Bruker BioSpin

Site Planning

for AVANCE Systems 300-700 MHz User Guide

Version 005

think forward

NMR Spectroscopy

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Introduction 1

This manual contains information about site planning and preparation prior to delivery of a Bruker BioSpin AVANCE system. The manual should be read through carefully as mistakes made initially may be costly to remedy at a later stage.

The systems covered by this manual are AVANCE spectrometers in the range of 300-700 MHz. **A separate manual is available for 750, 800 and 900 MHz systems**.

The chapters in this manual deal with various points that need to be considered for successful system operation. They have been included to familiarize you with general principles of successful site planning.

Appendix A contains some example sample room layouts for AVANCE 300-700 MHz systems.

For specific questions that may not be addressed in this manual, or for further information on a topic, do not hesitate to contact your local Bruker BioSpin office.

Note that site planning is not only relevant for the installation of a new system, rather also by any changes in the equipment or devices, and by any renovations or room changes!

Units Used Within This Manual 1.1

The SI Unit **Tesla** (mT) is used throughout this manual whenever magnetic field strengths are discussed. Some readers may however be more familiar with the **Gauss** (G) Unit.

Likewise the unit **kilowatt** is used for the measure of heat energy (e.g. amount of heat generated by a device per hour). Some readers may be more familiar with these measurements in **BTU/hour**.

Wherever possible both the metric and U.S. Standard measure units have been used throughout this manual. When compared to metric measurments, the U.S. Standard measurement units are often indicated by „**in USA**". This does not mean that the measurements are only limited to the United States, but rather are for all countries in **North America** and **South America** that use the U.S. Standard System.

In most cases the weights and measures have been rounded upwards where necessary. The following table offers the common metric to U.S. conversion factors used in this manual:

Table 1.1. SI to U.S. Conversion Factors

Measure	SI Units	U.S. Standard Units	Conversion Factor (rounded to nearest hundredth)
Linear	meter (m) centimeter (cm)	feet (ft.) inch (in.)	1 m = 3.28 ft. 1 m = 39.37 in. 1 cm = 0.394 in.
Distance	kilometer (km)	mile (mi.)	1 km = 0.62 mi.
Area	square meter (m^2)	square foot (ft^2)	1 m^2 = 10.76 ft^2
Volume	cubic meter (m^3) liter (l)	cubic foot (ft^3) quart (qt.)	1 m^3 = 35.32 ft^3 1 l = 1.06 qt. (liquid)
Weight	kilogram (kg)	pounds (lbs.)	1 kg. = 2.21 lbs.
Pressure	bar	pounds/square inch (psi) atmosphere (ATM)	1 bar = 14.51 psi 1 bar = 0.99 ATM (standard)
Flow (e.g. gas flow)	cubic meter/minute (m^3/min.)	cubic feet/minute (ft^3/min.)	1 m^3/min. = 35.32 ft^3/min.
Temperature	°C	°F	F = C × 1.8 + 32
	°F	°C	C = (F - 32) / 1.8
	°C	K	K = C + 273.15
	K	°C	C = K - 273.15
	°F	K	K = (F + 459.67) / 1.8
	K	°F	F = K × 1.8 - 459.67
Magnet Field Strength	Tesla (T)	Gauss (G)	1 T = 10^4G
Heat Energy	BTU/hour	kW	1 BTU/hour = 0.000293 kW
(BTU = British Thermal Unit which is the required heat to raise 1 pound of H_20 by 1 degree Fahrenheit) SI = International System of Units.			

Warnings and Notes 1.2

There are two types of information notices used in this manual. These notices highlight important information or warn the user of a potentially dangerous situation. The following notices will have the same level of importance throughout this manual.

Note: Indicates important information or helpful hints

WARNING: Indicates the possibility of severe personal injury, loss of life or equipment damage if the instructions are not followed.

Other Relevant Documentation 1.3

If you are considering a CryoProbe system be sure to request a copy of our latest **CryoProbe System Site Planning Guide**.

If you are considering a LC-NMR/MS system be sure to request a copy of our latest **LC-(SPE)-NMR(/MS) Site Planning Guide**.

Safety

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The safety notes presented here and with the magnet documentation must be read and understood by everyone who comes into contact with superconducting NMR Magnet Systems. Proper training procedures must be undertaken to educate all people concerned with such equipment about these requirements. It is essential that clear notices are placed and maintained to effectively warn people that they are entering a hazardous area.

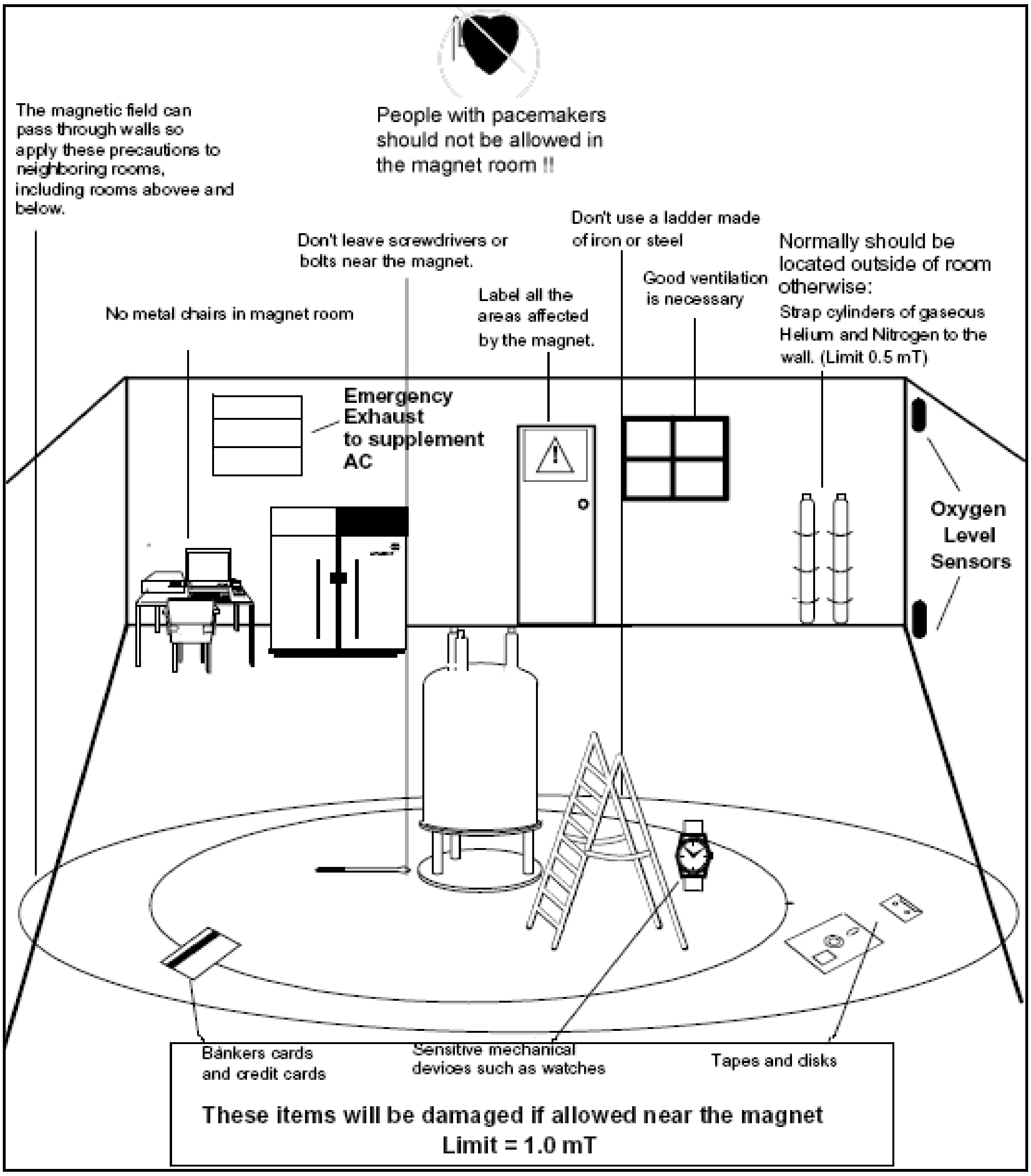
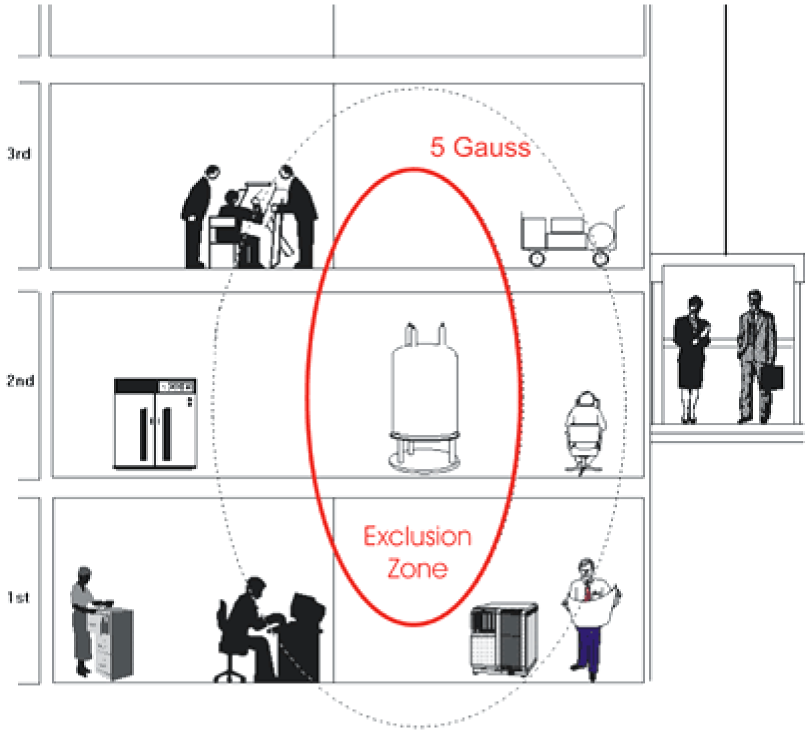


Figure 2.1. General Overview of Safety

The Magnetic Field *2.1*

Since the magnetic field of the NMR magnet system is three dimensional, consideration must be given to floors above and below the magnet, as well as to the surrounding space on the floor the magnet resides on. The magnetic field exerts **attractive forces** on equipment and objects in its vicinity. These forces, which increase drastically approaching the magnet, may become strong enough to move large equipment and to cause small objects or equipment to become projectiles.



It is important to consider personnel and equipment in the rooms above, below, and adjacent to the room where the magnet will be located

Figure 2.2. Stronger Stray Fields in Vertical Direction than Horizontal Direction

The magnetic field may affect the operation of electronic **medical implants** such as pacemakers, if exposed to fields greater than 5 gauss. Medical implants such as aneurysm clips, surgical clips or prostheses may also be attracted.

Further care must be taken around changing fields (e.g. pulsed gradient fields). Eddy currents could be generated in the implant resulting in heat generation and/ or unwanted torques.

Ensure that all **loose ferromagnetic objects** are outside the 5 gauss field zone of the magnet before the magnet is ramped to field. Human experience and reaction speed are totally inadequate to cope with the extremely nonlinear forces the magnet exerts on iron objects. Therefore no ferromagnetic objects should be allowed to enter the magnet room after the magnet is energized.

Exclusion Zone 2.1.1

The **Exclusion Zone** is the area inside the magnet's 5 gauss field line, extended in all directions, including rooms above and below the magnet area.

Individuals with **cardiac or other medically active implants** must be prevented from entering this area. The exclusion zone must be enforced with a combination of warning signs and physical barriers.

Security Zone 2.1.2

The **Security Zone** is usually confined to the room that houses the magnet.

Ferromagnetic objects must not be allowed inside the security zone to prevent them from becoming projectiles.

Safe Handling of Cryogenic Substances 2.2

Superconducting magnets use liquid helium and nitrogen as cooling agents, keeping the magnet core at a very low temperature. Cryogenic liquids can be handled easily and safely provided certain precautions are followed.

Refer to ***"Cryogens & Magnet Maintenance" on page 71*** for details on the properties and safe handling of cryogenic substances.

What is a Quench? 2.2.1

A magnet **quench** is the breakdown of superconductivity in a partially or fully energized magnet. The stored field energy is transformed into heat, leading to a fast evaporation of liquid helium. During a quench, an extremely large quantity of helium gas (i.e. 43 m^3 to 595 m^3 depending on the magnet type) is produced within a short time.

Although these gases are inert, if generated in large enough quantities, they can displace the oxygen in the room causing potential danger of suffocation (refer to ***"Emergency Ventilation During Magnet Installation and Quenches"***).

Emergency Planning 2.3

Due to the strong magnetic fields and presence of cryogens when using NMR systems, it is important to define and communicate what to do in case of problems or an emergency. An **Emergency Plan** can be defined as a documented set of instructions on what to do if something goes wrong. Emergency Plans are often defined as part of the Standard Operating Procedures (SOP), or as a stand-alone document. In any case every NMR laboratory should have an Emergency Plan in effect in case of problems or emergencies.

As every organization has its own policies and procedures, as well as varying laboratory layouts, an Emergency Plan should be individually defined for each laboratory as appropriate. Upon request Bruker can provide useful information on emergency planning.

Fire Department Notification 2.4

It is recommended that the magnet operator introduce the fire department and/or local authorities to the magnet site. It is important that these organizations be informed of the potential risks of the magnet system, i.e. that much of the magnetic rescue equipment (oxygen-cylinders, fire extinguishers, axe's etc.) can be hazardous close to the magnet system. On the other side, their expertise and experience can be invaluable in creating an Emergency plan.

- Within a NMR laboratory CO_2 magnetic fire extinguishers must NOT be used.
- Breathing equipment which uses oxygen tanks made out of magnetic material can be life threatening when used close to a magnet system which still has a magnetic field present.
- Helium gas escaping from the system must not be mistaken for smoke. Instruct the fire department and technical service not to „extinguish“ the magnet system with water. The outlet valves could freeze over and generate excess pressure within the system.
- NMR laboratory windows which are accessible during an emergency must be clearly marked with warning signs, visible from the outside.

Earthquake Safety 2.5

In regions where there is a potential risk of earthquakes, additional measures must be taken to reduce the chance of personal or property damage through movement or tipping of the magnet.

Many countries or regions have documented regulations, including building codes, regarding earthquakes. Before installing a magnet system, it is highly advisable that you check with local authorities on whether your area is prone to earthquakes and if there are any regulations in effect.

If your area is regarded as an earthquake area there are several shock absorbing measures or riggings available to reduce the likelihood of damage during an earthquake. Please contact Bruker for more information on earthquake securing equipment.

Country-specific Safety Regulations 2.6

In addition to the above safety precautions, any country-specific safety regulations for operating NMR systems must be fulfilled. These may include, for example, regulations on:

- Facilities of a controlled access area around the magnet.
- Working conditions at computer stations.
- Use of anesthesia gases.
- Handling of laboratory and transgenic animals.

Checklist for Safety 2.7

Determine the extent of the stray magnetic field for the magnet type ordered.	
Determine the position of the 0.5 mT (5G) relative to the proposed position of the magnet.	
Remove all moveable magnetic objects from within the 0.5 mT zone.	
Ensure that the site is adequately spacious for the free movement of cryogen dewars.	
Inventory equipment in the NMR lab and adjoining rooms that may be affected by the stray field.	
Inform relevant personnel of the potential hazards of super-conducting magnets.	
Position the worktable, cabinet, and magnet such that people can have access to the worktable without having to pass through the 0.5 mT zone.	
Provide adequate emergency exhaust system to provide proper ventilation in case of a quench.	

Equipment 3

Introduction 3.1

This section describes the types and functions of the various sub-systems that are delivered as part of our AVANCE UltraStabilized NMR spectrometer systems. These include the following:

- The superconducting magnet system.
- The console and monitoring unit.
- The probe system.
- Workstation.
- CryoProbe^{TM}.

Example of Available Spectrometer and Magnet Systems 3.2

This section lists the various parts of the console, magnet monitoring units and related options. Please also refer to the sections ***"Floor Plan" on page 42*** and ***"Sample Room Layouts" on page 91***. These sections provide an idea of where the various pieces of NMR equipment should be placed.

Magnet

The **magnet** generates the magnetic field required to induce NMR transitions. To maintain a superconducting system the magnet core is cooled to very low temperatures using liquid nitrogen and helium.

Equipment

AVANCE Console Main Cabinet

This **AVANCE** console may be single bay or double bay depending upon the system and houses most of the electronic hardware associated with a modern digital spectrometer. The principal units are the **AQS** (Acquisition Control System), the **BSMS** (Bruker Smart Magnet System), the **VTU** (Variable Temperature Unit) as well as various amplifiers.

The main funciton of the unit is to perform the actual NMR data acquisition.

Workstation

The **host computer** runs the Topspin program and handles all the data analysis and storage. All operations relevant to data acquisition are controlled by a second computing system called the Acquisition Control System (AQS) housed within the console itself.

The (optional) BSMS keyboard enables the user to control the lock and shim system as well as basic operations such as inserting, spinning and removing the NMR sample.

Probes

The **probe** is designed to hold the sample, transmit radio frequency signals which excite the sample and receive the emitted response. The transmission and reception is achieved by using specially designed RF coils. The probe is inserted into the bottom of the magnet and sits inside the room temperature shims. Coaxial cables carry the excitation signals from the console amplifiers to the probe and the NMR signal back from the sample to the receiver.

BCU-05/BCU-Xtreme Cooling System

The **BCU-05**:

- Cools VT gas to allow proper sample temperature regulation.
- Reduces the temperature of the air input (supplied by the variable-temperature unit) and provides cooling of the NMR sample within the magnet to at least -5 °C for a room temperature of 25 °C.

The **BCU-Xtreme**:

- Allows sample temperatures down to -60°C, both for solids and liquids NMR applications.
- Delivers a cold nitrogen or dry air stream through a flexible non-magnetic transfer line to any Bruker BioSpin probe.
- Allows you to regulate the sample temperature in high resolution probes, static solids probes as well sa magic angle spinning (MAS) probes.

Optional System Components *3.3*

Imaging Accessory Cabinet

The **imaging accessory** cabinet houses the gradient amplifiers for micro-imaging applications.

B-ACS Sample Changer

The Bruker Automatic Sample Changer (**B-ACS**), used in conjunction with Bruker software, provides dialog-guided facilities which allow the user to easily and effectively perform automatic (continuous) experiments.

Features include a 60 or 120 sample capacity, random accessing of samples, positive sample identification with the optional bar code reader, and temperature control of individual samples with the optional sample heater unit.

SampleJet Sample Changer

SampleJet is a robot which has been consciously designed to meet growing demand for simplicity, versatility and higher throughput in NMR sample tube automation.

