SPECIFICATIONS FOR A 4.7 TESLA/310MM BORE ACTIVELY SHIELDED MAGNET SYSTEM

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1. DESCRIPTION OF THE SYSTEM

The MRBR 4.7/310/AS system is a complete 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 (200MHz ^{1}P, 4.7 Tesla) housed in a horizontal room temperature bore (310mm), low-loss helium cryostat. Field shimming is accomplished using superconducting shim coils. A set of room temperature shim coils are required to achieve the ultimate homogeneity specifications, these are specified separately.

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 an 15cm diameter spherical volume and all orders of impurity up to 10th 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. Passive shims are also used. Final corrections are made by room-temperature correction coils 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	: Actively shielded multi-coil superconducting
Central field	: 4.7 Tesla (200MHz 'P)

Field stability measured a minimum of 72 hours after energisation	: Less than 0.05 ppm/hour

Field homogeneity values

Superconducting and passively shimmed	: Less than 10ppm over 15cm dsv*

Fringe field (position of 5 gauss contour, see Figure 1)**

Axially from magnet centre line	: 2.3 metres
Radially from magnet centre line	: 1.5 metres

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

**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.

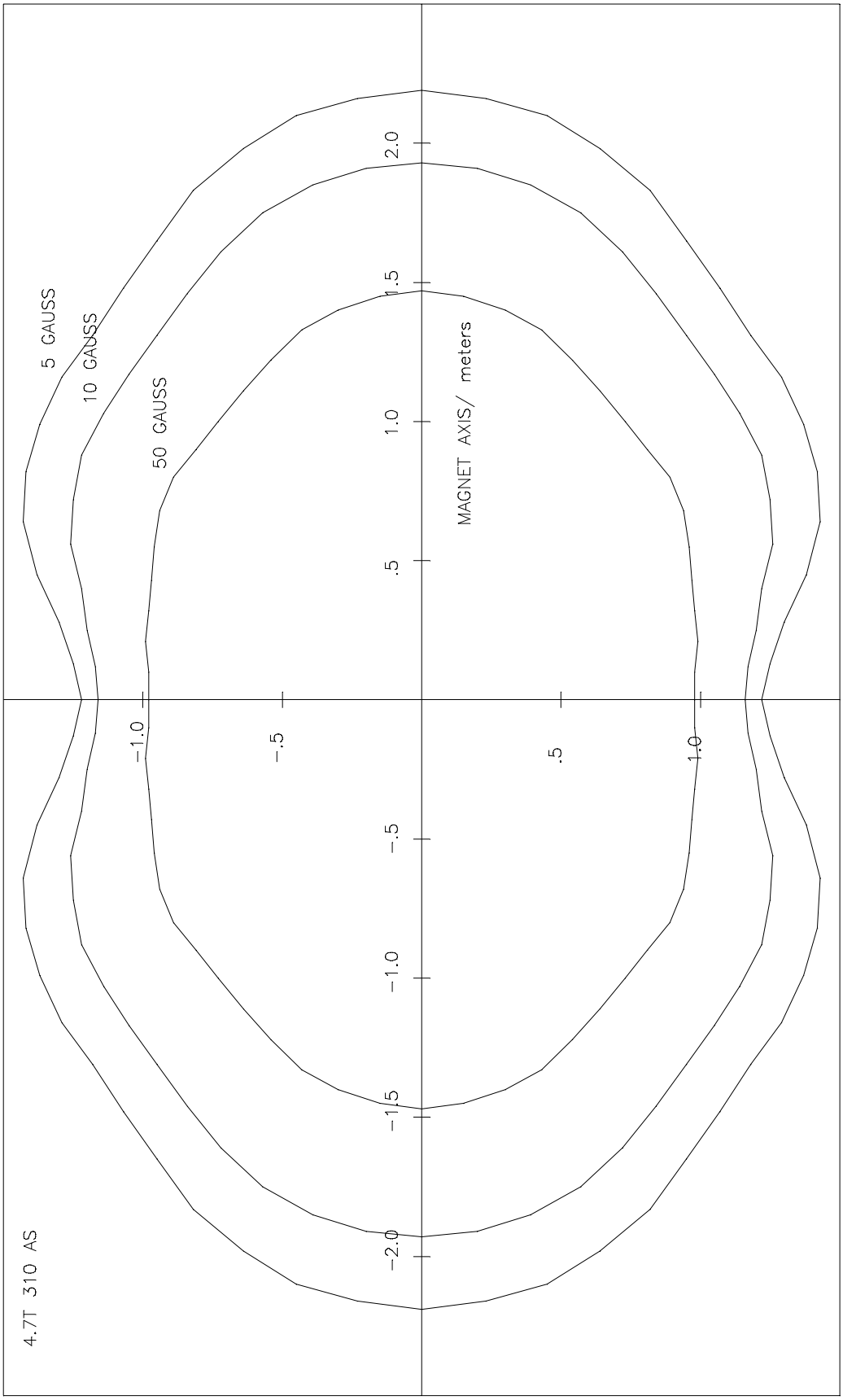
iii. Superconducting Shim Coils

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, Z3, Z4, X, Y, ZX, ZY, XY, X2-Y2
Maximum recommended current	: 25 amps
Coupling	: All shims are designed to be decoupled from main coil

Figure 1
Fringe Field



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 glass reinforced plastic.

