IBM FlashSystem A9000R
Models 9835-415 and 9837-415

Deployment Guide

GC27-8565-05

Note

Before using this information and the product it supports, read the information in “Safety and environmental notices” on page xi and “Notices” on page 91.

Edition Notice

Publication number: GC27-8565-05.

This publication applies to IBM FlashSystem A9000R, replacing GC27-8565-04, and shall remain applicable to all product releases and modifications until replaced by a newer publication.

Contents

Figures

Tables

Safety and environmental notices

Review the safety notices, environmental notices, and electronic emission notices for this product before you install and use the product.

Safety notices and labels

Review the safety notices and safety information labels before using this product.

IBM Systems safety notices and information

This publication contains the safety notices for the IBM Systems products in English and other languages. It also contains safety information labels found on the hardware in English and other languages. Anyone who plans, installs, operates, or services the system must be familiar with and understand the safety notices. Read the related safety notices before beginning work.

 IBM Systems Safety Notices (ibm.com/shop/publications/order/), G229-9054

The publication is organized into three sections:

Safety notices

Lists the danger and caution notices without labels, organized alphabetically by language.

The following notices and statements are used in IBM documents. They are listed in order of decreasing severity of potential hazards.

Danger notice definition
A special note that calls attention to a situation that is potentially lethal or extremely hazardous to people.

Caution notice definition
A special note that calls attention to a situation that is potentially hazardous to people because of some existing condition, or to a potentially dangerous situation that might develop because of some unsafe practice.

Labels Lists the danger and caution notices that are accompanied with a label, organized by label reference number.

Text-based labels
Lists the safety information labels that might be attached to the hardware to warn of potential hazards, organized by label reference number.

Note: This product has been designed, tested, and manufactured to comply with IEC 60950-1, and where required, to relevant national standards that are based on IEC 60950-1.

Finding translated notices

Each safety notice contains an identification number. You can use this identification number to check the safety notice in each language. The list of notices that apply to this product are listed in the “Special caution and safety notices” on page xii and “Environmental notices” on page xvi topics of this guide.

To find the translated text for a caution or danger notice:

1. In the product documentation, look for the identification number at the end of each caution notice or each danger notice. In the following examples, the numbers (D002) and (C001) are the identification numbers.

   DANGER

   A danger notice indicates the presence of a hazard that has the potential of causing death or serious personal injury. (D002)

   CAUTION:
   A caution notice indicates the presence of a hazard that has the potential of causing moderate or minor personal injury. (C001)
2. Open the IBM Systems Safety Notices.
3. Under the language, find the matching identification number. Review the topics concerning the safety notices to ensure that you are in compliance.

To view a PDF file, you need Adobe Reader. You can download it at no charge from the Adobe website (get.adobe.com/reader/).

Special caution and safety notices

This information describes special safety notices that apply to the FlashSystem A9000R. These notices are in addition to the standard safety notices supplied and address specific issues relevant to the equipment provided.

Laser safety

When using an NVRAM5 or NVRAM6 cluster media converter, the storage system must be installed in a restricted access location.

CAUTION:
This product contains a Class 1M laser. Do not view directly with optical instruments. (C028)

This equipment contains Class 1 laser products, and complies with FDA radiation regulations 21 CFR Subchapter J, international laser safety standard IEC 60825 parts -1 and -2, and relevant national standards based on these.

CAUTION:

Data processing environments can contain equipment transmitting on system links with laser modules that operate at greater than Class 1 power levels. For this reason, never look into the end of an optical fiber cable or open receptacle. (C027)

Attention: In the United States, use only SFP or GBIC optical transceivers that comply with the FDA laser registration, reporting and accessions per the Center for Devices and Radiological Health (CDRH) according to 21 CFR Subchapter J. Internationally, use only SFP or GBIC optical transceivers that comply with IEC standard 60825–1. Optical products that do not comply with these standards might produce light that is hazardous to the eyes.

Usage restrictions: The optical ports of the modules must be terminated with an optical connector or with a dust plug.

Ladder usage

A step or platform ladder might be necessary to service higher modules.

Use an OSHA/CSA approved non-conductive step or platform ladder specified for at least a 136.4 kg (300 lb.) load capacity.

Fire suppression systems

A fire suppression system is the responsibility of the customer. The insurance underwriter, local fire marshal, or a local building inspector, or all three, must be consulted in selecting a fire suppression system that provides the correct level of coverage and protection.

IBM® designs and manufactures equipment to internal and external standards that require certain environments for reliable operation. Because IBM does not test any equipment for compatibility with fire suppression systems, IBM does not make compatibility claims of any kind nor does IBM provide recommendations on fire suppression systems.

Power cables

Use only IBM approved UL power cables.

For your safety, IBM provides a power cable with a grounded attachment plug to use with this IBM product. To avoid electrical shock, always use the power cable and plug with a correctly grounded outlet. IBM power cables used in the United States and Canada are listed by Underwriters Laboratories (UL) and certified by the Canadian Standards Association (CSA). For units intended to be operated at 115 volts: Use a UL-listed and CSA-certified cable set consisting of a minimum 18 AWG, Type SVT or SJT, three-conductor cable, a maximum of 15 feet in length and a parallel blade, grounding-type attachment plug rated 15 amperes, 125 volts. For units intended to be operated at 230 volts (U.S. use), use a UL-listed and CSA-certified cable set consisting of a minimum 18 AWG, Type SVT or SJT, three-conductor cable, a maximum of 15 feet in length and a tandem blade, grounding-type attachment plug rated 15 amperes, 250 volts. For units intended to be operated at 230 volts (outside the U.S.), use a cable set with a grounding type attachment plug. The cable set must have the appropriate safety approvals for the country in which the equipment is to be installed. IBM power cables for a specific country or region are usually available only in that country or region.

Connect all power cables to a correctly wired and grounded electrical outlet. Ensure that the outlets supplies correct voltage and phase rotation according to the system rating plate. Ensure that all customer facility outlets are protected with circuit breakers rated at maximum for 30 Amps. The power cable plugs operate as the system main-disconnection method.

Note: For power cables outside of the U.S., IBM provides power cables with no connector. It is the client's responsibility to install the correct power plug with the aide of a certified electrician. For power requirements, see “Power requirements” on page 26.

Sound pressure

Hearing protection must be worn while you service the FlashSystem A9000R system.

Attention: Depending upon local conditions, the sound pressure might exceed 85 dB(A) during service operations. When working on the FlashSystem A9000R system while either the front or rear door is in the open position, hearing protection must be worn.

CAUTION:

Depending upon local conditions, the sound pressure might exceed 85 dB(A) during service operations. Hearing protection must be worn when you are in a room that has an FlashSystem A9000R system while either the front or rear door is open or when the front and rear doors are not installed.

Leakage current

The FlashSystem A9000R system incorporates electromagnetic-interference filter capacitors that are required to prevent electrical noise from penetrating the power grid. A characteristic of filter capacitors, during normal operation, is a high amount of leakage current.

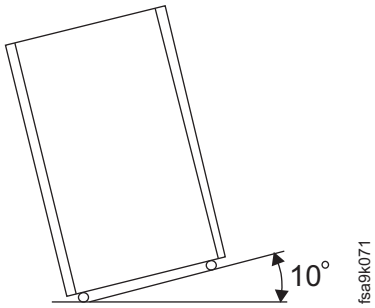
Depending on the storage configuration, this leakage current can reach 100 mA.

For the most reliable operation, do not use Ground Fault Circuit Interrupter (GFCI), Earth Leakage Circuit Breaker (ELCB), and Residual Current Circuit Breaker (RCCB) type circuit breakers with a FlashSystem A9000R system. The FlashSystem A9000R system is certified for safe operation and is compliant with IEC, EN, UL, CSA 60950-1 standards. However, if leakage detection circuit breakers are required by local electrical practice, the breakers must be sized for a leakage-current rating of 300 mA or greater to reduce the risk of server outage caused by erroneous and spurious tripping.

Site preparation

The IBM service representative can only minimally reposition the rack at the installation site, as needed to service the FlashSystem A9000R system. The customer is responsible for using professional movers or riggers in the case of equipment relocation or disposal.

Attention: Do not tilt the FlashSystem A9000R system rack more than 10 degrees.



If more clearance is needed for FlashSystem A9000R or racks the height-reduced shipping (feature code AFR2) should be ordered to reduce the height of the rack.

When the height-reduced feature is ordered, the top cover is removed before the IBM FlashSystem® A9000R is moved to its final location by professional movers. The top cover must be installed during the IBM FlashSystem A9000R installation.

If tilting or weight-reduction is needed for IBM FlashSystem A9000R or rack shipment, the weight-reduced shipping (feature code AFR3) should be ordered to reduce the weight of the rack.

When the weight-reduced feature is ordered grid controllers and flash enclosures are shipped separately: this allows the rack to be tilted as much as necessary in order to fit under low doorways. As a result, these components must be installed during IBM FlashSystem A9000R installation.

IBM FlashSystem A9000R arrives fully assembled with all components in place, unless the weight or height reduced shipping options is ordered.

If the site does not meet the delivery clearances and the height-reduced shipping is ordered, the doors, side panels, and rack top cover of the rack must be removed before moving to the final location.

DANGER

Heavy equipment - personal injury or equipment damage might result if mishandled. Use only professional movers.

Environmental notices

This publication contains all the required environmental notices for IBM Systems products in 26 languages. The environmental notices that are included are limitations, product recycling and disposal, product information, battery return program, flat panel display, monitors and workstations, refrigeration, and water-cooling system.

IBM Systems Environmental Notices and User Guide (ftp://public.dhe.ibm.com/systems/support/warranty/envnotices/environmental_notices_and_user_guide.pdf), Z125-5823

To view a PDF file, you need Adobe Reader. You can download it at no charge from the Adobe website (get.adobe.com/reader/).

About this guide

This manual defines information regarding the deployment, configuration, preinstallation requirements for IBM FlashSystem A9000R models 9835-415 and 9837-415. It is important to ensure that you meet all requirements to ensure a fast and reliable deployment and installation.

If you cannot meet the deployment and installation requirements explained in this document, notify your IBM representative to devise an alternative solution.

Who should use this guide

This publication is for personnel that are involved in planning. Such personnel include IT facilities managers, individuals responsible for power, cooling, wiring, network, and general site environmental planning and setup.

Roles and responsibilities

Both IBM and the customer have roles and responsibilities that they must adhere to, in order to ensure proper workflow, timely successful installation, properly configured Call Home and remote support, leading to a superior client experience.

Roles and responsibilities of the customer

- Review the product Deployment Guide
- Enable and work with the Remote Support Center (RSC) remote support in performing remote data collection and support
- Work with the IBM Planning Representative (IPR), Service Representative (SSR), Quality Practitioner (QPer), or other IBM personnel to fill out the Technical and Delivery Assessment (TDA) for accurate and quicker initial installation
- Provide and prepare a rack, adhering to the rack requirements, as specified in this guide.
- Provide adequate staffing/resources to support this solution.
- Provide sufficient bandwidth and host attachments to support this solution.
- Provide necessary Ethernet cabling
- Provide all initial host Fibre Channel (FC) and iSCSI cabling
- Provide proper power receptacles to match the requirements for the IBM FlashSystem A9000R ordered
- Provide proper thermal dissipation, airflow and cooling, and environmental requirements
- Provide proper floor space and clearance
- Provide access for the IBM service representative (SSR), including laptop or computer access
- Provide access for movers and vehicles
- Allow firewall access to Call Home servers
- Setup IP host network
- Setup SAN host networking
- Download and install appropriate Host Attachment Kit (HAK)

- Install the Management Server from Fix Central for IBM Hyper-Scale Manager UI use
- Perform logical configuration
- Complete the host attachment plan
- Prepare Fibre Channel (FC) connections
- Prepare raised floor, if required

Roles and responsibilities of IBM Service Support Representatives (SSRs)

- Complete Distant Learning (DL) education and hands-on education course
- Enroll in a hearing conservation program
- Perform product installation
- Configure Call Home and remote support
- Installation of software upgrades
- Installation of hardware Engineering Change Notices (ECA) also known as Field Bill of Materials (FBM)
- Conduct product relocation, at customer request
- Perform break/fix repairs
- Return of failed parts that are under warranty or have a Certified Spare Parts Value
- Keep customers informed of service activities
- Arrange time with customer/TA to facilitate upgrades
- Assist with break/fix support as requested by Remote Support Center, Top Gun, or PFE team member
- Complete accurate Quality Service Activity Reporting (QSAR) reporting

Note: Additional information can be found in your the customer *Enterprise Class Support for Storage* document, provided by the IBM Planning Representative (IPR).

Conventions used in this guide

These notices are used to highlight key information.

Tip: These notices provide important tips.

Note: These notices provide important guidance, or advice.

Important: These notices provide information or advice that might help you avoid inconvenient or difficult situations.

Attention: These notices indicate possible damage to programs, devices, or data. An attention notice is placed before the instruction or situation in which damage can occur.

CAUTION:

These notices indicate a situation that is potentially hazardous to people because of some existing condition or where a potentially dangerous situation might develop because of some unsafe practice.

DANGER

These notices indicate a situation that is potentially lethal or hazardous to people. For example, after a computer side panel is removed, exposed high-voltage wires might be lethal.

Related information and publications

You can find additional information and publications related to IBM FlashSystem A9000R on the following information sources.

- IBM FlashSystem A9000R on IBM Knowledge Center (ibm.com/support/knowledgecenter/STJKN5) – on which you can find the following related publications:
  - IBM FlashSystem A9000R – Release Notes
  - IBM FlashSystem A9000R – Product Overview
  - IBM FlashSystem A9000R – Command-Line Interface (CLI) Reference Guide
  - IBM FlashSystem A9000 and IBM FlashSystem A9000R – Application Programming Interface (API) Reference Guide
  - IBM Hyper-Scale Manager – Release Notes
  - IBM Hyper-Scale Manager – User Guide
  - IBM Hyper-Scale Manager – Representational State Transfer (REST) API Specifications
  - IBM XIV Remote Support Proxy – Release Notes
  - IBM XIV Remote Support Proxy – Installation and User Guide
- IBM FlashSystem A9000 on IBM Knowledge Center (ibm.com/support/knowledgecenter/STJKMM) – on which you can find the following related publications:
  - IBM FlashSystem A9000 – Release Notes
  - IBM FlashSystem A9000 – Product Overview
  - IBM FlashSystem A9000 – Deployment Guide
  - IBM FlashSystem A9000 – Command-Line Interface (CLI) Reference Guide
  - IBM FlashSystem A9000 and IBM FlashSystem A9000R – Application Programming Interface (API) Reference Guide
  - IBM XIV Remote Support Proxy – Release Notes
  - IBM XIV Remote Support Proxy – Installation and User Guide
- IBM Flash Storage and Solutions marketing website (ibm.com/systems/storage/flash)
- IBM Storage Redbooks® website (redbooks.ibm.com/portals/storage)

Getting information, help, and service

If you need help, service, technical assistance, or want more information about IBM products, you can find various sources to assist you. You can view the following websites to get information about IBM products and services and to find the latest technical information and support.

- IBM website (ibm.com®)
- IBM Support Portal website (www.ibm.com/storage/support)
- IBM Directory of Worldwide Contacts website (www.ibm.com/planetwide)

IBM Publications Center

The IBM Publications Center is a worldwide central repository for IBM product publications and marketing material.

The IBM Publications Center website (www.ibm.com/shop/publications/order/) offers customized search functions to help you find the publications that you need. You can view or download publications at no charge.

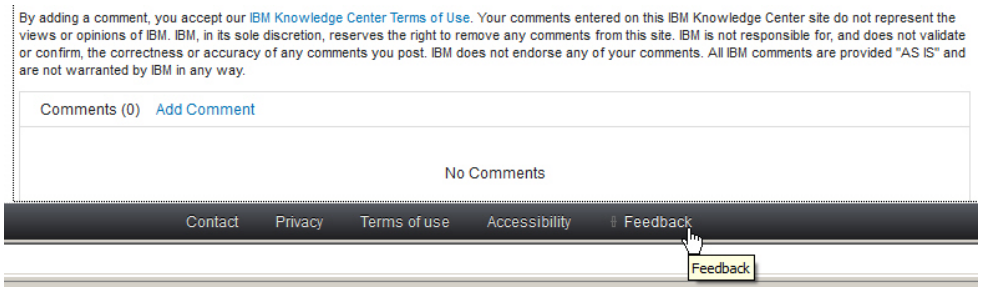
Sending or posting your comments

Your feedback is important in helping to provide the most accurate and highest quality information.

Procedure

To submit any comments about this guide:

- Go to IBM FlashSystem A9000R on IBM Knowledge Center (ibm.com/support/knowledgecenter/STJKN5), drill down to the relevant page, and then click the **Feedback** link that is located at the bottom of the page.



  The feedback form is displayed and you can use it to enter and submit your comments privately.
- You can post a public comment on the Knowledge Center page that you are viewing, by clicking **Add Comment**. For this option, you must first log in to IBM Knowledge Center with your IBM ID.
- You can send your comments by email to starpubs@us.ibm.com. Be sure to include the following information:
  - Exact publication title and product version
  - Publication form number (for example: GC01-0001-01)
  - Page, table, or illustration numbers that you are commenting on
  - A detailed description of any information that should be changed

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Chapter 1. Overview

IBM FlashSystem A9000R is a grid-scale, all-flash storage platform designed to drive your business into the cognitive era.

This guide defines deployment, planning, and preinstallation requirements for IBM FlashSystem A9000R storage systems. It is important to ensure that you meet all requirements to help achieve a fast and reliable installation.

FlashSystem A9000R provides consistent, extreme performance for dynamic data at scale. The FlashSystem A9000R storage system integrates the microsecond latency and high availability of IBM FlashCore® technology with grid architecture, comprehensive data reduction, and industry leading IBM software.

Figure 1. IBM FlashSystem A9000R storage system

IBM FlashSystem A9000R is an excellent platform for industry leaders with rapidly growing cloud storage and mixed workload environments. IBM software-defined storage capabilities and IBM FlashCore technology combine to produce the extreme performance and scalability required in enterprise-class storage solutions.

The storage system utilizes IBM MicroLatency® modules that leverage IBM-enhanced MLC flash to provide density, low latency, high I/O, and high availability. IBM FlashSystem A9000R aggregates grid elements (each containing two grid controllers and one flash enclosure) within a 42U integrated rack solution. (For more information about grid elements, see "FlashSystem A9000R grid elements" on page 9).

Due the combination of grid-scale architecture and flash storage media, the system delivers predictable high performance and ultra-low latency, even under heavy workloads with full data reduction enabled. As a result, the grid-scale architecture

maintains this performance by automatically self-optimizing workloads across all storage resources without manual intervention. Secure multi-tenancy and quality of service (QoS) features help ensure that tenant service levels are not compromised within your complex environment.

Advanced management capabilities allow it to integrate easily into your existing data center infrastructure and with a wide variety of hypervisor and virtualization software, including VMware, OpenStack, and Microsoft.

For more information regarding the IBM FlashSystem A9000R grid scale architecture, see Introduction > Architecture in the *IBM FlashSystem A9000R Product Overview* (SC27-8559).

Planning best practices and requirements

Good planning is essential for the successful setup and use of your FlashSystem A9000R. It ensures that you have everything you need and that you meet all the prerequisites for the storage system. It minimizes errors and helps for a faster installation process.

Use this planning information to place the FlashSystem A9000R system, plan power and environmental needs, plan for software and storage needs, and prepare for unique configurations that are based on how you plan to use the storage system.

It is imperative that you work with the sales team, IBM Installation Planning Representative (IPR), and IBM Service Representative (SSR) to capture information needed to install and configure the storage system. This information is collected during a Technical and Delivery Assessment (TDA) or Installation planning meeting. This information must be collected prior to the commencement of the installation, or delays may occur.

CAUTION:

You must prepare your environment to handle the FlashSystem A9000R system based on this planning information with assistance from an IBM installation planning representative (IPR) or an IBM service representative. The final installation site within the computer room must be prepared *before* **the equipment is delivered. If the site cannot be prepared before the delivery time, you must make arrangements to have the professional movers return to finish the transportation later. Only professional movers can transport the equipment. The IBM service representative can minimally reposition the rack at the installation site, as needed to complete required service actions. You are also responsible for using professional movers in the case of equipment relocation or disposal.**

If you cannot meet any of the installation requirements, notify your IBM service representative to devise alternative solutions.

Notes:

- This guide covers planning information for the IBM FlashSystem A9000R integrated rack storage system.

  For planning information for the IBM FlashSystem A9000 pod system, see *IBM FlashSystem A9000 Deployment Guide*, GC27-8564 on the IBM FlashSystem A9000 Knowledge Center website (ibm.com/support/knowledgecenter/STJKMM).
- For information regarding management, automation, and access security, see the following documentation, which can be found on the IBM FlashSystem A9000R Knowledge Center website (ibm.com/support/knowledgecenter/STJKN5):
  - *IBM Hyper-Scale Manager User Guide*, SC27-8560
  - *IBM Hyper-Scale Manager Release Notes*
  - *IBM FlashSystem A9000R Command-Line Interface (CLI) Reference Guide*, SC27-8711
  - *IBM Hyper-Scale Manager REST API Specifications*, SC27-6440

Chapter 2. System specifications

This information compares general properties, performance, physical features, and host connectivity for the IBM® FlashSystem™ A9000R storage system.

General properties

Specification	Details
Controllers	Up to 12 active grid controllers, each containing: • Two Intel Xeon E5 v3 10-core 2.3 GHz processors • 384 GB DDR4 memory • Redundant battery backup units and power supply units
Software	IBM FlashSystem A9000 and A9000R software v12.x
Models and warranties	• 9835-415: 1-year warranty • 9837-415: 3-year enterprise-class warranty Warranties include onsite service, same day 24×7
Data reduction and efficiency	• Pattern removal • Global, inline deduplication • Inline compression • Space-efficient snapshots • Thin provisioning
Encryption	Hardware-based AES-XTS 256-bit with centralized key management
Backplane interconnect	InfiniBand
Client operating system support	For a current list of platforms supported, please visit the IBM System Storage® Interoperation Center (SSIC) (ibm.com/systems/support/storage/ssic/interoperability.wss)

Storage capacity features

Specification	Details									
Flash type	IBM-enhanced MLC									
	900 TB configuration					**1.8 PB configuration**				
Flash enclosures	2	3	4	5	6	2	3	4	5	6
Effective capacity* (TB)	300	450	600	750	900	600	900	1200	1500	1800
Maximum capacity** (TB)	1400	2000	2600	3000	3000	1400	2000	2600	3000	3000
Raw capacity (TB)	105.6	158.4	211.2	264.0	316.8	211.2	316.8	422.4	528	633.6
Flash enclosure type	Flash enclosure-150					Flash enclosure-300				
Flash enclosures	2	3	4	5	6	2	3	4	5	6
Grid controllers	4	6	8	10	12	4	6	8	10	12
IBM MicroLatency modules per flash enclosure	12 × 2.9 TB					12 × 5.7 TB				

Specification	Details
*Typical effective capacity is the available capacity after system overhead (including over-provisioning and RAID protection) and after the data reduction benefits of pattern removal, deduplication and compression. this assumes data reduction of up to a multiple of 5.26 to 1. **Maximum capacity refers to the effective capacity provisioning limit.	

Physical features

Specification	Details
Rack dimensions (H × W × D)	201.5 cm (42U) × 66.44 cm × 129.7 cm (79.3 in. × 25.4 in. × 51.1 in.)
Front clearance	120 cm (47.2 in.)
Rear clearance	100 cm (39.4 in.)
Weight	Entry configuration: 649 kg (1430 lbs) Scaled out configuration: 969 kg (2136 lbs)
Input voltage	200–240 V AC, 50/60Hz (+/-10% tolerance) via 30A–63A **Note:** Dependent on input phase configuration type (single, delta, or wye)
Power usage	Entry configuration: 3.07 KW (typical); 4.82 KW (max) Maximum configuration: 8.81 KW (typical); 13.91 KW (max) See “Power consumption” on page 27.

Temperature

Specification	Details
Temperature	10 - 35° C (50 - 95° F)
Maximum altitude	2134 m (7000 ft.)
Humidity	25 - 80% non-condensing

Host connectivity

Specification		Details
Host system interfaces (per grid controller)	Storage systems with Fibre Channel (FC) capabilities)	4 × 16 Gb Fibre Channel + 2 × 10 Gb iSCSI
	Storage systems with iSCSI (Ethernet) capabilities only	4×10 Gb iSCSI

Specification		Details
Host connectivity for mirroring (per system)	Recommended minimum link bandwidth value	50 Mbps
	Recommended maximum round trip latency value	250 ms
	Attaching IBM FlashSystem A9000 and A9000R systems for mirroring	The connection between two FlashSystem A9000R systems, or between a FlashSystem A9000R and a FlashSystem A9000 system, has to pass through: • Ethernet LAN for iSCSI connections • SAN for FC connections
Note: Synchronous remote mirroring is supported by version 12.0.1 and later.		

