AVANCE 750-900 MHz

Introduction to Site Planning
User Manual

Version 004

This manual was written by:

Stanley J. Niles

Rheinstetten, Germany

P/N: Z31278
DWG-Nr: 990004

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Introduction to Site Planning

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Introduction 1.1

This manual serves only as a brief introduction to the site planning requirements for AVANCE systems. After reading this manual you should have enough information to make an initial decision as to whether a proposed site is suitable for locating an AVANCE spectrometer. Aspects regarding correct safety procedures and requirements for the actual installation are dealt with only briefly. A more detailed and comprehensive manual entitled “Site Planning for Avance Systems” is available upon request.

The systems covered by this manual are AVANCE spectrometers in the range of 750-900 MHz. A separate manual is available for 300-700 MHz systems.

Recommendations regarding site planning are based on the experience gained by Brukerengineers down through the years. Every effort has been made to make the site requirements realistic and readily achievable. It must be stressed however, that **the figures quoted are only recommendations**. Likewise, any performance values that are used are **minimum values that should be readily achievable by every system**. Predicting NMR performance is complicated by the fact that every site is unique. This manual has been written to help you plan the site, but it carries no guarantee of ultimate NMR performance.

While every effort has been made to ensure the information contained herein is accurate, Bruker accepts no liability for consequential loss or damage arising from its use. Specifications are subject to change and where a value (e.g., ceiling height) lies close to a recommended minimum value you are advised to check with Bruker before final delivery.

The standard AVANCE spectrometer consists of three units: the cabinet (see ***section 1.2***), the work table (see ***section 1.3***), and the magnet (see ***section 1.4***).

Figure 1.1. Cabinet, Work Table and Magnet

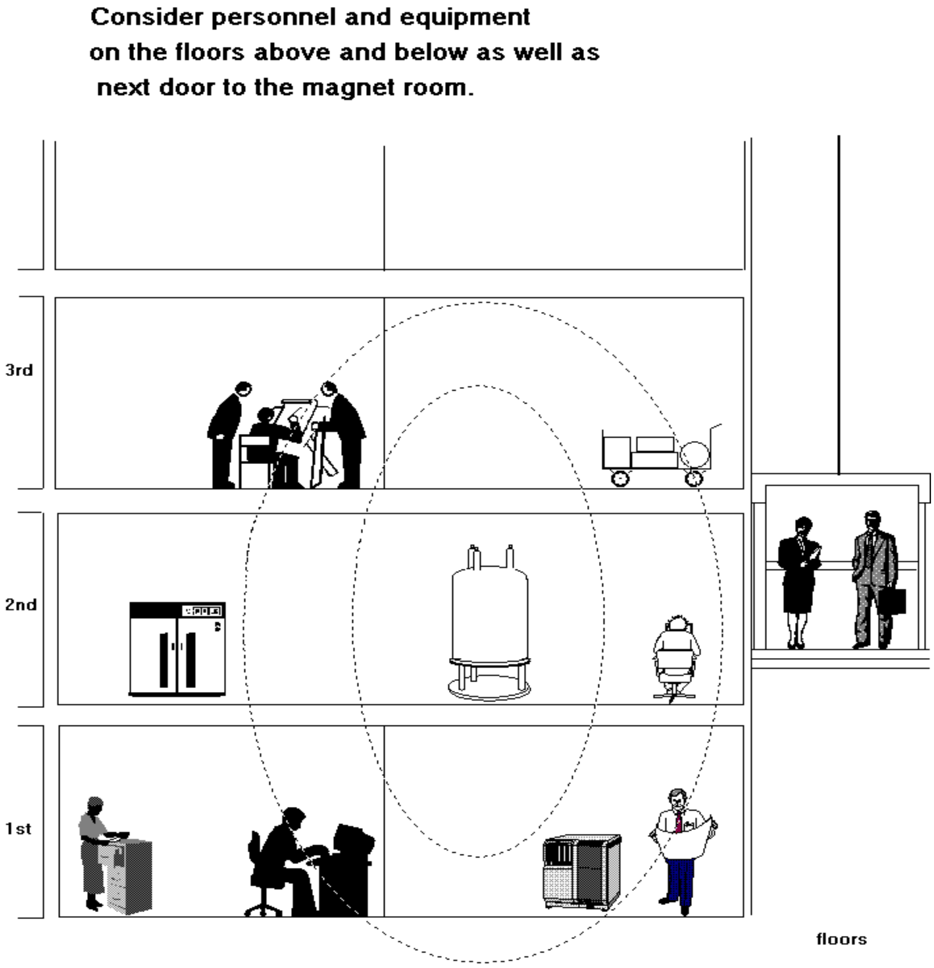
Safety 1.2

When planning the site for a new AVANCE system, the primary consideration should always be safety. With this in mind we recommend the following procedures:

1. Refer to ***Table 1.8.*** and ***Table 1.9.*** for the extent of the stray magnetic field appropriate to the magnet type which you have ordered.
2. Determine the position of the 0.5 mT (5 Gauss - medical exclusion zone) line relative to the proposed location of the magnet. Do not forget that the stray field exists in three dimensions. Assess the feasibility of ensuring that no members of the public are exposed to fields greater than 0.5 mT (5 Gauss). Apart from posting adequate warning signs you may want to limit access by means of locked doors or other suitable barriers such as plastic chains etc.
3. Ensure that no heavy moveable magnetic objects can pass within the 0.5 mT (5 Gauss) zone.
4. Ensure that the site is adequately spacious so that cryogen dewars can easily be moved in and out of the magnet room. Check that there is adequate working space immediately around the magnet.
5. Take an inventory of equipment in the NMR lab itself and in adjoining rooms that may be affected by the stray field.
6. Ensure that all relevant personnel are adequately informed of the potential hazards of super conducting magnets. This must include people working in adjoining rooms as well as cleaning and security staff. When non-NMR staff people have access to the magnet room, there should be at least one NMR staff member present in case of problems. A contact telephone number should always be posted in the NMR room.
7. Position the worktable, cabinet, and magnet such that people can have access to the worktable without having to pass through the 0.5 mT (5 Gauss) field zone.

8. Provide an adequate emergency exhaust system that can provide proper ventilation of cryogenic gases in case of a **magnet quench**. Please note that the cryogenic gases evaporate with an increase in volume of approx. 700 times greater than that of the liquid state.

Figure 1.2. Magnet Site Consideration: Personnel and Equipment



Note that the stray field is stronger in the vertical direction than in the horizontal direction.

Transportation and Shipping Information 1.3

Before delivery you must ensure that the system and magnet can be transported to the site. Some consoles and all magnets are shipped in crates. The table below gives the sizes of the crates in which the spectrometer is shipped. Should it be necessary to uncrate the system, the corresponding minimum door dimensions are also given.

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Table 1.1. Spectrometer & Magnet Width, Height and Crate Size

	Crate Size (m)			Minimum Door Dimensions (m)			
System	**L**	**W**	**H**	**Width Crated***	**Width Uncrated***	**Height Crated***	**Height Uncrated***
AVANCE Two Bay with Heightening	1.54	1.03	1.78	1.56	1.35	1.80	1.61
Magnet							
750 MHz/89 mm WB US	2.00	1.80	3.00	1.82	1.32	3.05	2.76
800 MHz/54 mm US	2.00	1.80	3.00	1.82	1.32	3.05	2.76
800 MHz/54 mm US[2]	2.20	2.20	3.00	2.22	1.90	3.08	2.89
900 MHz/54 mm US	2.20	2.20	3.00	2.22	1.90	3.08	2.89
For information on other magnets not listed, please contact your nearest Bruker representative. ***All heights should be increased by 15 cm for consoles or magnets on pallets. The use of a pallet jack may also require an additional 5-15 cm depending on the manufacturer.**							

Table 1.2. Transport Weights of NMR Cabinets and Accessories

Unit	Weight
AVANCE for Solids	460 Kg*
MAS Cabinet	160 Kg
Imaging Cabinet	150 Kg
HP Cabinet	200 Kg
UPS (optional - highly recommended when with Cryo-Probe system)	260 Kg + 165 Kg
Sample Changer (depending on model and options, e.g. B-ACS/60 = 93 Kg, B-ACS/120 = 95 Kg)	93-150 Kg
LC-NMR Unit, LC-NMR Console (MicroBay), LC-NMR Control Unit (host computer), plus any additional options	50-250 Kg + weight of MicroBay
Gilson	39.9 Kg + crate and accessories
BCU-05	50 Kg
CryoCooling Unit	400 Kg
UPS for Cryocooling Unit	260 Kg + 165 Kg
CryoProbe System He Compressor	120-140 Kg - varies for air and water cooled models

Table 1.2. Transport Weights of NMR Cabinets and Accessories

Unit	Weight
Emergency Generator (backup) for the He compressor and chiller (highly recommended)	Depends on manufacturer.
Weights include pallets and packing material as required. * Weights are for a standard AVANCE™ configuration, actual weights may increase depending on options selected.	

Table 1.3. Weight of the Magnet and Accessories

Magnet Type (Bruker OEM)	Magnet Weight with Crate (kg)	Magnet Weight without Crate (kg)	Magnet Weight Empty with Magnet Stand (kg)	Magnet Weight Filled with Magnet Stand (kg)
750 MHz/89 WB US	4200	4000	4130	4400
800 MHz/54 mm US	4220	4000	3950	4220
800 MHz/54 mm US^2	7000	approx. 6800	approx. 6100	approx. 7000
900 MHz/54 mm US	8400	approx. 7300	approx. 7500	approx. 8400
WB= Wide Bore, US= Ultra Shield™, US^2= Ultra Shield™ and Ultra Stabilized™ *For information on other magnets not listed, please contact your nearest Bruker representative*				

Table 1.4. Magnet Diameters

Magnet Type (Bruker OEM)	Diameter Including Pneumatic Stand (m)	Diameter of the Magnet (m)
750 MHz/89 WB US	1.295	1.28
800 MHz/54 mm US	1.295	1.28
800 MHz/54 mm US^2	1.874	1.688
900 MHz/54 mm US	1.874	1.688
WB= Wide Bore, US= Ultra Shield™, US^2= Ultra Shield™ and Ultra Stabilized™ *For information on other magnets not listed, please contact your nearest Bruker representative*		

Ceiling Height 1.4

The minimum ceiling height requirements depend on the clearance needed above the magnet for assembly, energization, and filling with liquid helium. The requirements for each magnet are listed in ***Table 1.5.***.

