Rear Door Heat eXchanger

Planning Guide

Rear Door Heat eXchanger

Planning Guide

Note:

Before using this information and the product it supports, read the general information in Appendix A, “Getting help and technical assistance,” on page 21 and Appendix B, “Notices,” on page 23.

First Edition (May 2005)

Contents

Figures

Tables

Planning for the installation of Rear Door Heat eXchangers

This planning guide contains information for preparing your location to facilitate the use of IBM Rear Door Heat eXchangers.

The Rear Door Heat eXchanger is a water-cooled device that mounts on the rear of the IBM NetBay42 Enterprise rack to cool 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. In this guide, we refer to this as a secondary cooling loop. The primary cooling loop supplies the building chilled water to secondary cooling loops, air conditioning units, and so on. The hoses for the secondary cooling loop are not included with this product. The rack on which you install this cooling feature can be on a raised floor or a non-raised floor. Each Rear Door Heat eXchanger can remove up to 50 000 BTU (or approximately 15 000 watts) of heat from your data center.

Suggestions for sources of hoses, water treament and cooling distribution units for supplying conditioned water are provided under “Suggested sources for secondary loop components” on page 17.

If you would like to procure IBM installation planning services regarding what is needed to plan for supplying conditioned water and installing the Rear Door Heat eXchangers, see “Installation and support from IBM Integrated Technology Services Offerings” on page 19.

This documentation might be updated occasionally to include information about new features, a translated version of the documentation might be available in your language, or technical updates might be available to provide additional information that is not included in the heat exchanger documentation. These updates are available from the IBM Web site. Complete the following steps to check for updated documentation and technical updates:

1. Go to http://www.ibm.com/pc/support/.
2. In the **Browse by topic** section, click **Publications**.
3. On the Publications page, in the **Brand** field, select **Servers**.
4. In the **Family** field, select **Rack/Storage Enclosures**.
5. In the **Type** field, select **9308**.
6. Click **Display documents**.

Related documentation

The following documentation provides related information for the heat exchanger:

- *IBM Rear Door Heat eXchanger: Installation and Maintenance Guide*
- *IBM NetBAY: Rack Safety Information*

Notices and statements in this document

The following notices and statements are used in this document:

- **Note:** These notices provide important tips, guidance, or advice.
- **Important:** These notices provide information or advice that might help you avoid inconvenient or problem situations

- **Attention:** These notices indicate potential damage to programs, devices, or data. An attention notice is placed just before the instruction or situation in which damage could occur.

Rear Door Heat eXchanger option kit

The IBM Rear Door Heat eXchanger option kit consists of the following components shown in Figure 1:

- Door assembly
- Hinge kit
- Air-purge tool
- Documentation package

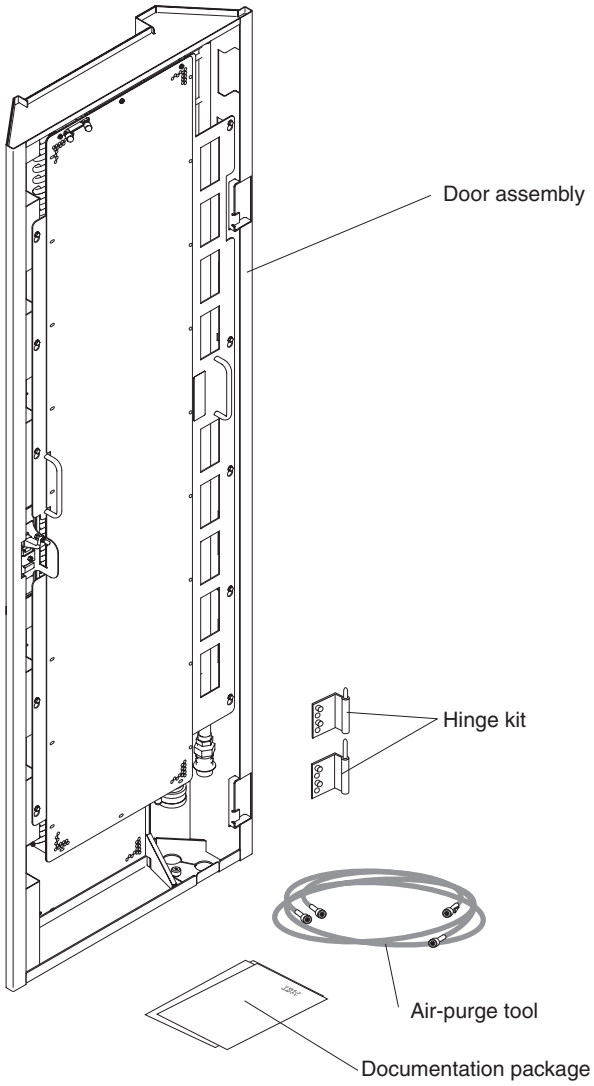

Figure 1. Components of the heat exchanger option kit

Heat exchanger specifications

The following information is a summary of the specifications of the Rear Door Heat eXchanger.

Table 1. Rear Door Heat eXchanger operating specifications

Door size • Depth: 142.6 mm (5.6 in.) • Height: 1945.4 mm (76.6 in.) • Width: 639 mm (25.2 in.) **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 lbs) • Filled: 35.6 kg (78.5 lbs)	**Air movement** • Provided by servers and other devices in the rack **Air temperature drop** • The temperature drop can be up to 25° Celsius (45° Farenheit) between the air exiting the rack devices and the air exiting the heat exchanger on high heat load products. **Water source** • User-supplied, compliant with specifications in this *Planning Guide* **Water pressure** • Normal operation: < 137.93 kPa (20 psi) • Maximum: 689.66 kPA (100 psi)	**Water Volume** • Exchanger: Approximately 5.7 liters (1.5 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** • 18° C +/- 1° (64.4° F +/- 1.8°) **Required water flow rate** (as measured at the supply entrance to the heat exchanger) • Minimum: 22.7 liters per minute (6 gallons per minute) • Maximum: 37.9 liters per minute (10 gallons per minute)

Planning considerations overview

High-level planning considerations for the Rear Door Heat eXchanger are as follows.

1. Provide chilled, conditioned water to the heat exchangers that meets the specifications outlined in “Water control and conditioning for the secondary cooling loop” on page 4.
2. Procure and install the water supply system that is suitable for your data center. Details are provided in “Water delivery specifications for secondary loops” on page 5.
3. Provide floor tile cutouts on raised floors, or protective coverings to avoid trip hazards on non-raised floors as part of hose management.

Water specifications for the secondary cooling loop

It is very important that the water being supplied to the heat exchanger meet the requirements described in this section. Otherwise, system failures might occur over time, as a result of:

- Leaks due to 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 heat exchanger’s ability 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 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 these issues.

