GE Medical Systems

Technical Publications

Direction 46–015120
Revision 12

GE 1.5T Magnet And Cryogens Subsystem

Operating Documentation

DAMAGE IN TRANSPORTATION

All packages should be closely examined at time of delivery. If damage is apparent, have notation "**damage in shipment**" written on **all** copies of the freight or express bill **before** delivery is accepted or "signed for" by a General Electric representative or a hospital receiving agent. Whether noted or concealed, damage **MUST** be reported to the carrier **immediately** upon discovery, or in any event, within **14** days after receipt, and the contents and containers held for inspection by the carrier. A transportation company will not pay a claim for damage if an inspection is not requested within this **14** day period.

Call Traffic and Transportation, Milwaukee, WI (414) 785–5052/8*323–5052 **immediately** after damage is found. At this time be ready to supply name of carrier, delivery date, consignee name, freight or express bill number, item damaged and extent of damage.

Complete instructions regarding claim procedure are found in Section "S" of the Policy & Procedure Bulletins.

3/12/92

GE Medical Systems

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WARNING

- THIS SERVICE MANUAL IS AVAILABLE IN ENGLISH ONLY.
- IF A CUSTOMER'S SERVICE PROVIDER REQUIRES A LANGUAGE OTHER THAN ENGLISH, IT IS THE CUSTOMER'S RESPONSIBILITY TO PROVIDE TRANSLATION SERVICES.
- DO NOT ATTEMPT TO SERVICE THE EQUIPMENT UNLESS THIS SERVICE MANUAL HAS BEEN CONSULTED AND IS UNDERSTOOD.
- FAILURE TO HEED THIS WARNING MAY RESULT IN INJURY TO THE SERVICE PROVIDER, OPERATOR OR PATIENT FROM ELECTRIC SHOCK, MECHANICAL OR OTHER HAZARDS.

AVERTISSEMENT

- CE MANUEL DE MAINTENANCE N'EST DISPONIBLE QU'EN ANGLAIS.
- SI LE TECHNICIEN DU CLIENT A BESOIN DE CE MANUEL DANS UNE AUTRE LANGUE QUE L'ANGLAIS, C'EST AU CLIENT QU'IL INCOMBE DE LE FAIRE TRADUIRE.
- NE PAS TENTER D'INTERVENTION SUR LES ÉQUIPEMENTS TANT QUE LE MANUEL SERVICE N'A PAS ÉTÉ CONSULTÉ ET COMPRIS.
- LE NON-RESPECT DE CET AVERTISSEMENT PEUT ENTRAÎNER CHEZ LE TECHNICIEN, L'OPÉRATEUR OU LE PATIENT DES BLESSURES DUES À DES DANGERS ÉLECTRIQUES, MÉCANIQUES OU AUTRES.

WARNUNG

- DIESES KUNDENDIENST–HANDBUCH EXISTIERT NUR IN ENGLISCHER SPRACHE.
- FALLS EIN FREMDER KUNDENDIENST EINE ANDERE SPRACHE BENÖTIGT, IST ES AUFGABE DES KUNDEN FÜR EINE ENTSPRECHENDE ÜBERSETZUNG ZU SORGEN.
- VERSUCHEN SIE NICHT, DAS GERÄT ZU REPARIEREN, BEVOR DIESES KUNDENDIENST–HANDBUCH NICHT ZU RATE GEZOGEN UND VERSTANDEN WURDE.
- WIRD DIESE WARNUNG NICHT BEACHTET, SO KANN ES ZU VERLETZUNGEN DES KUNDENDIENSTTECHNIKERS, DES BEDIENERS ODER DES PATIENTEN DURCH ELEKTRISCHE SCHLÄGE, MECHANISCHE ODER SONSTIGE GEFAHREN KOMMEN.

AVISO

- ESTE MANUAL DE SERVICIO SÓLO EXISTE EN INGLÉS.
- SI ALGÚN PROVEEDOR DE SERVICIOS AJENO A GEMS SOLICITA UN IDIOMA QUE NO SEA EL INGLÉS, ES RESPONSABILIDAD DEL CLIENTE OFRECER UN SERVICIO DE TRADUCCIÓN.
- NO SE DEBERÁ DAR SERVICIO TÉCNICO AL EQUIPO, SIN HABER CONSULTADO Y COMPRENDIDO ESTE MANUAL DE SERVICIO.
- LA NO OBSERVANCIA DEL PRESENTE AVISO PUEDE DAR LUGAR A QUE EL PROVEEDOR DE SERVICIOS, EL OPERADOR O EL PACIENTE SUFRAN LESIONES PROVOCADAS POR CAUSAS ELÉCTRICAS, MECÁNICAS O DE OTRA NATURALEZA.

ATENÇÃO

- ESTE MANUAL DE ASSISTÊNCIA TÉCNICA SÓ SE ENCONTRA DISPONÍVEL EM INGLÊS.
- SE QUALQUER OUTRO SERVIÇO DE ASSISTÊNCIA TÉCNICA, QUE NÃO A GEMS, SOLICITAR ESTES MANUAIS NOUTRO IDIOMA, É DA RESPONSABILIDADE DO CLIENTE FORNECER OS SERVIÇOS DE TRADUÇÃO.
- NÃO TENTE REPARAR O EQUIPAMENTO SEM TER CONSULTADO E COMPREENDIDO ESTE MANUAL DE ASSISTÊNCIA TÉCNICA.
- O NÃO CUMPRIMENTO DESTE AVISO PODE POR EM PERIGO A SEGURANÇA DO TÉCNICO, OPERADOR OU PACIENTE DEVIDO A‘ CHOQUES ELÉTRICOS, MECÂNICOS OU OUTROS.

AVVERTENZA

- IL PRESENTE MANUALE DI MANUTENZIONE È DISPONIBILE SOLTANTO IN INGLESE.
- SE UN ADDETTO ALLA MANUTENZIONE ESTERNO ALLA GEMS RICHIEDE IL MANUALE IN UNA LINGUA DIVERSA, IL CLIENTE È TENUTO A PROVVEDERE DIRETTAMENTE ALLA TRADUZIONE.
- SI PROCEDA ALLA MANUTENZIONE DELL’APPARECCHIATURA SOLO DOPO AVER CONSULTATO IL PRESENTE MANUALE ED AVERNE COMPRESO IL CONTENUTO.
- NON TENERE CONTO DELLA PRESENTE AVVERTENZA POTREBBE FAR COMPIERE OPERAZIONI DA CUI DERIVINO LESIONI ALL’ADDETTO ALLA MANUTENZIONE, ALL’UTILIZZATORE ED AL PAZIENTE PER FOLGORAZIONE ELETTRICA, PER URTI MECCANICI OD ALTRI RISCHI.

警告

・このサービスマニュアルには英語版しかありません。
・GEMS以外でサービスを担当される業者が英語以外の言語を要求される場合、翻訳作業はその業者の責任で行うものとさせていただきます。
・このサービスマニュアルを熟読し理解せずに、装置のサービスを行わないで下さい。
・この警告に従わない場合、サービスを担当される方、操作員あるいは患者さんが、感電や機械的又はその他の危険により負傷する可能性があります。

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SECTION 0 – MAGNET FUNCTIONAL CHECKS

The Commissioning and Operating Guidelines for the magnet system are provided in Table 0–1 (Magnet Commissioning / Operating Guidelines) and serve as the basis for all functional checks, with the exception of Emergency/Magnet Rundown Unit Operation. Checking and maintaining the guideline conditions, as recommended in the table, will ensure the optimum commissioning and operating of the magnet, The specific sections within Functional Checks cover the methodology and required apparatus for the individual checks.

TABLE 0 –1

MAGNET COMMISSIONING / OPERATING GUIDELINES

ELEMENT	GUIDELINE	CHECK / SETTING REQUIREMENTS
MAIN FIELD	15000 – 15002 GAUSS 63.866 MHz – 63.874 MHz	AFTER RAMPING & SHIMMING OR WHEN OUT OF GRADIENT AMP. BANDWIDTH,
DRIFT	<0.1 PPM (6.3 Hz) / HR (12 Hrs AFTER RAMP)	BEFORE MECHANICAL SHIMMING
HOMOGENEITY	<6.3 PPM S/C SHIMMING (C6 VOL - 30cm X 40cm)	AFTER MECH. SHIMMING, ENVIRONMENT CHANGES OR IMAGE DEGRADATION.
MAIN POWER SUPPLY	815 mA±5 MAIN HEATER 815 mA±5 AXIAL HEATER PASS VENDOR MANUAL CKS.	BEFORE RAMPING UP/ DOWN
SHIM POWER SUPPLY	710mA ±10 AXAIL, T1 , T2 HEATER PASS VENDOR MANUAL CKS.	BEFORE SHIMMING
RAMPING CIRCUIT VOLTAGE @ 500A	< 2.00V TOTAL <150 mV RAMP LEADS	BEFORE RAMPING UP / DOWN
MAIN HEATER RESISTANCE	5.9 – 8.0 or 20.5 – 25.0 OHMS	AT START OF COMMISSIONING

SECTION 0 - MAGNET FUNCTIONAL CHECKS (continued)

TABLE 0–1 (continued)

MAGNET COMMISSIONING / OPERATING GUIDELINES

ELEMENT	GUIDELINE	CHECK/SETTING REQUIREMENTS
AXIAL HEATER RESISTANCE	25.5 –31 .0 OHMS	AT START OF COMMISSIONING
T1 & T2 HEATER RESISTANCE	6.1 – 8.0 OHMS	AT START OF COMMISSIONING
RAMP LEAD PREP	NEW CONTACT BANDS GAS FLOW OUT TOP HOLES	BEFORE RAMPING UP/DOWN
SHIM LEAD PREP	VENT CAP OFF / V3 OPEN LEAD FROSTED	BEFORE SHIMMING
VENTING	PRESSURE DROP CALC. <17 PSI	AT MAGNET INSTALLATION
CRYOSTAT PRES.	0.25 – 0.50 PSIG	AFTER INSTALLATION, CRYOSTAT VENTING, RAMPING, SHIMMING
FLOW (F1)	0.4 – 0.6 SCFH	NOTE: SPEC VAULES ARE
FLOW (F2)	1.5 – 2.0 SCFH	STEADY STATE AFTER
BOIL OFF	<0.2 LITER / Hr. (AVE.)	PASSING LEAK CHECK,
HELIUM LEVEL	75% FOR RAMPING 50% MINIMUM	BEFORE RAMPING ON GOING
FILL CONDITIONS	V2 OPEN, DEWAR <7 PSIG CRYOSTAT <3 PSIG	HELIUM FILL / REFILL
SHIELD COOLER	1ST STAGE 32– 60K 2ND STAGE 7 – 17K	HIGH PRESSURE / BOIL OFF
"TAO"	< 17 mV PEAK to PEAK (USING 46-281406G1 TOOL)	HIGH PRESSURE / BOIL OFF

FUNCTIONAL CHECKS

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1	MAGNETIC FIELD STABILITY	1–1

SECTION 1 – MAGNETIC FIELD STABILITY

Description:

The following check is made to determine “uncompensated” main field drift of the magnet.

Procedure:

CAUTION

Moving equipment may effect the field readings.

1. Post signs indicating a magnetic drift test is in progress. Do not move or rearrange any articles or equipment in or near the exam room during the test.
2. Assemble the Field Mapping Fixture and Teslameter using the procedure in Set Up and Calibration, Section 5, Field Monitoring Equipment Set–Up.
3. Locate the Magnetometer probe at the physical center of the magnet bore (R = 0, Z = 0).
4. Set the Teslameter switch to NMR FREQUENCY (Hz), allow magnetometer to stabilize within 10 Hz band.
5. Turn Shim Switch Heaters on for three minutes then record the frequency reading. Freq. 1 ____________.
6. Stabilize magnetometer and repeat Step 5. Record frequency reading at 24 hour interval.
   Freq. 2 ____________.
7. Calculate the main field drift rate by using the following formula:

$$\text{Drift Rate (ppm / hr)} = \frac{(\text{Freq 1} - \text{Freq 2}) \times 10^6}{(\text{Freq 1})(24)}$$

   For the Initial drift rate use: Freq 1 = Initial reading
   Freq 2 = reading after 24 hours

8. If the drift rate is greater than 6.3 Hz / hr., drift rate is outside guidelines, contact the MAC Team Representative or the Regional Service Engineer. High drift rates will require frequent field adjustment and reshimming.

Note

The Magnetometer has a resolution of ± 5 Hz; therefore, a month or more may be required to establish a completely accurate frequency difference (drift rate).

FUNCTIONAL CHECKS

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2	MAGNET ELECTRICAL CHECKS	2-1

SECTION 2 – MAGNET ELECTRICAL CHECKS

This section provides go – no go tests for internal magnet circuitry faults.

WARNING!

ELECTRICAL CHECKS CAN ONLY BE PERFORMED WITH THE COILS (MAIN & SHIM) RAMPED DOWN (O AMPS). DO NOT MAKE CONTACT AT ANY CONNECTOR WITH COILS RAMPED UP.

Note

Resistance Table 2–1 is for cold superconducting roils (4.2 K).

1. Locate the Connector Pins using Table 2-1 and Schematics/ Interconnects, Illustration 1–1.
2. Use a digital meter to measure the resistance across the identified Connector Pins.
3. Measure the resistances and record them in Table 2–1, comparing them to acceptable range.

TABLE 2–1
MAGNET CIRCUITS RESISTANCE CHECK COLD (4.2 K)

			RESISTANCE (OHMS)	
FUNCTION	CONNECTOR	PIN #	ACCEPT. RANGE	MEASURED
MAIN COIL	MAIN COIL PWR LUGS	+ –	0 – 0.5	
SUPERCONDUCTING SHIM COILS	CANNON (P1A) AT MGT. VERT. STACK		0 – 0.5	
Z1		1, 19		
Z2		2, 20		
Z3		3, 21		
Z4		4, 22		
Z5		5, 23		
Z6		6, 24		
C11+		16, 19		
C11–		17, 20		
C22+		14, 21		
C22–		15, 22		
S11+		9, 19		
S11–		10, 20		
S22+		7, 21		
S22–		8, 22		
C31		13, 23		
S31		11, 23		
C33		18, 24		
S33		12, 24		
SUPERCONDUCTING SWITCH HEATERS MAIN SWITCH	J 5–1 & J 5–2 ON MGT. TERMINAL BOX (MS1–A3, A1)	1, 2	5.9 – 8.0 or 20.5 – 25.0	
AXIAL SHIMS		5, 6	* 25.5 – 31.0	
TRANSVERSE 1		7, 6	6.1 – 8.0	
TRANSVERSE 2		8, 6	6.1 – 8.0	

*** Early units have switch heaters resistance values of 19.0 – 25.0 ohms.**

THE FOLLOWING CHECKS ARE FOR SHORTS IN CIRCUIT AND CIRCUIT TO GROUND

FUNCTION	CONNECTOR	PIN #	RESISTANCE (OHMS)
CIRCUIT TO CIRCUIT	P1A	19, 21	OPEN
		19, 23	OPEN
		21, 23	OPEN
CIRCUIT TO GROUND	P1A	19, MAGNET CRD	OPEN
		21, MAGNET CRD	OPEN
		23, MAGNET GRD	OPEN

FUNCTIONAL CHECKS

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3	CRYOSTAT VACUUM CHECK	3-1

SECTION 3 - CRYOSTAT VACUUM CHECK

WARNING!

ENSURE THAT THE MAGNET IS RAMPED DOWN TO "0" FIELD BEFORE STARTING CRYOSTAT VACUUM CHECK PROCEDURE.

CAUTION

Do not take leak detectors in the proximity of a magnetic field as irreparable damage will result.

1. Connect Valve Port Operator Vacuum Gauge Service Tool to the Vacuum Monitoring Port (M S1-A1,A3).
2. Connect Helium Leak Detector Vacuum Pump System to the Valve Port Operator. See Illustration 3-1. Pump the internal area of the Valve Port Operator to 1×10^{-4} Torr. (approximately 15 minutes pumping time).
3. Connect Granville Phillips Gauge Controller and Combitron (CM330) to Valve Port Operator Vacuum Gauge Service Tool. See Illustration 3-1.
4. Turn on Combitron (CM330). Record reading ____________ Torr.
5. Leak test Valve Port Operator and connections with Helium Leak Detector.
6. Valve off Helium Leak Detector from Valve Port Operator.

CAUTION

Leak test of Valve Port Operator must be performed prior to opening the Vacuum Port Valve.

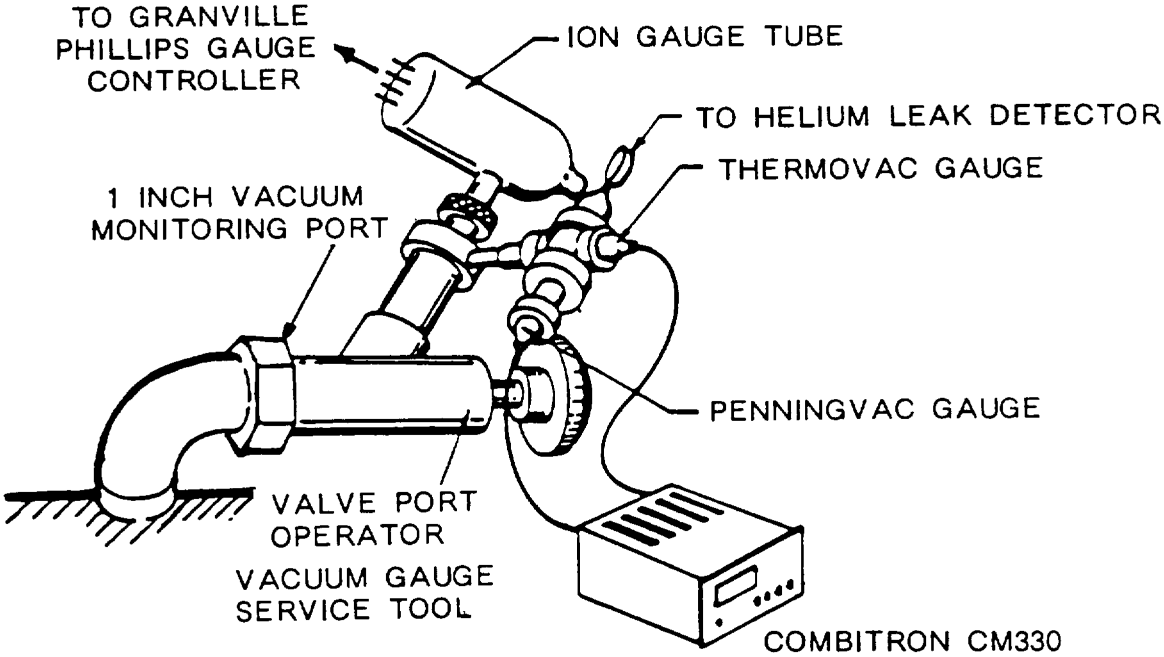
7. Rotate operator handle 5-6 turns C.W., then pull up on handle to open the Vacuum Port Valve.
8. Turn on Gauge Controller power and thermocouple. Record reading ______ Torr.
9. Select "AUTO" range on Gauge Controller and turn on Filament Controller.

SECTION 3- CRYOSTAT VACUUM CHECK (continued)

Note
1-2 hours may be required for the Ion Gauge to settle out.

10. When gauge is settled out, record vacuum level reading________Torr.

Note
Vacuum level is dependent upon Cryostat temperature, < 1 x 10^{-6} Torr. should be achieved with diode temperature reading below 100K. At diode temperature readings above 150K, vacuum may be in the order of 1 x 10^{-1} Torr., (100 microns).



CRYOSTAT VACUUM MONITORING SET-UP
ILLUSTRATION 3-1

FUNCTIONAL CHECKS

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4	EMERGENCY/MAGNET RUNDOWN UNIT (ERU/MRU)	4-1

SECTION 4 - EMERGENCY / MAGNET RUNDOWN UNIT (ERU / MRU)

WARNING!

PERFORM THE FOLLOWING CHECKS AT WEEKLY INTERVALS. IN THE EVENT OF ANY FAILURES, IMMEDIATELY CONTACT YOUR GENERAL ELECTIC SERVICE REPRESENTATIVE.

1. Verify that the green CHARGER LED is lighted.
2. Depress and hold TEST BATTERY switch for 15 seconds, the green BATTERY LED should light. If LED does not light replace battery.
3. Depress TEST HEATER switch, the green HEATER LED should light.
4. If LED does not light, depress TEST HEATER LED switch to verify LED is functioning. If LED is functioning but does not light when “TEST HEATER” is depressed, out of spec. heater resistance is indicated.

   See Functional Checks, Section 2 for Main Switch Heaters continuity check.

FUNCTIONAL CHECKS

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SECTION 5 - CRYOGEN BOIL OFF RATE

1. An instantaneous boil off rate estimate can be calculated by using the following equations:

   BOIL OFF RATE (LITERS/HOUR) = F1+F2 X 0.10
   BOIL OFF RATE (SCFH) = F1+F2 X 2.70

   Where:

   F1 = Flow meter 1 reading (located on Shim Lead Venting)
   F2 = Flow meter 2 reading (located on Instrumentation Lead Venting)

   Note
   Flow meter locations are shown in Set Up and Calibration, Illustration 3-1.

2. A more accurate, time averaged boil off rate is obtained by calculating helium boil off rate, at periodic refill intervals, In Functional Checks, Table 8-2 of this manual (CRYOGEN LOG). Time periods less than one month give misleading values.

   Note
   Helium Meter Volumetric conversion is given in Functional Checks, Graph/Table 8-3 of this manual.

3. Calibrate Cryogen Monitor at 12 month Intervals and whenever the helium boil off rate, calculated in Step 2, has shown a significant increase/ decrease.

FUNCTIONAL CHECKS

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6	SHIELD COOLER CHECKS	6-1

SECTION 6 - SHIELD COOLER CHECKS

Description:

The Shield Cooler System consists of a Shield Cooler Compressor, located in the Equipment Room and a Cold Head, thermally attached to the heat shields of the Cryostat. The Shield Cooler is designed to maintain a temperature on the Outside, "First Stage" Shield between 32K and 60K and the Inside, "Second Stage" Shield between 7K and 17K. Both the first and second stage interface points on the Shield Cooler Mounting Sleeve are equipped with temperature sensing silicon diodes for monitoring and troubleshooting purposes.

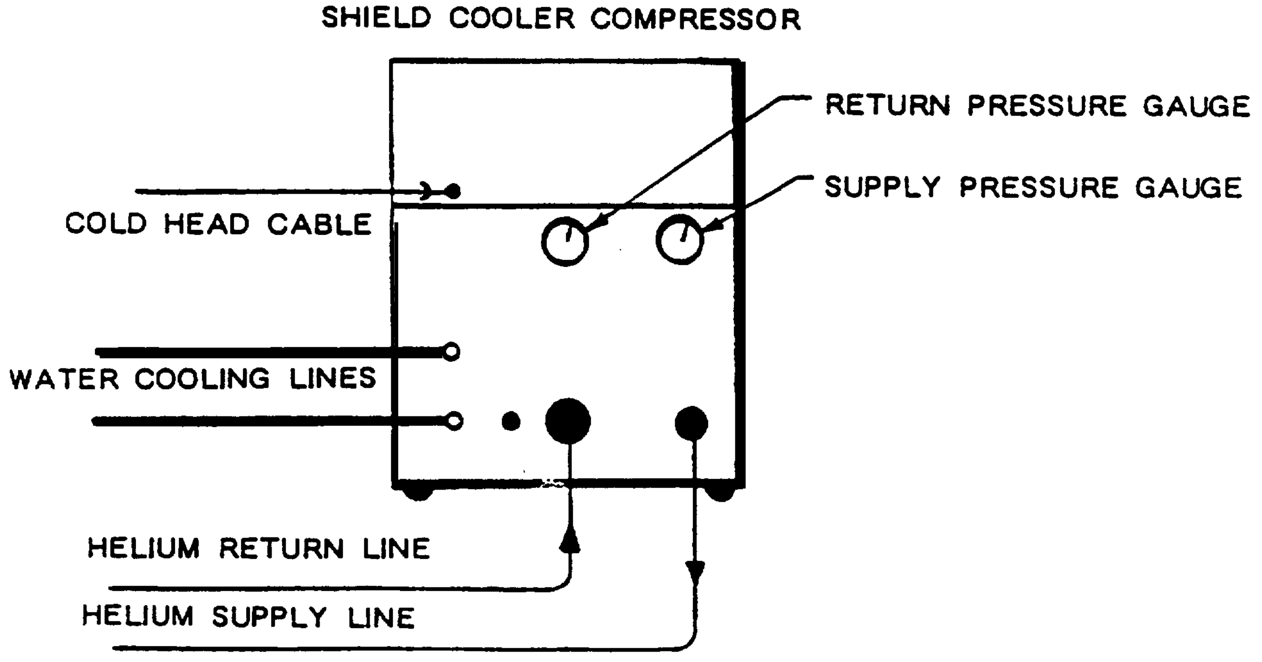
Perform Shield Cooler Checks at installation, when Cryostat Pressure/Boil Off is out of specification and at the yearly Preventative Maintenance (PM) Interval if the check was not performed within the year interval.

Note

Cold Head and Compressor appearance will differ for altemate vendors. Refer to the vendor manual(s) for the identification and location of components and areas covered in Functional Checks. Balzer's Shield Cooler Components are depicted for the Shield Cooler Functional Checks.

Procedure:

1. Turn the Shield Cooler Compressor off and allow the static gas pressure to equalize on the supply and return pressure gauge on the front panel of the unit. See Illustration 6-1.



SHIELD COOLER COMPRESSOR PRESSURE GAUGES
ILLUSTRATION 6-1

SECTION 6- SHIELD COOLER CHECKS (continued)

2. Read and record the equalized pressure on the gauges. The pressure should be between 230 psig and 240 psig. if the pressure is outside this range, add or remove helium as required to bring pressure into spec.

   Static Pressure Reading: ___________ (Spec. 230 psig -240 psig).

Note

If pressure is outside specified range in Step 2, see Set Up and Calibration, Section 1-3-2 (System Gas Charge Pressure Check) for adding or removing helium gas. Always use helium with a guaranteed purity of 99.9995% or better.

3. When static gas pressure is in the specified range, turn on Shield Cooler Compressor.
4. Check the water flow to the Shield Cooler Compressor. Ensure that water flow, quality and temperature are within specifications provided in the Vendor Manual.

Note

Water Flowmeter Kit (4-294052G1) is available for checking water flow rates.

5. Check Shield Cooler Temperatures. See Set Up and Calibration, Section 1-3-9 (Monitoring Shield Temperatures) for the correct precedure.
6. Read “First Stage” and” Second Stage” Shield Temperatures.

Specification:

First Stage Temperature ________________. (Spec. 32K - 60K).
Second Stage Temperature ______________. (Spec. 7K - 17K).

Note

Second Stage Temperature will be altered by *7° K when the magnet is ramped, due to the magnetic field’s effect on the diode.

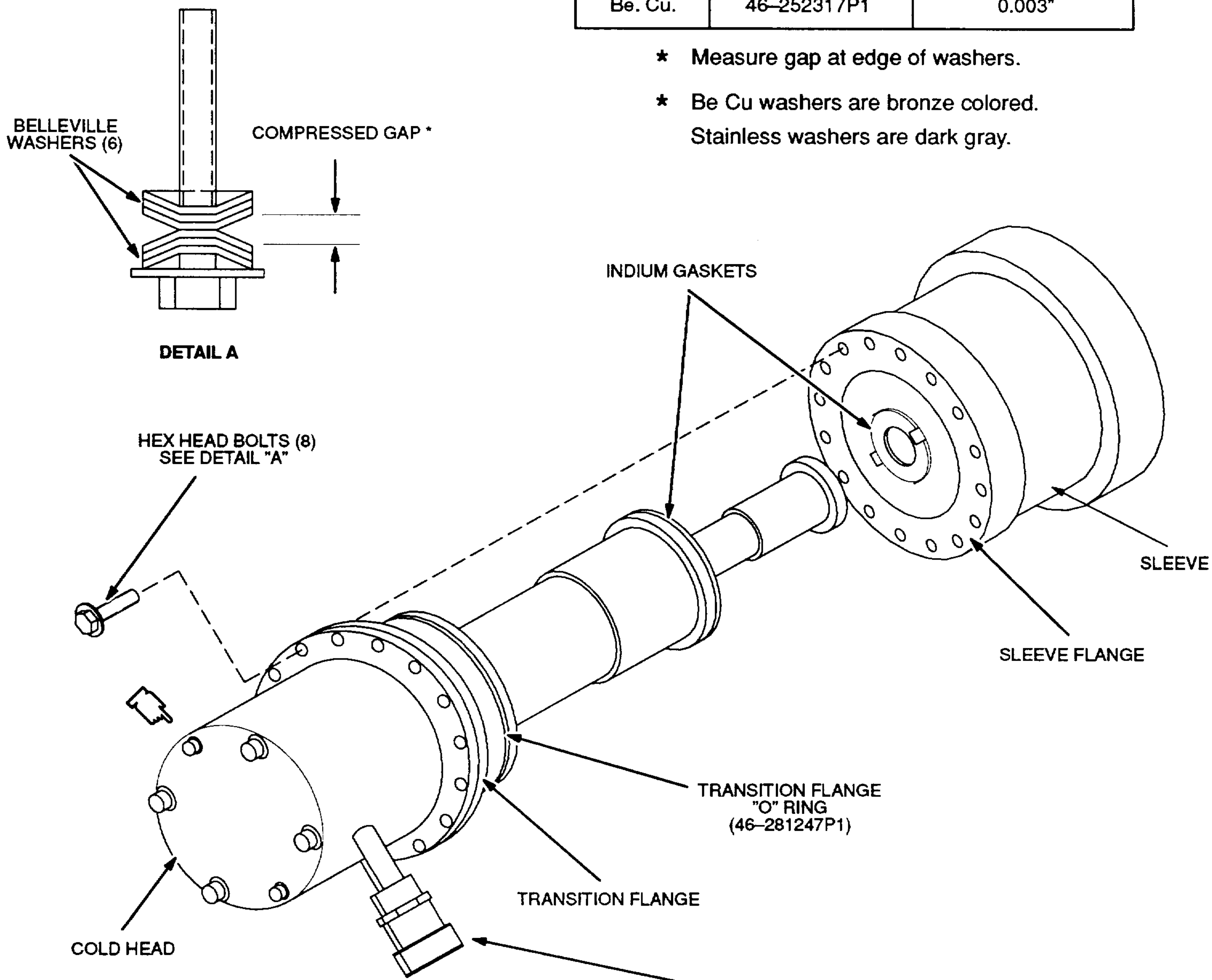
7. Compare these readings to specification and initial recorded readings obtained at equilibrium. Refer to Set Up and Calibration, Section 1–3-9.
8. If any Shield Temperature is out of specification or differs drastically (> 10K First Stage, > 5K Second Stage) from the previous equilibrium temperatures, check the eight mounting bolts securing the Cold Head for tightness. See Illustration 6-2. Refer to Set Up and Calibration, Section 1-3-10 for adjustment procedure.
9. If gas pressure, water supply and mounting bolt tension are within specification when Shield Temperature is out of specification, Shield Cooler Cold Head replacement is necessary. Contact your “MAC” Specialist prior to replacing Cold Head.

NOTE:
SET COMPRESSION GAP WHILE TIGHTENING BOLT. DO NOT SET GAP WHEN LOOSENING BOLT.

* Washer Type	P/N	COMPRESS GAP SETTING
Stainless	46–281387P1	0.010" – 0.015"
Be. Cu.	46–252317P1	0.003"

* Measure gap at edge of washers.

* Be Cu washers are bronze colored.
Stainless washers are dark gray.



NOTE:
ILLUSTRATION SHOWS LEYBOLD COLDHEAD. INFORMATION AND MAGNET INTERFACE ALSO APPLIES TO BALZERS COLDHEAD CONFIGURATIONS. SEE PAGE 2–9 IN RENEWAL PARTS SECTION FOR BALZERS COLDHEAD CONFIGURATION.

COLD HEAD MOUNTING BOLT GAP SETTING

ILLUSTRATION 6-2

FUNCTIONAL CHECKS

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SECTION 7- THERMAL ACOUSTIC OSCILLATION (TAO) CHECK

Descrlptlon:

The detailed functional checks /settings described below should be performed in conjunction with the Shield Cooler Checks (Functional Checks, Section 6) or when ever excessive Cryostat pressure and boil off are encountered. These checks will establish if the “TAO’s” in the Cryostat and Vertical Stack Gap are within specification and provide a method for optimizing the Surge Tank Valve settings. These checks /settings should be performed by a General Electric Authorized Service Representative.

A TAO Monitor Kit (46-281406G1) Fill Line Adapter (46-281232G1) and Digital Voltmeter or Oscilloscope are required for this procedure. If the magnet is at field, a Digital Voltmeter maybe used in the Exam Room or an Oscilloscope may be set up outside the Exam Room and connected to the TAO Monitor.

Some units may have a TAO” Assembly on the Shim Lead. Use the procedure and values in this section with adaptor tool (46-281232G2) for Functional Check of that assembly.

WARNING!

DO NOT BRING AN OSCILLOSCOPE INTO THE EXAM ROOM IF THE MAGNET IS AT FIELD.

Procedure:

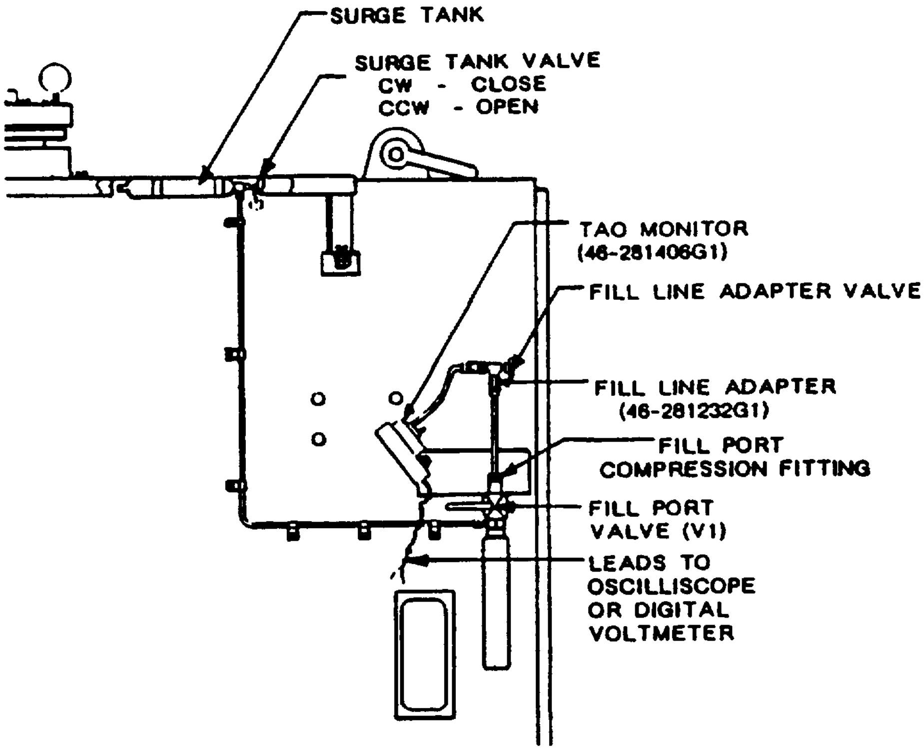
1. Observe Cryostat Pressure Gauge, if pressure is greater than 0.5 psig, slowly open Cryostat Vent Valve (V2) to bring pressure within 0.5 psig, then dose (V2) and allow pressure to stabilize.
2. Loosen Compression Fitting on Cryostat Fill Port above Fill Valve (V1) and remove cap/ plug.
3. Insert Fill Line Adapter Tube into Fill Port and tighten Compression Fitting. See Illustration 7–1.
4. Connect other end of Fill Line Adapter (smaller plastic tube) overtop port of the TAO Monitor Pressure Transducer.

Note

An Osalloscope or Digital Voltmeter may be used to monitor the signal from the TAO Monitor. The Osalloscope will display the signal, providing a more positive measurement; However, it must be located outside of the Exam Room if the magnet is at field.

5. Connect the TAO Monitor Leads to the Oscilloscope or Digital Voltmeter. Set the Oscilloscope Amplitude to 10mV / cm or the Digital Voltmeter Scale to 260 mVAC.

SECTION 7 - THERMAL ACOUSTIC OSCILLATION (TAO) CHECK (continued)



CRYOSTAT TAO ADJUSTMENT SET UP
ILLUSTRATION 7-1

6. Slowly open Fill Port Valve (VI) then open the valve on the Fill Line Adapter and read amplitude of signal. Signal amplitude is measured by the” peak to peak” reading on the Oscilloscope or the “max. – min.” readings on the Digital Voltmeter.

Note

If no signal is present, replacethebattery in the TAO Monitor. If signal is stlll absent, check replaced battery, circuit and TAO Monitor by putting a small positive pressure at tube connection.

7. Compare readings with the maximum allowable specification value of 175mV. If signal amplitude is greater than 175mV, adjust Surge Tank Valve (CCW than CW) to minimize the signal amplitude. See Illustration 7-1.

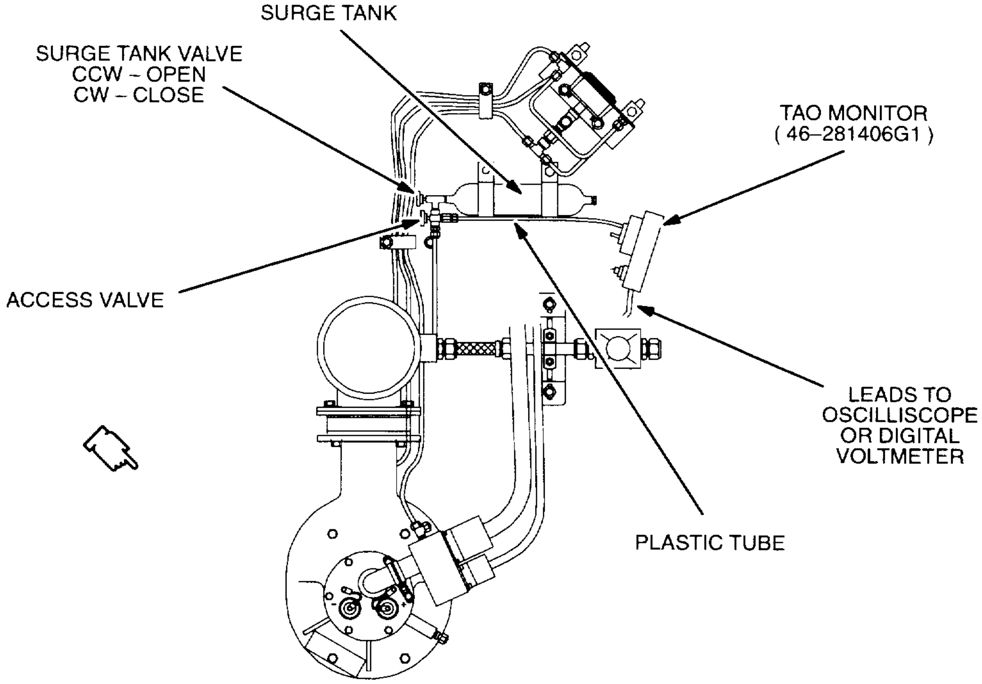
8. Record results for future reference (______________________________).

9. Close V1 and the Fill Line Adapter Valve. Disconnect setup leaving leads connected to the Oscilloscope or Digital Voltmeter.

10. Cap Fill Port and tighten Compression Fitting.

SECTION 7 – THERMAL ACOUSTIC OSCILLATION (TAO) CHECK (continued)

11. Remove TAO Monitor from Fill Line Adapter and connect (P2) of the TAO Monitor Pressure Tracducer to the plastic tube next to the Surge Tank for the Vertical Penetration Gap. See Illustration 7–2.
12. Slowly open access Valve at end of plastic tube and repeat Step 7 of this procedure.
13. Record results for future reference (______________________________)
14. Close Access Valve and remove set up,



VERTICAL PENETRATION GAP TAO ADJUSTMENT SET UP
ILLUSTRATION 7–2

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	8-4 Magnet Rampin & Parking Current Log	8-12

SECTION 8 - TABLES, CHARTS & RECORDS

TABLE 8-1

LIQUID HELIUM REFILL CHART

DATE__________________
FILLED BY____________________

DEWAR SERIAL#	TIME		DEWAR WEIGHT (LBS)		LITERS HELIUM USED (L_U) (Δ LBS x 3.63)	HELIUM LEVEL (L_I)				TRANSFER EFFICIENCY ($\Delta L_I/L_U$)
						START		FINISH		
	START	FINISH	START	FINISH		METER %	AMT (L)	METER %	AMT (L)	

TABLE 8-1

LIQUID HELIUM REFILL CHART (Continued)

DATE________________

FILLED BY________________

DEWAR SERIAL#	TIME		DEWAR WEIGHT (LBS)		LITERS HELIUM USED (L_U) (Δ LBS x 3.63)	HELIUM LEVEL (L_I)				TRANSFER EFFICIENCY (Δ L_I/L_U)
						START		FINISH		
	START	FINISH	START	FINISH		METER %	AMT (L)	METER %	AMT (L)	

TABLE 8-1

LIQUID HELIUM REFILL CHART (Continued)

DATE________________

FILLED BY________________

DEWAR SERIAL#	TIME		DEWAR WEIGHT (LBS)		LITERS HELIUM USED (L_u) (Δ LBS x 3.63)	HELIUM LEVEL (L_I)				TRANSFER EFFICIENCY ($\Delta L_I/L_u$)
						START		FINISH		
	START	FINISH	START	FINISH		METER %	AMT (L)	METER %	AMT (L)	

TABLE 8-1

LIQUID HELIUM REFILL CHART (Continued)

DATE__________________
FILLED BY__________________

DEWAR SERIAL#	TIME		DEWAR WEIGHT (LBS)		LITERS HELIUM USED (L_U) (Δ LBS x 3.63)	HELIUM LEVEL (L_I)				TRANSFER EFFICIENCY ($\Delta L_I/L_U$)
						START		FINISH		
	START	FINISH	START	FINISH		METER %	AMT (L)	METER %	AMT (L)	

TABLE 8-2

CRYOGEN LOG

DATE	TIME (t)	METER %	AMT (L)	CHANGE FROM PREVIOUS READING		BOIL-OFF RATE ($\Delta \ell \div \Delta t$)	DATE	TIME (t)	METER %	AMT (L)	CHANGE FROM PREVIOUS READING		BOIL-OFF RATE ($\Delta \ell \div \Delta t$)
				Δt	$\Delta \ell$						Δt	$\Delta \ell$	

TABLE 8-2

CRYOGEN LOG (Continued)

DATE	TIME (t)	METER %	AMT (L)	CHANGE FROM PREVIOUS READING		BOIL-OFF RATE ($\Delta \ell \div \Delta t$)	DATE	TIME (t)	METER %	AMT (L)	CHANGE FROM PREVIOUS READING		BOIL-OFF RATE ($\Delta \ell \div \Delta t$)
				Δt	$\Delta \ell$						Δt	$\Delta \ell$	

TABLE 8-2

CRYOGEN LOG (Continued)

DATE	TIME (t)	METER %	AMT (L)	CHANGE FROM PREVIOUS READING		BOIL-OFF RATE ($\Delta \ell \div \Delta t$)	DATE	TIME (t)	METER %	AMT (L)	CHANGE FROM PREVIOUS READING		BOIL-OFF RATE ($\Delta \ell \div \Delta t$)
				Δt	$\Delta \ell$						Δt	$\Delta \ell$	

TABLE 8-2

CRYOGEN LOG (Continued)

DATE	TIME (t)	METER %	AMT (L)	CHANGE FROM PREVIOUS READING		BOIL-OFF RATE ($\Delta \ell \div \Delta t$)	DATE	TIME (t)	METER %	AMT (L)	CHANGE FROM PREVIOUS READING		BOIL-OFF RATE ($\Delta \ell \div \Delta t$)
				Δt	$\Delta \ell$						Δt	$\Delta \ell$	

GRAPH 8-3
VOLUMETRIC CONVERSION OF UQUID HELIUM LEVEL

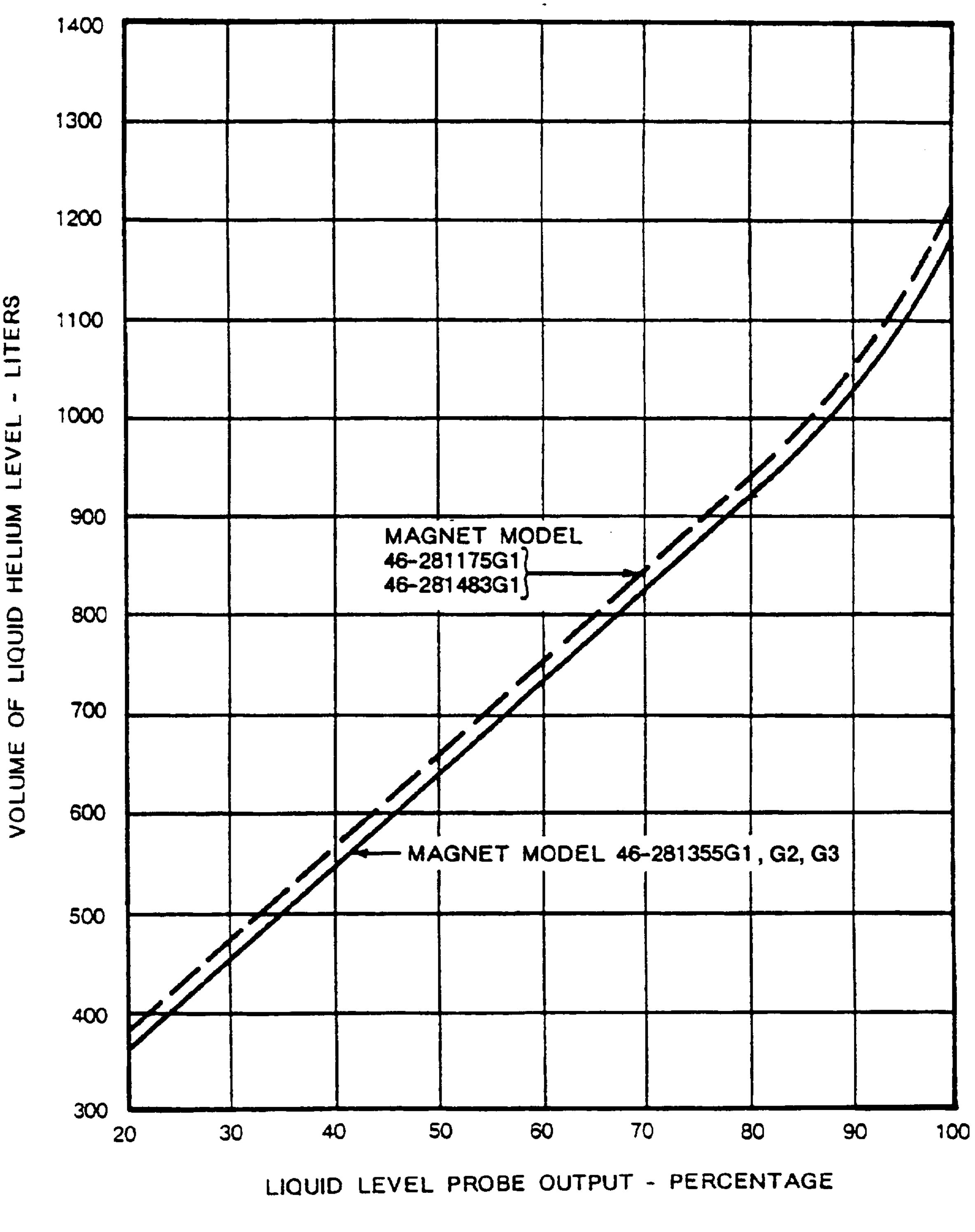

TABLE 8-3
VOLUMETRIC CONVERSION OF LIQUID HELIUM LEVEL
● LEVEL PERCENTAGE TO LIQUID LITERS CORRELATION*

PERCENT	MAGNET MODEL 46-281355G1, G2,G3 LITERS	MAGNET MODEL 46-281175G1 46-281483G1 LITERS	PERCENT	MAGNET MODEL 46-281355G1, G2,G3 LITERS	MAGNET MODEL 46-281175G1 46-281483G1 LITERS
20	377.7	386.5	60	732.1	752.0
21	385.5	397.1	61	742.1	761.6
22	395.0	404.8	62	752.0	771.1
23	403.7	414.1	63	762.0	780.8
24	412.3	423.3	64	771.9	790.3
25	420.9	432.4	65	781.7	799.8
26	429.6	442.5	68	791.7	809.4
27	438.3	450.8	67	801.6	819.0
28	447.2	460.1	68	811.5	828.6
29	456.1	469.2	69	819.8	838.2
30	463.1	478.2	70	827.6	847.6
31	468.6	487.7	71	835.7	857.1
32	475.1	497.1	72	844.1	866.8
33	483.7	506.6	73	854.1	876.2
34	493.2	516.1	74	863.8	885.7
35	502.6	525.6	75	873.6	895.3
36	512.1	534.0	76	883.5	904.7
37	521.7	542.2	77	893.3	913.9
38	531.1	550.6	78	903.2	924.3
39	540.6	559.2	79	913.2	933.0
40	550.1	567.5	80	923.5	942.8
41	559.6	575.7	81	934.0	953.0
42	569.2	584.2	82	943.2	963.3
43	576.7	592.6	83	952.1	973.7
44	582.1	600.8	84	961.3	984.3
45	589.9	609.1	85	971.4	995.6
46	599.9	617.5	86	983.2	1007.0
47	609.9	627.3	87	995.4	1018.6
48	619.8	636.7	88	1009.2	1030.9
49	629.7	646.3	89	1021.5	1043.5
50	639.7	655.9	90	1035.8	1057.4
51	650.8	665.5	91	1050.4	1071.5
52	659.6	676.3	92	1065.2	1086.9
53	669.6	684.9	93	1084.1	1104.5
54	679.4	694.4	94	1099.8	1120.6
55	689.4	704.0	95	1115.0	1135.4
56	697.4	713.4	96	1129.5	1149.4
57	704.3	723.3	97	1143.5	1163.8
58	712.3	732.8	98	1157.6	1180.3
59	722.2	742.3	99	1172.2	1198.0
			100	1188.4	1215.6

TABLE 8-4

MAGNET RAMPING & PARKING CURRENT LOG

MAGNET: MODEL NO. ____________________ **SERIAL NO.** ______________________________

SERVICE ENGINEER ______________________________

DATE	TIME	CONNECTION POLARITY +/- RED/BLK	* OUTPUT CURRENT(A)	MAIN COIL VOLTAGE(V)	MAGNETIC FIELD Hz (GAUSS)

* CIRCLE PARKING CURRENT

FUNCTIONAL CHECKS

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SECTION 9 - MAGNET QUENCHES

Description:

The following checks and operations have significant benefit in the prevention of and recovery from magnet quenches.

Procedure:

QUENCH PREVENTION

A. BEFORE RAMPING

1. Verify magnet is a minimum of 90% full of LHe.
2. Install new contact bands on the Ramping Lead Extensions.
3. Make sure gas flow is visible from Top Flow Holes in Ramping Lead Extensions before starting ramp.
4. Verify ramping circuit voltage drops are in spec range, ensuring acceptable contact resistance.
5. Ramp magnet in conformance with service manual.

B. RAMPED MAGNET

1. Verify Cryostat Pressure and flows are in spec, ensuring adequate cooling of Shim Lead Assembly and Vertical Stack.
2. Maintain strict adherence to the ramp down requirements/ prerequisites in the Replacement / Maintenance section of the service manual.
3. Do not insert any warm objects or blow warm gas into any entry port of the magnet, i.e. Vertical Stack, Fill Port
4. Do not allow a Helium Dewar to empty and blow warm gas into the Fill Port of the magnet during LHe refill.
5. Keep the LHe level greater than 500/. full at all times during magnet operation.

SECTION 9- MAGNET OUENCHES (continued)

QUENCH RECOVERY

REPORT ALL QUENCHES TO YOUR REGION MR SUPPORT ENGINEER.

1. Check and replace Burst Disc immediately if ruptured or cracked.
2. Order and replace LHe ASAP.

Note

Steps 1 and 2 are essential to maintain positive Cryostat pressure and prevent cryopumping and ice build up!

3. Check for ice buildup in Vertical Stack. Remove ice in conformance with service manual.
4. Inspect Vent System. Clear out any debris from a ruptured Burst Disc and/or disintegrated Shim Lead Baffles. Notify Site Administration of any damage to Vent System.
5. Order and replace Shim Lead Assembly (46-260815G1) if baffles are disintegrated. Return damaged assembly for repair.
6. Check Pressure Gauge for damage. Replace if damage suspected (46-281282P1).
7. Check Cryostat pressure and flows after LHe refill and stabilization.

Note

Do not adjust Cryostat flows/pressure at this time.

8. If a leak condition is suspect, check all external plumbing, relief valves and Shim Lead Assembly for leaks.
9. If pressure builds beyond 3 psig vent the Cryostat (V2) and check Cryostat and Shield Cooler temperatures and TAO'S": Continued pressure and flow build up could indicate Cryostat damage, if this is the case, contact the Region M R Support Engineer.
10. Ramp and Shim magnet in conformance to service manual.
11. Establish Cryostat pressure between 0.25-0.50 psig and check flow rates (Fl) & (F2).
12. After the system has stabilized, the following conditions should be maintained:

CRYOSTAT PRESSURE = 0.25-0.50 PSIG
(Fl) FLOW RATE = 0.4 –0.6 SCFH
(F2) FLOW RATE = 1.5 -2.0 SCFH

Note

Minimal adjustment, if any, should be required to maintain the conditions in Step 12. Slight variations will occur with changes in atmospheric pressure under steady state operating conditions.

SCHEMATICS / INTERCONNECTS

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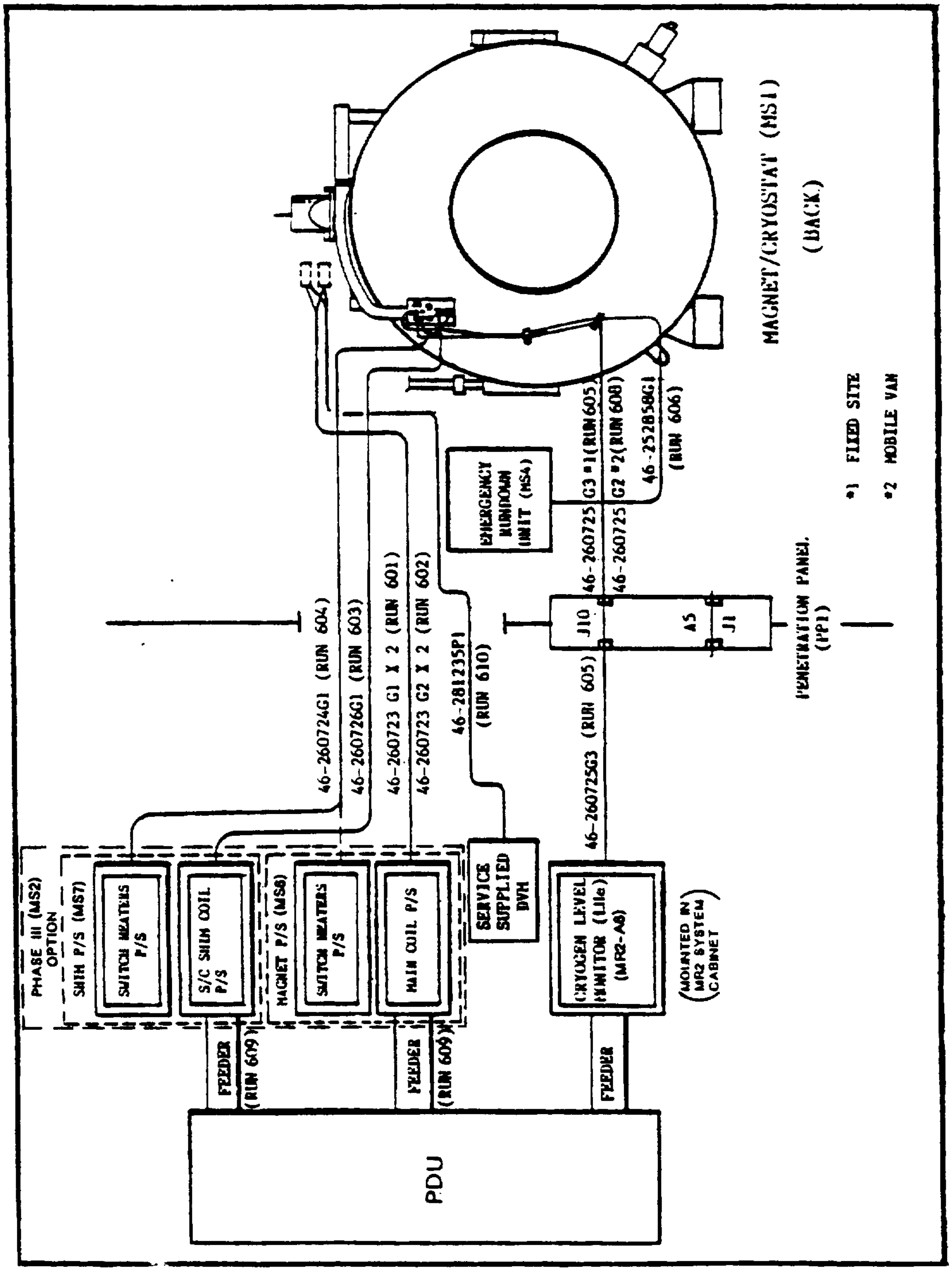
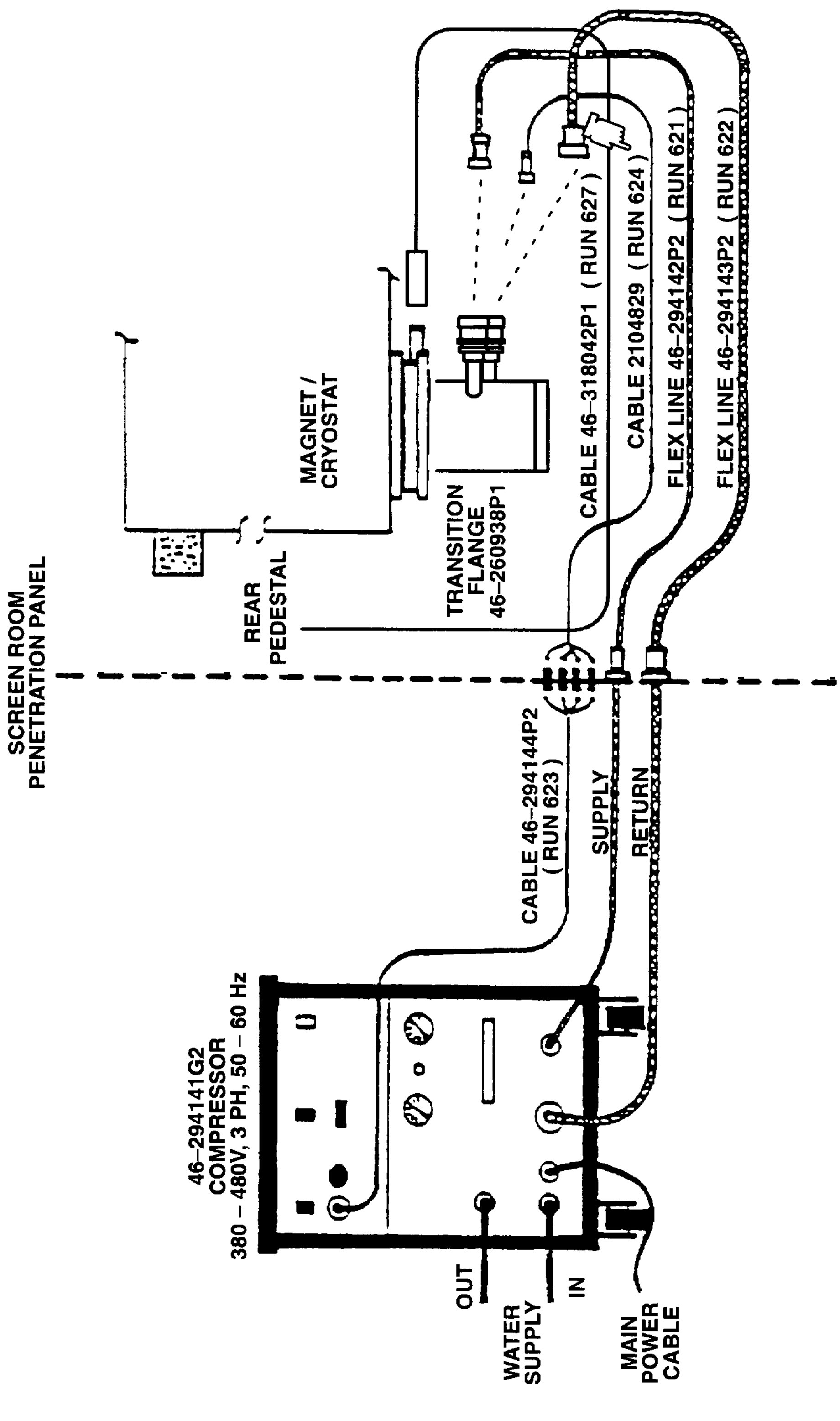


MAGNET SYSTEM INTERCONNECT DIAGRAM

ILLUSTRATION 1–1



MAGNET SHIELD COOLER INTERCONNECT DIAGRAM
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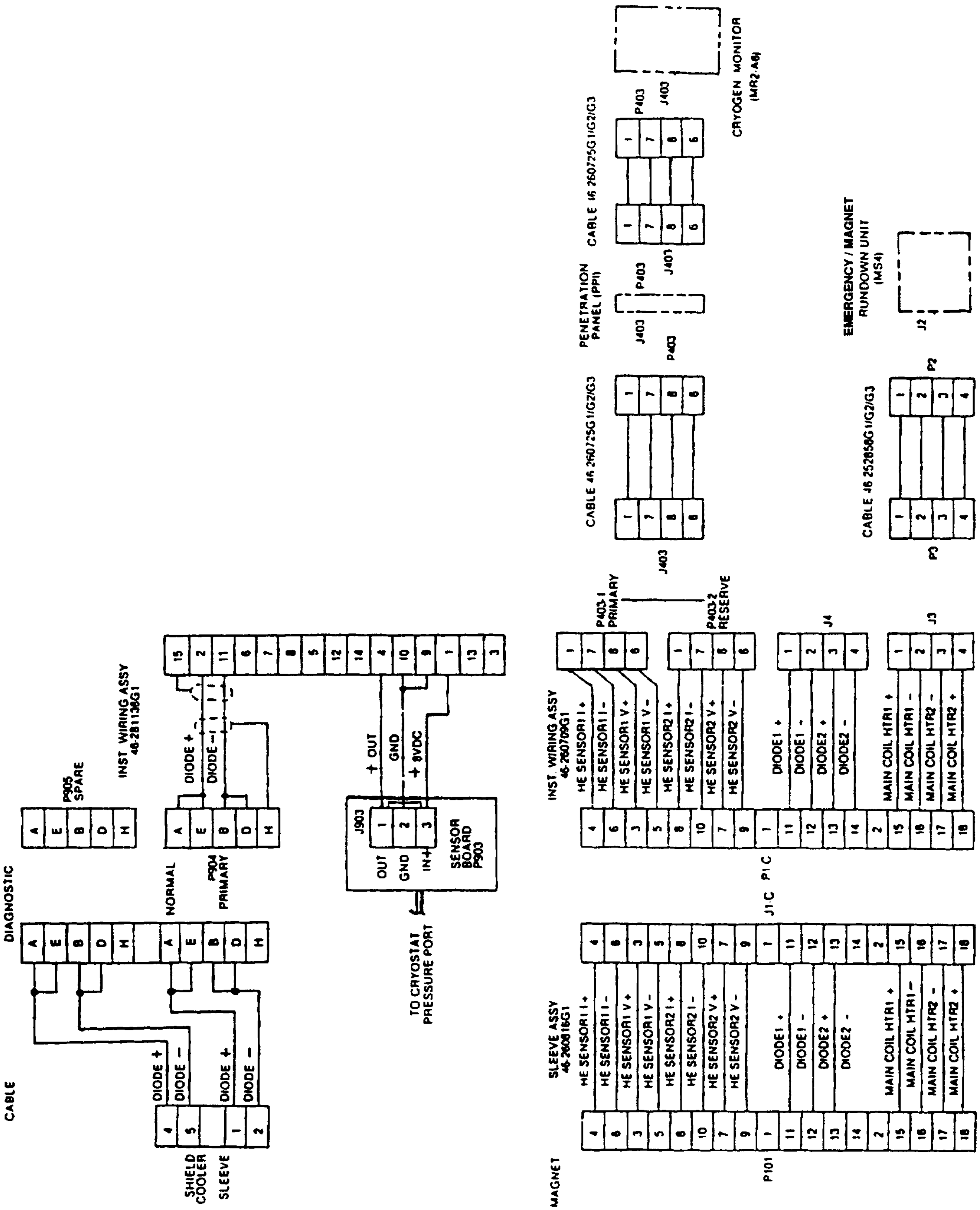
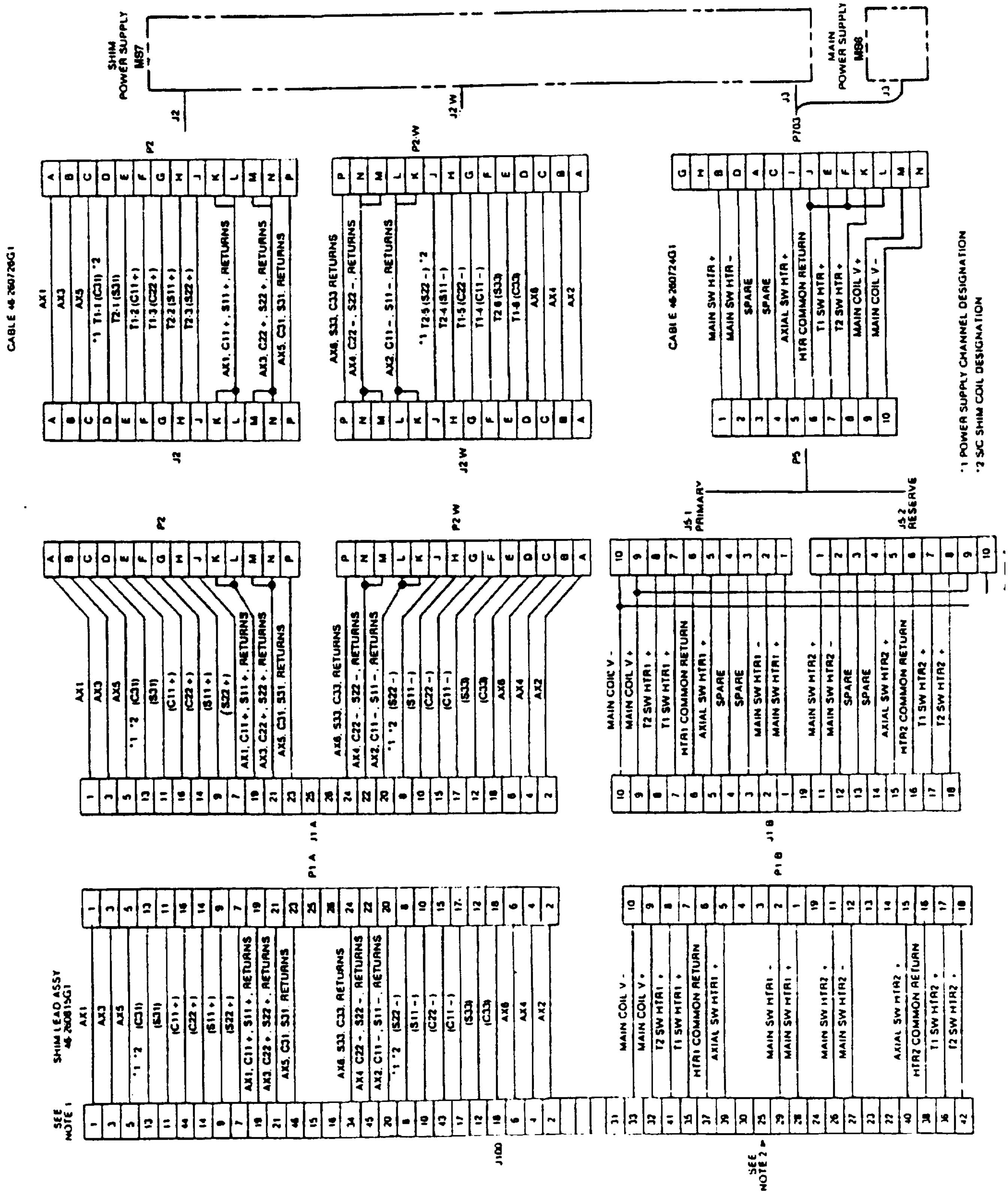
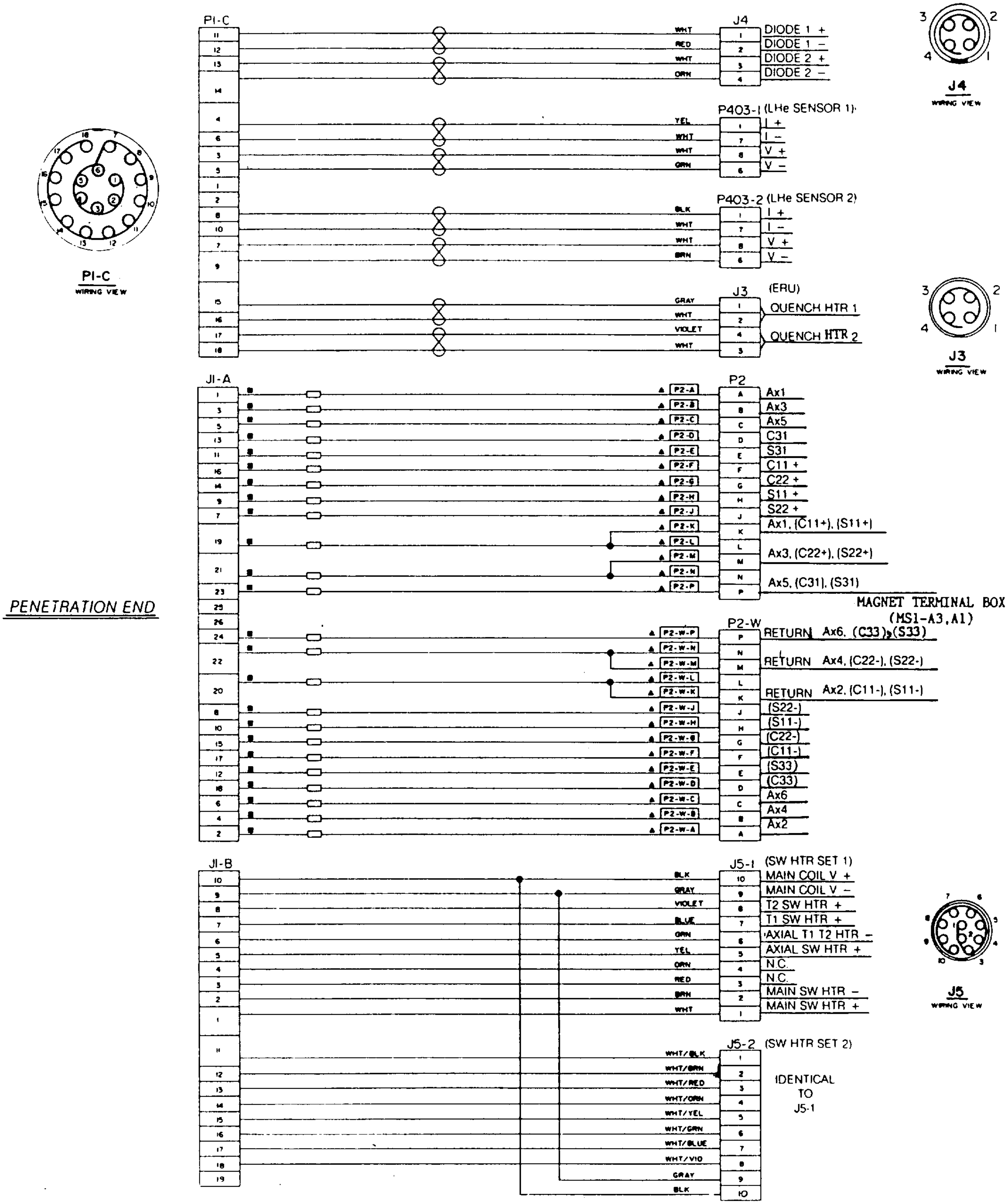


