IBM FlashSystem A9000R
Models 9835-415, 9837-415, 9835-425, 9837-425, and 9837-U25

Deployment Guide

GC27-8565-15

Note

Before using this information and the product it supports, read the information in “Safety and environmental notices” on page xiii and “Notices” on page 113.

Edition Notice

Publication number: GC27-8565-15.

This publication applies to IBM FlashSystem A9000R, replacing GC27-8565-13, 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 xvi and "Environmental notices" on page xix 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/).

Danger notices for IBM FlashSystem A9000R systems

Ensure that you understand the danger notices for IBM FlashSystem A9000R systems.

Danger notices

Use the reference numbers in parentheses at the end of each notice, such as (D001), to find the matching translated notice in *IBM Systems Safety Notices* .

DANGER: An electrical outlet that is not correctly wired could place hazardous voltage on the metal parts of the system or the devices that attach to the system. It is the responsibility of the customer to ensure that the outlet is correctly wired and grounded to prevent an electrical shock. (D004)

DANGER: When working on or around the system, observe the following precautions:

Electrical voltage and current from power, telephone, and communication cables are hazardous. To avoid a shock hazard:

- If IBM supplied the power cord(s), connect power to this unit only with the IBM provided power cord. Do not use the IBM provided power cord for any other product.
- Do not open or service any power supply assembly.
- Do not connect or disconnect any cables or perform installation, maintenance, or reconfiguration of this product during an electrical storm.
- The product might be equipped with multiple power cords. To remove all hazardous voltages, disconnect all power cords.
  - For AC power, disconnect all power cords from their AC power source.
  - For racks with a DC power distribution panel (PDP), disconnect the customer's DC power source to the PDP.
- When connecting power to the product ensure all power cables are properly connected.
  - For racks with AC power, connect all power cords to a properly wired and grounded electrical outlet. Ensure that the outlet supplies proper voltage and phase rotation according to the system rating plate.
  - For racks with a DC power distribution panel (PDP), connect the customer's DC power source to the PDP. Ensure that the proper polarity is used when attaching the DC power and DC power return wiring.
- Connect any equipment that will be attached to this product to properly wired outlets.
- When possible, use one hand only to connect or disconnect signal cables.
- Never turn on any equipment when there is evidence of fire, water, or structural damage.
- Do not attempt to switch on power to the machine until all possible unsafe conditions are corrected.
- Assume that an electrical safety hazard is present. Perform all continuity, grounding, and power checks specified during the subsystem installation procedures to ensure that the machine meets safety requirements.

- Do not continue with the inspection if any unsafe conditions are present.
- Before you open the device covers, unless instructed otherwise in the installation and configuration procedures: Disconnect the attached AC power cords, turn off the applicable circuit breakers located in the rack power distribution panel (PDP), and disconnect any telecommunications systems, networks, and modems.
- DANGER: Connect and disconnect cables as described in the following procedures when installing, moving, or opening covers on this product or attached devices.

  To Disconnect:

  1. Turn off everything (unless instructed otherwise).
  2. For AC power, remove the power cords from the outlets.
  3. For racks with a DC power distribution panel (PDP), turn off the circuit breakers located in the PDP and remove the power from the Customer's DC power source.
  4. Remove the signal cables from the connectors.
  5. Remove all cables from the devices.

  To Connect:

  1. Turn off everything (unless instructed otherwise).
  2. Attach all cables to the devices.
  3. Attach the signal cables to the connectors.
  4. For AC power, attach the power cords to the outlets.
  5. For racks with a DC power distribution panel (PDP), restore the power from the Customer's DC power source and turn on the circuit breakers located in the PDP.
  6. Turn on the devices.

  Sharp edges, corners and joints may be present in and around the system. Use care when handling equipment to avoid cuts, scrapes and pinching. (D005)

DANGER: Heavy equipment — personal injury or equipment damage might result if mishandled. (D006)

DANGER: Professional movers are to be used for all relocation activities. Serious injury or death may occur if systems are handled and moved incorrectly. (D008)

DANGER: Serious injury or death can occur if loaded lift tool falls over or if a heavy load falls off the lift tool. Always completely lower the lift tool load plate and properly secure the load on the lift tool before moving or using the lift tool to lift or move an object. (D010)

Caution notices for IBM FlashSystem A9000R systems

Ensure that you understand the caution notices for IBM FlashSystem A9000R systems.

Caution notices

Use the reference numbers in parentheses at the end of each notice, such as (C001), to find the matching translated notice in *IBM Systems Safety Notices* .

CAUTION: Only trained service personnel may replace this battery. The battery contains lithium. To avoid possible explosion, do not burn or charge the battery.

Do Not:

- Throw or immerse into water
- Heat to more than 100 degrees C (212 degrees F)
- Repair or disassemble

Exchange only with the approved part. Recycle or discard the battery as instructed by local regulations. (C002)

CAUTION: The doors and covers to the product are to be closed at all times except for service by trained service personnel. All covers must be replaced and doors locked at the conclusion of the service operation. (C013)

CAUTION: This product is equipped with a 3-wire (two conductors and ground) power cable and plug. Use this power cable with a properly grounded electrical outlet to avoid electrical shock. (C018)

Special caution and safety notices

This information describes special safety notices that apply to 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 power cables that are IBM approved, certified, or both.

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/or 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 might provide 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 32.

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 a 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, as depicted in Figure 1 on page xviii.

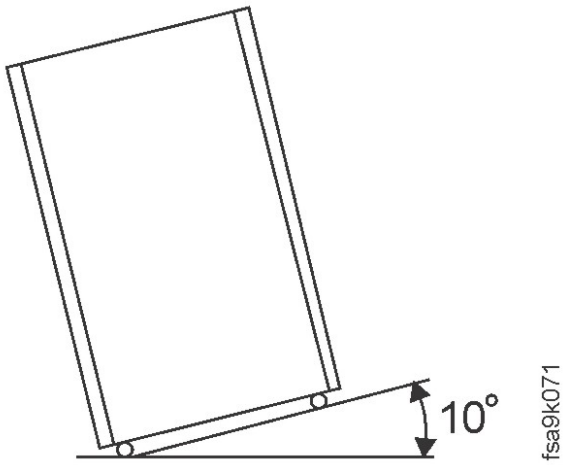


Figure 1. Rack tilt allowance

If more clearance is needed for FlashSystem A9000R or racks the Height Reduction feature code, AFR2, should be ordered to reduce the height of the rack.

When the height reduced shipping option is ordered, the doors, side panels, and rack top cover are removed before the IBM FlashSystem A9000R is moved to its final location by professional movers. These components must then be installed during the IBM FlashSystem A9000R installation.

If tilting or rack weight reduction is needed for IBM FlashSystem A9000R shipment or delivery, the Weight Reduction feature code, AFR3, should be ordered.

When the weight reduced shipping option 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 Height Reduction or Weight Reduction feature code shipping options are ordered.

DANGER:

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

Environmental notices

This information contains all the required environmental notices for IBM Systems products in English and other languages.

The *IBM Systems Environmental Notices* (ftp://public.dhe.ibm.com/systems/support/warranty/envnotices/environmental_notices_and_user_guide.pdf) information includes statements on limitations, product information, product recycling and disposal, battery information, flat panel display, refrigeration and water-cooling systems, external power supplies, and safety data sheets.

About this guide

This guide provides information regarding the deployment, configuration, and preinstallation requirements for IBM FlashSystem A9000R models 9835-415, 9837-415, 9835-425, 9837-425, and 9837-U25. 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 in order to help 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 and individuals responsible for power, cooling, wiring, network, and general site environmental planning and setup.

CAUTION:  Servicing of this product or unit is to be performed by trained service personnel only. (C032)

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, and 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 an 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 notebook computer or PC 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.
- Install software upgrades.
- Install hardware Engineering Change Notices (ECA) also known as Field Bill of Materials (FBM).
- Conduct product relocation, at customer request.
- Perform break/fix repairs.
- Handle the 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 *Enterprise Class Support for Storage* document, provided by your IBM representative.

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 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 Hyper-Scale Manager on IBM Knowledge Center (ibm.com/support/knowledgecenter/SSUMNQ)– on which you can find the following related publications:
  - IBM Hyper-Scale Manager – Release Notes
  - IBM Hyper-Scale Manager – User Guide
  - IBM Hyper-Scale Manager – Representational State Transfer (REST) API Specifications
- 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.

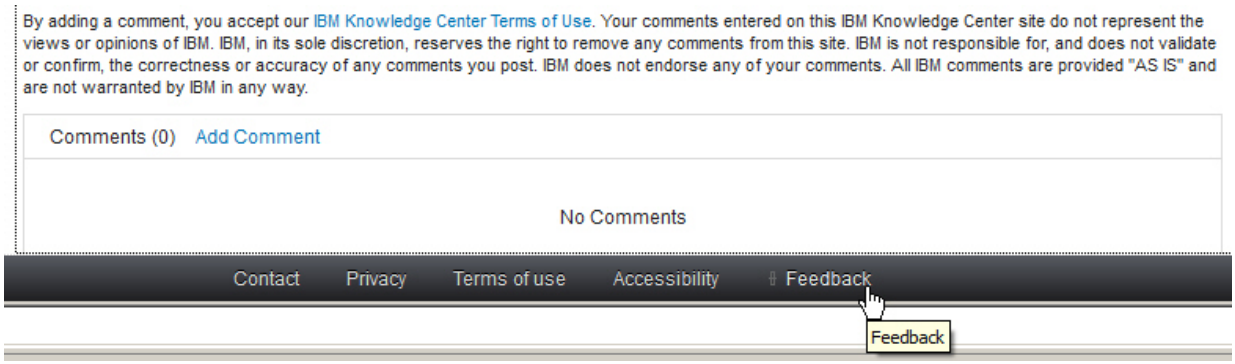
Sending or posting your comments

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

Note: When you send information to IBM, you grant IBM a nonexclusive right to use or distribute the information in any way it believes appropriate without incurring any obligation to you.

Chapter 1. Overview

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.

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

FlashSystem A9000R provides consistent, efficient 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 2. 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, providing density, low latency, high I/O, and high availability by leveraging IBM-enhanced MLC flash in model 415, and 3D triple-level cell (3D TLC) flash in models 425 and U25. 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 11).

Due to 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.

IBM FlashSystem A9000R provides native implementation of IBM HyperSwap capability as well as Multi-site high availability and disaster recovery (HA/DR) capabilities. HyperSwap delivers active-active data access and transparent failover, per volume, across IBM FlashSystem® A9000 and IBM FlashSystem

A9000R arrays and across data centers. Multi-site HA/DR supports high-availability with HyperSwap between two primary sites, and disaster recovery via simultaneous Asynchronous replication from the primary sites to a tertiary site.

IBM FlashSystem A9000R is ready for Kubernetes container environments and integrates with a wide variety of hypervisor and virtualization software, including IBM Bluemix, VMware, OpenStack, Linux, 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

Use the planning information in this guide 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.

Good planning is essential for the successful setup and use of your IBM FlashSystem A9000R. It ensures that you have everything you need and that you meet all specified system prerequisites. It also helps minimize errors and speeds up the installation process.

It is imperative that you work with the IBM sales team, IBM representative, 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: Customers must prepare their environments to handle the FlashSystem A9000R system based on this planning information with assistance from an IBM 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, customers 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. Customers 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 help devise alternative solutions.

Additional product information

This guide only covers deployment and planning information for the IBM FlashSystem A9000 storage system.

Additional product information

- 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 the IBM Storage Utility Offering (SUO) (Model U25), see the IBM Storage Utility Offering at IBM Marketplace (ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=TSS03238USEN).
- 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 FlashSystem A9000R Command-Line Interface (CLI) Reference Guide* , SC27-8711

- For IBM Hyper-Scale Manager (HSM) information, see the following documentation, which can be found on the IBM Hyper-Scale Manager on IBM Knowledge Center (ibm.com/support/knowledgecenter/SSUMNQ).
  - *IBM Hyper-Scale Manager User Guide* , SC27-8560
  - *IBM Hyper-Scale Manager Release Notes*
  - *IBM Hyper-Scale Manager REST API Specifications* , SC27-6440

Chapter 2. System specifications

This section provides information about the general properties, performance, physical features, storage capacity features, and host connectivity for the different IBM® FlashSystem™ A9000R storage system models.

General properties

Element	Model 415	Models 425 and U25
Grid 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	Up to 8 active grid controllers, each containing: • Two Intel Xeon E5 12-core 2.2 GHz processors • 384 GB DDR4 memory • Redundant battery backup units and power supply units
Software	IBM FlashSystem A9000 and A9000R software v12.0.x or later	IBM FlashSystem A9000 and A9000R software v12.2.x or later
Models and warranties	• 9835-415: 1-year warranty • 9837-415: 3-year enterprise-class warranty Warranties include onsite service, same day 24×7	• 9835-425: 1-year warranty • 9837-425: 3-year enterprise-class warranty • 9837-U25: 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
Model 415

Element	Details									
Flash storage type	IBM-enhanced MLC									
	900 TB configuration					**1.8 PB configuration**				
Effective capacity[1] (TB)	300	450	600	750	900	600	900	1200	1500	1800
Maximum capacity[2] (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				
Grid controllers	4	6	8	10	12	4	6	8	10	12
Flash enclosures	2	3	4	5	6	2	3	4	5	6
IBM MicroLatency® modules per flash enclosure	12 × 2.9 TB					12 × 5.7 TB				

[1]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.

[2]Maximum capacity refers to the effective capacity provisioning limit.

Models 425 and U25

Element	Details											
Flash storage type	IBM-enhanced 3D TLC											
	720 TB configuration				**1700 TB configuration**				**3600 TB configuration**			
Effective capacity[1] (TB)	180	360	540	720	425	850	1275	1700	900	1800	2700	3600
Maximum capacity[2] (TB)	1200	2400	3600	4800	1200	2400	3600	4800	1200	2400	3600	4800
Physical capacity[3] (TB)	36	72	108	144	85	170	255	340	180	360	540	720
Raw capacity (TB)	55.3	110.6	166.1	221.2	129	258	387	516	258	516	774	1032
Grid controllers	3	4	6	8	3	4	6	8	3	4	6	8
Flash enclosures	1	2	3	4	1	2	3	4	1	2	3	4
IBM MicroLatency modules per flash enclosure	12 × 3.6 TB				12 × 8.5 TB				12 × 18 TB			

[1]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 to 1.

[2]Maximum capacity refers to the effective capacity provisioning limit.

[3]Physical capacity is the available capacity after system overhead, including flash media over-provisioning and RAID protection.

Physical features (all models)

Physical feature	Model 415		Models 425 and U25
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	Minimum configuration:	616 kg (1358 lbs)	Prior to October 2018 (4 grid controllers and 2 flash enclosures): 616 kg (1358 lbs) From October 2018 (3 grid controllers and 1 flash enclosure): 550 kg (1212 lbs)
	Maximum configuration:	935 kg (2061 lbs)	774 kg (1706 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	Minimum configuration:	3.085 kW (typical); 4.516 kW (max)	Prior to October 2018 (4 grid controllers and 2 flash enclosures): 3.085 kW (typical); 4.516 kW (max) From October 2018 (3 grid controllers and 1 flash enclosure): 1.914 kW (typical); 2806 kW (max)
	Maximum configuration:	8.81 kW (typical); 13.91 kW (max)	5.996 kW (typical); 8.671 kW (max)
	See “Power consumption” on page 34.		

Operation environment (all models)

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

Host connectivity (all models)

Host connectivity feature		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
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: In model 415, synchronous remote mirroring is supported by version 12.0.1 and later.		

Chapter 3. Physical configuration options

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

Procedure

Note: Contact your IBM representative to help determine which configuration options are best for your needs.

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

1. Which model best fits your warranty requirements?

   See full warranty information detailed on the IBM FlashSystem A9000R Knowledge Center website (ibm.com/support/knowledgecenter/STJKN5).

2. What are your capacity needs?

   See “Storage capacity features” on page 6 for full capacity specifications and see “Flash enclosure components and feature codes” on page 17 for flash enclosure information and feature codes.

3. What are your performance requirements?

   See “Rack configurations” on page 11 to help determine how many grid elements you require.

4. What type of host connectivity do you need?

   See “Host connectivity (all models)” on page 8 for full host connectivity specifications and see “Grid controller components and feature codes” on page 19 for grid controller information and feature codes.

5. Do you require any of the following:

   - Water cooling?

     See “Rear-door heat exchanger” on page 20.

   - Weight or height reduced shipping?

     See “Weight reduced shipping option” on page 22 and “Height reduced shipping option” on page 22.

   - A radio frequency identification device (RFID) tag?

     See “Radio frequency identification device option” on page 23.

What to do next

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

- “FlashSystem A9000R grid elements” on page 11
- “Components and interconnect” on page 10
- “Rack configurations” on page 11
- “Flash enclosure components and feature codes” on page 17
- “Grid controller components and feature codes” on page 19
- “Rear-door heat exchanger” on page 20
- “Weight reduced shipping option” on page 22
- “Height reduced shipping option” on page 22
- “Radio frequency identification device option” on page 23

Components and interconnect

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

Table 1 on page 10 breaks down the various components and subcomponents of the IBM FlashSystem A9000R.

Table 1. Components and interconnection options in IBM FlashSystem A9000R

Component	Model 415	Models 425 and U25	Subcomponents
IBM T42 Enterprise rack			
Grid controllers	4 - 12, depending on ordered configuration	3 - 8, 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. Options include: – 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
Flash enclosures	2 - 6, depending on ordered configuration	1 - 4, depending on ordered configuration	• **Model 415:** 12 hot-swap 2.9, or 5.7 TB IBM MicroLatency modules **Models 425 and U25:** 12 hot-swap 3.6, 8.5, or 18 TB IBM MicroLatency modules • Two internal battery modules
Two InfiniBand switches			
Two power distribution units (PDUs)			
Utility patch panel			• Three management ports • One or two VPN ports (configuration dependent)
Internal cabling			

Note: The maintenance module previously provided with the 983x-415 is obsolete and no longer provided with this rack configuration.

Rack configurations

IBM FlashSystem A9000R configurations are ordered according to your performance and capacity needs. Valid configurations vary according to model. Use the information in this section to help determine the best configuration for your needs.

Performance and capacity vary according to rack configuration:

- The more grid controllers in the system:
  - Increases the amount of compute resources and provides better performance.
  - Increases the number of network ports and provides additional bandwidth.

  For more information on the different network options for the grid controllers, see "Grid controller components and feature codes" on page 19.
- The more flash enclosures in the system increases capacity in the system.

  For more information on the different capacity options for the flash enclosures, see "Flash enclosure components and feature codes" on page 17.
- The IBM MicroLatency module raw capacity size ordered.

  Select the flash enclosure feature code that best suits your needs. Larger MicroLatency modules provide higher capacity at constant performance.

  For more information on the different capacity options for the flash enclosures, see "Flash enclosure components and feature codes" on page 17.

For various configuration feature codes see:

- "Flash enclosure components and feature codes" on page 17
- "Grid controller components and feature codes" on page 19
- "Main power cables specifications" on page 36

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

Common components

All FlashSystem A9000R configurations include the following common components:

- Two InfiniBand switches
- Two power distribution units (PDUs)
- One utility patch panel

These components occupy a total of 5U in the rack.

Important: All space in the rack is to be left solely for the use of the IBM FlashSystem A9000R system. Do not use this rack for any other purpose.

FlashSystem A9000R grid elements

A *grid element* is the term used to describe a combination of one flash enclosure and two grid controllers within FlashSystem A9000R machines.

With the exception of model 425 and U25 minimum configurations starting October 2018 (see "Models 425 and U25" on page 14), all FlashSystem A9000R grid element valid configurations contain a number of flash enclosures and double that number of grid controllers.

For example, a three grid element configuration contains three flash enclosures and six grid controllers.

Note:

- A single grid element is **not** a functionally separate subsystem. In any single system each of the system grid controllers access each of the system flash enclosures.
- The size of each individual flash enclosure and grid controller is 2U. Hence, each grid element occupies 6U in the rack.

For more information on the various types of rack configurations, see “Model 415” on page 12 and “Models 425 and U25” on page 14.

Model 415

Model 415 rack configurations have a range between a minimum of two grid elements to a maximum of six grid elements.

A *minimum rack* configuration is comprised of two grid elements and common components. *Partially populated* rack configurations contain three, four, or five grid elements and common components. The maximum configuration (*full rack*) is comprised of six grid elements and common components.

Figure 3 on page 13 shows a model 415 minimum rack configuration. Figure 4 on page 14 shows a model 415 full rack configuration.