- Metal corrosion
- Bacterial fouling
- Scaling

The water cannot originate from the primary, building, chilled-water system, but 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 recommended for secondary loops

This section describes the recommended materials for use in supply lines, connectors, manifolds, pumps 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 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 loops

This section describes specific characteristics of the system that supplies the chilled conditioned water to the heat exchanger.

Temperature: The heat exchanger, its supply hose and return hoses are not insulated. Avoid any condition that could 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 - 6° C (39 to 43° F).

Important: If the system supplying the cooling water does not have the ability to measure the room dew point and automatically adjust the water temperature accordingly, the minimum water temperature that must be maintained is 18° Celsius plus or minus 1° (64.4° fahrenheit plus or minus 1.8°). This is consistent with the ASHRAE Class 1 Environmental Specification that requires a maximum dew point of 17° C (62.6 F). Refer to the ASHRAE document entitled *Thermal Guidelines for*

Data Processing Environments. Information on obtaining this document is found at www.ashrae.org. Search on document id ASHRAE TC 9.9.

Pressure: The water pressure in the secondary loop must be less than the maximum 689.66 kPa (100 pounds per square inch). Normal operating pressure at the Rear Door Heat eXchanger should 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 per minute (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 per minute (8 gallons per minute)

Water volume limits: The heat exchanger holds approximately 5.7 liters (1.5 gallons). Fifteen 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 product 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

This section describes the various hardware components that make up the delivery system secondary loop that provides the chilled, conditioned water to the Rear Door Heat eXchanger. The delivery system includes pipes, hoses and the required connection hardware to attach to the heat exchanger. Hose management on raised or non-raised floor environments is also described.

The Rear Door Heat eXchanger can remove 50-60% of the heat load from an individual rack when running under optimum conditions. For sizing purposes, consider a rack that produces a heat load of X watts. The heat eXchanger can remove 0.5X watts before the heated air enters the room.

The primary cooling loop is considered to be the building chilled-water supply or a modular chiller unit. The primary loop must not be used as a direct source of coolant for the Rear Door Heat eXchanger.

Procurement and the installation of the components needed to create the secondary cooling loop system are required for this design and are your responsibility. Suggestions on where to procure hoses and cooling distribution units are provided later in this chapter. The main purpose of this section is to provide examples of typical methods for secondary loop set-up and operating characteristics that are needed to provide an adequate, safe supply of water to the Rear Door Heat eXchanger.

Figure 2 on page 6 shows a typical cooling solution and defines the components of the primary cooling loop and the components of the secondary cooling loop.

Figure 3 below shows an example of a facilities fabricated solution. The actual number of Rear Door Heat eXchangers connected to a secondary loop depends on the capacity of the cooling distribution unit that is running the secondary loop.

Figure 4 on page 7 shows an example of an off-the-shelf modular cooling distribution unit. The actual number of Rear Door Heat eXchangers connected to a secondary loop depends on the capacity of the cooling distribution unit that is running the secondary loop.

