Cryogenic System Site Requirements

Varian, Inc. NMR Cryogenic Systems

Pub. No. 01-999267-00, Rev. B0905

NOTICE: This document contains references to Varian. Please note that Varian, Inc. is now part of Agilent Technologies. For more information, go to **www.agilent.com/chem.**

Agilent Technologies

Cryogenic System Site Requirements

Varian, Inc. NMR Cryogenic Systems

Pub. No. 01-999267-00, Rev. B0905

VARIAN

Cryogenic System Site Requirements
Varian, Inc. NMR Cryogenic Systems
Pub. No. 01-999267-00, Rev. B0905

Revision History:
Initial Release A0404
B0905– change the CryoBay to CCC distance to 25ft. (7.5 m)

Applicability of manual:
INOVA NMR systems

Technical contributor: Peter Lukens, Layne Howard, Susan Klein,
Judit Losonczi, Jeff Germenis
Technical editor and writer: Everett Schreiber

3120 Hansen Way, Palo Alto, California 94304
1-800-356-4437
http://www.varianinc.com

Table of Contents

Chapter 1. Introduction

A Varian Cryogenic system consists of a Cold Probe and closed-cycle cryogenic system:

- “Varian, Inc. Cold Probe,” next
- “Closed-Cycle Cryogenic System” on page 4

The cryogenic system circulates cold He gas to maintain key probe components at an operating temperature of approximately 25 Kelvin.

1.1 Varian, Inc. Cold Probe

Varian, Inc. Cold Probes (Figure 1) achieve significant gains in sensitivity through the application of advanced cryogenic technologies to cool key probe components.

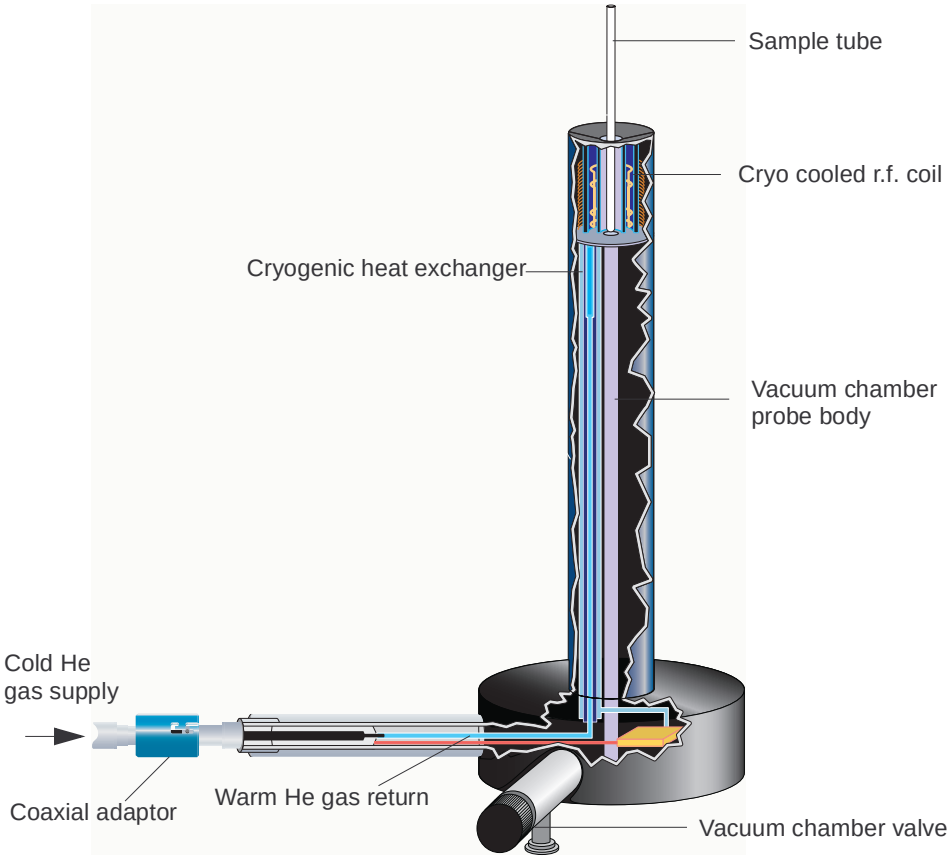

Figure 1. Varian, Inc. Cold Probe

1.2 Closed-Cycle Cryogenic System

The Varian closed cycle cryogenic system, shown in Figure 2 and described in Table 1, is designed for continuous long-term operation. During normal operations, the system does not consume or require additional He after initial setup. Routine service operations uses some He gas. The system cools the probe components to their operating temperature in about 4 hours. Optimal performance is realized when the system is allowed to stabilize overnight.

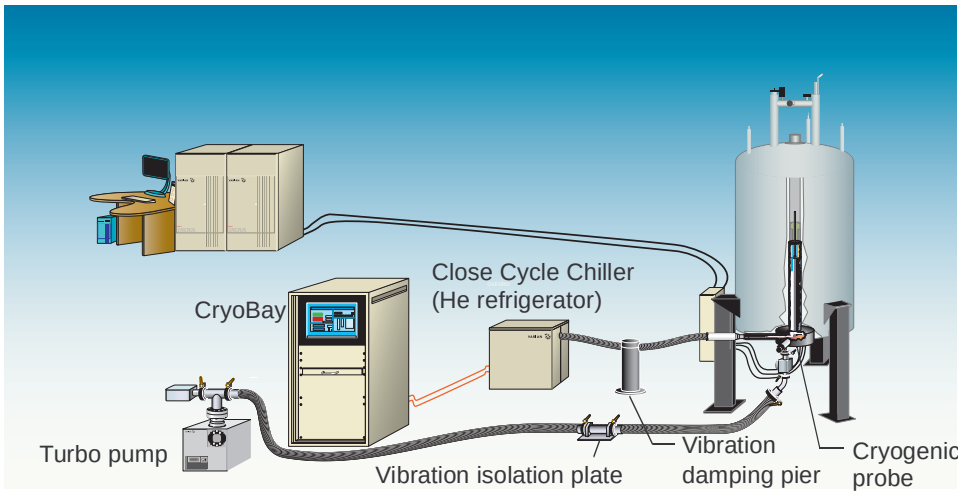

Figure 2. Varian, Inc. Cold Probe and Cryogenic System

.