MAGNET SYSTEM WIRING DIAGRAM

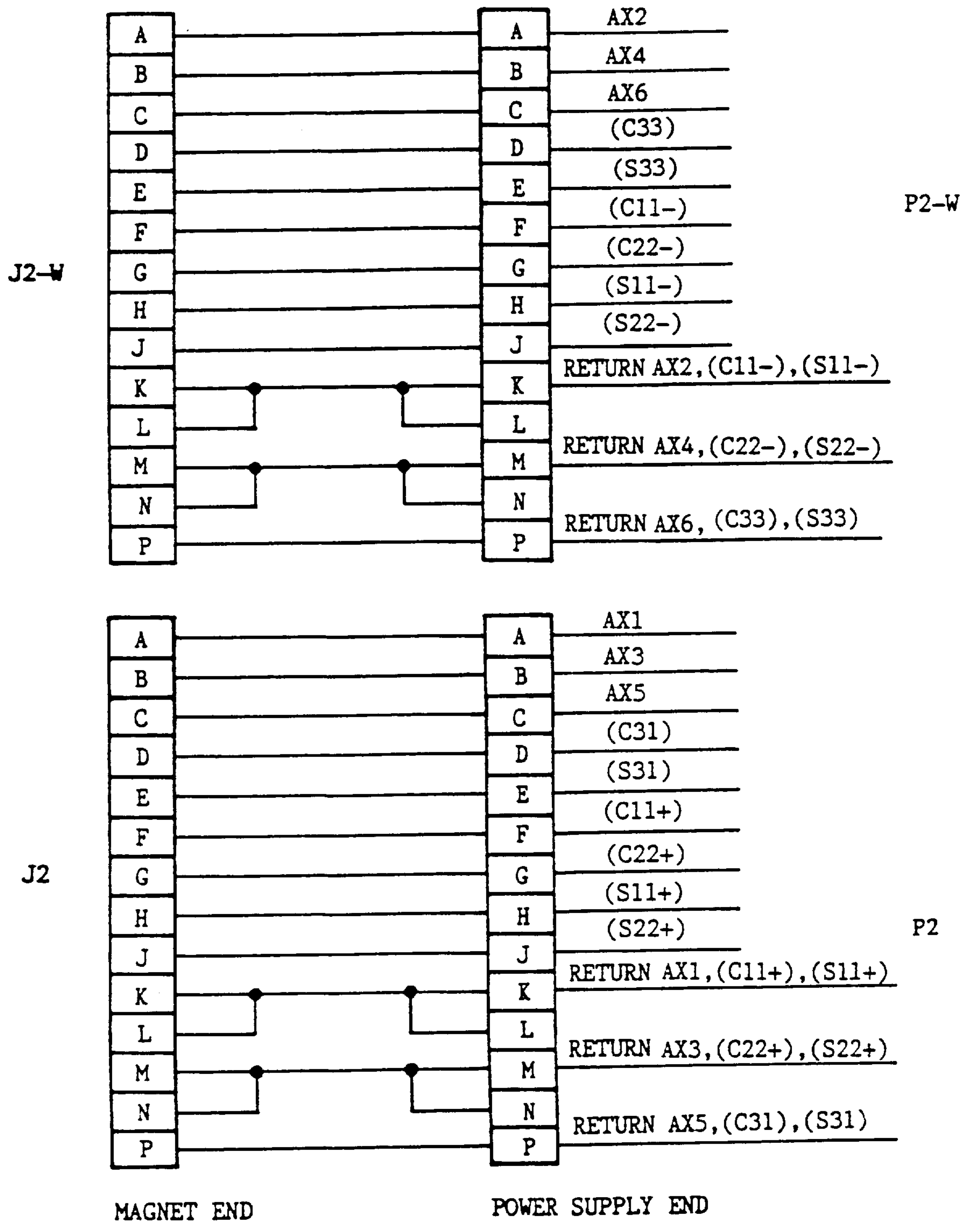
ILLUSTRATION 2–1



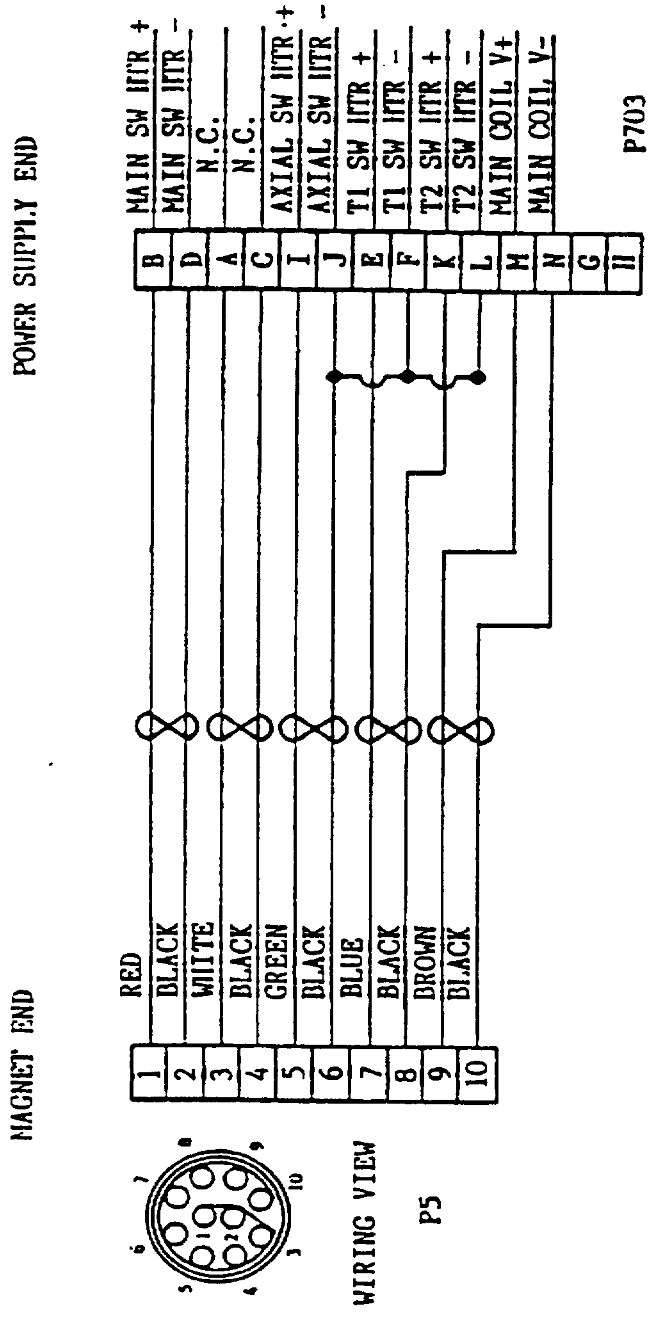
MAGNET SYSTEM WIRING DIAGRAM (continued)
ILLUSTRATION 2–1



WIRING DIAGRAM
MAGNET CABLE 46-260709G1
ILLUSTRATION 2-2



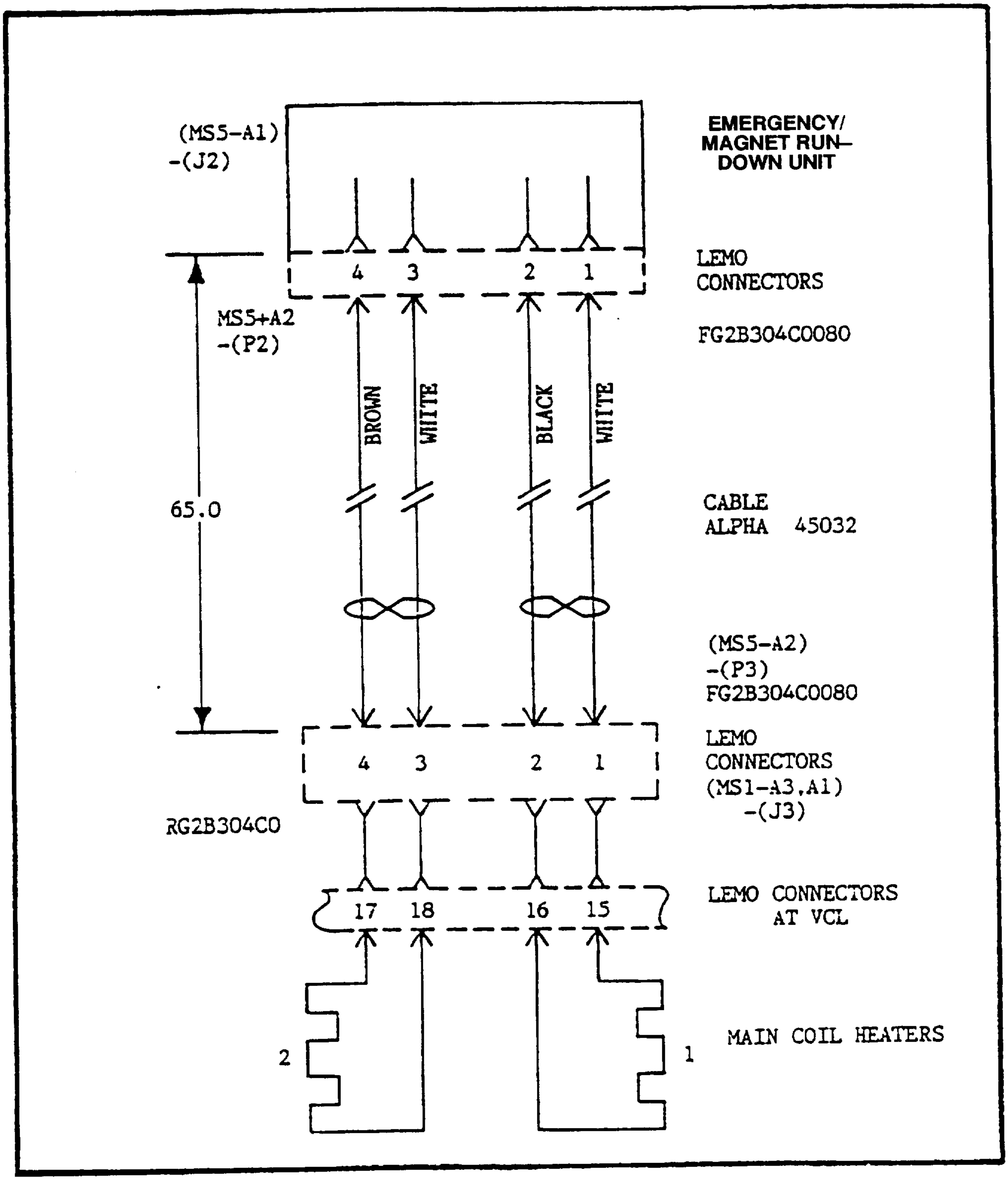
WIRING DIAGRAM
S/C SHIM COIL CABLE 46-260726G1
ILLUSTRATION 2-3



WIRING DIAGRAM

VOLTAGE MONITOR & SWITCH HEATERS CABLE 46-260724G1

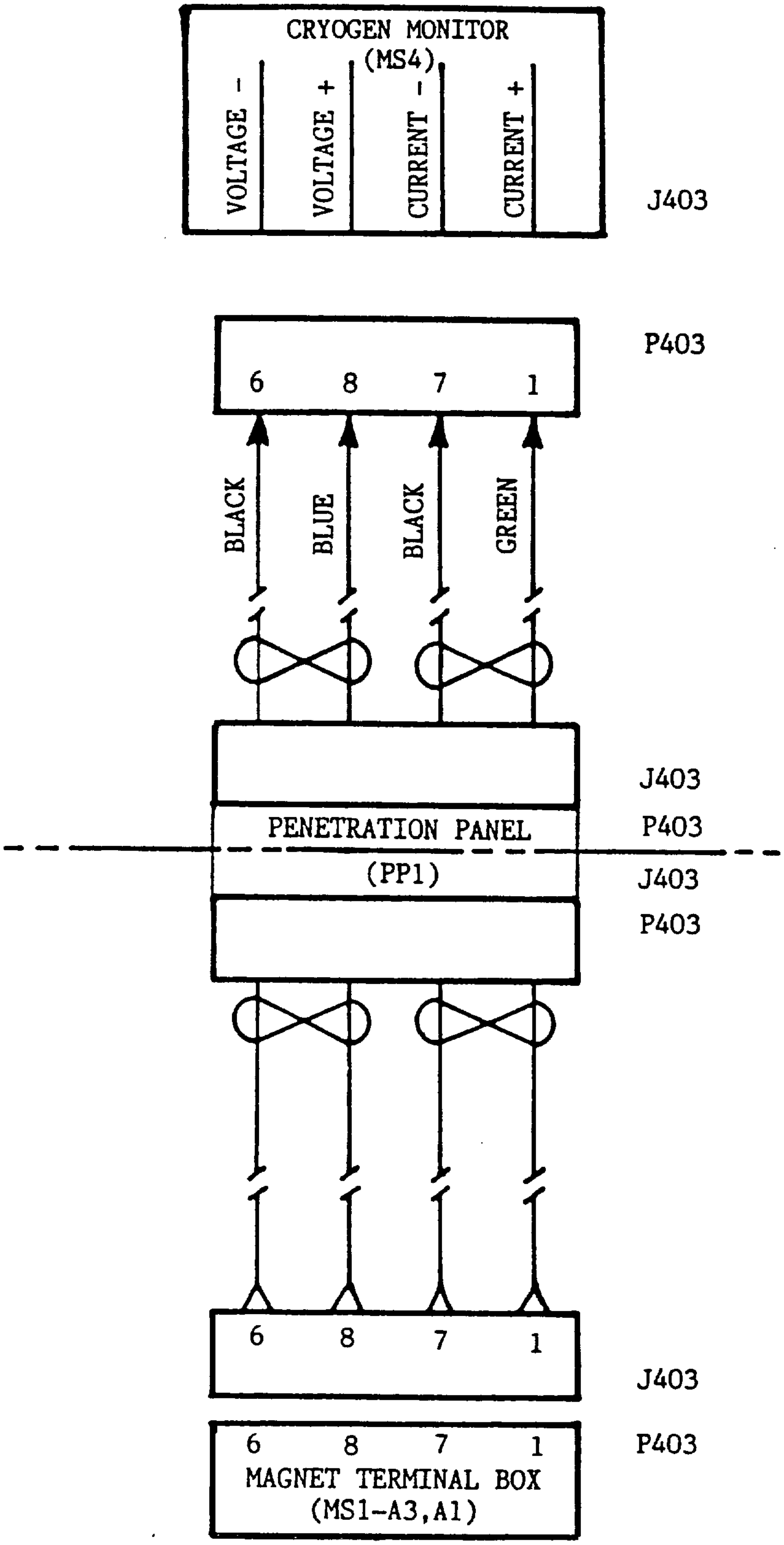
ILLUSTRATION 2-4



WIRING DIAGRAM

EMERGENCY / MAGNET RUNDOWN SYSTEM FOR MAIN COIL HEATERS

ILLUSTRATION 2-5



WIRING DIAGRAM
LIQUID HELIUM MONITOR CIRCUIT
ILLUSTRATION 2-6

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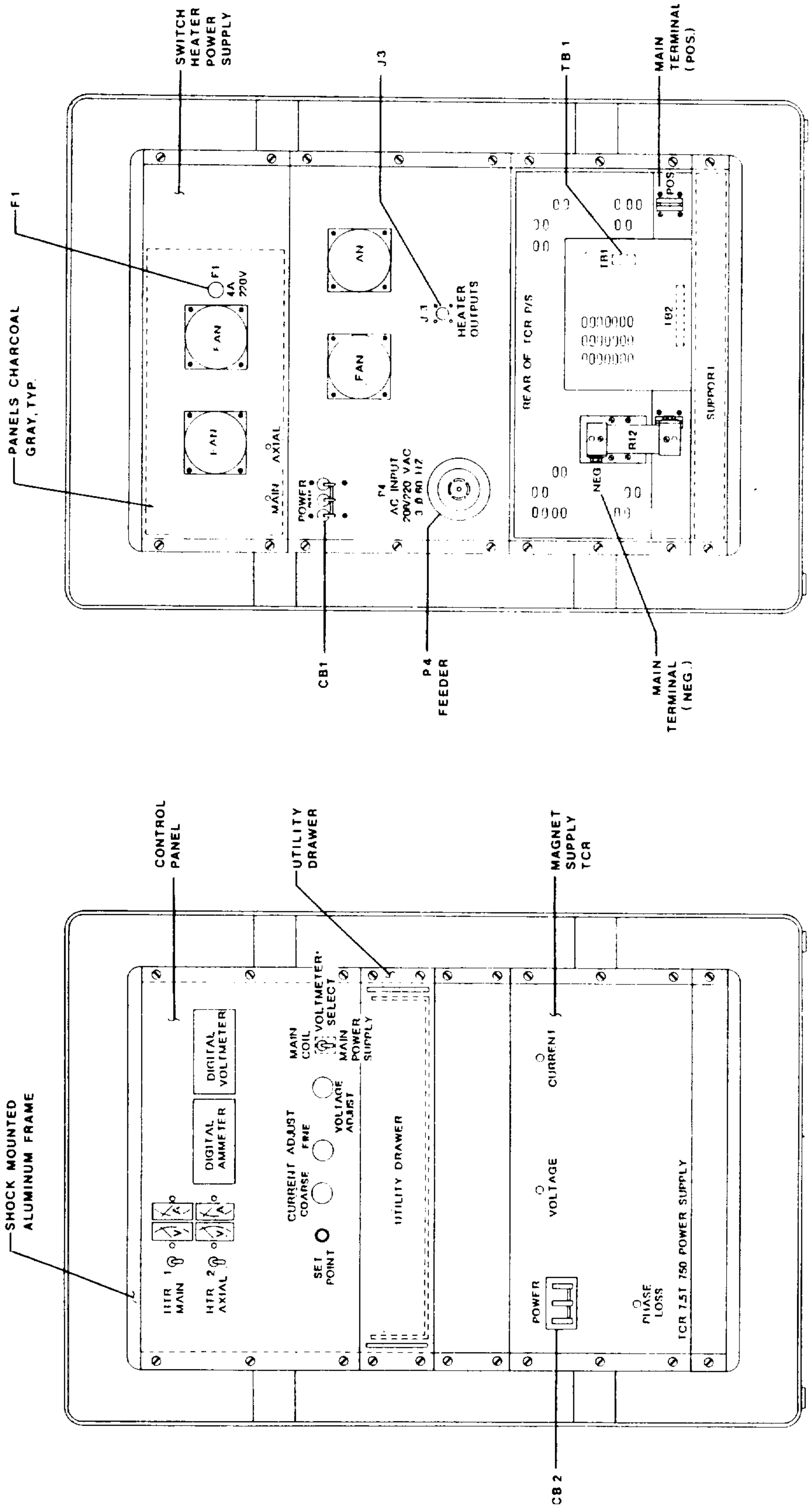


INPUT POWER

DESIGNATOR	RATING & TYPE	CONNECTION
P4	208/220 VAC. 50-60 HZ.	AC INPUT MAIN POWER SUPPLY
TB1	30 AMP. 602Y	

OUTPUT CONNECTION

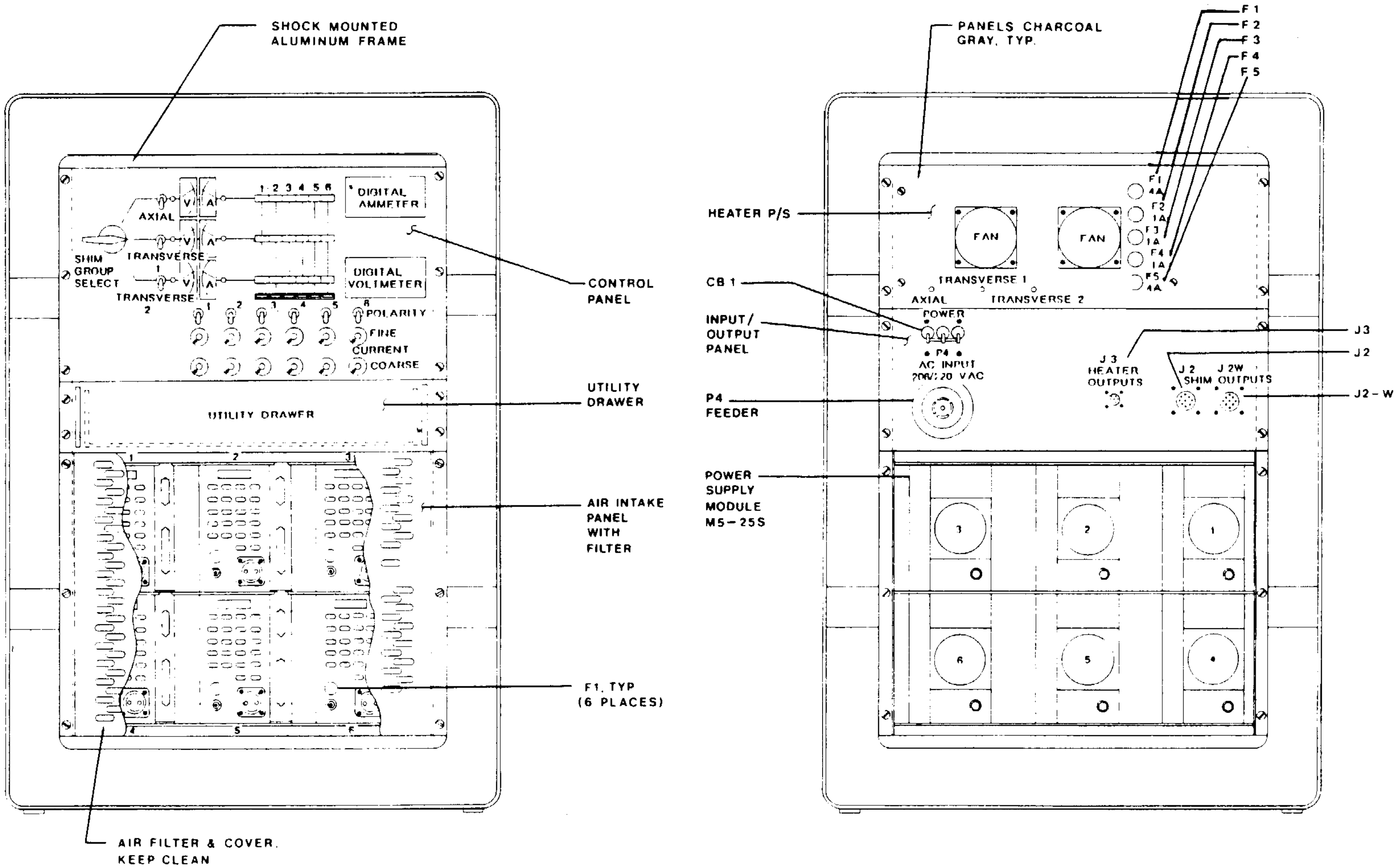
DESIGNATOR	RATING & TYPE	CONNECTION
MAIN TERMINAL POS.	750 A BUSS BAR	RED/POS. MAIN POWER LEADS (MS3-A2)
MAIN TERMINAL NEG.	750 A BUSS BAR	BLACK/NEG. MAIN POWER LEADS (MS3-A2)
J3	1 AMP. MS3106A20-27P	HEATER WIRE HARNESS (MS3-A5) P3

FUSES AND CIRCUIT BREAKERS

DESIGNATOR	RATING & TYPE
CB1 CABINET	3 POLE. 25 A. 250 VAC
CB1 SUPPLY	3 POLE. 25 A. 250 VAC
F1	4 A. 250 V. MDA

SUPERCONDUCTING MAIN COIL SERVICE POWER SUPPLY CABINET

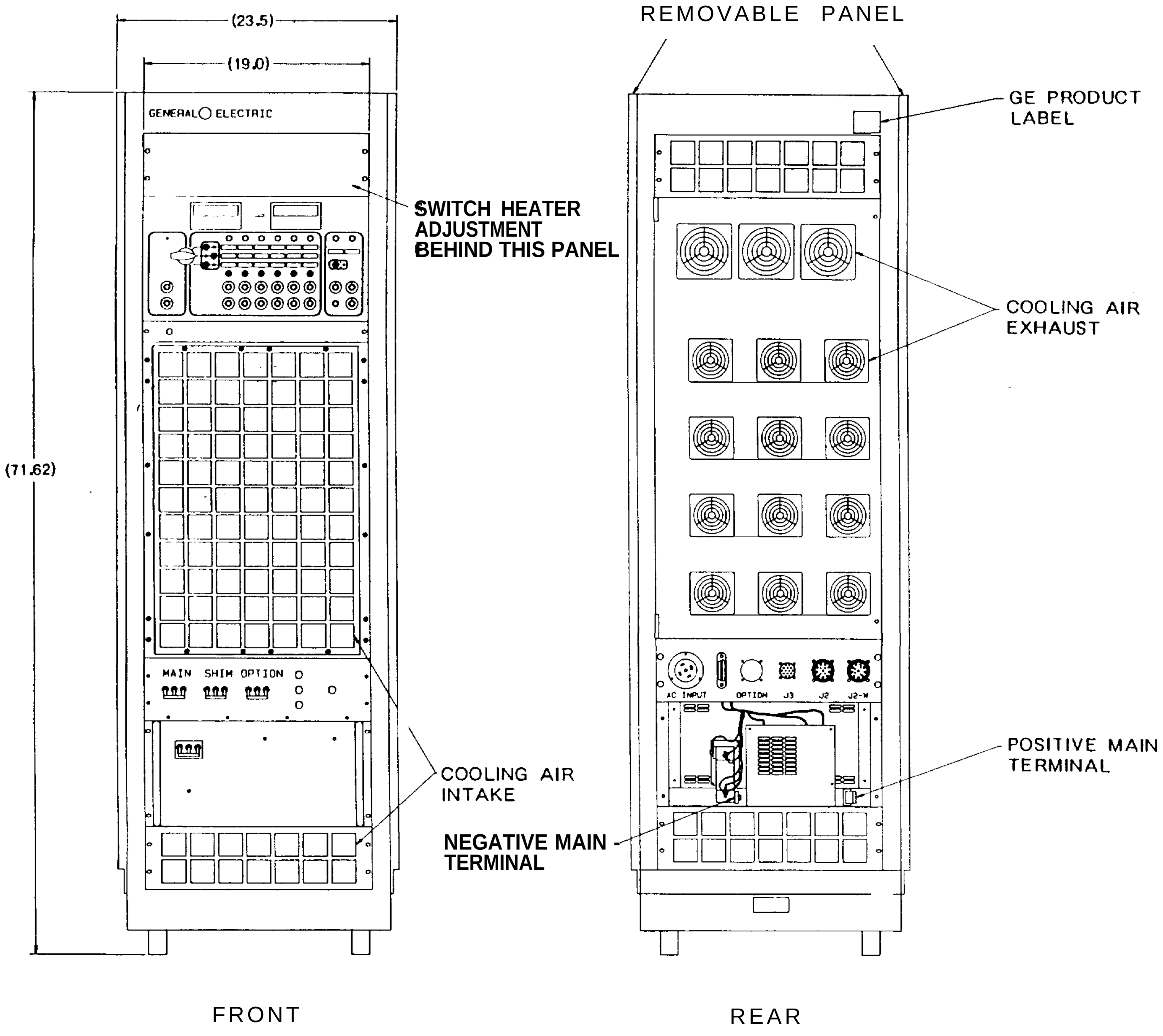
ILLUSTRATION 3-1



FUSES AND CIRCUIT BREAKERS	
DESIGNATOR	RATING & TYPE
CB 1	3 POLE, 25 A, 250 VAC
F1 (TYP 6 PLACES)	6.25 A, 250 V, MDA
F1, F5	4 A, 250 V, MDA
F2, F3, F4	1 A, 250 V, MDA

INPUT POWER		
DESIGNATOR	RATING & TYPE	
P4	208/220 VAC 50/60 HZ.	
OUTPUT CONNECTIONS		
DESIGNATOR	RATING & TYPE	CONNECTION
J2	25A, MS3012A 28-20S	S/C SHIM COIL WIRE HARNESS (MS3-A4) P1
J2-W	25A, MS3012A28-20SW	S/C SHIM COIL WIRE HARNESS (MS3-A4) P2
J3	1A MS3106A20-27P	HEATER WIRE HARNESS (MS3-A5) P3

SUPERCONDUCTING SHIM COIL
SERVICE POWER SUPPLY CABINET
ILLUSTRATION 3-2



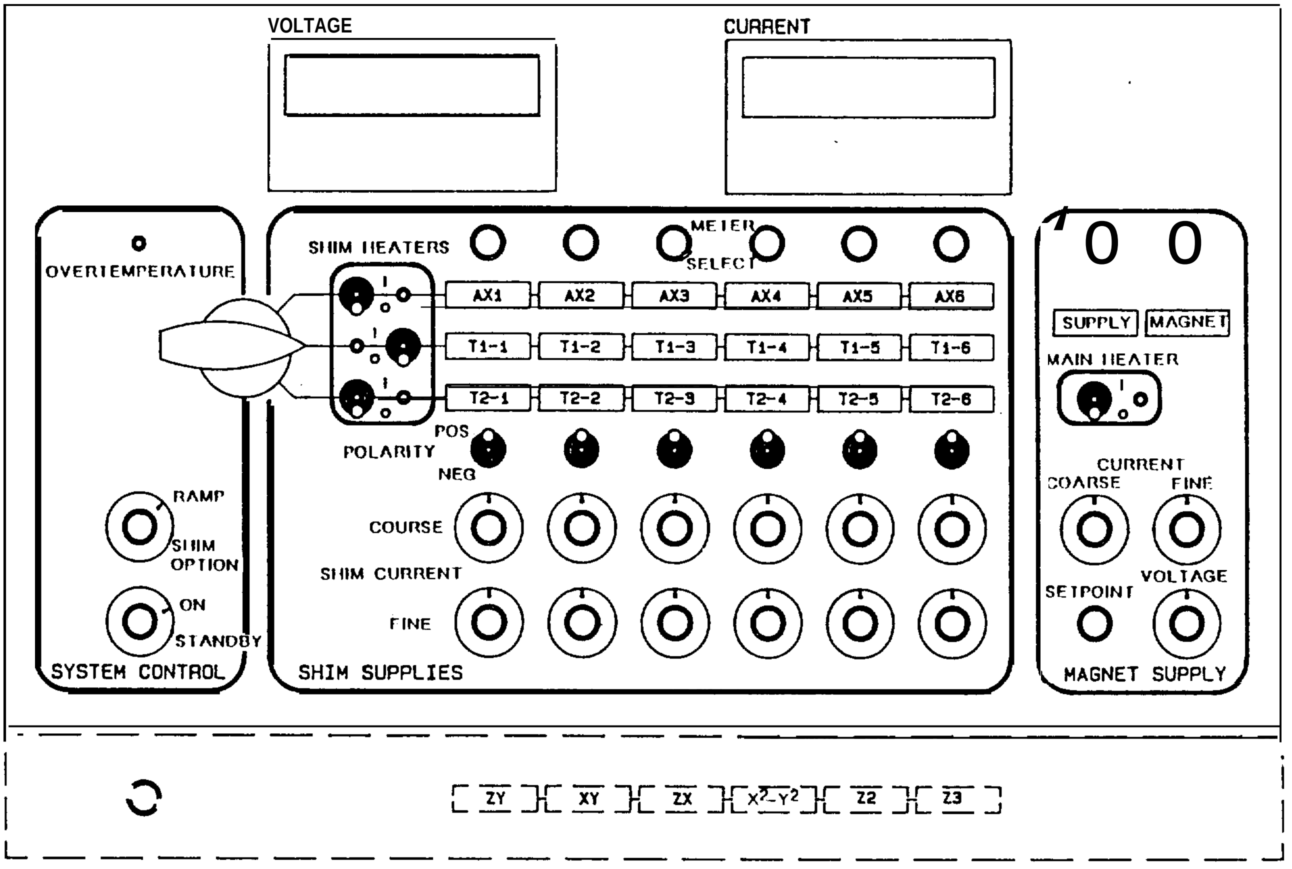
SPECIFICATIONS

WEIGHT: 750 LBS MAX

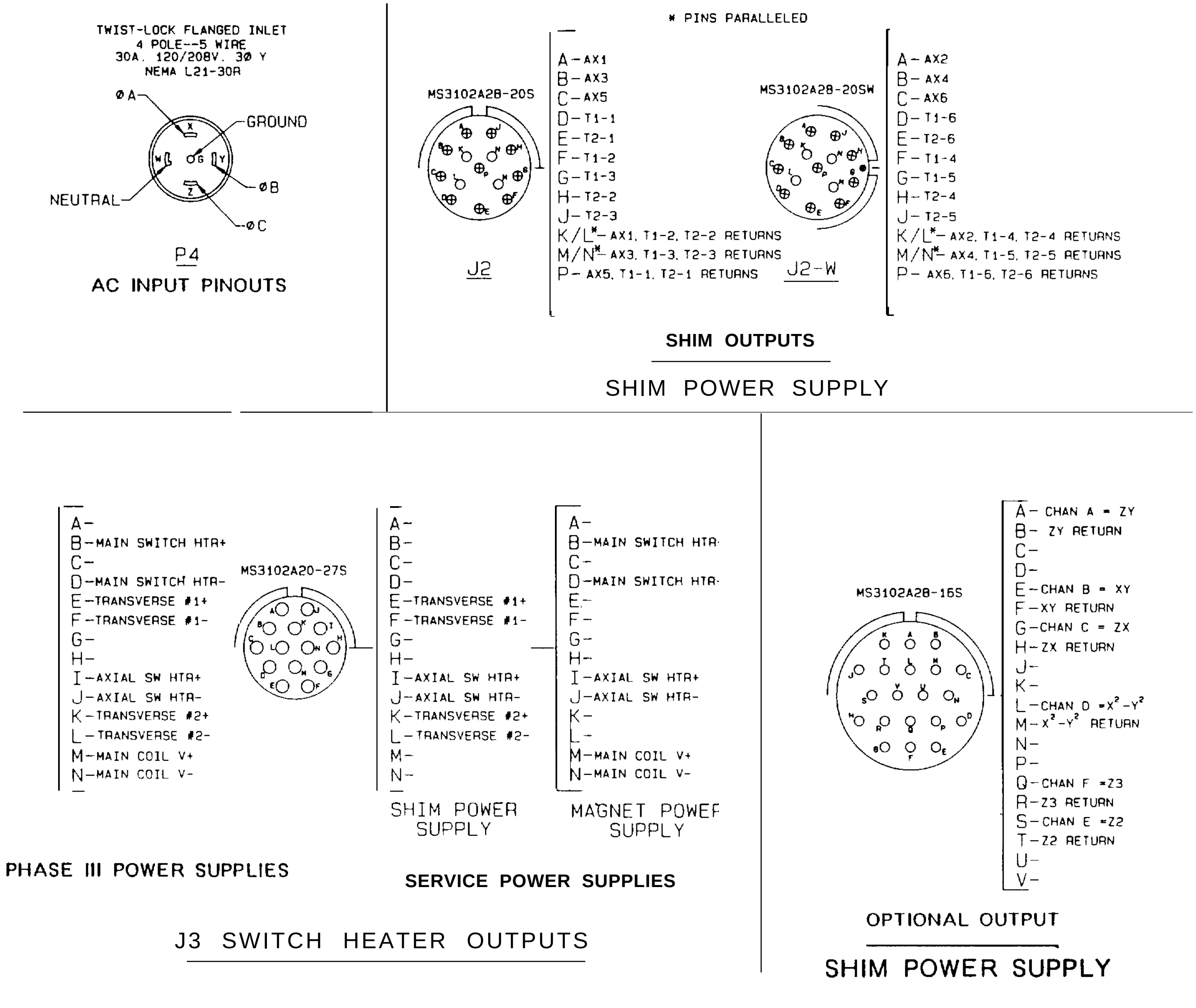
AC-INPUT REQUIREMENTS: 208 VAC +/- 10%
30A
55+/- 8 HZ
THREE PHASE /Y

SYSTEM COMPONENTS:
MAGNET SUPPLY 0-7.5 VDC. 0-75A
SHIM SUPPLY (6) 5 VDC, 0-25A

MAGNET/SHIM PHASE III-A POWER SUPPLY SYSTEM
ILLUSTRATION 3-3



MAGNET/SHIM PHASE III-A POWER SUPPLY CONTROL PANEL
ILLUSTRATION 3-4



POWER SUPPLY INPUT/OUTPUT CONNECTOR PINOUTS
ILLUSTRATION 3-5

SCHEMATICS / INTERCONNECTS

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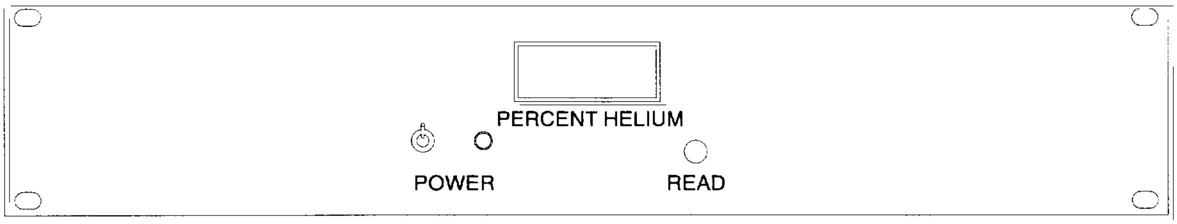
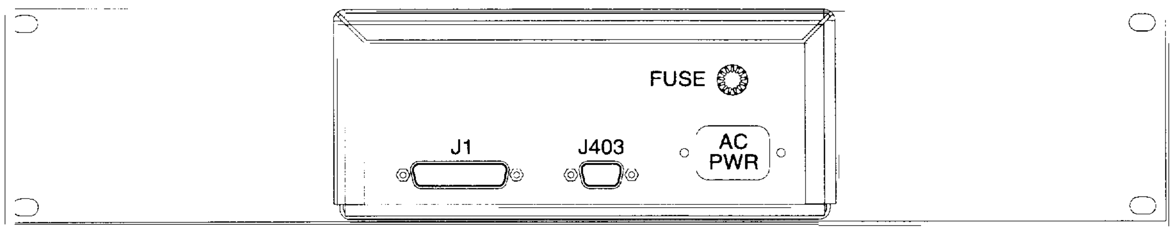
SECTION	TITLE	PAGE
4	CRYOGEN MONITOR	
	4-1 Cryogen Monitor Panel	4-1





CRYOGEN MONITOR PANEL
ILLUSTRATION 4–1

INTRODUCTION

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SECTION TITLE PAGE

1 DOCUMENTATION ORGANIZATION 1–1
1–1 System Documentation Organization 1–1
1–2 Subsystem Manual (Direction 15120) Organization 1–2

SECTION 1- DOCUMENTATION ORGANIZATION

1–1 SYSTEM DOCUMENTATION ORGANIZATION

The documentation structure for the Magnetic Resonance Signa® Advantage™ 1.5T System can be found in *Direction 15400, Signa® Advantage™* 1.5T & 0.5T.

The Signa Service Manuals have been divided Into an Installation Manual, a System Manual, a Subsystem Manual, Renewal Parts Manual, Schematics Manual, and a Mobile System Manual. The Installation Manual contains hardware installation instructions and acts as an overall steering document to guide you through Installation setup and adjustment procedures in the other manuals. The System Manual contains all system–level procedures, and the Subsystem Manual contain subsystem level procedures, The Option/Upgrade Installation Manual contains instructions for installing Signa options and a tabbed division which serves as a holding place for individual upgrade directions,

Note

Should you find any errors in this manual, or should you like to suggest additional material, please use the "Report on Technical Publications" format the front of this manual. Your feedback is important!

Note

All electrical installations that are preliminary to positioning of the equipment at the site prepared for the equipment shall be performed by licensed electrical contractors. In addition, electrical feeds into the Power Distribution Unit shall be performed by licensed electrical contractors. Other connections between pieces of electrical equipment, calibrations, and testing shall be performed by qualified GE Medical personnel. The products involved (and the accompanying electrical installations) are highly sophisticated, and special engineering competence is required. In performing all electrical work on these products, GE will use its own specially trained field engineers. All of GE's electrical work on these products will comply with the requirements of the applicable electrical codes. The purchaser of GE equipment shall only utilize qualified personnel (i.e., GE's field engineers, personnel of third–party service companies with equivalent training, or licensed electricians) to perform electrical servicing on the equipment.

1–2 SUBSYSTEM MANUAL (DIRECTION 15120) ORGANIZATION

INTRODUCTION

Documentation organization, system and component identification and safety considerations are in this section.

SET UP AND CALIBRATION PROCEDURES

Magnet system installation, commissioning, adjustment, and calibration procedures are in this section. Procedures from vendor manuals are referenced where applicable.

FUNCTIONAL CHECKS

Procedures for performing subsystem checks are in this section, such as procedures done for diagnostics and periodic maintenance. Tables for recording ramping history and liquid helium usage are provided along with Magnet Resistance Values.

REPLACEMENT / MAINTENANCE

Procedures and Illustrations to aid in subsystem maintenance and component and cryogen replacement are in this section.

SCHEMATICS / INTERCONNECTS

A cable Interconnect diagram for the system, schematics for all nonvendor subsystem circuits and power supply controls, meters and Indicators are in this section.

RENEWAL PARTS

Renewal part identification and exploded views for the Magnet /Cryogen Subsystem with the Add–On Shield and GE Part Number Reference Tables for vendor renewal parts are in this section,

RIGGING

Procedures and illustrations for uncrating, rigging and moving the magnet into the exam room are covered in this section. Add On Shield Assembly is also included.

1–2 SUBSYSTEM MANUAL (DIRECTION 15120) ORGANIZATION (continued)

Note

Manual sequence for Magnet Commissioning is shown in illustration 1–2.
All schematics / circuit diagrams, component parts lists, descriptions, adjustments/ calibrations and other information necessary for the field service of this Magnet System is contained within this service manual.

CAUTION

In accordance with International Standard, IEC 601–1, the manufacturer is not responsible for any consequences caused by unauthorized modification of this type B Equipment.

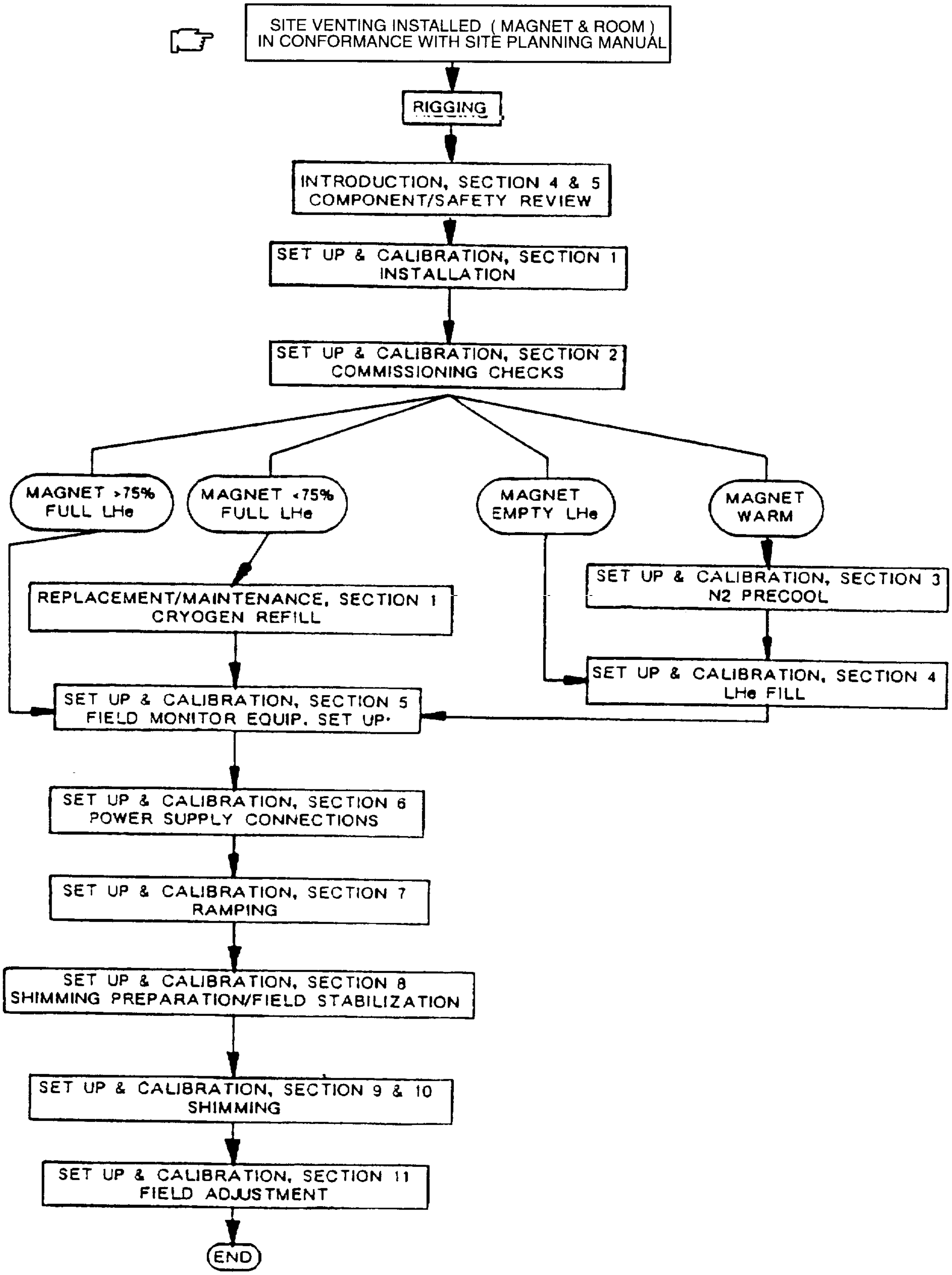
All procedures covered in this manual, other than the indicator lamp checks on the Emergency/ Magnet Rundown Unit, should be performed by a General Electric authorized service representative.

Note

Direction 15120 (46–01 5120) – GE 1.5T Magnet and Cryogens Subsystem covers 1.5T Magnet Systems used on 1.5T Signa products. Applicable magnet system / model numbers shown in Table 1–1.

TABLE 1-1
MAGNET SYSTEM / MODEL NUMBERS

MAGNET MODEL NUMBER	MAGNET ASSEMBLY NUMBER
46–260805G1	46–281175G1
46–260805G2	46–281483G1
46-281380G1	46–281355G1
46-281380G2	46–281355G2
46–281380G3 & G4	46–281355G3
46–281380G5	46–281355G5
46–281380G6	46–281355G5
46–281380G8	46–281355G6



MAGNET COMMISSIONING FLOW DIAGRAM
ILLUSTRATION 1–2

INTRODUCTION

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SECTION	TITLE	PAGE
2	VENDOR MANUALS	2–1

SECTION 2 – VENDOR MANUALS

EQUIPMENT	VENDOR	GE AND VENDOR MANUAL NUMBERS	GE AND VENDOR MODEL NUMBERS
CRYOGEN MONITOR CABINET	AMERICAN MAGNETICS INC. (AMI)	46–294439P1 AMI – MAY 1993	46–281811G1 AMI MODEL 133GE
CRYOGEN MONITOR CABINET	AMERICAN MAGNETICS INC. (AMI)	2120209 AMI	2122498 AMI MODEL 111GE
EMERGENCY RUNDOWN UNIT – SERVICE	COMMUNICATIONS RESOURCES DIVISION OF CHAMAR, INC.	46–294439P2 06MAY87 – REVISION 4	46–252138G4 ERU MODEL 1344
EMERGENCY RUNDOWN UNIT – OPERATION	COMMUNICATIONS RESOURCES DIVISION OF CHAMAR, INC.	46–294439P3 20OCT87 – REVISION 5	46–252138G4 ERU MODEL 1344
SHIELD COOLER COLD HEAD AND COMPRESSOR	LEYBOLD	46–294439P4 GA 12.117; REV. 6	2100832 – RGD 5/100–2 46–294100P1 / RGD 580–GE 46–294141G1,2 / MODEL 4000/4200
SHIELD COOLER COLD HEAD AND COMPRESSOR	LEYBOLD	2110836 REV. 0	2104828 = RGD 5/100 T–2 2104827 = COOLPOWER 6000 A–2
MAIN POWER SUPPLY CABINET	ELECTRONICS MEASUREMENTS INC. (EMI)	46–294439P6 83–452–010 REV 4 4/3/92	46–260776G3 EMI MODEL 452–62–1
SUPERCONDUCTING SHIM POWER SUPPLY CABINET	ELECTRONICS MEASUREMENTS INC. (EMI)	46–294439P7 83–452–011 REV 3 6/12/92	46–260777G3 EMI MODEL 452–62–2
SHIELD COOLER COMPRESSOR	BALZERS	46–294439P8 UC 800 007 BA 8904	46–260759G3, G5, G6 UC 010 700–T
SHIELD COOLER SCROLL COMPRESSOR	BALZERS	46–318395 UC 800 009 BE; JUNE 1, 1992	46–260759G8, G9 UC 010 700–ST and UC 010 702–ST (G8) UC 010 228–ST (G9)
SHIELD COOLER COLD HEAD	BALZERS	46–294439P9 UC 800 008 BA 8904	46–260995G1, G2, G3 UC 011 325–T
MAGNET RUNDOWN UNIT – SERVICE	AMERICAN MAGNETICS INC. (AMI)	46–318393 24MAR94 – REVISION 9	46–294231G1 GE–MRU
MAGNET RUNDOWN UNIT – OPERATION	AMERICAN MAGNETICS INC. (AMI)	46–318394 03MAY93 – REVISION 6	46–294231G1 GE–MRU

INTRODUCTION

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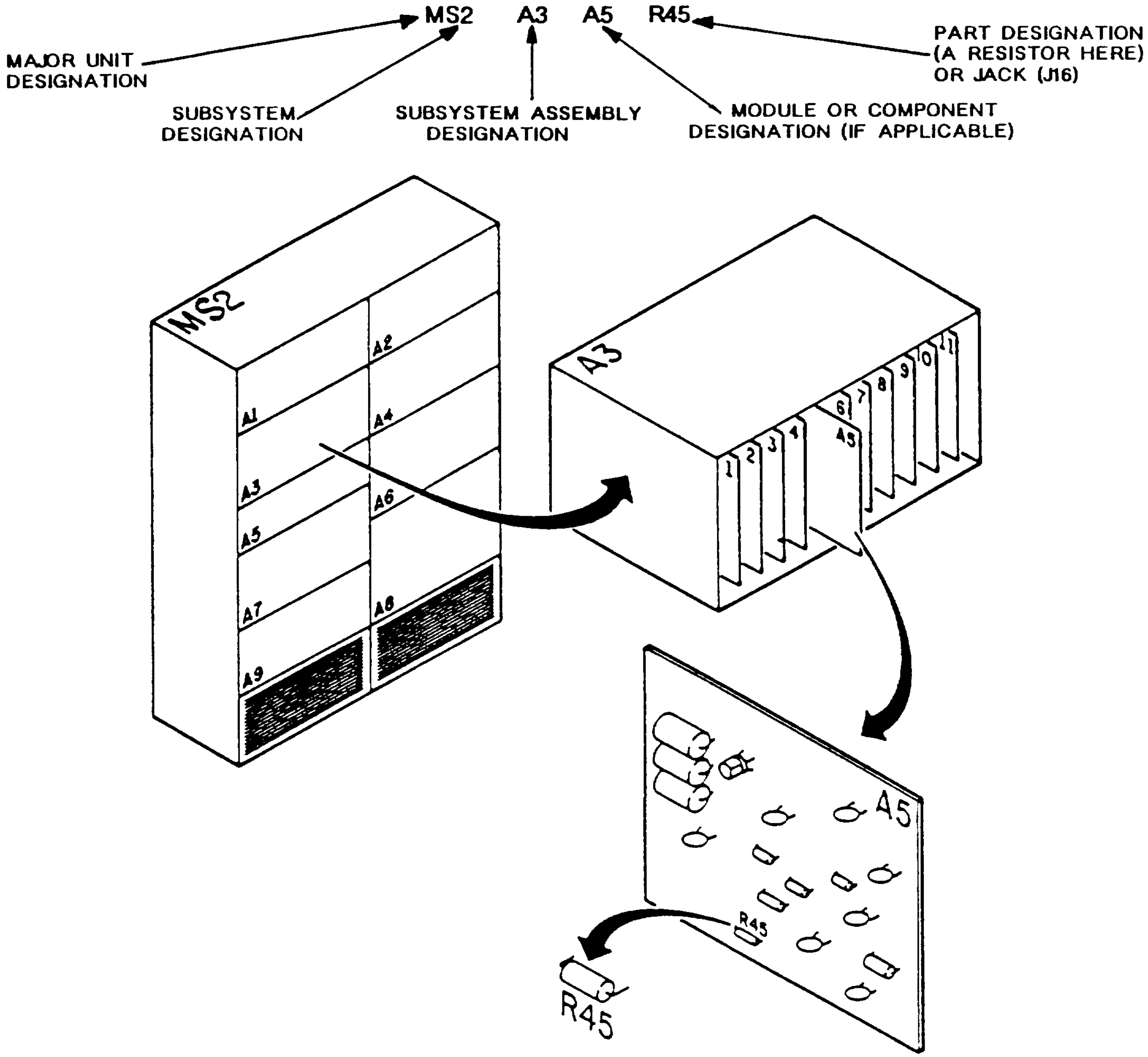
SECTION	TITLE	PAGE
3	EXPLANATION OF DESIGNATOR SYSTEM	3–1

SECTION 3 - EXPLANATION OF DESIGNATOR SYSTEM

The Component Designator System identifies all system components consistently throughout this manual. See Illustration 3-1 for an explanation of the system.



COMPONENT DESIGNATOR SYSTEM
ILLUSTRATION 3-1

INTRODUCTION

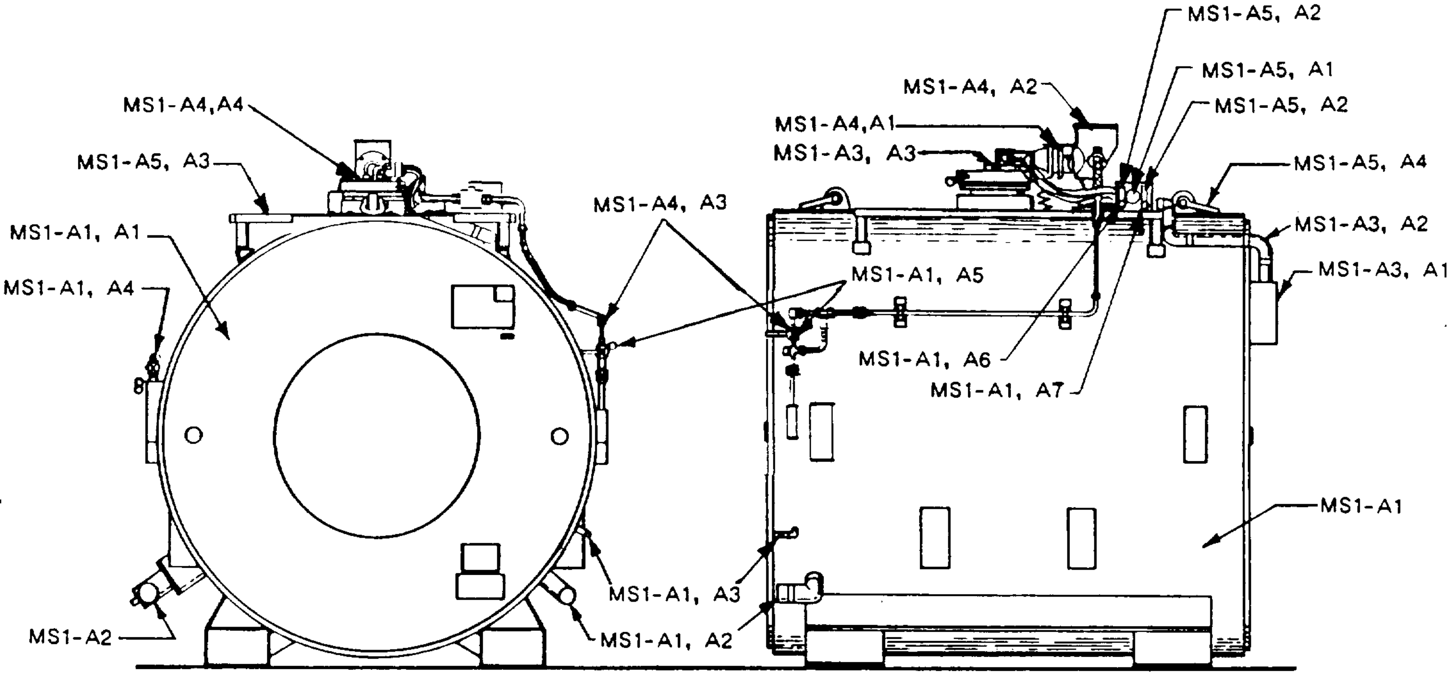
TABLE OF CONTENTS

SECTION	TITLE	PAGE
4	COMPONENT IDENTIFICATION	4–1

SECTION 4 - COMPONENT IDENTIFICATION

This manual covers the major components shown in Illustration 4-1 through 4-8.

MS1 I.ST SUPERCONDUCTING MAGNET/CRYOSTAT



FRONT
(TABLE END)

(TABLE END) (BACK END)
SIDE

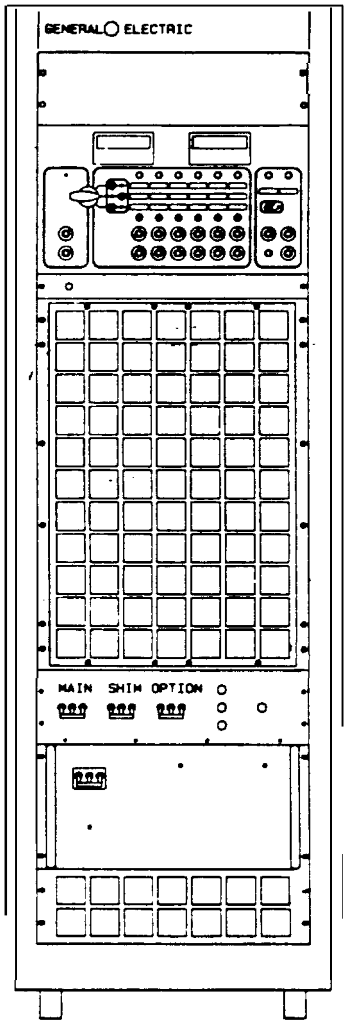
DESIGNATOR	DESCRIPTION
MS1-A1	CRYOSTAT
MS1-A1, A1	TABLE END FLANGE
MS1-A1, A2	VACUUM PUMP OUT PORT
MS1-A1, A3	VACUUM MONITORING PORT
MS1-A1, A4	HELIUM FILL VALVE (V1)
MS1-A1, A5	HELIUM VENT VALVE (V2)
MS1-A1, A6	SHIM LEAD VENT VALVE (V3)
MS1-A1, A7	INSTRUMENTATION LEAD VENT VALVE (V4)
MS1-A2	SHIELD COOLER COLD HEAD
MS1-A3	MAGNET ELECTRICAL HARNESS
MS1-A3, A1	TERMINAL BOX
MS1-A3, A2	HARNESS LEAD

DESIGNATOR	DESCRIPTION
MS1-A3, A3	SERVICE TURRET
MS1-A4	* HELIUM VENTING
MS1-A4, A1	BURST DISC
MS1-A4, A2	VENT ADAPTOR
MS1-A4, A3	VENT PLUMBING
MS1-A4, A4	EXHAUST PLUMBING
MS1-A5	* SERVICE EQUIPMENT/INSTRUMENTATION
MS1-A5, A1	PRESSURE GAUGE
MS1-A5, A2	FLOW METERS
MS1-A5, A3	SERVICE PLATFORM
MS1-A5, A4	LIFTING SHACKLES

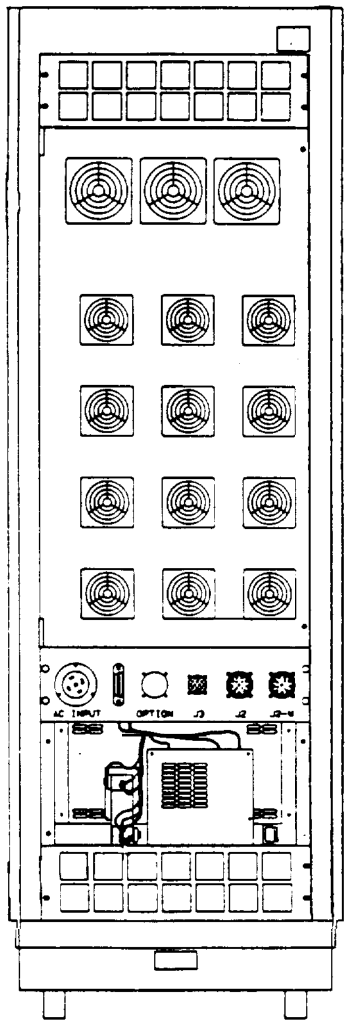
* SMALL VARIATIONS EXIST IN HELIUM VENT/EXHAUST PLUMBING & FLOWMETER/GAUGE LOCATION BETWEEN MAGNET MODELS AS SHOWN IN MAGNET RENEWAL PARTS.

1.5T SUPERCONDUCTING MAGNET/CRYOSTAT
COMPONENT DESIGNATIONS
ILLUSTRATION 4-1

MS2 MAGNET/SHIM PHASE II I-A POWER SUPPLY SYSTEM OPTION



FRONT

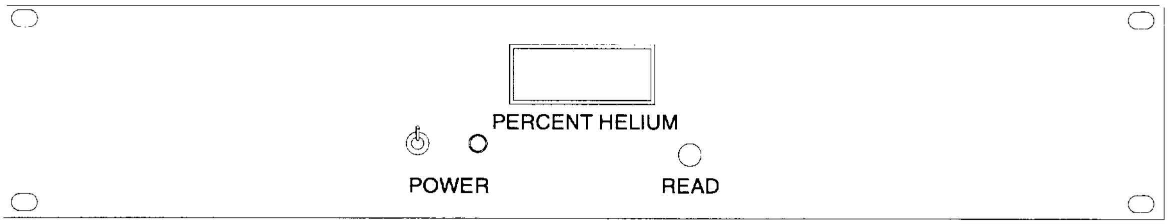


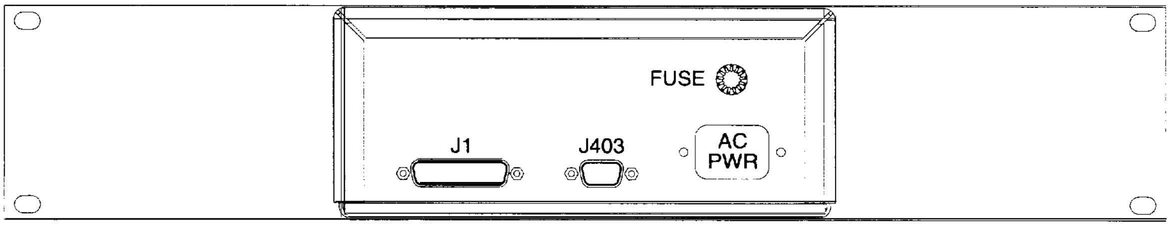
REAR

Note
MS2 Option used with same cabling delineated for MS6 & MS7 Service Power Supplies.

MS2 MAGNET/SHIM PHASE III-A POWER SUPPLY SYSTEM
ILLUSTRATION 4-2

MR2–A6 CRYOGEN MONITORING SYSTEM



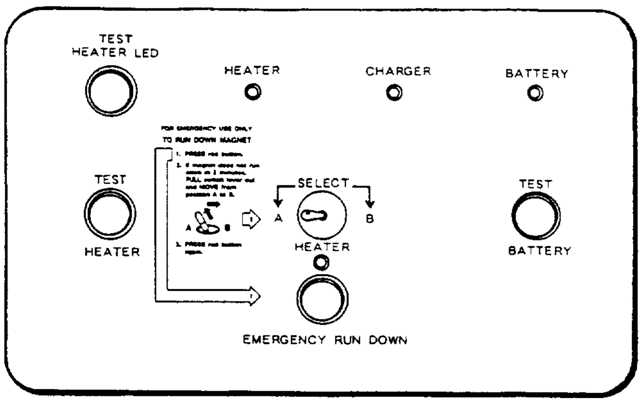


CRYOGEN MONITORING CABINET
MR2-A6, A 1

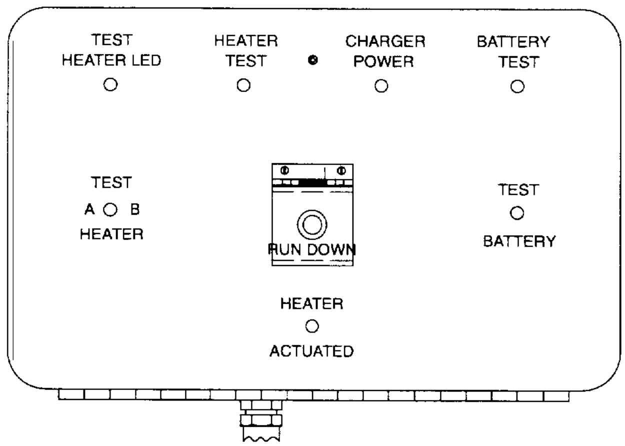
DESIGNATOR	DESCRIPTION
MR2–A6,A1	CRYOGEN MONITORING CABINET
MR2–A6,A2	INSTRUMENTATION CABLE

CRYOGEN MONITORING
COMPONENT DESIGNATIONS
ILLUSTRATION 4–3

MS4 EMERGENCY/ MAGNET RUNDOWN UNIT (ERU / MRU)



ERU



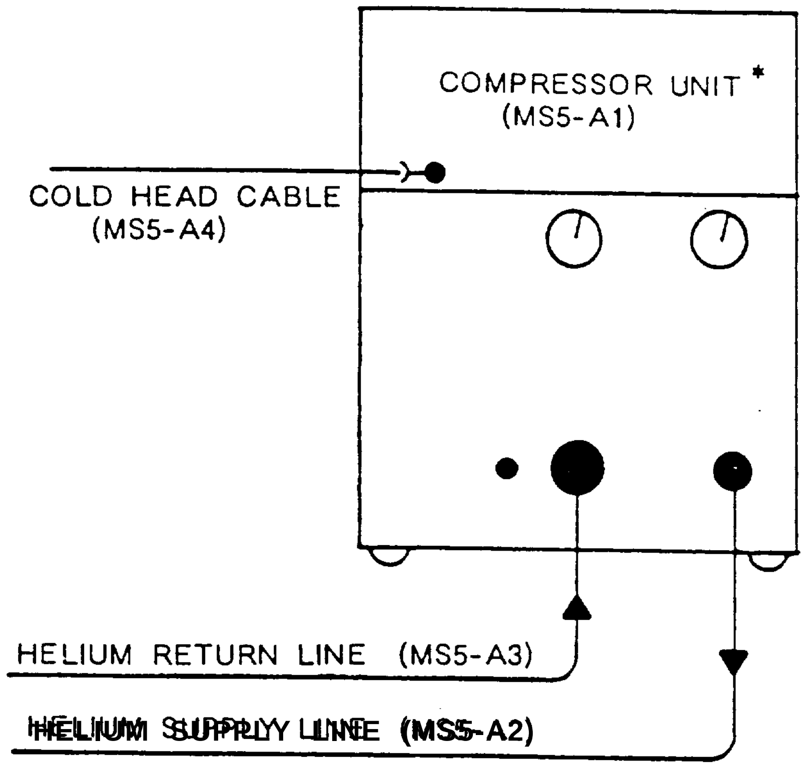
MRU

EMERGENCY / MAGNET RUNDOWN CABINETS
(MS4-A1)

DESIGNATOR	DESCRIPTION
MS4–A1	RUNDOWN UNIT
MS4–A2	RUNDOWN UNIT CABLE

EMERGENCY / MAGNET RUNDOWN UNIT (ERU / MRU)
COMPONENT DESIGNATIONS
ILLUSTRATION 4-4

MS5 SHIELD COOLER COMPRESSOR

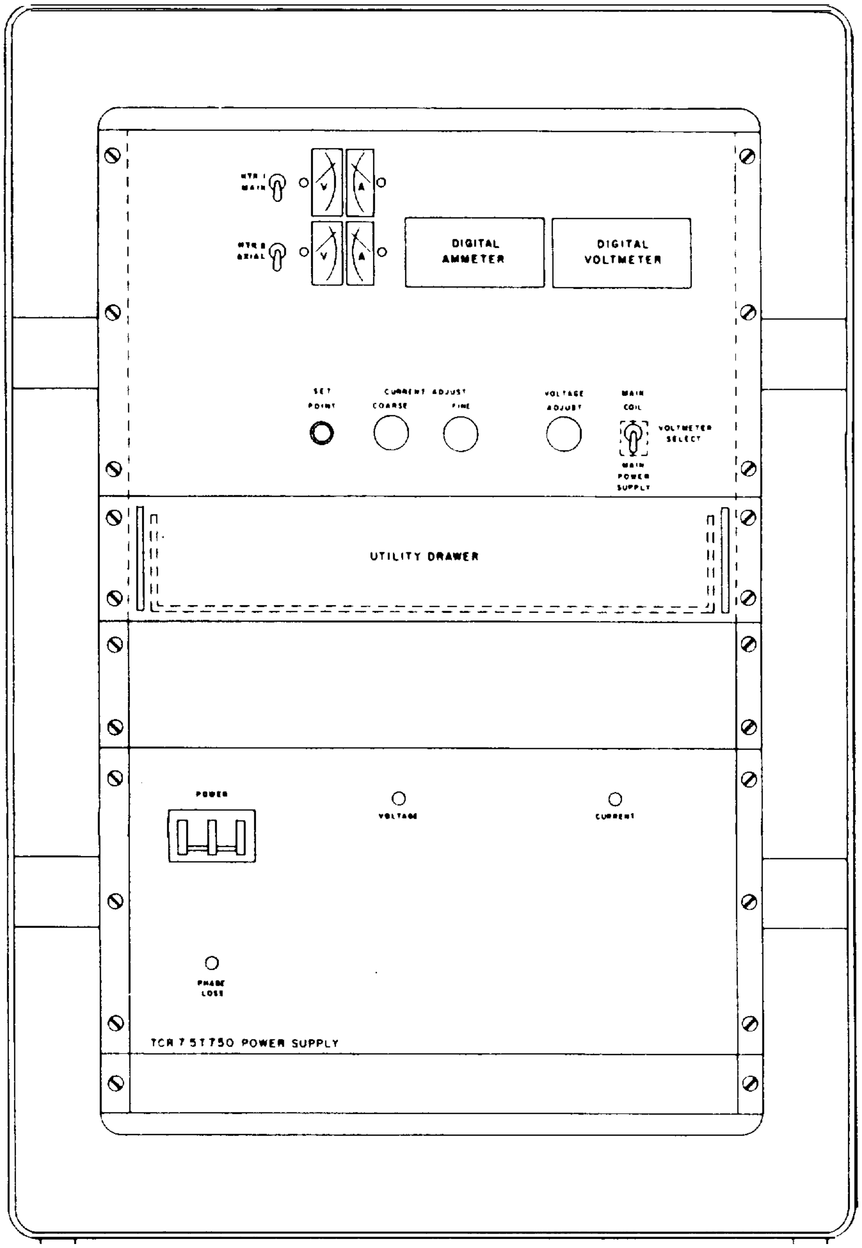


DESIGNATOR	DESCRIPTION
MS5-A1	*SHIELD COOLER COMPRESSOR
MS5-A2	HELIUM SUPPLY LINE
MS5-A3	HELIUM RETURN LINE
MS5-A4	COLD HEAD CABLE

*** APPEARANCE WILL DIFFER FOR ALTERNATE VENDORS.**

SHIELD COOLER COMPRESSOR
COMPONENT DESIGNATIONS
ILLUSTRATION 4-5

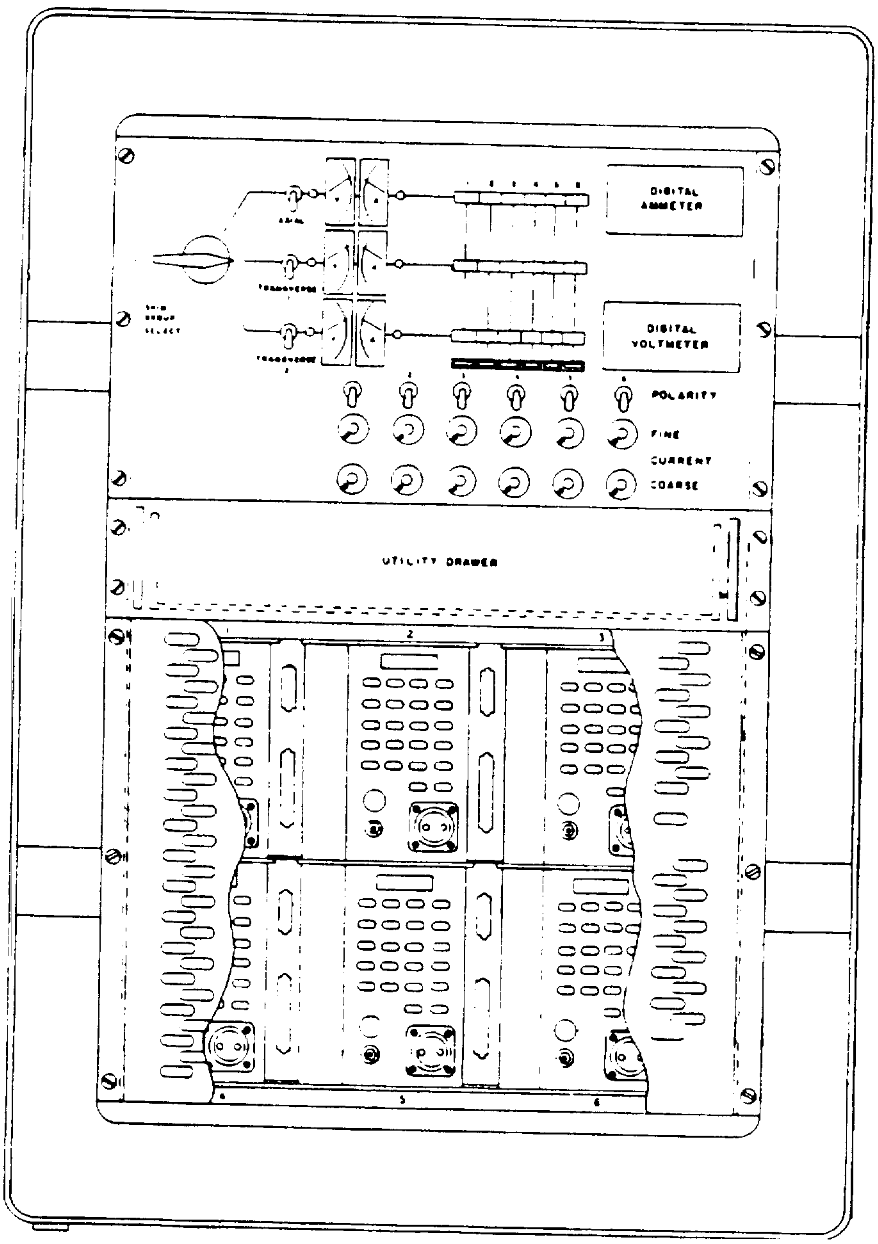
MS6 MAGNET SERVICE POWER SUPPLY CABINET



DESIGNATOR	DESCRIPTION
MS6-A1	MAGNET SERVICE POWER SUPPLY CABINET
MS6-A2	MAIN COIL POWER LEADS
MS6-A3	INPUT POWER CORD

MS6 MAGNET SERVICE POWER SUPPLY CABINET
ILLUSTRATION 4-6

MS7 SHIM SERVICE POWER SUPPLY CABINET



DESIGNATOR	DESCRIPTION
MS7–A1	SHIM SERVICE POWER SUPPLY CABINET
MS7–A2	SUPERCONDUCTING SHIM COIL WIRE HARNESS
MS7–A3	HEATER WIRE HARNESS
MS7–A4	INPUT POWER CORD

MS7 SHIM SERVICE POWER SUPPLY CABINET
ILLUSTRATION 4–7

INTRODUCTION

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	5–1 Magnetic Field Considerations	5–1
	5–2 Emergency Rundown of Magnetic Field	5-4
	5–3 Cryogen Safety	5 -5
	5-4 First Aid	5–7
	5–5 Training–The Best Investment in Safety	5–7

SECTION 5- SAFE CONSIDERATIONS

5-1 MAGNETIC FIELD CONSIDERATIONS

The magnetic field strength used in MR is approximately 30,000 times that of the Earth!!! This field is three–dimensional. Therefore, magnetic field precautions must be applied to the floors above and below the magnet, as well as to the surrounding space on the same level.

To prevent danger to persons and equipment when the magnet is at field, follow the precautions below:

o Post WARNING signs outside the 5 gauss zone alerting personnel with cardiac pacemakers, neurostimulators and other biostimulation devices of the effect of the magnetic field on these devices. See Illustration 5–1, Place these signs within two days of ramping magnet for maximum impact.

o Post SECURITY signs outside the magnet room a alert personnel of the high magnetic field and not to bring ferromagnetic objects into the magnet room. See Illustration 5–2,

Note

These signs will be provided by the local GE Field Service Operation, in the primary local languages. They are available in English from GE Medical Systems, Waukesha, Wl, USA, under the part numbers shown. Highly visible (orange, black& white) security and warning signs are available under the following catalog numbers:

E8819AA – MR Warning Sign Set (2 security signs, 10 exclusion signs) In English
E8819A – One MR Security, Warning Sign, in English.
E8819B – One MR Exclusion Warning Sign, in English.
E8819C – One MR Security Warning Sign, in Spanish.
E8819D – One MR Security Warning Sign, in French.
E8819BA - MR Warning Label Kit (Peel Off Back).

o Notify responsible personnel two days prior to ramping magnet a allow for preparatory actions to be accomplished.

