PRELIMINARY SPECIFICATIONS

MRBR 7.0 TESLA / 210MM ACTIVELY SHIELDED CRYO-COOLED MAGNET SYSTEM

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CONTENTS

1. DESCRIPTION OF THE SYSTEM

The MRBR 7.0/210/ASZ system is a complete superconducting magnet system intended primarily for research studies on the biological applications of NMR imaging (MRI) and NMR spectroscopy (MRS).

The system essentially consists of a highly homogeneous actively shielded superconducting magnet (300MHz ^{1}P, 7.0 Tesla) housed in a horizontal room temperature bore (210mm), low-loss helium cryostat. The magnet is operated with a pulse-tube type cryocooler to give nominally zero helium loss.

Field shimming is accomplished using superconducting shim coils and passive shims. The ultimate homogeneity specifications require room temperature shim coils.

The system is complemented with a helium cryomonitor and an emergency discharge unit (EDU).

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 precision machined aluminium alloy and GRP formers, then fully vacuum impregnated for robustness and long-term reliability.

The field homogeneity is defined over a spherical volume and all orders of impurity up to 8th 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.

The magnet coils are fully protected from accidental damage due to a quench by a diode resistor 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***

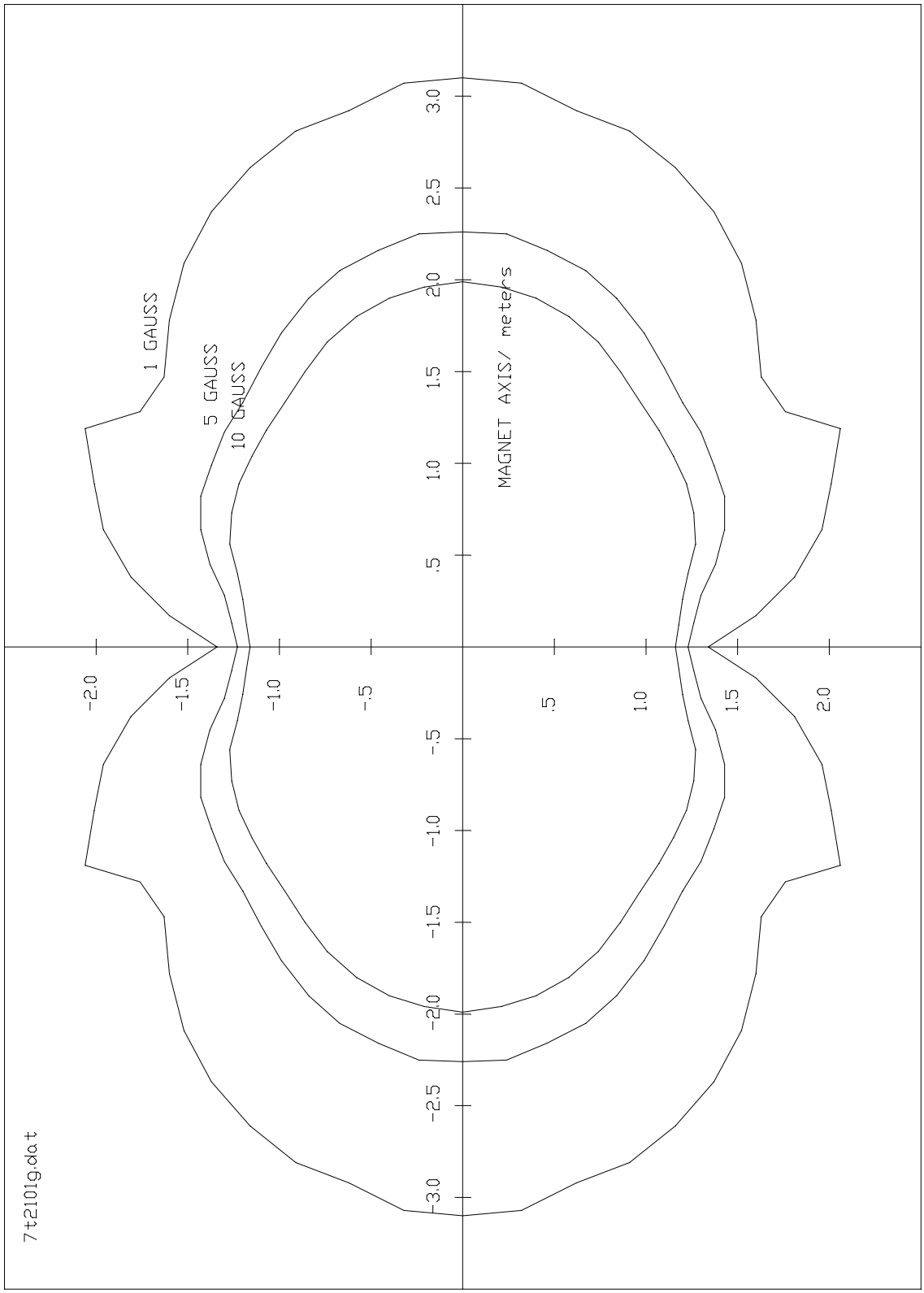
Magnet type	:	Actively shielded multi-coil superconducting
Central field	:	7.0 Tesla (^{1}P 300MHz)
Field stability measured a minimum of of 72 hours after energisation	:	Less than 0.05 ppm/hour
Operating current	:	300 Amps (nominal)
Field homogeneity values		
Superconducting only shimmed	:	Less than ± 4ppm over 8 cm dsv*
Fully shimmed	:	Less than ± 2ppm over 8 cm dsv* 0.1ppm hhlw over 6cm dsv**
Typical time to energise magnet to full field	:	180 mins
Fringe Field (position of 5 gauss contour)***		See figure ***
Axially from magnet centre line	:	2.5 metres
Radially from magnet centre line	:	1.5 metres

