SPECIFICATIONS FOR A 4.7 TESLA/400MM

ACTIVELY SHIELDED MAGNET SYSTEM

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CONTENTS

1. DESCRIPTION OF THE SYSTEM

The MRBR 4.7/400 AS system is a complete actively shielded superconducting magnet system intended primarily for research studies on the Clinical/Biological applications of NMR Imaging (MRI) and NMR Spectroscopy (MRS). The system is particularly useful where large access inside the shim and gradient coils is required.

The system essentially consists of a highly homogeneous superconducting magnet (4.7 Tesla) housed in a horizontal room temperature bore (400mm), low-loss helium cryostat. Field shimming is accomplished using superconducting shim coils and passive shim pieces.

2. THE SUPERCONDUCTING MAGNET

i) General Description

The magnet is wound from multi-filamentary NbTi conductor with a high percentage of copper to superconductor. The windings are placed on a precision machined aluminium alloy former and then fully vacuum impregnated for robustness and long-term reliability.

The field homogeneity is defined over a 18cm diameter spherical volume and all orders of impurity up to and including 12th order are theoretically cancelled within this volume. Inevitably winding tolerances and small amounts of environmental influence will distort the central field. Corrections for these distortions are made in the first instance by superconducting shim coils located on a former surrounding the main coil. Final corrections are made by passive shim pieces placed in the bore of the system.

The magnet coils are fully protected from accidental damage due to a quench by a cold diode network located within the helium reservoir.

In the event of the need to activate an emergency discharge of the magnet a quench heater circuit is incorporated within the windings.

The magnet is designed to conservative levels of stress and mechanical stability to ensure reliable and stable operation. In addition the use of high quality superconducting wire ensures that a highly stable magnet system is achieved.

*ii) **Specifications***

Magnet type	: Multi-coil superconducting
Central field	: 4.7 Tesla
Field stability measured a minimum of 72 hours after energisation	: Less than 0.05 ppm/hour
Operating current	: 283 Amps (Nominal)
Field homogeneity values	
Superconducting shims only	: Less than 20ppm over 18cm dsv*
	: Less than 12ppm over 15cm dsv*
Time to energise magnet to full field	: Less than 300 minutes
Fringe field (position of 5 gauss contour):	See Figure 2
Axially from magnet centre line	: 2.7 metres
Radially from magnet centre line	: 1.8 metres

* Defined as the peak to peak variations of points plotted over a seven plane plot on the surface of the stated spherical volume.