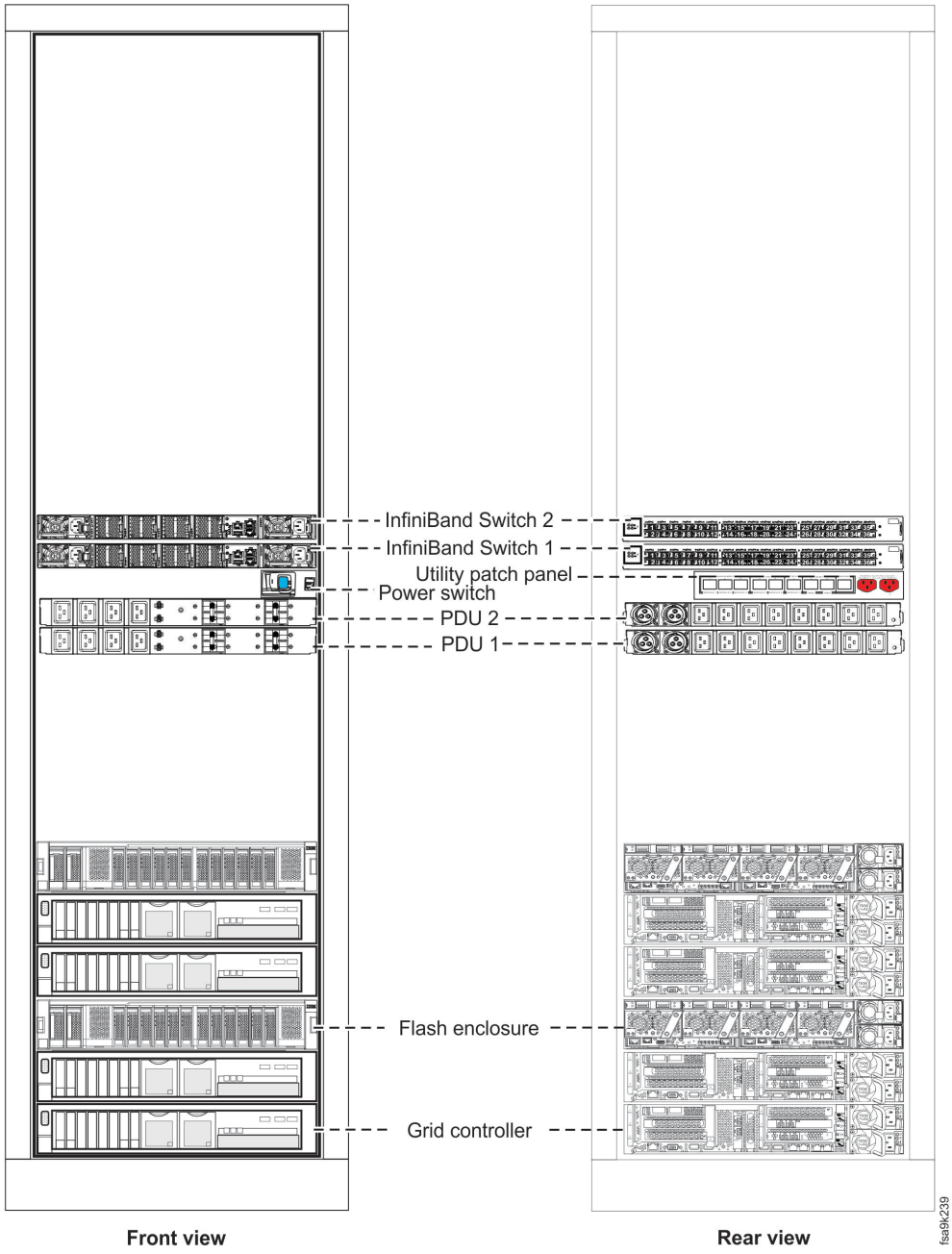


Figure 3. Model 415 minimum rack configuration

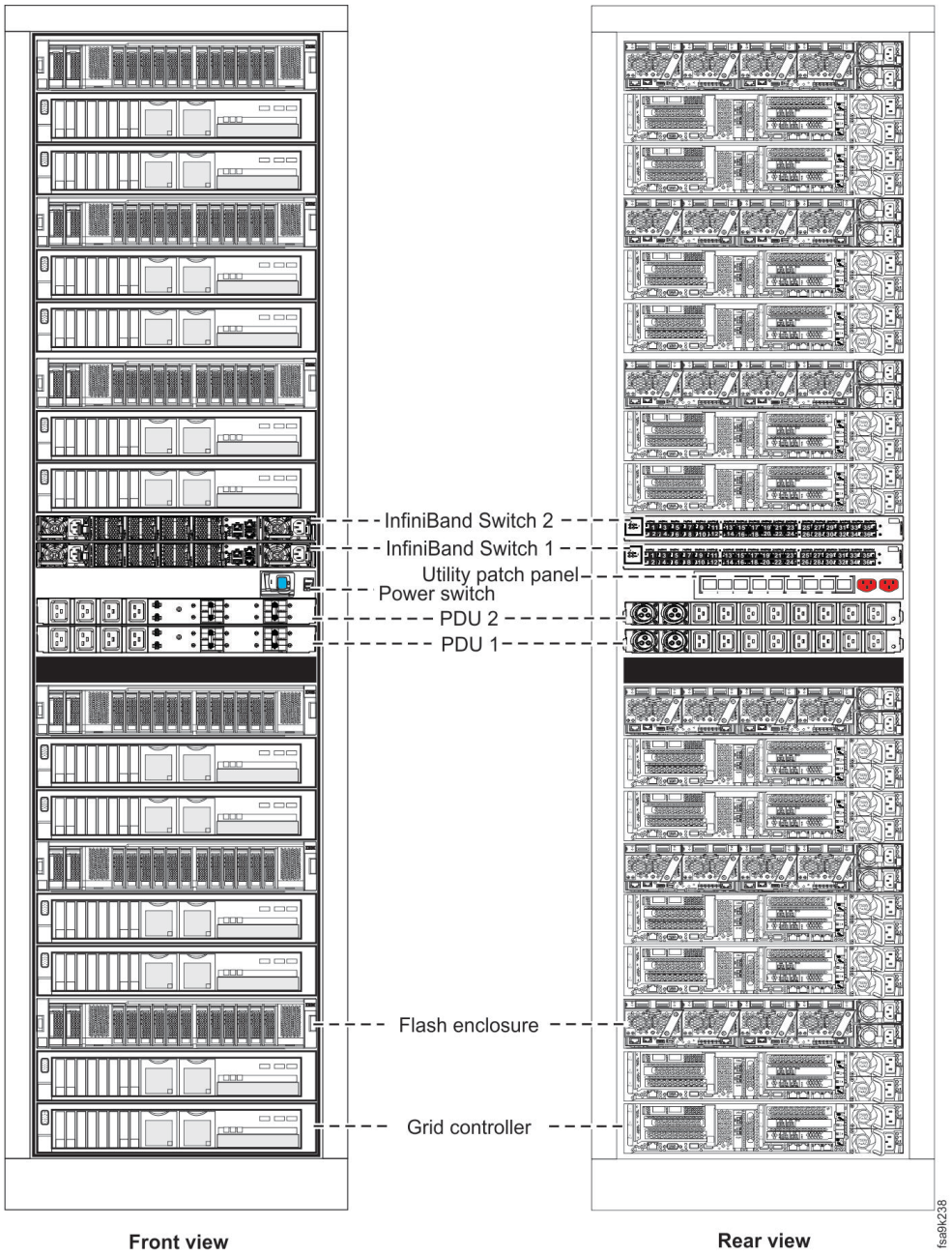


Figure 4. Model 415 full rack configuration

All flash enclosures contain 12 IBM MicroLatency modules. Depending on the flash enclosure ordered, MicroLatency modules are available with 2.9 TB or 5.7 TB raw capacity. For more information about flash enclosures components and feature codes, see "Flash enclosure components and feature codes" on page 17.

Models 425 and U25

Model 425 and U25 rack configurations have a range between a minimum configuration of three grid controllers and one flash enclosure (one grid element with one additional grid controller) to a maximum of four grid elements.

A *minimum rack* configuration is comprised of three grid controllers and one flash enclosure (one grid element and one additional grid controller) and common components. *Partially populated* rack configurations contain two or three grid elements and common components. The maximum configuration (*full rack*) is comprised of four grid elements and common components.

Note: Some regions only support a maximum of three grid elements. For more information, contact your IBM representative.

Minimum rack configurations contain one additional grid controller than the standard single grid element. This configuration ensures that a single grid controller failure does not result in a system shutdown.

Figure 5 on page 15 shows a model 425 and U25 minimum rack configuration. Figure 6 on page 16 shows a model 425 and U25 full rack configuration.

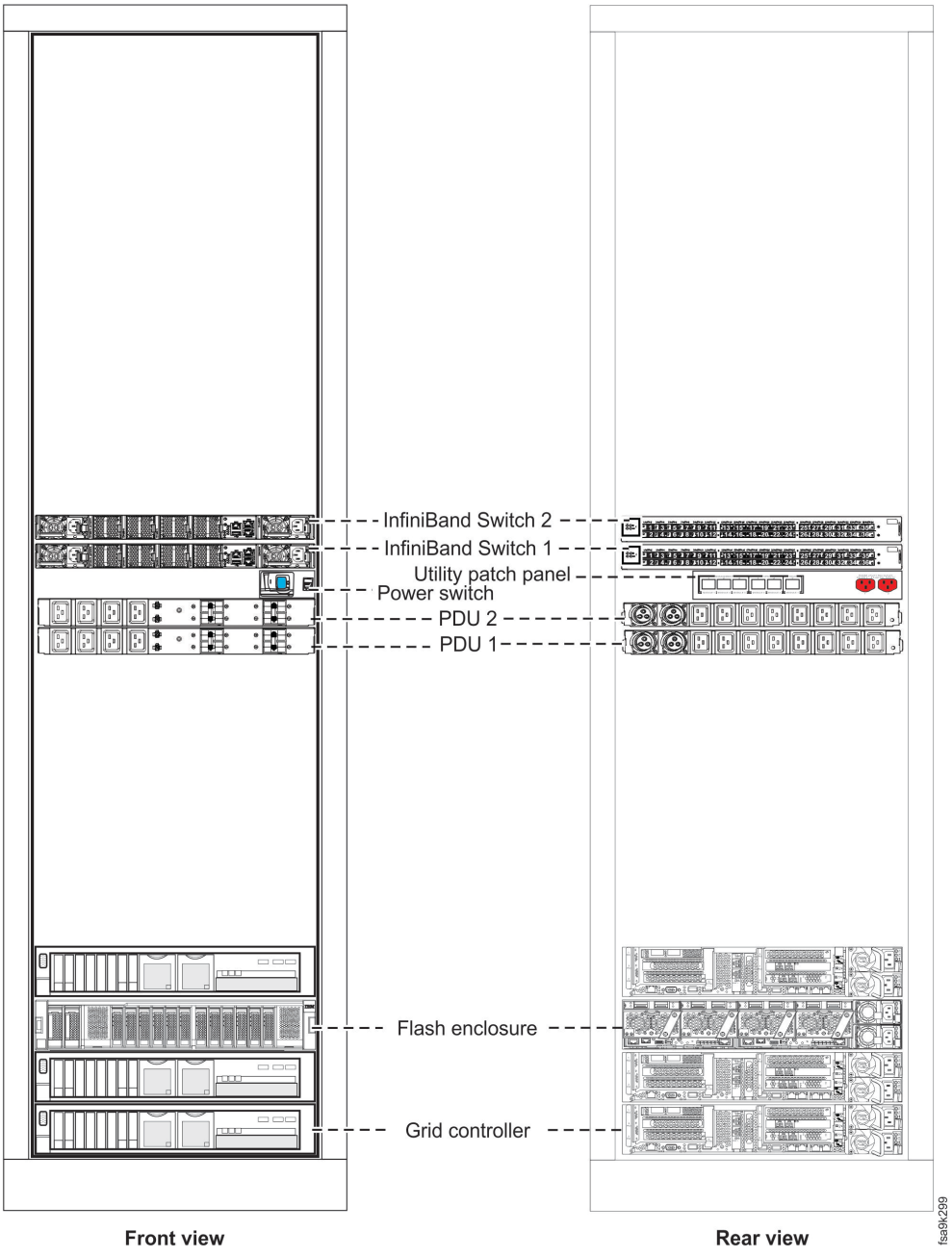


Figure 5. Models 425 and U25 minimum rack configuration

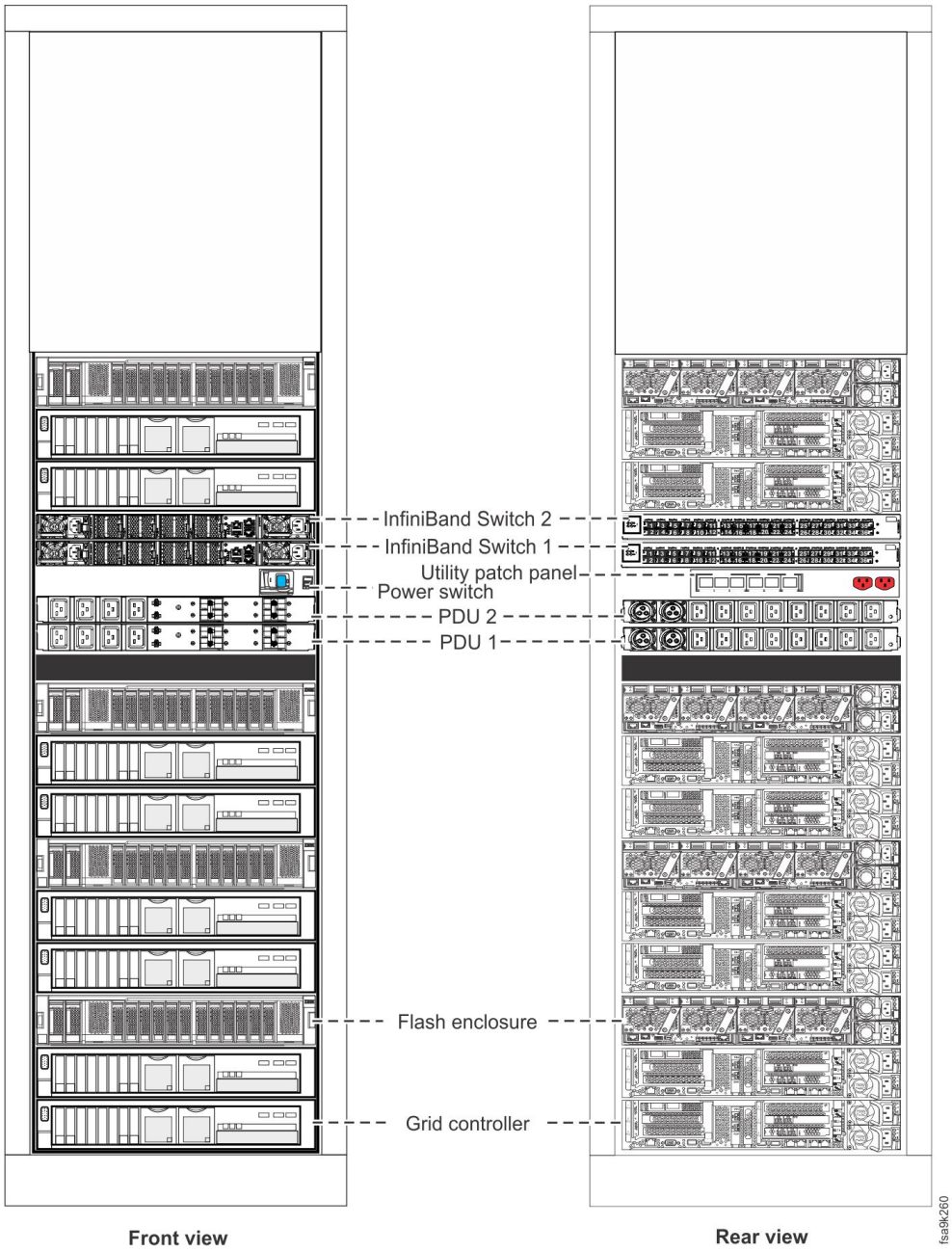


Figure 6. Models 425 and U25 full rack configuration

All flash enclosures contain 12 IBM MicroLatency modules. Depending on the flash enclosure ordered, MicroLatency modules are available with 3.6 TB, 8.5 TB, or 18 TB raw capacity. For more information about flash enclosures components and feature codes, see “Flash enclosure components and feature codes” on page 17.

Conducting system scale-out (MES)

System scale-out (MES) is a performance and capacity expansion option for your system rack, if your system is not already fully populated. Performing system scale-out is a non-disruptive process.

Table 2 on page 17 shows which system versions of each FlashSystem A9000R model and configuration support system scale-out.

Table 2. System scale-out availability		
Model	**Configuration**	**Earliest system version allowing system scale-out**
415	All configurations	12.0.3
425 and U25	2 grid elements and up (minimum of 4 grid controllers and 2 flash enclosures)	12.2.1
425 and U25	Minimum configuration (3 grid controllers and 1 flash enclosure)	12.3.1

When conducting system scale-out, additional grid controllers and flash enclosures are added to the system according to model configuration (see “FlashSystem A9000R grid elements” on page 11).

In order for the installation site to support any future capacity upgrade procedures, your site should adhere to all requirements listed in this document for a full rack. These requirements include:

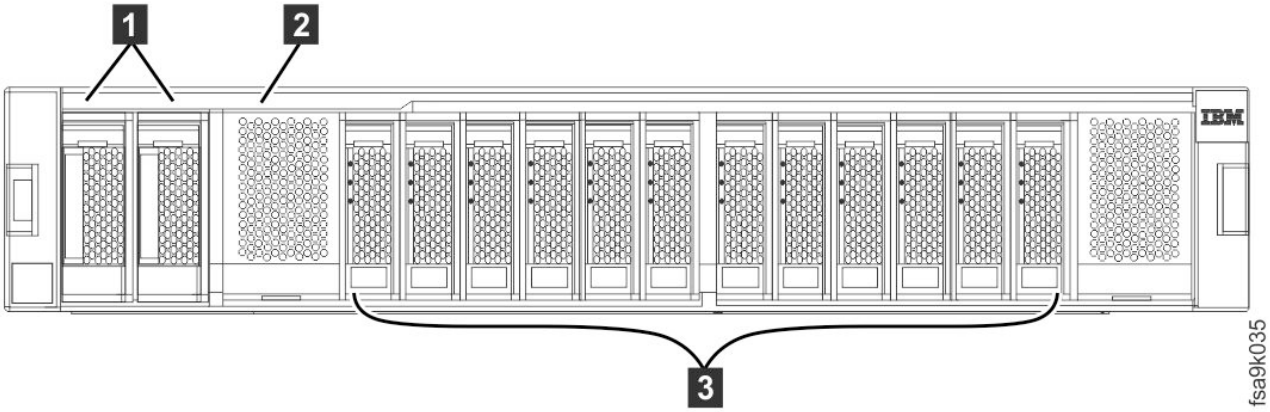
- “Floor-load requirements” on page 27
- “Power requirements” on page 32

For more information regarding system scale-out ordering and requirements, contact your IBM representative.

Flash enclosure components and feature codes

The flash enclosures are used for IBM FlashSystem A9000R storage functions.

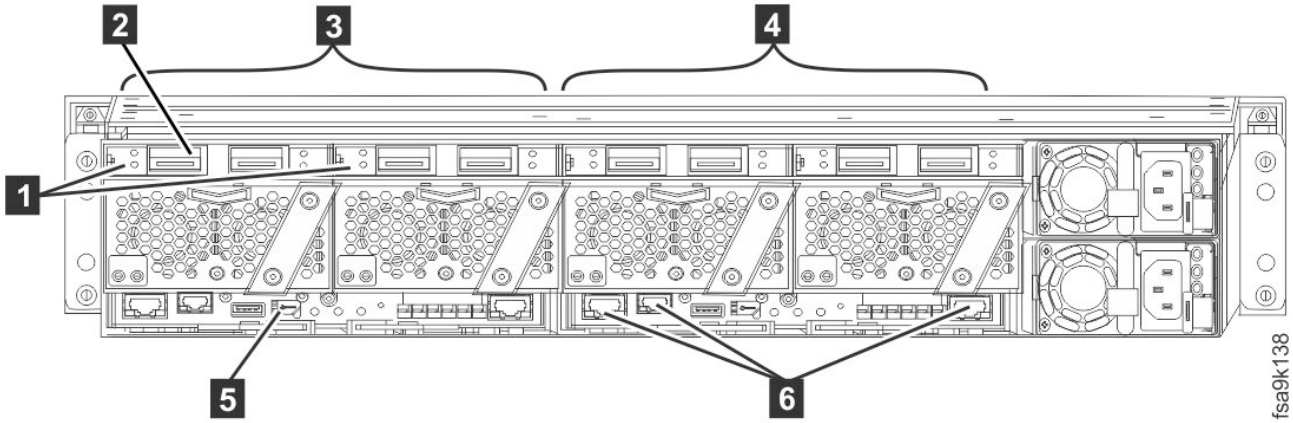
Figure 7 on page 17 shows the front view of a flash enclosure.



1 Battery modules
2 LED indicator panel
3 IBM MicroLatency modules

Figure 7. Front of a flash enclosure

Figure 8 on page 18 shows the rear view 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 8. Rear of a flash enclosure

Model 415

Each rack unit contains 2 - 6 flash enclosures, according to customer specifications. Every flash enclosure contains 12 hot-swap 2.9 TB or 5.7 TB IBM MicroLatency modules.

Figure 7 on page 17 and Figure 8 on page 18 illustrate the front and rear of the flash enclosure.

Table 3 on page 18 lists the feature codes for model 415.

Table 3. Feature codes for flash enclosures – model 415

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

Models 425 and U25

Each rack unit contains 1 - 4 flash enclosures, according to customer specifications. Every flash enclosure contains 12 hot-swap 3.6 TB, 8.5 TB, or 18 TB IBM MicroLatency modules.

Figure 7 on page 17 and Figure 8 on page 18 illustrate the front and rear of the flash enclosure.

Table 4 on page 18 lists the feature codes for models 425 and U25.

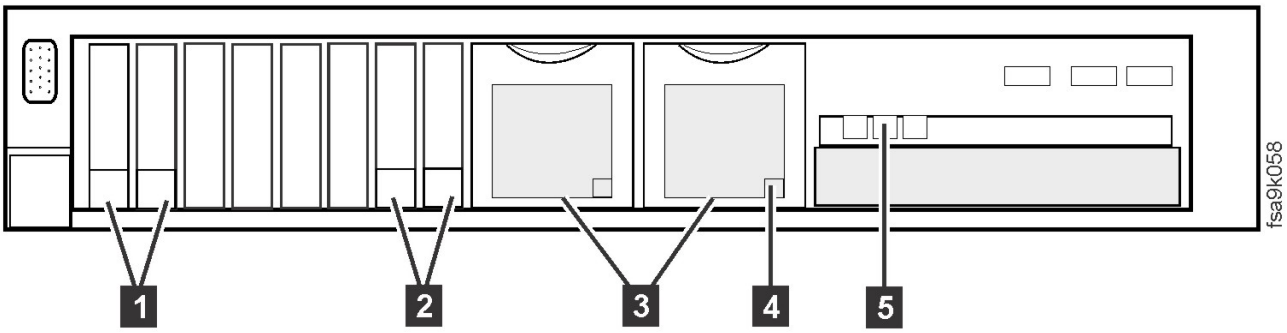
Table 4. Feature codes for flash enclosures – models 425 and U25

Description	Feature code
Flash enclosure with 12 x 3.6 TB IBM MicroLatency modules	AFE4
Flash enclosure with 12 x 8.5 TB IBM MicroLatency modules	AFE5
Flash enclosure with 12 x 18 TB IBM MicroLatency modules	AFE6

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.

Figure 9 on page 19 illustrates the front of the grid controller. Figure 10 on page 19 and Figure 11 on page 20 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 9. Front of a grid controller

Attention: Do not use the power button / LED (not shown in Figure 9 on page 19) to turn off the machine. This can lead to a customer impact event (CIE).

