Halon substitutes, like Intergen. Where fire suppresssion using water is dictated, HP recommends the use of dry pipe water valving, with suitably rated temperature heads. Dry pipe water valving lowers the business risks associated with accidental water pipe discharge.

### Lighting Requirements for Equipment Servicing

Adequate lighting and utility outlets in a computer room reduce the possibility of accidents during equipment servicing. Safer servicing is also more efficient and, therefore, less costly. For example, adequate lighting reduces the chances of connector damage when cables are installed or removed.

The minimum recommended illumination level is 70 foot candles (756 lumens per square meter) when the light level is measured at 30 inches (76.2 cm) above the floor.

### Cabinet Recommendations

HP recommends the use of third party cabinets whose product designs have been carefully considered. Consider the following important cabinet attributes:

- Strength
- Airflow considerations
- Cabling restrictions

Seismic or earthquake resistance can also be an important attribute in certain parts of the world.

### Working Space for Server Access

The recommended working space for performing maintenance is 3 feet from either side of, in front of, or behind the server. The work space must permit at least a 90-degree opening of equipment doors or hinged panels. When planning for the working-space area, consider whether access to the server will be at the front, the side, or the rear of the server.

## Power Consumption

Power consumption can be divided into two broad categories:

- Marked electrical amperage, which is listed on the required safety and regulatory labels, generally represents a “worst case” scenario that the customer cannot measure. Use this amperage to size the electrical infrastructure.
- Typical consumption, which is measured under normal circumstances, should be used only in customer calculations with UPS and air conditioning sizing where remaining capacities are needed.

In addition to the HP server hardware, you must consider any peripheral equipment that will be installed during initial installation or a later update. Refer to the safety and regulatory labels on equipment or applicable product-specific documentation for such devices to determine the power required to support these devices.

**NOTE:** HP recommends that you have dedicated breakers for peripheral equipment.

## Electrical Load Requirements (Circuit Breaker Sizing)

**IMPORTANT:** Local authority has jurisdiction (LAHJ) must determine the final decision regarding adherence to country-specific electrical codes and guidelines.

It is good practice to derate power distribution systems for one or both of the following reasons:

- To avoid nuisance tripping from load shifts or power transients, do not run circuit protection devices continuously above 80 percent of their root-mean-square (RMS) current ratings.
- Safety agencies derate most power connectors to 80 percent of their RMS current ratings.

## Power Quality

HP servers are designed to operate over a wide range of voltages and frequencies. (See the HP Corporate Power Standard HP-00005-03 at http://standards.corp.hp.com/smc/hpstd/pdf/F-HP0000503.pdf.) The servers are tested and shown to comply with EMC Specification EN50082. However, damage can occur if these ranges are exceeded. Severe electrical disturbances can exceed the design specifications of the equipment.

### Sources of Voltage Fluctuations

Voltage fluctuations affect the quality of electrical power. Common sources of these disturbances are:

- Fluctuations occurring within the facility's distribution system
- Utility service low-voltage conditions (such as sags or brownouts)
- Wide and rapid variations in input voltage levels
- Wide and rapid variations in input power frequency
- Electrical storms
- Large inductive sources (such as motors and welders)
- Faults in the distribution system wiring (such as loose connections)
- Microwave, radar, radio, or cell phone transmissions

### Power System Protection

Protect the server from the sources of many of these electrical disturbances by using:

- A dedicated power distribution system
- Power conditioning equipment
- Over- and under-voltage detection and protection circuits
- Screening to cancel out the effects of undesirable transmissions
- Lightning arresters on power cables to protect equipment against electrical storms

Precautions are taken during power distribution system design to provide immunity to power outages of less than one cycle. However, testing cannot conclusively rule out loss of service. Therefore, adherence to the following guidelines provides the best possible performance of power distribution systems for HP computer equipment:

- Dedicated power source—Isolates a server power distribution system from other circuits in the facility.
- Missing-phase and low-voltage detectors—Shut equipment down automatically when a severe power disruption occurs. For peripheral equipment, these devices are recommended but optional.
- Online UPS—Keeps input voltage to devices constant and should be considered if outages of one-half cycle or more are common.

Refer to qualified contractors or consultants for each situation.

## Distribution Hardware

This section describes wire selection and the types of raceways (electrical conduits) used in the distribution system.

### Wire Selection

Use copper conductors instead of aluminum conductors. Aluminum's coefficient of expansion differs significantly from that of other metals used in power hardware. Because of this difference, aluminum conductors can cause connector hardware to work loose, overheat, and fail.

### Raceway Systems (Electrical Conduits) (LAHJ)

Raceways (electrical conduits) form part of the protective ground path for personnel and equipment. Raceways protect the wiring from accidental damage and also provide a heat sink for the wires.

Any of the following types are acceptable:

- Electrical metallic tubing (EMT) thin-wall tubing
- Rigid (metal) conduit
- Liquidtight with RFI shield grounded (most commonly used under raised floors)
- Armored

### Building Distribution

Place all building feeders and branch circuitry in rigid metallic conduit with proper connectors (to provide ground continuity). Ensure that all conduit that is exposed and subject to damage is constructed of rigid galvanized steel.

## Grounding Systems

HP systems are tested and certified only with grounding systems in which a neutral return path and a protective earth are separate conductors without any inserted impedances. Additionally, protective earth and return neutral are shorted together at the X0 bonding junction on the secondary side of the newly derived power source.

#### IT Power System

This product has not been evaluated for connection to an IT power system (an AC distribution system having no direct connection to earth according to IEC 60950).

A server requires two methods of grounding:

- Power distribution safety grounding
- High-frequency intercabinet grounding

### Power Distribution Safety Grounding (LAHJ)

The power distribution safety grounding system connects various points in the power distribution system to earth ground using green (green/yellow) wire ground conductors. Having these ground connections tied to metal chassis parts that might be touched by computer room personnel protects personnel against shock hazard from current leakage and fault conditions.

Power distribution systems consist of several parts. HP recommends that these parts be solidly interconnected to provide an equipotential ground to all points.

### Main Building Electrical Ground

The main electrical service entrance equipment must have an earth ground connection, as required by applicable codes. Such connections as a grounding rod or building steel provide an earth ground.

### Electrical Conduit Ground

All electrical conduits must be made of rigid metallic conduit that is securely connected together or bonded to panels and electrical boxes, so as to provide a continuous grounding system.

### Power Panel Ground

Ground each power panel to the electrical service entrance with green (green/yellow) wire ground conductors. Size the green (green/yellow) wire ground conductors per applicable codes (based on circuit-over-current device ratings). The PE (Protective Earth) wire gauge may be larger diameter wire but never a smaller diameter wire than the AC input power distribution wire.

**NOTE:** The green wire ground conductor mentioned above can be a black wire with green tape. (LAHJ)

### Computer Safety Ground

Ground all computer equipment with the green (green/yellow) wire included in the branch circuitry. Connect the green (green/yellow) wire ground conductors to the appropriate power panel and size them per applicable codes (based on circuit-over-current device ratings).

### Dual Power Source Grounding

When using dual power sources, measure voltage potentials with a high impedence digital multi-meter (DMM). The use of dual power might create an electrical potential that can be hazardous to personnel and might cause performance issues for the equipment.

Dual power sources might originate from two different transformers or two different UPS devices. Measure voltage potentials from ground pin to ground pin of these sources and verify them to be at or near 0.0 V. Investigate voltage levels that deviate or that measure above 3.0 V because increased voltages can be hazardous to personnel.