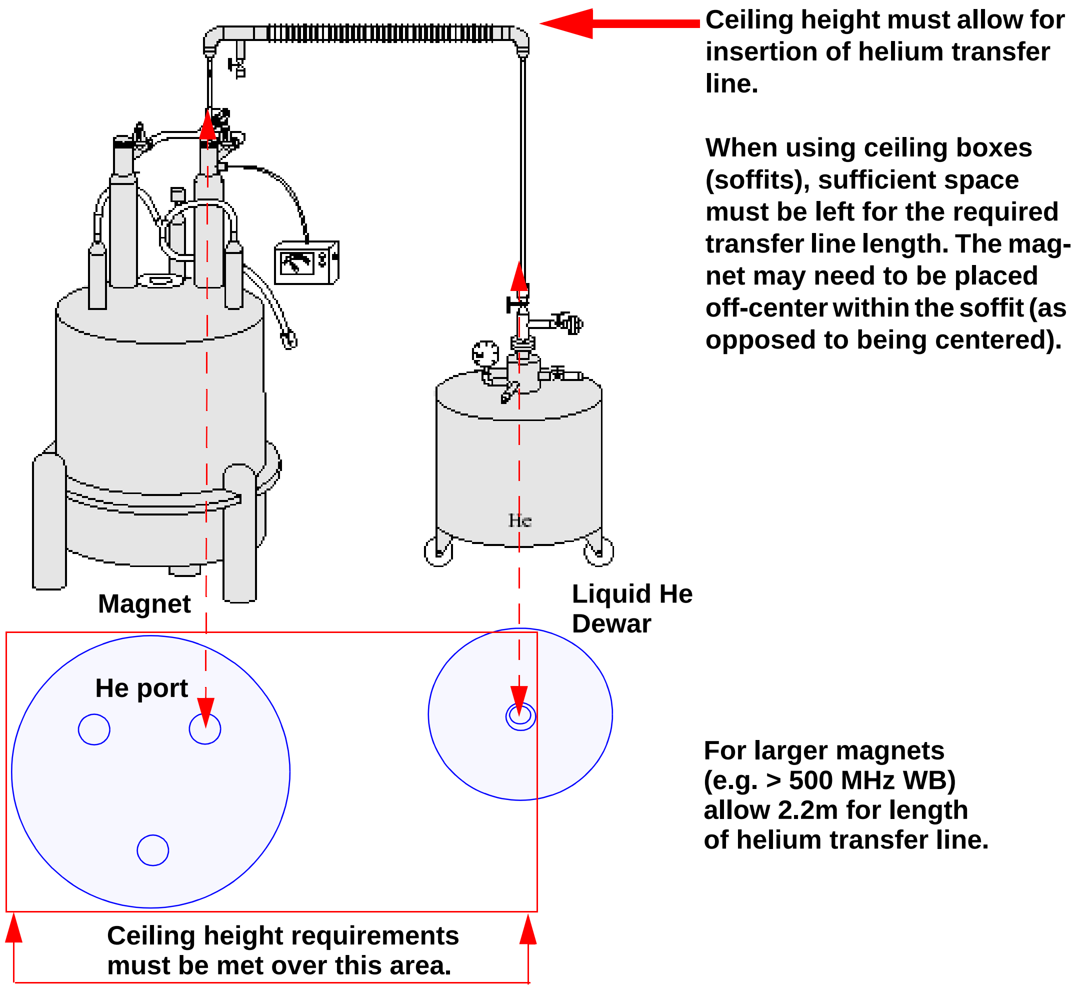
1. Note that the ceiling height requirements need not be met over the entire NMR room. ***Figure 1.2.*** illustrates that the height requirements are needed only above the magnet itself (and platform if installed), and over an area that extends out in one direction to allow for the helium transfer line.
2. For the assembly of the magnet you should provide a hook capable of supporting the magnet if possible. ***Table 1.5.*** shows the required minimum hook height and corresponding magnet weight for a range of magnets. If a hook can not be provided, please check with Bruker regarding special rigging equipment.

Table 1.5. Ceiling Height Requirements and Mass of Magnets

Magnet Type	Minimum Ceiling Height (m)	Minimum Hook Height (m)	System Weight Empty with Magnet Stand (Kg)	System Weight Filled Completely with Magnet Stand (Kg)
750 MHz/89 mm WB US	4.94	4.25	4130	4400
800 MHz 54 mm US	4.88	4.25	3950	4220
800 MHz 54 mm US[2]	5.30	4.75	6100	7000
900 MHz 54 mm US	5.30	4.75	7500	8400
For information on other magnets not listed, please contact your nearest Bruker representative				

Note that the ceiling heights that are listed represent the ***absolute minimum****. An extra 0.3-0.4 m above minimum requirements will make all procedures safer and more convenient.*

Figure 1.3. Ceiling Height Requirements



Room Layout 1.5

Floor Plan 1.5.1

To adequately plan the lab you should draw a scaled floor plan of the proposed site. ***Table 1.6.*** shows the maximum field strength at which standard NMR equipment should be operated or located. ***Table 1.7.*** shows the dimensions of various NMR units.

Use the magnet stray field data from ***Table 1.8.*** and ***Table 1.9.*** to check that all equipment can be positioned outside the limits as specified in ***Table 1.6.***. When drawing the floor plan refer to ***Table 1.4.*** for the magnet diameter.

Table 1.6. Maximum Field Strength for NMR Equipment

Unit	Maximum Field Strength
AVANCE Cabinet	10 Gauss (1.0 mT) line
Color Monitor (unshielded)	2 Gauss (0.2 mT) (for optimal picture)
Color Monitor (shielded) or LCD panel	10 Gauss (1.0 mT)
Computers e.g. NMR workstation, PC	10 Gauss (1.0 mT)
CPMAS, Micro-imaging, High Power units	10 Gauss (1.0 mT)
Printer Plotter	10 Gauss (1.0 mT)
Steel cylinder containing N_2 and He gas	5 Gauss (0.5 mT)
Movable metal chair	not recommended in magnet room
Heavy metal office furniture e.g. filing cabinet*	5 Gauss (0.5 mT) - not recommended in magnet room
BCU 05	*located 2.7 m max. from magnet center*
LC-NMR System & Accessories	5 Gauss (0.5 mT)
Gilson	5 Gauss (0.5 mT)
CryoProbe System Components (e.g. He steel cylinder and its transport path)	*5 Gauss (0.5 mT)*
CryoCooling unit	*50 Gauss (5.0 mT)*
** Use wooden furniture if access during critical measurements is required.*	

** Use wooden furniture if access during critical measurements is required.*

Table 1.7. Dimensions of NMR Equipment

Unit	Width*	Depth*	Height*
AVANCE for Solids	1.31 m	0.83	1.55 m (5’ 1“)
AVANCE Standard	1.31 m	0.83	1.29 m (4’ 3“)
Work table	1.20 m	1.00 m	0.75 m
CPMAS Cabinet with Heightening	0.69 m	0.83 m	1.55 m
High Power Cabinet with Heightening	0.69 m	0.83 m	1.55 m
Micro imaging Cabinet with Heightening	0.69 m	0.83 m	1.55 m
B-CU 05	0.50	0.55 m	0.48 m
LC-NMR Unit plus any additional options/accessories**	0.72 m diverse	0.80 m diverse	0.72 m diverse

Table 1.7. Dimensions of NMR Equipment

Unit	Width*	Depth*	Height*
Gilson	0.91 m	0.61 m	0.55 m***
CryoCooling unit	0.80 m	0.72 m	1.30 m

* All conversions from Metric/American Standard were rounded up.
** Accessories for the LC-NMR vary based on options that are ordered, but may include Cap-LC Interface, SPE-Interface, Autosampler's, Detector's, Injector's, Pump's and the host computer.
***Maximum height. Z-arm height is adjustable to accommodate vessel heights between 1 and 150 mm (dependant on installed Z-arm).

Magnet Position 1.5.2

When locating the magnet, take into consideration of the presence of permanent iron structures such as support beams and columns, as well as reinforced walls, floors, and ceilings. To increase temperature stability, the magnet should not be placed in direct sunlight or near any artificial heat source. Where possible avoid a situation where a significant stray fields >0.5 mT (5 Gauss) extend into adjacent rooms (see ***"Magnet Site Consideration: Personnel and Equipment"***). There should be open access to the magnet from all sides, and a minimum of 107cm (2' 6“) clearance to any adjacent wall should be provided. Sufficient space for accessing the cryogen dewars needs to be provided also.

If a **magnet platform** is required, e.g. due to the size of the magnet (normally 600 MHz and above), it should be large enough (depending on the magnet) to acomodate the magnet and provide proper access all around the system. A non-magnetic floor-level platform should be built around the magnet to allow access for changing samples and filling with cryogens. Consult your local Bruker office for further guidelines when using a magnet platform.

Figure 1.4. Magnet Platform

If a **pit** is required, due to limited ceiling height or to prevent stray fields from affecting the floor above, it should be large enough (depending on the magnet) to accommodate the magnet and provide proper access all around the system. It is extremely important to provide good ventilation when a pit is used. This is particularly true when refilling nitrogen. An oxygen warning device should be installed in the pit. Consult your Bruker office for further guidelines when using a pit.

Figure 1.5. An 800 MHz magnet with pit

Cabinet Position 1.5.3

Protection of the acquisition computer and digital electronics from the magnet's stray field is best achieved by positioning the cabinet so that the acquisition computer is no closer than the 1.0 mT (10 Gauss) line (***Figure 1.6.***). Any ancillary cabinets such as microimaging or high power should also be placed outside the 1.0 mT (10 Gauss) line (***Table 1.6.***).

