PRELIMINARY TECHNICAL SPECIFICATION

FOR A 7.0 TESLA / 400MM

ACTIVELY SHIELDED MAGNET SYSTEM

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1. DESCRIPTION OF SYSTEM

The MRBR 7.0/400/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 essentially consists of a highly homogeneous actively shielded superconducting magnet (300MHz ^{1}P, 7.05 Tesla) housed in a horizontal room temperature bore (400mm), low-loss helium cryostat. Field shimming is normally accomplished using superconducting shim coils. 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 a precision machined aluminium alloy former and then fully vacuum impregnated for robustness and long-term reliability.

The field homogeneity is defined over a 20cm 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 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	:	Multi-coil superconducting
Central field	:	7.0 Tesla (300MHz ^{1}P)
Field stability measured a minimum of 72 hours after energisation	:	Less than 0.05 ppm/hour
Operating current	:	TBC Amps (nominal)
Field homogeneity values		
Superconducting only shimmed	:	Less than 20ppm over 20cm dsv*
Fully shimmed using RT shims	:	Less than 5ppm over 20cm dsv*
Estimate of helium consumption during ramping to full field	:	Less than 10 litres
Fringe field (position of 5 gauss contour** in unshielded state)	:	See Figure 1
Axially from magnet centre line	:	4.2 metres
Radially from magnet centre line	:	2.3 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.

** 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.

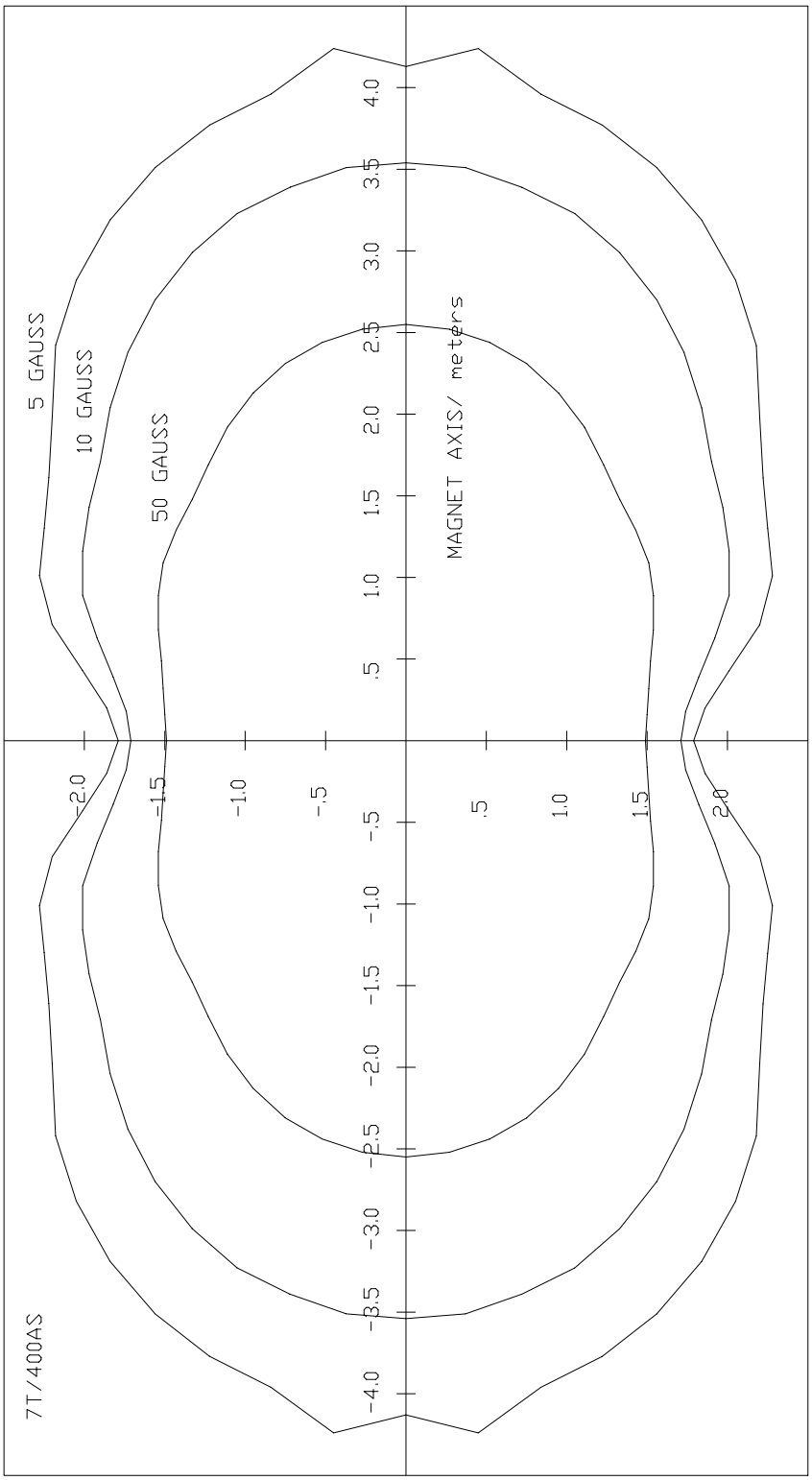
iii. Superconducting Shim Coils

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, ZXY, Z(X2-Y2)
Maximum recommended current	:	25 amps
Coupling	:	All shims are designed to be decoupled from main coil except Z1, Z2, Z3 and Z4

Figure 1 Stray 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 the 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 consists of load-spreading plates which have provision for fixing to the floor of the installation room. The helium reservoir contains approximately 2500 litres of liquid helium of which approximately 750 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.