## Cabinet Performance Grounding (High-Frequency Intercabinet Ground)

Some safety power distribution wires are too long and too inductive to provide adequate high-frequency return paths. Signal interconnects between system cabinets might need high-frequency ground return paths *in addition to* the safety or power distribution system 50–60Hz grounding system. HP recommends the use of a properly installed signal reference grid (SRG), also bonded to the 50–60Hz grounding system.

**WARNING!** Do not use cabinet-to-floor ground strap in place of a properly installed safety (50–60Hz) grounding system, nor in place of a properly installed Signal Reference Grid. An improperly installed grounding system can present a shock hazard to personnel.

Connect power panels ground buses and transformers XO bond in close proximity to the computer equipment to the site grounding grid as well. Methods of achieving a sufficiently high-frequency ground grid are described in the next sections.

## Raised Floor “High-Frequency Noise” Grounding

If you use a raised floor system, install a complete SRG to maintain equal potential over a broad band of frequencies. Connect the grid to the equipment cabinet and electrical service entrance ground at multiple connection points by using a minimum #6 AWG (16 mm) wire ground conductor. Figure 1-1 (page 16) illustrates a metallic strip grounding system.

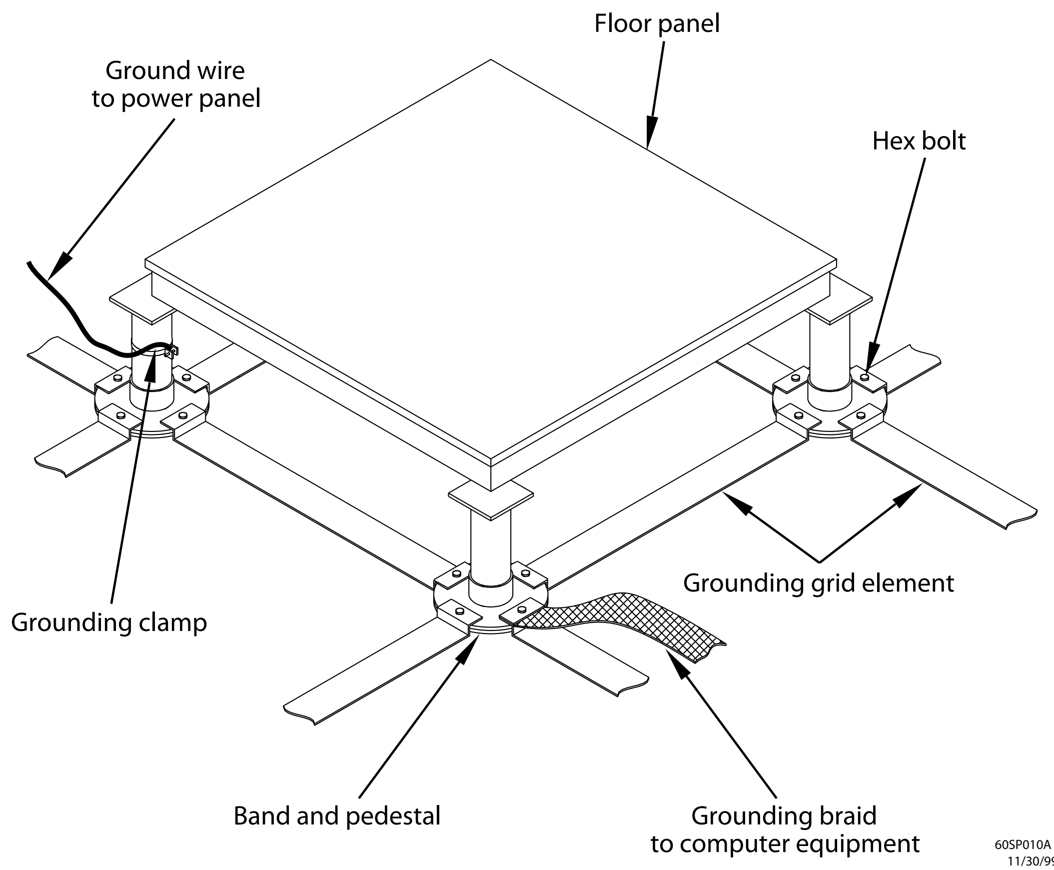
**IMPORTANT:** Regardless of the grounding connection method used, you must ground the raised floor as an absolute safety minimum.

HP recommends the following approaches to create an effective and safe 2-foot by 2-foot signal reference grid:

- Good—Use the raised floor structure as a ground grid. In this case, the floor must be designed as a ground grid with bolted down stringers and corrosion-resistant plating (to provide low resistance and attachment points for connection to service entrance ground and HP computer equipment). The use of conductive floor tiles with this style of grid further enhances ground performance. The structure needs to be mechanically bonded to a known good ground point.
- Better—Add a grounded #6 AWG (16mm) minimum copper wire grid mechanically clamped to floor pedestals and properly bonded to the building or site ground.
- Best—Add a grounding grid to the subfloor. Build the grounding grid with copper strips mounted to the subfloor. Use strips that are 0.032 inches (0.08 cm) thick and a minimum of 3.0 inches (8.0 cm) wide.

  Connect each pedestal to four strips using 1/4-inch (6.0-mm) bolts tightened to the manufacturer's torque recommendation.

**Figure 1-1 Raised Floor Metal Strip Ground System**




## Equipment Grounding Implementation Details

Connect all HP equipment cabinets to the site ground grid as follows:

1. Attach one end of each ground strap to the applicable cabinet ground lug.
2. Check that the braid contact on each end of the ground strap consists of a terminal and connection hardware (a 1/4-inch (6.0-mm) bolt, nuts, and washers).
3. Check that the braid contact connection points are free of paint or other insulating material and treated with a contact enhancement compound (similar to Burndy Penetrox).

4. Attach the other end to the nearest pedestal base (raised floor) or cable trough ground point (nonraised floor).
5. After achieving a safe and effective 50–60Hz grounding system and a safe and effective SRG, then consider cabinet-to-floor grounding. HP does not require this step.

## System Installation Guidelines

This section contains information about installation practices and highlights some common installation pitfalls. It addresses both power cable and data communications cable installations, and highlights installation.

**NOTE:** In domestic installations, install the proper receptacles before the HP equipment arrives. Refer to the appropriate installation guide for installation procedures.

### Wiring Connections

Expansion and contraction rates vary among different metals. Therefore, the integrity of an electrical connection depends on the restraining force applied. Connections that are too tight compress or deform the hardware and cause it to weaken. This usually leads to high impedance, preventing circuit breakers from tripping when needed. High impedence can also contribute to a buildup of high-frequency noise.

**CAUTION:** Connections that are too loose or tight can have a high impedance which cause serious problems, such as erratic equipment operation. A high-impedance connection overheats and sometimes causes fire or high temperatures that can destroy hard-to-replace components, such as distribution panels or system bus bars.

Wiring connections must be properly torqued. Many equipment manufacturers specify the proper connection torque values for their hardware.

Ground connections must be made only on a conductive, nonpainted surface. When equipment vibration is present, lock washers must be used on all connections to prevent connection hardware from working loose.

### Data Communications Cables

Power transformers create high-energy fields in the form of electromagnetic interference (EMI). Heavy foot traffic can create electrostatic discharge (ESD) which can damage electronic components. Route data communications cables away from these areas. Use shielded data communications cables that meet approved industry standards to reduce the effects of external energy fields.