Worktable Position 1.5.4

Based on acceptable MWC (**M**aximum **W**orkstation **C**oncentration) values, the working place should be placed outside of the 0.5 mT (5 Gauss) line.

The workstation and additional disks, tapes, CD-ROM drives, etc. which are normally placed on or under the worktable should not be exposed to fields greater than 1.0 mT (10 Gauss).

The graphics monitor is sensitive to the stray field, thus attention must be given to its position relative to the magnet. The monitor should be turned towards the magnet so as to be visible when tuning and matching. If unshielded, the monitor should ideally be placed no closer than the 0.2 mT (2 Gauss) line for optimal picture. With correct orientation you may locate the monitor as close as 0.5 mT (5 Gauss), though color distortion may result. Shielded monitors, as well as LCD flat panel monitors, can be safely placed as close as 0.5 mT (5 Gauss), or even 1.0 mT (10 Gauss), though slight picture distortion may occur.

Table 1.8. Horizontal Stray Fields

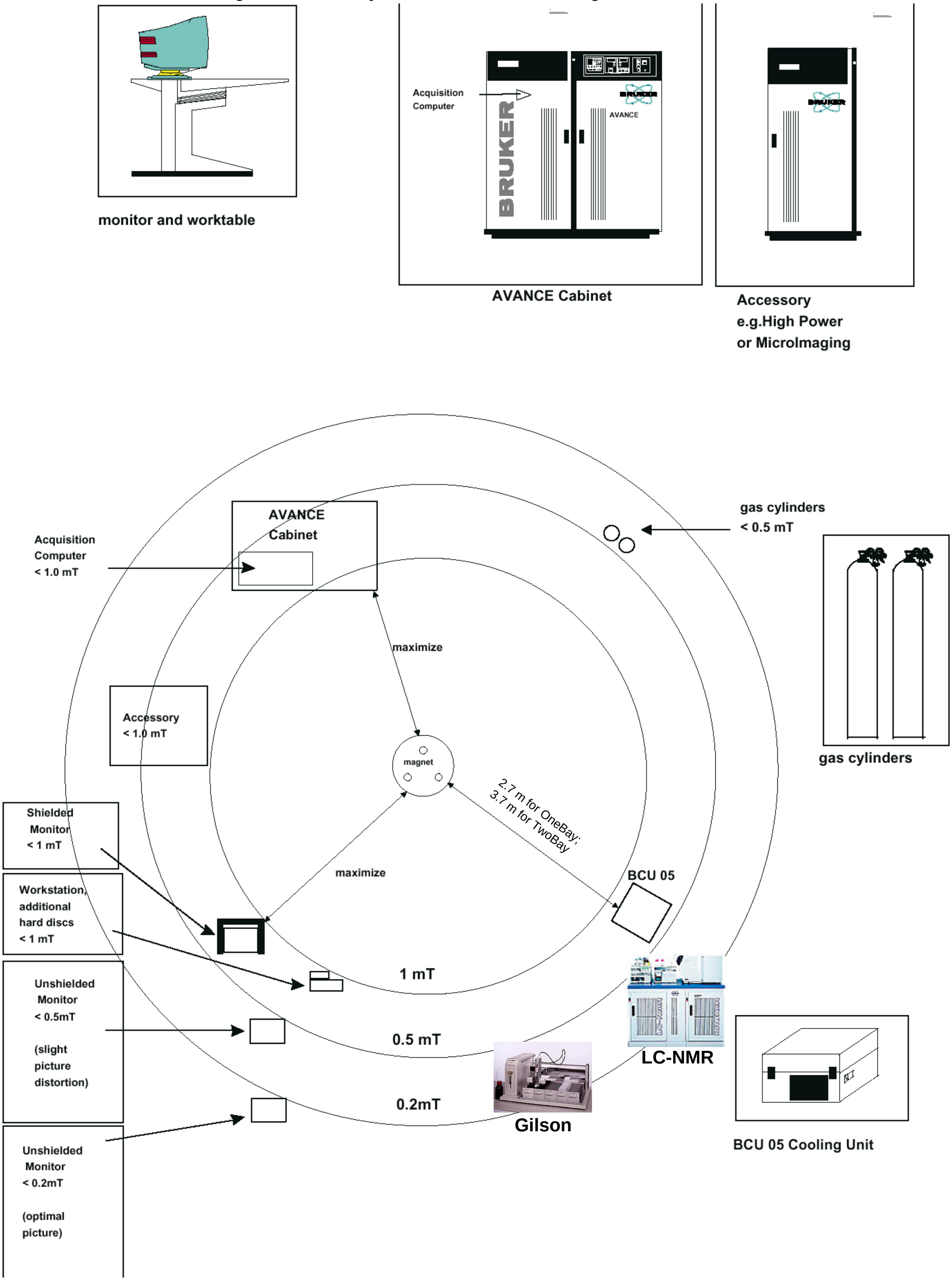
Magnet Type	5 mT (50G)	1 mT (10G)	0.5 mT (5G)	0.2 mT (2G)	0.1 mT (1G)	0.05 mT (0.5G)
750 MHz/89mm US	2.9m	4.9m	6.2m	8.3	10.6	13.4
800 MHz/54mm US	2.8m	4.8m	6.1m	8.2m	10.3m	13.0m
800 MHz/54mm US[2]	1.5m	2.15m	2.8m	3.8m	5.0m	6.4m
900 MHz/54mm US	3.6m	6.3m	7.8m	10.7m	13.5m	16.9m
(Distances are measured in radial direction from magnetic center)						

Table 1.9. Vertical Stray Fields

Magnet Type	MC to floor	5 mT (50G)	1 mT (10G)	0.5 mT (5G)	0.2 mT (2G)	0.1 mT (1G)	0.05 mT (0.5G)
750 MHz/89mm US	1.5m	3.7m	6.2m	7.8m	10.7m	13.4m	16.9m
800 MHz/54mm US	1.5m	3.6m	6.0m	7.6m	10.2m	13.0m	16.4m
800 MHz/54mm US[2]	1.6m	2.3m	3.2m	4.1m	5.6m	7.1m	8.8m
900 MHz/54mm US	1.6m	4.9m	7.8m	9.8m	13.5m	16.9m	21.2m
(Distances are measured in axial direction from magnetic center)							

Note: Stray fields correspond to the latest magnet designs as of the release date of this manual. For older systems, please refer to previous version of the Site Planning Guide, or contact your Bruker representative.

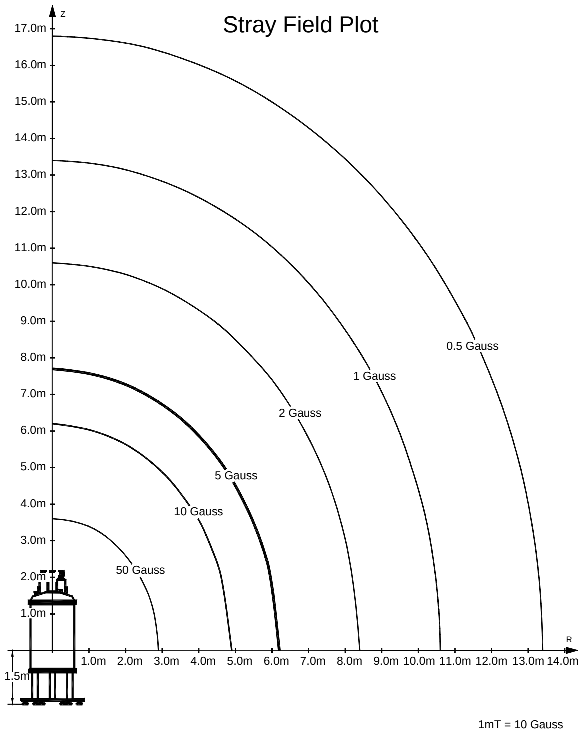
Figure 1.6. Stray Field Limits for Locating AVANCE 750-900



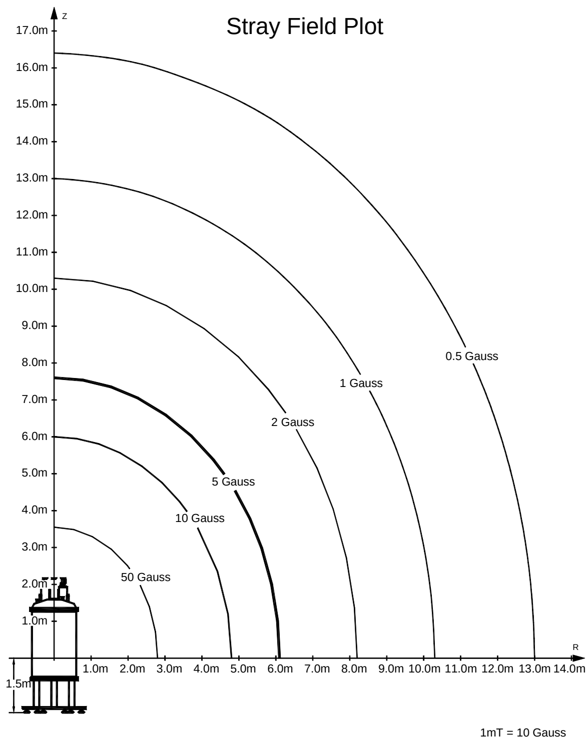
Note: Stray field not to scale, magnet does not have to be placed in center of room.