Chapter 3. Physical configuration options

Use these general guideline for determining and ordering the feature codes that you need to customize your IBM FlashSystem A9000R system.

Procedure

Note: Talk to your IBM planning representative (IPR) to help determine which options are best for your needs.

To determine the required ordering information, answer the following questions:

1. Which model best fits your warranty requirements?
2. What are your capacity needs?
3. What are your performance requirements?
4. What type of host connectivity do you need?
5. What type of power input do you have?
6. Does the installation site meet the physical site requirements for the FlashSystem A9000R and features that you plan to order? For example:
   - Can you space the racks to allow for sufficient floor strength?
   - Is there adequate cooling capacity to handle the new equipment?
   - Is sufficient power available?
   - Do you need 30A or 60A power cables?
   - Is water cooling required?
7. Do you require any of the following:
   - Any weight or height reduced shipping?
   - A radio frequency identification device (RFID) tag?

What to do next

See the following information on the various physical configuration options for your IBM FlashSystem A9000R storage system.

- "FlashSystem A9000R grid elements"
- "Components and interconnect" on page 10
- "Rack configurations" on page 11
- "Flash enclosure components and feature codes" on page 13
- "Grid controller components and feature codes" on page 14
- "Rear-door heat exchanger" on page 15
- "Weight-reduced shipping option" on page 17
- "Height reduced shipping option" on page 17
- "Radio frequency identification device option" on page 18

FlashSystem A9000R grid elements

A grid element is an orderable bundle that ensures only valid FlashSystem A9000R rack configurations.

Each grid element contains two grid controllers and one flash enclosure.

Grid elements can be ordered according to your performing and capacity needs. Configurations range between a minimum of two grid elements to a maximum of six grid elements. Partially populated configurations contain three, four, or five grid elements.

For more information on rack configurations, see “Rack configurations” on page 11.

All configurations have the same power, floor planning, hardware, and software configurations as fully populated systems.

Important: Each grid controller in a system rack is equally connected to each flash enclosure in the system, regardless of how many elements are in the system.

Components and interconnect

This section lists the components and interconnection options that are supplied with each IBM FlashSystem A9000R integrated rack.

Table 1 breaks down the various components and sub-components of the IBM FlashSystem A9000R.

Table 1. Components and interconnection options in IBM FlashSystem A9000R

Component	Sub-components
IBM T42 rack	
4 - 12 grid controllers, depending on ordered configuration	Each grid controller includes: • Two hot-swappable power supply units (PSUs) • Two internal battery modules • Two data reduction hardware acceleration cards • Two or three dual-ported host adapters, configuration according to customer request – Two 16 Gb Fibre Channel dual ports (total four ports) and a 10 Gb Ethernet (iSCSI) dual port (total two ports) adapter *or* – Two 10 Gb Ethernet (iSCSI) dual port (total four ports) adapters
2 - 6 flash enclosures, depending on ordered configuration	• 12 hot-swap 2.9 or 5.7 TB IBM MicroLatency modules • Two internal battery modules
Two InfiniBand switches	
Two power distribution units (PDUs)	
Utility patch panel	• Three management ports • Two VPN ports
Internal cabling	

Note: As of March 2017, the maintenance module is obsolete and no longer part of the rack configuration.

Rack configurations

IBM FlashSystem A9000R supports racks that contain a total of two to six grid elements.

For various configuration feature codes see:

- "Flash enclosure components and feature codes" on page 13
- "Grid controller components and feature codes" on page 14
- "Main power cables specifications" on page 29

Note: An IBM FlashSystem A9000R with less grid controllers also has fewer usable Fibre Channel and iSCSI ports, as well as less processing power.

For more information regarding capacity, processors, memory, and connectivity, see Chapter 2, "System specifications," on page 5.

Fully populated rack

A fully populated rack contains 12 grid controllers and 6 flash enclosures.

Note: A valid configuration always has two times the amount of grid controllers than flash enclosures.

Each grid controller contains 384 GB RAM capacity, for a total of 4608 GB RAM for a fully populated rack.

Each flash enclosure supports RAID 5 (10+1 MicroLatency modules with distributed parity, in accordance to RAID 5) with one spare MicroLatency module (total 12 MicroLatency modules). The physical capacity is equal to 10 MicroLatency modules with 2.9 TB or 5.7 TB, giving a total of either 29 TB or 57 TB per flash enclosure and 174 TB or 342 TB for a fully populated rack.

Figure 2 on page 12 shows an example the front and back of a fully populated IBM FlashSystem A9000R.

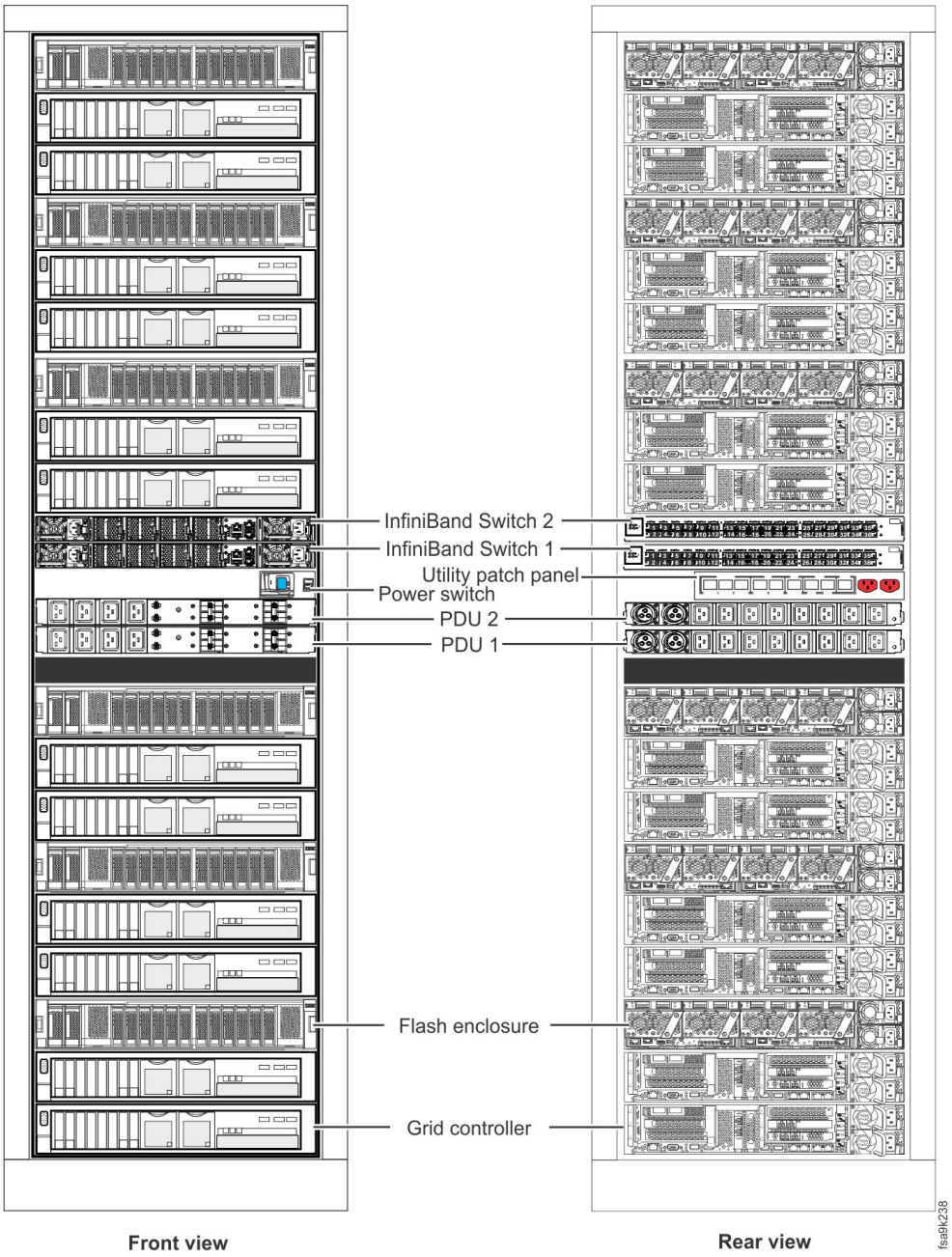


Figure 2. Fully-populated IBM FlashSystem A9000R

Minimally populated rack

A minimally populated rack contains four grid controllers and two flash enclosures.

Each grid controller contains 384 GB RAM, for a total of 1536 GB RAM for a minimally populated rack.

Each flash enclosure supports RAID 5 (10+1 MicroLatency modules with distributed parity, in accordance to RAID 5) with one spare MicroLatency module (total 12 MicroLatency modules). The physical capacity is equal to 10 MicroLatency

modules with 2.9 TB or 5.7 TB, giving a total of either 29 TB or 57 TB per flash enclosure and 58 TB or 114 TB for a minimally populated rack.

Figure 3 shows an example of the front and back of a minimally populated IBM FlashSystem A9000R.

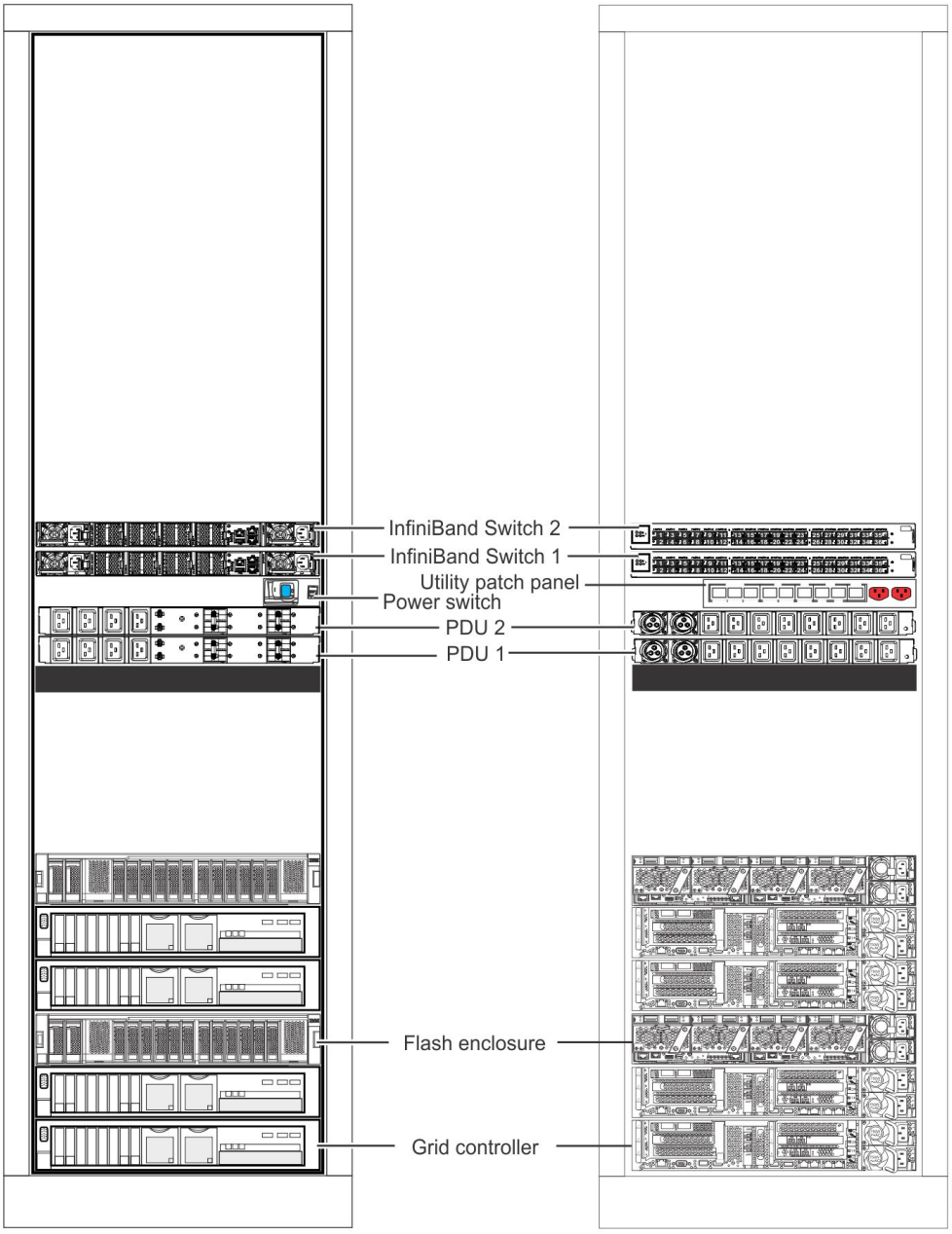
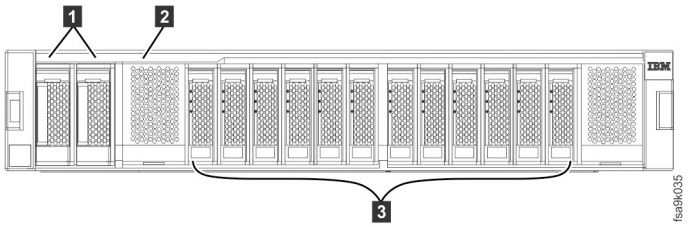


Figure 3. Minimally-populated IBM FlashSystem A9000R

Flash enclosure components and feature codes

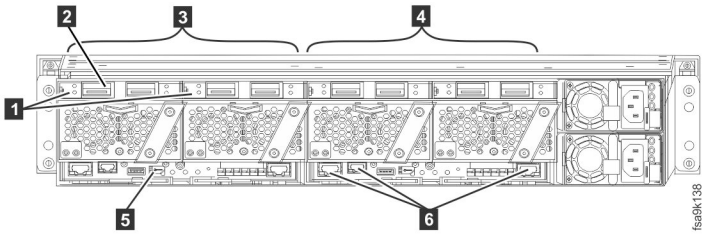
Each flash enclosure contains 12 hot-swap 2.9 TB or 5.7 TB IBM MicroLatency modules. The flash enclosures are used for IBM FlashSystem A9000R storage functions.

Each rack unit contains 2 - 6 flash enclosures, according to customer specifications. Figure 4 and Figure 5 illustrate the front and rear of the flash enclosure.



1 Battery modules
2 LED indicator panel
3 IBM MicroLatency modules

Figure 4. Front of a flash enclosure



1 InfiniBand Adapters (two per canister)
2 Internal interconnect Infiniband ports
3 Canister 1
4 Canister 2
5 Maintenance ports (serial) (IBM technician access)
6 Management ports (Ethernet) (IBM technician access)

Figure 5. Rear of a flash enclosure

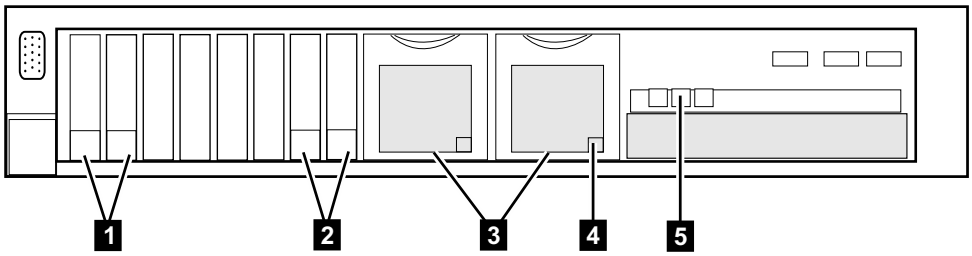
Table 2. Feature codes for flash enclosures

Description	Feature code
Flash enclosure with 12 x 2.9 TB IBM MicroLatency modules	AFE2
Flash enclosure with 12 x 5.7 TB IBM MicroLatency modules	AFE3

Grid controller components and feature codes

Each grid controller contains two hard disk drives (HDDs) and two solid state drives (SSDs) for IBM FlashSystem A9000R performance functions.

Each rack unit contains 4 - 12 grid controllers, according to customer specifications. Figure 6 on page 15 illustrates the front of the grid controller. Figure 7 on page 15 and Figure 8 on page 15 illustrate the two rear options for the grid controller.



1 HDDs (two per grid controller)
2 SSDs (two per grid controller)
3 Battery modules (two per grid controller)
4 Battery module Fault LED (one per unit)
5 General battery module LEDs

Figure 6. Front of a grid controller

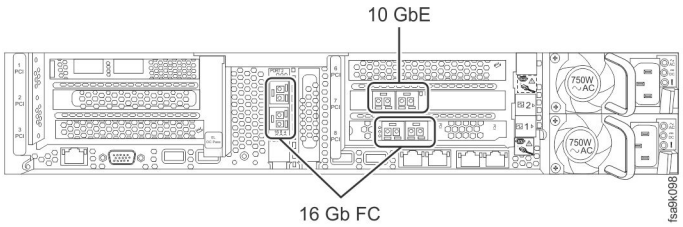


Figure 7. Rear of a grid controller with FC configuration

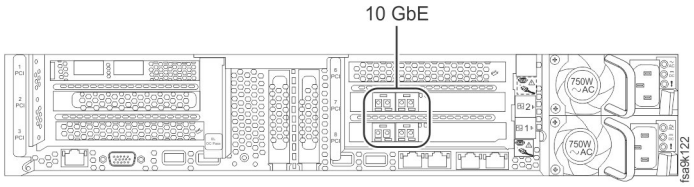


Figure 8. Rear of a grid controller with 10 Gb Ethernet configuration

Table 3. Feature codes for grid controllers

Description	Feature code
Grid controller with four 16 Gb Fibre Channel (FC) + two 10 GbE iSCSI ports	5001
Grid controller with four 10 GbE iSCSI ports	5002

Rear-door heat exchanger

The rear-door heat exchanger (feature code AFR1) is an optional water-cooled device that is mounted on the rear of an IBM FlashSystem A9000R system. It cools the air that is heated and exhausted by devices inside the rack.

A supply hose delivers chilled, conditioned water to the heat exchanger. A return hose delivers warmed water back to the water pump or chiller (referred to as the secondary cooling loop).

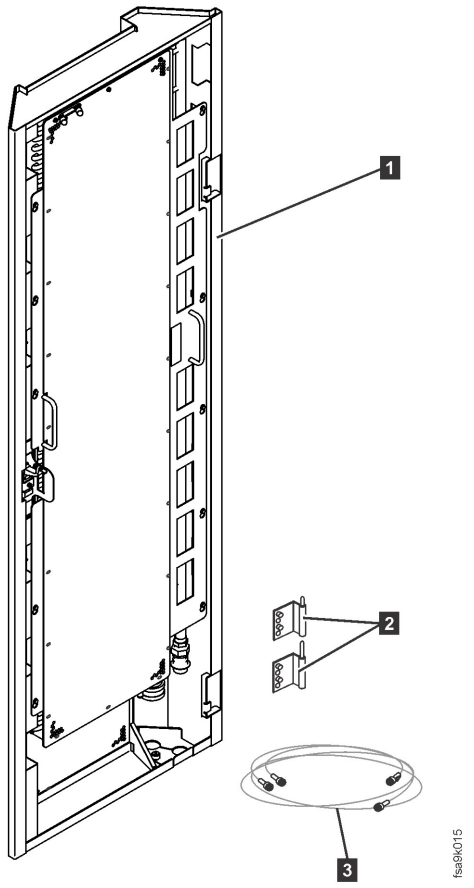
The primary cooling loop supplies the building chilled water to secondary cooling loops and air conditioning units.

Note: The hoses for the secondary cooling loop are not included with this option.

The rack on which you install the heat exchanger can be on a raised floor or a non-raised floor.

The rear-door heat exchanger option consists of the following components that are shown in Figure 9.

- Door assembly
- Hinge kit
- Air-purge tool



1 Door assembly
2 Hinge kit
3 Air-purging tool

Figure 9. Rear-door heat exchanger option kit

The following table lists the rear-door heat exchanger feature code for the FlashSystem A9000R system.

Table 4. Rear-door heat exchanger features

Feature description	Feature code
Rear-door heat exchanger	AFR1

See “Preparing for the rear-door heat exchanger” on page 26 for information about the requirements for preparing the installation site before the rear-door heat exchanger feature can be installed.

Weight-reduced shipping option

This information describes the Weight Reduction shipping option for the storage system, feature code AFR3.

IBM offers weight reduced shipping for all IBM FlashSystem A9000R system configurations. This optional feature provides that the weight of the rack is only approximately 423 kg (932 lb) for traversal at the delivery site.

This option is ordered for installations where receiving an assembled storage unit, or ordering feature code AFR2 would be impractical, due to greater weight limitations.

The unit is delivered fully tested but partially disassembled into several easily transported subassemblies. This feature allows racks to be safely transported on lower weight capacity elevators.

At the installation site the system is unpacked by IBM technicians, and the front door, rear door and side covers are temporarily removed so that the rack assembly can then be carried up stairs, hoisted via crane through windows, tipped to fit through low doorways, and rolled through low doorways in the customer's facility.

At the final destination, all devices that were shipped separately can be installed.

A fully configured FlashSystem A9000R system, including packaging, weighs approximately 969 kg (2136 lbs).

Attention: The storage system must not be tilted more than 10 degrees.

Note: This option greatly increases the system installation time. Onsite coordination is needed for both the IBM service representative and the professional movers.

Height reduced shipping option

This information describes the Height Reduction shipping option for IBM FlashSystem A9000R, feature code AFR2.

If your site does not meet the delivery clearances that are shown in “Rack dimensions and service clearance requirements” on page 22, the height reduced shipping option can be ordered to reduce the height of the rack by 30 cm (11.8 in.)

After the rack is delivered, the IBM service representative removes the rack top cover so that the rack can be moved to the final location. Only professional movers can transport the equipment.

After the rack is in its final location, the IBM service representative must return to complete the installation, including reinstalling the rack top cover.

A fully configured FlashSystem A9000R system, including packaging, weighs approximately 969 kg (2136 lbs) with dimensions of 66 cm × 118 cm (26 in. × 46.5 in.).

Attention: The storage system must not be tilted more than 10 degrees.

Note: This option greatly increases the system installation time. Onsite coordination is needed for both the IBM service representative and the professional movers.

Radio frequency identification device option

IBM offers an optional radio frequency identification device (RFID) for the storage system, feature code AFR5.

If you use frequency identification device (RFID) technology to track equipment in your data centers, you can order the RFID option to attach an RFID tag to system racks.

This RFID is designed to meet the performance and numbering specification as outlined by the radio frequency identification specifications. For information about the specification, see the Financial Services Technology Consortium website (www.bits.org/?id=29).

Important: This option is applicable only in environments that can use the correct RFID reading technology. Before you order this option, review the RFID capabilities with your IBM service representative.

When this option is ordered, IBM attaches one RFID tag per rack. Order one RFID option for each FlashSystem A9000R that you want to track. This option does not tag individual components.

This option can be ordered only when a new rack is ordered. The RFID option cannot be ordered as a miscellaneous equipment specification (MES).

Important: If the tag must be replaced for an IBM FlashSystem A9000R system, ensure that you update the asset-management database with the new RFID number for that FlashSystem A9000R.

Chapter 4. Physical installation site requirements

The location where you plan to install the storage system must meet all requirements.

Plan your installation site with assistance from an IBM installation planning representative (IPR) or an IBM service representative.

Prepare the site in advance so that professional movers or riggers can transport the equipment to the final site within the computer room. If the site cannot be prepared before the delivery time, you must make arrangements to have the professional movers return to finish the transportation later.

Attention: Only professional movers can transport the equipment.

An IBM service representative installs the storage system. The IBM service representative can only minimally reposition the rack within the room, as needed to complete required service actions.

Professional movers or riggers are required to transport the FlashSystem A9000R rack as close to the installation site as possible because of its weight.

Note: Professional movers or riggers are also required to relocate or dispose of the FlashSystem A9000R system.

The physical installation site requirements are listed in the following sections:

- "Floor and space requirements"
- "Power requirements" on page 26
- "Environmental requirements" on page 32
- "Planning for the rear-door heat exchanger" on page 38
- "Site security considerations" on page 60

Floor and space requirements

Ensure that the location of the FlashSystem A9000R system meets floor and space requirements.

Procedure

Complete the following steps to ensure that the planned installation location meets space and floor load requirements:

1. Decide whether the FlashSystem A9000R system is to be installed on a raised floor. See "Raised or non-raised floor considerations" on page 20.
2. Determine whether the floor meets the floor-load requirements for the FlashSystem A9000R system. See "Floor-load requirements" on page 21.
3. Calculate the amount of space needed for the rack footprint and service clearance requirements. See "Rack dimensions and service clearance requirements" on page 22.