0 Do not bring ferromagnetic objects (e,g.d tools, pens, tape measures, steel–toe shoes, vacuum pumps, etc.) into the magnet room. Do not bring large metal objects near the outside walls of the magnet room. Refer to MR Site Planning, Section 2, for equipment proximity limits.

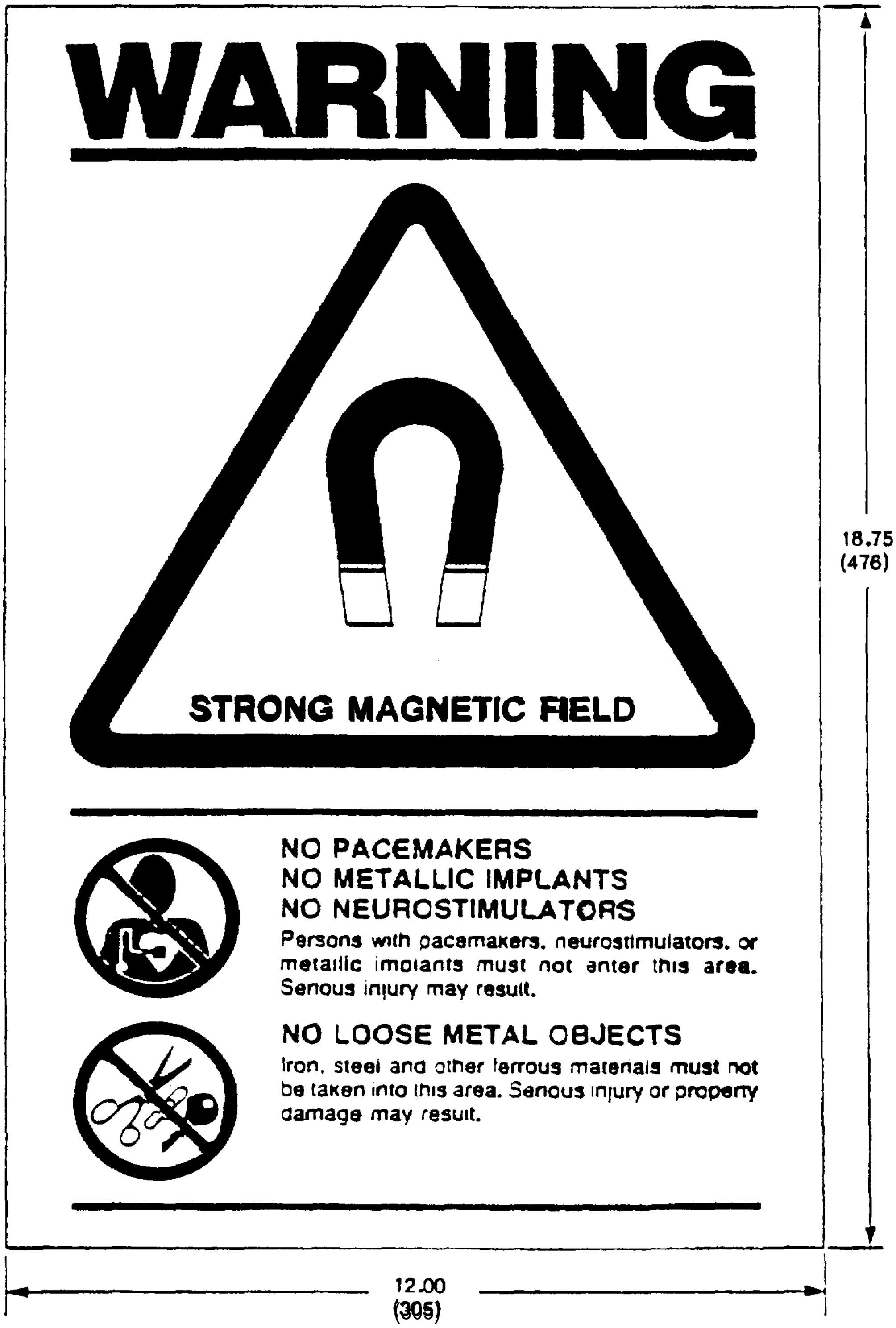
0 Use only nonmagnetic cylinders and dewars when transferring cryogens Into an energized magnet.

0 Do not take self–winding watches, magnetically-coded credit cards, magnetic recording heads, magnetic tapes or cameras near the magnet.

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)

46-255326P1
EXCLUSION ZONE WARNING SIGN
ILLUSTRATION 5–1

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



46-255325P1
SECURITY ZONE WARNING SIGN
ILLUSTRATION 5–2

5-2 EMERGENCY RUNDOWN OF MAGNETIC FIELD

Description

If a ferromagnetic object has become attached to the magnet and cannot be safely removed by two people, the magnet will have to ramped down in conformance with the Main Coil Ramp Down procedure covered in Replacement/Maintenance, Section 3.

If an Emergency Ramp Down of the magnet is required (a person is trapped between a ferromagnetic object and the magnet) use the following procedure to rapidly ramp the magnet down to zero field.

Follow the sequence given in the procedure to minimize the magnet damage resulting from the ramp down! Methods 2 through 4 are back up and normally will not be required.

Procedure:

WARNING!

MAKE SURE THAT MAGNET VENTING IS INSTALLED PRIOR TO RAMPDOWN TO REMOVE THE LARGE AMOUNTS OF GASEOUS HELIUM AND NITROGEN, CREATED BY THE RAMP DOWN, FROM THE MAGNET ROOM AND PREVENT ASPHYZIATION.

INCORPORATE THE SAFETY PRECAUTIONS LISTED IN THE NEXT SECTION (5–3) CRYOGENS.

1. Start the Emergency / Magnet Rundown Unit Heater #1 – Selector A
2. Start the Emergency / Magnet Rundown Unit Heater #2 – Selector B
3. Connect the Main Switch Heater Leads from J3 on the Power Supply to J5 on the Magnet Terminal Box (MSI – A3,A1) and energize the Main Switch Heater. See Set Up And Calibratlon, Section 6.
4. If attempts to ramp down the magnetlc fleld via Methods 1 through 3 fail, the Vacuum Break Tool (46–260852G3) may be connected to the Seal Off Valve on the Pump Out Port of the magnet and the vacuum broken to ramp down the magnetic fleld.

Note

If Method 4 is used a ramp down the magnetic field, the magnet may be damaged and will have to be warmed up and pumped down. The minimum time to restore the magnet to service will be one month.

5-3 CRYOGEN SAFETY

HANDLING:

Liquid helium and liquid nitrogen are odorless, colorless and nontoxic. They are extremely cold (liquid helium = -452° F [–269° C] and liquid nitrogen = –320° F [– 196°C]) and cause severe cold contact burns if the liquids or exhausting vapors contact the skin. Wear nonabsorbent, thermally insulated gloves and nonabsorbent clothing when handling cryogens or when exposed to cryogens exhaust from the magnet.

Contact of liquid cryogens or their vapors with the eyes can cause severe frostbite even when the contact is too brief to affect the skin, Protect eyes with safety goggles or face shield.

Gaseous helium and nitrogen both displace air without warning and can cause rapid asphyxiation if ventilation is insufficient. Store cryogen cylinders and dewars in a well–ventilated area.

Rooms where cryogen liquids are handled must be designated no smoking areas. The extreme low temperatures of liquid helium and nitrogen cause oxygen from the air to liquify on cold surfaces (e.g., on transfer lines) and thus increase its concentration locally. If hot grease or oil come in contact with these surfaces, they may catch on fire.

Vent helium boil-off to the outside air at all times except during precooking of the transfer line. Precool the transfer line with the plume directed award the ceiling.

Never allow any Unprotected part of the body to touch uninsulated pipes or vessels containing cryogenic fluid. The extreme cold causes the flesh a stick and tear when one attempts a withdraw from it. Wear face shield when working on top of the magnet.

CRYOGEN SAFETY:

WARNING!

HELIUM GAS IS EXHAUSTED INTO THE MAGNET ROOM DURING MAGNET RAMPING, SHIMMING, FILLING WITH LIQUID HELIUM AND SERVICE PROCEDURES WHICH OPEN THE HELIUM VESSEL TO ATMOSPHERE, SUCH AS SHIM LEAD REMOVAL. FURTHERMORE, IN THE UNLIKELY EVENT OF A MAGNET VENT FAILURE DURING A MAGNET QUENCH, LARGE QUANTITIES OF HELIUM GAS WOULD RAPIDLY ENTER INTO THE MAGNET ROOM.

IT IS ESSENTIAL THAT PROVISIONS ARE MADE TO EXHAUST THE HELIUM FROM THE MAGNET ROOM TO PREVENT DISPLACEMENT OF AIR AND THE POTENTIAL OF ASPHYXIATION DURING CONDITIONS OF HELIUM EXHAUST FROM THE MAGNET SUCH AS IDENTIFIED ABOVE.

BOTH MAGNET AND ROOM VENTING REQUIREMENTS / DESIGNS ARE PROVIDED IN THE SITE PLANNING MANUAL (REV. 4 AND ABOVE). IT IS ESSENTIAL THAT THESE VENT REQUIREMENTS ARE INCORPORATED INTO THE MAGNET ROOM AND INSPECTED BY A QUALIFIED PERSON PRIOR TO MAGNET DELIVERY INTO THE ROOM.

5–3 CRYOGEN SAFETY (continued)

CRYOGEN SAFETY:

WARNING!

MAKE SURE THE SAFETY PRECAUTIONS LISTED BELOW ARE COMPLETELY FOLLOWED WHEN PERFORMING ANY SERVICE THAT WILL RESULT IN HELIUM EXHAUST FROM THE MAGNET.

1. **MAKE SURE BOTH MAGNET AND ROOM VENT REQUIREMENTS ARE INCORPORATED, IN CONFORMANCE WITH THE SITE PLANNING MANUAL (REV. 4 AND ABOVE), PRIOR TO DELIVERING THE MAGNET INTO THE MAGNET ROOM.**

2. **SECURE THE MAGNET ROOM DOOR IN THE OPEN POSITION AND TURN ON MAGNET ROOM VENT EXHAUST FAN AND OPEN THE ROOM "HATCH" IF A MOBILE VAN, BEFORE INITIATING ANY MAGNET SERVICE THAT WILL RESULT IN HELIUM EXHAUST. IN ADDITION TO ELIMINATING THE POSSIBILITY OF ASPHYXIATION, THE ABOVE ACTION WILL PREVENT THE MAGNET ROOM FROM BECOMING PRESSURIZED, PREVENTING THE DOOR FROM BEING OPENED, IN THE UNLIKELY EVENT OF A MAGNET QUENCH AND SIMULTANEOUS VENT FAILURE.**

3. **MAKE SURE A SECOND PERSON IS PRESENT(GE OR HOSPITAL PERSONNEL) WHILE SERVICING THE MAGNET, IN CASE OF ANY EMERGENCY.**

4. **IN CASE OF A MAGNET QUENCH WHERE HELIUM ENTERS INTO THE ROOM, MAKE SURE THE MAGNET ROOM VENT EXHAUST FAN IS "ON" AND IMMEDIATELY EXIT THE ROOM.**
   IF THE DOOR CANNOT BE OPENED:

   A. **STAY NEAR THE FLOOR WHERE THE OXYGEN WILL BE.**

   B. **IMPLEMENT EMERGENCY EXITING PROCEDURES FOR THE MAGNET ROOM, I.E. REMOVE "POP-OUT" WINDOW . . .**

   C. **IF THE ROOM HAS PIPED IN OXYGEN OR AIR, KNOW WHERE IT IS AND HOW TO USE IT.**

Note

All hospital personnel involved with the MR equipment, need to be trained in the cryogen safety precautions identified above.

5-4 FIRST AID

Move persons suffering from lack of oxygen to an area with normal atmosphere. Seek medical assistance immediately. Self-contained breathing apparatus may be required to prevent asphyxiation of rescue workers.

Flush frostbitten or cold contact 'burn'' areas with large volumes of tepidwater (105° F to 115° F [41 "C to 46° C]). Do not rub frozen parts. Loosen any clothing restricting circulation. Do not apply dry heat.

5-5 TRAINING - THE BEST INVESTMENT IN SAFETY

Explain the following subjects to all persons working with cryogenic liquids:

- o Nature and properties of liquid and gaseous helium and nitrogen.
- o Specific instructions on the equipment and clothing.
- o Use and care of protective equipment and clothing.
- o Safety and first aid.
- o Handling emergency situations such as leaks, spills and fires.
- o Good housekeeping practices.

Note

The Compressed Gas Association's publication CGA P–12, Safe Handling of Cryogenic Liquids, is recommended as a reference,

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SECTION 1- LIQUID HELIUM REFILL

See SECTION 4 of SET-UP and CALIBRATION

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SECTION 2 – ICE PLUG REMOVAL

Description:

Ice Plugs can form in the Vertical Stack, Fill Port and Gas Plumbing, as a result of the cryopumping of air entering through a ruptured Burst Disc; open Cryogen Fill /Vent Ports; or a leak at plumbing joints or fittings. The method of ice plug removal is dependent on the location of the plug and is very "technique" sensitive. Read and understand the following precautions before performing this procedure.

- o Maintain a positive pressure inside the Cryostat at all times during this procedure to minimize the cryopumping of air.
- o Keep all valves closed in strict accordance with this procedure.
- o Insertion devices (snakes, tubing...) rapidly lose flexibility and may become extremely brittle when exposed to extremely low temperatures. Avoid excessive force, twisting or straining of insertion devices and keep insertion devices in motion.
- o Do not insert devices into the Vertical Stack deeper than 20 inches (500 mm).

Improper performance of the following procedures can result in more severe problems (ice blocks relocated deeper in the system, broken Insertion devices stuck in the system).

Procedure:

WARNING!

MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5–3 OF THE INTRODUCTION (CRYOGEN SAFETY).

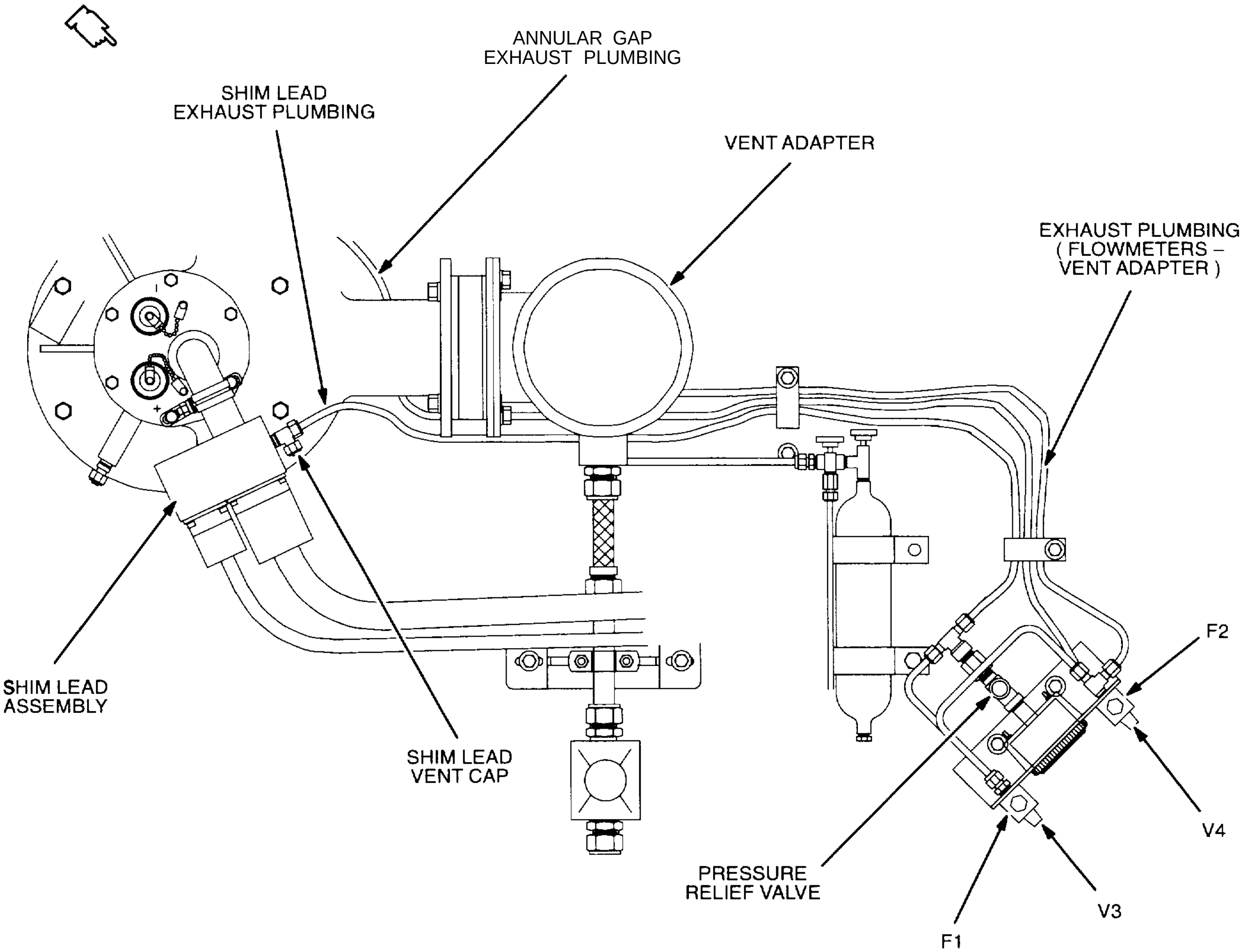
RAPID EXHAUSTING OF COLD HELIUM GAS MAY BE ENCOUNTERED DURING THE FOLLOWING PROCEDURES. WEAR NON ABSORBENT GLOVES AND GOGGLES OR FACE SHIELD WHEN PERFORMING THESE PROCEDURES.

MAKE SURE THAT THE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE REMOVING/REPLACING THE SHIM LEAD ASSEMBLY. A MAGNET QUENCH DURING REMOVAL/REPLACEMENT OF THE SHIM LEAD ASSEMBLY COULD RESULT IN THE RAPID EXPULSION OF LIQUID HELIUM OUT OF THE VERTICAL STACK.

2–1 BLOCK IN 1/4 INCH EXHAUST SYSTEM

Note

A block in the 1/4 inch Exhaust System, indicated by no gas flow through Flowmeter(s) F1 and/or F2 may occur between the Vertical Stack gap and exit port and the Vent Adapter. See Illustration 2–1.



1/4 INCH EXHAUST PLUMBING
ILLUSTRATION 2–1

2-1 BLOCK IN 1/4 INCH EXHAUST SYSTEM (continued)

1. Slowly open Vent Valve (V2) and vent the cryostat until the internal pressure is less than 0.3 psi. Close V2.

2. Remove the 1/4 inch Exhaust Plumbing between the flowmeters and the vent Adapter.

3. Observe the Flowmeters.

Note

If sufficient flow exists in both Flowmeters, the block is in the removed plumbing. if sufficient flow does not exist in both flowmeters, the block is further back toward the Vertical Stack.

4. If the block is in the removed line, take it out of the Exam Room and thaw it with a heat gun. Blow dry, compressed air through the line. if the line is not blocked, reconnect it to the Exhaust System.

Note

If flow restored in Step 4, Go to Step 12. If not perform Steps 5 and 6 on one section of plumbing at a time.

5. If the block is further back toward Vertical Stack, remove the section of pliumbing that is blocked and cap the port at the Vertical Stack with the 1/4 cap (46-260284P1) provided in the magnet accessory equipment.

6. Take the section of removed plumbing out of the Exam Room and thaw it with a heat gun. Blow dry, compressed air through it.

Note

If sufficient flow is established in both Flowmeters (ice block removed), go to Step 12. If flow is not established in F1, the block is in the Flow Outlet or Annular Gap of the Vertical Stack, Go to Step 7. If flow is not established in F2, the block is in the Vapor Cooling Passages of the Shim Lead Assembly, Go to Step 10.

7. If no flow exists in F2, disconnect the plumbing to F2 at the Vertical Stack Flow Outlet. See Illustration 2-1.

8. Insert a non ferromagnetic snake or rod = 1/8 inch (3mm) dia. into the Flow Outlet of the Vertical Stack.

Note

If it penetrates greater than 3 inches (76mm) the outlet is clear and the procedure in Replacement/Maintenance, Section 2-3 must be performed to clear the block from the Annular Gap of the Vertical Stack. if the penetration is less than 3 inches (76mm) the block is in the Flow Outlet and Step 9 must be performed.

2-1 BLOCK IN 1/4 INCH EXHAUST SYSTEM (continued)

9. Insert a heated insertion tool, used in Step 8, into the Flow Outlet and carefully chip the ice block with a pushing/twisting motion. Repeated heatings and insertions may be necessary. Wipe moisture from insertion tool before re-insertions.

Note

When the ice block is removed, cold helium gas should be observed expelling from Flow Outlet. If Step 9 does not restore flow, perform the procedure in Replacement/Maintenance, Section 2-3 to clear block from the Annular Gap of the Vertical Stack. If flow is restored, Go to Step 12.

10. If no flow exists in F 1, remove the Shim Lead Assembly in conformance with Replacement/Maintenance, Section 8.

11. Remove Shim Lead Assembly from Exam Room and thaw. Reassemble in conformance with Replacement/Maintenance, Section 8.

12. When flow is restored, remove protective cap, if applied and reconnect and leak test all Exhaust Plumbing.

CAUTION

Cryostat exhaust flow rates and pressure must be checked and adjusted as required after magnet installation, ramping and shimming to ensure that proper cooling conditions are maintained and **no leaks are present in the Helium Exhaust System or Vent Valve (V2).**

12. Open Vent Valve (V2) to de-pressurize the Cryostat to 0.25 psig. Close V2.

Note

Read al l flow rates from the bottom of the float (ball) on the flowmeters.

13. Set Flowmeter (F1) between 0.4 - 0.6 SCFH.

14. Set Flowmeter (F2) between 1.5 - 2.0 SCFH to maintain a Cryostat Pressure Gauge reading between 0.25 - 0.50 psig.

15. Ensure flow rate through F2 is equal or greater than 1.5 SCFH.

16. If flow rate through F2 is less than 1.5 SCFH or the pressure gauge reads less than 0.25 psig, pressurize the vessel and “bubble test” all exhaust plumbing joints, relief valve and Shim Lead Connector. Ensure V2 is fully closed. Repair any leaks. If a 1.5 SCFH flow rate through F2 cannot be achieved, under the above conditions, contact your Region Magnet Service Engineer.

2-1 BLOCK IN 1/4 INCH EXHAUST SYSTEM (continued)

17. Ensure the following conditions are maintained. Re-check settings in three days and again after one week:

    FLOWMETER (F1) = 0.4 - 0.6 SCFH
    FLOWMETER (F2) > 1.5 - 2.0 SCFH
    CRYOSTAT GAUGE PRESSURE - 0.25 - 0.50 psig

2-2 BLOCK IN 3/4 INCH HELIUM VENT SYSTEM

Note

An ice block in the Helium Vent System, indicated by no internal pressure drop when the Vent Valve (V2) is opened, may occur in the Check Valve at the Vent Adapter, the external plumbing, or the plumbing internal to the Cryostat.

1. Ensure Vent Valve (V2) is closed. Disconnect the vent plumbing, where indicated in Illustration 2-2 and slowly open V2. Close V2.

2. If no helium gas flow was observed when V2 was opened, the block is in the internal plumbing, Go to Step 3. If a flow occurs, the block is in the external plumbing or check valve, Go to Step 7.

3. Prepare an insertion device of 1/8 to 3/16 inch (3 to 5mm) diameter. (ie, Teflon tubing with warm helium gas flow through it; or a heated, flexible, nonferromagnetic cable).

4. Open V2 and carefully insert the insertion device (in small increments) into the internal plumbing, for up to 2 feet (600mm), with a pushing/twisting motion.

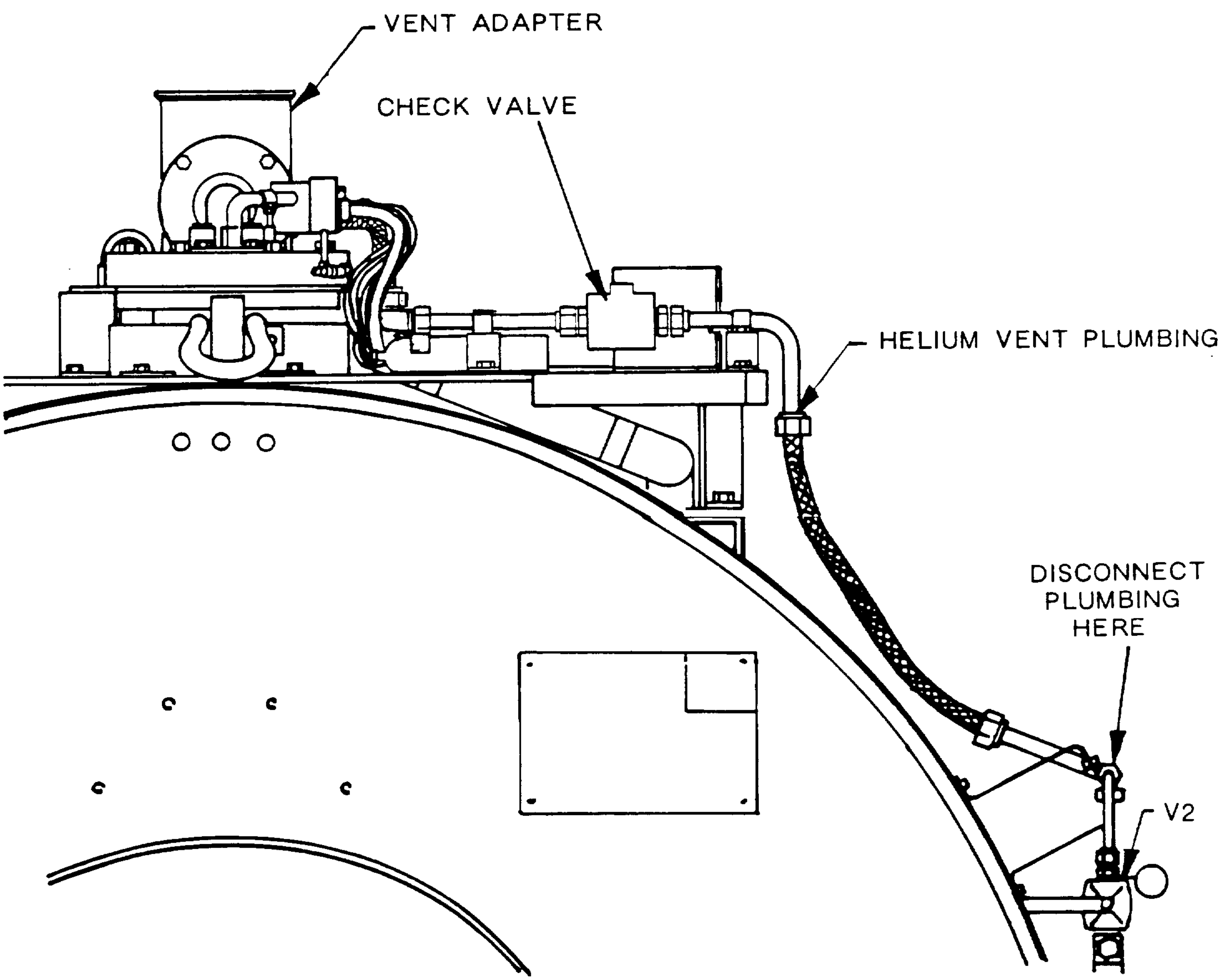
CAUTION

Do not insert any device into the internal plumbing beyond 2 feet (600mm), where the plumbing wraps around the 40K Heat Shield.

5. Remove moisture and reinsert the insertion device as required to remove the ice block. Close Vent Valve (V2) when the insertion device is removed.

6. When flow is restored, close V2 and reconnect and leak test Helium Vent Plumbing. Go to Step 12. If the ice block does not clear after insertion of 2 feet (600mm), contact your Regional Service Engineer.

7. If flow observed in Step 2, ensure Vent Valve (V2) is closed and disconnect 3/4 inch Helium Vent Plumbing Check Valve. See Illustration 2-2.



HELIUM VENT PLUMBING
ILLUSTRATION 2-2

2-2 BLOCK IN 3/4 INCH HELIUM VENT SYSTEM (continued)

8. Check for icing of the Check Valve. If the valve has an ice block, remove it from the Exam Room and thaw it with a heat gun. Blow dry, compressed air through it.

9. If ice block is in the External Vent Plumbing (not in Check Valve), disconnect the section of Vent Plumbing that has the ice block and remove from Exam Room.

10. Thaw block in External Vent Plumbing with a heat gun. Blow dry, compressed air through it.

11. When block is removed, reconnect and leak test External Vent Plumbing and Check Valve.

CAUTION

Cryostat exhaust flow rates and pressure must be checked and adjusted as required after magnet installation, ramping and shimming to ensure that proper cooling conditions are maintained and no leaks are present in the Helium Exhaust System or Vent Valve (V2).

12. Open Vent Valve (V2) to de-pressurize the Cryostat to 0.25 psig. Close V2.

Note

Read all flow rates from the bottom of the float (ball) on the fiowmeters.

13. Set Flowmeter (F1) between 0.4 - 0.6 SCFH.

14. Set Flowmeter (F2) between 1.5 - 2.0 SCFH to maintain a Cryostat Pressure Gauge reading between 0.25 - 0.50 psig.

15. Ensure flow rate through F2 is equal or greater than 1.5 SCFH.

16. If flow rate through F2 is less than 1.5 SCFH or the pressure gauge reads less than 0.25 psig, pressurize the vessel and “bubble test” all exhaust plumbing joints, relief valve and Shim Lead Connector. Ensure V2 is fully closed. Repair any leaks. If a 1.5 SCFH flow rate through F2 cannot be achieved, under the above conditions, contact your Region Magnet Service Engineer.

17. Ensure the following conditions are maintained. Re-check settings in three days and again after one week:

    FLOWMETER (Fl) = 0.4 - 0.6 SCFH
    FLOWMETER (F2) > 1.5 - 2.0 SCFH
    CRYOSTAT GAUGE PRESSURE - 0.25 - 0.50 psig

2-3 BLOCK IN VERTICAL STACK

Note

Ice blocks within the Vertical Stack generally result in increased boil off and/or the blocking of helium exhaust through F1/F2.

1. Ramp magnet down to zero field and remove the Shim Lead Assembly in conformance with Replacement/Maintenance, Sections 3 and 8.

WARNING!

ENSURE THAT THE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE REMOVING SHIM LEAD ASSEMBLY OR BRINGING ANY FERROMAGNETIC EQUIPMENT OR MATERIAL INTO THE EXAM ROOM.

2. Shine flashlight through the Plexiglas cover plate and determine the extent of icing.

3. Obtain 1/4 - 1/2 inch (6 - 12mm) dia. stainless tubing and apparatus to supply warm helium gas through the tube.

4. Locate spare Piexiglias 6 inch (152mm) dia. cover plate, P/N 46-260963P3. Take cover plate outside Exam Room and drill hole near center to allow stainless tube to just fit through, insert tube.

5. Slowly open Vent Valve (V2) and vent Cryostat until the internal pressure is less than 0.3 psi. Close V2.

6. Rapidly exchange Plexiglas cover plates and hook up warm helium gas supply to tube.

Note

Tube can be inserted up to 20 inches (500mm) into the Vertical Stack, depending on the nature and location of the ice block.

7. Blow warm helium gas through the tube at 5 psi to warm up the sleeve and melt the ice block.

8. Observe Cryostat Pressure Gauge. if internal pressure approaches 5 psi, open Vent Valve (V2) to drop pressure. Maintain pressure under 5 **psi during this** process.

9. When thawing completed (as indicated by flow through F2) turn off and disconnect helium gas supply and replace Shim Lead Assembly in conformance with Replacement/Maintenance, Section 8.

2-3 BLOCK IN VERTICAL STACK (continued)

Note

Save cover plate with hole and apparatus for future application in this procedure.

10. Reconnect all exhaust plumbing and check for gas flow and leaks.

11. Ramp the magnet up in conformance with Set Up and Calibration, Section 7.

CAUTION

Cryostat exhaust flow rates and pressure must be checked and adjusted as required after magnet installation, ramping and shimming to ensure that proper cooling conditions are maintained and no leaks are present in the Helium Exhaust System or Vent Valve (V2).

12. Open Vent Valve (V2) to de-pressurize the Cryostat to 0.25 psig. Close V2.

Note

Read all flow rates from the bottom of the float (ball) on the flowmeters

13. Set Flowmeter (Fl) between 0.4 - 0.6 SCFH.

14. Set Flowmeter (F2) between 1.5 - 2.0 SCFH to maintain a Cryostat Pressure Gauge reading between 0.25 - 0.50 psig.

15. Ensure flow rate through F2 is equal or greater than 1.5 SCFH.

16. If flow rate through F2 is less than 1.5 SCFH or the pressure gauge reads less than 0.25 psig, pressurize the vessel and "bubble test" all exhaust plumbing joints, relief valve and Shim Lead Connector. Ensure V2 is fully closed. Repair any leaks. If a 1.5 SCFH flow rate through F2 cannot be achieved, under the above conditions, contact your Region Magnet Service Engineer.

17. Ensure the following conditions are maintained. Re-check settings in three days and again after one week:

    FLOWMETER (Fl) = 0.4 - 0.6 SCFH
    FLOWMETER (F2) > 1.5 - 2,0 SCFH
    CRYOSTAT GAUGE PRESSURE - 0.25 - 0.50 psig

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SECTION 3 - MAGNET RAMPDOWN (DECREASE TO ZERO)

WARNING!

MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5-3 OF THE INTRODUCTION (CRYOGEN SAFETY).

A SUPERCONDUCTING MAGNET AT FIELD IS AN ENERGY STORAGE DEVICE CAPABLE OF DISCHARGING RAPIDLY DURING A QUENCH AND CREATING A DC VOLTAGE OF 100V OR MORE ACROSS THE MAIN LEADS AND EXTENSIONS.

NEVER TOUCH THE MAIN LEAD EXTENSIONS SIMULTANEOUSLY WHEN THE MAGNET IS AT "FIELD" AS A FATAL SHOCK AND/OR BURNS MAY RESULT IF A QUENCH OCCURS.

ENSURE INPUT POWER TO MAIN POWER SUPPLY IS DISCONNECTED WHEN CONNECTING MAIN POWER LEADS.

SECURE MAGNET ROOM DOORS IN THE OPEN POSITION BEFORE CHANGING MAGNETIC FIELD.

Note

Both Main Power Supply and Shim Power Supply are needed for the following procedure.

3-1 PREPARATION FOR FIELD CHANGE

1, Set up the field monitoring equipment, Probe and Teslameter in accordance with Set Up and Calibration, Section 5.

2. Ensure that the Magnet Power Supply is installed, checked and adjusted in accordance with the Vendor Manual (Sections 1 through 4) supplied with the unit. See Vendor Manual for location and description of power supply controls.
3. Ensure that the input Power Cable for the Power Supply is disconnected,
4. Retrieve the Main Coil connection polarity and latest final ramping current In Table 8-4 of Functional Checks.
5. Connect the Main Coil Power Supply to the magnet by making all cable connections In accordance with Set Up and Calibration, Section 6–2. Ensure power supplies connected with same polarity as retrieved In Step 4.

Note

This section allows one to remove all shim currents to find the actual main field to document and use as a target parking frequency when re–ramping the magnet. This will enable parking the magnet at a more accurate frequency and prevent retuning of the rest of the system.

6. Connect the heater cable, shim cable, and power cable to the Shim Power Supply in accordance with Set Up and Calibration, Section 8–1, Superconducting Shim Coil Power Supply Connection.

3–1 PREPARATION FOR FIELD CHANGE (continued)

WARNING!

MAKE SURE SHIM LEADS ARE "FROSTED" AND THERE IS SUFFICIENT FLOW OF HELIUM COOLING GAS THROUGH LEAD BEFORE SETTING ANY SHIM COIL CURRENTS IN THE POWER SUPPLY, TO PREVENT SHIM LEAD DAMAGE.

MAKE SURE THE CRYOGEN LEVEL IN THE MAGNET IS AT LEAST 75% TO PREVENT DAMAGE TO THE CORRECTION COILS OR A POSSIBLE QUENCH DURING THE FOLLOWING STEPS.

MAKE SURE CURRENT AND VOLTAGE CONTROLS ARE SET TO ZERO (FULL CCW) BEFORE TURNING ON THE POWER SUPPLY TO PREVENT UNINTENTIONAL SHIM LEAD CURRENT.

7. Remove the shim lead cap and precool the shim leads with GHe generated by the ramp lead extension insertion into the magnet.
8. Switch on the Shim Power Supply main power.
9. Turn on both Transverse Switch Heaters to dump all Transverse Shim currents,turn off switch heaters,
10. Set Axial Shim Coil currents in power supply to match currents in Axial Shims. See Table 9-4 in Set Up and Calibration,
11. Turn on Axial Heater, verify heater current is 810+/-10mA Allow two minutes for the heater to drive the switches resistive then slowly reduce all Axial Shim currents to zero,
12. Check the frequency reading on the Teslameter to make sure the Correction Coils are stable (i.e. there is no more than a 20 Hz change in total magnetic field over a two minute period).
13. Once the field is stable (see Step 12), record main field strength for reference when ramping magnet to operating conditions later, and turn off the Switch Heaters and allow the heater to cool.
    Gauss
14. Switch off the Shim Power Supply main power.
15. Disconnect the Input Power Cable from the Shim Power Supply and connect it to the Main Power Supply.

3-2 RESISTANCE CHECKS

1. Ensure 'CURRENT CONTROL" and "VOLTAGE CONTROL" on the Main Power Suppty are off (full CCW). Turn on Power Supply Input Power.

2. Turn on Axial Shim Heaters and observe current rise in ammeter (810±10 mA) to ensure circuit continuity. Ensure Main Heater Switch is off.

WARNING!

AXIAL SHIM SWITCH HEATERS MUST REMAIN ON DURING THE ENTIRE RAMPING PROCESS TO PREVENT IRREPARABLE SHIM COIL DAMAGE AND MAGNET QUENCH DURING RAMPING. THE POWER SUPPLY WILL NOT PASS CURRENT IN THE MAIN POWER LEAD CIRCUIT WITH THE AXIAL SHIM HEATERS OFF.

3. Connect a Digital Volt Meter (DVM) to the end of the Voltage Sense Leads terminated at the power supply.

4. Set "VOLTAGE CONTROL" on power supply to maximum (full CW).

5. Observe the Main Power Supply Ammeter and slowly turn the "CURRENT CONTROL" (CW) to pass 500A current through the Main Power Leads, Lead Extensions and persistent Main Switch.

6. Record the voltage reading on the (DVM) ______________ mV.

Note

A voltage reading less than 150 mV indicates acceptable internal contact resistance of the Lead Extensions. If the voltage reading is greater than 150 mV, turn "CURRENT CONTROL" off (full CCW), turn off Input Power and re-seat the Lead Extensions on the top of the magnet. Repeat Steps 1 through 7 when the Lead Extensions are re-seated. Repeated readings over 150 mV indicate the need to replace the Lead Extension Contact Bands. Refer to Replacement/Maintenance, Section 11.

Upon passing the internal resistance check, continue with Step 8.

7. Set the Power Supply Voltmeter to read voltage across the Power Supply Output Lugs.

8. Gradually increase the "CURRENT CONTROL" (CW) to pass 735A through the Main Power Leads, Lead Extensions and persistent Main Switch while observing the Power Supply Voltmeter. If the voltage exceeds 2.2V, discontinue the test.

3-2 RESISTANCE CHECKS (continued)

Note

A voltage less than 2.2V at 735A indicates acceptable system resistance. If the voltage exceeds 2.2V during the test, turn the "CURRENT CONTROL" off (full CCW), turn off input power and check/tighten the bolts securing the Main Power Cables to the PowerSupply and Lead Extensions. Turn on power supply and repeat Step 9, after tightening Main Power Cable Connections.

9. Record the frequency displayed on the Teslameter while the 735A current is flowing through the switch.

Frequency (Hz) ______________________

Note

This is the target frequency for when the magnet is reramped.

Note

If a different frequency is desired, a delta of this frequency can be made. Refer to Set Up and Calibration, Section 11, Field Adjustment After Shimming, Step 1.

10. Upon passing Step 9, turn the "CURRENT CONTROL" off (full CCW) and continue with the Rampdown procedure.

3-3 MAGNET RAMPDOWN (DECREASE TO ZERO)

CAUTION

If a Quench occur during change of magnetic field, Immediately turn "VOLTAGE CONTROL" and "CURRENT CONTROL" to zero.

WARNING!

ENSURE THAT THE CONNECTION POLARITY AND CURRENT SET ARE THE SAME AS THE LAST RECORD IN TABLE 8-4 OF FUNCTIONAL CHECKS. THE MAIN POWER SUPPLY MUST BE SET TO THE SAME CURRENT AND POLARITY IN THE MAIN COILS TO AVOID A QUENCH WHEN TURNING ON THE MAIN SWITCH.

3-3 MAGNET RAMPDOWN (DECREASE TO ZERO) (continued)

1. Set "CURRENT CONTROL" to pass the same current as retrieved in Replacement Maintenance, Section 3-1, Step 4, through the persistent Main Switch.

2. Turn on the Main Switch Heater. Leave the Axial Shim Switch Heater Supply on.

3. Allow approximately 1 minute for the Main Switch to go normal.

4. When the Main Switch is normal, gradually turn the "CURRENT CONTROL" to zero (over to a 1 minute period).

5. Turn the "VOLTAGE CONTROL" to zero (full CCW).

Note

When the "CURRENT CONTROL" is turned down the voltage across the magnet voltage taps will show a sudden decrease to (-1 to -2 V).

6. Observe voltmeter reading with voltmeter select switch in the "MAIN COIL" position. A 0.00X reading indicates that the magnet is fully discharged.

7. When magnet is fully discharged, turn off Axial Shim Heaters and Main Switch Heater.

8. Turn off Power Supply.

9. Disconnect input power from Power Supply.

CAUTION

Replace caps immediately after removing Main Power Lead Extensions to prevent ice build up inside Vertical Stack.

10. Disconnect the Main Power Leads on the top of the magnet and remove the Main Power Lead Extensions. Replace caps on Main Power Lead Extension Receptacles.

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SECTION 4 - WARMING UP CRYOSTAT

Description:

There will be extremely few situations that will equire the magnet to be warmed up in the field (the removal of an internal ice block or field repairable vacuum leak requiring re-evacuation). If a magnet warm up is required, contact the Regional Field Service Engineer before proceeding. The Cryostat is designed to allow for the recovery of liquid helium; however, because of the nature of failure modes requiring warm up, the liquid helium is most likely boiled off. If the unit is less than 25% full of liquid helium, warm up the magnet without liquid helium recovery. A prepared dewar (cold/containing Helium gas) is recommended for liquid helium recovery, significant quantity of liquid helium is evaporated in the cool down of a warm dewar.

Do not warm up the magnet if it is to be shipped from the site!

Procedure:

WARNING!

WEAR PROTECTIVE CLOTHING, NON ABSORBENT GLOVES AND GOGGLES O R FACE SHIELD, TO PROTECT AGAINST LIQUID CRYOGENS.

TURN ON EXAM ROOM EXHAUST FAN TO AID IN REMOVING CRYOGEN GASES. ENSURE PROPER VENTILATION EXISTS DURING WARM UP AS CONSIDERABLE QUANTITIES OF HELIUM AND NITROGEN GAS ARE EVOLVED.

SECURE EXAM ROOM DOORS IN THE OPEN POSITION BEFORE WARMING UP MAGNET.

ENSURE MAGNET IS RAMPED DOWN TO ZERO FIELD TO PREVENT ANY POSSIBILITY OF A QUENCH.

CAUTION

Ensure the Region Service Engineer is present and has determined that Magnet Warm Up is required before proceeding.

Ensure that all required equipment and sufficient prepared dewars to handle the liquid helium volume are on site.

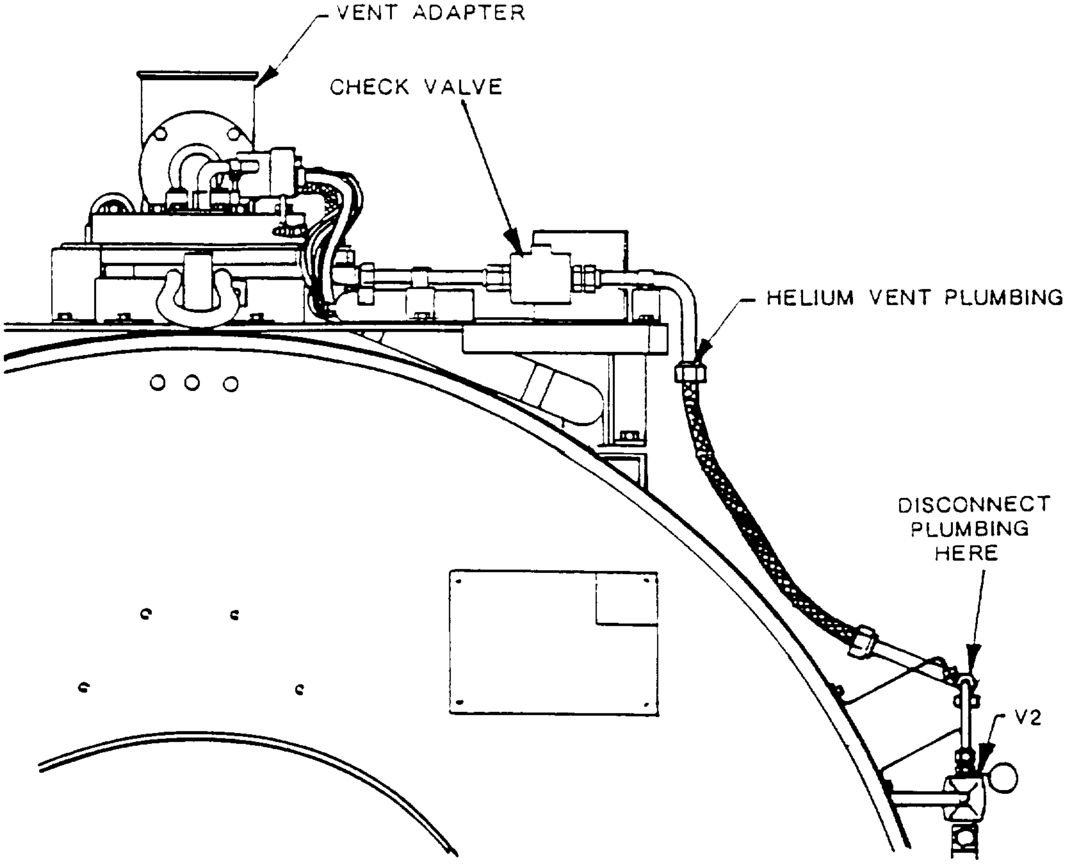
4-1 CRYOSTAT WARM UP (WITHOUT LIQUID HELIUM RECOVERY)

1. Turn off Shield Cooler Compressor and disconnect power cable and supply and return gas lines at the Cold Head.
2. Remove Helium Burst Disc and reconnect Vent Adapter. See Replacement/ Maintenance, Section 7.
3. Connect the lakeshore Cryotonic - DRC80 (46-265269G1) to monitor silicon diode temperature in conformance with Set Up and Calibration, Section 2-2-1.
4. Connect helium gas (99.995%) and regulator setup to the Helium Fill port at V1.
5. Open Helium Vent and Fill Valves (V2 & Vi).
6. Blow warm helium gas through the Cryostat, regulated at 4 to 6 psig, until silicon diode temperature readout exceeds 90K.
7. Shut off helium gas flow and close Helium Fill Valve (V 1).
8. Remove helium gas setup and connect nitrogen gas setup in its place.
9. Open Helium Fill Valve (Vi).
10. Start and continue nitrogen gas flow, regulated at 4 to 6 psig, until silicon diode temperature readout exceeds 273K.
11. Discontinue nitrogen gas flow, close Helium Fill and Vent Valves (Vl & V2) and remove setup.

4-2 CRYOSTAT AT WARM UP (WITH LIQUID HELIUM RECOVERY

1. Establish if magnet is 25% or more full of liquid helium. If there is less than 25% liquid helium use the warm up procedure in Replacement/Maintence,Section4-1.
2. Turn off Shield Cooler Compressor and disconnect power cable and supply and return gas lines at the Cold Head.
3. Connect Lakeshore Cryotonic - DRC80 (46-265269G1) to monitor silicon diode temperature in conformance to Set Up and Calibration, Section 2-2-1.
4. Open Vent Valve (V2) momentarily then close to purge Vent Pluming and reduce internal pressure to 0.3 psig immediately before connecting helium gas and regulator setup.
5. Disconnect Helium Vent Plumbing as indicated in illustration 4-1 and connect helium gas (99.995°/0) and regulator setup at that point.

4-2 CRYOSTAT WARM UP (WITH LIQUID HELIUM RECOVERY) (continued)



HELIUM VENT PLUMBING
ILLUSTRATION 4-1

6. Loosen Compression Fitting and remove Helium Fill Port Plug at V 1.

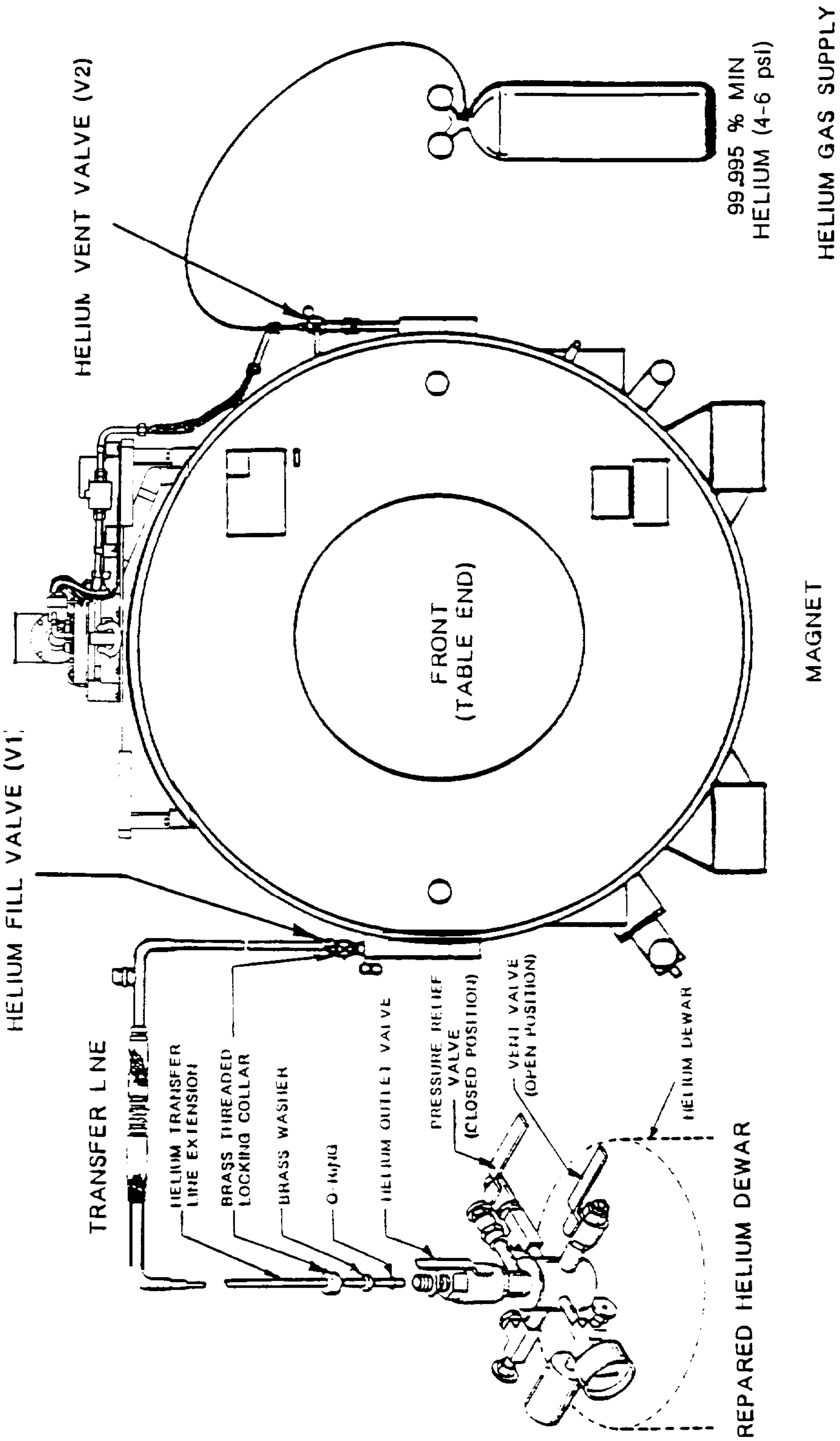
7. Insert Helium Transfer Line into Fill Port approximately 3/4 inch (20mm). Then tighten Compression Fitting slightly. See Illustration 4-2 for Liquid Helium Transfer setup.

8. Place Locking Collar, Washer and'0'Ring from prepared Helium Dewar onto the other end of the transfer line, as shown in IIllustration 4-2.

9. Open Valve (VI) and insert transfer line fully into Fill Port.

10. Tighten Compression Fitting.

11. Open Valve (V2) and blow helium gas, regulated at 4 to 6 psig through setup into Cryostat.



LIQUID HELIUM TRANSFER SETUP
ILLUSTRATION 4-2

4-2 CRYOSTAT WARM UP (WITH LIQUID HELIUM RECOVERY) (continued)

12. Set dewar valves in the following positions:

    Helium Outlet Valve - Closed
    Pressure Relief Valve - Closed
    Helium Vent Valve - Open

13. Wait for a bluish plume to start expelling from the transfer line then open Helium Outlet Valve and insert transfer line fully into dewar. Back off transfer line approximately 1 inch (25mm) from the bottom of the dewar and engage and lock the Locking Collar, Washer and "O" Ring, securing the transfer line onto the dewar.

Note

If a warm dewar is used, insert and lock transfer line onto dewar immediately for maximum coolling and flushing impact.

14. Monitor the cryogen level, gas pressure and vent valve to establish when dewar has filled and when Cryostat is empty of liquid helium.

Note

A small bluish plume 4-6 inches (100-150mm) wil lbe observed exiting from the Dewar Vent Valve during filling. When the dewar is full, the plume will increase to 2-3 feet (600-900mm). If a scale is available, full dewar weight can be calculated. Empty dewar weight is stamped on the dewar label and 3.6 liters of liquid helium = 1 pound (454 grams). The volumetric conversion for the Cryogen Monitor is provided i n Graph and Table 8-3 of Functional Checks. When the Cryogen !Moniter registers 0% there may be 200-300 liters of liquid left in the Cryostat. When the Cryostat becomes empty, the transfer pressure willl drop from 4 - 6 psig to less than 2 psig.

15. When the dewar is full 1, or the Cryostat is empty, turn off gas flow to the Cryostat and close Valve (V2).

16. Loosen the Fill port Compression Fitting and withdraw the Transfer line above Fill Valve (VI). Close Valve (Vi).

17. Leave the Transfer Line in the Fill Port approximately 3/4 inch (20mm) and retighten the Compression Fitting.

18. Loosen Dewar Compression Fitting and withdraw Transfer Line from the dewar.

4-2 CRYOSTAT WARM UP (WITH LIQUID HELIUM RECOVERY)(continued)

19. Set and wire the valves on the dewar in the following positions:

    Helium Outlet Valve - Closed
    Pressure Relief Valve - Open
    Helium Vent Valve - Closed

20. For continued liquid helium recovery with another prepared dewar, repeat Setups 9 through 19.

21. “When the Cryostat has been emptied of liquid helium, repeat Steps 15 through 19.

22. Remove the helium gas setup from the Magnet Vent Plumbing and reconnect the Vent Plumbing to the Vent Adapter.

23. Loosen Fill port Compression Fitting and remove Transfer Line. Insert Fill Port Plug and tighten Fill Port Compression ‘Fitting.

24. Continue warming up the magnet by performing Steps 5 through 12 in Replacement Maintenance, Section 4-1.

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SECTION 5 - RE-EVACUATION OF CRYOSTAT

A Vacuum Pump Cart System has been developed for the re-evacuation of the Cryostat. Connection, monitoring and pumping procedures are supplied with the Vacuum Pump Cart System. Contact your Region Magnet Support Engineer for further information.

Note

The temperature of the magnet and all internal components must be greater than 273K to ensure adequate pumping of water vapor and prevent potential cryopumping.

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6	RE–EVACUATION OF VACUUM JACKETED TRANSFER LINE	6-1

SECTION 6 - RE-EVACUATION OF VACUUM JACKETED TRANSFER LINE

A Vacuum Pump Cart System has been developed for the re-evacuation of the Vacuum Jacketed Transfer Line. Connection, monitoring and pumping procedures are supplied with Vacuum Pump Cart System. Contact your Region Magnet Support Engineer for further information.

Note

Frosting and loss of transfer efficiency are signs of a vacuum loss in Vacuum Jacketed Transfer Lines.

REPLACEMENT / MAINTENANCE

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7	BURST DISC REPLACMENT	7-1

SECTION 7 - BURST DISC REPLACEMENT

Description:

Burst Disc replacement is required as a result of rupture during a magnet quench or the result of a defect. It is important to replace a ruptured Burst Disc rapidly to prevent cryopumping and ice blocks from forming in the system. Cryogen refill will be required as a result of cryogen depletion during a quench. If cryogen refill does not take place during the Burst Disc replacement call, helium gas should be applied to the Helium Vessel to prevent continued cryopumping and ice block formation in the Helium Exhaust Lines and Vertical Stack. If the Burst Disc from the Spare Parts Kit is used, order a new Burst Disc for the kit,

Procedure:

WARNING!

MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5–3 OF THE INTRODUCTION (CRYOGEN SAFETY).

WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES OR FACE SHIELD, WHEN REPLACING BURST DISC ON COLD VENT SYSTEM.

CLAMP OR TIE NON-SELF–SUPPORTING HELIUM EXHAUST VENT TO PREVENT VENT SEPARATION PRIOR TO REMOVING VENT ADAPTER.

MAKE SURE MAGNET IS RAMPED DOWN TO ZERO FIELD TO PREVENT ANY POSSIBILITY OF A QUENCH.

CAUTION

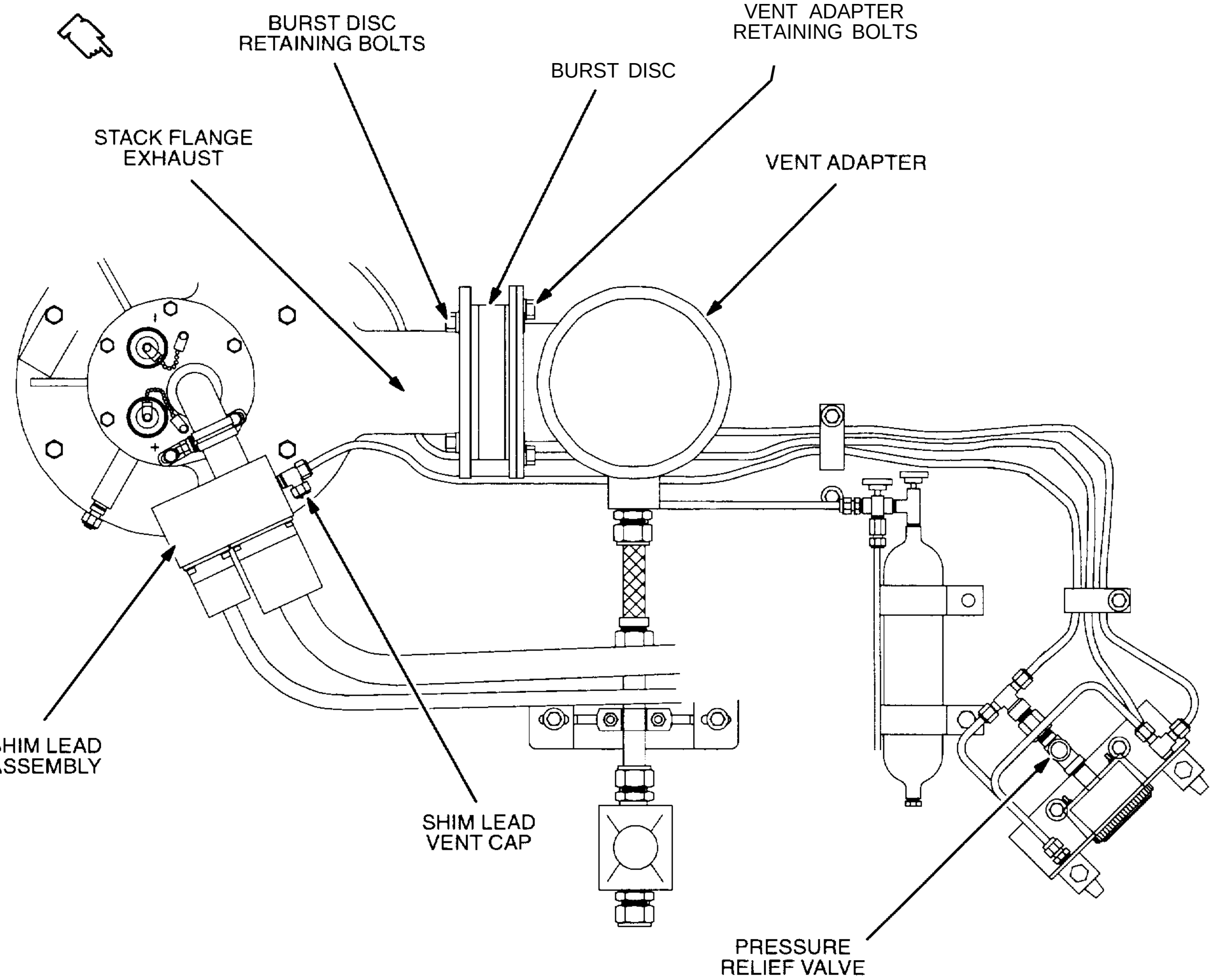
Replace Burst Disc immediately after rupturing to avoid cryopumping. Ice blocks can form inside the Exhaust Lines and Vertical Stack if the Burst Disc is not replaced promptly.

1. Unsnap and remove clamp holding Helium Exhaust Vent to Vent Adapter. Support Vent Adapter from the side.

Note

Heat gun may be required to remove frost on Vent Adapter prior to Step 2

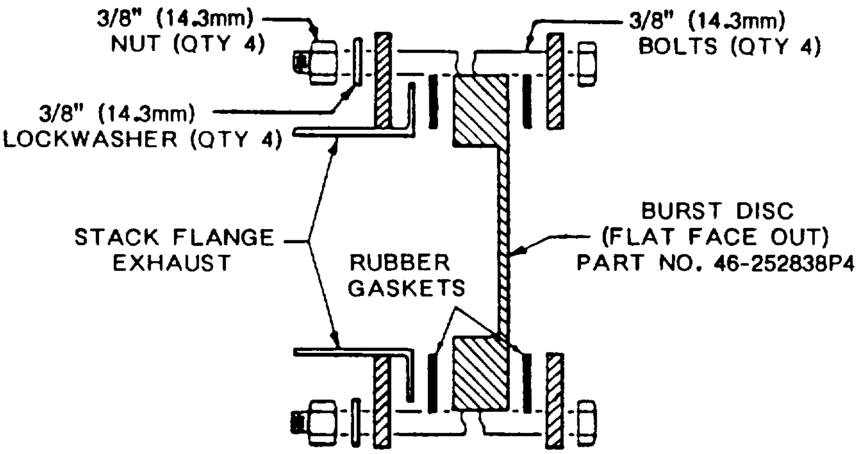
2. Loosen and remove magnet vent plumbing from Vent Adapter.
3. Unbolt and remove Vent Adapter to gain access to the Burst Disc Assembly and Retaining Bolts, See Illustration 7–1.



BURST DISC LOCATION
ILLUSTRATION 7–1

SECTION 7 - BURST DISC REPLACEMENT (continued)

4. Loosen and remove the four 3/8 inch Retaining Bolts and remove the top two bolts while holding the Burst Disc Assembly and Flange Disc to the Stack Flange Exhaust. See Illustration 7-2.



BURST DISC ASSEMBLY
ILLUSTRATION 7-2

5. Remove ruptured Burst Disc and clean any fragments out of vent system.

6. Unpack and inspect new Burst Disc for nicks and scratches. Assure that Burst Disc is undamaged and has proper part number and 20 psi rating on the rating plate.

7. Install new Burst Disc with flat face towards the Vent Adapter.

Note
Assure that the Burst Disc is fully sandwiched between the two rubber gaskets, i.e. the gaskets are flat and the Burst Disc is not in contact with the flanges.

8. Assemble and tighten the four Retaining Bolts sufficiently to prevent leakage around the gaskets.

SECTION 7 - BURST DISC REPLACEMENT (continued)

9. Reassemble Vent Adapter.

10. Reassemble Helium Exhaust vent.

CAUTION

If cryogen refill does not take place during the Bust Disc replacement call, pressurize the Helium Vessel in accordance with Steps 11 and **12 to prevent continued cryopumping and ice blocks in the Helium Exhaust Lines.**

11. Disconnect Annular Gap Exhaust Plumbing at Flowmeter (F2).

12. Connect 99.995% Helium Gas Cylinder with pressure gauge to removed plumbing in Step 11 and flow gaseous Helium into the Vertical Stack at 1/2 psi. Observe Flowmeter (F1) for Exhaust Flow.

13. If ice block present, follow procedure in Replacement/Maintenance, Section 2.

REPLACEMENT / MAINTENANCE

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8-1 Shim Lead Assembly Removal 8-1
8-2 Shim Lead Assembly Replacement 8-3
8-3 Baffle Assembly Replacement 8-6

SECTION 8 – SHIM LEAD, BAFFLE ASSEMBLY REMOVAL / REPLACEMENT

WARNING!

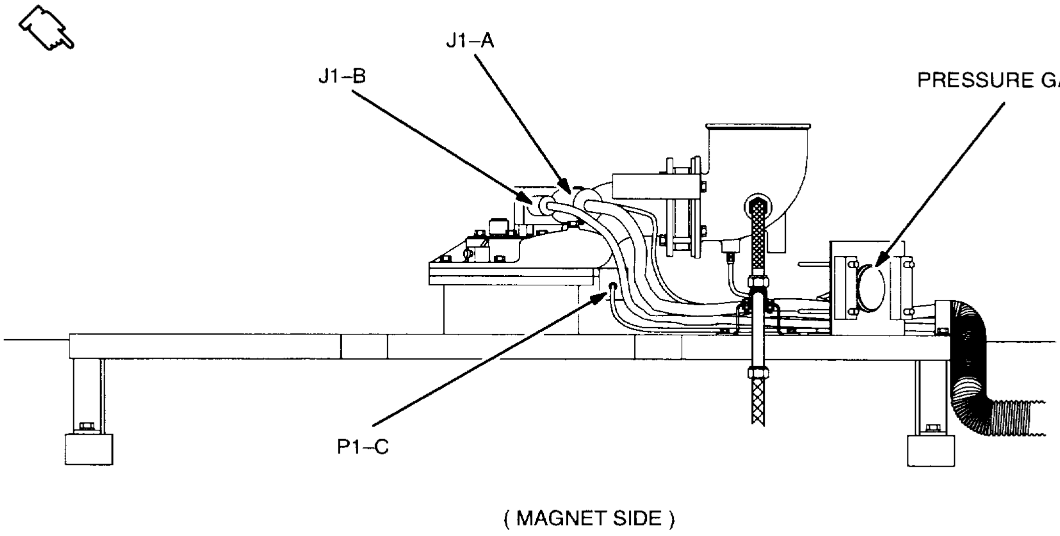
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5–3 OF THE INTRODUCTION (CRYOGEN SAFETY).

RAPID EXHAUSTING OF COLD HELIUM GAS MAYBE ENCOUNTERED DURING THE FOLLOWING PROCEDURES. WEAR NON ABSORBENT GLOVES AND GOGGLES OR FACE SHIELD WHEN PERFORMING THESE PROCEDURES.

MAKE SURE THAT THE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE REMOVING/REPLACING THE SHIM LEAD ASSEMBLY. A MAGNET QUENCH DURING REMOVAL/REPLACEMENT OF THE SHIM LEAD ASSEMBLY COULD RESULT IN THE RAPID EXPULSION OF LIQUID HELIUM OUT OF THE VERTICAL STACK.

8–1 SHIM LEAD ASSEMBLY REMOVAL

1. Ramp magnet down to zero field in conformance with Replacement/maintenance, Section 3.
2. Slowly open Vent Valve (V2) and vent magnet until internal pressure drops below 0.3 psi on the Cryostat Pressure Gauge. Close V2.
3. Disconnect connectors (J1–A & J1–B) from the Receptacle

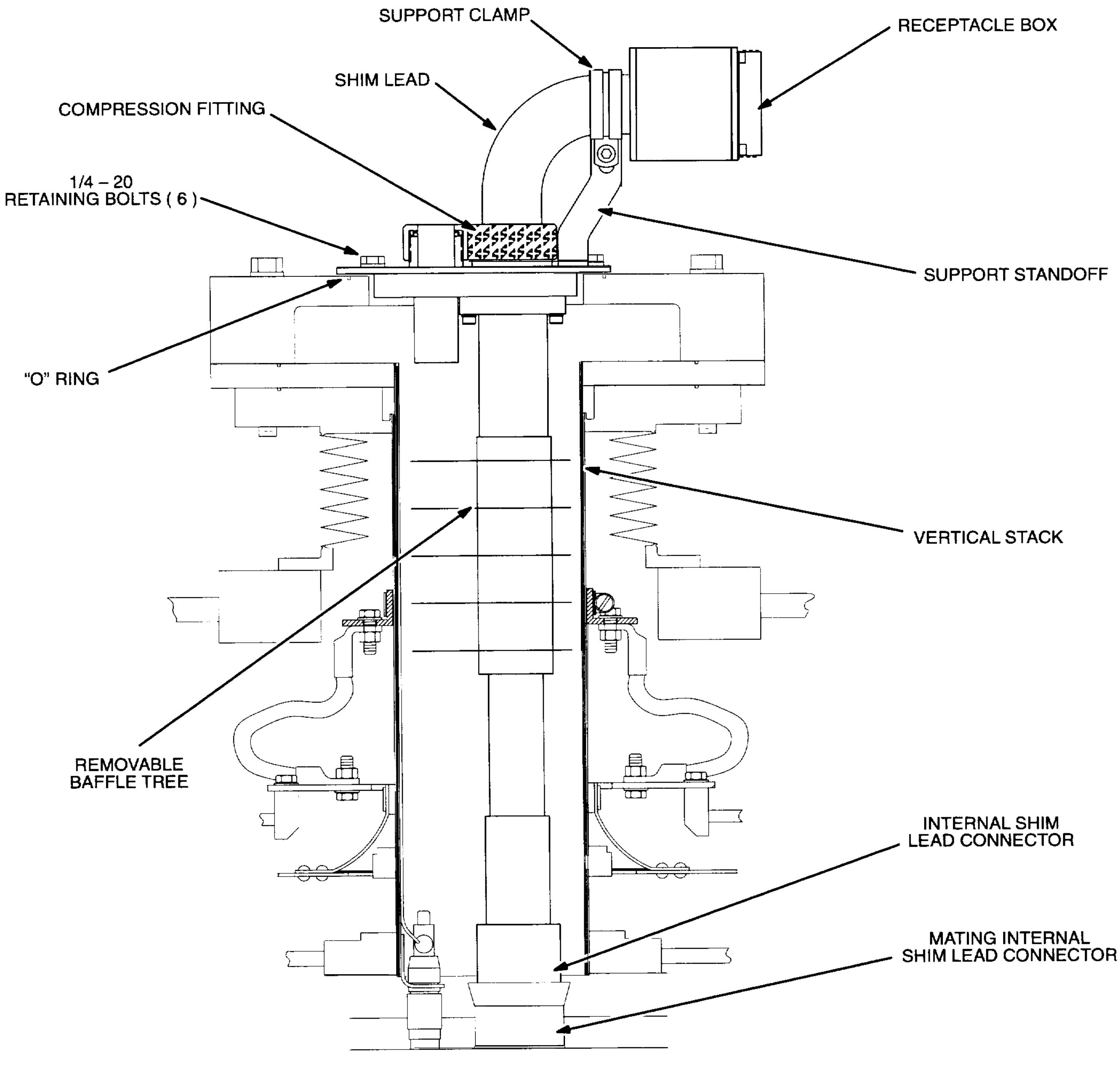


SHIM LEAD ASSEMBLY ELECTRICAL CONNECTIONS
ILLUSTRATION 8–1

8-1 SHIM LEAD ASSEMBLY REMOVAL (continued)

4. Disconnect 1/4 inch Exhaust Plumbing on the side of the Receptacle Box. Use 1/4” cap to blank off Port.

5. Unbolt the Support Clamp from the Support Standoff. Keep clamp on Shim Lead. See Illustration 8–2.



SHIM LEAD ASSEMBLY
ILLUSTRATION 8–2

8–1 SHIM LEAD ASSEMBLY REMOVAL (continued)

6. Loosen Compression Fitting around Shim Lead and gently disengage Internal Shim Lead Connector.

7. Withdraw Shim Lead approximately 1 inch and tighten Compression Fitting,

CAUTION

Perform Steps 8 and 9 rapidly to prevent cryopumping of air into the Vertical Stack. Ensure that the 6 inch (152 mm) Plexiglas Cover Plate P/N 46–260963P3 is on the service platform before removing the Shim Lead Assembly.

8. Loosen and remove the six 1/4–20 Retaining Bolts and remove the Shim Lead Assembly.

9. Immediately cover the Vertical Stack with the Plexiglas Cover Plate, Ensure that the “0” Ring is in the groove of the Vertical Stack.

10. Secure the Plexiglas Cover Plate onto the Vertical Stack with the six 1/4 –20 Retaining Bolts removed in Step 8.

8-2 SHIM LEAD ASSEMBLY REPLACEMENT

1. Check for icing on the mating internal Shim Lead Connector by shining a flashlight through Plexiglas Cover Plate.

2. If any icing exists, follow the procedure in Replacement/Maintenance, Section 2–3 (Block in Vertical Stack) to remove the ice, by directing the warm helium gas flow from the stainless steel tube over the Internal Shim Lead Connector.

3. Make sure that a functional Shim Lead Assembly is on the service platform and that the Shim Lead is in the retracted position, ie, Compression Fitting is at the bottom of the stainless steel tube.