Table 1. Closed Cycle Cryogenic System Components

Component	*Description*
Closed cycle chiller	(CCC), or helium (He) refrigerator, is shown in Figure 2. The CCC supplies cold He gas to the heat exchanger inside the Varian, Inc. Cold Probe.
CryoBay monitor software	Runs on the control PC — automates all routine cryogenic operations.
CryoBay (cryogenics bay)	Contains the intelligent temperature controller (ITC), control pc, and He compressor, see Figure 2 and Figure 3. The cabinet has a small foot print and reduces noise.
He compressor	The He compressor provides high-pressure He gas to the CCC.
Intelligent Temperature Controller (ITC)	The ITC regulates the temperature of the heat exchanger inside the Varian, Inc. Cold Probe.
Turbo pump	Maintains the vacuum in the Varian, Inc. Cold Probe. The turbo vacuum pump is connected to the probe's vacuum pump-out port using a flexible pumping line.
Damping pier	Reduces the transmission of vibrations from the CCC to the probe.
Vibration Isolation plate	Vibration isolation plate for vacuum line.

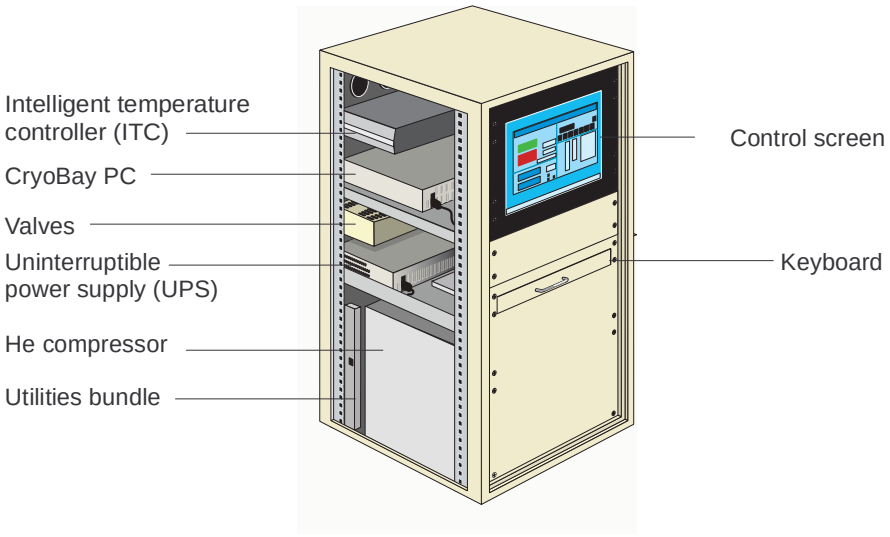

Figure 3. CryoBay - Left Side View

Chapter 2. Site Planning

Sections in this chapter

2.1 Assistance

If you need assistance, contact Varian, Inc. Customer Support Center at:

Fax: 650-855-9265

Tel: 1 (800) 356-4437

E-mail: nmr.customersupport@varianinc.com

2.2 General Site Planning and Spectrometer Requirements

All sites require the development of site plans that are specific to each facility. Placement of the magnet in a pit requires special planning. Use the blank grids provided in 3.2 “Room Layout Grids,” page 22, to arrange the cryogenic system.

The location of the magnet and magnetic field determines the placement of certain system components. Complete the site survey on Chapter 4 “Site Survey,” page 25 and Fax or send the survey to Varian, Inc. Customer Support. Contact. Contact Varian, Inc. Customer Support for assistance in completing this survey. Incomplete or inaccurate information can delay the installation of the Varian, Inc. Cryogenic system.

Site Planning Considerations

Consider the following when planning a site for the Varian, Inc. Cryogenic system:

- Components listed in Table 4 are sensitive to stray magnetic fields. Use the stray field Table 5 for correct positioning of these components.
- The flexible He transfer line with a minimum bending radius of 19.7 inches (50 cm), that extends from the CCC to the probe requires an unobstructed path. The recommended installation of flexible He transfer line is a bend of 90^{o} from the probe to the CCC. The flexible He transfer line from the CCC ends in a stinger that penetrates the sidearm of the probe.
- The turbo pump is connected to the probe's vacuum pump-out port along a path on the lab floor using two 4-inch (10.16 cm) diameter flexible corrugated stainless steel bellows pumping lines and a solid tube mounted to a vibration mitigation plate. The minimum bend radius of the flex tubing is 12-inch (30.5-cm). The turbo pump has an approximate 4-foot (0.42-meter) square footprint.
- The He compressor generates a significant amount of heat and requires a continuous supply of cooling water to prevent overheating. Water may be supplied from domestic water sources or by using a closed cycle water chiller see “Cooling Water Requirements,” page 13.
- The Varian, Inc. Cryogenic system requires either VNMR 6.1 C or VnmrJ 1.1 B and all current updates or newer version of VnmrJ.
- A 28–channel room temperature shim system is the minimum shim system for which Varian, Inc. Cold Probe line shape specifications are guaranteed.

Typical installation

A typical site plan is shown in Figure 4, refer to “Component–to–Component Distances,” page 15 for hose lengths and maximum component–to–component distances.