SampleRail

SampleRail features a sample preparation robot which can mix a target protein solution with various ligand libraries, followed by immediate transfer of the samples to the spectrometer for measurement and analysis.

The SampleRail is part of a system under the management of the SampleTrack™ Laboratory Information Management System and ICONNMR™ automation software, that provides automatic preparation and mixing of multiple compounds, and subsequent NMR measurements.

CryoProbe System

The Bruker **CryoProbe**™ Accessory for the AVANCE NMR Spectrometers offers dramatic increases in signal to noise ratio, stability, and ease of use. For site planning details for the CryoProbe Accessory, refer to the "CryoProbe™ Purchase and Siting Guide".

Magnet Access and Rigging

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The magnet is very heavy and fragile, thus requires special consideraton during delivery and movement to it's final installation point. The other components of the spectrometer system (console, BMPC, etc.) can typically be removed from delivery trucks with forklifts and are positioned in the NMR lab with a pallet jack. Specifications for these components are also included in this chapter for planning purposes.

Considerations for Off-loading on Site *4.1*

When planning for offloading the magnet and console during delivery, the following factors must be considered:

Delivery Area

There must be sufficient space in the driveway or parking area for the overhead crane (or forklift) and for the delivery truck. There must also be sufficient leveled area for uncrating the magnet and other crates.

Transport Weight

The transport weight (***Table 4.4.***) and size of the magnet system, console and their respective crates (***Table 4.2.***) will affect the choice of equipment required for offloading and movement of the magnet.

Loading Dock

The **size and overhead clearance** of the loading dock will influence the choice of forklift, crane, or other rigging equipment required to off load the magnet and system crates.

The **elevation** of the loading dock relative to the NMR room will determine if a crane is required, or if an elevator is needed for the transportation of the magnet from the loading dock to the NMR room.

The **load bearing capacity** of the loading dock must be sufficient for the system. Please refer to ***Table 4.4.*** and ***Table 4.5.*** for transport weights of the magnet system, console, and accessories.

If height/width restrictions require the magnet to be removed from the pallet (e.g. to pass through a doorway), rigging equipment will be needed both on the loading dock and inside the lab.

Equipment Requirements

All rigging equipment required to offload the magnet system must be selected to handle the size (***Table 4.1.***, ***Table 4.2.***) and transport weights (***Table 4.4.***, ***Table 4.5.***) of the system.

Generally a **pallet** is integrated in the magnet crate. The top and sides of the crate are removed or lifted off the magnet, leaving the pallet under the magnet for transportation into the lab.

Crane: For larger magnet systems, a crane meeting the load requirements for the specific magnet may be required to lift the magnet off the truck, place it on a flat surface for uncrating, and for lifting the magnet again for placement on air skates or a pallet.

Forklift: It may be feasible to use a forklift to pick the magnet from the truck and lower it to a flat surface for uncrating.

Pallet Jack: If a loading dock is available, it may be possible to roll the magnet off the truck using a pallet jack.

Considerations for Transport to the NMR Room *4.2*

Before delivery, you must ensure that the site provides adequate access for delivery of the system and magnet. The following factors must be considered:

Accessibility to NMR Room

The **access clearance** (height and width) and **floor loading capacity** must be checked along the entire route that the magnet and console will take from the loading dock to the NMR room.

Elevator capacity and dimensions must be considered if applicable.

The transport will also be affected by the **floor level** and the presence of door sills and steps. Use leveling sheets when using air skates to traverse floor irregularities, such as cracks and door seals.

The **turning radius** can also be a factor if, for example, corners must be navigated. It is important to make sure the rigging equipment for magnet assembly (e.g. a long I-beam for the gantry) can be brought into the lab.

Equipment Requirements

Depending on the situation it may be necessary to utilize air skates, a pallet jack, or a forklift to transport the console and magnet over floors and through passageways. The console and magnet must be moved in an **upright position**.

Air Skates (if used): A set of four air-skates is required to transport the magnet from the access doors to the NMR site. The air skates will require a large air compressor capable of supplying 1.72bar (25 psi) at ca. 2 cu.meter/min.

Leveling Sheets: Masonite (or other suitable material) sheets may be temporarily required to level the transport access route over irregular floors to the NMR site.

Considerations for Assembling the Magnet *4.3*

General Requirements

All the requirements discussed in this manual considering room layout must first be met before taking delivery of the system. The type of equipment used for assembly will ultimately depend on any limiting factors, such as **ceiling height**.

Equipment Requirements

Hydraulic Gantry: This device is specially designed to move magnet systems for short distances. The device can be used for 400-700 MHz systems.

Lifting Hook: Lifting the magnet inside the NMR room for assembly purposes requires either a fixed lifting hook or a hydraulic gantry capable of handling the magnet load with the given ceiling height requirements (***Table 15.2.***).

Fixed Lifting Gantry (A-frame): If a hook can not be provided, the fixed lifting gantry may be used instead.

Bruker can provide rigging equipment, such as air skates, lifting hooks, hydraulic gantries and A-frames at many sites upon request.

Table 4.1. Spectrometer Transport Width, Height and Crate Size

	Crate Size (m)			Dimensions (m) for Transport to Magnet Room			
Spectrometer System (spectrometer crate)	**L**	**D**	**H**	**Width Crated[1]**	**Width Uncrated[1]**	**Height Crated with Pallet Jack[2]**	**Height Uncrated (top and sides only) with Pallet Jack[2]**
AVANCE TwoBay	1.54	1.03	1.54	1.05	0.82	1.67	1.46
AVANCE OneBay	1.00	0.92	1.53	1.02	0.71	1.66	1.46
AVANCE MicroBay	1.01	0.83	1.16	0.85	0.71	1.19	1.13
AVANCE NanoBay	1.34	0.75	1.04	0.77	0.45	0.93	0.87

Note: The pallet is now integrated into the crate.
[1] Transport width = width indicated + minimum 1cm clearance on each side. These are the widths if the console is inserted lengthways through the entrance.
[2] Transport height = height indicated + 1 cm clearance on top + minimum 2 cm for pallet jack. The height will vary depending on how high the spectrometer needs to be jacked up to clear any floor irregularities (e.g. cracks).

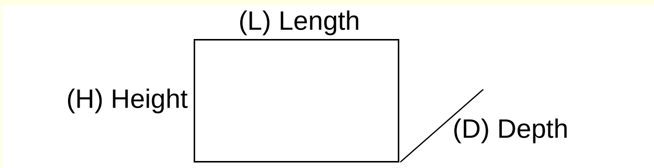


Table 4.2. Magnet Shipping Crate Dimensions and Transport Height

	Crate Size (m)			Magnet Transport Dimensions (m) (for transport to the magnet room)		
Magnet System (magnet crate)	L	D	H	Transport Width Uncrated	Transport Height Uncrated without Pallet Jack *	Transport Height Uncrated with Pallet Jack
200 MHz/154 mm US PLUS LH	1.05	1.25	1.80	0.85	1.53	1.76
300 MHz/54 mm US LH	0.91	0.91	1.59	0.72	1.13	1.36
300 MHz/54 mm US ULH	0.91	0.91	1.97	0.72	1.47	1.70
300 MHz/89 mm US LH	0.91	0.91	1.97	0.72	1.52	1.75
300 MHz/154 mm US PLUS LH	1.05	1.25	1.80	0.85	1.53	1.76
400 MHz/54 mm US PLUS LH	1.20	1.00	1.76	0.85	1.29	1.52
400 MHz/54 mm US PLUS ULH	1.20	1.00	1.76	0.85	1.53	1.76
400 MHz/54 mm US LH	0.91	0.91	1.97	0.72	1.47	1.70
400 MHz/54 mm US ULH	0.91	0.91	2.05	0.72	1.69	1.92
400 MHz/89 mm US PLUS LH	1.05	1.25	1.80	0.85	1.53	1.76
400 MHz/154 mm US PLUS LH	1.41	1.28	2.12	1.10	1.86	2.09
500 MHz/54 mm US PLUS LH	1.05	1.25	1.76	0.85	1.53	1.76
500 MHz/54 mm US PLUS ULH	1.15	1.36	2.02	0.95	1.75	1.98
500 MHz/54 mm US LH	0.91	0.91	1.97	0.80	1.50	1.76
500 MHz/89 mm US PLUS LH	1.15	1.36	2.02	0.95	1.74	1.98
500 MHz/89 mm US LH	1.40	1.40	2.05	1.10	1.86	2.09
500 MHz/154 mm US PLUS LH	1.41	1.28	2.12	1.10	1.86	2.09
600 MHz/54 mm US PLUS LH	1.15	1.36	2.02	0.95	1.74	1.98
600 MHz/54 mm US LH	1.01	0.99	2.05	0.91	1.74	1.89
600 MHz/89 mm US PLUS LH	1.41	1.28	2.12	1.10	1.86	2.09
600 MHz/89 mm US LH	1.75	1.75	2.18	1.37	1.93	2.12
700 MHz/54 mm US PLUS LH	1.51	1.28	2.12	1.10	1.86	2.09
700 MHz/54 mm US LH	1.75	1.75	2.18	1.37	1.93	2.12
700 MHz/89 mm US PLUS LH	1.75	1.75	2.18	1.37	1.93	2.16

- LH = Long Hold, ULH = Ultra Long Hold, US = UltraShield^{TM}
- For information on other magnets not listed, please contact your nearest Bruker BioSpin office.
- Note: The heights listed with pallet jack assume that the floor is level, thus the magnet needs only to be jacked up approx. 2 cm for transport. If the floor is uneven, the magnet may need to be jacked up accordingly, which could add as much as 10-15 cm to the transport height.

* Measured from magnet bottom plate to helium tower - this is the **absolute minimum height**!

Table 4.3. Magnet Stand and Accessories Crate Dimensions and Transport Height

	Accessories Crate Size - including stand if applicable (m)			
Magnet Stand & Accessories	L	D	H	
200 MHz/154 mm US PLUS LH	1.67	0.88	1.01	
300 MHz/54 mm US LH	0.91	0.91	1.59	Included in magnet case
300 MHz/54 mm US ULH	0.91	0.91	1.97	
300 MHz/89 mm US LH	0.91	0.91	1.97	
300 MHz/154 mm US PLUS LH	1.67	0.88	1.01	
400 MHz/54 mm US PLUS LH	1.67	0.88	1.01	
400 MHz/54 mm US PLUS ULH	1.67	0.88	1.01	
400 MHz/54 mm US LH	0.91	0.91	1.97	Included in magnet case
400 MHz/54 mm US ULH	0.91	0.91	2.05	
400 MHz/89 mm US PLUS LH	1.67	0.88	1.01	
400 MHz/154 mm US PLUS LH	1.80	0.86	1.23	
500 MHz/54 mm US PLUS LH	1.66	0.88	1.01	
500 MHz/54 mm US PLUS ULH	1.77	0.97	1.11	
500 MHz/54 mm US LH (2 boxes)	0.48 Stand 0.32 Acc.	0.77 Stand 0.52 Acc.	1.15 Stand 1.72 Acc.	
500 MHz/89 mm US PLUS LH	0.97	1.16	1.43	
500 MHz/89 mm US LH	0.98	1.16	1.43	
500 MHz/154 mm US PLUS LH	1.80	0.86	1.23	
600 MHz/54 mm US PLUS LH	1.77	0.97	1.11	
600 MHz/54 mm US LH	0.72	0.79	1.29	
600 MHz/89 mm US PLUS LH	1.80	0.86	1.23	
600 MHz/89 mm US LH	1.07	1.26	1.57	
700 MHz/54 mm US PLUS LH	1.80	0.93	1.34	
700 MHz/54 mm US LH	1.07	1.26	1.57	
700 MHz/89 mm US PLUS LH	1.57	1.07	1.26	

- LH = Long Hold, ULH = Ultra Long Hold, US = UltraShield™.
- Pallet is integrated in crate. Add 2-10 cm for pallet jack depending on floor quality. Allow **at least 1 cm** clearance on the sides and above the crate.
- For information on other magnets not listed, please contact your nearest Bruker BioSpin office.

Table 4.4. Transport Weights of Magnets and Accessories

Magnet Type	Magnet Weight with Crate (kg)	Magnet Weight w/o Crate & Stand (kg)	Weight of Accessories (kg)	Magnet Weight *Empty* with Magnet Stand (kg)**	Magnet Weight *Filled* with Magnet Stand (kg)
	Relevant for Transportation			Relevant for Installation	
200 MHz/154 mm US PLUS LH	~ 600	not available	~ 250	~ 750	~ 850
300 MHz/54 mm US LH	~ 330	205	*	242	292
300 MHz/54 mm US ULH	~ 390	261	*	298	379
300 MHz/89 mm US LH	~ 460	231	*	375	452
300 MHz/154 mm US PLUS LH	710	530	~ 250	651	766
400 MHz/54 mm US PLUS LH	~ 525	390	~ 265	510	596
400 MHz/54 mm US PLUS ULH	~ 525	426	~ 265	524	644
400 MHz/54 mm US LH	~ 450	323	*	360	438
400 MHz/54 mm US ULH	~ 470	346	*	383	480
400 MHz/89 mm US PLUS LH	~ 562	558	~ 250	683	798
400 MHz/154 mm US PLUS LH	~ 1900	not available	~ 350	~ 1200	~ 1400
500 MHz/54 mm US PLUS LH	~ 676	553	~ 262	675	791
500 MHz/54 mm US PLUS ULH	~ 1080	not available	~ 370	895	1114
500 MHz/54 mm US LH	~ 790	568	~ 110 (stand) ~ 30 (acc.)	648	749
500 MHz/89 mm US PLUS LH	1298	990	~ 370	1165	1377
500 MHz/89 mm US LH	1550	1300	~ 350	1520	1700
500 MHz/154 mm US PLUS LH	~ 1900	not available	~ 350	~ 1850	~ 2120
600 MHz/54 mm US PLUS LH	~ 1405	1022	~ 370	1200	1409
600 MHz/54 mm US LH	~ 1330	996	~ 550	1150	1300
600 MHz/89 mm US PLUS LH	~ 1900	1446	~ 350	~ 1850	~ 2120
600 MHz/89 mm US LH	~ 2300	1985	~ 450	2285	2675
700 MHz/54 mm US PLUS LH	~ 1615	not available	~ 350	~ 1620	~ 1890
700 MHz/54 mm US LH	~ 2800	2513	~ 450	2663	3040
700 MHz/89 mm US PLUS LH	~ 2830	2310	~ 430	2655	3029

- LH = Long Hold, ULH = Ultra Long Hold, US = UltraShield™.
- The weights of the accessories are approximations. The actual weight may vary depending on the options and accessories that are ordered.
- For information on other magnets not listed, please contact your nearest Bruker BioSpin office.

* Included in magnet crate. ** For standard stand, weight will vary with optional stands.

Table 4.5. Transport Weights of NMR Cabinets and Accessories

Unit	Weight
AVANCE TwoBay	400 kg*
AVANCE OneBay	210 kg*
AVANCE MicroBay (varies according to options)	approx. 210*
AVANCE NanoBay	120 kg (without pallet and packing material)
MAS Cabinet	160 kg
Imaging Cabinet	150 kg
HP Cabinet	200 kg
UPS (optional - highly recommended when with CryoProbe 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/accessories	50-250 kg + weight of MicroBay
Gilson	39.9 kg + crate and accessories
BCU-05, BCU-X	50 kg, 74 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
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.	

Checklist for Magnet Access and Rigging 4.5

Determine if there is sufficient space in the driveway or parking for the overhead crane (or forklift) and for the delivery truck.	
Determine if sufficient leveled area is available for uncrating the magnet crate.	
Determine the distance of reach required for the crane, estimated crane size.	
Determine if the elevation of the magnet room is different from the delivery area and make provision for overcoming this obstacle if necessary.	
Make provision for air skates if required.	
Determine if a suitable leveled slab (area) is available in front of the access doors for positioning the magnet on air skates (or other transport device). Is the slab capable of handling the size and weight of the magnet?	
Determine if masonite sheets are needed to correct imperfections and protect flooring.	
Determine if adequate clearance is available along the access path from the delivery area to the NMR room.	
Verify the load bearing capacity along the access path.	
Verify fork-lift or palette-jack accessibility.	
Determine if there is adequate height clearance for the rigging to lift the magnet in the NMR room. If a hook is used determine if hook height and lifting load is adequate.	

Ceiling Height 5

The minimum ceiling height requirements depend on the clearance needed above the magnet for assembly, energizing, and filling with liquid helium. The requirements for each magnet are listed in ***Table 5.2.***. However, when planning the site, an extra 0.3-0.4 m above the minimum requirements is helpful. This extra margin will make the procedure safer and more convenient.

Note that the ceiling height requirements need not be met over the entire NMR room, rather only over the area immediately 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 (see ***Figure 5.1.***). A length of 2.2 m will normally suffice for currently available magnets.