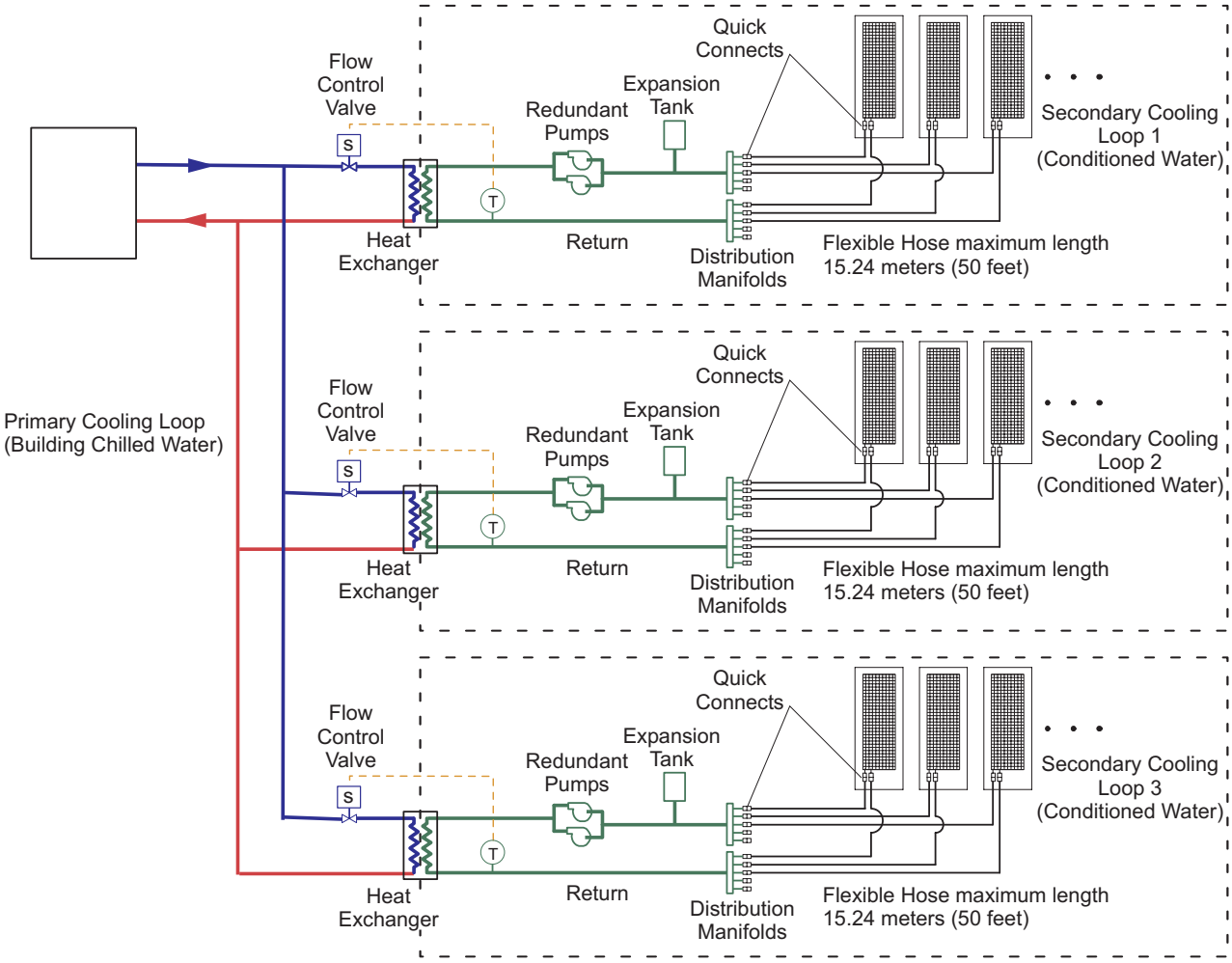

Figure 2. Primary and secondary cooling loops

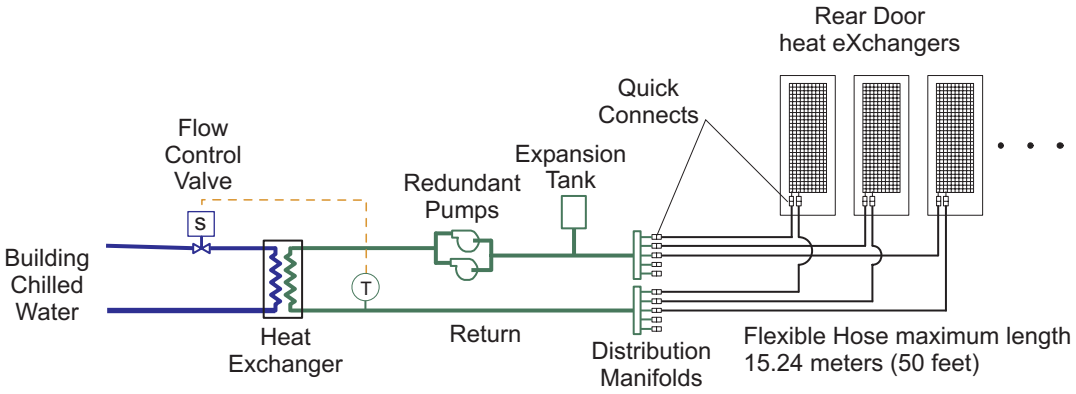

Figure 3. Coolant distribution using a fabricated facilities solution

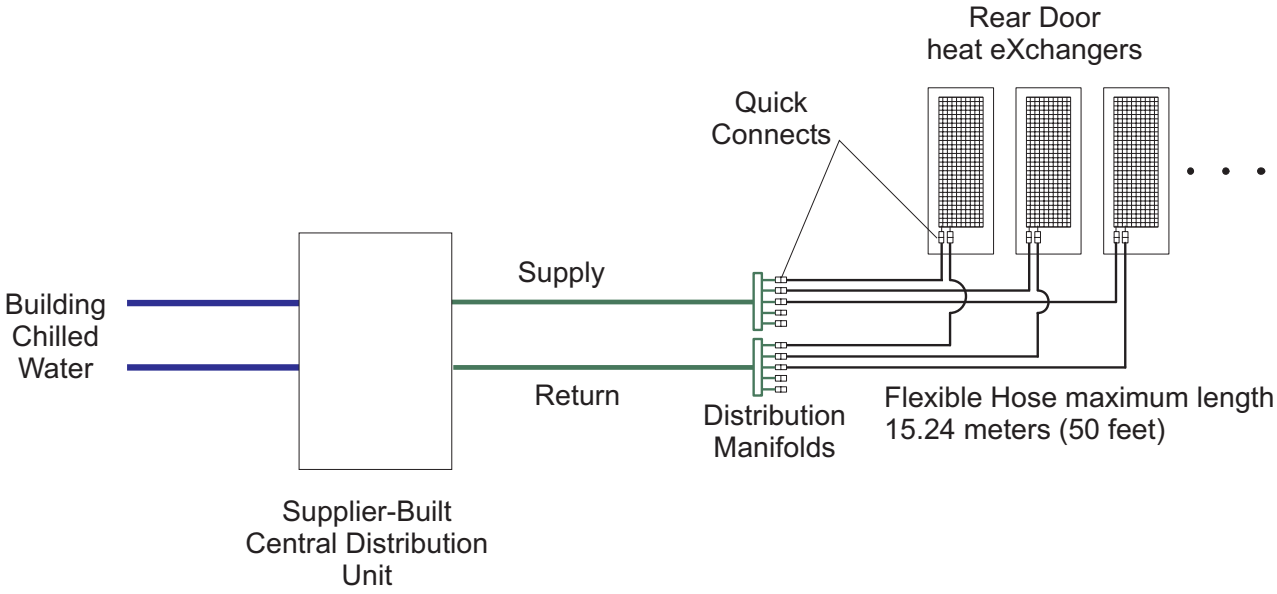

Figure 4. Coolant distribution using off-the-shelf supplier solutions

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 Rear Door Heat eXchangers. Manifolds must be constructed of materials compatible with the pump unit and related piping. See “Materials recommended for secondary loops” on page 4. 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 heat exchanger (between the secondary cooling loop and building chilled-water source). Anchor or restrain all manifolds to provide the required support to avoid movement when quick-connect couplings are plugged to the manifolds.

Example manifold supply pipe sizes

- Use a 50.8 mm (2 in.) supply pipe to provide the correct flow to six (100 kW CDU) 19 mm (0.75 in.) supply hoses.
- Use a 63.5 mm (2.50 in.) supply pipe to provide the correct flow to eight (120 kW CDU) 19 mm (0.75 in.) supply hoses.

- Use an 88.9 mm (3.50 in.) supply pipe to provide the correct flow to twenty (300 kW CDU) 19 mm (0.75 in.) supply hoses.

Shutoff valves are suggested for each supply line that exits the manifold to allow stopping the flow of water in individual legs of multiple circuit loops. This provides a way of servicing or replacing an individual heat exchanger without affecting the operation of other heat exchanges in the loop.

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

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 5 shows an example of a typical central manifold layout that supplies water to multiple heat exchangers.

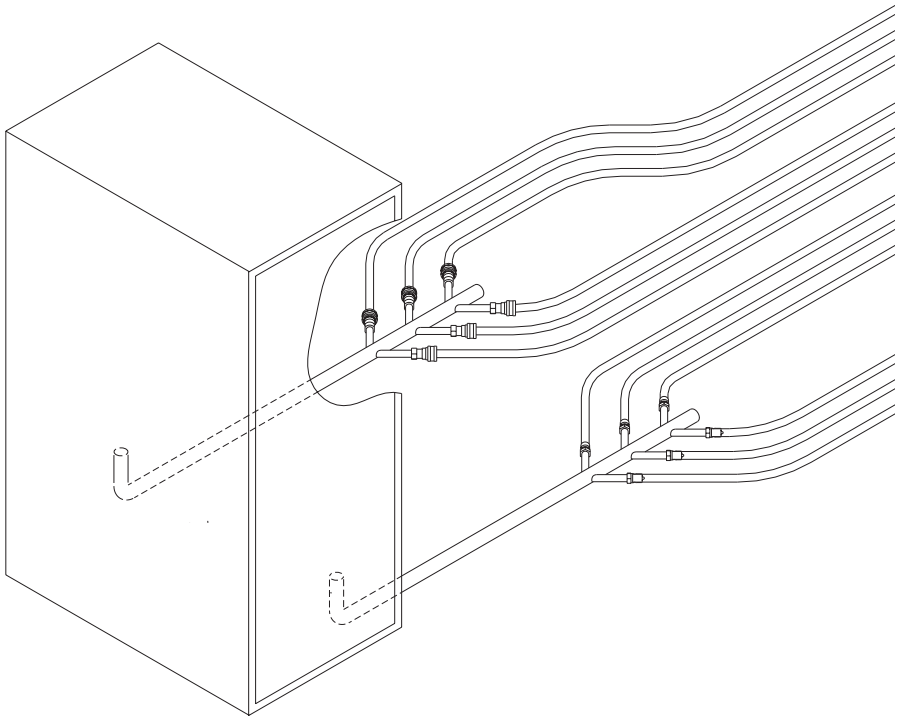

Figure 5. Typical central distribution manifold layout in a central location

Figure 6 on page 9 shows another layout for multiple water circuits.