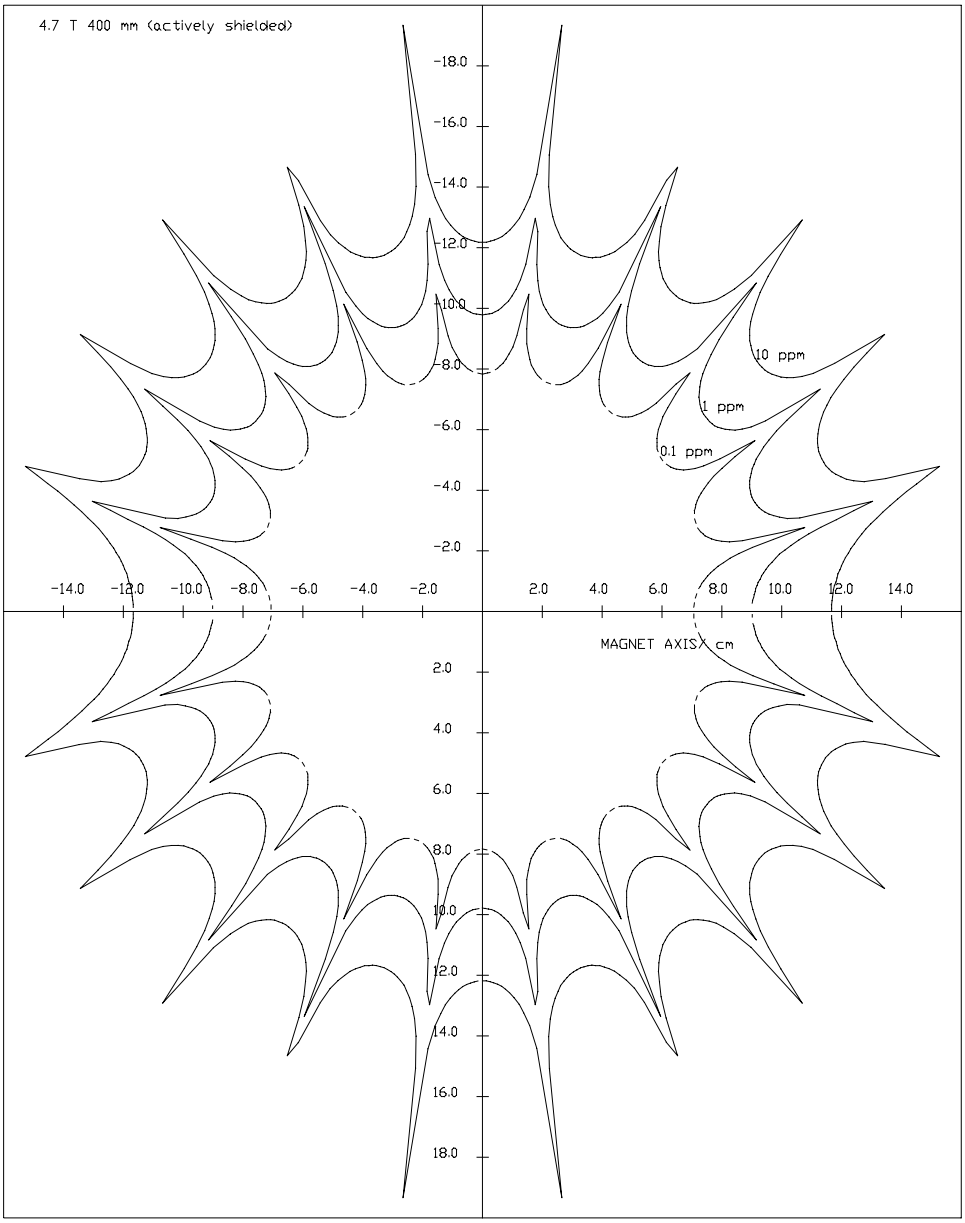


Figure 1
Homogeneity Plot

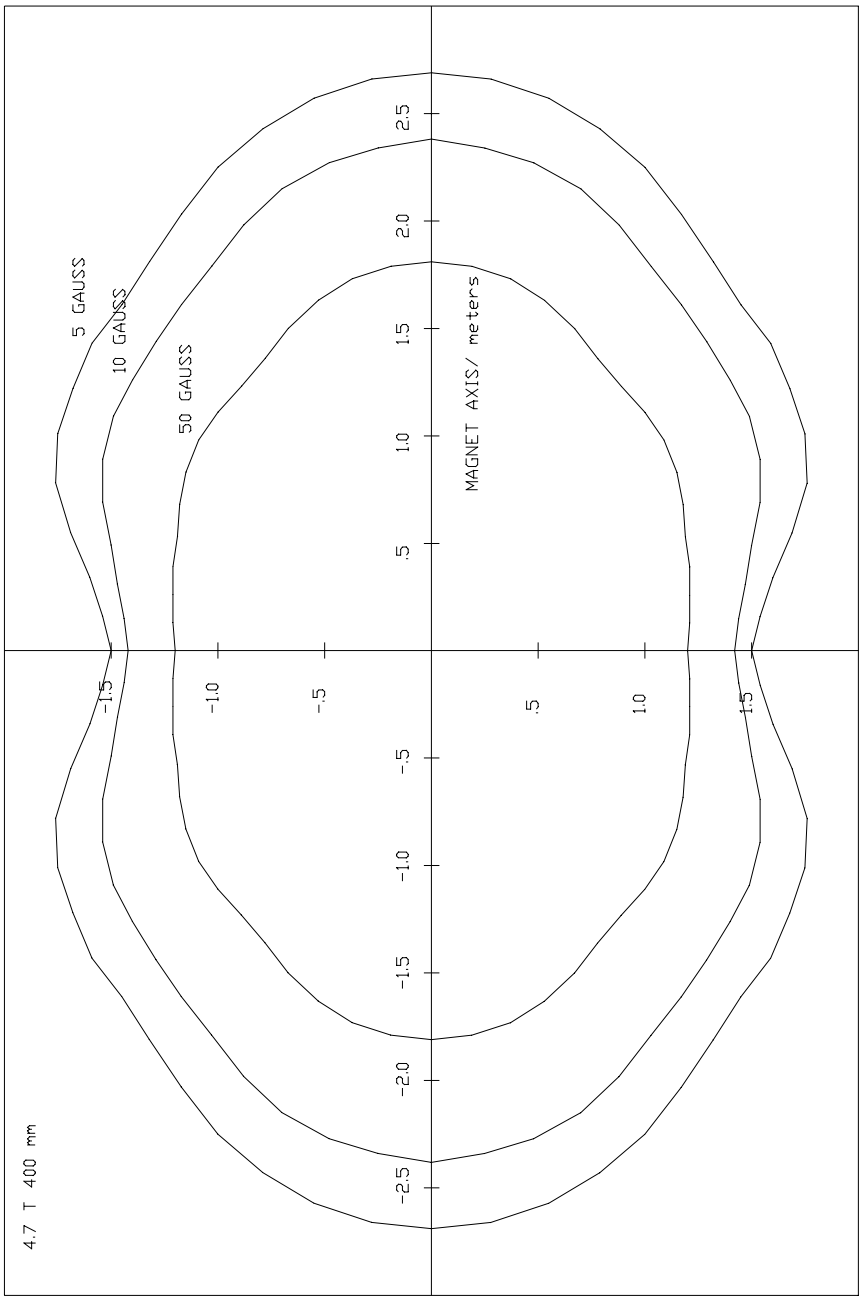


Figure 2
Fringe Field

Superconducting Shim Coils

These coils are positioned on a non-conducting former surrounding the main coil in the helium reservoir. Each coil set is fitted with a superconducting switch for persistent mode operation.

Coil details:-

Shims provided : Z1, Z2, Z3, Z4, X, Y, ZX, ZY, XY, X2-Y2, Z2X, Z2Y, ZXY, Z(X2-Y2)

Coupling : All shims are decoupled from main coil
Z1 and Z3 are coupled
Z2 and Z4 are coupled

Typical shim strength over 20cm diameter.

Shim	Strength (ppm/amp of main field)	% Impurity over Stated Spherical Volume
Z1	45.00	Less than 1%
Z2	36.00	Less than 1%
Z3	5.0	Less than 1%
Z4	4.0	Less than 5%
X(Y)	10.0	Less than 1%
ZX(ZY)	3.0	Less than 1%
XY(X2-Y2)	1.2	Less than 1%
Z2X(Z2Y)	1.1	Less than 1%
ZXY(Z(X2-Y2))	0.3	Less than 1%

3. THE CRYOSTAT

i) General Description

The cryostat is of conventional design, consisting of a central all-welded stainless steel helium vessel which is surrounded by an aluminium gas-cooled radiation shield and liquid nitrogen reservoir. The complete assembly is contained in a stainless-steel outer vacuum vessel with a vertical service turret located centrally on top of the cryostat. The turret provides access to the helium reservoir for the demountable magnet leads, helium level probe, and helium transfer siphon. The outer vessel has end-flange closures constructed from aluminium which are sealed to main body and bore-tube by compressed rubber 'O' ring seals. The room-temperature bore-tube is constructed from stainless steel.

The cryostat is supplied with a support stand that has provision for fixing to the floor of the installation room. The helium reservoir contains in total approximately 820 litres of liquid helium of which approximately 200 litres volume is above the minimum recommended operating level. Details of refill intervals are given below.

Cryogen level monitors are incorporated into both the liquid helium and liquid nitrogen vessels and the associated electronics provide liquid level display and low level alarms. A back-up liquid helium level probe is included for use in the event of failure of the primary probe. The probes will monitor helium levels continuously from empty to full conditions.

ii) Specifications

The cryostat is generally as shown in drawing number AHZ323159 and full specifications for the system are as follows:-

Dimensions:-

Length of cryostat	: 1500mm
Height with support frame	: 2281+/- 5mm
Room temperature clear bore (without shims and gradients)	: 400+/-1mm
Room temperature bore-tube material	: Stainless steel
Centre of field to base of stand	: 900+/-5mm
Cryostat end flange to centre of field	: 750mm
Minimum ceiling height for rigid demountable lead	: 3100mm
Minimum ceiling height for one-piece	: 3000mm