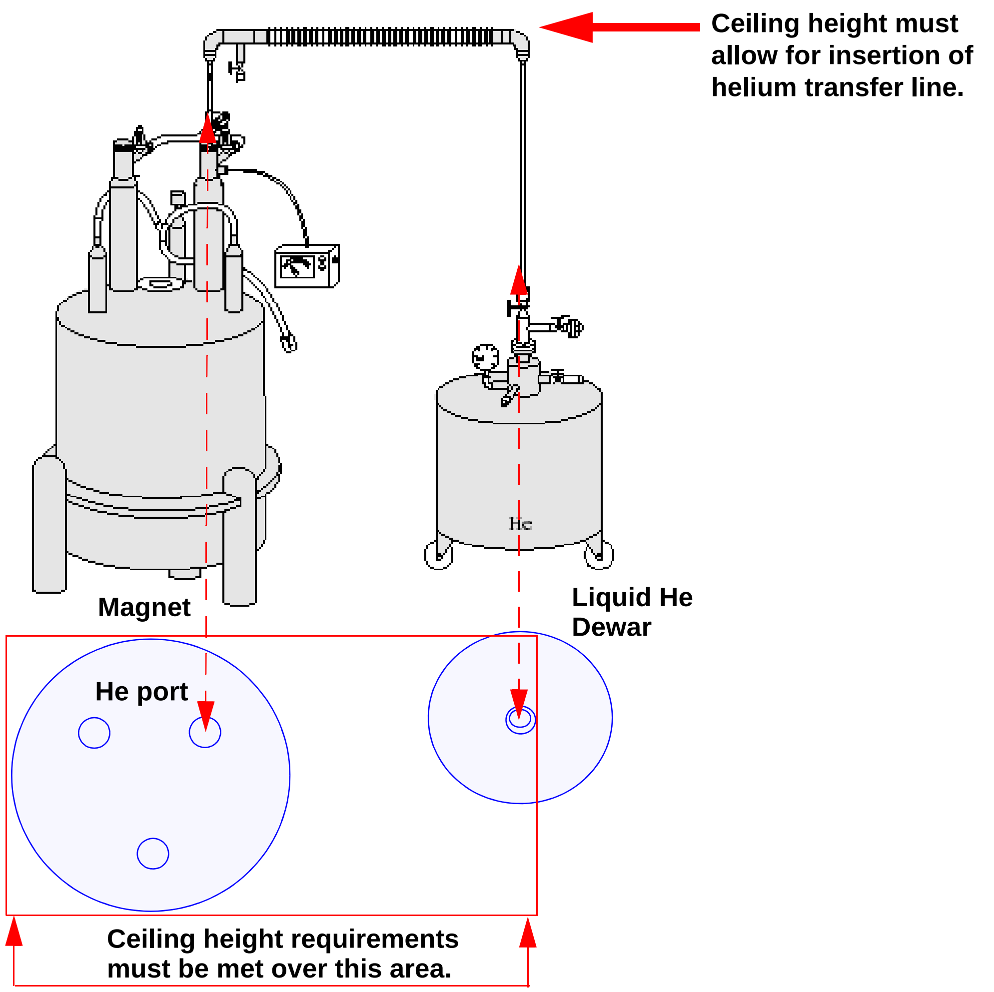


Figure 5.1. Ceiling Height Requirements

Helium Transfer Lines 5.1

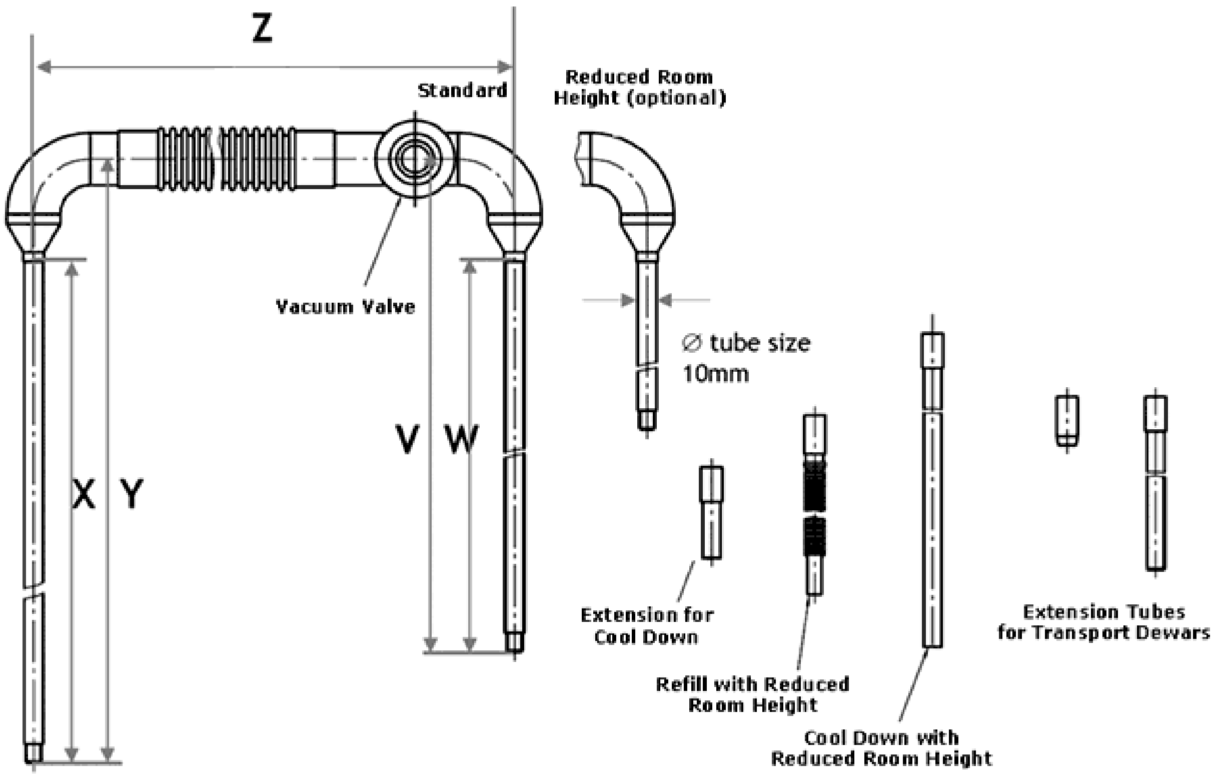


Figure 5.2. Helium Transfer Lines

Refer to ***Figure 5.2.*** for the following helium transfer lines dimensions.

Table 5.1. Helium Transfer Lines Dimensions

Part Nr.	X (mm)	Y (mm)	Z (mm)	V (mm)	W (mm)	Remarks
O0011	1455	1508	1250	708	655	Standard
29136	1455	1508	2060	638	585	D220/D260
53962	1455	1508	2060	708	655	D3XX
29515	1455	1508	1250	503	450	Reduced height
29085	1455	1508	2060	433	380	Reduced height
Note: When using soffits, sufficient space must be left for the required transfer line length. The magnet may need to be placed off-center within the soffit (as opposed to being centered).						

Ceiling Height Requirements *5.2*

The ceiling height requirements for each magnet are listed in ***Table 5.2.***. Note that the ceiling heights above represent the **absolute minimum**. As mentioned previously, an extra 0.3-0.4 m above minimum requirements will make all procedures safer and more convenient.

The following text explains how the ceiling height requirements in ***Table 5.2.*** are either calculated and/or their meaning:

Minimum Ceiling Height: The **minimum ceiling height** is calculated by adding the height of the shim upper part that has to be inserted into the cryostat, to the height of the top flange of the cryostat.

Ceiling Height Using Specialized Equipment: The **ceiling height using specialized equipment** is calculated by adding the height of the separable shim upper part that has to be inserted into the cryostat to the height of the top flange of the cryostat. In this case, bendable energizing rods and special helium transfer lines with flexible extensions must be used. It must be noted that with the use of flexible extensions, the transfer efficiency could be reduced by up to 10%.

Minimum Ceiling Height for MAS Transfer Systems: When using MAS transfer rods, the **minimum ceiling height for MAS transfer systems** is calculated to the top of the MAS transfer system.

Minimum Ceiling Height for Adapter WB -> SB: For all wide bore systems, the minimum ceiling height is calculated to the top of the upper part reduction **adapter WB -> SB**.

Minimum Hook Height (for assembly): For the installation of all NMR magnet systems, the minimum hook height needed during installation is calculated by adding the height of the body of the cryostat to the height of the different bore tubes that have to be inserted into the cryostat. In addition the height of the A-frame has to be taken into account.

Note: The ceiling height required to assemble the magnet may vary depending on the rigging equipment (i.e. lifting gantry) provided. For example, a minimum ceiling height for a 600/54 US LH magnet with flexible transfer lines is 3.05 m, with a minimum hook height of 3.0 m. However if the total ceiling height is 3.05 m, a hook in the ceiling or a special lifting gantry must then be provided.

Table 5.2. Ceiling Height Requirements

Magnet Type	Minimum Ceiling Height (m)	Ceiling Height using Specialized Equipment* (m)	Minimum Ceiling Height for Adapter WB -> SB (m)	Minimum Hook Height (for assembly) (m)
200 MHz/154 mm US PLUS LH - with F85-770 magnet stand - with F85-840 magnet stand - with F85-950 magnet stand - with F85-1050 magnet stand	 3.26 3.33 3.44 3.54	 2.98 3.05 3.16 3.26	 ---	 2.98 2.98 2.98 2.98
300 MHz/54 mm US LH	2.62	2.42	---	2.42
300 MHz/54 mm US ULH	3.00	2.80	---	2.80
300 MHz/89 mm US LH	3.05	2.85	2.85	2.85
300 MHz/154 mm US PLUS LH - with F85-770 magnet stand - with F85-840 magnet stand - with F85-950 magnet stand - with F85-1050 magnet stand	 3.26 3.33 3.44 3.54	 2.98 3.05 3.16 3.26	 ---	 2.98 2.98 2.98 2.98
400 MHz/54 mm US PLUS LH	2.86	2.46	---	2.46
400 MHz/54 mm US PLUS ULH	3.11	2.71	---	2.71
400 MHz/54 mm US LH	3.00	2.80	---	2.80
400 MHz/54 mm US ULH	3.20	3.00	---	3.00
400 MHz/89 mm US PLUS LH - with F85-770 magnet stand - with F85-840 magnet stand**	 3.26 3.33	 2.98 3.05	 ---	 2.98 2.98
400 MHz/154 mm US PLUS LH - with F95-880LC magnet stand - with F95-950LC magnet stand	 3.58 3.65	 3.39 3.43	 ---	 3.35 3.43
500 MHz/54 mm US PLUS LH	3.19	2.79	---	2.98
500 MHz/54 mm US PLUS ULH	3.40	3.05	3.05	3.05
500 MHz/54 mm US LH	3.00	2.80	---	2.90
500 MHz/89 mm US PLUS LH - with F95-880LC magnet stand - with F95-950LC magnet stand**	 3.58 3.65	 3.35 3.43	 3.35 3.43	 3.18 3.25
500 MHz/89 mm US LH	3.70	3.45	3.54	3.45
500 MHz/154 mm US PLUS LH - with F110-880LC magnet stand - with F110-950LC magnet stand	 3.71 3.78	 3.31 3.38	 3.60 3.67	 3.50 3.50
600 MHz/54 mm US PLUS LH	3.40	3.05	---	3.00
600 MHz/54 mm US LH	3.25	3.05	---	3.00

Table 5.2. Ceiling Height Requirements

Magnet Type	Minimum Ceiling Height (m)	Ceiling Height using Specialized Equipment* (m)	Minimum Ceiling Height for Adapter WB -> SB (m)	Minimum Hook Height (for assembly) (m)
600 MHz/89 mm US PLUS LH - with F110-880LC magnet stand - with F110-950LC magnet stand**	 3.71 3.78	 3.31 3.38	 3.88 3.95	 3.50 3.50
600 MHz/89 mm US LH	4.00	3.35	4.00	3.45
700 MHz/54 mm US PLUS LH - with F110-800LC magnet stand - with F110-880LC magnet stand	 3.66 3.74	 3.23 3.39	---	 3.23 3.39
700 MHz/54 mm US LH	3.63	3.25	---	3.45
700 MHz/89 mm US PLUS LH - with F136-950LC magnet stand - with F136-1050LC magnet stand**	 3.96 4.06	 --- ---	 3.96 4.06	 3.96 4.06
LH = Long Hold, ULH = Ultra Long Hold, US = UltraShield™ *For installation. ** Optional or when **imaging probes** are used. For information on other magnets not listed, please contact your nearest Bruker BioSpin office.				

Ceiling Boxes (Soffits) 5.2.1

In some rooms the ceiling height requirements may be met through use of a ceiling box (soffit).

When defining the soffit and magnet placement, one also needs to consider the space required by the gantry, A-frame, hooks etc. when assembling the magnet.

Figure 5.3. A Soffit (including gantry used for installation)

Checklist for Ceiling Height Requirements — *5.3*

Determine if ceiling height is adequate for lifting the magnet into place in the NMR room.	
Determine if height is adequate for energization based on type of transfer lines used.	
Determine if height above He transport dewar (for refilling) is adequate.	

Magnetic Stray Fields 6

Magnetic stray fields are three dimensional, and extend further in the vertical direction than in the horizontal direction. A number of studies have been carried out on the long term **effects of magnetic fields on personnel**. As a general rule the working place (e.g. workstation, sample preparation area etc.) must be placed outside the **0.5 mT (5 G)** line. For further information on acceptable magnetic field limits contact your countries health authorities or your area Bruker office.

We strongly recommend using all the mounting devices supplied to change gradient coils or probes. Furthermore, samples must be exchanged by using the sample supports without entering the extremities inside the magnet's bore. These preventive measures minimize doses of magnetic flux and must be applied as a general rule of thumb.

Various **devices are affected by the magnet** and must be located outside the limits specified in the following section (see ***Table 6.2.*** and ***Table 6.3.*** for corresponding stray field distances). For comparison the earth's magnetic field is 0.05 mT (0.5 G).

Table 6.1. Effects of Magnetic Fields on Equipment

Stray Field Distance	Device	Effects
5 mT (50 G)	Magnet power supply, RF power amplifier, Cryo-cooling platform.	Electrical transformers which are a component of many electrical devices may become magnetically saturated in fields above 50 Gauss (5 mT). The safety characteristics of equipment may also be affected.
2 mT (20 G)	Magnetic storage material	The information stored on tapes may be destroyed or corrupted.
1 mT (10 G)	Computers, X-ray tubes, credit cards, bank cards, watches, clocks, cameras, TFT computer monitor.	The magnetically stored information in computers and credit cards may be corrupted in fields greater than 1 mT (10 G). Small mechanical devices such as watches or cameras may be irreparably damaged. (Digital watches may be worn safely).
0.5 mT (5 G)	Cathode Ray tubes, CryoProbe system.	Magnetic fields greater than 0.5 mT (5 G) will deflect a beam of electrons leading to a distortion of the screen display.
0.1 mT (1 G)	Only very sensitive electronic equipment such as image intensifiers, nuclear cameras and electron microscopes will be affected.	

Table 6.2. Horizontal Stray Fields of Various Magnets

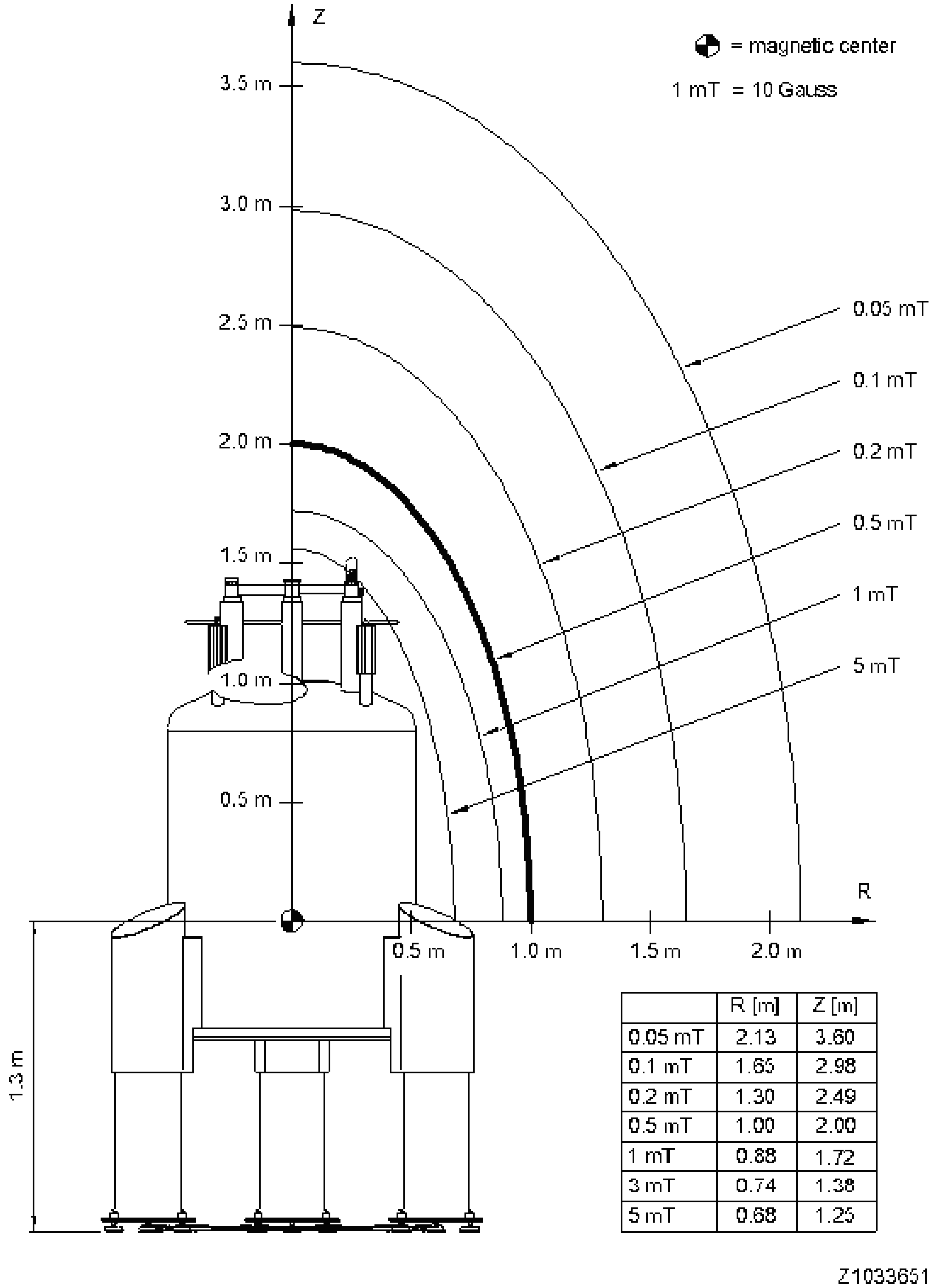
Magnet type	5.0 mT (50 G)	3.0 mT (30 G)	1.0 mT (10 G)	0.5 mT (5 G)	0.2 mT (2 G)	0.1 mT (1 G)	0.05 mT (0.5 G)
200 MHz/154 mm US PLUS LH	0.55	0.66	0.78	0.90	1.16	1.47	1.89
300 MHz/54 mm US LH	0.44	0.47	0.50	0.6	0.80	0.90	1.10
300 MHz/54 mm US ULH	0.44	0.47	0.50	0.6	0.80	0.90	1.10
300 MHz/89 mm US LH	0.80	0.90	1.00	1.10	1.50	1.80	2.20
300 MHz/154 mm US PLUS LH	0.61	0.74	0.86	1.00	1.33	1.70	2.21
400 MHz/54 mm US PLUS LH	0.38	0.41	0.46	0.50	0.65	0.83	1.08
400 MHz/54 mm US PLUS ULH	0.38	0.41	0.46	0.50	0.65	0.83	1.08
400 MHz/54 mm US LH	0.70	0.77	0.84	1.00	1.30	1.60	1.92
400 MHz/54 mm US ULH	0.70	0.77	0.84	1.00	1.30	1.60	1.92
400 MHz/89 mm US PLUS LH	0.47	0.50	0.56	0.60	0.74	0.96	1.26
400 MHz/154 mm US PLUS LH	0.75	0.90	1.05	1.20	1.55	1.96	2.52
500 MHz/54 mm US PLUS LH	0.47	0.50	0.56	0.60	0.74	0.96	1.26
500 MHz/54 mm US PLUS ULH	0.47	0.50	0.56	0.60	0.74	0.96	1.26
500 MHz/54 mm US LH	0.90	1.03	1.16	1.30	1.70	2.10	2.50
500 MHz/89 mm US PLUS LH	0.52	0.56	0.62	0.70	0.92	1.18	1.55
500 MHz/89 mm US LH	0.90	1.30	1.50	1.80	2.50	2.90	3.50
500 MHz/154 mm US PLUS LH	0.96	1.13	1.29	1.50	2.00	2.57	3.33
600 MHz/54 mm US PLUS LH	0.52	0.56	0.62	0.70	0.92	1.18	1.55
600 MHz/54 mm US LH	0.90	1.15	1.40	1.80	2.50	3.20	4.10
600 MHz/89 mm US PLUS LH	0.68	0.74	0.88	1.00	1.30	1.65	2.13
600 MHz/89 mm US LH	1.30	1.75	2.20	2.70	3.60	3.95	4.10
700 MHz/54 mm US PLUS LH	0.68	0.74	0.88	1.00	1.30	1.65	2.13
700 MHz/54 mm US LH	1.10	1.40	1.60	1.90	2.60	3.30	4.40
700 MHz/89 mm US PLUS LH	0.95	1.02	1.20	1.40	1.85	2.40	3.10

LH = Long Hold, ULH = Ultra Long Hold, US = Ultra Shield™
All measurements in meters! Distances are measured in **radial** direction from magnetic center.