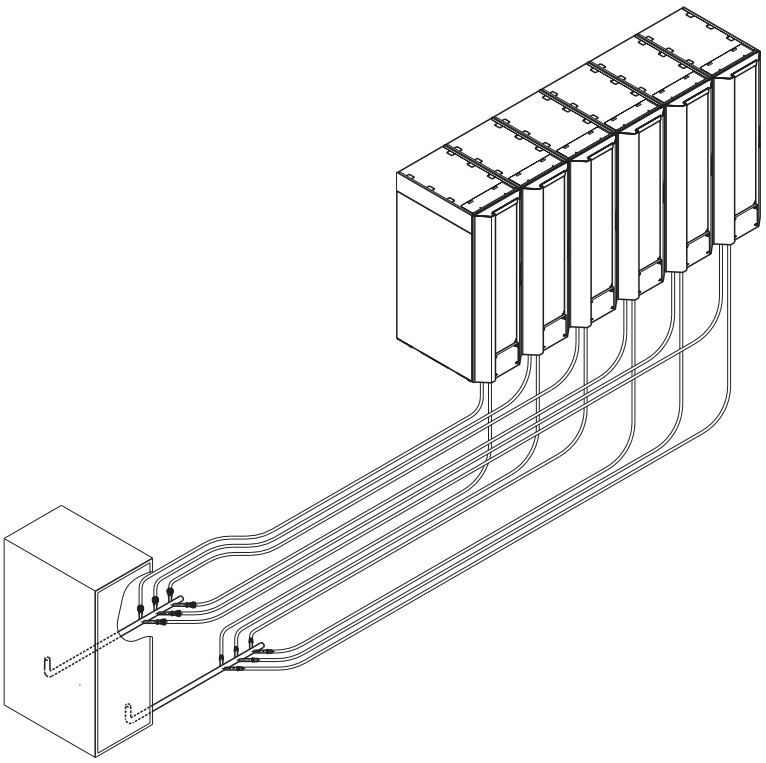

Figure 6. Typical central manifold (located at a central location for multiple water circuits)

Figure 7 on page 10 shows an extended manifold layout.

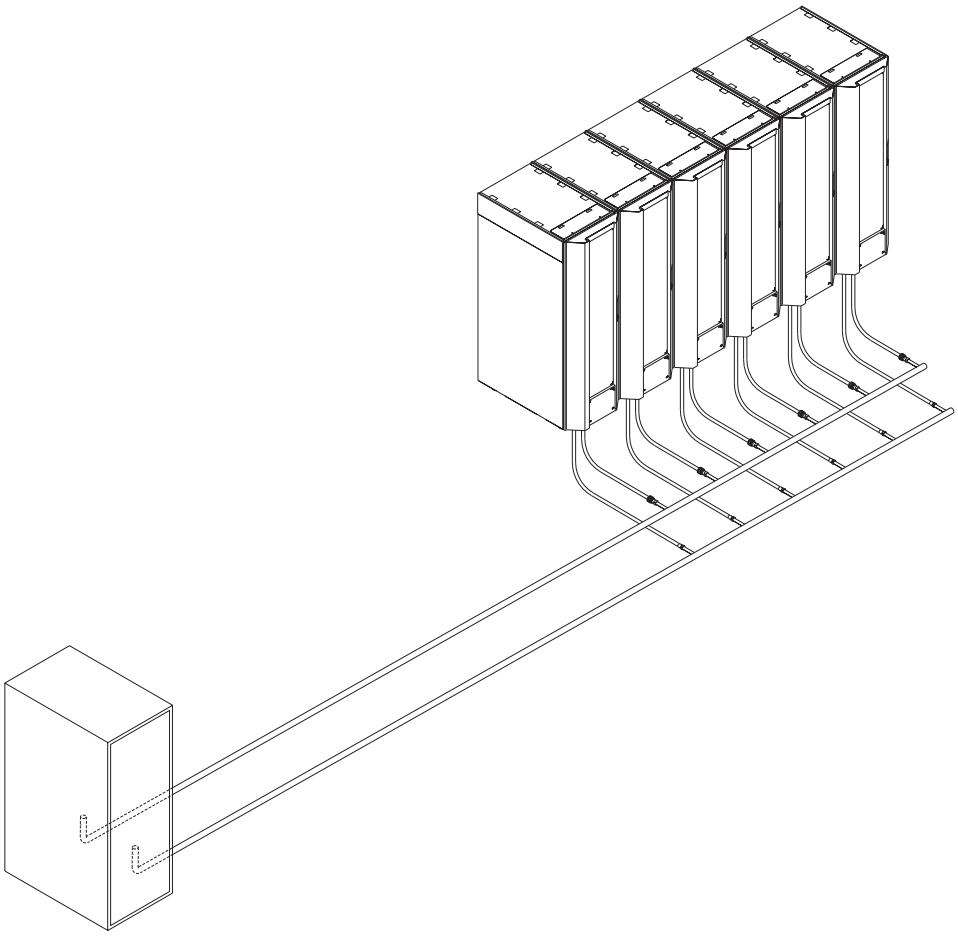

Figure 7. Typical extended manifold (located along aisles between racks)

Flexible hoses and connections to manifolds and heat exchangers

Pipes and hose configurations can vary and are determined 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 Rear Door Heat eXchanger, (allowing needed movement when 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 Ethylene Propylene Diene Monomer (EPDM) rubber - peroxide cured, non-metal oxide material and will have Parker Fluid quick-connect couplings at each end. These couplings are defined below and are compatible with the heat exchanger couplings. Hose lengths from 3 to 15 meters (10 ft to 50 ft), in increments of 3 meters (10 ft) are available. Hoses longer than 15 meters (50 ft) may create unacceptable pressure loss in the secondary circuit and reduce the water flow, and thus reduce the heat removal capabilities of the heat exchanger.