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

** hhlw measurement.

*** Safety Note: In the event of a quench it is possible for the magnetic field to momentarily bloom beyond this limit. For further details please consult the Magnex site planning guide for this magnet.

Figure 1 - Fringe field plot of 7.0T 210mm actively shielded magnet



iii) 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, X, Y, ZX, ZY, XY, X2-Y2
Maximum recommended current	:	25 Amps
Coupling	:	All shims are de-coupled from main coil

Typical shim strength over 10cm diameter.

Shim	Strength (ppm/amp of main field)	% Impurity over Stated Spherical Volume
Z1	10.8	Less than 1%
Z2	4.74	Less than 1%
X(Y)	7.6	Less than 1%
ZX(ZY)	0.61	Less than 1%
XY(X2-Y2)	0.49	Less than 1%

3. THE CRYOSTAT

i) General Description

The cryostat is of conventional lay-out, consisting of a central all-welded stainless steel helium vessel which is surrounded by an aluminium radiation shield cooled by the first stage of the cryocooler. The complete assembly is contained in a stainless steel outer vacuum vessel. The outer vacuum vessel is fitted with a single service turret located centrally on top of the cryostat. The turret provides access to the helium reservoir for the demountable magnet leads and helium transfer siphon and houses the cryocooler coldhead. The outer vessel is an all-welded stainless steel construction with a room-temperature bore-tube constructed from stainless steel.

The helium reservoir contains in total approximately 980 litres of liquid helium of which approximately 300 litres volume is above the minimum operating level. Details of refill intervals are given below.

A cryogen level monitor is incorporated into the helium vessel and the associated electronics provide liquid level display and low level alarm. 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 shown in drawing AHZ330722, full specifications for the system are as follows:-

Dimensions:-

Length of cryostat	:	1280mm
Room temperature clear bore (with passive shims)	:	210mm
Room temperature bore-tube material	:	Stainless steel
Centre of field to base of stand	:	875mm
Cryostat end-flange to centre of field	:	640mm
Minimum ceiling height for siphon	:	3125mm
Weight of cryostat (excluding cryogens and gradient coil)	:	2900kg (approx.)