Table 6.3. Vertical Stray Fields of Various Magnets

Magnet type	MC to Floor	5.0 mT (50 G)	3.0 mT (30 G)	1.0 mT (10 G)	0.5 mT (5 G)	0.2 mT (2 G)	0.1 mT (1 G)	0.05 mT (0.5 G)
200 MHz/154 mm US PLUS LH	1.18	1.10	1.32	1.53	1.80	2.26	2.71	3.30
300 MHz/54 mm US LH	0.91	0.52	0.66	0.80	0.90	0.96	1.36	1.56
300 MHz/54 mm US ULH	0.91	0.52	0.66	0.80	0.90	0.96	1.36	1.56
300 MHz/89 mm US LH	1.04	0.88	1.02	1.36	1.60	2.04	2.40	2.88
300 MHz/154 mm US PLUS LH	1.18	1.19	1.44	1.69	2.00	2.53	3.06	3.74
400 MHz/54 mm US PLUS LH	0.94	0.64	0.70	0.87	1.00	1.24	1.47	1.77
400 MHz/54 mm US PLUS ULH	0.94	0.64	0.70	0.87	1.00	1.24	1.47	1.77
400 MHz/54 mm US LH	0.95	0.80	1.05	1.30	1.50	1.96	2.36	2.76
400 MHz/54 mm US ULH	0.95	0.80	1.05	1.30	1.50	1.96	2.36	2.76
400 MHz/89 mm US PLUS LH	1.14	0.80	0.87	1.06	1.20	1.48	1.75	2.09
400 MHz/154 mm US PLUS LH	1.45	1.45	1.75	2.04	2.40	3.02	3.63	4.41
500 MHz/54 mm US PLUS LH	1.10	0.80	0.87	1.06	1.20	1.48	1.75	2.09
500 MHz/54 mm US PLUS ULH	1.10	0.80	0.87	1.06	1.20	1.48	1.75	2.09
500 MHz/54 mm US LH	1.01	1.10	1.35	1.60	1.90	2.40	2.90	3.40
500 MHz/89 mm US PLUS LH	1.31	0.90	0.99	1.21	1.40	1.71	2.03	2.45
500 MHz/89 mm US LH	1.28	1.50	1.80	2.10	2.50	3.30	3.80	4.50
500 MHz/154 mm US PLUS LH	1.45	1.74	2.13	2.52	3.00	3.83	4.65	5.70
600 MHz/54 mm US PLUS LH	1.13	0.90	0.99	1.21	1.40	1.71	2.03	2.45
600 MHz/54 mm US LH	1.12	1.50	1.80	2.10	2.50	3.30	4.10	5.10
600 MHz/89 mm US PLUS LH	1.36	1.25	1.38	1.72	2.00	2.49	2.98	3.60
600 MHz/89 mm US LH	1.36	1.80	2.30	2.80	3.50	4.60	5.20	6.10
700 MHz/54 mm US PLUS LH	1.30	1.25	1.38	1.72	2.00	2.49	2.98	3.60
700 MHz/54 mm US LH	1.23	1.80	2.20	2.60	3.10	4.10	4.90	6.10
700 MHz/89 mm US PLUS LH	1.52	1.70	1.90	2.40	2.80	3.50	4.20	5.10

LH = Long Hold, ULH = Ultra Long Hold, US = Ultra Shield^{TM}
All measurements in meters! Distances are measured in **axial** direction from magnet center.



	R [m]	Z [m]
0.05 mT	2.13	3.60
0.1 mT	1.65	2.98
0.2 mT	1.30	2.49
0.5 mT	1.00	2.00
1 mT	0.88	1.72
3 mT	0.74	1.38
5 mT	0.68	1.25

Figure 6.1. Example of a Stray Field Plot - 700 MHz/54 mm US PLUS LH

Magnetic Environment 7

The presence of any ferromagnetic materials in the immediate vicinity of the magnet will decrease the magnet´s homogeneity and may degrade overall performance. Although minimum requirements for routine NMR are not stringent, the magnetic environment must be optimized if more sophisticated experiments are being carried out. Usually, the effect of metal pipes, radiators, and other such objects can be “shimmed out”, but whenever possible, this must be avoided.

To assist in site planning two sets of guidelines are given below: “**minimum requirements**” and “**acceptable environment**”.

Minimum Requirements 7.1

Minimum requirements **must be met** or a different site should be considered because NMR performance is likely to be reduced.

Static Iron Distribution

There should not be any present within the 0.5 mT (5 G) 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 0.5 mT (5 G) limit is suitable for a mass of up to 200kg. 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

For all magnet systems, no moveable masses should be located within the 0.5 mT (5 G) region. Potential sources of moving iron are metal doors, drawers, tables chairs etc. For larger masses (> 200kg), distorting effects may be experienced at fields as low as 0.1 mT (1 G). For high precision work (e.g. NOE difference experiments) extending the region for no moveable magnetic material to 0.05 mT (0.5 G) may be justified. ***Table 7.2.*** serves as a guideline for moveable magnetic material.

Acceptable Environment 7.2

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

Static Objects

Table 7.1. 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 7.1. Recommendations for Static Magnetic Objects

Object	Actual Distance from Ultrashield Magnet	Actual Distance from Ultrashield PLUS Magnet
Iron or steel beams	4 m	3 m
Steel reinforced walls	4 m	3 m
Radiators, plumbing pipes	4 m	3 m
Metal table, metal door	4 m	3 m
Filing cabinet, steel cabinet	4 m	3 m
Massive objects e.g. boiler	4 m	3 m

Moving Objects

Table 7.2. serves as a guideline for moveable magnetic material.

Table 7.2. Recommendations for Movable Magnetic Objects

Object	Actual Distance from Ultrashield Magnet	Actual Distance from Ultrashield PLUS Magnet
Steel cabinet door	3 m	2 m
Large metal door, hand trolley	4 m	2 m
Elevators*	8 m	3 m
Cars, fork-lifts	8 m	6 m
Trains, trams*	8 m	8 m

** 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. Refer to the chapter* ***"Electromagnetic Interference" on page 65*** *for more information.*

Room Layout 8

This chapter has been included to give an overview of a suitable room layout. More precise details will be discussed in subsequent chapters. The reader may also wish to refer to ***"Sample Room Layouts" on page 91*** which contains room layouts for various magnets. The standard AVANCE^{TM} spectrometer consists of three main units: the magnet (section ***8.1.1***), the cabinet (section ***8.1.2***), and the worktable (section ***8.1.3***).

Figure 8.1. Main Units: Magnet, Cabinet, and Worktable

Floor Plan 8.1

To adequately plan the laboratory you should draw a scaled floor plan of the proposed site. ***Table 8.1.*** shows the maximum field strength at which standard NMR equipment must be operated or located. ***Table 8.2.*** shows the dimensions of various NMR units.

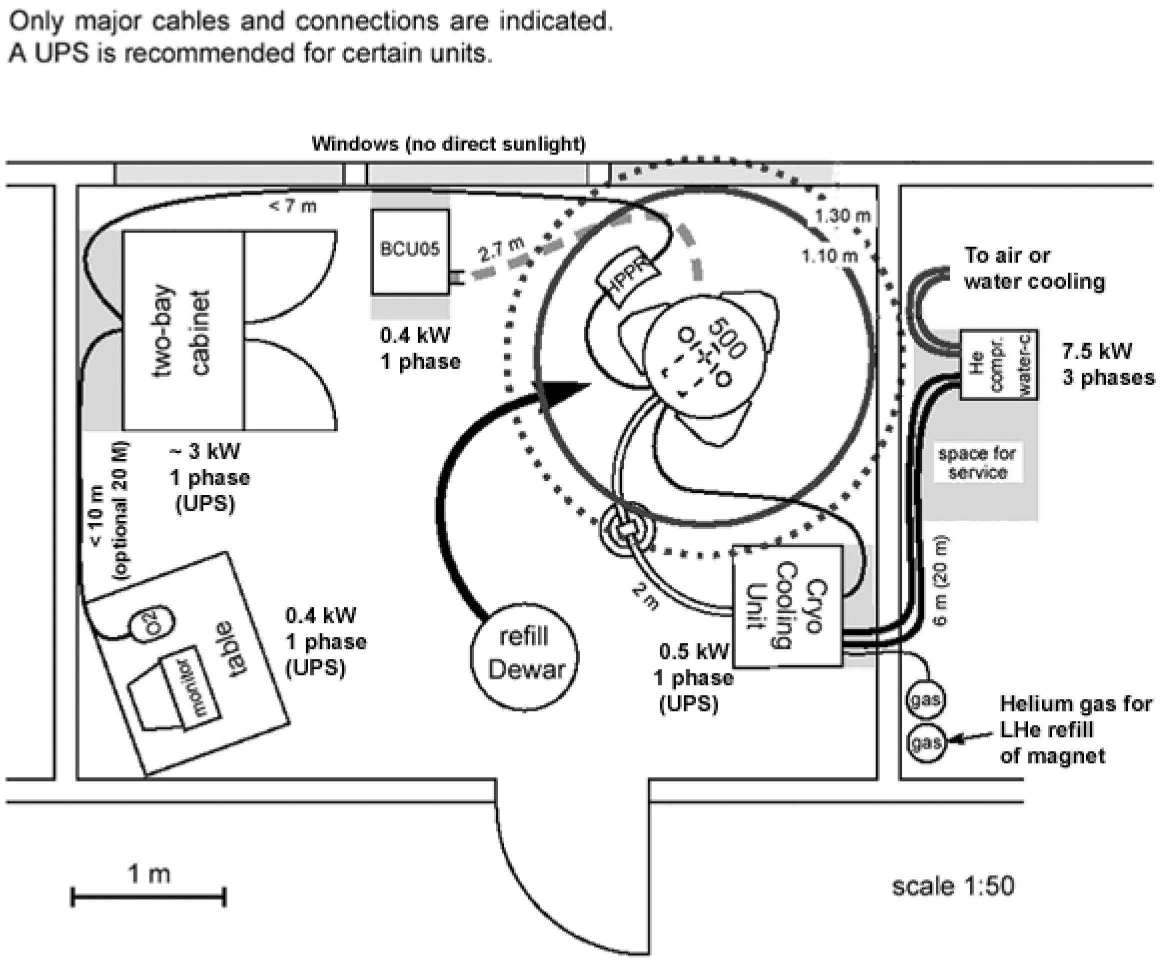


Figure 8.2. Site Planning Example (shown with CryoProbe System)

Use the magnet stray field data from ***Table 6.2.*** and ***Table 6.3.*** to check that all equipment can be positioned outside the limits as specified in ***Table 8.2.***. When drawing the floor plan refer to ***Table 8.3.*** for the magnet diameter.

Table 8.1. Maximum Field Strength for NMR Equipment

Unit	Maximum Field Strength
AVANCE cabinet	1.0 mT (10 G) line
TFT computer monitor	1.0 mT (10 G)*
Computers e.g. NMR workstation, PC	0.5 mT (5 G)
CPMAS, Micro-imaging, High Power units	1.0 mT (10 G)
Printer Plotter	0.5 mT (5 G)
Gas cylinders	0.5 mT (5 G)
Movable metal chair	not recommended in magnet room
Heavy metal office furniture e.g. filing cabinet**	0.5 mT (5 G) - not recommended in magnet room
BCU 05, BCU-X	located 2.7 m max. from magnet center
LC-NMR System & Accessories	0.5 mT (5 G)
Gilson	0.5 mT (5 G)
CryoProbe System Components (e.g. He steel cylinder and its transport path)	0.5 mT (5 G)
CryoCooling unit	5.0 mT (50 G)

* The working place for personnel must be outside the 0.5 mT (5 G) line. An additional TFT monitor and keyboard can be located at the 1.0 mT (10 G) line for probe adjustments etc.
** Use wooden furniture if access during critical measurements is required.

Table 8.2. Dimensions of NMR Equipment

Unit	Width	Depth	Height
AVANCE TwoBay	1.31 m	0.83 m	1.29 m
AVANCE OneBay	0.69 m	0.83 m	1.29 m
AVANCE MicroBay	0.64 m	0.83 m	0.96 m
AVANCE NanoBay	0.45 m	0.84 m	0.70 m
Worktable	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, BCU-X	0.50 m 0.55 m	0.55 m 0.59 m	0.48 m 0.74 m
LC-NMR Unit plus any additional options/accessories**	0.72 m diverse	0.80 m diverse	0.72 m diverse
Gilson	0.914 m	0.61 m	0.558 m**

Table 8.2. Dimensions of NMR Equipment

Unit	Width	Depth	Height
CryoCooling unit	0.80 m	0.72 m	1.30 m

* 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).

Refer to *Table 8.3.* for the values of A, B, and C for each magnet.

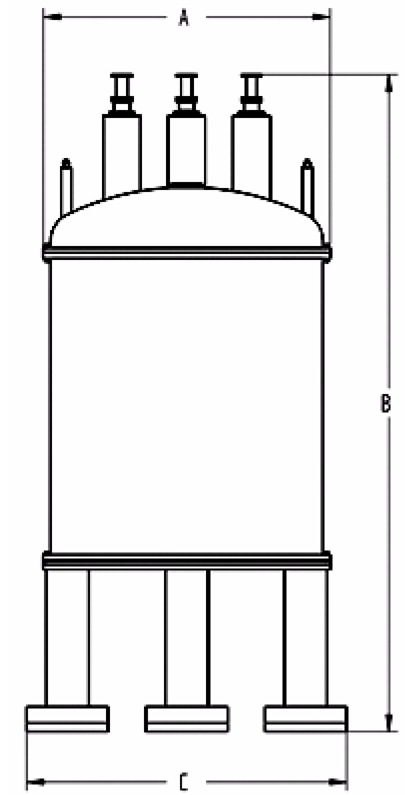


Figure 8.3. Magnet Dimensions

Table 8.3. Diameter, Weight of Magnets (filled) and Minimum Floor Capacity

Magnet	A Magnet Diameter (m)	B Magnet Height (m)	C Magnet Diameter Including Pneumatic Stand (m)	Magnet Weight Filled with Magnet Stand (kg)	Minimum Floor Capacity (kg/m^2)
200 MHz/154 mm US PLUS LH	0.85	2.47	1.29	~ 850	not available
300 MHz/54 mm US LH	0.72	1.93	0.72	~ 292	431
300 MHz/54 mm US ULH	0.72	2.27	0.72	~ 379	527
300 MHz/89 mm US LH	0.72	2.36	0.72	~ 452	603
300 MHz/154 mm US PLUS LH	0.85	2.47	1.29	~ 850	not available
400 MHz/54 mm US PLUS LH	0.85	2.07	1.30	~ 574	383
400 MHz/54 mm US PLUS ULH	0.85	2.32	1.30	~ 644	415
400 MHz/54 mm US LH	0.72	2.27	0.72	~ 438	645
400 MHz/54 mm US ULH	0.72	2.49	0.72	~ 480	686
400 MHz/89 mm US PLUS LH	0.85	2.47	1.30	~ 798	587
400 MHz/154 mm US PLUS LH	1.10	2.99	1.60	~ 1400	not available
500 MHz/54 mm US PLUS LH	0.85		1.30	~ 791	507
500 MHz/54 mm US PLUS ULH	0.95	2.61	1.48	~ 1114	561
500 MHz/54 mm US LH	0.80	2.31	1.05	~ 749	1026
500 MHz/89 mm US PLUS LH	0.95		1.48	~ 1377	695
500 MHz/89 mm US LH	1.10		1.10	~ 1700	749
500 MHz/154 mm US PLUS LH	1.10	2.99	1.58	~ 2.12	not available
600 MHz/54 mm US PLUS LH	0.95		1.48	~ 1409	715
600 MHz/54 mm US LH	0.91		1.22	~ 1300	1383
600 MHz/89 mm US PLUS LH	1.10		1.60	~ 2120	922
600 MHz/89 mm US LH	1.37		1.94	~ 2500	860
700 MHz/54 mm US PLUS LH	1.10	2.84	1.60	~ 1890	not available
700 MHz/54 mm US LH	1.37		1.94	~ 3200	1100
700 MHz/89 mm US PLUS LH	1.37		1.92	~ 3029	896

LH = Long Hold, ULH = Ultra Long Hold, US = UltraShield™
For information on other magnets not listed, please contact your nearest Bruker BioSpin office.
All measurements in meters!

Magnet Position *8.1.1*

When locating the magnet, take into consideration how close the magnet will be to permanent iron structures such as support beams and columns, as well as reinforced walls, floors and ceilings. The presence of any ferromagnetic materials in the immediate vicinity of the magnet will decrease the magnet´s homogeneity and may degrade overall performance. Refer to the chapter ***"Magnetic Environment" on page 39*** for details.

Smoke detectors, fire detectors and sprinklers must not be located within the 0.5 mT (5 G) line.

To increase temperature stability, the magnet must not be placed in direct sunlight or near any artificial heat source. Likewise, to avoid line frequency Electro Magnetic Interference (EMI), the magnet must not be placed directly under fluorescent lights.

Where possible avoid a situation where stray fields > 0.5 mT (5 G) extend into adjacent rooms (see ***Figure 2.1.***). There must be open access to the magnet from all sides, and a minimum of 77cm clearance to any adjacent wall must be provided. Sufficient space for access to the cryogen dewars needs to be provided as well (see ***"Ventilation" on page 53***). It is recommended that the magnet be located outside the main traffic area of a room, for example in a corner, to limit magnetic fluctuations.

