Agilent DD2 Installation Planning

Guide

Agilent Technologies

Notices

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Safety Notices

CAUTION

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Contents

1
Introduction

This guide assists in selecting and preparing a site to install an Agilent NMR spectrometer system, including the preparation of the NMR workstation. Use the provided checklists and information to enable a smooth transition from delivery to installation.

This guide includes the following sections:

- Chapter 1, “Introduction” —provides an overview of the guide and safety information.
- Chapter 2, “Site Selection, Planning, System Shipment and Delivery” —describes how to plan for the installation of an NMR spectrometer. This chapter also discusses system delivery and provides a table of shipping dimensions for NMR components. Begin with this chapter.
- Chapter 3, “Site Requirements” —lists the factors to consider when selecting the installation site.
- Chapter 4, “Site Preparation” —describes the factors to consider during installation site preparation: electrical, cooling, safety, supplies.
- Chapter 5, “Installation Supplies and Equipment” —describes the supplies required and recommended for the system installation.
- Appendix A, “Posting Requirements for Magnetic Field Warnings” —describes the posting requirements for magnetic field warning signs.
- Appendix B, “Acronyms” —describes acronyms used in this guide.
- Appendix C, “Standard Units, Conversion Tables” —provides select standard units and conversion factors relevant for this guide.
- Appendix D, “Ceiling Heights for Magnet Installation Ancillaries” —provides essential information for the magnet installation.

- Appendix E, “Anchor Bolts Specifications” —provides technical information required to determine whether the anchor bolts provided are suitable for site.

Importance of Communication

Good communication is essential between the customer, the facility planner or architect, and Agilent on a frequent basis in planning the system installation. Any questions or problems must be addressed immediately to avoid delays and additional costs. One person from the customer’s institution should be appointed to coordinate site planning and preparation. This person should represent all users of the system in dealing with Agilent and the facility planner or architect.

2
Site Selection, Planning, System Shipment and Delivery

Agilent's delivery responsibility ends at the Agilent factory shipping dock or at the customer's receiving dock depending upon the type of insurance obtained by the customer.

The customer must provide a moving crew to move the shipping crates holding the system from the delivery truck (or storage location) to the installation site for the smaller magnets, that is 400/54/ASP, 400/54/AR, 400/89/ASP, 500/54/ASP, 500/54/AR, 500/89/AS, 600/54/ASP, 600/54/ASC and 600/54/AR.

Agilent provides a moving crew for the larger magnets, that is 600/89/ASP, 700/54/ASP, 700/89/ASP, 750/89/ASP and 800/54/ASC.

Site Selection

Site selection is the process of finding a location for the NMR system, with least interference with the building it occupies.

Factors that contribute to site selection include: magnetic fringe field, ceiling height, console dimensions, floor conditions (weight/vibration), accessibility. Site selection may be complex due to interaction between the magnetic field and the surrounding environment.

NOTE For more information on magnetic field warnings, see Appendix A, "Posting Requirements for Magnetic Field Warnings".

1 Begin site selection with magnet placement as the primary consideration:
   - How will the content in the building affect the quality of the magnetic field?
   - How will the field from the magnet affect the surrounding areas?
2 Next, factor access into the site selection:
   - Can the system be delivered to the site?
   - Will the site limit public access in surrounding areas?
   - Can cryogen transfers be made quickly and safely?
   - Can magnetic storage media be taken to the area safely?
3 Then, factor the following considerations:
   - The site should be large enough to include the magnet, the 5-gauss line, and have the required minimum ceiling height, see Table 8 on page 24.
   - The floor type and strength, consider the floor type and strength and consider how the system will be supported. See "Building Floor Requirements" on page 26.
   - When an acceptable space has been found, look for steel and iron in the immediate area. Consider the structural steel of the building, iron pipes, machinery, etc.

- Look in the near area for elevators, vehicular traffic, large transformers, and other large amounts of steel and iron.
- Consider the ability to control, and if necessary restrict, the movement of ferromagnetic objects, such as elevators, automobiles, or carts, within the magnetic field.
- Look for potential causes of environmental electromagnetic disturbances, in particular trams and electric trains within a few kilometers of the site. See "Magnetic Environment" on page 37.
- Consider adequate access for the delivery of dewars containing liquid helium and nitrogen.
- Consider public access that might pass through the 5-gauss zone.
- Consider escape routes in case of emergency, including a magnet quench.
- Consider the location of sensitive electronic equipment that might be affected by the magnetic field. See "Magnetic Environment" on page 37.
- Make sure you have enough ventilation in case of a magnet quench. See "Room ventilation" on page 51.
- Check the transport route and system shipping dimensions. Where possible, move the crates in an upright position, with a forklift or hydraulic pallet mover, directly to the installation site.

The installation site must be accessible from the delivery location with adequate clearance for system crates and moving equipment (including magnet hoist) throughout the access route. See Table 1, Table 2, and Table 3 for the dimensions and weights needed for calculating vertical, horizontal, and turning clearances, and evaluating the structural strength of passageways. Moving the larger crates of the system requires a forklift or hydraulic pallet mover, which must be considered when calculating accessibility.

Table 1 System accessories dimensions as shipped with crates and pallets as appropriate

Accessory	Height cm (in)	Width cm (in)	Depth cm (in)	Weight kg (lb)
RF Front End	32.4 (12.75)	95.3(37.5)	88.9(35)	
High Field Preamp Station	33 (13)	20.3(8)	69.2(27.25)	
Pneumatics Router	33 (13)	20.3(8)	69.2(27.25)	34.6(77)

Table 1 System accessories dimensions as shipped with crates and pallets as appropriate (continued)

Accessory	Height cm (in)	Width cm (in)	Depth cm (in)	Weight kg (lb)
7600-AS Support Tower	140 (55)	96 (36)	196 (77)	230 (500)
7600-AS Robot	114 (45)	104 (41)	61 (24)	70 (154)
NMR work table	31 (12)	188 (74)	115 (45)	89 (196)
Solids Accessory cabinet	94 (37)	72 (28)	97 (38)	90 (198) Varies depending on configuration

Table 2 Cabinet dimensions as shipped, with crate and pallet

Cabinet	Height cm (in)	Width cm (in)	Depth cm (in)	Weight kg (lb)
NMR console	116.8 (46)	121.9 (48)	101.6 (40)	~ 335 (~ 744)
Third cabinet on 700MHz, or higher systems	148.6 (58.5)	67.5 (26.5)	102 (40)	~ 143 (~ 315)
High-power solids	168 (66)	81 (32)	102 (40)	< 285 (< 630)
Microimaging	168 (66)	81 (32)	102 (40)	~ 240 (~ 530)

Table 3 Actively shielded magnet dimensions as shipped with crate and pallet

Magnet/Bore* (MHz/mm)	Height in crate cm (in)	Width in crate† cm (in)	Depth in crate cm (in)	Height uncrated† cm (in)	Width and depth uncrated cm (in)	Weight with crate kg (lb)
400/54/ASP	175 (68.9)	123 (48.4)	109 (42.9)	130 (51.2)	86 (33.9)	615 (1356)
400/54/AR	175 (68.9)	123 (48.4)	109 (42.9)	130 (51.2)	86 (33.9)	615 (1356)
400/89/ASP	216 (85.0)	123 (48.4)	109 (42.9)	147 (58.9)	86 (33.9)	860 (1896)
500/54/ASP	216 (85.0)	123 (48.4)	109 (42.9)	167 (65.8)	86 (33.9)	860 (1896)
500/54/AR	228 (89.8)	123 (48.4)	136 (53.5)	192 (75.6)	103 (40.6)	1230 (2712)
500/89/AS	216 (85.0)	122 (48.0)	136 (53.5)	182 (71.7)	103 (40.6)	1450 (3197)
600/54/ASP	216 (85.0)	122 (48.0)	136 (53.5)	182 (71.7)	103 (40.6)	1350 (2976)
600/54/ASC	216 (85.0)	123 (48.4)	109 (42.9)	167 (65.8)	86 (33.9)	920 (2028)
600/54/AR	228 (89.8)	123 (48.4)	136 (53.5)	192 (75.6)	103 (40.6)	1290 (2844)
600/89/ASP	228 (89.8)	123 (48.4)	136 (53.5)	196 (77.2)	103 (40.6)	1750 (3558)
700/54/ASP	228 (89.8)	123 (48.4)	136 (53.5)	196 (77.2)	103 (40.6)	1755 (3569)
700/89/ASP	240 (94.5)	181 (71.3)	191 (75.2)	207 (81.5)	150 (59.1)	4000 (8819)
750/89/ASP	240 (94.5)	181 (71.3)	191 (75.2)	207 (81.5)	150 (59.1)	4250 (9370)
800/54/ASC	240 (94.5)	181 (71.3)	191 (75.2)	207 (81.5)	150 (59.1)	4000 (8819)

Table 3 Actively shielded magnet dimensions as shipped with crate and pallet (continued)

Magnet/Bore* (MHz/mm)	Height in crate cm (in)	Width in crate† cm (in)	Depth in crate cm (in)	Height uncrated† cm (in)	Width and depth uncrated cm (in)	Weight with crate kg (lb)
850/54/ASC	240 (94.5)	181 (71.3)	191 (75.2)	207 (81.5)	150 (59.1)	4000 (8819)

* AS: Actively shielded/Superscreened, ASP: Premium Shielded, ASC: PremiumCOMPACT, AR: Annual Refill

† Width is reduced by ~3 inches with crate sides removed.

All of the smaller magnets (400/54/ASP down to 600/54/AR in the table) can easily be removed from the crate using the magnet installation lifter, a fork lift or an overhead hoist. The larger magnets (600/89/ASP and below in the table) can be removed but will also require an overhead hoist. The given dimensions allow for the plywood transit disk that remains under the magnet during this operation. Extra height is required for the moving device and should be added to the uncrated height.

Installation Planning Process

Use the following steps to prepare for delivery of the system. Refer to the chapters in this guide for further details. Consult knowledgeable individuals, such as plant facilities personnel, for assistance in implementing these instructions.

1. Check the SHIP BY date on the Agilent Order Acknowledgment form. Use this date as a target for completing installation preparations. If you anticipate any delays in site readiness and need to delay shipment, notify the factory at least 90 days in advance. Select the site for installing and operating the system. (Note: a site survey is standard for spectrometer systems 500MHz systems and above).
2. Review the general considerations described in "Site Selection" on page 12 and make sure the site conforms to the requirements listed in Chapter 3, "Site Requirements" .
3. Prepare the installation site, including electrical outlets, compressed air supply, and air conditioning as described in Chapter 4, "Site Preparation" .
4. Make any computer preparations required, also described in Chapter 4, "Site Preparation" .
5. Order supplies and equipment for installation and startup operation, as described in "Required Installation Supplies and Equipment" on page 84.
6. Make arrangements for workers and equipment to move the system upon delivery to the installation site, as described in "System Shipment and Delivery" on page 17. They will also be required to carry out any work relating to the site for the installation, for example drilling holes in the floor in order to anchor the magnet legs, or connecting quench ducting.
7. Read carefully, sign, and mail to Agilent the Object Code License Form. (Note that acceptance of the products on the Order Acknowledgment form constitutes acceptance of the terms stated in the Object Code License Form, whether the form is signed or not.)

System Shipment and Delivery

The method of shipping and the current preparation conditions at the destination determine the extent of the receiving preparations. The Agilent Order Acknowledgment form indicates the shipping method for the order. The following service is usually provided:

- *Air Freight System* is delivered to unloading dock or other easily accessible outside unloading point. Factory to destination transit time is about two days (not including time to clear customs).
- *Motor or Moving Van System* is delivered to an easily accessible interior location or any interior location to which freight can be easily transported by movable dolly. Excluded is transport in elevators that cannot support the weight of the shipment or up stairways. Factory to destination within the United States is about eight days.

Selecting a local shipping company

Confirm that the local shipping company uses a vehicle that will allow the magnet to be transported in an upright position for all transport methods that will be used. Sea freight or motor freight with air cushion suspension is recommended for delivery of systems. See Table 1 on page 13, Table 2 on page 14, and Table 3 on page 14 for dimensions and weights of major system components.

Contact the shipping company locally about the service usually rendered. If moving equipment will be required at the site, obtain help from the plant facilities department or an outside moving service.

CAUTION

Move the crates in an upright position. Do not drop or mishandle. The crates are packed with G-force and “tip-and-tell” indicators that record mishandling. Be especially careful about moving the magnet crate. If one or more crates cannot be moved into the installation site because of doorway clearance, leave the affected crates in a clean, safe, dry location. Do not open any crate except with direct instructions from an authorized service representative.

Post-Delivery inspection

CAUTION Do not open any crate except with direct instructions from an authorized Agilent Service representative. In particular, the crate containing the magnet has components that could be irreparably damaged if opened incorrectly.

1. Upon delivery, check for shipping damage but do not open any shipping crates except with direct instructions from an authorized Agilent Service representative.
2. Examine crates for shipping damage as follows:
   a. Check the crates VISUALLY for damage.
   b. Check the tip-and-tell indicators fixed on the crate to see if they have triggered.
   c. Check the G-force/shock indicators fixed on the crates to see if they have triggered.

Table 4 shows the number of indicators present on each crate.

Table 4 Checklist for tip-and-tell and G-force indicators

Crate	Tip-and-tell indicators	G-force indicators
Magnet	2 x 10g, 2 x 15g on crate 1 x 10g, 1 x 15g on cryostat	2 on crate (for ≥800MHz, TinyTag on cryostat)
Anti-vibration legs	none	none

If there is no external indication of potential damage, then carefully move the crates to a clean, dry location (preferably the installation site) with the tip-and-tell and G-force/shock indicators still intact. Move the crates in an upright position and do not drop or mishandle. If one or more crates cannot be moved into the installation site because of doorway clearance, leave the affected crate in a clean, safe, dry location. After moving, check the crates and indicators again to check if they have triggered. Do not open any crate except with direct instructions from an Agilent Service representative. In particular, the crate containing the magnet has components that could be irreparably damaged if opened incorrectly.

If there is damage evident on receipt of the crates, please document the extent of the damage (preferably with photographs where relevant) and carry out the following procedure:

1 Note the nature of the damage on the carrier's waybill.
2 Request an inspection and written damage report by a carrier representative.
3 Contact the insurance company.
4 Contact your local Agilent Service representative for advice, with a copy of the damage report.

In case of damage, the FOB block on the Agilent Order Acknowledgment form determines owner responsibility:

- FOB WALNUT CREEK. Transfer of ownership occurs when the shipment leaves the factory. The customer is responsible for claims for shipping damage. Upon request, Agilent will provide assistance in filing claims.
- FOB DESTINATION. Transfer of ownership occurs at customer's point of receipt. Agilent is responsible for claims for shipping damage.

Damage discovered 15 or more days after delivery generally cannot be recovered. Such damage will be at the expense of the customer.

5 Once any potential damage has been reported, the crates can be carefully moved to a clean, dry location as described above.
6 After the shipment has been moved to the installation site, the required utilities have been installed and the non-Agilent installation parts and supplies have been provided, contact your Agilent Service representative to schedule an engineer for the system installation. To contact Agilent Service, please visit http://www.chem.agilent.com and click "Contact Us".
7 Please note that for systems ≥ 800MHz, an Electronic TinyTag will be fitted to the cryostat within the crate. Once the crate is opened, it is important that this TinyTag is returned to the shipping department for analysis. A pre-addressed box is provided in the shipment for this purpose.

3
Site Requirements

The NMR spectrometer has certain site requirements which are described in this chapter.

Accessibility of Site

The site must provide adequate access for the routine delivery of supply dewars containing liquid helium and nitrogen. The site must also be accessible for system delivery, as described in Chapter 1.

Site Size and Ceiling Height Requirements

The site size must be large enough to allow free access to all sides of the cabinet, magnet, and accessories for operation, maintenance, and cryogenic service. Table 5 - Table 7 list the dimensions of the system components.

Table 5 Cabinet dimensions and weights

System	Height cm (in)	Width cm (in)	Depth cm (in)	Weight kg (lb)
NMR console	102.9 (40.5)	110.5 (43.5)	77.5 (30.5)	~ 335(~ 744)
Accessory cabinets (if needed on higher field or solids systems)	102.9 (40.5)	55.4 (22)	77.5 (30.5)	~ 136 (~ 300) (depending on configuration)
Microimaging	102.9 (40.5)	55.4 (22)	77.5 (30.5)	230 (505)

Table 6 Magnet dimensions with legs attached

Magnet/Bore (MHz/mm)	Height mm(in)	Cryostat Dia.mm (in) (excluding anti-vibration legs)	Weight with anti-vibration and Cryogens kg (lb)
400/54/ASP	2054 (80.9)	860 (33.9)	630 (1389)
400/54/AR	2054 (80.9)	860 (33.9)	630 (1389)
400/89/ASP	2223 (87.5)	860 (33.9)	865 (1907)
500/54/ASP	2423 (95.4)	860 (33.9)	915 (2017)
500/54/AR	2651 (104.4)	1025 (40.4)	1410 (3109)
500/89/AS	2602 (102.5)	1025 (40.4)	1616 (3563)
600/54/ASP	2549 (100.4)	1025 (40.4)	1535 (3384)
600/54/ASC	2423 (95.4)	860 (33.9)	975 (2150)
600/54/AR	2651 (104.4)	1025 (40.4)	1470 (3241)

Table 6 Magnet dimensions with legs attached (continued)

Magnet/Bore (MHz/mm)	Height mm(in)	Cryostat Dia.mm (in) (excluding anti-vibration legs)	Weight with anti-vibration and Cryogens kg (lb)
600/89/ASP	2697 (106.2)	1025 (40.4)	2018 (4449)
700/54/ASP	2747 (108.2)	1025 (40.4)	2029 (4473)
700/89/ASP	3090 (121.7)	1495 (58.9)	4010 (8841)
750/89/ASP	3090 (121.7)	1495 (58.9)	4460 (9833)
800/54/ASC	3020 (118.9)	1495 (58.9)	4000 (8819)
850/54/ASC	3020 (118.9)	1495 (58.9)	4000 (8819)

Table 7 System accessories dimensions and weights

Configuration	Height cm (in)	Width cm (in)	Depth cm (in)	Weight kg (lb)
High Field Preamp Station	95.3(37.5)	32.4(12.75)	88.9(35)	
RF Front End	76.2(30)	20.3(8)	68(26.75)	
Pneumatics Router	53.3(21)	24.1(9.5)	71.1(28)	34.6(77)
MAS-controller (separate 3U enclosure, on top of console)	17.1(6.75)	52.1(20.5)	62.2(24.5)	20.4(45)
NMR work table	71 (28)	178 (70)	152 (60)	48 (107)

All cabinets have casters for easy movement, allowing the system to be placed in small locations as long as sufficient space exists for the cabinets to be moved to provide for access to all sides.