The contact information for a suggested supplier of these hoses is provided in Table 3 on page 18. Use solid piping or tubing that has a minimum inner diameter of 19 mm (0.75 in.) and the least number of joints possible between a manifold and a heat exchanger in each secondary loop.

Quick-connect couplings are used to attach the hoses or fixed pipes to the distribution manifolds and the Rear Door Heat eXchangers. Hose couplings that attach to the heat exchanger must have the following characteristics.

- The couplings should be constructed of passivated 300-L series stainless steel or brass couplings 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-conect couplings part number SH6-62-W, or equivalent.
- At the opposite (manifold) end of the hoses, it is suggested that similar quick-connect couplings be used. However, if other types are desired, it is also suggested that positive locking mechanisms be 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.

Layout and mechanical installation

This section provides an overview of the installation steps. The topics described are: installation of the heat exchanger door, raised floor environments including tile cuts, non-raised floor environments, and hose management. It also provides examples of typical layouts for water circuits. For detailed information about installing a heat exchanger, see the *IBM Rear Door Heat eXchanger: Installation and Maintenance Guide*.

Door installation overview

Installing the Rear Door Heat eXchanger consists of the following major tasks:

1. Preparing your facility to provide water to the rack per the specifications in this document.
2. Removing the existing rack rear door and installing new hinge assemblies.
3. Attaching the door assembly to the rack.
4. Routing flexible hoses, leaving enough length at the rack end to easily make connections to the heat exchanger.
5. Connecting the water-supply and water-return hose that runs from the cooling distribution unit or distribution manifold to the heat exchanger.
6. Filling the heat exchanger with water.
7. Adjusting the hoses to ensure there are no kinks in the hoses and that the hoses are not lying against any sharp edges.
8. Adjusting the door latch assembly to ensure the door fits flatly to the rack and the gasket seals to the rack.

Heat exchanger filling and draining overview

The following steps describes the requirements for draining and filling a heat exchanger.

1. Filling a heat exchanger with water includes using the air purge tool supplied with the heat exchanger to purge any air from the heat exchanger manifolds.

Containers must be available for capturing water. The container must hold a minimum of 2 L (0.5 gal) capacity for purging air and a minimum 6 L (1.6 gal) capacity for draining a heat exchanger.

2. Draining a heat exchanger is required before the door containing the heat exchanger can be removed from the rack, or before a rack with a heat exchanger installed can be moved. The air purge tool can be connected to the drain port on the bottom of the heat exchanger to drain the water.
3. Use absorbent materials, such as cloth, under the work area to capture any water that might spill when filling or draining a heat exchanger.

Raised floor environment

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

Raised floor hose requirements and management

In a typical example, each heat exchanger requires a special cut 0.6 m by 0.6 m (2 ft by 2 ft) floor tile below it and in front of the rack. 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 and 190.5 mm long +/– 12.7 mm (6.0 in. wide and 7.5 in. long +/– 0.5 in.) in the direction parallel to the door. See Figure 8 and Figure 9 on page 14.

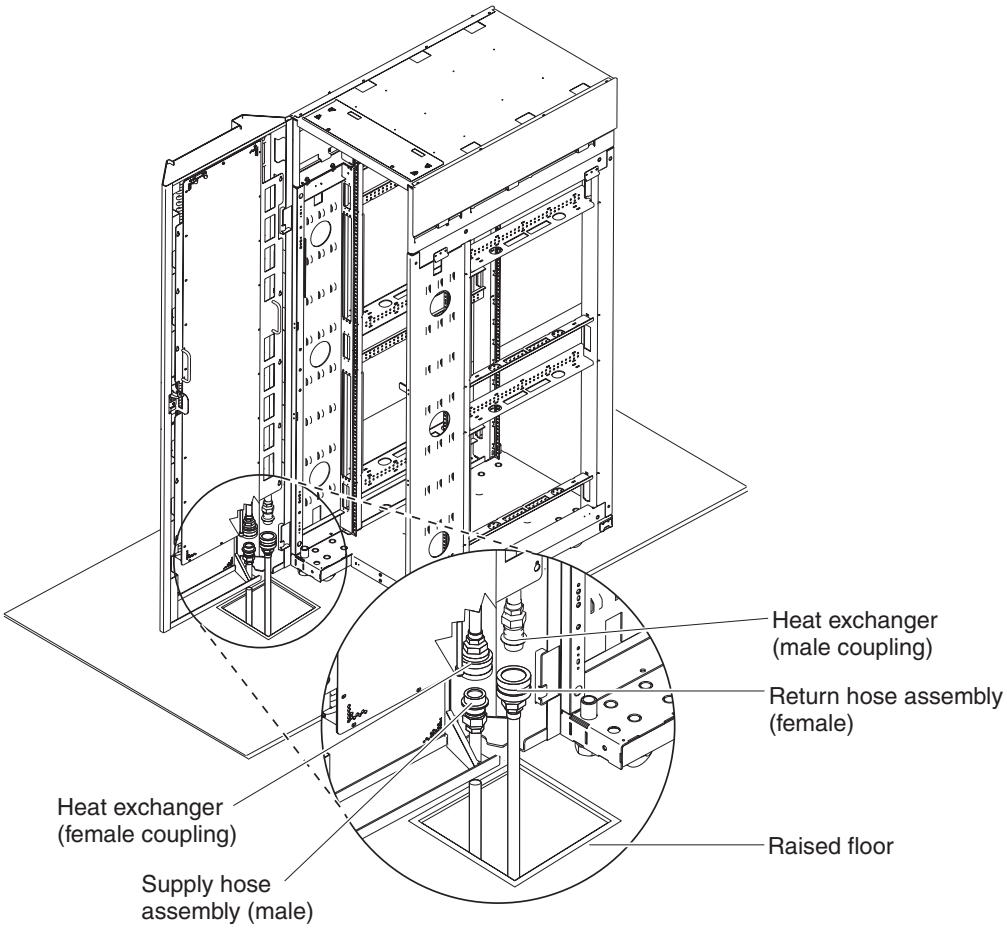

Figure 8. Raised floor hose management example 1; hose exit through floor tile at the door hinge

