SPECIFICATIONS FOR AN MRBR 7.0 TESLA / 210MM ACTIVELY SHIELDED MAGNET SYSTEM

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Document Ref : TS1322F

Date : October 2004

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1. DESCRIPTION OF THE SYSTEM

The MRBR 7.0/210 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 7 Tesla magnet housed in a horizontal room temperature bore (210mm), low-loss helium cryostat. 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 cryomonitors for helium and nitrogen. An emergency quench heater control unit is also provided.

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 8^{th} 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.

ii) Specifications

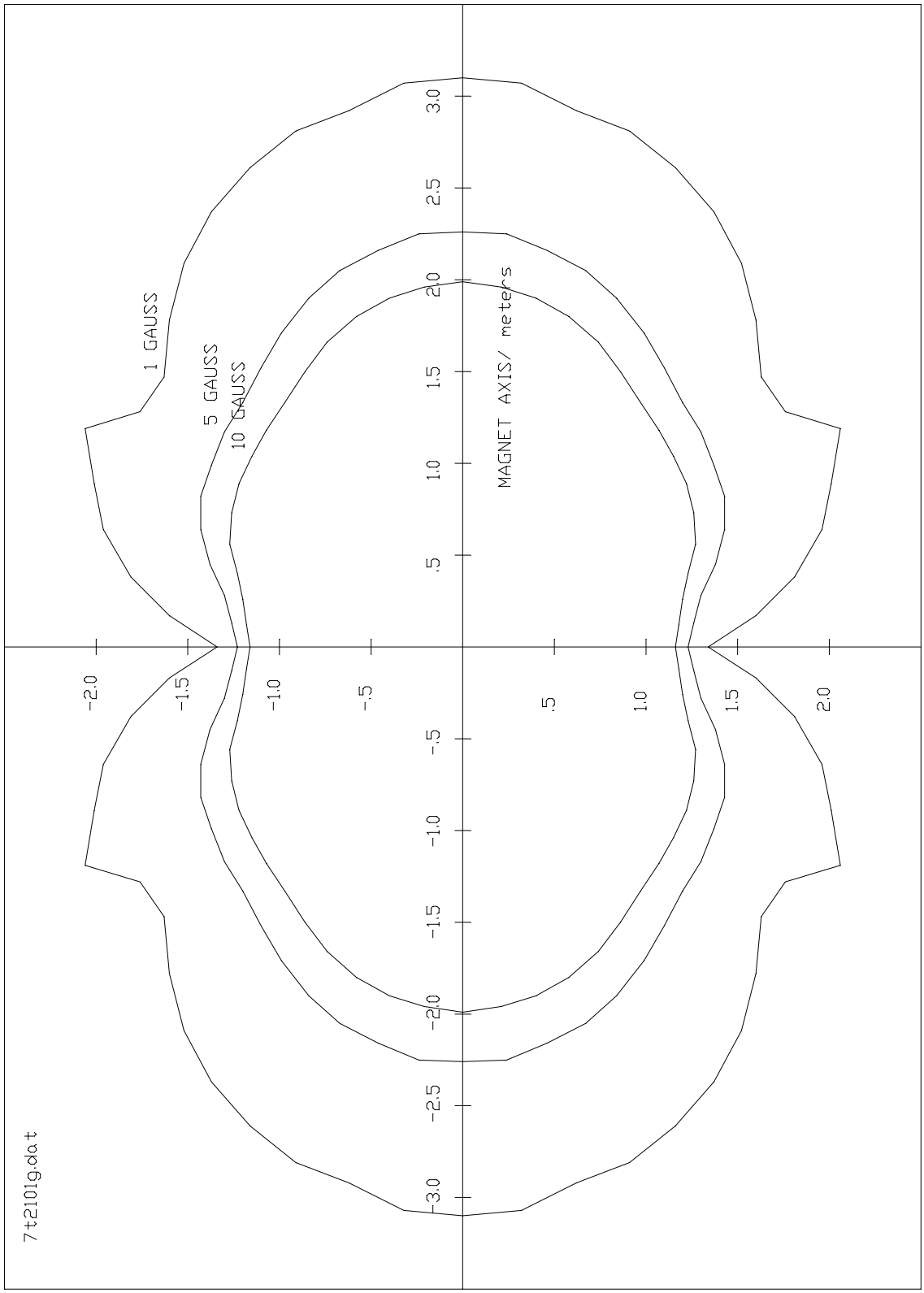
Magnet type	:	Actively shielded multi-coil superconducting
Central field	:	7.0 Tesla (^{1}H 300MHz)
Field stability measured a minimum of of 72 hours after energisation	:	Less than 0.05 ppm/hour
Operating current	:	300 Amps (nominal)
Field homogeneity values:		
Using superconducting and passive shims	:	Less than 30ppm over 10cm dsv[1]
Fully shimmed using RT shim coils[2]	:	Less than 5ppm over 10cm dsv[1]
Typical time to energise magnet to full field	:	180 mins
Fringe Field (position of 5 gauss contour)[3]		See figure 1
Axially from magnet centre line	:	2.5 metres
Radially from magnet centre line	:	1.5 metres
Screening factor	:	Greater than 10