For full information on how to properly shutdown a system, see the *IBM FlashSystem A9000R Command-Line Interface (CLI) Reference Guide* (SC27-8711).

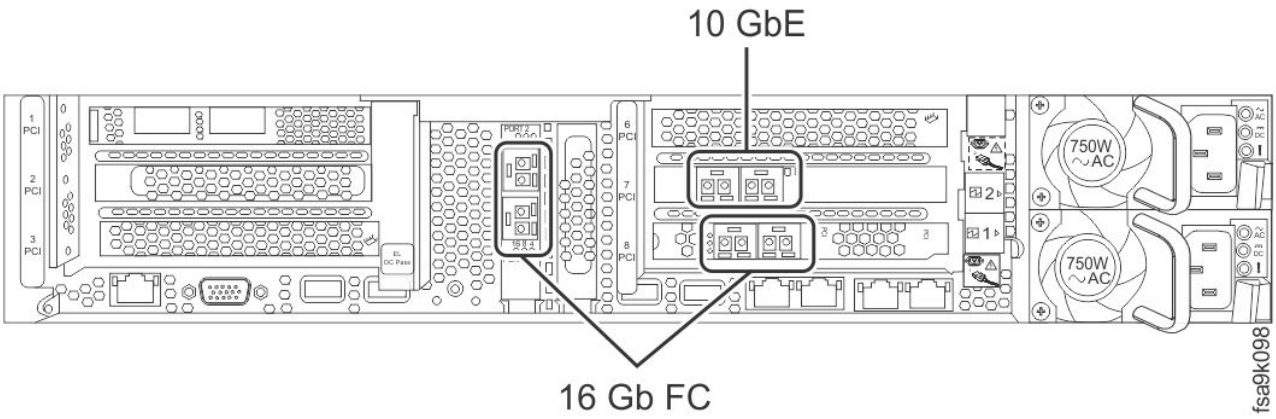


Figure 10. Rear of a grid controller with FC configuration

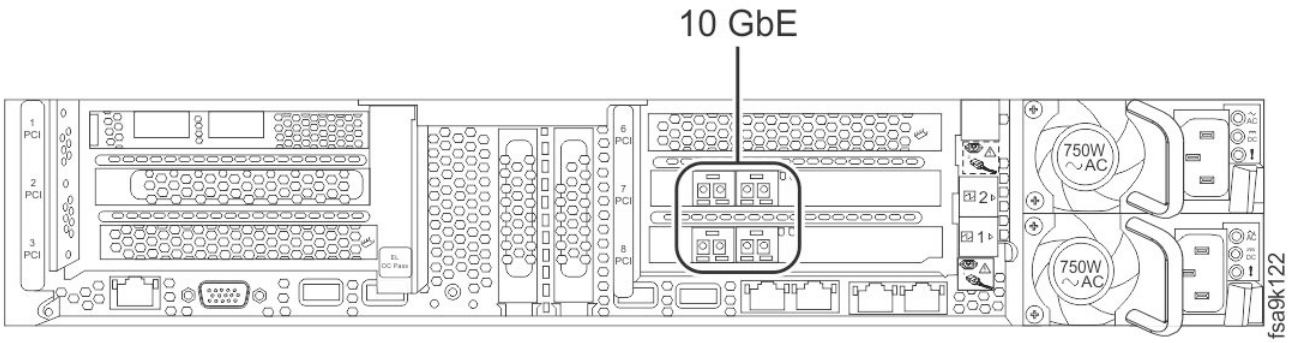


Figure 11. Rear of a grid controller with 10 Gb Ethernet configuration

Model 415

Each rack unit contains 4 - 12 grid controllers, according to customer specifications.

Table 5 on page 20 lists the feature codes for model 415.

Table 5. Feature codes for grid controllers – model 415

Description	Feature code
Grid controller with 4 x 16 Gb Fibre Channel (FC) + 2 x 10 GbE iSCSI	5001
Grid controller with 4 x 10 GbE iSCSI	5002

Models 425 and U25

Each rack unit contains 3 - 8 grid controllers, according to customer specifications.

Table 6 on page 20 lists the feature codes for models 425 and U25.

Table 6. Feature codes for grid controllers – models 425 and U25

Description	Feature code
Grid controller with 4 x 16 Gb Fibre Channel (FC) + 2 x 10 GbE iSCSI	5003
Grid controller with 4 x 10 GbE iSCSI	5004
Grid controller with 4 x 16 Gb Fibre Channel NVMe (FC-NVMe) ready + 2 x 10 GbE iSCSI	5005

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).

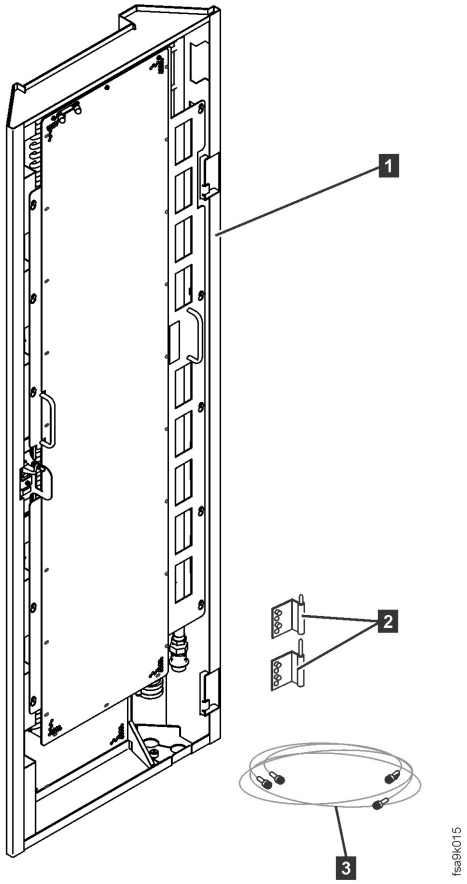
The primary cooling loop supplies the building chilled water to secondary cooling loops and air conditioning units.

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 12 on page 21.

- Door assembly
- Hinge kit
- Air-purge tool



1 Door assembly
2 Hinge kit
3 Air-purging tool

Figure 12. Rear-door heat exchanger option kit

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

Table 7. Rear-door heat exchanger features

Feature description	Feature code
Rear-door heat exchanger	AFR1

See “Preparing for the rear-door heat exchanger” on page 32 for information about the requirements for preparing the installation site before the rear-door heat exchanger feature can be installed.

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 28, 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 935 kg (2061 lbs) (model 415) or 774 kg (1706 lbs) (model 425) 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.

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.

The following are the approximate weights, including packaging, of a fully configured FlashSystem A9000R system:

- Model 415: 935 kg (2061 lbs)
- Models 425 and U25: 774 kg (1706 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.

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 more information about RFID, RFID numbering specifications, and general RFID best practices, see the *FSTC RFID IT Assets – Phase 2 Business Case and Best Practices* report, published by the Financial Services Technology Consortium (FSTC). This report can be found on the Publications page of the IBM FlashSystem A9000R Knowledge Center website (ibm.com/support/knowledgecenter/STJKN5).

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.

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 physical requirements.

Procedure

Note: Contact your IBM representative to help determine which configuration options are best for your needs.

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 should 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.

To determine the required ordering information, answer the following questions regarding the installation site:

1. What type of power input do you have?
   See “Input voltages and frequencies” on page 35.
2. 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? See “Floor and space requirements” on page 26.
   - Is there adequate cooling capacity to handle the new equipment? See “Air circulation and cooling” on page 41.
   - Is sufficient power available? See “Power consumption” on page 34.
   - Do you need 30A or 60A power cables? See “Main power cables specifications” on page 36.
   - If water cooling is required, see “Planning for the rear-door heat exchanger” on page 48.

What to do next

See the following information about the various physical installation site requirements for your IBM FlashSystem A9000R storage system.

- “Floor and space requirements” on page 26
- “Power requirements” on page 32
- “Environmental requirements” on page 40
- “Planning for the rear-door heat exchanger” on page 48
- “Site security considerations” on page 68

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 26.
2. Determine whether the floor meets the floor-load requirements for the FlashSystem A9000R system.
   See "Floor-load requirements" on page 27.
3. Calculate the amount of space needed for the rack footprint and service clearance requirements.
   See "Rack dimensions and service clearance requirements" on page 28.
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 30.
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 31.
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 32.
9. If absorbent padding is used where the rack casters (wheels) are located, be sure to follow instructions in "Bottom rack dimensions" on page 29.

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 30.

Non-raised floor considerations

Raised floors are preferred because they provide better support for the cabling and 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 31.

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 8 on page 27. 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 8. Floor weight-support requirements

Grid element configuration	Floor reinforcement area	Total weight
12 grid controllers and 6 flash enclosures Model 415 only.	66 cm × 118 cm (26 in. × 46.5 in.)	935 kg (2061 lbs)
10 grid controllers and 5 flash enclosures Model 415 only.	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)
3 grid controllers and 1 flash enclosure	66 cm × 118 cm (26 in. × 46.5 in.)	550 kg (1212 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 20.

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

Attention: 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.

Note:

- 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 9 on page 28 and Figure 13 on page 29 describe dimensions and minimum service clearance for the FlashSystem A9000R system.

Table 9. 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.)

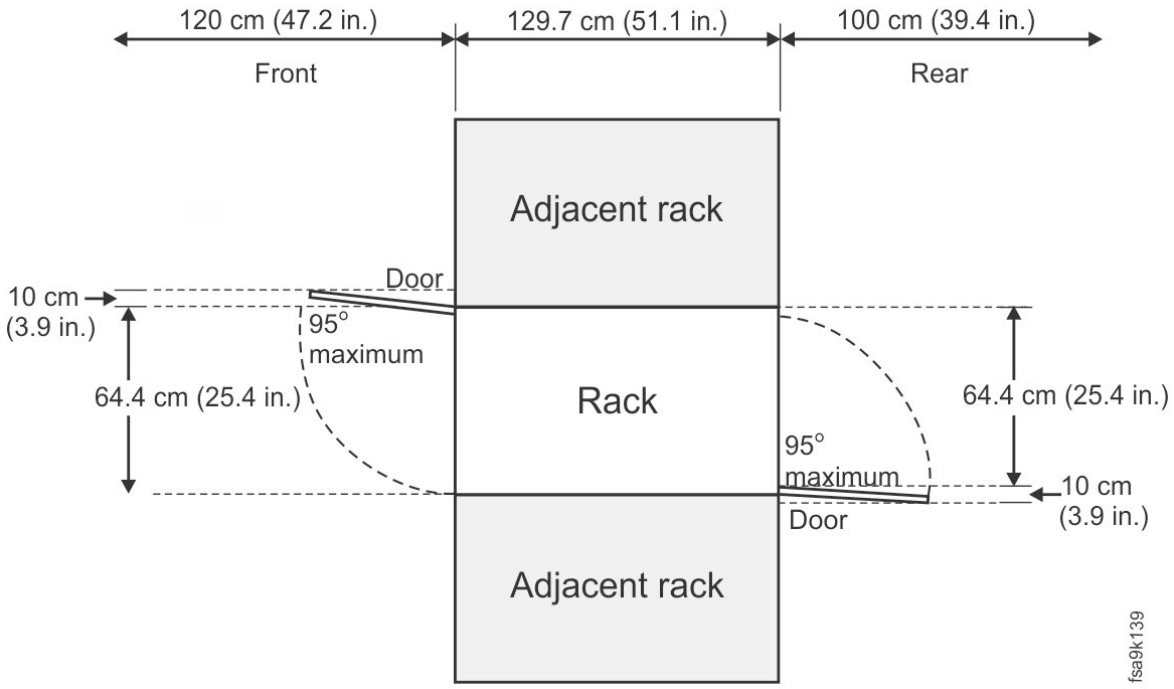


Figure 13. Clearance requirements for servicing the FlashSystem A9000R rack

Bottom rack dimensions

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

Figure 14 on page 30 shows the bottom rack dimensions and castor placements.

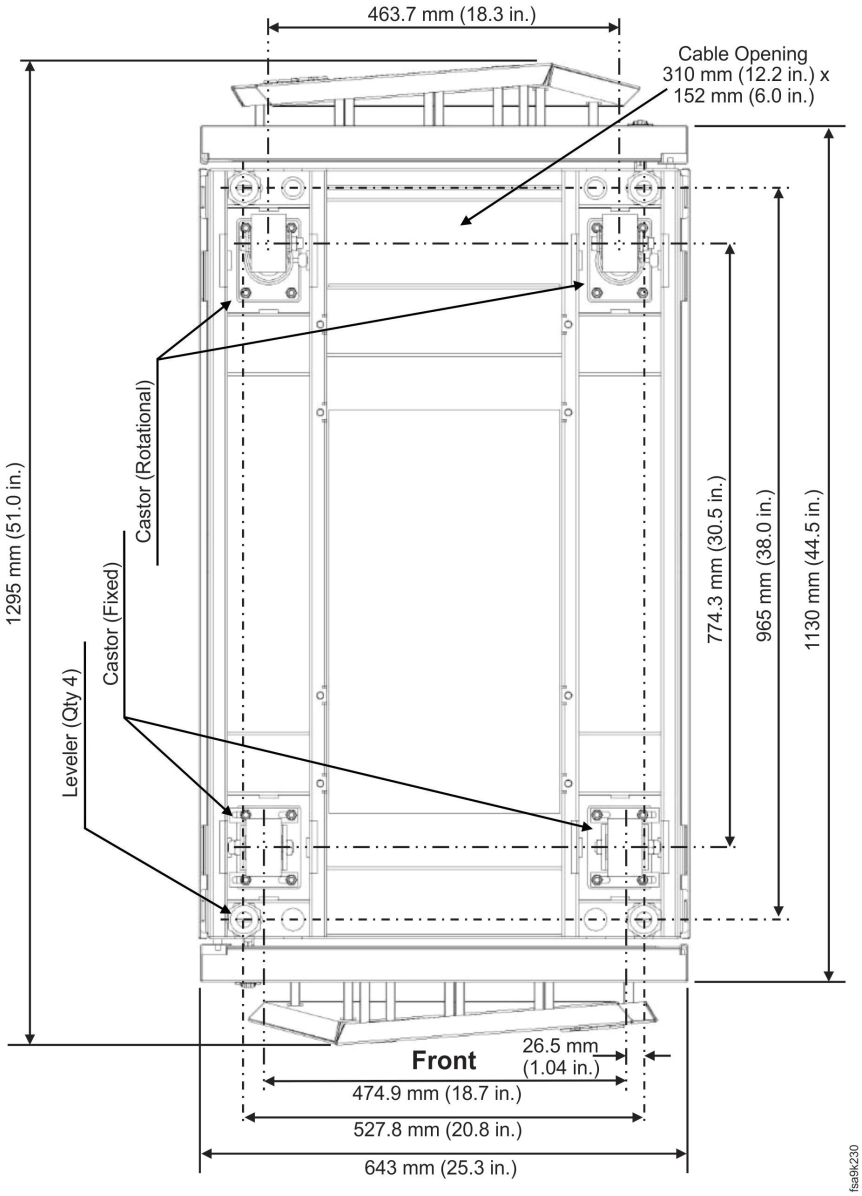


Figure 14. Bottom rack dimensions and castor placements

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 15 on page 31).

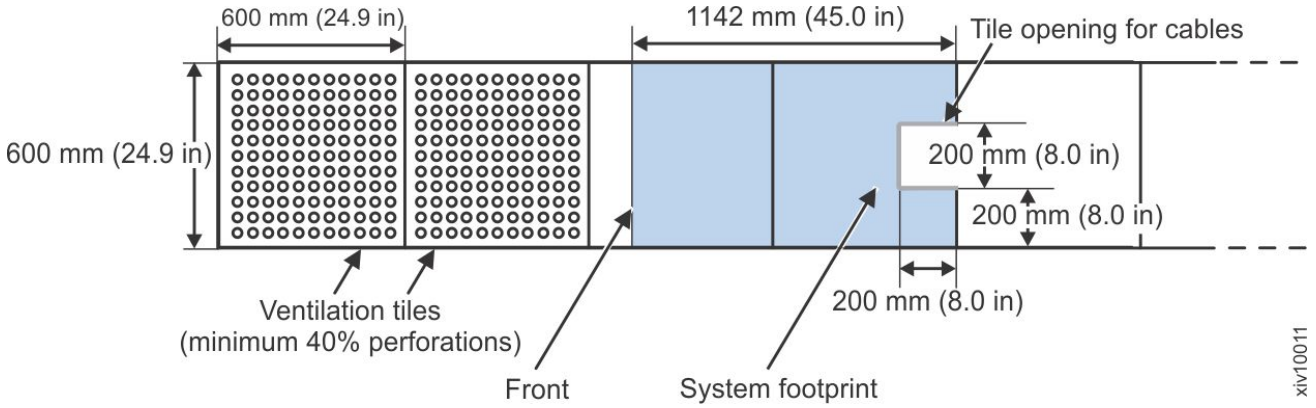


Figure 15. Raised floor requirements

3. Cut a 200 × 200 mm (8 × 8 in.) opening in the rear floor tile for under-floor cabling and electricity (see Figure 15 on page 31).

   Place the opening under the FlashSystem A9000R system, centered on the back edge of the tile along the rear of the rack.

   Important: Be sure to size the cutout correctly. 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 15 on page 31). 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 60 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.

- 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 63 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 48.

Power requirements

Ensure that your operating environment meets the AC-power and voltage requirements for IBM FlashSystem A9000R systems.

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

The following are the customer responsibilities for ensuring that your operating environment meets all power requirements.

- You must supply enough branch circuits to prevent overloading from the equipment that you install.

  At least two separate power grids are necessary for each system.
- You must ensure that each electrical outlet is correctly wired and grounded to prevent an electrical shock.

IBM responsibilities

The following are the IBM responsibilities for ensuring that your operating environment meets all power requirements.

- 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 grids are required for the main power cords for each FlashSystem A9000R system.

For systems with single-phase PDUs, two separate outlets on each of the power grids are required for the main power cords.

In order to eliminate a single point of failure, the main power cords from each PDU must connect to separate power grids (sources) and each power grid must have its own wall circuit breaker, as shown in Figure 16 on page 33.

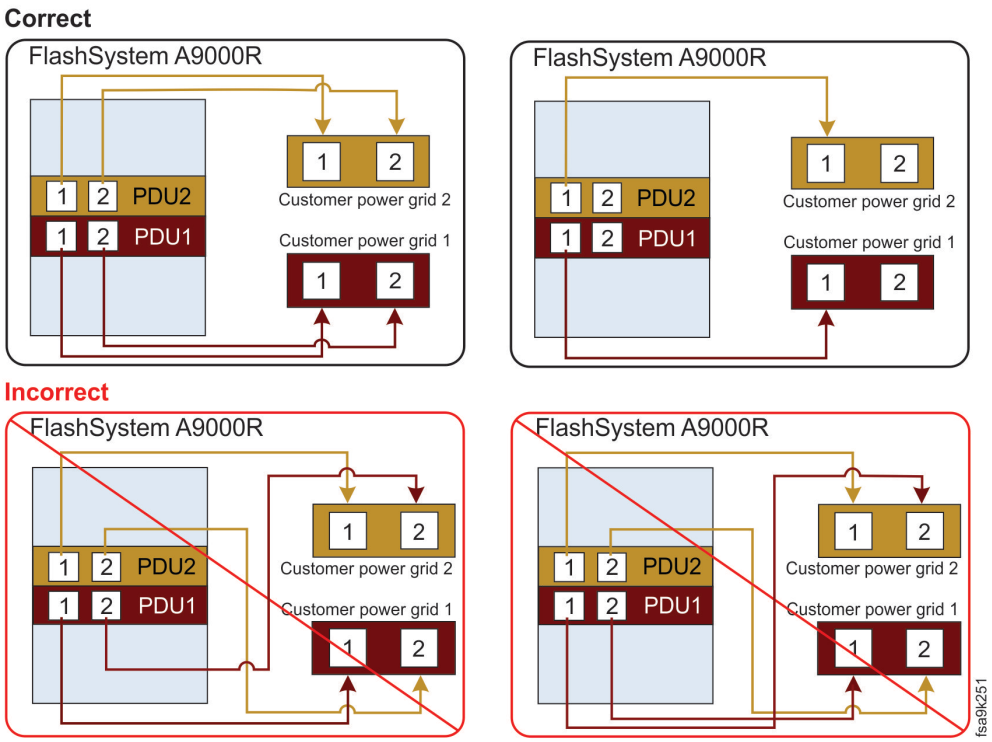


Figure 16. FlashSystem A9000R power sources

Note: When systems only require one main-power cable per power distribution unit (PDU), only Input 1 from each PDU is used. Two independent power grids are still required.

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.

- (Model 415 only) Four 60/63 A, 200-240 V AC, North American, EMEA, and Japan single-phase receptacles, each connected to a different power source.
- (Models 425 and U25 only) Two or four (dependent on configuration's scaled-out power load) 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 10 on page 34 and Table 11 on page 34 list 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: In order for the installation site to support any future capacity upgrade procedures, the site should adhere to all requirements for a full rack system.

The measurements in Table 10 on page 34 and Table 11 on page 34 were 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 10. Power consumption – model 415

Configuration	2.9 TB MicroLatency modules[1] Idle / light load power consumption		5.7 TB MicroLatency modules Idle / light load power consumption	
	kVA	kW	kVA	kW
4 grid controllers and 2 flash enclosures	3.420	3.089	3.820	3.450
6 grid controllers and 3 flash enclosures	5.034	4.547	5.634	5.089
8 grid controllers and 4 flash enclosures	6.448	5.824	7.448	6.728
10 grid controllers and 5 flash enclosures	8.262	7.363	9.262	8.366
12 grid controllers and 6 flash enclosures	9.876	8.921	11.076	10.005

[1]The numbers for power consumption of 2.9 TB MicroLatency modules are calculated estimates.