4. Place a 1/4 inch cap (if not already in place) to the fitting where the 1/4 inch Vent Plumbing mounts to the side of the Shim Lead Receptacle Box,

CAUTION

Do not leave the Vertical Stack uncovered for any significant period of time as cryopumping and Icing may result

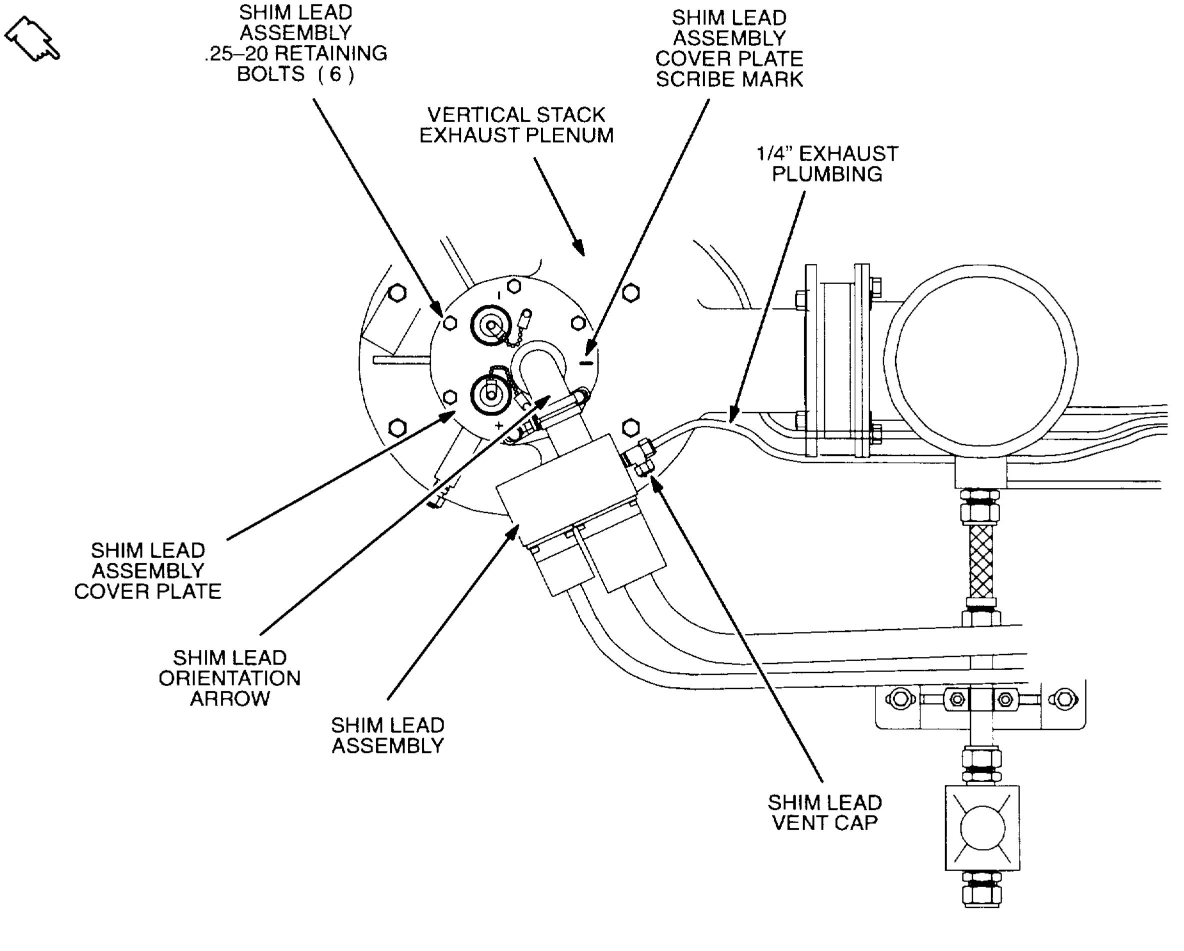
8–2 SHIM LEAD ASSEMBLY REPLACEMENT (continued)

5. Loosen and remove the six 1/4–20 Retaining Bolts and remove the Plexiglas Cover Plate.

CAUTION

Make sure the cap in Step 4 is **in place and the Shim Lead is carefully inserted into the Vertical Stack to prevent "cold shock" and possible permanent damage of the Shim Leads.**

6. Inspect the "O" Ring at the top of the Vertical Stack. Replace if nicked, scratched or damaged..
7. Carefully replace the Shim Lead Assembly into the Vertical Stack. Make sure that the "O" Ring is in the groove of the Vertical Stack..
8. Align the scribe mark on the Shim Lead Assembly Cover Plate with the Vertical Stack Exhaust Plenum. See Illustration 8–3,,



SHIM LEAD ASSEMBLY ORIENTATION
ILLUSTRATION 8–3

8-2 SHIM LEAD ASSEMBLY REPLACEMENT (continued)

9. Secure the Shim Lead Assembly Cover Plate to the Vertical Stack with the 1/4–20 Retaining Bolts removed in Step 5..
10. Loosen Compression Fitting and while aligning the Shim Lead with the Orientation Arrow on the Cover Plate, push the Shim Lead down to engage the keyway and connector. See Illustration 8-3.

Note

The Shim Lead will depress approximately 1 inch before the internal Shim Lead Connectors engage. When contact is felt, the Shim Lead will depress approximately 1/4 inch (with a moderate pressure) to fully seat the connectors. When the Shim Lead is fully engaged, it with not be able to be rotated out of alignment with the Orientation Arrow.

11. Tighten Compression Fitting.
12. Put Support Clamp around neck of Shim Lead and bolt to Support Standoff.
13. Open Helium Vent (V2) and vent Cryostat to reduce pressure to 0.2 – 0.3 psig.
14. Remove the Shim Lead Vent Cap put on in Step 4.
15. Connect 1/4 inch Exhaust Plumbing to side of the Receptacle Box. Tighten and leak test fitting.
16. Allow the Cryostat to build pressure of 1 PSI. Then check for leaks around the “O” Ring in the Vertical Stack and at Shim Lead Compression Fitting. Repair any leaks found.
17. Connect Shim Lead Connectors (J1–A and J1- B) to the Receptacle Box.
18. Ramp the magnet to field in conformance with Set Up and Calibration Section 7.,

CAUTION

Cryostat exhaust flow rates and pressure must be checked and adjusted as required after magnet installation, ramping and shimming to ensure that proper cooling conditions are maintained and no leaks are present in the Helium Exhaust System or Vent Valve (V2).

19. Open Vent Valve (V2) to depressurize the Cryostat to 0.25 psig. Close V2.

8-2 SHIM LEAD ASSEMBLY REPLACEMENT (continued)

Note

Read all flow rates from the bottom of the float (bail) on the flowmeters. Flow rates may be temporarily elevated. Do not adjust until the magnet has had time to stabilize (>1 day).

20. Set Flowmeter (F1) between 0.4- 0.6 SCFH..
21. Set Flowmeter (F2) between 1.5- 2.0 SCFH to maintain a Cryostat Pressure Gauge reading between 0.25 – 0.50 psig.
22. Make sure flow rate through F2 is equal or greater than 1.5 SCFH.
23. if flow rate through F2 is less than 1.5 SCFH or the pressure gauge readsless than 0.25 psig, pressurize the vessel and “bubble test” all exhaust plumbing joints, relief valve and Shim Lead Connector. Make sure V2 is fully closed. Repair any leaks. if a 1.5 SCFH flow rate through F2 cannot be achieved, under the above conditions, contact your Region Magnet Service Engineer.
24. Make sure the following conditions are maintained. Re-check settings in three days and again after one week:

FLOWMETER (F1) = 0.4– 0.6 SCFH
FLOWMETER (F2) = 1.5–2.0 SCFH
CRYOSTAT GAUGE PRESSURE -0.25-0.50 psig

8-3 BAFFLE ASSEMBLY REPLACEMENT

Note

Replacement of the Baffle Assembly is necessary after a Quench or if damaged when the Shim Lead Assembly is removed.

1. Remove Shim Lead Assembly in conformance with REPLACEMENT/ MAINTENANCE, Section 8-1.
2. Remove the 3 hex head screws that secure the Baffle Assembily to the Shim Lead Assembly
3. Remove the defective Baffle Assembiy and discard.

CAUTION

Care must be taken not to bend the baffles between the Shim Lead G10 tube and the Baffle Assembly, while installing, to avoid damaging the baffles.

4. Install the Baffle Assembly (46-318035G1) carefully pushing Baffle Assembly onto the Shim Lead Assembly, as in Illustration 8-4. Starting from the bottom of the Baffle Assembly and working towards the top; continue this process until the Baffle Assembly is attached to the Shim Lead Assembly G10 Tube.

8-3 BAFFLE ASSEMBLY REPLACEMENT (continued)

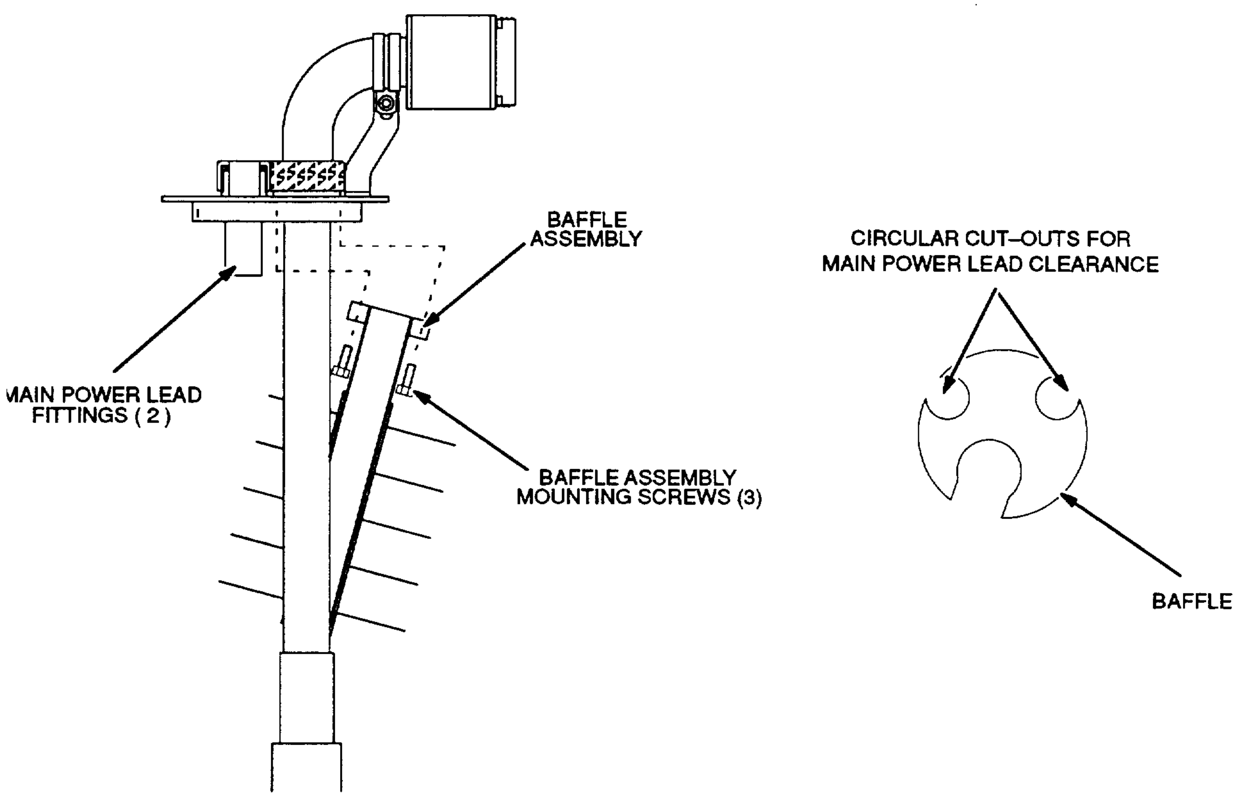
Note

Make sure the Baffle Assembly circular cutouts used for power lead clearance are aligned to the power lead fittings before securing to the Shim Lead.

5. Secure the Baffle Assembly to the Shim Lead Assembly using the three screws removed from step 2 above.

6. Reinstall the Shim Lead Assembly in conformance to Section 6-2, REPLACEMENT/ MAINTENANCE.

7. Ramp the magnet and check Flowmeters and Cryostat Pressure according to Section 7 in SETUP AND CALIBRATION.



BAFFLE ASSEMBLY REPLACEMENT
ILLUSTRATION 8--4

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9	CONNECTING AND DISCONNECTING AEROQUIP COUPLINGS	9-1

SECTION 9 - CONNECTING AND DISCONNECTING AEROQUIP COUPLINGS

Note
Refer to Illustrations 9-1 and 9-2 for this procedure.

CONNECTING

1. The system gas connections are shipped with caps and plugs to keep the fittings clean and free from damage. Remove the caps and plugs and thread them together for storage.

2. Wipe the faces of the couplings with a lint free cloth to insure they are clean and free of chips and dust.

3. Insure that the face seal is in place on the inside periphery of the male coupling and is not damaged.

Note
Excessive gas will escape if the fittings are not aligned properly during connection or disconnection.

4. To make the connection. start the hose side union nut onto the male connector by hand. Then, with the wrenches supplied, hold the stationary part of the female coupling while turning the union nut with the other wrench.

5. As the poppet begins to open there may be a slight venting of gas from the fitting, continue to tighten the connection until the female coupling is firmly seated against the face seal on the male coupling. The required torques are:

   35 ft-lbs (47.5 N-m) for the 1/2” connection

   45 ft-lbs (61.0 N-m) for the 3/4” connection

DISCONNECTING

1. To disconnect the gas line at the cold head, first use one wrench to turn the female coupling union nut about 1/8 turn, while holding the male coupling with the other wrench. This will overcome the initial torque required to break the connection without loosening the male connector from its adapter.

2. Ensure the hose does not rotate, to avoid a torsional force on the hose.

SECTION 9- CONNECTING AND DISCONNECTING AEROQUIP COUPLINGS (continued)

3. Place the second wrench on the stationary part of the female coupling and continue to unthread the union nut. Be sure the ma l e connector does not rotate when disconnecting.

4. To disconnect the gas line at the compressor, turn the union nut on the female coupling while holding the stationary part of female coupling with a second wrench. Since the male coupling is bulkheaded to compressor front panel with a lock washer, the male coupling should not rotate from Its adapter while removing.

5. Ensure the bulkhead jam nut is secure and the male coupling does not rotate when removing the gas line.

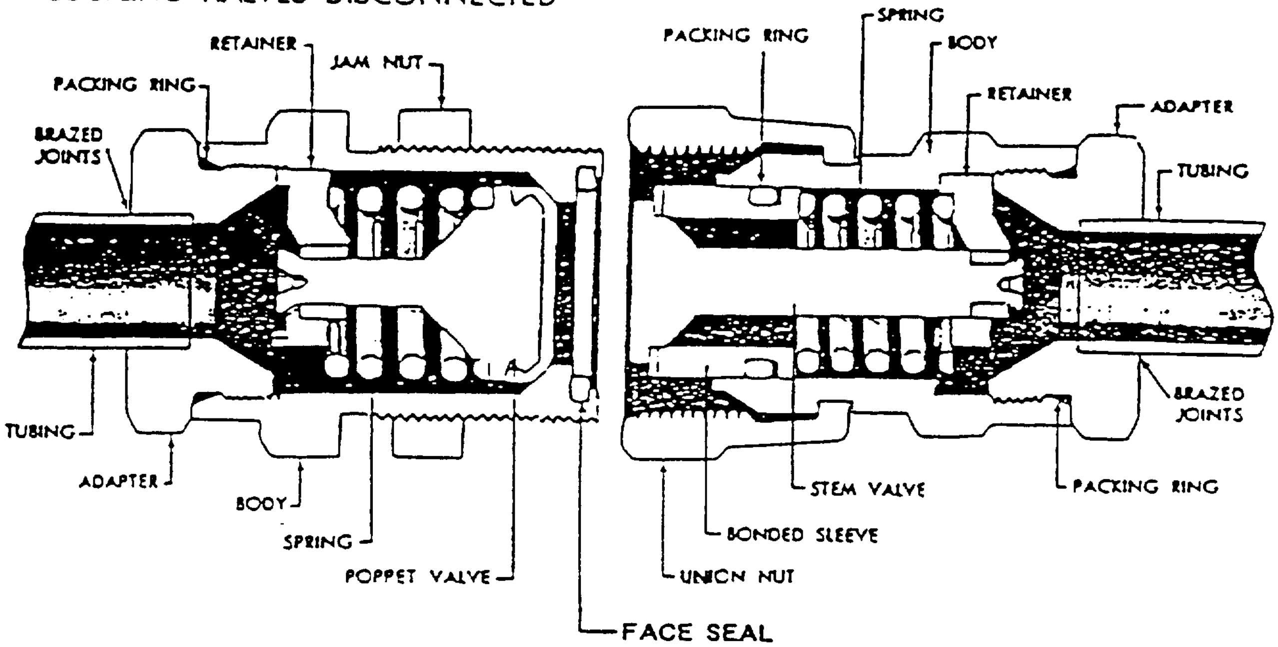
6. When the hoses are disconnected check each male coupling to ensure the face seal is in place.

Note

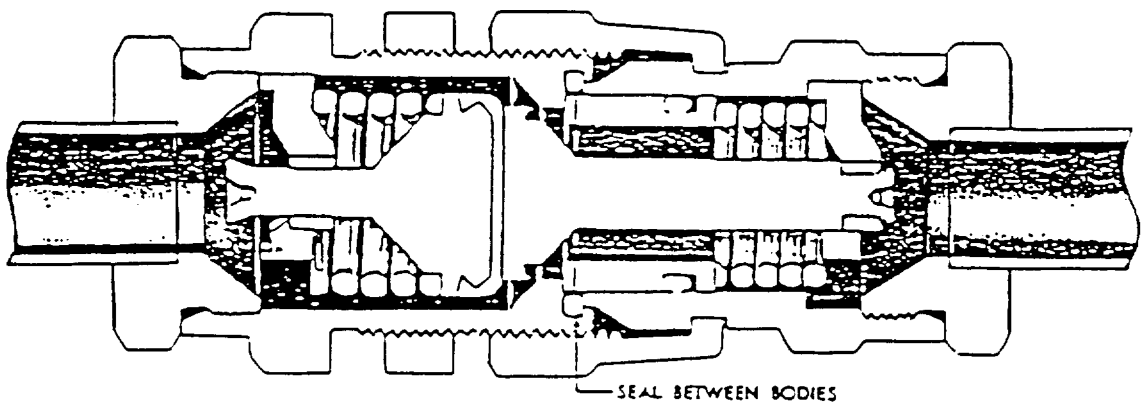
Many times, while the hose is venting during disconnection, the face seal will be blown out of its gland and to the female coupling. Failure to remove the seal from the female coupling will cause the connection to leak when reconnected, with or without another face seal installed.

7. If all seals are in place, replace the dust caps and plugs to the coupling halves.

COUPLING HALVES DISCONNECTED



COUPUNG HALVES CONNECTED

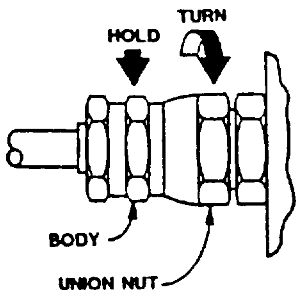


VIEW OF DISCONNECTED AND CONNECTED SELF-SEALING (AEROQUIP)

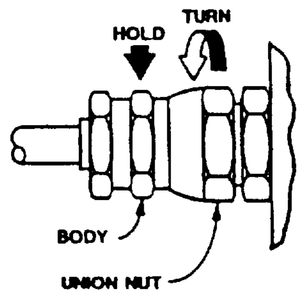
ILLUSTRATION 9-1

NOTES:

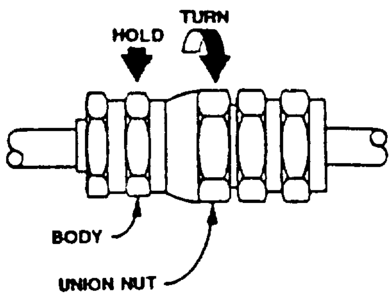
1. INSURE THE MALE COUPLINGS AT THE COMPRESSOR AND COLD HEAD, DO NOT ROTATE WHEN DISCONNECTING LINES.
2. AVOID TORSIONAL FORCES ON THE FLEX SECTIONS.



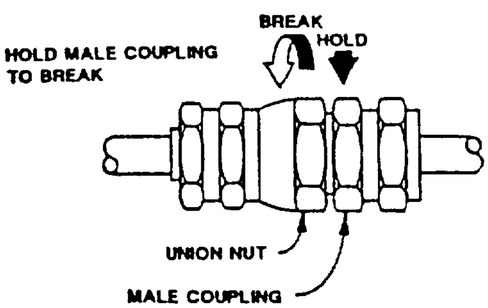
CONNECTING TO COMPRESSOR

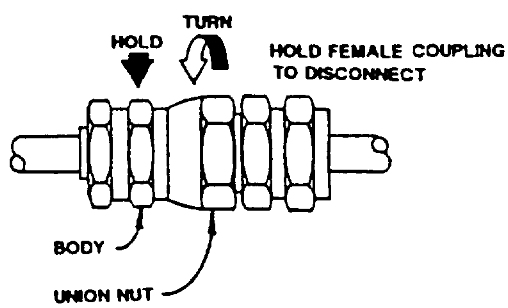


DISCONNECTING FROM COMPRESSOR



CONNECTING TO COLD HEAD





DISCONNECTING FROM COLD HEAD

CONNECTING AND DISCONNECTING GAS LINES
ILLUSTRATION 9-2

REPLACEMENT / MAINTENANCE

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SECTION 10- SHIELD COOLER COLD HEAD REPLACEMENT

Note

Illustrations show Leybold Coldheads. Procedures, components and magnet interface are the same for Balzers Coldhead configurations.

Description:

Shield Cooler Cold Heads require replacement for periodic maintenance and when out of spec, temperatures cannot be corrected by the actions in FUNCTIONAL CHECKS, Section 6 (Shield Cooler Checks).

It is recommended that the Cold Head replacement be peforrned by the “MAC” Team Representative in your district.

Make sure that the following parts and tools are on site before initiating this procedure:

- Reconditioned and Tested replacement Cold Head.
- Full Helium Gas Cylinder (99.9995% pure).
- Helium Transfer equipment indicated in RENEWAL PARTS, Section 4-4.
- Shield Cooler Maintenance Kit (46-281088G2).
- Heat Gun Kit (46-306830G1 / G2)
- Field Vacuum Pump Kit (46-294047G1)

Make sure that the number of Iridium Gaskets on the first and second stage stations of the removed cold head are determined and the same number are placed on the first and second stations of the new cold head before replacement; this will provide the proper spacing for the system.

WARNING!

THE MAGNET MUST BE RAMPED DOWN BEFORE BRINGING FERROMAGNETIC TOOLS OR EQUIPMENT INTO THE EXAM ROOM. FERROMAGNETIC OBJECTS BECOME DANGEROUS PROJECTILES IN A MAGNETIC FIELD.

RAMP MAGNET DOWN TO ZERO FIELD BEFORE STARTING THIS PROCEDURE.

Note

Refer to the vendor manual for the identification and location of components and areas covered in the following procedure.

SECTION 10- SHIELD COOLER COLD HEAD REPLACEMENT (continued)

CAUTION

Disconnect gas lines from Cold Head immediately after Cold Head is turned off to prevent any contamination frozen out In Cold Head from thawing and migrating into gas lines and compressor.

Procedure:

1. Turn off unit and disconnect the electrical cable from the Cold Head.

2. Immediately disconnect the gas lines at the Cold Head with the wrenches provided in the Shield Cooler Maintenance Kit. See REPLACEMENT MAINTENANCE, Section 9 (CONNECTING AND DISCONNECTING AEROQUIP COUPLINGS).

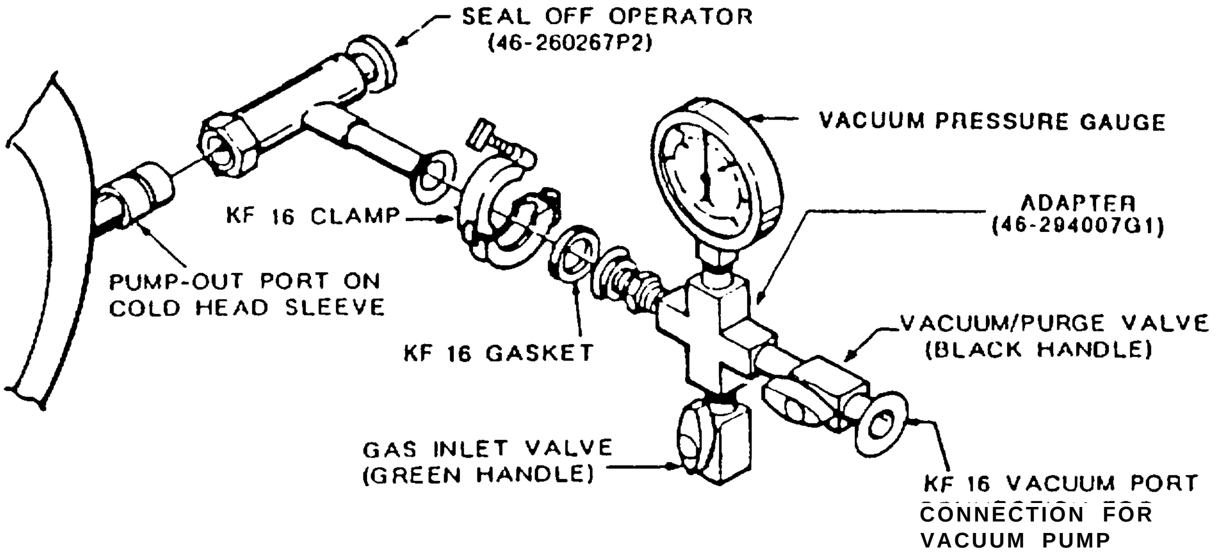
3. Compact Magnets have a magnetic shield around the Cold Head Motor. Remove the three bolts securing the shield and remove and save the shield and securing bolts.

Note

Clean all vacuum fittings on apparatus shown in Illustration 10-1 to make sure vacuum seals are tight.

4. Connect the Seal Off Operator (46-260267P2) to Adapter (4&294007GI).

5. Attach the Seal Off Operator and Adapter to the Pump Out Port on the Cold Head Sleeve. See Illustration 10-1. Tghten the Seal Off Operator to the Pump Out Port by holding the body of the operator and tightening the nut with a wrench.



COLD HEAD GAS/VACUUM SERVICE APPARATUS
ILLUSTRATION 10-1

SECTION 10- SHIELD COOLER COLD HEAD REPLACEMENT (continued)

6. Connect Helium Gas Regulator (4&258151 PI) to the Helium Gas Cylinder (99.9995% pure) then to Flexible Hose (46-258152PI). Connect the hose to the Adapter Inlet Valve (green handle). See Illustration 10-2

7. Make sure the Regulator Handle is backed out counterclockwise (CCW) to avoid regulator damage, then open the gas cylinder slowly, the high pressure gauge should indicate 2100-2400 psig if the cylinder is full.

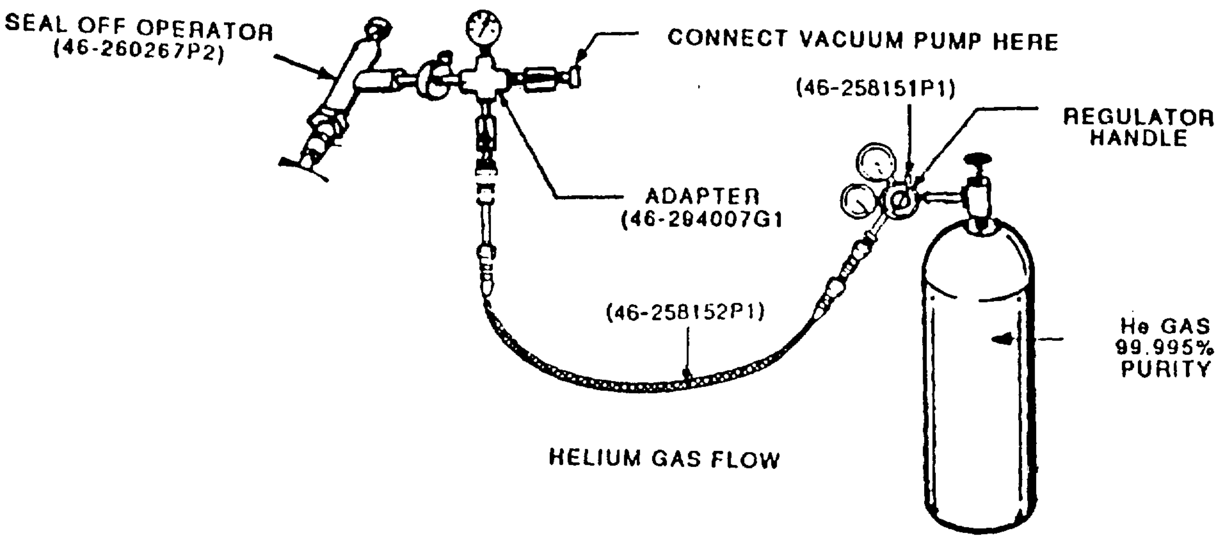
Note
A full gas cylinder is required for this procedure.

8. Open Inlet Valve and set a low pressure gas flow (1 psig) as indicated by the gauge on the Adapter.

9. Open the Vacuum Port Valve (black handle) on the Adapter and allow gas to flow out for one minute to purge the assembly of air.

10. Close the Vacuum Porl Valve and Inlet Valve.

11. Push in and rotate the Black Handle of the Seal Off Operator clockwise (CW) to engage the plug in the Pump Out Port. When the handle is engaged, pull the handle out to open the Pump Out Port.



HELIUM GAS CONNECTION
ILLUSTRATION 10–2

SECTION 10- SHIELD COOLER COLD HEAD REPLACEMENT (continued)

Note

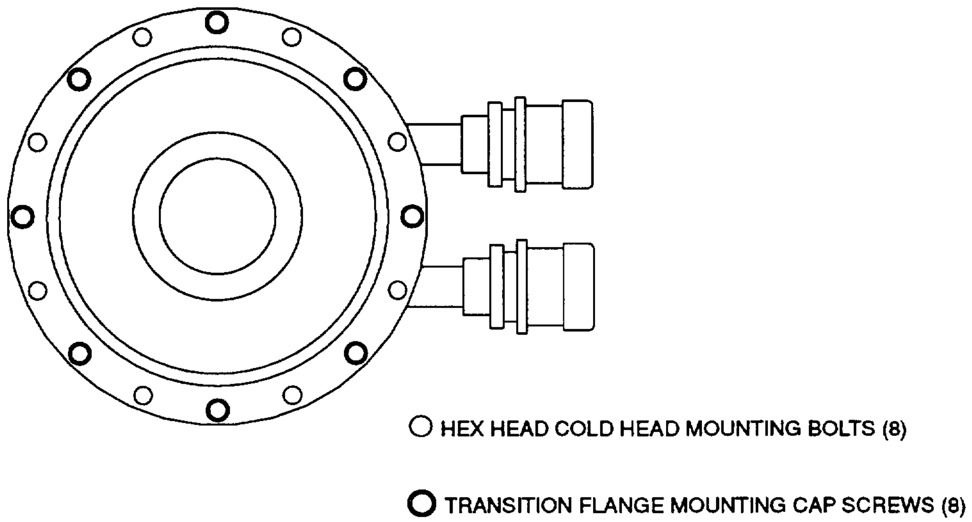
When the handle is pulled out, the gauge on the Adapter should indicate a vacuum.

6. Open the Gas Inlet Valve (green handle) and fill the vacuum space in the sleeve with Helium Gas at a small positive pressure (= 1 psig).

Note

Save the bolts and washers removed in Step 7, leaving the same number of washers on each bolt. These will be used to mount the new Cold Head and will make sure that the proper interface spacing is maintained.

7. Remove six of the eight Hex Head Bolts with Bellvlle Washers securing the Cold Head, leaving the remaining two bolts into prevent the Cold Head from sliding out. See Illustration 10-3.

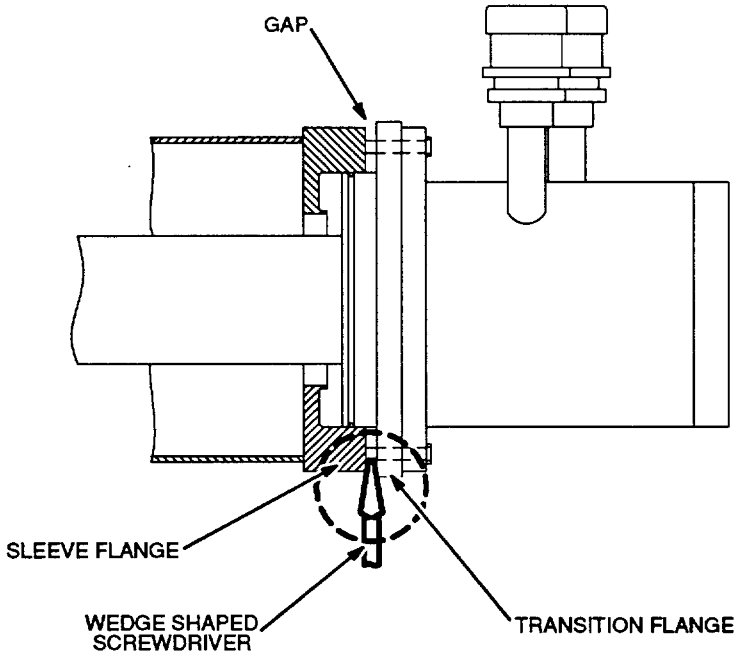


COLD HEAD MOUNTING
ILLUSTRATION 10–3

SECTION 10– SHIELD COOLER COLD HEAD REPLACEMENT (continued)

8. Loosen the remaining two bolts to produce a 6mm (1/4 inch) gap under the bolt head.

9. Carefully insert alarge screwdriver or other similar wedge shaped tool in the gap between the Cryostat Sleeve Flange and Transition Flange. Gradually pry the Transition Flange away from the Cryostat Sleeve Flange by tapping the end of a screwdriver or wedge while moving it around the circumference of the gap. See Illustration 10-4.



SEPARATION OF TRANSITION FLANGE-SLEEVE FLANGE
ILLUSTRATION 10-4

Note
It will be evident when the Cold Head “pops” away from the first stage contact in Step 9.

CAUTION

Make sure Helium Gas is flowing through the Pump-out Port connection and the Plexiglas Cover plate (46-29401OG1) is on hand before performing Step 10. When cold head is removed, Immediately cover hole with plexiglas cover plate to prevent contamination.

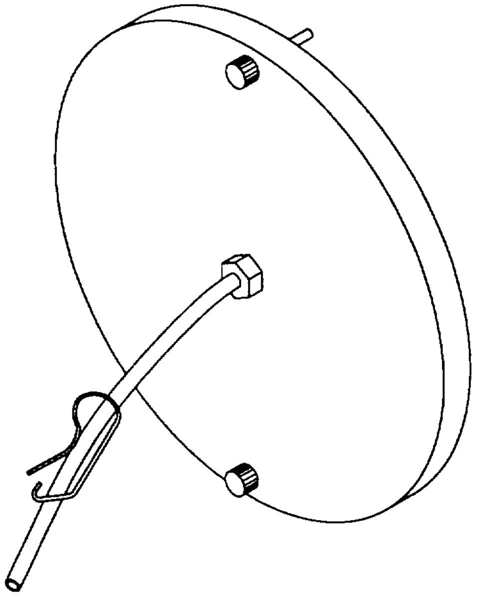
SECTION 10- SHIELD COOLER COLD HEAD REPLACEMENT (continued)

CAUTION

The Cold Head weighs approximately 45 pounds and will require lifting straight out to prevent binding. Make sure there is adequate reach and support for its weight before lifting it out.

10. When the Cold Head “Pops” free, remove the remaining two bolts. Lift the Cold Head straight out of the Cold Head sump and place the Cold Head on padded surface for protection.

11. Immediately install the Plexiglas Cover Plate onto the Sleeve Flange of the Cryostat with the thumb screws provided on the cover. Make sure that Helium Gas is continuing to flow out of the slit in the tubing (1 psig) while the cover plate remains on Sleeve Flange. See Illustration 10-5.



PLEXIGLAS COVER PLATE (46–294010G1)
ILLUSTRATION 10–5

Note

If Cold Head does not pull free in Step 10, Perform Steps 12 through 15 to loosen the cold Head then repeat Step 10 and 11. If the Cold Head has been removed and the Plexiglas cover plate installed in Steps 10 and 11 go to Step 16.

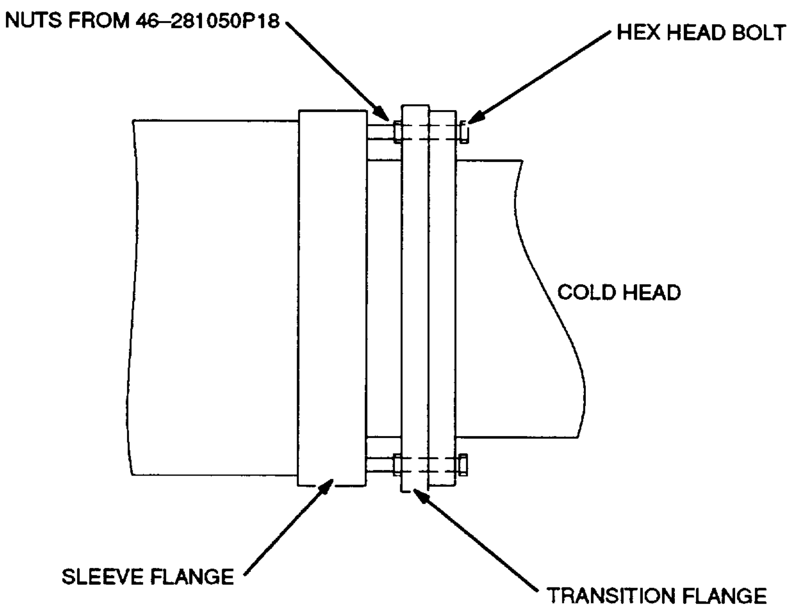
12. Insert two Hex Head Bolts through the bolt holes in the Transition Flange, 180 degrees apart. Remove the Bellville Washers temporarily from two bolts before inserting them.

13. Remove the two nuts from the underside of the Plexiglas Cover Plate. Insert them into the gap between the Transition Flange and Cryostat Sleeve Flange and thread them onto the two Hex Head Bolts inserted in Step 12. See Illustration 10-6.

SECTION 10- SHIELD COOLER COLD HEAD REPLACEMENT (continued)

14. Thread the Hex Head Bolts into the Threaded Holes in the Cryostat Sleeve Flange for approximately two turns.

15. Turn the nuts counterclockwise (CCW) on the Hex Head Bolt while holding the bolt head, turning each nut one turn at a time in succession, until the force of the nuts against the Transition Flange separates the second stage contact, then repeat Step 10.



NUT/BOLT MOUNTING FOR FLANGE SEPARATION
ILLUSTRATION 10–6

SECTION 10- SHIELD COOLER COLD HEAD REPLACEMENT (continued)

16. Inspect the inside of the Sleeve Cylinder through the Plexiglas Cover Plate using a flashlight. Make sure that no Iridium Gasket Material is present on the copper surfaces of the Heat Station. Determine the number of iridium Gaskets on the First and Second Stage Stations of the removed Cold Head. This information is required for the gasket replacements in Steps 29 and 30.

CAUTION

If Indium removal in Step 17 is required, do not keep the Sleeve Flange uncovered for an extended period of time (over 1 minute) to minimize icing.

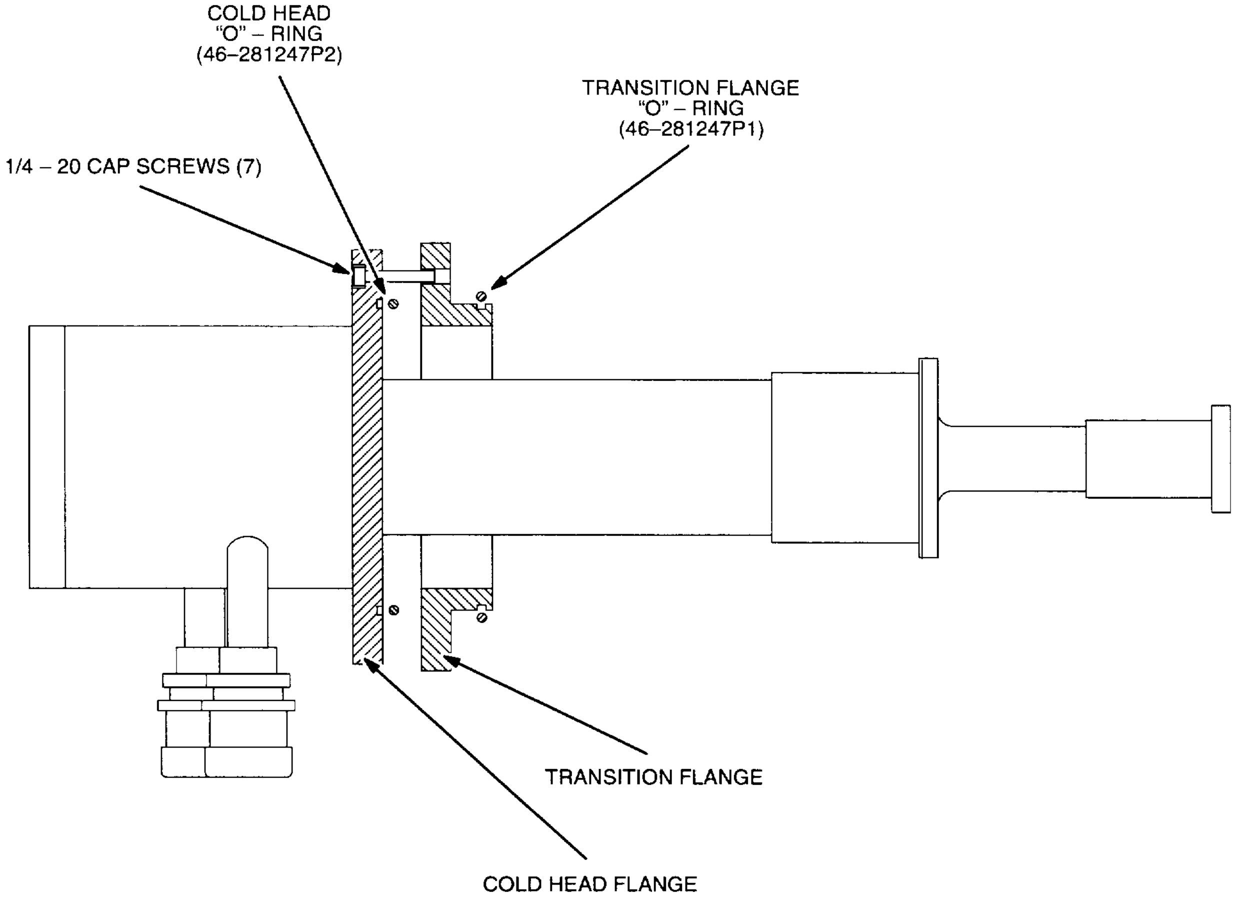
17. Continue the helium gas purge. If iridium material is present, remove one of the thumbscrews securing the cover plate and pivot the cover plate out on the remaining screw allowing access to the contaminated surface with a long handle screwdriver. Remove iridium material with the screwdriver and pivot the cover plate over the Sleeve Flange.

Note

Wear cotton gloves (46-252065P64) when performing Steps 18 through 44.

18. Remove Heat Gun (46-306830G1 / G2) for the Cold Head Sump and assemble in conformance with the instructions provided with the kit.
19. Clean all components of the Heat Gun with lint free cloth to make sure no contamination is present.
20. Loosen the thumb screws and remove the Lexan Cover Plate.
21. Carefully insert the Heat Gun into the Cold Head Sleeve and mount onto the Cold Head Sleeve Flange.
22. Close the Gas Inlet Valve (green handle) on the Pump Out Adapter and connect Helium Gas source to the Heat Gun.
23. Connect power and operate Heat Gun. Leave Heat Gun in place while preparing the new Cold Head.
24. Monitor Cold Head Diode temperatures while the Heat Gun is installed. Maintain the temperature between 285 and 300K. Do not allow the temperature to exceed 300 K.
25. Remove the new Cold Head from the box and place in an upright position. Clean all surfaces to be placed into the sleeve with a lint free cloth/towel and Freon or other commercially available non-residue forming degreaser.
26. Remove “O” - Ring (46-281247P2) from the Poly-bag attached to the Cold Head and wipe with a dry, lint free cloth/towel. Inspect the “O” - Ring for nicks or cuts.

SECTION 10- SHIELD COOLER COLD HEAD REPLACEMENT (continued)



COLD HEAD O – RING PLACEMENT
ILLUSTRATION 10–7

27. Coat the entire surface of the "O"- Ring with a thin film of Vacuum Grease and place the" O"- Ring into the groove on the Cold Head Flange. Apply a thin film of Vacuum Grease to the top surf ace of the "O" – Ring and groove. See Illustration 10–7.

28. Remove the Transition Flange (46–260938P1) from the removed Cold Head. See Illustrations 10–3 and 10–7. Save the seven Socket Head Cap Screws for installation of the flange on the new Cold Head.

29. Remove the "O" – Ring from the Transition Flange and clean the entire flange using the same materials as in Step 25.

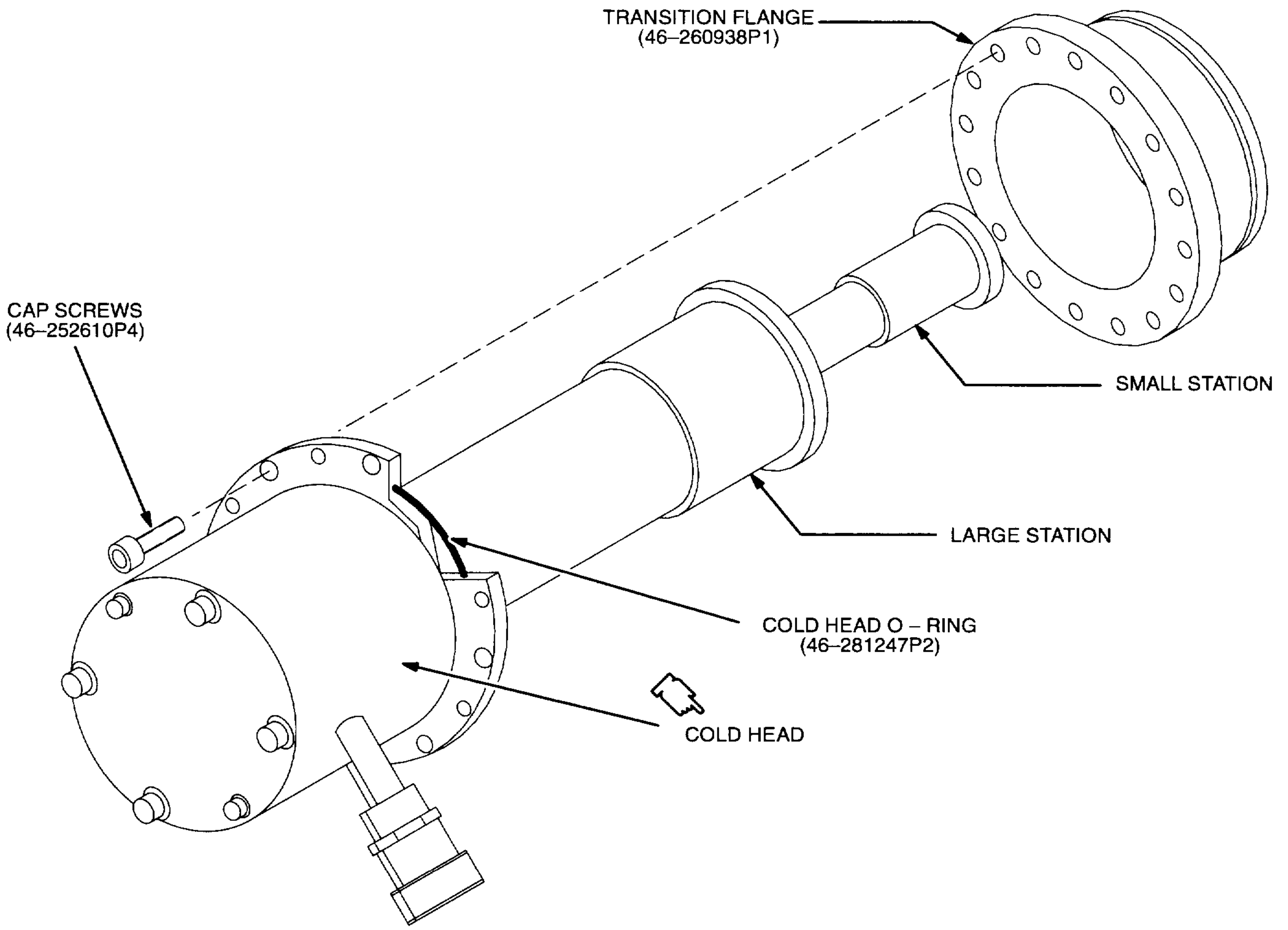
SECTION 10– SHIELD COOLER COLD HEAD REPLACEMENT (continued)

30. Apply a thin film of Vacuum Grease to the flat surface of the flange which contacts the “O” – Ring on the Cold Head Flange.

31. Slide the Transition Flange over the first and second stages of the Cold Head and rest the flange on the Cold Head “O” – Ring. See Illustration 10–7.

32. Align the bolt hole pattern of the Transition Flange and Cold Head Flange.

33. Insert the seven 1/4–20 Cap Screws (46–252610P4) through the bolt holes into Cold Head. Pull the Transition Flange flush to the Cold Head and hand tighten the Cap Screws until the Transition Flange is evenly sealed around the Cold Head “O” – Ring.TIghten each Cap Screw uniformity until the Transition Flange is tightly assembled against the Cold Head, See Illustration 10–8.



TRANSITION FLANGE MOUNTING
ILLUSTRATION 10–8

SECTION 10- SHIELD COOLER COLD HEAD REPLACEMENT (continued)

Note

Cold Head ”O’’– Ring (46-281247P2) and Transition Flange ’’O”– Ring (46-281247P1) are approximately the same size. Make sure proper “O”- Ring (46-281247P1) is used in the following steps.

34. Inspect new “O”– Ring (46-281247P1) for cuts and nicks. Clean the “O”- Ring with a lint free cloth/towel and apply a thin film of Vacuum Grease to the entire surface of the “O” – Ring.

35. Slide the lubricated “O” – Ring over the two stations of the Cold Head and place in the groove of the Transition Flange. See Illustration 10-8.

Note

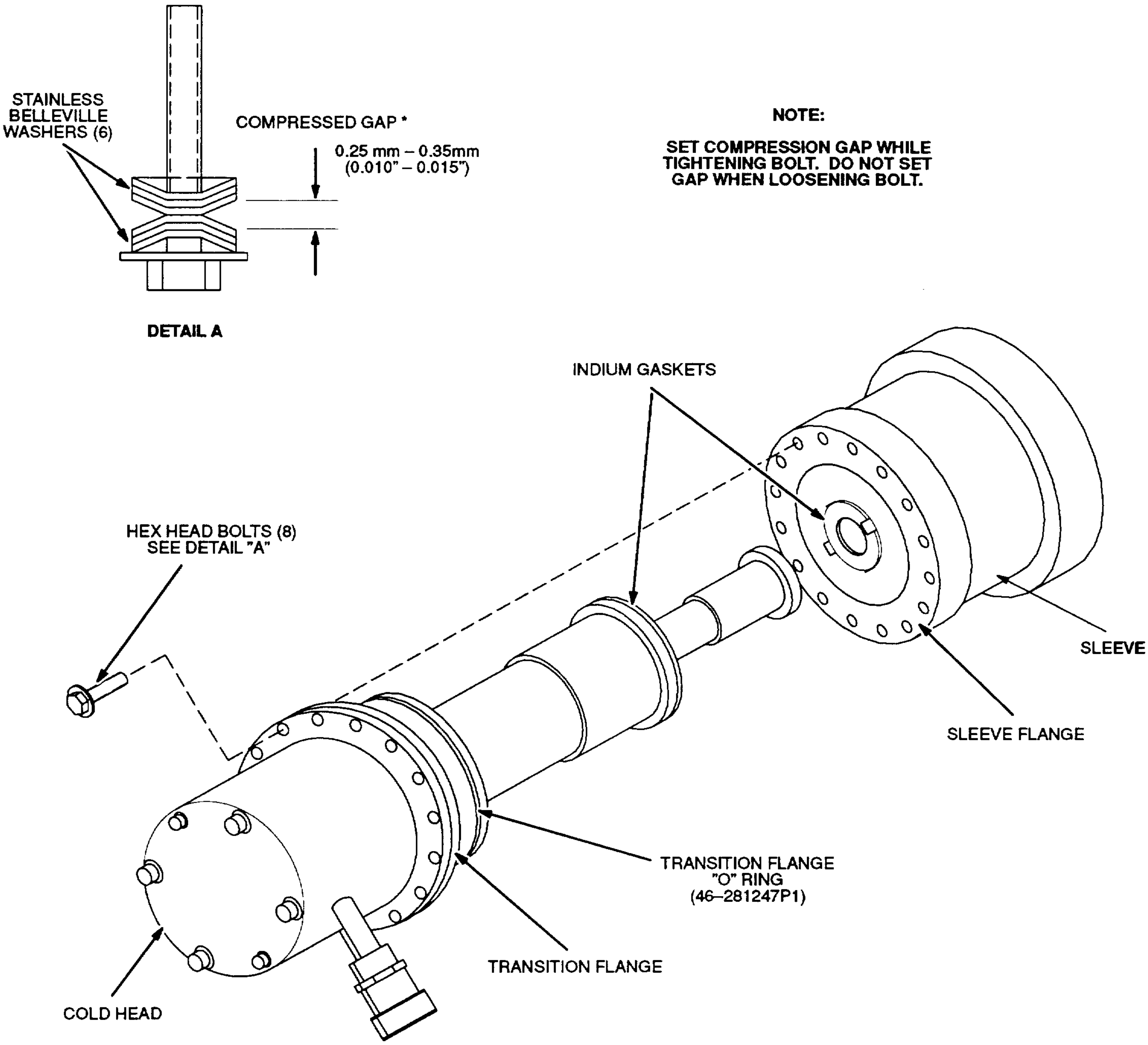
Assemble the same number of new Iridium Gaskets on the First and Second stage stations of the Cold Head that were on the same stations of the removed Cold Head. See Step 16. Handle the gaskets only with clean hands or cloth gloves. If number of gaskets are in question, consult the Acceptance Test Report included in the Data Sheet Section.

36. Place the required number of small Iridium Gaskets (46-281241P2) on the small Copper Station of the Cold Head. Fold the tabs on the gasket over the station to keep the gasket in place. See Illustration 10-8.

37. Place the required number of large Iridium Gaskets (46-281241P1) on the large Copper Station of the Cold Head. Secure the gaskets to the surface of the station by putting pressure on the gaskets forcing Iridium into the small inside diameter of the station.

38. Apply a thin film of anti-seize compound to the eight Hex Head Bolts that were removed in Steps 7–10. Make sure that all bolts have the same number and orientation of the washers noted in Step 13. Generally, the number and orientation of washers will be as shown in Illustration 10-9.

SECTION 10– SHIELD COOLER COLD HEAD REPLACEMENT (continued)



COLD HEAD MOUNTING BOLT GAP SETTING
ILLUSTRATION 10–9

SECTION 10- SHIELD COOLER COLD HEAD REPLACEMENT (continued)

39. Temporarily remove the Belliville Washers from three bolts, leaving the fiat washers on the bolts. These will be used to insert the new Cold Head.

40. After the Cold Head Sleeve Diodes have reached 285– 300 K, Discontinue operation of the Heat Gun.

41. Detach and remove the Heat Gun from the Cold Head Heater to the Cold Head Flange.

42. When cool, return Heat Gun to case for future use.

43. Clean all surfaces within the Flange using a lint free cloth/towel and alcohol or other commercially avaiiable non-residue forming substance.

CAUTION

Do not rotate the Cold Head from Its normal insertion position in Step 44 to prevent damaging the iridium Gasket. Be careful not to damageor displace the indium Gaskets during Cold Head Insertion.

44. Carefully insert the Cold Head into the slieeve on the Cryostat until the “O” - Ring contacts the opening of the sleeve.

CAUTION

Do not attempt to Insert the Cold Head by hand beyond the point of “O” - Ring contact as “O” - Ring damage will result.

45. insert the three bolts, with Beillvilie Washers removed in Step 39, equally spaced at 120 degree increments, in the mounting holes of the Cold Head Flange.

SECTION 10- SHIELD COOLER COLD HEAD REPLACEMENT (continued)

46. Thread and lighten each bolt 1/2 turn at a time, in a rotational pattern, to evenly tighten until the “O” – Ring is fully captured into the sleeve.

47. Assemble and tighten the remaining 5 bolts with Bellville Washers. checked in Step 38, through the mounting holes in the Cold Head Flange.

48. Remove the three bolts inserted in Step 45; reassemble the Bellville Washers with the proper orientation; insert and tighten through the mounting holes in the Cold Head Flange.

49. Tighten all eight bolts evenly (hand tight).

50. Connect the Mechanical Vacuum Gauge on the Operator. Open the Vacuum Valve (black handle) and operate the Vacuum Pump for ten minutes to evacuate the sleeve space. Close the vacuum Valve. See illustration 10-1.

51. Observe the Vacuum Gauge on the operator for five minutes. If the vacuum reading remains steady, the sealing is “OK".

Note

If sealing problem exists, a new Cold Head “O” - Ring (46-281247P2) is required and the Cold Head removal / replacement will have to be repeated using the same Cold Head.

52. When sealing “OK”, close the Pump Out Port Operator by pushing in on the knob and gently rotating it clockwise (CW). Then rotate the knob counterclockwise (CCW) until the Knob Extension is fully disengaged from the Pump Out Port and pull the knob out approximately 50 mm (2 inches).

53. Turn off and remove Gas Supply, close Vacuum Valve (black handle), turn off Vacuum pump, open Gas Inlet Valve (green handle) to vent system and disconnect and remove apparatus.

54. Install Gas Flex Lines and Power Cable. Turn on Compressor and check out System. See SETUP AND CALIBRATION, Section 1–3.

55. Place the removed Cold Head in the New Cold Head Carton and return for serving per instructions in carton. Make sure Cold Head is properly packaged and secure in the carton.

SECTION 10– SHIELD COOLER COLD HEAD REPLACEMENT (continued)

56. Monitor the Cold Head First and Second Stage Temperatures in conformance with the Magnet Service Manual, Section 1–3–9 of SET UP AND CALIBRATION ("Monitoring Shield Cooler Temperatures"),

57. Liter the Cold Head has cooled down for approximately four hours, tighten the Cold Head Mounting Bolts hand tight in a "CW" rotational pattern.

58. Continue to hand tighten the Cold Head Mounting Bolts in the above manner, at approximately four hour intervals, until the First and Second Stage Temperatures have stabilized,

59. When temperatures have stabilized, tighten all Cold Head Mounting Bolts evenly, in a "CW" rotational pattern, to result in the Bellville Washer Gap Setting shown in Illustration 10–9.

Note

First and Second Stage Temperature may decrease farther, after setting the Bellville Washer Gap.

60. Establish if the stabilized temperatures are within specification range (32 –60 K First Stage, 7 –17 K Second Stage). The temperatures that were found for your magnet in the factory are recorded in the Acceptance Test Report (ATR) found in the DATA SHEET Section or your manual. If temperatures are higher than those values, perform the tests listed in FUNCTIONAL CHECKS, Section 6 of this manual.

Note

Differences in diode mounting techniques and diode lead heat stationing used to intercept heat propagated down the leads from the outside the magnet, have produced increased variation in shield cooler diode temperature readings. Because of this condition, the acceptable diode temperature range (magnet operating with boil–off in specification) has exceeded the original temperature range established for field reference, for a small number of magnets. It is important to identify acceptable diode temperature readings which exceed the field reference range, as the "diagnostic threshold" for proper shield cooler operation. Diode temperature reading values are recorded on the Acceptance Test Report (ATR) sent with each magnet, Where the recorded value exceeds the field reference range documented in the above note, use the recorded value as the nominal value for proper shield cooler operation on the referenced magnet. Acceptable ranges around these nominal values are: ±10K FIRST STAGE ±5 K SECOND STAGE
Starting March 1, 1993 all diode temperature reading values which exceed the field reference range will be recorded on a label attached to the cold head sleeve, in addition to being recorded on the ATR.

REPLACEMENT / MAINTENANCE

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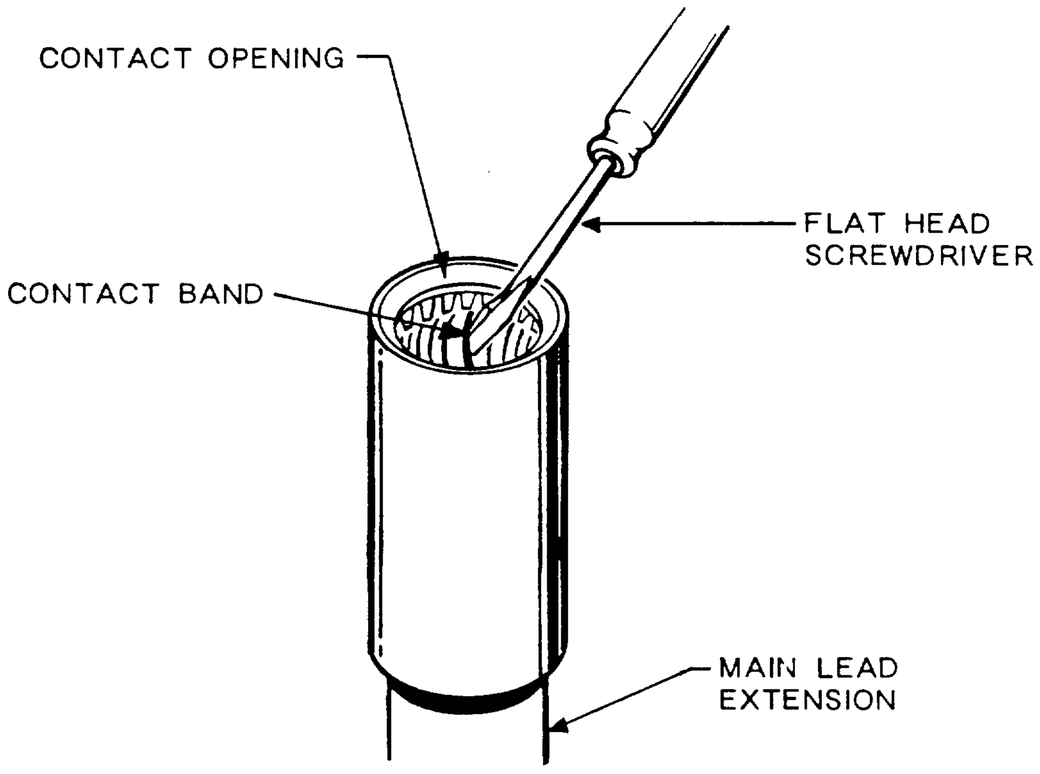
SECTION 11 - MAIN LEAD EXTENSION
CONTACT BAND REPLACEMENT

1. Insert flat head screwdriver into 1/2 inch contact opening on end of Main Lead Extension. See Illustration 11-1.

2. Engage louvers in Contact Band with tip of screwdriver and gradually pry Contact Band out of Contact opening without scouring wall of Contact opening.

3. Obtain and inspect new Contact Band (46-281256P1).



CONTACT BAND REMOVAL
ILLUSTRATION 11-1

SECTION 11 - MAIN LEAD EXTENSION CONTACT BAND REPLACEMENT (continued)

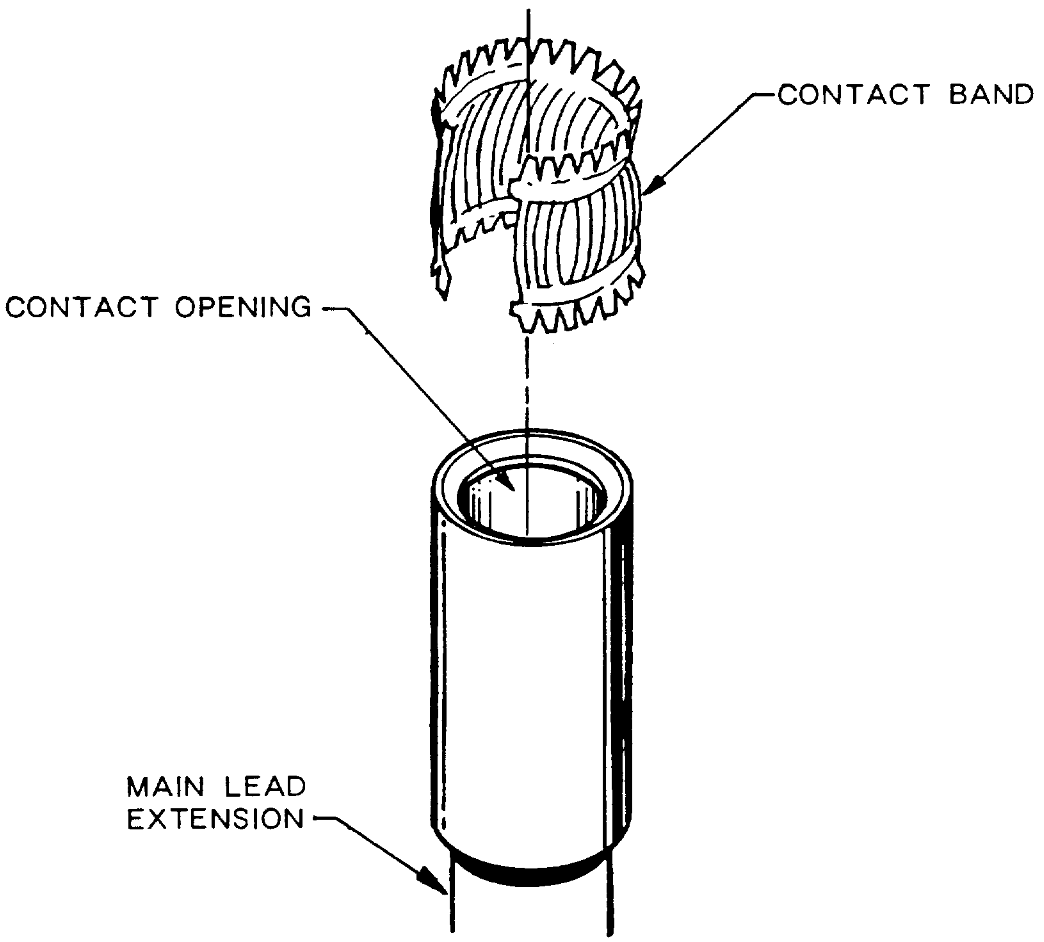
4. Roll new Contact Band into a uniform cylinder of less than 1/2 inch diameter and fully insert into Contact opening. See Illustration 11-2.

5. Ensure Contact Band has expanded against walls of the contact opening and is fully seated below rim on Contact opening.

Note

o For best results, use a new set of contact bands for every ramp.

0 Do not install more than one set of contact bands in the leads at a time. Extra sets will prevent the ramp lead from seating fully.



CONTACT BAND REPLACEMENT
ILLUSTRATION 11-2

REPLACEMENT / MAINTENANCE

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	12–2 Sav-Con Connector Replacement	12-6

SECTION 12 - SAV CON CONNECTOR REMOVAL / REPLACEMENT

DESCRIPTION:
This procedure is used with magnet model number 46–281355G4 which contain removable Sav–Con connectors. See Renewal Parts, Section 2, page 2–7.

WARNING!

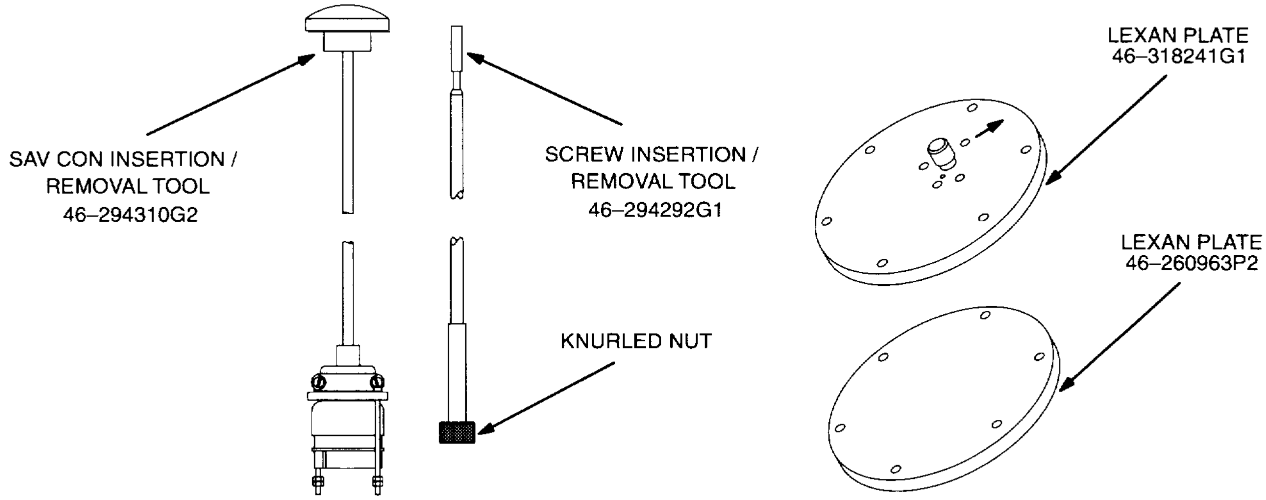
MAKE SURE SUFFICIENT VENTILATION EXISTS IN THE EXAM ROOM, TO DISPEL THE LARGE AMOUNTS OF GASEOUS HELIUM THAT MAYBE RELEASED DURING THE FOLLOWING PROCEDURES. ENSURE THAT THE OXYGEN MONITOR IS FUNCTIONAL.

RAPID EXHAUSTING OF COLD HELIUM GAS MAY BE ENCOUNTERED DURING THE FOLLOWING PROCEDURES. WEAR NON ABSORBENT GLOVES AND GOGGLES OR FACE SHIELD WHEN PERFORMING THESE PROCEDURES.

MAKE SURE THAT THE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE REMOVING/ REPLACING THE SHIM LEAD ASSEMBLY. A MAGNET QUENCH DURING REMOVAL / REPLACEMENT OF THE SHIM LEAD ASSEMBLY COULD RESULT IN THE RAPID EXPULSION OF LIQUID HELIUM OUT OR THE VERTICAL STACK.

REMOVAL/REPLACEMENT OF THE SAV CON CONNECTOR MUST BE PERFORMED QUICKLY TO PREVENT CONDENSATION AND ICING IN THE VERTICAL STACK AND ON THE Electrical CONNECTORS.

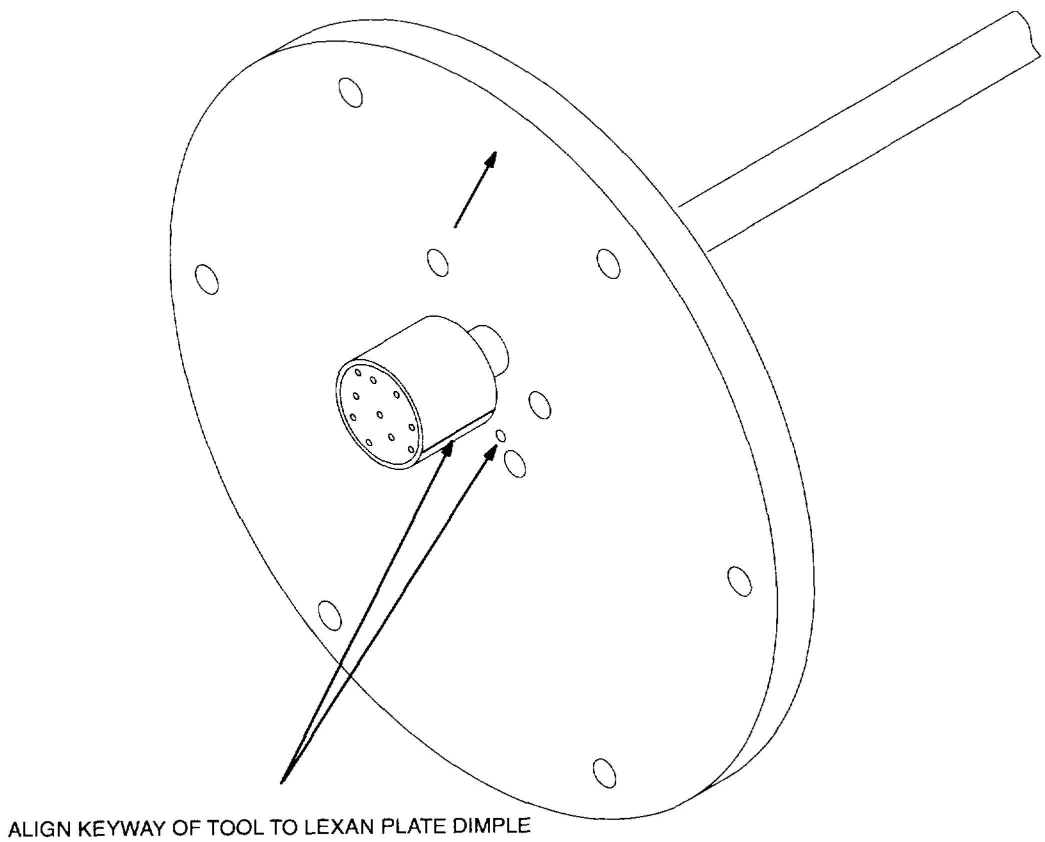
READ AND UNDERSTAND THIS PROCEDURE AND HAVE ALL REQUIRED TOOLS AND EQUIPMENT ON HAND INCLUDING: TOOL KIT P/N 46–294872G2, HELIUM GAS, HEAT GUN, WRENCHES, FLASHLIGHT, SNOOP, SAFETY FACESHIELD AND GLOVES BEFORE STARTING.



SAV CON REPLACEMENT / REMOVAL TOOLS
ILLUSTRATION 12–1

12–1 SAV CON CONNECTOR REMOVAL

1. Ramp magnet down to zero field in conformance with REPLACEMENT/ MAINTENANCE, Section 3.
2. Slowly open Vent Valve (V2) and vent magnet until internal pressure drops between 0.20 and 0.3 psi on the Cryostat Pressure Gauge. Close V2.
3. Assemble the Sav Con Insertion/Removal Tool to Lexan Plate (46–31 8241G2) by removing knob on the tool shaft and inserting shaft through center hole in Lexan plate.
4. Position connector end of tool towards the Lexan Plate and align Sav Con Tool keyway to dimple as shown in Illustration 12–2. Tighten knurled nut to hold in place. Reassemble knob to tool shaft.