[1] 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.

[2] Including up to 3rd order radial and 4th order axial shims

[3] **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 gas-cooled radiation shield and liquid nitrogen reservoir. The complete assembly is contained in a stainless steel outer vacuum vessel. The outer vacuum vessel is fitted 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 is an all welded stainless steel construction with a room-temperature bore-tube constructed from stainless steel.

The helium reservoir contains in total approximately 750 litres of liquid helium of which approximately 300 litres volume is above the minimum 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 shown in drawing CHZ325120, full specifications for the system are as follows:-

Dimensions:-

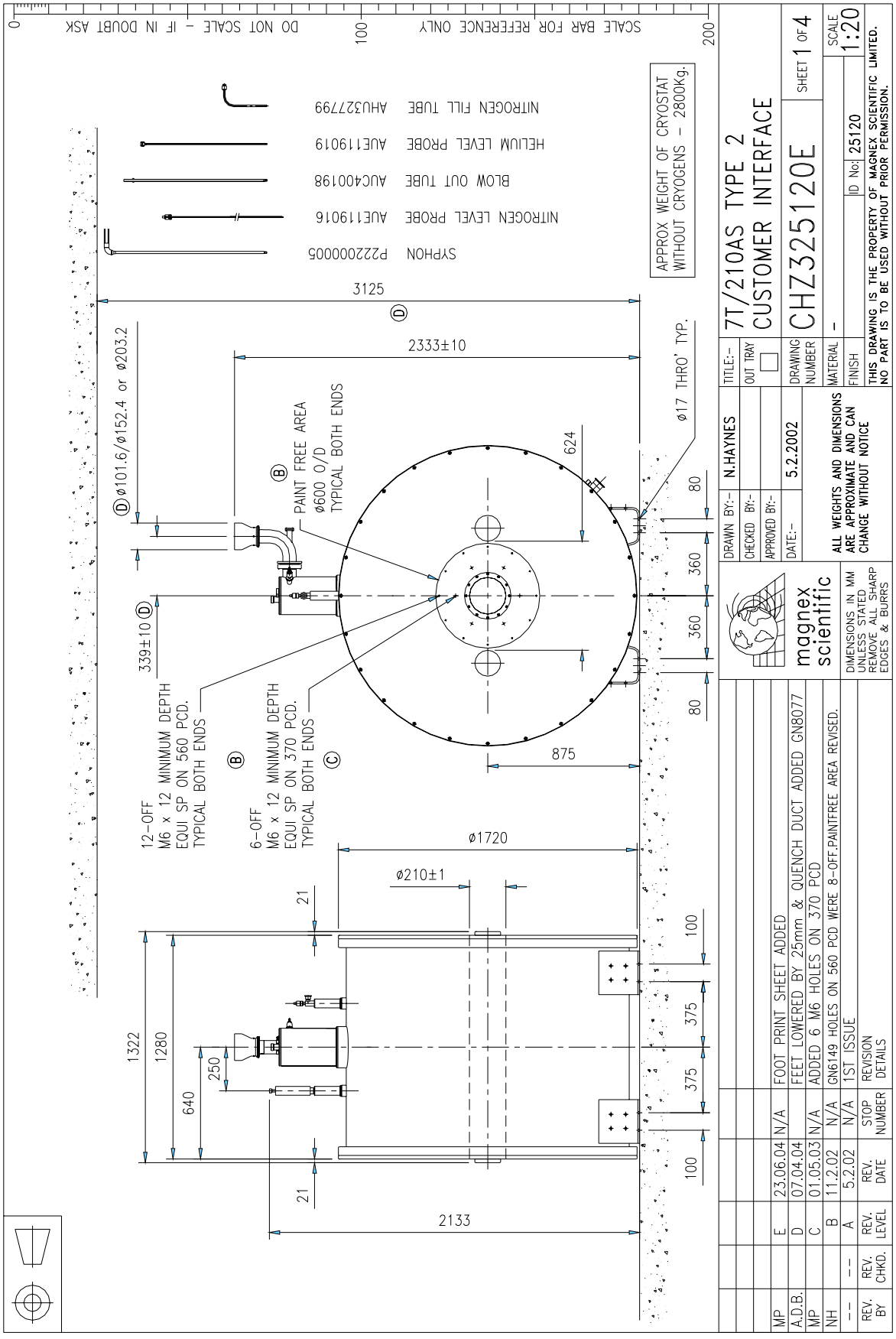
Length of cryostat	:	1280mm
Room temperature clear bore (with passive shims)	:	210mm
Room temperature bore-tube material	:	Stainless steel
Centre of field to base of stand	:	875mm
Cryostat end-flange to centre of field	:	640mm
Minimum ceiling height for siphon	:	3125mm
Weight of cryostat (excluding cryogens 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
Recommended refill volume during normal operation	:	240 litres
Maximum volume of reservoir	:	750 litres
Hold-time during normal operation (static magnetic field, leads withdrawn)	:	More than 90 days