Ladders

Ladders are most commonly used to facilitate sample insertion, cryogen fills, etc. Ladders must be constructed of wood or aluminum to keep magnetic interference down to a minimum.

Magnet Platforms

If climbing a ladder is not a feasible option, a magnet platform may be required. These are typically built to facilitate sample insertion on the larger systems (600 MHz and up), however smaller platforms can be used on smaller systems.

The platform must be constructed of wood or other non-magnetic material. It must accommodate the magnet and provide safe access for sample insertion and cryogen fills. Consult your Bruker BioSpin office for further guidelines when using a magnet platform.

Figure 8.4. Example of a Simple Magnet Platform

Pits

If a pit is required due to limited ceiling height or to prevent stray fields from affecting the floor above, it must be large enough to accommodate the magnet and any other units required.

It is important to think about how the equipment will be placed into the pit. Rigging within the NMR lab can be tricky and labor intensive when the magnet and any other equipment must be lowered into a pit.

DANGER! The accumulation of nitrogen in a pit may create a life-threatening situation if adequate ventilation is not provided. An oxygen warning device must also be installed in the pit.

The magnet must be so situated as to provide adequate space for access all around the system, particularly for fills (note: in some cases customized transfer lines can be provided as an option).

The wall of the pit must be outside the 1.0 mT (10 G) line, or built with non-magnetic material. A non-magnetic platform should be built around the magnet to allow access for changing samples and filling with cryogens. In some cases a half platform will suffice.

To provide adequate safety when using a pit, a stairway must be built allowing easy access to the pit. Likewise, a rail system should be installed to prevent personnel from falling into the pit.

Figure 8.5. Example of a Magnet Pit

Another complication with pits concerns the **CryoCooling unit** for the CryoProbe. It should ideally be located at the same level as the magnet. The pit must be large enough to accommodate both the magnet and the CryoCooling unit.

The **BCU05** also must be considered when using a pit. The hoses from a BCU05 are not very flexible, thus a pit must be large enough to provide sufficient space for the BCU05 and it's hoses. The BCU05 cooling unit must be as far as possible from the magnet so as to minimize influence from stray fields.

Please contact Bruker when considering a pit.

Cabinet Position *8.1.2*

The various units within the AVANCE^{TM} cabinet, especially the acquisition computer, must be kept at a minimum distance from the magnet. 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 G) line. Any ancillary cabinets such as microimaging or high power must also be placed outside the 1.0 mT (10 G) line (see ***Table 8.1.***). The preamplifier (e.g. HPPR/2) must be placed to the left side of the magnet.

To allow adequate ventilation for the cabinet, it must be positioned no closer than 15 cm from the back of the cabinet and any walls. In some circumstances it may be necessary to install supplementary exhaust systems, such as a passive exhaust system or a commercial ventilation system (***Figure 10.1.***). For service access to the rear, there must be sufficient space for the cabinet to be pulled out from the wall (see ***"Ventilation" on page 53***).

For ease of cabling, locate electrical outlets and compressed air supply close to the rear of the cabinet.

Worktable Position *8.1.3*

Based on acceptable MWC (**M**aximum **W**orkstation **C**oncentration) values, the working place must be placed outside of the 0.5 mT (5 G) line (refer to the section ***"The Magnetic Field" on page 12***).

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

The computer 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 G) line for optimal picture. With correct orientation you may locate the monitor as close as 0.5 mT (5 G), though color distortion may result.

TFT flat panel monitors can be safely placed as close as 0.5 mT (5 G), or even 1.0 mT (10 G), though slight picture distortion may occur.

Positioning Other Standard NMR Equipment *8.2*

Micro Imaging, High Power Cabinets

These accessories are not as sensitive to the magnet stray field as the units contained in the main AVANCE^{TM} 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 (see the layout examples in ***"Sample Room Layouts" on page 91***). 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 must 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. Note 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

The BCU 05 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 approximately 2.7 m from the magnet. The precise distance from the magnet center can be reduced by placing a bend in the heat exchanger.

LC-NMR/MS

The LC-NMR/MS system is available in a variety of configurations and can include many diverse accessories. Most configurations can be setup on existing tables and/or the LC-NMR/MS cabinet.

If you are considering a LC-NMR/MS system be sure to request a copy of our latest **LC-(SPE)-NMR(/MS) Site Planning Guide**.

Gilson Liquid Handler

The Gilson 215 Liquid Handler is an XYZ robot that can automate any number of liquid handling procedures. There are generally no specific room layout considerations for the Gilson, other than locating it outside of the 0.5 mT (5 G) line.

CryoProbe

The CryoProbe^{TM} accessory consists of three major components: the CryoProbe, CryoPlatform^{TM} and a compressor.

If you are considering a CryoProbe system be sure to request a copy of our latest **CryoProbe System Site Planning Guide**.

SampleRail

The SampleRail™ is part of a system for preparing an NMR sample, transporting it into an NMR magnet, performing NMR experiments on it and transporting it back to the preparation system - all in automation, for example, in automated protein screening.

The main site planning consideration for the room layout is that the room is long enough or wide enough to support the length of SampleRail. The height of the SampleRail generally should fall within the normal ceiling height requirements. For further information on SampleRail requirements, check with your Bruker representative.

Service Access Requirements 8.3

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

- Ventilation: A minimum of 30 cm must left between the back of the cabinet and any wall to ensure proper ventilation.
- Service access - AVANCE: Sufficient space (~ 60 cm) must be left in front of the AVANCE so the cabinet may be pulled away from the wall for service. Service access to the sides is not required.
- Service access - Magnet: There must be enough space between the magnet legs and the wall such that a service person can walk all the way around the magnet. Also, there must be enough available space to bring a cryogen refill dewar close to the magnet.

The following are miscellaneous, but important things to think about when creating a workable floor plan:

- For ease of cabling, locate electrical outlets and compressed air supply close to the rear of the cabinet and by the magnet.
- The door to the magnet room must be easily accessible from all parts of the room. It is advantageous to have the doors located so that traffic though the room does not approach the magnet.
- As a rule gas cylinders must be stored outside the room. If for any reason they must be placed in the magnet room they must be located as far away from the magnet as possible and secured properly to the wall.
- Ensure that convenient and safe pathways are available so that cryogen transport dewars can easily be moved into and out of the magnet room. This includes making sure that the cryogen dewars do not run over cabling, and that the equipment/furniture is located to allow for access.
- Make provision for sample/solvent preparation and storage space, documentation storage space, personal computers, printer/plotter tables, workstations etc.
- Under no circumstances should movable office chairs made of magnetic material be used in the NMR room.
- Make provision for installing a telephone and lines for, e.g. Internet access. It is most convenient if the operator can use the phone while sitting at the spectrometer worktable.

Finally, before a final layout is decided, consider future equipment that may need to be installed. Remember that once installed, the magnet must not be moved.

Structural Considerations 9

There are a number of structural factors that must be considered for the location and installation of the magnet system. 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.

When a ceiling hook or crane will be required to install the magnet, then the structure and strength of the **ceiling** will also be a factor.

Minimum Floor Capacity *9.1*

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. The weights for the various cabinets are listed in ***Table 4.5.***. For the total weight of the magnet (including cryogens and stand) refer to ***Table 8.3.***.

The floor must 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 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.

Floor Types *9.2*

Generally a **liquid nitrogen resistant floor material** must be used, such as PVC or wood that has been painted or varnished. Unfinished wood must not be used as this will absorb liquid nitrogen. This also implies that wood floors must be regularly 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 must be installed on an ESD resistant flooring such as vinyl, and properly grounded. One of the most important characteristics of an **ESD resistant floor** is its ability to conduct charges to ground. The second most important aspect is its **anti-static property**.

Vibration Isolation for the Floor and Foundation 9.3

Isolated slabs are recommended when strong vibrations coming from the building's foundation are present. However, if the vibrations are caused by outside sources (traffic etc.) an isolated slab may not help as the mass creating the vibration is much smaller than the mass of the object being shaken (the building foundation). In this case, **vibration isolation units** may be recommended over an isolated slab. For more information refer to the chapter ***"Vibrations" on page 61***.

Other Structural Considerations 9.4

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 must be checked, as they must not be located within the 0.5 mT (5 G) line.

Before a final layout is decided consider future equipment that may need to be installed. Remember that once installed, the magnet must not be moved.

Ventilation 10

Ventilation Requirements 10.1

Superconducting magnets use liquid nitrogen and liquid helium as cooling agents. During normal operation of the magnet system it can be expected that a boil-off of liquid cryogens will occur:

- A normal boil-off of liquids contained in the magnet will occur based on the established boil-off specifications.
- A boil-off of cryogens during regular refills with liquid nitrogen and liquid helium.

The gases are nontoxic and completely harmless as long as **adequate ventilation** is provided.

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 **vacuum 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 must be provided in the upper-most portion of the room where the magnet is located, such as in the ceiling or upper wall.

General Safety Rules Concerning Ventilation 10.2

General safety rules concerning ventilation include, but are no limited to:

- Cryogenic liquids, even when kept in insulated storage dewars, remain at a constant temperature by their respective boiling points and will gradually evaporate. These dewars must always be allowed to vent or dangerous pressure buildup will occur.
- Cryogenic liquids must be handled and stored in well ventilated areas.
- The very large **increase in volume** accompanying the **vaporization** of the liquid into gas and the subsequent process of warming up is approximately **740:1 for helium** and **680:1 for nitrogen**.
- For personnel safety, **oxygen level sensors** must be located in the magnet room, particularly when using a pit. These must 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.
- Room layout, ceiling clearance and magnet height must be such that an easy **transfer of liquid** nitrogen and helium is possible. This will considerably reduce the risk of accidents.

Air Conditioning *10.3*

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

Typically the air exchange rate must be kept at 3-5 times the room volume per hour. In some cases, however, this cannot be done. The key is to provide continuous flow at constant volume. The temperature must be regulated via a heating grill, hence avoiding temperature modulations.

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^{TM} electronics, ***Table 10.1.*** lists the heat generated by various systems. The system must operate continuously to stabilize the temperature and humidity of the magnet environment and must not cycle rapidly. Do not allow the air flow from any heating or cooling system to blow directly onto the magnet or console.

Table 10.1. Heat Generated by Typical AVANCE *Systems*

System	Heat Generated
AVANCE TwoBay (with 3 channels & BCU05)	3.00 kW peak*
AVANCE OneBay	2.50 kW peak
AVANCE MicroBay (3 channels)	2.00 kW peak
AVANCE NanoBay	not available
Imaging Cabinet	1.0 kW average
High Power Cabinet	1.5 kW average
BCU05, BCU-X	BCU05: 0.5 kW average BCU-X: 1.5 kW average, 2.4 kW peak
Gilson	approx. 0.5 kW average
CryoProbe CryoCooling Unit	0.5 kW average, 1.5 kW peak
He Compressor (note: heat from the outdoor He compressor is not dissipated inside the room)	7.5 kW average 8.5 kW peak
* A TwoBay configured for solids can generate a peak of 5.00 kW.	

The temperature of any air or nitrogen flow attached to the probe must be stable. This is particularly relevant if the compressed gas flow is piped into the magnet room from outside the building.

A commercial ventilation system much like those found in the kitchen of modern restaurants is a good example of an active exhaust system. These devices draw the heat generated by electronic devices in the room (e.g. consoles and accessories) out of the room, as opposed to recirculating the air as with some air conditioning systems. During a quench these systems will also aid in dispersing the gases rapidly.

Figure 10.1. Commercial Ventilation Systems

Atmospheric Pressure Changes 10.3.1

Rapid changes in the temperature may result in atmospheric pressure changes. High atmospheric pressure could reduce the helium boil off if the magnet cryostat is not equipped with an electronic atmospheric pressure device. The boil-off rate could be even lower than the minimum value which could be measured by the flow meter. Electronic **atmospheric pressure devices**, which hold the pressure at 1030 HPa, stabilize field drift and helium boil-off when changes in atmospheric pressure occur. The atmospheric pressure device is currently standard with 700 MHz Bruker magnets and is available as an option for other magnets.

Emergency Ventilation During Magnet Installation and Quenches 10.4

A separate emergency ventilation system must 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, refilling, and cooling of superconducting magnets, large volumes of nitrogen or helium gases may be generated under certain conditions.

Although these gases are inert, if generated in large enough quantities, they can **displace the oxygen in the room** causing potential danger of suffocation. The table below illustrates this with examples.

Table 10.2. Example of Gas Released During Pre-cool, Cooling, and a Quench

Magnet Type	N2 gas released during pre-cool	Time to release N2 gas during pre-cool	He gas released during cooling and filling	Time to evolve He gas during cooling and filling	He gas released during a „quench“	Time to release He gas during a „quench“
UltraShield 300/54	102 m^3	4 hours	150 m^3	3 hours	37 m^3	2 minutes
UltraShield 700/54	892 m^3	24 hours	850 m^3	6 hours	348 m^3	15 minutes

Notes:
- The He gas is not being released at a constant flow over the time specified in the table. The flow is the highest immediately after a quench. ***Table 10.3.*** lists the maximum flow for each of the magnets, based on the assumption that half of the volume of gas is being released during the first minute following a quench.
- The values in the table are approximate and may not reflect actual conditions. They are to be used for example only.
- Pre-cool times vary.
- Quench times are generally longer.
- Please consult with Bruker for values associated with your NMR magnet system.

Figure 10.2. Quench at 600 MHz WB (widebore magnet)

The following table lists the maximum helium capacity and the typical gas flow rates for helium gas during a quench for current magnet systems. Generally, the gas flow rate is equal to half the volume in one minute.

Table 10.3. Maximum Helium Capacity and Gas Flow Rate

Magnet	Maximum Helium Capacity (m^3)	Gas Flow Rate (m^3/minute)
200 MHz/154 mm US PLUS LH	not available	not available
300 MHz/54 mm US LH	37.1	18.6
300 MHz/54 mm US ULH	71.0	35.5
300 MHz/89 mm US LH	56.0	28.0
300 MHz/154 mm US PLUS LH	not available	not available
400 MHz/54 mm US PLUS LH	64.4	37.3
400 MHz/54 mm US PLUS ULH	100.8	50.4
400 MHz/54 mm US LH	56.0	28.0
400 MHz/54 mm US ULH	75.0	37.5
400 MHz/89 mm US PLUS LH	75.6	37.8
400 MHz/154 mm US PLUS LH	not available	not available
500 MHz/54 mm US PLUS LH	79.8	39.9
500 MHz/54 mm US PLUS ULH	not available	not available
500 MHz/54 mm US LH	54.6	27.3
500 MHz/89 mm US PLUS LH	88.9	44.5
500 MHz/89 mm US LH	198.0	99.0
500 MHz/154 mm US PLUS LH	not available	not available
600 MHz/54 mm US PLUS LH	94.5	47.3
600 MHz/54 mm US LH	111.3	55.7
600 MHz/89 mm US PLUS LH	179.2	89.6
600 MHz/89 mm US LH	315.0	157.5
700 MHz/54 mm US PLUS LH	not available	not available
700 MHz/54 mm US LH	348.0	174.0
700 MHz/89 mm US PLUS LH	331.1	165.6

LH = Long Hold, ULH = Ultra Long Hold, US = UltraShield™

For information on other magnets not listed, please contact your nearest Bruker BioSpin office.

Emergency Exhaust 10.5

In many cases doors and windows will provide sufficient ventilation in larger rooms. It is important to compare the volume of He gas that would be released after a quench and the space volume of the NMR magnet room, in order to determine the optimum and practical solution for emergency ventilation. Generically it is recommended that an emergency exhaust system be installed in smaller rooms, or rooms not connected to the outside.

There are various types of emergency exhaust that can be implemented to avoid oxygen depletion during a quench or during the installation of the magnet system. These include, but are not limited to:

Passive Exhaust Solutions 10.5.1

This solution is based on louvers in the ceiling that open by the gas due to the overpressure of helium gas during a quench.

An example of a passive exhaust solution is an exhaust which can be mounted to the corridor and opens with a pressure difference of 100 Pa.

Active Exhaust Solutions 10.5.2

These solutions are based on a motorized fans, vents and/or exhaust duct pipes that are not connected to the magnet itself. An active exhaust must be able to be activated both automatically by an O_2 sensor, as well as manually by a switch in the room. The latter is needed during magnet installation and regular refills to prevent cryogen build-up in the room by evacuating them faster than the regular HVAC (Heating Ventilation Air Conditioning) system.

Quench Pipes

Quench pipe(s) are connected directly to the magnet and routed to the outside of the building. It is convenient to split up the quench pipe system into two parts, specfically for the magnet and for the building. This approach allows you to define a clear interface between the two parts of the quench pipe system, and thus the respective responsibilities.

For the practical realization it would be ideal if BRUKER supplied that part of the quench pipe which is specific for the given magnet system.

The customer will need to plan and implement (if necessary by constructional means) the pipe within the building, taking into account BRUKER specifications. For detailed information please contact BRUKER directly.

Exhaust for Magnet Pits *10.5.3*

Special attention to ventilation and emergency exhaust must be given when magnets are placed inside pits. Magnet pits are confined spaces with a possibility of increased risk of oxygen depletion if appropriate exhaust measures are not taken.

- Nitrogen is heavier than air and starts filling the pit from the bottom during the magnet pre-cool or regular nitrogen fills.
- **It is essential to provide an exhaust system down inside the pit to efficiently evacuate the nitrogen gas and to prevent oxygen depletion and suffocation.**
- It is highly recommended that ***"Oxygen Monitors and Level Sensors"*** be placed inside a pit.

Exhaust for Ceiling Soffits *10.5.4*

The opposite of a pit, a soffit is a hole that has been cut in the ceiling to facilitate cryogen fills and/or the magnet installation. Though it is not required to install ventilation in a soffit, it is important to understand that the soffit will be the first area to fill up with helium gas during a quench or during a helium fill. It is important to elicit extra caution in this case.

- A passive louver or an exhaust duct with fan are practical solutions when soffits are used.

Air Conditioning as an Exhaust *10.5.5*

It is recommended that the air conditioning system be adequate to dissipate the sudden gas buildup during a quench. In addition the air conditioning must have a safety feature which **draws all the air out** of the room and **brings fresh air in** during a quench, rather than just recirculating the old air through the system. The air conditioning system could, for example, be connected to an oxygen level sensor.

Oxygen Monitors and Level Sensors 10.6

An oxygen monitor or level sensor is required inside the magnet room. At a minimum the following sensors must be provided:

- One oxygen level sensor must be above the magnet, to detect low oxygen levels caused by high He gas levels.
- One oxygen level sensor approx. 30 cm off the floor of the magnet room.
- One additional oxygen level sensor approx. 30 cm off the bottom of the pit, in case the magnet is located inside a pit.