# Environmental Elements

## Synopsis

### Air Quality

Proper computer room preparation improves air quality. It provides a return on investment by making a system more stable and by decreasing unexpected downtime. HP recommends putting appropriate effort into maximizing electrical and air conditioning efficiency to ensure higher reliability to meet business needs.

HP temperature and humidity recommendations follow newly established industry standards. HP recommends the following operating ranges:

- Temperature of 20–25˚C (68–77˚F)
- Humidity of 40–55 percent relative humidity

- Filtration at 35–55 percent spot efficiency per American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)
- Air conditioning heat load limits at 80 percent of total heating, ventilation and air conditioning (HVAC) capacity

## Airflow

An incorrect public perception exists that cool, ambient air is consistent throughout a datacenter. That is, if the temperature of the room is measured at 20˚ C (68˚F), then the equipment should be stable. In reality, microclimates can exist in various parts of the room such that generated heat in the equipment might not efficiently make its way out. Microclimates are difficult to detect and prove; therefore, prevent microclimates by encouraging a high rate of airflow from source to intake of HVAC and uniform distribution of the heated air. Underflow blockages, such as cabling and piping, can disrupt the airflow predictability. Improperly positioned floor vent tiles or equipment can create air dams and decrease airflow. Follow these general precautions to ensure proper airflow:

- Use a heat load to 80 percent of total HVAC capacity (maintain a thermal safety margin).
- Place vented floor tiles only in heat load areas.
- Do not place vented floor tiles within two floor tiles of HVAC (thermal short circuit).
- Do not place heat loads closer than two floor tiles of HVAC.
- Be sure the maximum distance from the HVAC to the heat load is less than 75 feet (22.86 m).
- Seal all cable openings (unsealed openings create a loss of static air pressure).
- Lay out equipment aisles parallel to airflow, not perpendicular to it.
- Concentrate high-density heat loads in a tightly controlled area. High-density loads are equivalent to one cabinet of 3 kilowatts or more.
- Maintain airspeed through vent tiles at more than 500 feet per minute (152.4 meters per minute), but at less than 700 feet per minute (213.36 meters per minute) for high-density cooling.

## Equipment Orientation

Data center equipment orientation or heat load must encourage sufficient airflow. If exhausted heat must move over or around a cabinet, air vortexes might be created, resulting in airflow inefficiency throughout the data center and inside the equipment. Equipment might develop internal hot spots, resulting in sluggish performance or even system failure.

Rather than designing a layout to maximize a planning grid worksheet whitespace, consider creating “hot” and “cold” aisles. In a hot aisle, equipment is oriented so that exhaust vents face other exhaust vents. In a cold aisle, intake vents face other intake vents. Place vent tiles in the cold aisles, with few to no vent tiles in the hot aisle. Position equipment in parallel to encourage the lowest air resistance and turbulences. Consider the following when determining equipment orientation:

- Orient equipment in parallel to airflow.
- Place cabling in such a way as to aid airflow rather than impede it.
- Layout equipment to form hot and cold aisles.
- Use vent tiles to control airflow in heat load areas.
- Place vent tiles in cold aisles.
- Place higher heat load devices at floor level.

## Electrostatic Discharge

Computer equipment is increasing in processor and memory density even as size continues to decrease. These smaller, more densely packed pieces of equipment are at greater risk to damage from electrostatic discharge (ESD). ESD created by the human body is consistent at approximately

3,000 volts. HP recommends building this consideration into your designs for floor coverings, humidity control, airflow, dust control, and personnel traffic. Consider the following precautions against ESD:

- Use antistatic flooring.
- Maintain humidity at 40–55 percent relative humidity.
- Follow airflow recommendations.
- If raised flooring is present, use a 2-foot x 2-foot (61-cm x 61-cm) grounding grid.
- Always use appropriately sized AC power ground wires.
- Limit personnel traffic to two floor tiles away from equipment.

### Cellular Telephone and Wireless Usage

HP recommends not using cell phones within a data center, especially within 9.8 feet (3 m) of any high-availability equipment.

## Comprehensive Discussion

The following environmental elements can affect a server installation:

- Computer room preparation
- Airflow
- Cooling requirements
- Humidity level
- ESD prevention
- Acoustics

## Computer Room Preparation

Consider the following guidelines when preparing a computer room for a server:

- Locate the computer room away from the exterior walls of the building to avoid the heat gain from windows and exterior wall surfaces.
- When exterior windows are unavoidable, use windows that are double- or triple-glazed and shaded to prevent direct sunlight from entering the computer room.
- Maintain the computer room at a positive pressure relative to surrounding spaces.
- Use a vapor barrier installed around the entire computer room envelope to restrain moisture migration.
- Caulk and vapor seal all pipes and cables that penetrate the envelope.
- Use a raised floor system at least 18 inches high for the minimum favorable room air distribution to ensure good static air pressure beneath the flooring (under floor distribution).
- Ensure a minimum clearance of 12 inches between the top of the server cabinet and the ceiling to allow for return airflow and to ensure that all ceiling tiles are in place, except where fire sprinkler heads call for greater clearance.
- Allow 18 inches (or local code minimum clearance) from the top of the server cabinet to the fire sprinkler heads.

## Airflow

- Ensure that hot and cold aisles are parallel to airflow patterns. This recommendation causes cooling air to be released into cold aisles, where opposing rows have intake grills oriented.
- Additionally, ensure that opposing row exhaust grills face each other, without cooling air.
- A parallel orientation encourages low impedance airflow back to the HVAC.

- If raised flooring is used, route cables underneath the floor to be parallel to the airflow to prevent airdams.
- Keep air throws from HVAC equipment to the heat loads they serve within 75 feet of each other.

## Row Orientation

Row orientation has an impact on the airflow, temperature, particulate contamination, and power distribution of the environment. Consider the following when planning equipment layout:

- HP recommends the use of hot aisle (exhaust) and cold aisle (intake) orientation.
- HP further recommends that the airflow (air conditioned supply and return) be parallel to the aisleways.
- HP recommends adherence to the temperature and humidity standards located at: http://standards.corp.hp.com/smc/hpstd/pdf/F-HP0000501.pdf.

  HP product specifications for temperature and humidity are measured at 200 mm from air intake center of device.

## Dust and Pollution Control

Computer equipment can be adversely affected by dust and microscopic particles in the site environment.

Specifically, disk drives, tape drives, and some other mechanical devices can have bearing failures resulting from airborne abrasive particles. Dust might also blanket such electronic components as printed circuit boards, causing premature failure due to excess heat or humidity buildup on the boards. Other failures to power supplies and other electronic components can be caused by metallically conductive particles, including zinc whiskers. These metallic particles are conductive and can short circuit electronic components. Use every effort to ensure that the environment is as dust- and particulate-free as possible. Refer to “Metallic Particulate Contamination” for additional details.

Smaller particles can pass through some filters and, over time, cause problems in mechanical parts. Prevent small dust particles from entering the computer room by maintaining the air-conditioning system at a high static air pressure level.

Other sources of dust, metallic, conductive, abrasive, and microscopic particles can be present. Some sources of these particulates are:

- Subfloor shedding
- Raised-floor shedding
- Ceiling-tile shedding

These particulates are not always visible to the naked eye. A good check to determine their possible presence is to check the underside of the tiles. The tile should be shiny, galvanized, and rust-free.