Liquid nitrogen cryogen details:-

Volume for initial installation (includes pre-cool of magnet to 77K and volume required to completely fill LN2 reservoir)	:	2500 litres
Volume of reservoir	:	180 litres
Refill volume	:	160 litres
Hold-time in static condition	:	More than 12 days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DO NOT SCALE – IF IN DOUBT ASK
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SCALE BAR FOR REFERENCE ONLY
200
NITROGEN FILL TUBE AHU327799
HELIUM LEVEL PROBE AUE119019
BLOW OUT TUBE AUC400198
NITROGEN LEVEL PROBE AUE119016
SYPHON P222000005
APPROX WEIGHT OF CRYOSTAT WITHOUT CRYOGENS – 2800Kg.
3125
Ⓓ
2333±10
Ⓓ ø101.6/ø152.4 or ø203.2
Ⓑ PAINT FREE AREA ø600 O/D TYPICAL BOTH ENDS
624
ø17 THRO' TYP.
339±10 Ⓓ
12–OFF M6 x 12 MINIMUM DEPTH EQUI SP ON 560 PCD. TYPICAL BOTH ENDS
Ⓑ
6–OFF M6 x 12 MINIMUM DEPTH EQUI SP ON 370 PCD. TYPICAL BOTH ENDS
Ⓒ
875
80
360
360
80
ø1720
ø210±1