These monitors and sensors generally must be located outside the 0.5 mT (5 G) line. Check with original equipment manufacturer for information on the effects of magnet fields on these devices.

Checklist for Ventilation 10.7

Use vented dewars to avoid pressure build-up.	
Cryogen storage must be located in a well-ventilated area.	
Use oxygen level sensors inside the magnet room.	
Magnet room exit doors must open to the outside.	
Adequate ventilation must be provided in the upper part of the room to prevent helium build-up.	
Adequate air conditioning must be available.	
Provision need to be made to maintain adequate relative humidity.	
An atmospheric pressure device must be available.	
Adequate ventilation must be available in case of a quench.	

Vibrations 11

External vibrations may cause field modulations in the sample cavity. This could result in vibration sidebands, matched NMR signals that appear on either side of a main signal peak.

The effect of vibrations on NMR performance will depend on several factors:

- **Customer requirements**: Ultimately the customer must decide what constitutes significant vibrational sidebands in NMR spectra. This will greatly depend on the type of work being carried out, e.g. inverse experiments and 2D experiments are much more sensitive to vibration interference than standard 1D experiments.
- **Type of system**: The effect of vibrations will depend on the construction, design and size of magnet. due to their increased sensitivity, larger magnets (e.g. 500, 600, 700 MHz) tend to be more susceptible to vibration problems.
- **Building Materials**: The materials used in the construction of the NMR site will play a significant role in determining to what extent external vibrations are transmitted to the magnet.

Sources of Vibrations 11.1

- **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.
- Sources of more **regular vibrations** are generators, compressors, fans, machinery etc. Compressors must **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, windows in the magnet room must be located and constructed in such a way that no sudden pressure fluctuations are produced by winds.
- Ideally the **site must always be at ground or basement level** to minimize building vibrations. High rise buildings may oscillate at frequencies below 1 Hz. Such oscillations may be noticeable in upper floors and are impossible to control. For XY oscillations, special dampers are now available, contact Bruker BioSpin for details.
- 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.

Vibration Guidelines 11.2

Measurements of floor accelerations (mm/sec^2) are required in both vertical and horizontal directions over a minimum frequency range of 0 to 100 Hz. Recording both average and peak-hold values is recommended.

All magnets are equipped with vibration dampers in order to reduce vibrations on the magnet. The isolation performance is given by a transmissibility characteristic for the specific dampers integrated within the magnet. The higher the frequency of floor vibrations, the better the damping (less of the vibration is transmitted). Also, the smaller the natural frequency of the dampers and the smaller their "Q" (amplification factor at the natural frequency), the higher the isolation performance.

The acceleration peaks measured directly on the proposed magnet floor must be multiplied by the transmissibility factor of the dampers at the specific frequencies at which these acceleration peaks have been recorded. The results must then be compared to the **maximum 0.1 mm/sec^2** that can be tolerated at the magnet.

Vibration Damping Measures 11.3

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.

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.

Passive damping of vibrations may be achieved by three methods

1. Placing ***"Anti-vibration Pads"*** beneath the magnet stand.
2. Mounting the magnet on inflatable ***"Pneumatic Dampers"***.
3. Mounting the magnet on a ***"Vibration Isolator Posts (VIP)"*** .

Regardless of what measures may be taken, the vibrations can only ever be reduced to an acceptable level, they are rarely completely removed.

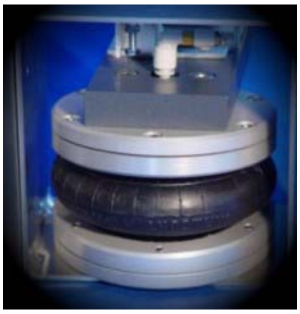
All Bruker BioSpin anti-vibration devices can be easily retrofitted to an existing system if required. Many spectrometers, and particularly those with fields of 300 MHz, require no such devices. Contact Bruker for more information.

Anti-vibration Pads 11.3.1

The magnet stand is fitted with circular anti-vibration pads, primarily to protect the floor. These will however provide some damping for frequencies above 15-20 Hz.

Additional soft rubber anti-vibration pads may successfully dampen frequencies above 8-15 Hz. However, since soft rubber pads may have a resonance frequency in the 8-15 Hz range, thus may be unsuitable if external vibrations at these frequencies are present.

Pneumatic Dampers 11.3.2



Supplied by Bruker BioSpin, these dampers work for frequencies > 8 Hz. Example of a Pneumatic Damper

The magnet is supported on three rubber feet inflated to a pressure in the region of 6 bar. The dampers may however enhance vibrations at or below their resonance frequency of 4-6 Hz.

Figure 11.1. is an example of the effect of pneumatic dampers on vibration sidebands.

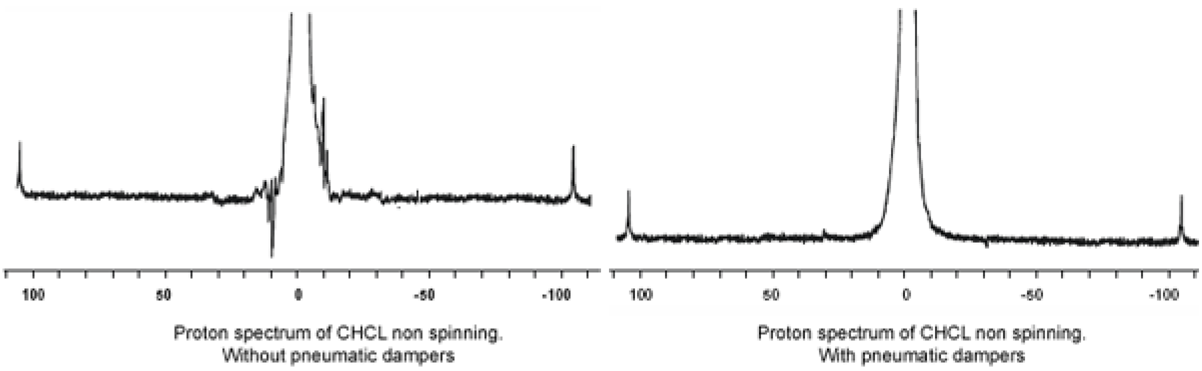


Figure 11.1. Effect of Pneumatic Dampers

Vibration Isolator Posts (VIP) 11.3.3

This is a rather more elaborate system, and is designed to improve performance of NMR spectrometers exposed to disturbing floor vibrations in the frequency range of 2-20 Hz. The advantage of the VIP over other systems is the superior damping in the range below 10 Hz. At these low frequencies other vibration dampers are ineffective.

Table 11.1. summarizes the magnet frequency ranges over which various damping measures have proven to be effective.

Table 11.1. List of Available Damping Measures by Magnet Frequency

Magnet	Rubber Pads	LC50	LC50XD	LC100	LC 100XD	LC300XD	LC500XD	PAL-9
200 MHz/154 mm US PLUS LH	Elsatomer							Optional
300 MHz/54 mm US LH	Optional	Optional	---	---	---	---	---	---
300 MHz/54 mm US ULH	Optional	Optional	---	---	---	---	---	---
300 MHz/89 mm US LH	Optional	Optional	---	---	---	---	---	---
300 MHz/154 mm US PLUS LH	Elsatomer							Optional
400 MHz/54 mm US PLUS LH	Elsatomer	---	---	---	---	---	---	Optional
400 MHz/54 mm US PLUS ULH	Elsatomer	---	---	---	---	---	---	Optional
400 MHz/54 mm US LH	Optional	Optional	---	---	---	---	---	---
400 MHz/54 mm US ULH	Optional	Optional	---	---	---	---	---	---
400 MHz/89 mm US PLUS LH	Elastomer	---	---	---	---	---	---	Optional
400 MHz/154 US PLUS LH					Included			
500 MHz/54 mm US PLUS LH	---	---	---	---	---	---	---	Included
500 MHz/54 mm US PLUS ULH	---	---	---	---	---	---	---	Included
500 MHz/54 mm US LH	Included	Optional	Optional	---	---	---	---	---
500 MHz/89 mm US LH	---	---	---	Included	Optional	---	---	---
500 MHz/89 mm US PLUS LH	---	---	---	---	Included	---	---	---
500 MHz/154 mm US PLUS LH						Included		
600 MHz/54 mm US PLUS LH	---	---	---	---	Included	---	---	---
600 MHz/54 mm US LH	---	---	---	Included	Optional	---	---	---
600 MHz/89 mm US PLUS LH	---	---	---	---	---	Included	---	---
600 MHz/89 mm US LH	---	---	---	---	---	---	Included	---
700 MHz/54 mm US PLUS LH						Included		
700 MHz/54 mm US LH	---	---	---	---	---	---	Included	---
700 MHz/89 mm US PLUS LH	---	---	---	---	---	---	Included	---

Electromagnetic Interference 12

Electro Magnetic Interference (EMI) can be defined as any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades the effective performance of electrical equipment. Possible sources of interference are power lines which may carry fluctuating loads, heavy duty transformers, large electric motors, air conditioning systems, power transformers, etc.

The fluctuating electromagnetic fields arising from such devices can interfere with the magnet homogeneity. Of particular concern are sudden changes in load as may be produced by elevators, trams, subways etc. Some laboratory equipment such as mass spectrometers and centrifuges will also give rise to fluctuating fields. Other sources of interference include radio and television stations, satellites and other RF transmitters that may operate in the vicinity of NMR frequencies of interest.

If you suspect that you have a source of interference located near the proposed magnet site then you should contact Bruker Biospin for a site survey.

Types of EMF Interference

- DC Interference
- 50/60 Hz Interference
- Radio Frequency (RF) Interference

DC Interference 12.1

DC interference generally comes from devices operated on DC, such as elevators, trains, subways, trams, etc. The locations of both the device and its power supply & lines relative to the proposed NMR site are essential to the amplitude and orientation of DC fields and how they may interfere with the NMR system. DC feeder lines are just as disturbing as a subway, and they do not run necessarily parallel to the track.

Measuring DC Fluctuating Fields 12.1.1

DC EMF measurements should be conducted using a **fluxgate magnetometer**. The fluxgate sensor is capable of accurately measuring magnetic field changes below 1mG. The sensor is connected to a magnetometer, and the voltage output from the meter is then converted into digital form. The magnetic field is recorded and plotted on a computer display in real time.

Reducing DC Interference 12.1.2

The amplitude of the "full external perturbation" (peak-to-peak) is measured with the fluxgate magnetometer at the proposed magnet location but in the absence of magnet. There are two levels of compensation against these external DC field perturbations:

- First, the magnet screens itself against external perturbations, hence only a fraction of the full perturbation is left at the magnet center. We call this *residual field perturbation after magnet screening*. It's value is relevant to NMR experiments *without lock*, relevant to many solids experiments and high resolution experiments using gradients which require lock hold.
- Second, the advanced digital NMR lock further minimizes the interference after magnet screening. The digital lock is less susceptible to field perturbations than the older analog lock. The final response may depend on the lock substance and concentration.

Guidelines: DC Interference 12.1.3

When determining the effect of fluctuating magnetic fields, two parameters are important: the size of the fluctuation and the rate of change (gradient).

- **Field changes of between 0-5 mG**, regardless of the gradient, are generally considered harmless for standard NMR work. Likewise with UltraShield magnets (only), field changes up to 10 mG are considered harmless. The effect of such changes would be observable in only the most critical of experiments such as NOE difference experiments.
- For field changes **larger than 5 mG** the lock system will compensate the fluctuation, as long as the gradient is less than 5 mG/sec. (10 mG for UltraShield magnets, 50 mG for UltraShield Plus magnets).
- For field gradients **greater than 5 mG per second** (10 mG for UltraShield magnets, 50 mG for UltraShield Plus magnets), NMR performance may be affected.

Table 12.1. lists the minimum distances between the source of interference and the magnet center.

Table 12.1. Minimum Distances from Electromagnetic Interference Sources.

Source of Interference	Recommended Minimum Distance from UltraShield Magnet	Recommended Minimum Distance from UltraShield PLUS Magnet
DC Trams, subways*	100 m	80 m
Elevators, fork-lifts**	8 m	6 m
Mass spectrometer (slow ramp)	10 m	8 m
Mass spectrometer (sudden fly-back)	30 m	24 m

* **Trams and subways are also a source of vibrational interference** (refer to section ***"Vibrations" on page 61***).
** Depends on the lift geometry and material. These specifications may vary.

16-2/3 Hz and 50/60 Hz Interference 12.2

Interference from 16-2/3 Hz generally comes from modern electric trains and/or streetcars that run at 16-2/3 Hz. Likewise, interference from 50/60 Hz generally comes from electrical wiring, transformers and fluorescent lights in the magnet system area. The magnetic field further modulates thess interferences, increasing the likelihood of disturbances.

Measuring 16-2/3 Hz and 50/60 Hz Fluctuating Fields 12.2.1

16-2/3 and 50/60 Hz EMF measurements should be conducted in the proposed NMR room with power lines active using a hand-held meter. Specific locations that must be checked include:

- Magnet area.
- Console area.
- Along the walll inside the NMR room at 5 cm (~2“) from the wall, and 10 cm (4“) from the war.
- Approximately 5 cm (~2“) below existing lights in the room.
- Near the main outlets 230V (USA - 208V) locations in the room.

Reducing 16-2/3 Hz and 50/60 Hz Interference 12.2.2

The general goal of reducing 16-2/3 and 50/60 Hz interference is to shield the source of the interference from the magnet system. Soft iron has been found to be effective in reflecting this interference, and thus providing an effective shield for the magnet. Bruker provides planning for shielding using various metals and shielding techniques, please contact your Bruker office for further information.

Guidelines: 16-2/3 Hz and 50/60 Hz Interference 12.2.3

The amplitude threshold for causing interference is approx. 200 nT (2 mG RMS) for unshielded magnets and 500 nT for shielded magnets, based on laboratory tests. Thus, acceptable limits must be well below this whenever possible.

The magnet must not be placed within a 6.1 m (20’) radius of a normally-sized transformer. If there is a large transformer adjacent to the proposed magnet location, measurements will be required to determine if the transformer will adversely affect NMR spectra.

The magnet must also not be placed directly under fluorescent lights, which may cause some 50/60 Hz EMF, and more importantly may switch off temporarily during a quench.

RF Interference 12.3

The NMR instrument is effectively a very sensitive radio frequency receiver. Possible sources of interference are local radio or television broadcasts, low Earth orbit satellite systems, and signals emitted by personal paging systems. Of particular concern will be interference at frequencies at which NMR experiments are carried out. 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 kilometers (3 miles) are likely sources of interference.

RF interference may also occur between two or more spectrometers located in close proximity and operating at the same nominal 1H resonance frequency.

Measuring RF Fluctuating Fields 12.3.1

Radio Frequency interference measurements should be conducted using a **spectrum analyzer**. The analysis should be done for the resonance frequency of each of the nuclei of interest (proportional to the 1H resonance frequency of the spectrometer). The minimum frequency sweep is 400 kHz. Any peaks with RF fields above -80 dBm should be recorded, as well as any broad frequency ranges with any level of RF signals.

Table 12.2. contains a list of the most common studied nuclei at the corresponding frequencies for the 200-700 MHz NMR systems.

Table 12.2. List of Commonly Studied Nuclei and Corresponding Resonance Frequencies

Nuclei		NMR Frequency (MHz)				
1H	200.000	300.000	400.000	500.000	600.000	700.000
2H	30.701	46.072	61.422	76.773	92.124	107.474
11B	64.167	96.294	128.378	160.462	192.546	224.630
13C	50.288	75.468	100.613	125.758	150.903	176.048
15N	20.265	30.423	40.560	50.697	60.834	70.971
19F	188.154	282.404	376.498	470.592	564.686	658.780
27AI	52.114	78.204	104.261	130.318	156.375	182.432
29SI	39.730	59.627	79.495	99.362	119.229	139.096
31P	80.961	121.495	161.976	202.456	242.937	283.418

Reducing RF Interference 12.3.2

Screening a site for possible RF Interference is complicated and expensive. Shielding of the NMR room with a Faraday cage is a possible solution, though having to take such measures is quite rare.

When designing and manufacturing the Bruker BioSpin spectrometers, care is taken to provide adequate shielding and the instruments rarely suffer from interference in normal RF environments. Furthermore, the advanced BSMS digital lock system - included with all Bruker BioSpin AVANCE spectrometers - allows a shift in the 2H lock frequency with certain limits. This may allow enough variation in the absolute magnet field strength to shift the NMR signal away from that of local broadcasting frequencies.

RF interference may occur between two or more spectrometers located in close proximity and operating at the same nominal 1H resonance frequency. These problems can be avoided by energizing the different magnets at slightly different fields, such that their operational frequencies are separated by ~ 200 kHz of the nominal 1H resonance frequency.

Guidelines: RF Interference 12.3.3

As a general guideline the level of any RF interference must be less than an electrical field strength of -65 dBm at the side of the magnet. However, past experience has shown that broadband RF fields having smaller intensity (about -80dBm) may interfere with the NMR experiments. Therefore, it is important to make a note of any measurements exceeding -80 dBm.

Checklist for EMF Interference 12.4

Determine if any trains, subways, trams or associated DC power lines are present within 150 meters distance from the magnet center.	
Determine if any mass spectrometers are located in the room or adjacent spaces.	
Measure DC EMF with fluxgate magnetometer.	
Determine if any large transformers, AC power lines, or powerful lighting is in close proximity to the magnet location.	
Measure AC EMF.	
Determine if any TV/Radio stations, celllar phone towers and antennas, or other possible sources of RF are in the building or within a radius of 5 kilometers.	
Determine if any other NMR or MRI systems present operating at the same frequency.	

Cryogens & Magnet Maintenance 13

Superconducting magnets use liquid helium and nitrogen as cooling agents, keeping the magnet core at a very low temperature. The safe handling of cryogenic liquids requires some knowledge of the physical properties of these liquids, common sense, and sufficient understanding to predict the reactions of such liquids under certain physical conditions.

General Properties of Cryogenic Substances *13.1*

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) is produced within a short time. Windows and doors are sufficient for ventilation even after a quench, but the NMR magnet system must never be in an airtight room.

Note that a quench may set off **fire alarms**. The fire department should be notified accordingly. The fire department must also be informed that during a quench water must 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 (see ***"Emergency Planning" on page 129***).

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

Do not use cryogens that have been stored in high pressure containers for cryogenic liquids! Failure to do this could present an explosive hazard for the magnet system and could lead to severe damage.

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

Table 13.1. Table of Properties of Cryogenic Substances

Properties	Nitrogen	Helium
Molecular weight.	28	4
Normal boiling point [°C / °K].	-196 / 77	-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
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

Introduction to Magnet Maintenance 13.2

Refilling of cryogens is the only regular maintenance required by the magnet. Ensuring **adequate safety procedures** when handling cryogens must be taken into account at the site planning stage.

