GE HealthCare

Magnet Room Venting

Preinstallation Requirements for MR Systems

5850263-1EN
Revision 10

Language Policy

DOC0371395 - Global Language Procedure

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Contents

1 Purpose

1.1 Who Should Read This Manual

The following personnel must be aware of the contents of this manual:

Icon	Personnel
	HVAC Contractor
	Architect
	Plumber

1.2 Introduction

This document details the magnet venting requirements for all new production systems. This information was previously located in the system Preinstallation Manual. Since there are common elements to magnet venting requirements for the different systems and magnets, this manual has been created, and the magnet venting requirements have been removed from the individual system Preinstallation Manuals.

When referencing 1.5T systems, the same dimensions, specifications, and any other information will also apply to 1.49T systems.

1.3 New Production Magnets

IMPORTANT
Make sure that you follow the venting requirements for the magnet that is being installed.

Table 1-1 Venting Specifications for Magnets That Are in New Production

Magnet Name(s)	Field Strength	Serial Numbers	Adaptor Type	Cryovent Initial Diameter	Maximum Pressure Drop	Adaptor Catalog Number	Products
LCC or CXK4	1.5T	Rxxxx / CRxxxx	Straight	203 mm (8 in.)	less than 117.2 kPa (17 psi)	N/A (included with magnet shipment)	SIGNA Artist Evo, SIGNA Creator, SIGNA Explorer, SIGNA MR355, SIGNA MR360, SIGNA Sprint Evo
			90 degree side exit	203 mm (8 in.)	less than 99 kPa (14.36 psi)	M70072AD	SIGNA Artist Evo, SIGNA Sprint Evo
LCC-W	1.5T	RDxxxx	Straight	203 mm (8 in.)	less than 117.2 kPa (17 psi)	N/A (included with magnet shipment)	SIGNA Creator, SIGNA Explorer, SIGNA MR355, SIGNA MR360, SIGNA MR380
			90 degree rear exit	203 mm (8 in.)	less than 99 kPa (14.36 psi)	M70072AF	SIGNA Creator, SIGNA Explorer, SIGNA MR355, SIGNA MR360, SIGNA MR380
			90 degree side exit	203 mm (8 in.)	less than 99 kPa (14.36 psi)	M70072AD	SIGNA Creator, SIGNA Explorer, SIGNA MR355, SIGNA MR360, SIGNA MR380
DVw	1.5T	HMxxxx	Straight	203 mm (8 in.)	less than 117.2 kPa (17 psi)	N/A (included with magnet shipment)	SIGNA Artist, Optima MR450w, Optima MR450w GEM
PM	1.5T	PMxxxx / PCxxxx	Straight	203 mm (8 in.)	less than 137.9 kPa (20 psi)	M6001AA	SIGNA Artist, SIGNA Voyager, SIGNA Prime, SIGNA Star AIR, SIGNA Aviator AIR, SIGNA Victor, SIGNA Champion, SIGNA Sprint, SIGNA Sprint Select

Table 1-1 Venting Specifications for Magnets That Are in New Production (Table continued)

Magnet Name(s)	Field Strength	Serial Numbers	Adaptor Type	Cryovent Initial Diameter	Maximum Pressure Drop	Adaptor Catalog Number	Products
			Straight	152 mm (6 in.)	Less than 137.9 kPa (20 psi)	M6001AE	SIGNA Artist, SIGNA Voyager, SIGNA Prime, SIGNA Star AIR, SIGNA Aviator AIR, SIGNA Victor, SIGNA Champion, SIGNA Sprint, SIGNA Sprint Select
			90 degree rear exit	152 mm (6 in.)	less than 120.6 kPa (18.5 psi)	M6001AB	SIGNA Prime, SIGNA Star AIR, SIGNA Aviator AIR, SIGNA Victor
			90 degree side exit	152 mm (6 in.)	less than 120.6 kPa (18.5 psi)	M6001AC	SIGNA Artist, SIGNA Voyager, SIGNA Prime, SIGNA Star AIR, SIGNA Aviator AIR, SIGNA Victor, SIGNA Champion, SIGNA Sprint, SIGNA Sprint Select
JXM	1.5T	JXMxxxx	Straight	203 mm (8 in.)	less than 170.8 kPa (25 psi)	N/A (included with magnet shipment)	SIGNA Prime MAX, SIGNA Prime Elite
DM	1.5T	DMxxxx / DCxxxx	N/A	N/A	N/A	N/A	SIGNA Sprint Select
3TLC	3.0T	UAxxxx	Straight	203 mm (8 in.)	less than 138 kPa (20 psi)	N/A (included with magnet shipment)	SIGNA Architect, Discovery MR750w, SIGNA Pioneer, SIGNA Premier, SIGNA Hero, SIGNA Performer, SIGNA Pilot, SIGNA PET/MR
			90 degree side exit	203 mm (8 in.)	less than 120 kPa (17.4 psi)	M70072AD (magnet side exit)	SIGNA Architect, Discovery MR750w, SIGNA Pioneer, SIGNA Premier, SIGNA Hero, SIGNA Performer, SIGNA Pilot, SIGNA PET/MR
AR	3.0T	ARxxxx / ACxxxx	Straight	203 mm (8 in.)	less than 137.9 kPa (20 psi)	M6001AA	SIGNA Architect, SIGNA Bolt, SIGNA Hero,

Table 1-1 Venting Specifications for Magnets That Are in New Production (Table continued)

Magnet Name(s)	Field Strength	Serial Numbers	Adaptor Type	Cryovent Initial Diameter	Maximum Pressure Drop	Adaptor Catalog Number	Products
			Straight	152 mm (6 in.)	less than 137.9 kPa (20 psi)	M6001AE	SIGNA MAGNUS, SIGNA Performer, SIGNA Pilot, SIGNA Pioneer, SIGNA Premier
			90 degree side exit	152 mm (6 in.)	less than 97.6 kPa (14.1 psi)	M6001AC	
7TKA	7.0T	7TKAxxxx	Straight	203 mm (8 in.)	less than 17.94 kPa (2.6 psi)	N/A (included with magnet shipment)	SIGNA 7T
			90 degree side exit	203 mm (8 in.)	less than 14.9 kPa (2.16 psi)	N/A (included with magnet shipment)	
			Straight	254 mm (10 in.)	less than 17.94 kPa (2.6 psi)	N/A (included with magnet shipment)	
			90 degree side exit	254 mm (10 in.)	less than 14.9 kPa (2.16 psi)	N/A (included with magnet shipment)	

2 Magnet Room Venting Requirements

2.1 Venting System Requirements

The Magnet Room requires the following venting systems:

1. HVAC
2. Emergency exhaust
3. Cryogenic venting (does not apply to systems with a DM magnet)

NOTE
Systems with a DM magnet do not require the Magnet Venting Conformance Assessment Form.

The Magnet Venting Conformance Assessment Form applies to all new production system installations, upgrades and replacements where a new GE HealthCare MR magnet will be installed. The purpose of this assessment is to ensure the responsible party has read, understood and followed the requirements outlined in this document to mitigate cryogen safety risks. The person/company responsible for the vent construction is to complete this form on page 56 (DOC2705036) and submit it to the GE HealthCare Project Manager of Installations (PMI) before the magnet can be delivered and installed. For sites where cryogen vent installation is not possible before magnet delivery (magnet delivery through the ceiling of the magnet room), the GE HealthCare PMI will document the process exception to allow for magnet delivery, and the form must be submitted prior to connection of the magnet to the cryogen vent system. This form represents the minimum required assessment. Additional information may be provided by the responsible party, such as calculations or drawings.

If a siting concession is applied to any requirement in this document, it must be noted in the form with the approved GE HealthCare concession record number.

2.2 HVAC Vent Requirements

1. The HVAC vendor must comply with Magnet Room temperature and humidity specifications and RF shielding specifications.
2. The RF shield vendor must install open pipe or honeycomb HVAC waveguides.
3. All serviceable parts in the Magnet Room (for example, diffusers) must be non-ferrous.
4. Waveguides must be non-ferrous and electrically isolated.
5. Incoming air must contain at least 5% air from outside the Magnet Room (inside or outside the facility) to displace residual helium.

2.3 Emergency Exhaust Vent Requirements

1. The Magnet Room exhaust vent system is supplied by the customer.
2. All items within the RF enclosure must be non-ferrous.
3. The magnet exhaust vent system must be tested and operational before the magnet is installed.

4. The exhaust intake vent must be located at the highest point on the finished or drop ceiling.
5. Any space between the finished ceiling and the RF ceiling must contain an additional exhaust intake vent (to prevent helium from pooling above the finished ceiling).
6. If there is no space between the RF ceiling and finished ceiling, the intake vent may be located on a side wall (must be on the coldhead side of the magnet, near the coldhead, with the top edge of the vent flush to the finished ceiling).

   NOTE
   If used, vent diffusers must not extend beyond the vent opening to prevent helium from pooling between the edge of the diffuser and the ceiling.

7. The Magnet Room exhaust fan and exhaust intake vent must have a capacity of at least 34 m^3/minute (1200 CFM) with a minimum of 12 room air exchanges per hour.
8. The exhaust fan must be installed outside of the RF shield and must remain fully functional in the magnetic field per the fan specification sheet.
9. The exhaust fan must have appropriate waveguides and dielectric break to maintain the RF shield requirements. (Refer to *RF Shielded Room Requirements*, 5850260-1EN.)
10. **(For Systems with a DM magnet)** The system must have a manual exhaust fan switch in the Magnet Room.

    (For All other systems) The system must have a manual exhaust fan switch near the Operator Workspace (OW) and in the Magnet Room near the door (the switches must be connected in parallel).

    NOTE
    If the Magnet Room contains an optional oxygen monitor that activates the exhaust fan, the Magnet Room switch is not required.

11. All emergency exhaust vent system components must be accessible for customer inspection, cleaning, and maintenance.
12. If building code requires that a fire dampening system must be installed, it must not compromise the overall magnet vent system, and only fusible link fire dampers can be used (with annual customer inspection).

Figure 2-1 Magnet Room Exhaust Fan Schematic

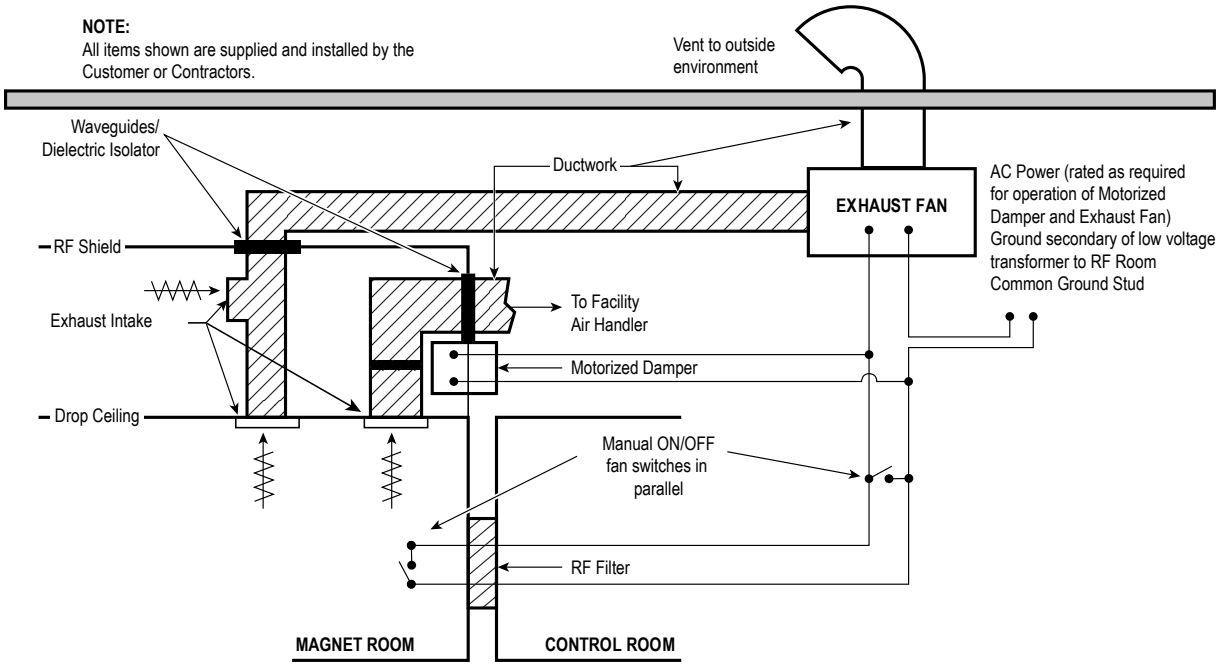
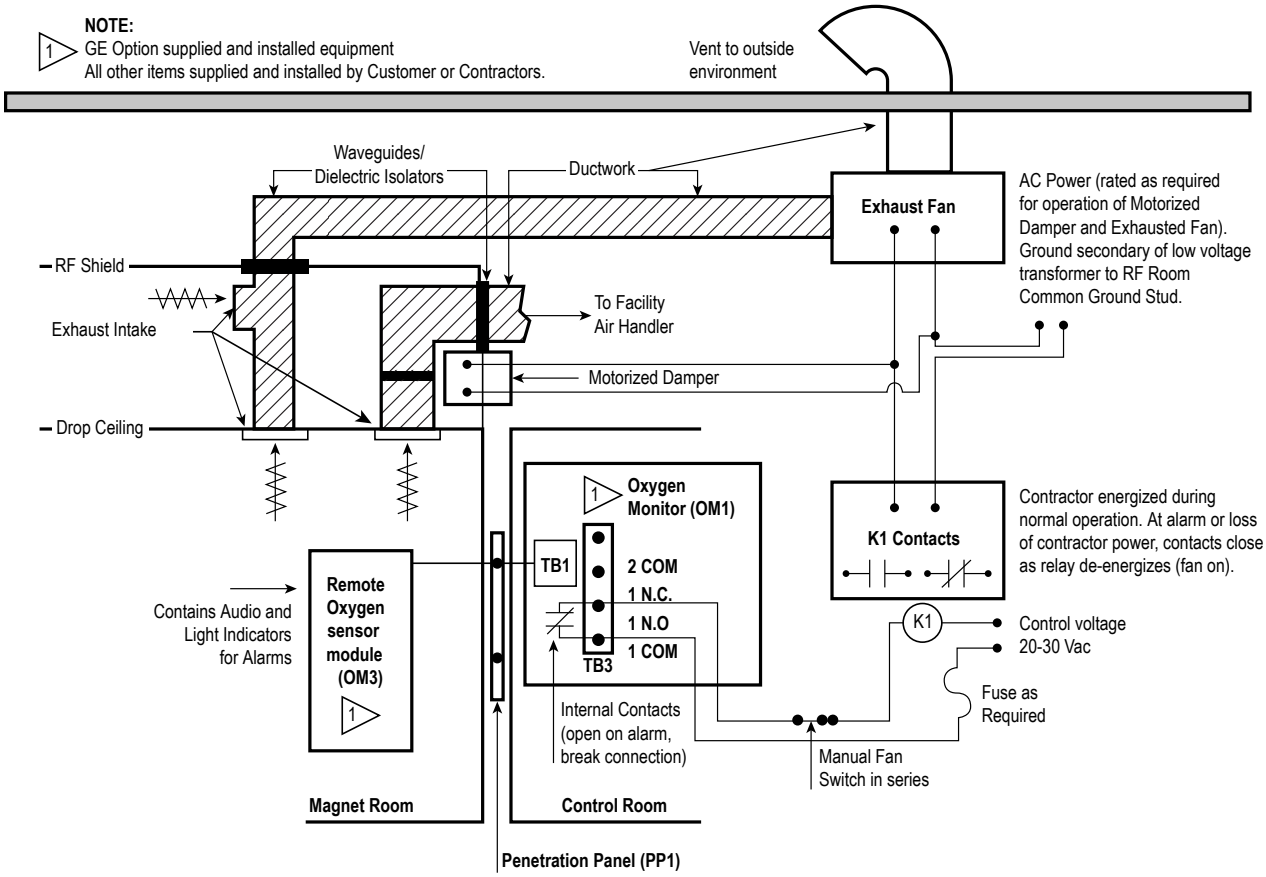


Figure 2-2 Magnet Room Exhaust Fan Schematic with Optional Oxygen Monitor



3 Cryogen Venting Requirements

NOTE
This chapter does not apply to systems with a DM magnet.

3.1 Cryogenic Venting

The MR System (magnet) requires a cryogenic venting system to direct helium gas to an unoccupied space in the event of a magnet quench. The cryogen venting system must direct all the helium gas outside the facility, and it must prevent helium from entering all nearby facilities.

NOTE
During a quench, the liquid helium in the magnet will rapidly change phase from liquid to gas, and the gas expands at a rapid and continuing rate as it moves toward the vent exit.

Venting systems may increase in pipe diameter, never decreasing, as the venting system length increases from the magnet to the vent exit.

The cryogen vent designer must adhere to the following requirements for the material, construction, and maintenance of the vent. The customer is responsible for the entire cryogenic venting system.

Note the following:

1. All pipe or tube dimensions specified in this document are outside diameters unless otherwise noted.
2. See Magnet Cryogenic Venting Pressure Drop Reference Tables on page 35 to calculate pressure drop for a specific magnet.

Table 3-1 Magnet Cryogen Specifications

Magnet Types	Helium Volume liters (gallons)	Peak Helium Flow During Quench m^3 per min (ft^3 per min)	Magnet Vent Pipe OD mm (in.)
3.0T UA series	1950 (515.14)	91 (3214) [Gas]	203.2 (8)
3.0T AR series	1919 (507)	72 (2542) [Gas]	203.2 (8) or 152.4 (6)
1.5T HM series	1770 (468)	77.5 (2737) [Gas]	203.2 (8)
1.5T R or RD series	1970 (520)	77.5 (2737) [Gas]	203.2 (8)
1.5T PM series	2000 (528)	40 (1412) [Gas]	203.2 (8) or 152.4 (6)
1.5T JXM series	1059 (279)	36.9 (1303) [Gas]	203.2 (8)
7.0T 7TKA series	2460 (650)	37.9 (1337) [Gas]	203.2 (8) or 254 (10)

WARNING

PREVENTING CRYOGEN SAFETY RISK IN THE INSTALLED SYSTEM

Failure to comply with the requirements in this section can cause extremely cold helium gas to enter the Magnet Room or other occupied building space. Direct contact could cause cryogenic burns. Helium displaces oxygen, which could cause asphyxiation and death.

Make sure the Magnet Room meets all requirements in this section.

3.2 Venting Requirements for All Magnets

1. The customer is responsible for design, installation, and maintenance of all cryogenic venting materials inside the Magnet Room.

   1.1. The cryogenic vent system must be erected and connected to the waveguide outside the Magnet Room per guidelines given in 3.5.2 Vent Construction on page 26 and 3.5.3 Vent Exit on page 27 before the magnet is installed.

   1.2. If the magnet cannot be connected to the cryogenic vent within 24 hours of delivery, the Emergency Exhaust Vent must be installed and functional. The Emergency Exhaust Vent must be on at all times until the cryogenic vent is connected, or it must be wired to an oxygen monitor such that it starts automatically if oxygen levels in the Magnet Room are lower than normal. See 2.3 Emergency Exhaust Vent Requirements on page 10.

2. The cryogenic vent must not transfer any load to the magnet vent adaptor.

3. GE HealthCare provides a number of vent adaptors that can be used for the different magnets. Straight vent adaptors or adaptors with a 90° elbow can be used for different magnet types. See Table 3-2 Magnet Vent Options and Dimensions on page 15 for details of the vent options and dimensions.