Liquid helium cryogen details:-

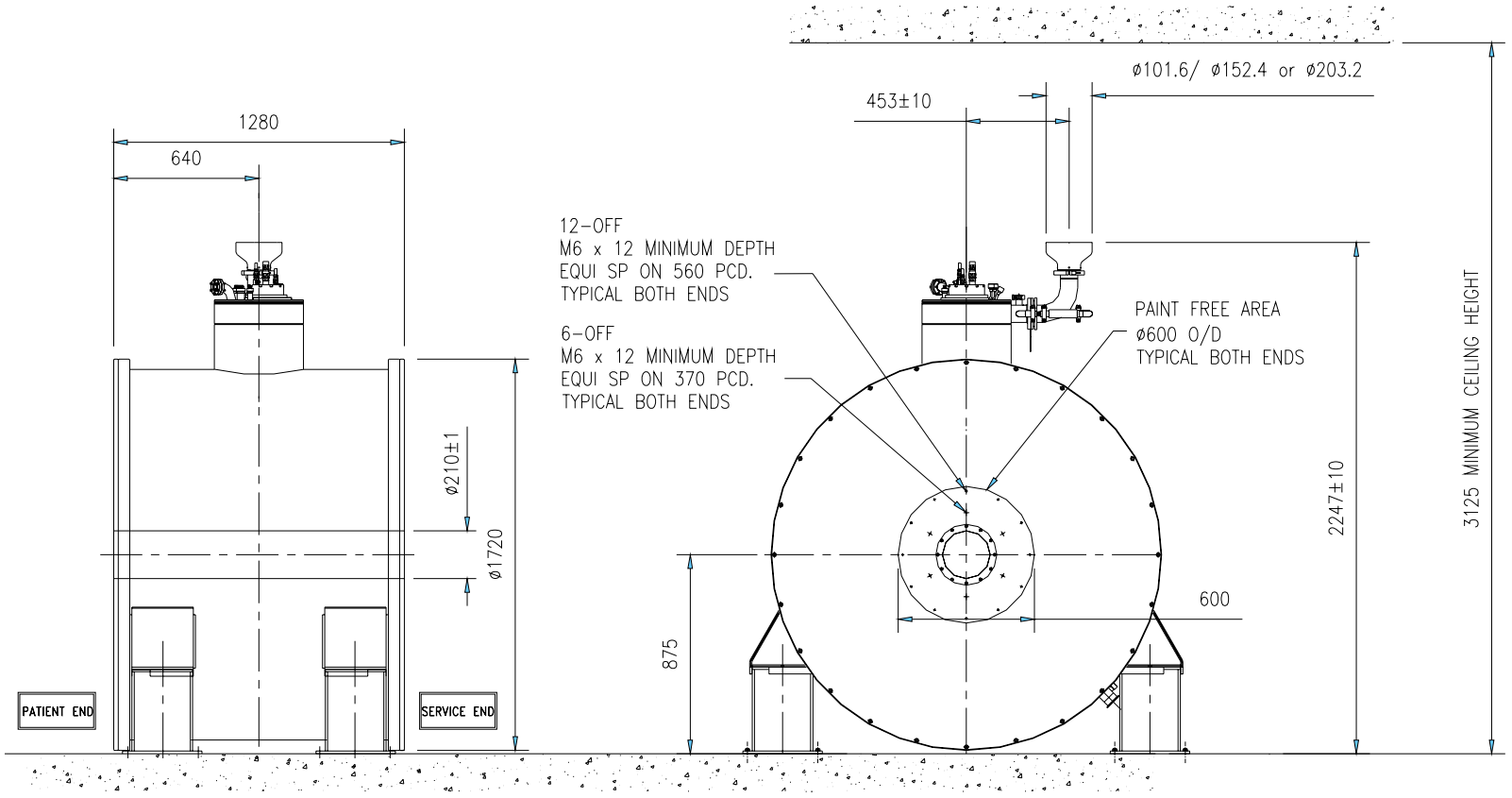
Volume for initial installation (includes cooling the magnet from 77K to 4.2K, volume required to completely fill helium reservoir and to top-up helium reservoir after magnet energisation)	:	2500 litres
Maximum volume of reservoir	:	980 litres
Hold-time (static magnetic field, leads withdrawn)	:	Nominally zero boil off Annual service recommended nominal 300 litre refill during annual service