21
100
375
375
100
1322
1280
640
250
21
2133
MP E 23.06.04 N/A FOOT PRINT SHEET ADDED
A.D.B. D 07.04.04 FEET LOWERED BY 25mm & QUENCH DUCT ADDED GN8077
MP C 01.05.03 N/A ADDED 6 M6 HOLES ON 370 PCD
NH B 11.2.02 N/A GN6149 HOLES ON 560 PCD WERE 8–OFF.PAINTFREE AREA REVISED.
-- A 5.2.02 N/A 1ST ISSUE
REV. BY | REV. CHKD. | REV. LEVEL | REV. DATE | STOP NUMBER | REVISION DETAILS
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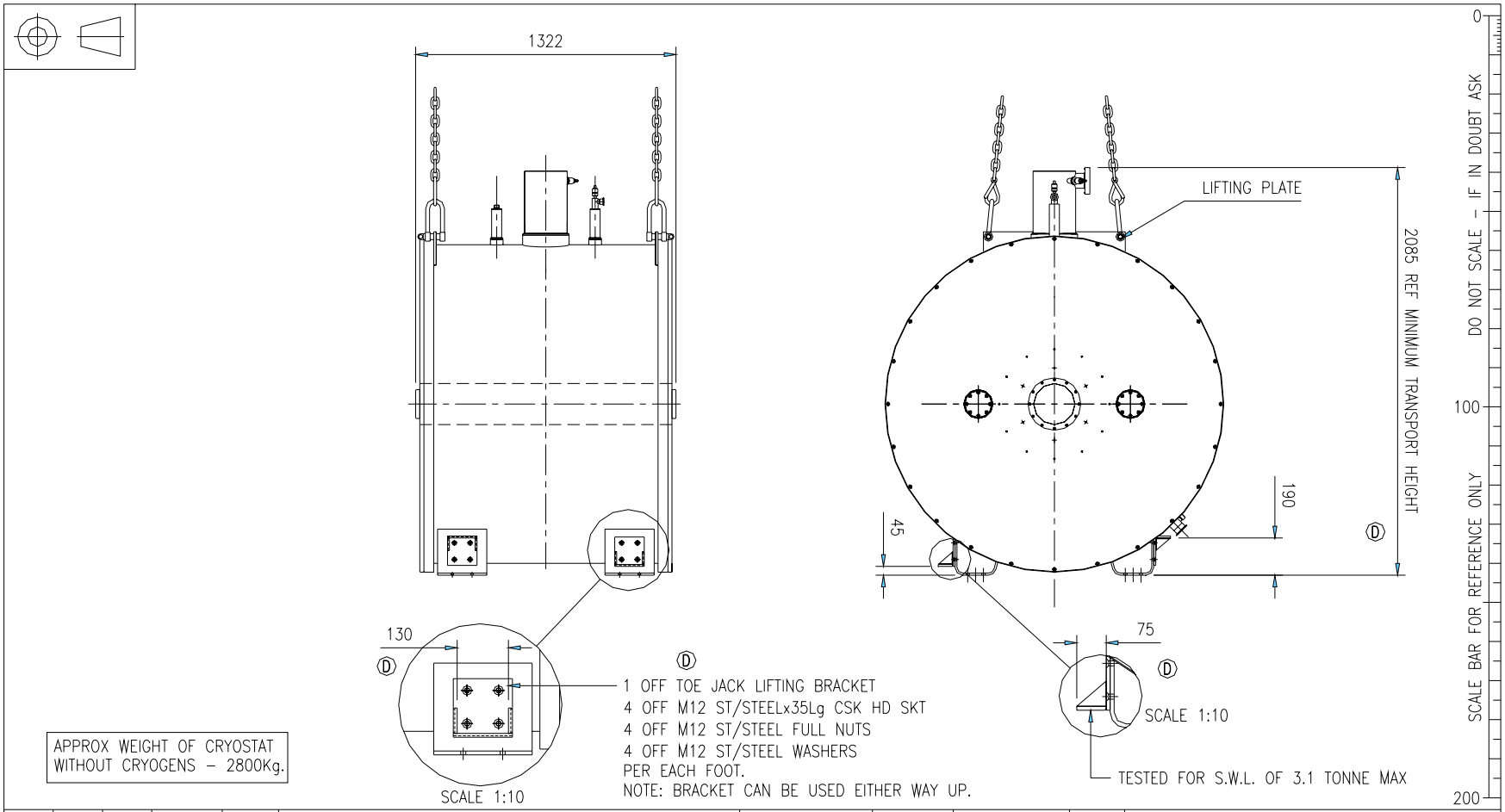
DIMENSIONS IN MM UNLESS STATED REMOVE ALL SHARP EDGES & BURRS
DRAWN BY:- N.HAYNES
CHECKED BY:-
APPROVED BY:-
DATE:- 5.2.2002
ALL WEIGHTS AND DIMENSIONS ARE APPROXIMATE AND CAN CHANGE WITHOUT NOTICE
TITLE:- 7T/210AS TYPE 2 CUSTOMER INTERFACE
OUT TRAY
DRAWING NUMBER CHZ325120E
SHEET 1 OF 4
MATERIAL –
FINISH
ID No: 25120
SCALE 1:20
THIS DRAWING IS THE PROPERTY OF MAGNEX SCIENTIFIC LIMITED. NO PART IS TO BE USED WITHOUT PRIOR PERMISSION.