Table 3-2 Magnet Vent Options and Dimensions

Magnet	90° Vent Catalog	Height from floor to Magnet Flange (including vibromat)	Height of magnet 90° adaptor	Total Height (floor to top of 90° adaptor)	Distance from center of 90° elbow flange to edge of elbow
LCC or R-series	M70072AD (only for Artist Evo and Sprint Evo)	2337 mm (92.0 in.)	286.4 mm (11.3 in.)	2623.4 ± 4 mm (103.3 ± 0.16 in.)	261 ± 2 mm (10.3 ± 0.08 in.)
LCC-W or RD-series	M70072AD	2337 mm (92.0 in.)	286.4 mm (11.3 in.)	2623.4 ± 4 mm (103.3 ± 0.16 in.)	261 ± 2 mm (10.3 ± 0.08 in.)
LCC-W or RD-series	M70072AF	2337 mm (92.0 in.)	286.4 mm (11.3 in.)	2623.4 ± 4 mm (103.3 ± 0.16 in.)	274 ± 2 mm (10.8 ± 0.08 in.)
DVw or HM-series	N/A; only straight vent adaptor is approved for this magnet.	2347 mm (92.4 in.)	N/A	N/A	N/A
PM-series	M6001AB, M6001AC	2247 mm (88.5 in.)	207.4 mm (8.2 in.)	2454.4 ± 4 mm (96.6 ± 0.16 in.)	251 ± 2 mm (9.9 ± 0.08 in.)
AR-series	M6001AC	2247 mm (88.5 in.)	207.4 mm (8.2 in.)	2454.4 ± 4 mm (96.6 ± 0.16 in.)	251 ± 2 mm (9.9 ± 0.08 in.)
3TLC or UA-series	M70072AD	2317 mm (91.2 in.)	286.4 mm (11.3 in.)	2603.4 ± 4 mm (102.5 ± 0.16 in.)	261 ± 2 mm (10.3 ± 0.08 in.)
JXM-series	N/A; only straight vent adaptor is approved for this magnet.	2263 mm (89.1 in.)	N/A	N/A	N/A

Table 3-2 Magnet Vent Options and Dimensions (Table continued)

Magnet	90° Vent Catalog	Height from floor to Magnet Flange (including vibromat)	Height of magnet 90° adaptor	Total Height (floor to top of 90° adaptor)	Distance from center of 90° elbow flange to edge of elbow
7TKA-series	N/A; included with magnet shipment upon request	3600 mm (141.7 in.)	N/A (to be determined during site plannning)	N/A (to be determined during site plannning)	N/A (to be determined during site plannning)

4. The customer must provide any additional vent tube (above the 10 to 32 mm (0.4 to 1.25 in.) gap). See Figure 3-4 Customer-supplied Vent on page 21.
5. Other cryogenic venting systems are allowable (for example, sidewall, ceiling offset) as long as all other cryogenic venting requirements are met.
6. Do not remove or modify the vent adaptor bolted to the magnet.

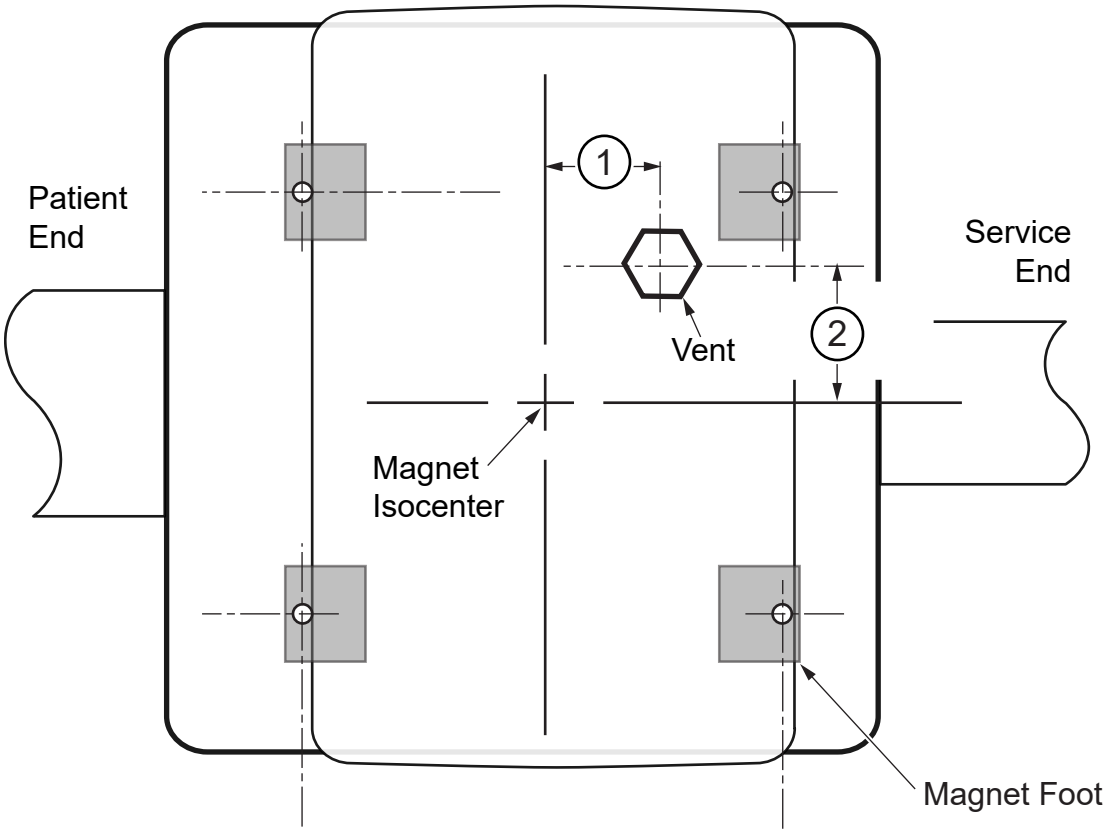
   NOTE
   The GE HealthCare-supplied flanged adaptor must be bolted directly to the magnet vent adaptor bolt flange.

7. The vent must be located within 6.35 mm (0.25 in.) of the location (in relation to magnet isocenter). See Figure 3-1 Magnet Cryogenic Vent Location to Magnet Isocenter on page 17 for details.

3.3 Vent Location

The following figure identifies the magnet vent location in reference to the center of the magnet.

Figure 3-1 Magnet Cryogenic Vent Location to Magnet Isocenter



Magnet Type	Item 1 (Distance)	Item 2 (Distance)
PM or AR series	349.5 ± 6.4 mm (13.76 ± 0.25 in.)	399.2 ± 6.4 mm (15.7 ± 0.25 in.)
3TLC or UA series, LCC or R/RD-series, DVw or HM series	349.5 ± 6.4 mm (13.76 ± 0.25 in.)	406.4 ± 6.4 mm (16 ± 0.25 in.)
JXM series	421 ± 5 mm (16.57 ± 0.2 in.)	485 ± 5 mm (19.1 ± 0.2 in.)
7TKA series	See below[1]	See below[1]

[1] Refer to Figure 5-1 Magnet Cryogenic Vent Location **(For SIGNA 7T)** on page 59

3.4 Vent Requirements Inside the Magnet Room

There are different vent requirements for different magnet types (R-series, UA, HM, PM, AR, 7TKA) and different vent options (straight vent or 90° adaptor). See Table 3-2 Magnet Vent Options and Dimensions on page 15 for a list of venting options for each magnet type.

3.4.1 Vent Materials

1. The vent material must be one of the following materials with the wall thickness indicated in the table below:

   Table 3-3 Vent Materials

Material	Minimum	Maximum
SS 304	0.89 mm (0.035 in.)	3.18 mm (0.125 in.)
AL 6061-T6	2.11 mm (0.083 in.)	3.18 mm (0.125 in.)
Copper DWV, M or L	2.11 mm (0.083 in.)	3.56 mm (0.140 in.)

2. Either tubes or pipes may be used and must be seamless or have welded seams.

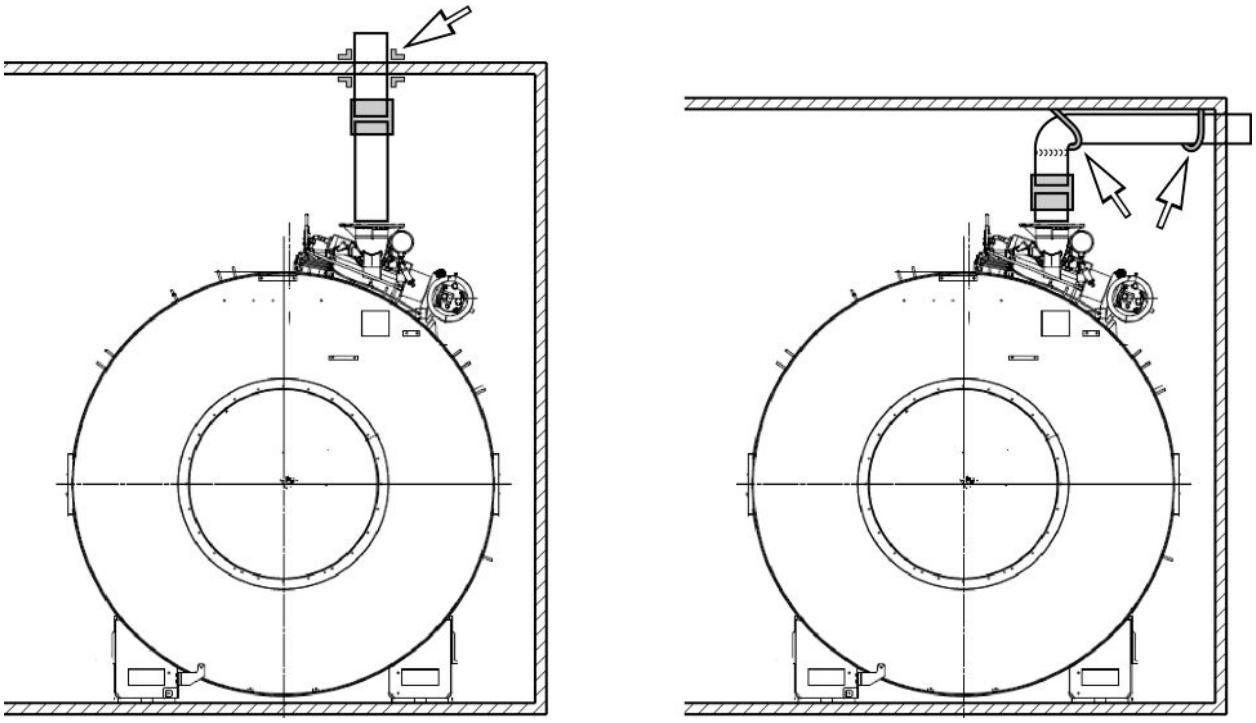
   NOTE
   All welds on the installed pipe must be ground down to a smooth surface to match the outer diameter of the provided pipe so that it can be clamped to the Ventglas with enough force. After a pipe has been welded, the inner and outer diameters must be the same for the whole length of the pipe.

3. Corrugated pipe or spiral duct must not be used.
4. If required, bellows pipe less than 305 mm (12 in.) in length may be used as a thermal expansion joint.
5. The vent pipe must withstand a maximum pressure of 241.4 kPa (35 psi).
6. Waveguide vent material must match the outside diameter of the magnet flanged vent adaptor.

3.4.2 Cryogen Vent Support

1. Refer to Table 1-1 Venting Specifications for Magnets That Are in New Production on page 7 for Maximum Pressure Drop for the applicable magnet and vent adaptor.
2. Any vent support connected to the RF shield must have a dielectric break.
3. The vent support must be designed to prevent any transfer of load across the dielectric break.
4. The Ventglas joint (GE HealthCare-supplied) must not be used as a vent system support.
5. Vent support must consider expansion and contraction of piping due to temperature change, including during a quench.
6. If the vent pipe design inside the Magnet Room includes elbows after the dielectric break or ventglass joint (as seen on the right side of Figure 3-2 Pipe Supports to Remove Vent Load from Ventglas Connection **(For all systems*)** on page 19), the venting system (including supports) must be sized to withstand helium flow reaction forces at vent elbows listed in 3.5.1 Cryogen Vent Support on page 26.

Figure 3-2 Pipe Supports to Remove Vent Load from Ventglas Connection (For all systems*)

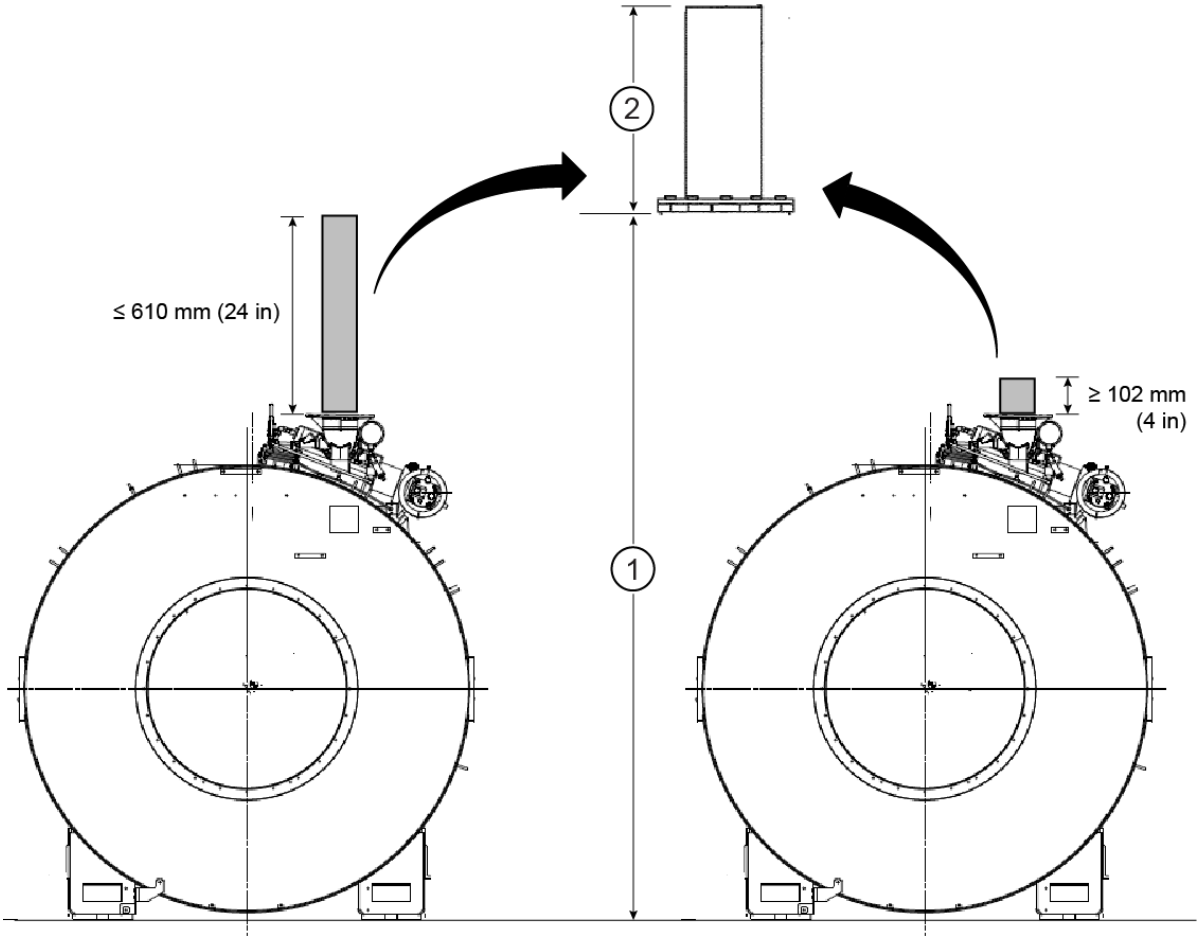


* **For 7.0T systems**, refer to Figure 5-2 Pipe Supports to Remove Vent Load from Ventglas Connection **(For SIGNA 7T)** on page 59.

3.4.3 Venting Requirements for Straight Vent Adaptors

1. For magnets that use a straight adaptor, the adaptor can be cut to length. The minimum length is 102 mm (4 in.). Refer to Figure 3-3 Straight Magnet Vent Adaptor on page 20 for an example of a straight adaptor.

Figure 3-3 Straight Magnet Vent Adaptor

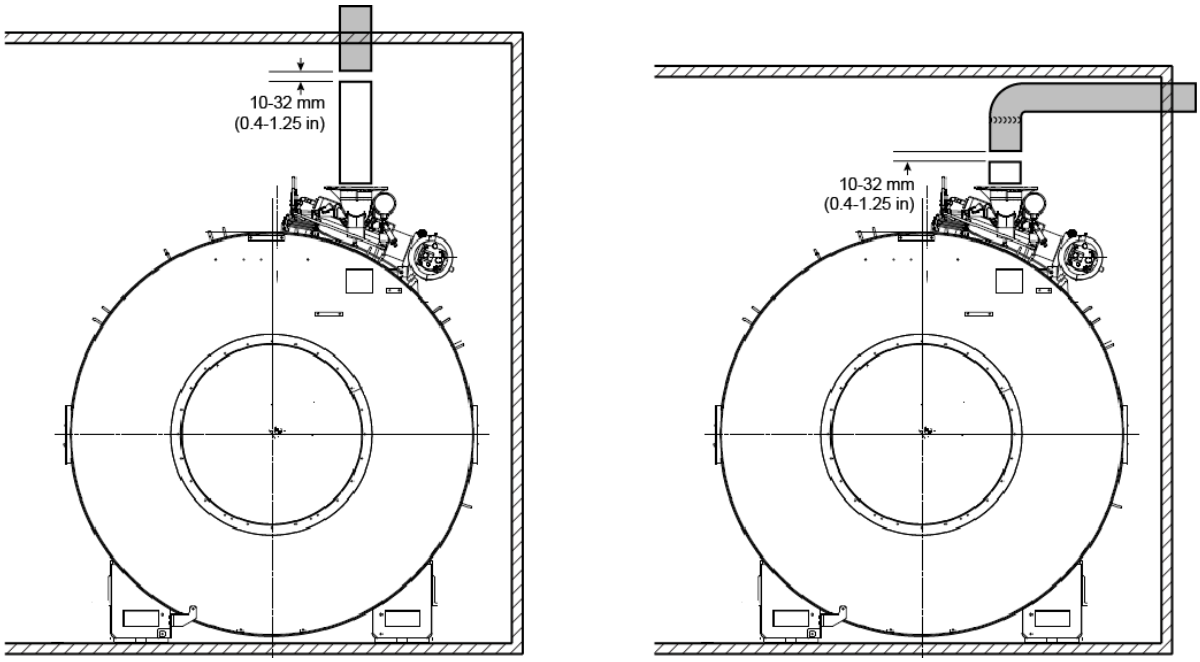


Magnet Type	Item 1 Height from floor to Magnet Flange (including vibromat)	Item 2 Adaptor Length
LCC/LCC-W or R/RD-series *	2337 ± 4 mm (92.0 ± 0.16 in.)	102 - 610 mm (4 - 24 in.)
DVw or HM series	2347 ± 4 mm (92.4 ± 0.16 in.)	102 - 610 mm (4 - 24 in.)
PM or AR series *	2247 ± 4 mm (88.5 ± 0.16 in.)	102 - 615 mm (4 - 24.2 in.)
3TLC or UA series	2317 ± 4 mm (91.2 ± 0.16 in.)	102 - 610 mm (4 - 24 in.)
JXM series	2259 ± 10 mm (88.9 ± 0.39 in.)	163 - 555 mm (6.4 - 21.9 in.)
7TKA series	3600 ± 4 mm (141.7 ± 0.16 in.)	102 - X mm (4 - X in.) Note: maximum length to be determined during site planning

* Refer to Table 1-1 Venting Specifications for Magnets That Are in New Production on page 7 for additional serial numbers for this magnet type.

2. The customer-supplied vent must be correctly located in reference to isocenter of the magnet. See Figure 3-1 Magnet Cryogenic Vent Location to Magnet Isocenter on page 17.
3. The customer must provide any additional vent tube (above the 10 to 32 mm (0.4 to 1.25 in.) gap) beyond the 610 mm (24 in.) provided. See Figure 3-4 Customer-supplied Vent on page 21.