When refilling the cryogen levels, large dewars must be brought close to the magnet. Ensure that the magnet room is suitably spacious to allow easy access for the dewars. If a platform is not used then there must also be enough room for a ladder. As a rule of thumb the magnet must be accessible to a distance of 2 m over at least half of its circumference and be no closer than 0.77 m to the nearest wall.

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 BioSpin.

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 croyogens and cryogen filling procedures.

Storage of Cryogenic Liquids *13.3*

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. It is highly recommended that an **Oxygen Level Sensor** be used.

Liquid Helium

Liquid helium is the coldest of all cryogenic liquids, therefore it will 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. The 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 *13.3.1*

In most cases only a cylinder of helium is required, however in rare cases when a self-pressurized dewar is not available a nitrogen cylinder may also be used:

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

The minimum purity of gases should be 99.99%.

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 G). If the cylinders are located in the same room as the magnet, they must be **strapped to the wall**!

It is important that the 2 stage regulator 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 13.3.2

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. Special attention is required for the **transportation of cryogens by elevator** (no one should be allowed to be in the elevator with a cryogen dewar).

Liquid Nitrogen Dewar

Various transport dewars are available, with capacities ranging from 50-240 liters. The dewar should be of the **low pressure type** for liquid withdraw only. **Do not use high pressure** „gas packs" (note: high pressure dewars can be used, if nothing else is available, if they are first slowly depressurized). The dewar should have a fixture for pressurizing and transferring via rubber hose (10 mm inner diameter). Where possible the dewar should be self pressurizing. The correct transport dewar pressure for transferring liquid nitrogen is 0.35 bar (5 psi).

Maximum transfer pressure:

Typical: 0.10 - 0.20 bar (1-3 psi)

Maximum: 0.35 bar (5 psi).

Liquid Helium Dewar

A 60 liter or 100 liter stainless steel transport dewar are the most convenient. The dewar outlet must be compatible with the helium transfer line (outer diameter of 9.6 mm, 3/8 inch or 12.7 mm, 1/2 inch depending on the magnet) or with the **NW25 adapter** that is supplied.

Helium Gas Recovery System 13.4

When a Helium Gas Recovery System (HGRS) is used it is possible that enough pressure builds, setting off the quench valves. To prevent this from happening an overpressure valve should be used near the magnet. The backpressure must not exceed 80 mbar.

Checklist for Cryogens and Refilling 13.5

Determine if adequate ceiling height is available for the refill transfer line.	
Determine if adequate magnet access is available for refilling.	
Ensure adequate ventilation has been provided.	
Ensure the magnet will not be located in direct sunlight or near heat sources.	
Determine storage requirements for dewars, gases and other accessories.	
Ensure that the local supply of cryogens is reliable.	

Utility Requirements

14

Electrical Power Requirements 14.1

When planning the electrical power requirements of your site make provision for extra equipment which you may install, e.g. Personal Computers, workstations, air conditioning systems, etc.

Each AVANCE™ cabinet (except NanoBay) comes supplied with four spare electrical outlets (230V/10A) which can be used to power standard ancillary equipment. Two outlets are designed to power the NMR Workstation and Imaging cabinet (optional). This leaves two spare outlets for accessories such as the Automatic Sample Changer etc. ***Table 14.1.*** lists the power requirements of other equipment which, because of their large power consumption, require power sources separate to that of the AVANCE™ cabinet.

Other Power Requirement Considerations

- For **installation** of the AVANCE™ system a 230V / 16A outlet is needed for the turbo-pumps, as well as an additional 230V / 16A outlet for the magnet power supply (during installation and service).
- A TwoBay with **Solid Accessory** 600/700 MHz can be approximated to a standard TwoBay plus High Power cabinet and so the total power requirements is 9.6 kW.
- The power requirements for the **CP-MAS** will depend on the amplifiers that are used. The control unit itself will not use more than 100W.
- If line voltage fluctuations exceed -5% to +10% a **voltage stabilizer** must be used. The lifetime of the various electrical components in the spectrometer will also be lengthened when a voltage stabilizer is used. Contact your local Bruker BioSpin office for more information on voltage stabilizers.
- 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.
- The power supply to the spectrometer must be "**clean**" (no spikes), i.e. it must not share with air conditioners, compressors, etc.
- All **grounding** for mains in the lab must be connected together to avoid differences in earth potential.
- 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™ series spectrometer then they must be rated at 100 mA. The lower value of 30 mA commonly used is too sensitive for these spectrometers.

Table 14.1. Power Requirements of Basic System (2 Channels)

System and Amplifiers	Mains Supply	Power Consumption (kW) *	No. of Spare Electrical Outlets	Length of Mains Cable (m)
TwoBay with BLARH100 + BLAX300	230V 50/60 Hz / 16A single phase; or 208V 60 Hz / 20A single phase in USA	2.6	4 (230V max. 10 amp.)	5.5
TwoBay with BLAXH300/50	230V 50/60 Hz / 16A single phase; or 208V 60 Hz / 20A single phase in USA	2.2 9.6	4 (230V max. 10 amp.)	5.5
TwoBay optimized for solids 300 to 700 MHz	230V 50/60 Hz / 32A single phase or 400V 50/60 Hz / 16A triple phase; or 208V 60 Hz / 32A single phase in USA	9.6	4 (230V max. 10 amp.)	5.5
OneBay with BLAXH100/50	230V 50/60 Hz / 16A single phase; or 208V 60 Hz / 20A single phase in USA	1.6 2.2	4 (230V max. 10 amp.)	5.5
MicroBay with BLA2BB	230V 50/60 Hz / 16A single phase; or 208V 60 Hz / 20A single phase in USA	1.2 1.6	4 (230V max. 10 amp.)2	5.5
NanoBay	230V 50/60 Hz / 16A single phase; or 208V 60 Hz / 20A single phase in USA	1.0	---	5.5
Imaging Cabinet	230V 50/60 Hz / 32A single phase or 400V 50/60 Hz / 16A triple phase; or 208V 60 Hz / 30A single phase in USA	2.4	---	---
Bayvoltex Chiller for MicroImaging Systems	230V 50/60 Hz / 16A single phase or 208V 60 Hz / 20A single phase in USA	approx. 0.45 kW	---	---
BCU 05/BCUX	230V 50/60 Hz / 16A single phase or 208V 60 Hz / 20A single phase in USA (power for BCUX must come from separate outlet)	0.45 kW (BCU 05) 2.3 kW (BCUX)	---	---
CryoCooling Unit**	230V 50/60 Hz / 16A single phase or 230V 50/60 Hz / 20A single phase in USA (requires step-up transformer) (do not use power from AVANCE)	0.5 kW average 1.5 kW peak	---	10
He Compressor	400V 50 Hz / 12A triple phase or 208V 60A / three phase, 5 wire in USA	7.5 kW average 8.3 kW peak	---	

Table 14.1. Power Requirements of Basic System (2 Channels)

System and Amplifiers	Mains Supply	Power Consumption (kW) *	No. of Spare Electrical Outlets	Length of Mains Cable (m)
UPS for Cryo-Cooling Unit**	UPS requirements: 500W for CryoCooling Unit and at least 2.6 kW for the spectrometer cabinet (depends on configuration). The battery time must be selected according to the maximum duration anticipated for a power failure.			
UPS for AVANCE Spectrometer Cabinet				
* Includes the NMR workstation and computer 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. ** Refer to the **CryoProbe System Site Planning Guide** for more information. - 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).				

Compressed Gas Requirements — *14.2*

General Requirements

Compressed gas line: The standard AVANCE system requires one compressed gas line with two regulated outputs. Two additional secondary connectors are preferred.

Regulators: Watts Regulator R119-03C (Watts Fluid Air Company), pressure range 0-8.6 bar (0 - 125 psi), with gage head included.

- Compressed nitrogen gas needed for temperature control with VT experiments in order to achieve optimal NMR performance. The BCU-05 cooling unit requires a DEW point of -51°C (-60°F) for the compressed gas.
- Compressed air or nitrogen gas for spinning.
- Compressed air or nitrogen gas for sample ejection, and for the magnet's vibration isolation units.
- Compressed air or nitrogen gas for the optional CryoProbe system.

Table 14.2. Compressed Gas Requirements

System	Operating Pressure (bar)	Average Consumption (l/min*)	Recommended Minimum Air Supply after Dryer (l/min*)
AVANCE	6-8	45	57
AVANCE + SampleJet	6-8	100***	100
AVANCE + BACS Sample Changer	6-8	52	57
AVANCE + MAS (DB **, 5 kHz/7 mm)	6-8	220	300
AVANCE + NMR CASE	6-8	52	57
AVANCE + SampleRail	6-8	> 52***	100
AVANCE + Gilson	6-8	46	57
Vibration Isolation Units	5-8	3	3
LCNMR/MS	Please refer to the LCNMR/MS Site Planning Manual		
CryoCooling Unit	Please refer to the CryoProbe Site Planning Manual		
Note: 1 bar = 10^5 Pascal (Pa) * At atmospheric pressure ** DB= Double Bearing *** Estimate - exact consumption was not available when this publication was written. + Operating pressure after dryer must be at least 5 bar.			

Compressed Gas Options 14.2.1

Option 1 (preferred for 500 MHz and up)

- Nitrogen gas for everything: 57 l/min. (2 scfm) for non-MAS experiments, or 227 l/min. (8 scfm) for MAS experiments. The pressure must be 6-8 bar (80-120 psi).

Option 2 (good for 500 MHz and up where spinning is common)

- Nitrogen gas for VT work and sample spinning (cannot be provided by a N2 separator).
- Compressed air: 57 l/min. (2 scfm) for lifting pneumatic dampers.
- N2 gas: 57 l/min. (2 scfm) for spinning and VT work.

Option 3 (good for 500 MHz and up where spinning is not common)

- Nitrogen gas for VT work (can be provided by a N2 separator): ~28 l/min. (1 scfm)
- Compressed air: 57 l/min. (2 scfm) for lifting, spinning, and pneumatic dampers.

Option 4 (good for lower-field instruments: 300-400 MHz)

- Compressed air for lifting, spinning, pneumatic dampers and VT work: 85 l/min. (3 scfm) at 4-8 bar (60-120 psi).

Note:

A **nitrogen separator** (supplied by Bruker BioSpin) can be built into the AVANCE cabinet if N2 gas is required (e.g. VT work) and only dry air is available. However, this is not suitable for larger flow rates required by MAS experiments.

The nitrogen separator is suitable for use with the BCU-05 cooling unit. However the nitrogen output from the separator is not pure enough and this unit must not be used with a N2 exchanger or BCU-X cooling unit for low temperature work.

Gas Requirements For Accessories 14.2.2

- If use of a Bruker Automatic Sample Changer (BACS) in high throughput mode is planned, a secondary regulator, T-split from the supply line, is recommended.
- For MAS (Double Bearing) a second regulator is mandatory. Make sure the supply line cross-section is sufficient to deliver the necessary volume at the required pressure.
- If a CryoCooling unit is to be installed, a secondary regulator, T-split from the supply line is recommended.
- If the Emergency Sample Protection Device is to be used in conjunction with the CryoProbe System, a cylinder of air or nitrogen gas is required.

Compressed Gas Specifications 14.2.3

Oil Content

< 0.005 ppm (0.005 mg/m^3)

Water Content

For the BCU05 cooling unit the compressed gas must have a DEW Point of -51°C (–60°F). For the BCU-X cooling unit, the DEW Point requirement is -100°C (-148°F).

For room temperature work and higher: DEW Point of < 4°C (39.2°F)

For low temperature work: The DEW Point must be at least 20°C (68°F) below the operating temperature.

If a cooling unit is used, then the DEW Point of the compressed nitrogen must be at least 10°C (50°F) below the temperature at the heat exchanger output.

Solid Impurities

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

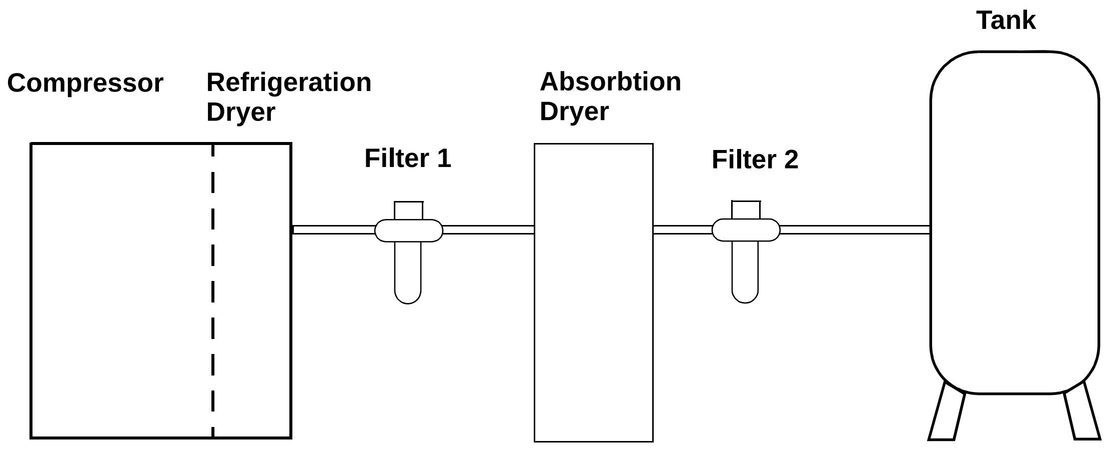
Compressed Air System 14.3

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

1. To prevent magnetic impurities from entering the magnet use only copper or stainless steel 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** must 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.

Figure 14.1. Example of a Typical Dryer/Filter System Setup



Filter 1: General purpose liquid and dust removal filter (0.1 mg/m^3 - 0.1 ppm, 1 micron)

Filter 2: High-efficiency dust, liquid and aeresol filter (0.1 mg/m^3 - 0.01 ppm, 1 micron)

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

Compressors 14.3.1

When installing a compressor the following points should be considered:

- The compressor must be installed in a **dust free**, cool and dry place.
- The compressor must be **oil-free**, e.g. use aTeflon coated scroll membrane or Teflon coated piston compressor and fit the compressor with a fine dust inlet filter.
- The compressor must be capable of delivering the **required flow rate** and pressure suited to your particular system (see ***Table 14.2.***).
- Take into account the pressure loss along the line between the compressor and the final gate valve. The pressure drop depends on the pipe diameters.
- Some types of dryers, e.g., absorption dryers can use up to 25% of the air flow to regenerate the drying material. If this type of dryer is used then the output capacity of the compressor must be sufficient to supply this requirement.
- Many compressors are fitted with dryer and a tray to collect excess water.In areas of higher humidity (> 80%) a cooling coil with an *automatic* water drain must be fitted to the compressor outlet.
- Consider using a compressor fitted with a vibration damping housing if it is to be situated close to the spectrometer. The output noise level must be < 75 dBA.
- Some compressor systems, such as those supplied by Bruker BioSpin, may be purchased with integrated filters and dryers.

Refrigeration Dryers 14.3.2

This type of dryer removes moisture from gas by cooling to within a few degrees of the freezing point of water. The condensed moisture is removed in a separator and drain trap mechanism located immediately downstream of the dryer. This drain should be valve switched automatically.

Advantages

- None of the compressed gas is wasted in regeneration which is more suitable if the capacity of the compressor is marginal.
- Maintenance free.
- Not as susceptible to oil mist contamination as adsorption dryers, thus do not have the same need for pre-filters.

Disadvantage

- These type of dryers are limited because of their inability to produce very low dew points. The recommended dew point for room temperature work of 4°C is only just achievable. Therefore if low temperature NMR is to be carried out, this type of dryer is unsuitable.

Absorption Dryers 14.3.3

The air is passed through cartridges of synthetic zeolite known as Molecular Sieves. The sieves are hygroscopic and retain water molecules when air is passed through them. Two sieves are normally used alternatively. A portion of the dry air output of sieve A is fed into sieve B to regenerate it. The amount used in regeneration is typically 15% but up to 25% may be required for very low dew-points.The process is automatically reversed at regular intervals with the output of sieve B used to regenerate sieve A.

Advantages

- Much lower dew points are achievable compared to refrigeration dryers.
- Automatic Regeneration: Normally the sieves will last for many years if they do not become contaminated with oil, e.g. from mist in the air.
- The drying agent may be easily replaced.

Disadvantages

- Up to 25% of throughput is used to achieve the automatic regeneration.
- Requires the use of more dust filters.
- Filters at the input (oil < 0.01 mg/m^3) are required due to the susceptibility to oil contamination from mist in the air.
- The use of absorption dryers may lead to the generation of dust and so the dried air output must be fed through an appropriate filter (1 micron).
- These dryers require more maintenance than refrigeration dryers.
- They can be noisy when switching between the two cartridges
- Due to the different absorption rates of nitrogen and oxygen the **N2/O2 composition** may change. To prevent this an absorption dryer should be placed between the compressor and buffer tank.

Filters 14.3.4

Micro-filters must be fitted as the last element in the supply line. For specification see the section ***"Compressed Gas Specifications" on page 79***.

Absorption dryers are prone to oil contamination and as such the input must be fitted with a oil filter (oil < 0.01 mg/m^3 99.9% removal efficiency). To protect the dryers, regardless of type, you are advised to install a water filter and an oil filter between the compressor and the dryer. Adsorption dryers may generate dust and may need extra dust filters at the output.

The output of refrigeration dryers must be fed through a carbon activated filter.

Water filters must be fitted with automatic water drains as opposed to manual drains. The use of valve switched drains is strongly recommended. Floater switched drains have a tendency to become jammed and hence require regular maintenance.

If you are particularly concerned about oil contamination in the air supply then you must consider using a submicron filter followed by an activated charcoal filter as this combination is particularly effective in removing oil.

Water *14.4*

If the system is equipped with the CryoProbe option and the compressor is water cooled, then cooling water is needed to remove the ca. 7.5 kW of heat output from the water-cooled type He compressor used in conjunction with the CryoProbe.

The cooling water requirements are found in the **CryoProbe Site Planning Guide**, which is available from your local Bruker Representative.

Lighting *14.5*

Operation is most convenient when the computer monitor(s) may be viewed under subdued lighting. However, normal office lighting will 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 must also be taken to minimize reflections from sources such as windows.

- Please do not direct spotlights toward the magnet; this could change the surface temperature.
- Consideration must be given to the relative placement of lights to the air conditioning inputs, which mostly contain the temperature sensors for the air conditioners. Otherwise the switching of lights might result in a system over-reaction and a considerable temperature change.
- Lights are generally not recommended within a radius of 3m (~10') from the magnet.
- Florescent lighting must be located **at least 2.5 m away** from the area considered for the magnet.