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A.D.B.		D	07.04.04		FEET LOWERED BY 25mm & BRACKET ADDED GN8077
MP		C	01.05.03	N/A	NO CHANGE TO THIS SHEET
NH		B	11.2.02	N/A	GN6149 END PLATES HOLES WERE 8-OFF
--	--	A	5.2.02	N/A	1ST ISSUE

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OUT TRAY

DRAWING NUMBER CHZ325120E

SHEET 2 OF 4

MATERIAL –

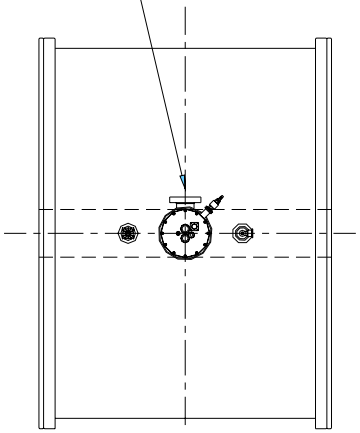
FINISH

ID No: 25120

SCALE 1:20

	LEGEND
1	He. EXHAUST / NON RETURN VALVE
2	He. LEVEL PROBE ENTRY
3	MAGNET CURRENT LEAD ENTRY
4	MAGNET SHIM LEAD ENTRY
5	19 PIN CONNECTOR (SYSTEM DIAGNOSTICS)
6	He. SYPHON ENTRY
7	BURSTING DISK (Pt. No. P200000002)
8	N2 FILL/VENT
9	N2 LEVEL PROBE

SEE ENLARGED DETAIL A



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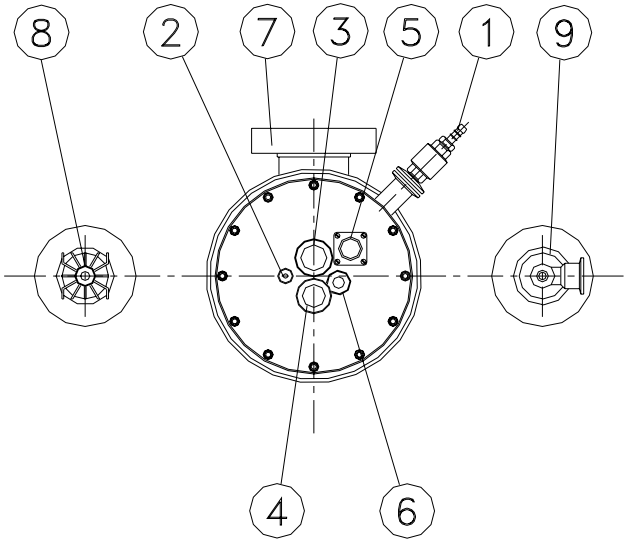

DETAIL A
SCALE 1:5

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DO NOT SCALE – IF IN DOUBT ASK
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SCALE BAR FOR REFERENCE ONLY
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A.D.B.		D	07.04.04		NO CHANGE TO THIS SHEET GN8077
MP		C	01.05.03	N/A	NO CHANGE TO THIS SHEET
NH		B	11.2.02	N/A	GN6149 NO CHANGE TO THIS SHEET
--	--	A	5.2.02	N/A	1ST ISSUE