*Figure 1.7.   Stray Fields: BRUKER **750-900 MHz** Magnets*

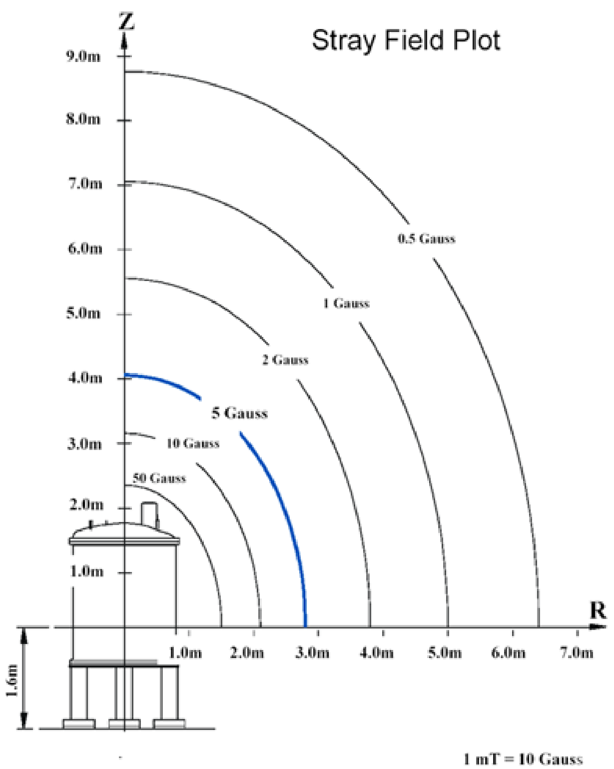
750 MHz/89mm WB US



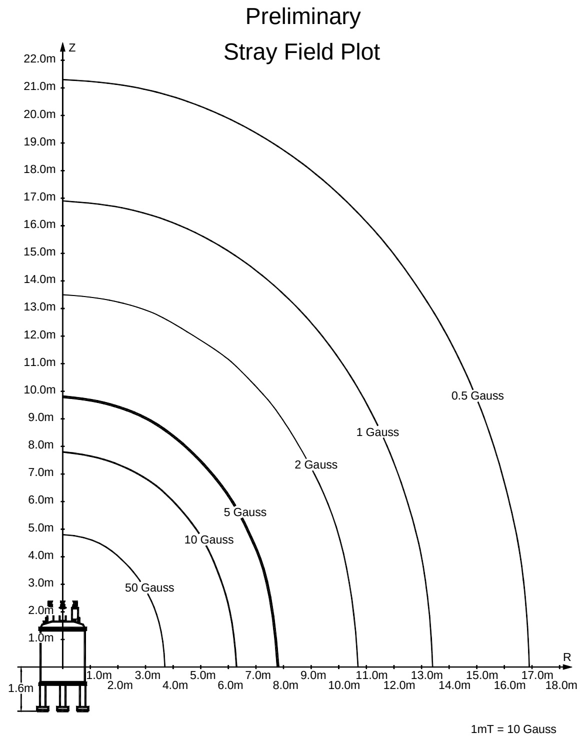
800 MHz/54mm US



800 MHz/54mm US[2]



900 MHz/54mm US



Mass of Equipment 1.5.5

The site floor must of course be sufficiently strong to support the AVANCE cabinet, the magnet (including cryogens and magnet stand), and the ancillary equipment. The weights of the various cabinets are listed in ***Table 1.2.***. For total weight of the magnet (including cryogens and stand) refer to ***Table 1.3.***. The floor should also be as rigid as possible to reduce the effect of vibrations.

Positioning other Standard NMR Equipment 1.5.6

Micro Imaging, High Power Cabinets

These accessories are not as sensitive to the magnet stray field as the units contained in the main AVANCE cabinets. In terms of performance they will operate satisfactorily at fields of up to 2 mT. However at this distance they may interfere with the magnet homogeneity and so it is recommended that they be kept beyond the 1 mT line. The standard layout places emphasis on making the cabling as convenient as possible. Where space is a problem, give priority to the position of the main cabinet over the accessory cabinet. Since these accessory cabinets are mobile the customer should consider securing the wheels if they are operated close to the magnet.

Automatic Sample Changer

The sample changer is designed to be located in front of the magnet and so its position is fixed. No extra ceiling height requirements are needed. You should note however that access to the magnet from one side will be slightly restricted. The sample changer has a width of 0.95 m and extends to a distance of 0.45 m from the magnet outer surface.

Cooling Unit: B-CU 05

This unit is connected to the magnet probe via a heat exchanger of 2.7 m in length. This effectively fixes the position of the cooling unit to a max.radius of approximatly 2.7 m from the magnet. The precise distance from the magnet centre can be reduced by placing a bend in the heat exchanger.

Service Access and Ventilation 1.6

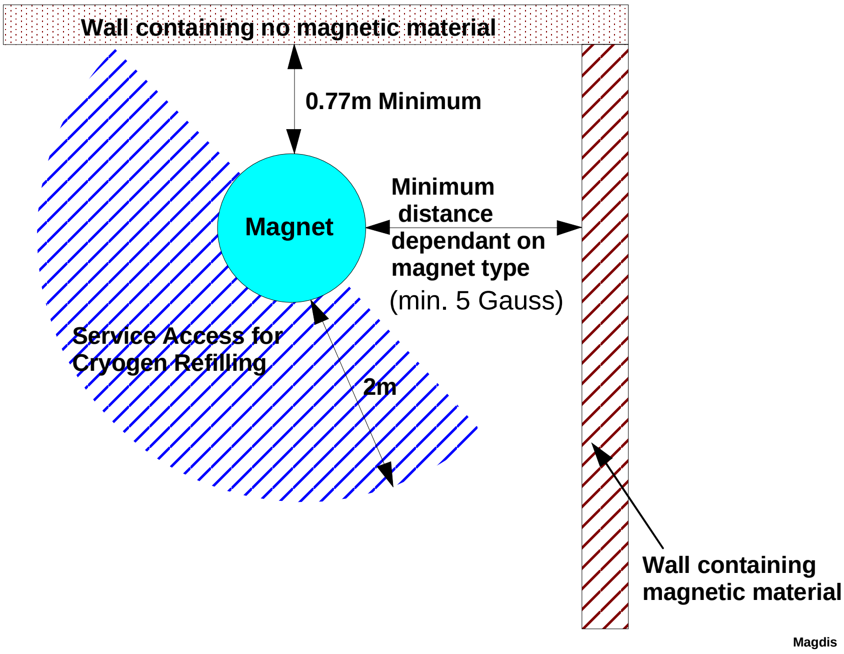
The following recommendations will ensure that there is suffiicient space for accessing the system, as well as providing adequate ventilation.

Service Access 1.6.1

Leave a minimum of 15 cm (about 6“) between the back of the cabinet and any walls. This is to ensure adequate ventilation. For service access to the rear, there must be sufficient space for the cabinet to be pulled out from the wall (approximately 60 cm/24 in.). Service access to the sides is not required.

There should be open access to the magnet from all sides, and a minimum of 77cm (2ft. 6in.) clearance to any adjacent wall should be provided. Sufficient space for access to the cryogen dewars needs to be provided as well.

Figure 1.8. Service Access Requirments for Magnet



Room for Ventilation 1.6.2

An **inadequately ventilated room will cause an excess buildup of helium**, which diffuses into the vacuum of the magnet (due to the helium molecules being very small). The long term effect of helium buildup is that the magnet will go soft, which means the vacuum installation of the magnet may no longer be efficient and the liquid helium boil off will start to increase. To help prevent helium buildup, ventilation should be provided in the upper-most portion of the room where the magnet is located, such as in the ceiling or upper wall.

Air Conditioning 1.6.3

Constant air pressure and temperature are important considerations for high performance operation. Ideally, an **absolute room temperature** should be selected from a range of 17-25°C. The room temperature should then be kept within +/- 1°C (2°F) for 300-500 MHz systems, and +/- 0.5°C for 600 Mhz and above.

An air exchange rate of 3-5 times the room volume per hour should be maintained.

A minimum of 30% humidity is required with a maximum of 80%. Conditions other than these may warrant the installation of an air conditioner with appropriate filters. The power supply for the air conditioning system must be separate to the spectrometer supply. If installing an air conditioning system an important consideration is the heat generated by the AVANCE™ electronics, ***Table 1.10.*** lists the heat generated by various systems. The system should operate continuously to stabilize the temperature and humidity of the magnet environment and should not cycle rapidly. Do not allow the air flow from any heating or cooling system to blow directly onto the magnet or console.

The standard AVANCE™ system and accessories can create significant heat as shown in the table below.

Table 1.10. Heat Generated by AVANCE™ *Systems*

System	Heat Generated
AVANCE (with 3 channels & BCU05)	2.6 kW average
Imaging Cabinet	1.0 kW average
High Power Cabinet	1.5 kW average
BCU05	0.5 kW average
Gilson	approx. 0.5 kW average
CryoProbe CryoCooling Unit	0.5 kW average 1.5 kW peak
He Compressor	7.5 kW average 8.5 kW peak

Emergency Ventilation During Magnet Installation and Quenches 1.6.4

A separate emergency ventilation system should be provided to prevent oxygen depletion in case of a quench or during the magnet installation.

During a **quench**, an extremely large quantity of helium gas (i.e. 43 m^3 to 595 m^3 depending on the magnet type) are produced within a short time.

During the installation and cooling of superconducting magnets, under certain conditions, large volumes of nitrogen or helium gases may be generated.

Although these gases are inert, if generated in large enough quantities, they can create dangerous circumstances if they displace the oxygen in the room.

In most cases doors and windows will provide sufficient ventilation in larger rooms. The door must be accessible from all parts of the magnet room. For smaller rooms it is highly recommended that quench gas exhaust pipes be installed.

In any case it is recommended that the air conditioning system be adequate to discipate the sudden gas buildup during a quench. In addition the air conditioning should have a safety feature which **draws all the air out** of the room and **brings fresh air in** during a quench, rather than just reciculating the air. The air conditional could, for example, be connected to an Oxygen level sensor.

For personal safety, **oxygen level sensors** should be located in the magnet room, particularily when using a pit. These should normally be located at a height of 2-2.5 meters. Contact Bruker for additional information.

Exit doors must open to the outside, otherwise during a quench the pressure buildup would make it impossible to open the door.

It should be noted that a quench may set off fire alarms, the fire department should be notified accordingly. The fire department should also be informed that during a quench water should not be sprayed on the magnet, as this may cause rapid icing. It is recommended that you post this information in plain site near the entrance of the magnet room as well.

Floor and Foundation *1.7*

There are a number of factors that should be considered concerning the floor and foundation. Among these are the capacity of the floor and foundation where the magnet and equipment will be located, the location of the magnet in regards to ferrous metals in the structure, and any external influences on the floor and foundation.