Table 11. Power consumption – models 425 and U25

Configuration	3.6 TB MicroLatency modules[1] Idle / light load power consumption		8.5 TB MicroLatency modules[1] Idle / light load power consumption		18 TB MicroLatency modules Idle / light load power consumption	
	kVA	kW	kVA	kW	kVA	kW
3 grid controllers and 1 flash enclosure	2.027	1.834	2.071	1.874	2.115	1.914

Table 11. Power consumption – models 425 and U25 (continued)						
Configuration	3.6 TB MicroLatency modules[1] Idle / light load power consumption		8.5 TB MicroLatency modules[1] Idle / light load power consumption		18 TB MicroLatency modules Idle / light load power consumption	
	kVA	kW	kVA	kW	kVA	kW
4 grid controllers and 2 flash enclosures	3.258	2.940	3.338	3.012	3.418	3.085
6 grid controllers and 3 flash enclosures	4.791	4.324	4.911	4.432	5.031	4.540
8 grid controllers and 4 flash enclosures	6.324	5.707	6.484	5.852	6.644	5.996
[1]The numbers for power consumption of 3.6 TB and 8.5 TB MicroLatency modules are calculated estimates.						

Input voltages and frequencies

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

Table 12 on page 35 provides the voltages and frequencies that are accepted by the FlashSystem A9000R system. For more information, see “Leakage current” on page xvii.

Table 12. Input voltages and frequencies			
Characteristics	3ØΔ (3-phase Delta) (3+PE) voltage or frequency	3ØY (3-phase Wye) (3+N+PE) voltage or frequency	1Ø (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
Maximum tolerant input voltage	264 V AC	LL: 457 V AC LN: 264 V AC	264 V AC
Maximum ground-leakage current	3.8 mA	5.1 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.

- 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.
- The IEC 60309 standard commercial/industrial pin and sleeve power connectors are often abbreviated "IEC '309" or simply "309 wall plug".

Table 13. Main power cables

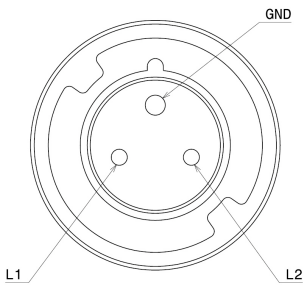
Main-power cable feature code	Wall connector	Description	Line cord connector	Customer facility	Inline receptacle	System (PDU) connector
(Model 415) 1050 (Models 425 and U25) 1054	Plug: 60/63 A 250VAC-IEC309-2P 3W-IP67	Main-power cable with IEC'309 service ready plug, for: United States, Canada, Latin America, Japan , and Taiwan (EMEA and other regions can optionally order); single-phase, 60 A plug-class (or 60 A rated class plug), two conductors+ground with plug 	Hubbell HBL360P6V 04	Hubbell HBL360R6 W	Hubbell HBL360C6 W	Single-phase PDU 3- position appliance coupler, application specific

Table 13. Main power cables (continued)

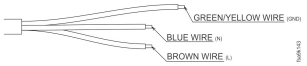
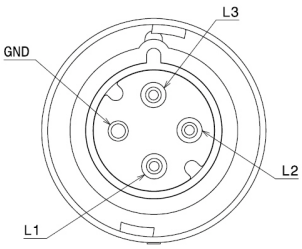
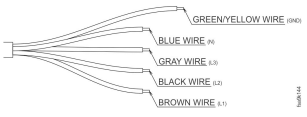
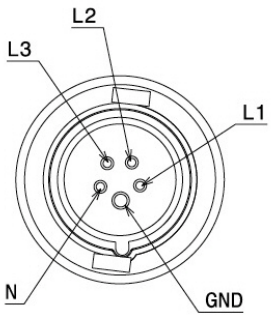
Main-power cable feature code	Wall connector	Description	Line cord connector	Customer facility	Inline receptacle	System (PDU) connector
(Model 415) 1051 (Models 425 and U25) 1055	N/A (stripped wires)	Main-power cable with no customer connector provided (pre-stripped wires, termination ready for EMEA (except Japan), hard-wired, or uses client provided customer connector/ plug as regionally allowed); single-phase, 60/63 A rated branch-circuit class, two conductors+ground, hardwired 	Hardwired or uses client-provided connector	Hardwired AC supply	N/A	Single-phase PDU 3- position appliance coupler, application specific
1052	Plug: 60/63 A 250VAC-IEC309-3P 4W-IP67	Main power cable with IEC '309 service ready plug, for: United States, Canada, Latin America, Japan, and Taiwan (EMEA and other regions can optionally order); three-phase delta, 60 A rated plug-class, three wires +ground with plug 	Hubbell HBL460P9V 05	Hubbell HBL460R9 W	Hubbell HBL460C9 W	Delta PDU 4-position appliance coupler, application specific
1053	N/A (stripped wires)	Main power cable with no customer connector provided (pre-stripped wires, termination ready for EMEA (except Japan), hard-wired, or uses client provided customer connector/ plug as regionally allowed) 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	Wye PDU 5-position appliance coupler, application specific

Table 13. Main power cables (continued)

Main-power cable feature code	Wall connector	Description	Line cord connector	Customer facility	Inline receptacle	System (PDU) connector
1056 Models 425 and U25 only.	Plug: 30/32 A	Main power cable with IEC'309 service ready plug, for EMEA (other regions under approved circumstances, such as United States, Canada, Latin America, Japan, and Taiwan can optionally order); three-phase wye, 30/32 A rated branch-circuit class, three wires +neutral+ground with plug 	Hubbell HBL530P6-V02	Hubbell HBL530P6-V02	Hubbell HBL530P6-V02	Wye PDU 5-position appliance coupler, application specific

Main power cables considerations

Use this information when considering the different main power cabling options.

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, 1052, 1054, 1056 are IEC309-compliant.
- Bulk wire conductor sizes for main power cable feature codes are:
  - 1050, 1051, 1052, 1054, and 1055: 8 AWG
  - 1053, 1056: 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.
- Each feature code has specific wall circuit breaker requirements. Choose the best powering options according to your circuit breaker needs:
  - Wall circuit breakers that have a rating of 60 A to 63 A require single-phase installations (200 V - 240 V) with two main power cables.

    For more information regarding single-phase minimum rack installations for models 425 and U25, see "Special considerations when powering a rack containing up to four grid controllers with a single-phase power distribution unit (models 425 and U25)" on page 39.

– Wall circuit breakers that have a rating of 30 A to 60 A require three-phase delta installations (200 V - 240 V).
– Wall circuit breakers that have a rating of 30 A to 32 A require three-phase wye installations (220 V - 240 V (Line-to-Neutral [LN])).

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.

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 xvii.

- Main power cable cords (bulk wire) of the above listed feature codes have met universal combination certifications: UL/CSA bi-national certification for North America as well as EU Harmonization (HAR) European approvals.

  Other regional approvals might be added as necessitated for industrial/commercial implementations.

Special considerations when powering a rack containing up to four grid controllers with a single-phase power distribution unit (models 425 and U25)

Note: These considerations apply for all model 425 and U25 racks with single-phase PDUs containing up to four grid controllers and two flash enclosures.

When powering a FlashSystem A9000R system with single-phase power distribution units and three or more grid elements, both main input cables of each PDU must always be connected.

When powering a FlashSystem A9000R model 425 or U25 less than three grid elements containing single-phase PDUs, power is taken only from Input 1 from each PDU. Therefore there are different main power cabling options.

For more information regarding the various types of rack configurations, see “Rack configurations” on page 11.

Note: All single-phase PDUs come with two main power cables, no matter the rack configuration.

There are two main power cabling scenarios with single-phase PDUs for racks containing four or less grid controllers. Choose the one that best suits your needs, together with your IBM representative.

1. Both main power cables are connected to the PDU and to the power grid wall socket.

   In this scenario, the system will still only draw power from one of the power cables from each PDU.
2. Only one main power cable is connected to each PDU and to each power grid wall socket.

   In this scenario, the second main power cable of each PDU is given to you for safe keeping. These cables are required to support future scale-out capability (MES) upgrades.

Important: Be sure that both your IBM representative **and** the IBM service provider installing your system are informed as to which option you have chosen.

Note: Scale-out (MES) for model 425 and U25 configurations from minimum rack (three grid controllers and one flash enclosure) is supported from system version 12.3.1. If needed, contact your IBM representative for more information.

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” on page 40
   - “Air circulation and cooling” on page 41
   - “Contamination information” on page 44
   - “Acoustic declaration ” on page 45
   - “Operating vibration requirements” on page 46

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

Non-operating (powered off)

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

Shipping

- Temperature: -40°C to 60°C (-40°F to 140°F)
- Relative humidity: 5% to 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 26.
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 31.
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 20.

4. Ensure that the installation site meets the cooling (thermal dissipation) requirements that are listed in one of the following:

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

- **For model 415:** Table 14 on page 42
- **For models 425 and U25:** Table 15 on page 42

Table 14. Thermal dissipation for FlashSystem A9000R system – model 415

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

Table 15. Thermal dissipation for FlashSystem A9000R system – models 425 and U25

Storage configuration	Thermal Dissipation kBTU/hour
3 grid controllers and 1 flash enclosure	7.5
4 grid controllers and 2 flash enclosures	10.5
6 grid controllers and 3 flash enclosures	15.8
8 grid controllers and 4 flash enclosures	21.0

5. Ensure that the installation site meets the airflow requirements that are listed in one of the following:

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

- **For model 415:** Table 16 on page 43
- **For models 425 and U25:** Table 17 on page 43

Table 16. Airflow requirements for FlashSystem A9000R system – model 415		
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

Table 17. Airflow requirements for FlashSystem A9000R system – models 425 and U25		
Storage configuration	**Cubic feet per minute (CFM)**	
	Nominal temperature (23°C) (73.4°F)	**Maximum temperature (35°C) (95°F)**
3 grid controllers and 1 flash enclosure	300	550
4 grid controllers and 2 flash enclosures	410	750
6 grid controllers and 3 flash enclosures	590	1100
8 grid controllers and 4 flash enclosures	770	1450

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.

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 18 on page 44 specifies 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 18. 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].

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.

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, additional factors may be considered when reviewing noise exposures, including, but not limited to, exposure duration and the use of hearing protection. IBM recommends that you consult with a qualified expert in the acoustical noise field prior to operating this system.

Model 415

The acoustic levels are shown in Table 19 on page 46. 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.

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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.

Note:

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 19. Acoustic declaration – model 415

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

Models 425 and U25

The acoustic levels are shown in Table 20 on page 46. 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.

Note:

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 20. Acoustic declaration – models 425 and U25

	Declared A-weighted sound power level, LWAd (B)	Declared A-weighted sound pressure level, LpAm (dB)
Operating	7.7	58
Idle	7.7	58

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 tables. More information includes random vibration PSD profile breakpoints and operational shock levels.

Model 415

Table 21. Vibration levels – model 415		
Class	**grms**	**g Peak Sine**
V1L	0.10	0.06 @ 50 & 60 Hz
Note: *g* is the peak *g* level of an approximate half-sine pulse.		

Table 22. Random vibration PSD profile breakpoints – model 415			
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 23. Operational shock levels – model 415			
Class	**Axis**	**g^1**	**pw^2**
S1	Vertical	3.5	3.0
Note: • *g* is the peak *g* level of an approximate half-sine pulse. • *pw* is the pulse width in milliseconds.			

Models 425 and U25

Table 24. Vibration levels – models 425 and U25		
Class	**grms**	**g Peak Sine**
V1H	0.05	0.03 @ 50 & 60 Hz
Note: *g* is the peak *g* level of an approximate half-sine pulse.		

Table 25. Random vibration PSD profile breakpoints – models 425 and U25			
Class	**5 Hz**	**17 Hz**	**500 Hz**
V1H	1.0×10^{-7}	5.2×10^{-6}	5.2×10^{-6}
Note: All values in this table are in g^2/Hz.			

Table 26. Operational shock levels – models 425 and U25			
Class	**Axis**	**g[1]**	**pw[2]**
S1	Vertical	3.5	3.0

Note:
[1]*g* is the peak *g* level of an approximate half-sine pulse.
[2]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” on page 48
- “Rear-door heat exchanger performance” on page 49
- “Preparing your site to provide water to the rear-door heat exchanger” on page 51
- “Secondary cooling loop parts and services information” on page 65
- “Maintenance schedule” on page 67

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 27. 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" on page 49. • 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 17 on page 50 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).

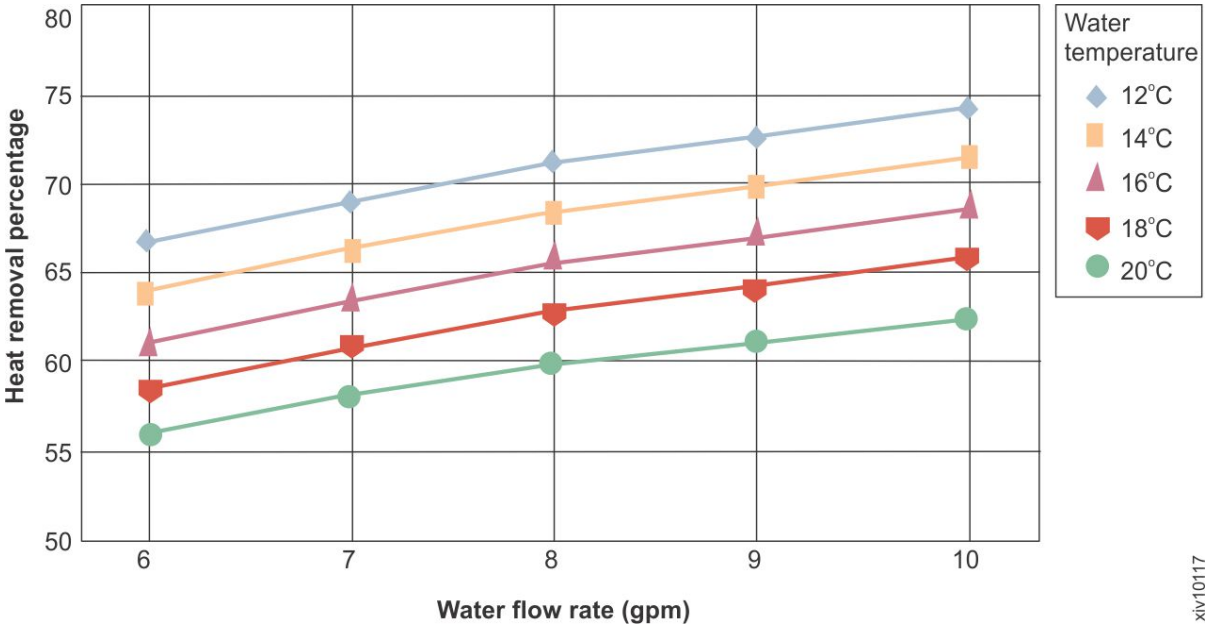


Figure 17. Typical performance of a rear-door heat exchanger, 32 kW heat load

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 18 on page 50 for identical conditions as in Figure 17 on page 50, 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.

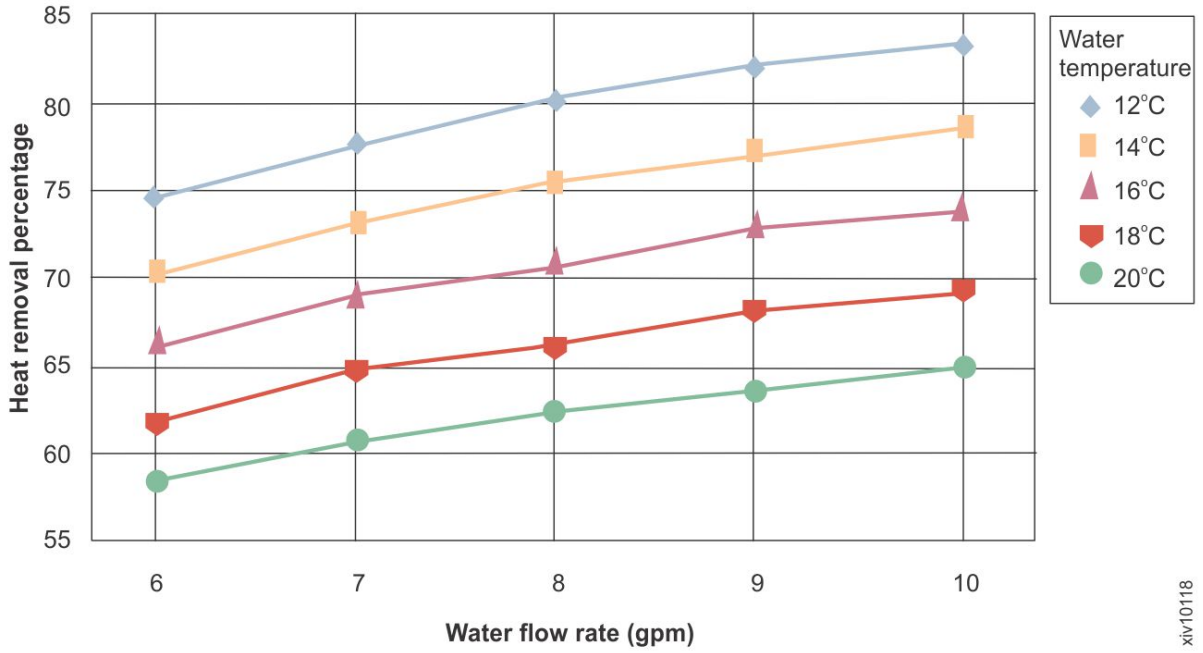


Figure 18. Typical performance of a rear-door heat exchanger, 20 kW heat load

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 51
- "Water delivery specifications for secondary loops" on page 53
- "Raised floor hose requirements and management" on page 60
- "Non-raised floor hose requirements and management" on page 63

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 51), 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 65 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 22 on page 57 shows a typical cooling solution and identifies the components of the primary cooling loop and secondary cooling loop.

Figure 21 on page 56 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 19 on page 54 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 20 on page 55 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.

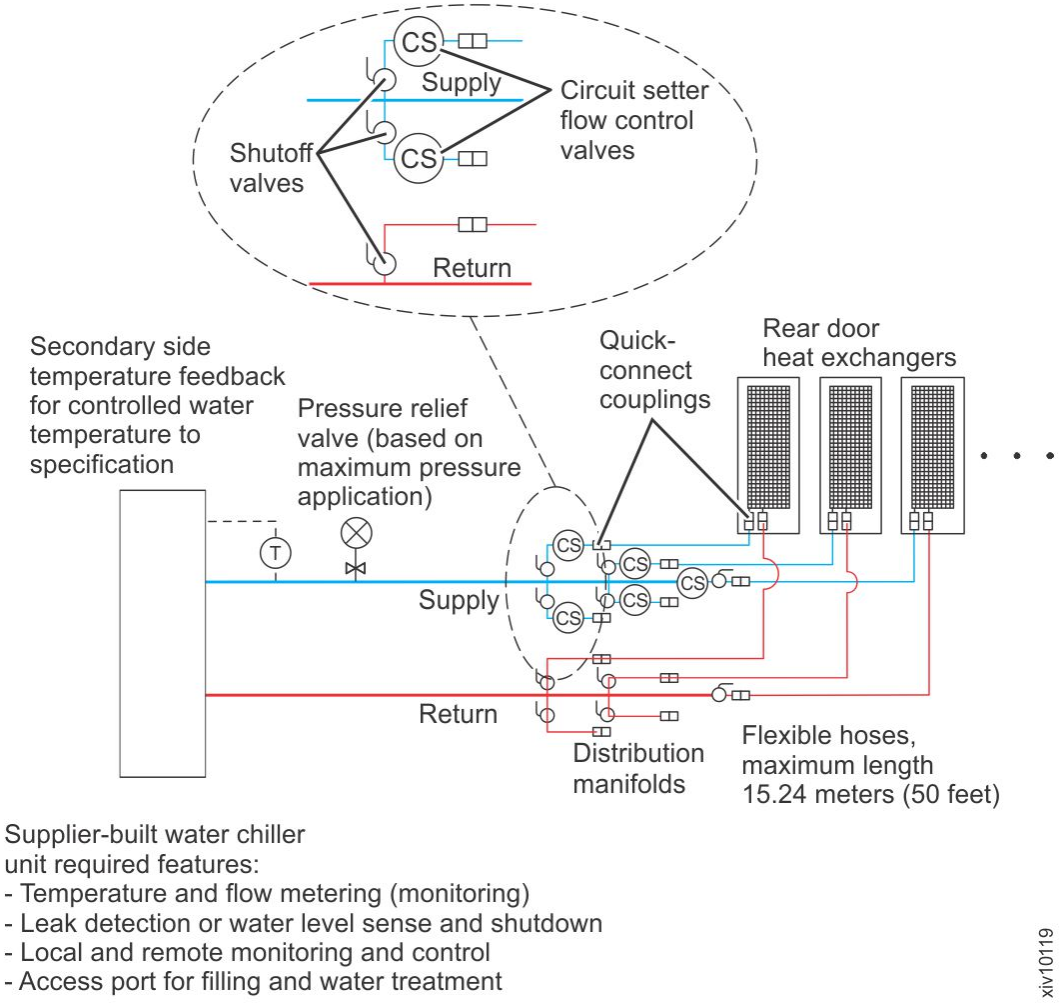


Figure 19. Cooling distribution unit that uses off-the-shelf supplier solutions

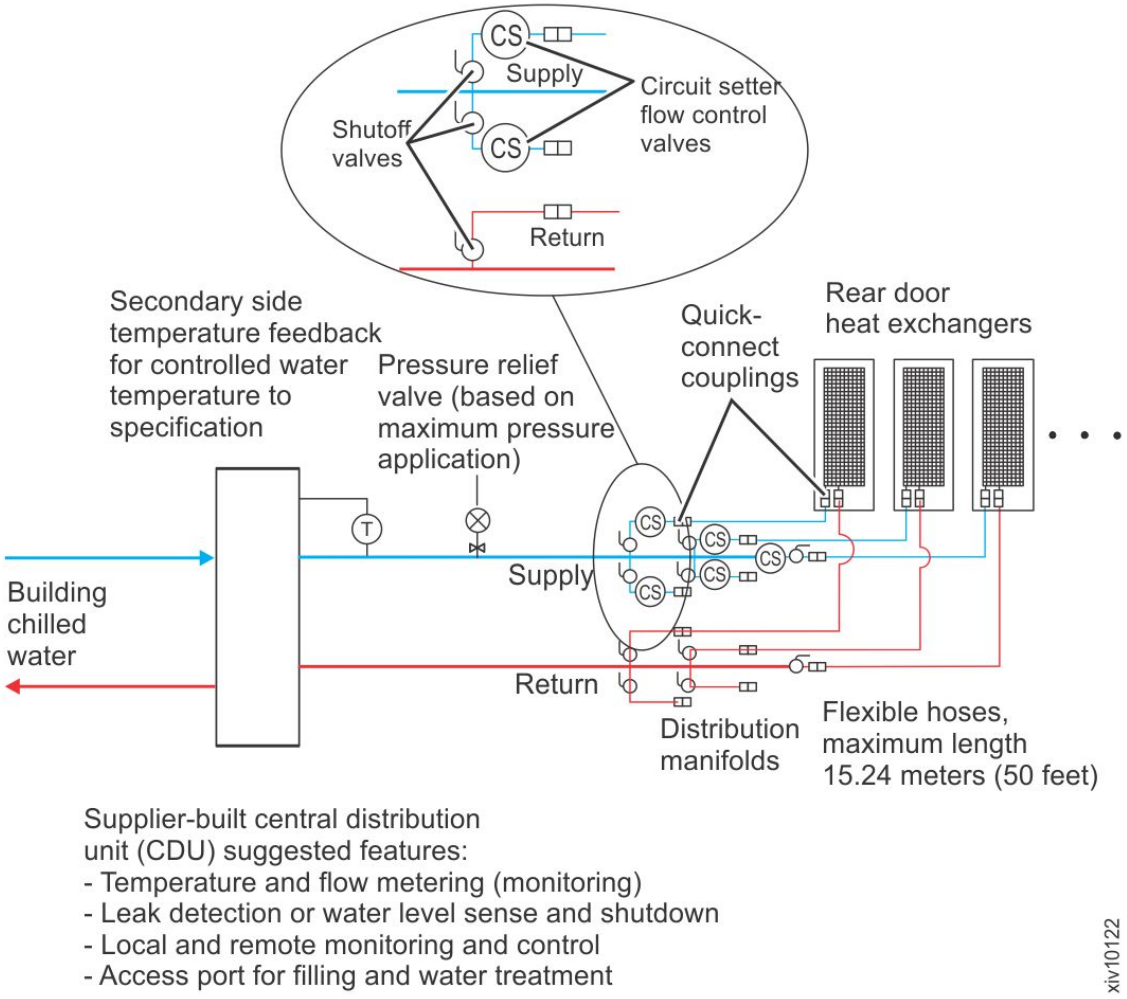


Figure 20. Cooling distribution unit that uses a water chiller unit to provide conditioned water