Keep the computer room clean. HP recommends the following guidelines:

- Smoking—Establish a no-smoking policy. Particulates of cigarette smoke will not improve the operation or reliability of surrounding equipment.
- Printer—Locate printers and paper products in a separate room to eliminate paper particulate problems.
- Eating or drinking—Establish a no-eating-or-drinking policy. Spilled liquids can cause short circuits in equipment such as keyboards.
- Tile floors—Use a dust-absorbent cloth mop rather than a dry mop to clean tile floors.
- Cleaning—Use only HP-approved cleaners.

Special precautions are necessary if the computer room is near a source of air pollution. Some air pollutants, especially hydrogen sulfide ($H_2S$), are not only unpleasant, but corrosive as well.

$H_2S$ damages wiring and delicate sound equipment. The use of activated charcoal filters reduces this form of air pollution.

### Metallic Particulate Contamination

Metallic particles can be especially harmful around electronic equipment. This type of contamination can enter the data center environment from a variety of sources, including but not limited to raised floor tiles, worn air-conditioning parts, heating ducts, rotor brushes in vacuum cleaners, or printer component wear. Because metallic particles conduct electricity, they have an increased potential for creating short circuits in electronic equipment. This problem is exaggerated by the increasingly dense circuitry of electronic equipment.

Over time, very fine whiskers of pure metal can form on electroplated zinc, cadmium, or tin surfaces. If these whiskers are disturbed, they can break off and become airborne, possibly causing failures or operational interruptions. For more than 50 years, the electronics industry has been aware of the relatively rare but possible threat posed by metallic particulate contamination. During recent years, concern has increased regarding metallic particulate contamination in computer rooms, where these conductive contaminants are formed on the bottom of some raised floor tiles.

Although this problem is relatively rare, it can be an issue within your computer room. Because metallic contamination can cause intermittent or permanent failures on your electronic equipment, HP strongly recommends that your site be evaluated for metallic particulate contamination before installation of electronic equipment.

## Cooling Requirements

Air-conditioning equipment requirements and recommendations are described in the following sections.

### Basic Air-Conditioning Equipment Requirements

The cooling capacity of the installed air-conditioning equipment for the computer room must be sufficient to offset the computer equipment dissipation loads, as well as any space envelope heat gain. This equipment must include:

- Air filtration
- Cooling or dehumidification
- Humidification
- Reheating
- Air distribution
- System controls adequate to maintain the computer room within specified operating ranges.

When calculating cooling requirements, include the heat generated by lighting and by personnel. For example, a person dissipates about 450 BTUs per hour while performing a typical computer room task.

At altitudes above 10,000 feet (3048 m), the lower air density reduces the cooling capability of air-conditioning systems. If your facility is located above this altitude, you might need to modify the recommended temperature ranges. For each 1,000 foot (305 m) increase in altitude above 10,000 feet (up to a maximum of 15,000 feet), subtract 0.83˚C (33.5˚F) from the upper limit of the temperature range.

### Air-Conditioning System Guidelines

Use the following guidelines when designing an air-conditioning system and selecting the necessary equipment:

- The computer room air-conditioning system should be capable of operating 24 hours a day, 365 days a year. It should also be independent of other systems in the building.
- Consider the long-term value of server availability, redundant air-conditioning equipment, or capacity.
- The system should be capable of handling any future server expansion.
- Air-conditioning equipment air filters should have a minimum rating of 45 percent (based on ASHRAE Standard 52-76, *Dust Spot Efficiency Test*).
- Introduce only enough outside air into the system to meet building code requirements (for human occupancy) and to maintain a positive air pressure in the computer room.

### Air-Conditioning System Types

The following three air-conditioning system types are listed in descending order of preference:

- Complete self-contained package units with remote condensers. These systems are available with up or down discharge and are usually located in the computer room.
- Chilled water package unit with remote chilled water plant. These systems are available with up or down discharge and are usually located in the computer room.
- Central station air-handling units with remote refrigeration equipment. These systems are usually located outside the computer room.

### Basic Air-Distribution Systems

A basic air-distribution system includes supply air and return air. Refer to Table 1-4: "Product Technical Requirements Based on Customer Environments" (page 27) for more information.

Configure the air-distribution system to deliver adequate supply air to the cooling air intake vents of the server equipment cabinets. Maintain supply air temperature within the following parameters:

- Ceiling air supply system—From 12.8°C (55˚F) to 15.6°C (60˚F)
- Floor air supply system—At least 15.6°C (60˚F)

If you use a ceiling plenum return air (CPRA) system or a ducted ceiling return air system, place the return air grills in the ceiling above the exhaust area or the exhaust row.

The following three types of air distribution systems are listed in descending order of preference:

- Under-floor air distribution system—Downflow air-conditioning equipment located on the raised floor of the computer room uses the cavity beneath the raised floor as plenum for the supply air.

  Return air from an under-floor air-distribution system can be ducted return air (DRA) above the ceiling.

  Locate perforated floor panels (available from the raised floor manufacturer) around the front of the system cabinets. Supply air emitted though the perforated floor panels is then available near the cooling air intake vents of the server cabinets.

- CPRA—Supply air is ducted into the ceiling plenum from upflow air-conditioning equipment located in the computer room or from an air-handling unit (remote).

  The ceiling construction should resist air leakage. Place perforated ceiling panels (with down discharge airflow characteristics) around the front of the system cabinets. The supply air emitted downward from the perforated ceiling panels is then available near the cooling air intake vents of the server cabinets.

Direct the return air back to the air-conditioning equipment though the return air duct above the ceiling.

- Above-ceiling ducted air-distribution system—Supply air is ducted into a ceiling diffuser system from upflow air-conditioning equipment located in the computer room or from an air-handling unit (remote).

  Return air from an above ceiling ducted air-distribution system can be DRA above the ceiling or CPRA.

  Adjust the supply air diffuser system grilles to direct the cooling air downward around the front of the server cabinets. The supply air is then available near the cooling air intake vents of the server cabinets.

### Air-Conditioning System Installation

All air-conditioning equipment, materials, and installation must comply with any applicable construction codes. Installation of the various components of the air-conditioning system must also conform to the air-conditioning equipment manufacturer's recommendations.

### Air-Conditioning Ducts

Ensure that the air-conditioning duct work in the computer room is separate from the duct work used for the rest of the building. If the computer room duct work is not separate from the rest of the building, it might be difficult to control cooling and air pressure levels.

Duct work seals are important for maintaining a balanced air-conditioning system and high static air pressure. Adequate cooling capacity means little if the direction and rate of air flow cannot be controlled because of poor duct sealing. Also, do not expose the ducts to warm air, or humidity levels might increase.

## Humidity Level

The recommended humidity level is between 40 and 55 percent relative humidity (RH). High humidity causes galvanic actions to occur between some dissimilar metals. This eventually causes a high resistance between connections, leading to equipment failures. High humidity can also have an adverse affect on some magnetic tapes and paper media.

**CAUTION:** Low humidity contributes to undesirably high levels of electrostatic charges. This increases the electrostatic discharge (ESD) voltage potential. ESD can cause component damage during servicing operations. Paper feed problems on high-speed printers are usually encountered in low-humidity environments.

Low humidity levels are often the result of the facility heating system and occur during the cold season. Most heating systems cause air to have a low humidity level, unless the system has a built-in humidifier.

## ESD Prevention

Static charges (voltage levels) are created when objects are separated or rubbed together. The voltage level of a static charge is determined by the following factors:

- Types of materials
- Relative humidity
- Rate of change or separation

## Humidity Levels Influence the Creation of Static Charges

Table 1-1 compares the static charges generated by different activities in different humidity levels.