There are a number of factors that should be considered concerning the floor and foundation. As discussed in section ***1.5.5*** the floor must be **sufficiently strong** to support the mass of the equipment plus the weight of any installation devices, e.g. forklifts, hoists etc.

A sheet of **stainless steel** under the magnet will increase the minimum floor capacity. Check with your Bruker representative for details if this a concern at your site.

When locating the magnet take consideration of the presence of permanent iron structures such as support beams in walls and floors, reinforced concrete or pipes and cables in the floor. Likewise, the location of any radiators and air conditioning units should be checked, as they should not be located within the 50 Gauss (5 mT) line.

Generally, a **liquid nitrogen resistant floor** material should be used, such as wood that has been painted or varnished or PVC. Unfinished wood shuld not be used as this will absorb liquid nitrogen. This also implies that wood floors should be regularily maintained to help prevent absorption.

Many of the system components contain highly sensitive electronic devices that must be protected from **Electrostatic Discharge** (ESD) by proper floor covering and grounding practices. To prevent ESD damage in the magnet room, the system should be installed on an ESD resistant flooring such as vinyl, and properly grounded. Contact your local Bruker office for more information.

Vibrations *1.8*

External vibrations may cause the field at the sample to be modulated. This may result in vibration sidebands on either side of a main signal peak. The sidebands, which will be located at the vibration frequency, always display the same pattern, i.e. the left and right sidebands are inverted with respect to each other. Vibrational sidebands are not phase coherent and their relative height will be reduced by increasing the number of scans.

The site floor must of course be sufficiently strong to support the AVANCE^{TM} cabinet, magnet and ancillary equipment. The floor should also be as rigid as possible to reduce the effects of vibration. Wooden floors tend to have resonance frequencies of 10-15 Hz, whereas concrete floors display a resonance frequency in the 30-50 Hz range. Since higher frequencies are much more easily dampened by various devices, concrete floors will lead to less vibration problem than wooden floors.

The floor underneath the magnet must of course be level. Pay particular attention if you are locating the magnet in a chemistry department. Some laboratory floors may have a gradient to assist water flow.

Sources of Vibrations

1. Random vibrations may be caused by moving chairs, doors, tables etc. in or around the magnet room. This type of vibration is usually controllable, but when planning the site you will need to take into consideration activities in rooms adjacent to the magnet room.
2. Sources of more regular vibrations are generators, compressors, fans, machinery etc. Compressors should **not** be located in the NMR room and, if close enough, you should consider mounting such items on vibration damping material. Air vibration can be caused by ventilation or fans, (refer to the section on air conditioning requirements). Windows in the magnet room should be located and constructed in such a way that no sudden pressure fluctuations are produced by winds.
3. Ideally the site should always be at ground or basement level to minimize building vibrations. High rise buildings may oscillate at frequencies below 1Hz. Such oscillations may be noticeable in upper floors and are impossible to control. For XY oscillations, special dampers are now available, contact Bruker for details.
4. Vibrations from external sources such as cars, trains, airplanes, building sites etc.; Here the critical factor is the distance from the source to the NMR site, as well as the type of ground over which the vibrations are transmitted.

Measuring the extent of vibrations at the magnet location is a relatively simple matter. If you suspect that you have a problem, you should contact your local Bruker office.

Vibration Damping Measures 1.8.1

When required, passive damping of vibrations may be achieved by mounting the magnet on rubber blocks, inflatable pneumatic dampers, or vibration isolator posts (VIP).These devices can be easily retrofitted to an existing system if required.

Regardless of what measures may be taken, the vibrations can only ever be reduced to an acceptable level, they may never be totally removed.

Passive damping devices will reduce vibrations above a certain frequency. However lower frequencies, and particularly those corresponding to the resonance frequency of the damping device, will actually be amplified. Therefore it is important to choose the correct damping device to suit the frequency of the disturbing vibrations. Please check with your Bruker office for details.

Magnetic Environment 1.9

While minimum requirements for routine NMR operation are not particularly stringent, it is worthwhile to optimize the magnet´s environment if more sophisticated experiments need to be carried out.

Presence of Ferromagnetic Materials 1.9.1

The presence of any ferromagnetic materials in the immediate vicinity of the magnet will decrease the magnet´s homogeneity and may degrade overall performance. The effect of objects such as metal pipes, radiators etc. can be overcome by appropriate shimming but where possible this should be avoided.

When estimating the effect of ferromagnetic materials the following points should be noted:

1. The strength of interaction depends most strongly on distance (by the 7th power) whereas it varies in direct proportion with mass. Distance of the object from the magnet is far more critical than the mass of the object itself.
2. Moving magnetic material will cause a much greater problem than static masses. Distortion caused by a stationary mass e.g. radiator can usually be overcome, whereas the effect of moving masses (e.g. metal doors, chairs etc.) is unpredictable.

To help in site planning two sets of guidelines are given in the upcoming sections: a) **minimum requirements**, and b) **acceptable environment**.

By „acceptable environment“ we mean an environment with which most customer sites comply. This is a situation which is desirable, though not always achievable.

If minimum requirements can not be met then the customer should consider a different site because NMR performance is likely to be reduced.

Minimum Requirements 1.9.2

Static Iron Distribution

There should be none present within the 5 mT (50 Gauss) region. You should consider removing iron piping that is likely to lie within such fields prior to installation. If the magnet must be located close to iron or steel support beams, a proper alignment is important. Support beams should pass through or be symmetric to the magnet axis.

The 5 mT (50 Gauss) limit is suitable for a mass of up to 200 kg (500 lbs). For greater masses the limiting area must be extended accordingly. (The presence of static magnetic material close to the magnet presupposes that these masses are firmly secured e.g. radiators, pipes.)

Moveable Magnetic Material

No moveable masses should be located within the 0.5 mT (5 Gauss) region. Potential sources of moving iron are metal doors, drawers, tables, chairs etc. For larger masses (> 200 kg/500 lbs) distorting effects may be experienced at fields as low as 0.1 mT (1 Gauss). For high precision work (e.g. NOE difference experiments) extending the region for no moveable magnetic material to 0.05 mT (0.5 Gauss) may be justified.

Acceptable Environment 1.9.3

Static Objects

Table 1.11. gives a list of common sources of magnetic distortion and the recommended limits outside of which these sources should be located. It must be emphasized however, that such recommendations represent a situation that may not always be achievable.

Table 1.11. Recommendations for Static Magnetic Objects

Object	Actual Distance from Ultra-shielded Magnet
Iron or steel beams	4m
Steel reinforced walls	4m
Radiators, plumbing pipes	4m
Metal table, metal door	4m
Filing cabinet, steel cabinet	4m
Massive objects e.g. boiler	4m

Moving Objects

Table 1.12. serves as a guideline for moveable magnetic material.

Table 1.12. Recommendations for Movable Magnetic Objects

Object	Actual Distance from Ultra-shielded Magnet
Steel cabinet door	3m
Large metal door, hand trolley	4m
Elevators*	8m
Cars, fork-lifts	8m
Trains, trams*	8m

** These are more likely to be a source of vibrational or electromagnetic interference. Note that D.C. operated trains will cause disturbances over much larger distances.*

Electromagnetic Interference (EMI) 1.10

Electro Magnetic Interference (EMI) can be defined as any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics/electrical equipment.

Any electromagnetic disturbance which interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics/electrical equipment. It can be induced intentionally, as in some forms of electronic warfare, or unintentionally, as a result of a spurious emissions and responses, intermodulation products, and the like. Additionally, EMI may be caused by atmospheric phenomena, such as lightning and precipitation static and non-telecommunication equipment, such as vehicles and industry machinery.

Fluctuating electromagnetic fields (EMF) from such devices can interfere with the magnet stability. Of particular concern are sudden changes in load as may be produced by elevators, trams, subways etc. Subways and trams, operating on DC, generate large and slow changes in magnetic fields, primarily during the starting and stopping of carriages (systems operating on AC do not cause such problems).

Possible sources of electromagnetic interference are power lines which may carry fluctuating loads, heavy duty transformers, large electric motors, air conditioning systems etc. Some laboratory equipment such as mass spectrometers and centrifuges will also produce fluctuating fields.

Generally, the use of an Ultrashield magnet will greatly reduce the problem of DC interference. The ultimate solution is to use an iron cage, but this is rarely a cost-effective or practical solution for most organizations, and normally is only considered when high precision results are demanded.

The effect of EMI has been greatly reduced with the introduction of the digital lock which is fitted as standard in all AVANCE two-bay spectrometers.

The digital lock is less susceptible to external magnetic field disturbances than the conventional lock. The effect of any instabilities is considerably decreased, by a factor which depends on the lock substance. Lock substances with high concentration and long relaxation times show the best improvement. The guidelines are listed in table 1.13 below:

Table 1.13. Minimum Distances from Sources of Electromagnetic Interference

Source of Interference	**Recommended Minimum Distance from Ultrashielded Magnet**
Trams, subways *	100 m
Elevators, fork-lifts**	8 m
Mass Spectrometer (slow ramp)	10 m
Mass Spectrometer (sudden fly-back)	30 m
* Trams and subways are also a source of vibrational interference ** Depends on the lift geometry and material. These specifications may vary.	

If rf interference is a problem, then shielding of the NMR room with a Faraday cage is a possible solution, though having to take such measures is practically unheard of.

Resulting problems from locating two spectrometers in close proximity can often be overcome by altering the field strength of one of the magnets slightly when it is being charged at the customer site. In this way the resonance frequencies of the two spectrometers no longer coincide.

If you suspect that you have a source of interference located near the magnet you should contact your Bruker office.

RF Environment 1.10.1

Since the NMR instrument is effectively a very sensitive radio frequency receiver, another possible source of interference is **Radio Frequency Interference** (RFI). Most RFI comes from local radio or television broadcasts, as well as signals emitted by personal paging systems or cellphones. Electrical devices located in the immediate area may also be a source of some interference.