SAV CON SETUP
ILLUSTRATION 12-2

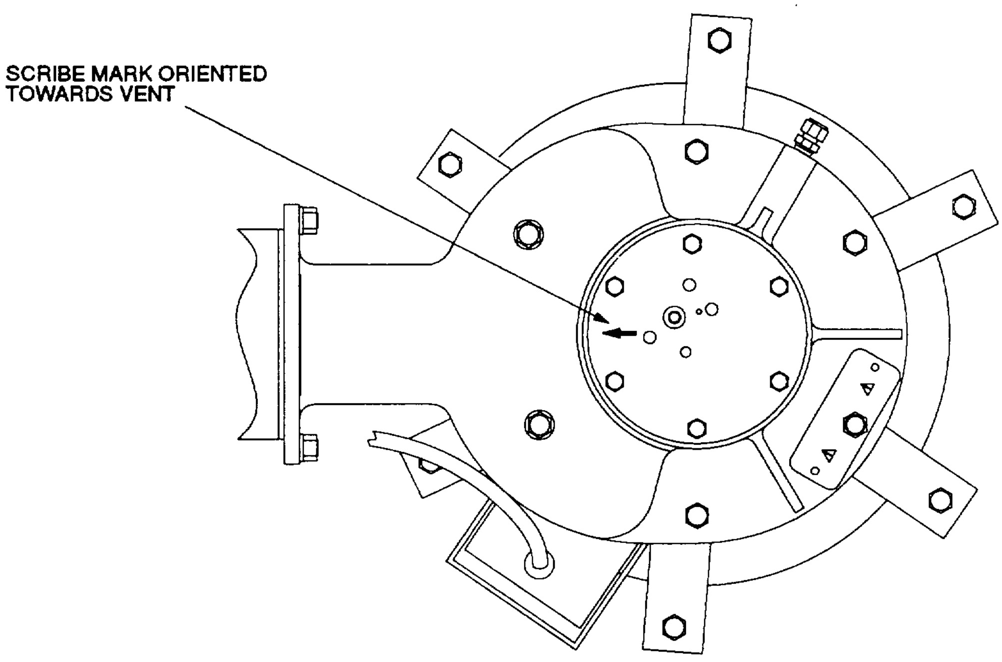
12–1 SAV CON CONNECTOR REMOVAL (continued)

Note

Quickly place this assembly onto the Vertical Stack upon removal of Shim Lead Assembly to prevent icing. Always replace Shim Lead “O” – Ring when performing this procedure.

5. Remove Shim Lead Assembly in conformance with REPLACEMENT/ MAINTENANCE, Section 8 and store carefully.

6. immediately position Lexan Plate / Tool assembly onto Vertical Stack; orient scribe mark as shown in Illustration 12-3.



SAV CON TOOL ASSEMBLY ALIGNMENT TO TURRET
ILLUSTRATION 12–3

7. Allow bluish plume of heilum exiting through holes in Lexan Plate to subside.

8. Make sure Shim Lead “O”– Ring on top of Vertical Stack is in its groove and firmly sandwiched between the Lexan Plate and Vertical Stack. Bolt Lexan Plate in place using bolts removed in Step 5.

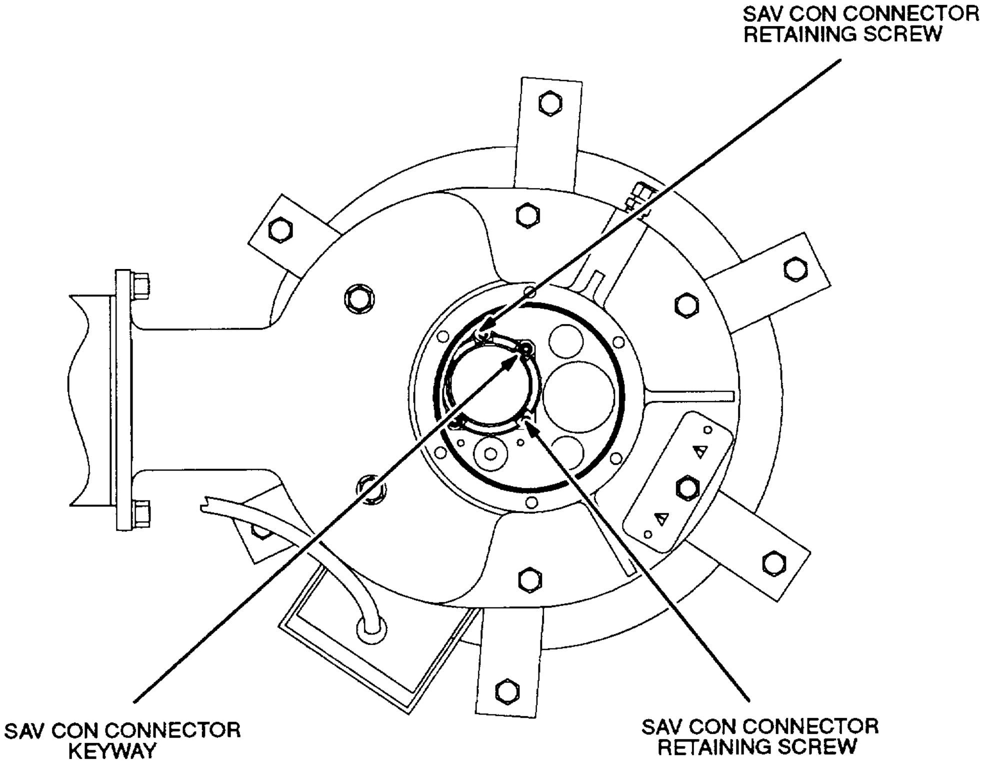
Note

if ice builds up on connector or associated hardware during procedure, insert Helium Gas Tube through the Lexan Plate to the ice point. Blowwarm heilum gas at 3-7 psig to remove ice, then allow bluish helium plume to subside.

12-1 SAV CON CONNECTOR REMOVAL (continued)

9. Shine flashlight through Lexan Plate and locate Sav Con Connector and its Retaining Screws. Check for any ice build up.

10. Locate the two Sav Con Connector Retaining Screws, location should be directly below insertion holes on Lexan Plate. See Illustration 124.



SAV CON CONNECTOR RETAINING SCREW LOCATION
ILLUSTRATION 12-4

Note
Sav Con Retaining Screws are captured by locking nut under Flange to prevent them from falling off the Sav Con Flange during removal.

11. Lower the Screw Insertion Tool through one of the two appropriate holes to contact the Allen head on either Retaining Screw.

12. Push downward to engage Screw Insertion Tool with Sav Con Retaining Screw, loosen each screw.

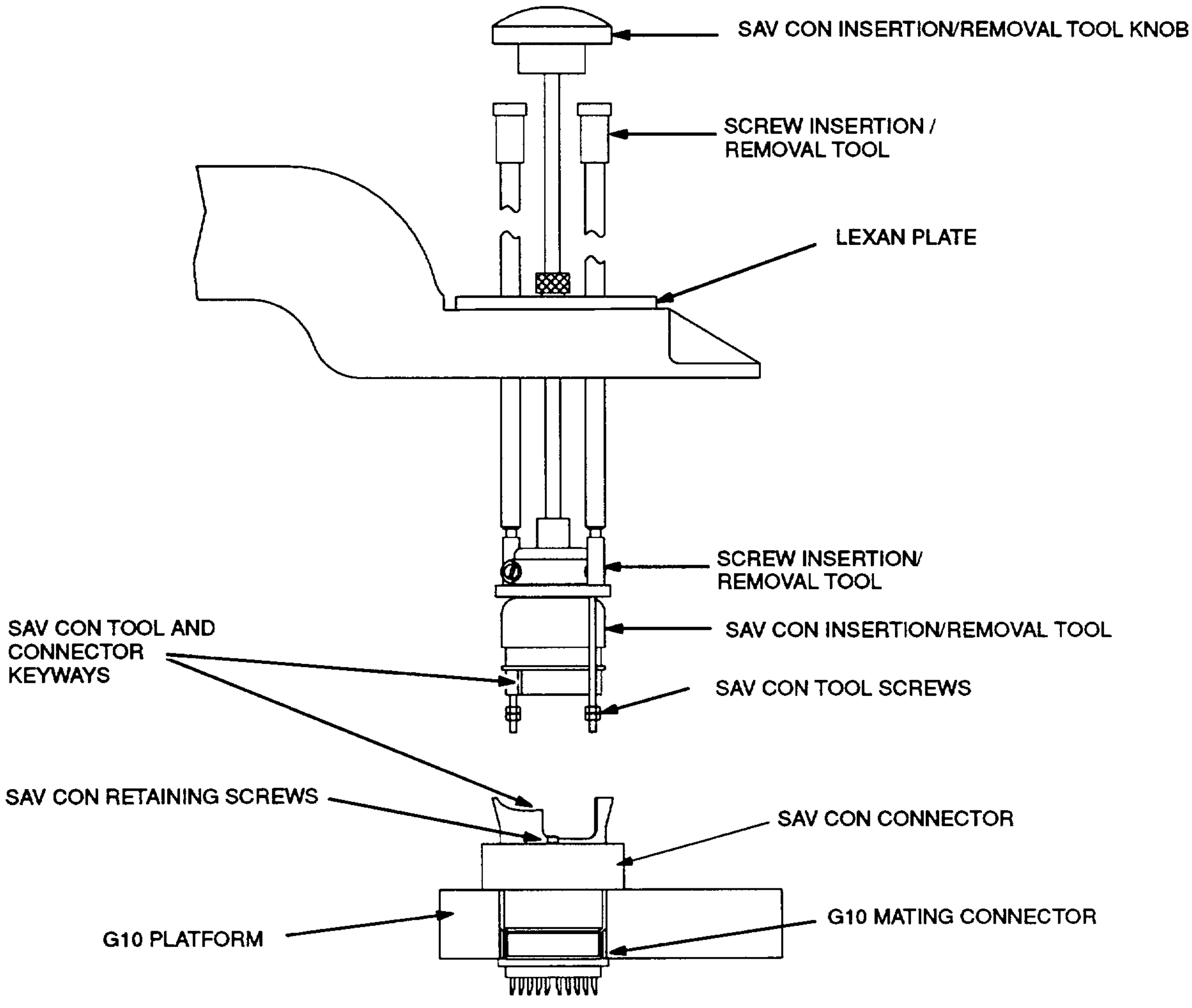
13. Withdraw the Screw Insertion / Removal Tools.

12–1 SAV CON CONNECTOR REMOVAL (continued)

CAUTION

Make sure the keyways of the Sav Con Connector and the G10 mating connector are lined up before connectlng the two together. Forcing the Sav Con Connector on to the Gl0 mating connector can result In bending of the G10 connector pins.

14. Loosen knurled nut holding the Sav Con Insertion/ Removal Tool. Push downward and carefully align keyways of the two mating connectors, then seat the Sav Con Insertion/Removal Tool onto the Sav Con Connector. See Illustration 12-5.



SAV CON TOOL ASSEMBLY AND CONNECTOR MATING
ILLUSTRATION 12–5

12-1 SAV CON CONNECTOR REMOVAL (continued)

Note
The Sav Con Tool Screws are needed to grip the Sav Con Connector for easy removal.

15. Insert the Screw Insertion / Removal Tool through the appropriate holes in the Lexan Plate and engage each screw on the Sav Con Connector Tool.

16. Carefully thread the Sav Con Tool Screws into the threaded bolt heads of the Sav Con Connector and tighten lightly. Remove Screw Insertion / Removal Tools.

17. Pull upward with the Sav Con Tool to remove the Sav Con Connector from the G10 Connector Platform. lighten the knurled nut to secure tool.

18. Remove Lexan Plate and Sav Con Tool Assembly. Quickly replace with Lexan Plate (46-260963P2)

12-2 SAV CON CONNECTOR REPLACEMENT

1. Remove old Sav Con Connector from tool and insert replacement Sav Con Connector onto the Sav Con Tool. Lightly tighten Sav Con Tool screws onto Sav Con threaded bolt head screws.

2. Remove Lexan plate from Vertical Stack and immediately position Sav Con Connector/Tool Assembly over Vertical Stack. Orient scribe mark on Lexan Plate towards Vent.

3. Repeat Steps 7 through 9 in Section 12–1.

Note
Always be sure to align all keyways on all connectors.

4. Loosen knurled nut and lower Sav Con Connector/TooI Assembly. Carefully engage Sav Con Connector into mating G10 platform connector.

5. Locate Sav Con Connector Retaining Screws. Location should be directly below in sertion holes on Lexan Plate.

6. Lower the Screw Insertion / Removal Tool to contact Allen head on Retaining Screws.

7. Engage and hand tighten Sav Con Retaining Screws. Withdraw Screw Insertion/ Removal Tools.

8. Unscrew Sav Con Tool screws from the Sav Con Connector. Disengage, pull Sav Con Tool upward, and secure in place with knurled nut.

9. Remove Sav Con Tool Assembly from the Vertical Stack and replace with Lexan plate.

10. Check for ice and remove before reinstalling the Shim Lead Assembly.

11. Reinstall Shim Lead Assembly and Shim Lead Exhaust plumbing. Engage Shim Lead before Ramping.

12. Check Vertical Penetration and Shim Lead plumbing for leaks before Ramping.

13. Ramp Magnet in conformance with SET UP AND CALIBRATION, Section 7.

RENEWAL PARTS

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SECTION 1 – MAGNET SYSTEM

1- GE 1.5T SUPERCONDUCTING MAGNET SYSTEM

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–281175G1	MAGNET	1	GE 1.5T MAGNET / CRYOSTAT ASSY
1A	46–281483G1	MAGNET	1	GE 1.5T MAGNET / CRYOSTAT ASSY
1B	46–281355G1	MAGNET	1	GE 1.5T MAGNET / CRYOSTAT ASSY
1C	46–281355G2	MAGNET	1	GE 1.5T MAGNET / CRYOSTAT ASSY
1D	46–281355G3	MAGNET	1	GE 1.5T MAGNET / CRYOSTAT ASSY
1E	46–281355G4	MAGNET	1	GE 1.5T MAGNET / CRYOSTAT ASSY
1F	46–281355G5	MAGNET	1	GE 1.5T MAGNET / CRYOSTAT ASSY
1G	46–281355G6	MAGNET	1	GE 1.5T MAGNET / CRYOSTAT ASSY
2	46–260759 G6,G7,G8,G9	COMPRESSOR	1	SHIELD COOLER, BALZERS MODEL #UCC 066 380V–460V, 3 PH, 50–60 Hz
2A	46–294141G1	COMPRESSOR (ALTERNATE)	1	SHIELD COOLER COMPRESSOR LEYBOLD MODEL RW4000 380V–480V, 3 PH, 50–60 Hz
3	46–260760G9	LINES	1	HELIUM SUPPLY, SHIELD COOLER FOR BALZERS MODEL #UCC 064
3A	46–294142P2	LINES	1	HELIUM SUPPLY, SHIELD COOLER FOR LEYBOLD MODEL RGD580–GE
4	46–260760G1	LINES	1	HELIUM RETURN, SHIELD COOLER FOR BALZERS MODEL #UCC 064
4A	46–294143P2	LINES	1	HELIUM RETURN, SHIELD COOLER FOR LEYBOLD MODEL RGD580–GE
5	46–260860G1	ADAPTER	2	ADAPTER, RF PENETRATION ASSY FOR SHIELD COOLER CABLE
6	46–260720G7	LEAD, POWER	1	COLD HEAD TO PENETRATION PANEL 50 FEET (15.24 m) (BALZER)
6A	2104829	LEAD, POWER	1	COLD HEAD TO PENETRATION PANEL 50 FEET (15.24 m) (LEYBOLD)
7	46–260720G8	LEAD, POWER	1	PENETRATION PANEL TO COMPRESSOR 50 FEET (15.24 m) (BALZER)

1 -GE 1.5T SUPERCONDUCTING MAGNET SYSTEM (continued)

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
7A	46–294144P2	LEAD, POWER	1	PENETRATION PANEL TO COMPRESSOR 50 FEET (15.24 m) (LEYBOLD)
8	46–252138G4	ERU	1	EMERGENCY RUNDOWN UNIT
8A	46–294231G1	MRU	1	MAGNET RUNDOWN UNIT
9	46–281794P3	ERU / MRU CABLE	1	EMERGENCY / MAGNET RUNDOWN UNIT CABLE (100 FEET)
10	46–260725G3	MONITOR CABLE	2	CRYOGEN MONITOR INSTRUMENTATION CABLE, #20 AWG, 80' LENGTH
11	46–281811G1	MONITOR, CRYO	1	CRYOGEN MONITOR ASSEMBLY
11A	2122498	MONITOR, CRYO	1	CRYOGEN MONITOR ASSEMBLY
12	46–260888G1	KIT, LEVEL	1	MAGNET LEVELING KIT
13	46–260852G3	TOOL, VACUUM	1	VACUUM BREAKING TOOL
14	46–281866G1	He VENT KIT	1	GE MAGNET VENT KIT (6.00" DIA.)
15	NOT USED			
16	46–252141G3	FLD. SPARE KIT	1	MAGNET SPARE PARTS KIT (46–281051)
17	46–318068P1	WOOL	6	BRONZE WOOL
18	46–260963P2	FLANGE, BLANK	1	10.5" FLANGE COVER PLATE (VERTICAL STACK)
19	46–260963P3	FLANGE, BLANK	2	5.75" FLANGE COVER PLATE (SHIM LEAD ASSY)
20	NOT USED			
21	NOT USED			
22	NOT USED			
23	NOT USED			

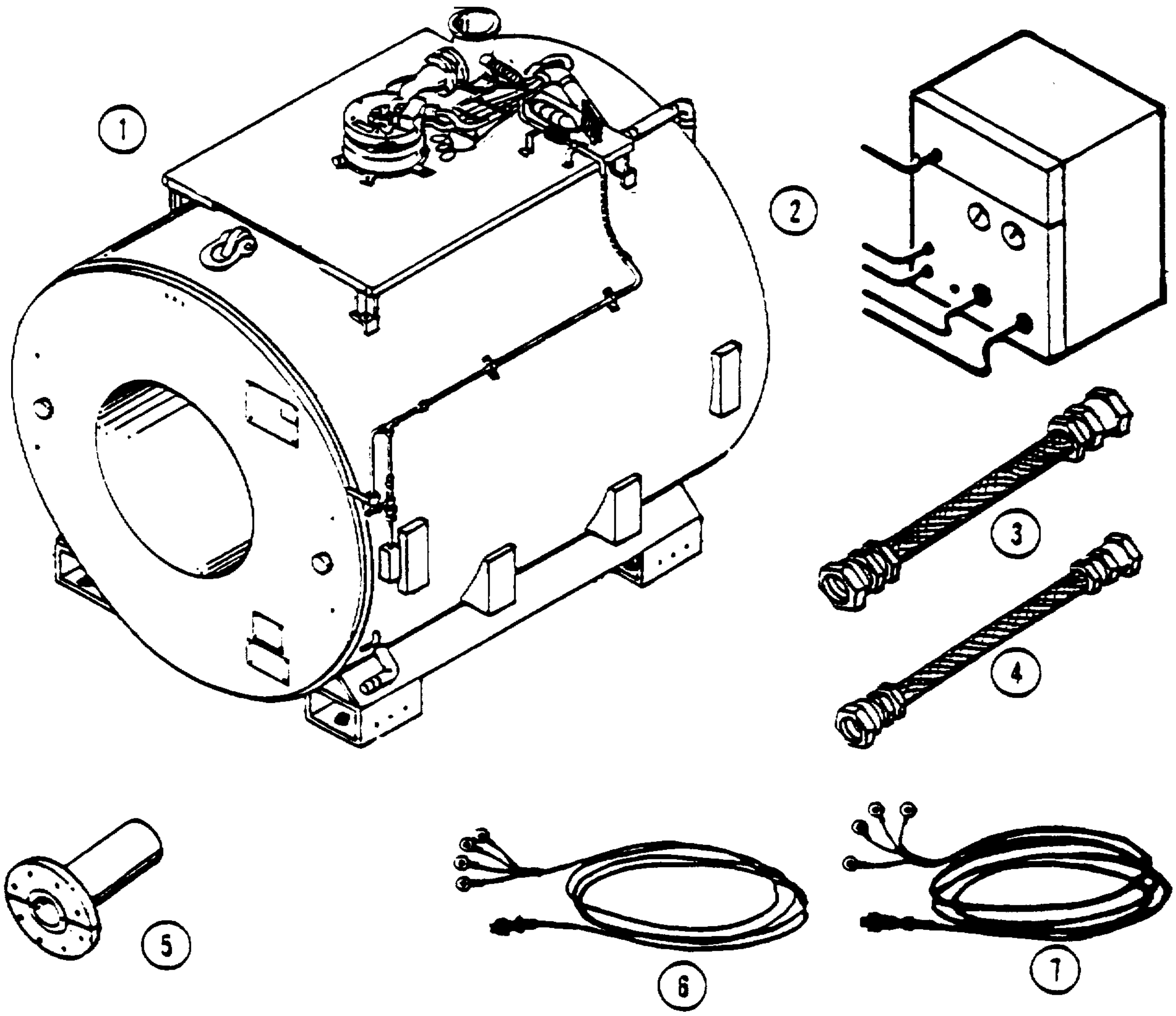
1 – GE 1.5T SUPERCONDUCTING MAGNET SYSTEM (continued)

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
24	NOT USED			
25	46–281792P1	CABLE	1	SHIELD COOLER COMPRESSOR POWER CABLE. BALZERS P/N UC010–644–X
26	46–260723G1	CABLE	2	MAIN POWER CABLE POSITIVE 4/0
27	46–260723G2	CABLE	2	MAIN POWER CABLE NEGATIVE 4/0
28	46–260724G1	CABLE	1	SWITCH HEATER CABLE
29	46–260726G1	CABLE	1	S/C SHIM COILS CABLE
30	46–318042P1	CABLE	1	COLD HEAD TO REAR PEDESTAL
31	46–252283P22	TIES	3	CABLE TIES
32	NOT USED			
33	NOT USED			
34	46–260960G3	CABLE	2	AC POWER CABLE FOR POWER SUPPLIES
35	46–015120	MANUAL	1	DIRECTION 15120 1.5T MAGNET & CRYOGENS SUBSYSTEM SERVICE MANUAL
36.	NOT USED			
37	46–281034P5	CAPACITOR	1	CAPACITOR,10 MICRO FD,370 VAC
38	46–294104P1	NUT	2	KNURLED NUT, BRASS
39	46–294105P1	RING	2	RETAINING RING, STAINLESS STEEL, A & N P/N 75–KM
40	NOT USED			
41	46–281235P1	SENSE LEAD	1	SENSE LEAD
42	46–255325P1	MR SECU SIGN	1	SECURITY ZONE WARNING SIGN
43	46–255326P1	MR SECU SIGN	1	EXCLUSION ZONE WARNING SIGN

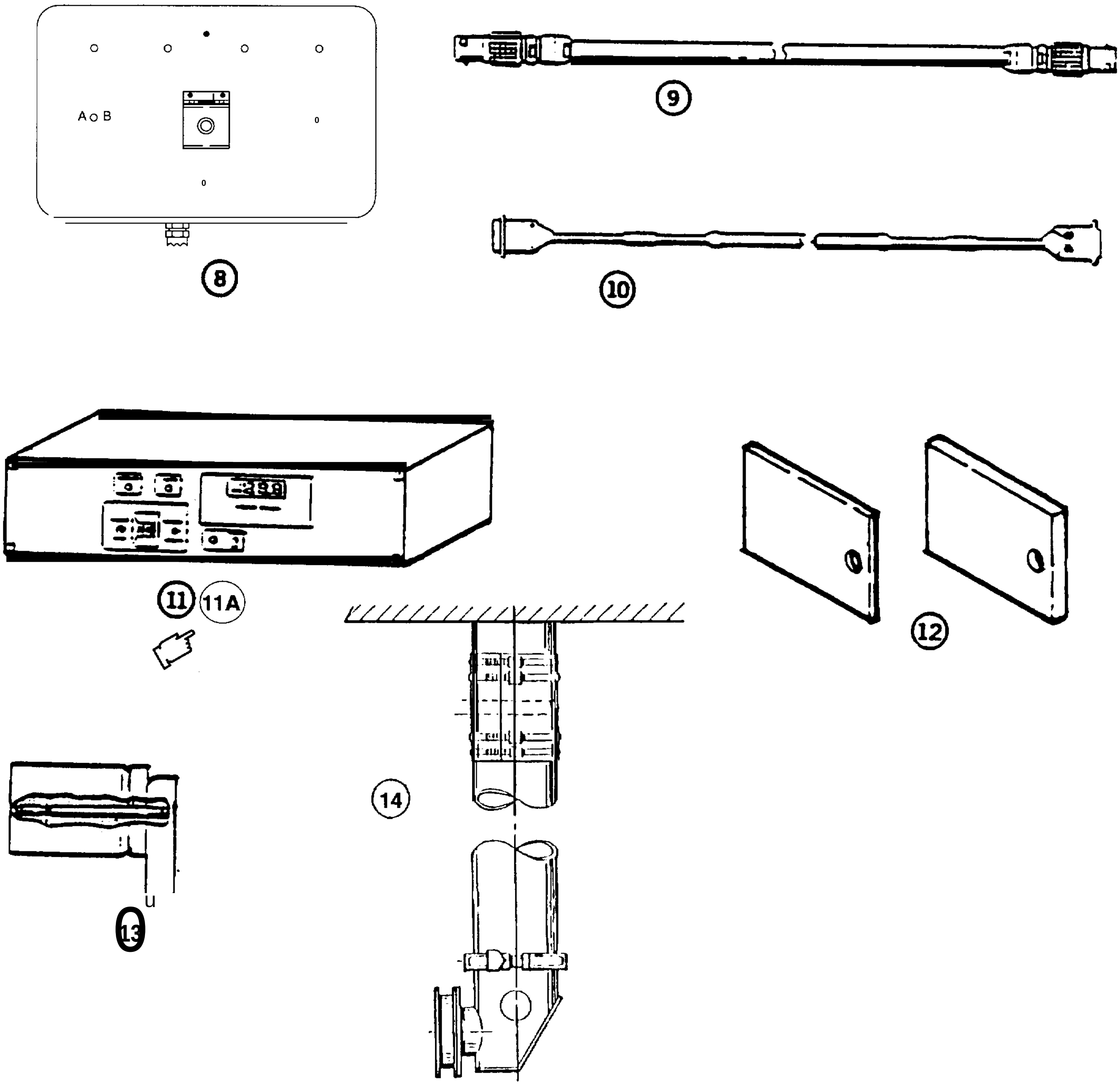
1 – GE 1.5T SUPERCONDUCTING MAGNET SYSTEM (continued)

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
44	46–260902P5	PLUG	3	1/4 OD TUBE FITTING PLUG
45	46–281126P1	VENT ADP SPT	1	SUPPORT, VENT ADAPTER
46	46–281227P14	HARDWARE	4	3/8–16 UNC X 2.00 LG, HEX HD, BRASS
47	46–221960P3	HARDWARE	4	3/8–16 0.563 HEX X 0.219 THK BRASS
48	46–252361 P3	HARDWARE	2	1/4–20 UNC X .75 LG STAINLESS STEEL BOLT
49	46–281162P9	HARDWARE	2	1/4 NOM SPRING STAINLESS STEEL WASHER
50	46–252635P7	HARDWARE	2	1/4 .062 THK, PLAIN STAINLESS STEEL WASHER
51	46–252318P15	HARDWARE	2	NUT, HEX .25–20 S.S.
52	46–281341P3	HARDWARE	4	METRIC, M4 X 10 PHILLIPS HEAD SCREW, SS 304
*53	46–318036G1	RAMP KIT	1	SIGNA RAMP CABLE KIT

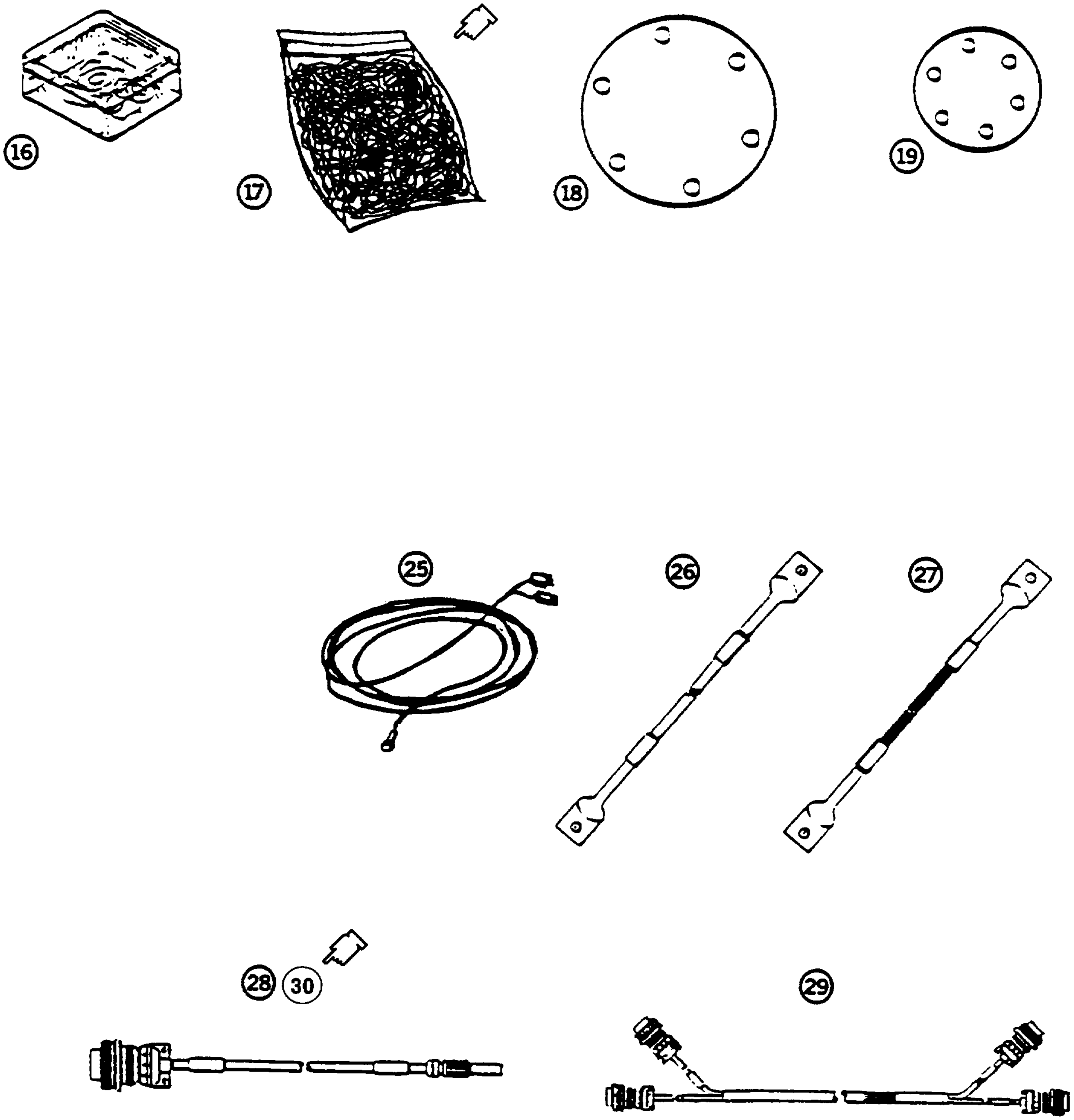
* USED FOR 46–281355G3, G4 & G5, G6 ONLY



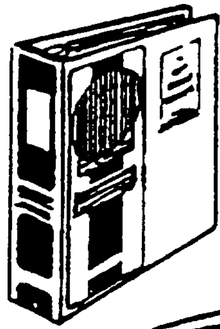
I-GE 1.5T SUPERCONDUCTING MAGNET SYSTEM (continued)



1 -GE 1.5T SUPERCONDUCTING MAGNET SYSTEM (continued)



1 – GE 1 ST SUPERCONDUCTING MAGNET SYSTEM (continued)



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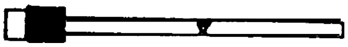

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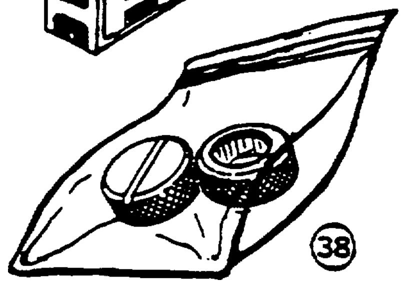

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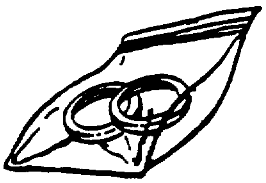
46-260815P2 (2)



46-260815P3 (2)

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1 -GE 1.5T SUPERCONDUCTING MAGNET SYSTEM (continued)

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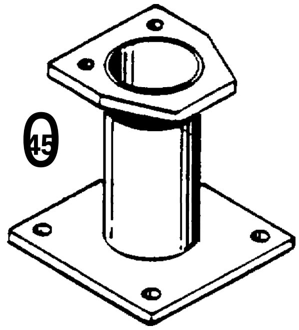

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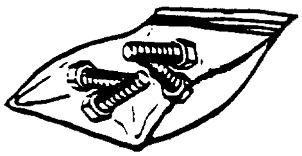

46-281227P14 (4)

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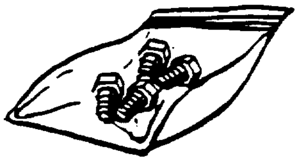

46-221960P3 (4)

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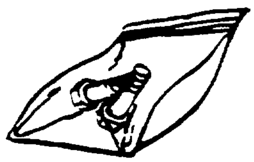

46-252361P3 (2)

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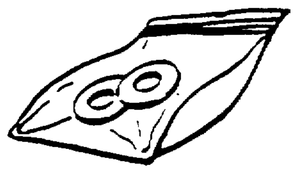

46-281162P9 (2)

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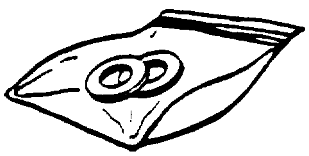

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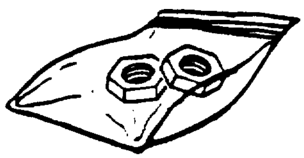

46-252318P15 (2)

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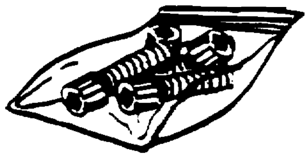

46-281341P3 (4)

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1 – GE 1.5T SUPERCONDUCTING MAGNET SYSTEM (continued)

RENEWAL PARTS

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SECTION 2 – MAGNET COMPONENTS

2 – MAGNET COMPONENTS 46–281175G1, 46–281483G1 & 46–281355G1, G2, G3, G4, G5, G6

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–260893G1	PLUMBING ASM	1	HELIUM VENT PLUMBING ASSEMBLY
2	46–281911G1	VALVE, HELIUM	1	VALVE, HELIUM FILL, 3/4 CRYOGENIC BALL
3	46–318665G1	TERMINAL BOX	1	TERMINAL BOX – INSTRUMENT & MAGNET WIRING ASSEMBLY
4	46–318711P1	VENT ADAPTER	1	CAST VENT ADAPTER (6.00" DIA.)
5	46–260420P1	FLANGE DISC	1	FLANGE DISC
6	46–252839P1	GASKET	2	3.75" ID X 5.25" OD ZOOK NEOPRENE GASKET
7	46–252365P13	.375 BOLT	4	3/8–16 UNC X 2.25 LG
8	46–281162P11	STN LCK WASH	22	3/8 NOM SPRING STN LOCK WASHER
9	46–252318P19	NUT–HEX	8	NUT, HEX .375–16 S.S.
10	46–252532P2	SCR AX IN CR	14	3/8–16 UNC X 5/8 LG SCREW
11	46–260342P5	O–RING	1	3.989 ID, VENT ADAPTER O–RING
12	46–252838P4	BURST DISK	1	20 PSIG–TUV APPROVED BURST DSK
*13	46–260818G1	PLENUM	1	METASTABLE PENETRATION PLENUM
13A	46–281438G1	PLENUM	1	CAST PLENUM
14	46–260815G1	LEAD ASM.	1	SHIM LEAD ASSEMBLY & COVER
**14A	46–318096G1	LEAD ASM.	1	SHIM LEAD ASSEMBLY – TEFLON
15	46–252635P9	STN STL WASH	16	3/8 NOM STAINLESS STEEL WASHER
16	46–260816G2	LEAD ASM	1	ERU LEAD ASSEMBLY (G10 SLEEVE)
16A	46–294241G1	LEAD ASM	1	MRU LEAD ASSEMBLY
17	46–252361P1	.250 BOLT	26	1/4–20 UNC X 1/2 LG BOLT
18	46–281162P9	STN LCK WASH	28	1/4 NOM SPRING LOCK WASHER
19	46–252635P7	STN STL WASH	16	1/4 X .062 THK PLAIN SS WASHER
20	46–252366P19	BOLT	6	3/8–16 UNC X 3.00 LG BRASS BOLT

* 46–281175G1 ONLY ** 46–281355G3, G4, G5, G6 ONLY

2 – **MAGNET COMPONENTS 46-281175G1, 46-281483G1 & 46-281355G1, G2, G3, G4, G5, G6 (continued)**

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
21	46–260863P1	FLOWMETER	1	PENETRATION SLEEVE, 1–10 SCFH
22	46–260864P1	FLOWMETER	1	SHIM, .20 – 2.0 SCFH FLOWMETER
23	46–281282P1	GAUGE	1	DUAL SCALE, 0–5 PSI / KPA, 2.50 DIAL GAUGE
24	46–281283P1	SNUBBER	1	ADAPTER (GAUGE PROTECTOR) CAJON P/N B–4SA–EG
25	46–294552G1	PLATFORM ASM	1	PLATFORM SERVICE ASSEMBLY
26	46–252635P11	STN STL WASH	8	.50 NOM S.S. PLAIN WASHER
27	46–260950P45	SCREW, CAP	4	.50–13 UNC X 1.50 LG, HEX HEAD STAINLESS STEEL SCREW
28	46–281162P13	STN LCK WASH	4	1/2 NOM SPRING LOCK WASHER
29	46–281286P1	BRACKET	1	FLOWMETER / GAUGE, SILKSCREENED BRACKET
30	46–281288G1	TUBE SUPPORT	1	FLOWMETER & GAUGE TUBING SUPPORT
3132	46–252318P23	NUT–HEX	4	.50 –13UNC–2B, STAINLESS STEEL 304 HEX NUT
	46–260898P28	CONNECTOR	3	3/4 NPT X 3/4 ODT, SWAGELOK B–1210–1–12 CONNECTOR
33	46–260348P12	FITTING, TUBE	1	3/4 ODT X 3/4 ODT, 90 DEG., ELBOW SWAGELOK B–1210–9
34	48–252361P7	.250 BOLT	2	1/4– 20 UNC X 1.25 LG, STAINLESS STEEL 304 BOLT
35	48–260985P2	TUBE – .75 OD	1	.75 OD TUBE
36	46–281315P1	TUBE – .T5 OD	1	CHECK VALVE TO FLEX
37	46–281316P2	TUBE – .75 OD	1	90 DEG. FLEX HOSE TO CHECK VALVE
38	46–260925P1	HOSE CONNECTOR	1	FLEX HOSE CONNECTOR
39	46–281284P1	FLEX TUBE	1	.75 OD FLEX TUBE CAJON P/N 321–12–X–6–B2

2 – MAGNET COMPONENTS 46–281175G1, 46–281473G1 & 46–281355G1, G2, G3, G4, G5, G6 (continued)

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
40	46–260926P1	CHECK VALVE	1	CHECK VALVE
41	46–260898P3	CONNECTOR	5	MALE CONNECTOR, 1/4 ODT X 1/8 NPT
42	46–281222P1	MALE RUN TEE	2	.250 ODT X .125 NPT, BRASS TEE
43	46–260898P4	CONNECTOR	2	MALE CONNECTOR, 1/4 ODT X 1/4 NPT
44	46–281325P4	TEE, FEM BR	1	FEMALE BRANCH (TTF), .25 ODT X .25 NPT
45	46–281317P1	TUBE – .25 OD	1	SHIM LEAD TO FLOWMETER BRKT
46	46–281318P1	TUBE – .25 OD	1	F1 TO F2
47	46–281319P1	TUBE – .25 OD	1	F1 TO TEE
48	46–281320P1	TUBE – .25 OD	1	FLOWMETER BRKT TO VENT ADAPTER
49	46–260298P1	SCREW, DRIVE	28	#10 X .375 SCREW
50	46–260195P1	FILL CAP LBL	1	FILL CAP LABEL
51	46–260322P1	LABEL PLUMBING	1	PLUMBING LABEL
52	46–260322P2	LABEL PLUMBING	1	PLUMBING LABEL
53	46–260902P5	PLUG	1	1/4 OD TUBE FITTING PLUG
54	46–260898P4	MALE CONNECTOR	3	1/4 ODT X 1/4 NPT
55	NOT USED			
56	46–252629P51	SCREW, MACH	4	#10 –32 UNF X .44 LG STAINLESS STEEL MACHINE SCREW
57	46–281162P7	STN LCK WASH	4	#10 NOM SPRING LOCK WASHER
58	46–281048P1	CLAMP	1	CONDUIT 2.50 CLAMP
59	46–260939P1	PROTECTOR	1	300K BELLOWS PROTECTOR
60	46–260325P1	BEAD CHAIN	3	3 INCH LONG SEGMENTS CHAIN

I 2- MAGNET COMPONENTS 46-28117551, 46-281483G1 & 46-281355G1, G2, G3, G4, G5, G6 (continued)

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
61	46–260326P1	CONNECTOR	8	CONNECTOR FOR #6 BEAD CHAIN
62	46–260322P14	LABEL, PLUMB	1	PLUMBING LABEL, CV
63	46–281103P3	TUBE SUP'T	2	TUBE SUPPORT
64	46–281118P1	TUBE CLAMP	4	TUBE CLAMP
65	46–281101P1	O–RING, TEFLON	1	TEFLON O–RING 4.239 ID X .070 THICK
66	46–281101P2	O–RING, TEFLON	2	TEFLON 0–RING 8.237 ID X.103 THICK
67	46–281104P1	SHACKLE	2	SHACKLE
68	46–281957P1	BOTTLE	1	DAMPENER BOTTLE ASSEMBLY
69	46–281108P1	ADAPTER	1	DAMPENER ADAPTER
70	46–281109P1	VALVE	3	DAMPENER ANGLE VALVE
71	46–252318P15	NUT – HEX	8	NUT, HEX .250 – 20 S.S.
72	46–281103P2	TUBE SUP'T	2	TUBE SUPPORT
73	46–260902P5	PLUG	2	1/4 OD TUBE FITTING
74	46–252362P3	SCREW, CAP	2	1/4 – 20 X .75 BRASS SCREW
75	46–260912P6	FEMALE CON.	2	BRASS FEMALE CONNECTOR .25 ODT X .25 NPT
76	46–252065P45	TUBING	1	POLYETHYLENE TUBING 1/4 OD X .040 CUT TO FIT
77	46–252360P5	CLAMP	6	TEFLON CUSHIONED CLAMP .25 ID .25 MTG
78	46–281119P1	TUBE CLAMP	4	TUBE CLAMP
79	46–252362P1	SCREW, CAP	4	1/4–20 X 0.50 BRASS SCREW
80	46–252322P6	WASHER	6	PLAIN, TYPE A NAR, BRASS, .25

2 – **MAGNET COMPONENTS 46–281175G1, 46-28148G1 & 46-281355G1, G2, G3, G4, G5, G6 (continued)**

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
81	46–252322P8	WASHER	6	3/8 BRASS WASHER
82	46–260322P16	LABEL, PLUMB	3	PLUMBING LABEL, FACTORY SET – DO NOT ALTER
83	46–281126P1	VENT ADP SPT	1	VENT ADAPTER SUPPORT
84	46–281227P14	SCREW, MACH	4	3/8–16 UNC X 2.00 LG, HEX HEAD, BRASS MACHINE SCREW
85	46–252361P3	.250 BOLT	2	1/4–20 UNC X .75 LG S.S. BOLT
86	46–281321P1	TUBE – .25 OD	1	TEE TO TAO BOTTLE
87	46–260900P2	UNION TEE	1	.25 ODT, BRASS TEE
88	46–281322P1	TUBE – .25 OD	1	TEE TO F2
89	48–281323P1	TUBE – .25 OD	1	PENETRATION TO TEE
90	46–252205P2	TEE	1	1/4 NPT BRASS TEE
91	46–252065P45	TUBING	1	10” LENGTH POLYETHYLENE TUBING, 1/4 OD X .040 WALL, IMPERIAL CAT# 44–P NATURAL
92	46–221960P3	NUT, HEX	4	3/8–16 0.563 HEX X 0.219 THICK BRASS NUT
93	46–252552P5	PIPE PLUG	1	PIPE PLUG
94	46–260938P1	TRANS REFRIG	1	COLD HEAD TRANSITION
95	46–260995G1, G2 & G3	COLD HEAD	1	BALZERS SHIELD COOLER COLD HEAD
95A	2100832	COLD HEAD	1	LEYBOLD SHIELD COOLER COLD HEAD
96	46–281241P1	GASKET	1	INDIUM, 3.37 OD GASKET
97	46–281241P2	GASKET	1	INDIUM, 1.75 OD GASKET
98	46–281247P1	O–RING – BUNA	1	4.987 ID X.103 THICK O–RING PARKER #2–159

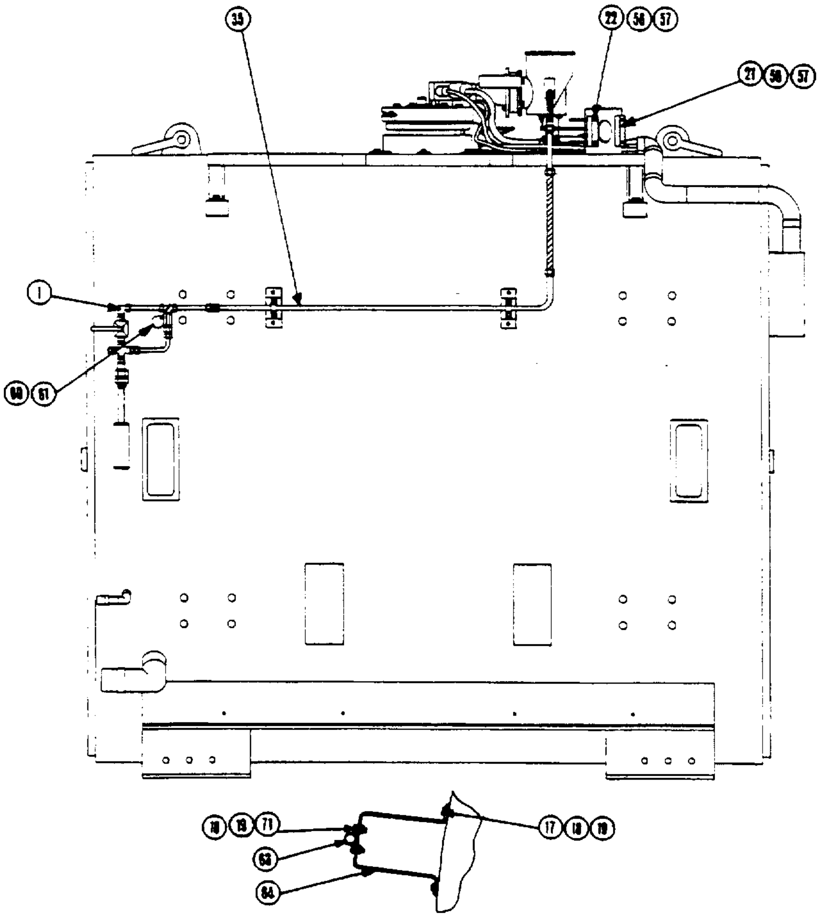
2- MAGNET COMPONENTS 46–281175G1, 46–281483G1 & 46-281355G1, G2, G3, G4, G5, G6 (continued)

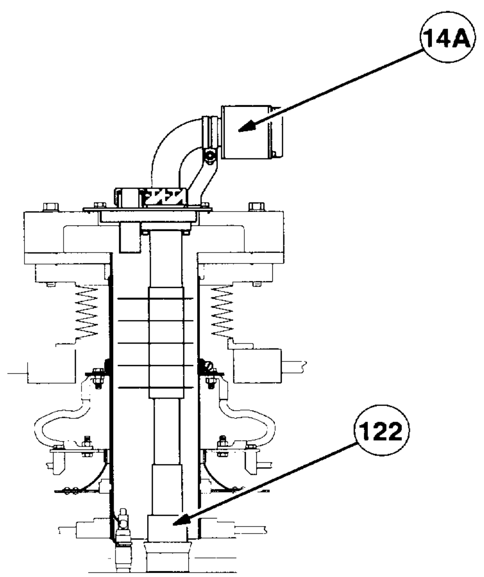
ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
99	46–252610P4	SCREW, CAP	7	HEX SOC HEAD, .25–20 UNC X .750 LG STAINLESS STEEL SCREW
100	46–252361P11	.250 BOLT	8	1/4–20 UNC X 1.75 LG, HEX HEAD, STAINLESS STEEL BOLT
101	46–252317P1	WASHER	16	BELLEVILLE, BE CU, 1/4 WASHER
101A	46–281387P1	WASHER	16	BELLEVILLE, STN. STL., 1/4 WASHER
102	46–252065P50	BOSTIK	AR	BOSTIK NEVER–SEEZE LUBRICATING AND ANTI–SEEZE COMPOUND
103	46–260695P6	STUD	1	1/2–13 UNC X 1.50 LG, SIL. BRNZ.
104	46–260166P3	NUT, HEX JAM	2	1/2–13 UNC, BRASS HEX NUT
105	46–281251G1	MOTOR SHIELD	1	FOR BAIZERS SHIELD COOLER MOTOR
105A	46–281251G2	MOTOR SHIELD	1	FOR BALZERS SHIELD COOLER MOTOR MAGNET #46–281355G2
105B	46–294014G1	MOTOR SHIELD	1	FOR LEYBOLD SHIELD COOLER MOTOR
105C	46–294583G1	MOTOR SHIELD	1	FOR LEYBOLD SHIELD COOLER MOTOR (FOLD–AWAY)
105D	46–318789G1	MOTOR SHIELD	1	FOR LEYBOLD SHIELD COOLER MOTOR (REMOVABLE LEG)
106	46–318672P38	.375 BOLT	2	3/8–1 6 UNC X 2.00 LG. HEX HEAD STN. STL. BOLT
107	46–281222P1	1/4” TEE	1	1/4” OD X .125 NPT MALE RUN TEE
108	46–260902P5	CAP	1	MALE RUN TEE CAP
109	48–260898P10	CONNECTOR	2	MALE 3/1 6“ X 1/8 NPT CONNECTOR
110	46–281501P1	3/16” TUBING	1	3/18” S.S. TUBING
111	46–281492P1	1/4” TUBE	1	1/4” TUBING F1 TO F2
112	46–281493P1	1/4” TUBE	1	1/4” TUBING F1 TO TEE
113	46–252206P1	TEE	1	1/4” NPT BRASS STREET TEE
114	46–281325P5	TEE	1	FEMALE TEE
115	48–260829P2	VALVE	1	RELIEF VALVE
116	46–281488P1	1/4” TUBE	1	1/4” TUBING, TEE TO F2
117	48–281490P1	1/4” TUBE	1	1/4” TUBING, TO VENT ADAPTER

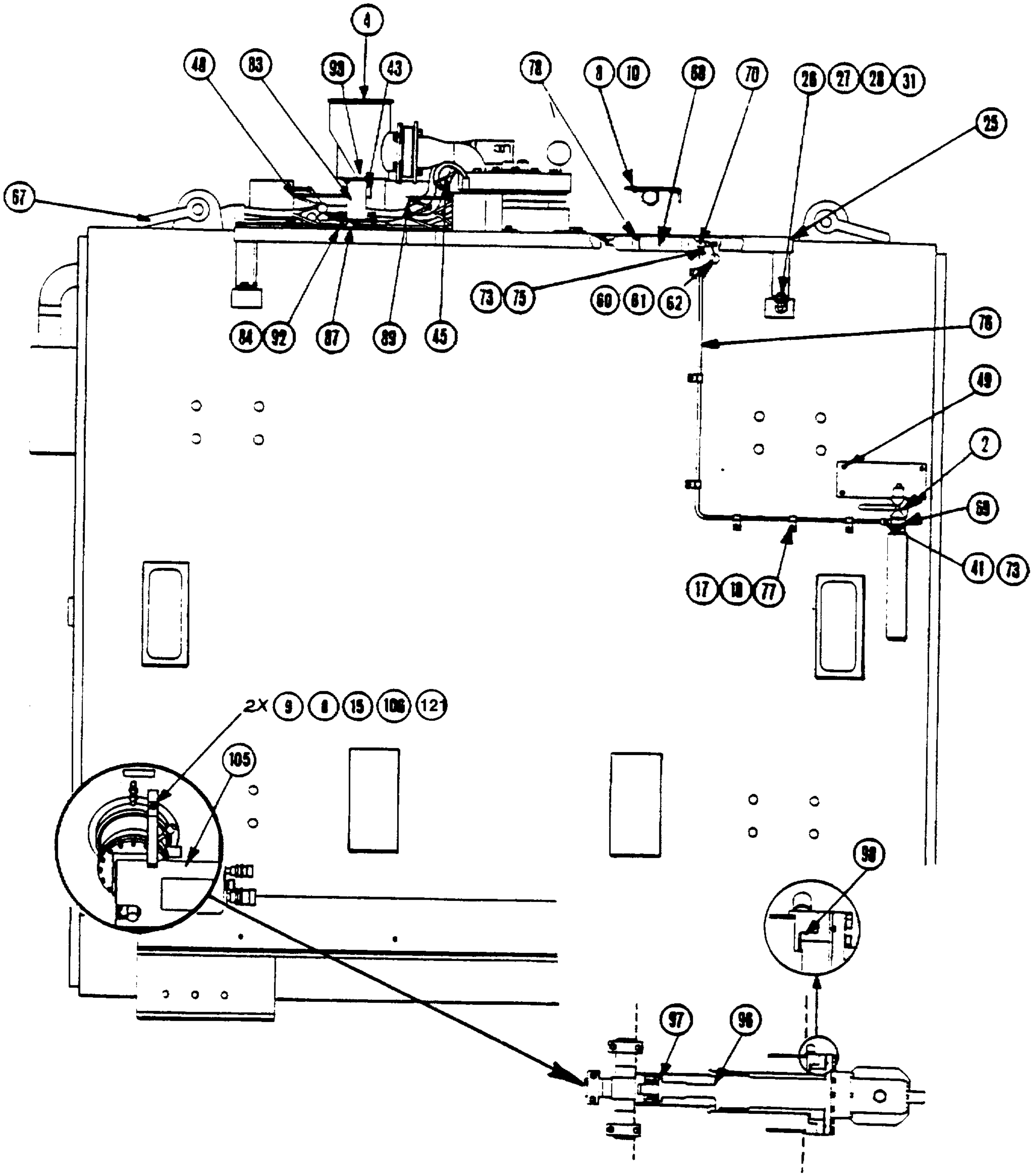
2- MAGNET COMPONENTS 46-281175G1, 46-281483G1 & 46-281355G1, G2, G3, G4, G5, G6 (continued)

ITEM	NUMBER	NAME	QTY	DESCRIPTION
118	46–281487P1	1/4" TUBE	1	1/4" TUBING, SHIM LEAD TO FLOWMETER
119	46–281489P1	1/4" TUBE	1	1/4" TUBING, PENETRATION TO TEE
120	46–281491P1	1/4" TUBE	1	1/4" TUBING, TEE TO TAO BOTTLE
121	46–294691P7	NUT, LOCK	2	STN. STL. SELF–LOCKING NUT
*122	46–318222P1	SAV–CON	1	SAV–CON CONNECTOR
**123	46–252360P13	CLAMP	2	TUBE CLAMP
**124	46–252360P20	CLAMP	1	CONDUIT CLAMP
**125	46–252360P21	CLAMP	2	TAO BOTTLE CLAMP
**126	46–252065P46	INSERT	11	BRASS INSERT FOR PLASTIC TUBING
**127	46–281174P2	NUT	11	.25" BRASS NUT
**128	46–281060P4	FERRULE	11	FRONT FERRULE
**129	46–281173P4	FERRULE	11	BACK FERRULE

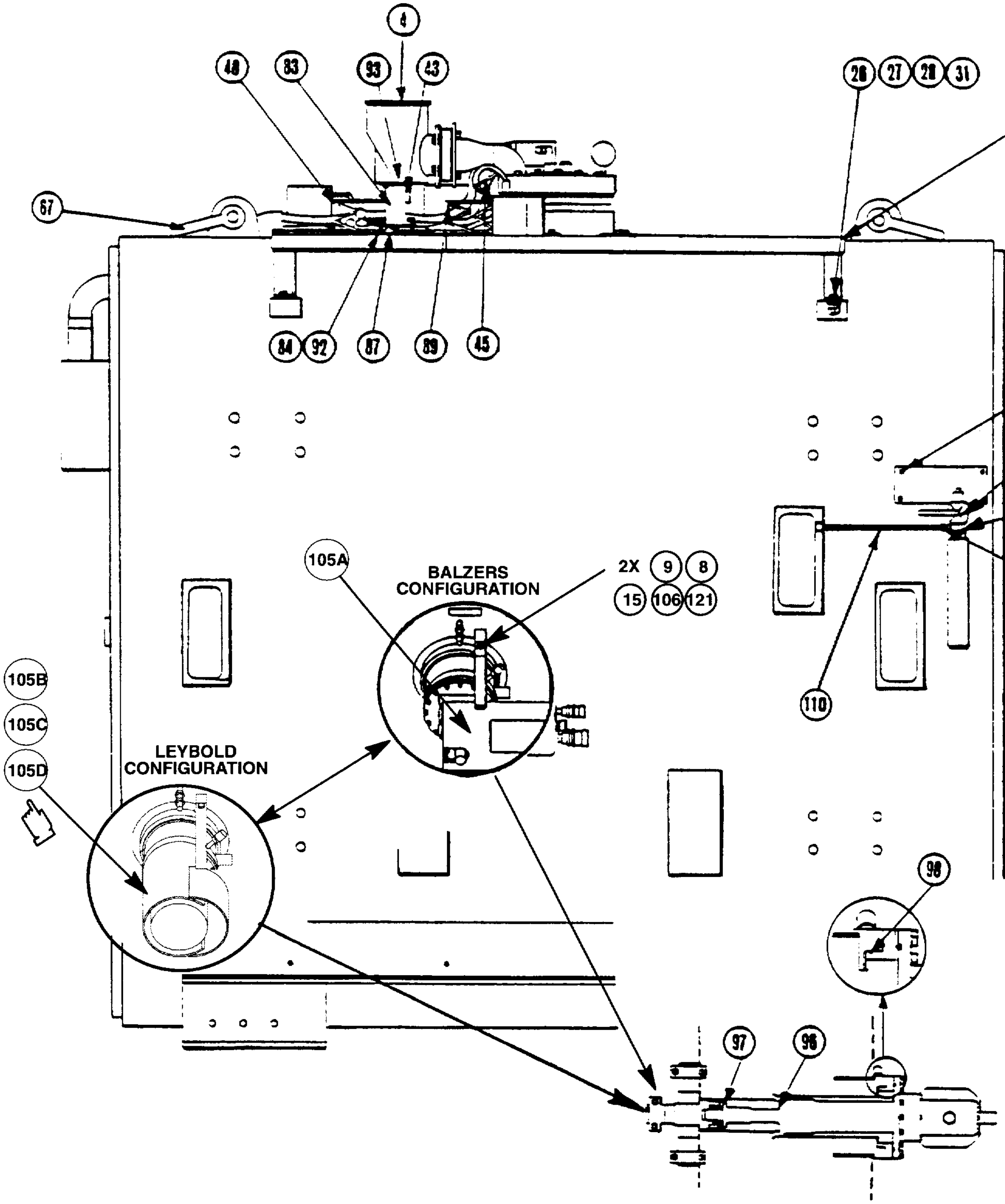
* 46–281355G4 & G5 ONLY ** 46–281355G5 & G6 ONLY



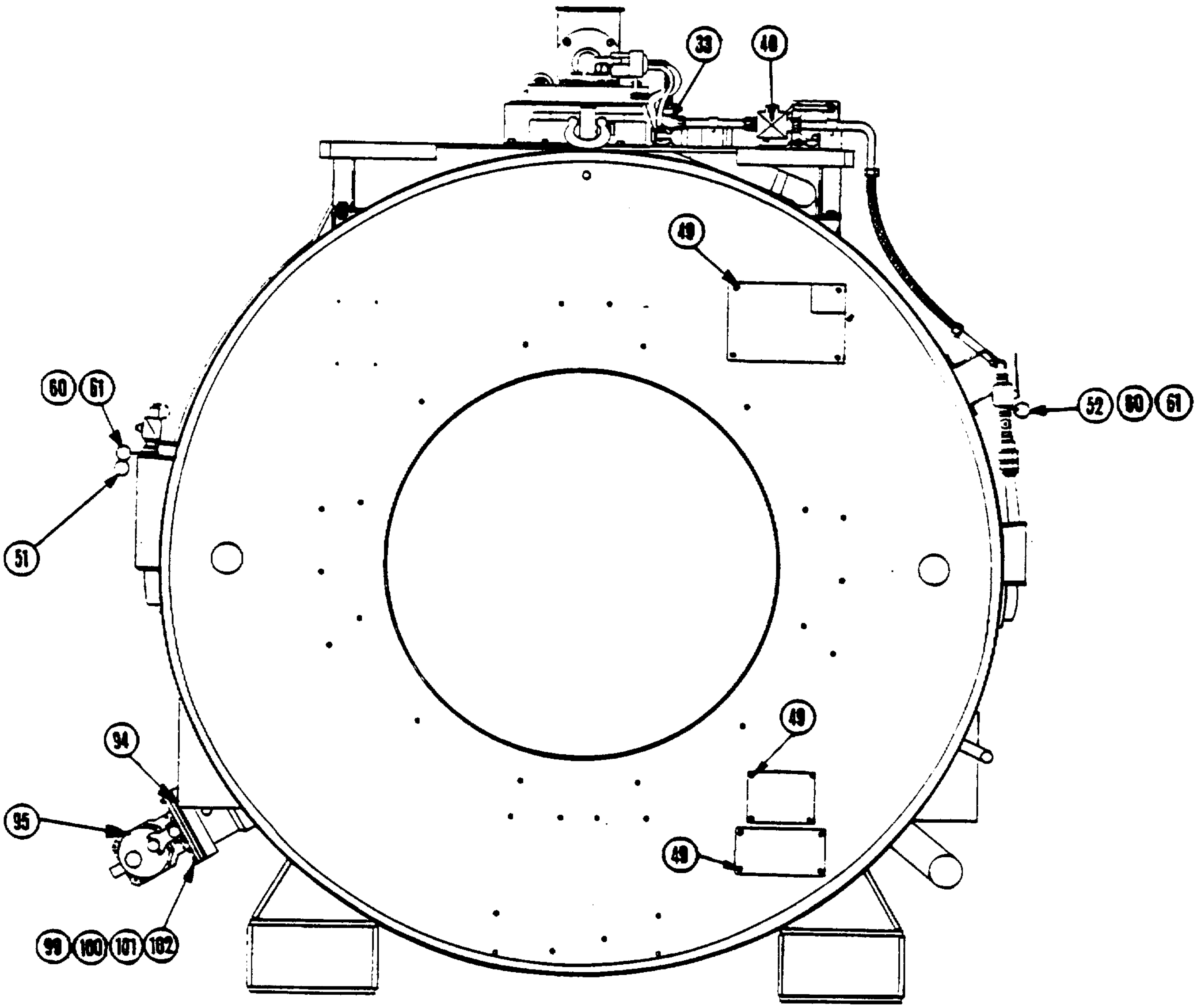




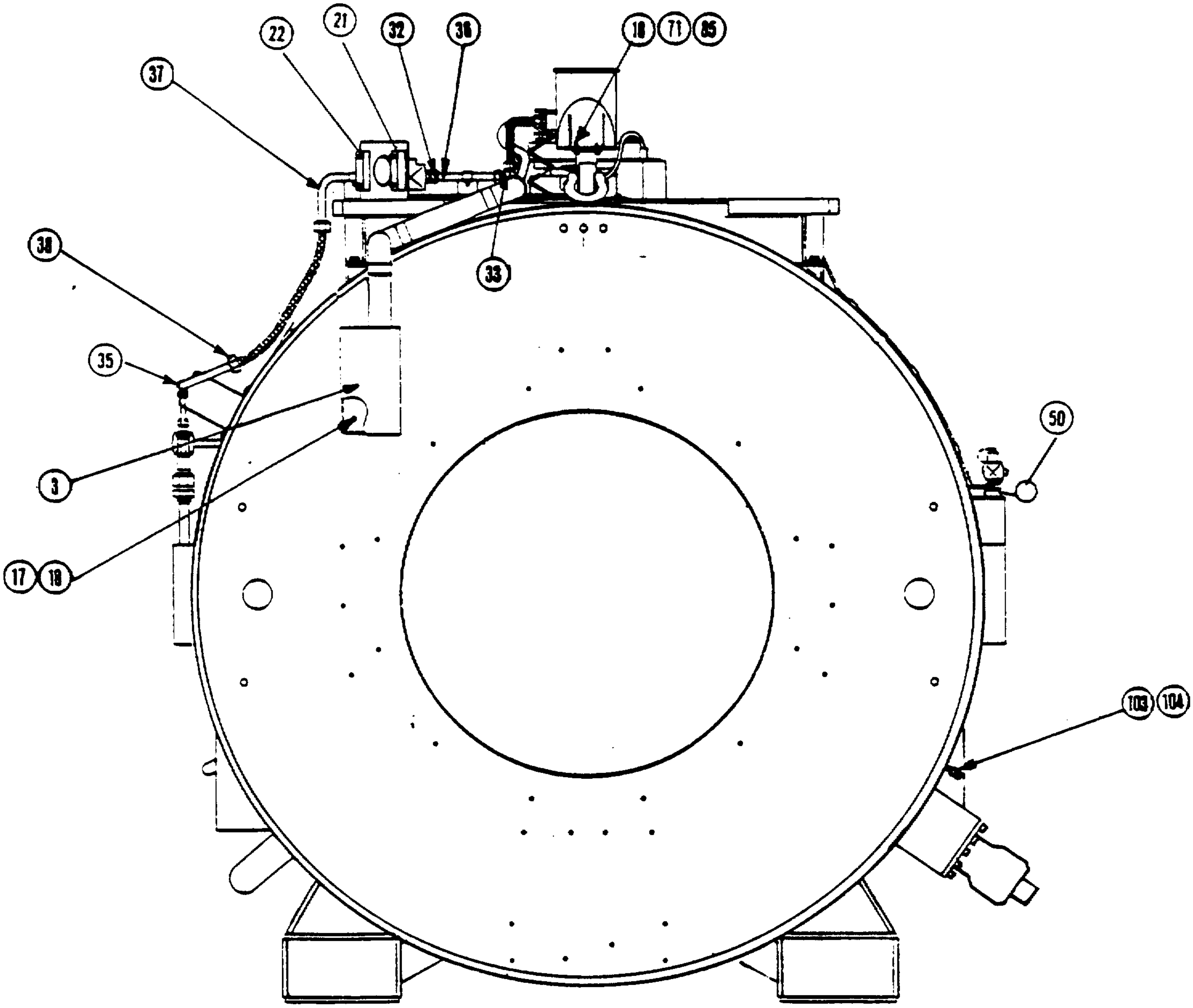
2- MAGNET COMPONENTS 46-281175G1 (**continued)**



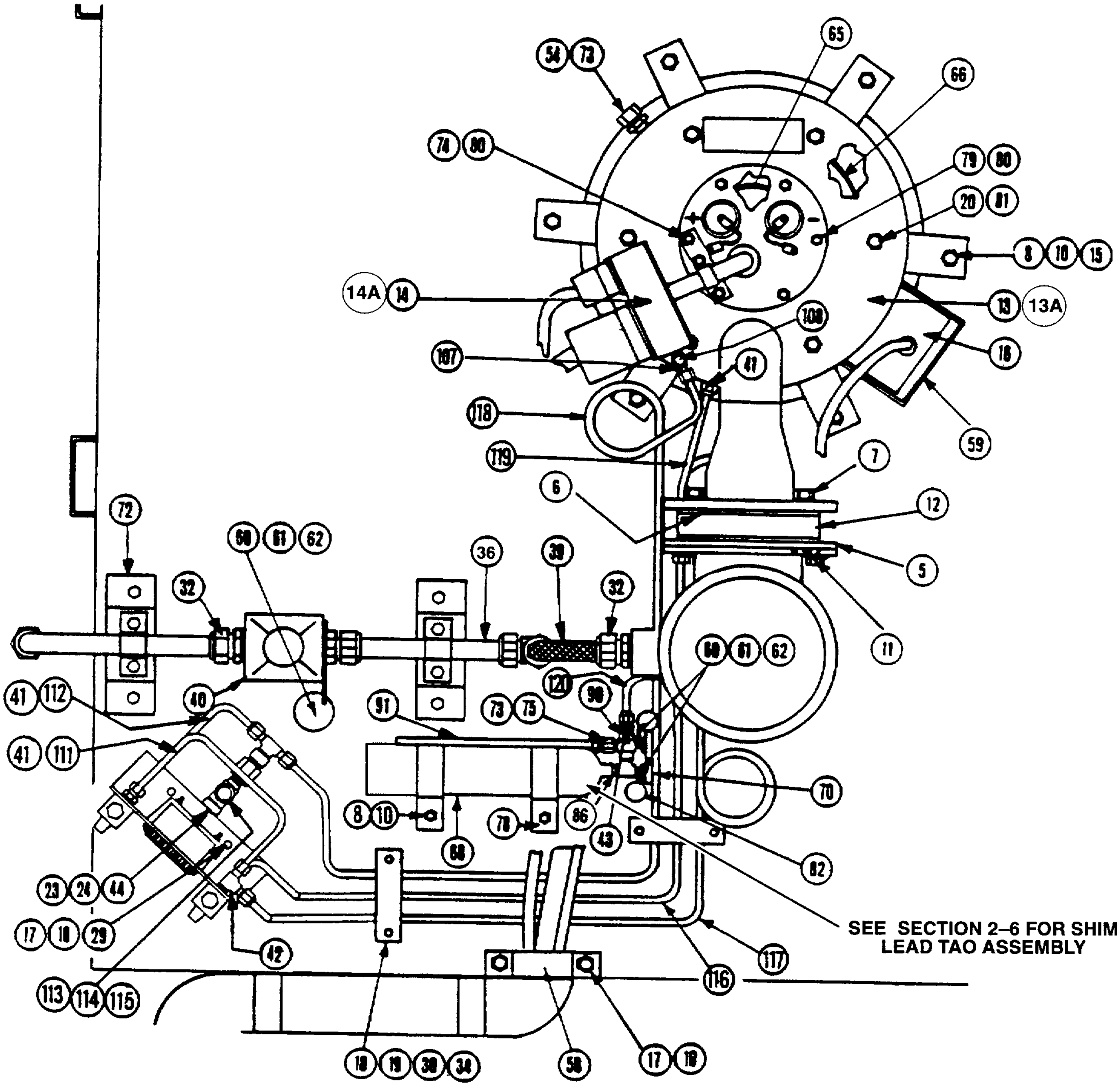
2 – MAGNET COMPONENTS 46–281483G1, & 46–281355G1, G2, G3, G4, G5, G6 (continued)



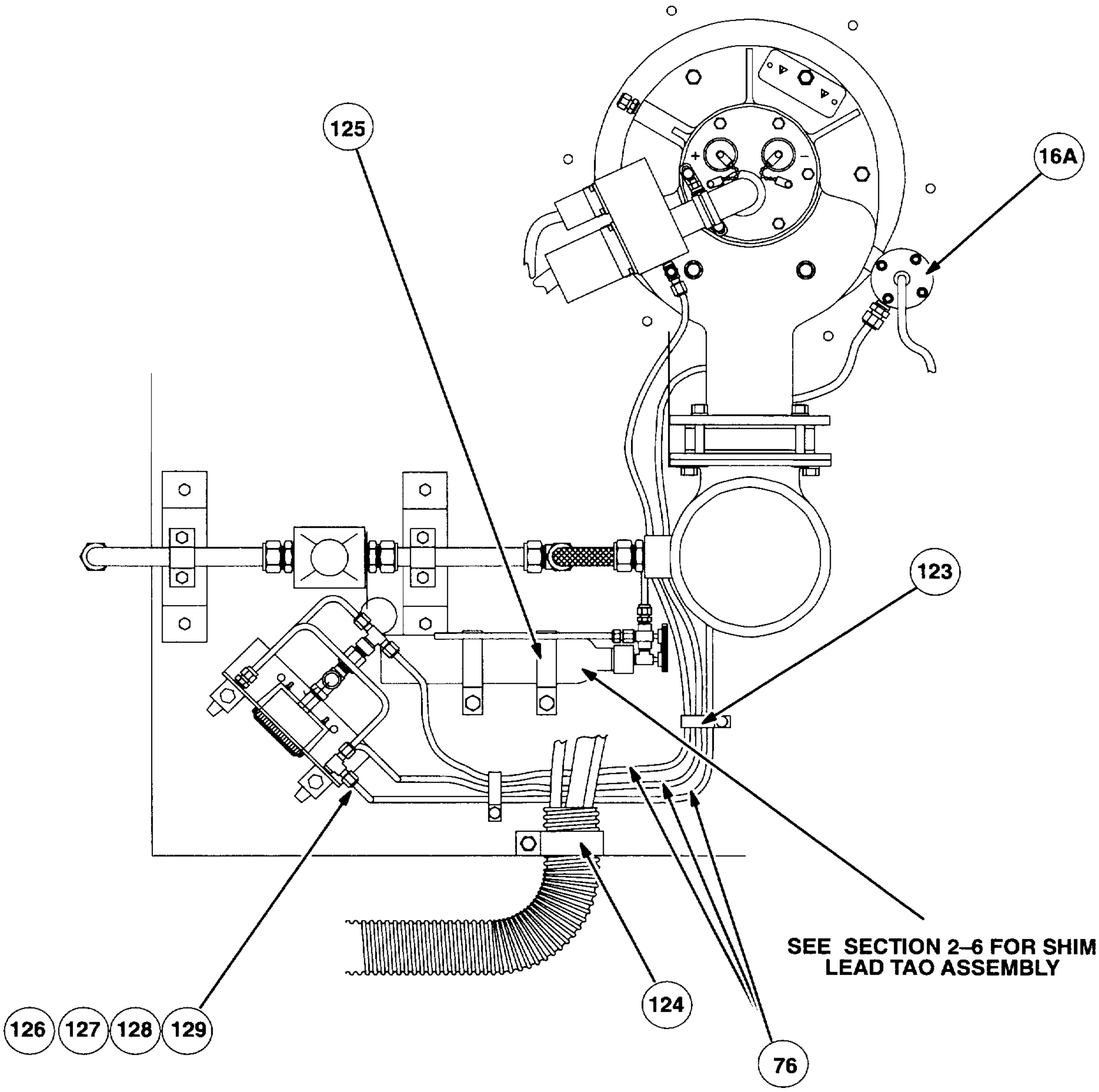
2 – MAGNET COMPONENTS 46–281175G1, 46–281483G1 & 46–281355G1, G2, G3, G4, G5, G6 (continued)