Figure 3-4 Customer-supplied Vent



3.4.4 Venting Requirements for 90° Vent Adaptors

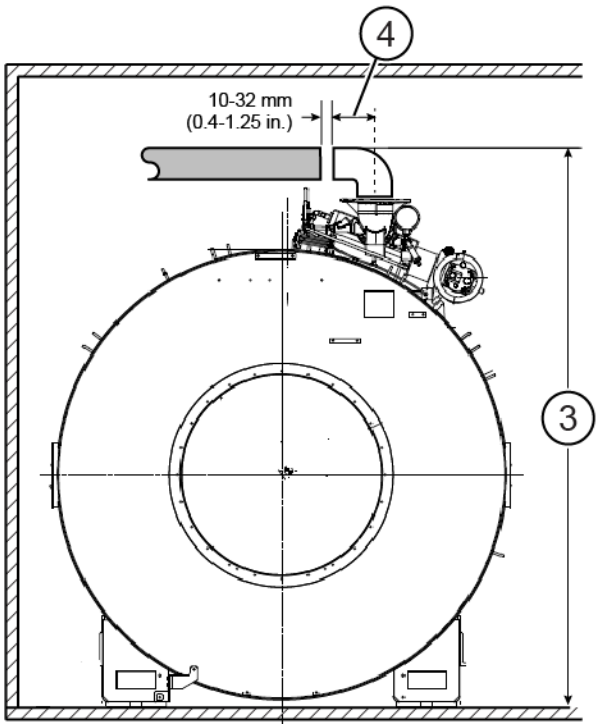
NOTE

- If a 90° vent adaptor is being used it is recommended to wait until the magnet is in position before completing the customer-supplied section of vent, provided that the vent can be installed within 24 hours after magnet delivery.
- No modifications can be made to the 90° vent.

1. For magnets utilizing a 90° vent adaptor, the 90° adaptor will attach to the magnet flange.
2. The customer is responsible for constructing the remaining vent that mates to the 90° adaptor. See the following for vent specifications and configuration examples:
   - Side Exit 90° adaptor (example): Figure 3-5 Dimensions of 90° Adaptor Side Exit on page 22

     NOTE
     Side Exit can only be directed to the non service side (right side when viewed from patient end).
   - Rear Exit 90° adaptor (example): Figure 3-6 Dimensions of 90° Adaptor Rear Exit on page 23
3. There must be a gap of 10-32 mm (0.4-1.25 in.) between the 90° adaptor and the customer-supplied magnet vent.

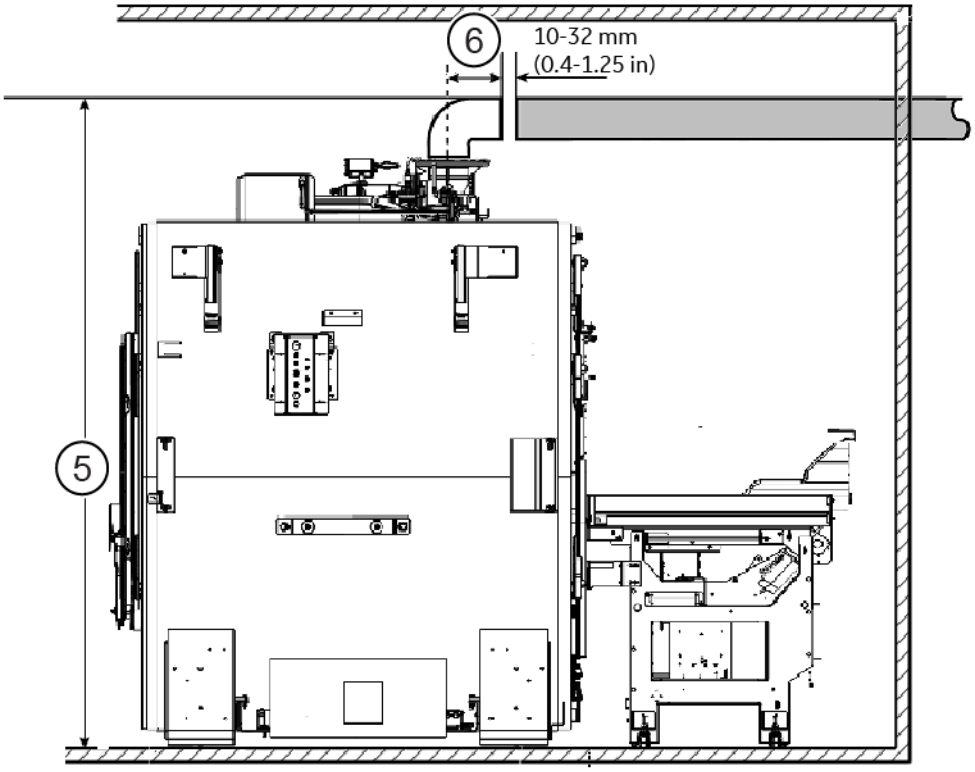
Figure 3-5 Dimensions of 90° Adaptor Side Exit



Magnet Type	Item 3 Total Height (floor to top of 90° adaptor)	Item 4 Distance from center of 90° elbow flange to edge of elbow
LCC/LCC-W or R/RD-series *	2623.4 ± 4 mm (103.3 ± 0.16 in.)	261 ± 2 mm (10.3 ± 0.08 in.)
3TLC or UA series	2603.4 ± 4 mm (102.5 ± 0.16 in.)	261 ± 2 mm (10.3 ± 0.08 in.)
PM or AR series *	2454.4 ± 4 mm (96.6 ± 0.16 in.)	251 ± 2 mm (9.9 ± 0.08 in.)
7TKA series	3896 ± 4 mm (153.4 ± 0.16 in.)	N/A (to be determined during site planning)

* Refer to Table 1-1 Venting Specifications for Magnets That Are in New Production on page 7 for additional serial numbers for this magnet type.

Figure 3-6 Dimensions of 90° Adaptor Rear Exit



Magnet Type	Item 5 Total Height (floor to top of 90° adaptor)	Item 6 Distance from center of 90° elbow flange to edge of elbow
LCC/LCC-W or R/RD-series *	2623.4 ± 4 mm (103.3 ± 0.16 in.)	274 ± 2 mm (10.8 ± 0.08 in.)
PM series *	2454.4 ± 4 mm (96.6 ± 0.16 in.)	251 ± 2 mm (9.9 ± 0.08 in.)
7TKA series	3896 ± 4 mm (153.4 ± 0.16 in.)	N/A (to be determined during site planning)

* Refer to Table 1-1 Venting Specifications for Magnets That Are in New Production on page 7 for additional serial numbers for this magnet type.

3.4.5 Vent Size

1. The sizing requirements of the vent are determined by the total pressure drop of the cryogenic vent system from the magnet vent interface to, and including, the vent cap.
2. The pressure drop of the RF shield waveguide must be included in the overall calculation.
3. This pressure drop must be included in the cryogenic vent system pressure drop design.

Refer to Table 1-1 Venting Specifications for Magnets That Are in New Production on page 7 and Magnet Cryogenic Venting Pressure Drop Reference Tables on page 35 for pressure drop specifications.

3.4.6 Construction

1. A single dielectric break (i.e., Ventglas connection) in the vent system is required in the Magnet Room.

   1.1. The gap between the RF waveguide and GE HealthCare-supplied magnet vent adaptor must be 10 to 32 mm (0.4 to 1.25 in.).

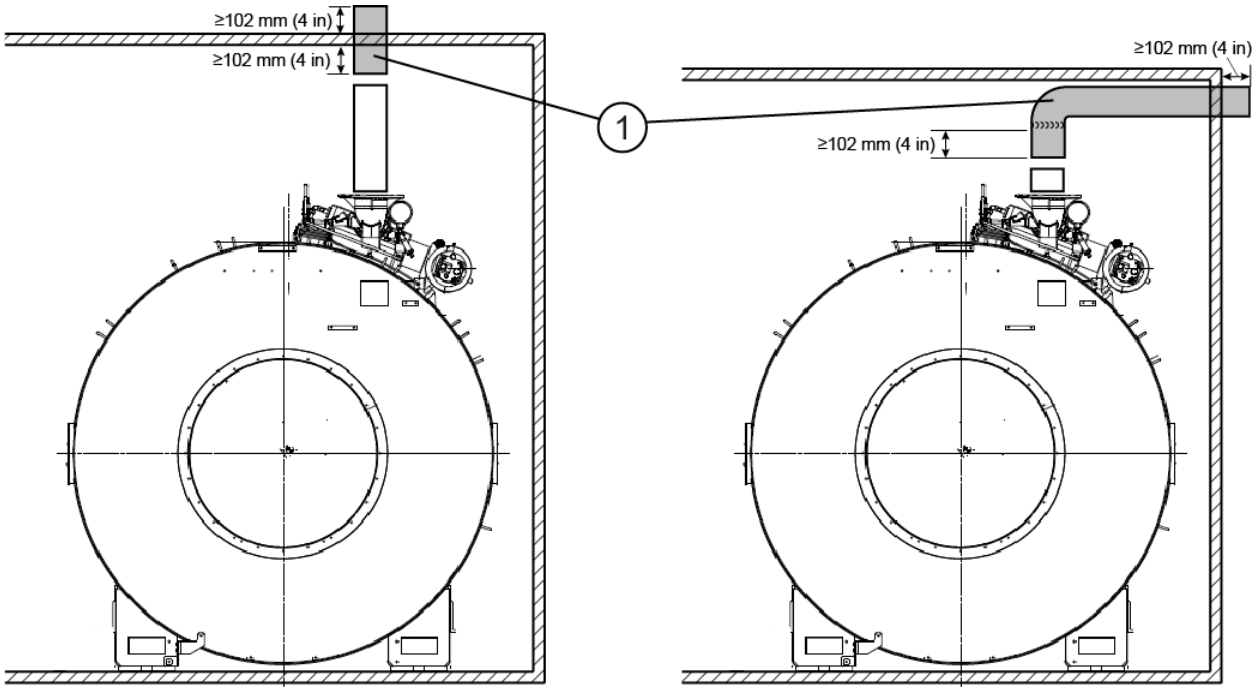
   1.2. The outside diameter of the waveguide must match the outside diameter of the magnet vent adaptor within ± 3 mm (0.125 in.).

   NOTE
   We recommend a pipe deflection of less than 0.5 mm (0.02 in.) between the magnet vent adaptor and waveguide.

   1.3. The Ventglas connection inside the Magnet Room must be accessible for maintenance and annual inspection.

2. The Ventglas connection may also serve as a thermal expansion joint.
3. All pipe section connections must be welded or brazed.
4. All isolation or thermal expansion elements (except the Ventglas joint) must be rated to 4.5 K (-451°F or -268°C) and 241.4 kPa (35 psi).
5. The vent system must be insulated with 38 mm (1.5 in.) thick flexible unicellular insulation to prevent condensation during magnet ramping. Exposed insulation must be covered with a white PVC jacket. The clearance area of the dielectric break must be left bare (without insulation) or the insulation must be easily removable for periodic inspection.
6. A minimum length of 102 mm (4 in.) of straight pipe is required at the dielectric break both inside and outside the Magnet Room to allow for proper installation of the Ventglas. The overall length of the waveguide must be at least four times the diameter of the vent pipe. For example, at least 812 mm (32 in.) overall length for a 203 mm (8 in.) diameter vent pipe.

Figure 3-7 Waveguide



Item	Description
1	Waveguide Overall length of the waveguide must be at least four times the diameter of the vent pipe

For 7.0T systems, refer to Figure 5-3 Waveguide **(For SIGNA 7T)** on page 60.

3.5 Vent Requirements Outside the Magnet Room

The customer is responsible for design, construction, and maintenance of all cryogenic venting materials outside the Magnet Room from the shielded room waveguide to the vent cap.

3.5.1 Cryogen Vent Support

1. **(For 3.0T magnets or UA or AR-series)** The venting system (including supports) must be sized to withstand 11125 N (2500 lb.) helium flow reaction force at vent elbows.

   (For 1.5T magnets or R, RD, HM or PM-series) The venting system (including supports) must be sized to withstand 8229 N (1850 lb.) helium flow reaction force at vent elbows.

   (For JXM-series) The venting system (including supports) must be sized to withstand 3521 N (792 lb.) helium flow reaction force at vent elbows.

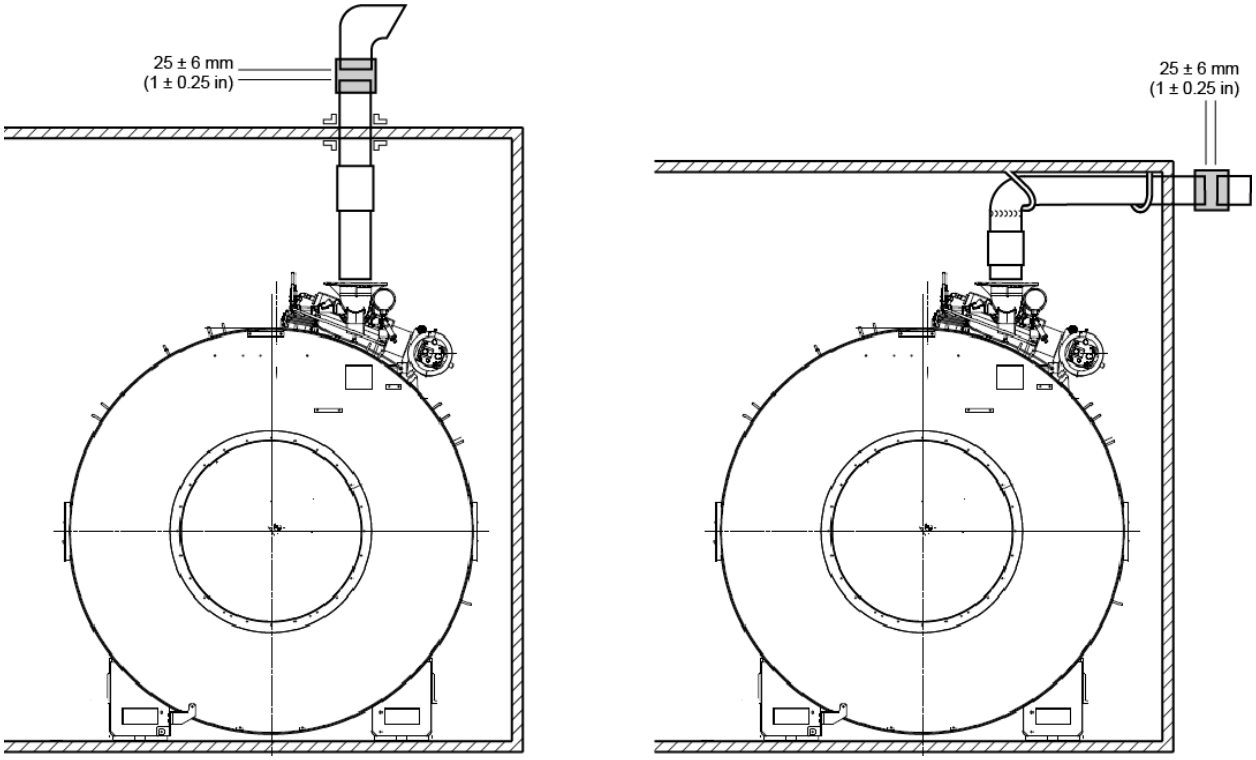
   (For 7.0T magnets or 7TKA-series) The venting system (including supports) must be sized to withstand 1700 N (382 lb.) helium flow reaction force at vent elbows.
2. The customer-supplied dielectric break must not be used to support the outside cryogenic vent pipe.
3. The vent support must be designed to prevent any transfer of load across the dielectric break.
4. Vent support must consider expansion and contraction of piping due to temperature change, including during a quench.

3.5.2 Vent Construction

1. GE HealthCare Engineering recommends that the cryogen vent be constructed to the same specification as required inside the Magnet Room.
2. The vent must be routed as directly as possible to the vent cap (that is, the venting system external protective cover).
3. Expansion or contraction elements must be provided for a temperature decrease from ambient to 4.5 K (-451°F or -268°C).
4. A dielectric break must be installed adjacent to the waveguide. See Figure 3-8 Outside Dielectric Break (Customer-supplied) on page 27.
   4.1. The dielectric break gap must be 25 ± 6 mm (1.0 ± 0.25 in.).
   4.2. A customer-supplied clamp may be used to connect the dielectric break.
   4.3. The dielectric break must be accessible for inspection or maintenance.
   4.4. The dielectric break and vent pipe support must be designed to prevent load transfer across the dielectric break.
5. All components must be rated to withstand the helium flow reaction force at temperatures from ambient to 4.5 K (-451°F or -268°C).
6. Electromechanical fire dampers must not be used. Fusible link fire dampers may be used (with annual inspection).
7. The vent cap must prevent ingress of weather elements (for example, rain, snow, hail, sand, and so on) and foreign material debris (for example, leaves, bird nests, and so on).

8. Condensate must be prevented from pooling inside any section of the venting system (for example, a downward tilted vent system or local minima with weephole).

Figure 3-8 Outside Dielectric Break (Customer-supplied)



3.5.3 Vent Exit

WARNING

CRYOGENIC BURNS OR ASPHYXIATION

During a quench, extremely cold gas or particles are released from the cryogenic venting system. A quench may occur at any time.

Make sure access to the cryogen vent exhaust area is restricted and the released gas does not reenter the building. Refer to the specifications below.

1. **(For 3.0T or 7.0T magnets or UA, AR or 7TKA-series)** An exhaust area in front of the vent 10700 mm (420 in.) long x 4600 mm (180 in.) wide is required. (See Figure 3-9 Cryogenic Exterior Venting Volume and Exclusion Area (Rooftop Vent) on page 29 and Figure 3-10 Cryogenic Exterior Venting Volume and Exclusion Area (Side Vent, Front View) on page 31.)

   (For 1.5T magnets or R, RD, HM, PM or JXM-series) An exhaust area in front of the vent 6100 mm (240 in.) long by 4600 mm (180 in.) wide is required. (See Figure 3-9 Cryogenic Exterior Venting Volume and Exclusion Area (Rooftop Vent) on page 29 and Figure 3-10 Cryogenic Exterior Venting Volume and Exclusion Area (Side Vent, Front View) on page 31.)

   1.1. The vent exit area must not include air intake vents to prevent cryogen exhaust from reentering the facility.

   1.2. The vent exit area must not include any personnel, building components, or objects (movable or stationary).

1.3. The facility is responsible for any exhaust area barriers, restrictions, and warning signs.

2. For a rooftop exit:

   2.1. Use either a horizontal exhaust vent with a 90° elbow with minimal pressure drop, or a roof cap with low pressure drop and a high flow rate.