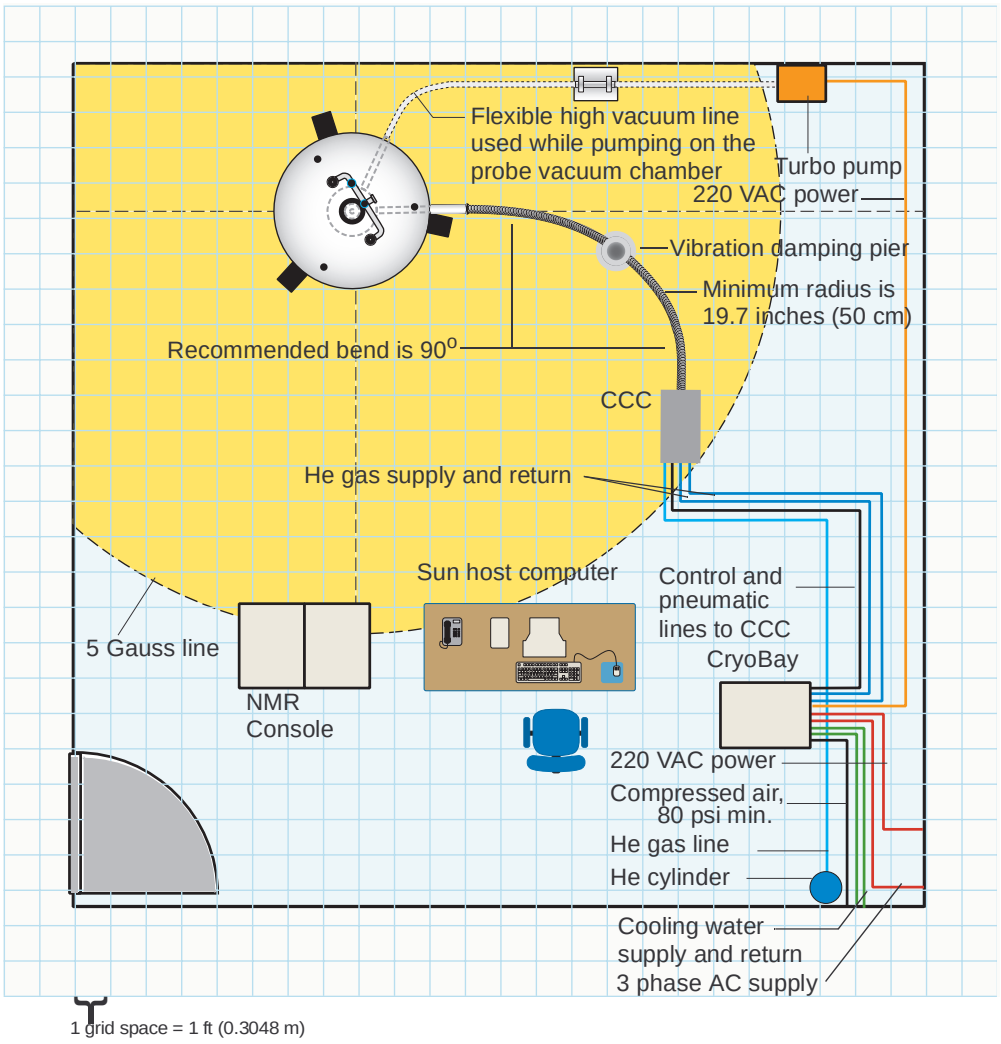

Figure 4. General Floor Plan for Typical Closed Cycle Cryogenic System Installation

Optional installation

An optional site plan is shown in Figure 5 and provides a layout with service room, refer to “Component–to–Component Distances,” page 15 for hose lengths and maximum component–to–component distances. The optional water chiller (and or the CryoBay - optional location not shown in this site plan) is located in either a utilities room or service chase. A special order flexible He hose extension (65.6 feet / 20 meters) is available.