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APPROVED BY:-			
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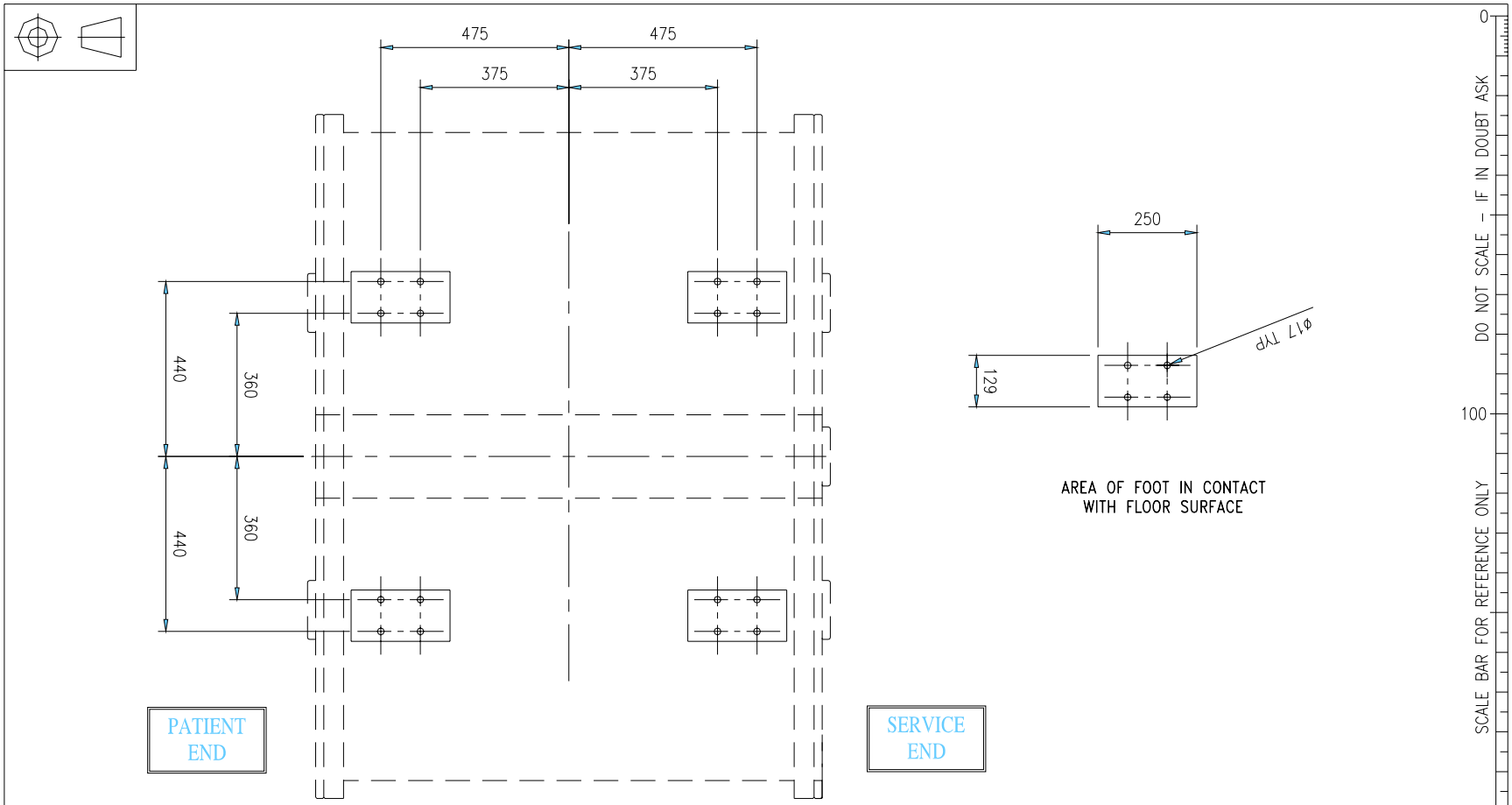

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MP		C	01.05.03	N/A	NO CHANGE TO THIS SHEET
NH		B	11.2.02	N/A	GN6149 NO CHANGE TO THIS SHEET
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DATE:-	5.2.2002

TITLE:- 7T/210AS TYPE 2 CUSTOMER INTERFACE

OUT TRAY

DRAWING NUMBER: CHZ325120E

SHEET 4 OF 4

MATERIAL: -

FINISH:

ID No: 25120

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 Ancillary Parts

1 off	Helium level monitor		E5011
1 off	De-mountable helium level probe		AUE119019
1 off	Nitrogen level monitor		E5031
1 off	Head oscillator		E5030
1 off	De-mountable nitrogen level probe		AUE119016
1 off	Emergency discharge unit		E7007
1 off	Helium monitor cable		C0090003
1 off	Nitrogen monitor cable		C0113085
1 off	Service cable		C0091085
1 off	Flexible siphon (2m)		P222000005
1 off	Nitrogen blow out tube		AUC400198
1 off	Nitrogen fill tube		AHU327799
1 off	Spares kit		
1 off	System manual		
1 off	Quench duct assembly. Either of:	4”	AHC327457
		6”	AHC327456
		8”	AHC327455