The minimum dimensions do not include compensation for external magnetic and RF interference that may be present. When setting up a spectrometer, you should try to keep the 5-gauss line inside the lab. The console, power bay, and workstation must be outside the 5-gauss line, see “Magnetic Environment” on page 37. If these criteria cannot be met please consult with your local Agilent representative. Each individual site must be analyzed to ensure optimum system performance.

Ceiling height requirements

The ceiling must provide sufficient headroom to insert the liquid helium transfer tube into the magnet dewar and the storage dewar. The height of the ceiling (or that part of the ceiling located directly above the magnet) without obstructions, such as lighting and heating ducts, must be equal to or greater than the minimum installation height listed in Table 8.

Table 8 states the absolute minimum ceiling height requirement to install the magnet.

Table 8 Minimum ceiling heights

Magnet/Bore (MHz/mm)	Min. Height Requirement for Installation in mm (in)	Ceiling heights for Special Split He Transfer Tube requirement in mm (in)
400/54/ASP	2605 (102.6)	2605 (102.6) to 2825 (111.2)
400/54/AR	2605 (102.6)	2605 (102.6) to 2825 (111.2)
400/89/ASP	2778 (109.4)	2778 (109.4) to 2998 (118.0)
500/54/ASP	2978 (117.2)	2978 (117.2) to 3198 (125.9)
500/54/AR	3203 (126.1)	3203 (126.1) to 3423 (134.8)
500/89/AS	3154 (124.2)	3154 (124.2) to 3374 (132.8)
600/54/ASP	3104 (122.2)	3104 (122.2) to 3324 (130.9)
600/54/ASC	2978 (117.2)	2978 (117.2) to 3198 (125.9)
600/54/AR	3203 (126.1)	3203 (126.1) to 3423 (138.8)
600/89/ASP	3249 (127.9)	3249 (127.9) to 3469 (136.6)
700/54/ASP	3299 (129.9)	3299 (129.9) to 3529 (138.9)
700/89/ASP	3610 (142.1)	3610 (142.1) to 3855 (151.8)
750/89/ASP	3610 (142.1)	3610 (142.1) to 3855 (151.8)
800/54/ASC	3540 (139.4)	3540 (139.4) to 3785 (149.0)
850/54/ASC	3540 (139.4)	3540 (139.4) to 3785 (149.0)

NOTE

Table 8 states the ceiling height range for which a low-ceiling height helium transfer tube will be required in order to maintain the magnet.

Special components will be required to install and maintain magnets in lower ceiling heights. This will be assessed by the

Service Engineer before installation.

For more information, see Appendix D, “Ceiling Heights for Magnet Installation Ancillaries” .

CAUTION The special helium transfer tube must be purchased as a cost-option and ordered before magnet delivery to prevent the magnet installation being delayed.

Some wide-bore system configurations for solids and micro-imaging applications may require additional clearances above/below the magnet. For these configurations it is recommended that the minimum ceiling height requirements are confirmed with your Agilent Representative.

If a footplate is being fitted between the floor and the anti-vibration legs (see “Building Floor Requirements” on page 26), then an additional 20mm of ceiling height must be added to the values in Table 8 on page 24.

The liquid helium storage dewars can also affect the minimum ceiling height requirement, especially if a large capacity dewar is used. In general, the ceiling height must be at least twice the height of liquid-helium storage dewar above the floor, but this can be reduced with the special low ceiling height transfer tube.

Building Floor Requirements

Careful consideration should be given to the construction of the floor. It is important that the floor is level and that the material from which the floor is constructed is strong enough to support the weight of the magnet on its legs and full of cryogens, will allow the anchor bolts for the legs to be held rigidly in place and will not have any adverse affects on the magnet when it is at field. From an operational point of view, the use of cryogens means that some floor coverings are more suitable than others. Also any vibrations may be transmitted to the magnet more readily by some types of floor than others.

Floor Loading

The customer is responsible for checking that the site floor has sufficient structural strength to support the combined weight of the entire spectrometer system and all moving equipment during installation. Contact a plant engineer, structural engineer, or registered civil engineer to confirm that the magnet (and anti-vibration system as applicable) does not exceed the structural floor loading rating. For system weights, see Table 5 on page 22, Table 6 on page 22 and Table 7 on page 23. If a quench manifold is to be fitted to the magnet, additional weight will be added to the magnet system. Allow an extra 7.5 kg for a 2 neck manifold (including the adapter), and an extra 10 kg for a 3-neck manifold (including the adapter).

The footprints for standard legs are shown in Figure 1 on page 28, Figure 2 on page 30, and Figure 3 on page 31. The contact surface area (needed to determine weight distribution) is summarized in Table 9.

Table 9 Leg surface area for floor loading calculations

Magnet/Bore* (MHz/mm)	Minimum Surface area* of footplate of each leg (m2)	Total for 3 legs (m2)
400/54/ASP, 400/54/AR, 400/89/ASP, 500/54/ASP and 600/54/ASC	0.041	0.123
500/89/AS, 500/54/AR, 600/54/ASP, 600/54/AR, 600/89/ASP and 700/54/ASP	0.061	0.184

Table 9 Leg surface area for floor loading calculations (continued)

Magnet/Bore* (MHz/mm)	Minimum Surface area* of footplate of each leg (m2)	Total for 3 legs (m2)
700/89/ASP, 750/89/ASP, 800/54/ASC, and 850/54/ASC	0.109	0.327

* A worst case calculation has been made, using the TMC leg footprint.

Where floor loading for the magnet is a concern, load-spreading plates may be required. These should be constructed from aluminum or some other non-ferrous material, It is preferable for these to be arranged locally by the customer. Fixing holes for the anti-vibration legs will be required in the load-spreading plates, information regarding the hole requirements is available on request. Agilent does offer cost-option Y-plates, which act both to “tie” the legs together (see “Magnet anchoring and additional support” on page 32) and help distribute the weight of the system. Floor-plates are not recommended in Seismic Zones unless additional support is provided. An example Y floor-plate is shown in Figure 4 on page 32.

There are 3 sizes of floor-plates, and the surface area and part numbers required for magnet types are detailed in Table 10.

CAUTION Floor-plates must be purchased as a cost-option before magnet delivery, otherwise the installation will be delayed.

If larger surface area spreader plates are required, contact your Service Engineer for advice.

Table 10 Floor-Plate surface area and part numbers (cost-option)

Magnet/Bore (MHz/mm)	Floor plate part numbers required	Surface area, m2
400/54/ASP, 400/54/AR, 400/89/ASP, 500/54/ASP and 600/54/ASC	DNC134553 & DNC334580	0.590
500/89/AS, 500/54/AR, 600/54/ASP, 600/54/AR, 600/89/ASP and 700/54/ASP	DNC134562 & DNC334580	0.691
700/89/ASP, 750/89/ASP, 800/54/ASC, 850/54/ASC	DNC139156 & DNC334580	0.814

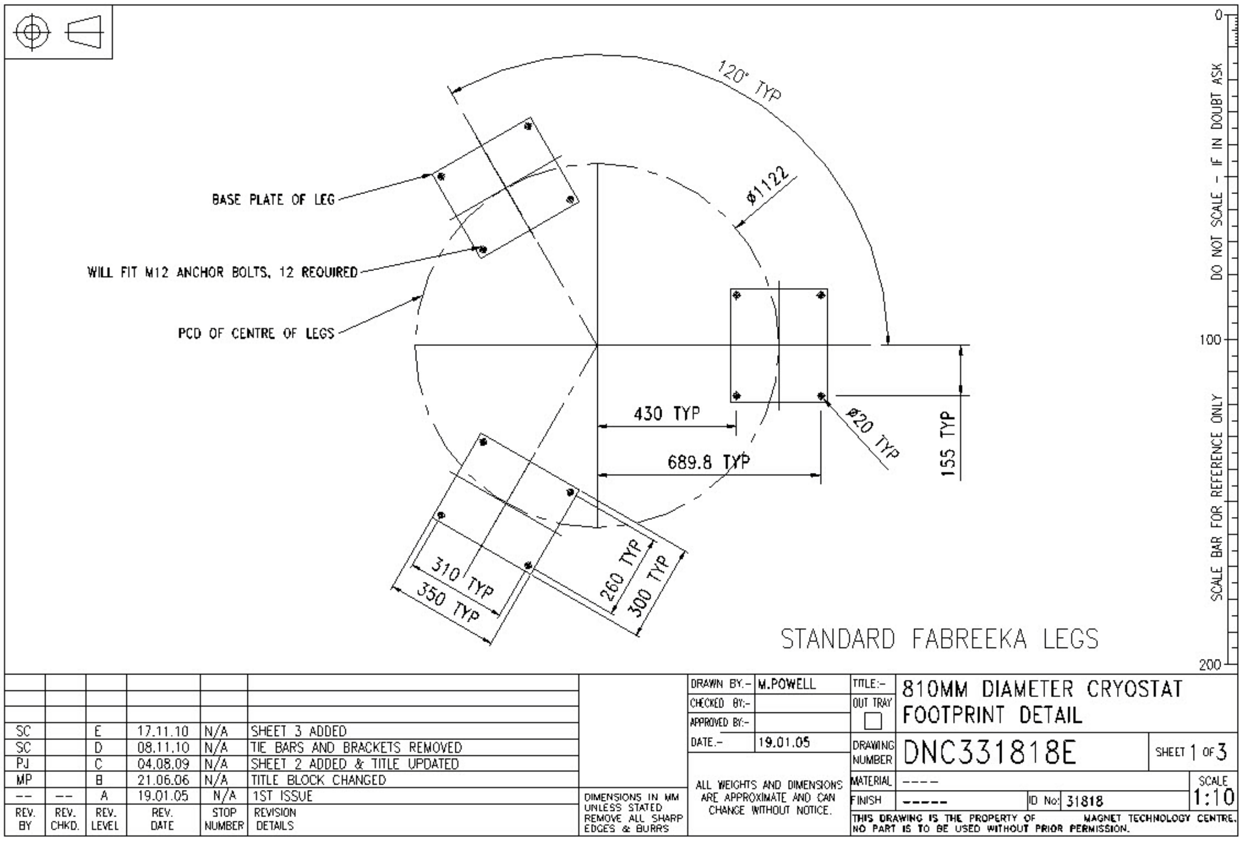
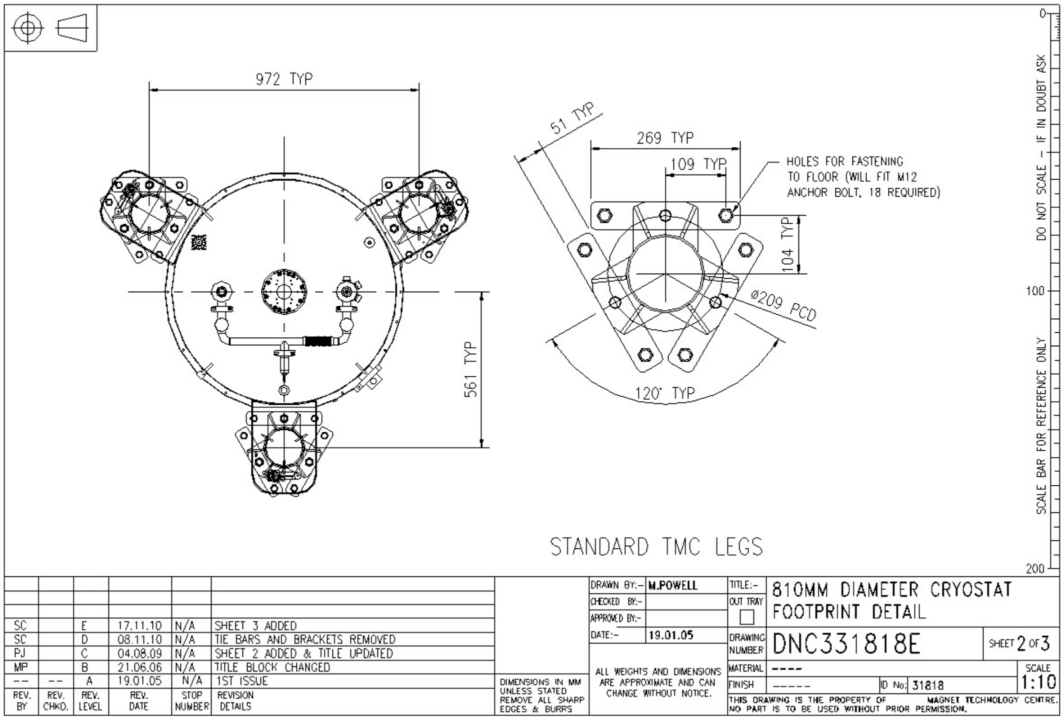


Figure 1 Footprints for 400/54/ASP, 400/54/AR, 400/89/ASP, 500/54/ASP, and 600/54/ASC Agilent Magnets



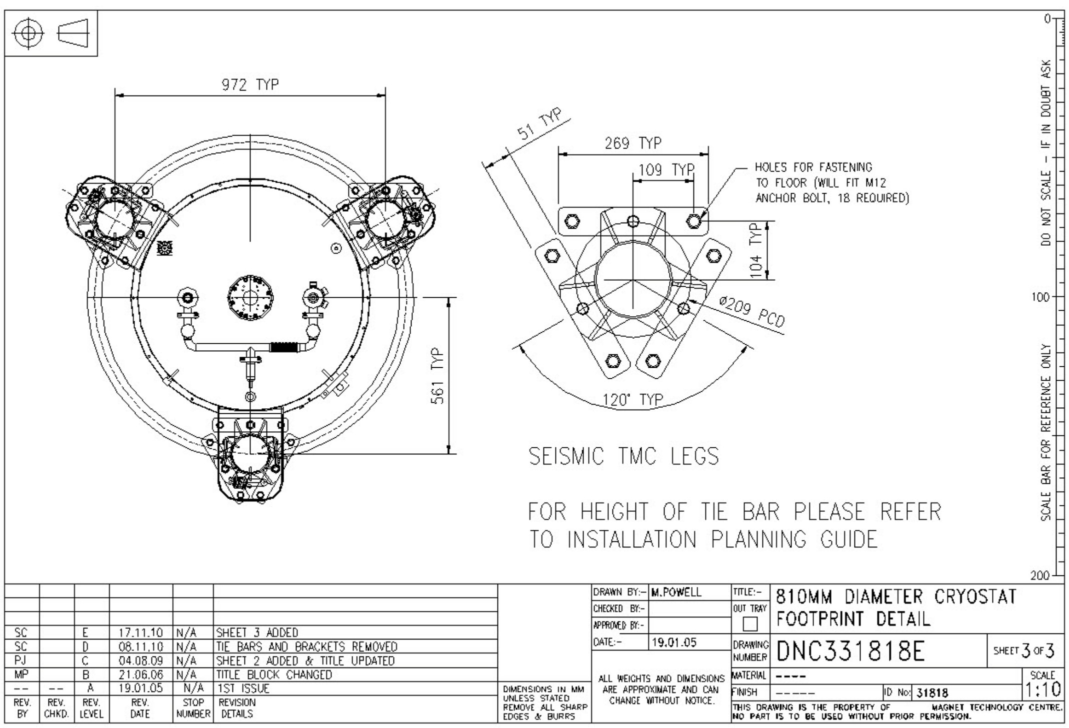


Figure 1 Footprints for 400/54/ASP, 400/54/AR, 400/89/ASP, 500/54/ASP, and 600/54/ASC Agilent Magnets (continued)

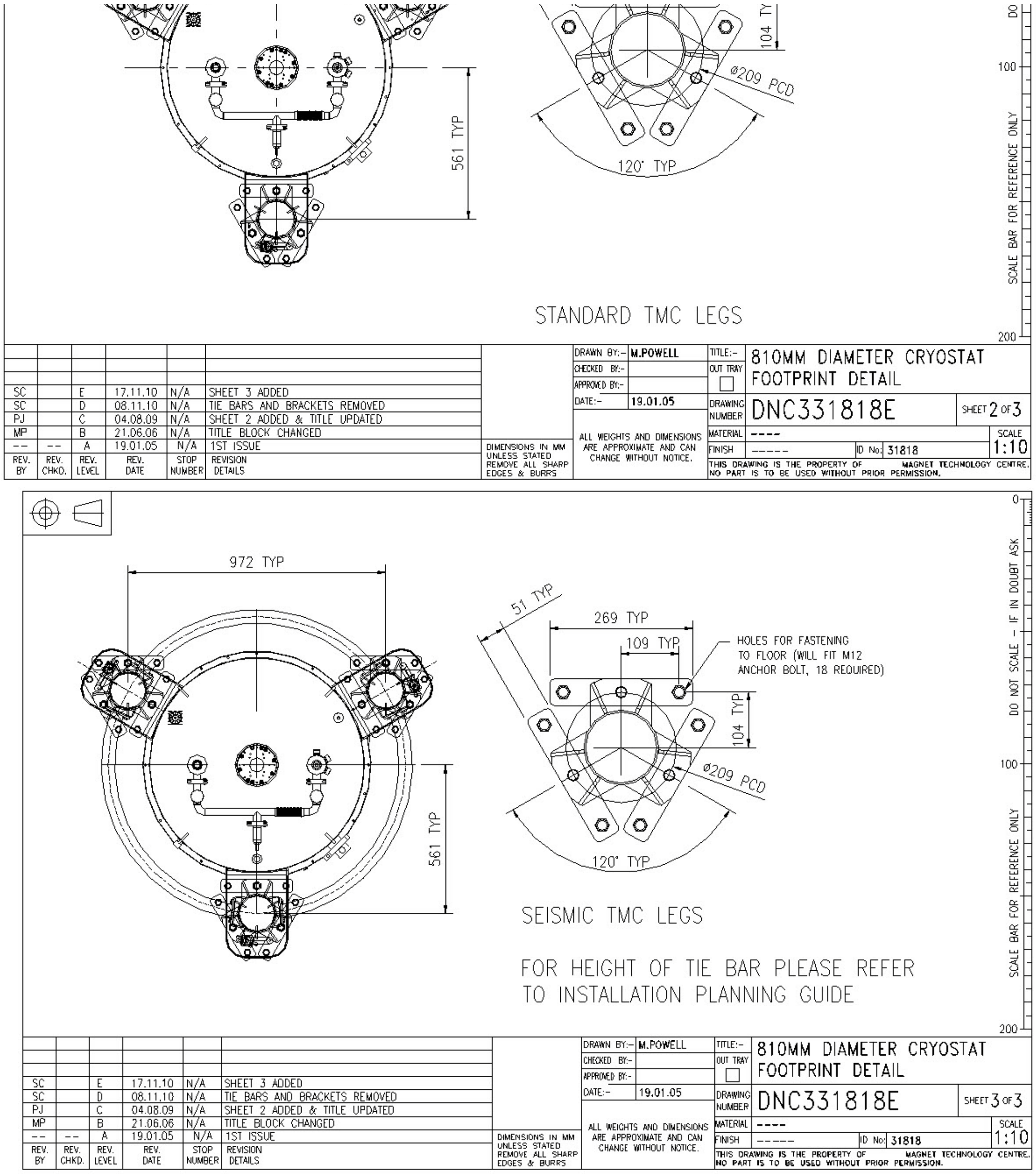


Figure 2 Footprints for 500/89/AS, 500/54/AR, 600/54/ASP, 600/54/AR, 600/89/ASP and 700/54/ASP Agilent Magnets