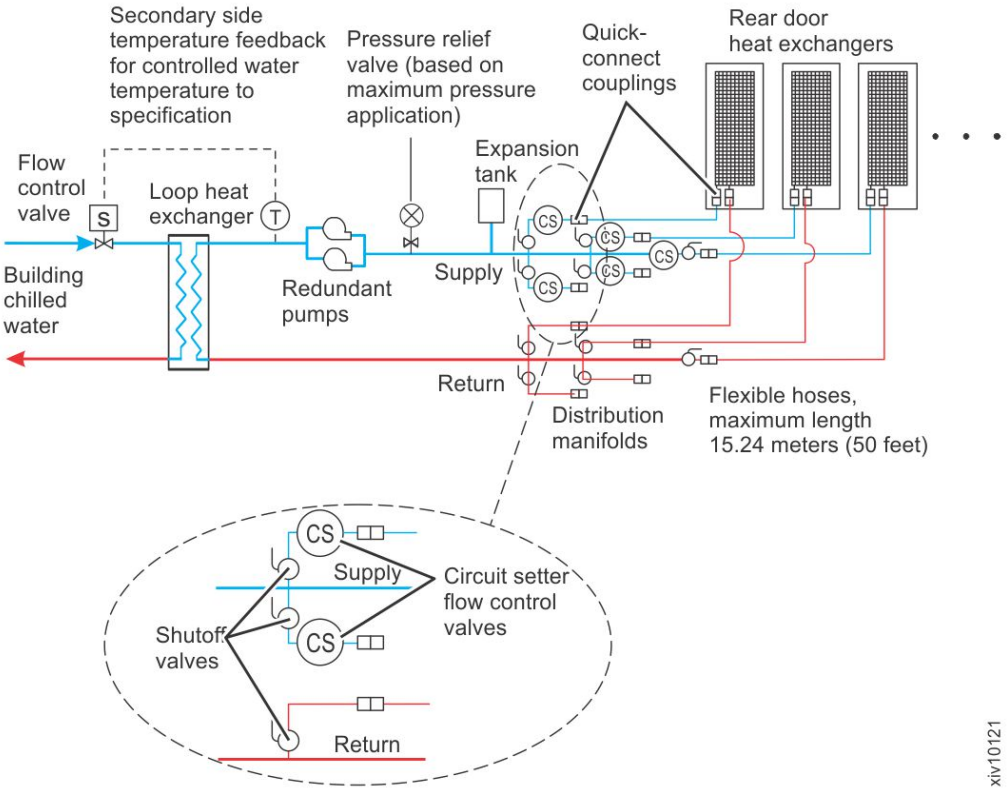


Figure 21. Cooling distribution unit that uses a fabricated facilities solution

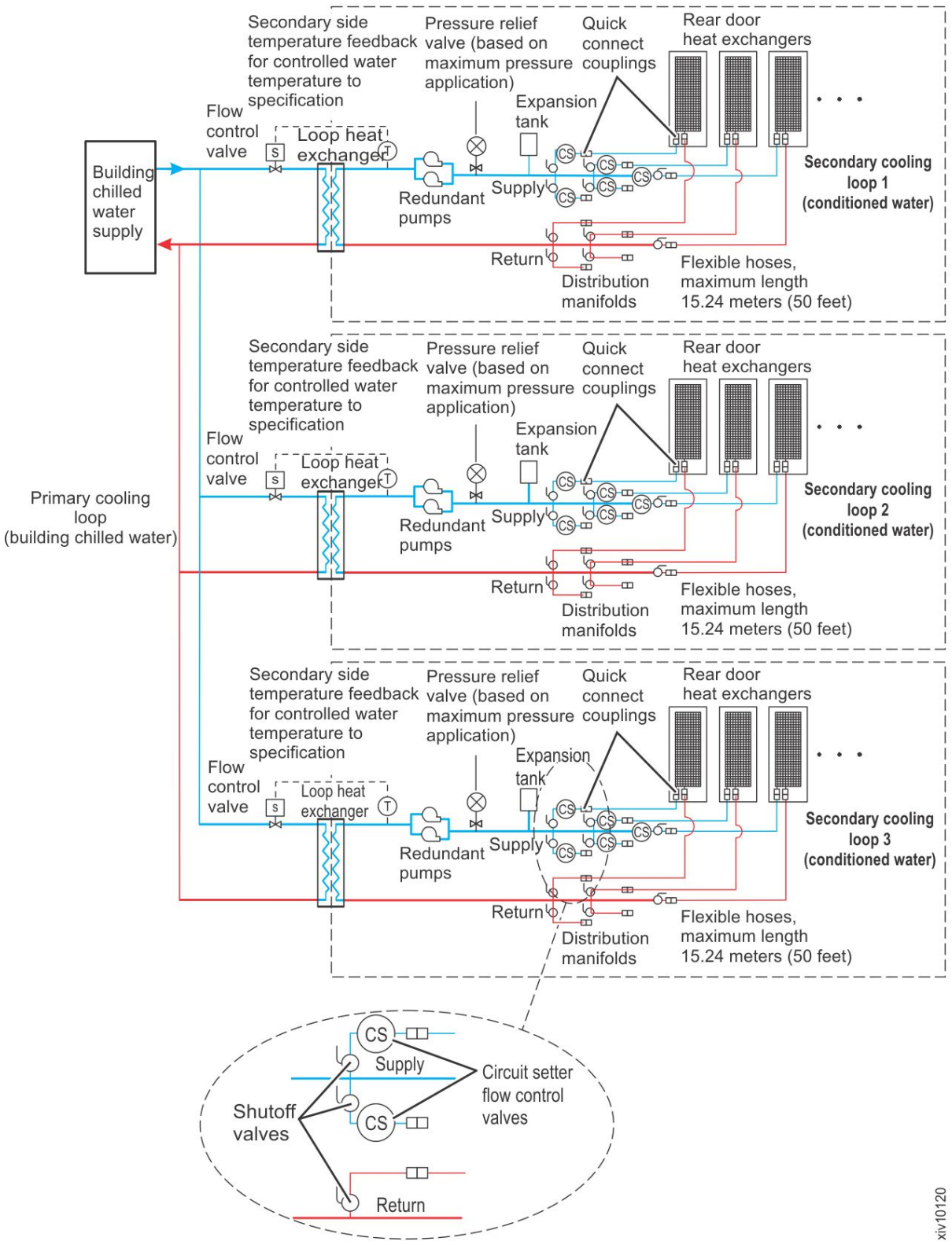


Figure 22. Primary and secondary cooling loops

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 51). 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 23 on page 58 and Figure 24 on page 59, 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 23 on page 58 shows a layout for multiple water circuits.

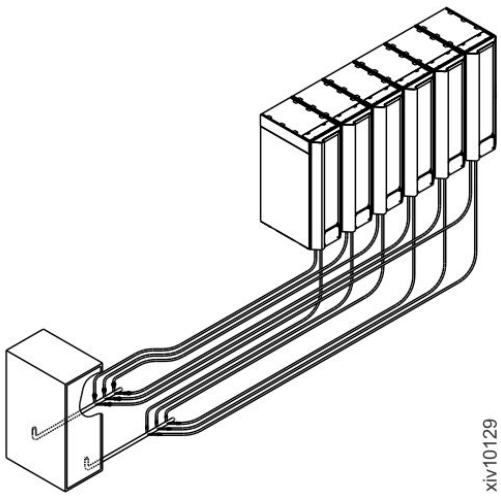


Figure 23. Typical central manifold (at a central location for multiple water circuits)

Figure 24 on page 59 shows an extended manifold layout.

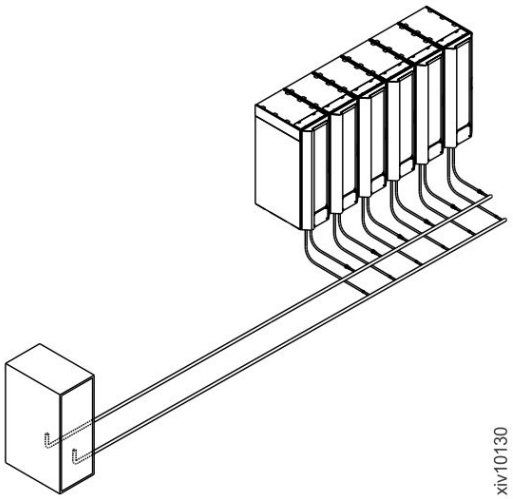


Figure 24. Typical extended manifold (located along aisles between racks)

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 65. 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.

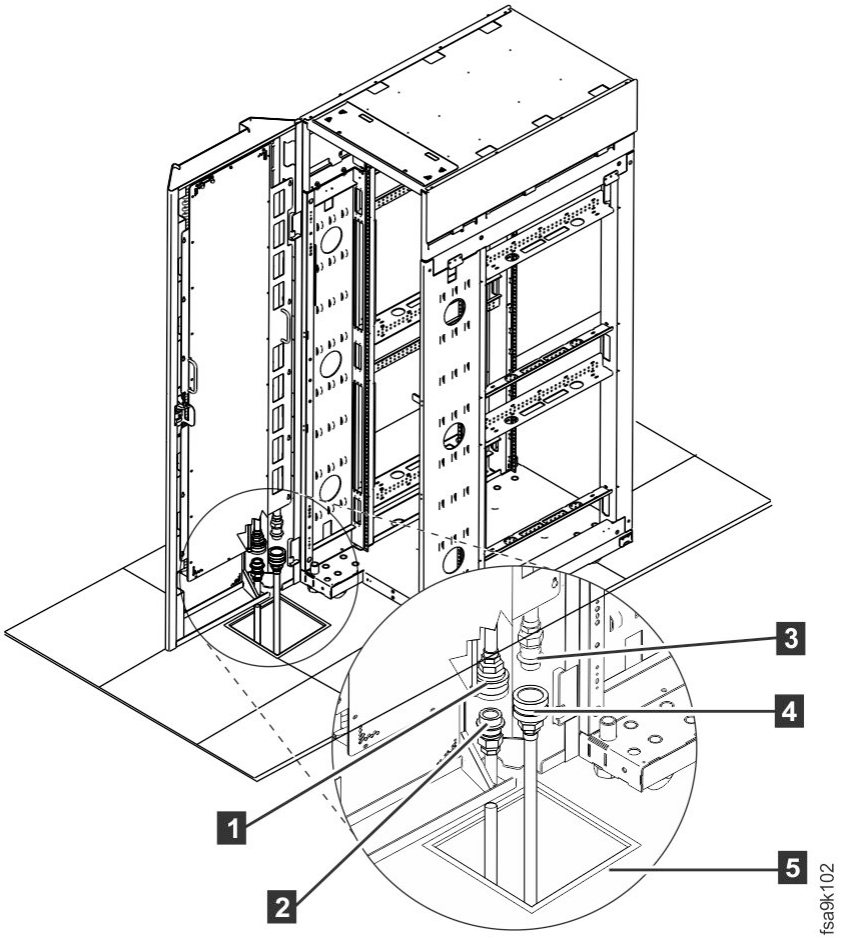
You can use quick-connect couplings to attach the hoses to the distribution manifolds. You must use quick-connect couplings to attach the hoses to the heat exchanger. Hose couplings that connect to the heat exchanger must have the following characteristics:

- 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 25 on page 60 and Figure 26 on page 61.



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

Figure 25. Raised-floor hose management example 1: hose exit through floor tile at the door hinge

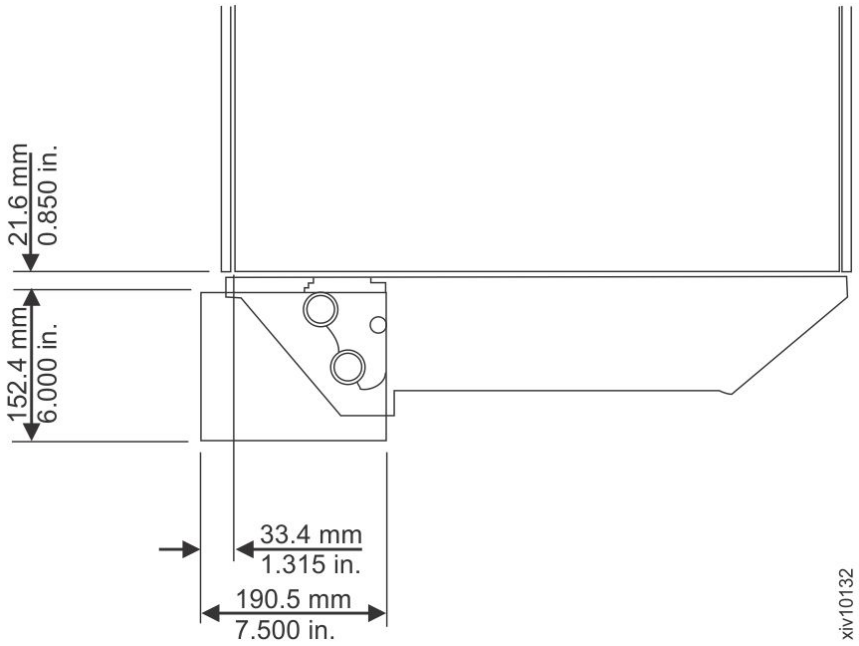


Figure 26. Raised-floor hose management example 2: tile cutout size and position

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 27 on page 62 and Figure 28 on page 63 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.

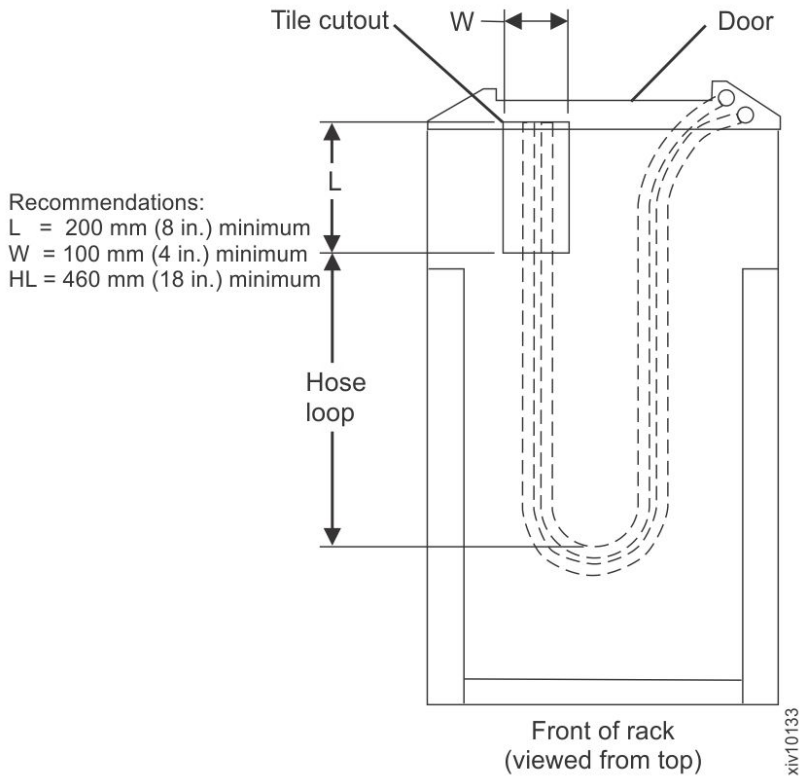


Figure 27. Raised-floor and non-raised-floor hose management example 2: loop under the rack with door closed

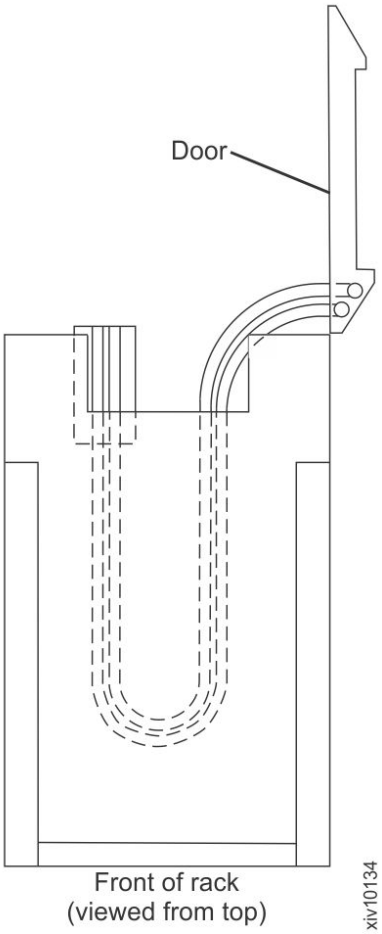


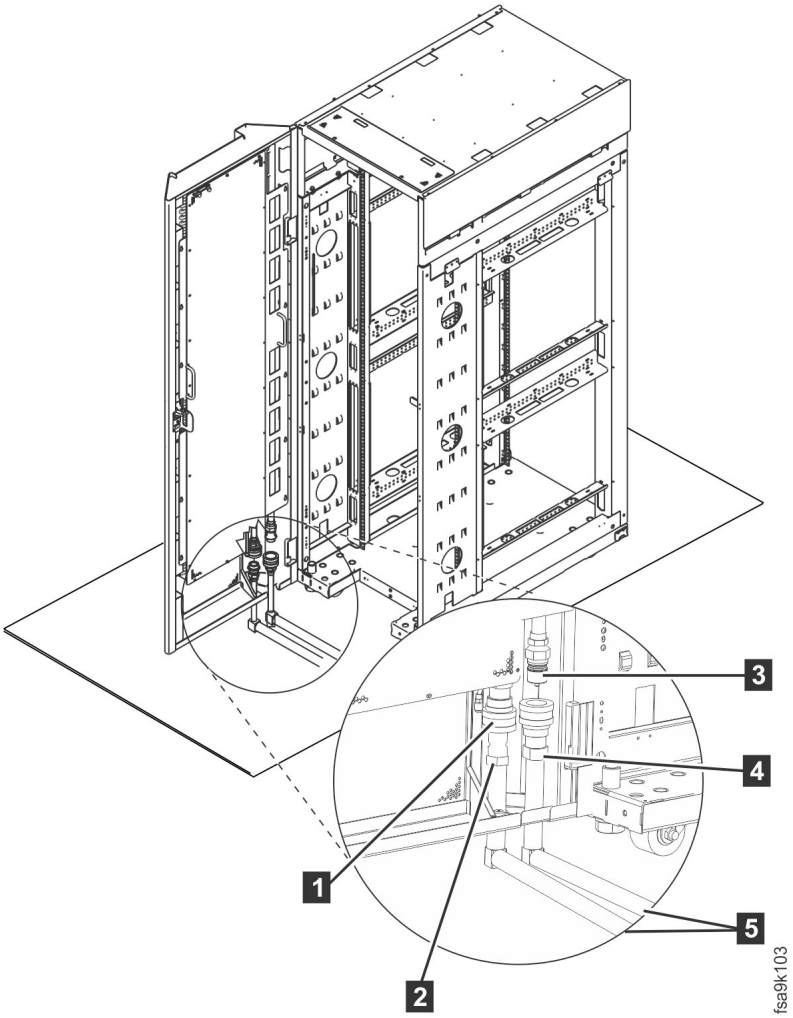
Figure 28. Raised floor and non-raised floor hose management example 2: loop under the rack with door open

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 29 on page 64).



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

Figure 29. 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.

Servicing and miscellaneous parts supplier

Table 28 on page 65 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 28. Servicing and miscellaneous secondary loop parts supplier information for customers in North America, Europe, Middle East, Africa, Asia Pacific

Supplier	Parts	Contact information
Wakefield-Vette, Inc.	• Rear door heat exchangers (designed for both non-IBM as well as IBM Enterprise racks) • Cooling distribution units • Hose kits • Water treatment • Chillers • Raised-floor grommets	**Website**: Wakefield-Vette, Inc. (www.wakefield-vette.com) **Phone**: 603- 635-280-0877 **Corporate Headquarters**: Wakefield-Vette 33 Bridge Street Pelham, NH 03076

Services supplier

Table 29 on page 65 provides supplier and contact information for services that can be provided for secondary loop parts.