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 600 litres of liquid helium. It is recommended that the system is operated with the superconducting shim coils only partially non-immersed in liquid helium. 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 accompanying drawing (Figure 2) and full specifications for the system are as follows:-

Dimensions:-

Length of cryostat	: 1280mm
Overall height	: 2158mm
Overall diameter	: 1720mm
Room temperature clear bore (without out shims and gradients)	: 310 +/- 1mm
Room temperature bore-tube material	: Glass reinforced plastic
Centre of field to base of stand	: 900mm
Minimum ceiling height for helium siphon	: 3150mm

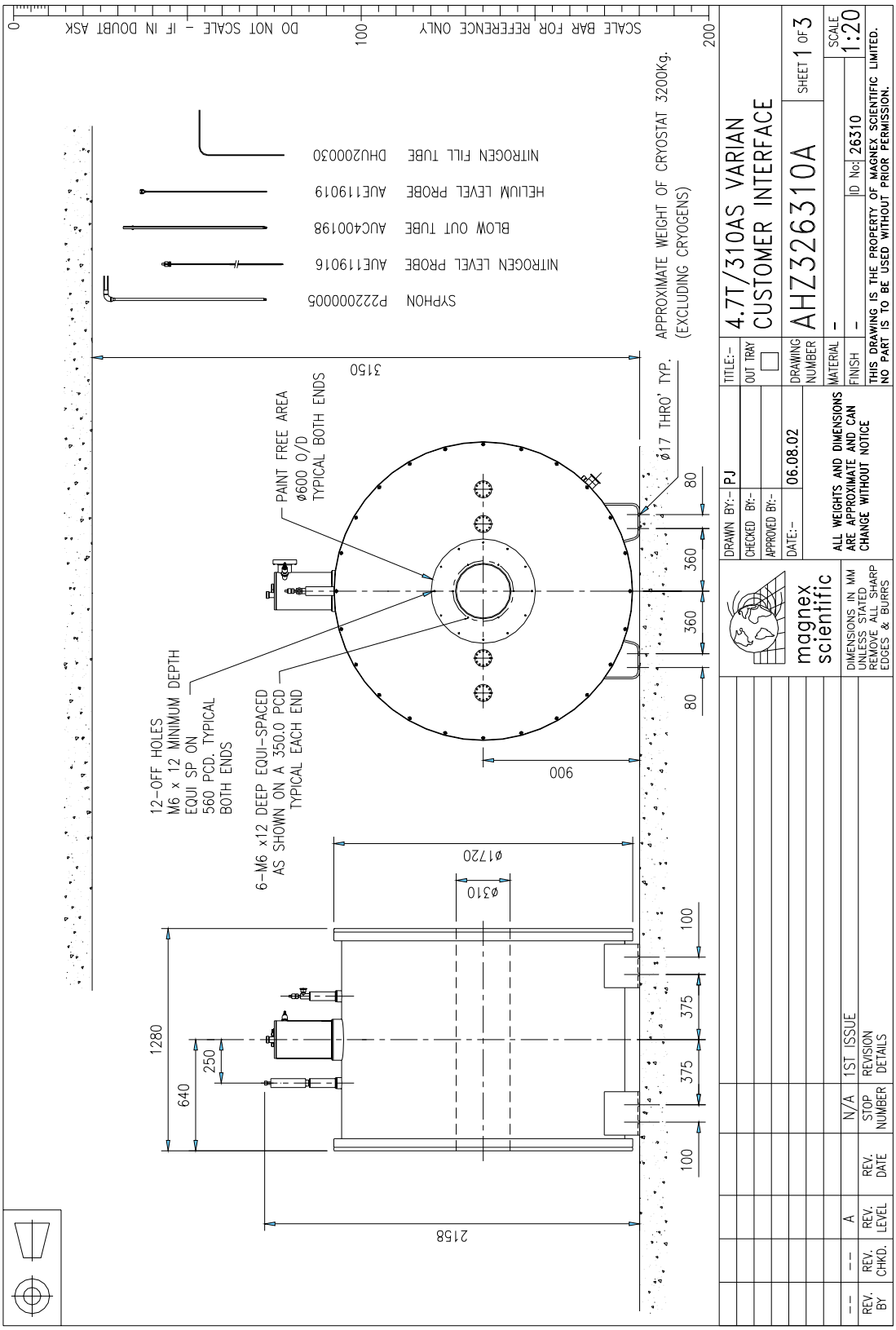
Weight of cryostat (excluding cryogens)	: 3200kg (approx)