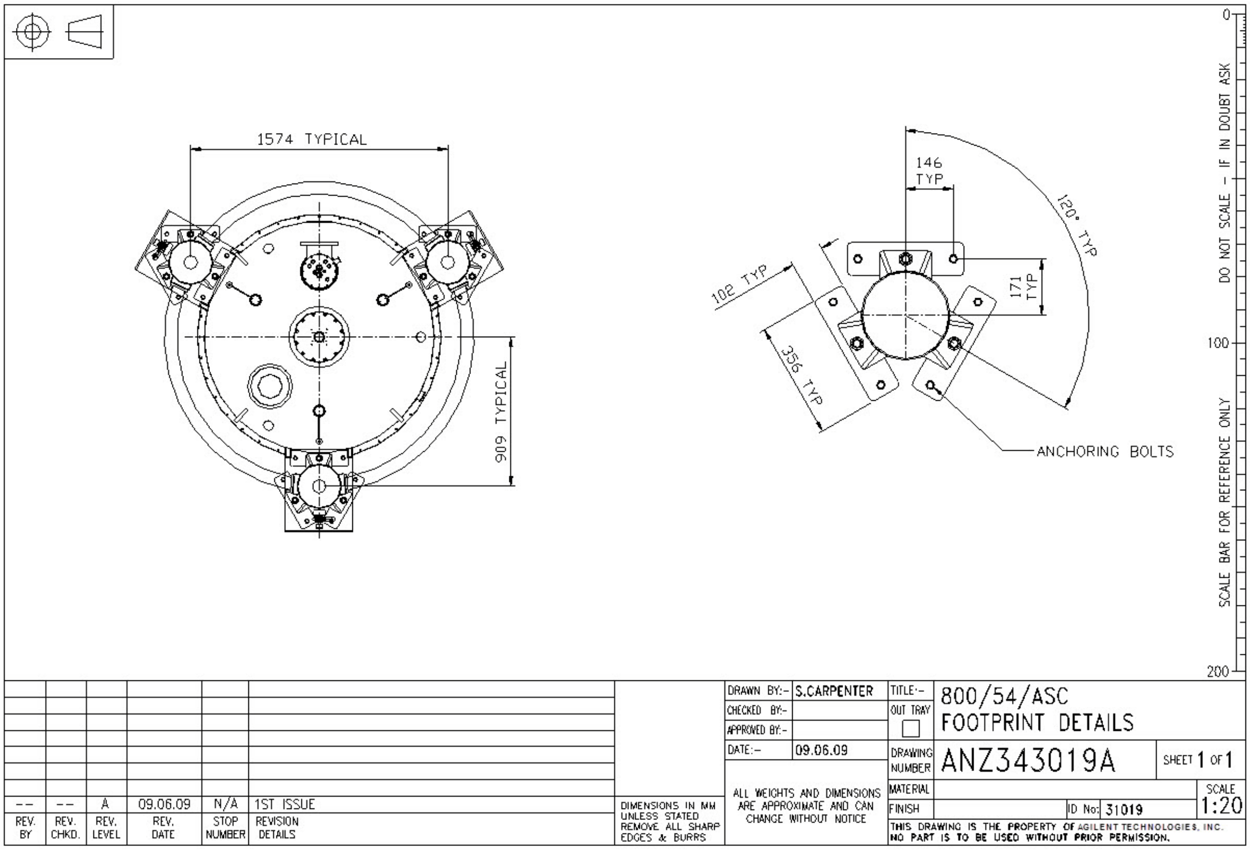


Figure 3 Footprint for 700/89/ASP, 750/89/ASP, 800/54/ASC, and 850/54/ASC Agilent Magnet

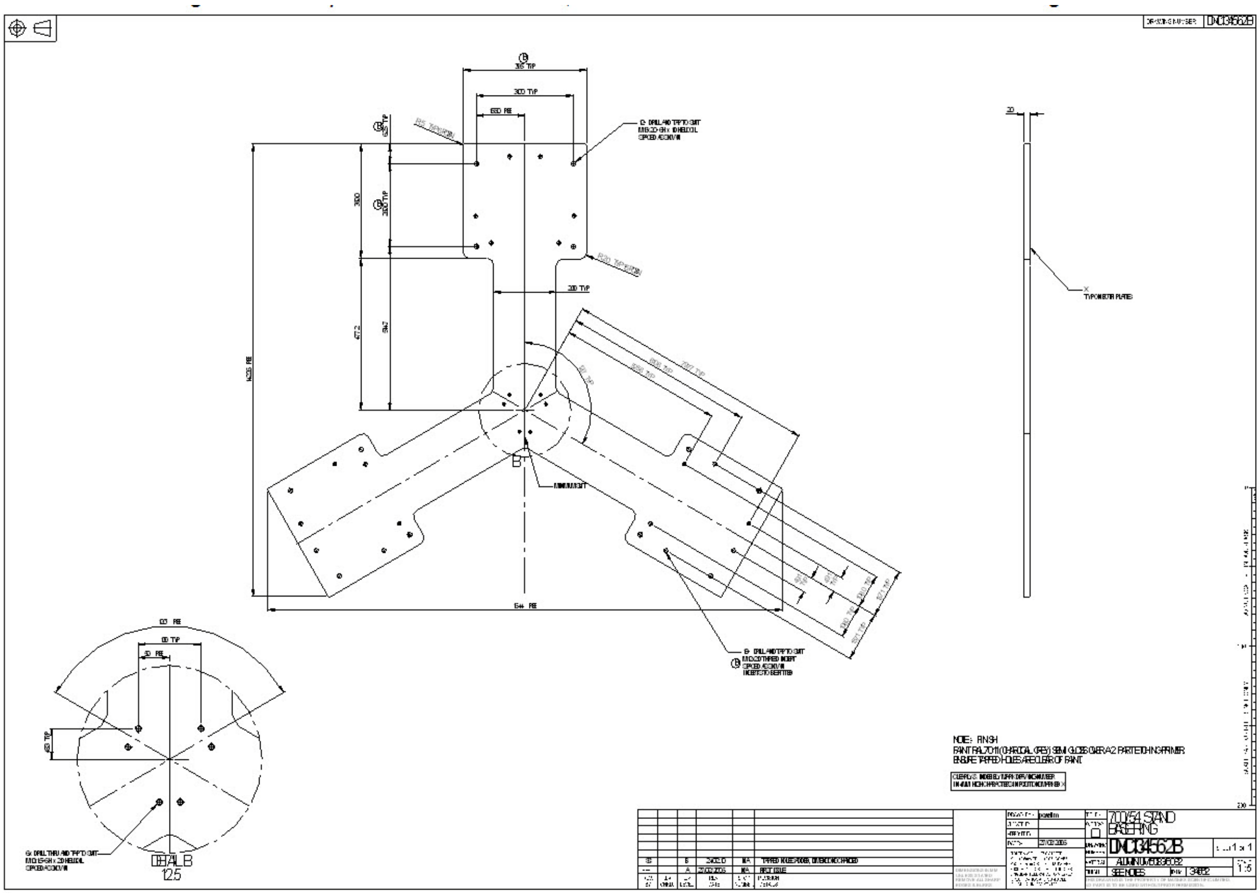


Figure 4 Example of a Y floor-plate for an Agilent magnet

Magnet anchoring and additional support

The magnet has a high center of gravity and could tip over if it is struck hard enough by a large object, or if it is shaken during an earthquake. Depending on the seismic requirement, the size of the magnet and the floor material, floor anchoring alone may not be adequate to circumvent the risk of the system tipping. It is the customer's responsibility to determine and provide suitable anchorage for their floor type and it is their responsibility to drill into their own floor. A structural engineer should be contacted for recommendations. Magnet dimensions and weights are listed in Table 6 on page 22.

Agilent NMR magnets are supplied with anti-vibration legs which must be fixed to the floor using adequate fixings for the floor type. The anti-vibration system used incorporates the dampening mechanism as an integral part of the magnet leg and the legs are not rigidly attached to the magnet. In order to function properly they must be firmly attached to the floor. Contact a structural engineer to determine the appropriate fixings required. Although Agilent supplies as standard 12mm diameter anchor bolts for each leg (16mm for the largest systems), it is the customers' responsibility to ensure that adequate and appropriate fixings/anchor bolts are used for their floor, and replacement fixings must be obtained if necessary. If the standard anchor bolts supplied are suitable for site use (information for the bolts provided can be found in Appendix E), a minimum depth of 65mm (2.5in) is required for each bolt. If floor fixing is not possible, a floor plate may be suitable to "tie" the legs together for non-seismic zones only. Please refer to "Floor Loading" on page 26.

In seismically active areas the magnet should have additional support to prevent tipping. Strengthened seismic legs with tie-bars are available as a cost option for all magnets, and have been engineered to support magnets located in up to and including UBC Seismic Zone 4. The footprints of these seismic legs are shown in Figure 1 on page 28 and Figure 2 on page 30. The dimensional information relating to the tie bars is provided in Table 11. This information needs to be used in conjunction with the standard Customer Interface drawing in the magnet's Technical Specification document. As an alternate seismic solution, the magnet can be installed on standard anti-vibration legs or stands with additional overhead supports using ropes to the ceiling. If overhead ropes are used, the ceiling of the building should be evaluated for structural strength. The ropes should have a small amount of slack so that building vibrations are not transmitted to the magnet. These vibrations can cause artifacts to appear in the NMR spectra. A structural engineer should be contacted to determine the best restraint method that meets local seismic requirement variations.

Agilent expects that the customer's plant or maintenance personnel will drill the holes in the floor and to provide suitable anchorage for the legs. Agilent will not accept responsibility for any damage caused to the floor, or for the consequences of an inadequately anchored/supported magnet.

Table 11 Seismic leg tie bar information

Magnet/Bore (MHz/mm)	Description of tie-bar.	Distance from underside of leg hood (when deflated) to center height of tie-bar.
400/54/ASP, 400/54/AR,	2” diameter tube centered on a diameter of 1122mm.	350.5mm
400/89/ASP, 500/54/ASP and 600/54/ASC	2” diameter tube centered on a diameter of 1122mm.	434.5mm
500/89/AS, 500/54/AR, 600/54/ASP, 600/54/AR, 600/89/ASP and 700/54/ASP	2” diameter tube centered on a diameter of 1289.3mm.	577.6mm

Floor level and flatness

In general the floor should be pre-prepared such that it is flat and level over the area where all three legs are to be installed. This is to make installation of the legs easier, where all three legs need to be in the vertical position, and at an equal height. A smooth, flat floor also ensures good surface contact and even load distribution.

A floor flatness to within ~2.5cm (1”) over the footprint of the magnet is acceptable, since each of the magnet legs is provided with a leveling mechanism (bolts or plates) which allows some adjustment. Please bear in mind that where relying on leveling bolts, the footplates will not have good contact with the floor, and point loading on the floor will increase accordingly.

Floor vibration requirements

Make vibrations measurements with an analyzer (Ono Sokki Model CF 200 field FFT analyzer, or equivalent) using 16 RMS time averages and with a seismic accelerometer that has 10 V/g sensitivity (Wilcoxen Model 731 or equivalent).

Ground floor or basement sites are generally preferred for systems because the natural resonant frequencies of most building structures are typically at low frequencies and horizontal in direction. Also cement slabs on grade are preferred to suspended floors because they are stiffer by nature and generally have less low frequency vibrations.

The maximum allowable vibrations for the anti-vibration pistons are listed in Table 12.

Table 12 Limitations on floor vibrations

Greater than 15 Hz	no single peak greater than 200 µg
10 to 15 Hz	no single peak greater than 100 µg
5 to 10 Hz	no single peak greater than 50 µg
Less than 5 Hz	no single peak greater than 5 µg

Systems can be installed in less suitable environments provided the customer assumes all responsibility for required changes should the resulting spectrometer performance not be acceptable as a result of building vibrations. This exception must be written into the acceptance criteria of the sales contract.

Floor covering

Concrete floors that are of a smooth finish and sealed with wax or painted with durable epoxy paint provide very good surfaces on which to place the magnet. Unfinished concrete floors are not recommended since they are prone to collect dirt and dust. If a floor covering is used, choose one that is hard-wearing (industrial grade) and that can withstand cryogen spills etc. Also consider any preparation materials beneath the covering, for example, underlay under carpet or insulation under wood flooring, which may make the system less stable. In these cases, it would be advisable to anchor the magnet to the solid floor first, and then fit the floor covering around the leg bases. Plan this ahead of the installation in conjunction with Agilent Service, since it is advisable to complete the floor covering before the magnet is energised.

Obviously once the magnet is commissioned it will not be possible to maintain the floor with either mechanical polishers or vacuum cleaners due to the magnetic field, and this may affect the choice of floor covering.

Please also see “Electrostatic Discharges” on page 78 for further floor covering considerations.

Magnetic Environment

The interaction between the magnet and the environment is a major site planning consideration. Each site must be carefully analyzed for safety and optimum performance of the system.

The presence of the magnet places restrictions on use of certain areas within the fringe field to maintain safety in the magnet environment.

The performance of the magnet and the quality of the results depend on maintaining the internal quality of the magnetic field. The site must be carefully considered so as not to detrimentally affect the quality of this internal magnetic field. In reality this means that minimum separation distances must be maintained between the magnet and anything that can cause a detrimental effect on the field homogeneity or the structural integrity of the magnet. Conditions that could interfere with the magnet include (but by no means limited to) a wall with metal sheathing or steel studding, a concrete support column with steel reinforcing bars, and a storage area containing steel dewars for cryogenic storage. Additional considerations include the exclusion of sources of fluctuating magnetic interference, for example, fluctuating loads on adjacent power lines, electric trains and trams, radio or television transmissions heavy-duty transformers, elevator motors and similar electromagnetic devices. The proximity of electromagnets, elevators, loading docks and parking areas may also be of concern.

The different considerations are separated into the following sub-sections:

- Magnet and Fringe Field Information.
- Safety Hazards of Strong Magnetic Fields. Direct safety considerations, such as the induced force on objects and the effect of magnetic field on pacemakers.
- Considerations of Static Ferromagnetic Objects in Magnetic Fields. The effect of static ferromagnetic (magnetizable) objects on the magnet. The possible effects of static ferromagnetic objects are on magnet homogeneity and the generation of an attractive force with the magnet. These effects are usually time-independent.

- Considerations of Moving Ferromagnetic Objects in Magnetic Fields. The effect of moving ferromagnetic (magnetizable) objects on the magnet. Moving ferromagnetic objects generate changing magnetic fields which change the field seen at the magnet and hence affect sensitive NMR experiments.
- Consideration of Unstable Magnetic Environments. The effect of a fluctuating magnetic environment, for example, caused by a local tram network.
- Consideration of Magnetic Field on Equipment. This section considers the safe placement of equipment which is sensitive to magnetic field. In this section, the safe placement of the NMR System components within the magnet room are also indicated.

Each section summarises expected “safe” distances for typical magnetic objects in the local environment. These are guidelines only and where objects are within these distances, it does not necessarily mean that the site is not suitable, it just highlights the need for further investigation and a site survey.

Magnet and fringe field information

Completely surrounding the magnet is a magnetic field called the fringe field. This can cause ferromagnetic objects in the vicinity to become magnetized more than the ambient earth’s magnetic field. (In many modern magnets where the fringe field is contained very close to the magnet, even the effect of the earth’s magnetic field alone must be considered.)

The Technical Specification document for each magnet type states the 5-gauss fringe field specification in the text and includes a design fringe field plot indicating the field profile, usually showing the 5, 10 and 30 gauss positions (some specification documents show the 50 gauss field profile).

A fringe field summary for all Agilent NMR magnets is given in Table 13 and Table 14. In general, the values stated are for indication only, especially at low fringe fields where the Earth’s magnetic field and the local environment can make significant contributions. Where the field profile is critical (for example, for cardiac pacemaker wearers) we advise that the fringe field should be checked after the magnet has been installed, since small variations can occur due to winding tolerances and local environment effects.

Table 13 Stray field data for nmr magnet systems - radial distance

Magnet Systems (MHz/mm)	Radial Distance (m) from Magnetic Center							
	1 G	5 G	10 G	30 G	100 G	300 G	600 G	6,000 G	20,000 G
400/54/ASP	0.80	0.55	0.50	0.45	a	a	a	a	a
400/54/AR	0.80	0.55	0.50	0.45	a	a	a	a	a
400/89/ASP	1.00	0.80	0.70	0.60	0.51	0.44	a*	a	a
500/54/ASP	0.90	0.80	0.70	0.65	0.55	0.47	0.42	a	a
500/54/AR	0.90	0.80	0.70	0.65	0.55	0.47	0.42	a	a
500/89/AS	3.30	2.00	1.60	1.10	0.76	0.60	0.52	a	a
600/54/ASP	1.10	1.00	0.90	0.80	0.65	0.56	0.50	a	a
600/54/ASC	1.00	0.70	0.65	0.55	0.46	a	a	a	a
600/54/AR	1.00	0.70	0.65	0.55	0.46	a	a	a	a
600/89/ASP	1.80	1.10	0.90	0.80	0.62	0.54	a	a	a
700/54/ASP	2.70	1.50	1.20	0.80	0.62	0.54	0.49	a	a
700/89/ASP	2.10	1.40	1.30	1.15	0.99	0.86	0.80	a	a
750/89/ASP	2.20	1.60	1.40	1.20	0.99	0.87	0.80	a	a
800/54/ASC	2.00	1.45	1.30	1.15	1.00	0.87	0.80	a	a
850/54/ASC	2.10	1.45	1.30	1.15	1.00	0.87	0.80	a	a

* Within the cryostat.