Table 29. Services supplier information for customers in North America, Europe, Middle East, Africa, Asia Pacific

Supplier	Services	Contact information
Wakefield-Vette, Inc.	• Installation of door and secondary loop items • Preventive maintenance	**Website**: Wakefield-Vette, Inc. (www.wakefield-vette.com) **Phone**: 603- 635-280-0877 **Corporate Headquarters**: Wakefield-Vette 33 Bridge Street Pelham, NH 03076

Cooling distribution unit suppliers

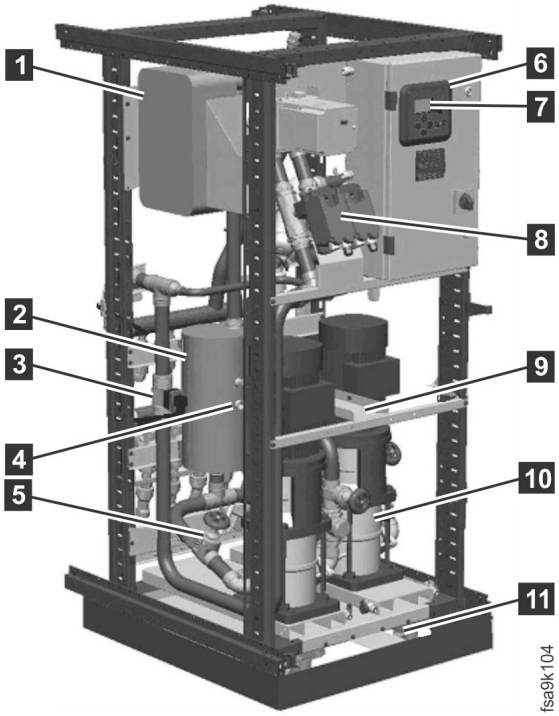
Table 30 on page 66 provides supplier and contact information for customers in Europe for a cooling distribution unit that was designed specifically for the IBM Rear Door Heat exchanger.

Note: Customers in other locations can contact Nortek Global HVAC (formerly Eaton-Williams Group) or Wakefield-Vette (see Table 29 on page 65).

Table 30. Cooling distribution unit supplier information for customers in Europe

Supplier	Cooling distribution units	Contact information
Nortek Global HVAC (formerly 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**: Nortek Global HVAC (www.nortekhvac.com/)

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 30. Eaton-Williams cooling distribution unit features

The cooling distribution unit specifications are described in Table 31 on page 67.

Table 31. 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) **Important:** Primary facilities input only. Note recommended for secondary loop, as noted in "Water control and conditioning for the secondary cooling loop" on page 51.
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)
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

Task	Schedule
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, physical contact with the machine presents the following security risks:

- Stealing of the machine or components
- Breaking components
- Manual shutdown of the machine or components by bypassing the preferred process

These cases could lead to losing the contents of the system and its volatile caches, resulting in loss of access.

Attention: Restricting physical access is especially critical when using local key management.

For more information on using local key management, see “Native user authentication” on page 90.

For more information on using external key management (LDAP), see “External authentication via Lightweight Directory Access Protocol (LDAP)” on page 91.

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

Important: In addition to lockable doors on the system itself, it is highly advised to secure access to the room in which the physical storage system is kept.

Chapter 5. Network and host connectivity requirements

This section details the host SAN connections and requirements for IBM FlashSystem A9000R storage systems.

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

- “Network connections for management” on page 69
- “Management port requirements” on page 71
- “Host network connectivity and multipathing configurations” on page 74
- “Network cable requirements” on page 88
- “Network and host connectivity security information” on page 88

Network connections for management

Network connectivity for the storage system is provided through the utility patch panel. Use this information to identify patch panel connectivity.

- Figure 31 on page 69 illustrates the utility patch panel for model 415.
- Figure 32 on page 69 illustrates the utility patch panel for models 425 and U25.
- Table 32 on page 70 describes the ports that are available in the patch panel and the component to which each patch panel port connects.

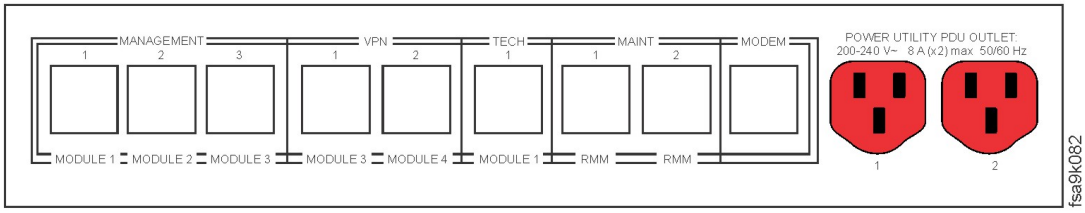


Figure 31. Utility patch panel – model 415

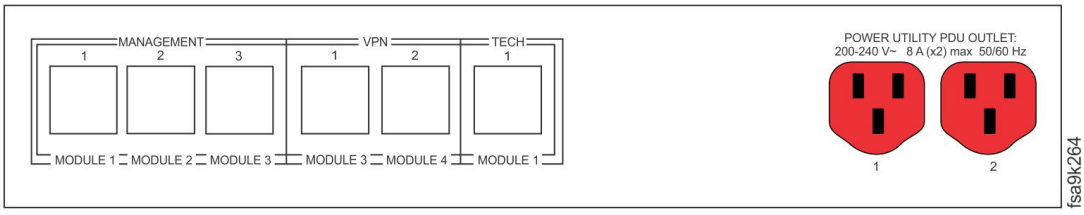


Figure 32. Utility patch panel – models 425 and U25

Table 32. 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. **Important:** 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 71.
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. • Some model 425 or U25 minimal rack configurations may only contain three grid controllers. In this case, only use grid controller 3 VPN connectivity.
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 (Model 415 only)	Maintenance module	(For technician use only.) Not in use.
Modem port (Model 415 only)	Modem	(For technician use only.) Not in use.

Management port requirements

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

IP configuration

Use this information for system storage IP configuration.

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

Each IP address is handled by different grid controllers in the initial grid element configuration.

Note: If you use only one path and the grid controller for that connection goes down, the ability to manage the system is lost.

For more information about IBM Hyper-Scale Manager, see the *IBM Hyper-Scale Manager User Guide* (SC27-8560) on the IBM Hyper-Scale Manager on IBM Knowledge Center (ibm.com/support/knowledgecenter/SSUMNQ).

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, 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)

Attention: Be careful when changing an Ethernet port MTU. If management connectivity is on, or a VPN is being used, this might break existing application connectivity unless the adjacent switch is configured properly.

This would be the result of the switch using a fixed MTU size lower than the new size being defined on the system.

For example, if the system sends 9000 byte packets while the switch can only receive packets up to 1500 bytes, the switch drops extra packets.

Note:

- 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.

- Virtual LAN (VLAN)

  VLAN tagging can be enabled or disabled for management and VPN ports. The ports can be configured as untagged (default) or tagged.

Note:

- A valid VLAN tag value can only be 1 - 4094.
- All management or VPN ports with VLAN tagging enabled must belong to the same VLAN tag, one per port type.

In addition, 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

Control (management) protocols

Communication to the system via Ethernet ports is divided into two: data Ethernet ports and control Ethernet ports. The control protocols are used for system management; monitoring; telemetry and support; and communication security. These control protocols are detailed in this section.

Note: For more information regarding the data Ethernet configurations, see "iSCSI network configurations" on page 83.

System management is carried out through the protocols detailed in Table 33 on page 72.

Note: *Inbound* protocol connections are initiated by external entities, such as IBM Hyper-Scale Manager and others. The *outbound* protocol connections are initiated by FlashSystem A9000R.

Table 33. Control (management) protocols

Use	Protocol	TCP port	Inbound/ Outbound	Encrypted?	Enabled by default (Yes/No)	Comments
Management						
Command-line interface (CLI) (includes Hyper-Scale Manager)	<proprietary>	7778	Inbound	Yes	Yes	Storage system management portal and CLI act as the client and initiate the connection, while FlashSystem A9000R acts as the server.
Common Information Model (CIM) agent	CIM	5989	Inbound	Yes	No	Storage system uses CIM agent to reply to management commands.
Common Information Model (CIM)	SLP	427	Inbound	No	No	Service Location Protocol (SLP) used for service discovery in conjunction with the CIM protocol.

Table 33. Control (management) protocols (continued)

Use	Protocol	TCP port	Inbound/ Outbound	Encrypted?	Enabled by default (Yes/No)	Comments
Time setting	NTP	123	Outbound	No	N/A	Storage system uses a Network Time Protocol (NTP) connection.
Monitoring						
SNMP requests	SNMP	161	Inbound	Yes	Yes	Storage system responds to SNMP requests when sending replies to SNMP managers.
SNMP traps/ notifications	SNMP	162	Outbound	No	N/A	Storage system initiates SNMP messages when sending traps/notifications to SNMP managers.
Syslog	UDP	514	Outbound	No	N/A	Storage system uses for collecting system logs.
Telemetry and Support						
Outbound mail	SMTP	25	Outbound	No	N/A	Storage system initiates SMTP traffic when sending emails for either event notifications or for SMS gateways. **Note:** Closing this port disconnects the IBM Service Center.
XRSC (SSH)	TCP	22, 2222	Inbound	Need to enable	Yes	Storage system uses port for remote connectivity. **Note:** The management ports should be on a different subnet than the VPN ports that are used for remote access.
Secure technician access	TCP	443	Inbound	Yes	No	Technician Assistant tool uses for data management platform (DMP) connectivity.
Communication security and access						
Connectivity	IPSec	1293	Inbound	Yes	No	Storage system uses IPSec for management and VPN communication. **Note:** The management ports should be on a different subnet than the VPN ports that are used for remote access.

Table 33. Control (management) protocols (continued)

Use	Protocol	TCP port	Inbound/ Outbound	Encrypted?	Enabled by default (Yes/No)	Comments
Domain Name System	DNS	53	Outbound	No	N/A	Storage system uses a Domain Name System (DNS) connection.
LDAP authentication	LDAP	389	Outbound	No	N/A	Storage system uses for LDAP authentication connectivity.
Other						
Key management	KMIP	5696	Outbound	Yes	N/A	Storage system communicates with key servers using the KMIP protocol.
Quorum Witness	<proprietary>	8460	Outbound	Yes	N/A	Storage system uses port with Quorum Witness for API communication (with a default Linux firewall).
Quorum Witness	<proprietary>	8461	Outbound	Yes	N/A	Storage system uses port with Quorum Witness for log retrieval (with a default Linux firewall).
Quorum Witness	<proprietary>	8462	Outbound	Yes	N/A	Storage system uses port with Quorum Witness for retrieval of Ngnix statistics (with a default Linux firewall).

Host network connectivity and multipathing 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.

Important: 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.

The administrator must ensure that multipathing is used. Multipathing is configured by ensuring the following:

- 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).

  Review the balancing periodically and when connections or traffic patterns change.

Important: 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.

Host connectivity should be done by installing the IBM Storage Host Attachment Kit.

- Host systems must have the appropriate host-attachment kit installed. Host attachment kits are available for various operating systems. For more information, see IBM Storage Host Attachment Kit on IBM Knowledge Center (ibm.com/support/knowledgecenter/SSEPRF).

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

For more information on host connectivity configurations using IBM Storage Host Attachment Kit, see:

- IBM Storage Host Attachment Kit on IBM Knowledge Center (ibm.com/support/knowledgecenter/SSEPRF)
- IBM FlashSystem A9000, IBM FlashSystem A9000R, and IBM XIV Storage System: Host Attachment and Interoperability Redbook, SG24-8368 (www.redbooks.ibm.com/redbooks/pdfs/sg248368.pdf)
- **Host Attachment** in the IBM FlashSystem A9000 and IBM FlashSystem A9000R: Architecture, Implementation and Usage Redbook, SG24-8345 (http://www.redbooks.ibm.com/redbooks/pdfs/sg248345.pdf)

Fibre Channel (FC) network configurations

Host systems can connect to the storage system over a Fibre Channel (FC) network. Use these important practices when configuring your Fibre Channel host port connections, in order to achieve high availability and high performance in your storage system.

Fibre Channel network configuration information is listed in the following sections:

- “Fibre Channel (FC) adapter types” on page 75
- “Fibre Channel host port configuration” on page 76
- “Fibre Channel connectivity requirements” on page 77
- “Fibre Channel best practices” on page 79
- “Fibre Channel zone types” on page 79
- “Fibre Channel connectivity during scale-out (MES)” on page 83

Fibre Channel (FC) adapter types

Use this information to learn about the FC adapter types being used in the IBM FlashSystem A9000R systems.

Both FC-NVMe and FC-FCP adapter types offer the same 16 Gb bandwidth.

The external physical difference between the two adapers is as follows:

- FC-FCP adapters are stamped with "PCIe x8 16GbFC".

  The FC-FCP port markings are stamped on each adapter.
- FC-NVMe adapters are stamped with "PCIe FC".

  The FC-NVMe port numbering is labeled on each adapter.

Figure 33 on page 76 shows the placement of the FC markings.

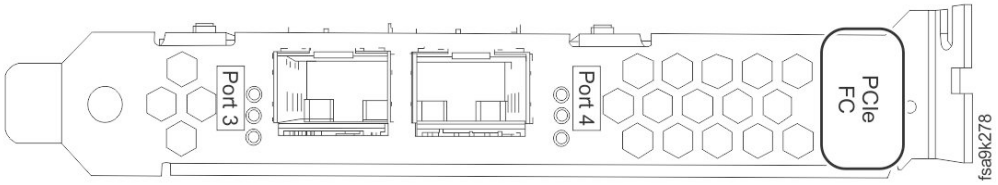


Figure 33. FC-NVMe adapter indication

Note: Figure 33 on page 76 shows an example of an FC-NVMe adapter in slot 8. The adapters in slot 4 looks slightly different, but all of the visual indicators described and shown in the image are present.

To determine which adapters are installed in your system, lookup the grid controller feature code, using the feature code information in "Grid controller components and feature codes" on page 19.

FC-NVMe adapters

NVM Express (NVMe) allows servers to leverage the native parallelism of today's SSD offerings, reduces overall I/O overhead, and increases bandwidth. FC-NVMe enables NVMe over a Fibre Channel (FC) network fabric, thus combining the benefits of all-flash SAN storage, with NVMe performance, over existing infrastructure.

Starting from system code level 12.2.1, all new orders of IBM FlashSystem A9000R models 425 and U25 systems (system code level 12.2.1 and higher) are shipped with an enhanced grid controller, with FC-NVMe ready adapters.

In these new controllers, the FC ports are dual-purposed: using a future software upgrade, you will be able to connect these ports with servers using FC, or servers using FC-NVMe, or both.

A system is FC-NVMe ready if it requires only a future software update to provide full FC-NVMe support. For a system to be FC-NVMe ready, all grid controllers in the system must be feature code 5005.

Until the software upgrade is offered, the FC-NVMe adapters serve FC only, just as the FC-FCP adapters currently do. In this type of FC configuration, a *system* may contain FC-FCP adapters; FC-NVMe adapters; or both. However, a *single grid controller* may contain only *one type* of adapter.

FC-FCP adapters

These adapters are used on grid controllers for model 415 and any model 425 that was proposed or ordered prior to 12.2.1.

Fibre Channel host port configuration

Use this information to properly configure your Fibre Channel host port connectivity.

Physical port connectivity

Be sure to connect port 1 of each grid controller in the system to switch 1 which belongs to fabric 1, and port 3 of each grid controller to switch 2 which belongs to fabric 2.

For more connectivity information regarding port connectivity, see "Fibre Channel connectivity requirements" on page 77. For a port–fabric connectivity example, see Figure 39 on page 81.

Connectivity for high performance

For high performance, follow these important practices:

- Spread grid controller port connections as evenly as possible.
- For high CPU utilization in each grid controller, use ports 1 and 3 for host connectivity and ports 2 and 4 for migration and mirroring activities (see Chapter 6, "Migration and mirroring connectivity," on page 95).

Ensuring high availability of each host

In order to ensure high availability of each host, follow these important practices:

- Ensure that you have more than one path from the host to the system.
- Divide the paths between the two fabrics: half the paths connecting to fabric 1 and the other half connecting to fabric 2.
- Spread the paths across different grid controllers.
- Use different adapters within each of the grid controllers, as shown in Figure 34 on page 77.

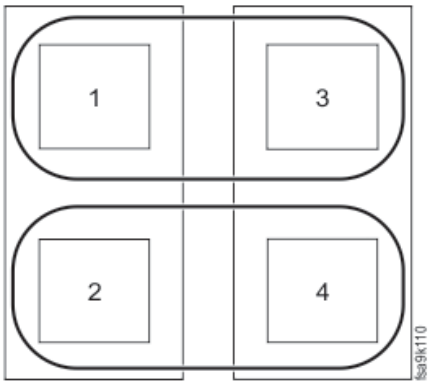
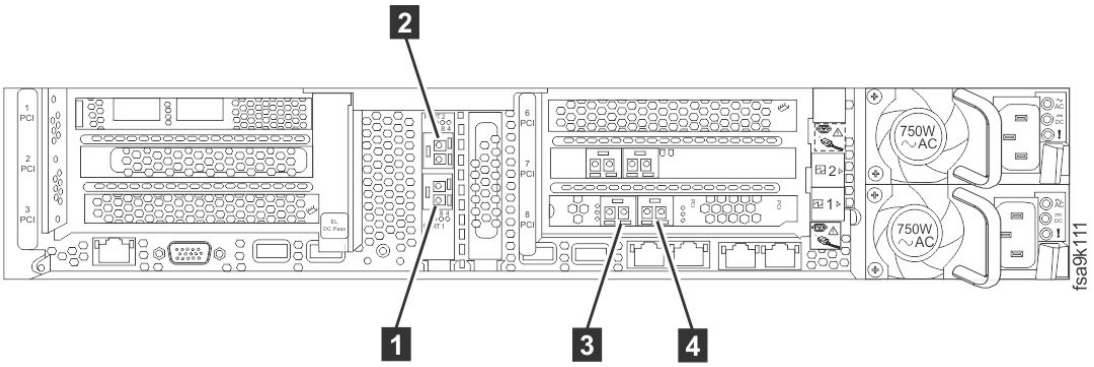


Figure 34. Crossing Fibre Channel grid controller ports

Important: It is important to use both Fibre Channel adapters for resiliency and high performance.

Figure 35 on page 77 shows the port numbers for each of the FC ports on the rear of the grid controllers.



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

Figure 35. Fibre Channel port numbering on the grid controllers

Only use non-redundant configurations when the risks of a single point of failure are acceptable, which is typically the case for test and development environments. Non-redundant configurations should generally not be used. For connectivity requirements, see “Fibre Channel connectivity requirements” on page 77.

Fibre Channel connectivity requirements

Use these connectivity requirements in order to ensure redundancy, further protecting your system data.

In a production environment, always connect Fibre Channel hosts to a **minimum** of two independent fabrics.

For rack configurations with two or more grid elements, be sure to minimally have four separate grid controller connections, two paths to each fabric, as illustrated in Figure 36 on page 78.

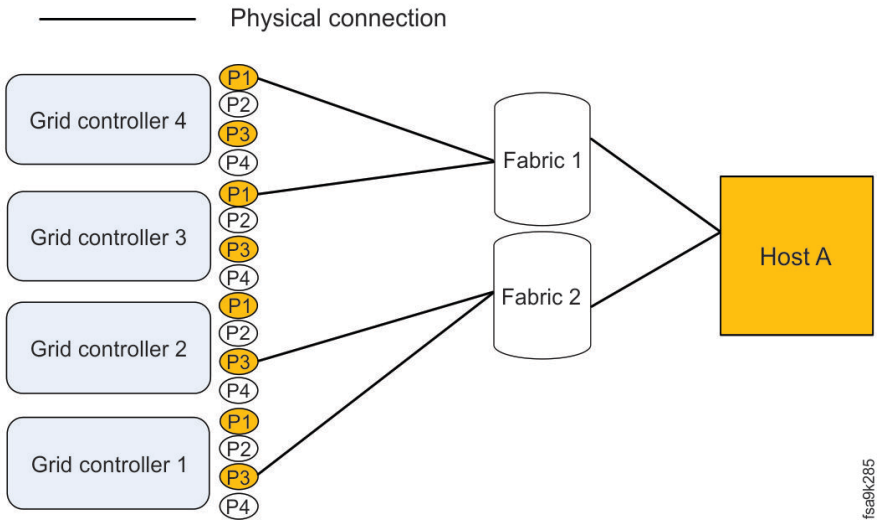


Figure 36. Minimum host connectivity for two or more grid elements

For model 425 or U25 minimum racks with three grid controllers, be sure to minimally have two separate grid controller connections, each path going to a separate fabric, as illustrated in Figure 37 on page 78.

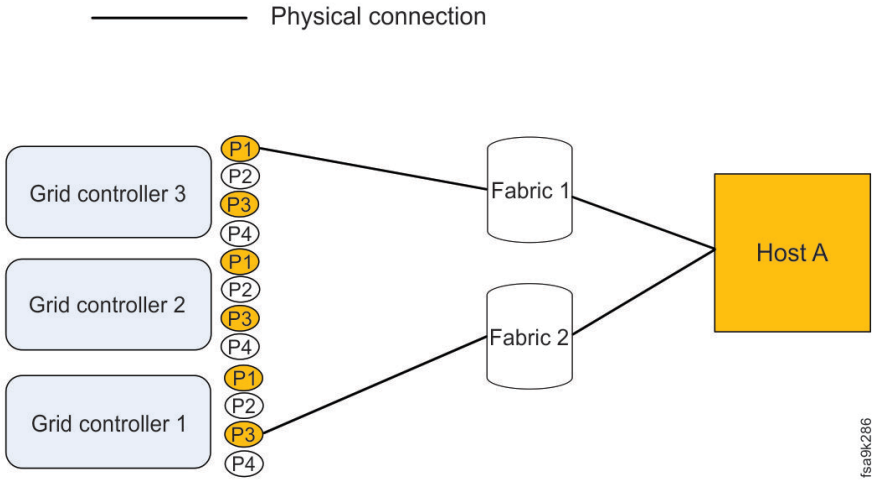


Figure 37. Minimum host connectivity for model 425 and U25 minimum racks

---

Important: Host multipath connectivity eliminates the risk of a single point-of-failure between the host and storage systems.