4. Determine where to place the rack in the installation site, based on the floor-load and space requirements.
5. If the location has a raised floor, prepare the raised floor with cable cutouts and required ventilation. See “Preparing for raised-floor installation and cabling” on page 24.
6. If the location is not a raised floor, resolve any safety concerns that are caused by the location of overhead-cable exits and cable routing. See “Preparing for non-raised-floor installation and cabling” on page 25.
7. Provide your IBM service representative with the following information before the installation:
   a. Whether under-floor or over-head power-cabling scheme is to be used.
   b. The distance of the rack from the power receptacles.
8. If a rear-door heat exchanger is being ordered, be sure to follow instructions in “Preparing for the rear-door heat exchanger” on page 26.
9. If absorbent padding is used where the rack casters (wheels) are located, be sure to follow instructions in “Bottom rack dimensions” on page 23.

Raised or non-raised floor considerations

The IBM FlashSystem A9000R storage system can be installed on a raised or a non-raised floor.

Raised floor considerations

Installing the racks on a raised floor provides the following benefits:

- Improves operational efficiency and provides greater flexibility in the arrangement of equipment.
- Increases air circulation for better cooling.
- Protects the interconnecting cables and power receptacles.
- Prevents tripping hazards because cables can be routed underneath the raised floor.

When you install on a raised floor, consider the following factors:

- The raised floor must be constructed of fire-resistant or noncombustible material.
- Avoid the exposure of metal or highly conductive material at ground potential to the walking surface when a metallic raised floor structure is used. Such exposure is considered an electrical safety hazard.
- The raised floor height must be at least 30.5 cm (12 in.). Clearance must be adequate to accommodate interconnecting cables, Fibre Channel (FC) cable raceways, power distribution, and any piping that is present under the floor. Floors with greater raised floor heights allow for better equipment cooling.
- When a raised floor tile is cut for cable entry or air supply, an extra floor tile support (pedestal) might be required to restore the structural integrity of the panel to the previous requirement.
- The use of a protective covering (such as plywood, tempered masonite, or plyron) is required to prevent damage to floor tiles, carpeting, and panels while equipment is being moved into or is relocated within the installation site. When the equipment is moved, the dynamic load on the casters is greater than when the equipment is stationary.
- Concrete subfloors require treatment to prevent the release of dust.

- Use noncombustible protective molding to eliminate sharp edges on all floor cutouts to prevent damage to cables and hoses, and to prevent casters from rolling into the floor cutout.
- Seal raised-floor cable openings to prevent the escape of chilled air.
- Pedestals must be firmly attached to the structural (concrete) floor by using an adhesive.

For more information, see "Preparing for raised-floor installation and cabling" on page 24.

Non-raised floor considerations

Raised floors are preferred because they provide better support for the cabling and to ensure efficient cooling for the FlashSystem A9000R system; however, overhead cabling at the rear of the rack is available when the FlashSystem A9000R system is installed on a non-raised floor.

Unlike raised-floor cabling, the installation planning, cable length, and the rack location, in relation to the cable opening at the top of the rack, are critical to the successful installation when using overhead cabling.

For more information, see "Preparing for non-raised-floor installation and cabling" on page 25.

Floor-load requirements

You must ensure that the floor load rating can support the weight of the FlashSystem A9000R system.

Floor reinforcement must support the weight of the FlashSystem A9000R system over a specific area, as shown in Table 5. These measurements are slightly less than the footprint area of the system, due to the overhang of the door.

To support future scale-out capability (MES) upgrades, the installation site must provide floor weight-support requirements to support a full rack configuration.

Table 5. Floor weight-support requirements

Grid element configuration	Floor reinforcement area	Total weight
12 grid controllers and 6 flash enclosures	66 cm × 118 cm (26 in. × 46.5 in.)	935 kg (2061 lbs)
10 grid controllers and 5 flash enclosures	66 cm × 118 cm (26 in. × 46.5 in.)	855 kg (1885 lbs)
8 grid controllers and 4 flash enclosures	66 cm × 118 cm (26 in. × 46.5 in.)	774 kg (1706 lbs)
6 grid controllers and 3 flash enclosures	66 cm × 118 cm (26 in. × 46.5 in.)	695 kg (1532 lbs)
4 grid controllers and 2 flash enclosures	66 cm × 118 cm (26 in. × 46.5 in.)	616 kg (1358 lbs)

Note: The same floor-loading requirements apply to partially populated and fully populated racks.

The rear-door heat exchanger adds more weight to the rack. For information about the weight of an empty and filled door, see “Rear-door heat exchanger” on page 15.

To ensure that all requirements are met, obtain the service of a qualified structural engineer to prepare the floor.

Important: If you do not know or are not certain about the floor-load rating of the installation site, you must check with the building engineer or another appropriate person.

Rack dimensions and service clearance requirements

The installation site must accommodate the rack dimensions and minimum service clearance for the FlashSystem A9000R system.

The IBM service representative must have enough space to open the front and rear covers to service the FlashSystem A9000R system, including removing components and other assemblies from the FlashSystem A9000R system.

Notes:

- You can position racks no closer than 45 cm (17.7 in.) to a wall.
- You can position racks alongside (next to) other racks.
- Because several rack designs are available from IBM and other vendors, space between adjacent racks might be required to open the door for service. You must determine the space requirement at the time of installation.

Table 6 and Figure 10 on page 23 describe dimensions and minimum service clearance for the FlashSystem A9000R system.

Table 6. Rack dimensions and clearance requirements

Dimension	Clearance
Height	201.5 cm (79.3 in.)
Depth	129.7 cm (51.1 in.)
Width	64.4 cm (25.4 in.)
Front clearance	120 cm (47.2 in.)
Rear clearance	100 cm (39.4 in.)
Side (door) clearance	10 cm (3.9 in.)

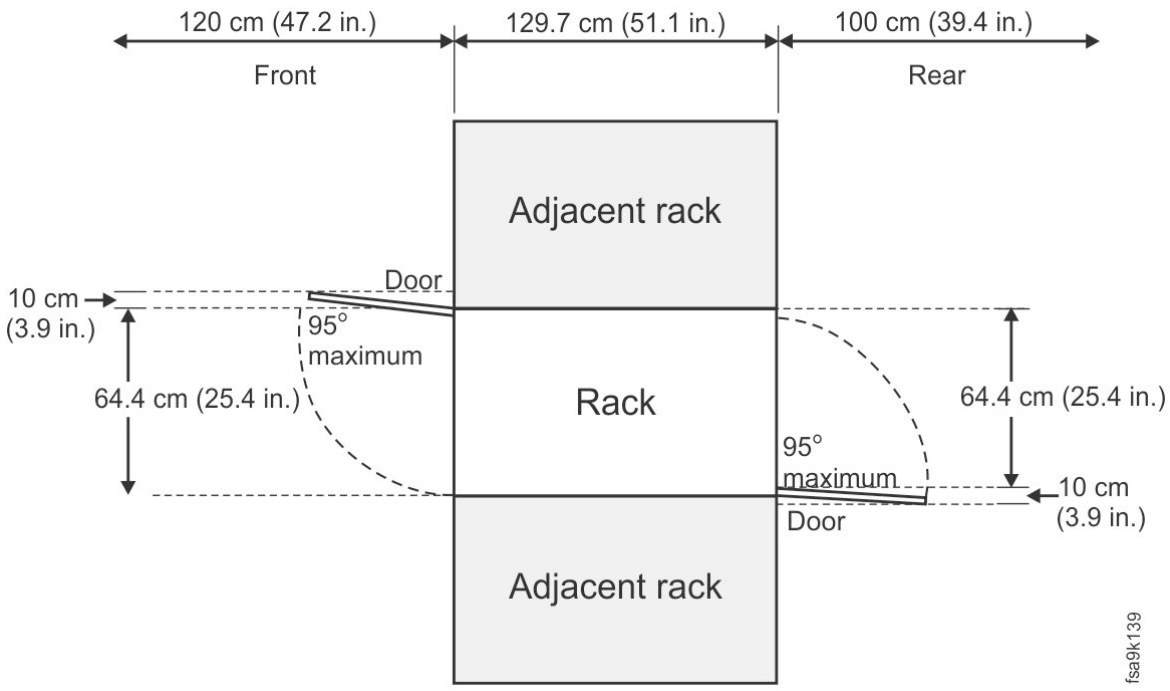


Figure 10. Clearance requirements for servicing the FlashSystem A9000R rack

Bottom rack dimensions

When using absorbent padding where the rack casters (wheels) are located, use this information for proper pad placement.

Figure 11 on page 24 shows the bottom rack dimensions and castor placements.

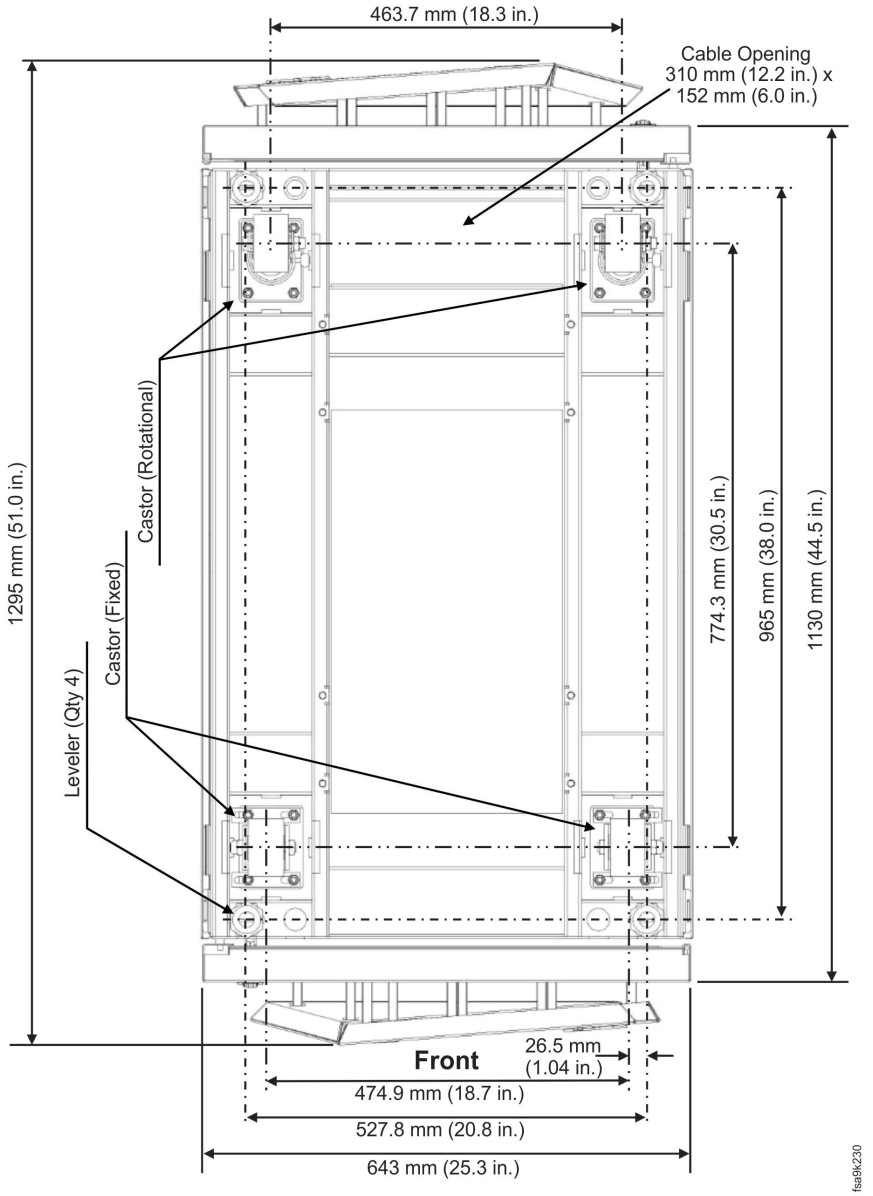


Figure 11. Bottom rack dimensions and castor placements

Preparing for raised-floor installation and cabling

Prepare the raised floor with cable cutouts, required ventilation, and additional floor support, if necessary.

Procedure

Complete the following steps to prepare for cabling each FlashSystem A9000R based on raised floor with 60 × 60 cm (24 × 24 in.) tiles:

1. Based on your planned layout, ensure that the installation site can accommodate the locations of the cables exiting each FlashSystem A9000R rack.
2. Plan for the FlashSystem A9000R system to be positioned on two tiles, with the rear of the rack aligned on a floor-tile seam and with two full rows of

perforated tiles immediately in front of the rack (see Figure 12).

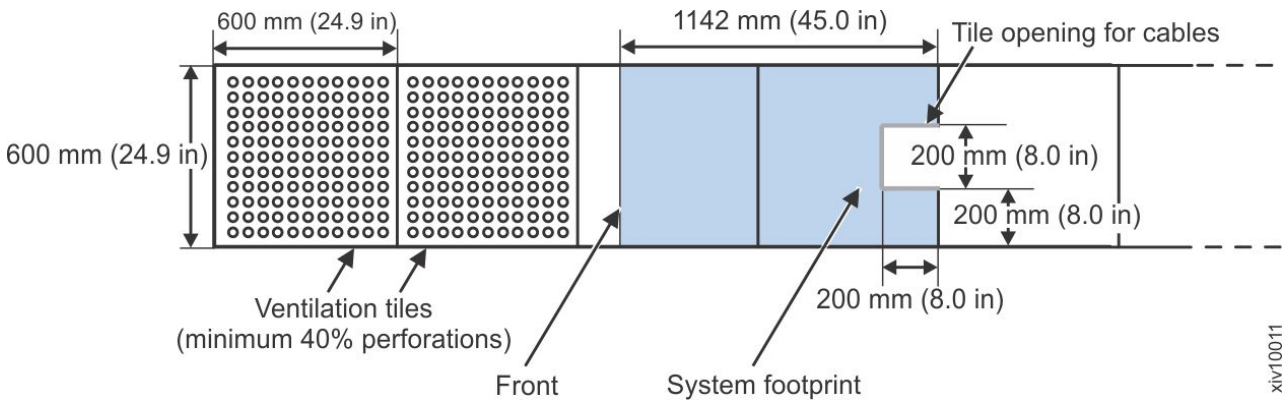


Figure 12. Raised floor requirements

3. Cut a 200 × 200 mm (8 × 8 in.) opening in the rear floor tile for under-floor cabling and electricity (see Figure 12).

Notes:

- Place the opening under the FlashSystem A9000R system, centered on the back edge of the tile along the rear of the rack.
- Sizing the cutout correctly is important. An oversized cutout permits excessive cooling loss and weakens the floor tile. An undersized cutout must be enlarged, which causes an installation delay while the tile is replaced or the cutout is enlarged.

4. To allow for ventilation for airflow and support system cooling requirements, have at least two tiles (and preferably more) in front of the FlashSystem A9000R system (see Figure 12). These tiles must have a minimum of 40% perforation.
5. If the rear-door heat exchanger is ordered, see "Raised floor hose requirements and management" on page 51 for additional floor preparation steps.

Preparing for non-raised-floor installation and cabling

Prepare the installation site to accommodate overhead cabling for mainline-power cables, customer Fibre Channel (FC) and Ethernet host cables as well as network Ethernet cables.

Using overhead cabling provides many of the cooling and safety benefits that are provided by raised flooring in a non-raised floor environment.

Unlike raised-floor cabling, the installation planning, cable length, and the system location in relation to the cable entry point are critical to the successful installation of a top cable exit.

Notes:

- Main power cables are routed to the rack by the customer, and internally routed and connected by an IBM service representative.
- Host-attachment cables are internally routed and connected by either the customer or by an IBM service representative.
- All remaining cables are internally routed and connected by an IBM service representative.

If the rear-door heat exchanger is ordered, see "Non-raised floor hose requirements and management" on page 55 for more floor preparation steps.

Installation and safety requirements

If the cables are too long, there might not be enough room inside of the rack to handle the extra length and the extra cable might interfere with the servicing tasks, preventing concurrent repair.

IBM Corporate Safety restricts the servicing of your overhead equipment to a maximum of 10 feet from the floor. Therefore, your power source must not exceed 10 feet from the floor and must be within 5 feet of the top of the rack.

Servicing any overhead equipment higher than 10 feet requires a special bid contract. Contact your IBM Representative for more information about special bids.

Preparing for the rear-door heat exchanger

An optional rear-door heat exchanger (feature code AFR1) may be ordered to help cool your system.

To complete the rear-door heat exchanger site preparation, follow the instructions in "Planning for the rear-door heat exchanger" on page 38.

Power requirements

Ensure that your operating environment meets the AC-power and voltage requirements.

The FlashSystem A9000R system is designed with backup battery modules in order to maintain power to the storage system in the event of an AC-power loss.

The FlashSystem A9000R system has redundant main power cables. For two-main-power-cable configuration, you must supply power from two independent sources of electricity.

Consult with an IBM service representative to discuss power source options for the four-main-power-cable configuration.

Note: Removing all AC power from the FlashSystem A9000R system causes an emergency shutdown. All modified data is then saved to drives, and the system turns off within 5 minutes.

Customer responsibilities

- You must supply enough branch circuits to prevent overloading from the equipment that you install.
- You must ensure that each electrical outlet is correctly wired and grounded to prevent an electrical shock.

IBM responsibilities

- The IBM service representative completes several checks, including voltage and grounding checks before the power to the FlashSystem A9000R system is connected.
- The IBM service representative connects power to the racks and initially powers on the equipment.

Power outlet requirements

Ensure that the installation site has the required power outlets.

Two independent power outlets are required for the two main power cords that are needed by each FlashSystem A9000R system.

Important: To eliminate a single point of failure, the outlets must be independent. This means that each outlet must use a separate power source and each power source must have its own wall circuit breaker.

For the most reliable operation, do not use Ground Fault Circuit Interrupter (GFCI), Earth Leakage Circuit Breaker (ELCB), and Residual Current Circuit Breaker (RCCB) type circuit breakers with the FlashSystem A9000R system.

The FlashSystem A9000R system is certified for safe operation and is compliant with IEC, EN, UL, CSA 60950-1 standards. However, if leakage detection circuit breakers are required by local electrical practice, the breakers must be sized for a leakage-current rating of 100 mA or greater to reduce the risk of server outage caused by erroneous and spurious tripping.

Power sources

Several AC power source configurations are available.

- Four 60/63 A, 200-240 V AC, North American, EMEA, and Japan single-phase receptacles, each connected to a different power source.
- Two 60 A, 200-240 V AC, US and Japan delta three-phase receptacles, each connected to a different power source.
- Two 30/32 A, 200-240 V AC (Line-to-Neutral [LN]), EMEA WYE three-phase receptacles, each connected to a different power source

The storage system is protected from a power outage by internal backup battery modules. However, you can reduce the risk of a power outage by connecting the system to an external uninterruptible power supply, a backup generator, or both.

Power consumption

This information describes the power consumption for partial and full rack configurations.

Table 7 on page 28 lists the power consumption for each rack configuration.

The power consumption for partial-rack configurations is the typical value and is provided only for reference purposes.

To support concurrent capacity upgrades (scale-out procedures), the installation site must provide sufficient power capacity to support performance on the new rack configuration.

Note: It is highly recommended that the installation site supports the requirements for a full rack system, in order to support any future capacity upgrade procedures.

The measurements in the Table 7 was taken in an environment with a room temperature of 18°C (64.4°F), all fans at nominal/idle speed, and battery modules were not charging.

Table 7. Power consumption

Configuration	2.9 TB MicroLatency modules[1] Idle / light load power consumption in kVA	5.7 TB MicroLatency modules Idle / light load power consumption in kVA
4 grid controllers and 2 flash enclosures	3.420	3.820
6 grid controllers and 3 flash enclosures	5.034	5.634
8 grid controllers and 4 flash enclosures	6.448	7.448
10 grid controllers and 5 flash enclosures	8.262	9.262
12 grid controllers and 6 flash enclosures	9.876	11.076
[1]The numbers for power consumption of 2.9 TB MicroLatency modules are estimates.		

Input voltages and frequencies

This information lists the voltages or frequencies that are accepted by the FlashSystem A9000R system.

Table 8 provides the voltages and frequencies that are accepted by the FlashSystem A9000R system. For more information, see “Leakage current” on page xiv.

Table 8. Input voltages and frequencies

Characteristics	3 Ø △ (3-phase Delta) (3W +PE) voltage or frequency	3 Ø Y (3-phase Wye) (3W + N+ PE) voltage or frequency	1 Ø (Single-phase, Line-to-Neutral (LN) or Line-to-Line (LL))
Nominal input operating rated range voltages	200 - 240 V AC	LL: 346 - 415 V AC LN: 200 - 240 V AC	200 - 240 V AC
Maximum branch circuit protection rating	60/63 A	30/32 A	60/63 A
Minimum tolerant input voltage	180 V AC	LL: 312 V AC LN: 180 V AC	180 V AC

Table 8. Input voltages and frequencies (continued)

Characteristics	3 Ø △ (3-phase Delta) (3W +PE) voltage or frequency	3 Ø Y (3-phase Wye) (3W + N+ PE) voltage or frequency	1 Ø (Single-phase, Line-to-Neutral (LN) or Line-to-Line (LL))
Maximum tolerant input voltage	264 V AC	LL: 457 V AC LN: 264 V AC	264 V AC
Maximum ground-leakage current	3.84 mA	3.45 mA	11.6 mA
Steady-state input frequencies	50±3 Hz or 60±3 Hz	50±3 Hz or 60±3 Hz	50±3 Hz or 60±3 Hz
Power line disturbance (PLD) input frequencies	50±3 Hz or 60±3 Hz	50±3 Hz or 60±3 Hz	50±3 Hz or 60±3 Hz

Main power cables specifications

Plan for power cable, connector, and receptacle requirements.

The FlashSystem A9000R system is available in multiple main power cable configurations.

Attention: The regional designations are general. If the input voltage for the country uses a wye circuit, use the appropriate main power cables for EMEA (Europe, Middle East, and Africa) and Asia/Pacific.

If input voltage for the country uses a delta circuit, use the appropriate main power cables for United States, Canada, Latin America.

For more information about electric currents for various countries, see the International Trade Administration website (http://trade.gov/publications/abstracts/electric-current-abroad-2002.asp).

Main power cable feature codes

The following table provides the feature codes and description details for each main power cable.

Note: The main power cables are provided with the connector feature codes listed in the following table. Receptacle feature codes in the following table are recommended.

Although equivalent receptacles can be used, it is the responsibility of the customer to verify compatibility.

Table 9. Main power cables

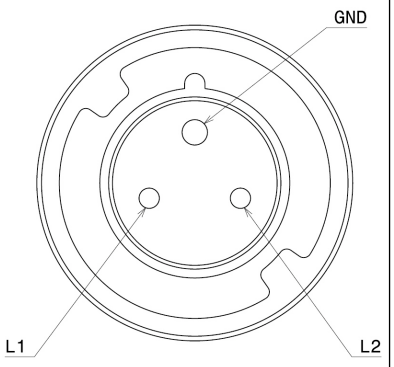
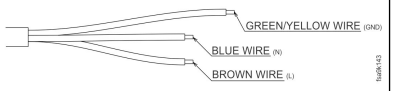
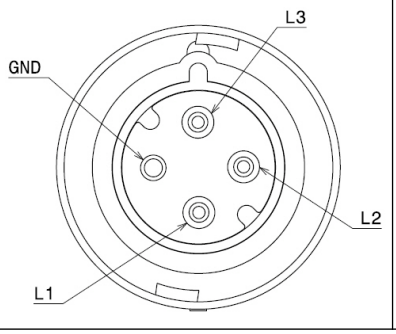
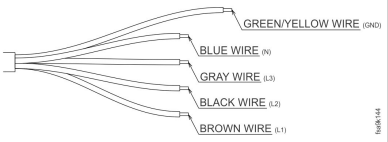
Main-power cable feature code	Wall connector	Description	Line cord connector	Customer facility	Inline receptacle	System (PDU) connector
1050	60A-250VAC-IEC309-2P3W-IP67	Main-power cable for United States, Canada, Latin America, and Japan (other regions can optionally order); single-phase, 60 A plug-class (or 60 A rated class plug), two conductors+ground with plug 	Hubbell HBL360P6V04	Hubbell HBL360R6W	Hubbell HBL360C6W	70A-500VAC(RMS)-3pos
1051	N/A	Main-power cable for Europe, Middle East, and Asia/Pacific (except Japan); single-phase, 60/63 A rated branch-circuit class, two conductors+ground, hardwired 	Hardwired or uses client-provided connector	Hardwired AC supply	N/A	70A-500VAC(RMS)-3pos
1052	60A-250VAC-IEC309-3P4W-IP67	Main power cable for United States, Canada, Latin America, and Japan; three-phase delta, 60 A rated plug-class, three wires+ground with plug 	Hubbell HBL460P9V05	Hubbell HBL460R9W	Hubbell HBL460C9W	70A-500VAC(RMS)-4pos

Table 9. Main power cables (continued)

Main-power cable feature code	Wall connector	Description	Line cord connector	Customer facility	Inline receptacle	System (PDU) connector
1053	N/A	Main power cable for Europe, Middle East, Asia/Pacific (except Japan), Australia, and New Zealand; three-phase wye, 30/32 A rated branch-circuit class, three wires+neutral + ground, hardwired 	Hardwired or uses client-provided connector	Hardwired AC supply	N/A	35A-500VAC(RMS)-5pos

Main power cable considerations

The following information provides details to consider regarding main power cables for IBM FlashSystem A9000R systems:

- Main power cables are up to 250 V 60/63 A or 250 V 30/32 A rated maximum branch circuit classes.