Liquid nitrogen cryogen details:-

Volume for initial installation (pre-cool of magnet to 77K)	:	2500 litres

Cryocooler details:-

Type	:	4.2K two stage pulse tube
Compressor		
Cooling	:	Water-cooled
Input Power	:	9 kW maximum
Electrical requirements	:	3 phase, 50Hz/60Hz, high voltage
Recommended Service Interval		
Compressor	:	2 years (20,000 hrs)
Coldhead	:	As needed 2-4 years (20-40,000 hrs) target



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PJ		B	10.10.05	N/A	FEET CHANGED AND ISOLATORS ADDED
--	--	A	14.06.04	N/A	1ST ISSUE

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DIMENSIONS IN MM UNLESS STATED REMOVE ALL SHARP EDGES & BURRS

DRAWN BY:-	PJ
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ALL WEIGHTS AND DIMENSIONS ARE APPROXIMATE AND CAN CHANGE WITHOUT NOTICE

TITLE:- 7T/210AS ZERO BOIL OFF CUSTOMER INTERFACE

OUT TRAY

DRAWING NUMBER AHZ330722B

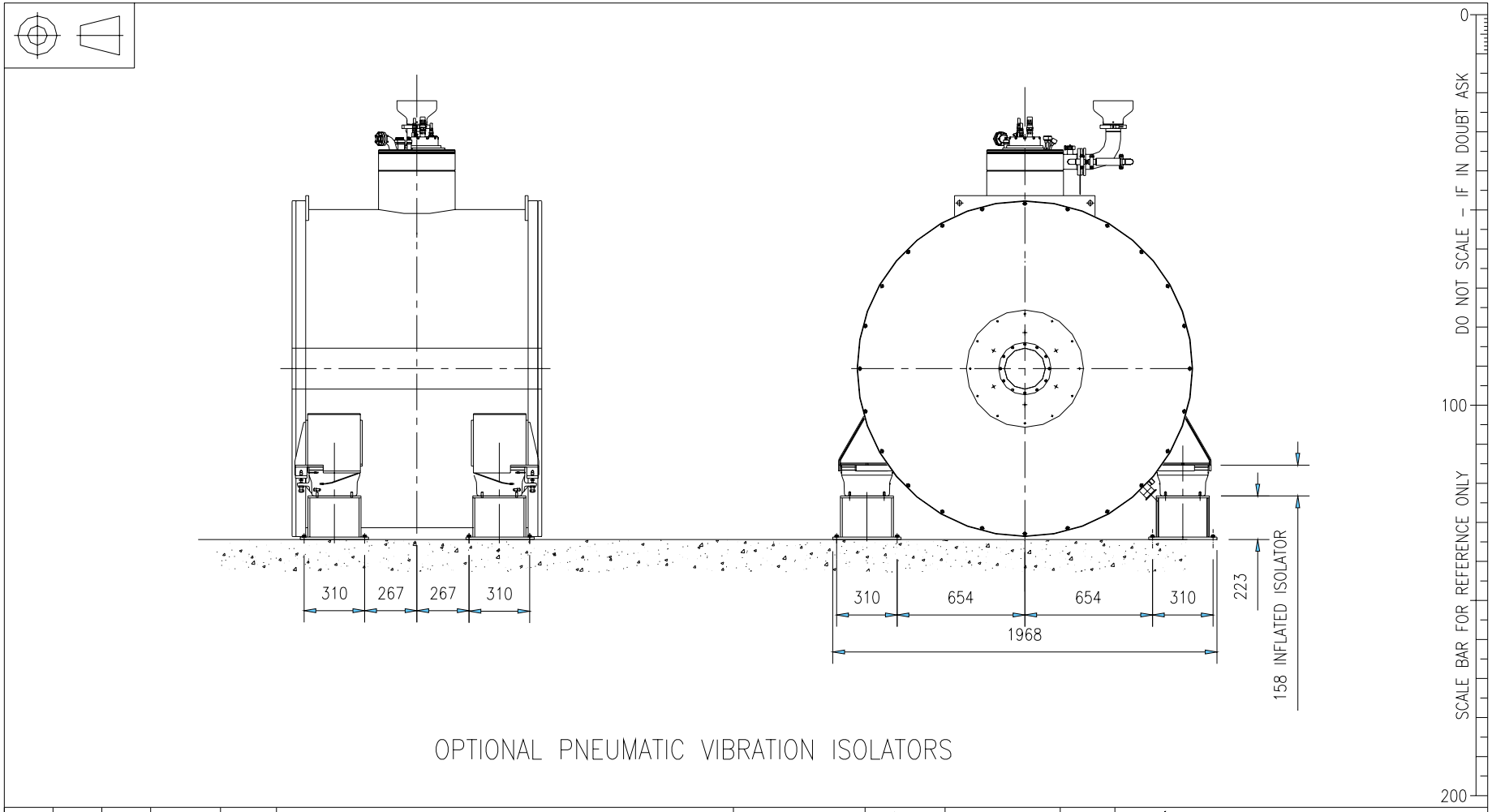
SHEET 1 OF 5

MATERIAL -

FINISH

ID No: 30722

SCALE 1:20



OPTIONAL PNEUMATIC VIBRATION ISOLATORS

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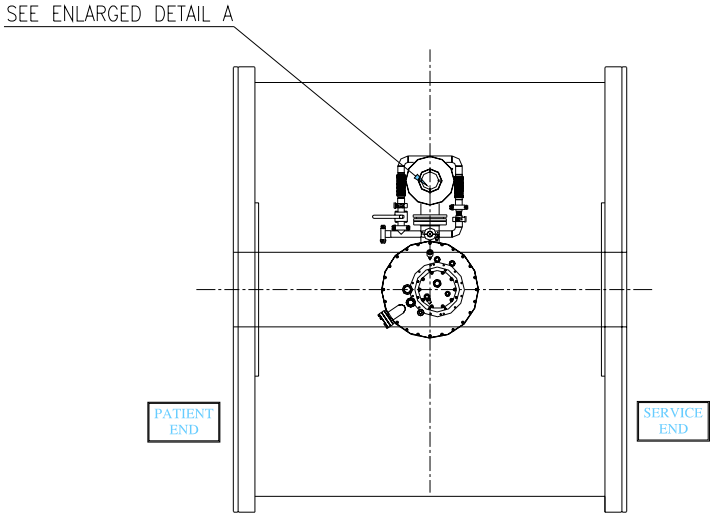
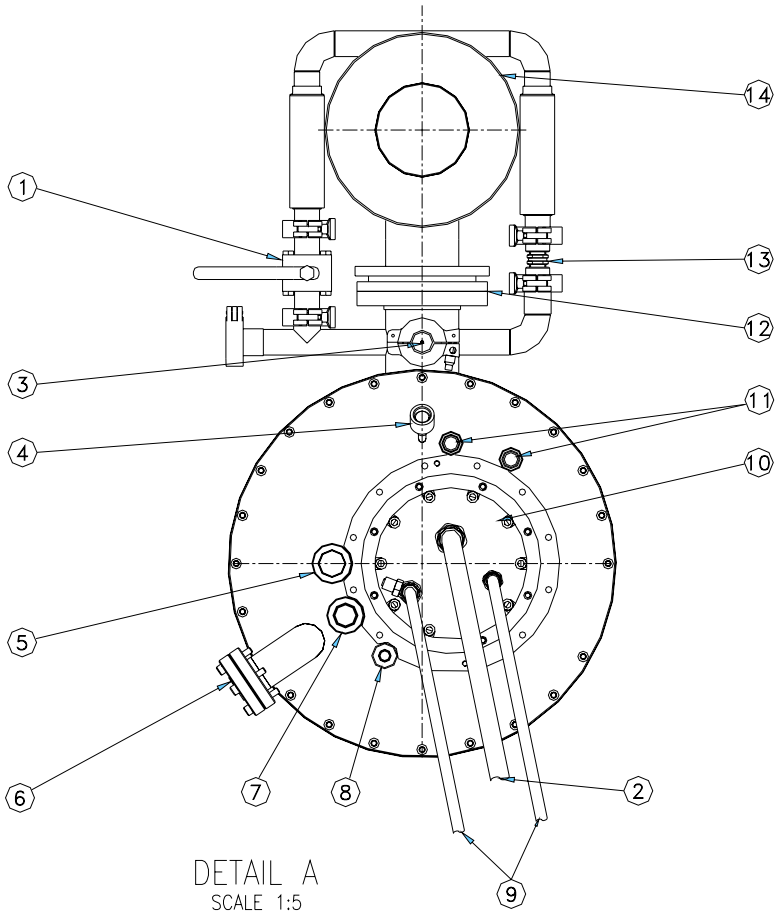
OUT TRAY
DRAWING NUMBER AHZ330722B
SHEET 2 OF 5
MATERIAL –
FINISH
ID No: 30722
SCALE 1:20