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)	: 1800 litres (approx)
Recommended refill volume during normal operation	: 180 litres
Maximum volume of reservoir	: 600 litres
Hold-time during normal operation (static magnetic field, leads withdrawn)	: Greater than 60 days

Liquid nitrogen cryogen details:-

Volume for initial installation (includes pre-cool of magnet to 77K and volume required to completely fill LN2 reservoir)	: 1800 litres (approx)
Volume of reservoir	: 150 litres
Refill volume	: 140 litres
Hold time in static condition	: Greater than 12 days


SCALE BAR FOR REFERENCE ONLY
DO NOT SCALE – IF IN DOUBT ASK
NITROGEN FILL TUBE DHU200030
HELIUM LEVEL PROBE AUE119019
BLOW OUT TUBE AUC400198
NITROGEN LEVEL PROBE AUE119016
SYPHON P222000005
APPROXIMATE WEIGHT OF CRYOSTAT 3200Kg.
(EXCLUDING CRYOGENS)
PAINT FREE AREA
ø600 O/D
TYPICAL BOTH ENDS
ø17 THRO' TYP.
12-OFF HOLES
M6 x 12 MINIMUM DEPTH
EQUI SP ON
560 PCD. TYPICAL
BOTH ENDS
6-M6 x12 DEEP EQUI-SPACED
AS SHOWN ON A 350.0 PCD
TYPICAL EACH END
3150
900
ø1720
ø310
2158
1280
640
250
80
360
360
80
100
375
375
100
DRAWN BY:- PJ
CHECKED BY:-
APPROVED BY:-
DATE:- 06.08.02
TITLE:- 4.7T/310AS VARIAN CUSTOMER INTERFACE
OUT TRAY
DRAWING NUMBER AHZ326310A
SHEET 1 OF 3
MATERIAL -
FINISH -
ID No: 26310
SCALE 1:20
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ALL WEIGHTS AND DIMENSIONS ARE APPROXIMATE AND CAN CHANGE WITHOUT NOTICE
DIMENSIONS IN MM UNLESS STATED
REMOVE ALL SHARP EDGES & BURRS
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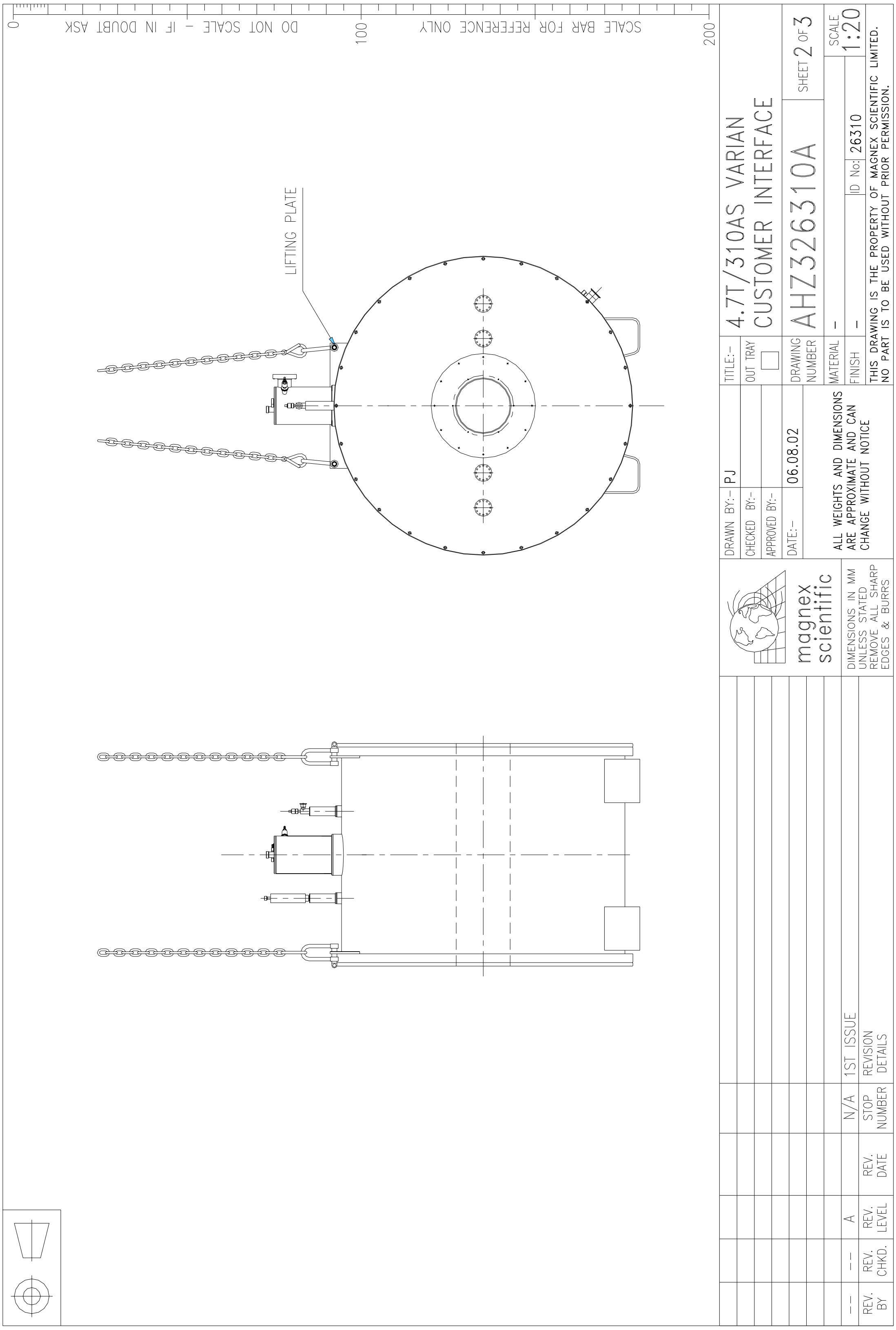