  Single-phase main power cables have two conductors (where the second conductor may be referred to as L2 or N, depending on the installation region mains type implementation) and three wires.

  Three-phase main power cables have three poles and four wires, or four poles and five wires.

  Plugs and receptacles for feature codes 1050 and 1052 are IEC309-compliant.
- Bulk wire conductor sizes for main power cable feature codes are:
  - 1050, 1051, and 1052: 8 AWG
  - 1053: 6 mm^2
- The main power cables extend 4.1 m (13 ft 4 in.) when they exit from the top of the frame and 4.3 m (14 ft) when they exit from the bottom of the frame.
- Some feature codes have specific wall circuit-breaker requirements:

Attention: Do not exceed the wire rating of the facility. Wall circuit breakers must be appropriate for power-supply applications to allow internal circuit breakers to function correctly and to avoid unnecessary service.

  - Single-phase installations (200 V - 240 V) and two main power cables require wall circuit breakers that have a rating of 60 A to 63 A.
  - Three-phase delta installations (200 V - 240 V) require wall circuit breakers that have a rating of 30 A to 60 A.
  - Three-phase wye installations (220 V - 240 V (Line-to-Neutral [LN])) require wall circuit breakers that have a rating of 30 A to 32 A.

  For the most reliable operation, do not use Ground Fault Circuit Interrupter (GFCI), Earth Leakage Circuit Breaker (ELCB), and Residual Current® Circuit Breaker (RCCB) type circuit breakers with the FlashSystem A9000R system.

The storage system is certified for safe operation and is compliant with IEC, EN, UL, CSA 60950-1 standards. However, if leakage detection circuit breakers are required by local electrical practice, the breakers must be sized for a leakage-current rating of 100 mA or greater to reduce the risk of server outage caused by erroneous and spurious tripping. For more information, see "Leakage current" on page xiv.

- Main power cables with the following feature codes must meet specific design certifications:
  - 1050 and 1052 use bulk wire that meets UL and CSA safety agency certifications, but not the EU harmonization certification.
  - 1051 and 1053 use bulk wire that meets the EU harmonization certification, but not UL and CSA safety agency certifications.

Environmental requirements

Ensure that the installation site meets all operating environment requirements for the IBM FlashSystem A9000R system.

Procedure

To ensure that the installation site meets the requirements, complete the following steps:

1. Use adequate ventilation, especially during the first 120 days of continuous operation. Ensure that there is an average room outdoor intake air rate of 0.4 air change per hour.
2. Keep the front and rear of the rack clear of obstruction.
3. Verify that you can meet the environmental operating requirements at the air intake locations.
4. Consider optimizing the air circulation and cooling for the rack by using a raised floor, adjusting the floor layout, and adding perforated tiles around the air intake areas.

   The following sections cover the environmental requirements for your FlashSystem A9000R system:

   - "Operating and shipping environment requirements"
   - "Air circulation and cooling" on page 33
   - "Contamination information" on page 35
   - "Acoustic declaration" on page 37
   - "Operating vibration requirements" on page 37

Operating and shipping environment requirements

You must verify that your operating environment is compatible with the required specifications.

With or without the rear-door heat exchanger option, the air that enters the front door of the FlashSystem A9000R system must meet the following requirements.

Operating (powered on)

- Temperature: 10 - 35°C (50 - 95°F)
- Relative humidity: 20 - 80%, non-condensing
- Maximum wet bulb temperature: 25°C (77°F)
- Maximum altitude: 2134 m (7000 ft)

Non-operating (powered off)

- Temperature: 5 - 45°C (41 - 113°F)
- Relative humidity: 20 - 80%, non-condensing
- Maximum wet bulb temperature: 27°C (80.6°F)

Shipping

- Temperature: -40 to 60°C (-40 to 140°F)
- Relative humidity: 5 - 95%, non-condensing
- Maximum wet bulb temperature: 29°C (84.2°F)

Important: A FlashSystem A9000R system that runs continuously must be within the specified operating environment.

A storage system can operate at the maximum allowable temperature for only short durations, such as might occur during a disk drive module or power-supply unit replacement.

Continuous operation above the maximum temperature increases the probability of component failure.

Air enters at the front of the rack and leaves at the back. To prevent the air that is leaving the rack from entering the intake of another piece of equipment, place racks in alternate rows, in a back-to-back, and front-to-front arrangement.

Align the front of racks on a floor-tile seam, with a full line of perforated tiles immediately in front of the rack.

System environmental acclimation

Condensation is a normal and natural occurrence if packaging is removed at time of delivery, during extreme cold weather delivery times.

All IBM equipment has been tested in climate chambers duplicating shipping temperatures of - 40°C (- 40°F) to 60°C (140°F) and condensation and frost do not impact reliability of the product.

It is highly recommended that the device not be removed from the shipping package for at least 24 hours, in order to acclimate to the new temperature conditions. If there are still visible signs of condensation after the initial 24 hour wait period, acclimate the system without the shipping bag for an additional 12 - 24 hours, or until no further visible condensation remains. If package material removal is necessary, equipment should be placed in a location away from any air vents.

Air circulation and cooling

You can take steps to optimize the air circulation and cooling for your IBM FlashSystem A9000R system.

Procedure

To optimize the cooling around your FlashSystem A9000R system, complete the following steps:

1. Install the FlashSystem A9000R system on a raised floor, which provides increased air circulation for better cooling.

   For more information, see “Raised or non-raised floor considerations” on page 20.

2. Install perforated tiles in the front and back of each base rack and expansion rack as follows:
   a. For a stand-alone base rack, install two fully perforated tiles in front of the base rack and one partially perforated tile at the back of the base rack.
   b. For a row of racks, install a row of perforated tiles in front of the racks and one or two fully perforated tiles at the back of each two racks.
   c. For groupings of racks, where a hot aisle and cold aisle layout is used, use a cold aisle row of perforated tiles in front of all racks. For hot aisles, install a perforated tile per pair of racks.

   For more information, see "Preparing for non-raised-floor installation and cabling" on page 25.
3. Consider using the rear-door heat exchanger (feature code AFR1) to reduce the temperature of the air that leaves the rack.

   The rear-door heat exchanger is a water-cooled door that is designed to remove heat that is generated from the rack before it enters the computer room. The door uses standard fittings and couplings. The door removes up to 50,000 BTUs of heat, which is approximately 15 kW, from the air that exits a rack that is full of servers.

   The rear-door heat exchanger can increase server density without increasing cooling requirements, making the option a more cost-effective solution than adding an air-conditioning unit. This door is an effective solution for a data center at the limit of its cooling capacity, but that still has usable floor space to add racks. The rear-door heat exchanger is also an efficient way to deal with computer room hotspots.

   For more information, see "Rear-door heat exchanger" on page 15.
4. Ensure that the installation site meets the cooling (thermal dissipation) requirements that are listed in Table 10.

   To support future scale-out capability (MES) upgrades, the installation site must provide cooling arrangements to support a full rack configuration.

Table 10. Thermal dissipation for FlashSystem A9000R system

Storage configuration	Thermal Dissipation kBTU/hour
4 grid controllers and 2 flash enclosures	16.4
6 grid controllers and 3 flash enclosures	24.14
8 grid controllers and 4 flash enclosures	31.96
10 grid controllers and 5 flash enclosures	39.6
12 grid controllers and 6 flash enclosures	47.3

5. Ensure that the installation site meets the airflow requirements that are listed in Table 11 on page 35.

   To support future scale-out capability (MES) upgrades, the installation site must provide sufficient air flow to support a full rack configuration.

Table 11. Airflow requirements

Storage configuration	Cubic feet per minute (CFM)	
	Nominal temperature (23°C) (73.4°F)	**Maximum temperature (35°C) (95°F)**
4 grid controllers and 2 flash enclosures	530	970
6 grid controllers and 3 flash enclosures	730	1330
8 grid controllers and 4 flash enclosures	940	1680
10 grid controllers and 5 flash enclosures	1140	2030
12 grid controllers and 6 flash enclosures	1340	2390

Temperature threshold and events

The storage system handles overheating by informing the administrator through warning events and initiating an automatic thermal shutdown as a last resort.

Notes:

- These event notifications indicate to the administrators if the system temperature is: normal, high, too high, and critically high; above which shutdown will be applied immediately. Table 12 depicts the temperature thresholds and events received.
- After a manual or automatic thermal shutdown due to thermal conditions, IBM support must be immediately contacted. Do not attempt to power up the system before contacting IBM support.

Table 12. FlashSystem A9000R system temperature thresholds and events

Temperature threshold	Event	Description
27°C (80°F)	SYSTEM_TEMPERATURE_IS_OK_NOW	No action required. This event is generated only when the normal system temperature is recovered from a higher temperature.
28°C (82.4°F)	SYSTEM_TEMPERATURE_IS_ABOVE_NORMAL	System temperature is above normal temperature range.
30°C (86°F)	SYSTEM_TEMPERATURE_IS_HIGH	System should be closely monitored, and action to cool down the system is recommended.
32°C (89.6°F)	SYSTEM_TEMPERATURE_IS_TOO_HIGH	Actions to cool down the system must be taken immediately.
35°C (95°F)	SYSTEM_TEMPERATURE_IS_CRITICALLY_HIGH	Manually shutdown the system by using the **shutdown** command.
38°C (100.4°F)	SYSTEM_TEMPERATURE_IS_CRITICALLY_HIGH_ SHUTTING_DOWN	Automatic system shutdown is in progress.

Contamination information

You must consider the air quality and contamination levels at your installation site.

Airborne particulates (including metal flakes or particles) and reactive gases acting alone or in combination with other environmental factors, such as humidity or

temperature, might pose a risk to the FlashSystem A9000R system hardware. Risks that are posed by the presence of excessive particulate levels or concentrations of harmful gases include damage that might cause the FlashSystem A9000R system to malfunction or cease functioning altogether. This specification describes limits for particulates and gases that are intended to avoid such damage. The limits must not be viewed or used as definitive limits because numerous other factors, such as temperature or moisture content of the air, can influence the impact of particulates or environmental corrosives and gaseous contaminant transfer.

In the absence of specific limits, implement practices that maintain particulate or gas levels that are consistent with the protection of human health and safety. If IBM determines that the levels of particulates or gases in your environment damaged the FlashSystem A9000R system, IBM might require implementation of appropriate remedial measures to mitigate such environmental contamination before providing repair or replacement of the FlashSystem A9000R system. Implementation of such remedial measures is a customer responsibility.

The following criteria must be met:

Gaseous contamination

Severity level G1 as per ANSI/ISA 71.04-1985[1], which states that the reactivity rate of copper coupons must be less than 300 Angstroms per month (Å/month, ≈ 0.0039 µg/cm^2-hour weight gain) [2]. In addition, the reactivity rate of silver coupons must be less than 300 Å/month (≈ 0.0035 µg/cm^2-hour weight gain) [3]. The reactive monitoring of gaseous corrosibleness must be conducted approximately 5 cm (2 in.) in front of the rack on the air inlet side at one-quarter and three-quarter frame height off the floor. For environments with special air handling equipment that alters the normal distribution of airflow into the rack, reactive monitoring of gaseous corrosibleness must be conducted at a location on the rack where air is entering at the highest rate.

Particulate contamination

Data centers must meet the cleanliness level of ISO 14644-1 class 8. For data centers without air-side economizers, the ISO 14644-1 class 8 cleanliness can be met by choosing one of the following filtration methods:

- The room air can be continuously filtered with MERV 8 filters.
- Air entering a data center can be filtered with MERV 11 or preferably MERV 13 filters.

For data centers with air-side economizers, the choice of filters to achieve ISO class 8 cleanliness depends on the specific conditions present at that data center. The deliquescence relative humidity of the particulate contamination must be more than 60% RH [4]. Data centers must be free of zinc whiskers [5].

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1. ANSI/ISA-71.04.1985. *Environmental conditions for process measurement and control systems: Airborne contaminants.* Instrument Society of America, Research Triangle Park, NC, 1985.
2. The derivation of the equivalence between the rate of copper corrosion product thickness growth in Å/month and the rate of weight gain assumes that Cu_2S and Cu_2O grow in equal proportions.
3. The derivation of the equivalence between the rate of silver corrosion product thickness growth in Å/month and the rate of weight gain assumes that Ag_2S is the only corrosion product.
4. The deliquescence relative humidity of particulate contamination is the relative humidity at which the dust absorbs enough water to become wet and promote corrosion, ion migration, or both.
5. Surface debris is randomly collected from 10 areas of the data center on a 1.5 cm (0.6 in.) diameter disk of sticky, electrically conductive tape on a metal stub. If examination of the sticky tape in a scanning electron microscope reveals no zinc whiskers, the data center is considered free of zinc whiskers.

Acoustic declaration

This information lists the acoustic (sound power) levels for the FlashSystem A9000R system.

CAUTION:

Depending upon local conditions, the sound pressure might exceed 85 dB(A) during service operations. Hearing protection must be worn when you are in a room that has a FlashSystem A9000R system while either the front or rear door is open or when the front and rear doors are not installed.

The acoustic levels are shown in Table 13. These measurements are based on a typical FlashSystem A9000R configuration with 8 grid controllers and 4 flash enclosures. All measurements are in conformance with ISO 7779 and declared in conformance with ISO 9296.

Notes:

1. LWAd is the statistical upper-limit A-weighted sound-power level (rounded to the nearest 0.1 B).
2. LpAm is the mean A-weighted emission sound-pressure level that is measured at the 1-meter bystander positions (rounded to the nearest dB).
3. 10 dB (decibel) = 1 B (bel)

Table 13. Acoustic declaration

	Declared A-weighted sound power level, LWAd (B)	**Declared A-weighted sound pressure level, LpAm (dB)**
Operating	8.0	62
Idle	8.0	62

Note: Government regulations (such as those prescribed by OSHA or European Community Directives) may govern noise level exposure in the workplace and may apply to you and your server installation. The actual sound pressure levels in your installation depend upon a variety of factors, including the number of racks in the installation; the size, materials, and configuration of the room; the noise levels from other equipment; the room ambient temperature, and employees' location in relation to the equipment. Further, compliance with such government regulations also depends upon a variety of additional factors, including the duration of employee exposure and whether employees wear hearing protection. IBM recommends that you consult with qualified experts in this field to determine whether you are in compliance with the applicable regulations.

Operating vibration requirements

The vibration levels that are designed for the FlashSystem A9000R system comply with class V1L requirements included in the product classes for vibration.

The FlashSystem A9000R system is designed to operate under the vibration V1L levels that are described in the following table. More information includes random vibration PSD profile breakpoints and operational shock levels.

Table 14. Vibration levels

Class	***g*rms**	***g* Peak Sine**
V1L	0.10	0.06 @ 50 & 60 Hz
Notes: • All values in this table are in g^2/Hz. • *g* is the peak *g* level of an approximate half-sine pulse.		

Table 15. Random vibration PSD profile breakpoints

Class	**5 Hz**	**17 Hz**	**500 Hz**
V1L	2.0×10^{-7}	2.2×10^{-5}	2.2×10^{-5}
Note: All values in this table are in g^2/Hz.			

Table 16. Operational shock levels

Class	**Axis**	g^1	**pw**[2]
1	Vertical	3.5	3.0
Notes: • *g* is the peak *g* level of an approximate half-sine pulse. • *pw* is the pulse width in milliseconds.			

Planning for the rear-door heat exchanger

If the optional rear-door heat exchanger (feature code AFR1) was ordered, you must prepare the installation site before an IBM service representative can install the rear-door heat exchanger on any of your FlashSystem A9000R.

See the following information in order to properly plan for your rear-door heat exchanger:

- "Rear-door heat exchanger operating specifications"
- "Rear-door heat exchanger performance" on page 39
- "Preparing your site to provide water to the rear-door heat exchanger" on page 41
- "Secondary cooling loop parts and services information" on page 57
- "Maintenance schedule" on page 60

Rear-door heat exchanger operating specifications

Rear-door heat exchanger operating specifications provide detailed information for your heat exchanger, including dimensions, weight, air source, water source, water pressure, and water volume.

The following table shows the specifications for the rear-door heat exchanger.

Table 17. Rear-door heat exchanger specifications

Door specifications	Air specifications	Water specifications
Door size • Depth: 142.6 mm (5.6 in.) • Height: 1945.4 mm (76.6 in.) • Width: 639 mm (25.2 in.) **Heat exchanger size** • Depth: 67 mm (2.6 in.) • Height: 1791.3 mm (70.5 in.) • Width: 438.6 mm (17.3 in.) **Door assembly weight** • Empty: 29.9 kg (66 lb) • Filled: 35.6 kg (78.5 lb) **Door heat removal capacity** • For examples of door heat removal capacity, see the illustrations in "Rear-door heat exchanger performance." • In general, the door heat removal capacity percentage increases if one or more of the following events occur: – The water temperature decreases. – The water flow increases. – The server heat loads decrease. • The door heat removal capacity varies with water temperature, water flow rate, air temperature and flow, and total heat load of the servers; however, a typical high-load cabinet (20 - 32 kW or approximately 70 000 - 105 000 Btu per hour) can achieve 55% - 85% heat removal.	**Air movement** • Provided by servers and other devices in the rack. No additional air moving devices are required. **Air source for servers** • Room air for front of the rack. Air is exhausted from the servers, moves through the heat exchanger, and exits into the room (open loop). **Air temperature drop** • With high-heat-load devices, up to 25°C (45°F) between the air that exits the rack devices and the air that exits the heat exchanger. **Air impedance** • Air pressure drop across the heat exchanger is equivalent to that of the IBM acoustic rear door	**Water source** • User-supplied, compliant with specifications in this document. • Couplings on door: 19 mm (0.75 in.) • ID hose required: 19 mm (0.75 in.) minimum **Water pressure** • Normal operation: <137.93 kPa (20 psi) • Maximum: 689.66 kPa (100 psi) • Pressure drop across heat exchanger: approximately 48 kPa (7 psi) **Water volume** • Exchanger: approximately 2.8 liters (0.75 gallons) • Exchanger plus supply and return hoses to the pump unit: Maximum of approximately 15.1 liters (4.0 gallons) excluding pump unit piping and reservoir **Water temperature** • If no dew point control:18°C ±1°C (64.4°F ±1.8°F) • If the water supply can monitor and adjust the relative-to-room dew point, lower temperature water is allowed. **Required water flow rate** (as measured at the supply entrance to the heat exchanger) • Minimum: 22.7 liters (6 gallons) per minute • Maximum: 37.9 liters (10 gallons) per minute

Rear-door heat exchanger performance

This information describes the performance of the rear-door heat exchanger.

An example of expected performance of the rear-door heat exchanger is illustrated in Figure 13 on page 40 for a typical inlet air temperature of 24 °C (75.2 °F), with a fully populated rack near uniform power dissipation, 32 kW heat load, and the node fans running near nominal fan speed (1530 cfm). By selecting the water inlet temperature and water flow rate, you can estimate the indicated heat removal.

These levels can be achieved with normal cable exits from the rack and with a small amount of hot air bypass at the base of the door (small amounts of hot air might escape from the rack without being cooled by the door).

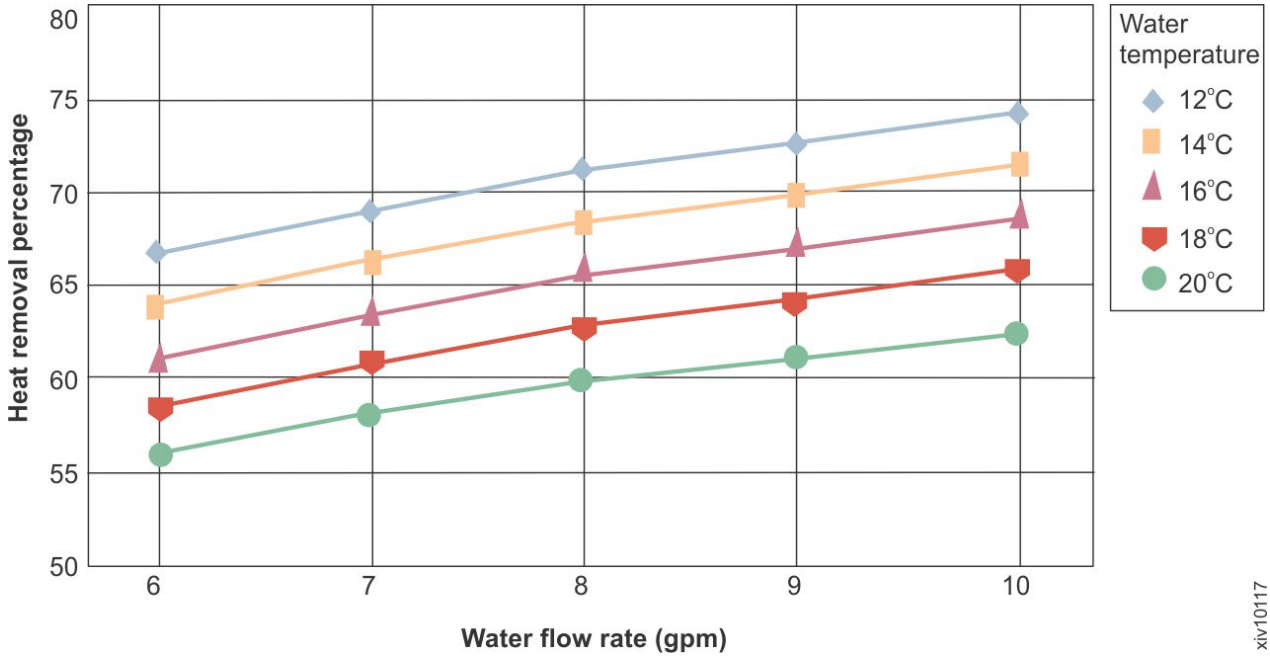


Figure 13. Typical performance of a rear-door heat exchanger, 32 kW heat load. Percentage heat removal as function of water temperature and flow rate. (24°C (75.2 °F) rack inlet air, 32 kW rack load, 1530 cfm air through the rear-door heat exchanger)

Water temperatures below 18°C (64.4°F) can be used only if the system that is supplying the water is able to measure the room dew point conditions and is able to automatically adjust the water temperature.

Another example of performance data is shown in Figure 14 on page 41 for identical conditions as in Figure 13, except reflecting a 20 kW heat load. Because of the lower heat load, a specific level of cooling can be achieved with warmer water, a lower flow rate, or both.

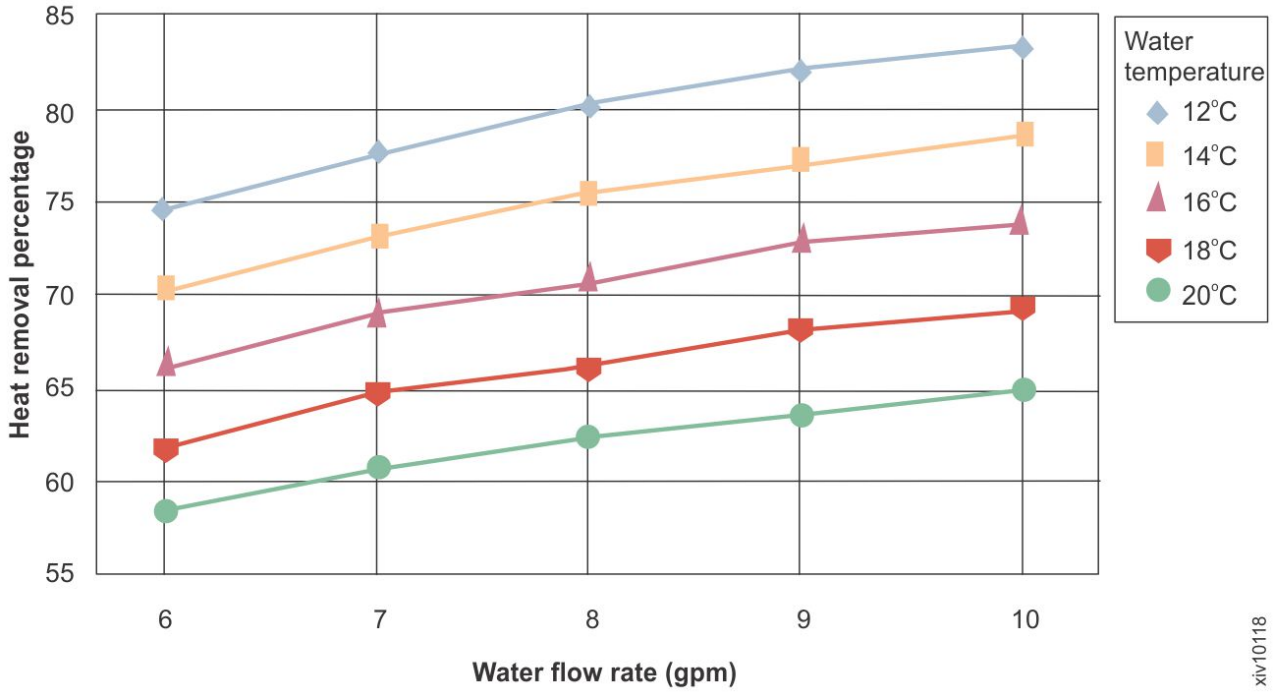


Figure 14. Typical performance of a rear-door heat exchanger, 20 kW heat load. Percentage heat removal as function of water temperature and flow rate. (24°C (75.2 °F) rack inlet air, 20 kW rack load, 1530 cfm air through the rear-door heat exchanger)

Preparing your site to provide water to the rear-door heat exchanger

You must prepare your site to provide water to the rear-door heat exchanger before the rack can be installed.