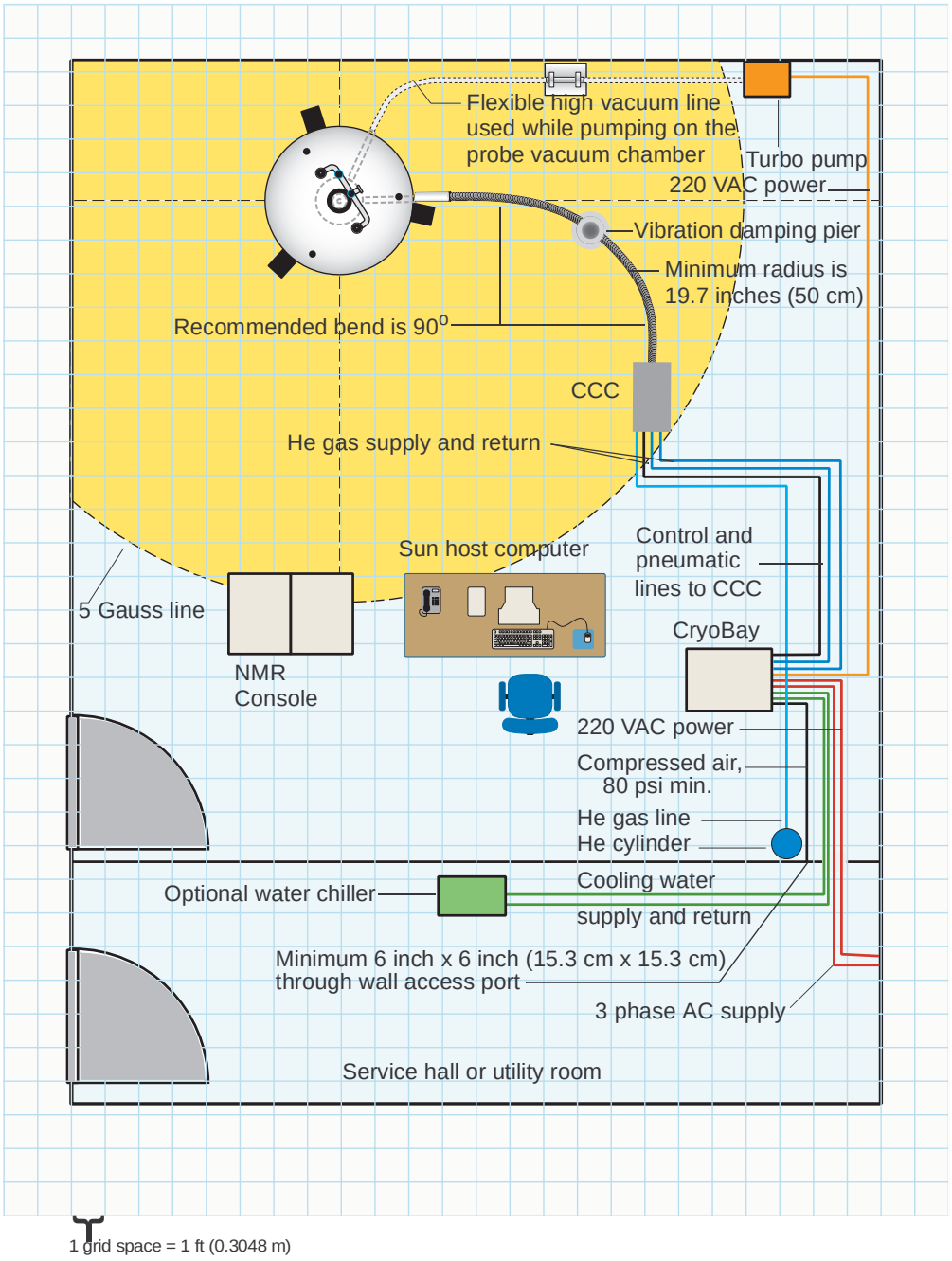

Figure 5. General Floor Plan for Closed Cycle Cryogenic System with Water Chiller in a Service Hall

2.3 Installation Supplies and Hardware

Customer Supplied Equipment and Hardware

Table 2 lists the equipment and supplies that the customer must provide for the installation of the Cryogenic system.

Table 2. Customer Supplied Equipment and Material

Requirement	*Specification*
AC Power connectors	**220 V single phase:** 600 VAC, 10 gauge, 3-conductor wire with ground (US and North America). All connectors for single phase operation that must conforming local electrical codes. For sites outside US and North America, all wires and connectors must conform to local electrical codes. **3 phase:** 4-conductor wire with ground (US and North America) and connectors for three phase operation conforming to local electrical codes. For sites outside US and North America, all wires and connectors must conform to local electrical codes.
High pressure He gas	He gas (99.999% purity) — full and unopened cylinder.
Compressed air or N_2 gas	Clean, dry, compressed air or N_2, min. 80 psi (5.6 bar).
5 micron water filter — for compressor cooling water	Serfilco PL-P 5 x 9 3/4 pleated polyester filter cartridge and GSO 10-3/4 filter chamber (www.serfilco.com) or equivalent.
Water — for cooling He compressor	See "Cooling Water Requirements," page 13.
Cooling water flow control and pressure regulation	Flow control located on the outlet side of the He compressor. Water pressure regulation located on the inlet side of the He compressor.
Pressure Regulator He gas	High purity, He cylinder regulator, 400 PSI (28 bar)— supplied to customers in North America - customers in other locations must supply the regulator. All must supply connector to 1/4" Cu tubing.
Optional Chiller	See "Water Chiller Specifications," page 16 for specifications in addition to "Cooling Water Requirements," page 13.

Varian, Inc. Supplied Equipment and Hardware

Varian, Inc. provides an installation kit, part number 01-909651-00, with the system, the contents are listed in Table 3. The customer must supply the electrical plugs and sockets that are in compliance with local ordinances, refer to "Electrical Requirements," page 12 for requirements. An electrician and, in some cases, a plumber should be available at the beginning of the installation to make the utility connections.

Table 3. Installation Components Supplied with the System

Component	*Components (quantity and description)*
Quick Disconnect, Male and Female, Water with 1/2 inch barb, 1/2 inch NPT thread	2 each
Water hose, 1/2 inch ID	150 feet (45.7 meters)

Table 3. Installation Components Supplied with the System

Component	*Components (quantity and description)*
Copper Tubing, ASTM-B280 high purity	50 feet (15.2 meters) 1/4 inch out side diameter
1/4” OD Swage lok to 1/4” female NPT taper thread	North American sites only. Sites outside North America must supply connector from the customer supplied He regulator to the copper tubing.
Pressure Regulator (compatible with high purity, 99.999% He gas), Bottle, 400 PSI (28 bar)	Supplied to North American sites only. Sites outside North America – the customer must supplied the regulator.
Compressed air pressure gauge	

2.4 Site Requirements

The cryogenic system electrical, water cooling, compressed gas, and air conditioning requirements must be met before the installation engineer arrives on site. These requirements are in addition to those requirements of the NMR console.

- “General Site Requirements,” this page
- “Electrical Requirements,” this page
- “Cooling Water Requirements,” page 13
- “Compressed Gas Requirements,” page 13
- “Component Heat Dissipation,” page 13
- “Magnetic Field Considerations,” page 14

General Site Requirements

The site must meet all site requirements for temperature, humidity, etc. as specified in the current *INOVA Site Planning Guide*. Requirements and specifications presented here are in addition to those specified in the current *INOVA Site Planning Guide*. Where there are potential conflicts in the specifications, the more stringent specification takes precedence.

Electrical Requirements

Determine the electrical power that is provided locally. If the local power does not conform to the following options, specify the power available in the space provided in the Chapter 4, “Site Survey,” .

Component	*Voltage, Phase, and Line Frequency*	*Power Consumption*	*Outlets Required*
CryoBay and turbo pump (excludes He compressor)	198 to 242 Vac 10 A 1 phase 50/60 Hz	750 W	1 outlet
He Compressor Model 6200	200 to 230 Vac 30 A 3 phase 60 Hz 180 to 220 Vac 30 A 3 phase 50 Hz	5.9-7.8 kW	1 outlet
He Compressor Model 6000	360 to 440 Vac 20 A 3 phase 50 Hz 414 to 504 Vac 20 A 3 phase 60 Hz	5.5-7.6 kW	1 outlet

Cooling Water Requirements

Use house water supply or a recirculating water chiller, see “Water Chiller Specifications,” page 16. Note that Cooling water pressure drop across compressor is typically 3 - 9 psi (0.2 to 0.6 bar).