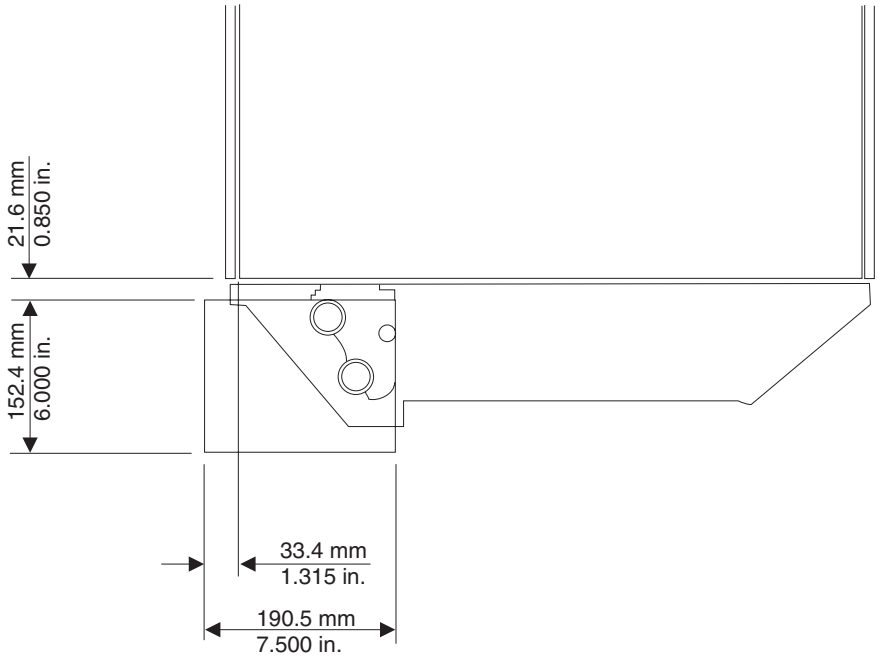

Figure 9. Raised floor hose management example 1; tile cut out size and position

In another example, for racks being installed at the same time a heat exchanger is being installed, 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 by 0.6 m (2 ft by 2 ft) floor tile. However the floor tile will be positioned completely within the footprint of the rack. A modified cable opening or independent hose cut out is used. Flexible hoses that 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 10 on page 15 and Figure 11 on page 16 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 cut outs for electrical or other cables can also be used for the hoses, if enough space is available.

Recommendations:
L = 200 mm (8 in.) minimum
W = 100 mm (4 in.) minimum
HL = 100 mm (18 in.) minimum

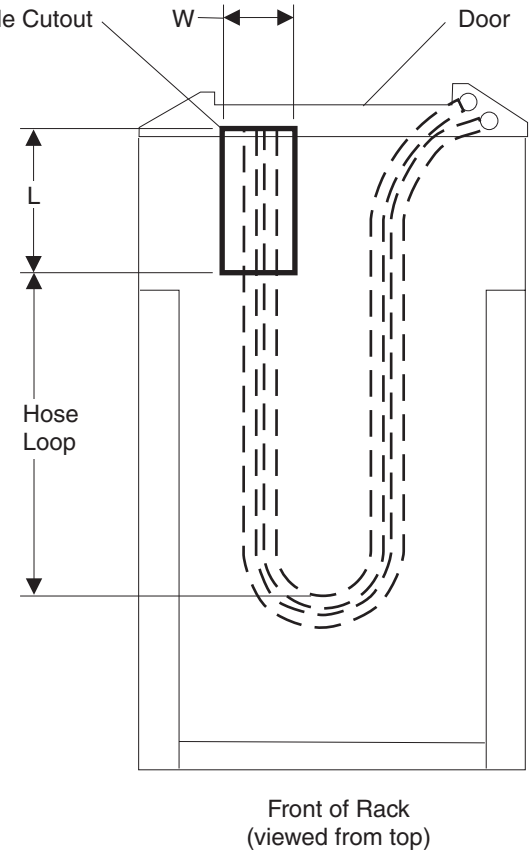

Figure 10. Raised floor and non-raised floor hose management example 2; loop under the rack with door closed

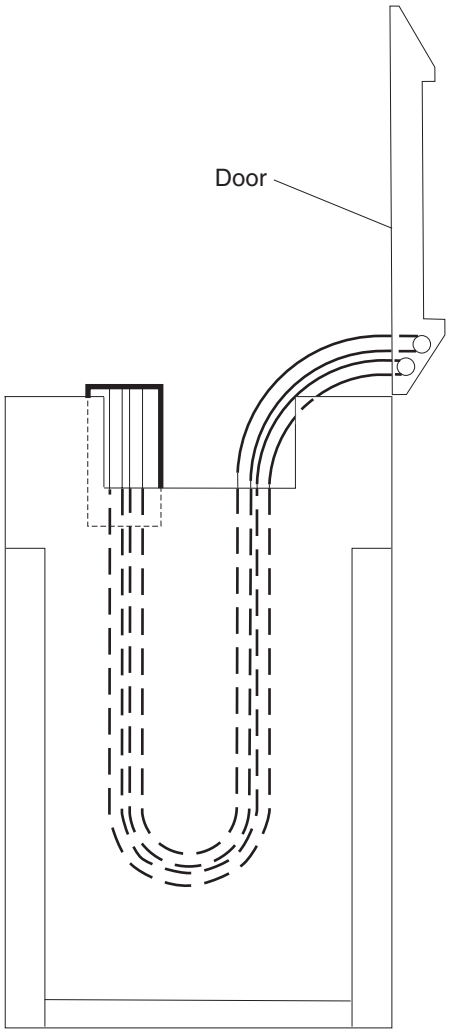

Figure 11. Raised floor and non-raised floor hose management example 2; loop under the rack with door open

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 attached and operating. When routing hoses, avoid sharp bends that cause hose kinks, and avoid hose contact with sharp edges.

Non-raised floor environment

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.

Non-raised floor hose requirements and management

Hose assemblies with right-angle metal elbows are needed. This allows the hoses to be routed along the floor, make the 90° turn upwards within the gap between the bottom of the heat exchanger door and the floor surface, and then connect to the heat exchanger couplings. This is shown in Figure 12 on page 17.