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LIFTING PLATE
TITLE:- 4.7T/310AS VARIAN CUSTOMER INTERFACE
OUT TRAY
DRAWING NUMBER AHZ326310A
SHEET 2 OF 3
SCALE 1:20
MATERIAL -
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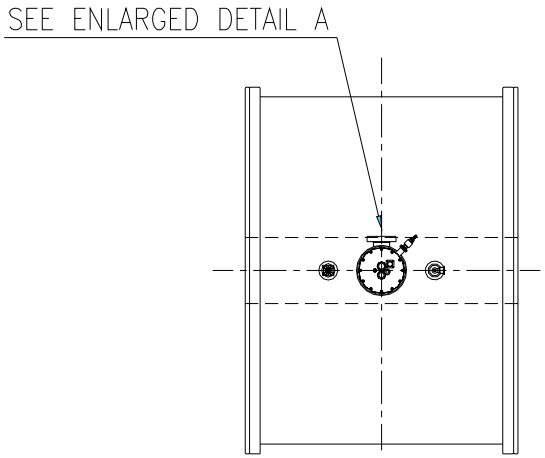
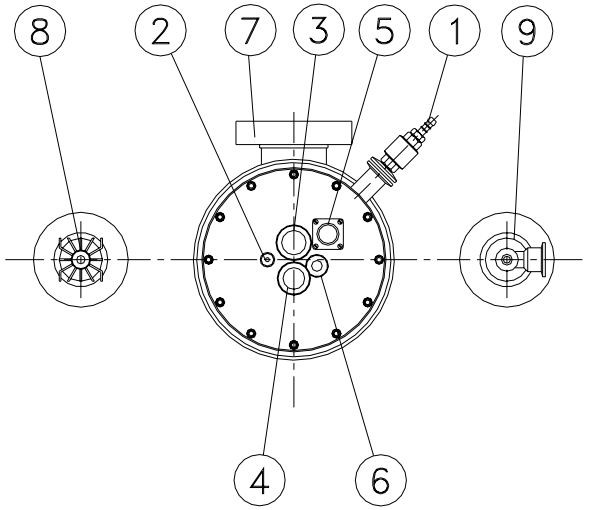
REV. CHKD.
REV. BY

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



PLAN VIEW



DETAIL A
SCALE 1:5

SCALE BAR FOR REFERENCE ONLY — DO NOT SCALE – IF IN DOUBT ASK
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DIMENSIONS IN MM UNLESS STATED
REMOVE ALL SHARP EDGES & BURRS

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TITLE:– 4.7T/310AS VARIAN CUSTOMER INTERFACE

OUT TRAY ☐

DRAWING NUMBER AHZ326310A

SHEET 3 OF 3

MATERIAL –

FINISH –

ID No: 26310

SCALE 1:20

4. SYSTEM COMPONENTS

i. Superconducting Magnet System Components

1 off 4.7T 310mm actively shielded 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