Requirement	*Specification*
Maximum inlet temperature	25° C
Minimum inlet temperature	5° C
Flow rate @ 25° C	Minimum 1.3 gal (5L)/min, max.2.6 gal (10L)/min.
Inlet pressure	Minimum 20 psi (2 bar) maximum 116 psi (11.6 bar)
Antifreeze (ethylene glycol) / Water ratio	≤ 50%
Particulate concentration	<10 mg / L (requirement is met if recommended filter is installed on the supply line)
Alkalinity (calcium carbonate)	7-8.5 pH
Carbonate hardness	7 to 10 °dH
Compressor inlet and outlet hose barbs	see “Helium Compressor Specifications,” page 16

Compressed Gas Requirements

The Cryogenic system requires compressed gas as follows:

Gas	*Supply*	*Specification*
Air or Nitrogen	House (independent of the magnet leg) or Cylinder	Minimum 80 psi (max 110 psi), clean and dry (dew point -40C)
He	Full Cylinder	99.999% purity

Component Heat Dissipation

The following table provides heat dissipation from Cryogenic system components to help determine the air conditioning load.

Component	*watts*	*BTUs / hour*
Cryobay, turbo pump, and He compressor	150	512
Turbo pump — at start up only	736	2550
He compressor only	100	350
Closed Cycle Chiller (He refrigerator)	nil	nil
Water Chiller	See “Water Chiller Specifications,” page 16	

Magnetic Field Considerations

More detailed magnetic field data can be found in the *INOVA Site Planning Guide*.

Cryogenic systems contain one or more components that are sensitive to magnetic fields, these components are listed in Table 4.

Table 4. System Components Affected by Magnetic Fields

Component	*Maximum Magnetic Field*
CryoBay	5 Gauss
CCC	100 Gauss
Turbo pump	10 Gauss

Refer to Table 5 to determine the distance from the center of the magnet bore to the 5 gauss line.

Table 5. Stray Field Data for NMR Magnet Systems

Magnet Systems		*Axial Distance from Magnet Center Line*			*Radial Distance from Magnet Center Line*		
(MHz/mm)	*(Tesla)*	*5-gauss (m)*	*10-gauss (m)*	*25-gauss (m)*	*5-gauss (m)*	*10-gauss (m)*	*25-gauss (m)*
200/54	4.69	1.75	1.45	1.05	1.50	1.20	0.90
200/89	4.69	2.65	2.05	1.49	2.00	1.60	1.15
300/54	7.04	2.20	1.75	1.26	1.70	1.30	0.97
300/89	7.04	2.75	2.20	1.63	2.20	1.75	1.26
400/54	9.39	2.80	2.24	1.65	2.20	1.76	1.29
400/54 AS	9.39	1.50	1.25	0.90	1.00	0.80	0.60
400/89	9.39	3.80	3.00	2.21	3.05	2.40	1.74
400/89 AS	9.39	1.8	1.5	1.17	1.03	.80	0.74
500/51	11.74	3.50	2.70	2.00	2.75	2.20	1.60
500/51 AS	11.74	1.80	1.50	1.10	1.30	1.00	0.70
500/89	11.74	4.50	3.55	2.60	3.55	2.80	2.10
500/89 AS	11.74	2.5	1.9	1.50	1.75	1.4	0.96
600/51	14.09	4.00	3.17	2.34	3.17	2.52	1.86
600/51 AS	14.09	2.50	1.90	1.40	1.75	1.40	0.90
600/89	14.09	5.00	3.97	2.92	3.95	3.14	2.32
750/51	17.63	7.60	6.04	4.45	6.1	4.79	3.53
800/63 (4.2K)	18.81	8.69	6.35	4.68	6.89	5.00	3.69
800/63 (2.2K)	18.81	7.6	6.0	4.41	6.0	4.75	3.51
900/54	21.1	10.5	8.35	5.80	8.30	6.60	4.60

2.5 System Component Specifications

This section lists the specifications of the individual system components.

The manufacturers of the individual components used in the Varian, Inc. Cryogenic System may have additional requirements not listed here. The requirements listed serve as a guide. Where the individual component manufacture's requirements are more stringent then those presented here, the individual component manufacture's requirements will take precedence.

Component–to–Component Distances

The distances provided are approximate maximum separation between components (or cabinets and components). The distances specified assume a 5 foot (1.5 meter) service or routing loss for the shortest cable, hose, or tubing that connects the components or cabinets. All distances are straight line distances. Routing around obstacles, for appearance, or traffic paths will reduce the distance between components. An optional extension kit is available for locating the CryoBay further from the CCC.

Components or cabinets	*Distance, systems*			
	up to 600 MHz	*700 MHz*	*800 MHz*	*900 MHz*
CryoBay to CCC	14 ft (4.3 m)	14 ft (4.3 m)	25 ft (7.6 m)	70 ft (4.3 m)
CryoBay to AC power sources	25 ft (7.6 m)	25 ft (7.6 m)	25 ft (7.6 m)	25 ft (7.6 m)
CryoBay to turbo pump	50 ft (15.2 m)	50 ft (15.2 m)	50 ft (15.2 m)	50 ft (15.2 m)
CCC to He cylinder	45 ft (13.7 m)	45 ft (13.7 m)	45 ft (13.7 m)	45 ft (13.7 m)
CryoBay to pneumatics gas supply	25 ft (7.6 m)	25 ft (7.6 m)	25 ft (7.6 m)	25 ft (7.6 m)
CryoBay to cooling water	70 ft (21.3 m)	70 ft (21.3 m)	70 ft (21.3 m)	70 ft (21.3 m)
Turbo pump to probe vacuum valve	12 ft (3.7 m)	23 ft (7.0 m)	23 ft (7.1 m)	31 ft (9.4 m)
CCC to probe	5 ft (1.5 m)	5 ft (1.5 m)	5 ft (1.5 m)	8 ft (2.4 m)

Cold Probe

The probe requires a minimum clearance between the floor and bottom of the shim tube. The orientation of the probe is limited only by the position of the cryogenic sidearm of the probe in relation to the magnet legs.

Probe	*Minimum clearance*
500 MHz Cryogenic Probe	28 inches (71.1 cm)

Probe	*Minimum clearance*
600 MHz Cryogenic Probe	28 inches (71.1 cm)
*Accommodates both new and older style magnets	

Helium Compressor Specifications

Compressor is installed in the Cryobay.