Table 14 Stray field data for nmr magnet systems - axial distance

Magnet Systems (MHz/mm)	Axial Distance (m) from Magnetic Center								
	1 G	5 G	10 G	30 G	100 G	300 G	600 G	6,000 G	20,000 G
400/54/ASP	1.30	1.00	0.85	0.70	0.55	0.46	a*	a	a
400/54/AR	1.30	1.00	0.85	0.70	0.55	0.46	a	a	a
400/89/ASP	1.80	1.30	1.10	0.90	0.72	0.60	0.55	0.37	a
500/54/ASP	1.70	1.25	1.10	0.90	0.74	0.62	0.55	a	a
500/54/AR	1.70	1.25	1.10	0.90	0.74	0.62	0.55	a	a
500/89/AS	4.20	2.70	2.10	1.55	1.10	0.86	0.74	0.48	a
600/54/ASP	1.90	1.45	1.30	1.10	0.88	0.74	0.66	0.46	a
600/54/ASC	1.70	1.25	1.10	0.90	0.70	0.58	0.52	a	a

Table 14 Stray field data for nmr magnet systems - axial distance (continued)

Magnet Systems (MHz/mm)	Axial Distance (m) from Magnetic Center							
600/54/AR	1.70	1.25	1.10	0.90	0.70	0.58	0.52	a	a
600/89/ASP	3.00	2.00	1.70	1.30	1.03	0.84	0.75	0.50	a
700/54/ASP	3.70	2.30	1.80	1.45	1.10	0.88	0.77	0.51	a
700/89/ASP	3.70	2.55	2.25	1.75	1.38	1.14	1.00	0.67	0.53
750/89/ASP	3.70	2.55	2.30	1.80	1.44	1.18	1.10	0.69	0.55
800/54/ASC	3.60	2.55	2.25	1.80	1.40	1.15	1.00	0.67	0.53
850/54/ASC	3.70	2.55	2.25	1.80	1.40	1.15	1.00	0.67	0.53

* Within the cryostat.

Table 15 shows the distance of the magnet isocentre from the floor and can be used to determine the axial locations of the different fringe fields in the proposed magnet location.

Table 15 Magnet centerline to floor

Magnet/Bore(MHz/mm)	Distance From Magnet Centerline to Floor (m)
400/54/ASP	1.082
400/54/AR	1.082
400/89/ASP	1.129
500/54/ASP	1.153
500/54/AR	1.153
500/89/AS	1.275
600/54/ASP	1.201
600/54/ASC	1.153
600/54/AR	1.153
600/89/ASP	1.201
700/54/ASP	1.251
700/89/ASP	1.420
750/89/ASP	1.420
800/54/ASC	1.350
850/54/ASC	1.350

Safety hazards of strong magnetic fields

The potential safety hazards of strong magnetic fields for devices such as certain pacemakers must be planned for and understood. Some unrestrained ferromagnetic objects can be drawn towards the magnet when they are within approximately 5 to 10 gauss of the magnet, become airborne and cause injury or damage to the equipment. Actual magnetic fields may vary from theoretical design and if critical, should be checked after a particular magnet has been installed.

WARNING

Cardiac pacemaker wearers must remain outside the 5-gauss perimeter from the magnet until safety is clearly established. An NMR superconducting magnet system generates strong magnetic and electromagnetic fields that can inhibit operation of some cardiac pacemakers, which could result in death or serious injury to the user. Consult the pacemaker user's manual, contact the manufacturer, or confer with a physician to determine the effect on a specific pacemaker. Agilent provides signs with each system to warn pacemaker wearers of this hazard. Post signs according Appendix A, "Posting Requirements for Magnetic Field Warnings" .

Cardiac pacemaker wearers should refrain from entering a zone that would subject a cardiac pacemaker to a magnetic intensity that could cause adverse effects. Refer to the pacemaker user's manual, contact the manufacturer, or confer with a physician to determine the magnetic field limits and the effect on a specific pacemaker. Actual field levels may vary and should be checked after a particular magnet has been installed.

Agilent, Inc. provides signs warning of magnetic field hazards. Refer to Appendix A, "Posting Requirements for Magnetic Field Warnings" , for an explanation of the types of signs and the sign posting requirements. Additional signs are available from Agilent, Inc. at no charge.

Magnetic field exists both horizontally and vertically. The effect of the magnetic field on persons, electronic equipment, computers and other objects located above and below the magnet must also be considered. Pacemaker hazard and other signs warning that a magnetic field is present may be needed in the space next to the floor above the magnet and on the floor below the magnet.

NMR workers are exposed to high levels of static magnetic fields. At this time, no conclusive evidence exists indicating adverse health effects at current exposure levels. Although some studies suggest a link between magnetic field exposure and adverse reproductive effects, the body of medical data available is not clear enough to draw any firm conclusions regarding risks to pregnancy. In other words, static magnetic field associated with the NMR spectrometer magnets are not considered by the scientific community at this time to comprise a risk to pregnancy or reproductive hazard.

An American Conference of Governmental Industrial Hygienists (ACGIH) article entitled *Threshold Limit Values and Biological Exposure Indices, 5th ed.*, states the following:

> "TLVs [Threshold Limit Values] refer to static magnetic flux densities to which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. These values should be used as guides in the control of exposure to static magnetic fields and should not be regarded as a fine line between safe and dangerous levels."

> "Routine occupational exposures should not exceed 60 millitesla (mT)—equivalent to 600 gauss—whole body or 600 mT (6000 gauss) to the extremities on a daily [8 hour], time-weighted average basis. A flux density of 2 tesla (20,000 gauss) is recommended as a ceiling value."

Considerations of static ferromagnetic objects in magnetic fields

Large ferromagnetic objects close to the magnet should be avoided and unrestrained ferromagnetic objects should be excluded from the vicinity of the magnet (see also "Safety hazards of strong magnetic fields" on page 41). The effects on the magnet homogeneity of moderate amounts of structural steel in the magnet's fringe field can usually be compensated for using the magnet's superconducting shims. The force between the magnet and steel objects must be small enough to avoid any possibility of effects on the structural integrity of the magnet. Nearby static ferromagnetic objects subject to significant vibrations or large temperature fluctuations can also generate time-dependant field changes. The safe placement of static ferromagnetic objects relative to the centre of the magnet are indicated in Table 16.

NOTE

Please note that this table indicates a minimum distance and a maximum fringe field value. Both of these criteria need to be fulfilled, that is whichever of these is the largest distance from the magnet.

Table 16 Recommended maximum fringe field values (minimum distances for static ferromagnetic objects)

Objects	Maximum recommended fringe field (subject to a typical minimum distance of 4 m or 13 ft)
All ferromagnetic construction materials except small amounts of steel reinforcing bar, normally not exceeding 11 kg/m2 (2.5 lb/ft2)	10 gauss
Ferromagnetic objects over 45 kg (100 lb)	5 gauss
Ferromagnetic objects over 450 kg (1000 lb)	1 gauss

Forces on the magnet caused by structural and other ferrous materials within the fringe fields indicated can break the internal structure of the cryostat can cause cryogenic and vacuum problems. The strength of these forces on the magnet is dependent upon the density, distance from the magnet centre, and the symmetrical (preferred) or asymmetrical distribution of the material within the fringe field.

In general, rebar used in reinforced concrete floors and walls is rarely a problem, whereas a mild steel structural I-beam may cause excessive force. If the only possible site for the magnet has ferrous materials within the fringe fields indicated in the table, please contact your Agilent Representative with details of the ferrous material and its exact location relative to the magnet so that specific calculations can be run to determine whether or not the site is, or can be made, suitable for the magnet.

Considerations of moving ferromagnetic objects in magnetic fields

The safe placement of moving ferromagnetic objects relative to the centre of the magnet are indicated in Table 17.

NOTE

This table indicates a maximum fringe field value (from Table 16) and a minimum distance. Both of these criteria need to be fulfilled, that is whichever of these is the largest distance from the magnet.

Table 17 Recommended minimum distances for moving ferromagnetic objects

Object (approximate mass of steel)	Minimum recommended distance (also subject to maximum fringe field values specified in Table 16)
Filing cabinet, metal door, etc	4 meters (13 ft)
Pallet mover	4 meters (13 ft)
Elevator (approx 500 kg, 1100 lb)	4 meters (13 ft) (Consider also directly generated electromagnetic disturbances – see "Considerations of unstable magnetic environments")
Forklift truck (approx 4000 kg, 8800 lb)	6 meters (20 ft)
Automobile (approx 1000 kg, 2200 lb)	4 meters (13 ft)
Delivery trucks (approx 5000 kg, 11000 lb)	7 meters (20 ft)
Trains and trams	DC trains and trams dominated by directly generated electromagnetic disturbances (see "Considerations of unstable magnetic environments")

The effect of moving on some types of NMR experiments is more significant than on others. For more information, see "Considerations of unstable magnetic environments" .

Considerations of unstable magnetic environments

In addition to distance considerations for objects affecting and being affected by the magnetic field, the frequency and amplitude of the environmental magnetic disturbance must also be considered. Table 18 indicates the maximum allowable oscillating magnetic fields depending on the disturbance frequency and the application.

Table 18 Maximum allowable oscillating magnetic field limits

Application	Field, milligauss
High Resolution Liquids (Locked)	less than 14
High Resolution Liquids (Unlocked)	less than 2
General Solids	less than 14
Biosolids	less than 4
Micro-imaging	less than 4

Where there are potential concerns regarding the magnetic environment, measurements can be made to determine the suitability of the site. For this, a calibrated magnetometer (Bartington Spectramag-6 with Mag-03 3-axis fluxgate sensor, or where unavailable, Walker Scientific, Fluxgate

Magnetometer FGM-3D2, or equivalent) is required, and measurements should be taken as close to the required position of the new magnet as possible. Monitor the oscillating magnetic fields in the Z axis with the sensitivity set to capture the full amplitude of the field change. Where data fulfills the guidelines in Table 9 on page 260, then no further action is required. However, where the guidelines are exceeded, the data needs to be passed on to your local service representative so that the data can be analysed in more detail, and suitability can be determined on a site specific basis.

Consideration of magnetic field on equipment

Table 19 lists some magnetically sensitive devices and guidelines for the acceptable fringe field (in gauss) within which they can effectively operate.

Table 19 Equipment affected by magnetic field

Magnetic field	Objects affected by the magnetic field
10 gauss line or closer	Ferromagnetic implant, and unrestrained ferromagnetic objects*, such as tools, keys, electronic equipment, analog watches, magnetic data storage media, and credit cards.
5 to 10 gauss	Cardiac pacemakers* and electronic equipment, such as shielded CRT monitors, computers, shielded image intensifiers, and shielded photomultiplier tubes.
1 to 5 gauss	Very sensitive electronic equipment, such as unshielded image intensifiers, photomultiplier tubes, linear accelerators, electron microscopes, and CRT monitors.

* See safety information

The CRT in color monitors needs to be degaussed in magnetic fields above 1 to 2 gauss. Above 5-gauss, color monitors may need additional shielding to prevent display distortion.

NMR workstations and peripherals are also affected by the magnetic field. See "Host Workstation Preparation" on page 79 for a discussion of magnetic field considerations.

Radio-Frequency Environment

The site should be checked for radio-frequency (RF) interference at or near the operating frequencies for the most common nuclei in Table 20 and of the spectrometer.

Table 20 Operating frequencies for common nuclei

Nuclei	400	500	600	700		800		900		999.75
1H	399.75	499.75	599.75	699.75	749.75	799.75	849.75	899.75	949.75	999.75
19F	376.14	470.23	564.33	658.42	705.47	752.52	799.56	846.61	893.66	940.70
31P	161.82	202.30	242.78	283.26	303.50	323.74	343.98	364.22	384.46	404.70
13C	100.52	125.66	150.81	175.95	188.52	201.10	213.67	226.24	238.81	251.39
29Si	79.42	99.29	119.15	139.02	148.95	158.89	168.82	178.75	188.69	198.62
2H	61.36	76.71	92.06	107.41	115.09	122.76	130.44	138.11	145.79	153.46
15N	40.52	50.65	60.79	70.93	75.99	81.06	86.13	91.20	96.27	101.33
39K	18.65	23.32	27.98	32.65	34.98	37.32	39.65	41.98	44.32	46.65
183W	16.65	20.82	24.99	29.15	31.23	33.32	35.40	37.48	39.57	41.65
103Rh	12.74	15.92	19.11	22.29	23.89	25.48	27.07	28.67	30.26	31.85

Table 21 Spectrometer operating frequencies

1H (MHz)	Range (MHz)
200	12 to 215
300	12 to 325
400	12 to 430
500	12 to 538
600	12 to 645
700	12 to 751
750	12 to 807
800	12 to 859
850	12 to 913
900	12 to 965
950	12 to 1018
1000	12 to 1018

The level of any interference should be attenuated to electrical field strength of less than 150 uV/m at the site of the magnet. At higher RF level, consult with your local service engineer for options. Interference often occurs when two spectrometers are located in the same room, referenced to the same power system, or operating at the same frequency.

Radio-Frequency interference

Most radio-frequency interference comes from transmissions for radio, television, paging systems, and cellular telephones. Some emission comes from electrical and electronic equipment in the immediate area.

RF emissions from Agilent NMR equipment has been measured and compared with IEEE/ANSI C95.1–1991, “Standard for Safety Levels with Respect to Human Exposure to RF Radiation.” The RF tests included general measurements of systems with particular interest directed toward amplifiers, transmitter boards, and probes. With maximum observe transmitter and decoupler transmitter power applied (parameters tpwr and dpwr set to 63), measurements were taken both 12 inches away and as close as possible to the RF source while the source was installed in the console or magnet.

The results of the tests, Table 22, show the RF emissions from Agilent NMR equipment either were not detectable or were detectable at levels far below the IEEE/ANSI C95.1–1991 Standard levels, which are shown in Table 23.

Table 22 Results of RF Emissions Tests on Agilent NMR Equipment

Spectrometer System and NMR Experiment	Frequency (MHz)	RF at Probe (mW/cm2)	RF at Amplifier (mW/cm2)	IEEE/ANSI C95.1-1991
600-MHz				
Carbon observe tpwr=58 pulse	150	0 E-field 0 H-field	0 E-field 0 H-field	1.0 E-field 1.0 H-field
Carbon observe tpwr=63 pulse, 50-ohm load	150	0 E-field 0 H-field	0 E-field 0 H-field	1.0 E-field 1.0 H-field
Proton observe tpwr=63 pulse	600	0 E-field 0 H-field	0 E-field 0 H-field	2.0 E-field 2.0 H-field

Table 22 Results of RF Emissions Tests on Agilent NMR Equipment (continued)

Spectrometer System and NMR Experiment	Frequency (MHz)	RF at Probe (mW/cm2)	RF at Amplifier (mW/cm2)	IEEE/ANSI C95.1-1991
Proton observe tpwr=63 pulse, 50-ohm load	600	0 E-field 0 H-field	0.05 E-field 0.05 H-field	2.0 E-field 2.0 H-field
500-MHz				
Carbon observe tpwr=63, dpwr=63 pulse terminated	125	0 E-field 0.05 H-field	0 E-field 0.01 H-field	1.0 E-field 1.0 H-field
Carbon observe tpwr=63 pulse, 50-ohm load	125	0.01 E-field 0.2 H-field	0.05 E-field 0.02 H-field	1.0 E-field 1.0 H-field
Proton observe tpwr=63 pulse	500	0.25 E-field 0.25 H-field	0.05 E-field 0.05 H-field	1.7 E-field 1.7 H-field
Proton observe tpwr=63 pulse, 50-ohm load	500	0.25 E-field 0.25 H-field	0.05 E-field 0.05 H-field	1.7 E-field 1.7 H-field
400-MHz				
Cross-polarization 300 W, 2 ms pulse	75	0.005 E-field 0.05 H-field	0 E-field 0.005 H-field	1.0 E-field 1.8 H-field
Cross-polarization 100 W, 20 ms pulse	300	0.1 E-field 0.1 H-field	0 E-field 0 H-field	1.0 E-field 1.0 H-field
CMA amplifier				
Cross-polarization 300 W, 2 ms pulse	75	0.005 E-field 0.05 H-field	0 E-field 0.005 H-field	1.0 E-field 1.8 H-field
Cross-polarization 100 W, 20 ms pulse	300	0.1 E-field 0.1 H-field	0 E-field 0 H-field	1.0 E-field 1.0 H-field

Table 23 IEEE/ANSI C95.1–1991 standard for RF radiation levels

Frequency (MHz)	E-Field (mW/ cm2)	H-Field (mW/cm2)
50	1.0	4.0
75	1.0	1.8

Table 23 IEEE/ANSI C95.1–1991 standard for RF radiation levels

Frequency (MHz)	E-Field (mW/ cm2)	H-Field (mW/cm2)
125,150	1.0	1.0
200,300	1.0	1.0
500 0	1.7	1.7
600	2.0	2.0
700,750,800,900	2.5	2.5

Temperature, Humidity and Ventilation Requirements

Ambient Temperature and Humidity

Table 24 lists the required ambient temperature ranges, temperature stability, and humidity levels for the site. For optimal performance, the ambient temperature around the magnet should not vary. Magnet homogeneity is optimized if the ambient temperature stability is maintained for the duration of an experiment and between shimming. Sunlight should never shine directly on the magnet or the area surrounding the magnet.

Table 24 Ambient temperature and relative humidity

Mode	Temperature		Relative humidity noncondensing
	°C	°F	
Operational range	17 to 24	60 to 75	20% to 80%
Optimum	20	68	40% to 60%
Temperature stability	± 1.0	± 1.8	
Nonoperational range	–20 to 60	–4 to 140	8% to 80%

If necessary, install an air conditioning system to maintain the required conditions. Keep the air conditioning system operating continuously to stabilize the temperature and humidity surrounding the spectrometer system. The air flow from the room heating and cooling system must be directed away from the magnet. Do not allow moisture to collect on, in, or around the system. At high altitudes (above 5000 ft), the cooling efficiency for the electronics is lower. This can be compensated for by lowering the room temperature by one or two degrees from the room temperature specification.