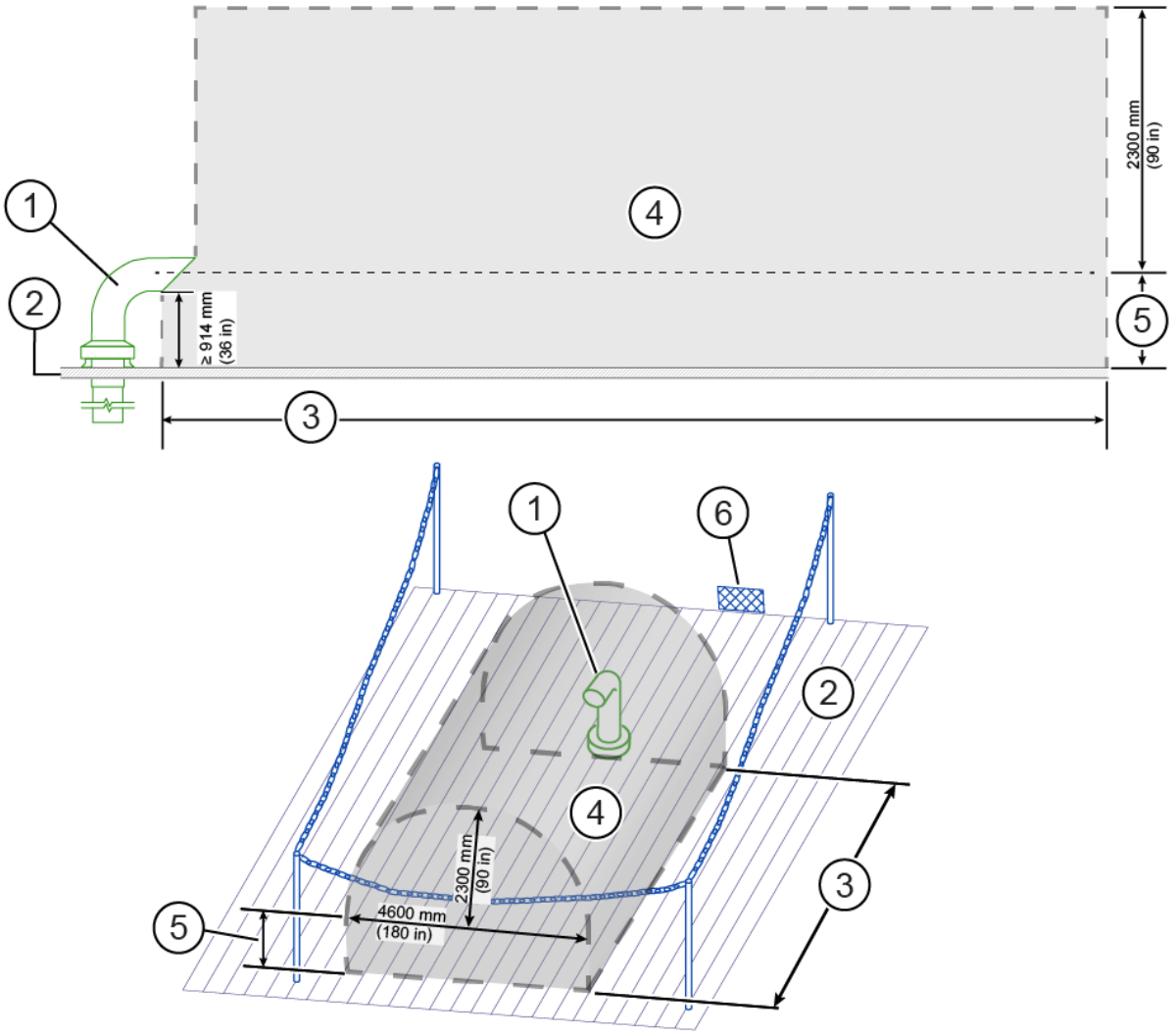
   2.2. The bottom of the 90° elbow must be at least 914 mm (36 in.) above the roof deck (or higher if at risk of being blocked by drifting snow, sand, and so on).

   2.3. The outlet must be covered with a 12.7 mm (0.5 in.) square screen mesh.

   2.4. The exhaust vent cover or cap must be included in the pressure drop calculation.

   2.5. Physical barriers must be used to keep all persons out of the exclusion area.

Figure 3-9 Cryogenic Exterior Venting Volume and Exclusion Area (Rooftop Vent)



Item	Description
1	Vent cap (customer-supplied)
2	Rooftop
3	Length of venting area: 6100 mm (240 in.) **(For 1.5T magnets)** 10700 mm (420 in.) **(For 3.0T or 7.0T magnets)**
4	Exclusion area
5	2300 mm (90 in.) or distance to surface of rooftop
6	Warning sign

3. For a sidewall exit:

   3.1. You can use an exhaust vent with a 45° elbow (with a deflector rated for the helium reaction force), a 90° elbow, or vent cap with no restriction in gas flow.

   3.2. The exhaust exit must be at least 3660 mm (144 in.) above the ground.

   3.3. The outlet must be covered with a 12.7 mm (0.5 in.) square screen mesh.

3.4. The vent exit must be covered to prevent foreign material from entering or blocking the opening (for example, louvers).

3.5. The exhaust vent exit must be included in the pressure drop calculation.

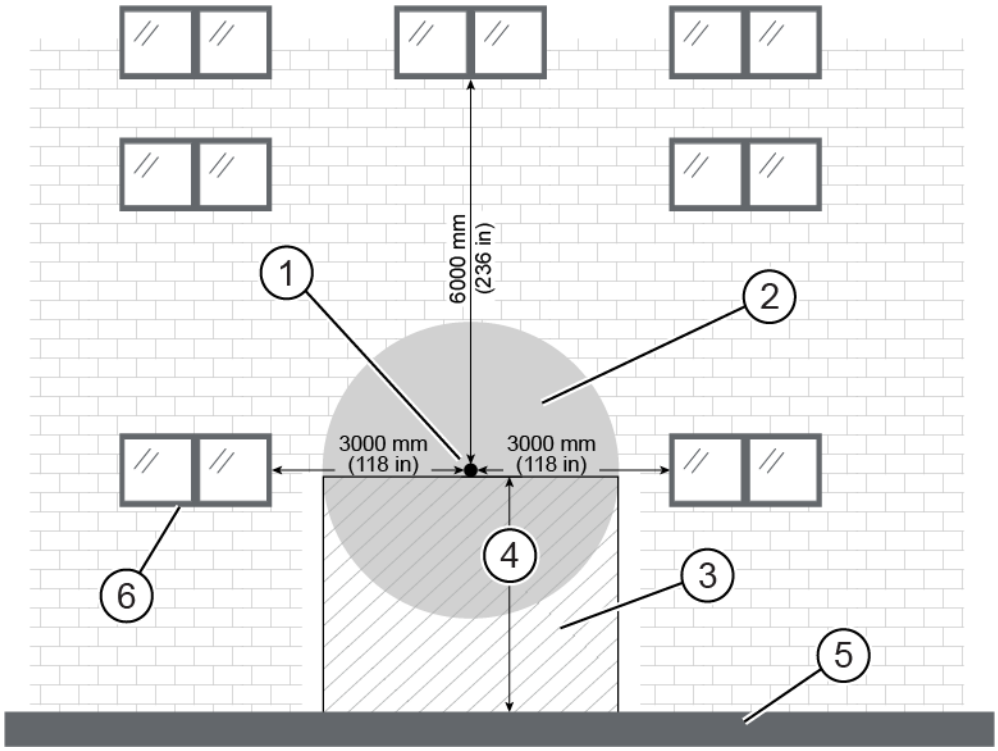
4. The exclusion area shown below must not include any personnel, building components, or objects (movable or stationary).

NOTE
A minimum height of 3660 mm (144 in.) is needed for safe operation of the venting system.

5. If the height from the vent to the ground is greater than 3660 mm (144 in.) and less than 5000 mm (197 in.), physical barriers must be used to keep all persons out of the exclusion area. If the height from the vent to the ground is greater than 5000 mm (197 in.), physical barriers are not required. See Figure 3-10 Cryogenic Exterior Venting Volume and Exclusion Area (Side Vent, Front View) on page 31.

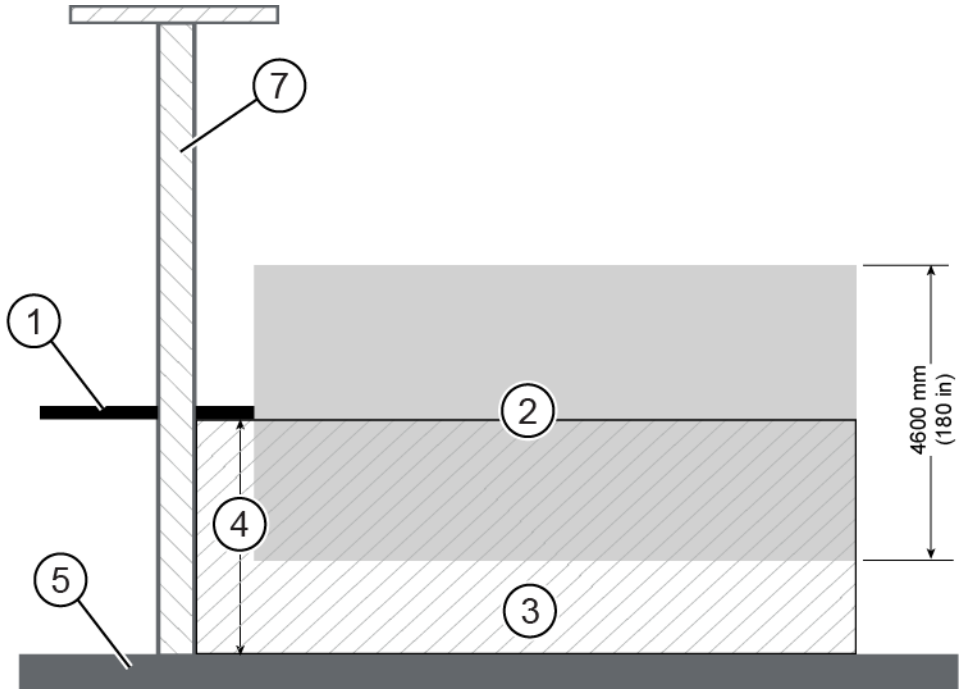
6. The vent must be at least 3000 mm (118 in.) away from windows on both sides, and it must be at least 6000 mm (236 in.) away from windows above the vent. If the windows cannot open, there is no minimum specification.

Figure 3-10 Cryogenic Exterior Venting Volume and Exclusion Area (Side Vent, Front View)



Item	Description
1	Vent exit
2	Cylindrical vent volume (absolute clearance volume): Diameter 4600 mm (180 in.) x Length 6100 mm (240 in.) **(For 1.5T magnets)** Diameter 4600 mm (180 in.) x Length 10700 mm (420 in.) **(For 3.0T or 7.0T magnets)**
3	Exclusion area
4	Distance between the vent pipe and ground. Minimum height = 3660 mm (144 in.) Barriers are not required if the height is > 5000 mm (197 in.).
5	Ground
6	Window

Figure 3-11 Cryogenic Exterior Venting Volume and Exclusion Area (Side Vent, Side View)



Item	Description
1	Vent exit
2	Cylindrical vent volume (absolute clearance volume): Diameter 4600 mm (180 in.) x Length 6100 mm (240 in.) **(For 1.5T magnets)** Diameter 4600 mm (180 in.) x Length 10700 mm (420 in.) **(For 3.0T or 7.0T magnets)**
3	Exclusion area
4	Distance between the vent pipe and ground. Minimum height = 3660 mm (144 in.) Barriers are not required if the height is > 5000 mm (197 in.).
5	Ground
7	Exterior wall

3.5.4 Combined Vent

NOTE
This section does not apply to the JXM series.

A site can combine cryogen venting from two GE HealthCare MR Systems.

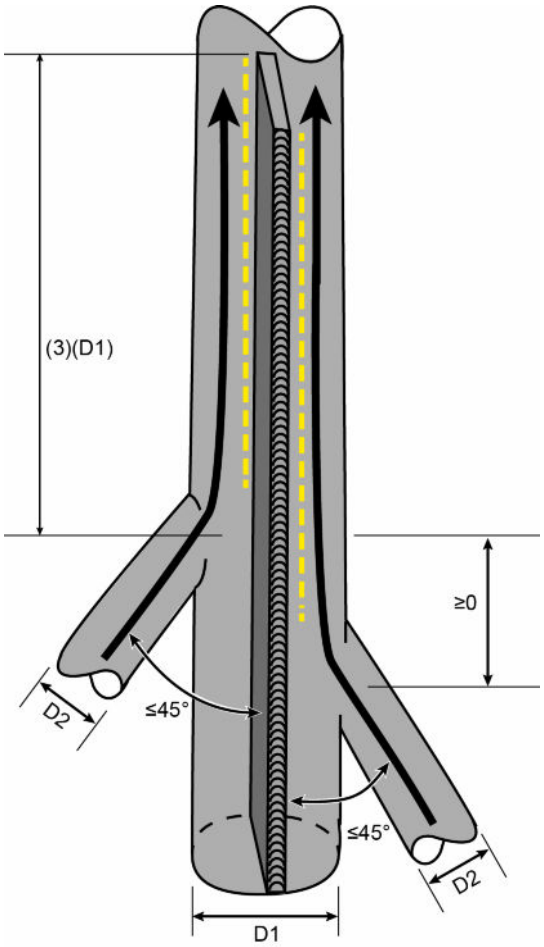
NOTE
The customer chooses this option with the risk that a magnet quench may quench the second magnet.

The waveguides of each system can connect with 45° elbow connectors to a 305 mm (12 in.) pipe as shown in the illustration below. The pipe must be sealed at the bottom, and a plate must be fully

welded to the inside of the pipe to correctly direct all cryogens out of the Magnet Room. The plate and pipe used for the combined vent must be the same as the waveguide material.

1. The total pressure drop of the cryogenic vent system from the magnet vent interface to, and including, the vent cap of each magnet must not exceed the specifications in Table 1-1 Venting Specifications for Magnets That Are in New Production on page 7.
2. The pressure drop in the shared section of the vent must not exceed 27.6 kPa (4 psi).
3. The combined vent pipe diameter selected to maintain the pressure drop will require the combined pipe section diameter meet the back pressure and 241.3 kPa (35 psi) internal pressure forces.
4. The two magnet vents require a plate separating the entering pipes to prevent one magnet quench from imposing a back pressure to the other magnet.
5. The separation plate must be able to withstand the quench up to 241.3 kPa (35 psi) internal pressure caused by the impinging gas flow. If the separation plate in the combined pipe section becomes distorted after a quench, it must be inspected or replaced.
6. The venting system must have a structural support along any pipe section elbow and at the joining of the two (2) magnet vents to the combined vent.

Figure 3-12 Combined Vent



Combined Vent Illustration Notes:

1. The distance between the magnet and the tie-in point to the large diameter common pipe should be minimized as much as possible.

2. The maximum pressure drop for each magnet between the magnet tie-in to the common pipe and the vent exit to outside shall be less than or equal to 27.6 kPa (4 psi).

   NOTE
   This is required to protect the second magnet. When one magnet quenches, this decreases the pressure in the section of the other magnet. If that pressure drop is greater than 27.6 kPa (4 psi), the burst disk of the other magnet will crack and possibly burst.

3. An additional pressure drop, equivalent to a standard 90° elbow, shall be added to each magnet branch due to the entrance effect to the common pipe section.
4. Use the hydraulic diameter (instead of pipe diameter) when calculating the pressure drop after a magnet branch ties into the common vent pipe until it leaves the edge of the separation plate (area indicated by yellow dashed lines in Figure 3-12 Combined Vent on page 33).
5. For a circular cross section of diameter D1, with the divider of width D1:

   Hydraulic diameter = (πD1) / (π+2)

6. D2 is typically 203 mm (8 in.) in diameter (Figure 3-12 Combined Vent on page 33 is not to scale).

4 Reference

4.1 Magnet Cryogenic Venting Pressure Drop Reference Tables

1. Use the following tables to calculate the cryogenic vent pressure drop through the pipe used. See Table 3-1 Magnet Cryogen Specifications on page 13 for the flow rate during a quench.
2. Use the following equivalent lengths to calculate the elbow and miter pressure drops as needed. Elbows with angles greater than 90° must not be used. Gas temperature at the magnet interface starts at 4.5 K (-268°C or -452° F).
   2.1. 90° standard sweep elbow K = 9.14 m (30 ft.)
   2.2. 90° long sweep elbow K = 6.1 m (20 ft.)
   2.3. 45° standard sweep elbow K = 4.9 m (16 ft.)
   2.4. 45° long sweep elbow K = 3.04 m (10 ft.)
   2.5. 90° miter K = 18.29 (60 ft.)

Term	Definition
K	Straight length equivalent of the fitting
R	Radius of the bend
D	Diameter of the pipe
Standard sweep elbow	R/D = 1.0
Long sweep elbow	R/D = 1.5

NOTE
Make sure you reference the correct table for the magnet that is being installed.

Table 4-1 1.5T HM, R and RD Series Magnet Cryogenic Vent System Pressure Drop Matrix

Outer Diameter of Pipe (OD)	Distance of vent system component from magnet		Straight pipe		45° elbow (Standard sweep)		45° elbow (Long sweep)		90° elbow (Standard sweep)		90° elbow (Long sweep)		90° miter	
	m	ft.	(kPa/m)	(psi/ft.)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)
200 mm (8 in.)	0.00-3.05	0-10	1.629	0.072	3.877	0.562	2.585	0.375	7.269	1.054	4.846	0.703	14.539	2.108
	3.05-6.10	10-20	2.784	0.123	6.393	0.927	4.262	0.618	11.987	1.738	7.992	1.159	23.975	3.476
	6.10-9.15	20-30	4.172	0.184	8.712	1.263	5.808	0.842	16.335	2.369	10.890	1.579	32.670	4.737
	9.15-12.19	30-40	5.391	0.238	10.847	1.573	7.231	1.049	20.338	2.949	13.559	1.966	40.677	5.898
	12.19-15.25	40-50	6.460	0.286	12.812	1.858	8.541	1.239	24.023	3.483	16.015	2.322	48.046	6.967
	15.25-18.29	50-60	7.394	0.327	14.620	2.120	9.747	1.413	27.413	3.975	18.275	2.650	54.826	7.950
	18.29-24.39	60-80	8.913	0.394	17.813	2.583	11.875	1.722	33.400	4.843	22.266	3.229	66.799	9.686
	24.39-30.49	80-100	10.049	0.444	20.514	2.974	13.676	1.983	38.463	5.577	25.642	3.718	76.926	11.154
250 mm (10 in.)	0.00 - 6.10	0-20	0.824	0.036	2.382	0.345	1.588	0.230	4.467	0.648	2.978	0.432	8.934	1.295
	6.10-12.19	20-40	1.607	0.071	4.035	0.585	2.690	0.390	7.565	1.097	5.043	0.731	15.130	2.194
	12.19-18.29	40-60	2.239	0.099	5.477	0.794	3.651	0.529	10.269	1.489	6.846	0.993	20.537	2.978
	18.29-24.39	60-80	2.745	0.121	6.733	0.976	4.489	0.651	12.625	1.831	8.416	1.220	25.249	3.661
	24.39-30.49	80-100	3.145	0.139	7.827	1.135	5.218	0.757	14.676	2.128	9.784	1.419	29.353	4.256
	30.49-36.58	100-120	3.459	0.153	8.780	1.273	5.853	0.849	16.463	2.387	10.975	1.591	32.925	4.774
	36.58-42.67	120-140	3.703	0.164	9.609	1.393	6.406	0.929	18.017	2.612	12.011	1.742	36.034	5.225
	42.67-48.77	140-160	3.888	0.172	10.330	1.498	6.887	0.999	19.370	2.809	12.913	1.872	38.739	5.617
	48.77-54.87	160-180	4.026	0.178	10.958	1.589	7.305	1.059	20.546	2.979	13.697	1.986	41.092	5.958
	54.87-60.96	180-200	4.127	0.182	11.504	1.668	7.669	1.112	21.570	3.128	14.380	2.085	43.139	6.255
12" (300mm)	0.00 - 6.10	0-20	0.424	0.019	1.486	0.215	0.991	0.144	2.786	0.404	1.858	0.269	5.573	0.808
	6.10-12.19	20-40	0.829	0.037	2.501	0.363	1.667	0.242	4.689	0.680	3.126	0.453	9.377	1.360
	12.19-18.29	40-60	1.169	0.052	3.408	0.494	2.272	0.329	6.389	0.926	4.260	0.618	12.779	1.853
	18.29-24.39	60-80	1.453	0.064	4.218	0.612	2.812	0.408	7.908	1.147	5.272	0.764	15.816	2.293

Table 4-1 1.5T HM, R and RD Series Magnet Cryogenic Vent System Pressure Drop Matrix (Table continued)