	Specification
Weight	207 lb. (94 kg)
Height	23.6 inches (60 cm)
Length	20.2 inches (51.1 cm
Width	17.4 inches (44 cm)
Flexible He hose diameter (supply)	1.13 inches (2.9 cm) / fitting 1.19 inches (3.07 cm)
Flexible He hose line diameter (return)	1.13 inches (2.9 cm) / fitting 1.63 inches (3.17 cm)
Cooling water supply and return	1.25 inches (3.2 cm) with fitting, 1/2 inch (1.27 cm) ID
Operating temperature	5º C to 40º C

CryoBay Specifications

	Specification
Height	49 inches (124.46 cm)
Depth and width	30.5 inches x 21.75 inches (77.47 cm x 55.25 cm)
Minimum clearance, front and rear	3 feet (1 meter)
Weight with He compressor	470 lb. (213.2 kg)

Closed Cycle Chiller Specifications

	Specifications
Height	29 inches (73.7 cm)
Depth and width	32 inches x 18 inches (45.72 cm x 81.28 cm)
Weight (with vibration plates)	267 lb. / 121 kg (498 lb. / 226 kg)

Vibration Damping Pier Specifications

Vibration damping pier height is 26 inches (66.04 cm) and footprint diameter is 10 inches (25.4 cm). The pier is located between the CCC and the probe.

Water Chiller Specifications

The water chiller must meet the following specifications:

Requirements	*Specification*
Cooling Capacity	8 kW (27,000 BTU)
Temperature range	$+5^{o}$C to $+25^{o}$C

Requirements	*Specification*
Pressure, minimum (pumping)	20 psi (1.4 bar)
Flow rate (minimum)	5 L/min

The customer is responsible for verification that the water chiller specifications meet the He compressor requirements. Haskris Co. Cooling Systems has provided the following information about their chillers that meet these requirements — these water chillers are available through Varian Inc., other vendors offer compatible water chillers:

Model	*Description*	*Heat Dissipation*	*Site Requirements*	*Voltage/Current (phase) @ 60 Hz*	*Fusing (Time Delay)*
R300-R	Refrigerated water chiller with an air cooled condenser	Heat load of 10.4 kW from the Leybold compressor and Haskris chiller is transferred to room ambient air.	Room/Lab ambient air temperature min. 40°F, max. 100°F.	208/230 V/18.0 A (3 phase)	25 A
R300-CR	Refrigerated water chiller with a water cooled condenser	Heat load from the Leybold compressor and Haskris chiller is transferred to building water source	Requires a source of building water 85°F or colder	208/230 V/15.4 A (3 phase)	20 A
WW1-R	Non-Refrigerated, water-to-water heat exchanger	Heat load from the Leybold compressor and Haskris chiller is transferred to building water source	Requires a source of building water 55°F or colder	115 V/6.87 A (1 phase) 208/230 V/ 3.4 A (1 phase)	10 A 5 A

Contact Haskris Co. Cooling Systems for any additional information.

Haskris Co. Cooling Systems
100 Kelly Street
Elk Grove Village, Il 60007
www.haskris.com
Contact:
Dan Falotico, Jr.
Telephone: (847)-956-6420 ext. 222
E-mail: dan@haskris.com

Chapter 3. Critical Measurements and Layout Grids

Sections in this chapter

3.1 Critical Measurements

Provide answers to the following regarding your site, refer to Figure 6, and Figure 7 as necessary.