For systems at 700 MHz above, and where the best long-term stability and data quality is desirable such as for high-performance Biosolids applications, the following, more stringent requirements need to be taken into consideration and met.

Constant air pressure and temperature are important considerations for high performance operation.

The air conditioning system should operate continuously to stabilize the temperature and humidity of the magnet environment and should not cycle rapidly.

Room temperature should be kept between 18 °C (63 °F) and 25 °C (77 °F).

The room temperature should not fluctuate at a rate faster than ±0.5 °C (±1 °F) per hour. Near the magnet or cabinets, the temperature fluctuation should not exceed ±0.5 °C (1 °F). Air drafts, particularly those created from air conditioning or heating systems, can have negative effects on the magnet. The location and orientation of air-diffusers must be carefully chosen to prevent the air from blowing towards the magnet and spectrometer cabinet, since this would have a negative impact on the system stability and its performance.

The following considerations are also critical, as they have been found to cause system instabilities due to the associated temperature changes:

- Please do not direct spotlights toward the magnet; this could change the surface temperature of the magnet.
- Consider the placement of lights relative to the air conditioning inputs, which often contain the temperature sensors for the air conditioners. This can result in a considerable change of the room temperature as a function of lights being turned on or off, caused by the heat dissipated by the lights.
- Lights are generally not recommended within a radius of 3m (~10 ft) from the magnet, as they can change the temperature distribution in the vicinity of the magnet.

There should be no sunshine allowed into the lab, as it can heat up system components such as magnet, console, or cables, but also indirectly change the temperature distribution within the lab when it just warms up the lab floor.

Similarly, poorly insulated outside walls and windows should be avoided, as they can also cause considerable drafts and temperature changes in response to outside thermal conditions.

For specific questions related to high-stability requirements, please consult with your local service engineer.

Room ventilation

For everyday operation the room ventilation system must be capable of exchanging 2 times the volume of the room air per hour to meet the minimum safety standards for working with cryogens. We also recommend the following for all magnet rooms:

- sensors for monitoring air flow into the room
- high level and low level oxygen sensors for oxygen monitoring (cold helium rises and cold nitrogen falls). If the magnet is installed in a pit, then an oxygen sensor should be installed at the bottom of the pit. If the ceiling height is extended above the magnet, then an oxygen sensor should be installed in the recess.
- Installation of an emergency (passive) vent and/or outward opening doors in case of extreme failure, to prevent the room pressurizing during a gas release.

Further safety precautions are required to those mentioned above to protect personnel in the event of a quench. A quench occurs when the magnet loses its superconductivity and warms the liquid helium, rapidly generating a large volume of gas. If it is vented into the magnet room this gas can create a danger of asphyxiation by displacing the air within the room, as well as the potential hazards if the room becomes pressurized. A minimum oxygen level of 19.5% needs to be maintained in the room during a magnet quench, preventing the risk of asphyxiation. This can be achieved in one of 3 ways; having a large enough room, piping the quench gases out of the room, or by fitting suitable extraction.

Helium has a volume expansion ratio of liquid helium to helium gas at room temperature of approximately 740:1. The volume of He gas released upon quenching of a 400/54 Premium Shielded magnet (the smallest vertical magnet in the range) is 89.54 m^3 and results in the displacement of ALL the oxygen in a room 5.86 m x 5.86 m x 2.61m (square room, min. ceiling height) with room temperature He gas. For comparison (the largest 4.2K magnet in the range), the volume of helium gas released during a quench of a 800/54 PremiumCOMPACT magnet is 684.50 m^3 and results in the displacement of ALL the oxygen in a room 13.91 m x 13.91 m x 3.54 m (square room, min. ceiling height).

Table 25 on page 53 lists the maximum amount of liquid helium contained within each magnet system. It is unlikely that a magnet quench will boil off the entire amount listed in the table so these values are safe for ventilation planning purposes. The table also shows the minimum volume of the room required to safely site each vertical NMR magnet. This information is based on maintaining the oxygen level in the room above 19.5%. Given this information, the aspect ratio of the room also needs to be taken into consideration. Helium is lighter than air and will in general fill the room from the top down. Rooms with low ceilings will pose more of an asphyxiation risk than an equal volume room with small floor area and tall ceiling.

Table 25 Liquid helium displacement of air

Magnet/Bore(MHz/mm)	LHe Maximum Volume (liters)	Minimum “Safe” Room Volume* (m3)
400/54/ASP	121	1100
400/54/AR	121	1100
400/89/ASP	147	1350
500/54/ASP	189	1725
500/54/AR	425	3875
500/89/AS	295	2675
600/54/ASP	275	2500
600/54/ASC	190	1750
600/54/AR	425	3875
600/89/ASP	260	2400
700/54/ASP	263	2400
700/89/ASP	925	8400
750/89/ASP	925	8400
800/54/ASC	925	8400
850/54/ASC	925	8400

* based on 19.5% oxygen, and not considering the aspect ratio of the room.

If the proposed magnet room is larger than the “safe” volume recommended, then no additional requirements need to be taken into account. The magnet is provided with the quench valves as standard, which vent helium gas into the magnet room in the event of a quench.

If the proposed magnet room has a volume less (or close to) the minimum “safe” volume stated in Table 25 on page 53, we recommend connecting the magnet to a quench pipe, so that the quench gases can be safely ducted out of the magnet room to outside. This method is both the simplest and often the cheapest to implement. Please read section “Quench Manifolds and Piping” for further information. In the event that an active extraction system is preferred, please contact your Agilent Representative so that general advice on rates of extraction can be provided on a site specific basis.

Remember that vented helium gas fills the room from the ceiling down, so place fans and ducts accordingly.

WARNING

Risk of asphyxiation.

Ensure the magnet is adequately ventilated to maintain an oxygen level of 19.5% Oxygen in the room in the event of a magnet quench.

Quench Manifolds and Piping

If the magnet room requires quench piping, please read all the notes in this section in order to understand the requirements, and then contact your Agilent representative with the following information:

- The magnet type that is to be installed.
- Choice of horizontal or vertical adapter (for calculation purposes)
- Details of the proposed piping route, starting at the magnet end and ending where the pipe exhausts outside. This should include the length of the overlapping section with the stub tube. Please include (in sequential order) the lengths of straight sections, and number and type of bends (for example, 45 degrees, 90 degrees, long or tight bends).

An Agilent Magnet Project Engineer will then run a calculation to ensure that the proposed route keeps the resultant back-pressure on the magnet within acceptable limits.

General configuration

In order to safely connect a vertical magnet to quench piping, the following needs to be taken into consideration:

- At the magnet end, for the standard 2 and 3-neck systems (up to and including 700/54 Premium Shielded) the following cost-options are required:
  - A quench manifold is required, replacing the standard manifold on the magnet.
  - Then an adapter which fits to the magnets burst disk is required. There is a choice of a vertical (preferred) or horizontal adapter. Connected to the chosen adapter is an expansion tube, with a “stub tube” fitted, which is the internal tube for the overlap connection to the room’s ducting.
- At the magnet end, for the large systems with a single service turret, a burst disk with adapter and quench stub tube in the horizontal configuration are fitted as standard.

- At the room end, for all systems, the customer needs to supply piping which starts at the overlap to the magnet's quench "stub tube" and is routed to outside the building. Currently we only have a configuration available for ≥8 in ducting. In all cases there are pressure-drop limitations for the piping, dependent on the magnet type, which must be considered.

Quench manifold and adapter considerations

The magnet and piping need to be carefully positioned with (a) maximum overlap and minimum radial gap between the stub tube and the room piping to avoid helium gas being forced back into the magnet room and (b) a non-contact or soft contact overlap between the pipe and stub tubes to prevent vibration transmission through to the magnet. Non-contact overlaps need particular care and attention since the magnet can move vertically due to the inflation of the anti-vibration legs. For this reason the overlap is preferred to be in the vertical orientation, so that the tubes can slide up and down with the legs, without compromising radial clearance. Sift contact overlaps are easier to achieve. In this case the outer tube needs to be ~10", and the radial gap is filled with sheets of soft foam wrapped around the stub tube.

There needs to be adequate access in the manifold/piping configuration to be able to remove the adapter to check the integrity of the magnet's burst disk. In principle, vertical configurations are simpler, since the 90 degree adapter can be unscrewed and dropped out from the piping. For horizontal configurations this is more difficult to achieve, and some kind of flexibility in the horizontal direction is required in the customer's piping in order to pull the external ducting away from the stub tube, so that the adapter can then be removed to access the burst disk.

Table 26 Quench manifold/adapter part numbers

	Magnet/ (MHz/mm)	Cost option part numbers	
		Quench manifold	Adapter with expansion tube
2-neck cryostats	400/54/ASP, 400/54/AR, 400/89/ASP, 500/54/ASP, 500/54/AR, 500/89/AS, 600/54/ASP, 600/54/ASC and 600/54/AR	AHC542688	AHC142689 (vertical) AHC142690 (horizontal)
3-neck cryostats	600/89/ASP and 700/54/ASP	AHC542687	AHC142689 (vertical) AHC142690 (horizontal)

Table 26 Quench manifold/adapter part numbers

	Magnet/ (MHz/mm)	Cost option part numbers	
		Quench manifold	**Adapter with expansion tube**
Service turret cryostats	700/89/ASP, 750/89/ASP, 800/54/ASC, and 850/54/ASC	Included with standard supply	

The magnet's customer interface drawing within the technical specification document includes a drawing of the side view of the magnet with the height to the centre of the helium exhausts specified and an additional drawing of top of the magnet with the optional quench manifold fitted. If this information is not present in the document please ask for it to be provided. This shows the configuration of the manifold (only) and provides dimensional information which is required as part of the calculation to determine where the quench pipe needs to start.

The horizontal and vertical adapters with the expansion tubes are shown in Figure 5 on page 58. Please note that on the external side of the burst disk on the quench manifold there is a retaining ring. On installation this needs to be fitted with the hole on the edge facing downwards. This is a drainage hole and allows any moisture or condensation to safely drain without compromising the burst disk.

Please also note that both the vertical and horizontal adapters incorporate an NW25 port, which in normal use is blanked off. During installation and for a cryogenic fill, it is recommended that the exhausted gases are connected up to this port so that they can be safely exhausted out of the room.

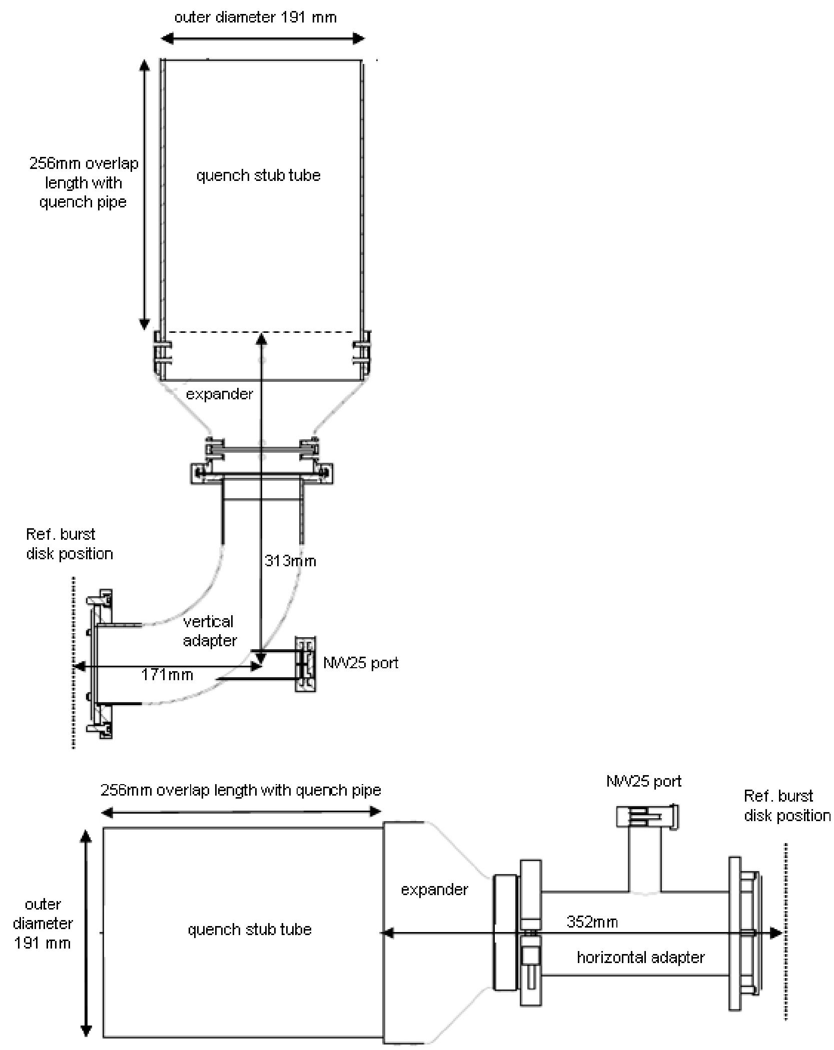


Figure 5 Schematic diagrams with dimensions for the vertical and horizontal quench adapter, expander and stub tube

Quench piping considerations

The customer is responsible for incorporating the quench pipe at the site, ready to connect up to the magnet at the beginning of the installation. Agilent, Inc provides the necessary equipment at the magnet side (to order) as explained above, however the quench pipe, the overlap joint and the ease of access to the burst disk including the piping installation are the responsibility of the customer. Please note that for NMR magnets, a non-contact or soft-contact “joint” to the quench pipe is required. This requires a little patience to achieve, and it may be prudent to fit the section closest to the magnet in conjunction with the magnet being brought into place in case minor adjustments to the fit are required. The design considerations for the start, centre and end sections for the room piping are given below:

General guidelines for the piping

- It is advised that multiple magnets should not share the same quench pipe.
- ≥ 8" (external diameter) round pipe is required.
- The pipe needs to be made from non-magnetic material for at least the first 6 meters approx. from the magnet (for example, aluminium or stainless steel).
- The pipe needs to be capable of withstanding temperatures as low as -200 °C (-328 °F) for short periods of time
- The pipe needs to be able to cope with an internal overpressure of 10psi.
- Pipes must have smooth inside walls.
- Joints can be welded or utilize bolted flanges.
- The pipe should be screened off and/or insulated to guard against being touched. Although quenches are short-lived and infrequent phenomena, the temperature of the quench pipe can become low enough to cause cold burns on unprotected skin. This low temperature might also damage electrical wiring or other services routed close enough to touch the quench duct.
- The thermal insulation required for the quench pipe should be fire resistant, at least 50mm (2 inches) thick, and resistant to freeze/thaw deterioration upon contact with water. Closed-cell flexible insulation materials are recommended (for example, 50mm thick Armaflex).
- Water pipes should not be routed near quench pipes.

The start or "magnet end"

For configurations using a horizontal adapter, the quench pipe needs to incorporate a flexible section or an alternative provision to be able to remove the quench pipe from the adapter, to access/service the burst disk.

The quench pipe needs to form a non-contact or soft-contact overlap of approx 256mm with the quench stub tube. This will prevent vibrations being transmitted from the quench pipe back to the spectrometer, which can appear as artefacts in the spectra.

The length of the overlap needs to be kept as long as possible. The non-contact and soft-contact methods of exhausting helium allows a small proportion of helium back into the room. This is minimized by keeping the gap between the tubes/foam as small as possible and ensuring the longest overlap between them.

All the information has been provided to work out where the magnet room's quench pipe needs to interface with the magnet.

- The customer interface drawing in the magnet technical specification document states (a) the height from the floor to the centre of the helium exhausts (please remember to amend this if a floor-plate is implemented) and (b) the horizontal position of the centre of the quench manifold burst disk relative to the centre position of the magnet.
- Figure 5 on page 58 shows the vertical and horizontal quench adapters. These drawings specify the horizontal and vertical dimensions from the centre of the manifold's burst disk to the top of the expander (that is where the rooms duct is aiming to meet the adapter after it has overlapped)

The piping

Each magnet system has a limit on the amount of back-pressure that the quench pipe can contribute to the magnet. The pipe must be designed to keep within this limit. Back-pressure can be kept to a minimum by

- keeping to a direct route
- minimizing the number of bends. Where bends are required, 45 degree bends and long 90 degree bends are preferred.

The end or "external end"

- The external exit should be configured to protect against rain and snow, and should be protected with a mesh wire to prevent animals, birds and debris from entering and blocking the duct. It is recommended that the duct exit is inspected periodically to ensure that it is clear.
- If the pipe exits the building horizontally it should ideally be given a slight downward slope to minimize the chance of any water getting into it.

- The external exit of the pipe needs to be to open air. There should be no public access to the exit of the quench duct or within 3 meters of the gas flow. It will usually be acceptable for the exit to be above an external area of public access as long as it is high enough to prevent direct access.
- Helium gas venting from the pipe will rapidly rise. Care must be taken to ensure that any gas which vents from the quench pipe cannot be drawn into any air-conditioning or ventilation system intakes. The location of the pipe’s exit should be carefully sited to prevent this from happening.
- Keep the pipe’s external exit free of obstructions at all times.

4
Site Preparation

Verify the configuration with an Agilent, Inc. representative before designing the room layout. Site preparation must conform to federal, state, and local codes, which take precedence over recommendations in this guide. Approval by a building inspector may be necessary.

CAUTION

Before installing the NMR spectrometer, confirm that the mains power for the site is supplied by a dedicated distribution transformer. Do not connect the spectrometer directly to the public low voltage network. Contact an Agilent representative if the site does not have a dedicated transformer.

Electric Utility Installation Requirements

Electrical Requirements and Outlets

Table 27 lists the electrical outlet requirements of system components. The section below details the requirements of each component.