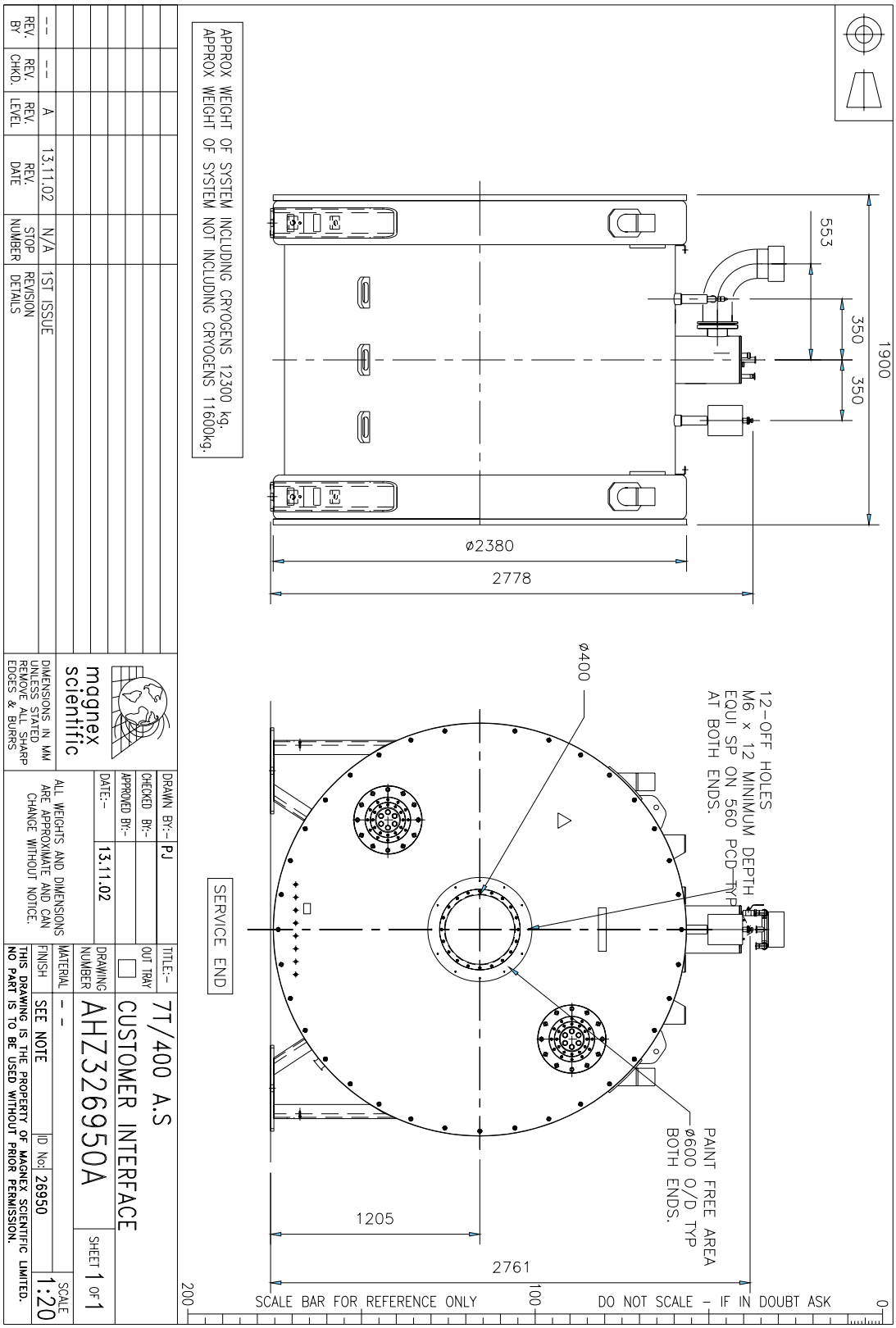
ii. Specifications

The cryostat specifications (see figure 2) are as follows:-

Dimensions:-

Length of cryostat	: 1900mm nominal
Height with support frame	: 2824mm
Room temperature clear bore (without shims and gradients)	: 400mm
Room temperature bore-tube material	: Stainless steel
Centre of field to base of stand	: 1205mm

Figure 2 Drawing of cryostat



Cryostat end flange to centre of field	:	926mm
Outside diameter	:	2380 mm
Minimum ceiling height for helium transfer tube	:	3335mm
Weight of cryostat (excluding cryogens)	:	11,600 (approx)

Liquid helium cryogen details :-

Volume for initial installation (includes cooling the magnet from 77K to 4.2K, and volume required to completely fill helium reservoir and top-up after magnet energisation)	:	7000 litres
Recommended refill volume during normal operation	:	750 litres
Hold-time during normal operation (static magnetic field, leads withdrawn)	:	More than 100 days

Liquid nitrogen cryogen details :-

Volume for initial installation (includes pre-cool of magnet to 77K and volume required to completely fill LN2 reservoir)	:	7000 litres
Volume of reservoir	:	400 litres nominal
Refill volume	:	400 litres nominal excluding transfer losses
Hold-time in static condition	:	More than 14 days

4. SYSTEM COMPONENTS

1 off	7T/400mm actively shielded magnet system with integral s/c shims, housed in a low loss cryostat.
1 off	Stand
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