Outer Diameter of Pipe (OD)	Distance of vent system component from magnet		Straight pipe		45° elbow (Standard sweep)		45° elbow (Long sweep)		90° elbow (Standard sweep)		90° elbow (Long sweep)		90° miter	
	m	ft.	(kPa/m)	(psi/ft.)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)
	24.39-30.49	80-100	1.688	0.075	4.941	0.716	3.294	0.478	9.263	1.343	6.176	0.895	18.527	2.686
	30.49-36.58	100-120	1.881	0.083	5.585	0.810	3.724	0.540	10.472	1.519	6.982	1.012	20.945	3.037
	36.58-42.67	120-140	2.040	0.090	6.160	0.893	4.107	0.595	11.551	1.675	7.700	1.117	23.101	3.350
	42.67-48.77	140-160	2.168	0.096	6.673	0.968	4.449	0.645	12.512	1.814	8.341	1.209	25.023	3.628
	48.77-54.87	160-180	2.271	0.100	7.130	1.034	4.753	0.689	13.368	1.938	8.912	1.292	26.737	3.877
	54.87-60.96	180-200	2.353	0.104	7.537	1.093	5.025	0.729	14.132	2.049	9.421	1.366	28.264	4.098
	60.96-67.07	200-220	2.417	0.107	7.900	1.145	5.267	0.764	14.812	2.148	9.875	1.432	29.624	4.296
	67.07-73.17	220-240	2.465	0.109	8.223	1.192	5.482	0.795	15.418	2.236	10.279	1.490	30.837	4.471
	73.17-79.27	240-260	2.502	0.111	8.511	1.234	5.674	0.823	15.958	2.314	10.639	1.543	31.917	4.628
	79.27-85.37	260-280	2.528	0.112	8.768	1.271	5.845	0.848	16.440	2.384	10.960	1.589	32.879	4.767
	85.37-91.56	280-300	2.545	0.113	8.996	1.304	5.998	0.870	16.868	2.446	11.246	1.631	33.737	4.892
350 mm (14 in.)	0.00 - 6.10	0-20	0.235	0.010	0.970	0.141	0.647	0.094	1.819	0.264	1.213	0.176	3.639	0.528
	6.10-12.19	20-40	0.459	0.020	1.619	0.235	1.079	0.157	3.036	0.440	2.024	0.293	6.072	0.880
	12.19-18.29	40-60	0.652	0.029	2.209	0.320	1.473	0.214	4.142	0.601	2.761	0.400	8.284	1.201
	18.29-24.39	60-80	0.817	0.036	2.745	0.398	1.830	0.265	5.147	0.746	3.431	0.498	10.293	1.493
	24.39-30.49	80-100	0.958	0.042	3.231	0.469	2.154	0.312	6.059	0.879	4.039	0.586	12.117	1.757
	30.49-36.58	100-120	1.079	0.048	3.673	0.533	2.448	0.355	6.886	0.998	4.591	0.666	13.772	1.997
	36.58-42.67	120-140	1.180	0.052	4.073	0.591	2.715	0.394	7.636	1.107	5.091	0.738	15.273	2.215
	42.67-48.77	140-160	1.266	0.056	4.436	0.643	2.957	0.429	8.317	1.206	5.545	0.804	16.634	2.412
	48.77-54.87	160-180	1.338	0.059	4.765	0.691	3.176	0.461	8.934	1.295	5.956	0.864	17.868	2.591
	54.87-60.96	180-200	1.398	0.062	5.063	0.734	3.375	0.489	9.493	1.376	6.329	0.918	18.986	2.753
	60.96-67.07	200-220	1.447	0.064	5.333	0.773	3.555	0.516	10.000	1.450	6.667	0.967	20.000	2.900

Table 4-1 1.5T HM, R and RD Series Magnet Cryogenic Vent System Pressure Drop Matrix (Table continued)

Outer Diameter of Pipe (OD)	Distance of vent system component from magnet		Straight pipe		45° elbow (Standard sweep)		45° elbow (Long sweep)		90° elbow (Standard sweep)		90° elbow (Long sweep)		90° miter	
	m	ft.	(kPa/m)	(psi/ft.)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)
	67.07-73.17	220-240	1.487	0.066	5.578	0.809	3.719	0.539	10.459	1.517	6.973	1.011	20.918	3.033
	73.17-79.27	240-260	1.519	0.067	5.800	0.841	3.867	0.561	10.875	1.577	7.250	1.051	21.751	3.154
	79.27-85.37	260-280	1.545	0.068	6.001	0.870	4.001	0.580	11.252	1.632	7.502	1.088	22.505	3.263
	85.37-91.56	280-300	1.564	0.069	6.183	0.897	4.122	0.598	11.594	1.681	7.729	1.121	23.188	3.362
	91.56-97.56	300-320	1.579	0.070	6.349	0.921	4.232	0.614	11.904	1.726	7.936	1.151	23.807	3.452
	97.56-103.66	320-340	1.590	0.070	6.498	0.942	4.332	0.628	12.184	1.767	8.123	1.178	24.368	3.533
	103.66-109.76	340-360	1.598	0.071	6.634	0.962	4.422	0.641	12.438	1.804	8.292	1.202	24.876	3.607
	109.76-115.85	360-380	1.602	0.071	6.756	0.980	4.504	0.653	12.668	1.837	8.446	1.225	25.337	3.674
	115.85-121.95	380-400	1.604	0.071	6.868	0.996	4.578	0.664	12.877	1.867	8.585	1.245	25.754	3.734
400 mm (16 in.)	0.00 - 6.10	0-20	0.184	0.008	0.875	0.127	0.584	0.085	1.641	0.238	1.094	0.159	3.283	0.476
	6.10-12.19	20-40	0.356	0.016	1.444	0.209	0.962	0.140	2.707	0.392	1.804	0.262	5.413	0.785
	12.19-18.29	40-60	0.508	0.022	1.968	0.285	1.312	0.190	3.689	0.535	2.460	0.357	7.379	1.070
	18.29-24.39	60-80	0.642	0.028	2.451	0.355	1.634	0.237	4.596	0.666	3.064	0.444	9.191	1.333
	24.39-30.49	80-100	0.759	0.034	2.896	0.420	1.931	0.280	5.430	0.787	3.620	0.525	10.861	1.575
	30.49-36.58	100-120	0.862	0.038	3.306	0.479	2.204	0.320	6.199	0.899	4.133	0.599	12.399	1.798
	36.58-42.67	120-140	0.951	0.042	3.684	0.534	2.456	0.356	6.907	1.002	4.605	0.668	13.815	2.003
	42.67-48.77	140-160	1.029	0.045	4.031	0.585	2.688	0.390	7.559	1.096	5.039	0.731	15.118	2.192
	48.77-54.87	160-180	1.096	0.048	4.351	0.631	2.901	0.421	8.159	1.183	5.439	0.789	16.318	2.366
	54.87-60.96	180-200	1.154	0.051	4.646	0.674	3.097	0.449	8.711	1.263	5.807	0.842	17.421	2.526
	60.96-67.07	200-220	1.203	0.053	4.917	0.713	3.278	0.475	9.218	1.337	6.146	0.891	18.437	2.673
	67.07-73.17	220-240	1.246	0.055	5.166	0.749	3.444	0.499	9.686	1.404	6.457	0.936	19.371	2.809
	73.17-79.27	240-260	1.281	0.057	5.395	0.782	3.597	0.522	10.115	1.467	6.744	0.978	20.231	2.933

Table 4-1 1.5T HM, R and RD Series Magnet Cryogenic Vent System Pressure Drop Matrix (Table continued)

Outer Diameter of Pipe (OD)	Distance of vent system component from magnet		Straight pipe		45° elbow (Standard sweep)		45° elbow (Long sweep)		90° elbow (Standard sweep)		90° elbow (Long sweep)		90° miter	
	m	ft.	(kPa/m)	(psi/ft.)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)
	79.27-85.37	260-280	1.311	0.058	5.606	0.813	3.737	0.542	10.511	1.524	7.007	1.016	21.021	3.048
	85.37-91.56	280-300	1.336	0.059	5.800	0.841	3.866	0.561	10.874	1.577	7.250	1.051	21.749	3.154
	91.56-97.56	300-320	1.357	0.060	5.978	0.867	3.985	0.578	11.209	1.625	7.473	1.084	22.418	3.251
	97.56-103.66	320-340	1.374	0.061	6.142	0.891	4.095	0.594	11.516	1.670	7.678	1.113	23.033	3.340
	103.66-109.76	340-360	1.387	0.061	6.293	0.912	4.195	0.608	11.799	1.711	7.866	1.141	23.599	3.422
	109.76-115.85	360-380	1.398	0.062	6.432	0.933	4.288	0.622	12.059	1.749	8.040	1.166	24.119	3.497
	115.85-121.95	380-400	1.406	0.062	6.559	0.951	4.373	0.634	12.299	1.783	8.199	1.189	24.597	3.567

Table 4-2 1.5T PM and JXM Series Magnet Cryogenic Vent System Pressure Drop Matrix

Outer Diameter of Pipe (OD)	Distance of vent component from magnet		Straight pipe		45° elbow (Standard sweep)		45° elbow (Long sweep)		90° elbow (Standard sweep)		90° elbow (Long sweep)		90° miter	
	(m)	(ft.)	(kPa/m)	(psi/ft.)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)
150 mm (6 in.)	0.00-3.05	0-10	3.311	0.146	5.544	0.804	3.696	0.536	10.394	1.507	6.93	1.005	20.789	3.014
	3.05-6.10	10-20	5.715	0.253	9.355	1.356	6.237	0.904	17.54	2.543	11.694	1.696	35.081	5.087
	6.10-9.15	20-30	8.451	0.374	12.727	1.845	8.485	1.23	23.864	3.46	15.909	2.307	47.727	6.92
	9.15-12.19	30-40	10.699	0.473	15.708	2.278	10.472	1.518	29.453	4.271	19.635	2.847	58.906	8.541
	12.19-15.25	40-50	12.534	0.554	18.342	2.66	12.198	1.773	34.392	4.987	22.928	3.325	68.783	9.974
	15.25-18.29	50-60	14.019	0.62	20.668	2.997	13.779	1.998	38.753	5.619	25.835	3.746	77.506	11.238
200 mm (8 in.)	0.00-3.05	0-10	0.564	0.025	1.294	0.188	0.862	0.125	2.426	0.352	1.617	0.234	4.851	0.703
	3.05-6.10	10-20	0.97	0.043	2.158	0.313	1.439	0.209	4.046	0.587	2.697	0.391	8.092	1.173
	6.10-9.15	20-30	1.45	0.064	2.944	0.427	1.963	0.285	5.52	0.8	3.68	0.534	11.04	1.601
	9.15-12.19	30-40	1.862	0.082	3.658	0.53	2.439	0.354	6.859	0.995	4.573	0.663	13.718	1.989
	12.19-15.25	40-50	2.215	0.098	4.307	0.624	2.871	0.416	8.075	1.171	5.383	0.781	16.15	2.342
	15.25-18.29	50-60	2.516	0.111	4.895	0.71	3.263	0.473	9.179	1.331	6.119	0.887	18.357	2.662
	18.29-24.39	60-80	2.987	0.132	5.914	0.857	3.942	0.572	11.088	1.608	7.392	1.072	22.176	3.216
	24.39-30.49	80-100	3.318	0.147	6.752	0.979	4.501	0.653	12.659	1.836	8.439	1.224	25.318	3.671
	30.49-36.58	100-120	3.545	0.157	7.44	1.079	4.96	0.719	13.95	2.023	9.3	1.349	27.901	4.046
	36.58-42.67	120-140	3.693	0.163	8.006	1.161	5.338	0.774	15.012	2.177	10.008	1.451	30.024	4.353
	42.67-48.77	140-160	3.784	0.167	8.471	1.228	5.648	0.819	15.884	2.303	10.589	1.535	31.768	4.606
	48.77-54.87	160-180	3.833	0.169	8.853	1.284	5.902	0.856	16.6	2.407	11.067	1.605	33.2	4.814
250 mm (10 in.)	0.00 - 6.10	0-20	0.24	0.011	0.681	0.099	0.454	0.066	1.277	0.185	0.852	0.123	2.555	0.37
	6.10-12.19	20-40	0.467	0.021	1.157	0.168	0.772	0.112	2.17	0.315	1.447	0.21	4.341	0.629
	12.19-18.29	40-60	0.643	0.028	1.564	0.227	1.043	0.151	2.933	0.425	1.955	0.284	5.866	0.851
	18.29-24.39	60-80	0.779	0.034	1.911	0.277	1.274	0.185	3.583	0.52	2.389	0.346	7.167	1.039

Table 4-2 1.5T PM and JXM Series Magnet Cryogenic Vent System Pressure Drop Matrix (Table continued)

Outer Diameter of Pipe (OD)	Distance of vent component from magnet		Straight pipe		45° elbow (Standard sweep)		45° elbow (Long sweep)		90° elbow (Standard sweep)		90° elbow (Long sweep)		90° miter	
	(m)	(ft.)	(kPa/m)	(psi/ft.)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)
	24.39-30.49	80-100	0.881	0.039	2.207	0.32	1.471	0.213	4.137	0.6	2.758	0.4	8.275	1.2
	30.49-36.58	100-120	0.958	0.042	2.458	0.356	1.639	0.238	4.609	0.668	3.073	0.446	9.218	1.337
	36.58-42.67	120-140	1.014	0.045	2.672	0.387	1.781	0.258	5.01	0.726	3.34	0.484	10.02	1.453
	42.67-48.77	140-160	1.053	0.047	2.854	0.414	1.903	0.276	5.351	0.776	3.567	0.517	10.702	1.552
	48.77-54.87	160-180	1.08	0.048	3.009	0.436	2.006	0.291	5.641	0.818	3.761	0.545	11.282	1.636
	54.87-60.96	180-200	1.098	0.049	3.14	0.455	2.093	0.304	5.887	0.854	3.925	0.569	11.775	1.707
	60.96-67.07	200-220	1.108	0.049	3.252	0.471	2.168	0.314	6.097	0.884	4.065	0.589	12.194	1.768
	67.07-73.17	220-240	1.112	0.049	3.347	0.485	2.231	0.324	6.275	0.91	4.183	0.607	12.55	1.82
	73.17-79.27	240-260	1.112	0.049	3.427	0.497	2.285	0.331	6.426	0.932	4.284	0.621	12.853	1.864
	79.27-85.37	260-280	1.112	0.049	3.496	0.507	2.331	0.338	6.555	0.95	4.37	0.634	13.11	1.901
	85.37-91.56	280-300	1.112	0.049	3.554	0.515	2.369	0.344	6.664	0.966	4.443	0.644	13.328	1.933
	91.56-97.56	300-320	1.112	0.049	3.604	0.523	2.403	0.348	6.757	0.98	4.505	0.653	13.514	1.96
	97.56-103.66	320-340	1.112	0.049	3.646	0.529	2.431	0.352	6.836	0.991	4.557	0.661	13.672	1.982
	103.66-109.76	340-360	1.112	0.049	3.682	0.534	2.454	0.356	6.903	1.001	4.602	0.667	13.806	2.002
	109.76-115.85	360-380	1.112	0.049	3.712	0.538	2.475	0.359	6.96	1.009	4.64	0.673	13.92	2.018
	115.85-121.95	380-400	1.112	0.049	3.738	0.542	2.492	0.361	7.009	1.016	4.672	0.677	14.017	2.032
300 mm (12 in.)	0.00 - 6.10	0-20	0.08	0.004	0.277	0.04	0.184	0.027	0.519	0.075	0.346	0.05	1.037	0.15
	6.10-12.19	20-40	0.157	0.007	0.47	0.068	0.313	0.045	0.88	0.128	0.587	0.085	1.761	0.255
	12.19-18.29	40-60	0.22	0.01	0.638	0.093	0.425	0.062	1.197	0.174	0.798	0.116	2.393	0.347
	18.29-24.39	60-80	0.269	0.012	0.786	0.114	0.524	0.076	1.473	0.214	0.982	0.142	2.946	0.427
	24.39-30.49	80-100	0.309	0.014	0.914	0.133	0.609	0.088	1.714	0.248	1.142	0.166	3.427	0.497
	30.49-36.58	100-120	0.34	0.015	1.026	0.149	0.684	0.099	1.923	0.279	1.282	0.186	3.847	0.558

Table 4-2 1.5T PM and JXM Series Magnet Cryogenic Vent System Pressure Drop Matrix (Table continued)

Outer Diameter of Pipe (OD)	Distance of vent component from magnet		Straight pipe		45° elbow (Standard sweep)		45° elbow (Long sweep)		90° elbow (Standard sweep)		90° elbow (Long sweep)		90° miter	
	(m)	(ft.)	(kPa/m)	(psi/ft.)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)
	36.58-42.67	120-140	0.364	0.016	1.123	0.163	0.749	0.109	2.106	0.305	1.404	0.204	4.212	0.611
	42.67-48.77	140-160	0.382	0.017	1.208	0.175	0.805	0.117	2.265	0.328	1.51	0.219	4.529	0.657
	48.77-54.87	160-180	0.396	0.018	1.282	0.186	0.854	0.124	2.403	0.348	1.602	0.232	4.806	0.697
	54.87-60.96	180-200	0.406	0.018	1.346	0.195	0.897	0.13	2.523	0.366	1.682	0.244	5.046	0.732
	60.96-67.07	200-220	0.41	0.018	1.395	0.202	0.93	0.135	2.615	0.379	1.743	0.253	5.229	0.758
	67.07-73.17	220-240	0.415	0.018	1.443	0.209	0.962	0.139	2.705	0.392	1.803	0.261	5.41	0.784
	73.17-79.27	240-260	0.417	0.018	1.485	0.215	0.99	0.144	2.784	0.404	1.856	0.269	5.568	0.807
	79.27-85.37	260-280	0.419	0.019	1.521	0.221	1.014	0.147	2.852	0.414	1.901	0.276	5.704	0.827
	85.37-91.56	280-300	0.419	0.019	1.553	0.225	1.035	0.15	2.912	0.422	1.941	0.281	5.823	0.844
	91.56-97.56	300-320	0.419	0.019	1.58	0.229	1.054	0.153	2.963	0.43	1.976	0.286	5.927	0.859
	97.56-103.66	320-340	0.419	0.019	1.604	0.233	1.07	0.155	3.008	0.436	2.005	0.291	6.016	0.872
	103.66-109.76	340-360	0.419	0.019	1.625	0.236	1.083	0.157	3.047	0.442	2.031	0.295	6.094	0.884
	109.76-115.85	360-380	0.419	0.019	1.643	0.238	1.096	0.159	3.081	0.447	2.054	0.298	6.162	0.894
	115.85-121.95	380-400	0.419	0.019	1.659	0.241	1.106	0.16	3.111	0.451	2.074	0.301	6.221	0.902
350 mm (14 in.)	0.00 - 6.10	0-20	0.032	0.001	0.13	0.019	0.086	0.013	0.243	0.035	0.162	0.024	0.486	0.071
	6.10-12.19	20-40	0.063	0.003	0.219	0.032	0.146	0.021	0.411	0.06	0.274	0.04	0.823	0.119
	12.19-18.29	40-60	0.088	0.004	0.299	0.043	0.2	0.029	0.561	0.081	0.374	0.054	1.122	0.163
	18.29-24.39	60-80	0.11	0.005	0.37	0.054	0.247	0.036	0.694	0.101	0.463	0.067	1.389	0.201
	24.39-30.49	80-100	0.127	0.006	0.433	0.063	0.289	0.042	0.812	0.118	0.542	0.079	1.625	0.236
	30.49-36.58	100-120	0.141	0.006	0.489	0.071	0.326	0.047	0.917	0.133	0.611	0.089	1.834	0.266
	36.58-42.67	120-140	0.152	0.007	0.539	0.078	0.359	0.052	1.01	0.146	0.673	0.098	2.02	0.293
	42.67-48.77	140-160	0.161	0.007	0.582	0.084	0.388	0.056	1.092	0.158	0.728	0.106	2.184	0.317

Table 4-2 1.5T PM and JXM Series Magnet Cryogenic Vent System Pressure Drop Matrix (Table continued)