The following requirements must be met before the rear-door heat exchanger can be installed:

- Provide chilled, conditioned water that meets the specifications.
- Procure and install the water supply system that is suitable for your data center.
- Provide a redundant secondary-cooling-loop water supply or enough room air conditioning to handle a tolerable heat load if the function of one or more of the heat exchangers is compromised. If the rear door is opened for rack maintenance or if conditioned water supply to the door is stopped, the rack heat load is sent into the room and must be handled by room air conditioning until the conditioned water supply is restored.
- Provide floor or ceiling tile cutouts or protective coverings to avoid tripping hazards on non-raised floors as part of hose management.

This information can be found in the following sections:

- "Water specifications for the secondary cooling loop" on page 42
- "Water delivery specifications for secondary loops" on page 44
- "Raised floor hose requirements and management" on page 51
- "Non-raised floor hose requirements and management" on page 55

Water specifications for the secondary cooling loop

In order to avoid system failures, it is important to follow the water specification requirements for the secondary cooling loop of your rear-door heat exchanger.

The water that is being supplied to the heat exchanger must meet the following requirements; otherwise, system failures might occur over time, as a result of:

- Leaks that are caused by corrosion and pitting of the metal components of the heat exchanger or the water supply system.
- Buildup of scale deposits inside the heat exchanger, which can cause the following problems:
  - A reduction of the ability of the heat exchanger to cool the air that is exhausted from the rack.
  - Failure of mechanical hardware, such as a hose quick-connect adapter.
- Organic contamination, such as bacteria, fungi, or algae. This contamination can cause the same problems as described for scale deposits.

Water control and conditioning for the secondary cooling loop

The water that is used to fill, refill, and supply the heat exchanger must be particle-free deionized water or particle-free distilled water with appropriate controls for avoiding the following issues:

- Metal corrosion
- Bacterial fouling
- Scaling

Because of typical water temperatures (described in "Preparing your site to provide water to the rear-door heat exchanger" on page 41), the water might not be able to originate from the primary building chilled-water system. Conditioned water for the heat exchanger must be supplied as part of a secondary, closed-loop system.

Important: Do not use glycol solutions because they can adversely affect the cooling performance of the heat exchanger.

Materials for the secondary cooling loops

You can use any of the following materials in supply lines, connectors, manifolds, pumps, hoses, and any other hardware that makes up the closed-loop water-supply system at your location:

- Copper
- Brass with less than 30% zinc content
- Stainless steel – 303, 304, or 316
- Ethylene Propylene Diene Monomer (EPDM) rubber, peroxide cured, non-metal oxide

Materials to avoid in secondary loops

Do not use any of the following materials in any part of your water supply system.

- Oxidizing biocides (such as, chlorine, bromine, and chlorine dioxide)
- Aluminum
- Brass with greater than 30% zinc
- Irons (non-stainless steel)

Water supply requirements for secondary cooling loops

Ensure that the following requirements are met for the system that supplies the chilled conditioned water to the heat exchanger.

Temperature

The heat exchanger, supply hose, and return hoses are not insulated and do not have features that are designed to address the creation and collection water from condensate. Avoid any condition that might cause condensation. The temperature of the water inside the supply hose, return hose, and the heat exchanger must be kept above the dew point of the location where the heat exchanger is being used.

Attention: Typical primary chilled water is too cold for use in this application because building chilled water can be as cold as 4°C - 6°C (39°F - 43°F).

Important: If the system that supplies the cooling water is not able to measure the room dew point and automatically adjust the water temperature, the minimum water temperature that must be maintained is 18°C±1°C (64.4°F±1.8°F). The minimum water temperature is consistent with the ASHRAE Class 1 Environmental Specification that requires a maximum dew point of 17°C (62.6°F). See the ASHRAE document Thermal Guidelines for Data Processing Environments. You can find information about obtaining this document on the ASHRAE website (www.ashrae.org/home/search?k=Thermal%20Guidelines%20for%20Data%20Processing%20Environments).

Pressure

The water pressure in the secondary loop must be less than 689.66 kPa (100 psi). Normal operating pressure at the heat exchanger must be 137.93 kPa (20 psi) or less.

Flow rate

The flow rate of the water in the system must be in the range of 23 - 38 liters (6 - 10 gallons) per minute.

Pressure drop versus flow rate for heat exchangers (including quick-connect couplings) is defined as approximately 48 kPa (7 psi) at 30 liters (8 gallons) per minute.

Water volume limits

The heat exchangers hold 2.8 - 5.3 liters (0.75 - 1.4 gallons). 15 meters (50 ft) of 19 mm (0.75-in.) supply and return hoses hold approximately 9.4 liters (2.5 gallons). To minimize exposure to flooding in the event of leaks, the entire cooling system (heat exchanger, supply hose, and return hose) excluding any reservoir tank must have a maximum 15.1 liters (4 gallons) of water. This is a cautionary statement not a functional requirement. Also, consider using leak detection methods on the secondary loop that supplies water to the heat exchanger.

Air exposure

The secondary cooling loop is a closed loop, with no continuous exposure to room air. After you fill the loop, remove all air from the loop. Air bleed valves are provided at the top of each heat exchanger manifold for purging all air from the system.

Water delivery specifications for secondary loops

The delivery system for the secondary cooling loop provides chilled water to the rear-door heat exchanger. The delivery system includes pipes, hoses, and the required connection hardware to connect to the heat exchanger. This information provides examples for setting up the secondary cooling loop and operating characteristics that are needed to provide an adequate, safe supply of water to the heat exchanger.

The *primary cooling loop* is considered to be the building chilled-water supply or a modular chiller unit. The primary cooling loop must not be used as a direct source of coolant for the heat exchanger for the following reasons:

- If the supply water temperature is below the room dew point, condensation forms and causes dripping from the door components.
- If a leak develops in the door, supply hose, or return hose, a large amount of water is available.

Procurement and installation of the components that are needed to create the secondary cooling loop system are required for this design and are your responsibility. See "Secondary cooling loop parts and services information" on page 57 for information about suppliers of hoses and cooling distribution units.

Attention: The overpressure safety device must meet the following requirements:

- Comply with ISO 4126-1. For more information, go to the ANSI Standards Store website (webstore.ansi.org/default.aspx), and search on document number ISO 4126–1.
- Be installed so that it is easily accessed for inspection, maintenance, and repair.
- Be connected as close as possible to the device that it is intended to protect.
- Be adjustable only with the use of a tool.
- Have a discharge opening that is directed so that discharged water or fluid does not create a hazard or directed toward any person.
- Be of adequate discharge capacity to ensure that the maximum working pressure is not exceeded.
- Be installed without a shutoff valve between the overpressure safety device and the protected device.

Figure 18 on page 48 shows a typical cooling solution and identifies the components of the primary cooling loop and secondary cooling loop.

Figure 17 on page 47 shows an example of a fabricated facilities solution. The actual number of heat exchangers that are connected to a secondary loop depends on the capacity of the cooling distribution unit that is running the secondary loop.

Figure 15 on page 45 shows an example of an off-the-shelf modular cooling distribution unit. The actual number of heat exchangers that are connected to a secondary loop depends on the capacity of the cooling distribution unit that is running the secondary loop.

Figure 16 on page 46 shows an example of a water-chiller unit that supplies conditioned water to one or more heat exchangers. This water-chiller unit must be a closed system (no exposure of the water to air) and meet all materials, water quality, water treatment, and temperature and flow specifications that are defined

in this document. A water chiller unit is considered an acceptable alternative to use as a building chilled water source for removing heat from the rear-door heat exchanger.

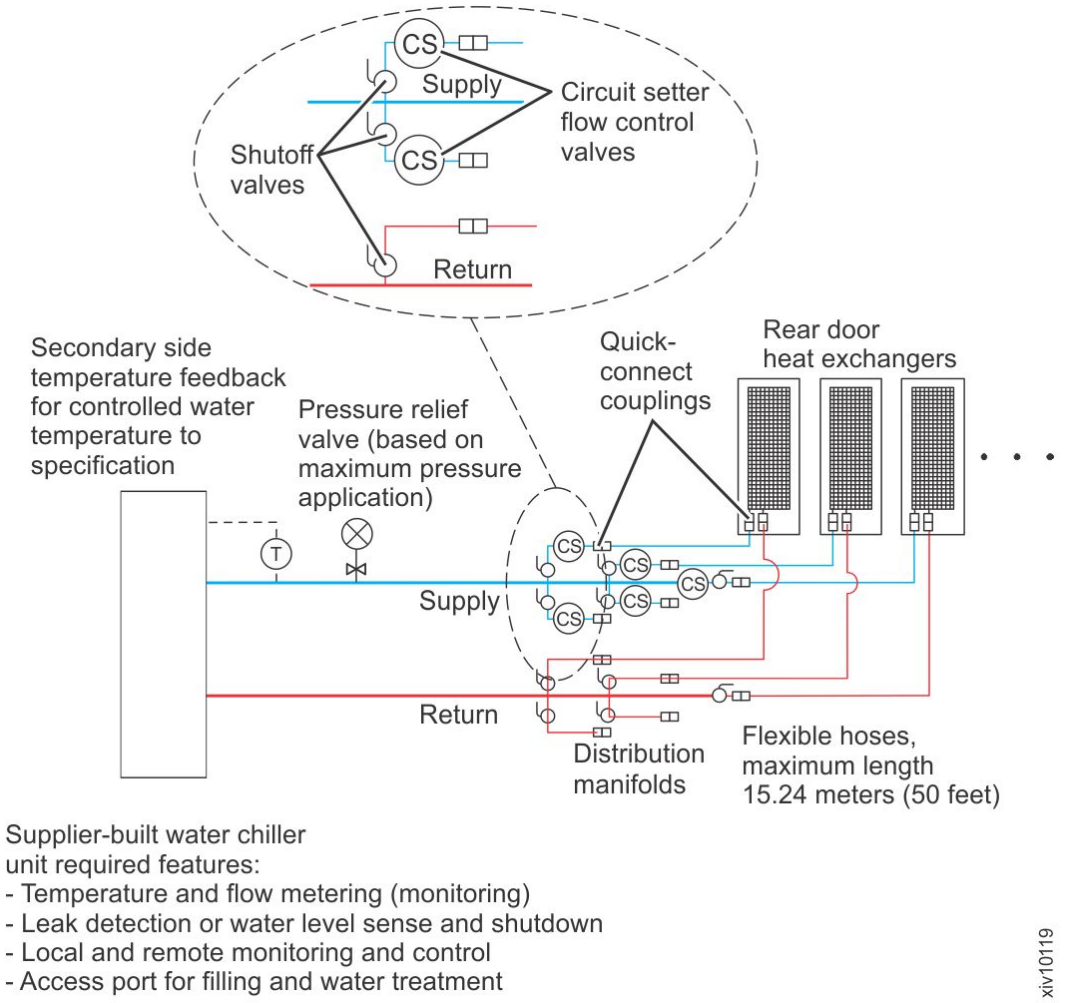


Figure 15. Cooling distribution unit that uses off-the-shelf supplier solutions

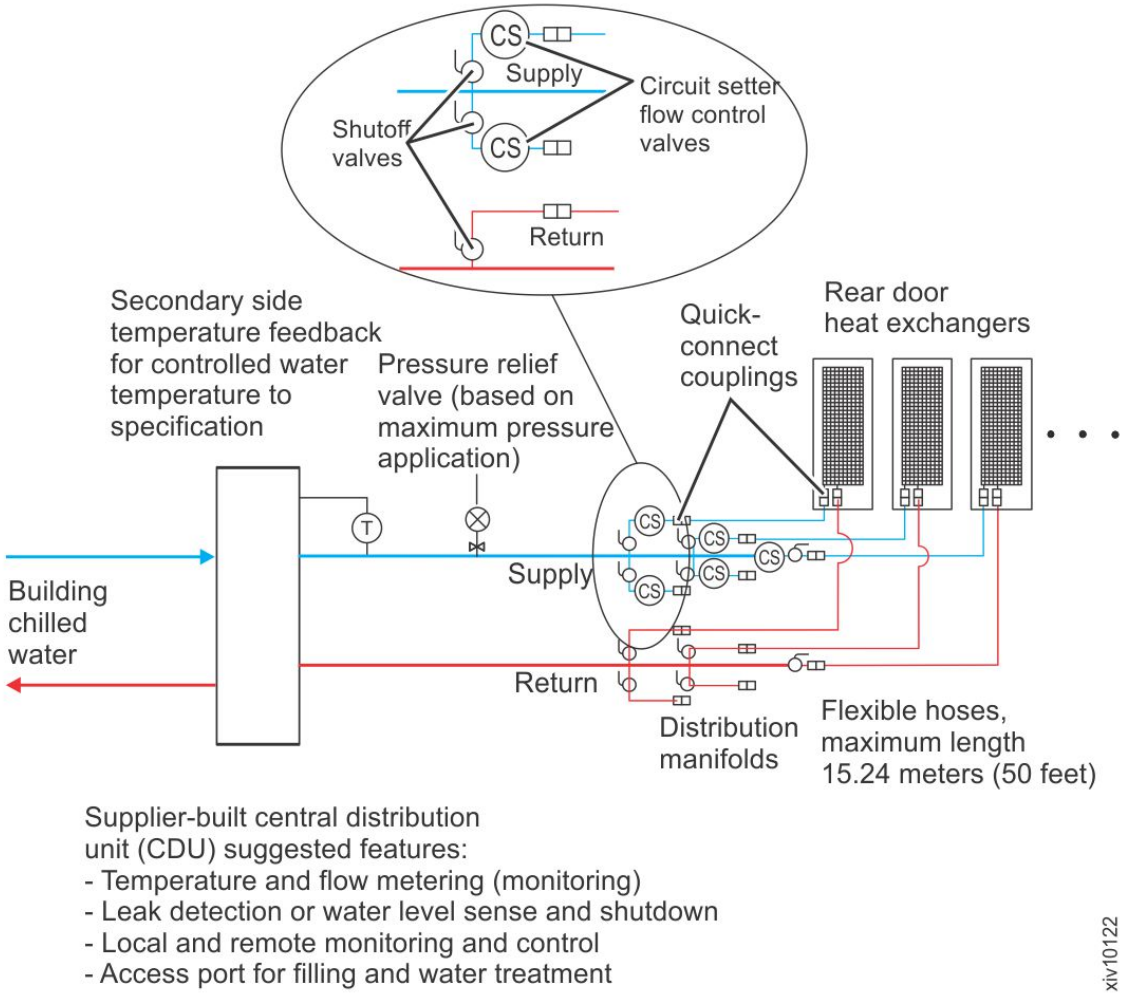


Figure 16. Cooling distribution unit that uses a water chiller unit to provide conditioned water

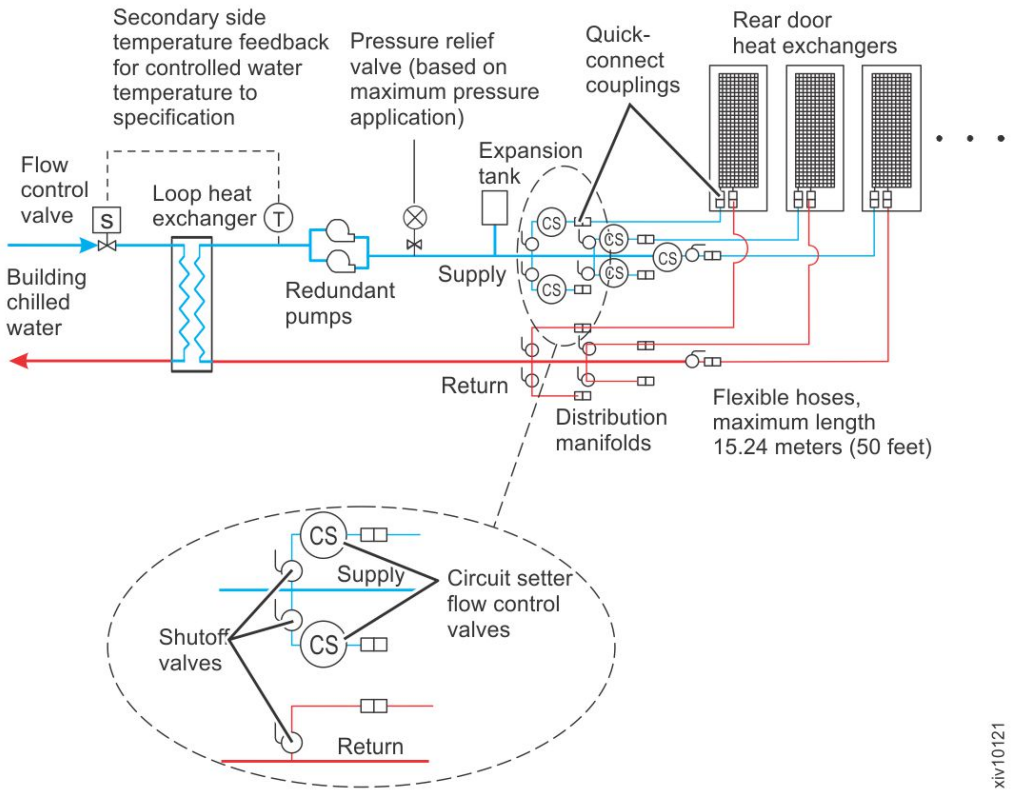


Figure 17. Cooling distribution unit that uses a fabricated facilities solution

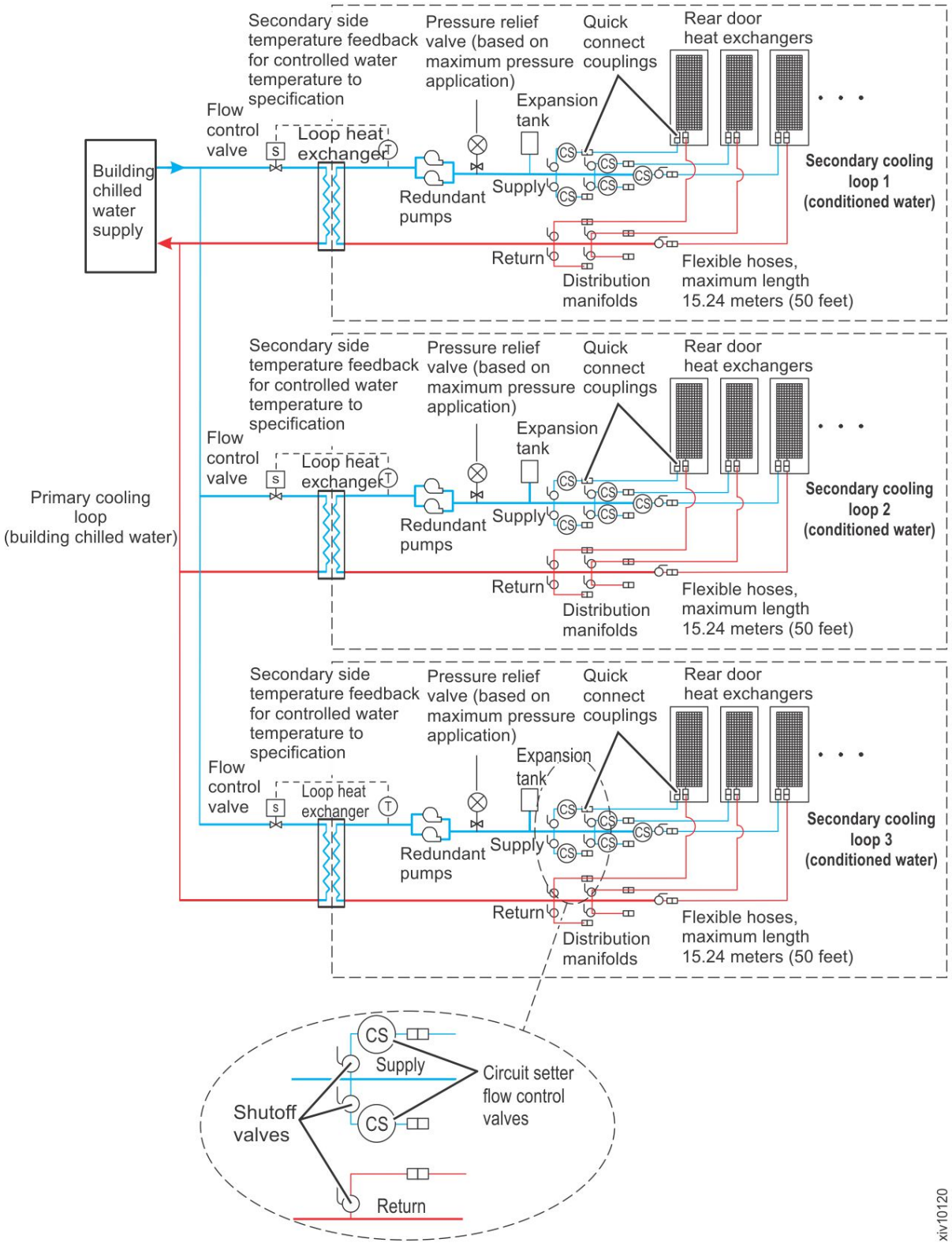


Figure 18. Primary and secondary cooling loops

Manifolds and piping

Manifolds that accept large-diameter feed pipes from a pump unit are the preferred method for splitting the flow of water to smaller-diameter pipes or hoses that are routed to individual heat exchangers. Manifolds must be constructed of materials that are compatible with the pump unit and related piping (see "Water specifications for the secondary cooling loop" on page 42). The manifolds must provide enough connection points to allow a matching number of supply and return lines to be attached, and the manifolds must match the capacity rating of the pumps and the loop heat exchanger (between the secondary cooling loop and the building chilled-water source). Anchor or restrain all manifolds to provide the required support to avoid movement when quick-connect couplings are connected to the manifolds.

Manifold supply pipe sizes

- Use a 50.8 mm (2 in.) supply pipe to provide the correct flow to six 19 mm (0.75 in.) supply hoses, with a 100 kW cooling distribution unit.
- Use a 63.5 mm (2.50 in.) supply pipe to provide the correct flow to eight 19 mm (0.75 in.) supply hoses, with a 120 kW CDU.
- Use an 88.9 mm (3.50 in.) supply pipe to provide the correct flow to twenty 19 mm (0.75 in.) supply hoses, with a 300 kW CDU.

Use shutoff valves for each supply line that exits the manifold to enable the flow of water to be stopped in individual legs of multiple-circuit loops. The shutoff valves provide a way of servicing or replacing an individual heat exchanger without affecting the operation of other heat exchangers in the loop.

Use adjustable flow control valves, called circuit setters, on each supply line to enable control of the flow and compliance with specifications for each heat exchanger.

Use temperature and flow metering (monitoring) in secondary loops to provide assurance that water specifications are being met and that the optimum heat removal is taking place.

Use circuit setters, placed as shown in Figure 19 on page 50 and Figure 20 on page 50, to enable the adjustment of water flow to each water circuit off a main manifold system.

Anchor or restrain all manifolds and pipes to provide the required support and to avoid movement when quick-connect couplings are being attached to the manifolds.

Figure 19 on page 50 shows a layout for multiple water circuits.