Table 27 Electrical outlets/circuits requirements

Component	Required Number of Outlets/ Circuits	Electrical Requirements (single phase at 50-60 Hz)
Two-cabinet console	1	200, 208, 220, 230, 240V ac, 20 A
Pneumatics Router	1	120/240V ac
Host workstation and peripherals	6	120 @ 15A 240V ac @ 7.5A minimum
7510-AS	1	120 @ 15A 240V ac @ 7.5A minimum
7600-AS*	1	120 @ 15A 240V ac @ 7.5A minimum
VAST Autosampler accessory	2	120 @ 15A 240V ac @ 7.5A minimum
Accessories and test equipment	6	120V ac @ 20 A 240V ac @10 A
Solid-state Power cabinet (Channels 1&2)	1	220V ac, 30 A
Solid-state Power cabinet (Channels 3&4)	1	220V ac, 30 A
Microimaging module cabinet	1	see text
Third cabinet for 700-1000 MHz	1	220V ac, 30 A
VT CP/MAS module	1	110–125V ac, 15A (USA) 220–240V ac, 7.5A (Europe)
Diffusion (L500)	1	3Ø 208-240V ac 10A (USA) 3Ø 380-415V ac, 5A (Europe)
Cold probe system		Refer to the *Cold Probes Installation and Operation* manual.

* Use a separate, dedicated power source for the 7600-AS.

Two-Cabinet Console

The standard two-cabinet has a selectable power supply (200, 208, 220, 230, 240V ac) to match the building ac voltage. The console requires a dedicated single-phase, continuous-duty 200 to 240V ac (± 5%), 50/60 Hz power line with 20-A minimum service (for up to 4 channels). Terminate this line within 3 m (10 ft) of the left side (looking from the rear) of the standard cabinet with a fused, quick-disconnect switch box or circuit breaker. Run a separate, insulated, low-resistance earth ground to the main electrical service entrance ground.

Pneumatics Router

One, 110/220V ac, 15 A, outlet within 3 m (9 ft),where the Pneumatics Router will be placed. Autoswitching occurs between 100-240V ac, 47-63 Hz.

Host Workstation and Peripherals

The host workstation and accessories require a minimum of six 120-V_{ac}, single-phase power outlets. If your location has ac voltages over 132V ac, you should check with your local Agilent service center for power outlet requirements. Locations with ac voltages over 125V ac might need at least one step-down transformer. The Host workstation and peripherals can operate in the Asian market 190 to 205 V range. To minimize ground loop interference, electrical outlets should all be on the same 20-A service. Surge protection is strongly recommended.

Third Cabinet for 700-MHz and Higher Field Systems

The third cabinet requires a dedicated single-phase, continuous-duty 220V ac (± 7%), 50/60 Hz power line with 30-A minimum service. Terminate this line within 3 m (10 ft) of the left side (looking from the rear) of the standard cabinet with a fused, quick-disconnect switch box or circuit breaker. Run a separate, insulated, low-resistance earth ground to the main electrical service entrance ground.

Solid-State Power Cabinets (Channels 1 & 2/Channels 3 & 4)

Systems with high power amplifiers on channels 1 & 2 (supplied in a third cabinet) require an additional 208/220/240-V_{ac} single-phase, 30 A dedicated line. Systems with high power amplifiers on channels 3 & 4 (supplied in a fourth cabinet) require one more 208/220/240-V_{ac}

single-phase, 30 A dedicated line. These lines are required for these power bays only and are in addition to the line for the main two-cabinet console. For solids modules that do not have the higher power amplifiers in these cabinets no additional electrical power is required except when a Solids Accessory cabinet is part of the system, that is discussed in its own paragraph in this section.

Solid-State Accessories Cabinet

The Solid-State Accessory cabinet can be powered off of either a 90-132V ac 15 A circuit or a 190-240V ac 15 A circuit. The cabinet is supplied with cord with a three prong (NEMA-5-15P) plug except in Europe where it is supplied with a “Schuko” plug (CEE 7/7).

VT CP/MAS Module

A dedicated, single-phase, continuous-duty 50/60 Hz power line is required. The line should be 110 to 124V ac, 15-A in the United States and 220 to 240V ac, 15-A elsewhere. In addition, the customer must supply a 3-prong polarized plug compatible with the site voltage.

Microimaging Module Cabinet

The gradient power cabinet of the microimaging module contains three Highland L500 gradient amplifiers and a power distribution unit PDU). Because the cabinet requires considerable electrical power, customers must provide a dedicated three-phase (3Ø) power line to a wall-mounted circuit breaker and wiring from the circuit breaker to the PDU. All wiring must conform to local electrical codes. For three-phase wiring configuration and requirements, check with your Agilent representative. The 5-m (16.5-ft) 5-conductor cable to the PDU is supplied by Agilent without connectors. Figure 6 shows the internal wiring of the gradient cabinet.

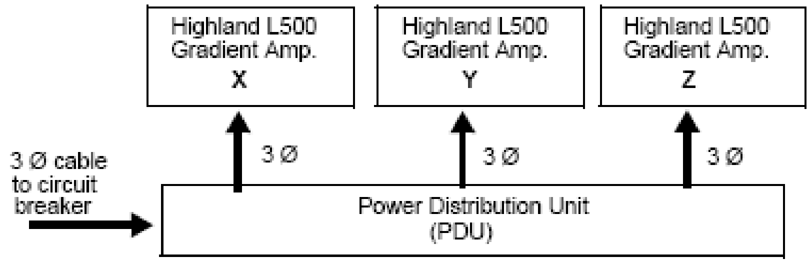


Figure 6 Internal wiring of gradient cabinet

As shown in Table 28, Highland L500 amplifiers can be configured to the four input voltages. Agilent recommends the 208V ac model for U.S. installations and the 380V ac model for most other installations (for example, Europe). The customer must communicate the choice of power input voltage and mains frequency to Agilent well in advance of the spectrometer shipping date so that the correct Highland L500 models are included.

Table 28 Models of Highland L500 gradient amplifiers

Wall (3Ø)	PDU Breaker	Highland
208V ac, 30 amp	30 A	208V ac
240V ac, 30 amp	30 A	240V ac
380V ac, 15 amp	15 A	380V ac
415V ac, 15 amp	15 A	415V ac

LC-NMR Accessory

Five, 110V ac or 220V ac outlets within 2 m (6 ft) of where the table holding the LC hardware will be located. Several extension cords should be for the installation.

7510 Autosampler

A120 or 220V ac, single-phase, continuous-duty 50/60 Hz power line, 15 A minimum service, is required.

7600 Autosampler

VAST Autosampler

Two 120 or 220V ac, single-phase, continuous-duty 50/60 Hz power lines, 15 A minimum service, are required within 2 m

(6 ft) of VAST table.

Diffusion Accessory

requires 3-phase power for the L500 amplifier.

Other Accessories and Test Equipment

At least six outlets are needed within 1.8 m (6 ft) of the host workstation, standard cabinet, and magnet. The outlets must have ground connections and provide a minimum of 2.30 kVA at the local single-phase line voltage (120V ac at 20 A, or 230V ac at 10 A).

Line voltage variation

400-, 500-, and 600-MHz spectrometers require one line tap at 200, 208, 220, 230, or 240V ac, single phase, depending on the voltage selector setting. 700-, 800-, and 900-MHz systems require two 220V ac, single-phase lines. Current ratings for these taps are listed in Table 27 on page 64.

Measure and record the ac line voltage for 48 hours using a suitable power line analyzer such as the BMI Model 4800 or equivalent. Provide a copy for the Agilent installation engineer. Requirements are the following:

- Long-term voltage variations (slow average) do not exceed 7% of nominal line tap voltages.
- Short-term voltage variations (sag or surge), with duration between several milliseconds and several seconds, do not exceed 10% of nominal line tap voltage.
- Line transients (impulse), with a duration between 1 ?s and 800 ?s, do not exceed 50 V peak above or below nominal line tap voltage. These transients must be measured at the power plug with a load connected that draws the same power as the spectrometer.
- AC line frequency does not vary by more than +0.5 to –1.0 Hz.

Installing a line conditioner and regulator is strongly recommended. By providing protection against transients and improving line regulation, total system “up-time” improves and the electronic components within the system last longer. In many locations, a good power conditioning system can pay for itself within a few years. Contact a local power consultant for suitable equipment in your area.

Uninterrupted power supply (UPS)

If your site experiences frequent and short (less than 10 minutes) power outages, you should consider installing an uninterrupted power supply UPS). UPS systems are limited in how long they can supply power when house power is out. Consider the placement of a UPS when planning your lab. If you want to use a single UPS, it must have output for 220V ac and 120V ac and it must be installed such that both the NMR console and the host workstation can use it. Solids systems require more than one transformer.

To determine the power rating for the UPS (in kW), refer to Table 27 on page 64 and add the values (kW) for the accessories with your system.

Separate Air Sources for System Options

The vibration isolation table and anti-vibration legs require a separate air regulator supplied by Agilent. The air pressure requirements should be 80 psi. Using the spectrometer or sample changer regulator with the anti-vibration system causes the magnet to vibrate.

A system equipped with a vibration table or isolators for the magnet also requires a separate air source and regulator. Bottled gas is not recommended for long-term operation.

The CP/MAS and CRAMPS solids options also require a separate regulated air source (or nitrogen gas for variable temperature operation) with 620 kPa (90 psig) pressure at the wall. Dewpoint should be –193 °C (80 K) and oil removal greater than 99.5%. Filtration should be to 0.6 microns. The minimum flow rate at the wall is 80 lpm.

CAUTION Contaminated air can cause extensive damage to the solids probe.

Compressed Air Supply

The house compressed air supply must provide a source of air that is clean, dry, and free of contaminants, with a dew point of –40 °C (–40 °F) minimum. The dew point must be -60 °C for the FTS coolers (preconditioning units) that are standard on 700-MHz and higher field magnets. The source should include a reservoir and be capable of delivering the air pressures (in kilopascals or pounds-per-square-inch-gauge) and flow rates (in liters-per-minute or standard cubic-feet-per-hour) after filtering as given in Table 29.

Table 29 Compressed air supply source

System configuration	Pressure	Flow rate
200- 900 systems for liquids, micorimaging, or liquids and microimaging, no options (air source needed for spin, probe/shim cooling, VT, eject and antivibration legs):		
Normal operation	585 kPa (80 psig)	54 LPM (114 SCFH)
During sample eject	585 kPa (80 psig)	75 LPM (159 SCFH)
System with gHX Nano probe	585 kPa (80 psig)	45 LPM (95 SCFH)
System with Doty probe, Solid-State MAS Spinning:	620 kPa (90 psig)	50 LPM (106 SCFH)
System with Agilent solids probes, Solid-State VT and Probe purge:	585 kPa (80 psig)	169 LPM (360 SCFH)
System with Agilent solids probes, Solid-State MAS Spinning:	620 kPa (90 psig)	141 LPM(300 SCFH)

Install a gate valve on the permanent outlet of the air supply line. gate valve must be rated at least 860 kPa (125 psi or 9 kg/cm^2). If the house line pressure is greater than this level, the valve must be rated at a level that exceeds the house pressure. Attach to the valve a minimum 1 cm (0.4 in) pipe terminated with a 1/4-inch male NPT. Make the pipe long enough so that its termination fitting is within 4.5 m (15 ft) of the planned location of the magnet. A primary air regulator capable of ± 2 psi is also required upstream from the gate valve.

In areas where humidity is high or where moisture in the air supply is a problem, consider installing a prefilter with an automatic drain to help prevent overload of the filter. In extreme cases, an air dryer assembly may be necessary.

These units must be provided by the customer. The source should include a reservoir and be capable of delivering the air pressures (in kilopascals or pounds-per-square-inch-gauge) and flow rates (in liters-per-minute or standard cubic-feet-per-hour) after filtering as given in Table 29 on page 71, should give optimum compressor life with a high quality of air. A coalescing filter and particulate filter are required for solids accessories and must be supplied by the customer. The particulate filter should be capable of filtering to 0.1 micron.

If a portable compressor is used as the air supply, the unit should have a holding tank capacity of 80 gallons (303 liters) to avoid the compressor cycling off and on. In moist environments, an air dryer is also usually necessary, as well as an automatic drain on the holding tank. Systems with anti vibration legs require 80 psi.

The installation engineer will install on your air termination fitting an Agilent-supplied assembly that includes a 0 to 690 kPa (0 to 100 psi) pressure gauge, a reduction valve, a standard 20 micron air filter, a coalescing oil filter (99.9 percent oil removal efficiency), and an air line to the magnet.

Compressed Nitrogen Gas

During operation of the variable temperature accessory, a compressed nitrogen gas supply (from a cylinder or a fixed line) is required that is dry, oil-free, and magnetically clean (for example, free of rust), with a dew point of −193 °C (80 K). The flow and pressure rates through the regulators are the same as those listed for the compressed air supply.

Gas Supplies for Solids Systems

Agilent, Inc. recommends using a three-way or diverting-ball valve to allow switching of gas sources. With this valve installed, each supply line will have a shut-off valve and regulator on the supply side of the switching valve. The first stage regulators can be omitted if the line pressure downstream of the regulator will be less than 90 psi with the regulator in-line. As a general practice, both VT and spinning will run off of nitrogen gas or compressed air; the sources are not normally different for the two outputs. Agilent, Inc. does not recommend using a quick -connect fitting to switch sources since they usually introduce a significant flow restriction. Agilent, Inc. supplies a Tee fitting with adaptors to go from 1/2-inch NPT female fitting to the connections for the air management box and the MAS speed controller. A 3/8-inch hose barb fitting is included as an alternate input in the Tee in case the 1/2-inch NPT is not available. Refer to Figure 7.

The delivery pipes should be at least 1/2-inch copper piping specified as air handling lines.

Install a ball valve on the permanent outlet of the air supply line. The ball valve must be rated at least 860 kPa (125 psi or 9 kg/cm2), with an open diameter matched to the copper piping. If the house line pressure is greater than this level, the valve must be rated at a level that exceeds the house pressure. Attach to the valve a minimum 1 cm (0.5 in) pipe terminated with a 1/2-inch male NPT. The termination fitting should be within 6 m (20 ft) of the planned location of the accessory cabinet. A first stage air regulator, see Figure 7, capable of ± 2 psi is also suggested upstream from the ball valve when 90 psi, or greater, can be reached at the output.

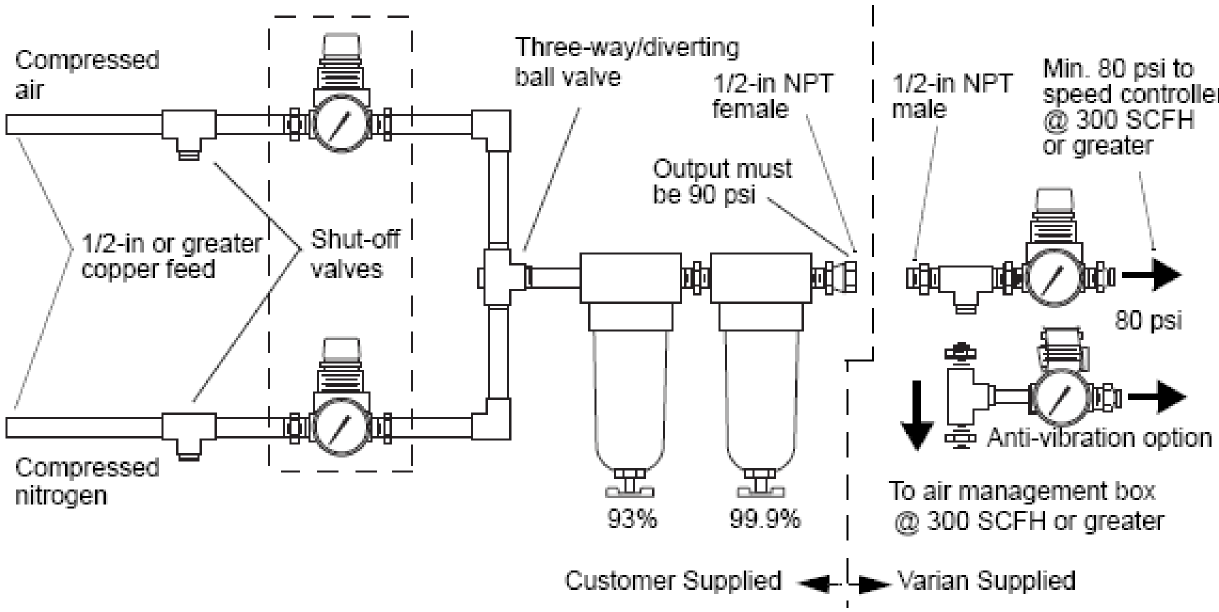


Figure 7 Setup for switching gas supplies

AC Power and Air Conditioning

Use Table 30 to help determine maximum surge current, line conditioning, and air conditioning requirements. The surge current can be reduced by setting each RF amplifier to the off position using the RF amplifier switch on the rear panel, and then switching on the spectrometer power and turning on each RF amplifier separately.

A filter on the air conditioning unit intake and special air filtration is required in installations exposed to corrosive gases, salt air, or unusual dirt or dust conditions. The air conditioning system requires a power line separate from the spectrometer system.

Table 30 Maximum air conditioning requirements

System	Power (kW)	Surge current* (A)	Power factor†	BTU/hr‡
300-600 MHz 2-bay standard** system	0.7	85	0.925 leading	2400
700-900 MHz standard 3-bay, 4-channel, liquids system	2.3	78	0.925 leading	7850
host workstation, monitor, peripherals††	0.9			3100

* Decay time < 150 ms.

† Leading and lagging is the phase relationship between voltage and current.

‡ Conversion of the unit of heat energy between BTU and the amount of system power is calculated using 1 kwh = 3413 BTU.

** Measurements are only for the standard acquisition and RF console, which does not share an ac power branch with the host workstation. Includes low-power solids systems.

†† Measurements are only for the host workstation, which does not share an ac power branch with the acquisition and RF console.

System	kW	BTU/hr
Autosampler	0.18	615
Additional solids, high-band channel	0.82	2800
Additional extra high-power, solids, low-band channel	1.32	4500
Additional liquids RF channel	0.5	1700
Microimaging module	1.5	5120
Solids Accessory cabinet	0.02	68

Telephone and Internet Access

Agilent recommends locating a regular voice telephone line near the host workstation. This telephone would enable the spectrometer operator to discuss the spectrometer system as it operates.

Agilent also strongly recommends that Internet access be provided during and after system installation. By providing external access to the spectrometer, technical problems can be quickly analyzed by the engineering and scientific staff. After the system is installed, applications-related questions can be answered in real time by Agilent's NMR applications people. As a matter of policy, Agilent provides online support during installation and during the warranty period. If direct access to the Internet is not technically feasible, a high-quality analog telephone line can be used. Agilent provides a high-speed modem during the system installation.

If internal security policies preclude ready modem or Internet access to the spectrometer, contact Agilent's installation department for a list of options that might satisfy security concerns.