Outer Diameter of Pipe (OD)	Distance of vent component from magnet		Straight pipe		45° elbow (Standard sweep)		45° elbow (Long sweep)		90° elbow (Standard sweep)		90° elbow (Long sweep)		90° miter	
	(m)	(ft.)	(kPa/m)	(psi/ft.)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)
	48.77-54.87	160-180	0.169	0.007	0.621	0.09	0.414	0.06	1.164	0.169	0.776	0.113	2.329	0.338
	54.87-60.96	180-200	0.174	0.008	0.655	0.095	0.437	0.063	1.229	0.178	0.819	0.119	2.457	0.356
	60.96-67.07	200-220	0.18	0.008	0.69	0.1	0.46	0.067	1.293	0.188	0.862	0.125	2.587	0.375
	67.07-73.17	220-240	0.183	0.008	0.717	0.104	0.478	0.069	1.344	0.195	0.896	0.13	2.688	0.39
	73.17-79.27	240-260	0.185	0.008	0.741	0.107	0.494	0.072	1.388	0.201	0.926	0.134	2.777	0.403
	79.27-85.37	260-280	0.186	0.008	0.762	0.11	0.508	0.074	1.428	0.207	0.952	0.138	2.856	0.414
	85.37-91.56	280-300	0.187	0.008	0.78	0.113	0.52	0.075	1.463	0.212	0.975	0.141	2.925	0.424
	91.56-97.56	300-320	0.187	0.008	0.796	0.115	0.531	0.077	1.493	0.217	0.996	0.144	2.987	0.433
	97.56-103.66	320-340	0.187	0.008	0.811	0.118	0.541	0.078	1.521	0.22	1.014	0.147	3.041	0.441
	103.66-109.76	340-360	0.187	0.008	0.824	0.119	0.549	0.08	1.545	0.224	1.03	0.149	3.089	0.448
	109.76-115.85	360-380	0.187	0.008	0.835	0.121	0.557	0.081	1.566	0.227	1.044	0.151	3.132	0.454
	115.85-121.95	380-400	0.187	0.008	0.845	0.123	0.563	0.082	1.585	0.23	1.056	0.153	3.169	0.46
400 mm (16 in.)	0.00 - 6.10	0-20	0.014	0.001	0.068	0.01	0.045	0.007	0.127	0.018	0.084	0.012	0.253	0.037
	6.10-12.19	20-40	0.028	0.001	0.114	0.017	0.076	0.011	0.213	0.031	0.142	0.021	0.427	0.062
	12.19-18.29	40-60	0.04	0.002	0.156	0.023	0.104	0.015	0.292	0.042	0.195	0.028	0.584	0.085
	18.29-24.39	60-80	0.05	0.002	0.193	0.028	0.129	0.019	0.362	0.053	0.242	0.035	0.725	0.105
	24.39-30.49	80-100	0.059	0.003	0.227	0.033	0.151	0.022	0.426	0.062	0.284	0.041	0.852	0.124
	30.49-36.58	100-120	0.066	0.003	0.258	0.037	0.172	0.025	0.483	0.07	0.322	0.047	0.966	0.14
	36.58-42.67	120-140	0.072	0.003	0.285	0.041	0.19	0.028	0.534	0.077	0.356	0.052	1.069	0.155
	42.67-48.77	140-160	0.076	0.003	0.309	0.045	0.206	0.03	0.58	0.084	0.387	0.056	1.16	0.168
	48.77-54.87	160-180	0.08	0.004	0.331	0.048	0.221	0.032	0.621	0.09	0.414	0.06	1.243	0.18
	54.87-60.96	180-200	0.083	0.004	0.351	0.051	0.234	0.034	0.658	0.095	0.439	0.064	1.316	0.191

Table 4-2 1.5T PM and JXM Series Magnet Cryogenic Vent System Pressure Drop Matrix (Table continued)

Outer Diameter of Pipe (OD)	Distance of vent component from magnet		Straight pipe		45° elbow (Standard sweep)		45° elbow (Long sweep)		90° elbow (Standard sweep)		90° elbow (Long sweep)		90° miter	
	(m)	(ft.)	(kPa/m)	(psi/ft.)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)	(kPa)	(psi)
	60.96-67.07	200-220	0.086	0.004	0.37	0.054	0.247	0.036	0.694	0.101	0.462	0.067	1.387	0.201
	67.07-73.17	220-240	0.088	0.004	0.386	0.056	0.257	0.037	0.723	0.105	0.482	0.07	1.446	0.21
	73.17-79.27	240-260	0.09	0.004	0.4	0.058	0.267	0.039	0.75	0.109	0.5	0.072	1.499	0.217
	79.27-85.37	260-280	0.091	0.004	0.413	0.06	0.275	0.04	0.774	0.112	0.516	0.075	1.547	0.224
	85.37-91.56	280-300	0.091	0.004	0.424	0.061	0.283	0.041	0.795	0.115	0.53	0.077	1.59	0.23
	91.56-97.56	300-320	0.092	0.004	0.434	0.063	0.289	0.042	0.814	0.118	0.543	0.079	1.628	0.236
	97.56-103.66	320-340	0.092	0.004	0.443	0.064	0.295	0.043	0.831	0.12	0.554	0.08	1.662	0.241
	103.66-109.76	340-360	0.092	0.004	0.451	0.065	0.301	0.044	0.846	0.123	0.564	0.082	1.692	0.245
	109.76-115.85	360-380	0.092	0.004	0.459	0.066	0.306	0.044	0.86	0.125	0.573	0.083	1.72	0.249
	115.85-121.95	380-400	0.092	0.004	0.465	0.067	0.31	0.045	0.872	0.126	0.581	0.084	1.744	0.253

Table 4-3 3.0T AR Series Magnet Cryogenic Vent System Pressure Drop Matrix

Outer Diameter of Pipe (OD)	Distance of vent system component from magnet		Pressure drop for straight pipe		Standard sweep 45° elbow		Long sweep 45° elbow		Standard sweep 90° elbow		Long sweep 90° elbow		90° miter bend	
	m	ft.	kPa/m	psi/ft.	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi
150 mm (6 in.)	0.00-3.05	0-10	9.954	0.440	16.770	2.432	11.180	1.621	31.443	4.559	20.962	3.040	62.887	9.119
	3.05-6.10	10-20	17.154	0.758	28.146	4.081	18.764	2.721	52.774	7.652	35.183	5.101	105.548	15.304
	6.10-9.15	20-30	25.502	1.127	38.349	5.561	25.566	3.707	71.905	10.426	47.937	6.951	---	---
200 mm (8 in.)	0.00-3.05	0-10	1.684	0.074	3.898	0.565	2.599	0.377	7.308	1.060	4.872	0.706	14.617	2.119
	3.05-6.10	10-20	2.881	0.127	6.444	0.934	4.296	0.623	12.083	1.752	8.055	1.168	24.165	3.504
	6.10-9.15	20-30	4.315	0.191	8.784	1.274	5.856	0.849	16.470	2.388	10.980	1.592	32.939	4.776
	9.15-12.19	30-40	5.570	0.246	10.932	1.585	7.288	1.057	20.498	2.972	13.665	1.981	40.996	5.944
	12.19-15.25	40-50	6.664	0.295	12.904	1.871	8.603	1.247	24.195	3.508	16.130	2.339	48.391	7.017
	15.25-18.29	50-60	7.615	0.337	14.713	2.133	9.809	1.422	27.588	4.000	18.392	2.667	55.176	8.000
	18.29-24.39	60-80	9.151	0.405	17.895	2.595	11.930	1.730	33.554	4.865	22.369	3.244	67.108	9.731
250 mm (10 in.)	0.00 - 6.10	0-20	0.719	0.032	2.051	0.297	1.367	0.198	3.845	0.558	2.563	0.372	7.690	1.115
	6.10-12.19	20-40	1.401	0.062	3.476	0.504	2.317	0.336	6.517	0.945	4.345	0.630	13.034	1.890
	12.19-18.29	40-60	1.948	0.086	4.714	0.683	3.142	0.456	8.838	1.282	5.892	0.854	17.676	2.563
	18.29-24.39	60-80	2.382	0.105	5.788	0.839	3.858	0.559	10.852	1.574	7.235	1.049	21.704	3.147
	24.39-30.49	80-100	2.723	0.120	6.719	0.974	4.479	0.649	12.598	1.827	8.399	1.218	25.196	3.653
	30.49-36.58	100-120	2.987	0.132	7.526	1.091	5.017	0.727	14.111	2.046	9.407	1.364	28.222	4.092
	36.58-42.67	120-140	3.190	0.141	8.225	1.193	5.483	0.795	15.422	2.236	10.281	1.491	30.843	4.472
	42.67-48.77	140-160	3.342	0.148	8.830	1.280	5.887	0.854	16.557	2.401	11.038	1.600	33.114	4.801
	48.77-54.87	160-180	3.454	0.153	9.355	1.356	6.236	0.904	17.540	2.543	11.693	1.696	35.080	5.087
	54.87-60.96	180-200	3.534	0.156	9.809	1.422	6.539	0.948	18.391	2.667	12.261	1.778	36.782	5.333
300 mm (12 in.)	0.00 - 6.10	0-20	0.239	0.011	0.829	0.120	0.553	0.080	1.555	0.225	1.036	0.150	3.109	0.451
	6.10-12.19	20-40	0.468	0.021	1.400	0.203	0.933	0.135	2.625	0.381	1.750	0.254	5.250	0.761

Table 4-3 3.0T AR Series Magnet Cryogenic Vent System Pressure Drop Matrix (Table continued)

Outer Diameter of Pipe (OD)	Distance of vent system component from magnet		Pressure drop for straight pipe		Standard sweep 45° elbow		Long sweep 45° elbow		Standard sweep 90° elbow		Long sweep 90° elbow		90° miter bend	
	m	ft.	kPa/m	psi/ft.	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi
	12.19-18.29	40-60	0.657	0.029	1.906	0.276	1.271	0.184	3.574	0.518	2.383	0.346	7.149	1.037
	18.29-24.39	60-80	0.813	0.036	2.355	0.341	1.570	0.228	4.415	0.640	2.944	0.427	8.831	1.280
	24.39-30.49	80-100	0.940	0.042	2.752	0.399	1.835	0.266	5.160	0.748	3.440	0.499	10.319	1.496
	30.49-36.58	100-120	1.043	0.046	3.103	0.450	2.069	0.300	5.818	0.844	3.879	0.562	11.636	1.687
	36.58-42.67	120-140	1.126	0.050	3.413	0.495	2.276	0.330	6.400	0.928	4.267	0.619	12.800	1.856
	42.67-48.77	140-160	1.192	0.053	3.688	0.535	2.458	0.356	6.914	1.003	4.610	0.668	13.829	2.005
	48.77-54.87	160-180	1.243	0.055	3.930	0.570	2.620	0.380	7.369	1.069	4.913	0.712	14.738	2.137
	54.87-60.96	180-200	1.283	0.057	4.144	0.601	2.763	0.401	7.771	1.127	5.181	0.751	15.542	2.254
	60.96-67.07	200-220	1.313	0.058	4.334	0.628	2.889	0.419	8.126	1.178	5.417	0.785	16.252	2.356
	67.07-73.17	220-240	1.335	0.059	4.501	0.653	3.001	0.435	8.439	1.224	5.626	0.816	16.879	2.447
	73.17-79.27	240-260	1.350	0.060	4.649	0.674	3.099	0.449	8.716	1.264	5.811	0.843	17.432	2.528
	79.27-85.37	260-280	1.360	0.060	4.779	0.693	3.186	0.462	8.961	1.299	5.974	0.866	17.922	2.599
	85.37-91.56	280-300	1.366	0.060	4.894	0.710	3.263	0.473	9.177	1.331	6.118	0.887	18.354	2.661
	91.56-97.56	300-320	1.368	0.060	4.996	0.724	3.331	0.483	9.368	1.358	6.245	0.906	18.735	2.717
	97.56-103.66	320-340	1.368	0.060	5.086	0.737	3.391	0.492	9.536	1.383	6.357	0.922	19.072	2.765
	103.66-109.76	340-360	1.368	0.060	5.165	0.749	3.444	0.499	9.685	1.404	6.457	0.936	19.370	2.809
	109.76-115.85	360-380	1.368	0.060	5.235	0.759	3.490	0.506	9.816	1.423	6.544	0.949	19.633	2.847
	115.85-121.95	380-400	1.368	0.060	5.297	0.768	3.532	0.512	9.932	1.440	6.622	0.960	19.865	2.880
350 mm (14 in.)	0.00 - 6.10	0-20	0.097	0.004	0.393	0.057	0.262	0.038	0.738	0.107	0.492	0.071	1.475	0.214
	6.10-12.19	20-40	0.189	0.008	0.661	0.096	0.441	0.064	1.239	0.180	0.826	0.120	2.479	0.359
	12.19-18.29	40-60	0.267	0.012	0.902	0.131	0.601	0.087	1.691	0.245	1.127	0.163	3.382	0.490
	18.29-24.39	60-80	0.333	0.015	1.119	0.162	0.746	0.108	2.097	0.304	1.398	0.203	4.195	0.608

Table 4-3 3.0T AR Series Magnet Cryogenic Vent System Pressure Drop Matrix (Table continued)

Outer Diameter of Pipe (OD)	Distance of vent system component from magnet		Pressure drop for straight pipe		Standard sweep 45° elbow		Long sweep 45° elbow		Standard sweep 90° elbow		Long sweep 90° elbow		90° miter bend	
	m	ft.	kPa/m	psi/ft.	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi
	24.39-30.49	80-100	0.389	0.017	1.313	0.190	0.875	0.127	2.462	0.357	1.642	0.238	4.925	0.714
	30.49-36.58	100-120	0.435	0.019	1.488	0.216	0.992	0.144	2.790	0.405	1.860	0.270	5.580	0.809
	36.58-42.67	120-140	0.474	0.021	1.645	0.239	1.097	0.159	3.084	0.447	2.056	0.298	6.168	0.894
	42.67-48.77	140-160	0.505	0.022	1.786	0.259	1.190	0.173	3.348	0.485	2.232	0.324	6.696	0.971
	48.77-54.87	160-180	0.531	0.023	1.912	0.277	1.274	0.185	3.584	0.520	2.390	0.347	7.169	1.040
	54.87-60.96	180-200	0.551	0.024	2.025	0.294	1.350	0.196	3.797	0.551	2.531	0.367	7.593	1.101
	60.96-67.07	200-220	0.568	0.025	2.126	0.308	1.418	0.206	3.987	0.578	2.658	0.385	7.974	1.156
	67.07-73.17	220-240	0.581	0.026	2.217	0.321	1.478	0.214	4.157	0.603	2.771	0.402	8.314	1.206
	73.17-79.27	240-260	0.591	0.026	2.299	0.333	1.532	0.222	4.310	0.625	2.873	0.417	8.620	1.250
	79.27-85.37	260-280	0.598	0.026	2.372	0.344	1.581	0.229	4.447	0.645	2.965	0.430	8.894	1.290
	85.37-91.56	280-300	0.603	0.027	2.437	0.353	1.625	0.236	4.570	0.663	3.046	0.442	9.139	1.325
	91.56-97.56	300-320	0.607	0.027	2.496	0.362	1.664	0.241	4.680	0.679	3.120	0.452	9.359	1.357
	97.56-103.66	320-340	0.609	0.027	2.548	0.370	1.699	0.246	4.778	0.693	3.185	0.462	9.556	1.386
	103.66-109.76	340-360	0.610	0.027	2.595	0.376	1.730	0.251	4.866	0.706	3.244	0.470	9.733	1.411
	109.76-115.85	360-380	0.610	0.027	2.638	0.382	1.758	0.255	4.946	0.717	3.297	0.478	9.891	1.434
	115.85-121.95	380-400	0.610	0.027	2.675	0.388	1.784	0.259	5.016	0.727	3.344	0.485	10.033	1.455
400 mm (16 in.)	0.00 - 6.10	0-20	0.044	0.002	0.204	0.030	0.136	0.020	0.383	0.056	0.256	0.037	0.767	0.111
	6.10-12.19	20-40	0.085	0.004	0.341	0.050	0.228	0.033	0.640	0.093	0.427	0.062	1.280	0.186
	12.19-18.29	40-60	0.121	0.005	0.466	0.068	0.311	0.045	0.874	0.127	0.583	0.085	1.749	0.254
	18.29-24.39	60-80	0.152	0.007	0.580	0.084	0.387	0.056	1.087	0.158	0.725	0.105	2.175	0.315
	24.39-30.49	80-100	0.178	0.008	0.683	0.099	0.456	0.066	1.281	0.186	0.854	0.124	2.562	0.372
	30.49-36.58	100-120	0.201	0.009	0.777	0.113	0.518	0.075	1.457	0.211	0.971	0.141	2.914	0.423

Table 4-3 3.0T AR Series Magnet Cryogenic Vent System Pressure Drop Matrix (Table continued)

Outer Diameter of Pipe (OD)	Distance of vent system component from magnet		Pressure drop for straight pipe		Standard sweep 45° elbow		Long sweep 45° elbow		Standard sweep 90° elbow		Long sweep 90° elbow		90° miter bend	
	m	ft.	kPa/m	psi/ft.	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi
	36.58-42.67	120-140	0.220	0.010	0.862	0.125	0.575	0.083	1.617	0.234	1.078	0.156	3.234	0.469
	42.67-48.77	140-160	0.236	0.010	0.940	0.136	0.627	0.091	1.762	0.256	1.175	0.170	3.524	0.511
	48.77-54.87	160-180	0.249	0.011	1.010	0.146	0.673	0.098	1.894	0.275	1.263	0.183	3.788	0.549
	54.87-60.96	180-200	0.261	0.012	1.074	0.156	0.716	0.104	2.013	0.292	1.342	0.195	4.026	0.584
	60.96-67.07	200-220	0.270	0.012	1.131	0.164	0.754	0.109	2.121	0.308	1.414	0.205	4.243	0.615
	67.07-73.17	220-240	0.277	0.012	1.184	0.172	0.789	0.114	2.220	0.322	1.480	0.215	4.439	0.644
	73.17-79.27	240-260	0.284	0.013	1.231	0.179	0.821	0.119	2.309	0.335	1.539	0.223	4.617	0.670
	79.27-85.37	260-280	0.288	0.013	1.274	0.185	0.850	0.123	2.389	0.346	1.593	0.231	4.779	0.693
	85.37-91.56	280-300	0.292	0.013	1.313	0.190	0.876	0.127	2.463	0.357	1.642	0.238	4.925	0.714
	91.56-97.56	300-320	0.295	0.013	1.349	0.196	0.899	0.130	2.529	0.367	1.686	0.244	5.058	0.733
	97.56-103.66	320-340	0.297	0.013	1.381	0.200	0.921	0.133	2.589	0.375	1.726	0.250	5.178	0.751
	103.66-109.76	340-360	0.299	0.013	1.410	0.204	0.940	0.136	2.643	0.383	1.762	0.256	5.287	0.767
	109.76-115.85	360-380	0.299	0.013	1.436	0.208	0.957	0.139	2.693	0.390	1.795	0.260	5.386	0.781
	115.85-121.95	380-400	0.300	0.013	1.460	0.212	0.973	0.141	2.738	0.397	1.825	0.265	5.475	0.794