Checklist for Utility Requirements *14.6*

Provision must be made for any additional electrical power requirements for extra equipment that will be installed.	
Additional electrical outlets are required for the turbo-pumps and the magnet power supply during installation and service.	
A voltage stabilizer must be available if line voltage fluctuations exceed -5% to + 10%.	
An UPS should be considered if power outages are frequent.	
The power supply to the spectrometer should be clean.	
A minimum of one compressed gas line with two regulated outputs must be available.	
Provision must be made for the gas requirements of any accessories used.	
Compressors, dryers and filters must meet the standards outlined in this manual.	
The placement of lighting must be regarded in reference to the location of the magnet.	

Installation 15

All the general requirements such as power supply, compressed air supply, etc. which were discussed in the preceding chapters must first be arranged before taking delivery of the system. It must be stressed that any installation requirements listed below such as cryogen supplies, are ***in addition*** to those needed for normal system operation.

Where necessary the customer is advised to contact the local Port Authorities to clarify arrangements for custom clearance. If the transport crates must be opened you must first contact Bruker, as the crates are shipped utilizing Shockwatch^{TM} and Tiltwatch^{TM}. Failure to do this may invalidate the warranty. If the transport crates are opened for any reason they must then be stored indoors (out of direct sunlight).

Overview 15.1

The spectrometer will arrive at the site in crates. The crates must not be uncrated as this must be assembled by a Bruker BioSpin engineer. The commissioning of the magnet involves several stages as outlined in ***Table 15.1.***. The precise duration of the various stages will depend on the size of the magnet.

Table 15.1. Overview of Magnet Commissioning

Duration	Procedure
ca. 3-8 hours	Transport fixtures are removed. Cryostat is assembled.
2-4 days	The magnet is evacuated and flushed through with nitrogen.
1-3 days	Cool down of the magnet with liquid nitrogen.
1 day	Cool down of the magnet with liquid helium.
1-2 days	Charging of the magnet.
1 day	Cryo-shimming of the magnet.

Accessibility 15.2

Before delivery you must ensure that the equipment can be transported to the NMR site. ***Table 4.2.*** lists the crate sizes of various systems and magnets. Ensure that doorways, passageways and lifts have sufficient clearance. Extra large doorways are required for the larger magnets. Ensure that adequate lifting equipment such as forklifts or hydraulic pallet jacks are available.

Installation Procedures 15.3

The following sections will address some of the details of the various steps outlined in ***Table 15.1.***.

Magnet Assembly 15.3.1

When the magnet is delivered (do not uncrate it!) it must first be assembled by the installation engineer. The assembly area must be clean, dry and free of dust.

The assembly may require that the engineer works beneath the magnet and thus special rigging equipment is required.

Refer to ***"Considerations for Assembling the Magnet" on page 23*** for special equipment requirements for assembly.

Magnet Evacuation and Flushing with Nitrogen gas. 15.3.2

Once the magnet has been assembled and placed in the magnet room, rough pumping of the cryostat can begin. At the same time the cryostat is flushed through with dry Nitrogen gas. The customer **must** provide a 50l/200 bar cylinder of dry Nitrogen gas (99.99% purity). The cylinder must be fitted with a secondary regulator value to deliver a pressure of 0.5 bar, see the section ***"Cylinders" on page 73***. For some installations the customer is asked to provide a roughing pump, e.g. rotary pump capable of reducing pressures within the cryostat to 10^{-2} mB.

Further pumping of the cryostat is then carried out to reduce the internal pressure to 10^{-6} mB. It is convenient, particularly for foreign installations, if the customer can provide a suitable pump such as a diffusion or turbo pump. If such a pump is available the customer must contact Bruker BioSpin to confirm its suitability. Where no such pump is available then it will be supplied by Bruker BioSpin.

Cooling the Magnet to Liquid Nitrogen Temperatures 15.3.3

This next stage involves filling the magnet with liquid Nitrogen. The quantity of liquid nitrogen required is listed in column 3 of ***Table 15.2.***. To transfer the nitrogen a transport dewar is required. This must have a minimum volume of 50l with fixture for pressurizing and transferring via a rubber hose of 10 mm diameter, refer to the section ***"Dewars" on page 74***.

Cooling the Magnet to Liquid Helium Temperatures — *15.3.4*

For this procedure the customer must provide:

- One cylinder of helium gas: 50l / 200bar (99.996% purity) with secondary regulator value to deliver pressure of max 0.2 bar (see ***Table 5.2.***).
- Quantities of liquid helium as specified in column 4 ***Table 15.2.***.
- Liquid Helium dewar:

  Bruker Magnets: 50l, 100l or 250l. Type SHS with NW25 flange or suitable outlet compatible with the 9.6 mm helium transfer line.

When ordering the helium the customer must arrange to have it delivered immediately before the installation. Otherwise losses due to evaporation must be taken into account.

Charging the Magnet — *15.3.5*

The final stage involves bringing the magnet to field. This will take 1-2 days depending upon the magnet. During the charging there is a possibility that the magnet may quench. The quantities of liquid helium specified in column 5 of ***Table 15.2.*** allow enough for one quench. It is important that the customer ensures that, if required, extra supplies of liquid helium are available.

To determine the required amounts of liquid cryogens on-site:

- Liquid Nitrogen: ***Table 15.2.*** shows the minimum requirements amount to cool the magnet. It is advisable to order 20-30% more than what is listed in the table, especially if the lab is located in an area where liquid nitrogen is difficult to obtain.
- Liquid Helium: ***Table 15.2.*** shows two columns. The minimum amount of helium that must be on-site at installation is the sum of the cooldown and the amount of LHe required after a quench. Additionally, it is advisable to order 20-30% more, especially if the lab is located in an area where liquid nitrogen is difficult to obtain.

Note: Many suppliers will buy back any unused cryogens!

Table 15.2. Crogenic Requirements During Installation for a Range of Magnets

Magnet Type	Magnet Weight Empty with Stand (kg)	Magnet Weight Filled with Magnet Stand (kg)	Liquid Nitrogen for Cool down (l)	Liquid Helium for Cool down (l)*	Liquid Helium Required after Quench (l)
200 MHz/154 mm US PLUS LH	~ 750	~ 850	600	400	150
300 MHz/54 mm US LH	242	292	150	150	50
300 MHz/54 mm US ULH	298	379	250	250	100
300 MHz/89 mm US WB LH	375	452	300	300	150
300 MHz/154 mm US PLUS LH	~ 750	~ 850	600	400	150
400 MHz/54 mm US PLUS LH	510	596	300	300	100
400 MHz/54 mm US PLUS ULH	524	644	600	400	150
400 MHz/54 mm US LH	360	438	300	300	100
400 MHz/54 mm US ULH	383	480	350	350	150
400 MHz/89 mm US PLUS LH	683	798	600	400	150
400 MHz/154 mm US PLUS LH	~ 1200	~ 1400	750	750	350
500 MHz/54 mm US PLUS LH	675	791	600	400	150
500 MHz/54 mm US PLUS ULH	895	1114	600	400	150
500 MHz/54 mm US LH	648	749	400	400	150
500 MHz/89 mm US PLUS LH	1165	1377	750	750	350
500 MHz/89 mm US LH	1520	1700	700	600	400
500 MHz/154 mm US PLUS LH	~ 1850	~ 2120	700	600	400
600 MHz/54 mm US PLUS LH	1200	1409	750	750	350
600 MHz/54 mm US LH	1150	1300	800	600	250
600 MHz/89 mm US PLUS LH	~ 1850	2120	700	600	400
600 MHz/89 mm US LH	2285	2675	1500	1400	600
700 MH7/54 mm US PLUS LH	~ 1620	~ 1890	850	600	400
700 MHz/54 mm US LH	2663	3040	1700	1600	700
700 MHz/89 mm US PLUS LH	2655	3029	1700	1600	700

LH = Long Hold, ULH = Ultra Long Hold, US = UltraShield™

* This number is the volume of LHe for cool-down, energization, and top-off without any quenches.

Checklist of Installation Requirements *15.4*

For the installation the customer must provide the following:	
Lifting equipment and minimum ceiling heights as outlined in ***Table 5.2.***. On request Bruker can provide an A-frame for installation.	
One cylinder of nitrogen gas (identical to that described in section ***13.3.1***).	
One cylinder of helium gas (identical to that described in section ***13.3.1***).	
Quantities of liquid helium and nitrogen as specified in ***Table 15.2.***.	
Liquid helium and nitrogen transport dewars (identical to those described in section ***13.3.2***).	
Three power sockets (230V/50 Hz / 16A single phase or 208V 60 Hz / 20A single phase in USA). These will be used to run a vacuum pump, a heat gun and a power supply unit. These power outlets must be available **in addition** to the power source used to run the spectrometer. Since they are only required during installation they may be installed temporarily.	
Step ladder (non magnetic, e.g. aluminium or wood).	
Where possible the customer should provide a heat gun or powerful handheld hair dryer (min. 800 W), a roughing pump (10^{-2} mbar) and a pair of insulated gloves.	

Sample Room Layouts

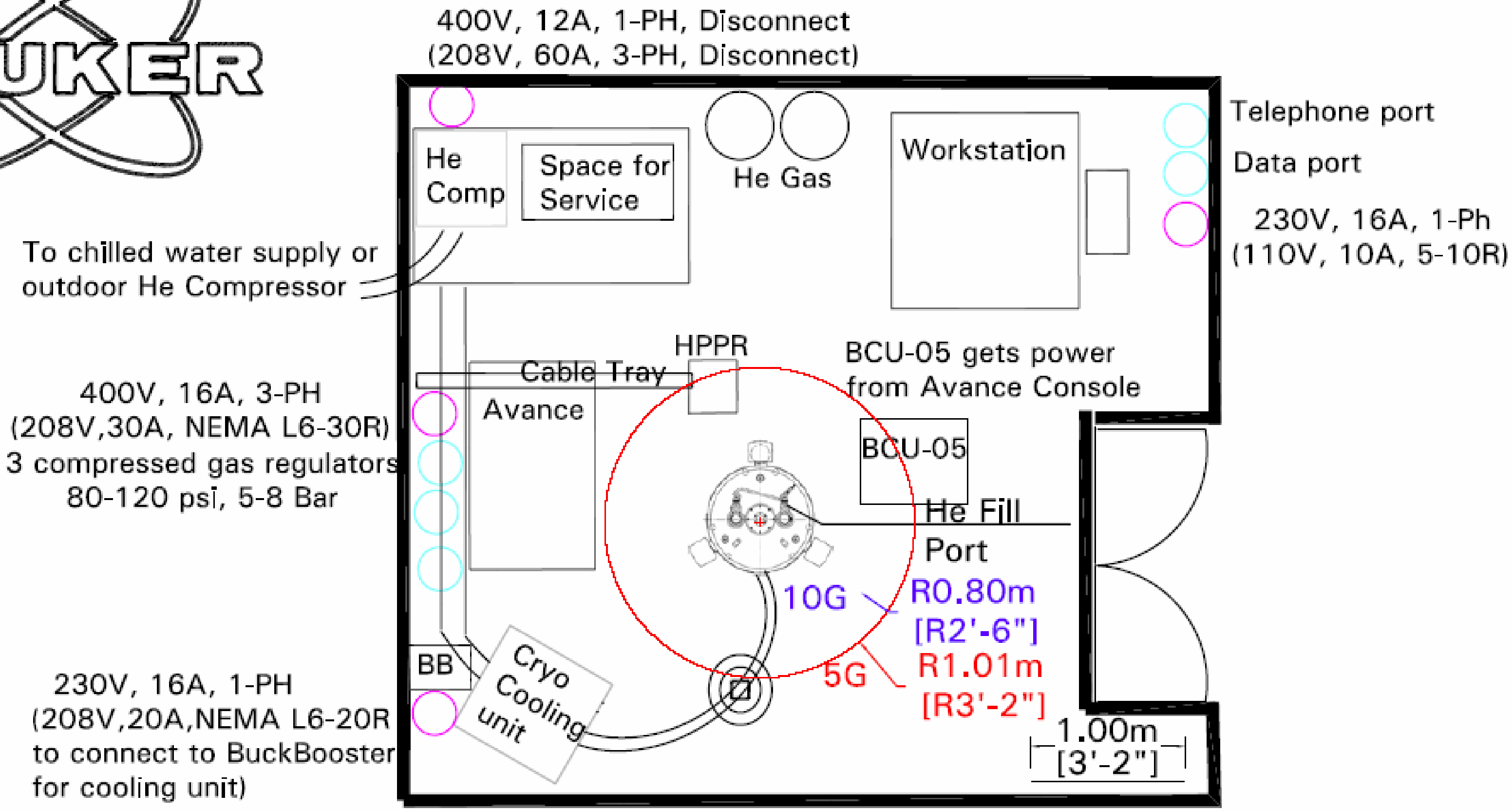
A

Introduction A.1

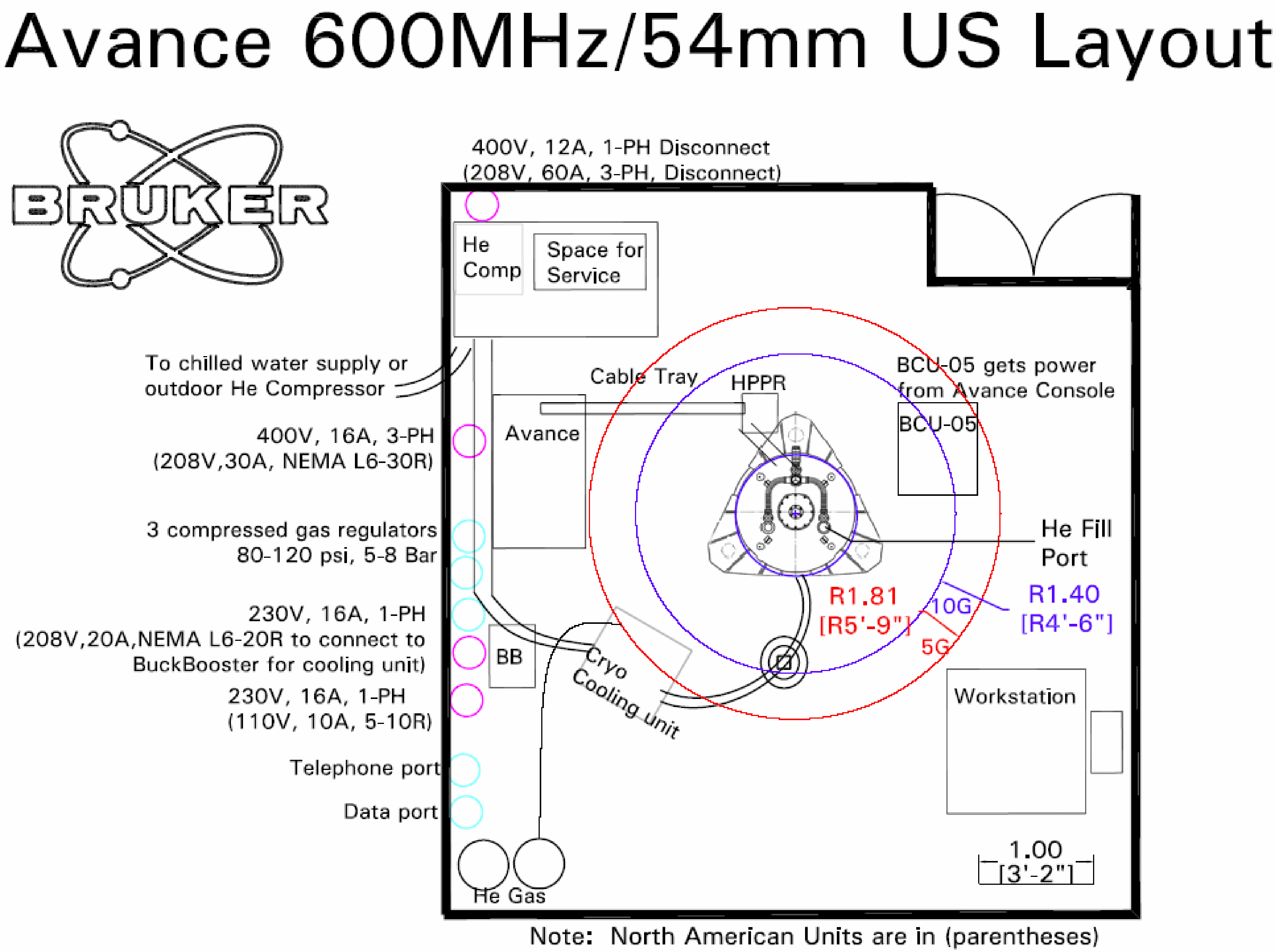
The following drawings illustrate some general layouts for basic AVANCE systems. Please understand that these are only examples, an individual room layout will dependent on a variety of factors that were outlined throughout this manual, as well as an individual buildings characteristics and layout. These examples, along with the chapter ***"Room Layout" on page 41***, should form a basis for planning your own individual layout. If you have further questions, or require assistance please contact your nearest Bruker sales representative.

If a CryoProbe System is planned, be sure to refer to the CyroProbe System Sight Planning Guide for specific information on CryoProbe site requirements.

Avance 400MHz/54mm US Layout



NOTE: North American Units are in (parentheses)


Avance 600MHz/54mm US Layout
BRUKER
400V, 12A, 1-PH Disconnect
(208V, 60A, 3-PH, Disconnect)
He Comp
Space for Service
To chilled water supply or outdoor He Compressor
400V, 16A, 3-PH
(208V,30A, NEMA L6-30R)
3 compressed gas regulators
80-120 psi, 5-8 Bar
230V, 16A, 1-PH
(208V,20A,NEMA L6-20R to connect to BuckBooster for cooling unit)
230V, 16A, 1-PH
(110V, 10A, 5-10R)
Telephone port
Data port
Cable Tray
HPPR
Avance
BCU-05 gets power from Avance Console
BCU-05
He Fill Port
R1.81
[R5'-9"]
10G
5G
R1.40
[R4'-6"]
BB
Cryo Cooling unit
Workstation
1.00
[3'-2"]
He Gas
Note: North American Units are in (parentheses)

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End of Document

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Bruker BioSpin provides a world class, market-leading range of analysis solutions for your life and materials science needs.

Our ongoing efforts and considerable investment in research and development illustrates our long-term commitment to technological innovation on behalf of our customers. With more than 40 years of experience meeting the professional scientific sector's needs across a range of disciplines, Bruker BioSpin has built an enviable rapport with the scientific community and various specialist fields through understanding specific demand, and providing attentive and responsive service.

Our solution-oriented approach enables us to work closely with you to further establish your specific needs and determine the relevant solution package from our comprehensive range, or even collaborate with you on new developments.

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