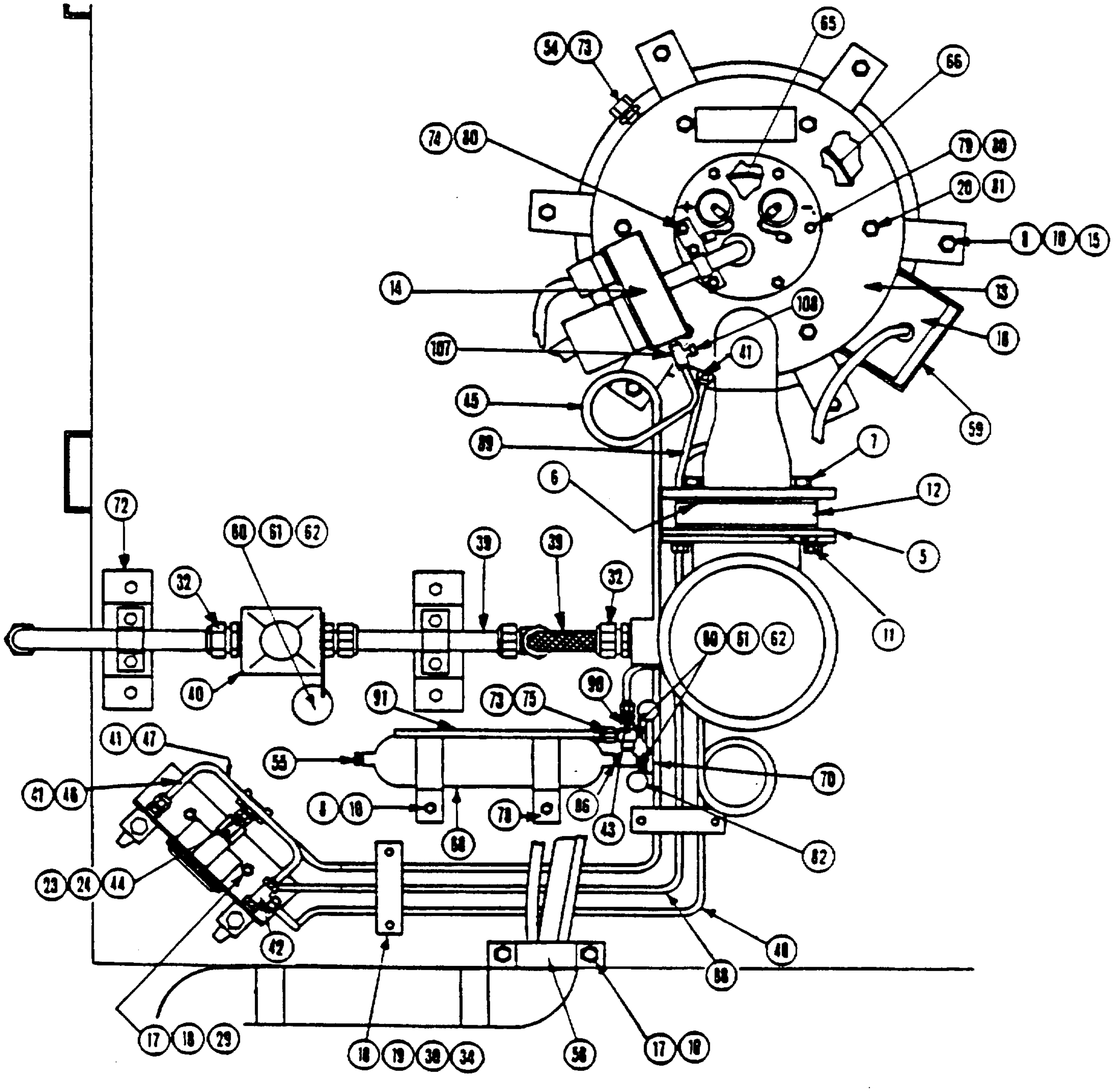
2 – MAGNET COMPONENTS 46–281175G1, 46–281483G1 & 46–281355G1, G2, G3, G4, G5, G6 (continued)



2 – MAGNET COMPONENTS 46-281483G1 & 46-281355G1, G2, G3, G4 (continued)



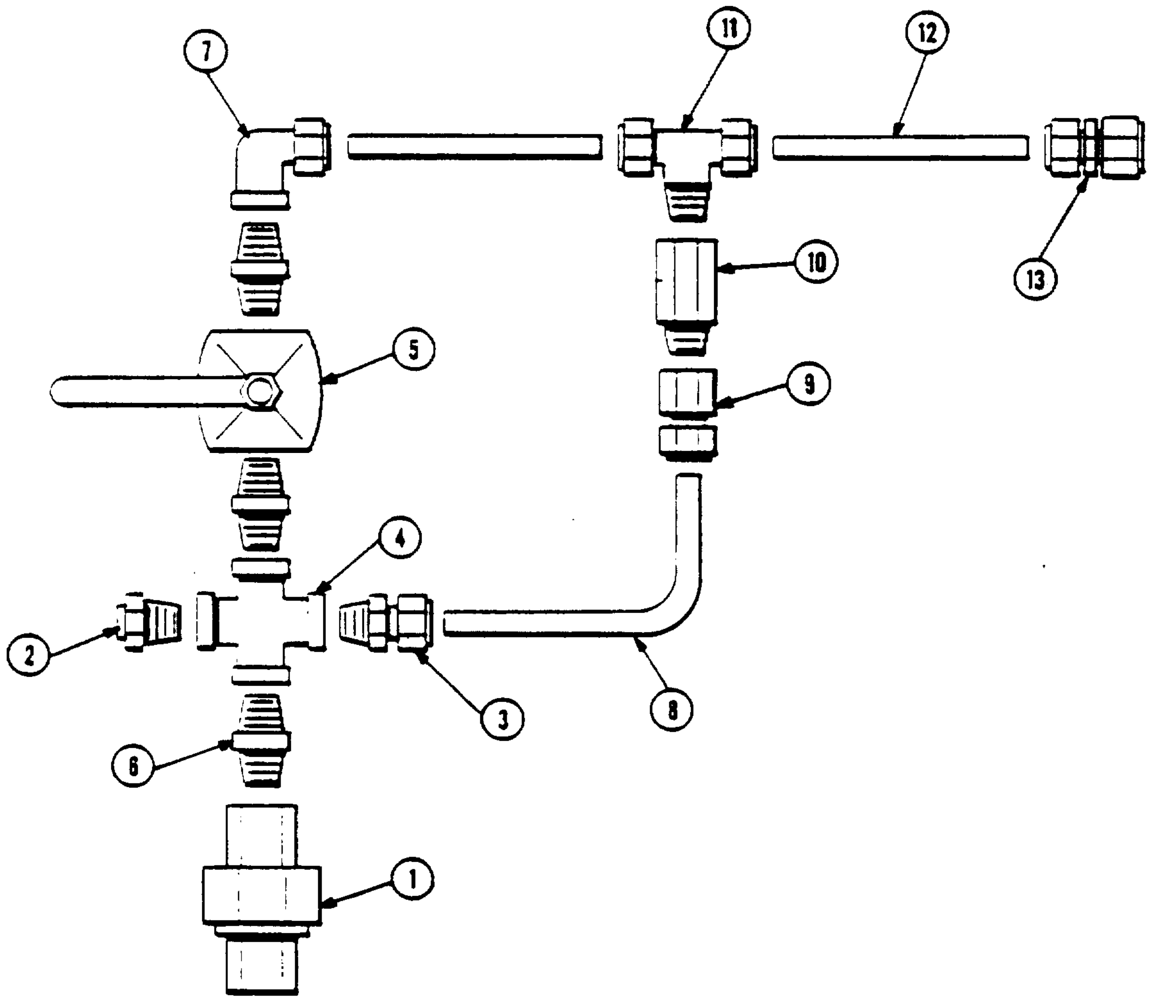
2- MAGNET COMPONENTS 46–281355G5, G6 (**continued**)



2 – MAGNET COMPONENTS 46-281175G1 (continued)

2–1 HELIUM VENT PLUMBING 46–260893G1

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–260897P2	BALL JOINT	1	BALL JOINT
2	46–252552P4	PIPE PLUG	1	PIPE PLUG
3	46–260898P1	CONNECTOR	1	CONNECTOR
4	46–252208P3	CROSS	1	CROSS
5	46–252223P1	BALL VALVE	1	CRYOGENIC BALL VALVE .50 PIPE THREAD
6	46–252203P1	CLOSE NIPPLE	3	1/2 NPT BRASS NIPPLE
7	46–252539P3	FEMALE ELBOW	1	FEMALE ELBOW
8	46–260899P2	TUBE .50 OD	1	TUBE .50 OD
9	46–260912P1	FEMALE CON.	1	FEMALE CONNECTOR
10	46–252405P1	RELF VALVE	1	1/2" NPT BRASS RELIEF VALVE
11	46–260911P1	MALE RUN TEE	1	.50 NPT X .50 ODT
12	46–260937P2	TUBE	2	TUBE
13	46–260901P1	REDUCING UNI	1	REDUCING UNIT
14	46–252065P19	MATERIALS	AR	TEFLON TAPE .50 WIDE

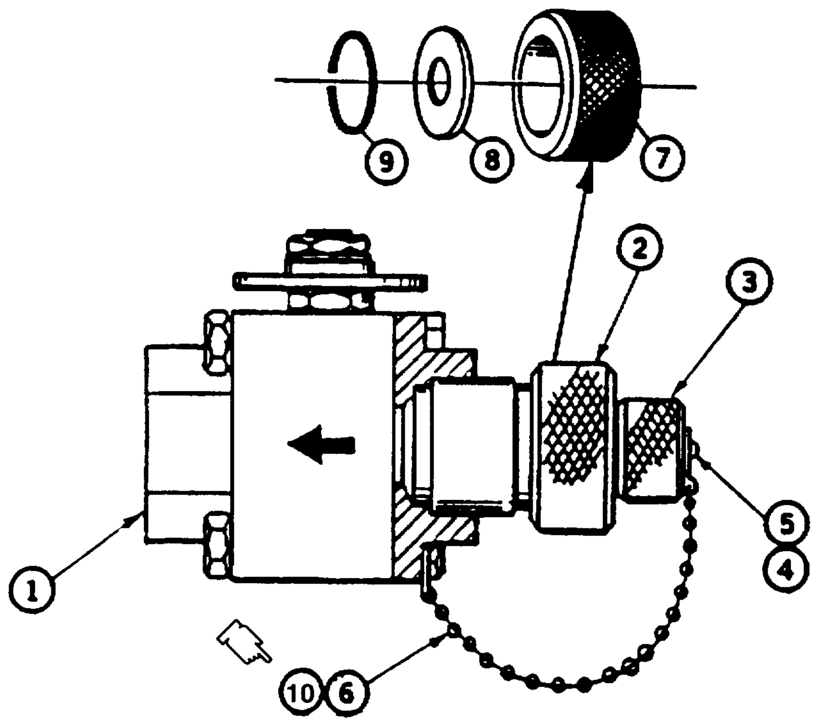


2–1 – HELIUM VENT PLUMBING 46-260893G1 (continued)

2–2 HELIUM FILL VALVE 46–281911G1

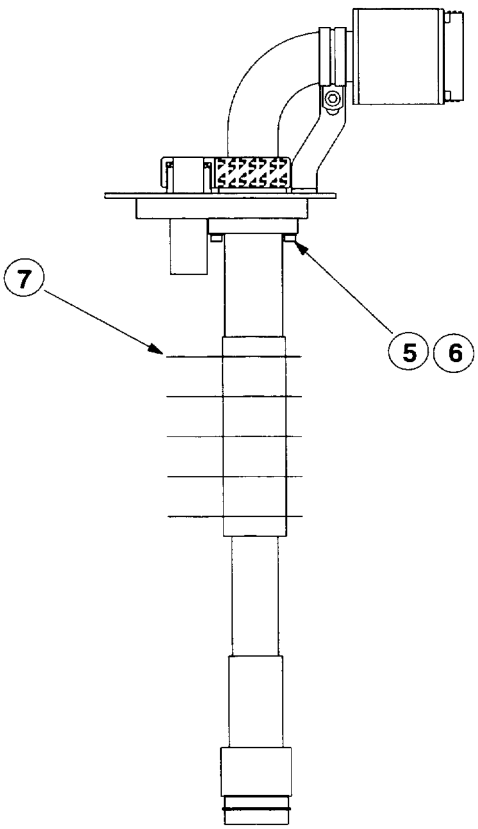
ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–252223P2	BALL VALVE	1	BALL VALVE
2	46–281912P1	NIPPLE BRASS	1	THREADED BRASS NIPPLE
3	46–260780P1	PLUG	1	QUICK SEAL 1/2 A&N CORP P/N B–50–P BRASS PLUG
4	46–260435P1	*CHAIN CLAMP	1	CHAIN CLAMP
5	46–260298P2	SCREW, DRIVE	1	SCREW, DRIVE
6	46–260325P1	*BEAD CHAIN	1	5 INCH LONG SEGMENTS CHAIN
7	46–252835P1	NUT	1	15/16 DIA. COMPRESSION NUT
8	46–252322P17	WASHER	1	11/16 DIA. RETAINER WASHER
9	46–260342P12	O RING	1	.487 ID X .693 OD BUNA–N “O” RING
10	46–260435P2	*CHAIN CLAMP	1	CHAIN CLAMP

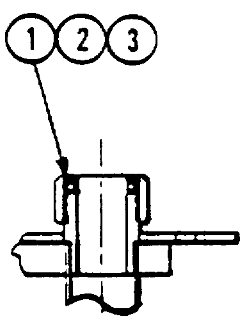
*** ORDER AS ASSEMBLED UNIT**



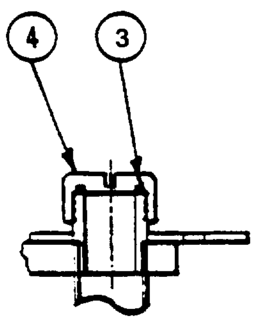
2–3 SHIM LEAD WITH REMOVABLE BAFFLE ASSEMBLY 46-318096G1

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–294397P1	CAP	2	KNURLED BRASS CAP
2	46–294398P1	RETAINING RING	2	RETAINING RING, STAINLESS
3	46–260389P3	O–RING	2	O–RING, NITRILE
4	46–294337P1	CAP	2	KNURLED BRASS CAP
5	46–252546P6	SCREW	3	BRASS SOCKET HEAD X .62 LG.
6	46–260800P4	WASHER	3	SPRING LOCK WASHER
7	46–318035G1	BAFFLE ASS'Y.	1	REMOVABLE BAFFLE ASSEMBLY





RAMPING CONFIGURATION



OPERATING CONFIGURATION

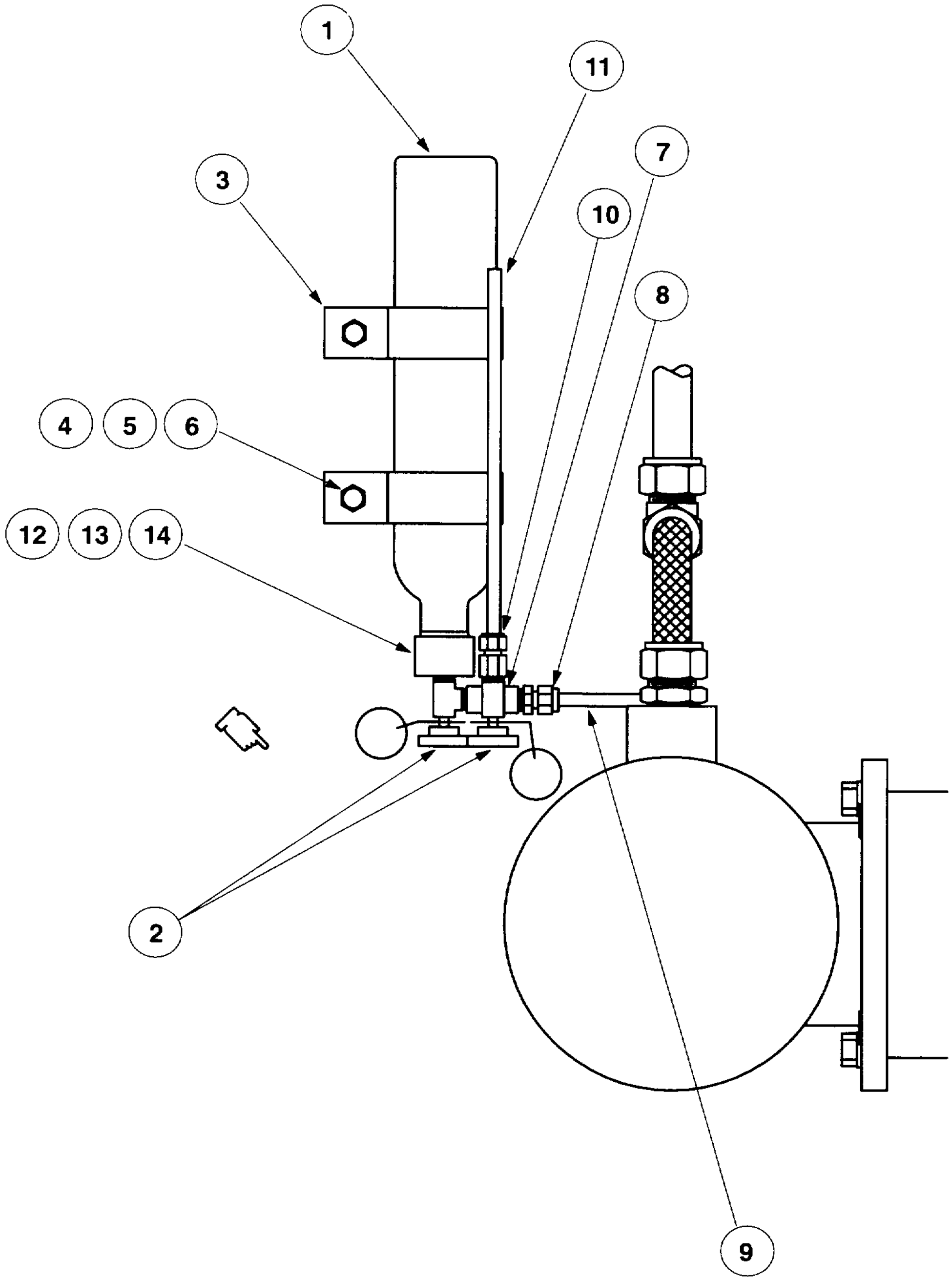
2-4 SHIELD COOLER COLD HEAD ASSEMBLY COMPONENT (SLEEVE MOUNT)

46-260995 G1,G2 (BALZER) & 2100832 (LEYBOLD)

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–281247P1	0RING	1	0 RING 2–159, O.D. OF, 46–260938G1
2	46–281247P2	0 RING		0 RING 2–160, BETWEEN 46–260938G1 AND 46–260995G" FLANGES
3	46–281241P1	0 RING		INDIUM GASKET, BETWEEN 46–260995G1 FIRST STAGE AND SLEEVE 46–260932G1
4	46–281 241 P2	GASKET	2	INDIUM GASKET, BETWEEN 46–260995G1 SECOND STAGE AND SLEEVE 46–260932G1
5	46–281387P1	WASHER	48	BELLVILLE WASHER, 1/4 I. D., SIX USED UNDER EACH 46–252361 PI 1 BOLT
	46–25206P51	ANT–SIEZE COMPOUND	1	ANTI–SIEZE COMPOUND, 1 OZ TUBE USED ON BOLTS 46–25261OP4 AND 46–252361 Pll TO PREVENT GALLING
	46–252065P24	VACUUM GREASE	1	DOW CORNING VACUUM GREASE #14-635-5D
	46–252065P64	COTTON GLOVES	1	PAIR OF COTTON GLOVES, ATLAS #615
	46–260932P20	PLUG	1	VACUUM PORT PLUG AND O–RING ON COLD HEAD SLEEVE

2-5 SHIM LEAD TAO ASSEMBLY

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–281957P1	BOTTLE	1	DAMPENER BOTTLE ASSEMBLY
2	46–281109P1	VALVE	2	DAMPENER ANGLE VALVE
3	46–252360P21	TUBE CLAMP	2	TUBE CLAMP
4	46–252365P1	.375 BOLT	2	.375–16 X .75 LG. STN. STL.
5	46–281162P11	STN LCK WASH	2	3/8 NOM SPRING
6	46–252635P9	STN STL WASH	2	PLAIN 3/8 NOM STAINLESS STEEL
7	46–252205P2	TEE	1	1/4 NPT BRASS
8	46–260898P4	CONNECTOR	1	MALE, 1/4 OD X 1/4 NPT
9	46–281491P1	TUBE, BRASS	1	.25” OD, TEE TO TAO BOTTLE
10	46–260912P6	CONNECTOR	2	FEMALE, BRASS, .25” ODT TO .25” NPT
11	46–252065P45	POLY TUBING	1	TUBE .25 OD X .040 WALL
12	46–281909P1	FITTING	1	TAO FITTING
13	46–260342P11	O–RING	1	NITRILE, .614” ID X .070” DIA.
14	46–252065P19	TAPE	AR	TEFLON TAPE X .50” WIDE



2-5 SHIM LEAD TAO ASSEMBLY (continued)

RENEWAL PARTS

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SECTION 3 - MAGNET ACCESSORIES

3-1 ● BALZER'S SHIELD COOLER COMPRESSORS 46–260759G6,G7, G8,G9 AND REMOTE CONTROL BOX 46-294414G1 (VENDOR RENEWAL PARTS CROSS REFERENCE)

ITEM	VENDOR PART NUMBER	DESCRIPTION	GE PART NUMBER	
1	B 4779068DJ	TIME DELAY RELAY	46–281034P1	[1, 2]
2	B 4776124NT	THERMAL RELAY ON CONTACTOR	46–281034P2	[1]
3	B 4776100AL	THERMAL RELAY ON CONTACTOR	46–281034P3	[2]
4	U0 149 911	CAPACITOR 15 micro Fd, 370VAC	46–281034P4	[2]
5	U0 149 904	CAPACITOR 10 micro Fd, 660VAC	46–281034P5	[1]
6	U0 148 013	RESISTOR, 100 OHMS, 100 WATTS	46–281034P6	
7	B 46664471BC	FUSE, F1, F4 SLO BLO 2A	46–281034P7	[1, 2]
8	B 4666436	FUSE F3 SLO BLO 1A	46–281034P8	
9	UC010274–U	SOLENOID VALVE, OIL CIRCUIT	46–281034P9	
10	UC010379X	THERMAL MONITOR SWITCH	46–281034P10	
11	UC010004T	CHARCOAL ABSORBER	46–281034P11	
12	B4666432	FUSE, F2 SLO BLO 0.63A	46–281034P12	
13	22008–4	QUICK CONNECT FITTING GASKETS #4 AEROQUIP	46–281034P13	
14	22008–8	QUICK CONNECT FITTING GASKETS #8 AERIQUIP	46–281034P14	
15	22008–12	QUICK CONNECT FITTING GASKETS #12 AEROQUIP	46–281034P15	
16	U4779151	TIME DELAY RELAY	46–281034P16	[3, 5]
17	U4776100AL	THERMAL RELAY ON CONTACTOR	46–281034P17	[3, 5]
18	U4666395	FUSE, 2A	46–281034P18	[3, 5]

* VENDOR PARTS SHOWN IN VENDOR SERVICE MANUAL.

3–1 BALZER’S SHIELD COOLER COMPRESSORS 46-260759 G6,G7,G8,G9 AND REMOTE CONTROL BOX 46-294414G1 * (VENDOR RENEWAL PARTS CROSS REFERENCE) (cont.)

ITEM	VENDOR PART NUMBER	DESCRIPTION	GE PART NUMBER	
19	U0152 012	ELAPSE TIME METER	46–281034P19	[1]
20	U0I 52013	ELAPSE TIME METER	46–281034P20	[2]
21	U05232 101	ELAPSE TIME METER	46–281034P21	[3]
22		FLOW SWITCH	46–281829P1	
23		INPUT POWER CABLE	46–281792P1	[3, 5]
24	UC010811–U	TEMPERATURE SWITCH	46–294412G1	
25	U526040	THERMOSTAT	46–294412P2	
26	** B–6–HC–1–4	MALE CONNECTOR 25 MALE NPT TO .375 ID HOSE	46–294412P3	
27	U0136038	HOSE CLAMP 43– .78 DIA.	46–29441 2P4	
28	** B–810–1–4	MALE CONNECTOR 25 MALE NPT TO .50 TUBE	46–29441 2P5	
29	** B–8–TA–1–4	MALE TUBE ADAPTER 25 MALE NPT TO .50 TUBE	46–29441 2P6	
30		WIRE NUT	46–294412P7	
31	JC010812–U	FUSE ASSEMBLY	46–294415P1	
32	JC010781–T	REMOTE CONTROL BOX	46–294414G1	
• 33	J5005610	LAMP (L2)	46–294414P3	
• 34	J4782110	RELAY (K10)	46–294414P6	
• 35	J4779158	TIME DELAY RELAY	46–294414P7	
• 36	J4750110	PUSH BUTTON SWITCH	46–294414P8	
• 37	J495543004	GREEN CAP LENS COVER	46–294414P4	
• 38	J 5005 610	RED CAP LENS COVER	46–294414P2	
39	U 4778 705	PHASE RELAY	46–281034P22	[8, 9]
40	UC 010 950–T	WATER FLOW SWITCH REMOVAL KIT	46–281034P24	[8, 9]

Note

Numbers in brackets indicate applicable compressor models. [1 = Model 46–260759G1, 2 = Model 46–260759G2] Absence of a number indicates a part used on all models.

* VENDOR PARTS SHOWN IN VENDOR SERVICE MANUAL – ** SWAGELOK PART NUMBERS

• These items are contained in 46-294414G1 (Item 32) REMOTE CONTROL BOX
[8, 9] used on 46-260759G8 & G9 only.

3–1A LEYBOLD SHIELD COOLER COMPRESSOR 46–294141G1
* (VENDOR RENEWAL PARTS CROSS REFERENCE)

ITEM	VENDOR PART NUMBER	DESCRIPTION	GE PART NUMBER
1	200–20–1 79	POWER LEAD PLASTIC COVER	46–294147P1
2	200–19-805	POWER LEAD CLUSTER CONNECTOR	46–294148P1
3	200–1 9-816	COMPRESSOR ADSORBER	46–294156P1
4	200–1 9-850	SWIVEL CASTOR	46–294150P2
5	725–52-421	FLAT WASHER (AEROQUIP P / N 22008-4)	46–281034P13
6	725–52–21 6	DUST CAP	46–294150P1
7	200–1 9–900	BRACKET	46–294150P3
8	200–1 9–854	LOCK SCREW	46–294150P4
9	200–80–380	HIGH VOLTAGE POWER MODULE	46–294150P5
10	200–80–260	LOW VOLTAGE POWER MODULE	46–294150P6
11	200–19-460	HOSE NIPPLE	46–294150P7
12	200–19–775	SPRING RING	46–294150P8
13	212–12–117	RETAINING NUT	46–294150P9
14	722–78-037	LEYBOLD SERVICE MANUAL	46–294150P10

• VENDOR PARTS SHOWN IN VENDOR SERVICE MANUAL.

3–2 EMERGENCY RUNDOWN UNIT 46-252138G4
* (VENDOR RENEWAL PARTS CROSS REFERENCE)

ITEM	VENDOR PART NUMBER	DESCRIPTION	G.E. PART NUMBER
1	1344-4061	LID,ZERO CORP. Z–120–192	46–281302P1
2	1344–7061	FUSE,0.4A BUSSM AN GDC TIME – LAG	46–281302P2
3	1344–7060	TRANSFORMER, SIGNAL A41–25–24	46–281302P3
4	1 344–7013	CAPACITOR,500mfg 50v,MALLORY TCG5010050N1C (C1)	46–281302P4
5	1344–701 6	POT,1K ohm 20T, ALLEN BRADLEY 94P102 (R3 & R26)	46–281302P5
6	1 344–7017	RES, 2.2K 1 WATT, MOUSER 295J901	46–281302P6
7	1344-7018	RES, 5620 ohm 1%,, MOUSER 29MF500 (R5)	46–281302P7
8	1344-7020	POT,25 ohm 12.5w, OHMITE 0108 (R9)	46–281302P8
9	1344–7021	RES, 35 ohm 7.5w 1%, DALE RH5–35 (R10)	46–281302P9
10	1344–7022	RES,1 ohm 3w 1%, DALE RS–2B (R11)	46–281302P10
11	1344-7023	RES, 100K ohm 1/4 W ATT MOUSER 295J250 (R12–15, R29, R30, R32)	46–281302P11
12	1344–7026	POT,100 ohm 20T, ALLEN BRADLEY 94P101 (R8)	46–281302P12
13	1344–7027	POT,200 ohm 20T, ALLEN BRADLEY 94P201 (R20)	46–281302P13
14	1344–7033	12v,1.2 AH GEL CEL YUASA NP 1.2–12 (BT1)	46–281302P14
15	1344–7064	KNOB FOR R9 MOUSER 45KN050(N1)	46–281302P15

• VENDOR PARTS SHOWN IN VENDOR SERVICE MANUAL.

3–2 EMERGENCY RUNDOWN UNIT 46–252138G4

*(VENDOR RENEWAL PARTS CROSS REFERENCE) (continued)

ITEM	VENDOR PART NUMBER	DESCRIPTION	GE PART NUMBER
16	1344–7036	RED LED,DIALIGHT 559–01 01–003 (DS4)	46–281302P16
17	1344–7037	GREEN LED,DIALIGHT 559–0201–0D3 (DS2, DS3, DS1)	46–281302P17
18	1344–7040	SPST mom PB SWITCH, ALCO MPA 206F (S4)	46–281302P18
19	1344–7041	DPST mom PB SWITCH, ALCO MPA 206R (S1, S2)	46–281302P19
20	1344–7042	DPDT LATCHING TOGGLE SWITCH, ALCO MTL 206P (S3)	46–281302P20
21	1344–7040	SPDT mom PB SWITCH,ALCO MPA 208F (S5)	46–281302P21
22	1344–7047	HEATER CONNECTOR,LEMO RG2B304CA222 (J2)	46–281302P22
23	1344–7052A	TD RELAY,(KI)	46–281302P29
24	1344–7063	RELAY, Hg WETTED, CLARE HRB 2A 1524	46–281302P24
25	1344–7062	FUSE, 2.0A BUSSMAN GDB	46–281302P25
26	1344–7500	PC CARD,ASSEMBLED,TESTED	46–281302P26
27	1344–4301	RETAINER, BATTERY	46–281302P27
28	1344–7050	TEST LOAD RESISTOR 20 OHM, 20 WATT ROCKFORD PW20	46–281302P30

* VENDOR PARTS SHOWN IN VENDOR SERVICE MANUAL.

3-2A MAGNET RUNDOWN UNIT 46-294231G1 (VENDOR RENEWAL PARTS CROSS REFERENCE)

ITEM	VENDOR PART NUMBER	DESCRIPTION	G.E. PART NUMBER
1	EF–1001	.400 GDC TIME LAG FUSE	46–294231P1
2	EF–1002	.125 GDC TIME LAG FUSE	46-294231P2
3	EF–1008	2.5A GDC TIME LAG FUSE	46-294231P3
4	EF–1004	1.25A GDB FUSE	46–294231P4
5	GS-4063	GEL CELL (3 REQ'D. PER BATTERY)	46–294231P5
6	EC–1140	CAPACITOR (C1), 470 UF, 63V	46–294231P6
7	ES–1018	3 PDT HEATER TEST SWITCH	46–294231P7
8	1344-7050	TEST LOAD RESISTOR, 20 OHM, 20 WATT, ROCKFORD PW20	46–281302P30

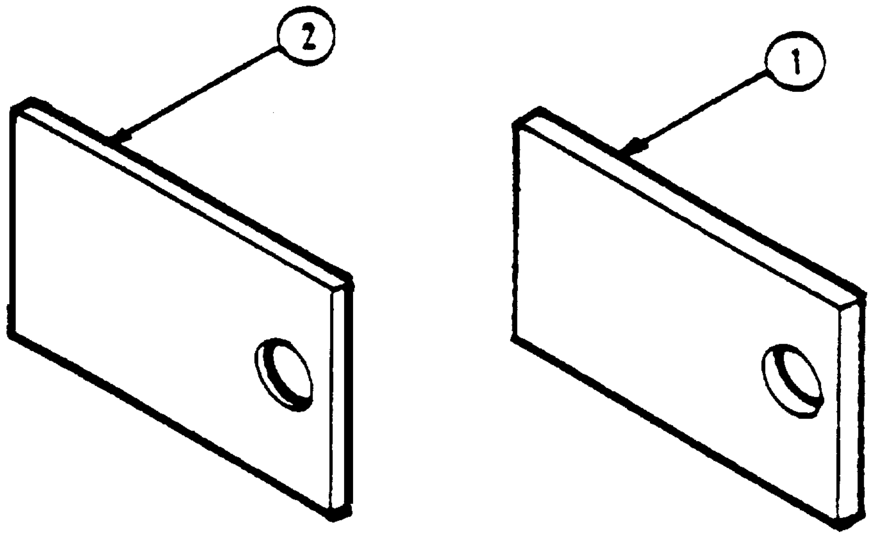
3-3 CRYOGEN MONITOR 46-281811G1, 2122498 (VENDOR RENEWAL PARTS CROSS REFERENCE)

ITEM	VENDOR PART NUMBER	DESCRIPTION	G.E. PART NUMBER
1	EF–1000	0.3A FUSE	46–281025P1
2	EL–1000	RED LED	46–281025P4
3	ES–1000	FRONT PANEL TOGGLE SWITCH	46-281025P6
4	EL–1010	YELLOW LED	46–281025P5
5	ES–1010	FRONT PANEL PUSHBUTTON SWITCH	46-281025P7
6	EX-1015	POWER TRANSFORMER	46-281025P11
7	ES-1025	FRONT PANEL THUMBWHEEL SWITCH	46–281025P8
8	ET-1110	POWER TRANSISTOR	46–281025P10
9	EM–1525	PERCENT LEVEL DISPLAY	46-281025P9
10	EM/133/GE/PCB	MAIN PC BOARD	46–281025P2
11	EM/133/GE/PSB	POWER SUPPLY BOARD	46-281025P3
** 12	EF–1000	FUSE, 0.3A, 250V, 3AG, 100-115 VAC	2122500–2
** 13	EF–1520	FUSE, 0.2A, 250V, 3AG, 200–230 VAC	2122500–3
** 14	BM/111GE/PCB	MAIN PRINTED CIRCUIT BOARD	21225004
'* 15	EM–1015	DISPLAY METER	2122500–5

* VENDOR PARTS SHOWN IN VENDOR SERVICE MANUAL.
** USED ON 2122498 ONLY

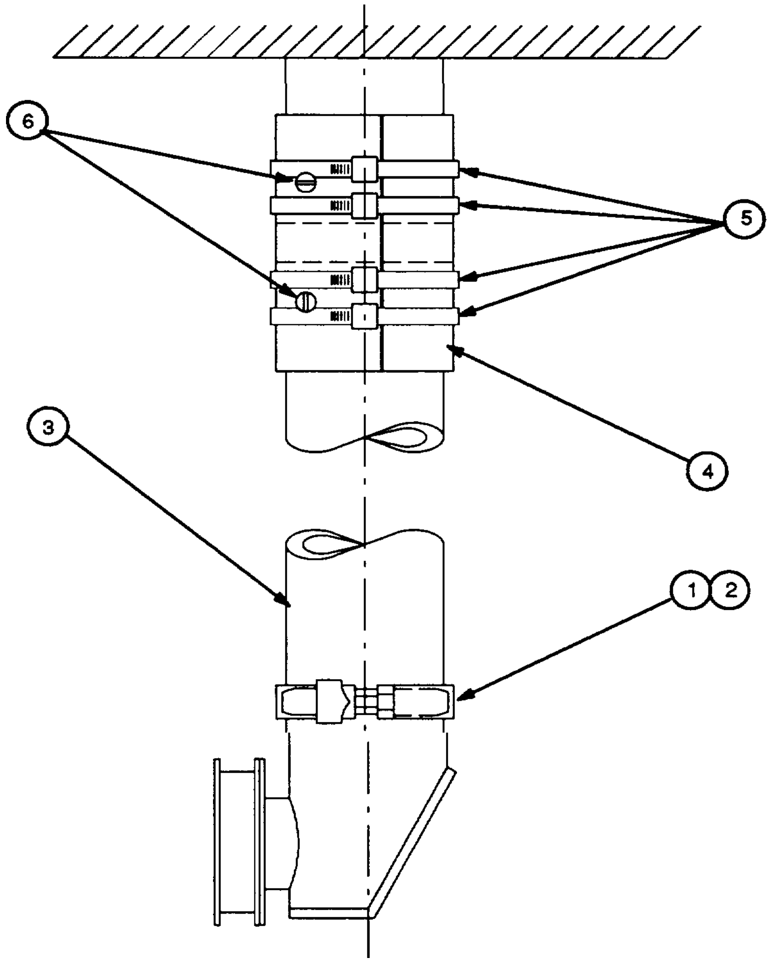
3-4 MAGNET LEVELING KIT 46-260888Gl

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46-260886P2	SHIM PLATE	12	.062" THICK AL. ALLOY PLATE
2	46-260886P3	SHIM PLATE	8	.020" THICK AL. ALLOY PLATE



3-5 HELIUM VENT KIT 46-281866G1

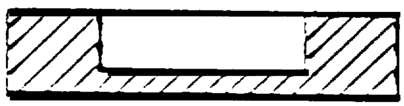
ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46-281969P1	GASKET	1	HELIUM VENT GASKET
2	46-281970P1	CLAMP	1	HELIUM VENT S.S. “V” CLAMP
3	46-281868G1	VENT	1	VERTICAL VENT PIPE
4	46-281971P1	CONNECTOR	1	FIBERGLASS CONNECTOR SLEEVE 60.00” X 8.00”
5	46-281972P1	CLAMP	4	DIA. RANGE 5 5/8”–6 1/2” 302/305 SST HOSE CLAMP
6	46-281866P7	SCREW	2	#1 O X 1.00” LG PAN HEAD SELF-TAPPING, STN STL



3-6 MAGNET SPARE PARTS KIT 46–252141G3

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–252838P4	BURST DISC	1	GRAPHITE BURST DISC, 20 PSI
2	46–252839P1	GASKET	2	NEOPRENE GASKET (He VESSEL) 3.75” ID X 5.25” OD ZOOK
3	46–260342P12	O–RING	2	.487” ID X .625” OD FILLPORT
* 4	46–281034P18	FUSE	1	FUSE 2A SLO BLO BALZERS U 466395
* 5	46–281034P8	FUSE	1	FUSE F3 1A SLO BLO B 4666448
6	46–281 101 PI	O–RING	2	TEFLON “O” RING 4.24” 1 D
7	46–281101 P2	O–RING	2	TEFLON “O” RING 8.24” 1 D
* 8	46-281034P12	FUSE	2	FUSE F2 SLO BLO 0.63A
9	46–260389P1	O–RING	2	“O” RING, POWER LEAD EXTENSIONS
* 10	46-281256P1	CONTACT BANDS	2	CONTACT BANDS FOR RAMP LEADS

* ITEMS NOT INCLUDED IN LATEST KIT.



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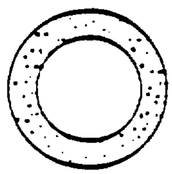

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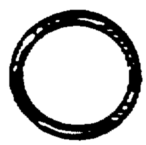
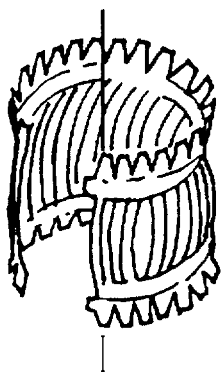


3 6 7 9

4 5 8



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3–7 SIGNA RAMP CABLE KIT 46–318036G1 (46–281355G3, G4, G5, G6 ONLY)

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–260723GI	CABLE	2	MAIN POWER, POSITIVE 4/0
2	46–260723G2	CABLE	2	MAIN POWER, NEGATIVE 4/0
3	46–260724GI	CABLE	1	SWITCH HTR CABLE ASSEMBLY
4	46–260726G 1	CABLE	1	SHIM COIL CABLE ASSEMBLY
5	46–281235P1	LEAD	1	VOLTAGE SENSE LEAD X 40” LG.
6	46–294104P1	NUT	2	QUICK COUPLING VACUUM NUT
7	46–294105P1	RING	2	QUICK COUPLING RETAINING RING

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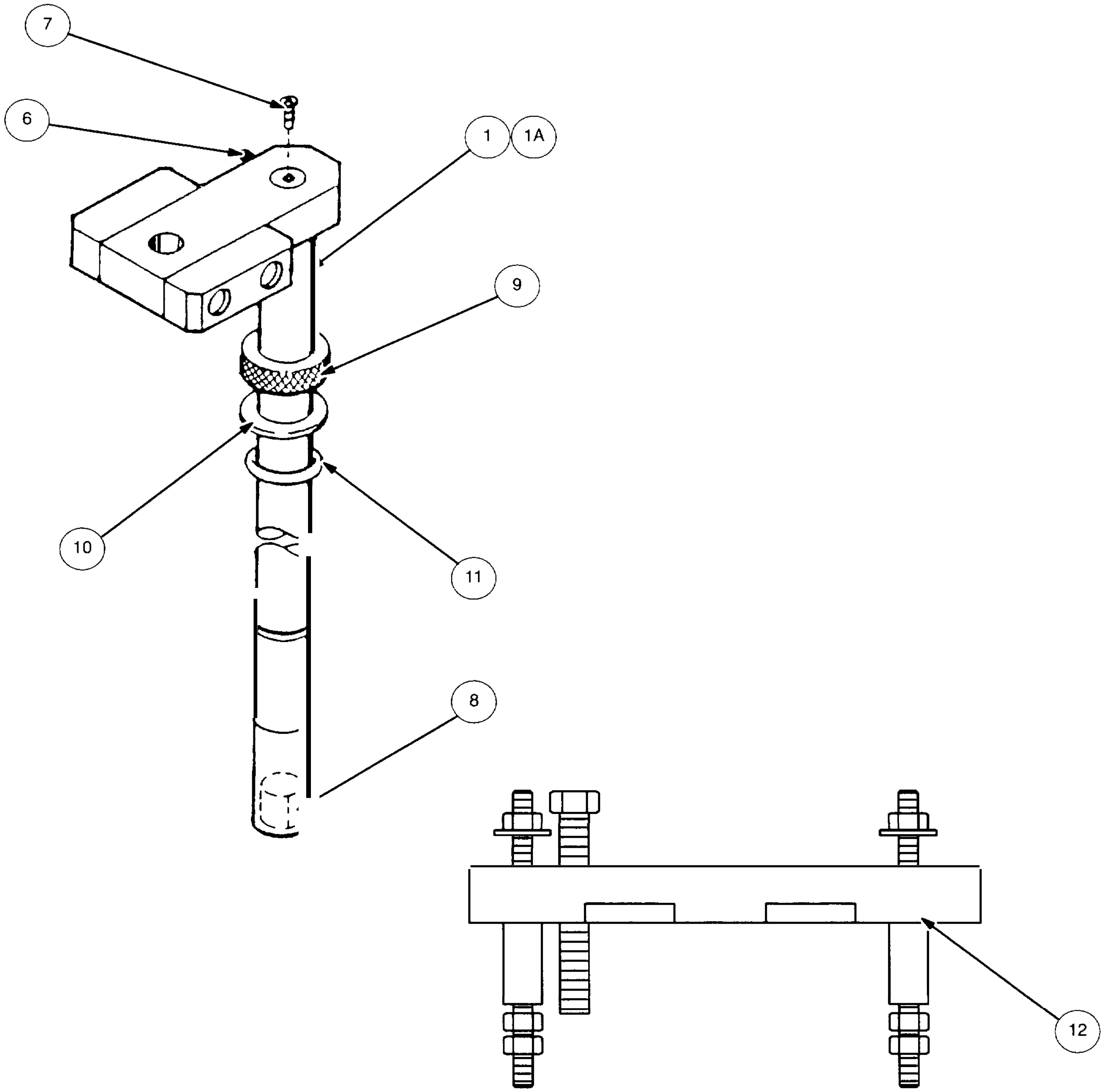
SECTION 4- SERVICE KITS OPTIONS & COMPONENTS

Note

The Service Tools Section contains tools used on many GE magnets. Please refer to Section 4–29, the Magnet Tool Matrix to determine which tools are used for each magnet type.

4-1 MAGNET RAMPING EQUIPMENT KIT 46–260703G2



4-1 MAGNET RAMPING EQUIPMENT KIT 46-260703G2 (continued)

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–260817G3	SII, SIII, & MR MAX MAIN LEADS	2	VAPOR COOLED MAIN LEAD EXTENSIONS
1A	46–294204G1	SIV AS MAIN LEADS	2	VAPOR COOLED MAIN LEAD EXTENSIONS
2	46–252366P4	CAP SCREW	3	3/8–16 X 1.00 CAP SCREW
3	46–252320P19	NUT	6	3/8–1 6 BRASS NUT
4	46–252322P8	WASHER	12	3/8 BRASS WASHER
5	46–281046P35	CAP SCREW	3	3/8–16 X 1.250 BRASS CAP SCREW
6	46–252351 P2	#10 SCREW	4	BRASS SCREW RD HD #10–24 x .500
7	46–252351 P51	#1 O SCREW	4	BRASS SCREW RD HD #10–32 X .438
8	46–281 256P1	CONTACT BAND	20	CONTACT BANDS FOR MAIN LEAD EXTENSIONS
9	46–2941 04P1	RETAINING NUT	4	KNURLED BRASS RETAINING NUT
10	46–294105P1	RETAINING RING	4	S/S RETAINING RING
11	46–260389P1	“O” RING	8	SILICON “O” RING
12	46–323015G1	RAMPING FIXTURE	1	HOLD DOWN TOOL FOR RAMP LEADS
13	46–294236G1	CASE/FOAM	1	CASE FOR RAMPING ITEMS

4-2 MAIN RAMP POWER SUPPLY AND RAMPING EQUIPMENT 46–294998G1

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–260703G2	RAMP EQUIP.	1	750A RAMPING EQUIP.
2	46–260776G3	MAIN P / S	1	MAIN POWER SUPPLY

4–3 POWER SUPPLIES

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–260776G3	MAIN P/S	1	MAIN COIL POWER SUPPLY
2	46–260777G3	SHIM P/S	1	SHIMMING POWER SUPPLY

4-4 SERVICE POWER SUPPLY RENEWAL PARTS 46-260776G2, G3 & 46-260777G2
*** (VENDOR RENEWAL PARTS CROSS REFERENCE)**

ITEM	VENDOR PART NUMBER	DESCRIPTION	GE PART NUMBER
1	12-452-028	PANEL, CONTROL ASSEMBLY	46–281468P1
2	12-452-026	HEATER, P/S, HEATER & 24 VDC PS	46–281468P2
3	25–61 1–000	PANEL, INPUT/OUTPUT CONNECT	46–281468P3
4	00-467-498	TCR 7.5T750, MAIN COIL PS	46–281468P4
5	51-001-001	FAN, 3.12", 115V	46–260219P12
6	58-005-010	FUSE, MDA, 4A, 250V	46–281468P5
7	20–292–002	PWB, PRINTED CIRCUIT ASSY	46–281468P6
8	20–230–000	PWB, +24& tl 5 PS ASSY	46–281468P7
9	71-024-000	DIAL TURNS COUNTING	46–26021 9P27
10	66-065-006	VOLTMETER, ANALOG, 0-36 VDC	46–281468P8
11	62–062–009	AMMETER, ANALOG,0–1 ADC	46–281468P9
12	66-082-007	VOLMETER, DIGITAL 3.5 DIGIT	46–281 468P10
13	66-082-008	AMMETER, DIGITAL 5.5 DIGIT	46–281468P11
14	67-055-007	POT, 10 TURN, 5K, WW	46–281468P12
15	68-01 2–005	SWITCH, PUSH BUTTON, MOM, WHT	46–26021 9P33
16	68-004-001	SWITCH, DPDT TOGGLE	46–281468P13
17	68-008-003	SWITCH, DPDT, LOCKING TOGGLE	46–281468P14
18	20–354–000	PWP, PCB P–SET AMPLIFIER	46–281468P15
19	58-006-010	FUSE, MDV, 0.125A, 250V	46–281468P16
20	58–001–008	FUSE, AGC, 2A, 250V	46–281468P17
21	20–1 37–087	PCB, AlOO, CONTROL	46–281468P18
22	54-072-002	CAPACITOR, 350 KM F/10V	46–281468P19
23	61-011-001	SCR, DUAL PACK	46–281468P20
24	56-069-004	BREAKER, 3 POLE, 30A	46–281468P21
25	51-002-002	FAN, 468" SQ, 220V	46–260219P2

4-4 SERVICE POWER SUPPLY RENEWAL PARTS 46-260776G2, G3 & 46-260777G2 (VENDOR RENEWAL PARTS CROSS REFERENCE) (continued)

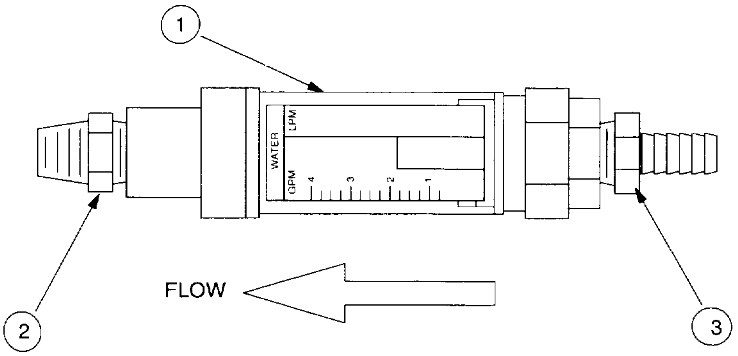
ITEM	VENDOR PART NUMBER	DESCRIPTION	GE PART NUMBER
26	67–023–005	RESISTOR, 3 OHM, 25W	46–281468P22
27	63–004–001	JINDICATOR, LED, RED	46–281468P23
28	51–009–001	FAN, BISCUIT	46–281468P24
29	51–002–001	FAN, 4.68 SW. 115V	46–260219P20
30	56–001–002	BREAKER, 3 POLE, 30A	46–281468P25
31	12–452–027	PANEL, CONTROL ASSEMBLY	46–281469P1
32	58–005–013	FUSE, MDA, 6.25A, 250A	46–281469P2
33	12–452–025	SUPPLY SWITCH HEATER & INTERNAL POWER	46–281469P3
34	25–612–000	PANEL, INPUT/OUTPUT	46—281469P4
35	00–452–084	MODULE, SHIM P/S #1 THRU #6	46–281469P5
36	58–005–006	FUSE, MDA, 1A, 250V	46–281469P11
37	60–010–001	DIODE, DUAL PAK, 600V, 15A	46–281469P12
38	20–292–001	PWB, A700, PCB ASSY	46–281469P13
39	65–047–001	RELAY, DPDT, 24VDC	46–281469P14
40	66–082–012	VOLTMETER, DIGITAL, 4 1/2 DIGIT	46–281469P15
41	66–082–011	AMMETER, DIGITAL, 4 3/4 DIGIT	46–281469P16
42	68–037–007	SWITCH, *8PL, 6STN, SELECT	46–281469P17
43	67–055–011	POT, 2000 OHM, 10 TURN	46–281469P18
44	65–024–007	RELAY, 4PDT, 25A	46–281469P19
45	68–008–001	T'STAT N/O 195 DEGREES F	46–281469P20
46	62–005–020	TRANSISTOR, 2N5685	46–281469P21
47	62–005–014	TRANSISTOR, MJ2955	46–281469P22
48	68–002–002	T'STAT N/C, 210 DEGREES F	46–281469P23
49	20–350–001	PWB, A100 ASSY	46–281469P24
50	67–055–005	POT, 20K, 10 TURN, 2W	46–281469P25
51	67–055–001	POT, 10 TURN, 100 OHM, WW	46–281468P26

*** VENDOR PARTS SHOWN IN VENDOR SERVICE MANUAL**

4-5 RAMP CABLE / CART ASSEMBLY 46-318833G1

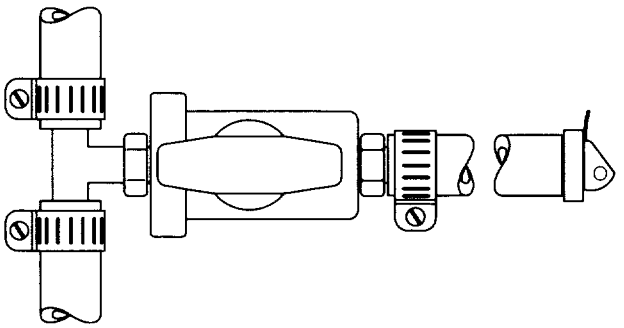
ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–318833G1	RAMP ASSEMBLY	1	RAMP CABLE / CART ASS'Y,

4-6 WATER FLOW METER KIT 46–294052G1



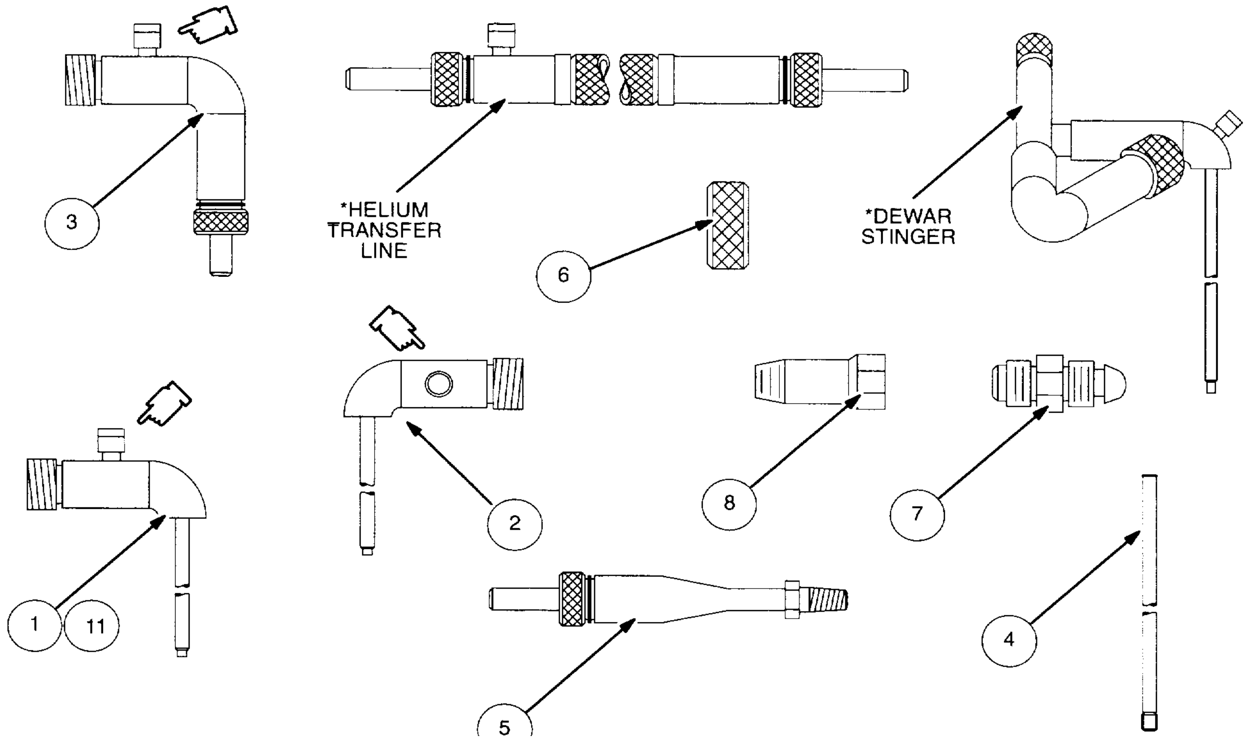
ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–294052P1	FLOW METER	1	INLINE FLOW METER
2	46–294052P2	HEX NIPPLE	1	BRASS, .50 NPT X ,50 NPT
3	46–294052P3	HOSE CONNECTOR	1	BRASS, .50 NPT X ,50 I.D.

4-7 WATER TEE ASSEMBLY 46-318696G1



ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–318696G1	WATER TEE	1	WATER TEE ASSEMBLY

4-8 UNIVERSAL FILL LINE KIT 46–294705G1



* ITEMS ARE NOT INCLUDED IN UNIVERSAL FILL LINE KIT

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–294512P3	7" STINGER	1	7" CRYOSTAT STINGER AIR PRODUCTS# CSA–7
2	46–294512P4	14.75" STINGER	1	14.75 CRYOSTAT STINGER AIR PRODUCTS #CSA–14
3	46–294512P5	3" MALE BAYONET	1	.50"X3.00" MALE BAYONET AIR PRODUCTS #MBR–6–3
4	46–294512P12	16" STINGER EXT. TIP	1	16" CRYOSTAT STINGER AIR PRODUCTS #CSE–16
5	46–294512P13	ADAPTER	1	PURGE/PRECOOL ADAPTER AIR PRODUCTS #PPA–1
6	46–294512P15	BLANKING CAP	1	BRASS BLANKING CAP 1.5" OD AIR PRODUCTS #BBC–1.5

4-8 UNIVERSAL FILL LINE KIT 46-294705G1 (continued)

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
7	46–294512P16	NITROGEN ADAPTER	1	NITROGEN FILL LINE ADPTR AIR PRODUCTS #FLA–1
8	46–294512P17	HELIUM ADAPTER	1	HELIUM FILL LINE ADPTR AIR PRODUCTS #GLA–1
9	46–294512P14	CASE/FOAM	1	BLACK CARRYING CASE AIRPRODUCTS #PCC–27
10	NOT USED			
11	46–294512P25	17" STINGER	1	17" MAGNET STINGER AIR PRODUCTS #CSE–17

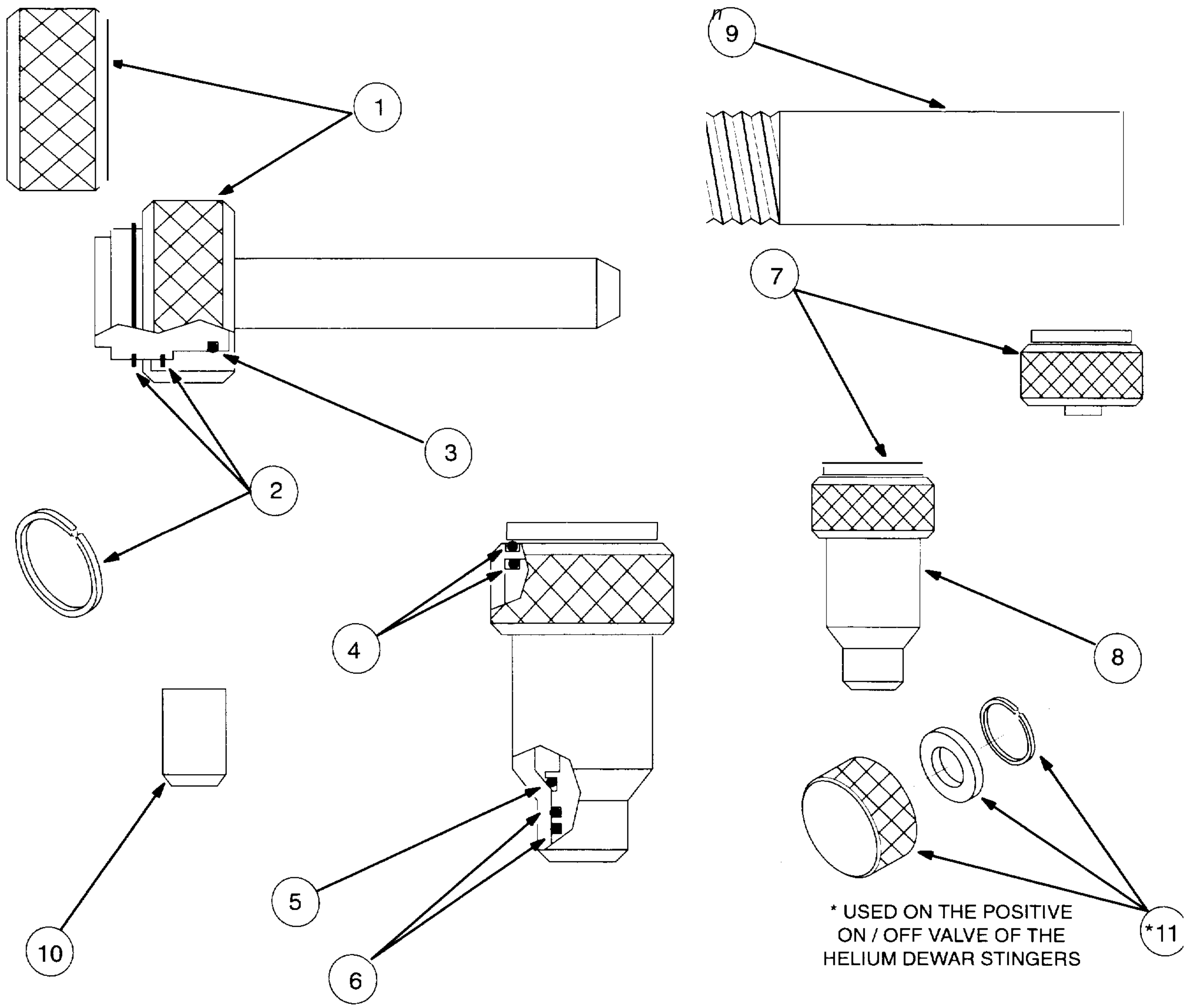
-9 DEWAR STINGERS, HELIUM AND NITROGEN TRANSFER LINES

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–294511P1	DEWAR STINGER	1	250 LITER DEWAR STINGER AIR PRODUCTS #DSA–59
2	46–294511P2	DEWAR STINGER	1	500 LITER DEWAR STINGER AIR PRODUCTS #DSA–64
3	46–294512P1	TRANSFER LINE	1	12' HELIUM TRANSFER LINE AIR PRODUCTS #FS–12–2B6
4	46–294512P2	TRANSFER LINE	1	8' HELIUM TRANSFER LINE AIR PRODUCTS #FS–8–2B6
5	46–252805P2	TRANSFER LINE	1	10' NITROGEN TRANSFER LINE
6	46–252805P3	TRANSFER LINE	1	15' NITROGEN TRANSFER LINE.
7	46–271135P1	FLEX HOSE	1	FLEX HOSE WITH NPT FIT–TINGS FOR HE BOTTLE

4–10 OTHER HELIUM TRANSFER SERVICE ITEMS

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–271137G1	SAFETY KIT	1	SAFETY FACE SHIELD KIT AIR PROD. #295–A–MRK500
2	46–265286G1	HEL. RES. BOX	1	GE MAGNET HELIUM RES BOX
3	46–306734G1	REGULATOR KIT	1	HELIUM HIGH PRESS. REG AND HOSE KIT
4	46–258150P1	HELIUM CART	1	NON–MAGNETIC CYLINDER CART

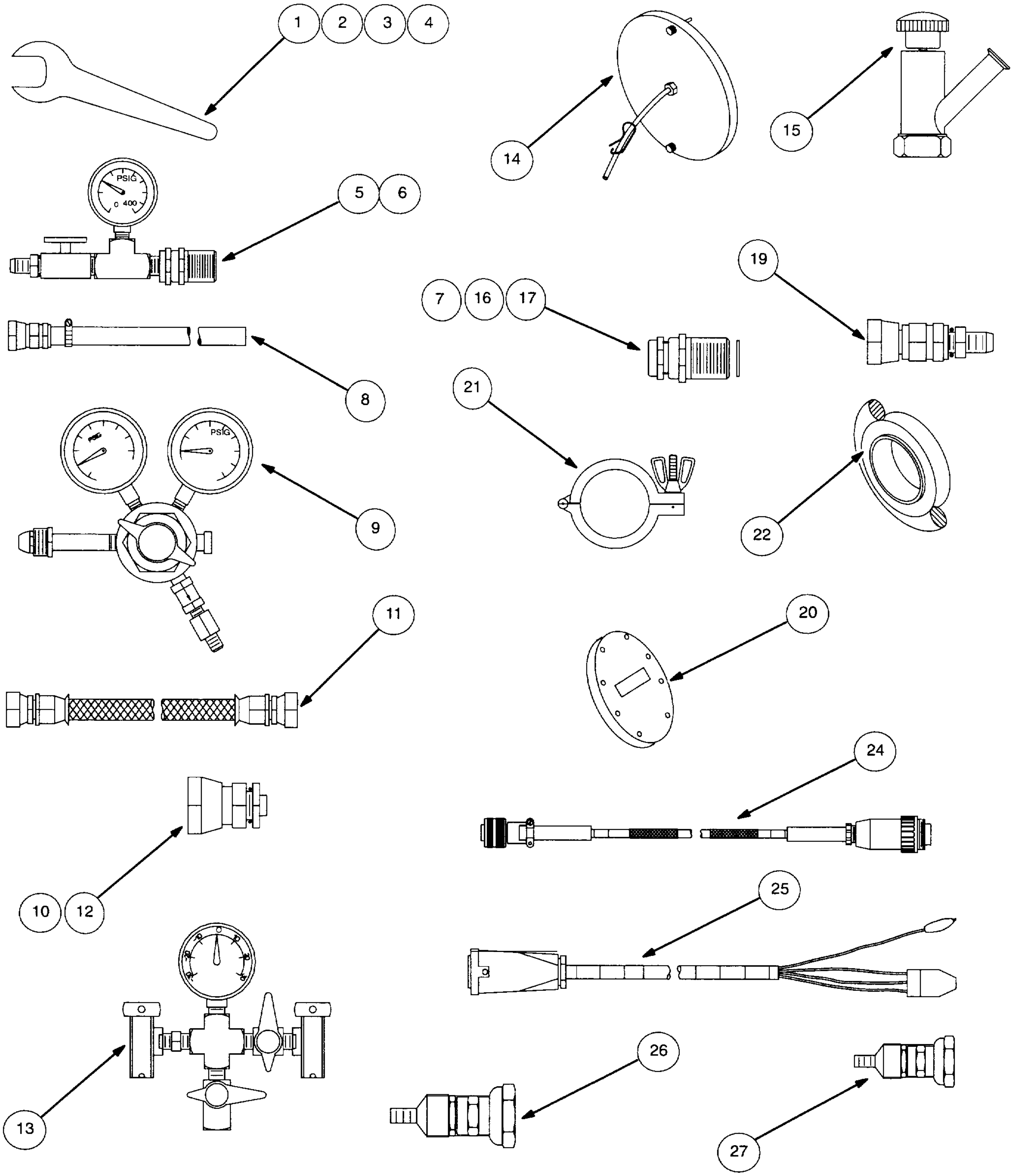
4–11 HELIUM TRANSFER LINE KIT RENEWAL PARTS



I 4-11 HELIUM TRANSFER LINE KIT RENEWAL PARTS (continued)

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–294512P6	COUPLING NUT		MALE BAYONET COUPLING NUT AP #BCN–1
2	46–294512P7	RETAINER RING	1	MALE BAYONET NUT RETAIN ER RING AP #BRR–1
3	46–294512P8	O–RING	1	MALE BAYONET O–RING AP #BOR–1
4	46–294512P9	O-RING	2	VAC PORT AND RELIEF VALVE O–RING AP #VPOR–1
5	46–29451 2P10	O–RING	1	VAC PORT AND RELIEF VALVE O–RING AP #VPOR–2
6	46-294512P11	O–RING	2	VAC PORT AND RELIEF VALVE O–RING AP #VPOR–3
7	46–294512P18	CAP	1	VAC PORT CAP AP #VPC–1
8	46–294512P19	VALVE	1	VAC PORT VALVE AP #VPV–1
9	46–294512P20	PROTECTOR	1	BAYONET PROTECTOR AP #BP–PVC
10	46–294512P21	TEFLON TIP	1	TEFLON TIP AP #STT–1
11	46–294512P22	VALVE STEM REP	1	VALVE STEM AP #VSC–K

4-12 COLD HEAD / COMPRESSOR INSTALLATION/ MAINTENANCE KIT 46-281088G3



4-12 COLD HEAD / COMPRESSOR INSTALLATION/ MAINTENANCE KIT 46–281088G3 (continued)

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–294150P14	WRENCH	1	1 3/16” OPEN END WRENCH LEYBOLD #722–81–019
2	46–294150P13	WRENCH	1	1” OPEN END WRENCH LEYBOLD #722–81–018
3	46–294150P15	WRENCH	1	1 3/8” OPEN END WRENCH LEYBOLD #722–81–020
4	46–294150P16	WRENCH	2	1 5/8” OPEN END WRENCH LEYBOLD #722–81–021
5	46–317904P1	PURGE TOOL	2	#8 (1/2”) AEROQUIP MALE PURGE TOOL
6	46–317904P2	PURGE TOOL	2	#12 (3/4”) AEROQUIP MALE PURGE TOOL
7	46–294937P1	#4 MALE AEROQUIF	1	COUPLING WITH TUBE ADPT.
8	46–294003P1	#4 FITTING	1	#4 CHARGING TOOL
9	46–294009P1	HIGH PRESS. REG.	1	HIGH PRESSURE HELIUM REGULATOR FOR CHARGING
10	46–294936P1	#8 FEM. AEROQUIP	1	COUPLING WITH TUBE ADPT.
11	46–294002P1	LINE ADAPTER	1	LINE ADAPTER HOSE
12	46–294006G1	DISCHARGE TOOL	1	#12 DISCHARGE FITTING
13	46–294007G1	BACKFILL PMPDWN ADAPTER	1	COLD HEAD CHANGE ADAPTER
14	46–294010G1	PURGE COVER PLATE	1	PLEXIGLASS COVER PLATE
15	46–260267P2	SEAL OFF OPER.	1	SLEEVE SEAL OFF OPERATOR
16	46–294000G1	#12 COUPLING	1	#12 MALE FITTING
17	46–281999G1	#8 COUPLING	1	#8 MALE FITTING
18	46–252065P63	WIRE BRUSH	1	WELDER’S BRUSH
19	46–294005G1	#4 ADAPTER ASM	1	#4 AEROQUIP
20	46–281989G1	COVER	1	COLDHEAD PORT COVER

4–12 COLD HEAD / COMPRESSOR INSTALLATION/ MAINTENANCE KIT 46-281088G3 (continued)

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
21	46–294026P1	KF 16 CLAMP	1	KF 16 CLAMP
22	46–294030G1	CENTERING RING	1	O–RING CENTERING RING
23	46–294939G50	CASE / FOAM ASM.	1	CARRYING CASE FOR TOOLS
24	46–318911P1	POWER CABLE	1	BALZERS CLDHD TO COMP.
25	46–318910P1	POWER CABLE	1	LEYBOLD CLDHD TO COMP.
26	2100316	LARGE ADAPTER	1	AEROQUIP FIT. TO HE LINE
27	2100317	SMALL ADAPTER	1	AEROQUIP FIT. TO HE LINE
28	2102476DDW	INSTRUCTIONS	1	SHLD. CLR. KIT UPGRADE
29	2102181	TOOL KIT LABEL	1	SHLD. CLR. UPGRADE KIT

4–13 EXTRA EQUIPMENT NEEDED TO SERVICE COLD HEAD AND COMPRESSOR

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–306734G1	HELIUM TANK REGULATOR AND HOSE	1	REGULATOR KIT
2	46–294047G1	SHIELD COOLER KIT	1	VACUUM PUMP KIT

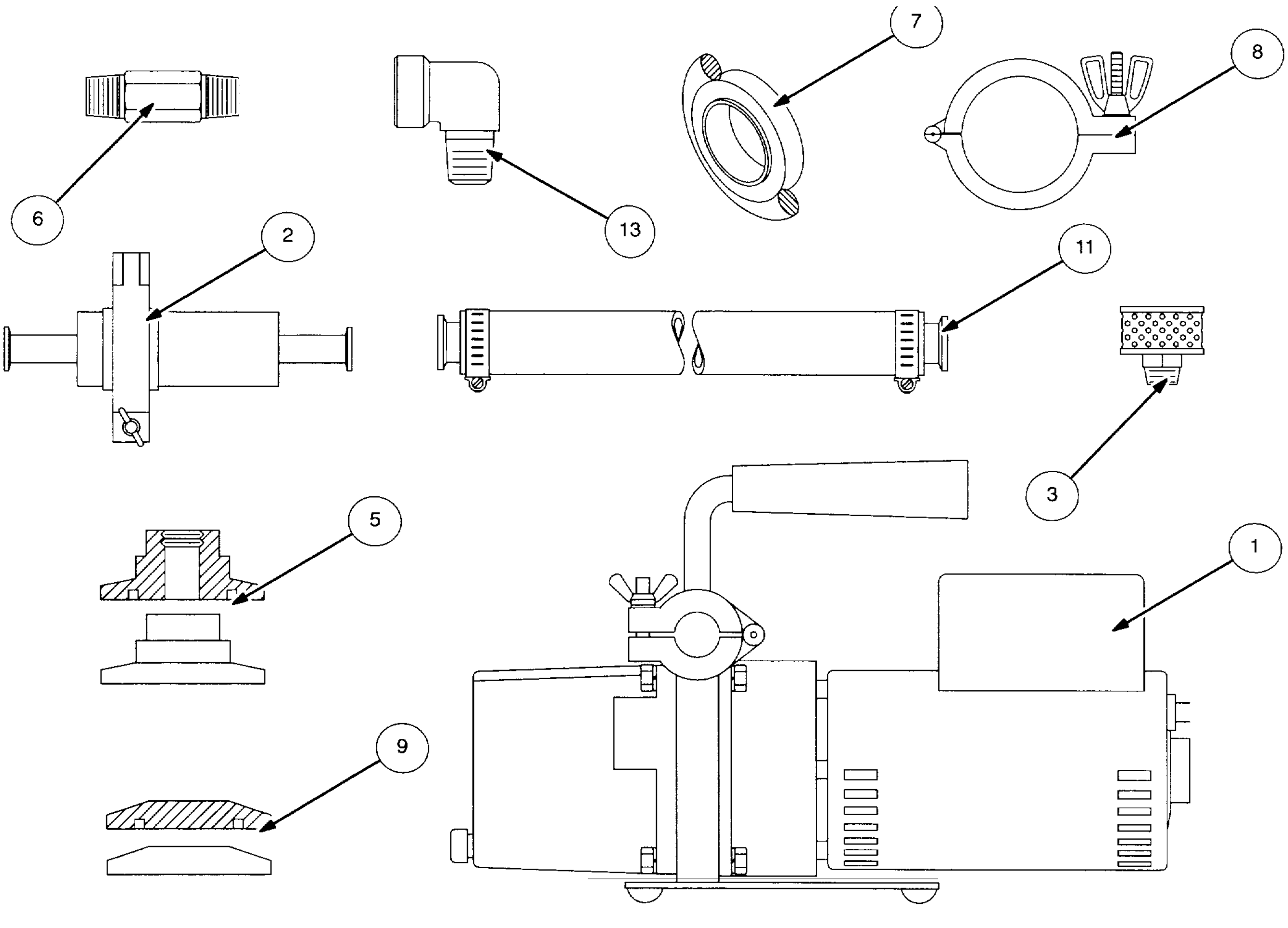
4–14 LAKESHORE 208 THERMOMETER KIT 46–301477G1

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–301453P6	CASE	1	14 X 103/4 X 53/4
2	46–301618P1	INSERT, FOAM	1	TOP – CONVOLUTING FOAM
3	46–301618P2	INSERT, FOAM	1	BOTTOM – 2 LAYERS
4	46–301478P1	THERMOMETER	1	LAKESHORE MODEL 208
5	46–301619P1	CABLE, DIODES	1	INTERCONNECT TO DIODES
6	46–301620P1	CABLE, MAGNET	1	INTERFACE TO GE MAGNET
7	46–301621P1	LABEL	1	GE MED SYS LAKESHORE THERMOMETER & INTERFACE CABLE 46–301477G1