**IMPORTANT:** Use ESD processes and ESD prevention equipment whenever equipment needs servicing.

**Table 1-1 Effect of Humidity on ESD Charge Levels**

| Personnel Activity[1] | Humidity[2] and Charge Levels (voltages)[3] | | | |
|---|---|---|---|---|
| | **26%** | **32%** | **40%** | **50%** |
| Person walking across a linoleum floor | 6,150 V | 5,750 V | 4,625 V | 3,700 V |
| Person walking across a carpeted floor | 18,450 V | 17,250 V | 13,875 V | 11,100 V |
| Person getting up from a plastic chair | 24,600 V | 23,000 V | 18,500 V | 14,800 V |

1 Source: B.A. Unger, Electrostatic Discharge Failures of Semiconductor Devices (Bell Laboratories, 1981)

2 For the same relative humidity level, a high rate of airflow produces higher static charges than a low airflow rate.

3 Some data in this table has been extrapolated.

For more information regarding ESD, refer to the HP ESD Standard HP-00005-04 at: http://standards.corp.hp.com/smc/hpstd/pdf/F-HP0000504.pdf.

## Relative Humidity

Where possible, maintain a humidity range of 40 percent to 55 percent.

## Static Protection Measures

Follow these precautions to minimize possible ESD-induced failures in the computer room:

- Maintain recommended humidity level and airflow rates in the computer room.
- Install conductive flooring (use conductive adhesive when laying tiles).
- Use conductive wax if waxed floors are necessary.
- Ensure that all equipment and flooring are properly grounded and are at the same ground potential.
- Use conductive tables and chairs.
- Use a grounded wrist strap (or other grounding method) when handling circuit boards.
- Store spare electronic modules in antistatic containers.

## Acoustics

Computer equipment and air-conditioning blowers cause computer rooms to be noisy. Ambient noise level in a computer room can be reduced as follows:

- Dropped ceiling—Cover with a commercial grade of fire-resistant, acoustic-rated, fiberglass ceiling tile.
- Sound deadening—Cover the walls with curtains or other sound-deadening material.
- Removable partitions—Use partitions constructed of foam rubber for greatest effectiveness.

# Facility Characteristics

This section contains information about facility characteristics to consider when preparing the site for the installation and operation of the server. Facility characteristics are:

- Floor loading
- Windows

## Floor Loading

The computer room floor must be able to support the total weight of the installed server plus the weight of the individual cabinets, cabling and peripheral devices.

## Floor Loading Terms

**Table 1-2 Floor Loading Term Definitions**

| Term | Definition |
| --- | --- |
| Dead load | The weight of the raised panel floor system, including the understructure. (Expressed in $lb/ft^2$ ($kg/m^2$)). |
| Live load | The load that the floor system can safely support (Expressed in $lb/ft^2$ ($kg/m^2$)). |
| Concentrated load | The load that a floor panel can support on a 1-$in^2$ (6.45-$cm^2$) area at the panel's weakest point (typically the center of the panel), without the surface of the panel deflecting more than a predetermined amount. |
| Ultimate load | The maximum load (per floor panel) that the floor system can support without failure. Failure is expressed by floor panels breaking or bending. Ultimate load is usually stated as load per floor panel. |
| Rolling load | The load a floor panel can support (without failure) when a wheel of specified diameter and width is rolled across the panel. |
| Average floor load | Computed by dividing total equipment weight by the area of its footprint. (Expressed in $lb/ft^2$ ($kg/m^2$)). |

Floor loading can be an issue in both raised and nonraised flooring environments. Rolling load can be the most detrimental in a raised flooring environment, while total dead load can be an issue for either. The information presented in this section addresses raised floor installations.

**NOTE:** Have a floor system consultant for the appropriate flooring environment verify any floor system under consideration for a server installation.

## Raised Floor Loading

Raised floor loading is a function of the manufacturer's load specification and the positioning of the equipment relative to the raised floor grid. While HP cannot assume responsibility for determining the suitability of a particular raised floor system, it does provide the following guidelines:

- Because many raised floor systems do not have grid stringers between floor stands, the lateral support for the floor stands depends on adjacent panels being in place. To avoid compromising this type of floor system while gaining under-floor access, remove only one floor panel at a time.
- Larger floor grids (bigger panels) are generally rated for lighter loads.

**CAUTION:** Do not position or install any equipment cabinets on the raised floor system until you have carefully examined it to verify that it is adequate to support the appropriate installation.

## Average Floor Loading

The average floor load value is not appropriate for addressing raised floor ratings at the floor grid spacing level. However, it is useful for determining floor loading at the building level, such as the area of solid floor or span of raised floor tiles covered by the server footprint.

## Typical Raised Floor Site

This section contains an example of a computer room raised floor system that is satisfactory for the installation of a server.

Based on specific information provided by HP, Tate Access Floors has approved its Series 800 all-steel access floor with bolt-together stringers and 24 inches (61.0 cm) by 24 inches (61.0 cm) floor panels.

When the flooring is replaced or a new floor is installed, Tate Access Floors recommends using the Series 1250 all-steel access floor with bolt-together stringers and 24 inches (61.0 cm) by 24 inches (61.0 cm) floor panels to support the HP installation.

**NOTE:** If the specific floor being considered is other than a Tate Series 800 floor, contact the specific floor manufacturer to evaluate the floor.

Table 1-3 lists specifications for the Tate Access Floors Series 800 raised floor system.

**Table 1-3 Typical Raised Floor Specifications**

| Item | Rating |
|---|---|
| Dead load | 7 lb/ft $^2$ (34.2 kg/m$^2$) |
| Live load | 313 lb/ft $^2$ (1528.3 kg/m$^2$) |
| Concentrated load[1] | 1250 lb (567 kg) |
| Ultimate load | 4000 lb (1814 kg) per panel |
| Rolling load | 400 lb (181 kg) |
| Average floor load | 500 lb (227 kg) |

1 With 0.08 in (0.2 cm) of span maximum deflection.

### Windows

Do not house computers in a room with windows. Sunlight entering a computer room can cause problems. Magnetic tape storage media is damaged if exposed to direct sunlight. Also, the heat generated by sunlight places an additional load on the cooling system.

## Space Requirements

This section contains information about space requirements for the server. Use this data as the basic guideline for space plan developments. Also consider factors as airflow, lighting, and equipment space requirements.

### Delivery Space Requirements

The site must have enough clearance to move equipment safely from the receiving area to the computer room. Permanent obstructions such as pillars or narrow doorway's can cause equipment damage.

Include the possible removal of walls or doors in the delivery plans.

### Operational Space Requirements

Consider the following factors in addition to the basic equipment dimensions:

- Eliminate obstructions to equipment intake or exhaust flow.
- The locations of lighting fixtures and utility outlets affect sevicing operations. Plan equipment layout to take advantage of lighting and utility outlets. Do not forget to include clearance for opening and closing equipment doors.
- Provide sufficient clearance around the cabinets for proper cooling airflow through the equipment.

If other equipment is located so that it exhausts heated air near the cooling air intakes of the server cabinets, more space is needed to keep ambient air intake to the server cabinets within the specified temperature and humidity ranges. Refer to Table 1-4 for operating ranges.