Although the interference effects will depend greatly on the strength of the transmitter, as a rule of thumb only broadcasting transmitters located within a radius of approximately 5 km (3 miles) would normally be a possible source of interference. Of particular concern will be interference at frequencies that NMR experiments are carried out.

As a general guideline a site should be checked at the respective frequencies shown in ***Table 1.14.***. The level of any RFI should be attenuated to an electrical field strength of < 150µV/m at the side of the magnet.

Table 1.14. NMR Spectrometer Operating Frequencies

Frequency (MHz)	Frequency Range (MHz)
750	12 to 807
800	12 to 860
900	12 to 970

A further source of interference is between two spectrometers located in close proximity and operating at the same frequency. Where possible this situation should be avoided. Resulting problems can often be overcome by altering the field strength of one of the magnets slightly when it is being charged at the customer site. In this way the resonance frequencies of the two spectrometers no longer coincide.

Cryogens and Magnet Maintenance 1.11

The key point in storing and using cryogenic liquids is that **good ventilation is essential!**

Superconducting magnets use liquid helium and nitrogen as cooling agents, keeping the magnet core at a very low temperature. Cryogenic liquids, even when kept in insulated storage vessels (dewar vessels), remain at a constant temperature by their respective boiling points and will gradually evaporate. These liquids expand their volume by a factor of 700 when they are evaporated and then allowed to warm up to room temperature.

The gases are nontoxic and completely harmless as long as an adequate ventilation is provided to avoid suffocation. During normal operation only 3-5 m^3/day of nitrogen are evaporated, but during a **quench**, an extremely large quantity of helium gas (i.e. 43 m^3 to 595 m^3 depending on the magnet type) are produced within a short time. Windows and doors are sufficient for ventilation even after a quench, but the NMR magnet system should never be in an airtight room.

The magnet location should be selected such that the door and the ventilation can be easily rached from all places in the room.

Superconducting magnets use liquid helium and nitrogen as cooling agents, keeping the magnet core at a very low temperature. Cryogenic liquids, even when kept in insulated storage vessels (dewar vessels), remain at a constant temperature by their respective boiling points and will gradually evaporate. The very large increase in volume accompanying the vaporization of the liquid into gas and the subsequent process of warming up is approximately 700:1 for helium and nitrogen.

Do not use cryogens that have been stored in high pressure containers for cryogenic liquids! If no other containers are available, the pressure must be released completely before connecting the high pressure transport container to the cryostat. Failure to do this could present an explosive hazard for the magnet system and could lead to severe damage.

Room layout, ceiling and magnet height should be such that an easy transfer of liquid nitrogen and helium is possible. This will considerably reduce the risk of accidents.

Employees working with cryogens should be aware of the following properties of these substances:

Table 1.15. Table of Properties of Cryogenic Substances

Properties	Nitrogen	Helium
Molecular weight.	28	4
Normal boiling point [°C / °K].	approx. 196 / 77	approx. 269 / 4.2
Approximate expansion ration (volume of gas at 15°C and atmospheric pressure produced by unit volume of liquid at normal boiling point).	680	740
Density of liquid at normal boiling point [kg m^{-3}].	810	125
Color (liquid).	none	none
Color (gas).	none	none
Odor (gas).	none	none
Toxicity.	very low	very low
Explosion hazard with combustible material.	no	no

Table 1.15. Table of Properties of Cryogenic Substances

Properties	Nitrogen	Helium
Pressure rupture if liquid or cold gas is trapped.	yes	yes
Fire hazard: combustible.	no	no
Fire hazard: promotes ignition directly.	no	no
Fire hazard: liquefies oxygen and promotes ignition.	yes	yes

Refer to the magnet manual for more information on cryogens.

Introduction to Magnet Maintenance 1.11.1

Liquid helium and nitrogen are used to cool the magnet so that it remains superconducting. Refilling of cryogens is the only regular maintenance required by the magnet. The procedures to be used for fills represent an important site planning consideration.

Some customers prefer to contract the cryogen maintenance out to local suppliers. Other customers may decide to install a permanent on site supply of cryogens. Helium, in particular, is expensive and recycling of evaporated gas is often economically viable. Financial considerations depend mostly on price and availability of liquid helium, and must be considered in each case individually. In general however, a low loss magnet in an area with regular helium supply will not consume enough helium to pay off the installation costs of a **Helium Gas Recovery System**. For further information regarding such a system contact Bruker.

Storage tanks of course must be situated well away from the magnet room. Where an in-house nitrogen supply is available, the customer must decide whether to pipe the liquid nitrogen directly to the magnet room or to use transport dewars. Experience has shown that the latter option is simpler. Using transport dewars it is easier to keep track of the cryogen evaporation rate when the magnet is filled regularly from a dewar of fixed volume.

Please visit our Internet site at ***http://www.bruker-biospin.com/nmr/products/magnets.html*** or read the magnet manual that is delivered with your system to learn more about cryogen filling procedures.

The key point in storing and using cryogenic liquids is that **good ventilation is essential!**

Liquid Nitrogen

Store and use in a well ventilated area. If sufficient gas evaporates from the liquid in an unventilated area (e.g. overnight in a closed room) the oxygen concentration in the air may become dangerously low. Unconsciousness may result suddenly without prior warning symtons and may be fatal. For example, the evaporation of 40 liters of liquid nitrogen produces 27,000 liters of nitrogen gas. If this vaporisation takes place in an unventilated room of $27m^3$ (3m x 3m x 3m) it can produce a very dangerous situation. Appropriate multiplication of these parameters will indicate actual site conditions. It is highly recommended that an Oxygen Level Sensor be used.

Liquid Helium

Liquid helium is the coldest of all cryogenic liquids. It will therefore condense and solidify any other gas (air) coming in contact with it. The consequent danger is that pipes and vents may become blocked with frozen gas!

Liquid helium must be kept in specially designed storage or transport dewars. Dewars should have a one way valve fitted in the helium neck at all times, in order to avoid air entering the neck and plugging it with ice. Vacuum insulated pipes should be used for liquid transfer. Breakdown of the insulation may give rise to the condensation of oxygen.

The following items will be required to maintain the cryogen levels within the magnet.

Cylinders

Two cylinders (one containing helium gas, and one with nitrogen gas) are required:

> **Nitrogen gas cylinder**: 50l/200 bar with 2 stage regulator to deliver pressure of 0.5 bar (1-10 psi).
>
> **Helium gas cylinder**: 50l/200 bar with 2 stage regulator to deliver pressure of 0.2 bar (1-10 psi).

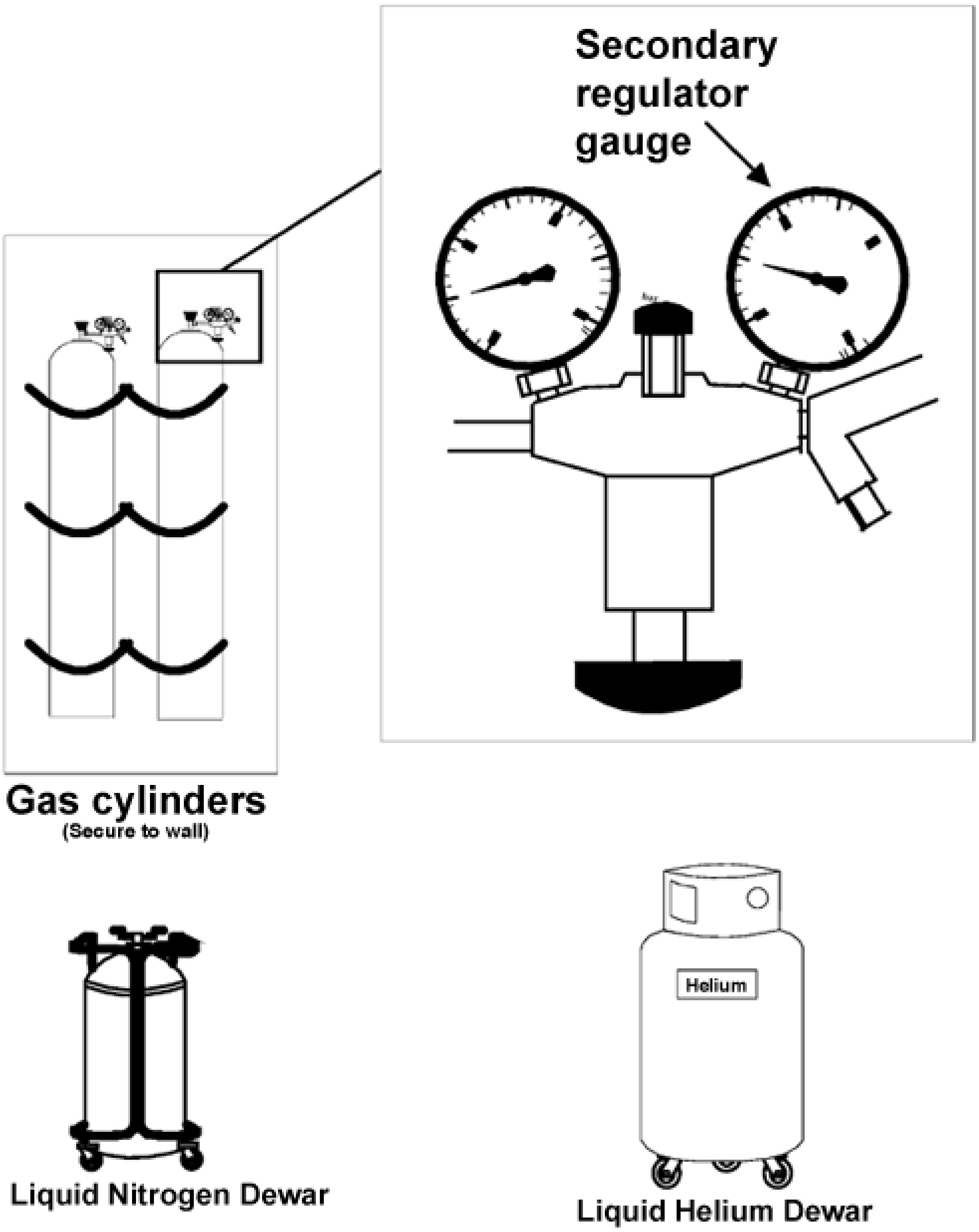
Gases used should be of the highest purity available (nitrogen 99.99%, helium 99.996%). The cylinders may be made of magnetic material such as iron or steel as long as they are kept well away from the magnet (maximum safe field strength 0.5 mT (5 Gauss).