Table 4-4 3.0T UA Series Magnet Cryogenic Vent System Pressure Drop Matrix

Outer Diameter of Pipe (OD)	Distance of vent system component from magnet		Pressure drop for straight pipe		Standard sweep 45° elbow		Long sweep 45° elbow		Standard sweep 90° elbow		Long sweep 90° elbow		90° miter bend	
	m	ft.	kPa/m	psi/ft.	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi
200 mm (8 in.)	0.00-3.05	0-10	3.222	0.143	7.697	1.116	5.131	0.744	14.430	2.093	9.620	1.395	28.860	4.186
	3.05-6.10	10-20	5.489	0.243	12.630	1.832	8.415	1.220	23.668	3.433	15.778	2.288	47.335	6.865
	6.10-9.15	20-30	8.229	0.364	17.195	2.494	11.454	1.661	32.214	4.672	21.476	3.115	64.427	9.344
	9.15-12.19	30-40	10.655	0.471	21.418	3.106	14.263	2.069	40.115	5.818	26.743	3.879	80.230	11.636
	12.19-15.25	40-50	12.797	0.566	25.323	3.673	16.860	2.445	47.418	6.877	31.612	4.585	94.836	13.754
	15.25-18.30	50-60	14.685	0.650	28.933	4.196	19.259	2.793	54.167	7.856	36.111	5.237	108.334	15.712
250 mm (10 in.)	0.00 - 6.10	0-20	1.481	0.065	4.290	0.622	2.858	0.414	8.037	1.166	5.358	0.777	16.075	2.331
	6.10-12.19	20-40	2.890	0.128	7.254	1.052	4.829	0.700	13.580	1.970	9.053	1.313	27.160	3.939
	12.19-18.29	40-60	4.038	0.179	9.856	1.429	6.557	0.951	18.441	2.674	12.294	1.783	36.881	5.349
	18.29-24.39	60-80	4.859	0.215	12.138	1.760	8.071	1.171	22.700	3.292	15.133	2.195	45.400	6.584
	24.39-30.49	80-100	5.626	0.249	14.139	2.051	9.398	1.363	26.431	3.833	17.621	2.556	52.862	7.667
	30.49-36.58	100-120	6.370	0.282	15.892	2.305	10.560	1.532	29.699	4.307	19.800	2.872	59.399	8.615
300 mm (12 in.)	0.00 - 6.10	0-20	0.509	0.023	1.782	0.258	1.187	0.172	3.337	0.484	2.225	0.323	6.675	0.968
	6.10-12.19	20-40	0.994	0.044	2.997	0.435	1.994	0.289	5.609	0.813	3.739	0.542	11.217	1.627
	12.19-18.29	40-60	1.401	0.062	4.084	0.592	2.715	0.394	7.637	1.108	5.091	0.738	15.273	2.215
	18.29-24.39	60-80	1.702	0.075	5.055	0.733	3.359	0.487	9.446	1.370	6.298	0.913	18.893	2.740
	24.39-30.49	80-100	1.991	0.088	5.922	0.859	3.933	0.570	11.061	1.604	7.374	1.069	22.121	3.208
	30.49-36.58	100-120	2.283	0.101	6.696	0.971	4.445	0.645	12.500	1.813	8.333	1.209	25.000	3.626
	36.58-42.67	120-140	2.469	0.109	7.387	1.071	4.901	0.711	13.784	1.999	9.189	1.333	27.568	3.998
	42.67-48.77	140-160	2.620	0.116	8.002	1.161	5.308	0.770	14.929	2.165	9.952	1.443	29.857	4.330
	48.77-54.87	160-180	2.741	0.121	8.552	1.240	5.671	0.822	15.949	2.313	10.633	1.542	31.898	4.626
	54.87-60.96	180-200	2.836	0.125	9.041	1.311	5.994	0.869	16.859	2.445	11.239	1.630	33.718	4.890

Table 4-4 3.0T UA Series Magnet Cryogenic Vent System Pressure Drop Matrix (Table continued)

Outer Diameter of Pipe (OD)	Distance of vent system component from magnet		Pressure drop for straight pipe		Standard sweep 45° elbow		Long sweep 45° elbow		Standard sweep 90° elbow		Long sweep 90° elbow		90° miter bend	
	m	ft.	kPa/m	psi/ft.	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi
	60.96-67.07	200-220	2.911	0.129	9.478	1.375	6.283	0.911	17.670	2.563	11.780	1.708	35.340	5.125
350 mm (14 in.)	0.00 - 6.10	0-20	0.207	0.009	0.850	0.123	0.566	0.082	1.592	0.231	1.061	0.154	3.184	0.462
	6.10-12.19	20-40	0.403	0.018	1.421	0.206	0.945	0.137	2.658	0.386	1.772	0.257	5.316	0.771
	12.19-18.29	40-60	0.572	0.025	1.939	0.281	1.288	0.187	3.623	0.525	2.415	0.350	7.246	1.051
	18.29-24.39	60-80	0.699	0.031	2.408	0.349	1.598	0.232	4.495	0.652	2.997	0.435	8.991	1.304
	24.39-30.49	80-100	0.824	0.036	2.832	0.411	1.879	0.272	5.284	0.766	3.523	0.511	10.568	1.533
	30.49-36.58	100-120	0.954	0.042	3.216	0.466	2.132	0.309	5.997	0.870	3.998	0.580	11.994	1.740
	36.58-42.67	120-140	1.040	0.046	3.564	0.517	2.361	0.342	6.641	0.963	4.427	0.642	13.282	1.926
	42.67-48.77	140-160	1.111	0.049	3.878	0.562	2.568	0.372	7.223	1.048	4.816	0.698	14.447	2.095
	48.77-54.87	160-180	1.170	0.052	4.162	0.604	2.755	0.400	7.749	1.124	5.166	0.749	15.499	2.248
	54.87-60.96	180-200	1.219	0.054	4.418	0.641	2.924	0.424	8.225	1.193	5.483	0.795	16.449	2.386
	60.96-67.07	200-220	1.259	0.056	4.650	0.674	3.077	0.446	8.654	1.255	5.769	0.837	17.308	2.510
	67.07-73.17	220-240	1.291	0.057	4.859	0.705	3.215	0.466	9.042	1.311	6.028	0.874	18.084	2.623
	73.17-79.27	240-260	1.316	0.058	5.049	0.732	3.340	0.484	9.393	1.362	6.262	0.908	18.785	2.724
	79.27-85.37	260-280	1.336	0.059	5.220	0.757	3.452	0.501	9.709	1.408	6.473	0.939	19.418	2.816
	85.37-91.56	280-300	1.351	0.060	5.374	0.779	3.554	0.515	9.995	1.450	6.664	0.966	19.991	2.899
	91.56-97.56	300-320	1.362	0.060	5.514	0.800	3.646	0.529	10.254	1.487	6.836	0.991	20.507	2.974
	97.56-103.66	320-340	1.370	0.061	5.640	0.818	3.729	0.541	10.487	1.521	6.991	1.014	20.974	3.042
	103.66-109.76	340-360	1.375	0.061	5.754	0.834	3.804	0.552	10.698	1.552	7.132	1.034	21.396	3.103
	109.76-115.85	360-380	1.377	0.061	5.856	0.849	3.871	0.561	10.889	1.579	7.259	1.053	21.777	3.158
	115.85-121.95	380-400	1.378	0.061	5.949	0.863	3.933	0.570	11.061	1.604	7.374	1.069	22.121	3.208
400 mm (16 in.)	0.00 - 6.10	0-20	0.095	0.004	0.449	0.065	0.299	0.043	0.840	0.122	0.560	0.081	1.681	0.244

Table 4-4 3.0T UA Series Magnet Cryogenic Vent System Pressure Drop Matrix (Table continued)

Outer Diameter of Pipe (OD)	Distance of vent system component from magnet		Pressure drop for straight pipe		Standard sweep 45° elbow		Long sweep 45° elbow		Standard sweep 90° elbow		Long sweep 90° elbow		90° miter bend	
	m	ft.	kPa/m	psi/ft.	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi
	6.10-12.19	20-40	0.184	0.008	0.745	0.108	0.495	0.072	1.394	0.202	0.929	0.135	2.787	0.404
	12.19-18.29	40-60	0.263	0.012	1.017	0.148	0.675	0.098	1.899	0.275	1.266	0.184	3.798	0.551
	18.29-24.39	60-80	0.323	0.014	1.266	0.184	0.840	0.122	2.361	0.342	1.574	0.228	4.722	0.685
	24.39-30.49	80-100	0.383	0.017	1.493	0.217	0.990	0.144	2.783	0.404	1.855	0.269	5.566	0.807
	30.49-36.58	100-120	0.447	0.020	1.702	0.247	1.127	0.163	3.169	0.460	2.112	0.306	6.337	0.919
	36.58-42.67	120-140	0.490	0.022	1.892	0.274	1.252	0.182	3.520	0.511	2.347	0.340	7.041	1.021
	42.67-48.77	140-160	0.526	0.023	2.066	0.300	1.366	0.198	3.842	0.557	2.561	0.371	7.683	1.114
	48.77-54.87	160-180	0.557	0.025	2.224	0.323	1.470	0.213	4.135	0.600	2.757	0.400	8.270	1.199
	54.87-60.96	180-200	0.584	0.026	2.369	0.344	1.565	0.227	4.403	0.639	2.935	0.426	8.806	1.277
	60.96-67.07	200-220	0.606	0.027	2.502	0.363	1.652	0.240	4.647	0.674	3.098	0.449	9.295	1.348
	67.07-73.17	220-240	0.624	0.028	2.623	0.380	1.732	0.251	4.870	0.706	3.247	0.471	9.741	1.413
	73.17-79.27	240-260	0.640	0.028	2.733	0.396	1.804	0.262	5.074	0.736	3.383	0.491	10.148	1.472
	79.27-85.37	260-280	0.652	0.029	2.834	0.411	1.870	0.271	5.260	0.763	3.507	0.509	10.520	1.526
	85.37-91.56	280-300	0.662	0.029	2.926	0.424	1.931	0.280	5.430	0.787	3.620	0.525	10.859	1.575
	91.56-97.56	300-320	0.670	0.030	3.010	0.437	1.986	0.288	5.585	0.810	3.723	0.540	11.169	1.620
	97.56-103.66	320-340	0.676	0.030	3.086	0.448	2.036	0.295	5.726	0.830	3.817	0.554	11.452	1.661
	103.66-109.76	340-360	0.681	0.030	3.156	0.458	2.082	0.302	5.855	0.849	3.903	0.566	11.710	1.698
	109.76-115.85	360-380	0.684	0.030	3.220	0.467	2.124	0.308	5.973	0.866	3.982	0.578	11.946	1.733
	115.85-121.95	380-400	0.686	0.030	3.278	0.475	2.162	0.314	6.080	0.882	4.054	0.588	12.161	1.764
450 mm (17.7 in.)	0.00 - 6.10	0-20	0.020	0.001	0.107	0.015	0.071	0.010	0.199	0.029	0.133	0.019	0.399	0.058
	6.10-12.19	20-40	0.039	0.002	0.177	0.026	0.118	0.017	0.331	0.048	0.220	0.032	0.661	0.096
	12.19-18.29	40-60	0.056	0.002	0.242	0.035	0.160	0.023	0.451	0.065	0.300	0.044	0.901	0.131

Table 4-4 3.0T UA Series Magnet Cryogenic Vent System Pressure Drop Matrix (Table continued)

Outer Diameter of Pipe (OD)	Distance of vent system component from magnet		Pressure drop for straight pipe		Standard sweep 45° elbow		Long sweep 45° elbow		Standard sweep 90° elbow		Long sweep 90° elbow		90° miter bend	
	m	ft.	kPa/m	psi/ft.	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi
	18.29-24.39	60-80	0.069	0.003	0.302	0.044	0.199	0.029	0.560	0.081	0.374	0.054	1.121	0.163
	24.39-30.49	80-100	0.081	0.004	0.357	0.052	0.235	0.034	0.660	0.096	0.440	0.064	1.321	0.192
	30.49-36.58	100-120	0.095	0.004	0.406	0.059	0.267	0.039	0.752	0.109	0.501	0.073	1.504	0.218
	36.58-42.67	120-140	0.104	0.005	0.452	0.066	0.297	0.043	0.835	0.121	0.557	0.081	1.671	0.242
	42.67-48.77	140-160	0.112	0.005	0.494	0.072	0.324	0.047	0.912	0.132	0.608	0.088	1.823	0.264
	48.77-54.87	160-180	0.119	0.005	0.532	0.077	0.349	0.051	0.981	0.142	0.654	0.095	1.962	0.285
	54.87-60.96	180-200	0.124	0.006	0.567	0.082	0.371	0.054	1.045	0.152	0.697	0.101	2.090	0.303
	60.96-67.07	200-220	0.129	0.006	0.599	0.087	0.392	0.057	1.103	0.160	0.735	0.107	2.206	0.320
	67.07-73.17	220-240	0.133	0.006	0.628	0.091	0.411	0.060	1.156	0.168	0.770	0.112	2.311	0.335
	73.17-79.27	240-260	0.136	0.006	0.655	0.095	0.428	0.062	1.204	0.175	0.803	0.116	2.408	0.349
	79.27-85.37	260-280	0.139	0.006	0.679	0.098	0.444	0.064	1.248	0.181	0.832	0.121	2.496	0.362
	85.37-91.56	280-300	0.141	0.006	0.701	0.102	0.458	0.066	1.288	0.187	0.859	0.125	2.577	0.374
	91.56-97.56	300-320	0.143	0.006	0.721	0.105	0.471	0.068	1.325	0.192	0.883	0.128	2.650	0.384
	97.56-103.66	320-340	0.144	0.006	0.740	0.107	0.483	0.070	1.359	0.197	0.906	0.131	2.717	0.394
	103.66-109.76	340-360	0.145	0.006	0.757	0.110	0.494	0.072	1.389	0.202	0.926	0.134	2.779	0.403
	109.76-115.85	360-380	0.146	0.006	0.772	0.112	0.504	0.073	1.417	0.206	0.945	0.137	2.835	0.411
	115.85-121.95	380-400	0.146	0.006	0.786	0.114	0.513	0.074	1.443	0.209	0.962	0.140	2.886	0.419

Table 4-5 7.0T 7TKA Series Magnet Cryogenic Vent System Pressure Drop Matrix

Outer Diameter of Pipe (OD)	Distance of vent system component from magnet		Pressure drop for straight pipe		Standard sweep 45° elbow		Long sweep 45° elbow		Standard sweep 90° elbow		Long sweep 90° elbow		90° miter bend	
	m	ft.	kPa/m	psi/ft.	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi
200 mm (8 in.)	0.00-3.05	0-10	1.131	0.050	4.596	0.666	3.064	0.444	8.206	1.190	5.471	0.793	16.413	2.379
	3.05-6.10	10-20	2.263	0.100	9.191	1.332	6.127	0.888	16.413	2.379	10.942	1.586	32.826	4.758
250 mm (10 in.)	0.00-3.05	0-10	0.352	0.0016	1.883	0.273	1.256	0.182	3.363	0.488	2.242	0.325	6.727	0.975
	3.05-6.10	10-20	0.704	0.031	3.767	0.546	2.511	0.364	6.727	0.975	4.484	0.650	13.453	1.950
	6.10-9.15	20-30	1.056	0.047	5.650	0.819	3.767	0.546	10.090	1.463	6.727	0.975	20.180	2.925
	9.15-12.19	30-40	1.407	0.062	7.534	1.092	5.023	0.728	13.453	1.950	8.969	1.300	26.906	3.900
300 mm (12 in.)	0.00-3.05	0-10	0.134	0.006	0.910	0.132	0.607	0.088	1.625	0.236	1.083	0.157	3.249	0.471
	3.05-6.10	10-20	0.268	0.012	1.820	0.264	1.213	0.176	3.249	0.471	2.166	0.314	6.499	0.942
	6.10-9.15	20-30	0.402	0.018	2.730	0.396	1.820	0.264	4.874	0.707	3.249	0.471	9.748	1.413
	9.15-12.19	30-40	0.535	0.024	3.639	0.528	2.426	0.352	6.499	0.942	4.333	0.628	12.998	1.884
	12.19-15.25	40-50	0.669	0.030	4.549	0.659	3.033	0.440	8.124	1.178	5.416	0.785	16.247	2.355
	15.25-18.29	50-60	0.803	0.035	5.459	0.791	3.639	0.528	9.748	1.413	6.499	0.942	19.497	2.826
	18.29 - 21.35	60-70	0.937	0.041	6.369	0.923	4.246	0.615	11.373	1.649	7.582	1.099	22.746	3.297
350 mm (14 in.)	0.00-3.05	0-10	0.059	0.003	0.490	0.071	0.327	0.047	0.875	0.127	0.584	0.085	1.751	0.254
	3.05-6.10	10-20	0.119	0.005	0.981	0.142	0.654	0.095	1.751	0.254	1.167	0.169	3.502	0.508
	6.10-9.15	20-30	0.178	0.008	1.471	0.213	0.981	0.142	2.626	0.381	1.751	0.254	5.253	0.761
	9.15-12.19	30-40	0.237	0.010	1.961	0.284	1.307	0.190	3.502	0.508	2.335	0.338	7.004	1.015
	12.19-15.25	40-50	0.297	0.013	2.451	0.355	1.634	0.237	4.377	0.635	2.918	0.423	8.755	1.269
	15.25-18.29	50-60	0.356	0.016	2.942	0.426	1.961	0.284	5.253	0.761	3.502	0.508	10.506	1.523
	18.29- 21.35	60-70	0.415	0.018	3.432	0.497	2.288	0.332	6.128	0.888	4.086	0.592	12.257	1.777
	21.34-24.38	70-80	0.475	0.021	3.922	0.569	2.615	0.379	7.004	1.015	4.669	0.677	14.008	2.030
	24.38-27.43	80-90	0.534	0.024	4.412	0.640	2.942	0.426	7.879	1.142	5.253	0.761	15.759	2.284

Table 4-5 7.0T 7TKA Series Magnet Cryogenic Vent System Pressure Drop Matrix (Table continued)

Outer Diameter of Pipe (OD)	Distance of vent system component from magnet		Pressure drop for straight pipe		Standard sweep 45° elbow		Long sweep 45° elbow		Standard sweep 90° elbow		Long sweep 90° elbow		90° miter bend	
	m	ft.	kPa/m	psi/ft.	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi
	27.43-30.48	90-100	0.593	0.026	4.903	0.711	3.268	0.474	8.755	1.269	5.837	0.846	17.510	2.538
400 mm (16 in.)	0.00-3.05	0-10	0.030	0.001	0.287	0.042	0.192	0.028	0.513	0.074	0.342	0.050	1.027	0.149
	3.05-6.10	10-20	0.059	0.003	0.575	0.083	0.383	0.056	1.027	0.149	0.684	0.099	2.053	0.298
	6.10-9.15	20-30	0.089	0.004	0.862	0.125	0.575	0.083	1.540	0.223	1.027	0.149	3.080	0.446
	9.15-12.19	30-40	0.119	0.005	1.150	0.167	0.767	0.111	2.053	0.298	1.369	0.198	4.106	0.595
	12.19-15.25	40-50	0.148	0.007	1.437	0.208	0.958	0.139	2.566	0.372	1.711	0.248	5.133	0.744
	15.25-18.29	50-60	0.178	0.008	1.725	0.250	1.150	0.167	3.080	0.446	2.053	0.298	6.159	0.893
	18.29 - 21.35	60-70	0.208	0.009	2.012	0.292	1.341	0.194	3.593	0.521	2.395	0.347	7.186	1.042
	21.34-24.38	70-80	0.237	0.010	2.300	0.333	1.533	0.222	4.106	0.595	2.738	0.397	8.213	1.190
	24.38-27.43	80-90	0.267	0.012	2.587	0.375	1.725	0.250	4.620	0.670	3.080	0.446	9.239	1.339
	27.43-30.48	90-100	0.297	0.013	2.874	0.417	1.916	0.278	5.133	0.744	3.422	0.496	10.266	1.488
	30.48-33.53	100-110	0.326	0.014	3.162	0.458	2.108	0.306	5.646	0.818	3.764	0.546	11.292	1.637
	33.53-36.58	110-120	0.356	0.016	3.449	0.500	2.300	0.333	6.159	0.893	4.106	0.595	12.319	1.786
	36.58-39.62	120-130	0.386	0.017	6.899	1.000	4.599	0.667	12.319	1.786	8.213	1.190	24.638	3.571
	39.62-42.67	130-140	0.415	0.018	10.348	1.500	6.899	1.000	18.478	2.678	12.319	1.786	36.957	5.357
	42.67-45.72	140-150	0.445	0.020	13.797	2.000	9.198	1.333	24.638	3.571	16.425	2.381	49.276	7.142
450 mm (17.7 in.)	0.00-3.05	0-10	0.016	0.001	0.180	0.026	0.120	0.017	0.321	0.047	0.214	0.031	0.642	0.093
	3.05-6.10	10-20	0.032	0.001	0.359	0.052	0.240	0.035	0.642	0.093	0.428	0.062	1.283	0.186
	6.10-9.15	20-30	0.048	0.002	0.539	0.078	0.359	0.052	0.962	0.140	0.642	0.093	1.925	0.279
	9.15-12.19	30-40	0.063	0.003	0.719	0.104	0.479	0.069	1.283	0.186	0.855	0.124	2.566	0.372
	12.19-15.25	40-50	0.079	0.004	0.898	0.130	0.599	0.087	1.604	0.233	1.069	0.155	3.208	0.465
	15.25-18.29	50-60	0.095	0.004	1.078	0.156	0.719	0.104	1.925	0.279	1.283	0.186	3.850	0.558