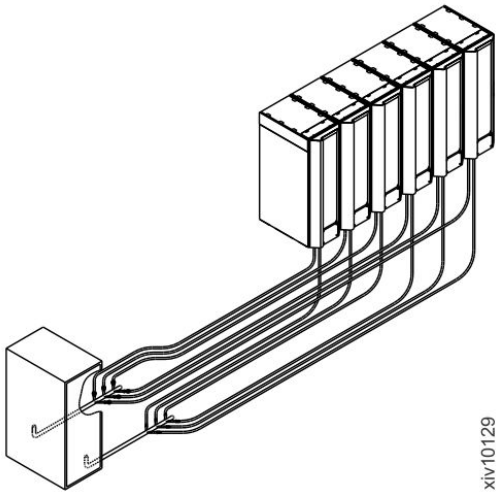


Figure 19. Typical central manifold (at a central location for multiple water circuits)

Figure 20 shows an extended manifold layout.

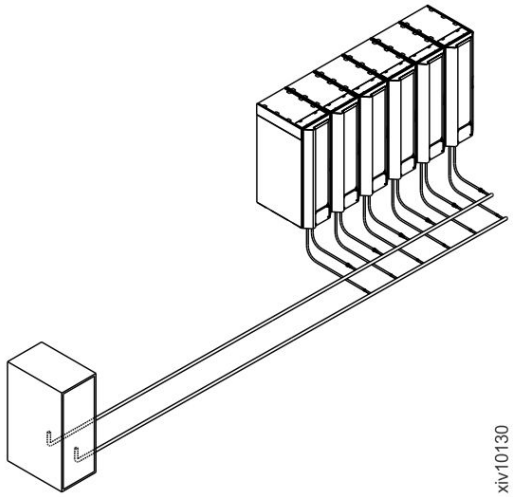


Figure 20. Typical extended manifold (located along aisles between racks)

Flexible hoses and connections to manifolds and heat exchangers

Pipe and hose configurations can vary. You can determine the best configuration for your installation by analyzing the needs of your facilities, or a site preparation representative can provide this analysis.

Flexible hoses are needed to supply and return water between your hard plumbing (manifolds and cooling distribution units) and the heat exchanger, allowing needed movement for opening and closing the rack rear door.

Hoses are available that provide water with acceptable pressure-drop characteristics and that help prevent depletion of some corrosion inhibitors. These hoses must be made of peroxide cured ethylene propylene diene monomer (EPDM), non-metal-oxide material and must have Parker Fluid Connectors quick-connect couplings at each end. These couplings are compatible with the heat exchanger couplings. Hose lengths from 3 to 15 meters (10 - 50 ft), in increments of

3 meters (10 ft), are available. Hoses that are longer than 15 meters (50 ft) might create unacceptable pressure loss in the secondary circuit and reduce the water flow, reducing the heat removal capabilities of the heat exchanger.

For information about a supplier of these hoses, see "Secondary cooling loop parts and services information" on page 57. Use solid piping or tubing that has a minimum inner diameter of 19 mm (0.75 in.) and the fewest possible joints between a manifold and a heat exchanger in each secondary loop.

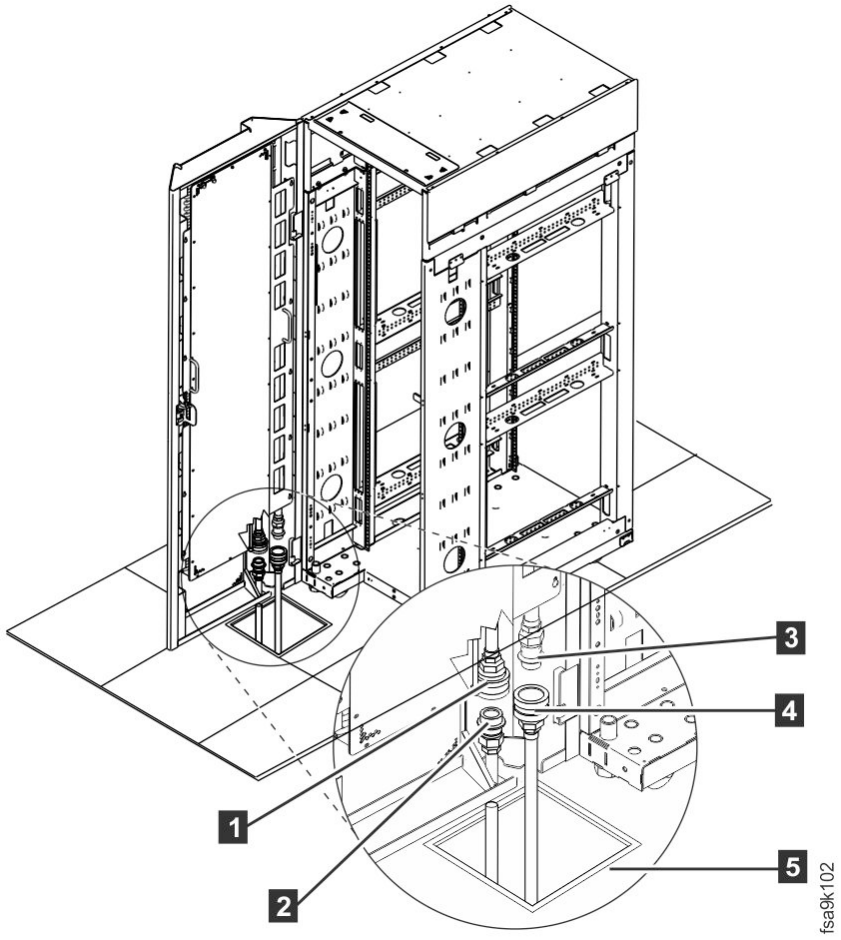
You can use quick-connect couplings to attach the hoses to the distribution manifolds. You must use quick-connect couplings to attach the hoses to the heat exchanger. Hose couplings that connect to the heat exchanger must have the following characteristics:

- The couplings must be constructed of passivated 300-L series stainless steel or brass with less than 30% zinc content. The coupling size is 19 mm (0.75 in.).
- The supply hose must have a Parker (male) quick-coupling nipple, part number SH6-63-W, or equivalent. The return hose must have a Parker (female) quick-connect coupling, part number SH6-62-W, or equivalent.
- At the opposite (manifold) end of the hoses, use similar quick-connect couplings. However, if you want to use other types of connectors, make sure that positive locking mechanisms are used to prevent loss of water when the hoses are disconnected. The connections must minimize water spill and air inclusion into the system when they are disconnected. You can also permanently attach hoses to the manifolds by using barbed fittings and clamps.

Raised floor hose requirements and management

On a raised floor, hoses can be routed under the floor tiles and can be brought up from beneath the rack through special tile cutouts. The hoses are connected to the quick-connect couplings on the bottom of the heat exchanger.

In a typical example, each heat exchanger requires a special cut 0.6 m × 0.6 m (2 ft × 2 ft) floor tile below it with the opening outside of the rack footprint. A portion of the tile is cut away and correctly covered to protect against sharp edges. The corner opening is placed directly under the hinge side of the rack rear door. The opening size of the cut is 152.4 mm wide × 190.5 mm long ±12.7 mm (6.0 in. wide × 7.5 in. long ±0.5 in.) in the direction parallel to the door. See Figure 21 on page 52 and Figure 22 on page 53.



1 Heat exchanger (female coupling)
2 Supply hose assembly (male)
3 Heat exchanger (male coupling)
4 Return hose assembly (female)
5 Raised floor

Figure 21. Raised-floor hose management example 1: hose exit through floor tile at the door hinge

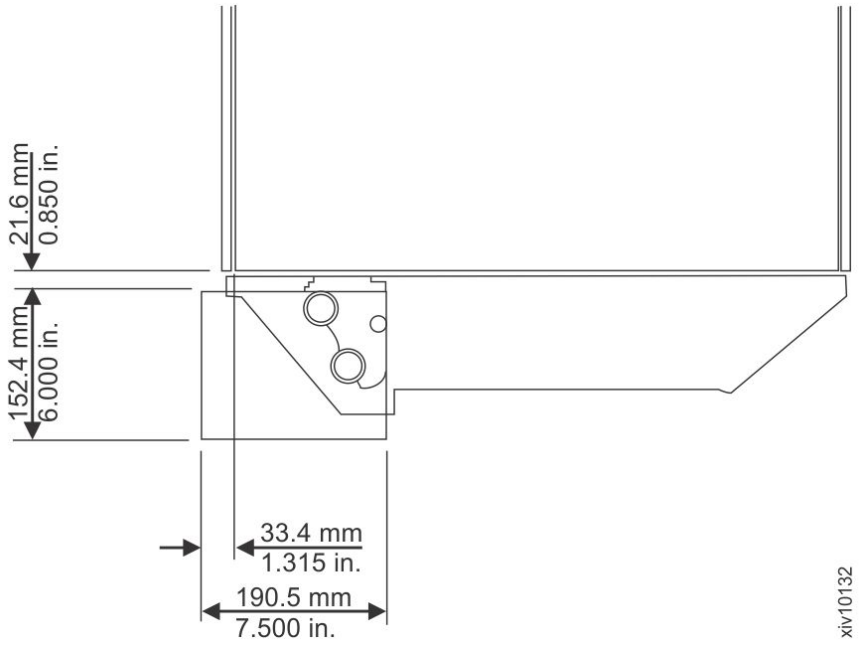


Figure 22. Raised-floor hose management example 2: tile cutout size and position

In another example, for a rack that is installed at the same time as a heat exchanger, or in cases where a rack is moved to install new floor tiles under it, each heat exchanger still requires a special cut 0.6 m × 0.6 m (2 ft × 2 ft) floor tile. However, the floor tile is positioned completely within the footprint of the rack. A modified cable opening or independent hose cutout is used.

Flexible hoses that each contain a right-angle elbow are used to route the hoses under the rack in a large loop to allow hose movement when the door is opened and closed. Figure 23 on page 54 and Figure 24 on page 55 show how to route hoses under the rack with enough hose length to allow the hose to move freely as the door is opened and closed.

Note: Existing tile cutouts for electrical or other cables can also be used for the hoses, if enough space is available.

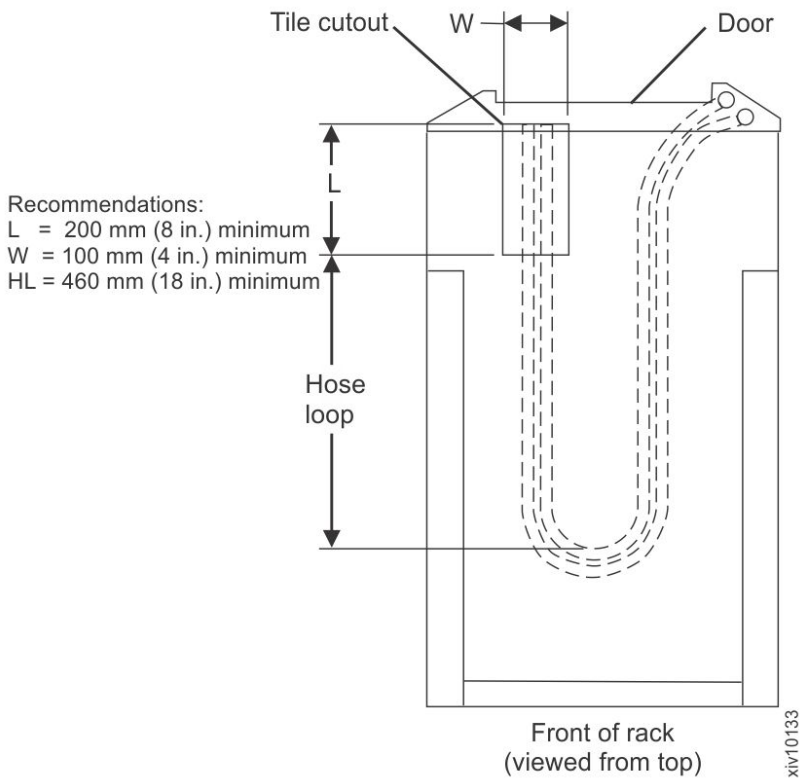


Figure 23. Raised-floor and non-raised-floor hose management example 2: loop under the rack with door closed

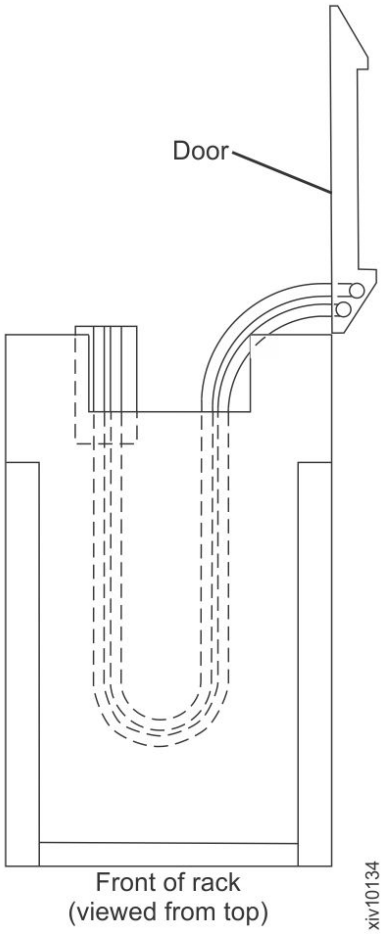


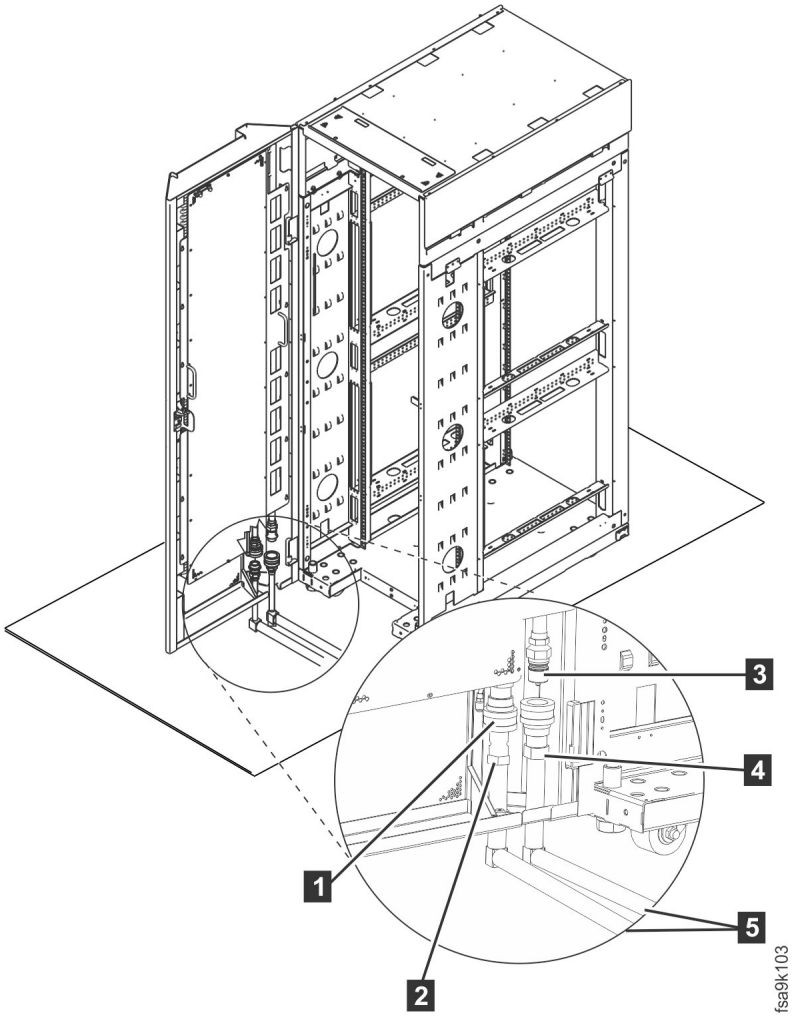
Figure 24. Raised floor and non-raised floor hose management example 2: loop under the rack with door open

Lay hoses side-by-side as they run between the heat exchanger and the pump unit manifold, and allow the hoses to freely move. Leave enough slack in the hoses below the rear door so that no pressure is exerted on the mated couplings when the hoses are connected and operating. When you route hoses, avoid sharp bends that cause hose kinks and avoid hose contact with sharp edges.

Non-raised floor hose requirements and management

In data centers without a raised floor, straight hose assemblies cannot make the sharp bend to exit between the floor and the rack door without kinking the hose.

Hose assemblies with right-angle metal elbows are needed to route the hoses along the floor. Make the 90° turn upwards within the gap between the bottom of the heat exchanger and the floor surface, and then connect to the heat exchanger couplings (see Figure 25 on page 56).



1 Heat exchanger (female coupling)
2 Supply hose assembly (male)
3 Heat exchanger (male coupling)
4 Return hose assembly (female)
5 Elbow extensions

Figure 25. Non-raised floor hose requirements

Hoses that exit the heat exchanger are routed in a manner similar to that of power cables in a non-raised-floor data center. For example, place the hoses side-by-side and allow them to move freely as they approach the rack (within approximately 3 meters [10 feet] of the rack).

When you open the door, it is acceptable for the hoses to move slightly and rotate in parallel at the coupling interface inside the door. As you close the door, the hoses rotate back to their original positions.

Note: When you open or close the door, some manipulation of the hose along the floor might be necessary to prevent unwanted forces on the door and to make it easier to open and close the door.

Hose coverings or protective devices are not provided by IBM. Routing and protection of the hose assemblies exterior to the rack are your responsibility.

Secondary cooling loop parts and services information

IBM supplies a heat exchanger that is designed for IBM enterprise-server racks, a hinge kit (for those racks), and an air purge tool. This information provides sources and information for other parts and services that are needed for correct function and reliability of the secondary cooling loop.

Miscellaneous parts supplier

Table 18 provides supplier and contact information for miscellaneous secondary loop parts. You can contact the supplier that is listed in the table for all or some of the items that are listed, depending on your needs.

Table 18. Miscellaneous secondary loop parts supplier information for customers in North America, Europe, Middle East, Africa, Asia Pacific

Supplier	Parts	Contact information
Vette Corporation	• Rear door heat exchangers (designed for non-IBM Enterprise racks) • Cooling distribution units • Hose kits • Water treatment • Chillers • Raised-floor grommets	**Website**: Vette Corp (www.vettecorp.com) **Email**: datacom_facilities@vettecorp.com **Phone**: 877-248-3883 or 508-203-4690 **Address**: Vette Corp Datacom Facilities Division 201 Boston Post Road West Marlborough, MA 01752

Services supplier

Table 19 on page 58 provides supplier and contact information for services that can be provided for secondary loop parts.

Table 19. Services supplier information for customers in North America, Europe, Middle East, Africa, Asia Pacific

Supplier	Services	Contact information
Vette Corporation	• Installation of door and secondary loop items • Preventive maintenance	**Website**: Vette Corp (www.vettecorp.com) **Email**: datacom_facilities@vettecorp.com **Phone**: 877-248-3883 or 508-203-4690 **Address**: Vette Corp Datacom Facilities Division 201 Boston Post Road West Marlborough, MA 01752

Cooling distribution unit suppliers

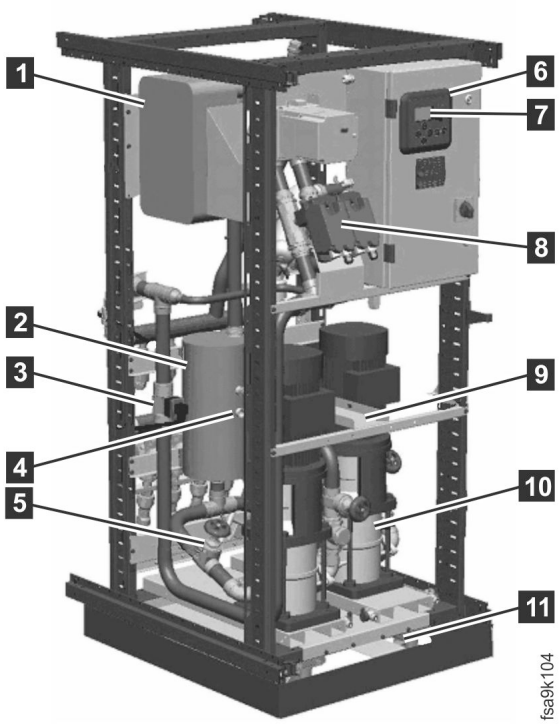
Table 20 provides supplier and contact information for customers in Europe for a cooling distribution unit that was designed specifically for the IBM Rear Door Heat exchanger.

Note: Customers in other locations can contact Eaton-Williams Group or Vette Corporation (see Table 19).

Table 20. Cooling distribution unit supplier information for customers in Europe

Supplier	Cooling distribution units	Contact information
Eaton-Williams Group, Ltd (UK)	• CDU120 (120 kW, 400® - 480V) • CDU121 (120 kW, 208 V) • CDU150 (150 kW, 400 - 480V) • CDU151 (150 kW, 208 V)	**Website**: Eaton-Williams (www.eaton-williams.com/) **Phone**: (0) 1732 866055 **Fax**: (0) 1732 867937 **Address**: Eaton-Williams Group Ltd. Station Road Edenbridge Kent TN8 6EZ

The following illustration shows the Eaton-Williams cooling distribution unit features.



1 Plate heat exchanger
2 Reservoir tank
3 Primary flow meter
4 Level switch
5 Pump isolation valves
6 Control panel
7 Control display (user interface)
8 Primary control valves (run and standby)
9 Pump transit bracket (remove after installation)
10 Secondary pumps (run and standby)
11 Lockable castor and adjustable plinth

Figure 26. Eaton-Williams cooling distribution unit features

The cooling distribution unit specifications are described in the following table.

Table 21. Eaton-Williams cooling distribution unit specifications

Performance	Properties
Maximum cooling capacity	120 kW (409 450 Btu/hr) *or* 150 kW (511 815 Btu/hr)
Pump capacity (design flow)	240 L/min (63.4 GPM)
Maximum pump head pressure	355 kPa (51.5 psi) at design duty, excluding cabinet losses
Coolant (liquid) type	Chilled water (with up to 30% glycol)
Primary liquid connections	1 1/2 in. flex tail for sweat connection, top or bottom
Secondary liquid connections	3/4 in. quick connects, hydraulic ISO-B
Unit internal primary circuit liquid capacity	Approximately 10.0 liters (2.6 gallons)

Table 21. Eaton-Williams cooling distribution unit specifications (continued)

Performance	Properties
Unit internal secondary circuit liquid capacity	Approximately. 32.0 liters (8.5 gallons)
Noise	< 55 dBA at 3 meters
Electrical	
Power® supply	200 - 230 V, 3Ø, 50/60 Hz *or* 400 - 480 V, 3Ø, 50/60 Hz
Maximum power consumption	5.6 kVA at 480 V, 4.9 kVA at 208 V
Physical	
Height	1825 mm (72 in.)
Width	800 mm (31.5 in.)
Depth	1085 mm (43 in.)
Weight (empty)	396 kg (870 lb)
Weight (filled)	438 kg (965 lb)

Note: Other industrial cooling distribution units can be used in a secondary cooling loop with the rear-door heat exchanger, if they meet the specifications and requirements that are described or referred to in this document.

Maintenance schedule

Maintenance tasks are required at certain time intervals.

Task	Schedule
Check the manifolds for temperature (make sure that the top of the manifolds is cool) and sounds of air in the system to ensure that the exchanger is correctly filled.	One month after installation and again annually
Inspect the heat-exchanger fins for air blockage at the fins (such as dust, dirt, and debris)	Annually
Inspect the entire length of the supply hose and return hose for damage, age cracks, and kinks. Be sure to inspect at the door and outside of the rack.	Annually

Site security considerations

When installing an IBM FlashSystem A9000R storage system, you need to apply the same security practices that you apply to any other business critical IT system.

Note: A good reference on storage security can be found at the Storage Networking Industry Association (SNIA) website: http://www.snia.org/forums/ssif/programs/best_practices.

A common risk with storage systems is the retention of volatile caches. Your FlashSystem A9000R storage system is perfectly safe in regard to external operations and a loss of external power. If there is a power failure, the internal battery backup modules provide power to the system. These battery modules allow your storage system to gracefully shut down.

If desired, you can install your own uninterruptible power supply (UPS) unit(s) or generators in order to provide further power-failure protection.

However, if someone gains physical access to the equipment, that person might manually shut off components by bypassing the preferred process. In this case, the storage system is likely to lose the contents of its volatile caches, resulting in a data loss and system unavailability.

To eliminate or greatly reduce this risk, the IBM FlashSystem A9000R rack can be equipped with lockable doors (feature code AFR6).

Important: Protect your storage system by locking the rack doors and monitoring physical access to the equipment.

Chapter 5. Network and host connectivity requirements

This information describes the IBM FlashSystem A9000R storage systems and host-SAN connections and requirements.

Network and host connectivity requirements are listed in the following sections:

Network connections for management

Network connectivity for the storage system is provided through the utility patch panel.