Side View

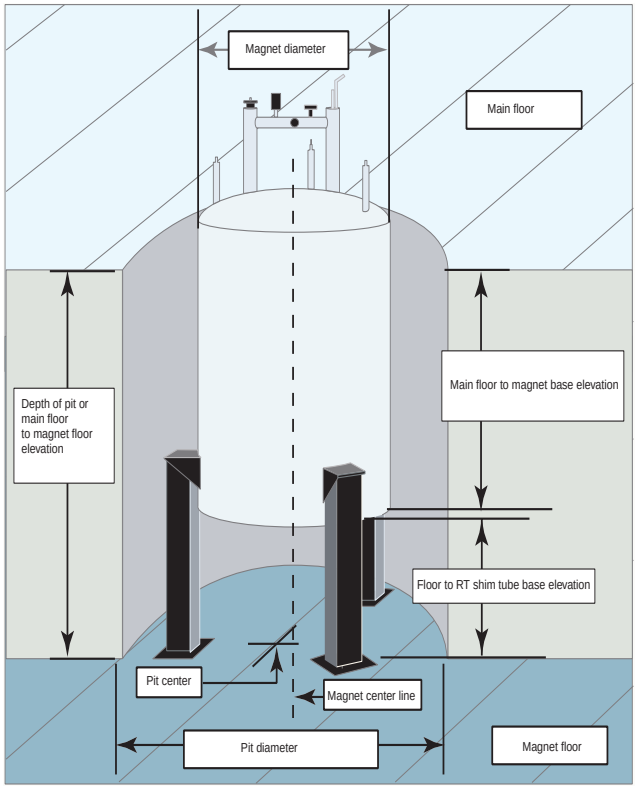

Figure 6. Pit, Multi, and Single Level Lab Required Dimensions

Top View

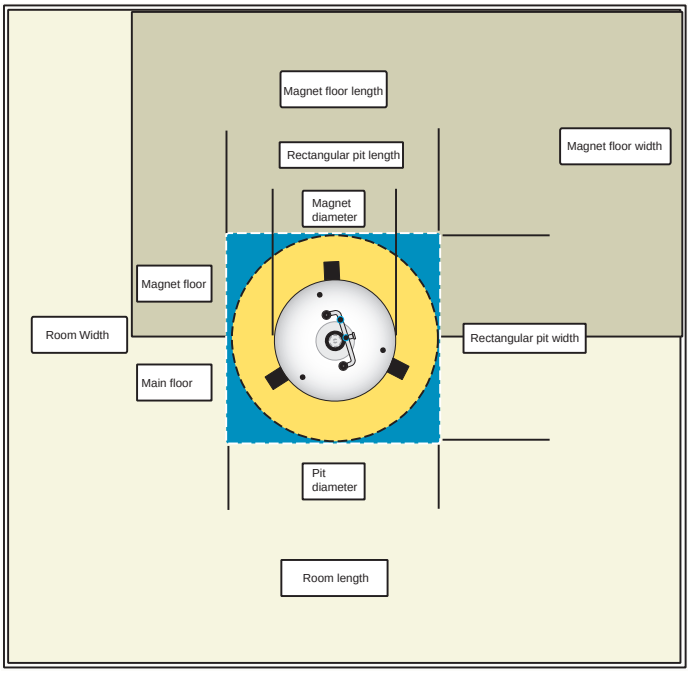

Figure 7. Pit, Multi, and Single Level Lab Required Dimensions - Top Down View

3.2 Room Layout Grids

Use the provided grids to sketch the floor plan, Figure 8, and elevation, Figure 9. Include proposed location of cryogenic system components