**Table 1-4 Product Technical Requirements Based on Customer Environments**

| Environment | | Industry Equivalent: ASHRAE[1] | Operating Environment (ambient)[2] | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Temp (°C, dry bulb)[3] | | Relative Humidity %: Noncondensing | | Dew-point (max)[4] | Rate of Chg (°C/hr, max) |
| | | | Allowable[5] | Recommended | Allowable[6] | Recommended[7] | | |
| Controlled Computer Room | | 1 | 15 to 32 | 20 to 25 | 20 to 80 | 40 to 55 | 17 | 5 |
| Office | Controlled | 2 | 10 to 35 | 20 to 25 | 20 to 80 | 40 to 55 | 21 | 5 |
| | Uncontrolled | 3 | 5 to 35 | NA[8] | 8 to 85 | NA | 28 | NA |
| Home | | 4 | 5 to 35 | NA | 8 ot 85 | NA | 28 | NA |
| Light Industrial | | 4 | 5 to 40 | NA | 8 to 90 | NA | 28 | NA |
| Portable/Mobile | | 4 | 5 to 40 | NA | 8 to 90 | NA | 28 | NA |
| Special (or Contract) | | Product specifications controlled by contract or other requirements. | | | | | | |

1 The values in each row meet or exceed the stated industry equivalent class specifications.
2 The maximum elevation for all operating environmental classes is 3050 m.
3 Dry bulb temperature is the regular ambient temperature. Derate maximum dry bulb temperature 1°C/300 m above 900 m.
4 Must be noncondensing environment.
5 With installed media, the minimum temperature is 10°C and the maximum relative humidity is limited to 80 percent. Specific media requirements may vary.
6 Allowable: equipment design extremes as measured at the equipment inlet.
7 Recommended: target facility design and operational range.
8 For all values listed as "NA": local product groups must make business decisions for the appropriate values.

Include the possible addition of equipment or other changes in space requirements to the space plan, and create an equipment layout plan which contains provisions for the following:

- Channels or fixtures used for routing data cables and power cables
- Access to air-conditioning ducts, filters, lighting, and electrical power hardware
- Power conditioning equipment
- Cabinets for cleaning materials
- Maintenance area and spare parts

## Floor Plan Grid

Use a floor plan grid to plan the location of equipment in the computer room. In addition to its use for planning, also use the floor plan grid when planning the locations of the following items:

- Air-conditioning vents
- Lighting fixtures
- Utility outlets
- Doors
- Access areas for power wiring and air-conditioning filters
- Equipment cable routing

## Power Plug Configuration

Several different power cables are designed for use with HP servers. The region the server ships to will determine which power cable ships with the server. Figures 1-2 to 1-11 provide an overview of the possible power plug configurations available.

**NOTE:** Several examples follow, though this list is not meant to be all-inclusive nor is this list meant to imply every plug shown is one that is available for the server.

## Female End of Power Cable

The female end of the HP server is a C19 plug that mates with the C20 receptacle in each power supply installed in the HP server.

**Figure 1-2 C20 Male Receptacle (at Power Supply)**

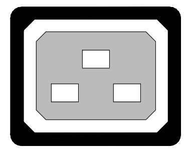
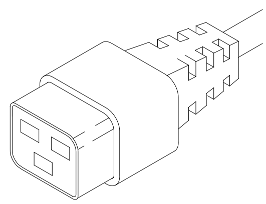


**Figure 1-3 C19 Female Plug (on One End of the Power Cord)**



## Male End of Power Cable

The male plug on the other end of the power cable will vary depending on the region the HP server ships.

**Figure 1-4 Unterminated Plug**

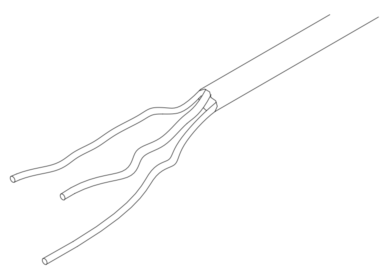


**Figure 1-5 L6-20 Plug**

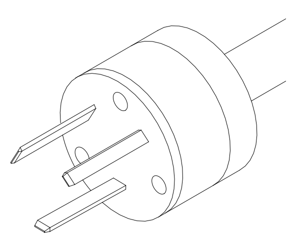


Figure 1-6 IEC 309 Plug

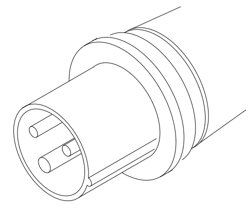


Figure 1-7 CEE 7-7 Plug

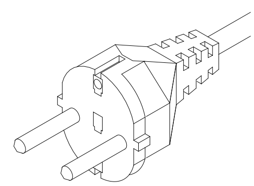


Figure 1-8 L6-30 Plug

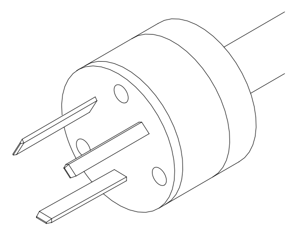


Figure 1-9 NEMA 5-20P Plug (left) and receptacle (right)

Figure 1-10 ISI 32 Plug

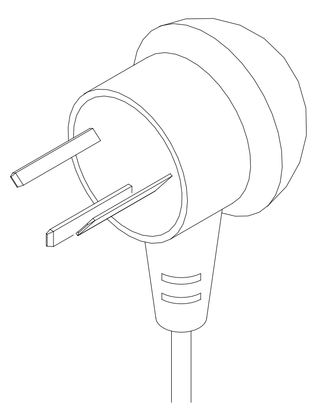
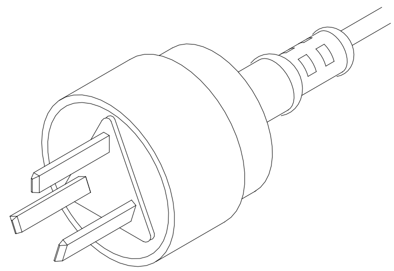


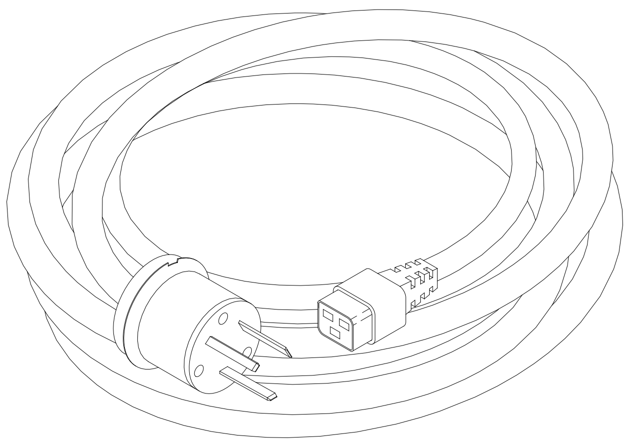
**Figure 1-11 GB 1002 Plug**



## Power Cable

The power cable length and configuration varies based on the region the server ships to. Figure 1-12 provides an example of one power cable configuration used to supply power to the server.

**Figure 1-12 L6-20 Power Cable**



# Conversion Factors and Formulas

The conversion factors provided in this section are intended to ease data calculation when planning for systems that do not conform specifically to the configurations listed in this guide. The following list includes the conversion factors used in this document, as well as additional conversion factors that might be helpful in determining those calculations required for site planning.