helium transfer tube

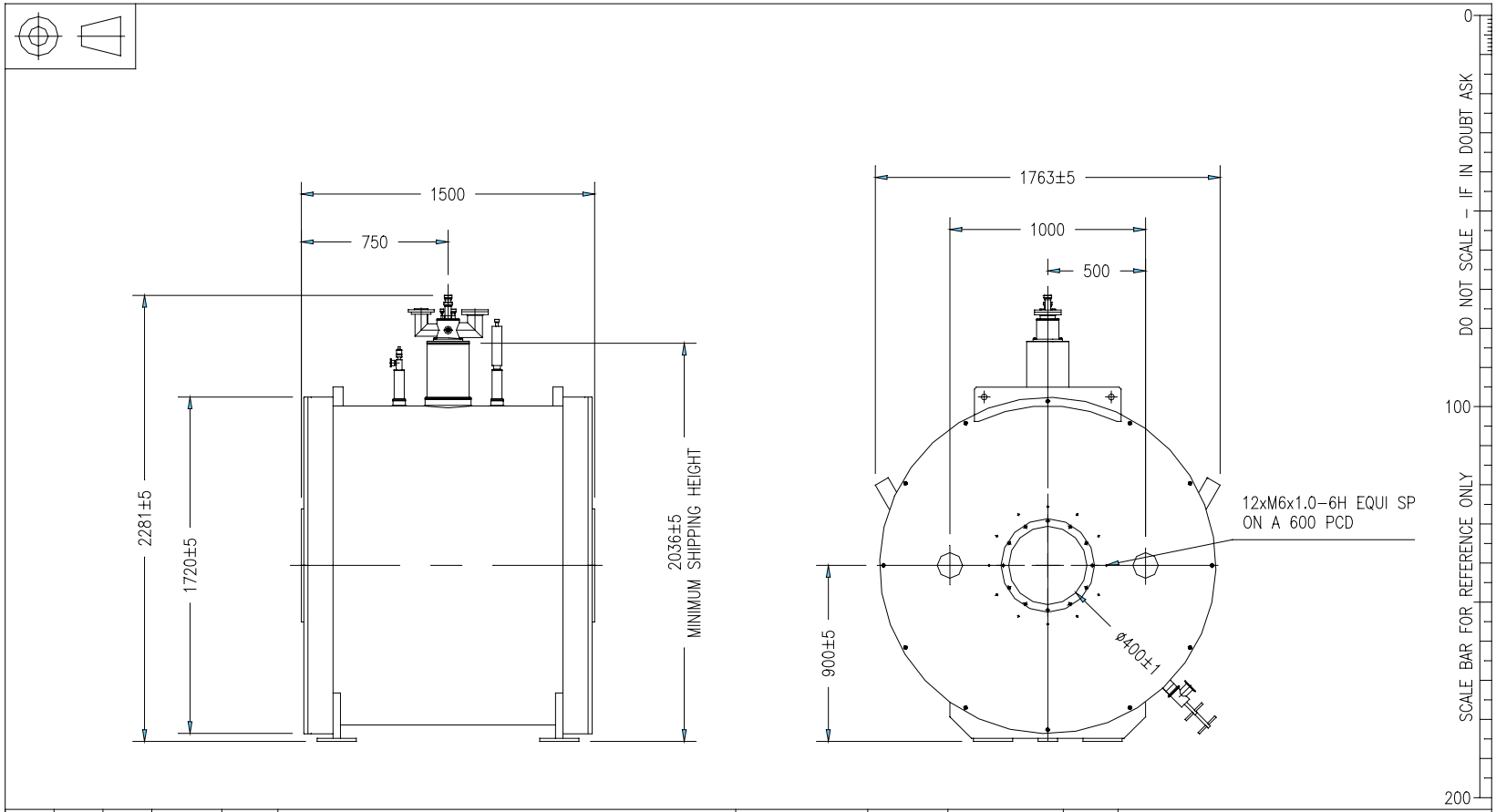
Minimum installation ceiling height using split siphon and flexible current leads	:	2900mm
Weight of cryostat (including cryogens)	:	4000kg

Liquid helium cryogen details:-

Volume for initial installation (includes cooling the magnet from 77K to 4.2K, volume required to completely fill helium reservoir and to top up helium reservoir after magnet energisation)	:	1800 litres (approx)
Recommended refill volume during normal operation	:	200 litres
Maximum volume of reservoir	:	820 litres
Hold-time during normal operation (static magnetic field, leads withdrawn)	:	Greater than 55 days

Liquid nitrogen cryogen details:-

Volume for initial installation (includes pre-cool of magnet to 77K and volume required to completely fill LN2 reservoir)	:	2,000 litres (approx)
Volume of reservoir	:	175 litres
Refill volume	:	170 litres
Hold time in static condition	:	Greater than 12 days



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DIMENSIONS IN MM
UNLESS STATED
REMOVE ALL SHARP
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DRAWN BY:–	C.SIRET
CHECKED BY:–	
APPROVED BY:–	
DATE:–	23.01.01