It is important that the 2 stage regulator (see ***Figure 1.9.***) on the gas cylinders be sufficiently sensitive so that fine control of the output pressure is possible. The 2 stage regulator should have a pressure range no greater than 0.5 bar (1-10 psi).

Dewars

Two transport dewars (one for liquid helium, one for liquid nitrogen) are also required. These **must** be made of non-magnetic material as they are normally brought close to the magnet during cryogen filling. Such dewars are often provided by the cryogen supplier and do not need to be purchased.

Figure 1.9. Cryogen Equipment



Utilities 1.12

Electrical Power Requirements 1.12.1

The power for the 750-900 MHz BRUKER magnet systems are exclusively controlled by the BMPC (Bruker Magnet Pump Control) Unit. This unit provides the required power for the two-bay cabinet and cooling unit, and ancillary units such as the helium pumps used for the magnet itself.

You must supply a single mains connection 230V with fuse rated at 50A. For precise details of the frequency and voltage of the required power supply please consult with BRUKER.

Figure 1.10. displays the BMPC and the various units that it powers (for the 800 MHz system). All power is routed through the UPS which also has the advantage of serving as a line conditioner. In the event of a power failure, the power source is designed to automatically switch to the UPS batteries which will provide power long enough to allow the computer and two-bay cabinet electronics to be shutdown. If the power failure exceeds 6 minutes the supply to the two-bay cabinet will be cut off automatically. This will enable the UPS to power the helium pumps for typically 8 hours. You must also provide a backup diesel generator to maintain power supply to the helium pumps in the case of power failures which are longer than 8 hours. The BPMC also contains a set of security backups should a power failure occur overnight. We recommend that you locate all these units in a separate location to the magnet itself. With this mind you are asked to provide a 20A single phase connection from the BMPC to the two-bay cabinet as well as a 10A single phase connection from the BMPC to the cooling unit. In particular the compressor (used to drive a source of compressed nitrogen for sample lift/spinning) will be a source of vibration and should be situated well away from the magnet and powered by a separate supply.

The magnet requires electric power during charging or discharging only and this supply (230 V/50 or 60 Hz) can be temporarily installed during installation.

Figure 1.10. Power Supply for 800 MHz Systems

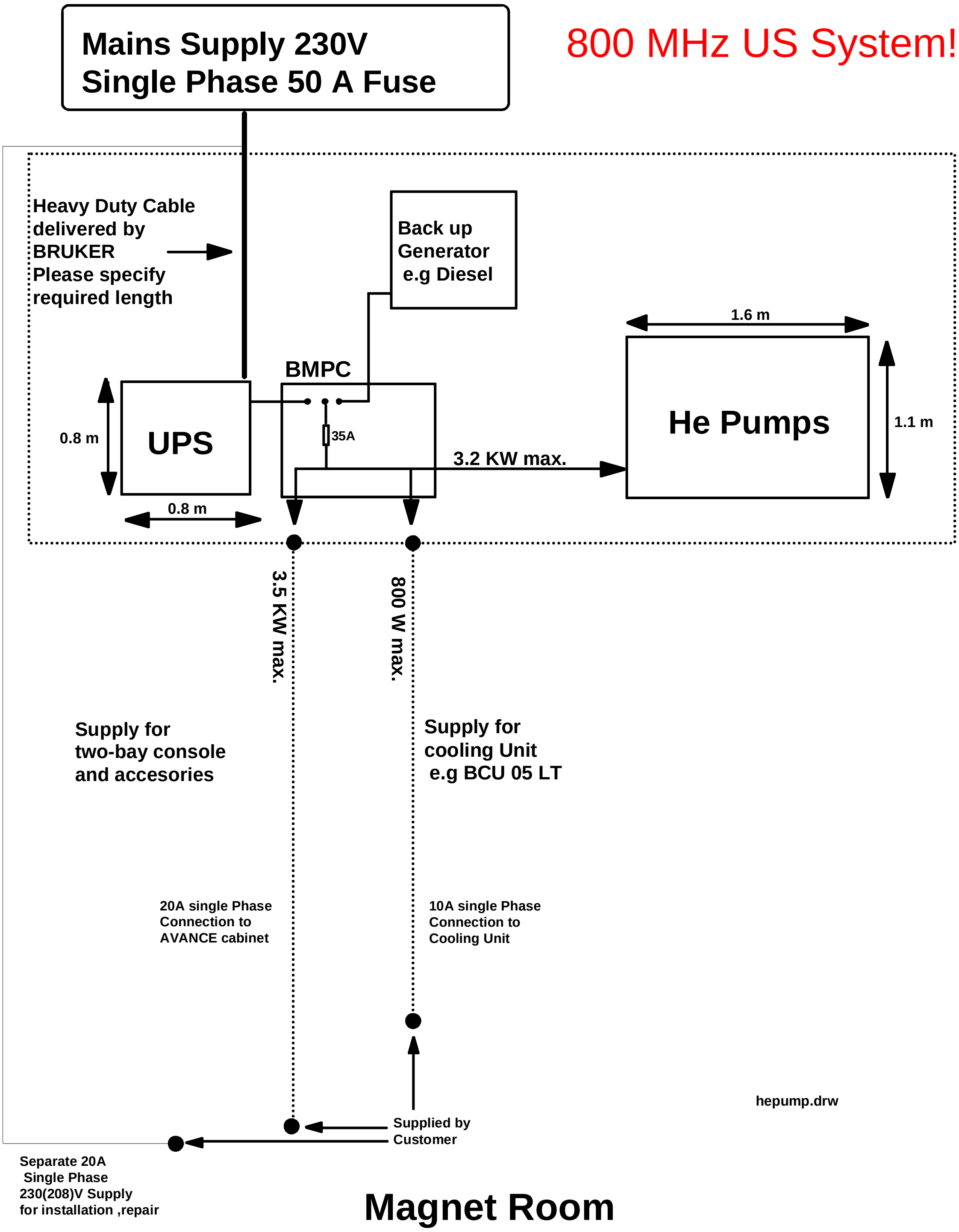


Table 1.11 lists the power requirements and power consumption of various AVANCE consoles.

The power consumption quoted, includes the NMR workstation and graphics monitor, and was measured using 2 amplifiers operating at maximum output in CW mode. For systems fitted with additional amplifiers allow 300W for each additional amplifier.

For a 230V system a 16A slow-blow fuse or circuit breaker must be installed (for a 110V system a 20A slow-blow fuse or circuit breaker must be installed).

Table 1.16. Power Requirements of Basic System (2 Channels)

System and Amplifiers	Mains Supply	Power Consumption (kW)	No. of Spare Electrical Outlets	Length of Mains Cable
OneBay with BLA2BB	230V 50/60 Hz / 16A single phase 208V 60 Hz / 20A single phase	1.2 1.6	2	5.5 m / 18 ft.
OneBay with BLAXH100/50	230V 50/60 Hz / 16A single phase 208V 60 Hz / 20A single phase	1.6 2.2	2	5.5 m / 18 ft.
TwoBay with BLARH100 + BLAX300	230V 50/60 Hz / 16A single phase or 230V/400V 50/60 Hz/10A triple phase or 208V 60 Hz / 20A single phase	2.6	2	5.5 m / 18 ft.
TwoBay with BLAXH300/50	230V 50/60 Hz / 16A single phase 208V 60 Hz / 20A single phase	2.2 9.6	2	5.5 m / 18 ft.
TwoBay optimized for solids 200 to 500 MHz	230V 50/60 Hz / 16A triple phase 208V (400V*) 60 Hz / 20A single phase	9.6	4	5.5 m / 18 ft.
Imaging Cabinet	230 V / 50/60 Hz / 16 A single phase 208V 60 Hz / 20A single phase (power from AVANCE)	2.4	---	---
Bayvoltex Chiller for MicroImaging Systems	230V / 50/60Hz / 16A single phase 110V 60 Hz / 15A single phase	approx. 0.45kW	---	---
BCU 05	230V 50/60Hz / 16A single phase 208V 60Hz / 20A single phase (power from separate outlet or AVANCE)	0.45 kW	---	---
CryoCooling Unit**	230V 50/60Hz / 16A single phase 208V 60Hz / 20A single phase (do not use power from AVANCE)	0.5 kW average 1.5 kW peak	---	10m
He Compressor**	380V 50Hz / 12A triple phase 200V 50/60Hz / 25A triple phase	7.5 kW average 8.3 kW peak	---	
UPS for CryoCooling Unit**	UPS requirements: 500W for CryoCooling Unit and at least 2.6 kW for the spectrometer cabinet (depends on configuration). The battery time should be selected according to the maximum duration anticipated for a power failure.			
UPS for Avance Spectrometer Cabinet				

* A step-up transformer to 400V is supplied by Bruker
** Refer to the **CryoProbe System Site Planning Guide** for more information.

Each AVANCE cabinet comes supplied with four electrical outlets (230V/10A) which can be used to power standard ancillary equipment. Two outlets are designed to power the NMR workstation and (optional) Imaging cabinet. This leaves two outlets free for accessories such as an Automatic Sample Changer etc..

Two Bay with Solid Accessory

This spectrometer can be approximated to a standard two bay plus High Power Cabinet and so the total power requirements is 2.6 + 5.1 = 7.7 kW.

CP MAS:

The power requirements of this unit will depend on the amplifiers that are used. The control unit itself will not use more than 100W.

Voltage stabilizers

If line voltage fluctuations exceed -5% to +10% a voltage stabilizer must be used.