## Conversion Factors

- Refrigeration
  - 1 watt = 0.86 kcal/hour
  - 1 watt = 3.412 Btu/hour
  - 1 watt = 2.843 x 10-4 tons
  - 1 ton = 200 Btu/minute
  - 1 ton = 12,000 Btu/hour
  - 1 ton = 3,517.2 watts
- Metric Equivalents
  - 1 centimeter = 0.3937 inch
  - 1 meter = 3.28 foot
  - 1 meter = 1.09 yards
  - 1 in. = 2.54 centimeters

- 1 ft. = 0.305 meters
- 1 CFM = 1.7$m^3$/hour

- kVA conversions

  Three phase

  kVA = V × A × √3 / 1000
- Single phase
  kVA = V × A / 1000

### Formulas

- kVA = voltage x current (amps)
- Watts = VA x PF
- Btu = Watts x 3.41
- a°C = (32 + 1.8a)˚F

## Example of an Installation Schedule

The following schedule lists the sequence of events for a typical system installation:

- Sixty days before installation
  - Floor plan design is completed and mailed to HP (if required to be an HP task).
- Thirty days before installation
  - Primary power and air-conditioning installation are completed.
  - Telephone and data cables are installed.
  - Fire protection equipment is installed.
  - Major facility changes are completed.
  - Special delivery requirements are defined.
  - Site inspection checklist is completed. Refer to Table 1-5 and Table 1-6 for sample customer information forms and site inspection checklists.
  - Delivery survey is completed. Refer to Figure 1-13 and Figure 1-14 for a sample delivery survey.

  - A signed copy of the site inspection and delivery survey is mailed to HP.
  - Site inspection and predelivery coordination meeting is arranged with an HP representative to review the inspection checklist and to arrange an installation schedule.
- Seven days before installation
  - Final check is made with an HP site preparation specialist to resolve any last-minute problems.

**NOTE:** Not all installations follow a schedule like the one previously noted. Sometimes a server is purchased through another vendor, which can preclude a rigid schedule. Other conditions could also prevent following this schedule. For those situations, consider a milestone schedule.

- Site Preparation—Schedule with the customer as soon as possible after the order is placed.
- Site Verification—Schedule with the customer a minimum of 1 to 2 days before the product is scheduled to be installed.

## Sample Site Inspection Checklist

**Table 1-5 Customer and HP Information**

| **Customer Information** | |
|---|---|
| Name: | Phone number: |
| Street address: | City or Town: |
| State or province: | Country |
| Zip or postal code: | |
| Primary customer contact: | Phone number: |
| Secondary customer contact: | Phone number: |
| Traffic coordinator: | Phone number: |
| HP information | |
| Sales representative | Order number: |
| Representative making survey | Date: |
| Scheduled delivery date | |

**Table 1-6 Site Inspection Checklist**

| **Check either Yes or No. If No, include comment number or date.** | | | | **Comment or Date** |
|---|---|---|---|---|
| Computer Room | | | | |
| Number | Area or condition | Yes | No | |
| 1. | Is there a completed floor plan? | | | |
| 2. | Is adequate space available for maintenance needs? Front 36 inches (91.4 cm) minimum, rear 36 inches (91.4 cm) minimum are recommended clearances. | | | |
| 3. | Is access to the site or computer room restricted? | | | |
| 4. | Is the computer room structurally complete? Expected date of completion? | | | |
| 5. | Is a raised floor installed and in good condition? | | | |
| 6. | Is the raised floor adequate for equipment loading? | | | |
| 7. | Are channels or cutouts available for cable routing? | | | |

**Table 1-6 Site Inspection Checklist** *(continued)*

| Check either Yes or No. If No, include comment number or date. | | | | Comment or Date |
|---|---|---|---|---|
| 8. | Is a network line available? | | | |
| 9. | Is a telephone line available? | | | |
| 10. | Are customer-supplied peripheral cables and LAN cables available and of the proper type? | | | |
| 11. | Are floor tiles in good condition and properly braced? | | | |
| 12. | Is floor tile underside shiny or painted? If painted, judge the need for particulate test. | | | |
| Power and Lighting | | | | |
| Number | Area or Condition | Yes | No | |
| 13. | Are lighting levels adequate for maintenance? | | | |
| 14. | Are AC outlets available for servicing needs? (for example, laptop) | | | |
| 15. | Does the input voltage correspond to equipment specifications? | | | |
| 15A. | Is dual source power used? If so, identify types and evaluate grounding. | | | |
| 16. | Does the input frequency correspond to equipment specifications? | | | |
| 17. | Are lightning arrestors installed inside the building? | | | |
| 18. | Is power conditioning equipment installed? | | | |
| 19. | Is a dedicated branch circuit available for equipment? | | | |
| 20. | Is the dedicated branch circuit less than 75 feet (22.86 meters)? | | | |
| 21. | Are the input circuit breakers adequate for equipment loads? | | | |
| Safety | | | | |
| Number | Area or Condition | Yes | No | |
| 22. | Is an emergency power shutoff switch available? | | | |
| 23. | Is a telephone available for emergency purposes? | | | |
| 24. | Does the computer room have a fire protection system? | | | |
| 25. | Does the computer room have antistatic flooring installed? | | | |
| 26. | Do any equipment servicing hazards exist (loose ground wires, poor lighting, and so on)? | | | |
| Cooling | | | | |
| Number | Area or Condition | Yes | No | |
| 27. | Can cooling be maintained between 5°C (41˚F) and 35°C (95˚F) (up to 5000 ft)? Derate 1°C/1000 ft (33.8˚F) above 5000 ft and up to 10,000 ft. | | | |
| 28. | Can temperature changes be held to 5°C (41˚F) per hour with tape media? Can temperature changes be held to 20°C (68˚F) per hour without tape media? | | | |
| 29. | Can humidity level be maintained at 40% to 55% at 35°C (95˚F) noncondensing? | | | |
| 30. | Are air-conditioning filters installed and clean? | | | |
| Storage | | | | |

**Table 1-6 Site Inspection Checklist** *(continued)*

| Check either Yes or No. If No, include comment number or date. | | | | Comment or Date |
|---|---|---|---|---|
| Number | Area or Condition | Yes | No | |
| 31. | Are cabinets available for tape and disc media? | | | |
| 32. | Is shelving available for documentation? | | | |
| | Training | | | |
| Number | Area or Condition | | | |
| 33. | Are personnel enrolled in the System Administrator's Course? | | | |
| 34. | Is on-site training required? | | | |

# Delivery Survey

The delivery survey forms list delivery or installation requirements. If any of the items on the list apply, enter the appropriate information (Figure 1-13 and Figure 1-14) in the areas provided on the form.

Enter any special instructions or recommendations on the special instructions or recommendations form. The following list gives examples of special instructions or issues:

- Packaging restrictions at the facility, such as size and weight limitations
- Special delivery procedures
- Special equipment required for installation, such as tracking or hoists
- What time the facility is available for installation (after the equipment is unloaded)
- Special security requirements applicable to the facility, such as security clearance

**Figure 1-13 Delivery Survey (Part 1)**

DELIVERY CHECKLIST

DOCK DELIVERY

Is dock large enough for a semitrailer? Yes _______ No _______

Circle the location of the dock and give street name if different than address.

North

West East

South

STREET DELIVERY

Circle the location of access door and list street name if different than address.

North

West East

South

List height __________ and width ________ of access door.