In Fibre Channel network configurations, there are two dual-port connections per grid controller. This setup contains a total of four paths (two paths to each fabric), providing protection from fabric failure and failure of up to two grid controllers.

For models 425 and U25 minimum configuration containing three grid controllers, the setup contains a total of two paths (one path to each fabric), providing protection against single fabric failure or a failure of up to one grid controller.

Note:

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

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

Fibre Channel best practices
Use this information for FC host connectivity best practices.

Talk to your IBM representative to help optimally setup your host connections, according to your needs.

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. Use ports 1 and 3 for host connectivity and then ports 2 and 4 for migration and mirroring.

To achieve balancing, all hosts should be spread across all *zone types* evenly. The amount of *zone types* depends on the number of grid controllers in the system being used for connectivity.

For more information on *zone types*, see "Fibre Channel zone types" on page 79.

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

Fibre Channel zone types
A *zone type* is defined as a set of targets from a certain combination of grid controllers. Each zone defined in each fabric is based on a single *zone type*.

Zoning that follows the *zone type* configuration should guarantee the following:

- High availability of host connectivity.
- All grid controllers and ports are used evenly (as described in "Fibre Channel host port configuration" on page 76).
- Once the *zone type* is defined, it should not be changed on any scale-out (MES) situations.

  For information on host connectivity during scale-out, see "Fibre Channel connectivity during scale-out (MES)" on page 83.

While Host A may be associated to Zone 1 and Host B may be associated to Zone 2, they are physically connected to the same system ports on different zones, therefore they have the same *zone type*. "Zone type for 2 grid elements (4 grid controllers)" on page 80 shows an example of this type of zoning scheme.

For more information on *zone types*, zoning, connectivity during scale-out, and general host connectivity, see IBM Storage Host Attachment Kit on IBM Knowledge Center (ibm.com/support/knowledgecenter/SSEPRF).

Zone type examples
Use the following *zone type* examples to properly configure your Fibre Channel host connectivity.

Zone type for model 425 and U25 minimal rack (3 grid controllers)

A model 425 or U25 minimal rack with three grid controllers will have only one (1) *zone type* (Z123). Physically each grid controller is connected to two different fabrics.

Table 34. Map of ports according to zone type – models 425 and U25 minimal rack

Zone type name	Grid controller 1	Grid controller 2	Grid controller 3
	Ports 1 and 3	Ports 1 and 3	Ports 1 and 3
Z123		✓	

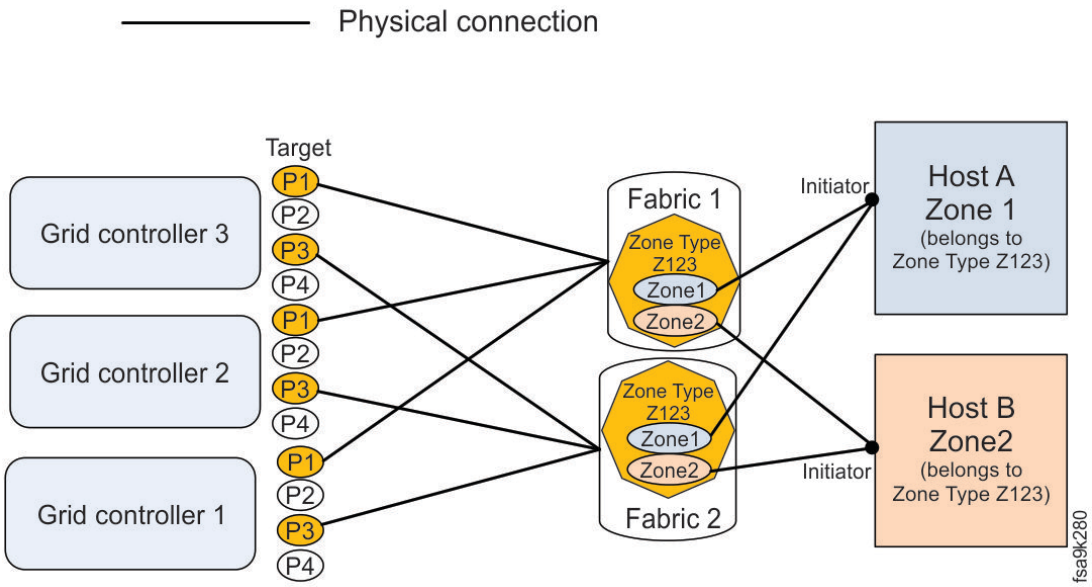


Figure 38. Single zone type for model 425 and U25 minimum racks

Zone type for 2 grid elements (4 grid controllers)

A two grid element (minimal rack for model 415) will have only one (1) *zone type* (Z1234). Each host is attached to the system through a zone which is defined by this *zone type* (Z1234).

Physically each grid controller is connected to two different fabrics through a single zone, being defined on both of the fabrics. This particular zone is based on a single *zone type*.

Table 35 on page 80 shows how all ports across all grid controllers are configured within the same *zone type*. Figure 39 on page 81 illustrates the port connections across the different hosts and fabrics, with zoning examples, where P1 and P3 are the port number connections.

Table 35. Map of ports according to zone type – 2 grid elements

Zone type name	Grid controller 1	Grid controller 2	Grid controller 3	Grid controller 4
	Ports 1 and 3	Ports 1 and 3	Ports 1 and 3	Ports 1 and 3
Z1234	✓			

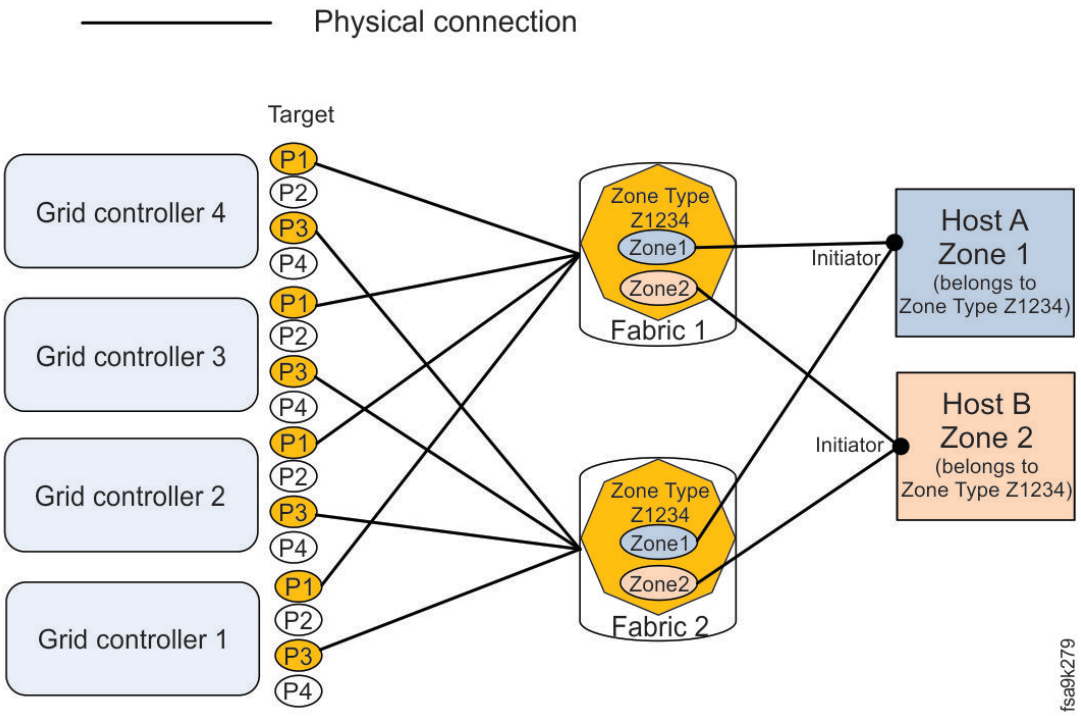


Figure 39. Single zone type for 2 grid elements

Zone type for 3 grid elements (6 grid controllers)
When a system has six (6) grid controllers, three (3) *zone types* should be used. Host zoning is spread across the *zone types* evenly, in order to achieve balancing.

Each host is based on a specific *zone type* in such a way that all host zones are spread across all the *zone types*.

Table 36 on page 81 shows how the ports on the different grid controllers are configured in three different *zone types*. Figure 40 on page 82 illustrates the port connections across the different hosts and fabrics, according to *zone type*, where P1 and P3 are the port number connections.

Table 36. Map of ports according to zone type – 6 grid controllers

Zone type name	Grid controller 1	Grid controller 2	Grid controller 3	Grid controller 4	Grid controller 5	Grid controller 6
	Ports 1 and 3	Ports 1 and 3	Ports 1 and 3	Ports 1 and 3	Ports 1 and 3	Ports 1 and 3
Z1234	✓					
Z3456			✓			
Z1256	✓				✓	

Figure 40. Zoning example for 3 grid elements

Fibre Channel connectivity during scale-out (MES)
Use this information for preparing host connectivity during system scale-out (MES).

For more information on system scale-out, see "Conducting system scale-out (MES)" on page 16.

- The original physical port connections are kept.
- Continue the physical port connection divisions, as described in "Fibre Channel host port configuration" on page 76.
- *Zone types* may need to be added or removed, depending on the number of grid controllers that were originally connected to the system and how many are being added during scale-out.

Important: In order to preserve proper balancing be sure that the host zones remain spread evenly across all *zone types* when reconfiguring zoning during scale-out.

Note: During scale-out, in order to maintain a proper connectivity balance, it may be necessary to remap some of the hosts that were previously within one *zone type* to be mapped into one of the new *zone types*.

- Be sure to add the new targets before deleting the ones that are no longer necessary.

  Use the following steps for reconfiguring the zoning:

  1. Add the new targets.
  2. Rescan the ports in the host.
  3. Delete the targets from the host side that are no longer needed.
  4. Rescan the host ports.
  5. Verify that all paths are working properly.

Example of adding zone types during scale-out
Use this example as a guideline of adding *zone types* during scale-out.

The following is an example of adding *zone types* during a scale-out scenario of adding one (1) grid element to an existing system with two (2) grid elements (a minimal system).

In this case, there was a single zone type (Z1234) to which all of the existing hosts were mapped. Now, some of the mapping is split and all mapping is across three (3) zone types, as seen in Table 37 on page 83.

Table 37. Map of ports according to zone type – scale-out from 4 to 6 grid controllers

Zone type name	Grid controller 1	Grid controller 2	Grid controller 3	Grid controller 4	Grid controller 5	Grid controller 6
	Ports 1 and 3	Ports 1 and 3	Ports 1 and 3	Ports 1 and 3	Ports 1 and 3	Ports 1 and 3
Z1234	✓					
Z3456			✓ Added			
Z1256	✓ Added				✓ Added	

iSCSI network configurations

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

your iSCSI host port connections, in order to achieve high availability and high performance in your storage system.

iSCSI network configuration information is listed in the following sections:

- “iSCSI host post configuration” on page 84
- “iSCSI connectivity requirements” on page 85
- “iSCSI best practices” on page 86
- “iSCSI connectivity during scale-out (MES)” on page 88

iSCSI host post configuration

Use this information to properly configure your iSCSI (Ethernet) host port connectivity.

Disabling and enabling Spanning Tree Protocol (STP) or Rapid Spanning Tree Protocol (RSTP)

When setting up your Ethernet switch for host port connectivity, disable the STP or RSTP for each port connected to the FlashSystem A9000R system system on the switch. Keeping these enabled can cause loss of host connectivity to the FlashSystem A9000R during hot upgrade.

Your network administrator can disable and enable the STP or RSTP at any time.

The following are examples of how to disable and enable a STP on a specific interface, when using a Cisco Nexus 5000 Series Switch:

To disable the STP

```
switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
switch(config)# interface Eth101/1/12
switch(config-if)# no spanning-tree port type edge trunk
switch(config-if)#
```

To enable the STP

```
switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
switch(config)# interface Eth101/1/12
switch(config-if)# spanning-tree port type edge trunk
Warning: Edge port type (portfast) should only be enabled on ports connected to a single
 host. Connecting hubs, concentrators, switches, bridges, etc... to this
 interface  when edge port type (portfast) is enabled, can cause temporary bridging loops.
 Use with CAUTION
switch(config-if)#
```

Physical host port configuration

Be sure to connect port 1 of each grid controller in the system to switch 1 and port 3 of each grid controller to switch 2.

Connectivity for high performance

For high performance, follow these important practices:

- 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 3 for host connectivity and ports 2 and 4 for migration and mirroring activities (see Chapter 6, “Migration and mirroring connectivity,” on page 95).

Ensuring high availability of each host

In order to ensure high availability of each host, follow these important practices:

- Divide the paths between the two subnets: half the paths connecting to subnet 1 and the other half connecting to subnet 2.
- If possible, spread the paths across different grid controllers.
- Use different adapters within each of the grid controllers, as shown in Figure 41 on page 85.

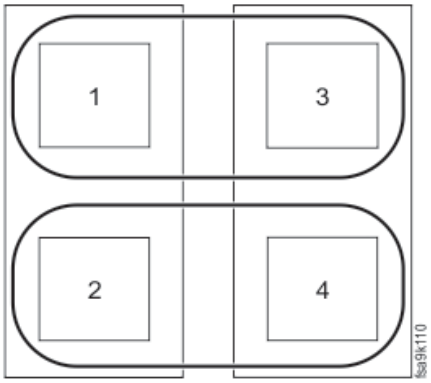
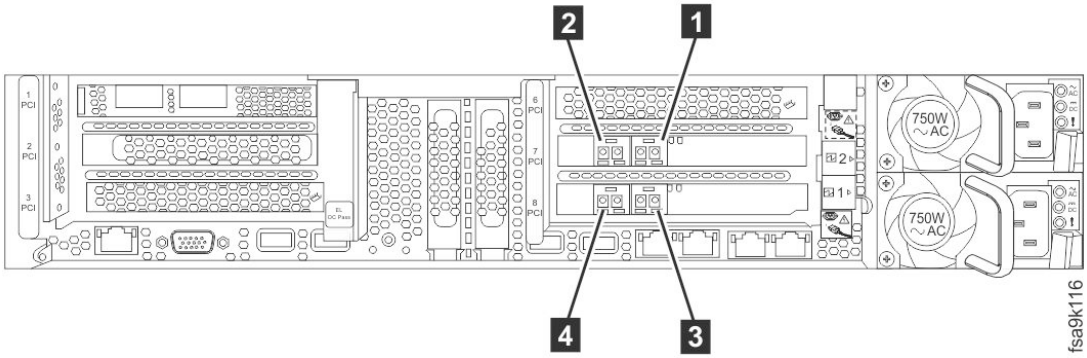


Figure 41. Crossing Fibre Channel grid controller ports

Important: It is important to use both Ethernet adapters for resiliency and high performance.

Figure 42 on page 85 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 42. iSCSI port numbering on the grid controllers

Only use non-redundant configurations when the risks of a single point of failure are acceptable, which is typically the case for test and development environments. Non-redundant configurations should generally not be used. For connectivity requirements, see “iSCSI connectivity requirements” on page 85.

iSCSI connectivity requirements

Use these connectivity requirements in order to ensure redundancy, further protecting your system data.

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.

Note:

- 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.

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

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)

Note the following when setting up your iSCSI network:

- If two or more iSCSI connections exist in your iSCSI network, iSCSI ports for mirroring must be defined on switches with flow control set to on.
- 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.
- 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.
- If present, Ethernet VLANs and IP routers must be configured to enable connectivity between the host systems and the FlashSystem A9000R system.
- 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

Use this information for iSCSI (Ethernet) host connectivity best practices.

Talk to your IBM representative 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 3 and then ports 2 and 4.

It is recommended to use half the ports in each grid controller (ports 1 and 3) and create three identical subnets in each switch.

Table 38 on page 87 is an example of how the subnets should be divided in a full rack configuration.

Table 38. Example of recommended switch subnets

Model	Switches	Subnet	Grid controllers	Port numbers
415, 425, and U25	1, 2	1	Grid controllers 1, 2, 3, 4	1, 3
415, 425, and U25	1, 2	2	Grid controllers 5, 6, 7, 8	1, 3
415 only	1, 2	3	Grid controllers 9, 10, 11, 12	1, 3

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

See Table 39 on page 87 for an example of how the host connections should be divided in model 425 and U25 minimum racks with three grid controllers.

Table 39. Example of recommended Ethernet host connections for model 425 and U25 minimum rack installations

Switch	Subnet	Grid controllers	Port number
1	1	Grid controllers 1, 2, 3	1
2	1	Grid controllers 1, 2, 3	3

iSCSI connectivity during scale-out (MES)
Use this information for preparing host connectivity during system scale-out (MES).

For more information on system scale-out, see "Conducting system scale-out (MES)" on page 16.

- The original physical port connections are kept.
- Continue the physical port connection divisions, as described in "iSCSI host post configuration" on page 84.

Important: When reconfiguring subnets for scale-out situations, be sure that the hosts remain spread across the subnets evenly.

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 40 on page 88 shows the various cable type requirements for your system.

Table 40. 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.

Network and host connectivity security information can be found in the following sections:

- "Internet Protocol Security (IPSec)" on page 89
- "Data-at-rest encryption" on page 89
- "User authentication and access control" on page 90
- "PCI DSS compliance" on page 92

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).

Data-at-rest encryption

The storage system secures all written data with industry-standard AES encryption for data-at-rest.

Encryption key management can be carried out through an external or an internal scheme.

Encryption can be enabled during the installation of the system or at any time later. While encryption is not enabled, the system might not meet customers or legal compliance standards and the data might not be protected against security issues. Encryption can be disabled only when no volumes are defined.

Encryption is configured through the CLI.

- For more information on data-at-rest encryption, see the *IBM FlashSystem A9000R Product Overview* , SC27-8559 on the IBM FlashSystem A9000R Knowledge Center website (ibm.com/support/knowledgecenter/STJKN5).
- For information regarding encryption CLI commands, 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).

More about the different types of data-at-rest encryption options can be found in the following sections:

- “Internal data-at-rest encryption scheme” on page 89
- “External data-at-rest encryption scheme” on page 89

Internal data-at-rest encryption scheme

The internal encryption key management scheme generates and stores the encryption key locally, within the storage system.

The default encryption for your FlashSystem A9000R system is the internal encryption key management scheme.

With the internal encryption key management scheme, keys are not affected by software upgrades and remain available upon the failure of up to two grid controllers.

Because the encryption is internal, it contains more security risks if the system is physically accessed. (For steps of preventing physical access to your system, see “Site security considerations” on page 68).

In addition, further precautions are necessary during relocation of your system. The boot drives contain the encryption keys and must be shipped separately for the security of your system. For specific instructions on relocating with an internal encryption key management scheme, see “Relocation shipping requirements for systems with local encrypted schemes” on page 101.

External data-at-rest encryption scheme

An external encryption key management scheme stores the keys separately from the data, thereby presenting a secured and well-defined interface for key services.

The separation of key storage from data storage and key management is accomplished with external Key Management Interoperability Protocol (KMIP) compliant servers, such as IBM® Security Key Lifecycle Manager (SKLM) or Gemalto SafeNet KeySecure server.

The separation of the keys from the data provide another layer of security should your system be physically accessed (see “Site security considerations” on page 68).

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).

For more information, and purchasing options, speak to your IBM representative.

User authentication and access control

Use this information to understand how to securely maintain your passwords.

The storage system features role-based authentication, either natively or through use of LDAP-based authentication.

Attention:

- Be careful when saving user credentials locally. This information can be accessed if site or system access is obtained.

  For more information, see "Site security considerations" on page 68.
- To properly ensure password safety, be sure to change passwords often to limit security risks.

- For more information on mirroring, see:
  - Chapter 6, "Migration and mirroring connectivity," on page 95
  - *IBM FlashSystem A9000R Product Overview* , SC27-8559 on the IBM FlashSystem A9000R Knowledge Center website (ibm.com/support/knowledgecenter/STJKN5)
- For more information on user authentication and access control, see the *IBM FlashSystem A9000R Product Overview* , SC27-8559 on the IBM FlashSystem A9000R Knowledge Center website (ibm.com/support/knowledgecenter/STJKN5)

More about the different types of user authentication and access control can be found in the following sections:

- "Native user authentication" on page 90
- "External authentication via Lightweight Directory Access Protocol (LDAP)" on page 91

Native user authentication

Native user authentication is the default mode for authenticating users and user groups.

In this mode, users and groups are authenticated against a database locally on the system. The authentication is based on the submitted username and password, which are compared to user credentials defined and stored on the storage system.

The authenticated user must be associated with a user role that specifies the system access rights.

Note: Technicians use a different form of native user authentication. For more information regarding technician authentication, see "Support and software maintenance security information" on page 110.

External authentication via Lightweight Directory Access Protocol (LDAP)
IBM FlashSystem A9000R systems offer the capability to use LDAP server-based user authentication.

Note:

- For supported LDAP server products, see "Product selection" on page 91.
- For more detailed information about LDAP products, role mapping, defining on your storage system, and more, speak to your IBM representative and 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 enabling LDAP authentication, LDAP credentials must be granted for any users who need access to the system. Internal users (such as technicians, Admin, and so on) do not use LDAP authentication.

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

While using LDAP authentication is possible, native user authentication is the default and the identity manager option must be set up separately. For more information about native user authentication, see "Native user authentication" on page 110.

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 the LDAP directory for authentication.

Note: LDAPs are all located externally, posing less risk should the system be physically accessed by unwanted persons.

For more information about the physical security of your system, see "Site security considerations" on page 68.

Because the user's password is stored in the LDAP directory, all connected storage systems authenticate the user with the same 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). 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 about remote mirroring, see the IBM FlashSystem A9000R Product Overview, SC27-8559 on the IBM FlashSystem A9000R Knowledge Center website (ibm.com/support/knowledgecenter/STJKN5).

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.

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 are never transferred 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 LDAP server. Server configuration includes generating a certificate request, obtaining a server certificate from a CA, and installing the server and CA certificates.

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. LDAP registration through the UI can be done with a simple file upload. When using the CLI, Windows users can drag and drop the certificate into the XCLI utility window. Other uses need to copy and paste a long string containing the certificate, noting the correct formatting.

Maintaining SSL certificates

New SSL certificates must be installed before the existing ones expire.

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 41 on page 92 describes how IBM FlashSystem A9000R complies with these standards.

Table 41. 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.