Electrostatic Discharges

Electrostatic discharges less than 15 kV generally do not result in any perceivable errors or problems. Discharges greater than 15 kV, however, might result in loss of data and errors perceivable to the operator. Discharges greater 25 kV can cause damage to the equipment.

To prevent electrostatic discharge damage, the system should be installed on vinyl-covered floors and be properly grounded. If carpeting is installed, the carpet should contain only a small percentage of nylon and be installed over antistatic pads. Alternatively, regular use of a good quality antistatic spray can help considerably in alleviating the problem. Whenever a printed circuit board must be touched or handled, the person should wear grounded wrist straps.

CAUTION

Many components in the system contain highly sensitive electronic devices that must be protected from electrostatic discharges by proper floor coverings and grounding practices. A person walking across a nylon carpet or wearing synthetic fabrics can generate an electrostatic charge that can discharge to the next object that is touched. If this happens to be the system, the system components can be damaged. An overly dry atmosphere also tends to create an electrostatic charge. As with any system based on integrated circuits, the system is susceptible to static spikes, both those generated on the power line and those generated in the lab area that must be suppressed. Contaminated air can cause extensive damage to the solids probe.

Host Workstation Preparation

Agilent NMR spectrometers are operated using a host workstation that runs the VnmrJ software

Magnetic field considerations

The host workstation system and magnetic storage media (hard disk, streaming magnetic tape cartridge, etc.) must be located beyond the 5 gauss field of the magnet, so that the magnetic field cannot damage data. See Appendix A, “Posting Requirements for Magnetic Field Warnings” for typical distances at which various gauss levels exist for particular magnets, but be aware that these distances vary somewhat for each magnet and should be checked after a magnet is installed.

Required peripherals

A CD-ROM drive is required to load the operating system and VnmrJ software onto the host workstation. The CD-ROM drive might not automatically be included with a Sun workstation; it is included when the Sun computer is part of a NMR spectrometer purchase. While loading the software remotely is possible, loading the software locally is preferred. Often, the remote computer is password protected and thus requires the presence of the system administrator to enter the password and grant access. Should any troubleshooting or software reloads be required, the process would be complicated by the need for the system administrator.

Operating system installation

Host workstations operating either as an NMR acquisition host or as a separate data station require specific setup and configuration for the operating system (OS, including Solaris, Linux, Macintosh) installation. Agilent, Inc. provides instructions for configuring the Host workstation and installing OS software for optimum NMR spectrometer performance.

If you have purchased your host workstation from Agilent, Agilent assumes full responsibility and the Agilent installation engineer will install both the OS and VnmrJ software.

Collecting system and network information

Collect the following system and network information before beginning the OS installation. Use Table 31 to record system information. Each field on the worksheet is described below.

Table 31 Pre-installation worksheet OS installation

Category	Your configuration
Host Name Example: *mysystem* Do not use: inova,inovaauto,gemcon,or wormhole	
Primary Network Interface Network card attached to the NMR console	
Secondary Network Interface. Network card attached to the NMR console	
IP Address, Primary Network Interface Use: *10.0.0.1 or 172.16.0.1* for network card attached to the NMR console	.
IP Address, Secondary Network Interface For Network card attached to the site network. Local network administrator must supply this.	
Name Service Choices: NIS, NIS+, Other or None	
Domain Name Example: our. domain	
Name Server Host Name Example: ourserver	
Name Server IP Address Example: 195.5.2.25	
Subnet Mask Example: 255.255.255.0	

If your system is not connected to a network, you need to know or create only the Host name, root password, and the time zone. If your system is on a network, you need additional information, contact your network administrator for this information.

System configuration type

You are asked to configure your NMR workstation as one of the following: server, standalone, or dataless client. A server is a system that provides network services such as file transfer and storage space. A standalone system is a system that contains its own hard disk and boot-up files. A dataless client, sometimes called *diskless client*, is a system without its own hard disk and uses an NFS server for the operating system, storage, and other services. For the purposes of VnmrJ, you must install your system as a standalone system.

Selecting a host name

Each computer on a network has a host name that uniquely identifies the computer. If you already have a version of UNIX or Linux installed, you can use the command uname -n from within a shell to display this information for a host workstation.

Note that VnmrJ reserves the IP names inova, inovaauto, and wormhole. Do not use these names for your host name. When choosing a host name, make sure the name you select is unique within both your local area network and, if applicable, your name service domain.

In many networks, the choice of a host *name* is left up to the owner of the host workstation (subject to the requirement of uniqueness). A host name can be up to 64 uppercase or lowercase characters. It is strongly recommended that you use all lowercase characters in the host name because some networking software that might be used in other computers on the network could require lowercase host names. Choose a name that starts with a lowercase letter, followed by any combination of lowercase letters, numbers, or hyphens. The name, however, cannot end with a hyphen.

Obtaining the IP address

Your host workstation must have a unique Internet Protocol (IP) network address if your NMR workstation is to be attached to a network. Consult your network administrator about the address. If the software is being installed on a host workstation that is already connected to a network, the command y pcat hosts | grep `uname -n` can be used to display the IP address of your workstation. Note the use of back quotes (`) in this command.

If NIS is not enabled, use the command: cat /etc/hosts | grep uname -n

One of the IP addresses specified in RFC1597 must be available. These are:

10.0.0. x
172.16.0.x
192.168.0.x

where x is 1 through 4.

Selecting a subnet mask

The subnet mask is a number that is used to split IP addresses into the network (Internet) and host parts. If your site does not use multiple subnets, use the default number; otherwise, consult your network administrator. For a NMR workstation connected to a network, the command cat /etc/netmasks can be used.

Selecting the name service type

The name service prompt allows choosing between NIS, NIS+, and none. If you choose NIS or NIS+, you need to enter the host name and the IP address of the computer from which you receive the service. If you choose none, you are not prompted for additional information. Ask your network administrator what name service the network uses.

Entering the host name and IP address of the name server

If you select either NIS or NIS+ as the name service type, it is assumed that there is another computer on the network that is the current NIS or NIS+ server. You are asked to enter the host name and IP address of the server that provides the name service. On an existing computer, the server's name can be displayed by entering the command ypwhich. The server's IP address and other information can be displayed by entering the command ypcat hosts | grep `ypwhich`. Again, note the use of back quotes (`).

Domain name

The domain name is the name assigned to a group of computers that are administered together. All computers in the group (domain) are accessed by the same NIS or NIS+ maps. Your network administrator should be able to provide the domain name. You can also find your domain name by entering the command domain name.

5
Installation Supplies and Equipment

Certain supplies not provided by Agilent, such as helium and nitrogen supplies, must be obtained by the customer before the Agilent installation engineer can start the installation.

Required Installation Supplies and Equipment

CAUTION Specify that supply dewars be made of nonmagnetic materials. A magnetic supply dewar can also be pulled into the magnet, possibly damaging the magnet or causing the magnet to quench.

The installation engineer will need the following non-Agilent supplies and equipment during installation:

- Liquid helium supply
- Liquid nitrogen supply
- Helium gas supply
- Nitrogen gas supply for magnet installation
- Face mask and thermal gloves
- Heat gun
- Nonferromagnetic ladder
- Hoist
- Isopropyl alcohol and acetone solvents

Locating a reliable local source of liquid helium and nitrogen is particularly important. As soon as possible after ordering a system, make arrangements for an initial delivery and an ongoing supply of liquid helium and nitrogen.

Liquid helium supply

Request delivery just prior to the scheduled visit of the Agilent installation engineer to minimize loss liquid helium (LHe). Table 32 on page 84 lists the amount of Helium recommended at installation.

Table 32 Cryogen and gas requirements for magnet commissioning

Magnet/Bore (MHz/mm)	Initial Helium Supply (liters)	Short Notice Helium Supply (liters)	Helium Gas (cylinders)	Nitrogen supply (liters)
400/54/ASP	300	100	2	500
400/54/AR	300	100	2	500
400/89/ASP	300	200	3	500
500/54/ASP	500	200	3	700
500/54/AR	650	200	4	750
500/89/AS	800	400	4	1000

Table 32 Cryogen and gas requirements for magnet commissioning

Magnet/Bore (MHz/mm)	Initial Helium Supply (liters)	Short Notice Helium Supply (liters)	Helium Gas (cylinders)	Nitrogen supply (liters)
600/54/ASP	800	400	4	1000
600/54/ASC	500	250	3	700
600/54/AR	650	200	4	750
600/89/ASP	1100	500	5	1600
700/54/ASP	1100	500	5	1600
700/89/ASP	2800	1000	9	4000
750/89/ASP	3000	1000	9	4000
800/54/ASC	2800	1000	9	4000
850/54/ASC	2800	1000	9	4000

The amount of loss due to boil-off as the magnet is cooled varies. An initial LHe supply about 50% more than the amount expected to be necessary for cooling down the magnet is usually adequate; however, an additional supply for delivery on short notice is also advisable should the initial amount be insufficient. Table 32 shows the quantities recommended.

All magnets use a flexible transfer tube with 12.7mm(0.5”) diameter legs. Please ask for an appropriate adapter/fitting from your cryogen supplier when ordering.

Liquid nitrogen supply

Table 32 lists the recommended amount of liquid nitrogen (LN_2). LN_2 storage containers suffer a loss of contents from boiloff, so request delivery of the supply just prior to the scheduled visit of the installation engineer.

Rubber tubing is not recommended for transferring LN_2 and every Agilent NMR magnet ships with a braided LN_2 transfer line which terminates in a 37 degree 3/4 in JIC fitting. Transfer efficiency can be improved if insulation is fitted to the transfer line. Simple, cheap and easily available and replaceable expanded foam pipe lagging will help. Trials have shown that Armaflex Tuffcoat insulation (20mm internal diameter, and ≥ 13mm insulation thickness), although slightly more expensive, was more robust and was the most effective insulation trialled to improve nitrogen transfer efficiency.

A refrigerant is required for low-temperature operation using the variable temperature accessory. Liquid nitrogen is the common refrigerant used in the VT cooling bucket.

Helium gas supply

Table 32 on page 84 lists the recommended number of helium gas cylinders. A low pressure regulator of 30 psi or less and a He gas flow regulator and flow meter with a range of approximately 0 to 80 CFH (0 to 40 LPM) are required. The flow meter scale does not have to read in helium gas if the gas to He gas conversion factor is known.

Example:

Multiply an air flow rate scale by 2.7 to convert to helium gas flow rate.

Each cylinder should hold at least 8000 liters (285 cubic feet). The helium gas must be the highest purity available: no less than 99.995% or U.S. Bureau of Mines Grade A. A magnetic helium gas container can be used provided the unit remains outside the 5 gauss limit of the magnet and the cylinder is firmly secured to avoid movement caused by the magnetic field.

Nitrogen gas supply for magnet installation

CAUTION

To avoid movement caused by magnetic field attraction, helium gas and nitrogen gas cylinders made of magnetic material must be kept outside the 5-gauss limit of the magnet and firmly secured.

One cylinder of nitrogen gas is required for pre-cooling the magnet and for transfer of liquid nitrogen during installation. A regulator must be provided. A magnetic nitrogen gas container can be used provided the unit remains outside the 5 gauss limit of the magnet and the cylinder is firmly secured to prevent attraction to the magnet.

A nitrogen gas supply is required if the system is equipped with the variable temperature accessory. Use either a fixed source of nitrogen gas or obtain a nitrogen gas cylinder with pressure regulator.

Use prepurified grade gas (99.99%, –85 °C dew point) low-temperature operation. Set the flow rate and pressure to 19 LPM (40 SCFH) at 207 kPa (30 psig).

Face mask and thermal gloves

A serious injury (similar to a burn) can occur if liquid helium or nitrogen contacts living tissue. Order appropriate safety coverings for use during dewar servicing, including a mask that protects the face completely and a loose-fitting pair of thermal gloves.

WARNING **Avoid helium or liquid nitrogen contact with any part of the body. If liquid helium or nitrogen contacts living tissue, a serious injury (similar to a burn) can occur. Never place your head over the helium and nitrogen exit tubes on top of the magnet. If helium or nitrogen contacts the body, seek medical attention, especially if the skin is blistered or the eyes are affected.**

Heat gun

A 1600 W heat gun and a heavy-duty extension cord is required for thawing ice accumulation and drying out moisture on dewar servicing equipment.

CAUTION These heat guns contain ferrous magnetic materials. Avoid helium or liquid nitrogen contact with any part of the body.

Nonferromagnetic ladder

A 180 cm (6 ft) nonferromagnetic ladder is required for reaching the top of the dewar while inserting and removing the helium transfer tube. The ladder must be sturdy and self-supporting with rubber feet. A taller ladder 250–300 cm (8–10 ft) is required for 750- and 800-MHz magnets.

Hoist

A hoist may be required to remove the magnet from the crate, assemble it, and move it into place. The capacity of the hoist depends on the weight of the magnet being installed. Table 6 on page 22 specifies magnet weights. Allow a safety factor of at least 100% above the weight shown. Be sure adequate space is available for bringing the hoist and magnet in through the lab door.

WARNING **Death or serious injury may result if the magnet is lifted with improperly assembled or improperly rated equipment.**

The hoist can be a chain hoist suspended from a moveable mechanism, such as an A-frame, or it can be permanently fixed above the area designated for the magnet, such as a beam. A vertical lifting device is required for magnets with anti-vibration legs; this vertical lifting device would eliminate the need for a “cherry picker” type device. Consult your plant facilities department or Agilent representative to ensure that facilities are available.

Isopropyl alcohol and acetone solvents

Obtain 1 pint (500 cm^3 each) of isopropyl alcohol and acetone. These solvents are needed to clean the magnet parts before assembly. Acetone should never be used for general cleaning as it can damage some plastics and paints.

Recommended Installation Supplies and Equipment

The following additional items are recommended:

- Cryogenic equipment rack
- Electrical power surge protector
- Monitor degaussing coil

Cryogenic equipment rack

Various items are used around the magnet for routine maintenance and handling, including a helium transfer tube and extensions, helium fill adapter, nitrogen transfer tube and nitrogen fill adapter. To protect the cryogenic equipment from damage and to keep it conveniently available, provide a rack to hold the items. A 1.2 m × 2.4 m (4 ft × 8 ft) peg board hung on a laboratory wall, with wood or plastic pegs, works very well.

Electrical power surge protector

A good quality surge protector should be inserted in the power circuit serving the components to protect the delicate electrical components (monitor, disk drive unit, CPU base, etc.) of the NMR workstation. A single surge protector with six outlets should suffice if the components are located relatively close to one another. Contact an electronic professional for advice on quality surge protection in your area. If a UPS is to be used for line conditioning, a surge protector is unnecessary.

Monitor degaussing coil

A workstation monitor or other monitors on other systems, that are not a LCD displays, can gradually become somewhat magnetized due to its proximity to the magnet. This condition can be corrected with a degaussing coil.

If the host workstation system or other system monitor is to be located near the edge of the 1–2 gauss stray field of the magnet, the degaussing coil is a necessity. For example, GC Electonics model 9317 (1801 Morgan St., Rockford Il; 61102, (815) 968-9661).

LC-NMR Equipment, Supplies, and Solvents

The following equipment, samples, and solvents must be on hand before the LC-NMR accessory is installed:

- A nonmagnetic table (at least 3 ft by 4 ft) to hold the LC hardware.
- Either gas cylinder of helium, outfitted with 0.25-inch OD Teflon tubing with aerator (this will be used for sparging the acetonitrile solvent), or the necessary degassing equipment. Do not use an aspirator.
- At least 300 mL of D_2O, 99.8 atom percent or better.
- At least 100 mL of acetone-d6.
- At least 300 mL of OmniSolv brand acetonitrile (EM Science part no. AX014-1).
- Research grade sucrose.
- At least three, 100 mL volumetric flasks for preparing standard samples.
- An appropriate waste container for HPLC effluent. The cover of the container must have a hole in the top of about 2 mm diameter. The hole is used for the outlet of the LC-NMR Microflow probe.
- Air supply for the pneumatic valve.

A
Posting Requirements for Magnetic Field Warnings

The strong magnetic fields that surround a superconducting magnet are capable of causing death or serious injury to individuals with implanted or attached medical devices such as pacemakers or prosthetic parts. Strong field gradients can also snatch nearby magnetic tools, equipment, and dewars into the magnet body with considerable force and can cause personal injury or serious damage. Moreover, strong magnetic fields can erase magnetic media such as tapes and floppy disks, disable the information stored on the magnetic strip of credit cards and can damage some watches.

To warn of the presence and hazard of strong magnetic fields, the customer is responsible for posting clearly visible signs warning of magnetic field hazards. This responsibility includes measuring stray fields with a gaussmeter.

Radio-frequency emissions may also pose a danger to some individuals. The RF emission levels from Agilent NMR equipment have been measured and compared to the IEEE/ANSI C95.1-1991 standard. For further information, refer to the RF Environment section of the Installation Planning Guide.

Warning Signs

Agilent provides signs to help customers meet this posting responsibility. These signs must be posted according to the following requirements before the magnet is energized:

1 10-gauss warning signs (Figure 8) – Post along the 10-gauss perimeter of the magnet so that a sign can be easily seen by any person about to enter the 10-gauss field from any direction. Refer to the manuals supplied with the magnet for the size of a typical 10-gauss stray field. Check this gauss level after the magnet is installed.

NOTE The stray field may extend vertically to adjacent floors, and additional signs may be needed there. A sign is not required if the 10-gauss field extends less than 30 cm (12 in) beyond a permanent wall or less than 61 cm (24 in) beyond the floor above the magnet.

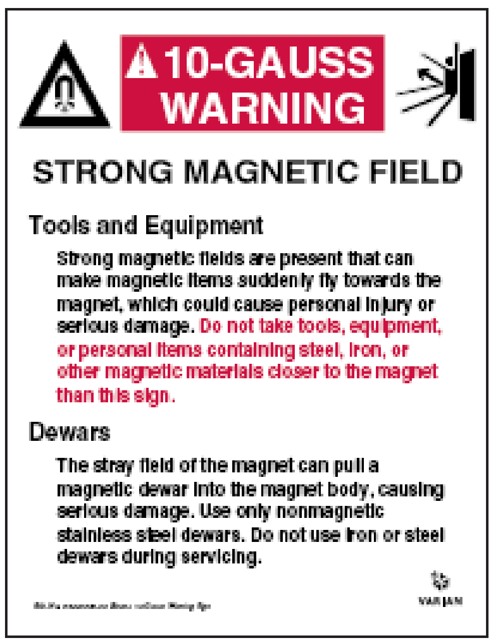


Figure 8 10-gauss warning sign

2 5-gauss warning signs– Post along the 5-gauss perimeter of the magnet so that a sign can be easily seen by any person about to enter the 5-gauss field from any direction. Refer to the manuals supplied with the magnet for the size of a typical 5-gauss stray field. Check this gauss level after the magnet is installed. Note that the

stray field may extend vertically to adjacent floors, and additional signs may be needed there.