LEGEND	
1	NW25 BALL VALVE
2	COLD HEAD VALVE UNIT LINE
3	PRESSURE SENSOR
4	VESSEL DIAGNOSTICS 10 PIN SEAL
5	MAGNET CURRENT LEAD ENTRY
6	19 PIN CONNECTOR (SYSTEM DIAGNOSTICS)
7	MAGNET SHIM LEAD ENTRY
8	He. SYPHON ENTRY
9	COLD HEAD BUFFER TANK LINES
10	COLD HEAD
11	COLD HEAD DIAGNOSTICS 10 PIN SEAL (2 OFF)
12	BURSTING DISC
13	He. EXHAUST / NON RETURN VALVE
14	QUENCH DUCTING



PLAN VIEW



DETAIL A
SCALE 1:5

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OUT TRAY

DRAWING NUMBER AHZ330722B

SHEET 3 OF 5

MATERIAL –

FINISH

ID No: 30722

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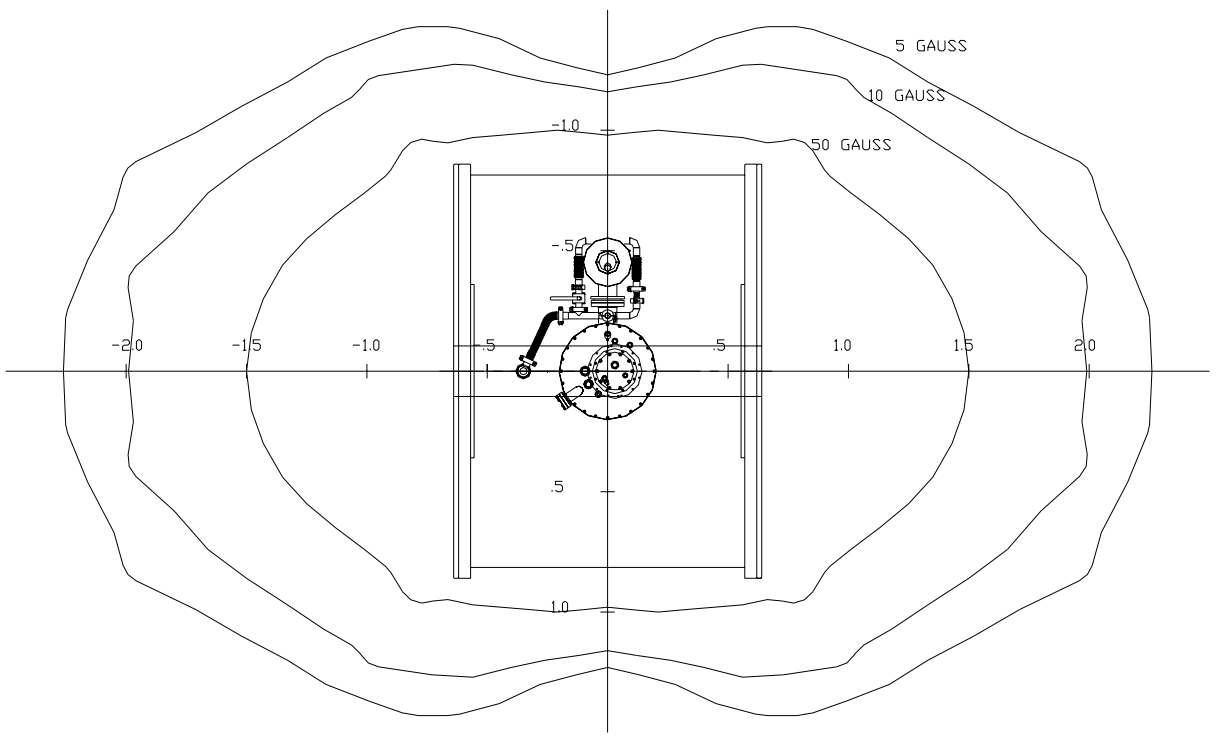