Table 22 describes the ports that are available in the patch panel and the component to which each patch panel port connects. Figure 27 illustrates the utility patch panel.

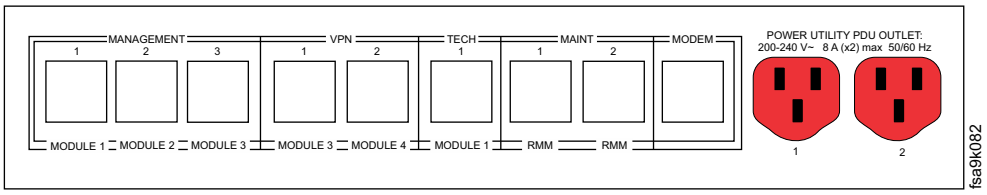


Figure 27. Utility patch panel

Table 22. Utility patch panel connections

Patch panel port	Component	Description
Management ports	Grid controllers 1, 2, 3	Use these three redundant ports to connect to systems that are used for managing the IBM FlashSystem A9000R system using the IBM Hyper-Scale Manager UI (UI) and command-line interface (CLI). These ports can also be used for sending email notifications and SNMP traps about event alerts, NTP server time synchronization, and communication with key servers for managing encryption keys. **Note:** Use all three connections for redundancy. If you use only one path and the grid controller for that connection goes down, the ability to manage the IBM FlashSystem A9000R system is lost. For information about IP configuration and protocol requirements, see "Management port requirements" on page 64.

Table 22. Utility patch panel connections (continued)

Patch panel port	Component	Description
VPN (remote support) ports	Grid controllers 3, 4	These two virtual private network (VPN) ports are used to connect to the IBM FlashSystem Remote Support Center. **Note:** Use both VPN connections for redundancy to avoid losing remote support if one of the grid controllers fails.
Tech (technician) ports	Grid controller 1	(For technician use only.) This port is used by the IBM service representative to connect a notebook computer to the storage system, for initial configuration and servicing the system. A Dynamic Host Configuration Protocol (DHCP) server is implemented over this port. The DHCP server automatically assigns IP addresses to the notebook computer and establishes a connection to the IBM FlashSystem A9000R system. **Note:** There is a second identical technician port on the front of the rack, next to the power button. This technician port connects to grid controller 2.
Maint (maintenance module) ports	Maintenance module	(For technician use only.) Not in use.
Modem port	Modem	(For technician use only.) Not in use.

Management port requirements

The management ports provide the connectivity required for IBM Hyper-Scale Manager, IBM FlashSystem A9000R command-line interface (CLI), and other management tools to monitor and control the IBM FlashSystem A9000R system.

IP configuration

The IBM FlashSystem A9000R storage system has three redundant management port IP addresses, over Ethernet interfaces, in case of failure.

Each IP address is handled by different grid controllers in the initial grid element configuration. It is recommended that the IBM Hyper-Scale Manager and CLI be configured with all three IP addresses that are defined for IBM FlashSystem A9000R for high availability. For more information about the IBM Hyper-Scale Manager, see *IBM Hyper-Scale Manager User Guide* (SC27-8560) on the IBM FlashSystem A9000R Knowledge Center website (ibm.com/support/knowledgecenter/STJKN5)

Management functions can be performed through any of the IP addresses. These addresses can be accessed simultaneously by multiple clients.

For each of the three management ports, the customer or technical assistant must provide the following information to the IBM service representative before starting the installation process:

- IP address of the port
- Net mask
- Default gateway IP

- Maximum transmission unit (MTU)

Notes:

- All management IP interfaces must be connected to the same subnet and use the same network mask, gateway, and MTU.
- MTU configuration is required if the network supports an MTU that is greater than the default 1536 bytes. The largest possible MTU supported is 9216 bytes.

In addition, the customer or technical assistant must provide the following system-level IP information:

Note: IPV6 is supported.

- IP address of the primary and secondary DNS servers
- IP addresses or DNS names of the SMTP servers
- IP addresses or DNS names of the NTP server
- IP addresses and port numbers of the Remote Support servers

Protocols

IBM FlashSystem A9000R is managed through dedicated management ports that are running TCP/IP over an Ethernet connection.

All traffic over these ports are encrypted through the Secure Sockets Layer (SSL) protocol.

Note: The management ports must be on a different subnet than the VPN ports that are used for remote access.

Management is carried out through following protocols detailed in Table 23.

Table 23. Management protocols through TCP/IP

Use	Protocol	TCP port	Comments
Command-line interface (CLI) (includes Hyper-Scale Manager)	Proprietary	7778	Storage system management portal and CLI act as the client and initiate the connection, while IBM FlashSystem A9000R acts as the server.
SNMP requests	SNMP	161	Storage system responds to SNMP requests when sending replies to SNMP managers.
SNMP traps/notifications	SNMP	162	Storage system initiates SNMP messages when sending traps/notifications to SNMP managers.
Outbound mail	SMTP	25	Storage system initiates SMTP traffic when sending emails for either event notifications or for SMS gateways.
Time setting	NTP	123	Storage system uses a network time protocol (NTP) connection.
Connectivity	IPSec	1293	Storage system uses IPSec for management and VPN communication.
Key management	KMIP	5696	Storage system communicates with key servers using the KMIP protocol.

Network configurations

Host systems can connect to an IBM FlashSystem A9000R over a Fibre Channel (FC) network by using the Small Computer System Interface (SCSI) protocol or over an Ethernet network by using the Internet Small Computer System Interface (iSCSI) protocol.

Restriction: A host must be attached to FlashSystem A9000R system through a Fibre Channel fabric or Ethernet switch.

While a host can connect through FC and iSCSI simultaneously, the same LUN can only be mapped through FC *or* iSCSI.

Host traffic can be directed to any of the grid controllers.

Important:

- The administrator must ensure that:
  - Host connections avoid single points of failure, by applying redundant connections.
  - All host workload is adequately balanced across the connections and grid controllers, ensuring system resource utilization is maximized.
- Always employ multipathing for data connections. If multipathing is not used, the Health widget on the Dashboard of the UI indicates that multipathing is not used.
  Note: Some operating systems may not support multipathing, with some protocols.
- Host workload balancing should be done by installing the relevant host-attachment kit.
  - Review the balancing periodically and when traffic patterns change.
  - Host systems must have the appropriate host-attachment kit installed. Host attachment kits are available for AIX®, HP-UX, Linux, Solaris, and Microsoft Windows operating systems. For more information, see IBM Storage Host Attachment Kit (ibm.com/support/knowledgecenter/STJKN5).

    For supported interoperability configurations, see the System Storage Interoperation Center website (www.ibm.com/systems/support/storage/config/ssic). Also see Host Attachment in the IBM FlashSystem A9000 and IBM FlashSystem A9000R: Architecture, Implementation and Usage Redbook, SG24-8345.

Host ports configuration

Use these important recommendations, in order to achieve high availability and high performance in your storage system.

- For high performance:
  - Try to spread all ports of grid controllers in the system, evenly.
  - Utilize the CPU in each grid controller, as much as possible, for high CPU utilization. To achieve this, it is recommended to use ports 1 and 4; and then ports 2 and 3.
- For high availability in each host:
  - Divide the paths between the two switches/fabrics: half the paths connecting to switch 1 and the other half connecting to switch 2.
  - If possible, spread the paths across different grid controllers.

– Use different adapters within each of the grid controllers.

Important: It is important to cross the Fibre Channel or iSCSI ports for resiliency and high performance, as depicted in Figure 28.

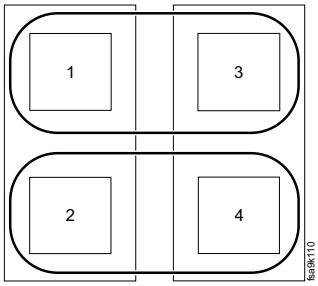


Figure 28. Crossing Fibre Channel grid controller ports

For Fibre Channel port numbering on the rear of the grid controllers see Figure 29 on page 68.

For Ethernet port numbering on the rear of the grid controllers see Figure 30 on page 69.

Be sure that half of the ports in each grid controller connect to the first switch and half of the ports of each grid controller connect to the second switch.

Important: Non-redundant configurations, such as single fabric/zone and single-port host configurations may be implemented, however they are not recommended.

Use non-redundant configurations only when the risks of a single point of failure are acceptable, which is typically the case for test and development environments.

Fibre Channel (FC) network configurations

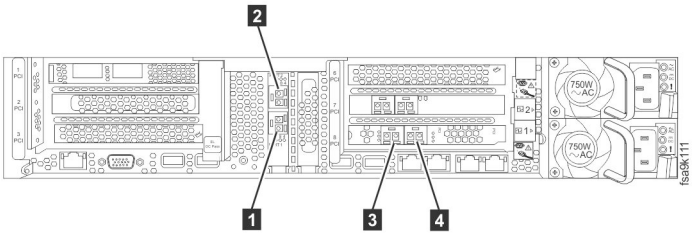
Host systems can connect to the storage system over a Fibre Channel (FC) network.

In a production environment, always connect Fibre Channel hosts to a minimum of two separate SAN switches in independent fabrics to provide redundancy. In Fibre Channel network configurations, there are two dual-port connections per grid controller.

Notes:

- For best performance, use a 16 Gb Fibre fabric and HBA on the host.
- Host system can have as many HBAs as needed to support the operating system, application, and overall performance requirements.
- In a FlashSystem A9000R with Fibre Channel configuration, each grid controller has two dual 16 Gb Fibre Channel ports.

Figure 29 on page 68 shows the port numbers for each of the FC ports on the grid controllers.



1 FC port 1
2 FC port 2
3 FC port 3
4 FC port 4

Figure 29. Fibre Channel port numbering on the grid controllers

Several network configurations that use Fibre Channel are technically possible, and each configuration varies in terms of cost, flexibility, performance, and reliability.

Fibre Channel (FC) best practices

Talk to your IBM installation planning representative (IPR) to help optimally setup your host connections, according to your needs.

In order to achieve high performance, it is important to:

1. Spread the host connections to each grid controller evenly.
2. Utilize the CPU in each grid controller as much as possible; therefore, it is recommended to use ports 1 and 4 and then ports 2 and 3.

It is recommended to use half the ports in each grid controller (ports 1 and 4) and create three identical zones in each fabric.

Table 24 is an example of how the zones should be divided in a full rack configuration.

Table 24. Example of recommended fabric zoning

Fabrics	Zones	Grid controllers	Port numbers
1, 2	1	Grid controllers 1, 2, 3, 4	1, 4
1, 2	2	Grid controllers 5, 6, 7, 8	1, 4
1, 2	3	Grid controllers 9, 10, 11, 12	1, 4

This configuration creates high availability, high performance, and balancing. In addition, all grid controllers are utilized for each host.

For supported interoperability configurations, see the System Storage Interoperation Center website (www.ibm.com/systems/support/storage/config/ssic).

iSCSI network configurations

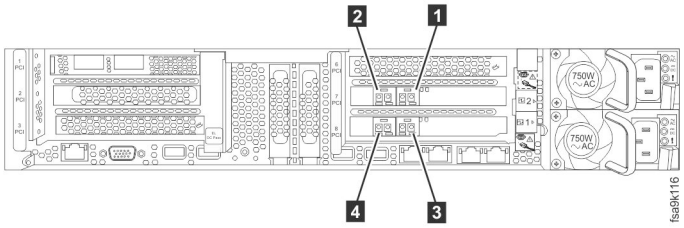
Host systems can connect to a FlashSystem A9000R over an Ethernet network using the Internet Small Computer System Interface (iSCSI) protocol.

In a production environment, always connect Ethernet hosts to a minimum of two separate Ethernet switches to provide redundancy. In Ethernet network configurations, there are two dual-port connections per grid controller.

Notes:

- For best performance, use a 10 Gb Ethernet switch and HBA on the host to obtain maximum performance or throughput.
- Host system can have as many HBAs as needed to support the operating system, application, and overall performance requirements.
- In a FlashSystem A9000R system with iSCSI configuration, each grid controller has two dual 10 Gb Ethernet ports.

Figure 30 shows the port numbers for each of the iSCSI ports on the grid controllers.



1 10GbE port 1
2 10GbE port 2
3 10GbE port 3
4 10GbE port 4

Figure 30. iSCSI port numbering on the grid controllers

Several network configurations using Ethernet are technically possible, and each configuration varies in terms of cost, flexibility, performance, and reliability.

Important: Non-redundant iSCSI configurations, such as single switch and single-port host configurations may be implemented, however they are not recommended.

Use non-redundant configurations only when the risks of a single point of failure are acceptable, which is typically the case for test and development environments.

In the FlashSystem A9000R system, each iSCSI port is defined with its own IP address. Before you set up the iSCSI network, gather the following information for each iSCSI port:

- IP address
- Net mask
- Default gateway
- Maximum transmission unit (MTU)

Notes:

1. If two or more iSCSI connections exist in your iSCSI network, iSCSI ports for mirroring must be defined on switches with **Flow Control Send On**.
2. MTU configuration is required if the network supports an MTU that is greater than the default 1536 bytes.

   The maximum MTU value supported is 9216 bytes.
3. Because the FlashSystem A9000R system acts as a TCP server for iSCSI connections, packets are always routed through the Ethernet port from which the iSCSI connection was initiated. The default gateways are required only if the hosts are not on the same layer-2 subnet as the FlashSystem A9000R system.
4. If present, Ethernet VLANs and IP routers must be configured to enable connectivity between the host systems and the FlashSystem A9000R system.
5. If present, IP routers must be configured to enable access between the hosts and the FlashSystem A9000R system.

Important: Link aggregation is not supported. Ports cannot be bonded.

For supported interoperability configurations, see the System Storage Interoperation Center website (www.ibm.com/systems/support/storage/config/ssic).

iSCSI best practices

Talk to your IBM planning representative (IPR) to help optimally setup your host connections, according to your needs.

In order to achieve high performance, it is important to:

1. Spread the host connections to each grid controller evenly.
2. Utilize the CPU in each grid controller as much as possible; therefore, it is recommended to use ports 1 and 4 and then ports 2 and 3.

It is recommended to use half the ports in each grid controller (ports 1 and 4) and create three identical subnets in each switch.

Table 25 is an example of how the subnets should be divided in a full rack configuration.

Table 25. Example of recommended switch subnets

Switches	Subnet	Grid controllers	Port numbers
1, 2	1	Grid controllers 1, 2, 3, 4	1, 4
1, 2	2	Grid controllers 5, 6, 7, 8	1, 4
1, 2	3	Grid controllers 9, 10, 11, 12	1, 4

This configuration creates high availability, high performance, and balancing. In addition, all grid controllers are utilized for each host.

Network cable requirements

The customer is responsible for supplying cables that connect to the patch panel, including host attachment (Fibre Channel or iSCSI) cables, management cables, maintenance cables, and virtual private network (VPN) cables.

Table 26. Required cable types

Cables	Required cable type
Fibre Channel	50 µm (micrometer) multimode Fibre Channel cables with LC/LC or LC/SC connectors (if applicable). **Note:** If you require 62.5-µm fibers, contact an IBM service representative for assistance.
Ethernet (iSCSI)	50 µm (micrometer) multimode optical cables with LC/LC or LC/SC connectors.
Management	Straight copper gigabit CAT5e-rated Ethernet cables with RJ-45 connectors.
Virtual private network (VPN)	Straight copper CAT5e-rated Ethernet cables with RJ-45 connectors.

Network and host connectivity security information

The storage system integrates various security features, to protect your network and host systems.

Use this information to help understand and plan for network and host connectivity security for your IBM FlashSystem A9000R storage system.

IPv6 addresses

IPv6 addressing for IBM FlashSystem A9000R management and virtual private network (VPN) ports is supported throughout the storage system.

IPv6 addressing can be configured during initial system setup, by your IBM service provider, or at any time using the IBM Hyper-Scale Manager UI or XCLI utility.

Note: For configuring IPv6 during initial setup, be sure to give all information to your SSR/IPR, to fill in IPv6 details in your Technical and Delivery Assessment (TDA) pre-installation checklist and worksheets.

Internet Protocol Security (IPSec)

Internet Protocol Security (IPSec) is a protocol suite that allows for enhanced security of IP communications through the authentication and encryption of IP packets.

The IBM FlashSystem A9000R system software and IBM management tools allow for the use of passkey or certificate authentication to establish IPSec connectivity between management workstations and the management or VPN ports of the storage system.

Configuration of the IPSec is done through the command-line interface (CLI). For IPSec configuration, see the *IBM FlashSystem A9000R Command-Line Interface (CLI) Reference Guide*, SC27-8711 on the IBM FlashSystem A9000R Knowledge Center website (ibm.com/support/knowledgecenter/STJKN5).

Authorization rules for managing multiple systems

Use this information to understand authorization rules for managing multiple systems.

Because user credentials are stored locally on each storage system, you must keep the same user name and password on each separate IBM FlashSystem A9000 and A9000R system to allow for quick transitions between systems in the IBM Hyper-Scale Manager UI.

This approach is especially useful in remote mirroring configurations, where the storage administrator is required to switch from source to target system. For more information on mirroring, see *IBM FlashSystem A9000R Product Overview*, SC27-8559 on the IBM FlashSystem A9000R Knowledge Center website (ibm.com/support/knowledgecenter/STJKN5).

To allow simultaneous access to multiple systems, the simplest approach is to have corresponding passwords manually synchronized among those systems. The storage administrator can easily switch between these systems for the activities without needing to log on each time with another password. Each storage system where the user was successfully authenticated is listed in the System view of the UI.

For information about managing multiple systems in LDAP authentication mode, see "Lightweight Directory Access Protocol (LDAP)."

Lightweight Directory Access Protocol (LDAP)

The IBM FlashSystem A9000R systems offer the capability to use LDAP server-based user authentication.

For more detailed information about LDAP products, role mapping, defining on your storage system, and more, see Security > LDAP with FlashSystem A9000 and FlashSystem A9000R in the IBM FlashSystem A9000 and IBM FlashSystem A9000R: Architecture, Implementation and Usage Redbook, SG24-8345.

When LDAP authentication is enabled, the storage system accesses a specified LDAP directory to authenticate users whose credentials are maintained in the LDAP directory (except for the admin, technician, maintenance, and development users, which remain locally administered and maintained).

Important: As a preferred practice, the LDAP server and the FlashSystem A9000R storage system must have their clocks synchronized to the same time source, be registered, and be configured to use the same DNS servers.

Product selection

LDAP authentication of the storage system supports three LDAP server products:

- Microsoft Active Directory
- Oracle Directory Server Enterprise Edition
- OpenLDAP

The current skill set of your IT staff is always an important consideration when choosing any products for centralized user authentication. If you have skills in running a particular directory server, it might be a wise choice to standardize on

this server because your skilled people will best be able to customize and tune the server. your experts will be able to provide the most reliable and highly available implementation for the LDAP infrastructure.

Role mapping

Before any LDAP user can be granted access to the storage system, the user must be a member of an appropriate LDAP group.

Important: An LDAP user cannot be a member of more than one LDAP group, so it cannot be associated with more than one storage system role mapping.

When initially planning to use LDAP-based authentication with your storage system, the LDAP attribute can be used for role mapping. The type of LDAP object classes used to create a user account for system authentication depends on the type of LDAP server being used.

The Oracle Directory server and Open LDAP use the **inetOrgPerson** LDAP object class, and Active Directory uses the **organizationalperson** LDAP object class for definition of user accounts for storage system authentication.

For a definition of the **inetOrgPerson** LDAP object class and list of attributes, see the Internet FAQ archive website:

www.faqs.org/rfcs/rfc2798.html

For a definition of the **organizationalperson** LDAP object class and list of attributes, see the Microsoft website:

msdn.microsoft.com/en-us/library/ms683883 (VS.85).aspx

The role mapping can be done by either assigning the appropriate attribute value through the **ldap_config_set** CLI command, or through the IBM Hyper-Scale Manager UI.

Managing multiple systems in LDAP authentication mode and single sign-on (SSO)

The task of managing multiple IBM FlashSystem A9000 and A9000R systems can be simplified by using LDAP authentication mode.

As a result of all user credentials being stored centrally in the LDAP directory, it is no longer necessary to synchronize user credentials among multiple storage systems. After a user account is registered in LDAP, multiple storage systems can use credentials stored in LDAP directory for authentication.

Because the user's password is stored in the LDAP directory, all connected storage systems authenticate the user with the password. If the password is changed, all storage systems automatically accept the new password.

This mode of operation is often referred to as *single sign-on* (SSO). SSO allows for quick transitions between systems in the IBM Hyper-Scale Manager UI because the password is only entered once.

This approach is especially useful in remote mirroring configurations, where the storage administrator is required to frequently switch from source to target system.

For more information on remote mirroring, see the IBM FlashSystem A9000R Product Overview, SC27-8559 on the IBM FlashSystem A9000R Knowledge Center website (ibm.com/support/knowledgecenter/STJKN5).

Security LDAP with Secure Sockets Layer (SSL)

In any authentication scenario, information is exchanged between the LDAP server and your storage system where access is being sought. SSL can be used to implement secure communications between the LDAP client and server. LDAP over SSL (LDAPS), the secure version of the LDAP protocol, allows a setup where user passwords never appear on the wire in clear text.

SSL provides methods for establishing identity using X.509 certificates and ensuring message privacy and integrity using encryption.

To create an SSL connection, the LDAP server must have a digital certificate signed by a trusted certificate authority (CA). Companies have the choice of using a trusted CA from another vendor or creating their own certificate authority.

To be operational, SSL must be configured on both the client (IBM FlashSystem A9000 or FlashSystem A9000R storage system) and the server (LDAP server). Server configuration includes generating a certificate request, obtaining a server certificate from a CA, and installing the server and CA certificates.

When a new LDAP server is added to the storage system configuration, a security certificate can be entered in the optional certificate field. If the LDAP server was originally added without a certificate, you must remove that definition first and add a definition with the certificate.

Important: When defining the LDAP server with a security certificate in the storage system, the fully qualified name of the LDAP server must match the "issued to name" in the client's certificate.

LDAP registration in the server can be done either through the UI or through the CLI, however, the UI has file upload capabilities and when using the CLI, you will need to cut and paste a long string containing the certificate.

Maintaining SSL certificates:

- New SSL certificates must be installed before the existing ones expire.
- If you let an SSL certificates expire, your storage system LDAP authentication is no longer possible until you either disable SSL or install the new certificate on both the LDAP server and the FlashSystem A9000 and/or FlashSystem A9000R servers.
- Before an SSL certificate expires, the storage system issues three notification events. Events are generated 30, 14, and 7 days before expiration.

Chapter 6. Planning for physical shipment

Ensure that your environment meets the standard delivery clearance and weight requirements for the IBM FlashSystem A9000R system.

Prepare for equipment delivery so that professional movers or riggers can transport the equipment to the final installation site. If you cannot complete preparations at the time of delivery, you must make your own arrangements for the professional movers to complete transportation later.

Important: Use only professional movers to transport the equipment.

The IBM service representative can minimally reposition the rack at the installation site, as required.

The following information describes how to plan for the physical shipment of your storage system:

- "Planning to receive delivery"
- "Planning for relocation" on page 76
- "Shipment weights and dimensions" on page 78

Planning to receive delivery

The professional movers or riggers are responsible for delivering and unloading the IBM FlashSystem A9000R system as close to its final destination as possible. You must ensure that the loading ramp and receiving area can accommodate the storage system shipment.

Procedure

Use the following steps to ensure that the receiving area and loading ramp can safely accommodate the delivery of your storage system:

1. Coordinate a technical survey with the IBM service representative to plan the loading path from the truck to the server room.
2. Determine the packaged weight and dimensions of the FlashSystem A9000R system container and other containers that you to be received (see "Shipment weights and dimensions" on page 78).
3. Ensure that the loading dock, receiving area, all doors, and elevators can safely support the packaged weight and dimensions of the shipping containers.

   If the rack height or weight must be reduced for delivery to locations where doorway heights are smaller than the delivery clearances, the height and weight reduced shipping features (feature codes AFR2 or AFR3) must be ordered. For information about the weight and height reduction features, see "Height reduced shipping option" on page 17 and "Weight-reduced shipping option" on page 17.

Important: The rack is more easily moved when on a pallet, and the rack casters might damage floors and carpets; therefore, roll the rack into position on its own casters only when necessary.

4. Ensure that there is a clear and level path from the truck to the building entrance. Ensure that there are no steps from the truck to the installation site.
5. Ensure that the loading ramp at your site does not exceed an angle of 10 degrees, as shown in the following figure.