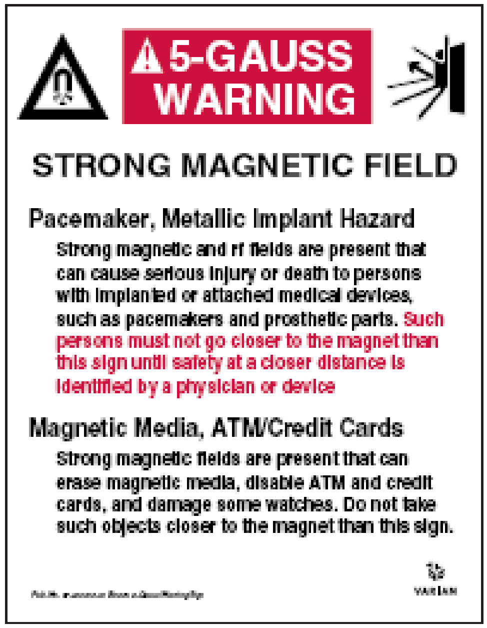


Figure 9 5-gauss warning sign

3 Magnet area danger signs – Post at each entrance to the magnet area. Be sure each sign is outside the 5-gauss perimeter.

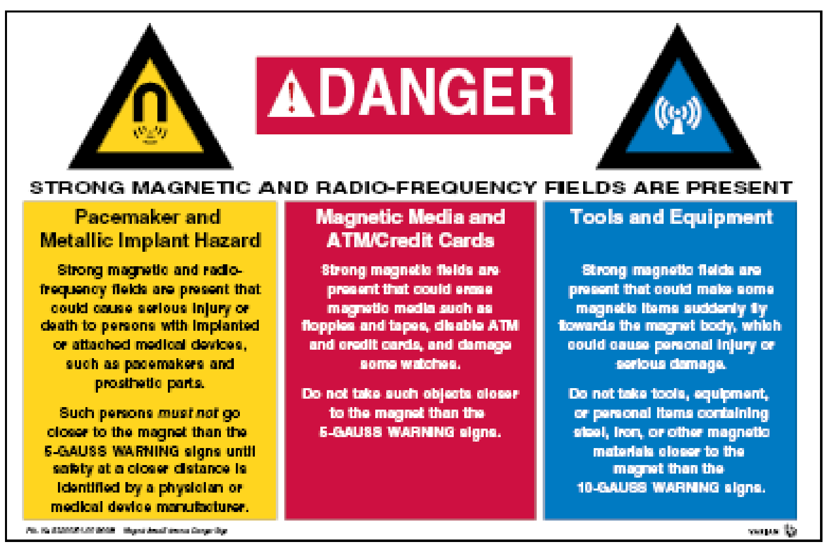


Figure 10 Magnet area danger sign

4 Stray magnetic fields can reach beyond the published distances when two or more magnetic fields intersect or when the field extends over large ferromagnetic masses or structures (steel doors, steel construction beams, etc.). In this case, the customer must measure the stray field using a gaussmeter to determine how the 5- and 10-gauss fields are altered (contact a scientific instrumentation supplier for information on acquiring a gaussmeter).

You can request additional signs from Agilent by telephoning 1-800-356-4437 in the United States or by contacting your local Agilent office in other countries.

B
Acronyms

Acronyms

AC	alternating current
AR	Annual Refill
AS	Actively Shielded/SuperscreenedTM
ASC	PremiumCOMPACT^{TM}
ASP	Premium Shielded
CPMAS	Cross Polarization Magic Angle Spinning
CPU	central processing unit
CRT	cathode ray tube
DC	direct current
He	helium
HPLC	high pressure liquid chromatography
LC	liquid chromatography
LHe	liquid helium
LN_2	liquid nitrogen
MAS	magic angle spinning
MHz	megaHertz (10^6 Hertz)
MB	Medium bore (usually 63mm room temperature bore tube diameter)
N_2	nitrogen
NB	Narrow bore (usually 54mm room temperature bore tube diameter)
NMR	nuclear magnetic resonance
NPT	type of fitting, standard National Pipe Thread
NW25	type of vacuum fitting, 25mm diameter
OP	outer diameter
OS	operating system
PDU	power distribution unit
RF	radio-frequency
RMS	root mean square

RT	room temperature
TLV	threshold limit values
V_{AC}	voltage for alternating current
VAST	Agilent’s liquid sample handler
VT	variable temperature
UBC	uniform building code
UPS	uninterrupted power supply
WB	Wide bore (usually 89mm room temperature bore tube diameter)

C
Standard Units, Conversion Tables

Following are select standard units and conversion tables.

Standard Units

Table 33 Definition of standard units

Quantity	Symbol	Name
temperature	°C	degree celsius (1.8C + 32 = F)
temperature	°F	degree fahrenheit (0.56(F – 32) = C)
temperature	K	kelvin
force	N	newton
force	ft-lb	foot-pound
power	kcal	kilocalorie
mass	g	gram
mass	kg	kilogram
length	m	meter
length	mm	millimeter
length	in	inch
length	ft	foot
area	m^2	square meter
area	cm^2	square centimeter
area	sq. in	square inch
area	sq. ft	square foot
volume	m^3	cubic meter
volume	cm^3	cubic centimeter
volume	cu. in	cubic inch
volume	cu. ft	cubic foot
time	h	hour
magnetic field strength	A/m	ampere per meter
magnetic flux density (induction)	T	tesla (1 T = 10^4 gauss, 1 T = 1 Wb/m^2)
magnetic flux	Wb	weber

Conversion Tables

This section includes:

- Table 34 Length conversions
- Table 35 Volume conversions
- Table 36 Power conversions
- Table 37 Energy conversions
- Table 38 Pressure/force conversions

Table 34 Length conversions

Unit	mm	m	in	ft
1 mm =	1	0.001	0.0393701	0.0032808
1 m =	1000	1	39.37	3.281
1 in =	25.4	0.0254	1	0.08333
1 ft =	304.8	0.3048	12	1

Table 35 Volume conversions

Unit	cm3	m3	cu in	cu ft
1 cm^3 =	1	0.000001	0.06702	0.03531
1 m^3 =	1000000	1	61023	35.31
1 cu in =	16.39	0.0006452	1	0.000579
1 cu ft =	28316	0.028316	1728	1

Table 36 Power conversions

Unit	kcal/h	kJ/h	kW
1 kcal/h =	1	4.1868	0.00163
1 kJ/h =	0.2388	1	0.0002777
1 kW =	860	3600	1

Table 37 Energy conversions

Unit	kcal	kJ	kWh
1 kJ =	0.2388	1	0.0002777
1 kWh =	860	3600	1

Table 38 Pressure/force conversions

Unit	N/m2 (Pa)	N/cm2	kp/m2	kp/cm2	lb/sq. ft	lb/sq. in (psi)
1 N/m^2 =	1	0.0001	0.1019	0.1019×10^{-4}	2.088×10^{-2}	1.45×10^{-5}
1 N/cm^2 =	10000	1	1019	0.1019	208.8	1.45
1 kp/m^2 =	9.80665	9.8066×10^{-4}	1	0.001	0.2084	1.422×10^{-3}
1 kp/cm^2 =	98066.5	9.80665	10000	1	2048	14.22
1 lb./sq. ft =	47.87	4.787×10^{-3}	4.882	4.882×10^{-4}	1	6.943×10^{-3}
1 lb./sq. in =(psi)	6896	0.6896	703	7.032×10^{-2}	144	1

D
Ceiling Heights for Magnet Installation Ancillaries

Minimum and Ancillary Ceiling Height Requirements

The following table provides ceiling heights for magnet installation ancillaries. See Table 39 for information on minimum ceiling heights.

Table 39 Minimum and ancillary ceiling height requirements

Magnet/Bore(MHz/mm)	Ancillary requirements for installation		
400/54/ASP Premium Shielded	Below this ceiling height you will need:	Ceiling height	Above this ceiling height you will need:
	Flexi-current lead	2936 mm	Current lead
	AUE031933		AUE131704
	Bendy shim lead	2876 mm	Shim lead
	AUE131970		AUE131709
	Split He Transfer tube*	2886 mm	He Transfer Tube
	ATZ033481 & ATZ333482		P222000072
	Split blow-out tube	2851 mm	Blow out tube
	AUC131979		AUC331710
	2605 mm minimum ceiling height for installation		
400/54/AR Annual Refill	Below this ceiling height you will need:	Ceiling height	Above this ceiling height you will need:
	Flexi-current lead	2936 mm	Current lead
	AUE031933		AUE131704
	Bendy shim lead	2876 mm	Shim lead
	AUE131970		AUE131709
	Split He Transfer tube*	2886 mm	He Transfer Tube
	ATZ033481 & ATZ333482		P222000072
	Split blow-out tube	2851 mm	Blow out tube
	AUC131979		AUC331710
	2605 mm minimum ceiling height for installation		
400/89/ASP Premium Shielded	Below this ceiling height you will need:	Ceiling height	Above this ceiling height you will need:
	Flexi-current lead	3088 mm	Current lead
	AUE031933		AUE131704
	Bendy shim lead	3028 mm	Shim lead

Table 39 Minimum and ancillary ceiling height requirements (continued)

Magnet/Bore(MHz/mm)	Ancillary requirements for installation		
	AUE131970		AUE131709
	Split He Transfer tube*	2998 mm	He Transfer Tube
	ATZ033481 & ATZ333482		P222000072
	Split blow-out tube	3003 mm	Blow out tube
	AUC131979		AUC331710
	2778 mm minimum ceiling height for installation		
500/54/ASP Premium Shielded	Below this ceiling height you will need:	Ceiling height	Above this ceiling height you will need:
	Flexi-current lead	3288 mm	Current lead
	AUE031933		AUE131704
	Bendy shim lead	3228 mm	Shim lead
	AUE131970		AUE131709
	Split He Transfer tube*	3198 mm	He Transfer Tube
	ATZ033481 & ATZ333482		P222000072
	Split blow-out tube	3203 mm	Blow out tube
	AUC131979		AUC331710
	2978 mm minimum ceiling height for installation		
500/54/AR Annual Refill	Below this ceiling height you will need:	Ceiling height	Above this ceiling height you will need:
	Flexi-current lead	3513 mm	Current lead
	AUE031933		AUE131704
	Bendy shim lead	3453 mm	Shim lead
	AUE131970		AUE131709
	Split He Transfer tube*	3423 mm	He Transfer Tube
	ATZ033481 & ATZ333482		P222000072
	Split blow-out tube	3428 mm	Blow out tube
	AUC131979		AUC331710
	3203 mm minimum ceiling height for installation		
500/89/AS Superscreened	Below this ceiling height you will need:	Ceiling height	Above this ceiling height you will need:
	Flexi-current lead	3464 mm	Current lead
	AUE031933		AUE131704

Table 39 Minimum and ancillary ceiling height requirements (continued)

Magnet/Bore(MHz/mm)	Ancillary requirements for installation		
	Bendy shim lead AUE131970	3404 mm	Shim lead AUE131709
	Split He Transfer tube* ATZ033481 & ATZ333482	3374 mm	He Transfer Tube P222000072
	Split blow-out tube AUC131979	3379 mm	Blow out tube AUC331710
	3154 mm minimum ceiling height for installation		
600/54/ASP Premium Shielded	Below this ceiling height you will need:	Ceiling height	Above this ceiling height you will need:
	Flexi-current lead AUE031933	3414 mm	Current lead AUE131704
	Bendy shim lead AUE131970	3354 mm	Shim lead AUE131709
	Split He Transfer tube* ATZ033481 & ATZ333482	3324 mm	He Transfer Tube P222000072
	Split blow-out tube AUC131979	3329 mm	Blow out tube AUC331710
	3104 mm minimum ceiling height for installation		
600/54/ASC PremiumCOMPACT	Below this ceiling height you will need:	Ceiling height	Above this ceiling height you will need:
	Flexi-current lead AUE031933	3288 mm	Current lead AUE131704
	Bendy shim lead AUE131970	3228 mm	Shim lead AUE131709
	Split He Transfer tube* ATZ033481 & ATZ333482	3198 mm	He Transfer Tube P222000072
	Split blow-out tube AUC131979	3203 mm	Blow out tube AUC331710
	2978 mm minimum ceiling height for installation		
600/54/AR Annual Refill	Below this ceiling height you will need:	Ceiling height	Above this ceiling height you will need:
	Flexi-current lead	3513 mm	Current lead

Table 39 Minimum and ancillary ceiling height requirements (continued)

Magnet/Bore(MHz/mm)	Ancillary requirements for installation		
	AUE031933		AUE131704
	Bendy shim lead	3453 mm	Shim lead
	AUE131970		AUE131709
	Split He Transfer tube*	3423 mm	He Transfer Tube
	ATZ033481 & ATZ333482		P222000072
	Split blow-out tube	3428 mm	Blow out tube
	AUC131979		AUC331710
	3203 mm minimum ceiling height for installation		
600/89/ASP Premium Shielded	Below this ceiling height you will need:	Ceiling height	Above this ceiling height you will need:
	Split current lead	3504 mm	Current lead
	AUE031933 (or similar "horizontal style" split current lead to seal on 692 mm length)		AUE130954
	Bendy shim lead	3499 mm	Shim lead
	AUE131970		AUE131709
	Split He Transfer tube*	3469 mm	He Transfer Tube
	ATZ033481 & ATZ333482		P222000072
	Split blow-out tube	3474 mm	Blow out tube
	AUC131979		AUC331710
	3249 mm minimum ceiling height for installation		
700/54/ASP Premium Shielded	Below this ceiling height you will need:	Ceiling height	Above this ceiling height you will need:
	Split current lead	3554 mm	Current lead
	AUE031933 (or similar "horizontal style" split current lead to seal on 692 mm length)		AUE130954
	Bendy shim lead	3549 mm	Shim lead
	AUE131970		AUE131709
	Split He Transfer tube*	3529 mm	He Transfer Tube
	ATZ033481 & ATZ333482		P222000072

Table 39 Minimum and ancillary ceiling height requirements (continued)

Magnet/Bore(MHz/mm)	Ancillary requirements for installation		
	Split blow-out tube AUC131979	3524 mm	Blow out tube AUC331710
	3299 mm minimum ceiling height for installation		
700/89/ASP Premium Shielded	Below this ceiling height you will need:	Ceiling height	Above this ceiling height you will need:
	Split current lead AUE031933 (or similar "horizontal style" split current lead to seal on 692 mm length)	3890 mm	Current lead AUE130954
	Bendy shim lead AUE131970	3915 mm	Shim lead AUE131709
	Split He Transfer tube* ATZ033481 & ATZ333482	3855 mm	He Transfer Tube P222000072
	Split blow-out tube AUC131979	3860 mm	Blow out tube AUC331710
	3610 mm minimum ceiling height for installation		
750/89/ASP Premium Shielded	Below this ceiling height you will need:	Ceiling height	Above this ceiling height you will need:
	Split current lead AUE031933 (or similar "horizontal style" split current lead to seal on 692 mm length)	3890 mm	Current lead AUE130954
	Bendy shim lead AUE131970	3915 mm	Shim lead AUE131709
	Split He Transfer tube* ATZ033481 & ATZ333482	3855 mm	He Transfer Tube P222000072
	Split blow-out tube AUC131979	3860 mm	Blow out tube AUC331710
	3610 mm minimum ceiling height for installation		
800/54/ASC PremiumCOMPACT	Below this ceiling height you will need:	Ceiling height	Above this ceiling height you will need:
	Split current lead	3820 mm	Current lead

Table 39 Minimum and ancillary ceiling height requirements (continued)

Magnet/Bore(MHz/mm)	Ancillary requirements for installation		
	AUE031933 (or similar "horizontal style" split current lead to seal on 692 mm length)		AUE130954
	Bendy shim lead	3845 mm	Shim lead
	AUE131970		AUE131709
	Split He Transfer tube*	3785 mm	He Transfer Tube
	ATZ033481 & ATZ333482		P222000072
	Split blow-out tube	3790 mm	Blow out tube
	AUC131979		AUC331710
	3540 mm minimum ceiling height for installation		
850/54/ASC PremiumCOMPACT	Below this ceiling height you will need:	Ceiling height	Above this ceiling height you will need:
	Split current lead	3820 mm	Current lead
	AUE031933 (or similar "horizontal style" split current lead to seal on 692 mm length)		AUE130954
	Bendy shim lead	3845 mm	Shim lead
	AUE131970		AUE131709
	Split He Transfer tube*	3785 mm	He Transfer Tube
	ATZ033481 & ATZ333482		P222000072
	Split blow-out tube	3790 mm	Blow out tube
	AUC131979		AUC331710
	3540 mm minimum ceiling height for installation		

E
Anchor Bolts Specifications

Technical Information for Anchor Bolts provided with Magnet Systems

Please ensure that you read “Magnet anchoring and additional support” on page 32 about the importance of anchoring the anti-vibration legs of a magnet to the floor. The customer is ultimately responsible for ensuring that suitable anchor bolts are used to fix the magnet to the floor type on site. Agilent does provide some anchor bolts as standard, but these must only be used if their suitability has been confirmed. Below is a summary of the anchor bolts which are provided as standard with our systems:

Agilent part number	**P213000003**	**P213000008**
Description	Steel anchor fixings, 12 mm drill 100 mm L	Through bolt, stainless steel M16 x 125
Fixing hole diameter	12 mm	16 mm
Material	Steel (carbon steel, zinc plated)	Stainless steel (A4-316 grade)
Max. fixing thickness	35 mm	20 mm
Thread size	M12	M16
Type	Captive stud through bolt anchor	Captive stud through bolt anchor
Manufacturer	Fischer Fixings	RS
Manufacturer’s part number	41948	622-2010
Supplier’s additional information	Suitable for use in masonry and concrete. Heavy duty fixing.	Suitable for use in concrete over $20 N/mm^2$

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