4–15 LOW COST SHIELD TEMPERATURE DIODE BOX 46–317543G1

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–317537P1	METER	1	CURRENT SOURCE METER
2	46–317537P2	CABLE	1	METER CABLE
3	46–317537P3	CASE	1	CARRYING CASE

4–16 SHIELD COOLER VACUUM PUMP KIT 46–294047G1



ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–294041P1	VAC. PUMP	1	SARGENT–WELCH PUMP
2	46–294041P3	OIL TRAP (INLET)	1	INLET FORELINE TRAP
3	46–294041P2	EXHAUST FILTER	1	EXHAUST FILTER

4–16 SHIELD COOLER VACUUM PUMP KIT 46-294047G1 (continued)

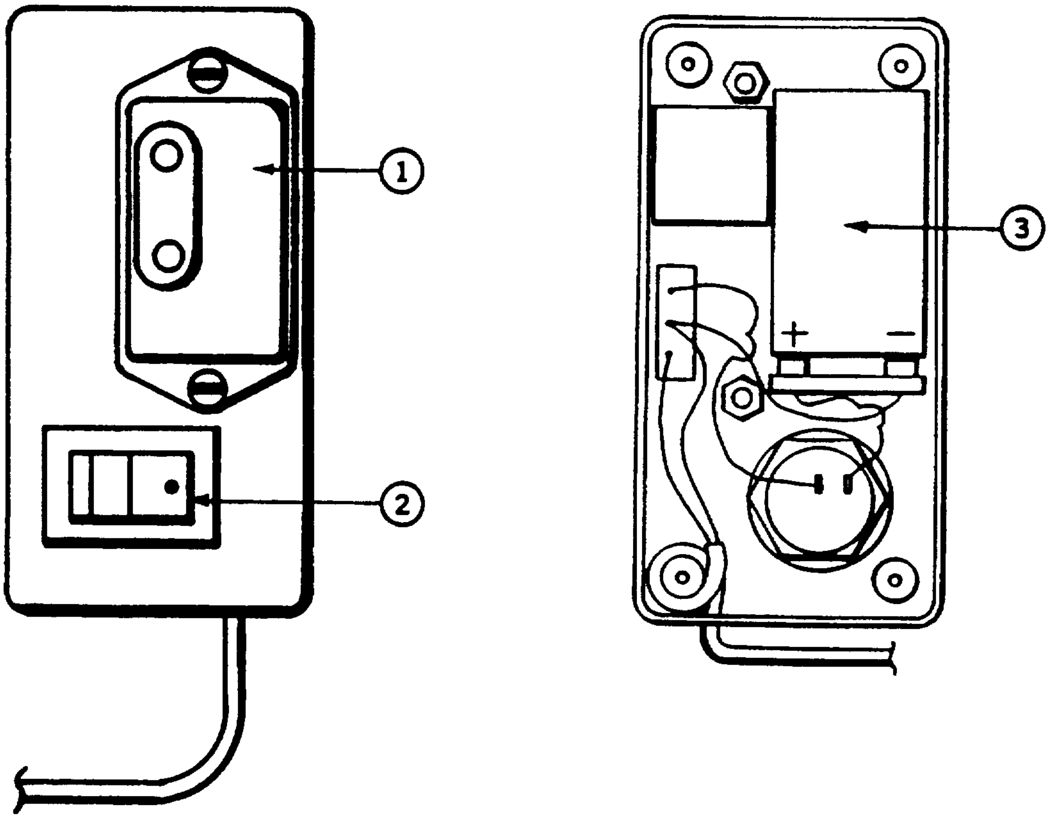
ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
4	46–294041P4	CARTRIDGE FOR OIL TRAP	1	TRAP REPLACEMENT
5	46–294027P1	INLET ADAPTER	1	KF16 TO .25 NPT ADAPTER
6	46–294029P1	NIPPLE	1	2"NIPPLE
7	46–294030G1	CENTERING RING	1	CENTER AND O RING
8	46–294026P1	KF 16 CLAMP	1	KF 16 HOSE CLAMP
9	46–294028P1	BLANK KF FLANGE	1	KF 16 BLANKING FLANGE
10	46–294041P5	OIL FOR VAC PUMP	1	ONE QUART OIL
11	46–294040G1	HOSE FOR PUMP	1	HOSE AND KF 16 ADAPTERS
12	46–294837G50	CASE AND FOAM	1	FOR PUMP KIT
13	46–252557P2	90° ELBOW	1	90° PLUMBING ELBOW
*14	46–XXXXXXX	CAP	1	EXHAUST CAP

● **Part in development**

4-17 VACUUM MAINTENANCE EQUIPMENT

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–252210P1	VALVE OPERATOR	1	3" PORT VALVE OPERATOR
2	46–265273G1	HELIUM METER	1	HELIUM LEVEL METER
3	46–265387G1	He GAGE ASM	1	HELIUM GUAGE ASSEMBLY
4	46–251867G1	PUMPDOWN KIT	1	MAGNET VAC. PMPDWN KIT
5	46–260201P1	N2 PRECOOL SYPH	1	N2 PRECOOL SYPHON
6	46–260267P2	SEAL–OFF OPER.	1	1" INSTR. PORT OPERATOR

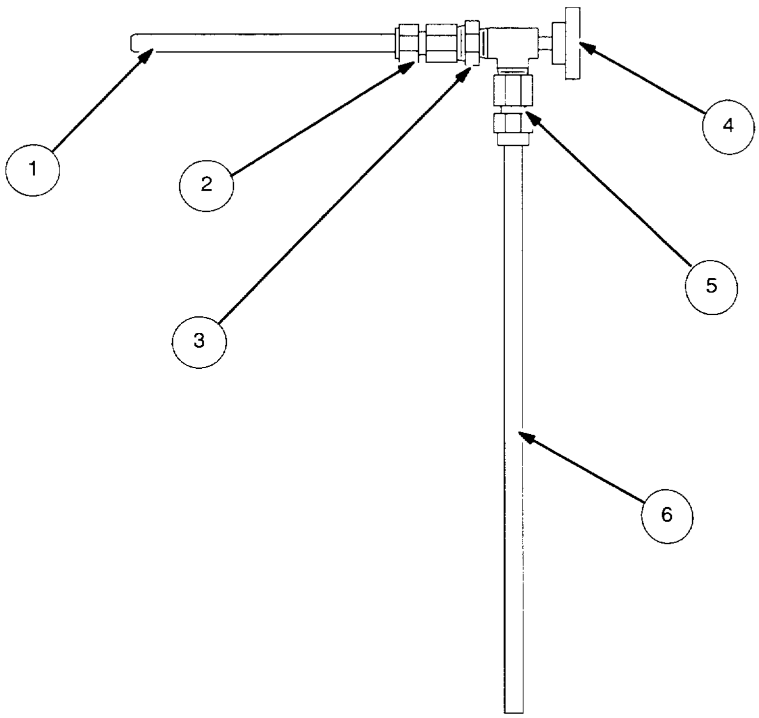
4–18 TAO MONITOR 46–281406G1



ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
*1	46–281406P2	TRANSDUCER	1	TRANSDUCER, LOW PRES SURE DIFFERENTIAL TYPE, RANGE 0–27.68 INCHES H20 OMEGA NO. PX162–027D5V
*2	46–281406P5	SWITCH	1	SWITCH, ROCKER TYPE, SPST, 6 AMP AT 125VAC, RA DIO SHACK NO. 275–690
*3	46–281406P7	BATTERY	1	BATTERY, 9V RECT. RADIO SHACK NO. 23–464 OR EQUAL

* PARTS ARE NOT AVAILABLE AS INDIVIDUAL ITEMS, ONLY AS ASSEMBLED PART,

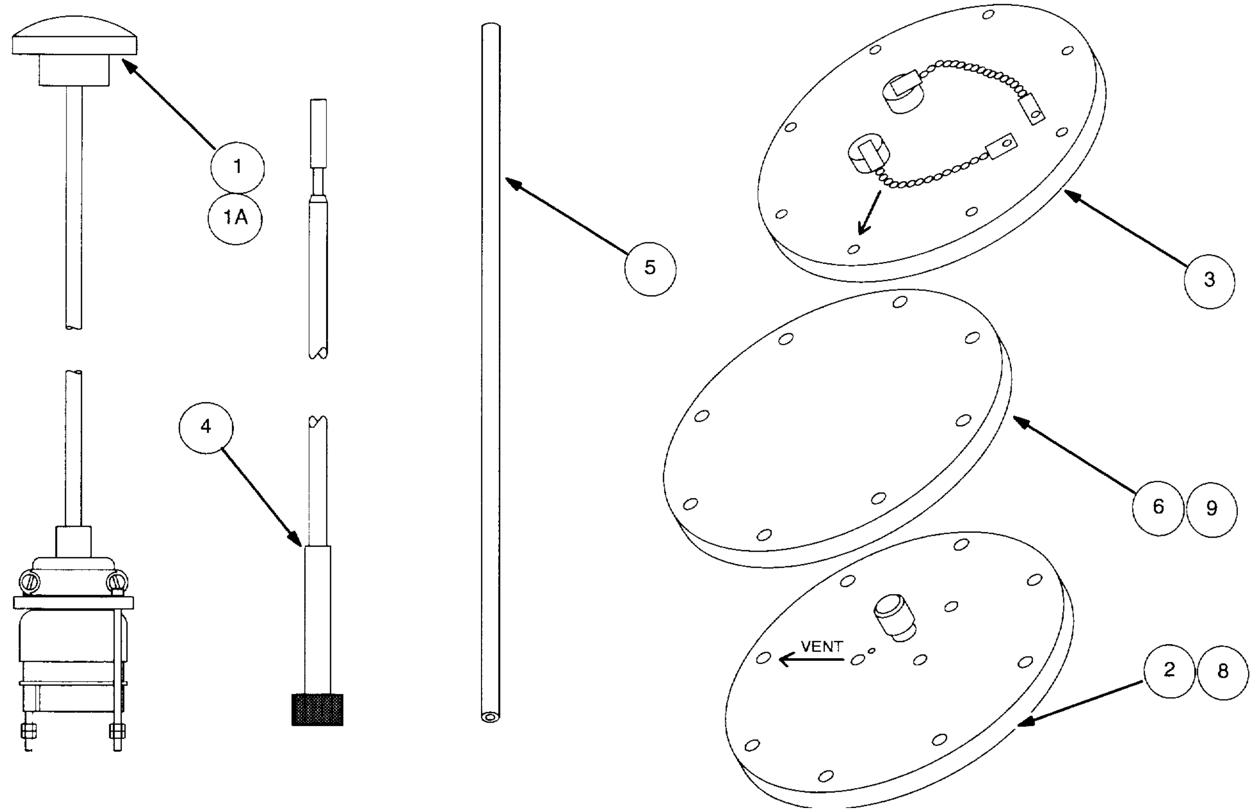
4-19 FILL LINE ADAPTER FOR TAO MONITORING 46-281232G1



ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–281232P1	TUBE	1	STN. STL. TUBING .5 OD X .049 WALL THICK
2	46–260912P1	CONNECTOR	1	1/2 OD X 1.5 NPT BRASS FE MALE CONNECTOR
3	46–252204P3	BUSHING	1	2“– 1“ NPT BRASS REDUC TION BUSHING
4	46–281109P1	VALVE	1	ANGLE - FILL LINE DAM PENER VALVE
5	46–281169P1	CONNECTOR	1	.25 ODT X .25 NPT BRASS FE MALE CONNECTOR
6	46–252065P45	TUBING	1	TUBING POLYETHYLENE, 1/4 OD X .040 WALL, IMPERIAL CAT. # 44–P NATURAL

** AVAILABLE AS AN ASSEMBLY ONLY

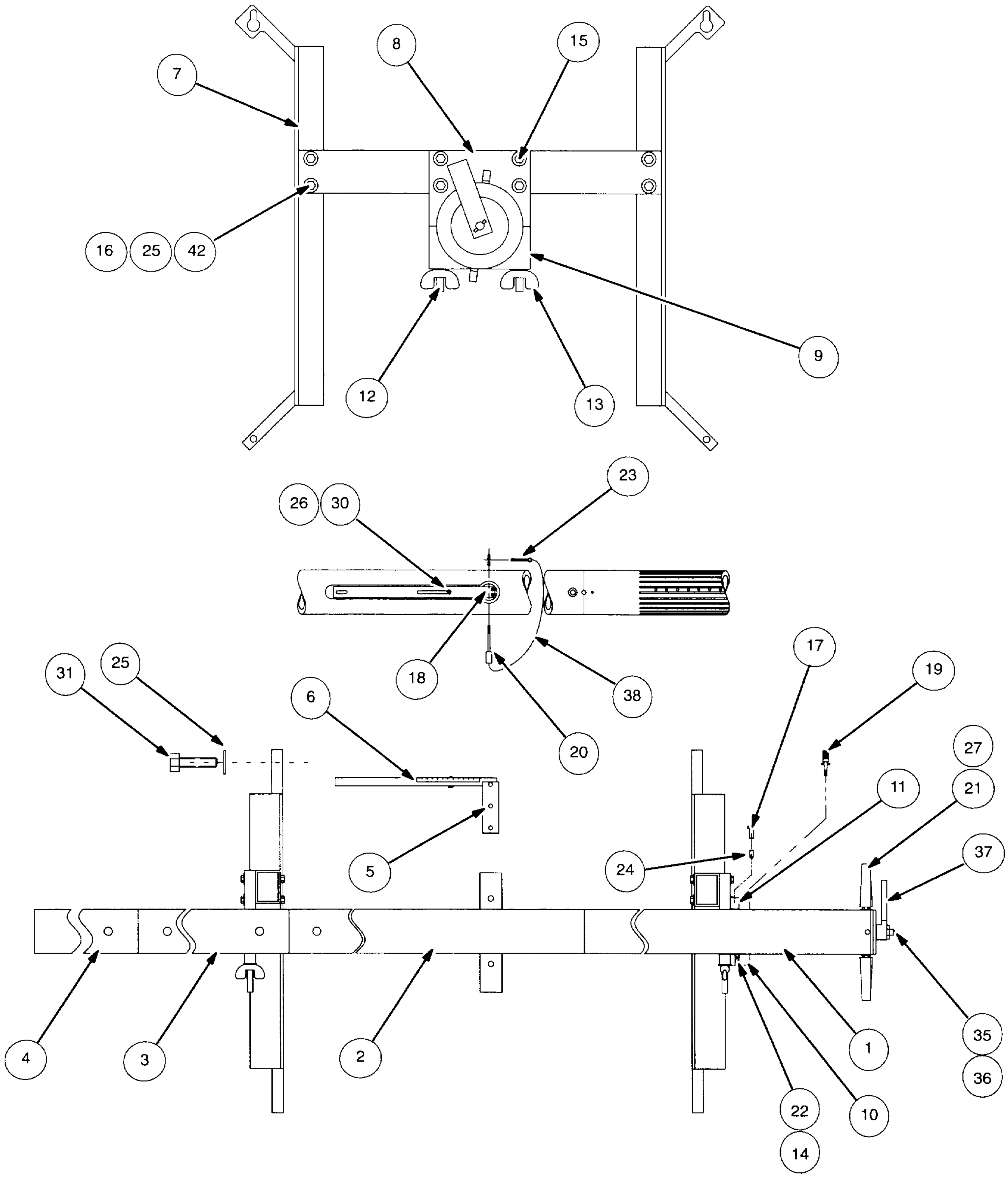
4–20 SAV–CON AND INSTRUMENTATION LEAD INSTALLATION/ REMOVAL KIT 46–294872G2



ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–294310G1	SAV CON TOOL	1	AV CON INSTALLATION/RE– IOVAL TOOL
1A	46–294310G2	SAV CON TOOL	1	SAV CON INSTALLATION/RE– MOVAL TOOL
2	46–294306G1	LEXAN PLATE	1	CLEAR PLATE TO GUIDE TOOLS – SIV
3	46–294765G1	LEXAN PLATE	1	PLATE FOR PURGING VERT. PEN. WITH HE GAS – SIV
4	46–294292G1	EXTENDED ALLEN	1	TOOL TO REMOVE ALLEN HEAD SCREWS IN SAV CON
5	46–281934P1	TAPPED G–10 ROD	1	INSTR. LEAD REMOVAL TOOL
6	46–318561P1	TURRET COVER	1	LEXAN TURRET COVER – SIV
7	46–318612G50	CASE/FOAM	1	CASE AND FOAM ASSEMBLY
8	46–318241G1	LEXAN PLATE	1	PLATE TO GUIDE TOOLS *
9	46–260963P2	LEXAN PLATE	1	EXAN TURRET COVER *

* MAX AND SIGNA III ONLY

4-21 SERVICE TOOL MAPPING FIXTURE 46–294060G2



4-21 SERVICE TOOL MAPPING FIXTURE 46-294060G2 (continued)

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–294054G1	TUBE SUPPORT	1	FRONT TUBE SUPPORT
2	46–294055G1	TUBE SUPPORT	1	MAGNETOMETER SUPPORT
3	46–294062G1	TUBE SUPPORT	1	REAR TUBE SUPPORT
4	46–294063G1	TUBE SUPPORT	1	REAR TUBE EXTENSION
5	46–294137G1	RADIAL SLIDER	1	RADIAL SLIDER
6	46–281418P1	MAGT. SUPPORT	1	MAGNETOMETER SUPPORT
7	46–294553G1	H–FRAME ASSM	2	H–FRAME ASSEMBLY
8	46–281408P1	BEARING	2	TOP HALF BEARING
9	46–281437P1	BEARING	2	BOTTOM HALF BEARING
10	46–294056P1	AXIAL POS. RING	1	AXIAL POSITIONING RING
11	46–281330P1	PLUNGER RING	1	PLUNGER RING
12	46–252188P5	BRASS ROD	4	6IN BRASS THREADED ROD
13	46–281435P7	WING NUT	5	.5–13 WING NUT
14	46–252322P10	BRASS WASHER	5	BRASS WASHER
15	46–281046P71	CAP SCREW	10	3/8–16 X3.5 BOLT
16	46–252320P19	BRASS NUT	12	3/8–16 BRASS NUT
17	46–281046P31	CAP SCREW	1	3/8–16 X .74 BRASS SCREW
18	46–252338P9	#6 SCREW	3	6–32 X .812 LONG FLAT HEAD
19	46–294058G1	PIN	2	PIN
20	46–281334P2	RADIAL PIN	1	RADIAL POSITIONING PIN
21	46–294167P1	HANDLE	2	

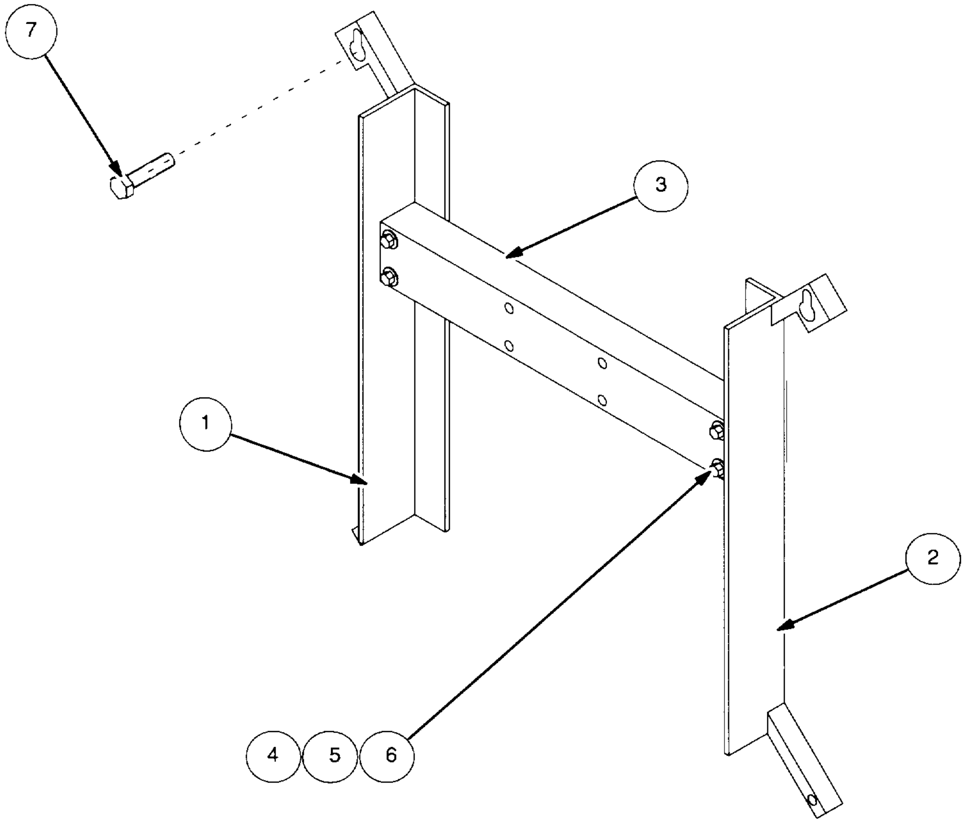
4-21 SERVICE TOOL MAPPING FIXTURE 46–294060G2 (continued)

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
22	46–281046P36	CAP SCREW	6	3/8–16 CAP SCREW
23	46–260422P3	COTTER PIN	1	.078 DIA COTTER PIN
24	46–252065P57	BALL PLUNGER	1	STN ST BALL PLUNGER
25	46–252322P8	WASHER	30	WASHERS
26	46–252320P13	BRASS NUT	1	10–24 BRASS HEX NUT
27	46–252188P6	THREADED RODS	2	3/8–16 X 2 IN THREADED R(
28	46–281464P1	CENTER LABEL	1	CENTER LINE LABEL
29	46–281465P1	SCALE LABEL	1	SCALE LABEL
30	46–252352P24	SCREW	1	10–24 X 2IN SCREW
31	46–281046P31	BRASS SCREW	10	3/8–16 X .75 BRASS SCREW
32	46–294019P1	BAR	2	TORQUING BARS
33	46–252065P65	NOALOX	1	8 OZ. BOTTLE NOALOX
34	46–294059P1	SPACER RINGS	5	.010 THICK NYLON RINGS
35	46–294057P1	THREADED ROD	1	.75 BRASS THREADED ROD
36	46–252322P12	BRASS WASHER	1	.750 BRASS WASHER
37	46–294072P1	BARNUT	1	.75–10 BARNUT
38	46–294167P2	STRETCH CORD	1	.042 DIA STRETCH CORD
39	46–294048G1	CRATE	1	CRATE
40	46–294059P2	SPACER	8	NYLON SPACER SHIM
41	NOT USED			
42	46–281046P70	BRASS SCREW	2	3/8X2.751NBRASSSCREW

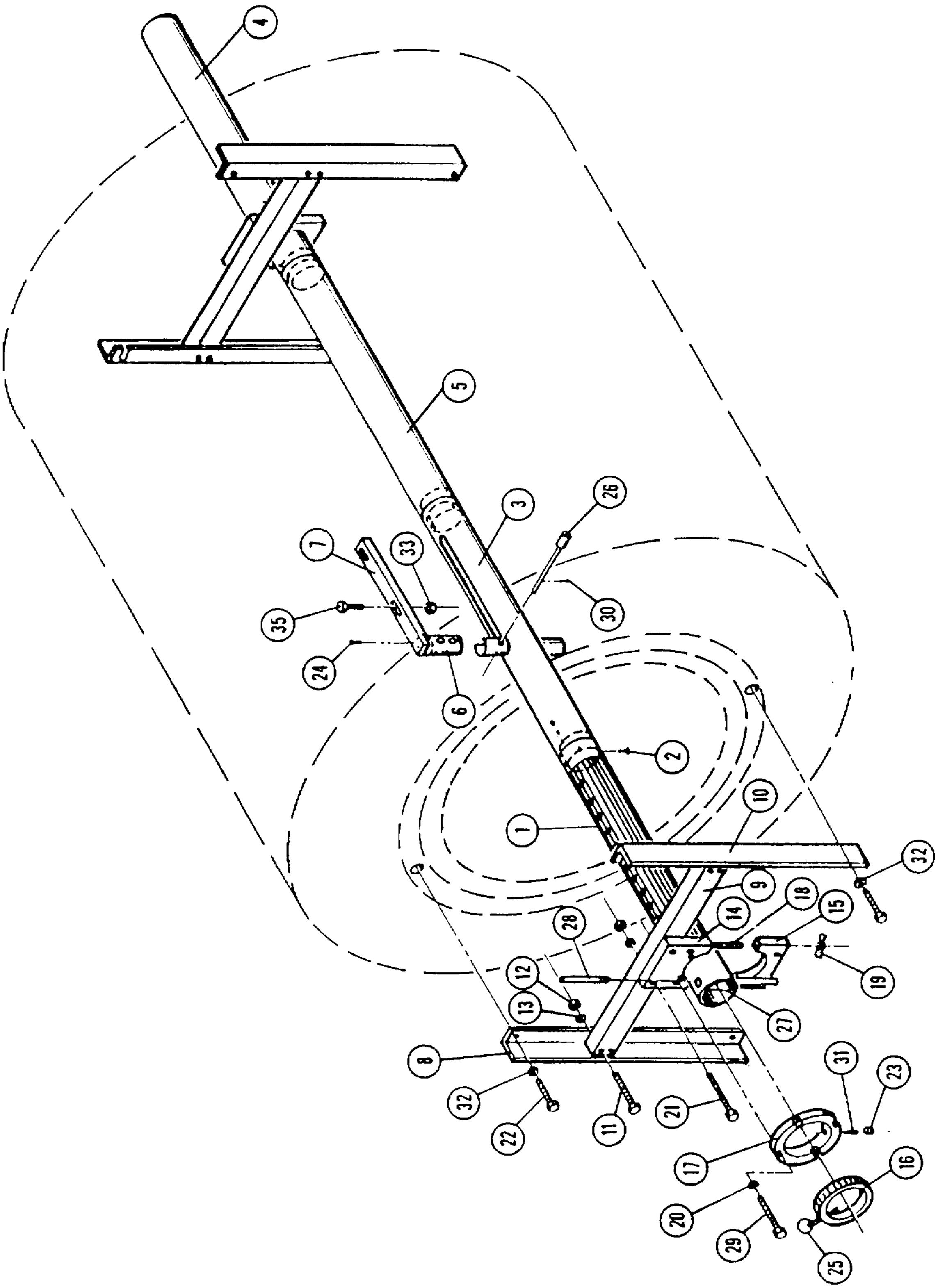
I 4-21 SERVICE TOOL MAPPING FIXTURE 46-294060G2 (continued)

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
43	46–252320P19	BRASS NUT	2	3/8–1 6 BRASS NUT
44	46–252322P8	WASHER	2	WASHER

4-22 MAPPING FIXTURE H–FRAME 46–294553G1



ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–294553P1	H–FRAME	1	LEFT MOUNTING BAR
2	46–294553P2	H–FRAME	1	RIGHT MOUNTING BAR
3	46–294553P3	H–FRAME	1	CROSS BAR
4	46–281046P70	BRASS SCREW	4	CROSS BAR SCREW .375 X 2.75 LG BRASS
5	46–252320P19	BRASS NUT	4	.375–16 BRASS NUT
6	46–252322P8	WASHER	8	WASHER
7	46–281046P37	BRASS SCREW	4	3/8–16 X 1.5LG BRASS SCREW



4–23 MAPPING FIXTURE 46–281420G2

4-23 MAPPING FIXTURE 46-281420G2 (continued)

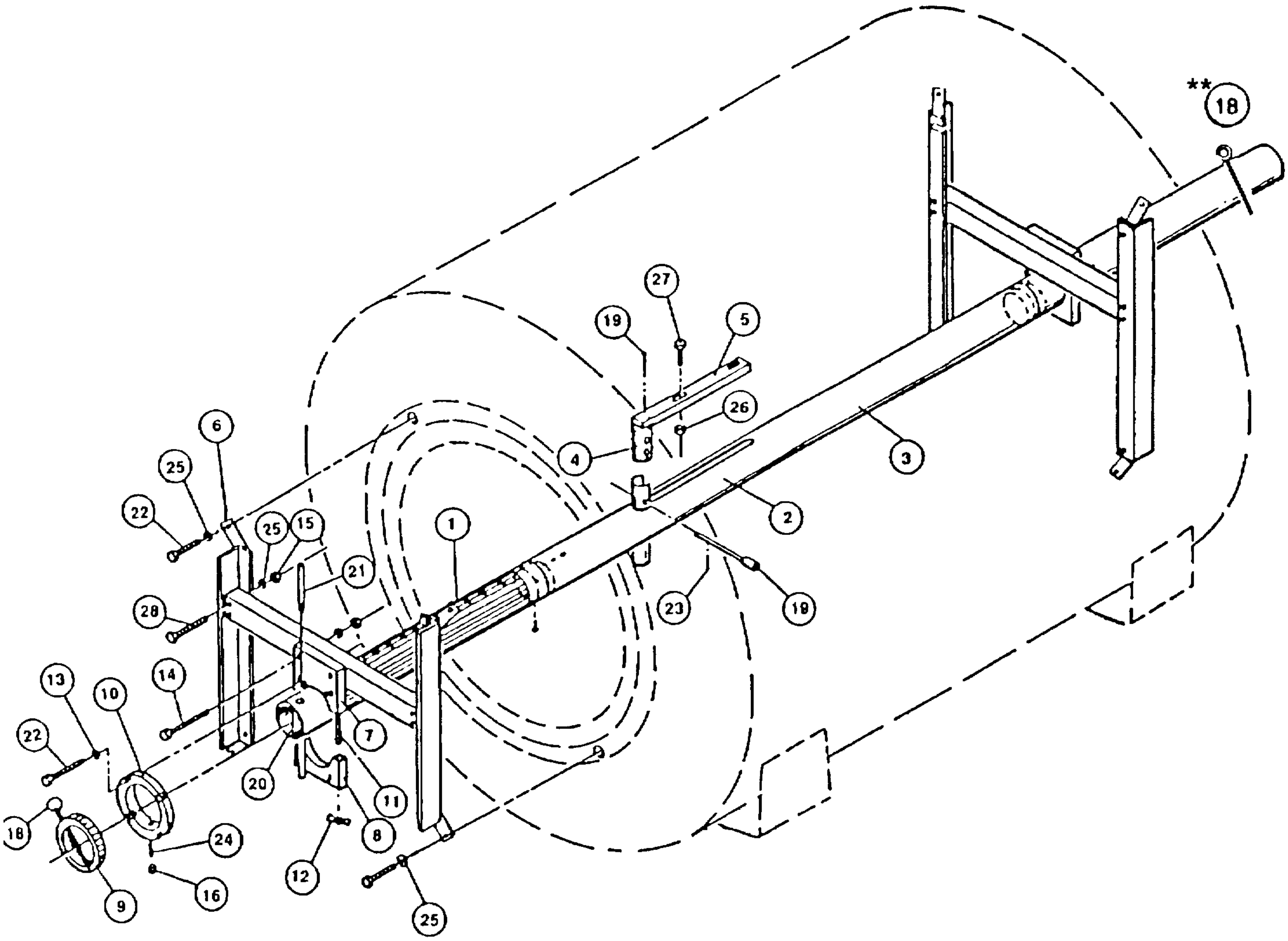
ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–281414G1	TUBE	1	AXIAL POSITIONING SUPPORT TUBE
2	46–252350P26	SCREW	18	0–24 X 0.313 LONG BRASS FLAT HEAD SCREW
3	46–281413G1	TUBE	1	AXIAL MAGNETOMETER SUPPORT TUBE & SLIDER
4	46–281415G1	TUBE	1	AXIAL REAR SUPPORT TUBE
5	46–281416G1	TUBE	1	AXIAL EXTENSION SUPPORT TUBE
6	46–281417G1	TUBE	1	RADIAL SLIDER TUBE
7	46–281418P1	TABLE SUP'T	1	MAGNETOMETER TABLE SUPPORT
8	* 46–2814· 9P1	H–FRAME	2	H–FRAME – LEFT LEG
9	* 46–2814· 9P2	H–FRAME	2	H–FRAME – CROSS MEMBER
10	* 46–2814· 9P3	H–FRAME	2	H–FRAME – RIGHT LEG
11	46–2812046P70	BOLT	8	.375–16 X 2.75 HEX HEAD BRASS BOLT
12	46–252320P19	NUT	8	.375–16 HEX BRASS NUT
13	46–252322P8	WASHER	16	3/8" BRASS PLAIN WASHER
14	** 46–281408P1	BEARING	2	TOP HALF BEARING
15	46–281437P1	BEARING	2	BOTTOM HALF BEARING
16	46–281333P1	AXIAL RING	1	AXIAL POSITIONING RING
17	46–281330P1	PLUNGER RING	1	PLUNGER RING
18	** 46–252188P5	THD RODS	4	.50–13 UNC 61N LG BRASS RODS
19	46–281435P7	NUT	4	WING NUT

* ORDER AS A SET (46-281419G1)

•* ORDER AS AN ASSEMBLED SET

4–23 MAPPING FIXTURE 46–281420G2 (continued)

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
20	46–252322P10	WASHER	4	.536 ID 1.073, .074 T, BRS FLAT WASHER
21	46–281046P69	SCREW, CAP	8	3/8–16 X 3.75 BRASS SCREW
22	46–260795P59	SCREW	8	.500 BRASS SCREW
23	46–281462P19	SCREW	1	.375–16 X .50 SET SCREW
24	46–252338P9	SCREW	3	6–32 X .812 LONG #6 BRASS FLAT HEAT SCREW
25	46–281463P2	PIN	1	QUICK RELEASE PIN
26	46–281334P1	PIN	1	TUBE LOCKING PIN
27	46–252188P3	ROD	1	.375–24 UNF BRASS THD ROD
28	46–252065P53	HANDLE	2	.375–24 THD HANDLE
29	46–281046P36	SCREW, CAP	4	.375–16 X 1.50 CAP SCREW
30	46–260422P3	PIN	2	BRASS COTTER PIN FOR .078 DIA. HOLE
31	46–252065P57	PLUNGER	2	BALL PLUNGER
32	46–252322P8	WASHER	24	3/8 BRASS PLAIN WASHER
33	46–252320P13	NUT	1	10–24 BRASS HEX NUT
34	46–252350P6	SCREW	3	.190–24 X 0.75 BRASS FLAT HEAD SLT SCREW
35	46–252352P12	BOLT	1	10–24 X 1.125 BRASS BINDING HEAD BOLT
36	46–294019P1	TORQUE BAR	2	TORQUE BARS FOR USE DURING ASSEMBLY
37	46–252065P65	NOALOX	1	NOALOX LUBRICANT, 8oz. BOTTLE



**MODEL 46–294238G1

4-24 MAPPING FIXTURE 46–281609G1 & 46–294238G1
(NEW TOOL FOR COMPACT MAGNET)

4–24 MAPPING FIXTURE 46–281609GI & 46–294238GI (continued) (NEW TOOL FOR COMPACT MAGNET)

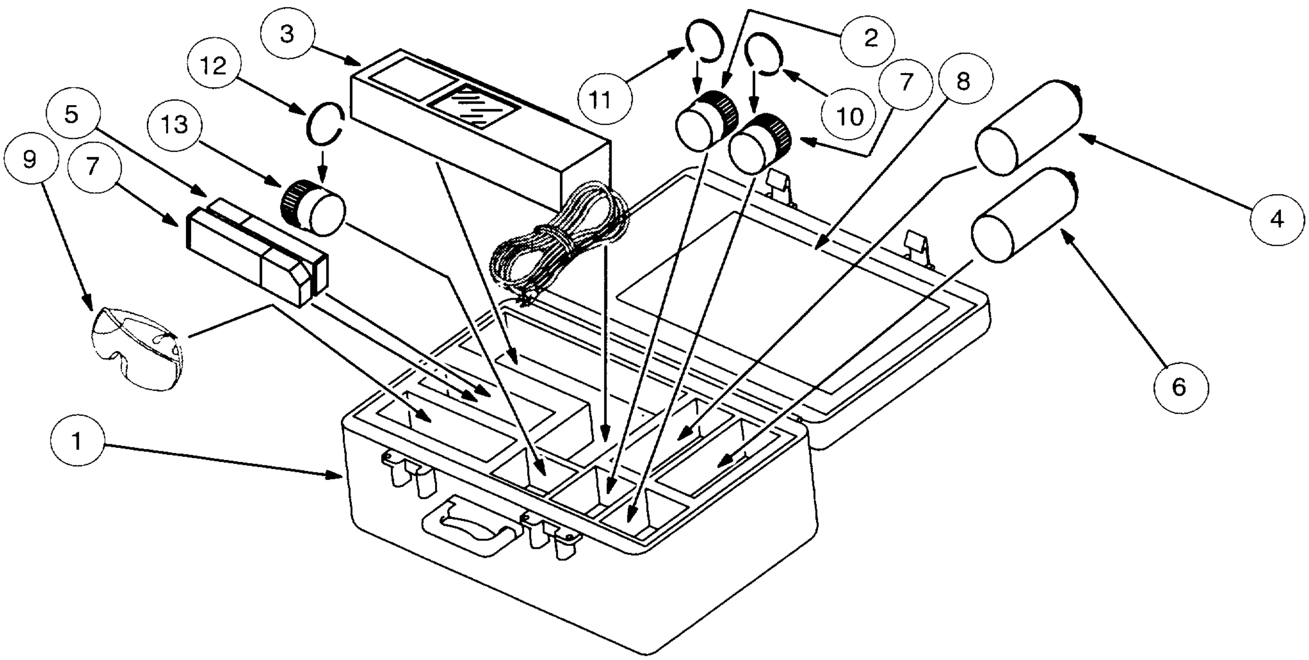
ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–281796G1	TUBE	1	FRONT POSITIONING (ITEM 1 &2 ORDER AS SET)
2	46–281797G1	TUBE	1	RADIO, SLIDER SUPPORT (ITEM 1 & 2 ORDER AS SET)
3	46–281798G1	TUBE	1	REAR
4	46–281799P1	SLIDER	1	RADIAL
5	46–281418P1	TABLE	1	TABLE SUPPORT
6	46–281800G1	H FRAME	2	MOUNTING H–FRAME TO PAS SIVE SHIM BORE END
6A**	46–294239G1	H–FRAME	2	MOUNTING H–FRAME TO MAGNET END FLANGE
7	46–281408P1	BEARING	2	BEARING, FIXED HALF (ITEM 7 & 8 ORDER AS SET)
8	46–281437P1	BEARING	2	BEARING ADJUSTABLE MAP PING FIXTURE (ITEM 7 & 8 OR DER AS SET)
9	46–281333P1	RING	1	RING, AXIAL POSITIONING
10	46–281330P1	RING	1	RING, PLUNGER
11	46–252100P5	THD RODS	4	.5–13 UNC 6 IN LONG BRASS
12	46–281435P7	NUT, WING	4	.5–13 UNC WING NUT
13	46–252322P10	WASHER	4	FLAT,.536 ID. 1.073
14	46–252366P23	BOLT	8	3/8–16 X 3.50 BRASS
15	46–252320P19	NUT	8	NUT, HEX BRASS, .375–16
16	46–281462P19	SCREW SET	1	.375–16 X .50
17	46–252330P9	#6 SCREW	3	6–32 X .812 LONG BRASS FLAT
18	46–281463P2	PIN	2	PIN, QUICK RELEASE
19	46–281334P1	PIN	1	
20	46–252188P3	THD RODS	1	.375–24 UNF BRASS
21	46–252065P53	MATERIALS	2	HANDLE.375–24 THD
22	46–252366P6	BOLT	8	BOLT, HEX HD BRASS
22A	46–281046P37	BOLT	8	BOLT, HEX HD BRASS
23	46–260422P3	PIN	2	COTTER, FOR.078 DIA HOLE
24	46–252065P52	MATERIALS	1	BALL PLUNGER, NYLON
25	46–252322P8	WASHER	24	3/8 BRASS, PLAIN
26	46–252320P13	NUT	1	HEX NUT BRASS 10–24
27	46–252250P6	SCREW	3	FLT HD SLT. BRASS
28	46–252366P17	BOLT	8	.375–16 X 2.75 HEX HD BRASS
29	46–260795P59	SCREW	8	.500 BRASS SCREW

* MODEL 46–281609G1** MODEL 46–294238G1

I 4-25 SPECIALTY TOOLS FOR SPECIFIC MAGNET TYPES

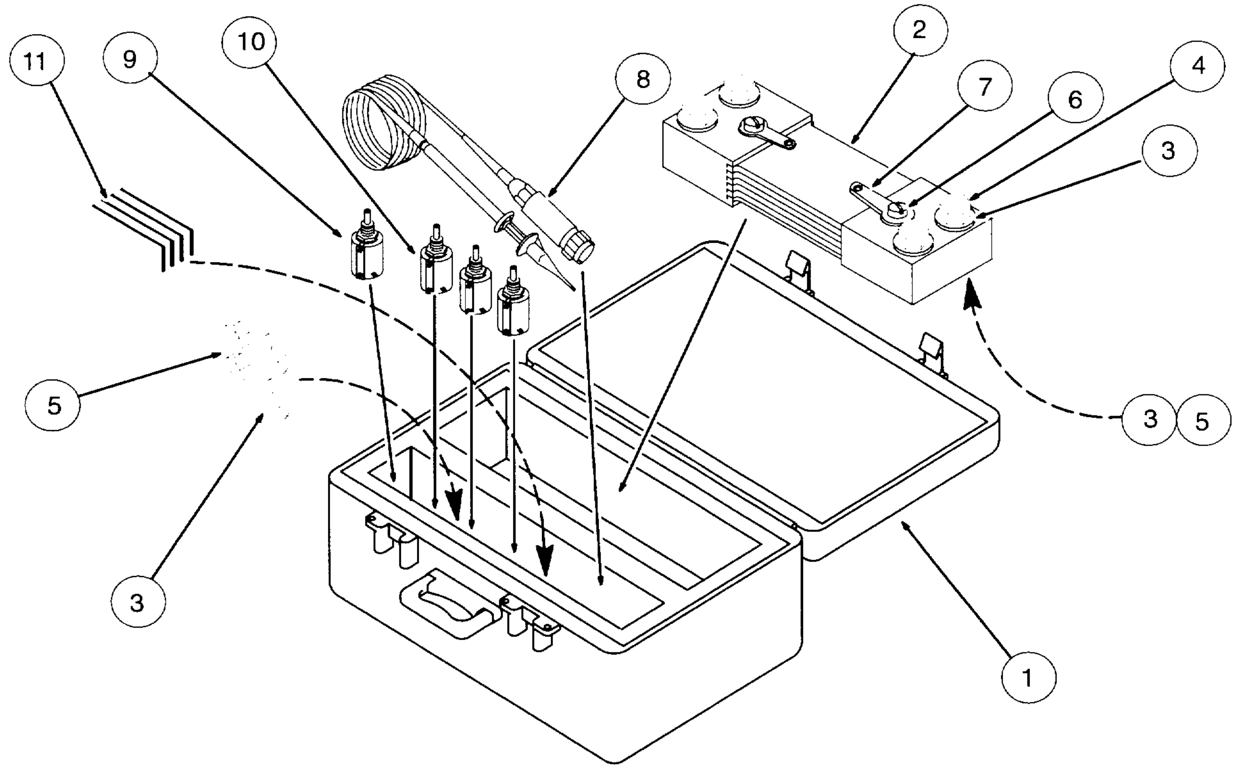
ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	46–281847G1	3" VALVE OPERATOR	1	ADD 0N SHIELD EXTENDED 3" VALVE OPERATOR
2	46–281050P4	COLD HEAD TOOL	1	SECOND STAGE ASSEMBLY TOOL FOR WELDED IN COLD HEAD
	46–281967G1	CENTERING KIT	1	ADD ON SHIELDCENTERING KIT
	46–281935P1	LEXAN PLATE	1	LEXAN COVER FOR INSTRU MENTATION LEADFOR COM PACT MAGNET
5	46–281936G1	LEXAN PLATE	1	LEXAN COVER FOR VERTICAL STACK OF COMPACT MAGNET
6	46–260705G1	SAV CON TOOLS	1	SAV CON TOOLS FOR SI MAG NET
7	46–260705G1	LEXAN PLATE	1	LEXAN COVER FOR P3 PLUG
8	46–252065P29	THREADED RODS	3	THREADED RODS FOR P3 PLUG REMOVAL
9	46–281432G1	TAO DAMPER KIT	1	TAO DAMPER KIT FOR SI MAGNET
10	46–294052G1	WATER FLOW KIT	1	WATER FLOW METER KIT

4–26 SHIELD COOLER TEST KIT ASSEMBLY 46-318784G2



ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1.	2100644	CASE ASSEMBLY		KIT CASE ASSEMBLY
2.	2100660	CONTAINER	1	SPECIMEN CONTAINER
3.	2100976	UV LIGHT	1	UV LIGHT & LABEL
4.	2100661	SOLUTION	1	FOR SOLIDS
5.	46–318649P1	TESTER	1	DISSOLVED SOLIDS
6.	2100662	SOLUTION	1	FOR PH
7.	46–318648P1	METER	1	PH METER
8.	2101994APR	INSTRUCTIONS	1	KIT OPERATING
9.	46–318649P1	GOGGLES	1	UV LIGHT SAFETY
10.	2101986	LABEL	1	SAMPLE, ADHESIVE BACKING
11.	2101987	LABEL	1	SOLIDS, ADHESIVE BACKING
12.	2101988	LABEL	1	PH, ADHESIVE BACKING
13.	2100660	SAMPLE	1	EMPTY – FOR SAMPLES

4-27 POWER SUPPLY CALIBRATION KIT 2101360



ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1.	2101356	CASE	1	CASE ASSEMBLY
2.	2101358	AMMETER SHUNT	1	TYPE B – DC
3.	46–252322P8	WASHER	6	PLAIN, BRASS
4.	46–281046P3	CAP SCREW	4	HEX HEAD, BRASS
5.	46–260942P3	NUT	6	HEX, BRASS 3/8–16UNC
6.	46–294167P1	LOCK WASHER	4	#10 INTERNAL TOOTH
7.	2101361	LUG	4	SOLDER LUG
8.	46–294167P1	PROBE	1	X1 MONOLITHIC
9.	46–281468P2	POTENTIOMETER	1	10 TURN, 100 OHM, WW
10.	46–281468P1	POTENTIOMETER	3	10 TURN, 5K, WW
11.	46–294167P1	ALLEN WRENCH	1	HEX. .050" ACROSS FLATS

4-28 OXYGEN MONITORS

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	2107184	KIT	1	ENMET OXYGEN MONITOR KIT
	KIT CONTENTS:	OXYGEN MONITOR	1	46–317271G1
		SUPPLIER MANUAL	1	46–294439P5
		SERVICE MANUAL	1	46–015336
2	2106236	MONITOR	1	CONNECTICUT ANALYTICAL PORTABLE OXYGEN MONITOR (PREFERRED MODEL)
3	2106237	MONITOR	1	MCNEILL INTERNATIONAL PORTABLE OXYGEN MONITOR (ALTERNATE MODEL)

4-29 MAGNET TOOL MATRIX

SERVICE TOOLS	SIII	SIV SX	MR MAX 0.5T	VECTRA	VMX	MRT
MAGNET RAMPING EQUIPMENT KIT 46–260703G2	X	X	X	X	X	
MAIN POWER SUPPLY 46–260776G3	X	X	X	X	X	
SHIM POWER SUPPLY 46–260777G3	X	X	X			
RAMPING SUPPLY AND EQUIPMENT 46–294998G1	X	X	X	X	X	
UNIVERSAL FILL LINE KIT 46–294705G1	X	X	X	X	X	
250 LTR DEWAR STINGER 46–294511P1	X	X	X	X	X	
500 LTR DEWAR STINGER 46–294511P2	X	X	X	X	X	
DEWAR LEVEL TOOL KIT 46–306812G1	X	X	X	X	X	
12 FT He TRANSFER LINE 46–294512P1	X	X	X	X	X	
8 FT He TRANSFER LINE 46–294512P2	X	X	X	X	X	
10 FT NITROGEN TRANSFER LINE 46–252805P2	X	X	X	X	X	
15 FT NITROGEN TRANSFER LINE 46–252805P3	X	X	X	X	X	
SAFETY KIT 46–271137G1	X	X	X	X	X	
He RESISTANCE BOX 46–265286G1	X	X	X	X	X	
HIGH PRESSURE REGULATOR KIT 46–306734G1	X	X	X	X	X	
NONMAGNETIC HELIUM CART 46–258150P1	X	X	X	X	X	
SHIELD COOLER INST. / MAINT. KIT 46–281088G3	X	X	X	X	X	
SHIELD COOLER VACUUM PUMP KIT 46–294047G1	X	X	X	X	X	
LAKESHORE THERMOMETER KIT 46–301477G1	X	X	X	X	X	

4–29 MAGNET TOOL MATRIX (continued)

SERVICE TOOLS	SIII	SIV SX	MR MAX 0.5T	VECTRA	VMX	MRT
LOW COST SHIELD TEMP BOX 46–317543G1	X	X	X	X	X	
3 IN. VALVE OPERATOR 46–252210P1	X	X	X	X	X	
3 IN. VALVE OPERATOR 46–281847G1	MAGNI-SHIELD					
He LEVEL METER 46–265273G1	X	X	X	X	X	
MAIN VACUUM PUMP DOWN KIT 46–251867G1	X	X	X	X	X	
N_2 PRECOOL SYPHON 46–260201P1	X	X	X	X	X	
TAO MONITOR 46–281406G1	X	X	X	X	X	
FILL LINE ADAPTER FOR TAO MONITORING 46–281232G1	X	X	X			
MAPPING FIXTURE 46–281420G2	X		X			
MAPPING FIXTURE 46–294238G1				X	X	
SERVICE MAPPING FIXTURE 46–294060G2	X	X	X			
H–FRAME ADAPTER KIT 46–294842G1 (UPGRADES 46–294060G1 TO G2)	X	X	X			
SAV–CON / INSTRUMENTATION LEAD SERVICE KIT 46–294872G2	X	X	X			
LEXAN / ALUMINUM BELLOWS COVER 2119965					X	
LEXAN COVER VERT STACK 2117683				X	X	
LEXAN COVER VERT. STACK 46–281936G1				X	X	
LEXAN COVER FOR P3 PLUG 46–260192P1						
ENMET OXYGEN MONITOR KIT 2107184	X	X	X	X	X	
CONNECTICUT ANALYTICAL PORTABLE OXYGEN MONITOR – 2106236	X	X	X	X	X	
McNEIL INTERNATIONAL PORTABLE OXYGEN MONITOR – 2106237	X	X	X	X	X	

4-29 MAGNET TOOL MATRIX (continued)

SERVICE TOOLS	SIII	SIV	MR MAX 0.5T	VECTRA	VMX	MRT
LEXAN COVER INSTR. LEAD 46–281935P1				X		
SECOND STAGE ASSEMBLY TOOL 46–281050P4 (FOR WELDED IN COLD HEAD)			X			
MAGNISHIELD CENTERING KIT 46–281967G1	X					
SAV–CON KIT 46–260705G1						
THREADED RODS 46–252065P29						
TAO DAMPER KIT 46–281432G1						
RAMP CABLE HOLDER 46–318314G2	X	X	X	X	X	
RAMP CABLE HOLDER 46–318833G1	X	X	X	X	X	
WATER FLOW METER KIT 46–294052G1	X	X	X	X	X	
MAGNET CENTERING / VERIFICATION KIT 46–281967G1	MAGNI– SHIELD					
WATER TEE ASSEMBLY 46–318696G1	X	X	X	X	X	
SIV REGION SHIM KIT 46–318832G1		X				
SHIELD COOLER TEST KIT 46–318784G2	X	X	X	X	X	
WRENCH KIT (FERROUS) 2103333	X	X	X	X	X	
WRENCH KIT (NON–FERROUS) 46–294804G1	X	X	X	X	X	
BELL GAUSSMETER KIT 46–306801G1	X	X	X	X	X	
1.00” VACUUM CHECK TOOL 46–228192P1	MAGNI- SHIELD					
50 Hz HEAT GUN 46–306830G11	X	X	X	X	X	X
60 Hz HEAT GUN 46–306830G12	X	X	X	X	X	X

4-29 MAGNET TOOL MATRIX (continued)

SERVICE TOOLS	SIII	SIV SX	MR MAX 0.5T	VECTRA	VMX	MRT
METROLAB TESLAMETER KIT 46–251865G2	X	X	X	X	X	
He DEWAR ADAPTER KIT 46–271136G1	X	X	X	X	X	
He MECHANICAL GAS FLOWMETER 46–306781G1	X	X	X	X	X	
ALUMINUM PLATFORM LADDER 46–307476G1	X	X	X	X	X	
ENMET OXYGEN MONITOR CALIBRATION KIT 46–328021G1	X	X	X	X	X	
LARGE SHIM LEAD CAPS 42102831	X	X	X			
SMALL SHIM LEAD CAPS 2102832		X				
COMPACT REGION SHIM KIT 46–318831G1				X		
TESLAMETER 46–251865G2	X	X	X	X	X	
THERMOCOUPLE ADAPTER AND K PROBE 46–194427P285	X	X	X	X	X	
POWER SUPPLY CALIBRATION 2101360	X	X	X	X	X	
ADAPTER FITTING 2122261						X
HEAT EXCHANGER COUPLING 2115923						X
TEST PLUG – DB25 PIN 2122539						X
TEST PLUG – DB9 PIN 2122540						X
VACUUM ASSEMBLY COMPONENTS 2123165	X	X	X	X	X	X
PORTABLE TEMPERATURE INDICATOR 2125073						X
1.00" VALVE OPERATOR 2135559	X	X	X	X	X	X
MAPPING FIXTURE 2115039						X
HEAT EXCHANGER COVER PLATE 2132223						X

SET UP AND CALIBRATION

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SECTION 1- MAGNET SYSTEM INSTALLATION

WARNING!

MAKE SURE BOTH MAGNET AND ROOM VENTING SYSTEMS ARE INSTALLED IN THE MAGNET ROOM, IN CONFORMANCE WITH THE SITE PLANNING MANUAL (REV. 4 AND ABOVE), PRIOR TO BRINGING THE MAGNET INTO THE ROOM. LARGE QUANTITIES OF GASEOUS HELIUM ARE DISCHARGED FROM THE MAGNET DURING INSTALLATION AND COMMISSIONING ACTIVITIES, WHICH WILL REQUIRE EXHAUSTING TO PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5-3 OF THE INTRODUCTION (CRYOGEN SAFETY).

Procedures for moving the magnet into the magnet room and leveling the magnet are covered in GE Magnet Rigging section of this manual.

It is essential that these procedures are completed and that the magnet is in its permanent location and leveled before commencing with this Section.

Review component identification and safety considerations in Introduction, Section 4 and 5 of this manual prior to initiating the installation.

1–1 CONVERSION TO OPERATING CONFIGURATION

Description:

The magnet arrives at the installation site in a “shipping” configuration and requires the actions covered in this procedure to convert it a the “operating” configuration. Ground shipments (over land or sea) are made with all Helium Vent Plumbing installed on the magnet. Air shipments are made with the Vent Adapter and connected plumbing removed and a blanking plate and relief valve installed in place of the Burst Disc.

Procedure:

1. Make sure plumbing valves are in the following positions. See Illustration 1 – 1,

VI – Closed	*V3 – Partially Open
V2 – Closed	*V4 – Partially Open

* V3 and V4 factory set for shipment to achieve maximum cooling / efficiency during shipment.

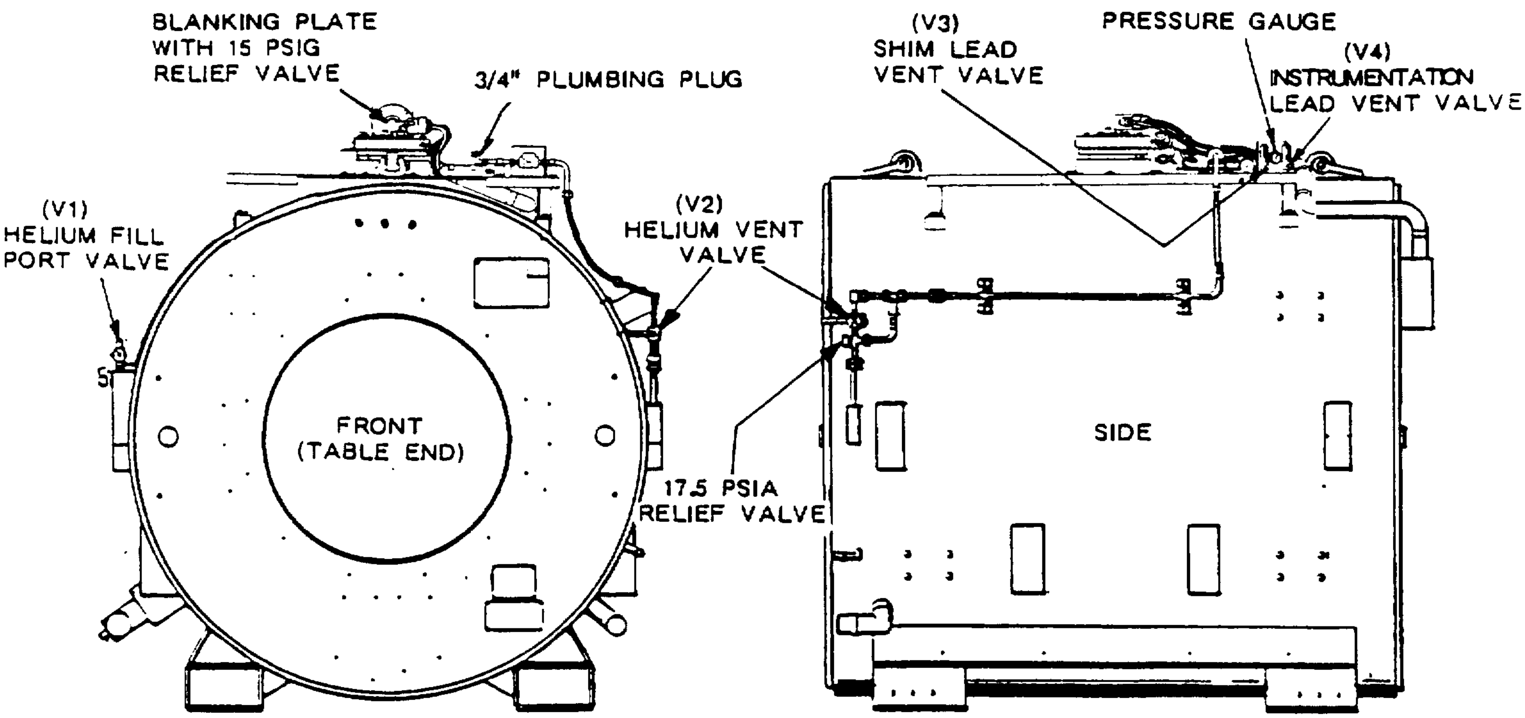
1–1 CONVERSION TO OPERATING CONFIGURATION (continued)

2. Record the pressure indicated on the pressure gauge on top of the magnet, ________________

Note

Steps 3 through 17 are not performed for Ground shipped magnets. Perform these steps only for Air shipped magnets with the Vent Adapter Plumbing and Burst Disc removed.

3. Close valves V3 and V4 at the base of the flow meters. See Illustration 1–1.
4. Remove the plug at the end of the 3/4 inch plumbing off of V2. See Illustration 1 – 1,



MAGNET AIR SHIPMENT CONFIGURATION
ILLUSTRATION 1–1

1–1 CONVERSION TO OPERATING CONFIGURATION (continued)

WARNING!

MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5–3 OF THE INTRODUCTION (CRYOGEN SAFETY).

RAPID EXHAUSTING OF COLD HELIUM GAS WILL BE ENCOUNTERED WHEN REPLACING THE HELIUM VENT PLUMBING AND BURST DISC. WERE NON–ABSORBENT GLOVES AND GOGGLES OR FACE SHIELD WHEN PER FORMING THESE OPERATIONS.

MAKE SURE THAT NO PERSON IS ON THE SERVICE PLATFORM WHEN HELIUM VENT VALVE (V2) IS OPENED.

5, Slowly open Vent Valve V2 and allow the Cryostat to exhaust until the pressure, indicated on the pressure gauge on top of the magnet, is less than 0.3 psi. Close V2.

6. Remove the 17.5 psia, Absolute Pressure Relief Valve, located on the Magnet Vent Plumbing adjacent a Valve V2. Quickly place the Threaded Cap, contained in the plastic bag located in the Conversion Kit (packed Inside of the Magnet Crate) onto the Threaded Tee where the relief valve was removed.

7, Unpack the 20 psi Burst Disc from its container, located in the Conversion Kit, and inspect it for visible damage **(** nicks/ scratches), Assure that the Burst Disc has the proper part number (46–252838P4) and rating plate marking of 20 psi.

CAUTION

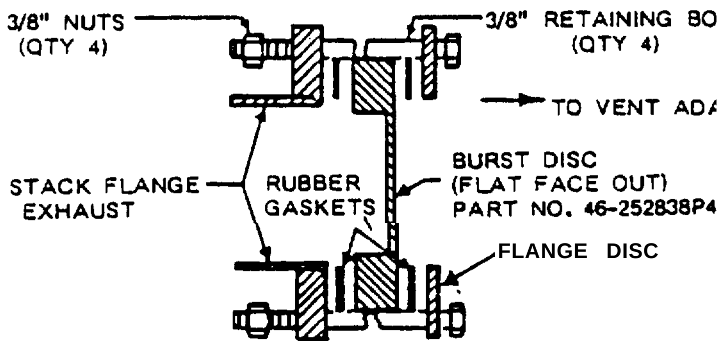
Perform Step 8 through 11 rapidly to prevent condensation and icing within the Vertical Sack.

8. Loosen the four 3/8 inch Retaining Bolts holding the 15 psi Shipping Relief Valve and Blanking Plate to the Stack Flange Exhaust and remove the top two bolts, while holding the Blanking Plate and Flange Disc. See Illustrations 1–1 and 1–2.

9. Remove the 15 psi Shipping Relief Valve and Blanking Plate.

10. Install the Burst Disc and Gaskets with the flat face of the disc facing out from the Stack Flange. See illustration 1–2.

1–1 CONVERSION TO OPERATING CONFIGURATION (continued)



HELIUM VESSEL BURST DISC ASSEMBLY
ILLUSTRATION 1–2

Note
Ensure that the Burst Disc is fully sandwiched between the two rubber gaskets, i.e., the gaskets are flat and the Burst Disc is not in contact with the flanges.

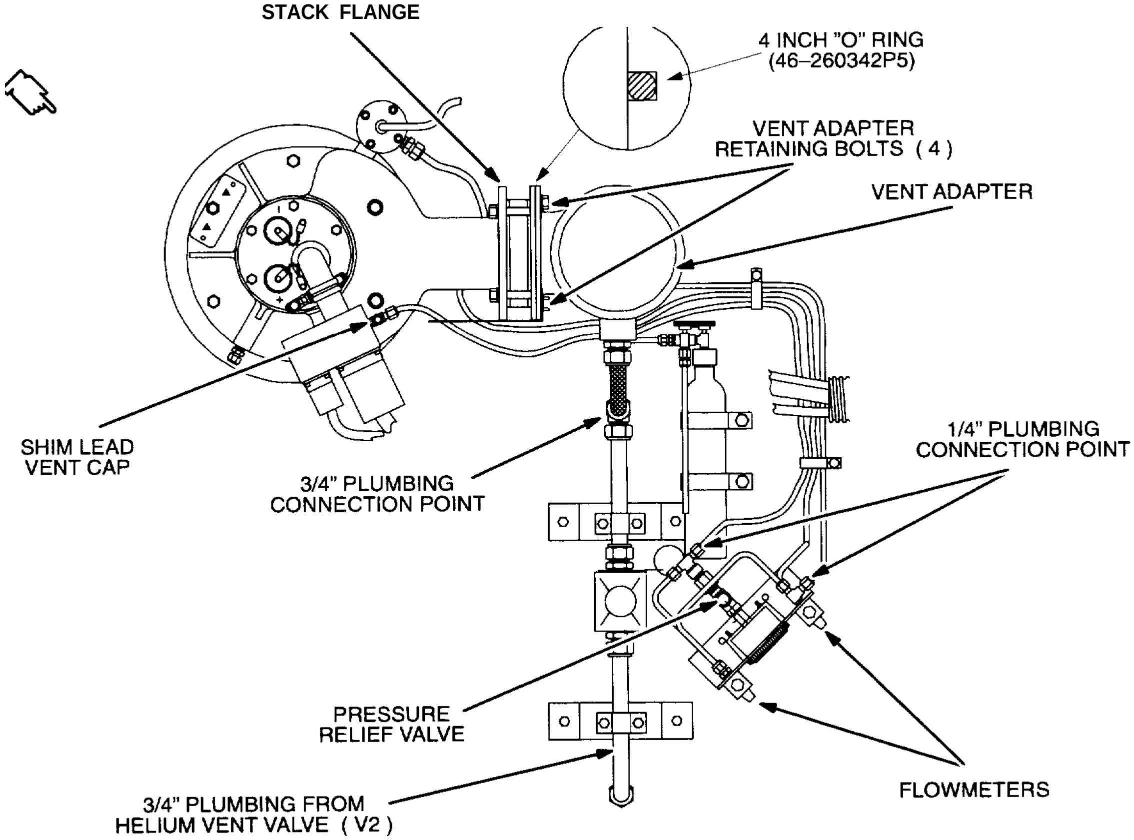
11. Assemble and tighten the four Retaining Bolts sufficiently to prevent leakage around the gaskets,

Note
See Illustration 1–3 for Steps 12 through 15.

12. Install the 4 inch "O" Ring (46–260342P5) located in the Conversion Kit, in the groove of the Vent Adapter.
13. Remove the four Retaining Bolts for the Vent Adapter from the Stack Flange and install the Vent Adapter and Plumbing Connections to the Sack Flange, using the same bolts.

14, Connect the 3/4 inch Plumbing from the Vent Adapter to the Swagelok Fitting on the 3/4 inch Plumbing Line where the Threaded Cap was removed.

1-1 CONVERSION TO OPERATING CONFIGURATION (continued)



VENT ADAPTER & PLUMBING CONNECTIONS
ILLUSTRATION 1–3

15. Connect the 1/4 inch Plumbing from the under side of the Vent Adapter to the Swagelok Fitting on the Flowmeter Vent Plumbing,

16. Open valves V3 and V4.

17, Remove the 15 psi Relief Valve from the Blanking Plate. Pack and return the 17.5 psia and 15 psig Relief Valves to:

GE MAGNET SYSTEMS
3001 W. RADIO DRIVE
FLORENCE, SOUTH CAROLINA 29501
ATTN: MATERIALS GROUP

1–1 CONVERSION TO OPERATING CONFIGURATION (continued)

CAUTION

Cryostat exhaust: flow rates and pressure must be checked and adjusted as required after magnet installation, ramping and shimming to ensure that proper cooling conditions are maintained and no leaks are present in the Helium Exhaust System or Vent Valve (V2).

18. Open Vent Valve (V2) to de–pressurize the Cryostat to 0,25 psig. Close V2,

Note

Read all flow rates from the bottom of the float (ball) on the flowmeters

19, Set Flowmeter (F1) between 0.4– 0.6 SCFH.

20, Set Flowmeter (F2) between 1.5– 2.0 SCFH a maintain a Cryostat Pressure Gauge reading between 0.25–0.50 psig.

21. Make sure flow rate through F2 is equal or greater than 1.5 SCFH

22. If flow rate through F2 is less than 1.5 SCFH or the pressure gauge reads less than 0.25 psig, pressurize the vessel and “bubble test” all exhaust plumbing joints, relief valve and Shim Lead Connector. Make sure V2 is fully closed. Repair any leaks. If a 1.5 SCFH flow rate through F2 cannot be achieved, under the above conditions, contact your Region Magnet Service Engineer.

1–1 CONVERSION TO OPERATING CONFIGURATION (continued)

23. Make sure the following conditions are maintained. Re-check settings in three days and again after one week:

    FLOWMETER (F1) = 0,4– 0.6 SCFH
    FLOWMETER (F2) = 1.5– 2.0 SCFH
    CRYOSTAT GAUGE PRESSURE – 0.25– 0.50 psig

Note

Until the Cold Head is operating and has reached its stabilized temperatures, either the flowrates or the pressure will be elevated. Try to minimize flows, but do not leave the pressure higher than 3 psig.

24. Remove the Lifting Shackles from the Magnet Lifting Brackets and store outside of the magnet room.

1-2 VENTING INSTALLATION

WARNING!

TO AVOID BURNS FROM COLD EXHAUST GAS, MAKE SURE THAT ACCESS TO WITHIN 3.048 m (10 FT) OF THE EXHAUST DUCT EXIT, IS RESTRICTED.

PROTECT THE VENTILATION EXHAUST OPENING FROM ENTRY OF RAIN, SNOW OR DEBRIS THAT COULD BLOCK THE EXHAUST SYSTEM.

MAKE SURE THAT THE PRESSURE DROP IN THE VENT SYSTEM DOES NOT EXCEED 17 PSI FROM THE VENT ADAPTER TO THE EXIT AT THE OUTSIDE OF THE BUILDING. THIS WILL PREVENT ANY POSSIBLE DAMAGE TO THE MAGNET AND VENT SYSTEM DURING A QUENCH. USE TABLE 1-1 TO COMPUTE THE PRESSURE DROP IN THE SYSTEM.

CAUTION

Insulate Vent Pipe In magnet room if there are horizontal sections that could collect condensation end drip on personnel.

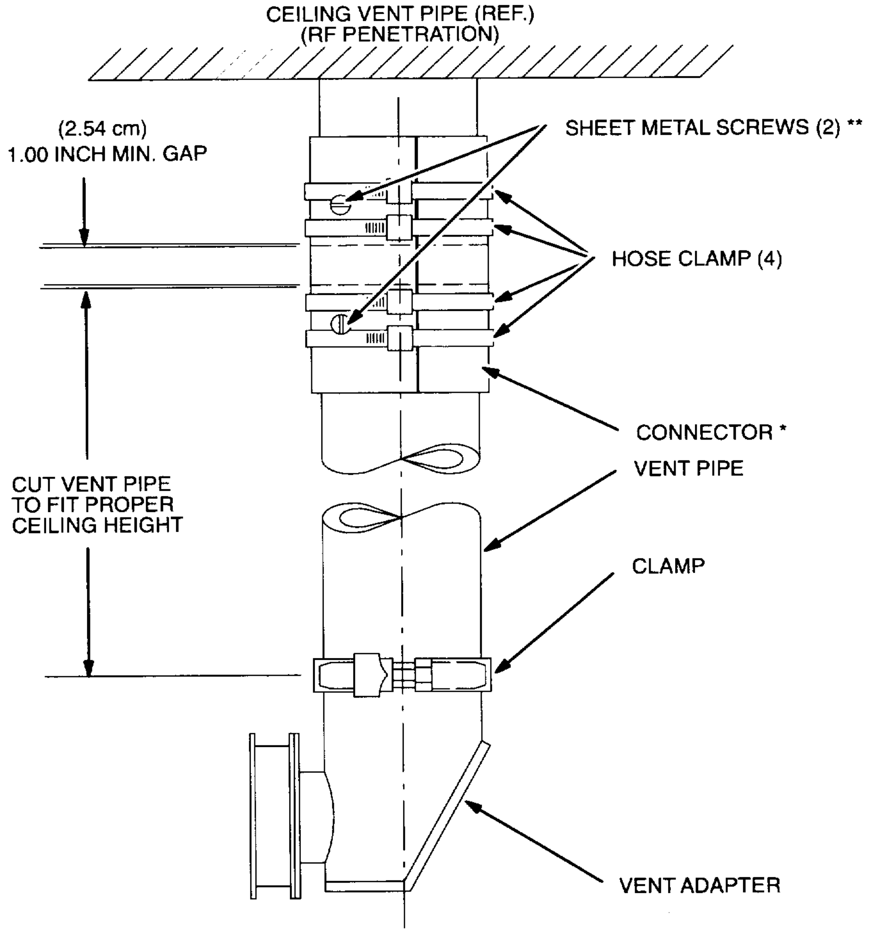
Inspect the Vent System for integrity and blockages prior to connecting it to the Magnet.

6.00” VENT SYSTEM:

Assemble the 6.00” dia. Helium Vent Kit (46–281866G1) between the Magnet Vent Adapter and the Outside Vent to the “RF Penetration” point. Cut Vent Pipe to required length. Use the clamps and connector provided in the Kit to connect the vent to the Outside Vent at the “RF Penetration” point. See Illustration 1–5.

Connect the Vent to the Vent Adapter of the Magnet using the Clamps and Gasket provided.

1–2 VENTING INSTALLATION (continued)



* 60.00” X 8.00” FIBERGLASS CONTINUOUS WRAP SLEEVE
** INSTALL SCREWS AS LAST STEP IN ASSEMBLY AFTER DRILLING HOLES (11/64") ADJACENT TO HOSE CLAMPS AS SHOWN.