Table 41. PCI-DSS Support (continued)

Requirement	PCI-DSS Section	FlashSystem A9000R solution
Render all passwords unreadable during transmission and storage on all system components using strong cryptography	8.4	XIV stores secure and irreversible hashes of user passwords
Enable accounts used by vendors for remote access only during the time period needed. Monitor vendor remote access accounts when in use.	8.5.6	**xiv_support_enable**/**disable** is used to temporarily enable remote access
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.

Chapter 6. Migration and mirroring connectivity

Use this information in order to plan for physical connectivity for data migration and mirroring.

This section covers only the important physical connection setup required for migration and mirroring. For more in-depth information, see the following relevant publications:

- *IBM FlashSystem A9000R Product Overview* , SC27-8559

  This publication can be found on the IBM FlashSystem A9000R Knowledge Center website (ibm.com/support/knowledgecenter/STJKN5).
- IBM FlashSystem A9000 and A9000R Business Continuity Functions Redbook, REDP-5401 (www.redbooks.ibm.com/abstracts/redp5401.html?Open)

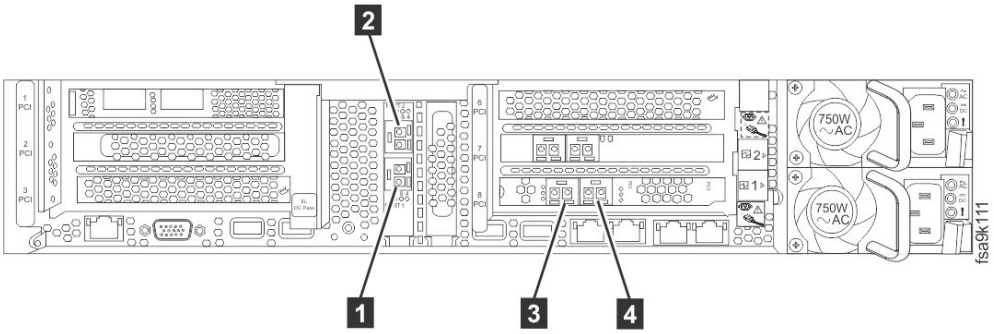
Physical connectivity for mirroring and migration using Fibre Channel

Be sure to use ports 2 and 4, 4 being the initiator, when conducting mirroring or migration using FC connectivity.

Ports 1 and 3 are used for host connectivity. For more information, see “Host network connectivity and multipathing configurations” on page 74.

For more information about FC adapters, see “Fibre Channel (FC) adapter types” on page 75.

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 43. FC port numbering on the grid controllers

For more information about grid controller feature codes and connectivity options, see “Grid controller components and feature codes” on page 19.

Physical connectivity for mirroring and migration using iSCSI

Port connectivity for mirroring and migration using the Ethernet ports depends on the grid controller type being used in the system.

Ports 1 and 3 are used for host connectivity. For more information, see “Host network connectivity and multipathing configurations” on page 74.

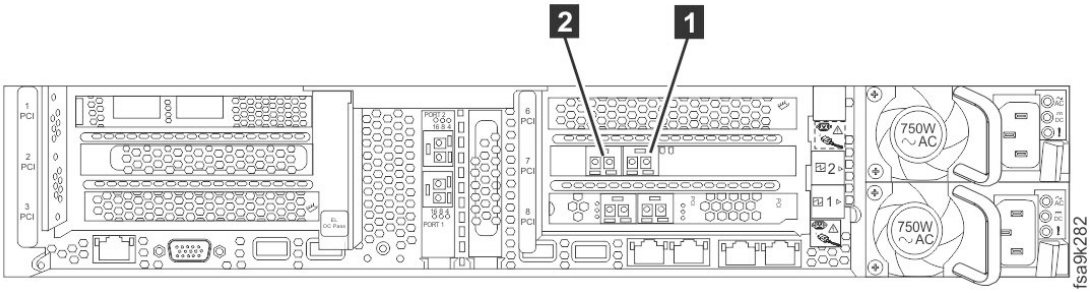
iSCSI on grid controllers containing FC ports (feature codes 5001, 5003, 5005)

Important: In this grid controller setup, migration can **only** be done via FC port connections (see “Physical connectivity for mirroring and migration using Fibre Channel” on page 95).

When conducting mirroring using Ethernet port connectivity, use ports 2 and 4 (where applicable).

Ports 1 and 3 are used for host connectivity. For more information, see “Host network connectivity and multipathing configurations” on page 74.

Figure 44 on page 96 shows the port numbers for each of the Ethernet ports on the grid controllers.



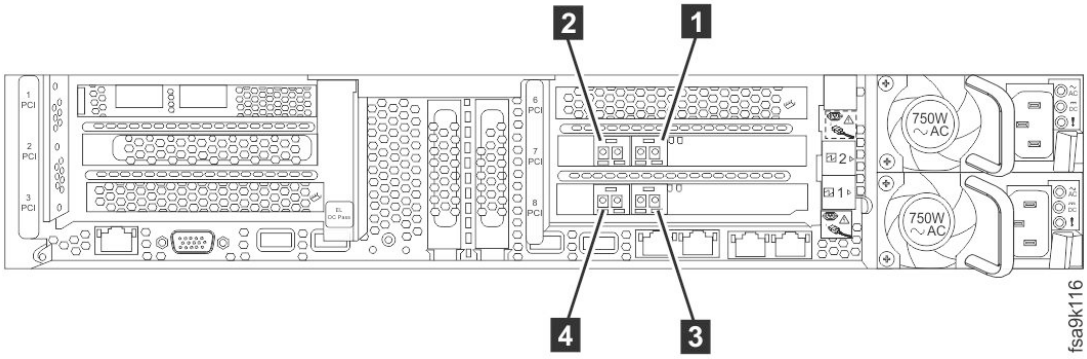
1 10GbE port 1
2 10GbE port 2

Figure 44. Ethernet (10 Gb) port numbering on the grid controllers (mixed FC and iSCSI configuration)

iSCSI on grid controllers containing full iSCSI connectivity (feature codes 5002, 5004)

When conducting mirroring or migration using Ethernet port connectivity, use ports 2 and 4.

Figure 45 on page 97 shows the port numbers for each of the Ethernet ports on the grid controllers.



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

Figure 45. Ethernet (10 Gb) port numbering on the grid controllers

Migration and mirroring best practices

Use this information in order to achieve high availability and high performance in your storage system when performing migration and mirroring.

Talk to your IBM representative to help optimally setup any migration and mirroring connectivity, according to your needs.

To achieve high availability and performance, it is important to:

- Spread all ports being used for migration or mirroring connectivity over multiple grid controllers, evenly distributing the mirroring load.
- Use both Fibre Channel or iSCSI adapters within each of the grid controllers, as shown in Figure 46 on page 97.

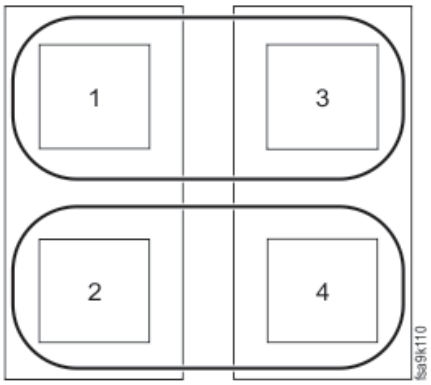


Figure 46. Crossing grid controller adapter ports

- Divide the paths between the two switches or subnets: half the paths connecting to switch/subnet 1 and the other half connecting to switch/subnet 2.

  When possible, P2 connects to switch/subnet 1 and P4 connects to switch/subnet 2.

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.

Be sure to follow these **minimum** connectivity requirements:

Note: For more information on grid elements, see "FlashSystem A9000R grid elements" on page 11

Fibre Channel connections in systems with two or more grid elements

Use a minimum of three FC ports configured as *initiator* and an additional three FC ports configured as *target* on each system. Each pair of FC ports (one initiator and one target) must reside on separate grid controllers, in order to provide redundancy and sustain two grid controller failures.

Using additional FC ports helps improve performance.

Fibre Channel connections in model 425 and U25 minimum configurations (3 grid controllers)

Use a minimum of two FC ports configured as *initiator* and an additional two FC ports configured as *target* on each system. Each pair of FC ports (one initiator and one target) must reside on separate grid controllers, in order to provide redundancy and sustain a grid controller failure.

Using additional FC ports helps improve performance.

Ethernet connections in systems with two or more grid elements

Use a minimum of three bi-directional Ethernet connections, using three iSCSI ports on each system. Each Ethernet connection must reside on separate grid controllers, in order to provide redundancy and sustain two grid controller failures.

Using additional bi-connections on iSCSI ports helps improve performance.

Ethernet connections in model 425 and U25 minimum configurations (3 grid controllers)

Use a minimum of two bi-directional Ethernet connections, using two iSCSI ports on each system. Each Ethernet connection must reside on a separate grid controller, in order to provide redundancy and sustain a grid controller failure.

Using additional bi-connections iSCSI ports helps improve performance.

Chapter 7. 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” on page 99
- “Planning for relocation” on page 100
- “Shipment weights and dimensions” on page 101

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 101).
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 reduction shipping options (feature codes AFR2 or AFR3) must be ordered. For information about the height and weight reduction feature codes, see “Height reduced shipping option” on page 22 and “Weight reduced shipping option” on page 22.

   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.

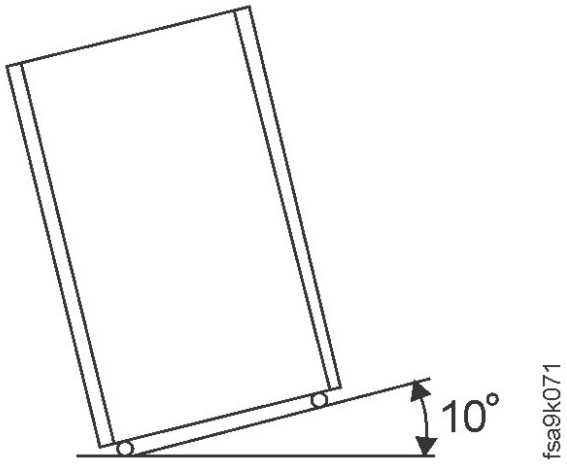


Figure 47. Maximum tilt for a packaged rack is 10 degrees

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 the 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 labeling 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” on page 101.

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.

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 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 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 safety of your system, it is strongly recommended to 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 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 your 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 42. 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 43. Floor weight-support requirements	
Grid element configuration	**Total weight**
12 grid controllers and 6 flash enclosures (model 415 only)	969 kg (2136 lbs)
10 grid controllers and 5 flash enclosures (model 415 only)	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)
3 grid controllers and 1 flash enclosure (models 425 and U25 only)	578 kg (1274)

Chapter 8. Planning for remote support, on-site service, and maintenance

This section provides you with information to help 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 (RSC) 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 RSC 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 69.

The RSC has three components:

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.

***Front servers* that serve as a hub at which the storage system and the remote-support back server connect.**
The front servers are located in an IBM demilitarized zone (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 (RSP) to facilitate the connection to IBM. For more information, see the *IBM XIV® Remote Support Proxy User Guide* (GA32-0795).

Figure 48 on page 104 illustrates the remote support components.

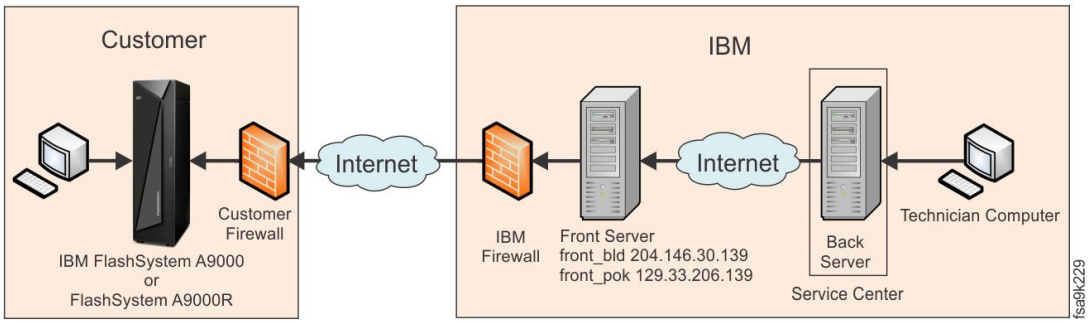


Figure 48. Remote support components

The RSC 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 RSC 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 RSC.
2. The RSC identifies the storage system and marks it as connected.
3. The IBM service representative connects to the RSC using SSH.
4. The RSC 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 RSC.

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 RSC.

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.

Note: XRSC on severe system conditions (XRSC) is compliant with General Data Protection Regulation (GDPR) EU 2016/679. For more information, refer to http://ibm.biz/gdpr-storage-paper.

Remote support for severe system conditions permits a remote support access without the need for the customer to initiate the SSH session towards the RSC. 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.

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** > **Configuring the support center connection to enable automatic connect 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.

Note: Call Home is compliant with General Data Protection Regulation (GDPR) EU 2016/679. For more information, refer to http://ibm.biz/gdpr-storage-paper.

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.

If required, the customer email gateway can be configured to send Call Home information to IBM only via a secured channel. For more information, see Monitoring and Troubleshooting > Encrypting Call Home and heartbeat notifications in IBM FlashSystem A9000 and IBM FlashSystem A9000R: Architecture, Implementation and Usage Redbook, SG24-8345 on the IBM Redbooks website (www.redbooks.ibm.com) .

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.

Customer responsibility

As the customer, it is your 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 or repair of the FlashSystem A9000R system.

Table 44 on page 106 lists requirements that must be met to configure the Call Home function.

Table 44. 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 105) 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 49 on page 107 shows the flow between IBM Call Home and Call Home Web.

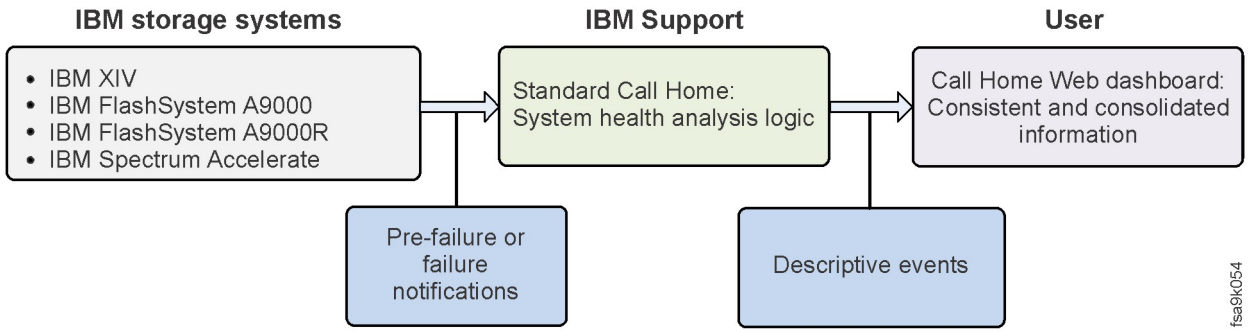


Figure 49. IBM Call Home and Call Home Web

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 105.

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 for the following FlashSystem A9000R 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:

- Go to 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 the Call Home Web tab on the IBM Support Site assistance webpage (ibm.com/support/home/widgets/siteAssistance/siteAssistance.html).

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 50 on page 109 depicts the location of the serial number on the front of a FlashSystem A9000R rack.

Figure 51 on page 110 depicts the location of the serial number on the rear of a FlashSystem A9000R rack.

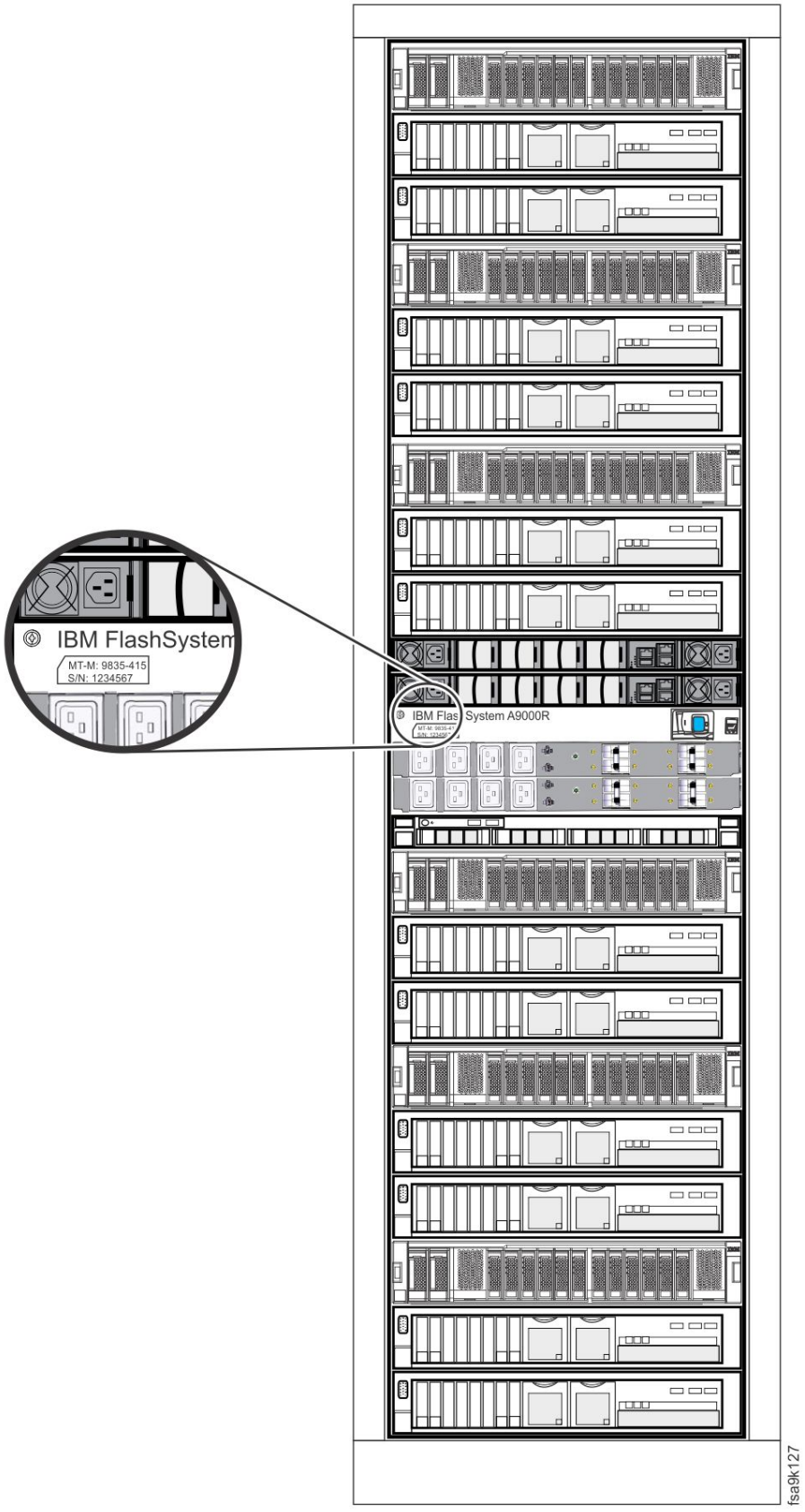


Figure 50. Machine type and model, and serial number label on front of rack

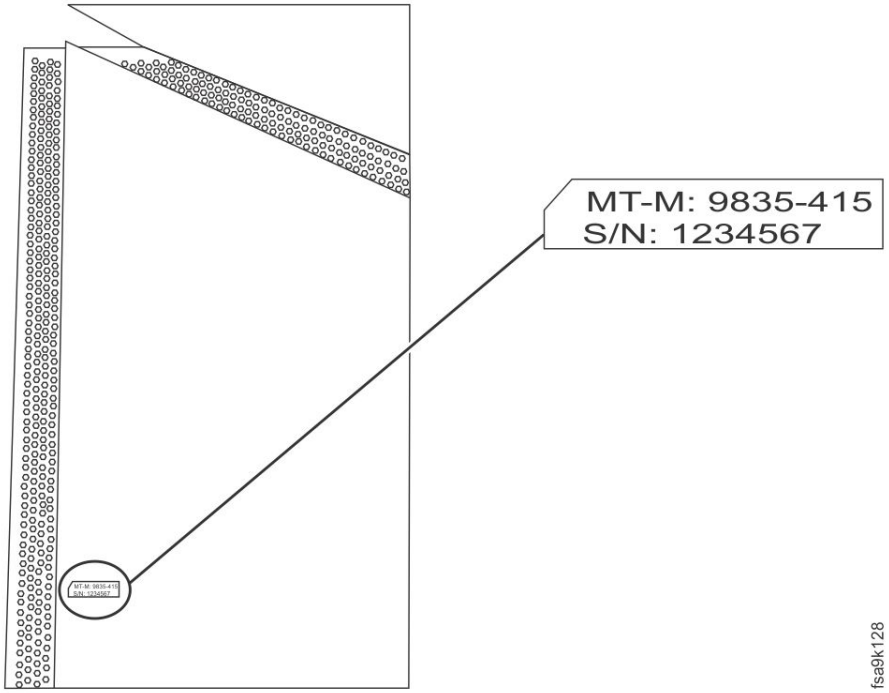


Figure 51. Machine type and model, and serial number on rear of rack

Support and software maintenance security information

The IBM Remote Support Center (RSC) 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 various forms of user authentication.

Customer user authentication

Customer's use password-based user authentication.

Note: For more information on customer user authentication, see “User authentication and access control” on page 90.

Technician user authentication

Service technicians have a challenge-response authentication protocol, establishing the authenticity of the technician.

This is done 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) .

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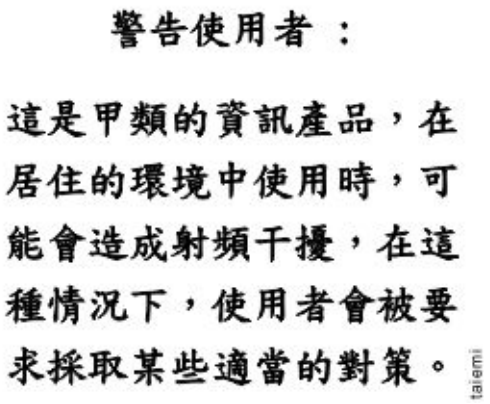

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