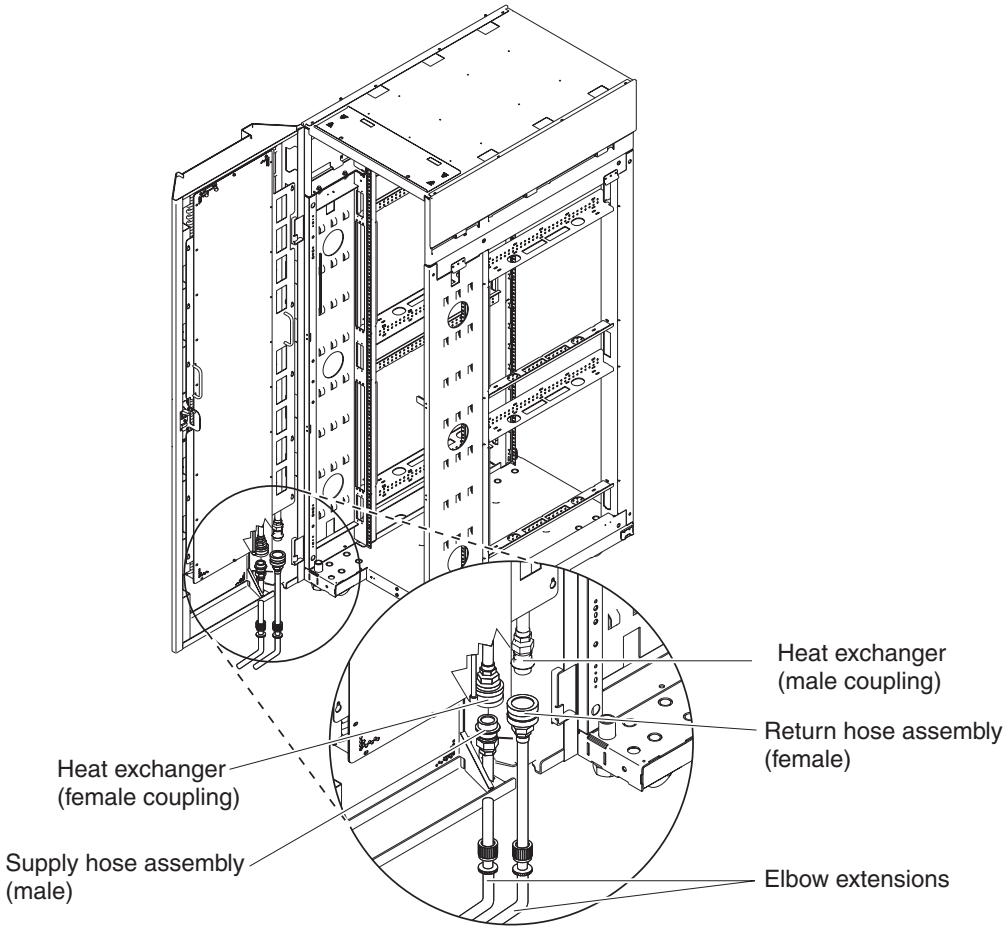

Figure 12. Non-raised floor hose requirements

Hoses exiting 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 the door is opened, it is acceptable for the hoses to move slightly and rotate in parallel at the coupling interface inside the door. As the door is closed, the hoses rotate back to their original positions.

Note: When opening or closing 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 is your reponsibility.

Suggested sources for secondary loop components

This section provides lists of suggested suppliers that can provide cooling distribution solutions, and sources for either flexible hose assemblies, or for providing water treatment that meets the suggested water quality requirements.

Cooling distribution unit suppliers

Table 2. Suggested sources of cooling distribution units

North America		
Vendor	**Unit capacity**	**Contact information**
Lytron Corporation	Coolant distribution unit - 100 KW nominal capacity	www.lytron.com Lytron Corporation Sales (USA) (781) 933-7300
North America, Europe, Middle East, Africa, Asia Pacific		
Liebert Corporation	Coolant distribution unit - 100 KW nominal capacity	www.liebert.com Select **Contacts** and search for a local office and telephone number.
Affinity, Lydall Industrial Thermal Solutions Inc	Coolant distribution units 60 KW nominal capacity 100 KW nominal capacity 120 KW nominal capacity 300 KW nominal capacity	www.affinitychillers.com email: affinity_sales@lydall.com (603) 539-1420
Knurr Inc	Coolant distribution unit - 75 KW nominal capacity	www.knurr.com USA (514) 865-9454
Europe, Middle East, Africa, Asia Pacific		
Knurr Inc	Coolant distribution unit - 75 KW nominal capacity	www.knurr.com +49 619-291-0455

Flexible hose supplier

Table 3 provides a suggested source of flexible hose assemblies that are fabricated from IBM approved materials. These assemblies have the required quick-connect couplings and are offered in various lengths, providing choices in the type of hook-up and routing of hoses in your secondary loops.

Table 3. Suggested source for flexible hose supplier

North America, Europe, Middle East, Africa, Asia Pacific		
Dff Corporation	Flexible hose assemblies with required quick-connect couplings. Available in these lengths. 3 meters (10 ft) 6 meters (20 ft) 9 meters (30 ft) 12 meters (40 ft) 15 meters (50 ft) Hoses can be straight for raised floor applications, or hoses can use a 90° elbow at one end for non-raised floor applications or raised floor applications.	59 Abrams Drive Agawam, MA USA, 01001 (413) 786-8880 www.dffcorp.com

Water treatment supplier

Table 4. Suggested source of water treatment supplier

North America, Europe, Middle East, Africa, Asia Pacific

Table 4. Suggested source of water treatment supplier (continued)

Nalco Company Chemical kits are available for treating the water in secondary cooling loops. Treatment can typically consist of anti-corrosion coatings and biocides. Obtain details for the contents of these chemical kits from the supplier.	www.nalco.com **North America: USA** 1601 W. Diehl Road Naperville, Illinois 60563-1198 **North America: Latin America** Av. Das Nocoes Unidas 17.891 6 Andar 04795-100 Sao Paulo, SP Brazil **Europe:** Ir.G.Tjalmaweg 1 2342 BV Oegstgeest The Netherlands **Asia Pacific:** 2 International Business Park #02-20 The Strategy Tower 2 Singapore 609930 **Wordwide contact:** USA (480) 213-8915

Installation and support from IBM Integrated Technology Services Offerings

If you would like assistance with coordinating and managing the installation and support of rear door heat exchangers is desired, IBM can supply a focal point.

Before calling the 800 number shown in the table please have the following information available:

Serial numbers of the racks.
Phone number where the racks are located.
Contact name and phone number
Building location and location of the racks within the building.

To access the correct contact area in OSC Dispatch, dial the 800 number, request option 1, 1, 1 and when prompted, enter your 4-digit rack machine type.

Table 5. IBM Integrated Technology Services contact information

North America	1-800-426-7378 (OSC Dispatch) Request contact with an IBM Installation Planning Representative in the service branch office closest to your location.
Europe, Middle East, Africa	
Asia Pacific	

Appendix A. Getting help and technical assistance

If you need help, service, or technical assistance or just want more information about IBM® products, you will find a wide variety of sources available from IBM to assist you. This appendix contains information about where to go for additional information about IBM and IBM products, what to do if you experience a problem with your @server® or IntelliStation® system, and whom to call for service, if it is necessary.

Before you call

Before you call, make sure that you have taken these steps to try to solve the problem yourself:

- Check all cables to make sure that they are connected.
- Check the power switches to make sure that the system is turned on.
- Use the troubleshooting information in your system documentation, and use the diagnostic tools that come with your system. Information about diagnostic tools is in the *Hardware Maintenance Manual and Troubleshooting Guide* or *Problem Determination and Service Guide* on the IBM Documentation CD that comes with your system.