Even if the fluctuations are well within these limits, the purchase of a line conditioner may prove to be a good investment. The lifetime of the various electrical components in the spectrometer will be lengthened when the supply is stabilized. When deciding on a stabilizer you should take note of the following:

1. Power Requirement: The stabilizer must be capable of delivering the total power requirements of the various units you wish to protect. A surplus capacity of at least 10% is recommended.
2. Remember to consider future equipment that you may decide to install.
3. The stabilizer must of course be compatible with the input voltage, number of phases and A.C. frequency. Typically the stabilizers can cope with input fluctuations of 20%.
4. Output: The NMR units described in this manual normally use 230V/50-60Hz/single phase with the exception of the High Power Cabinet which uses 380V/50-60Hz/triple phase.
5. The regulation accuracy of the output need be no greater than 1% for single phase and 2% for three phase.
6. Single phase stabilizers use saturated transformers to regulate the voltage and should have fast response times, typically 10-20 msec. Three phase stabilizers however use motors and have slower response times.A regulation speed of 15V/s is usually sufficient to overcome mains fluctuations in most countries.

Other considerations are lifetime, size, noise output, and maintenance requirements.

Contact your local Bruker office for advice on a voltage stabilizer suited to your particular system.

If ordering a stabilizer you should specify:

- Input voltages.
- Number of phases.
- Special requirements, e.g. output connectors, meters, housing etc.
- Details of units and accessories that require protection.

UPS

Where total interruption of power occurs frequently, you should consider installing a UPS (Uninterruptable Power Supply) possibly linked to an automatic cut-in generator. This is particularly advisable when long-time experiments are to be run.

While a total loss of power will not damage the spectrometer hardware, NMR data acquired immediately prior to a power cut, and which has not been stored on the computer hard disk may be lost. The difference between UPS systems and a voltage stabilizer is that the UPS system contains a battery back-up pack which will maintain the power supply to the spectrometer for a limited period after a total loss of mains supply. Typically the battery back-up will last for up to 10 minutes at the rated power. This gives time for a generator to replace the mains power or for the spectrometer computer to be shut down according to the correct procedures. Additional battery packs which extend the back-up period to 30 minutes at the rated power are also available. As well as maintaining supply, the UPS system also serves as a line conditioner. Typical output voltage stability is 2% static and dynamic with frequency stability of 1%.

When selecting a UPS you must consider the power consumption of the system and amplifiers, your operating voltage, the desired run time during a power outage, as well as any future spectrometer power expansion requirements. Check with a reputable UPS dealer in your area for specifications on their products.

Note:

1. The power supply to the spectrometer should be "clean" (no spikes), i.e. it should not share with air conditioners etc.
2. All mains earths in the lab should be connected together to avoid differences in earth potential. This will avoid problems when, for example, a Personal Computer powered externally is connected to the spectrometer via a RS232 link.
3. Some customers fit RCCB (residual current circuit breakers) to the spectrometer supply.These are designed to switch off the supply if there is an imbalance in the current in the live and neutral lines. If these are fitted to an AVANCE^{TM} series spectrometer then they should be rated at 100mA. The lower value of 30mA commonly used is too sensitive for these spectrometers.

General UPS requirements: At least 2.6 kW for the spectrometer cabinet (depends on configuration) and 500W for CryoCooling Unit (if using CryoProbe system). The battery time should be selected according to the maximum duration anticipated for a power failure.

Requirements for Compressed Gas Supply *1.12.2*

With a 750-900 MHz system nitrogen gas must be used for temperature control.

Sample ejection, spinning and temperature control are achieved by means of a stream of compressed air or nitrogen. The air/gas supply is piped via plastic tubing to the rear of the AVANCE^{TM} cabinet. The standard tubing has an internal diameter of 6 mm and an external diameter of 8 mm and is supplied by Bruker. The site must contain a compressed air/gas outlet that is compatible with the 8 mm tubing. Although not critical it is convenient if the outlet is located close to the rear of the AVANCE^{TM} cabinet. The required air/gas pressure and flow rate is detailed in ***Table 1.17.***. The AVANCE^{TM} cabinet should never be subjected to a pressure of more than 10 bar. Install a pressure regulator valve followed by a gate valve on the final outlet of the compressed air supply line.

The Vibration Isolation units and CryoCooling unit also need compressed gas. Normally, two or three regulated lines are adequate to meet the compressed gas supply requirements. If Vibration Isolation units and a CryoCooling unit are used contact Bruker for verification on the adequacy of the planned compressed gas supply.

Nitrogen vs. Compressed Air

There are advantages to using **nitrogen** (required for 500 MHz and up), though for lower field magnets compressed air is most popular. In particular, a supply of gaseous nitrogen, obtained by evaporating air, will normally be very dry, making it particularly suitable for low temperature work. Where a customer uses air, then the process of achieving the required quality is much more difficult. For this reason this chapter will deal principally with providing a suitable supply of compressed air. The specifications of air quality are of course equally applicable to compressed nitrogen.

Table 1.17. Compressed Gas Requirements

System	Operating Pressure (Pa*)	Average Consumption (l/min)	Recommended Minimum Air Supply after Dryer at $5*10^5$Pa
AVANCE	$6\text{-}8*10^5$Pa	45	57 l/min
AVANCE + BACS**	$6\text{-}8*10^5$Pa	52	57 l/min
AVANCE + MAS (DB ***, 5 kHz/7mm)	$6\text{-}8*10^5$Pa	220	300 l/min
AVANCE + NMR CASE	$6\text{-}8*10^5$Pa	52	57 l/min
AVANCE + SampleRail	$6\text{-}8*10^5$Pa	> 52****	100 l/min
AVANCE + Gilson	$6\text{-}8*10^5$Pa	46	57 l/min
Vibration Isolation Units	Please check with Bruker for latest specifications.		
LCNMR/MS	Please check with Bruker for latest specifications.		
CryoCooling Unit	$6\text{-}8*10^5$Pa	approx. 52	57 l/min
* Pa= Pascal (1 bar = 100,000 Pa) ** BACS= Bruker Automatic Sample Changer *** DB= Double Bearing **** Estimate - exact consumption was not available when this publication was written.			

NOTE: One main compressed gas line with two separate regulated outputs (T split with two regulators) is required. An additional line may be required if using a CryoCooling unit.

If N2 gas is required, but only dry air is available, Bruker can provide N2 separators built-in to the consoles. Producing N2 gas from air is also much more cost effective than buying nitrogen gas.

Please note that N2 separators may not be appropriate for HRMAS experiments, and only for limited flow rates. Also note that the output of the N2 separator is not pure enough for use with the N2 exchanger for low temperature work. The residual Oxygen will freeze in the exchanger coil and block it, thus will become a hazard when warming up.

Air Quality 1.12.3

Trouble free operation can be guaranteed only when dry, oil-free, dust free compressed gas is used.

Besides the serious corrosion effects, water vapor in the compressed air may condense when operating at low temperatures. If this water freezes, the sample may become trapped inside the probe. If the probe fills with water this may ruin the ceramics of the probe. The BCU05 may also become blocked with water from the water vapor.

The effect of **oil impurities** is even more devastating as the oil film left in hoses or on surfaces inside the probe will make any measurements impossible. Oil contamination may lead to improper tuning, arcing, spinning hindrance and spurious signals, and will require a difficult and expensive cleaning of every single component. Oil in combination with high temperatures may form a solid deposit within the probe causing serious and permanent damage. Compressed air lines and valvies that have been contaminated with oil can not be cleaned, they must be replaced. If you are locating the system in a site which already has a compressed air line, then it is likely that you will have to replace the existing lines and valves with new ones.

The consequences of dust in compressed air are particularly serious for MAS probes. Nozzles and valves get blocked, sediments cause valve leaks and wear of rotating parts. Ferrous dust from air tanks or pipes destroy the field homogeneity, and cannot always be removed when the magnets are on field.

Oil Content Specifications:

< 0.005 ppm (0.005 mg/m^3)

Water Content Specifications

For room temperature work and higher: dew point of < 4°C (35°F)

For low temperature work: The dew point must be at least 20°C (30°F) below the operating temperature.

If a cooling unit is used then the dew point of the compressed air should be at least 10°C (20°F) below the temperature at the heat exchanger output.

Note: For the BCU05 the compressed nitrogen should have a dew point of -50°C (-60°F)

Solid Impurities Specifications:

Use 5 micron filters for high resolution NMR. For MAS probes use 1 micron filters. The filters should retain a minimum of 99.99% of the specified particles.

When designing a suitable compressed air system the following points should be taken into consideration:

1. To prevent magnetic impurities from entering the magnet use only copper lines. Do not use iron or steel pipes. Plastic piping is unsuitable where very low dew points are required. Water vapor in the air will permeate plastic piping limiting minimum dew points to typically -25°C.
2. To avoid surges in the air pressure (e.g. during sample lift) install a container of 10-20 liters in the air supply line to act as a buffer. Locate the buffer after the dryers in the supply line. **Buffer containers** should meet the appropriate safety requirements. They must have a working pressure of 16 bar and be proofed up to 30 bar. Use tanks which are internally coated with water and acid resistant material. This will prevent corrosion from impurities such as SO_2.

The three major components of a suitable compressed gas supply line are compressor, dryer and appropriate filters. Further details may be obtained from Bruker .

In some regions Bruker can supply you with a system suitable to your needs on request.

Lighting 1.12.4

Florescent lighting **should not be used** in the area considered for the magnet. Cold helium gas will cause the florescent lighting to turn off temperarily, particularly during a quench. For normal operation it is most convenient when the graphics monitor may be viewed under subdued lighting. However, normal office lighting will of course be needed in other areas of the NMR room. The most convenient arrangement is to have separately switchable lights using standard light bulbs. Make sure that reflections from strong artificial light do not fall upon the monitor screen. Care should also be taken to minimize reflections from sources such as windows.

Miscellaneous 1.13

Make provision for sample/solvent preparation and storage space, documentation storage space, personal computers, plotter tables, workstations etc. Finally, before a final layout is decided consider future equipment that may need to be installed. Remember that once installed, the magnet should not be moved.

Static Electricity

As regards to static electricity discharges, you should treat the AVANCE NMR electronics as you would any sensitive electronic components. In atmospheres with low humidity, avoid the use of carpets that may lead to build-up of static electricity.

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