Table 4-5 7.0T 7TKA Series Magnet Cryogenic Vent System Pressure Drop Matrix (Table continued)

Outer Diameter of Pipe (OD)	Distance of vent system component from magnet		Pressure drop for straight pipe		Standard sweep 45° elbow		Long sweep 45° elbow		Standard sweep 90° elbow		Long sweep 90° elbow		90° miter bend	
	m	ft.	kPa/m	psi/ft.	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi
	18.29 - 21.35	60-70	0.111	0.005	1.258	0.182	0.838	0.122	2.246	0.326	1.497	0.217	4.491	0.651
	21.34-24.38	70-80	0.127	0.006	1.437	0.208	0.958	0.139	2.566	0.372	1.711	0.248	5.133	0.744
	24.38-27.43	80-90	0.143	0.006	1.617	0.234	1.078	0.156	2.887	0.419	1.925	0.279	5.775	0.837
	27.43-30.48	90-100	0.159	0.007	1.797	0.260	1.198	0.174	3.208	0.465	2.139	0.310	6.416	0.930
	30.48-33.53	100-110	0.175	0.008	1.976	0.286	1.317	0.191	3.529	0.512	2.353	0.341	7.058	1.023
	33.53-36.58	110-120	0.190	0.008	2.156	0.312	1.437	0.208	3.850	0.558	2.566	0.372	7.699	1.116
	36.58-39.62	120-130	0.206	0.009	4.312	0.625	2.874	0.417	7.699	1.116	5.133	0.744	15.399	2.232
	39.62-42.67	130-140	0.222	0.010	6.467	0.937	4.312	0.625	11.549	1.674	7.699	1.116	23.098	3.348
	42.67-45.72	140-150	0.238	0.011	8.623	1.250	5.749	0.833	15.399	2.232	10.266	1.488	30.797	4.464
	45.72-48.77	150-160	0.254	0.011	10.779	1.562	7.186	1.042	19.248	2.790	12.832	1.860	38.497	5.580
	48.77-51.82	160-170	0.270	0.012	12.935	1.875	8.623	1.250	23.098	3.348	15.399	2.232	46.196	6.696
	51.82-64.01	170-210	0.286	0.013	15.091	2.187	10.060	1.458	26.948	3.906	17.965	2.604	53.895	7.812

5 Appendix

5.1 Magnet Venting Conformance Assessment Form

Site Identification:	
Customer/Hospital/Clinic Name:	
Site name:	
Country:	

Requirement	**Check Correct Response**	
Section 2.2: HVAC Vent Requirements		
Does the incoming air contain at least 5% air from outside the Magnet Room?	☐ Yes	☐ No
Comment		
Date of Report:		
Completed by (Company name):		
Completed By (First and last name):		
Completed by (Title):		
Signature		

Requirement	**Check Correct Response**	
Section 2.3: Emergency Exhaust Vent Requirements		
Is the emergency exhaust vent installed at the highest point of the finished/drop ceiling or at the top of the side wall on the coldhead side?	☐ Highest point	☐ Side wall
Has the emergency exhaust vent been tested and is it operational?	☐ Yes	☐ No
Do the emergency exhaust fan and the exhaust intake vent each have a capacity of at least 34 m^3/minute (1200 CFM) with a minimum of 12 room air exchanges per hour?	☐ Yes	☐ No
Is there a manual exhaust fan switch near the Operator Workspace (OW) and in the Magnet Room near the door?	☐ Yes	☐ No
Is the exhaust fan activated by an oxygen monitor?	☐ Yes	☐ No
Is the Magnet Room exhaust fan installed per Figure 2-1 or Figure 2-2 of 5850263-xxx? List applicable ***Figure number***.	☐ Yes	☐ No
Comment		
Date of Report:		
Completed by (Company name):		
Completed By (First and last name):		
Completed by (Title):		
Signature		

Requirement	Check Correct Response	
Section 3.1: Cryogen Venting Requirements		
Does the vent pipe diameter meet the specifications per Table 3-1 of 5850263-xxx where the pipe interfaces with the magnet adaptor?	☐ Yes	☐ No
Is the vent size designed per the vent pressure drop table listed in section *4 Reference* of 5850263-xxx? List applicable ***Table number***.	☐ Yes	☐ No
Section 3.2: Venting Requirements		
Is the cryogenic vent supported in such a way that it will not transfer any load to the magnet vent adaptor?	☐ Yes	☐ No
Are the vent options and dimensions selected from Table 3-2 of 5850263-xxx? List the ***Magnet*** used from Table 3-2 of 5850263-xxx here.	☐ Yes	☐ No
Section 3.4: Vent Requirements Inside the Magnet Room		
Is the vent made of one of the materials listed in Table 3-3 of 5850263-xxx? List the ***Material*** used from Table 3-3 of 5850263-xxx here.	☐ Yes	☐ No
Are the tubes or pipes seamless or do they have welded/brazed seams and joints between sections? (Corrugated pipe and/or spiral duct is not permitted)	☐ Yes	☐ No
Are the vent pipes designed to withstand 241.4 kPA (35 psi)?	☐ Yes	☐ No
Are the vent supports designed to withstand loads, expansion and contraction during a quench? List the ***Product*** from Table 1-1 of 5850263-xxx here.	☐ Yes	☐ No
Is the vent adaptor a straight adaptor or a 90 degree adaptor? Answer one of the following two questions.	☐ Straight	☐ 90 degree
For straight adaptor configurations: Is there enough clearance to accommodate at least 102 mm (4 in.) for the magnet vent adaptor, in addition to the required gap of 10 to 32 mm (0.4 to 1.25 in.) per Figures 3-3 and 3-4 of 5850263-xxx?	☐ Yes	☐ No
For 90 degree adaptor configurations: Is there enough clearance to accommodate the required gap of 10 to 32 mm (0.4 to 1.25 in.) per Figures 3-5 or 3-6 of 5850263-xxx?	☐ Yes	☐ No
Is only one dielectric break installed in the Magnet Room and is it installed at the magnet interface?	☐ Yes	☐ No
Is there a minimum clearance of 102 mm (4 in.) between the ceiling or wall both inside and outside the Magnet Room to accommodate the dielectric breaks per Figure 3-7 of 5850263-xxx? NOTE: The overall length of the waveguide must be at least 812 mm (32 in.)	☐ Yes	☐ No

Comment	
Date of Report:	
Completed by (Company name):	
Completed By (First and last name):	
Completed by (Title):	
Signature	

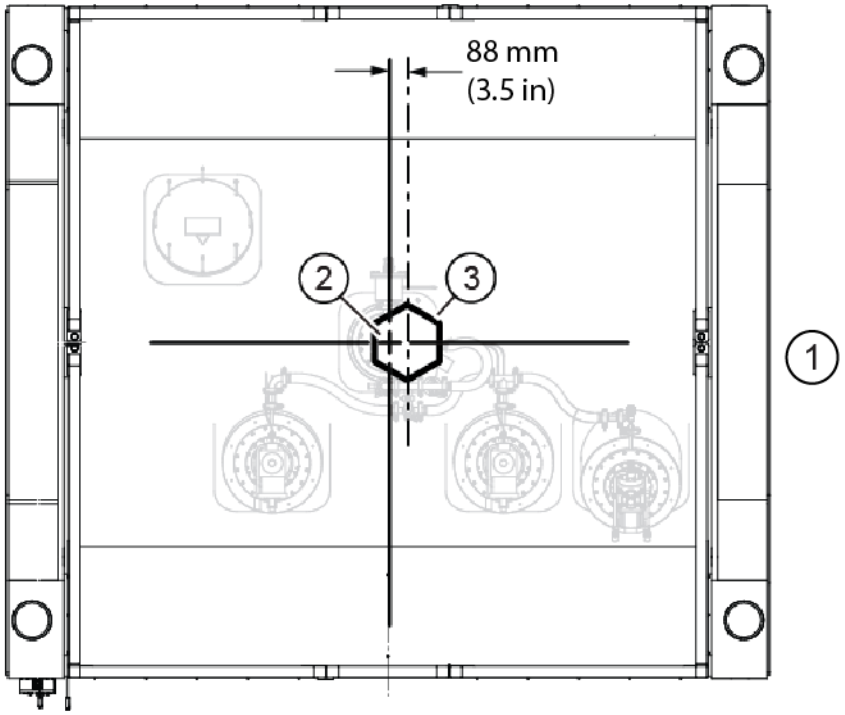
Requirement	Check Correct Response	
Section 3.5: Vent Requirements Outside the Magnet Room		
Are the tubes or pipes seamless or do they have welded/brazed seams and joints between sections? (Corrugated pipe and/or spiral duct is not permitted)	☐ Yes	☐ No
Are the vent supports designed to withstand loads, expansion and contraction during a quench? List the ***Product*** used from Table 1-1 of 5850263-xxx here.	☐ Yes	☐ No
Is only one dielectric break installed outside the Magnet Room, adjacent to the wave guide, and is there a 19 to 32 mm (0.75 to 1.25 in.) gap to the vent pipe per Figure 3-8 of 5850263-xxx?	☐ Yes	☐ No
Are any electromechanical fire dampers used?	☐ Yes	☐ No
Is condensate prevented from pooling inside any section of the venting system by use of downward tilt or weep holes?	☐ Yes	☐ No
Does the vent exhaust exit have an exclusion area per Figures 3-9, 3-10 and 3-11 of 5850263-xxx?	☐ Yes	☐ No
Is the vent exit area free of air intake vents and windows to prevent cryogen exhaust from reentering the facility per Figures 3-9, 3-10 and 3-11 of 5850263-xxx?	☐ Yes	☐ No
Is the vent outlet covered with square screen mesh and does it have a cover/cap over the pipe, if the vent outlet is orientated in the vertical up position?	☐ Yes	☐ No
Was the exhaust vent cover or cap included in the pressure drop calculation?	☐ Yes	☐ No
Combined cryogen venting from two GE HealthCare MR systems must be noted and can be used if construction follows this requirement with separation plates, supports and properly designed pressure drops per Figure 3-12 of 5850263-xxx. Is there a combined vent?	☐ Yes	☐ No
Are all other requirements contained within the Magnet Room Venting manual understood and adhered to?	☐ Yes	☐ No
Comment		
Date of Report:		
Completed by (Company name):		
Completed By (First and last name):		
Completed by (Title):		
Signature		

Site Identification:	To be filled out by GE HealthCare
SYSID/GON:	
Type of GE HealthCare system (Product name):	
Type of GE HealthCare magnet:	
GE HealthCare Concession (if applied):	
Date Received:	
Received By (Name and SSO):	
Received by (Title):	

5.2 Information for 7TKA-series (7.0T) only

The following figure identifies the magnet vent location in reference to the center of the magnet.

Figure 5-1 Magnet Cryogenic Vent Location (For SIGNA 7T)



Item	Description
1	Magnet Front (Top View)
2	Magnet Geometric Isocenter
3	Vent Opening

Figure 5-2 Pipe Supports to Remove Vent Load from Ventglas Connection (For SIGNA 7T)

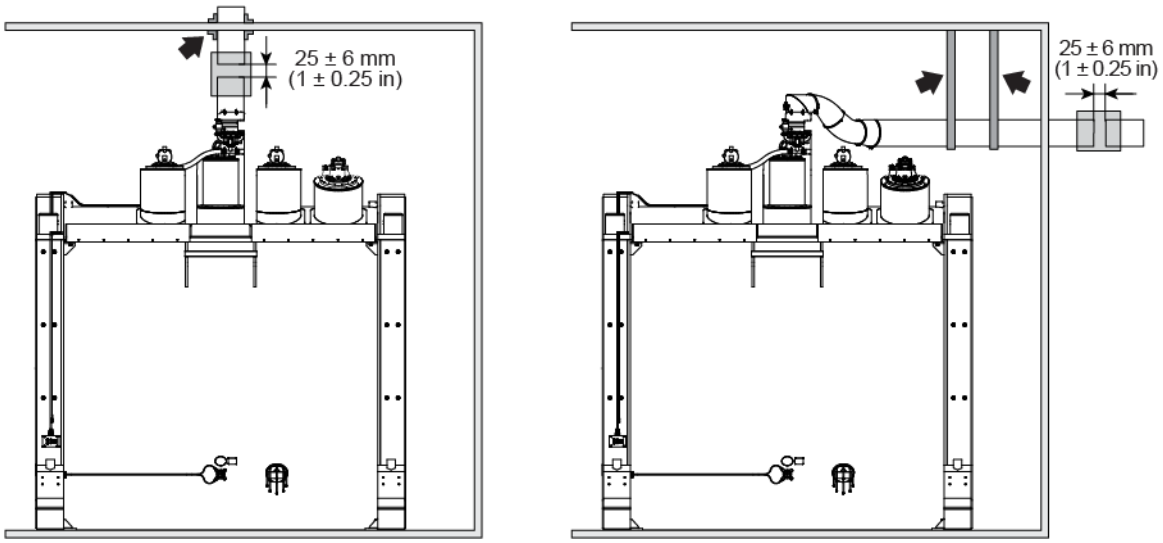
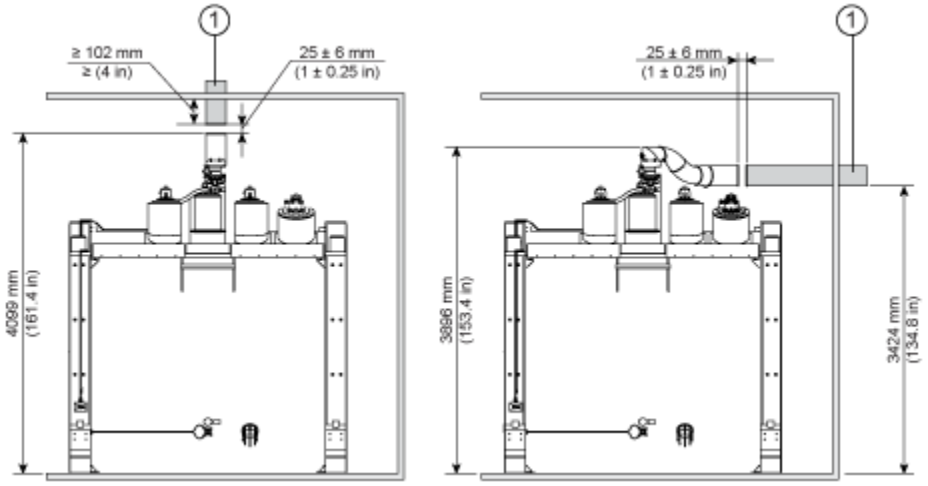


Figure 5-3 Waveguide (For SIGNA 7T)



Item	Description
1	Waveguide Overall length of the waveguide must be at least four times the diameter of the vent pipe. For example, at least 1016 mm (40 in.) overall length for a 254 mm (10 in.) diameter vent pipe.

Revision History

English Document review and approval per DOC2348809		
Rev	**Date**	**Description**
Rev 10	October 2025	**Section 1.3, Table 1-1:** • Row for LCC magnet: Removed serial number YRxxxx, removed products SIGNA Prime and SIGNA Victor, added product SIGNA Sprint Evo • Row for LCC-W magnet: Removed product SIGNA Voyager • Row for PM magnet: added product SIGNA Sprint Select • Added new row for DM magnet • Row for AR magnet: added serial number ACxxxx, added products SIGNA Bolt and SIGNA MAGNUS **Section 2.1:** Added DM magnet information **Section 2.3, Step 10:** Added DM magnet information **Chapter 3:** Added Note for DM magnet **Section 3.2, Table 3-2:** In row for LCC magnet, added information for 90° vent **Section 3.4.3, Figure 3-3:** Updated dimensions for callout 1 of LCC series and added a footnote for additional serial numbers **Section 3.4.4, Figure 3-5:** Updated dimensions for callout 3 of LCC series and added a footnote for additional serial numbers **Section 3.4.4, Figure 3-6:** Updated dimensions for callout 5 of LCC series and added a footnote for additional serial numbers **Section 3.5.1, Step 1:** Added RD series to list of 1.5T magnets
Rev 9	April 2025	**Section 1.3, Table 1-1:** Added product SIGNA Sprint to row for PM magnet; Removed product SIGNA Winner from row for PM magnet **Section 3.4.3, Figure 3-3:** Updated dimensions for JXM series **Section 4.1, Table 4-2:** Changed 144 mm (6 in.) to 150 mm (6 in.) **Section 4.1, Table 4-5:** Updated incorrect value 4.699 to 7.699 kPa
Rev 8	October 2024	**Section 1.3, Table 1-1:** Added product SIGNA Prime to row for LCC magnet; added product SIGNA Performer and SIGNA Pilot to rows for 3TLC and AR Magnet **Section 3.4.4, Figure 3-5:** Updated value for callout 3 in first row of table **Section 3.4.4, Figure 3-6:** Updated value for callout 3 in first row of table
Rev 7	March 2024	**Section 1.3, Table 1-1:** Added product SIGNA Winner to row for PM magnet and added new row for JXM Magnet **Section 3.1, Table 3-1:** Added JXM series **Section 3.2, Table 3-2:** Added JXM series **Section 3.3, Figure 3-1:** Added JXM series **Section 3.5.1, Step 1:** Added paragraph for JXM series **Section 3.5.3, Step 1:** Added JXM series **Section 3.5.4:** Added Note for JXM series **Section 4.1, Table 4-2:** Added JXM series

English Document review and approval per DOC2348809		
Rev	**Date**	**Description**
Rev 6	December 2023	**Section 1.3:** Added serial number YRxxxx to Rxxxx / CRxxx; added product SIGNA Victor to row for LCC or CXK4 magnet; added product SIGNA Champion to row for PM magnet; added product SIGNA Architect and SIGNA Pioneer to row for AR magnet; updated maximum pressure drop values for 7TKA magnet. **Section 3.1, Table 3-1:** Updated magnet vent pipe OD for 7TKA series **Section 3.2, Table 3-2:** Updated values for LCC series **Section 3.4.6:** Updated step 6 for clarity **Section 4.1, Table 4-5:** Updated values **Section 5.1:** Added multiple signature blocks to the Requirements table
Rev 5	September 2022	**Section 1.3:** Added serial number PCxxxx to PMxxxx; added product SIGNA Star AIR, SIGNA Aviator AIR and SIGNA Victor to row for PM/PC magnet **Section 3.4.6:** Updated Step 5: Added "insulation must be easily removable"
Rev 4	March 2022	**Section 1.3:** Added product Artist Evo to row for LCC or CXK4 magnet **Section 2.1:** Added section for vent system certification of conformance **Section 3.4.6:** Updated Step 5: Added sentence clearance area of dielectric break **Section 4.1:** Updated Table 4.3 **Section 5.1:** New section for Magnet Venting Conformance Assessment Form
Rev 3	July 2021	Added magnet types AR (3.0T) and 7TKA (7T) information throughout the manual
Rev 2	January 2021	Corrected revision number on front page. Content remains unchanged. Routed in MyWorkshop with DOC2348809 Rev. 3
Rev 1	August 2020	Initial Release of 5850263-1EN based on DOC2348809 Rev. 2

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