List special permits (if required) for street delivery.

| Permit type: | Agency obtained from: |
| --- | --- |
| ______________________ | ______________________ |
| ______________________ | ______________________ |

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**Figure 1-14 Delivery Survey (Part 2)**

ELEVATOR

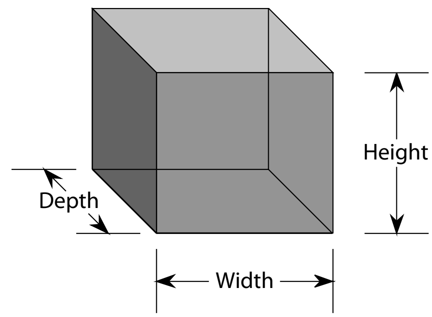
Fill in the following information if an elevator is required to move equipment.

Capacity (lb or kg) ____________

Depth ____________

Height ____________

Width ____________



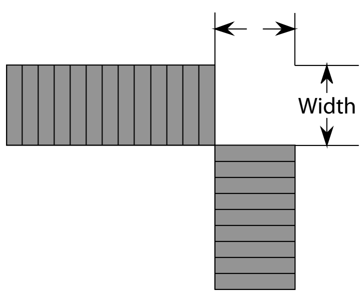

STAIRS

Please list number of flights and stairway dimensions.

Number of flights ____________

Width ____________

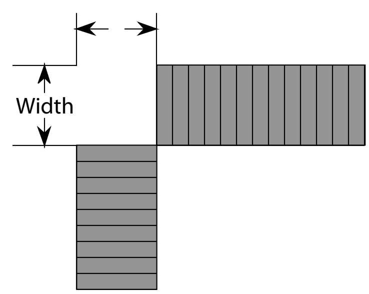
Width ____________




Number of flights ____________

Width ____________

Width ____________

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# Glossary

## A-B

**apparent power** A value of power for AC circuits that is calculated as the product of RMS current times RMS voltage, without taking the power factor into account.

**ASHRAE Standard 52-76** Industry-standard term for air filtration efficiency set forth by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

**ASL** Above sea level.

**board** A printed circuit assembly (PCA). Also called a card or adapter.

**Btu/h** British thermal unit. The amount of heat required to raise one pound of water 1°F in an hour, a common measure of heat transfer rate.

## C

**CFM** Cubic feet per minute, commonly used to measure the rate of air flow in an air-conditioning system.

**chilled water system** A type of air-conditioning system that has no refrigerant in the unit itself. The refrigerant is contained in a chiller, which is located remotely. The chiller cools water, which is piped to the air conditioner to cool the space.

**CompactPCI** The newest specification for PCI-based industrial computers is called CompactPCI. It is electrically a superset of desktop PCI with a different physical form factor. Refer to http://www.picmg.org/v2internal/productlistings.htm for details.

## D-K

**daisy chain** Hardware devices that are connected one to another in series.

**dehumidification** The process of removing moisture from the air within a critical space.

**derate** To lower the rated capability of an electrical or mechanical apparatus.

**downflow** Refers to a type of air-conditioning system that discharges air downward, directly beneath a raised floor, commonly found in computer rooms and modern office spaces.

**EIA unit** The Electronic Industries Association (EIA) defines this unit of measurement to be 1.75 in. in height. One (1) U equals 1.75 in. (1 U equals 44.45 mm).

**ESD** Electrostatic discharge.

**humidification** The process of adding moisture to the air within a critical space.

**inrush current** The peak current flowing into a power supply the instant AC power is applied. This peak is usually much higher than the typical input current because of the charging of the input filter capacitors. When switching power supplies are first turned on, they present high initial currents as a result of filter capacitor impedance. These large filter capacitors act like a short circuit, producing an immediate inrush surge current with a fast rise time. The peak inrush current can be several orders of magnitude greater than the supply's typical current.

**KVA** Kilovolt-amperes (1000 x volt-amperes).

## L-N

**LAHJ** Local authority has jurisdiction.

**latent cooling capacity** The capability of an air-conditioning system to remove heat from the air.

**leakage current** A term relating to current flowing between the AC supply wires and earth ground. The term does not necessarily denote a fault condition. In power supplies, leakage current usually refers to the 60-Hz current, which flows through the EMI filter capacitors that are connected between the AC lines and ground.

**maximum input current** The operating current of the product equal to the maximum load divided by the minimum input voltage.

**NEBS** All electronic equipment has the potential to interfere with other electronic equipment. Interference can be caused by electromagnetic radiation, the grounding system, the electrical power connection, excessive heat or blocking the natural airflow, and connecting wires or cables. The Federal Communications Commission (FCC) regulates a portion of this problem through Part 15 of its rules and regulations. Even more stringent than the FCC Part 15 requirements, Network Equipment Building Standards (NEBS) covers a large range of requirements, including criteria for personnel safety, protection of property, and operational continuity. The documents cover such physical requirements as: space planning, temperature, humidity, fire, earthquake, vibration, transportation, acoustics, air quality, and illumination. The documents also cover such electrical criteria as: electrostatic discharge (ESD), electromagnetic interference (EMI), lightning and AC power fault, steady state power induction, corrosion, DC potential difference, electrical safety and bonding, and grounding.

## O-R

**PCA** Printed Circuit Assembly; also referred to as a printed circuit board (PCB).

**PCI** Currently, the most popular local I/O bus, the Peripheral Component Interconnect (PCI) bus was developed by Intel® and introduced in 1993.

**PICMG** A consortium of companies involved in utilizing PCI for embedded applications. The PCI Industrial Computer Manufacturers Group (PICMG) controls the PICMG specification.

**power factor** The ratio of true power to apparent power in an AC circuit. In power conversion technology, power factor is used in conjunction with describing the AC input current to the power supply.

**RMS** Root mean square. Term that refers to the most common mathematical method of defining the effective voltage or current of an AC wave. To determine RMS value, three mathematical operations are carried out on the function representing the AC waveform: (1) The square of the waveform function (usually a sine wave) is determined. (2) The function resulting from step 1 is averaged over time. (3) The square root of the function resulting from step 2 is found.

## S-T

**theoretical maximum power consumption** Maximum wattage of a given configuration, assuming worst-case conditions (thermal tolerances, work loads, and so forth) on all system components. It is extremely unlikely that any customer will experience this level of power consumption.

**tonnage** The unit of measure used in air-conditioning to describe the heating or cooling capacity of a system. One ton of heat represents the amount of heat needed to melt 1 ton (2000 lb) of ice in 1 hour and 12,000 Btu/h equals 1 ton of heat.

**true power** In an AC circuit, true power is the actual power consumed. It is distinguished from apparent power by eliminating the reactive power component that may be present.

**typical input current** The operating current of the product measured using a typical load and target voltage.

**typical power consumption** Represents the expected power consumption of a given configuration. The typical value is the approximate power consumption that a customer will most likely experience and can use for power budgeting purposes.

## U-Z

**vapor seal** A vapor seal is an essential part of preventing moisture infiltration into or migration out of a critical space, such as a data processing center or other room that contains sensitive electronic instrumentation. Essentially, a vapor seal is a barrier that prevents air, moisture, and contaminants from migrating through tiny cracks or pores in the walls, floor, and ceiling into the critical space. Vapor barriers can be created using plastic film, vapor-retardant paint, vinyl wall coverings, and vinyl floor systems, in combination with careful sealing of all openings (doors and windows) into the room.

**watt** A unit of electricity consumption representing the product of amperage and voltage. When the power requirement of a product is listed in watts, you can convert to amperes (A) by dividing the wattage by the voltage. (for example, 1200 W divided by 120 V equals 10 A).

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