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OUT TRAY	
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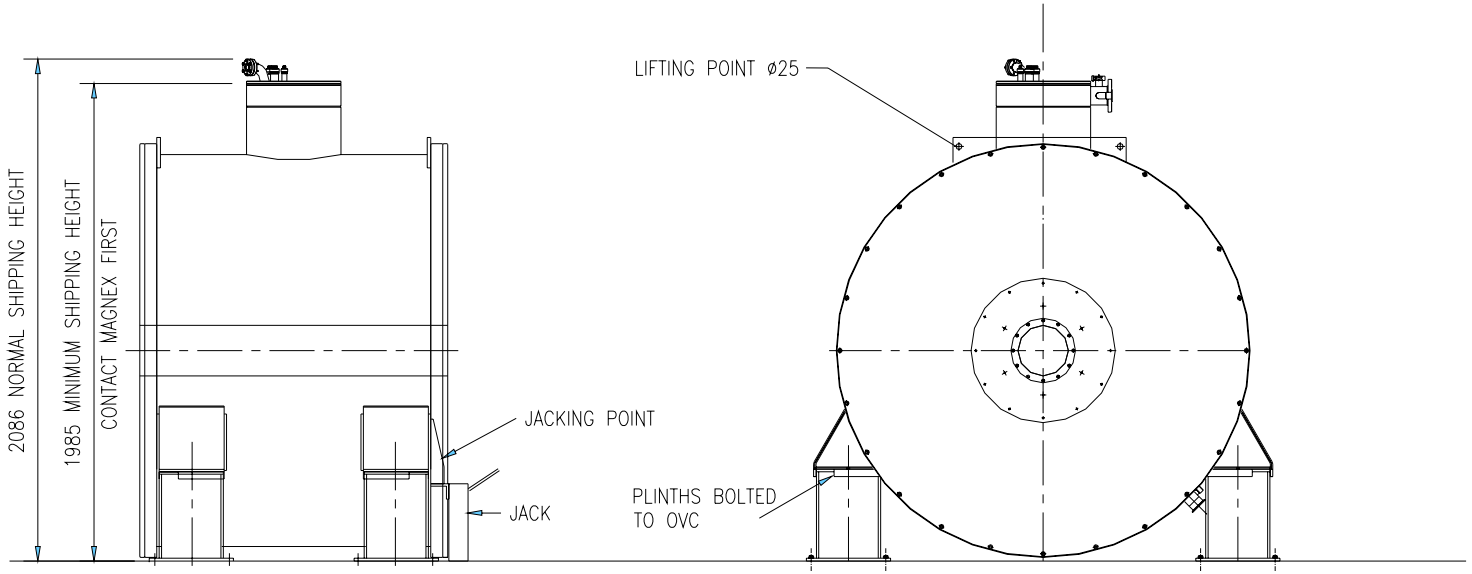
SHEET	4 OF 5
MATERIAL	-
FINISH	
ID No:	30722
SCALE	1:20

SHIPPING CONFIGURATION



NOTE: PLEASE INFORM MAGNEX IF MINIMUM SHIPPING HEIGHT IS REQUIRED

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MATERIAL –
FINISH
ID No: 30722
SCALE 1:20

4. SYSTEM COMPONENTS

i. Superconducting Magnet System Components

1 off	Superconducting 7.0T magnet with integral superconducting shim coils, housed in a low loss horizontal bore cryostat.		

ii. Standard Components

1 off	Pulse tube 4.2K coldhead with compressor and 20m flexible gas lines		P196000110
1 off	Cryogen monitor		E5083
1 off	Emergency discharge unit		E7002
1 off	Helium monitor cable		C0090003
1 off	Service cable		C0368085
1 off	Flexible siphon (2m)		P222000005
1 off	Nitrogen blow out tube (for pre-cool)		AUC400198
1 off	Spares kit		TBD
1 off	System manual		TBD
1 off	Quench duct assembly. Either of:	4”	AHC327457
		6”	AHC327456
		8”	AHC327455