TITLE:– MRBR 4.7T/400 AS CUSTOMER INTERFACE

OUT TRAY

DRAWING NUMBER AHZ323159A

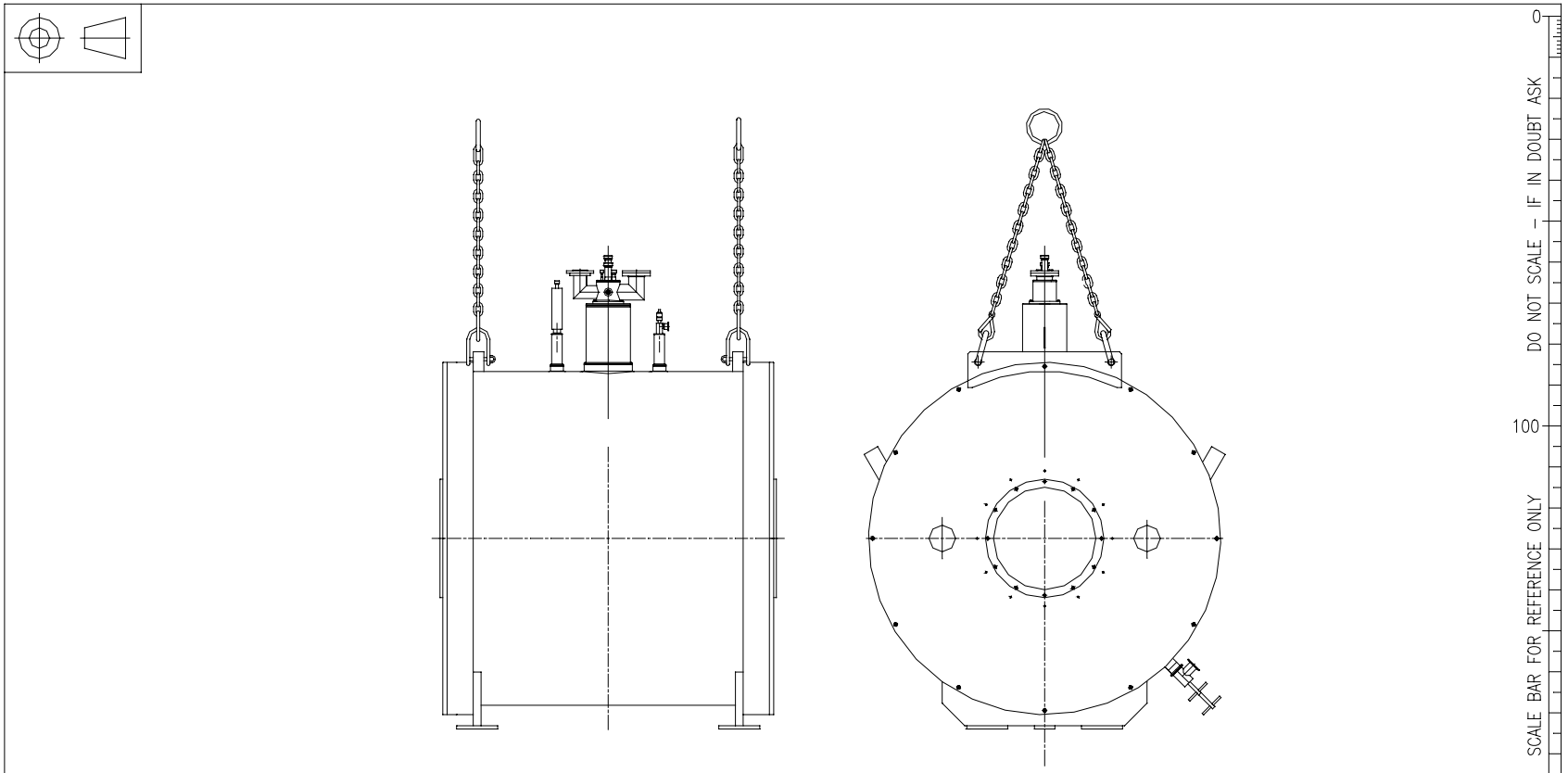
SHEET 1 OF 2

MATERIAL SEE DETAILS

FINISH CLEAN

ID No: 23159

SCALE 1:20



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4. SYSTEM COMPONENTS

i) Superconducting Magnet System Components

1 off 4.7T/400/AS magnet system with integral s/c shims, housed in a low loss cryostat.

1 off Stand

ii) Standard Ancillary Parts

1 off De-mountable main current lead

1 off De-mountable s/c shim current lead

1 off E5011 helium level monitor

1 off E5031 nitrogen level monitor

1 off Head oscillator

1 off E7002 emergency discharge unit

1 off Service cable

1 off Helium monitor cable

1 off Nitrogen monitor cable

1 off Flexible siphon (2.0m)

1 off Nitrogen blow-out tube

1 off Nitrogen fill tube

1 off Spares kit

1 off De-mountable helium level probe

1 off De-mountable nitrogen level probe

1 off System manual