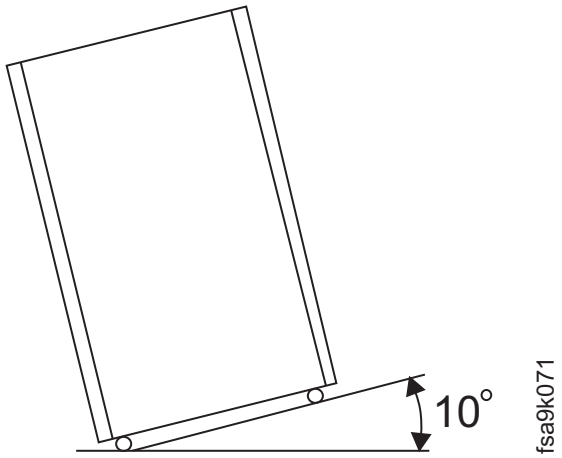


Figure 31. Maximum tilt for a packaged rack is 10 degrees.

A ramp with a maximum angle of 10 degrees must not be higher than 5.4 cm (2.1 in.) vertically for each 30.5 cm (12 in.) of horizontal length.

Planning for relocation

When unpacking your storage system delivery, be sure to keep original packaging material, in case it is needed for relocation at a later date.

Important: Whenever IBM FlashSystem A9000R units need to be physically moved to another location, the relocation must only be performed by an IBM service provider.

Customer responsibilities

When relocating systems, the customer is responsible for the following:

- Informing their IBM representative what packing requirements are necessary for their relocation (based off of machine type, model, and encryption type)
- **(For locally encrypted systems only):** Shipping the drive packages

IBM responsibilities

When relocating systems, IBM is responsible for the following:

- Ordering the packaging material for the customer (at customer expense)
- **(For locally encrypted systems only):** Packaging and label the location of the boot drives
- **(For locally encrypted systems only):** Reinstalling the boot drives at the new customer location

Relocation shipping requirements for systems with external encryption schemes

IBM FlashSystem A9000R systems that are encrypted with external key management schemes must have access to key servers with the original key upon restart.

About this task

Only use this procedure for systems that are encrypted with external key management schemes. For systems encrypted with local key management schemes, see "Relocation shipping requirements for systems with local encrypted schemes."

Procedure

Use the following procedures on systems using external key encryption before relocation.

1. Ensure that you have any new IP addresses needed for the new location (ie. system IP, network component IPs, SMTP GW, and any other IP addresses).
2. Give the new IP address to your service technician before system shutdown, for use when connecting the system upon relocation.

Important: If these steps are not taken for externally encrypted systems, the system will not be able to restart.

Note: To protect against the possibility that all Security Key Lifecycle Managers (SKLMs) become unusable and unrecoverable (for example, following a disaster, or other difficulties during the relocation process), the system enables you to create a *recovery key*. With a recovery key, Security Administrators can unlock an IBM FlashSystem A9000R system without the involvement of a key server.

For more information regarding recovery keys and how to use them, see the Redbook publication Data-at-rest Encryption for the IBM Spectrum Accelerate Family: IBM XIV and IBM FlashSystem A9000 and A9000R (www.redbooks.ibm.com/redpapers/pdfs/redp5402.pdf).

Relocation shipping requirements for systems with local encrypted schemes

Shipping systems that contain encrypted data, with the encryption keys, outside of secure customer premises, increases the risk of confidential data exposure.

To ensure the confidentially of the encrypted data, it is strongly recommended to perform the perform the following during relocation of locally encrypted systems:

- Separate the data (system) and the encryption keys (boot media devices) prior to relocation. This action can only be performed by IBM.
- Ship the boot media devices separately from the rest of the system data.
- Ship the boot media devices in separate packages.
  The shipments should be a *minimum* of two (2) separate packages.

Note: In order to avoid risk of loss of access to system data, all drives labeled 0 should be shipped in a separate shipment and using a different carrier than drives labeled 1.

Shipment weights and dimensions

To help you plan for the delivery of the FlashSystem A9000R, ensure that the loading dock and receiving area can support the weight and dimensions of the packaged FlashSystem A9000R shipments.

At least one shipping container is delivered for each FlashSystem A9000R that you order. The container is a wooden pallet that is covered by a corrugated fiberboard (cardboard). This container contains the FlashSystem A9000R system rack with components installed, and other items such as, power cords, CDs and printed publications, and other features or peripherals for your model. Additional containers are delivered for optional features such as the rear-door heat exchanger.

Delivery clearance requirements

The clearance measurements (height × width × depth) that are required for delivery through all doors and elevators are listed in the following table. These measurements are for the typical height of the pallet. The measurements do not include more clearance that is needed to raise the pallet on a pallet jack for movement.

Table 27. Typical delivery clearance requirements

Dimension	Clearance requirement
Height	216 cm (85.0 in.)
Depth	144 cm (56.7 in.)
Width	94 cm (37.0 in.)

Delivery weight requirements

The path from the truck and to the server room must support the weight of the rack, including packaging materials.

Table 28. Floor weight-support requirements

Grid element configuration	Total weight
12 grid controllers and 6 flash enclosures	969 kg (2136 lbs)
10 grid controllers and 5 flash enclosures	889 kg (1960 lbs)
8 grid controllers and 4 flash enclosures	809 kg (1783 lbs)
6 grid controllers and 3 flash enclosures	729 kg (1607 lbs)
4 grid controllers and 2 flash enclosures	649 kg (1430 lbs)

Chapter 7. Planning for remote support, on-site service, and maintenance

This section provides you with information in order to prepare you for optimal support and software maintenance.

Remote support, on-site service, and maintenance planning considerations are listed in the following sections:

Planning for remote support connection

IBM Remote Support Center is a management system used by authorized IBM service representatives to provide remote support and problem-determination assistance over a secure network interface. The remote support connection is used either before or after parts are called out by the internal diagnostic tests of the storage system. IBM authorized personnel use remote support connections to perform real-time problem analysis and isolation.

Remote support access is obtained over a dedicated network connection. When using this method, the storage system is connected to the IBM Remote Support Center through one of the virtual private network (VPN) ports or management ports on the patch panel. For more connectivity information, see "Network connections for management" on page 63.

The IBM Remote Support Center has three components:

- The IBM Remote Support Center is software that is installed on the storage system and handles remote support connectivity.

  It relies on a single outgoing TCP connection and is not able to receive inbound connections of any kind. The remote support client is controlled by using the command-line interface (CLI) commands and starts a connection, terminates a connection (due to timeout or customer request), and attempts to reconnect when the connection is terminated unexpectedly.
- The *front servers* serve as a hub at which the storage system and the remote-support back server connect.

  The front servers are located in an IBM DMZ and receive and maintain connections from the remote support client and the back server. The front servers are strictly inbound and do not initiate any outbound communication.

  No sensitive information is stored on the front server, and all data passing through the front server from the client to the back server is encrypted, so the front server or a malicious entity in control of a front server cannot access this data.
- One or more *back servers* are located within the IBM intranet. Only IBM service representatives that are authorized to perform remote support of the storage system can access these servers.

  The back server authenticates the IBM service representative, provides the IBM service representative with a user interface through which to choose a system to

support, and manages the remote support session as it progresses. The IBM service representative connects to the back server by using a Secure Shell (SSH) client or an HTTPS connection with any browser.

Requirement: To perform remote support through the Remote Support Center, your storage system must be able to initiate an outbound SSH connection to IBM. If the system does not have direct access to the Internet (for example, due to a firewall), you can use the IBM Remote Support Proxy to facilitate the connection to IBM. For more information, see the *IBM XIV® Remote Support Proxy User Guide* (GA32-0795).

Figure 32 illustrates the remote support components.

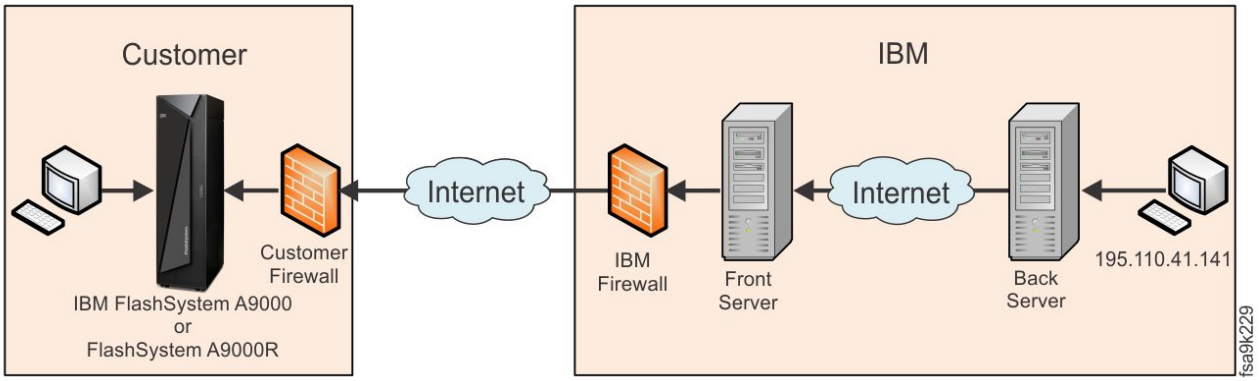


Figure 32. Remote support components

The IBM Remote Support Center uses the Secure Shell (SSH) protocol for transporting data. The encryption used by SSH provides confidentiality and integrity of the transferred data even over insecure mediums.

To conduct a remote support session, the IBM service representative must explicitly connect to the IBM Remote Support Center back server. The following secure remote connection process occurs when a support session is opened:

1. The customer initiates an Internet SSH connection to the IBM Remote Support Center.
2. The IBM Remote Support Center identifies the storage system and marks it as connected.
3. The IBM service representative connects to the IBM Remote Support Center using SSH.
4. The IBM Remote Support Center authenticates the IBM service representative.
5. The IBM service representative is shown a list of currently connected storage systems that correspond with the defined permissions, or the IBM service representative manually enters the serial number to view the system.
6. The IBM service representative chooses the storage system to support. Only permitted systems are displayed, and all activity is logged.
7. The fully recorded support session commences.
8. The IBM service representative terminates the support session.
9. The system disconnects from the IBM Remote Support Center.

While a support session is in progress, the storage system displays the system status on the IBM Hyper-Scale Manager user interface (UI). You can view the

process of phasing out a component or the restart of customer-visible system services as it happens. The customer has full control over whether to proceed with a support session by using mechanisms such as timeout or force-disconnect. If a session disconnects unexpectedly, the IBM service representative can resume the session when the storage system next connects to the Remote Support Center.

Remote support for severe system conditions

A remote support connection may be established automatically, when activated, if severe system conditions (critical issues) are seen in the system and access to the machine is blocked to the host. Immediate action is necessary so that waiting for session connection is not necessary. This function is also known as "XRSC on severe system conditions".

Important: Enabling the remote support for severe system conditions is strongly recommended in order to keep system repair time to a minimum and in order to resume connectivity to hosts as fast as possible. This allows an IBM service representative to access the system remotely and start the repair action immediately.

Remote support for severe system conditions permits a remote support access without the need for the customer to initiate the SSH session towards the remote support center. It also eliminates the need to dispatch an IBM service representative to the customer site in order to initiate this session to do so.

The remote support for severe system conditions can be configured by the IBM service representative at the time of the storage system installation. This information is communicated through the Technical and Delivery Assessment (TDA) checklist and worksheets.

Note: If automatic remote support activation is not enabled at the time of installation, you can enable these actions at any time, using the XCLI utility. Use the **support_center_config** command to configure the automatic connection to a support center, setting **automatically_connect** to **yes**. For more detailed information, see IP configuration commands > Defining a support center connection on restart in the *IBM FlashSystem A9000R Command-Line Interface (CLI) Reference Guide* (SC27-8711).

Planning for Call Home

Using Call Home, you can set up the IBM FlashSystem A9000R system to automatically send pre-failure or failure notifications to the IBM Troubleshooting Ticketing System in the IBM Service Center. You can also configure the storage system to automatically send alerts directly to you. Call Home cannot accept incoming communication, which means that the IBM Service Center cannot contact the FlashSystem A9000R system using Call Home.

When certain events occur in the FlashSystem A9000R system, Call Home sends a notification to the IBM Service Center. After receiving the notification, IBM service personnel analyze the problem promptly and take appropriate action. If the problem requires service, an IBM service representative is sent to your site with any necessary replacement parts. With access to the FlashSystem A9000R system, IBM service personnel can perform service tasks, such as viewing error logs and problem logs or initiating trace and dump retrievals.

Call Home proactively reduces problem handling efforts and provides more efficient self-service solutions. This ensures success when using IBM products and services, reducing critical situation events. This will also help you save time and money while maintaining your IT environment.

Call Home notifications are sent through email from an SMTP server. You must have an SMTP email system available that the FlashSystem A9000R system can use to send outgoing Call Home emails to IBM.

Call Home information is configured by the IBM service representative at the time of storage system installation. This information is communicated through the Technical and Delivery Assessment (TDA) checklist and worksheets.

Important: It is the customer's responsibility to configure the SMTP email system to enable the FlashSystem A9000R system to send outgoing emails for the call home function. The email configuration rules must not inhibit call home emails from being sent in real time. Emails with “Importance” or “X-Priority” in the email header must not be delayed. For example, FlashSystem A9000R emails must not be placed in a queue for later delivery or filtered for priority. The administrator must verify correct configuration and function of the email system before installation. Failure to verify the email system might delay the successful installation of the FlashSystem A9000R system.

Table 29 lists requirements that must be met to configure the Call Home function.

Table 29. Call Home configuration information

Call Home configuration requirement	Value	Comment
Customer SMTP port	25	The customer SMTP server must be reachable on port 25 from the customer-provided management IP address.
Customer SMTP address	IP address	This IP address is supplied by the customer.
Email destination address	xiv-callhome-eastern-hemisphere@vnet.ibm.com or xiv-callhome-western-hemisphere@vnet.ibm.com	Customer SMTP server must allow relaying to the following IBM email addresses based on geographical location: • East: EMEA, Asia, Australia, Africa, and the rest of the world • West: USA, Canada, Latin America, and the Caribbean Islands
Email source address	xiv@il.ibm.com or customer-defined	The default email address from which the email is sent. This email address can be customer-defined to conform to the customer email relay rules.

Planning for Call Home Web

Call Home Web allows you to view online support information for one or more IBM storage systems in a consistent and consolidated manner.

The standard Call Home option (see "Planning for Call Home" on page 81) allows you to set up the system to automatically send pre-failure or failure notifications to the IBM Troubleshooting Ticketing System in the IBM Service Center. This information can help IBM Support to better diagnose issues with your systems and proactively assist in identifying them and in developing an action plan for their fast resolution.

While the standard Call Home information is accessible to IBM Support only, you can now view the information online through Call Home Web on the IBM Support Portal (support.ibm.com). The information is presented in a consistent and consolidated manner. It includes descriptive events, generated by the standard Call Home, an exportable system summary, software levels, and your system information.

Additional features allow you to view such details as the last automated problem report received, maintenance contract expiration date, last inventory received, and last heartbeat received. When configured to send notifications, Call Home web notifies you via email upon receipt of an event from Call Home.

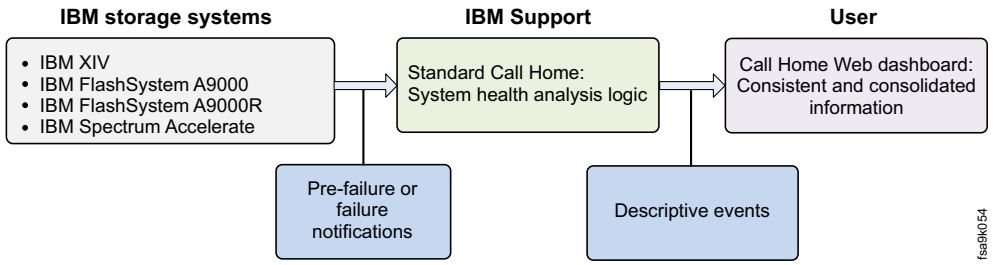


Figure 33. IBM Call Home and Call Home Web

Attention: To use Call Home Web, you must first enable the standard Call Home option on your system, as explained in "Planning for Call Home" on page 81.

Note: Call Home Web is only available for systems under warranty or maintenance contract.

After Call Home has been enabled, you can add your system to Call Home Web. This operation is authorized to the following IBM FlashSystem A9000 and A9000R systems user roles:

- Storage integration administrator
- Storage administrator
- Application administrator

To add your system to Call Home Web, one of the above storage system users must issue the custom event similar to the following, but with properly substituted information values:

```
custom_event custom_event_description= "Connect System to Web Call Home" [severity = <INFORMATIONAL ]
Contact Name = 'Your Name': Contact Phone Number = '555-555-5555':
Contact Email Address = 'jdoe@company_name.com': ICN= '1234567'"
```

Upon receiving this event, the IBM Service Center generates a test event and establishes an association with your system.

To disconnect a storage system from Call Home Web:

- From the System Details page and click **Remove System from Call Home Web**.

Note: You can only remove a system that is fully added (activated and confirmed). If you need to remove a system that was accidentally added or cannot be confirmed, click **Feedback** and request that the system be removed.

For comprehensive information about Call Home Web, see IBM Call Home assistance webpage (ibm.biz/call-home-guide).

Required support information

Use this information to help prepare for support requests.

Have the following information on hand when calling for a support request for a storage system:

- Phone number of machine location
- Machine serial number

Figure 34 on page 85 depicts the location of the serial number on the front of a FlashSystem A9000R rack.

Figure 35 on page 86 depicts the location of the serial number on the rear of a FlashSystem A9000R rack.

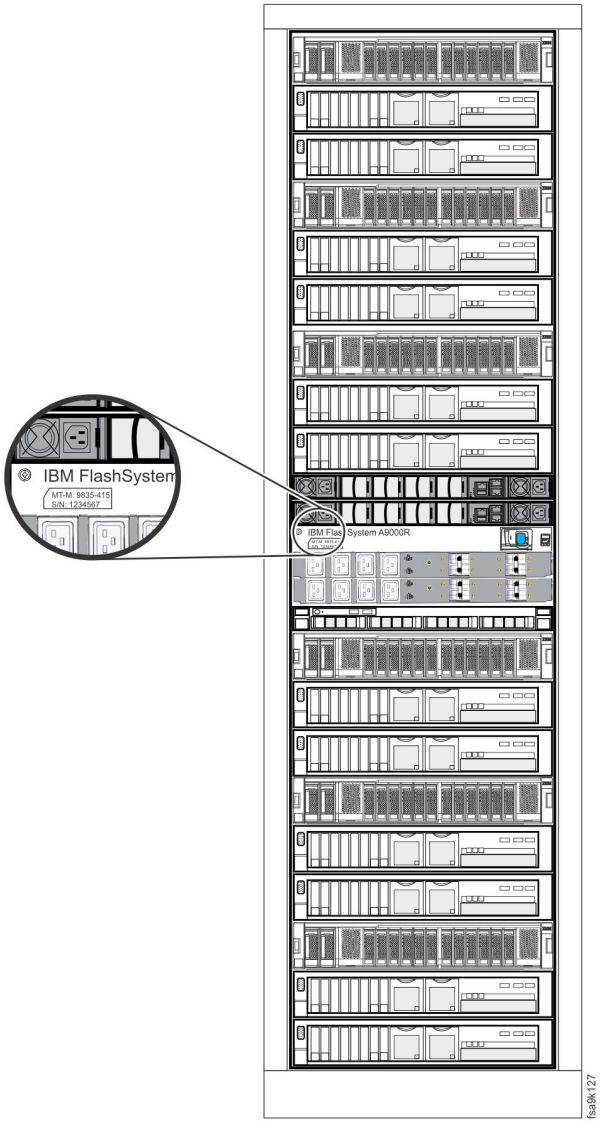


Figure 34. Machine type and model, and serial number label on front of rack

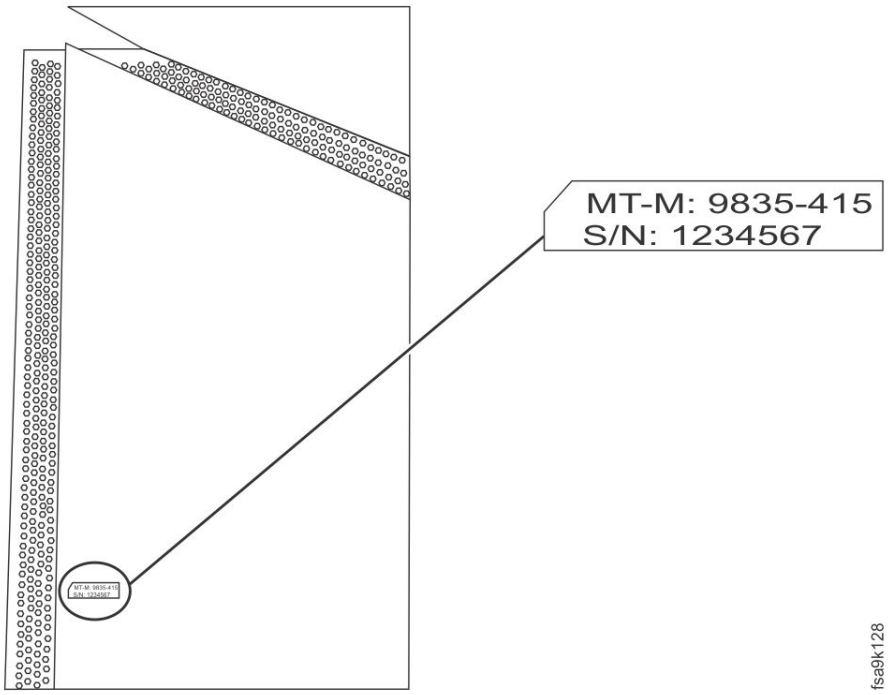


Figure 35. Machine type and model, and serial number on rear of rack

Support and software maintenance security information

The IBM Remote Support Center provides a high level of security for a remotely supported FlashSystem A9000R system through encryption, authentication, authorization, auditing, and field-proven security components.

On-site service security

Service representatives need a valid time certificate in order to connect to any given system.

Native user authentication

To prevent unauthorized access to the configuration of the storage system and ultimately to the information stored on its volumes, the IBM FlashSystem A9000R storage system uses password-based user authentication. Password-based authentication is a form of challenge-response authentication protocol where the authenticity of a user is established by presenting that user with a question "challenge" and comparing the answer "response" with information stored in a credential repository.

Local credential repository

By default, the IBM FlashSystem A9000R storage system is configured to use native (FlashSystem A9000R system managed) user authentication. Native user authentication uses the credential repository stored locally on the storage system. The FlashSystem A9000R local credential repository maintains the following information:

- User name
- User password
- User role
- User group
- Optional account attributes (such as email and phone numbers)

For more information about these role definitions and how to use them, see Security > Native user authentication > Local credential repository in IBM FlashSystem A9000 and IBM FlashSystem A9000R: Architecture, Implementation and Usage on the IBM Storage Redbooks website (www.redbooks.ibm.com/portals/storage).

Chapter 8. PCI DSS compliance

The Payment Card Industry Data Security Standard (PCI DSS) is the global information security standard, for organizations that process, store, or transmit data with any of the major credit card brands. IBM FlashSystem A9000R systems comply with PCI DSS standards.

Table 30 describes how IBM FlashSystem A9000R comply with these standards.

Table 30. PCI-DSS Support

Requirement	PCI-DSS Section	FlashSystem A9000R solution
Encrypt all non-console administrative access	2.3	All management connections are secured via IPSec.
Implement a data retention and disposal policy that includes...Processes for secure deletion of data when no longer needed	3.1.1	FlashSystem A9000R provides data-at-rest encryption by use of SED capabilities of the flash enclosure IBM MicroLatency modules and by encrypting the SSD vault devices.
Disk encryption and key management requirements	3.4.1, 3.5, 3.6	Key management using IBM's SKLM key server services, using KMIP key exchange protocol. Disks are encrypted using AES256 in XTS mode.
Change user passwords at least every 90 days	8.5.9	Enforcement of password expiration may be provided using LDAP servers, as configured by the system administrator. **Note:** Password expiration rules do not apply to the storage admin user.
Minimum password length ... passwords containing both numeric and alphabetic characters ... Limit repeated access attempts ... Set the lockout duration to a minimum of 30 minutes	8.5.10 - .14	Enforcement of password rules may be provided using LDAP servers, as configured by the system administrator. **Note:** Password enforcement rules do not apply to the storage admin user.
If a session has been idle for more than 15 minutes, require the user to re-authenticate	8.5.15	Supported by IBM Hyper-Scale Manager UI and XCLI utility.
Audit trails	10.5.1- .7	The audit trails are supported through the syslog (Service Center) server.

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Tele: +49 (0) 800 225 5423 or +49 (0) 180 331 3233
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Germany Electromagnetic Compatibility Directive

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要領に基づく定格入力電力値： Knowledge Centerの各製品の
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This statement explains the Japan Electronics and Information Technology Industries Association (JEITA) statement for products less than or equal to 20 A per phase.

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