  Note: For some IntelliStation models, the *Hardware Maintenance Manual and Troubleshooting Guide* is available only from the IBM support Web site.
- Go to the IBM support Web site at http://www.ibm.com/pc/support/ to check for technical information, hints, tips, and new device drivers or to submit a request for information.

You can solve many problems without outside assistance by following the troubleshooting procedures that IBM provides in the online help or in the publications that are provided with your system and software. The information that comes with your system also describes the diagnostic tests that you can perform. Most @server and IntelliStation systems, operating systems, and programs come with information that contains troubleshooting procedures and explanations of error messages and error codes. If you suspect a software problem, see the information for the operating system or program.

Using the documentation

Information about your IBM @server or IntelliStation system and preinstalled software, if any, is available in the documentation that comes with your system. That documentation includes printed books, online books, readme files, and help files. See the troubleshooting information in your system documentation for instructions for using the diagnostic programs. The troubleshooting information or the diagnostic programs might tell you that you need additional or updated device drivers or other software. IBM maintains pages on the World Wide Web where you can get the latest technical information and download device drivers and updates. To access these pages, go to http://www.ibm.com/pc/support/ and follow the instructions. Also, some publications are available through the IBM Publications Ordering System at http://www.elink.ibmlink.ibm.com/public/applications/publications/cgibin/pbi.cgi.

Getting help and information from the World Wide Web

On the World Wide Web, the IBM Web site has up-to-date information about IBM @server and IntelliStation products, services, and support. The address for IBM xSeries and BladeCenter information is http://www.ibm.com/eserver/xseries/. The address for IBM IntelliStation information is http://www.ibm.com/pc/us/intellistation/.

You can find service information for your IBM products, including supported options, at http://www.ibm.com/pc/support/.

Software service and support

Through IBM Support Line, you can get telephone assistance, for a fee, with usage, configuration, and software problems with xSeries servers, BladeCenter products, IntelliStation workstations, and appliances. For information about which products are supported by Support Line in your country or region, see http://www.ibm.com/services/sl/products/.

For more information about Support Line and other IBM services, see http://www.ibm.com/services/, or see http://www.ibm.com/planetwide/ for support telephone numbers. In the U.S. and Canada, call 1-800-IBM-SERV (1-800-426-7378).

Hardware service and support

You can receive hardware service through IBM Services or through your IBM reseller, if your reseller is authorized by IBM to provide warranty service. See http://www.ibm.com/planetwide/ for support telephone numbers, or in the U.S. and Canada, call 1-800-IBM-SERV (1-800-426-7378).

In the U.S. and Canada, hardware service and support is available 24 hours a day, 7 days a week. In the U.K., these services are available Monday through Friday, from 9 a.m. to 6 p.m.

Appendix B. Notices

This information was developed for products and services offered in the U.S.A.

IBM may not offer the products, services, or features discussed in this document in other countries. Consult your local IBM representative for information on the products and services currently available in your area. Any reference to an IBM product, program, or service is not intended to state or imply that only that IBM product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any IBM intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any non-IBM product, program, or service.

IBM may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not give you any license to these patents. You can send license inquiries, in writing, to:

IBM Director of Licensing
IBM Corporation
North Castle Drive
Armonk, NY 10504-1785
U.S.A.

INTERNATIONAL BUSINESS MACHINES CORPORATION PROVIDES THIS PUBLICATION "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some states do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. IBM may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

Any references in this information to non-IBM Web sites are provided for convenience only and do not in any manner serve as an endorsement of those Web sites. The materials at those Web sites are not part of the materials for this IBM product, and use of those Web sites is at your own risk.

IBM may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation to you.

Edition notice

Trademarks

The following terms are trademarks of International Business Machines Corporation in the United States, other countries, or both:

Active Memory	Predictive Failure Analysis
Active PCI	PS/2
Active PCI-X	ServeRAID
Alert on LAN	ServerGuide
BladeCenter	ServerProven
C2T Interconnect	TechConnect
Chipkill	ThinkPad
EtherJet	Tivoli
e-business logo	Tivoli Enterprise
@server	Update Connector
FlashCopy	Wake on LAN
IBM	XA-32
IBM (logo)	XA-64
IntelliStation	X-Architecture
NetBAY	XceL4
Netfinity	XpandOnDemand
NetView	xSeries
OS/2 WARP	

Intel, MMX, and Pentium are trademarks of Intel Corporation in the United States, other countries, or both.

Microsoft, Windows, and Windows NT are trademarks of Microsoft Corporation in the United States, other countries, or both.

UNIX is a registered trademark of The Open Group in the United States and other countries.

Java and all Java-based trademarks and logos are trademarks of Sun Microsystems, Inc. in the United States, other countries, or both.

Adaptec and HostRAID are trademarks of Adaptec, Inc., in the United States, other countries, or both.

Linux is a trademark of Linus Torvalds in the United States, other countries, or both.

Red Hat, the Red Hat “Shadow Man” logo, and all Red Hat-based trademarks and logos are trademarks or registered trademarks of Red Hat, Inc., in the United States and other countries.

Other company, product, or service names may be trademarks or service marks of others.

Important notes

Processor speeds indicate the internal clock speed of the microprocessor; other factors also affect application performance.

CD-ROM drive speeds list the variable read rate. Actual speeds vary and are often less than the maximum possible.

When referring to processor storage, real and virtual storage, or channel volume, KB stands for approximately 1000 bytes, MB stands for approximately 1 000 000 bytes, and GB stands for approximately 1 000 000 000 bytes.

When referring to hard disk drive capacity or communications volume, MB stands for 1 000 000 bytes, and GB stands for 1 000 000 000 bytes. Total user-accessible capacity may vary depending on operating environments.

Maximum internal hard disk drive capacities assume the replacement of any standard hard disk drives and population of all hard disk drive bays with the largest currently supported drives available from IBM.

Maximum memory may require replacement of the standard memory with an optional memory module.

IBM makes no representation or warranties regarding non-IBM products and services that are ServerProven®, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. These products are offered and warranted solely by third parties.

IBM makes no representations or warranties with respect to non-IBM products. Support (if any) for the non-IBM products is provided by the third party, not IBM.

Some software may differ from its retail version (if available), and may not include user manuals or all program functionality.

Product recycling and disposal

IBM offers product-return programs in several countries. Information on product recycling offerings can be found on IBM's Internet site at http://www.ibm.com/ibm/environment/products/prp.shtml.

IBM encourages owners of information technology (IT) equipment to responsibly recycle their equipment when it is no longer needed. IBM offers a variety of programs and services to assist equipment owners in recycling their IT products. Information on product recycling offerings can be found on IBM's Internet site at http://www.ibm.com/ibm/environment/products/prp.shtml.

Part Number: 31R1070

Printed in USA

(1P) P/N: 31R1070