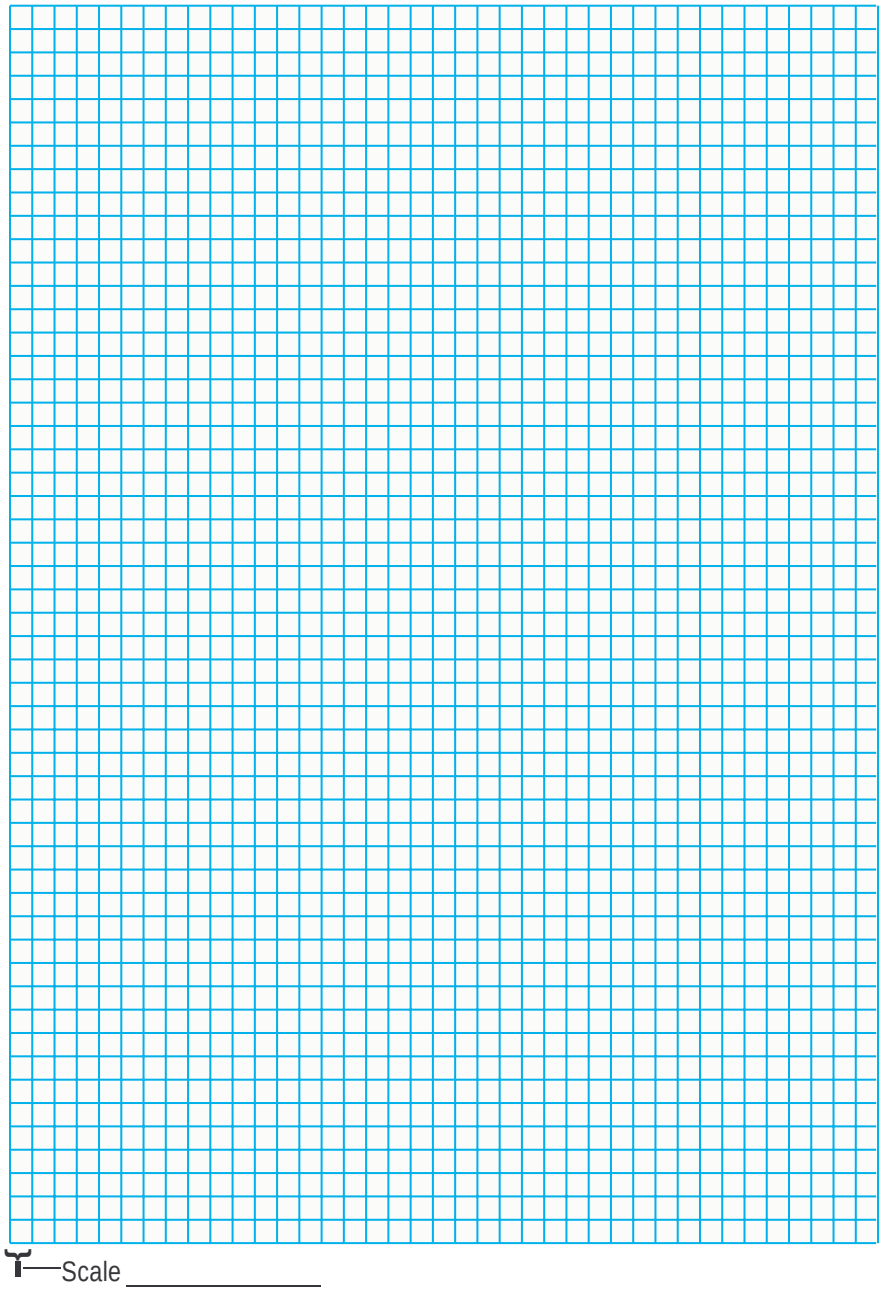

Figure 8. Grid for Floor Plane

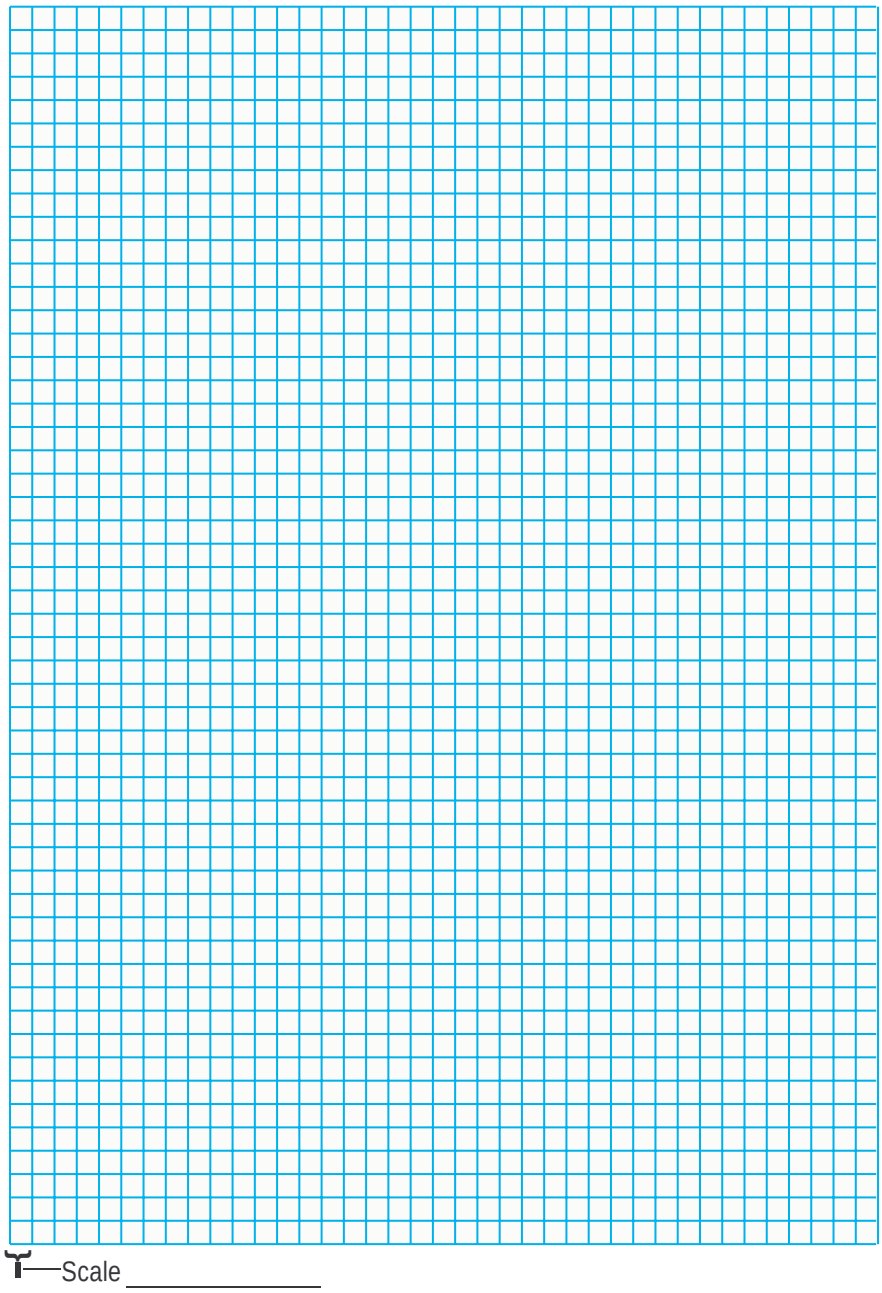

Figure 9. Grid for Elevation

Chapter 4. Site Survey

Fill in the site survey form and fax it to **650-855-9265**.

Use the following if you have questions regarding this form:

E-mail: nmr.customersupport@varianinc.com
tel: 1-800-356-4437

The survey contains the following sections:

4.1 Magnet

Survey Element	*Dimension*	*Measurements, Descriptions, other information*
Magnet	Field	
	Bore size	
	Actively Shielded	( )Yes or ( ) No
	Distance from floor to the bottom of the shim tube	
	Flange type	
	Magnet bottom	( ) Flat or ( ) Round
Manufacturer	Purchase Date	
	Serial Number	

4.2 NMR System

NMR System Element	*Component*	
Console (Serial number:)	Unity	( )
	Unityplus	( )
	Unity INOVA	( )
Shim System	Varian (channels)	( )
	Ultra Shim (channels)	( )
	RRI shim system	( )
Pulse Field Gradient Amplifier Type	Performa I	( )
	Performa II	( ) Part Number:
	Performa XYZ	( )
	Other	( )
Accessories	SMS	( )
	Carousel	( )
	NMS	( )
	LC-NMR	( )
	VAST	( )
Software	( ) VNMR version:	( ) VnmrJ version:

4.3 Room and Floor

Room Elements		*Measurements, Descriptions, other information*
Magnet in Pit	( ) yes ( ) No	If yes complete Pit survey
Multi Level	( ) yes ( ) No	If yes complete multi level survey
Single Level	( ) yes ( ) No	If yes complete single level survey
Obstructions	( ) yes ( ) No	If yes indicate on survey
Floor type	( ) raised ( ) solid	
Provide digital pictures of the site		

4.4 Utilities

Utility		*Measurements, Descriptions, other information*		
AC power	Country			
	Single phase	Voltage=	Current=	Line frequency =
	Three phase	Voltage=	Current=	Line frequency =
Cooling Water	Flow rate			
	Pressure			
Compressed Air	Pressure, at max flow			
	Flow			
Air Conditioning	BTU/hr.			

4.5 Pit Information

Pit Element		*Measurements, Descriptions, other information*
Rectangular Pit	Length	
	Width	
	Depth	
Round Pit	Diameter	
	Depth	
Main floor elevation relative to:	Magnet Base	
Location of Magnet in pit	Center line of magnet relative to pit center line	
Diameter of Magnet		
Obstructions	Inside the pit	
	Outside the pit	
Provide digital pictures of the site		

4.6 Multi Level Room

Survey Element		*Measurements, Descriptions, other information*
Room upper level dimensions	Length	
	Width	
Lower level dimensions	Length	
	Width	
	Depth	
Main floor elevation relative to:	Magnet base	
Main floor elevation relative to:	Magnet Floor	
Obstructions	Obstructions - upper level	
	Obstructions - lower level	

Survey Element		*Measurements, Descriptions, other information*
	Additional Magnets in the same room	
Provide digital pictures of the site		

4.7 Single Level Room

Survey Element		*Measurements, Descriptions, other information*
Room dimensions	Length	
	Width	
Obstructions and other magnets		
Provide digital pictures of the site		

4.8 Installation and Delivery Contact

Name	
E-mail address	
Street address	
Street address	
City	
State Zip Code	
Country	
Contact listed is for: Installation ( ), Delivery ( ), Both ( )	

Name (Alternate)	
E-mail address	
Street address	
Street address	
City	
State Zip Code	
Country	
Contact for: Installation ( ), Delivery ( ), Both ( )	