HELIUM VENT KIT ASSEMBLY (6.00” DIA.)
ILLUSTRATION 1–5

1–2 VENTING INSTALLATION (continued)

TABLE 1–1
HELIUM VENT LINE PRESSURE DROP MATRIX

CRYOGENIC VENT SYSTEM PRESSURE DROP MATRIX FOR A 1.5 TESLA MAGNET					PRESSURE DROP PER ELBOW USED ANYWHERE WITHIN A 20 FT VENT SEGMENT			
INSIDE DIAMETER OF VENT PIPE in (mm)	DISTANCE OF VENT SYSTEM COMPONENT FROM MAGNET ft	(m)	PRESSURE DROP FOR STRAIGHT VENT PIPE WITH SMOOTH INSIDE SURFACE psi/ft	(KPa/m)	STANDARD SWEEP 45° ELBOW psi (KPa)	STANDARD SWEEP 90° ELBOW psi (KPa)	LONG SWEEP 45° ELBOW psi (KPa)	LONG SWEEP 90° ELBOW psi (KPa)
6 (152)	0–20	(06.1)	0.41	(9.27)	3.40 (23.44)	6.60 (45.51)	1.71 (11.79)	3.28 (22.62)
	2040	(6,1-12.2)	0.83	(18,77)	6.20 (42.75)	11.50 (79.29)	3.10 (21 .37)	5.75 (39.65)
	40–60	(12.2-18.3)	1.21	(27.37)	8.80 (60,68)	16.40 (11 3.08)	4.38 (30.20)	8.22 (56.68)
	60–80	(18.3-24,4)	1.60	(36.19)	11.40 (78.60)	21 .20(146,17)	5.69 (39.23)	10.62 (73.22)
	80-100	(24.4-30.5)	2.05	(46.37)	14,20 (97.91)	26.60 (183.41)	7.12 (49.09)	13.29 (91 .63)
8(203)	0–20	(0-6,1)	0.10	(2.26)	1.10 (7.58)	2.06 (14.20)	0.55 (3.79)	1.03 (7.10)
	2040	(6.1-12.2)	0.21	(4.75)	2.10 (14.48)	3.70 (25.51)	1.03 (7.10)	1.85 (12.76)
	40–60	(12.2-18.3)	0.30	(6.79)	2.88 (19.86)	5.21 (35.92)	1.44 (9.93)	2.60 (17.92)
	60–80	(18.3-24.4)	0.38	(8.60)	3.70 (25.51)	6.71 (46.27)	1.85 (12,76)	3.36 (23.17)
	80–100	(24.4-30.5)	0.47	(10.63)	4.52 (31 .17)	8.22 (56.68)	2.26 (15.58)	4.11 (28.34)
10(254)	0-20	(0-6.1)	0.03	(0.68)	0.55 (3.79)	0.82 (5.65)	0.27 (1 .86)	0.41 (2.83)
	20-40	(6.1-12,2)	0.07	(1.58)	0.82 (5.65)	1.51 (10.41)	0.41 (2.83)	0.75 (517)
	40-60	(12.2-18,3)	0,10	(2.26)	1.23 (8.48)	2.19 (15.10)	0.62 (4.27)	1.10 (7,58)
	6&80	(18.3-24.4)	0,12	(2.71)	1.51 (10.41)	2.74 (18.89)	0.75 (5.17)	1.37 (9,45)
	80-100	(24.4-30.5)	0.16	(3.62)	1,92 (13,24)	3.43 (23.65)	0.96 (6,62)	1.71 (11 ,79)
12(305)	0–20	(M I)	0.013	(0.29)	0.27 (1 ,86)	0.41 (2.83)	0.14 (0.97)	0.21 (1,45)
	20-40	(6.1-12.2)	0.027	(0.61)	0.41 (2.83)	0,82 (5.65)	0.21 (1,45)	0,41 (2,83)
	40-60	(12.2-18.3)	0.041	(0,93)	0.55 (3.79)	1.10 (7.58)	0.27 (1.86)	0.55 (3.79)
	60–80	(1 8.3-24.4)	0.054	(1 ,22)	0.69 (4.76)	1.37 (9.45)	0.34 (2.34)	0.69 (4.76)
	80–100	(24.4-30.5)	0.069	(1 ,56)	0,96 (6.62)	1,51 (10,41)	0,48 (3.31)	0.75 (5,17)
	1 00–120	(30.5-36.6)	0.08	(1.81)	1.09 (7.52)	1,77 (12,2)	0,55 (3.79)	0.88 (6.07)
	120–140	(36.642.7)	0.10	(2.26)	1.27 (8,76)	2,07 (14.3)	0.63 (4.34)	1.04 (7,17)
	140–160	(42.7-48.8)	0.11	(2.49)	1.43 (9.86)	2.36 (16.3)	0.72 (4.96)	1.19 (8.21)
	160–180	(48.8-54.9)	0.12	(2.71)	1.6 (11 .0)	2.53 17.4)	0.80 (5.52)	1,27 (8.76)
	180–200	(54.9-61.0	0.17	(3.85)	1.75 (12.1)	2.93 (20.2)	0.88 (6.07)	1.47 (10.14)

Note l: Elbows with angles greater than 90° must not be used.

Note 2: The table data is based on the following:

a. Initial flow conditions at magnet interface
b. Gas temperature starting at 4.5 Kelvin (-452° For –268° C).
c. Helium gas flow rate of 2737 cubic feet' per minute (77.5 cubic meters per minute)
d. 45° standard sweep elbow K = 15 F_t
e. 90° standard sweep elbow K = 30 F_t
f, 45° long sweep elbow K = 7.5 F_t
g. 90° long sweep elbow K = 15 F_t
h. No offset between magnet vent adapter and ceiling RF vent adapter.

NOTE: MAXIMUM PRESSURE DROP .17 PSI (117.22 KPa)
PRESSURE DROP MEASURED FROM MAGNET VENT ADAPTER TO EXIT OF BUILDING

Note

If the total pressure drop calculated exceeds the maximum specified pressure drop off 17 psi (117.22 KPa), then larger diameters for some of the vent line sections would have to be selected and the total pressure drop recalculated until it is less than 17 psi (117.22 KPa).

1–3 SHIELD COOLER INSTALLATION AND CHECK OUT

Description:

The Shield Cooler Assembly comes with a Cold Head already installed on the Magnet and a separate Compressor Unit, which will be located in the Equipment Room. A power cable and gas supply and return lines connect the two units, Alternate vendors may supply the Shield Cooler System. Locate and read the vendor manual(s) supplied with your system to become thoroughly familiar with the configuration and procedures for the system supplied prior to installation. Compressor installation instructions are covered in the vendor manual, The Shield Cooler Interconnect Diagram is shown in Schematics/Interconnects, Illustration 1–2.

Note

Compressor and Cold Head appearance will differ for alternate vendors and models. Refer to the vendor manual(s) for the identification and location of components and areas covered in the procedures. Balzer Shield Cooler Components are depicted for the procedures in this manual.

Procedure:

1-3-1 Compressor Installation

1. Unpackand install the compressor in conformance with the vendor service manual. Note any visible damage and notify the shipper.

2. Position the compressor in the equipment room as required for power and water connections

CAUTION

Make sure all shipping bolts are removed (see vendor manual) prior to connecting power. Damage will result if compressor is operated without shipping bolts removed.

3. Connect the input power cable in conformance with the vendor manual and local electrical code.

1–3–l Compressor Installation (continued)

Note

The cable for the Balzer's Compressor is supplied separate with the unit. The Compressor Power Cable color code is shown below:

UL CABLE *1	NON–UL CABLE *2	
Black	Brown'	
Red	Black	– 3 Phase Connections (As Required by IEC 601)
Orange	Black	
White	Blue	– Neutral
Green	Green/Yellow	– Ground (Protective Earth)

*1 UL Cable (46–281792P1) is supplied with compressors 46–260759G3,G5

*2 Non–Ul Cables were supplied with older compressors 46–260759G1 ,G2

CAUTION

Do Not connect the flex lines at this time.

1-3-2 System Gas Charge Pressure Check

Description:

The compressor static gas pressure should be in the range given in the vendor service manual. Check the static pressure reading on the Compressor Pressure Gauge. If the pressure is not within specification, use the following procedure to adjust the pressure to specification. Static pressure is effected by ambient temperature. Small variances will occur with temperature variances around 70 deg. F.

Increasing Gas Pressure:

CAUTION

The following procedure purges air out of the regulator and connecting lines before the line is connected to a new cylinder of certified 99.999% helium gas.

Note

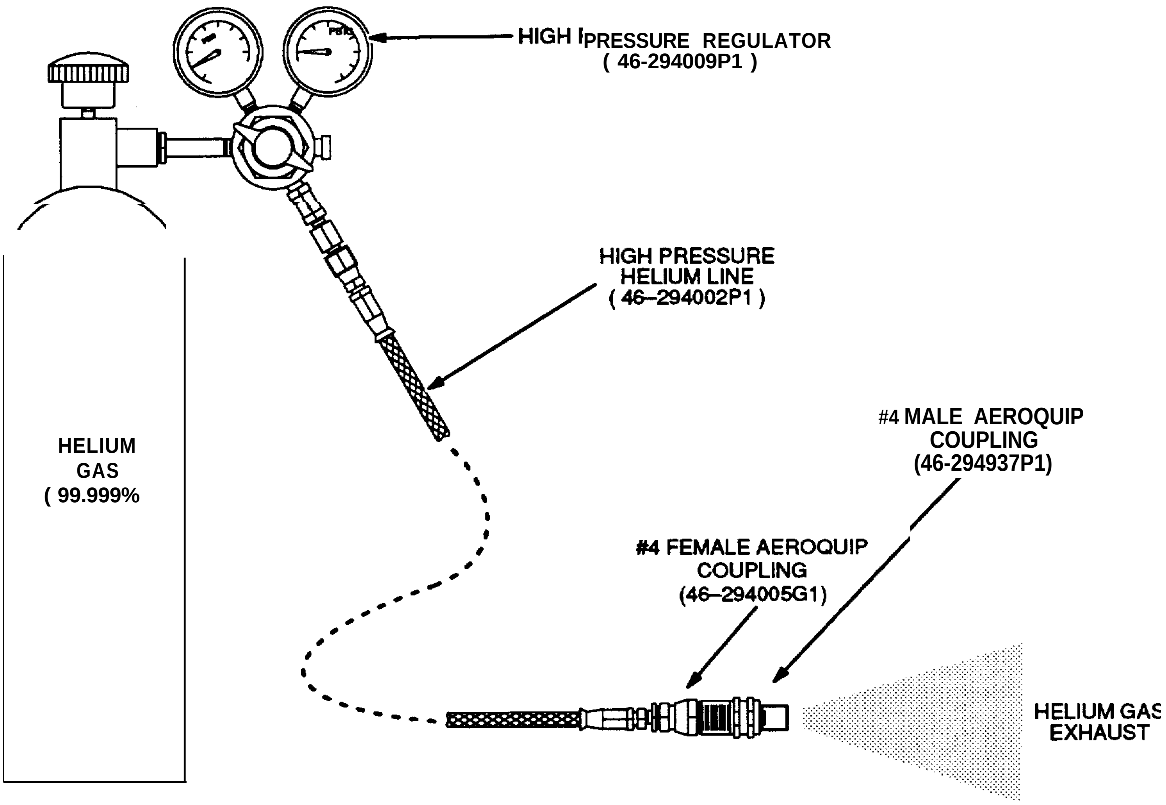
Use the Shield Cooler Installation / Maintenance Kit (46–281088G3) to perform all necessary maintenance to Shield Cooler Systems.

Increasing Gas Pressure: (continued)

1. Obtain a cylinder of 99.999% Helium Gas.

2. Loosely attach th high pressure regulator (46-294009P1) to the gas cylinder, per the following steps.
   A. Thread in the screw that connects the regulator to the Helium bottle about 2 turns.
   B. Turn Regulator handle fully clockwise to open the regulator.
   C. Open Helium bottle, and immediately tighten the Regulator to the Helium bottle.
   D. Close the Regulator Valve by turning the handle counterclockwise.

3. Attach high pressure helium line (46-294002P1) to regulator at shut off valve. See Illustration 1-5B.



SET-UP FOR COMPRESSOR CHARGING
ILLUSTRATION 1-5B

4. **Attach the #4 Female Aeroquip Coupling (46-294005G1) to the end of the high pressure charging line. See Illustration 1–5C.**

DANGER!!

FATAL EXPLOSIVE HAZARD!! TO PREVENT POSSIBLE FATAL EXPLOSIVE RELEASE OF GAS, OPEN MAIN VALVE ON GAS CYLINDER VERY SLOWLY. GAS IS AT 2400 PSI.

Increasing Gas Pressure: (continued)

5. Attach #4 Male Aeroquip Coupling (46-294937Pl) to the #4 Female Aeroquip Coupling. Hand tighten the fittings together. This will open the Helium circuit to allow the charging assembly to be purged.

6. Establish gas flow through the Helium line and fittings by slowly opening the main valve on the gas cylinder and tightening the male fitting into the female Aeroquip.

7. Allow Helium to purge out the assembly for 2 minutes.

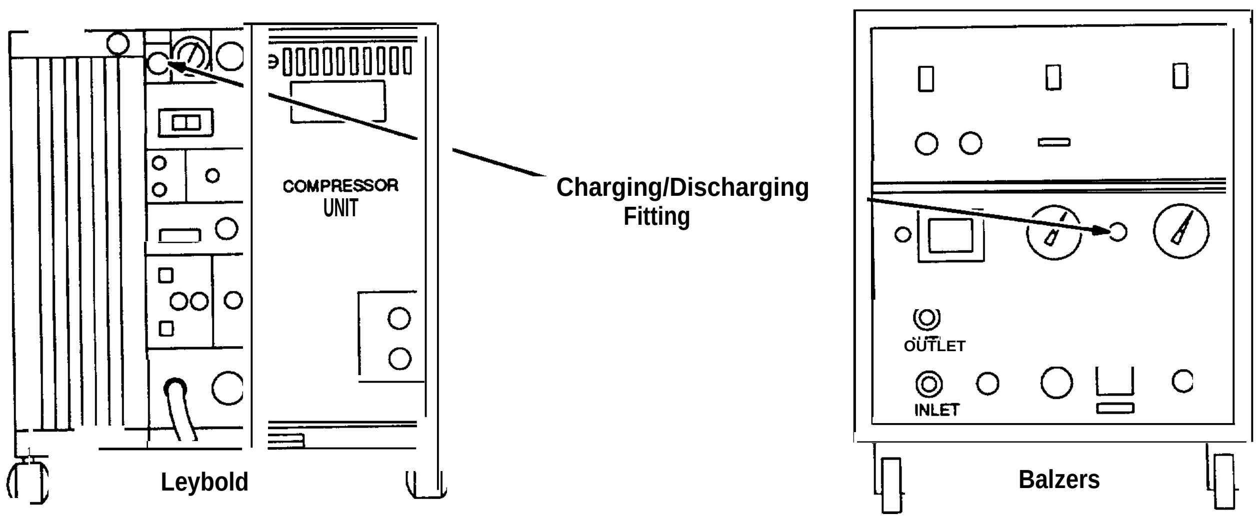
8. Remove the male Aeroquip fitting coupling from the female coupling.

9. Close regulator. Shut off compressor power to let supply and return pressures equalize in compressor.

10. Fully open valve on cylinder.

11. Adjust regulator control valve to achieve a pressure of approximately 200 psig.

12. Attach purged charging line assembly with the female Aeroquip coupling to the charging fitting on the front of the compressor. See Illustration 1–5C.



CHARGE / DISCHARGE FITTING LOCATION
ILLUSTRATION 1-5C

13. Increase compressor Helium pressure by adjusting regulator until compressor's high side guage reads 235 psig for Balzers or 218-232 psig for Leybold.

14. If too much Helium gas has been added, refer to section on Decreasing Shield Cooler Gas Pressure, to lower the Helium Pressure.

Disconnection and Stowage of Hoses and Regulator:

1. Remove Aeroquip Coupling from Compressor. Restore Compressor power.
2. Close regulator.
3. Attach high pressure hose and Female Aeroquip to the Male Aeroquip #4 until the Helium circuit is opened and gas is flowing.
4. Allow high pressure line and Aeroquip to depressurize.
5. Remove #4 male Aeroquip, and remove the female Aeroquip from the high pressure charging line.
6. Remove the high pressure charging line from the regulator.
7. Close valve on Helium cylinder. Bleed off pressure from regulator.
8. Remove regulator from Helium bottle.
9. Store all equipment in carrying case from kit 46–281088G3, Shield Cooler Installation/ Maintenance Kit.

Decreasing Shield Cooler Gas Pressure:

1. Remove Protective Cap from compressor front panel fitting.
2. Connect oil charging hose and fitting (46–294003P1) to the small fitting on the front of the compressor. See Illustration 1–5C.

Note

Use the Shield Cooler Installation / Maintenance Kit (46–281088G3) to perform all necessary maintenance to Shield Cooler Systems.

3. Slowly tighten fitting until you hear gas escaping.
4. When a pressure of 235 psig forBalzersor218–232 psig for Leybold is reached, immediately unscrew fitting and hose to prevent further gas removal.
5. Replace protective cap on front panel fitting.

1-3-3 Compressor Phase Check (Balzer's Unit)

Note

After Checking/Adjusting Gas Pressure, Section 1–3–2, test the Balzer's Compressor to make sure the phases are correct, using the following procedure. For Leybold Units, refer to the Vendors Manual, Section 2–5 (Making the Electrical Connections).

CAUTION

Read and understand this procedure before starting, as the compressor can be safely operated for only one minute without the water supply conected.

1. Connect to main power by plugging in or operating the system disconnect switch. (whichever is applicable fo your installation).

1-3-3 Compressor Phase Check (Balzer's Unit) (continued)

2. Turn on the right hand power switch (white rocker switch)

3. Turn on the compressor rocker switch.

Note

There is a time delay relay set for a delay of approximately one minute. The compressor does not start when the switch is first operated. Wait for the compressor to start.

4. When the compressor comes on, note what happens to the readings of the pressure gauges.

5. If the wiring phases are incorrect, the gauges will not indicate a pressure differential pressure of approximately 150 psi as shown in Illustration 1-6.

RETURN **SUPPLY**

PRESSURE GAUGE READING
(WIRING PHASES CORRECT)
ILLUSTRATION 1-6

CAUTION

If wiring phases are incorrect, immediately turnoff the compressor. Continued operation with incorrect phasing can damage the compressor motor.

1-3-3 Compressor Phase Check (Balzer's Unit) (continued)

6. If the wiring phases are incorrect, the gauges will not indicate a pressure differential but each will vibrate about the value noted in the preceding step (approximately 235 psi), as shown in Illustration 1 –7.

PRESSURE GAUGE READING
(WIRING PHASES INCORRECT)
ILLUSTRATION 1-7

7. To correct the phases, disconnect the main power and interchange the two black wires in either the plug or the interconnection panel as appropriate.
8. If wires have been interchanged, repeat the procedure in Set Up and Calibration, Section 1–3-3.
9. Turn off compressor after correct phasing has been checked.

1-3-4 Cooling Water Supply Connection

1. Verify that the cooling water supply meets all water specifications and site planning in the vendor manual.
2. Connect the water supply hose to the cooling water inlet connection. Secure with a worm drive screw-type hose clamp.
3. Similarly connect the water drain hose to the cooling water outlet connection of the compressor.
4. Turn on the cooling water supply and operate the compressor alone for at least 30 minutes to ensure that cooling water is sufficient and that the compressor is operating properly.
5. Check the system for water leaks.

WARNING!

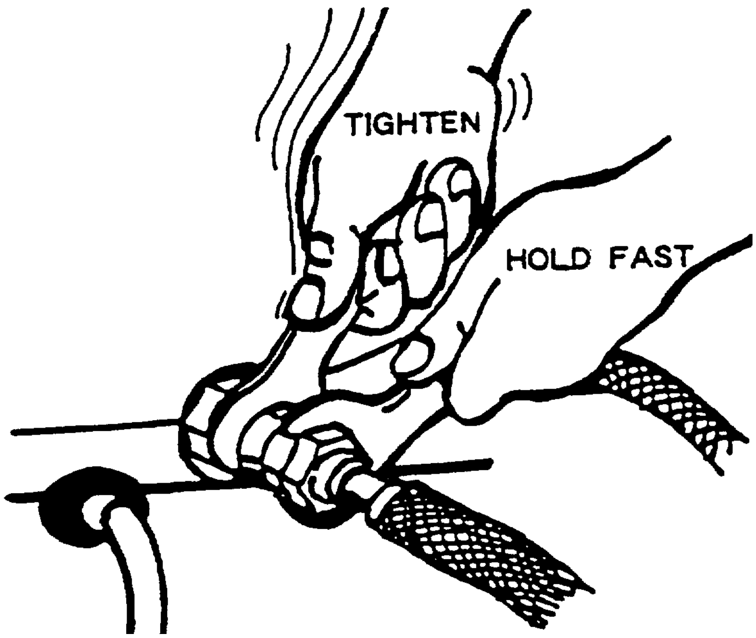
ANTIFREEZE IS POISONOUS TO AQUATIC, ANIMAL AND HUMAN LIFE. BECAUSE OF ITS SWEETNESS, ANIMALS MAYBE DRAWN TO IT. CONSEQUENTLY IT IS CLASSIFIED AS HAZARDOUS BOTH FOR SHIPMENT AND AS A WASTE. THEREFORE, IT MAY NOT BE SHIPPED BY UNTRAINED PEOPLE. SHIELD COOLER COMPRESSORS WHICH CONTAIN ANTIFREEZE MUST BE DRAINED BEFORE BEING RETURNED TO THE VENDOR. MAKE ARRANGEMENTS WITH THE HOSPITAL MAINTENANCE DEPARTMENT FOR DISPOSAL.

1-3-5 Flexible Gas Line Connections

Note
Refer to Replacement/Maintenance, Section 9 for details on connecting and disconnecting Aeroquip couplings.

1. Feed the flexible gas supply line (RUN 621) through either port (55mm hole) in the penetration panel and position it to have one end at the compressor and the other at the cold head on the Magnet Cryostat.
2. Similarly feed the flexible gas return line (RUN 622) through the other port in the penetration panel and route in parallel with the supply line.
3. Connect the lines to the compressor using the appropriate Aeroquip connection wrenches. See Illustration 1-8. Always use two wrenches as shown, so that the back adaptor connection is not disturbed, to prevent system gas leaks from occurring.
4. Observe the compressor pressure gauge readings after connecting the gas lines, readings should remain constant.

Note
if the readings are lower, this indicates that the gas lines were not fully charged when received, or that one could have a leak. If this condition occurs, go to Set Up and Calibration, Section 1–3-6.



PROPER CONNECTION OF AEROQUIP COUPLINGS
ILLUSTRATION 1-8

5. Route the Flexible Gas Lines through the base pad of the magnet before connecting them to the Cold Head. See Illustration 1-9.
6. Connect the other ends of the flex lines to the Cold Head. Connect the free ends of the flex lines to the mating fittings on the Cold Head, using two wrenches on the fittings. See Illustration 1-8.

7 . Observe the readings of the compressor pressure gauges. If they are constant, then a leak is not suspected.

8. If the reading is above 232 psig or below 218 psig then refer to vendor manual for troubleshooting instructions.

CAUTION

Flex Lines, with a 1 inch (25.4 mm) Inside diameter, have a minimum "Flexing Bend Diameter" of 17 Inches (432mm). Bending the flex lines beyond this point can damage the flex lines.

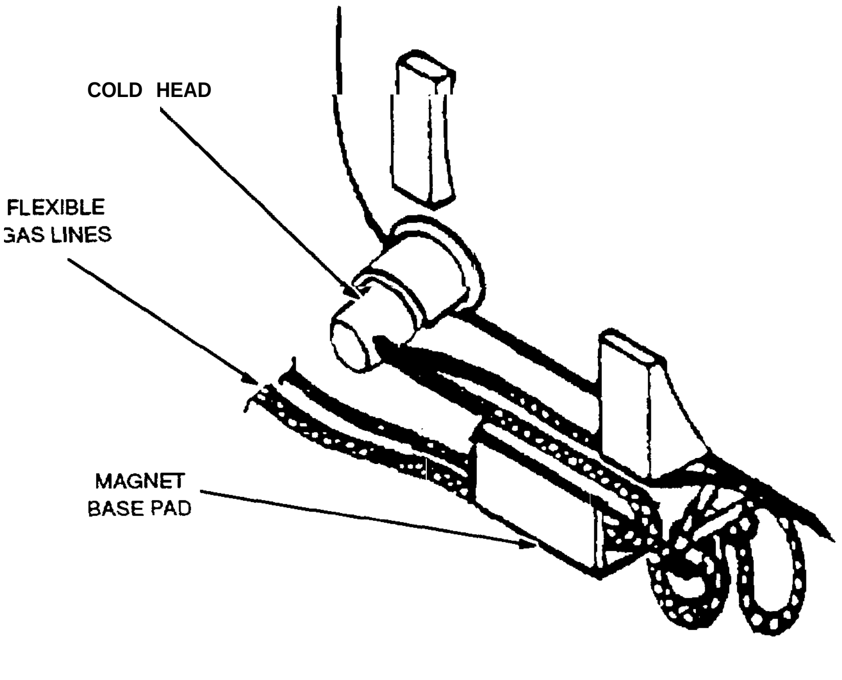
Flexling noise (chirping) is a function of the number of loops in the Flexline. Try to mlnlmlze number of loops formed when storing the Flexllne slack.

9. Press lines in a gentle curve award the center of the magnet and adjust line slack and angles a minimize tension and noise (chirping).

Note

The lines will eventually be routed out of a rectangular opening at the bottom, center of the Rear Enclosure Cover. Always adjust line slack after routing.

If site conditions permit, the line .slack can be neatly placed below the floor either in the Exam Room or the Computer Room.



FLEXIBLE GAS LINE ROUTING AT MAGNET
ILLUSTRATION 1–9

1-3-6 Leak Test

1. If the pressure continues to drop, remove the lines from the compressor, using the two wrenches as before.

Note

If the lines are suspected to have a leak, they may be tested using the regulator, charging line and manifold.

2. Connect the regulator, charging line and manifold and purge as previously described in Set Up and Calibration, Section 1–3-2, Steps 7 through 23.
3. Connect one of the flex lines to the appropriate fitting on the manifold, and pressurize to approximately 100 psi.
4. Reduce the supply pressure using the regulator control and observe whether the pressure is maintained on the manifold pressure gauge. If the pressure drops, then that line may have a gas leak.
5. Maintain 100 psi with the regulator and check the line with a liquid soap solution or a commercial leak testing solution such as Leak-Tee.
6. If the line has a leak, then notify Magnet Systems to obtain a replacement.
7. Repeat above process for the other line.

Note

If the compressor pressure gauge readings had dropped and stayed constant then the charge may have just been low and the system will be recharged in the next step. Return to Step 5 in Set Up and Calibration, Section 1–3–5.

1–3–7 Shield Cooler Electrical Cable Connection

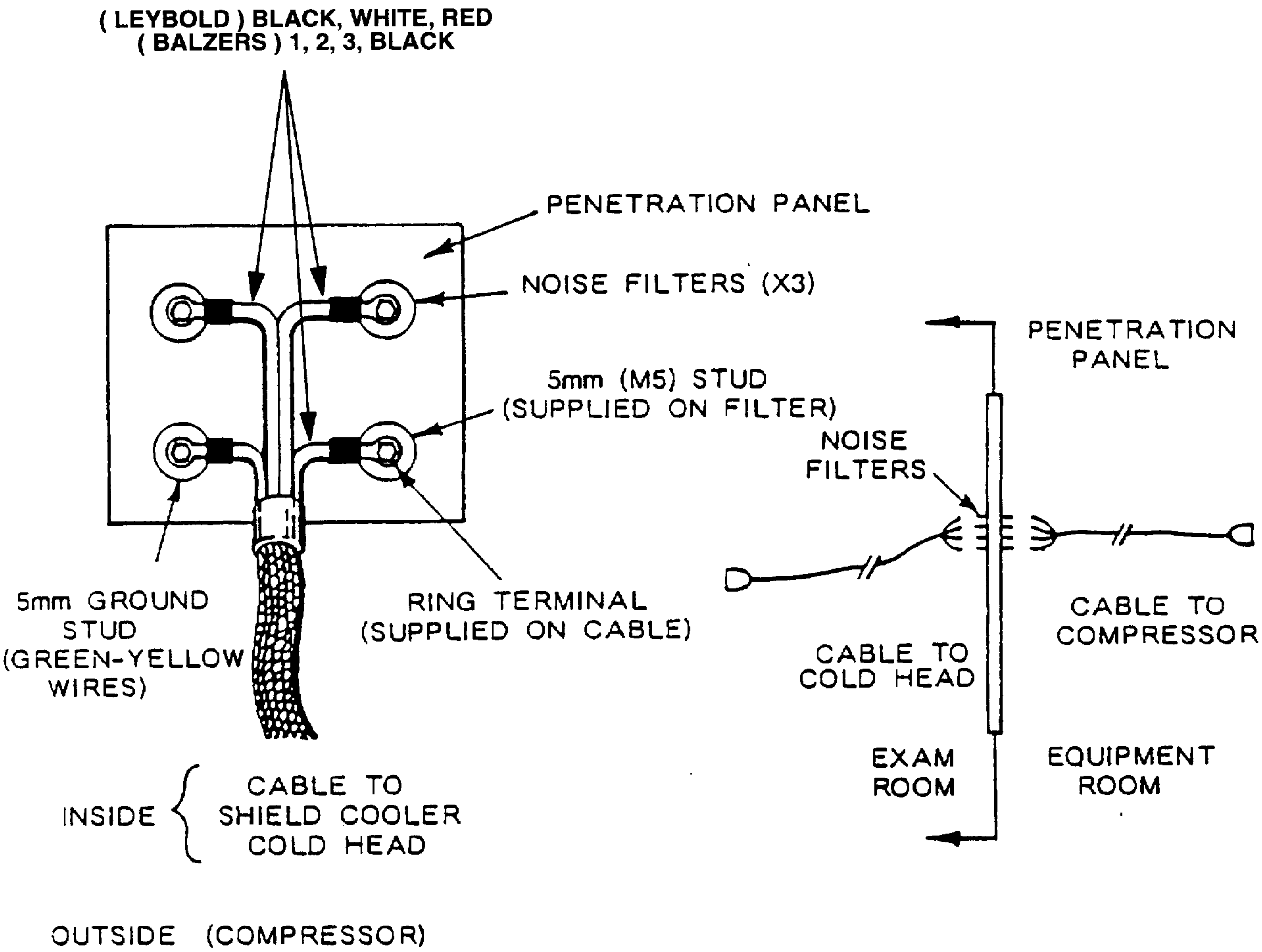
1. Connect the four ring terminals on the end of the Cold Head electrical cable (RUN #624) to the four studs of the noise filter on the inside of the penetration panel. See Illustration 1–10.
2. Connect the other end of the cable to the mating connector on the Cold Head.
3. Connect the four ring terminals on the end of the compressor electrical cable (RUN #623) to the four studs of the noise filter on the outside of the penetration panel (equipment room side).

CAUTION

Make sure that the wire code (color and number) is properly matched on the noise filter studs on both sides of the Penetration Panel.

4. Connect the other end of this cable to the Cold Head Connector on the Compressor.

1-3–7 Shield Cooler Electrical Cable Connection (continued)



SHIELD COOLER ELECTRIC CABLE CONNECTIONS
ILLUSTRATION 1–10

1–3-8 Shield Cooler Operation

1. Turn on the main power switch.
2. Turn on the compressor power switch.
3. For the Balzer’s Unit, wait for the compressor to start and allow it a run for a few minutes to reach equilibrium. Turn on the Cold Head Power Switch (left rocker switch), The Cold Head Motor should begin operating,

1–3-9 Monitoring Shield Cooler Temperatures

1. Use the Lakeshore Cryotonics Digital Cryogenic Thermometer Model DRC–80 (46–265269G1) or 208 Thermometer Kit (46–301477G1) to monitor Cold Head first and second stage temperatures.

2. Connect the Cryogenic Thermometer to the Cold Head in conformance with Illustration 1–11.

3. Select the Cold Read stage to be monitored as shown below,

STAGE	DRC–80	208 THERMOMETER KIT
FIRST	PRESS “A” BUTTON	SELECT CHANNEL 1
SECOND	PRESS “B” BUTTON	SELECT CHANNEL 2

4. Refer to vendor operations manual for 208 Thermometer, Ensure curve 2 (DT–500DCR – D) is selected.

Note

Both temperatures should begin falling after the Cold Head begins operating. Equilibrium temperatures are 32° K to 60° K for the first stage and 7° K to 17“ K for the second stage. Time to reach equilibrium may be up to four days, depending upon initial shield temperatures.

5, Read and record “FIRST STAGE” and “SECOND STAGE” Shield Temperatures at equilibrium:

First Stage Temperature ______________________ (32° - 60° K)

Second Stage Temperature ____________________ (7° - 17° K)

CAUTION

The magnet temperature sensors are designed to be driven by a 10 microampere source; some ohmmeters exceed this rating. Do not use any sensing or troubleshooting equipment which exceeds 10 microampere. The equipment/circuit in this section maybe used with a voltmeter to troubleshoot the sensor circuit

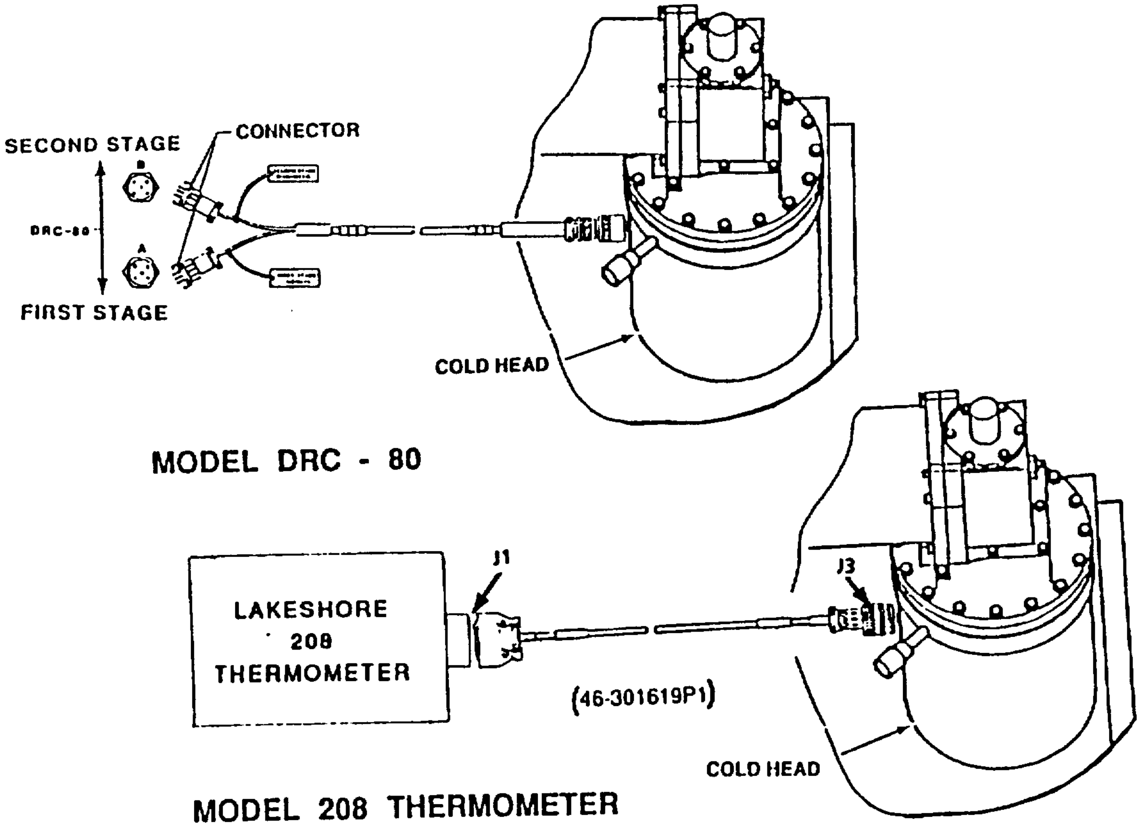
Note

Differences in diode mounting techniques and diode lead heat stationing used to intercept heat propagated down the leads from the outside the magnet, have produced increased variation in shield cooler diode temperature readings. Because of this condition, the acceptable diode temperature range (magnet operating with boil–off in specification) has exceeded the original temperature range established for field reference, for a small number of magnets. It is important to identify acceptable diode temperature readings which exceed the field reference range, as the “diagnostic threshold” for proper shield cooler operation. Diode temperature reading values are recorded on the Acceptance Test Report (ATR) sent with each magnet. Where the recorded value exceeds the field reference range documented in the above note, use the recorded value as the nominal value for proper shield cooler operation on the referenced magnet. Acceptable ranges around these nominal values are: ± 10 K FIRST STAGE ± 5 K SECOND STAGE
Starting March 1, 1993 all diode temperature reading values which exceed the field reference range will be recorded on a label attached to the coldhead sleeve, in addition to being recorded on the ATR.

1-3-9 Monitoring Shield Cooler Temperatures (continued)

Note

A SHORTED sensor circuit will cause the meter to display a reading of approximately 400° K whereas an OPEN sensor circuit will cause the meter display to flash. Check for problems in the connector cable or for proper plug termination before ruling the sensing diode defective.



SHIELD COOLER TEMPERATURE MEASUREMENT SET–UP
ILLUSTRATION 1–11

1-3-10 Setting Cold Head Tension

Description:

During magnet installation or anytime the Cold Head has been shut off for a considerable length of time (days), the Cold Head will contract as it begins operating and cooling down. The tightness of the Cold Head Mounting Bolts will need to be checked, and they may need to be adjusted periodically to ensure that good contact is maintained between the Cold Head and the Cold Head Sleeve.

Procedure:

1. Monitor the Cold Head first and second stage temperatures using a Lakeshore Digital Thermometer as described in Section 1–3–9 of Set–Up and Calibration.

2. When the Cold Head is first turned on , the Mounting Bolts should be adjusted finger tight. Leave the Belleville Washers noncompressed for now.

3. After the Cold Head has been operating and cooling for approximately two hours, tighten the mounting bolts in a CW rotation pattern to achieve the Belleville Washer Gap setting shown in Illustration 1–12 . Set the gap by tightening to the proper point. Do not set gap by overtightening then loosening as insufficient pressure will result.

   Note

   Do not overcompress the Belleville Washers. If overcompressed, the washers lose their tensioning ability. Overtightening may also overcompress the Indium Gaskets so that they do not provide good thermal conduction

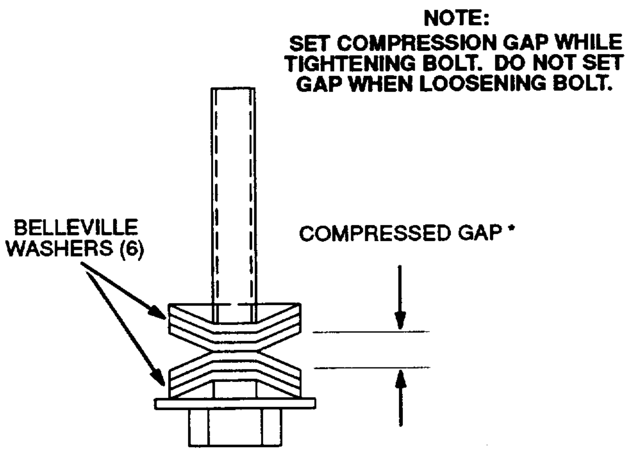
4. After tightening the Mounting Bolts, the Sleeve temperatures will decrease rapidly for a period of time, then will stabilize as the Cold Head cools and contracts away from the Sleeve. So periodically check the Mounting Bolts for tightness (approximately every 8 hours) and tighten them as needed to restore the proper Belleville Washer Gap. See Illustration 1–12.

5. This process will continue from 1 to 4 days until the Cold Head reaches its ultimate operating temperature. At this time, the Belleville Washers will be set to the proper gap, but the temperatures will no longer decrease.

6. The operating temperatures should be within the following ranges

   First Stage: 32° – 60° K
   Second Stage: 7° – 17° K

   The temperatures that were found for your magnet in the factory are recorded in the Acceptance Test Report (ATR) found in the Data Sheet Section of your manual. If temperatures are higher than those values, perform the tests listed in Functional Checks, Section 6 of this manual.

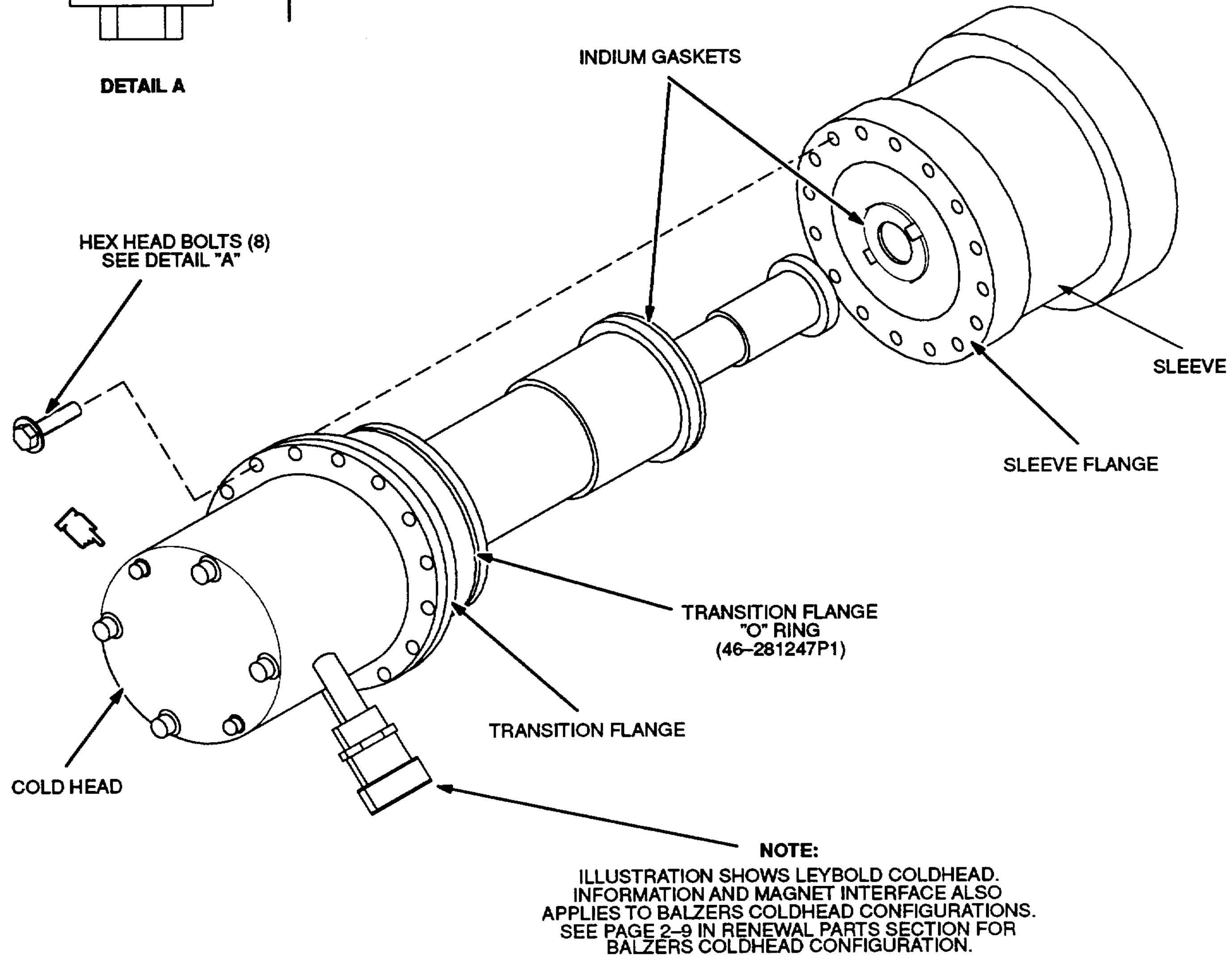


DETAIL A

Washer Type	P/N	COMPRESS GAP SETTING
Stainless	46–281387P1	0.010" – 0.015"
Be. Cu.	46–252317P1	0.003"

* Measure gap at edge of washers.

* Be Cu washers are bronze colored.
Stainless washers are dark gray.



COLD HEAD MOUNTING BOLT GAP SETTING

ILLUSTRATION 1–12

1-3-11 RF Shielding

Note

The shielding is performed from the Equipment Room side of the Penetration Panel using the following procedure. The procedure is applicable for both the Helium Supply and Return Lines.

1. Adjust th e slack on the Helium Supply and Return Flex Lines for the most suitable length on both sides of the Penetration Panel.

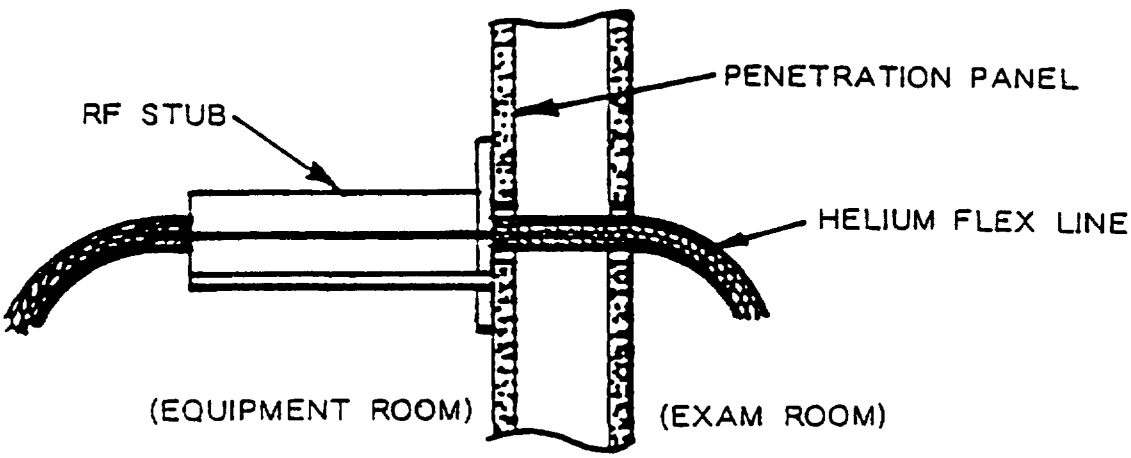
2. Position 1/2 of the RF Stub Assembly (46-260860G1) underneath the Helium Supply Line, with the flange end oriented toward the Penetration Panel. See Illustration 1-13.

Note

Make sure RF Stub Assembly is clean (bright copper appearance), wire brush surface as required to effect clean surface..

3. Secure the flange of the RF Stub Assembly to the Penetration Panel with four screws, aligning the flange holes with the holes in the Penetration Panel.

4. insert Bronze Wool (46-318068P1) around the Helium Supply Line (top and bottom) over the length of the RF Penetration Stub.



RF STUB A8SEMBLY MOUNTING
ILLUSTRATION 1–13

1–3–11 RF Shielding (continued)

5. Position the other 1/2 of the RF Stub Assembly over the Helium Supply Line, with the flange oriented toward the Penetration Panel and align it over the lower 1 /2.

6 Secure the flange of the top 1/2 of the RF Penetration Stub Assembly to the Penetration Panel with four screws, aligning the flange holes with the holes in the Penetration Panel.

7, Repeat the procedure for the Helium Return Line.

1-4 EMERGENCY / MAGNET RUNDOWN UNIT (ERU / MRU) INSTALLATION

WARNING!

THE EMERGENCY / MAGNET RUNDOWN UNIT MUST BE MOUNTED WITH THE FRONT PANEL IN A VERTICAL PLANE ($\pm 15^\circ$) BEFORE MAKING ANY CONNECTIONS. THIS IS NECESSARY TO PREVENT FALSE ACTUATION AND QUENCHING OF THE MAGNET.

MAKE SURE THAT THE HEATERS (ERU / MRU) ARE NOT CONNECTED TO J2 UNTIL UNIT IS THOROUGHLY CHECKED PER VENDOR SERVICE MANUAL. ALSO MAKE SURE THAT THE HEATER SWITCH (RED BUTTON) IS NOT DEPRESSED (PULL OUT IF NECESSARY) TO PREVENT AN INADVERTENT MAGNET QUENCH.

1. Install and inspect the '"ERU / MRU" in conformance with the vendor service manual supplied with the unit.

2. Connect batteries as indicated in the vendor service manual and plug power input cord into wall outlet supplying 100–120V AC at 50-60 Hz.

Note

Unit is shipped with power cord wired for the electrical specifications in Step 2. Rewiring for local requirements is covered in the vendor manual. Plug change on the power cord maybe required.

3. Install and adjust ERU / MRU in conformance with Section 2 of the vendor service manual supplied with the unit.

CAUTION

ERU/MRU Cable is a shielded cable open at the Magnet End (P3). It is essential that the cable is properly connected, Magnet End (P3) connected to Magnet Terminal Box.

4. Connect Lemo Connector (P2)on ERU / MRU Cable (RUN #606) to (J2) on ERU /MRU. Wiring diagram shown in Schematics/Interconnects, Illustration 2–5.

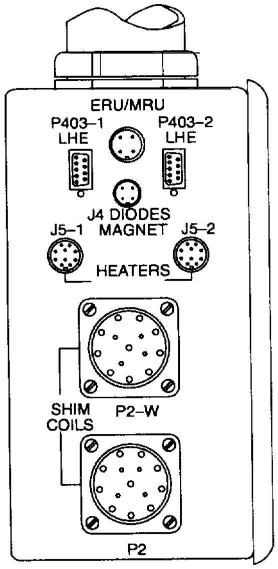
1-4 EMERGENCY / MAGNET RUNDOWN UNIT (ERU / MRU) INSTALLATION (continued)

5. Connect connector (P3) on ERU / MRU Cable (RUN #606) to (J3) on Magnet Harness Terminal Box (MS1-A3,A1) on Back Flange of magnet; ERU / MRU is now operable. See Illustration 1–14 for (J3) Location.

6. Verify that all connectors are mated on the top of the magnet: (J1-A), (J1-B), (PI-C).

7. Perform functional checks covered in Sections 2.09, 2.10 and 3 of the vendor service manual.

Note
ERU / MRU functional checks are also covered in Functional Checks, Section 4 of this manual.



MAGNET HARNESS TERMINAL BOX
ILLUSTRATION 1–14

Checks:

IMPORTANT !!!

Perform checks daily to make sure MRU is operative. See Illustration 1-15.

CAUTION

Maanet auench will result if Red Rundown Button is depressed.

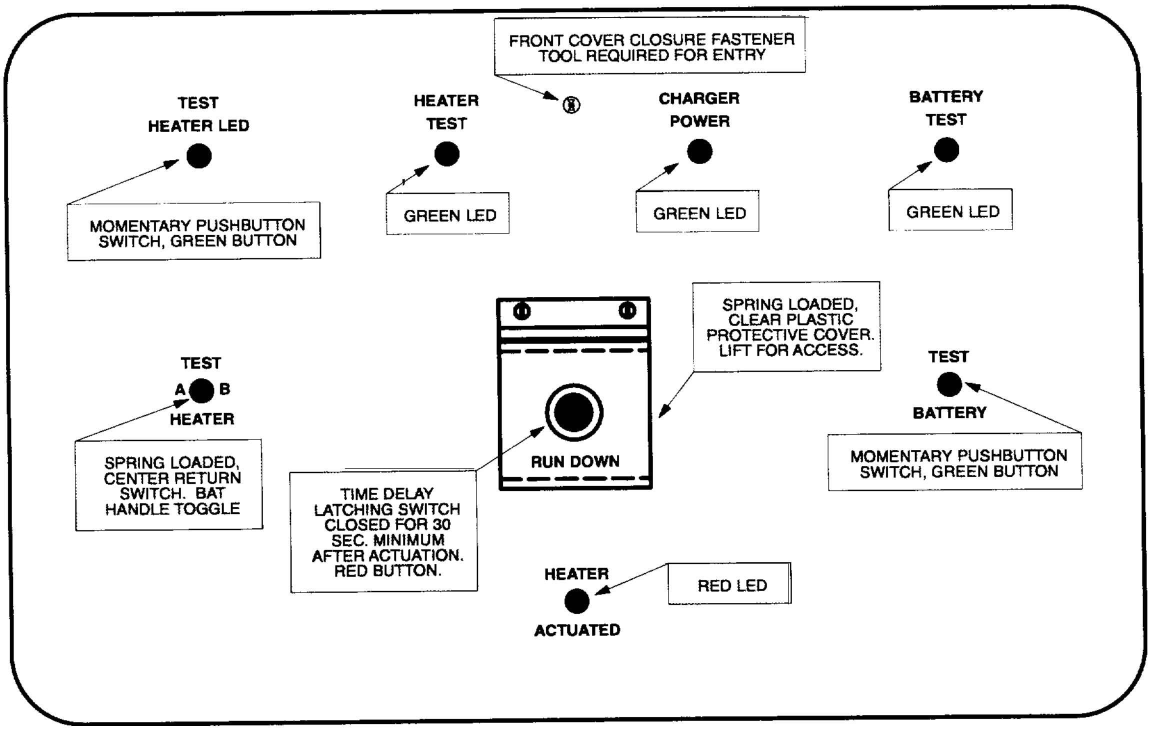
1. Verify green CHARGER POWER “LED” is lit.

2. Verify green BATTERY TEST “LED” lights when the TEST BATTERY SWITCH is depressed for 15 seconds.

3. Verify HEATER TEST “LED” lights when the TEST HEATER SWITCH is depressed.

4. Verify HEATER TEST “LED” lights when the spring loaded TEST HEATER SWITCH is held in both the A and B positions.

1-4 EMERGENCY / MAGNET RUNDOWN UNIT (ERU / MRU) INSTALLATION (continued)



MRU FRONT PANEL LAYOUT, LABELING & CONTROL FUNCTIONAL DESCRIPTIONS
ILLUSTRATION 1–15

1–5 CRYOGEN MONITOR INSTALLATION

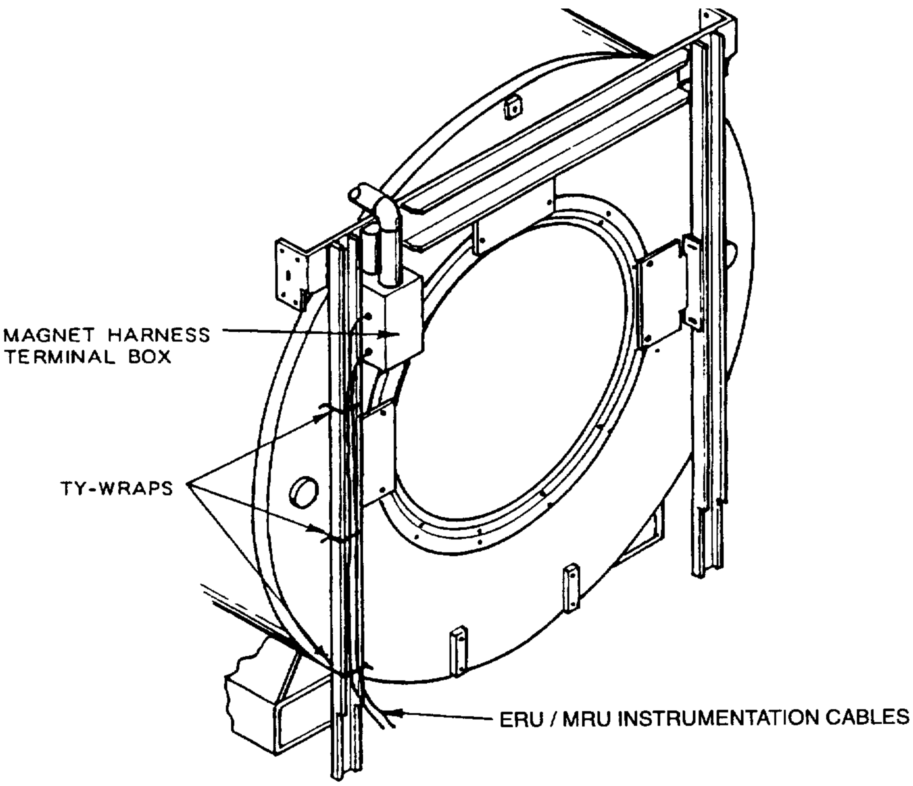
1. Install and inspect the Cryogen Monitor in conformance to Section 3 of the vendor service manual supplied with the unit. This unit is installed in the MR System Cabinet (MR2).

CAUTION

Establish power source values and ensure Cryogen Monitor is properly wired for input power per Step 5, Section 3 of the vendor manual for proper operation. Plug change on power cord may be required.

2. Connect Instrumentation Cable #1 (RUN #605) from (J403) on the Cryogen Monitor to (P403) on the Penetration Panel. Wiring diagram shown in Schematics/Interconnects, Illustration 2-6.
3. Connect Instrumentation Cable #2(RUN #605) from (P403) on the Magnet Harness Terminal Box to (J403) on the Penetration Panel. See Illustration 1–14 for (P403) location.
4. Ty–wrap ERU / MRU Cable (RUN #606) and Instrumentation Cable (RUN #605) to Back End, left Vertical Shroud Channel. See Illustration 1–16.

Note
Cryogen Monitor Calibration is covered in Section 5 of the vendor service manual.



ERU / MRU & INSTRUMENTATION CABLE ROUTING
ILLUSTRATION 1–16

1-5 CRYOGEN MONITOR INSTALLATION (continued)

5. Perform the calibration procedure covered in Section 5 of the vendor service manual supplied with the unit. Perform sensor length calibration and warning / alarm setting.

Note

A Helium Resistance Box Service Tool (46-265286G1) should be obtained for fast / accurate calibration, checking of sensor length calibration linearity and check out of warning and alarm set points.

6. Use the following values for the warning and alarm set points.

FUNCTION	LHe%.
WARNING	50
ALARM	50

7. Set sample interval to 24 hours using thumbwheels on front of cryomonitor.

8. Record the Liquid Helium Level ______________________________

SET UP AND CALIBRATION

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2–3 Cryostat Vacuum Check... 2–7
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SECTION 2 - MAGNET COMMISSIONING CHECKS

Refer to FUNCTIONAL CHECKS, Section 0, for Commissioning Specifications.

2–1 MAGNET ELECTRICAL CHECK

Perform electrical checks called out in Functional Checks, Section 2.

2-2 CRYOSTAT TEMPERATURE CHECK & COOLING/FILLING REQUIREMENTS

Descrlption:

This Section describes the procedures and equipment used to establish the temperature inside the Helium Vessel of the Cryostat. It is essential to establish this temperature in order to determine the cool down and Liquid Helium Filling requirements so If the Cryostat prior to the magnet commissioning.

The GE Magnet is equipped with two sensors requiring a 10 microampere current source with a stability of +0.005%. Sensor (Diode) 1 is mounted on the top, Table End of the Magnet Assembly. Sensor (Diode) 2 is mounted on the bottom, Back End of the Magnet Assembiy. The Magnet Assembly is inside of the Helium Vessel. (These sensor diodes are identical to those found on the Cold Head Sleeve).

CAUTION

Magnet temperature sensors are designed to be driven by a 10 microampere source; some ohmmeters exceed this rating. Do not use any sensing or troubleshooting equipment which exceeds 10 mlcroamperes. A Voltmeter can also be used to troubleshoot the sensor circuit.

Procedure:

2-2-1 Use of Lakeshore Cryotronics Digital Thermometer Model DRC-80 (46-265269G1) or 208 Thermometer Klt (46-301477G) or Low Cost Shield Temperature Diode Box (46-317543G1)

1. Use the equipment referenced above to establish the Cryostat temperature.

2. Connect the Temperature Monitoring Equipment to the Diode Connector on the Magnet Connector Assembly (MS1–A3, Al) in conformance with Illustration 2–1.

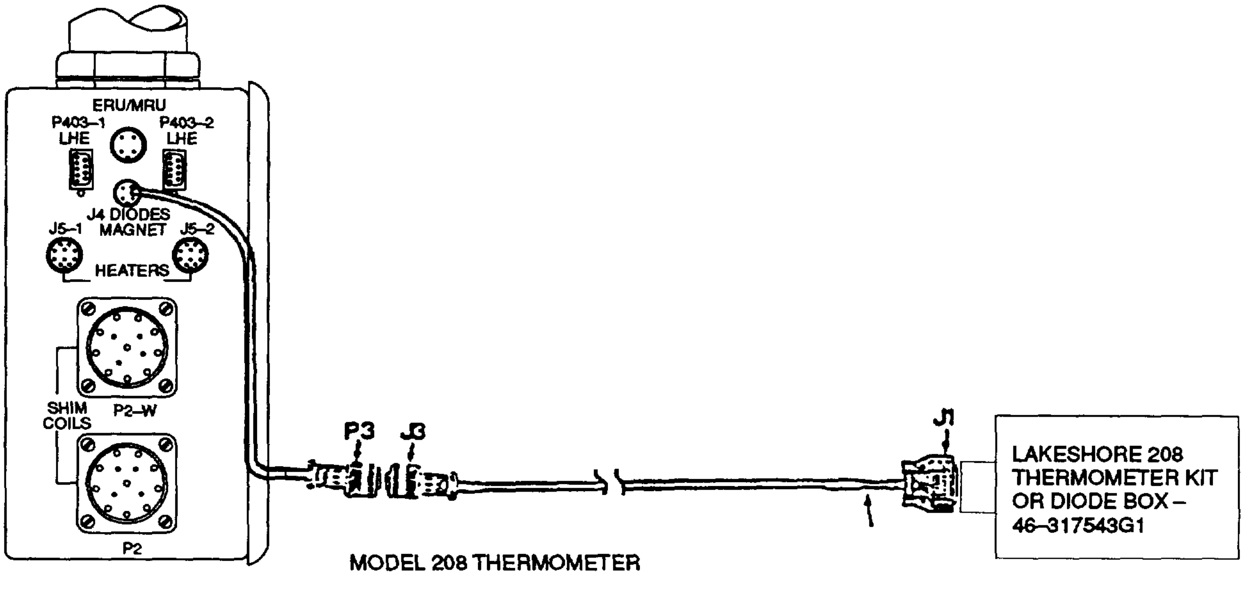
3. Select the Diode to be monitored as shown in Table 2-1.

2-2-1 Use of Lakeshore Cryotronics Digital Thermometer Model DRC-80 (46-265269Gl) or 208 Thermometer Kit (46-301477G1) or Low Cost Shield Temperature Diode Box (46-317543GI) (continued)

TABLE 2-1
HELIUM VESSEL TEMPERATURE MONITOR DIODES

STAGE	208 THERMOMETER KIT
DIODE 1 DIODE 2	SELECT CHANNEL #1 SELECT CHANNEL #2

4. Ensure Curve 2 (DT-500DRC-D) is selected for 208 Thermometer. Refer to Vendor Operations Manual.



CRYOSTAT TEMPERATURE MEASUREMENT SET-UP
ILLUSTRATION 2-1

Note

A SHORTED sensor circuit will cause the meter to display a reading of approximately 400K, whereas an OPEN sensor circuit will cause the meter display to flash. Check for problems with the instrumentation box connector and external wiring before ruling the temperature sensing diode as being defective.

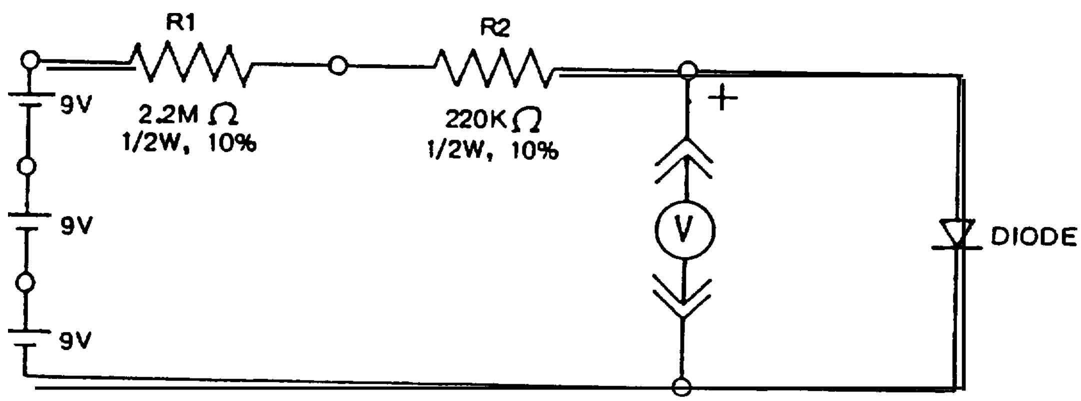
2-2-2 Diode Temperature Sensing Circuit

Descrlptlon:

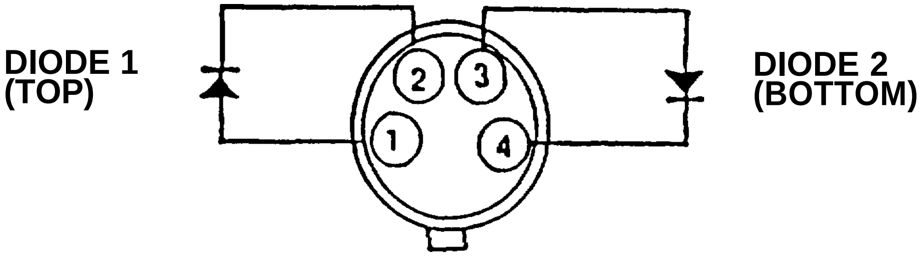
If the Lakeshore Cryotronics DRG-80, 208 Thermometer Kit or Low Cost Diode Box is not available, the following temperature sensing circuit can be fabricated from commonly available components for temperature measurements.

Procedure:

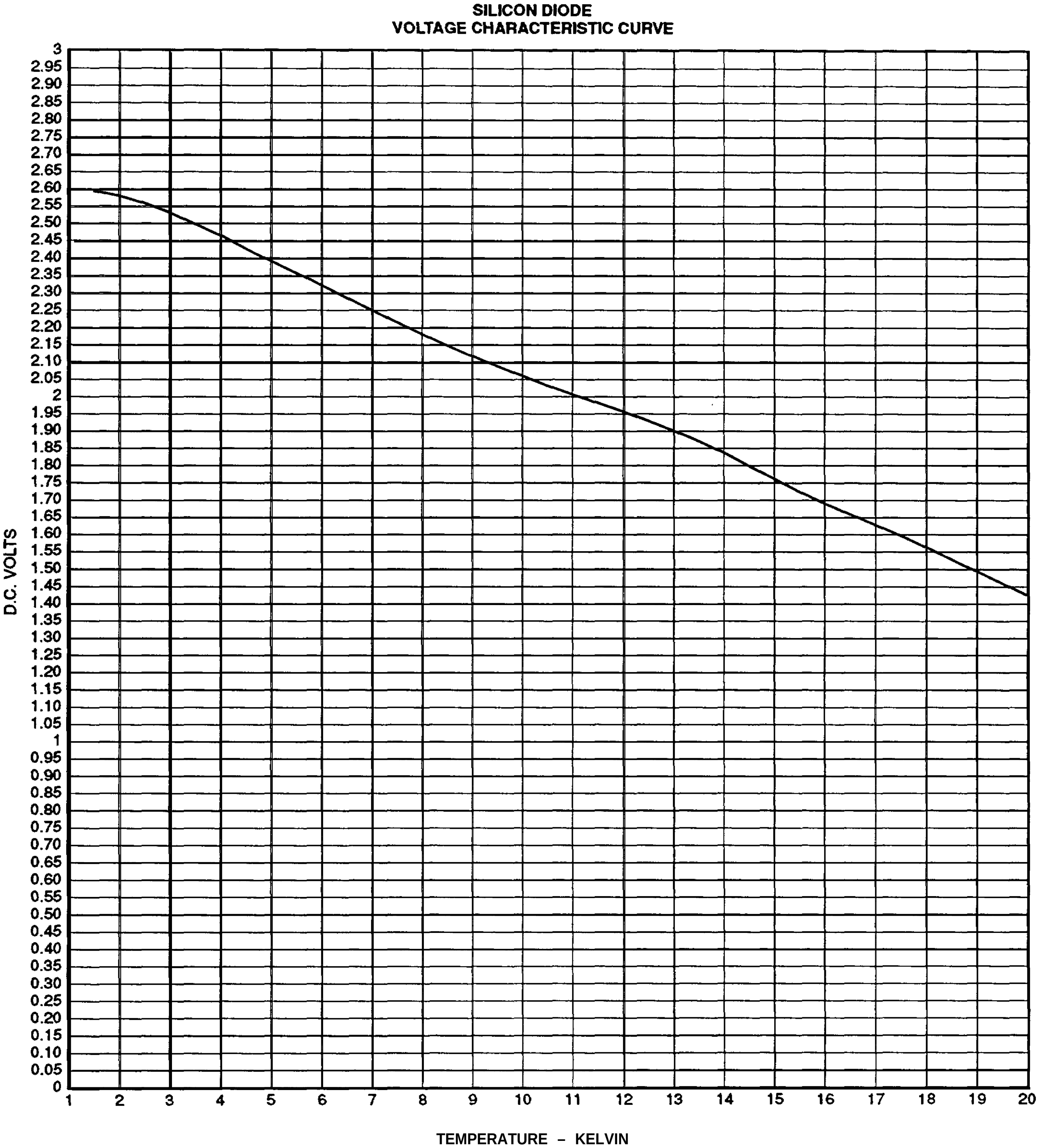
1. Assemble three 9 VDC Batteries and a series resistance of 2.4 to 2.7 Megohms, as depicted in Illustration 2–2. Adjust resistance as required to obtain 10+ 1 µ A current.
2. Connect a Digital Voltmeter (DVM) across the diode with the polarity shown in Illustration 2–2. See Illustration 2–3 for the pin polarities at the J4 Connector.
3. Record the voltage reading on the DVM and determine the temperature readings from Graph 2–1.



TEMPERATURE SENSING CIRCUIT
ILLUSTRATION 2-2

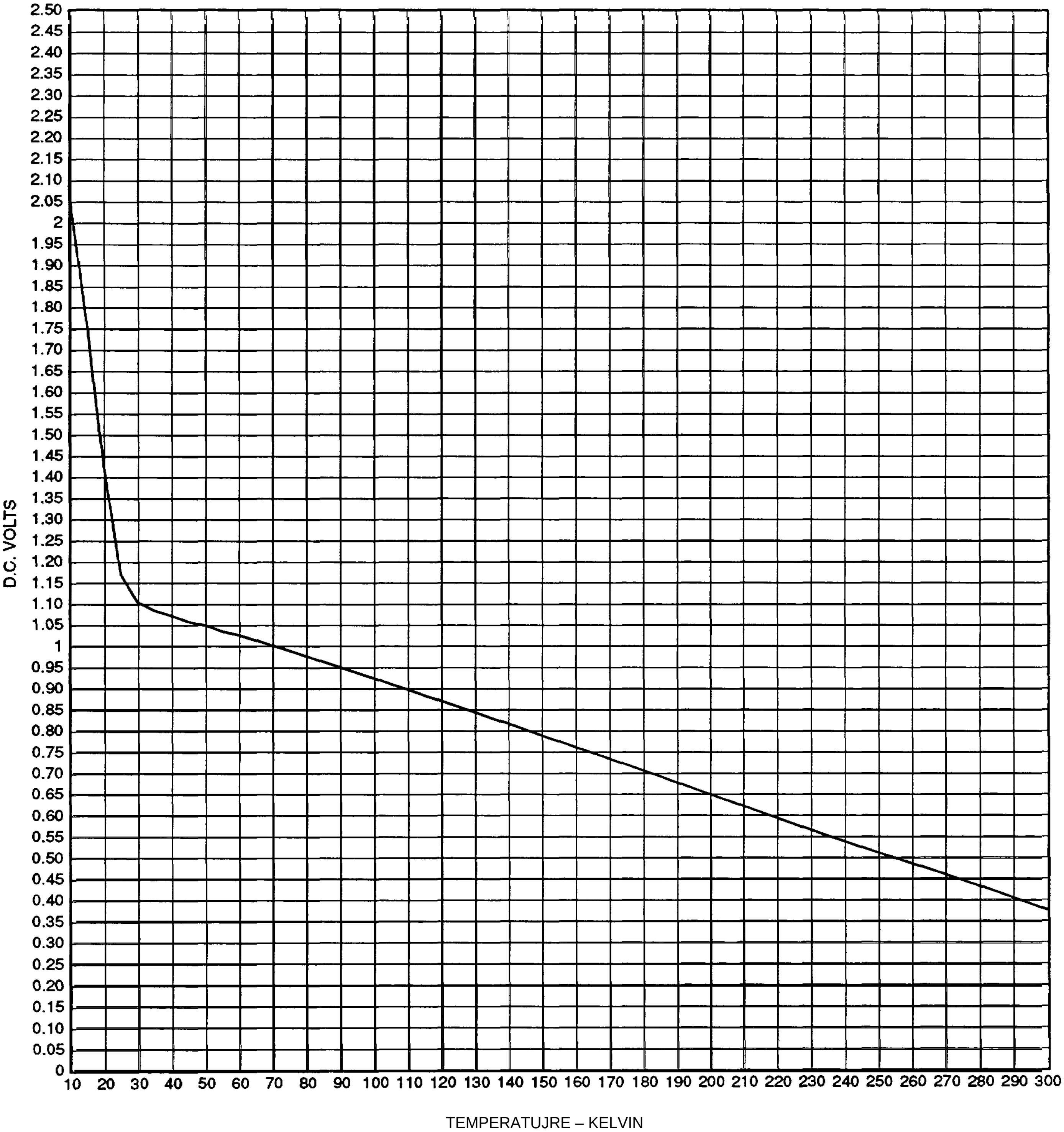


DIODE POLARITIES
ILLUSTRATION 2-3



GRAPH 2-1
DIODE VOLTAGE TO TEMPERATURE CONVERSION

SILICON DIODE
VOLTAGE CHARACTERISTIC CURVE



GRAPH 2-2
DIODE VOLTAGE TO TEMPERATURE CONVERSION

2-2-3 Cryostat Cooling / Cryogen Filling Requirements

1. Record temperature sensing diode readouts..

   Diode 1 ______________________ Diode 2 ______________________

CAUTION

Magnet temperature checks are performed during installation to determine the Cryostat cooling /cryogen filling requirements prior to ramping. It Is essential that the magnet Is greater than 75% full of helium before ramping.

2. Use chart below to establish the required Cryostat cooling/cryogen filling requirements, based upon temperature readout and Cryogen Monitor reading (installed in Set–Up and Calibration, Section 1-5).

readout and Cryogen Monitor reading (installed in Set–Up and Calibration, Section 1–5).

DIODE TEMPERATURE	CRYOSTAT COOLING / CRYOGEN FILLING REQUIREMENTS (MANUAL SECTIONS)
> 220 K	SET–UP AND CALIBRATION SECTION 3–1 THROUGH 4
> 100 K, < 220 K	SET–UP AND CALIBRATION SECTION 3–2 THROUGH 4
< 100K	REPLACEMENT / MAINTENANCE SECTION 1 IF < 75% FULL OF LHe SET UP AND CALIBRATION SECTION 4 IF EMPTY NO ACTION IF >75% FULL OF LHe

CAUTION

Do not proceed with Set Up and Callbratlon, section 3 through 4 or initiate magnet ramping, Set Up and Calibration, Section 7, prior to establishing the Cryostat cooling/cryogen filling requirements In conformance with this Sectlon.

2-3 CRYOSTAT VACUUM CHECK

If temperature check in Set Up and Calibration, Section 2-2–3 was > 220K, perform vacuum check called out in Functional Checks, Section 3 (Cryostat Vacuum Check).

2-4 CRYOSTAT PRESSURE FLOW CHECK

1. **Observe Cryostat Pressure and Exhaust Flow readings. If readings outside of specified range shown below, per-**form adjustments in Step 2 through 7.

   FLOWMETER (Fl) = 0.4– 0.6 SCFH
   FLOW METER (F2) = 1.5 – 2.0 SCFH
   CRYOSTAT GAUGE PRESSURE. 0.25-0.50 psig.

2. Open Vent Valve (V2) to de~pressurize the Cryostat to 0.25 psig. Close V2.

Note
Read all flow rates from the bottom of the float (ball) on the flowmeters.

3. Set Flowmeter(Fl) between 0.4– 0.6 SCFH.
4. Set Flowrneter (F2) between 1.5– 2.0 SCFH to maintain a Cryostat Pressure Gauge reading between 0.25 – 0.50 psig.
5. Make sure flow rate through F2 is equal or greater than 1.5 SCFH.
6. If flow rate through F2 is less than 1.5 SCFH or the pressure gauge reads less than 0.25 psig, pressurize the vessel and “bubble test” all exhaust plumbing joints, relief valve and Shim Lead Connector. Make sure V2 is fully closed. Repair any leaks. If a 1.5 SCFH flow rate through F2 cannot be achieved, under the above conditions, contact your Region Magnet Service Engineer.
7. Make sure the following conditions are maintained. Re~check settings in three days and again after one week:.

   FLOWMETER (Fl) = 0.4 –0.6 SCFH
   FLOW METER (F2) = 1.5 – 2.0 SCFH
   CRYOSTAT GAUGE PRESSURE = 0.25-0.50 psig.

SET UP AND CALIBRATION

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3 NITROGEN PRECOOL 3–1
3-1 Gaseous Nitrogen Purge 3-1
3-2 Liquid Nitrogen Precool 3–3
3-3 Nitrogen Purge from Helium Vessel 3-5
3-4 Changing Liquid Nitrogen Cylinders 3–5

SECTION 3 - NITROGEN PRECOOL

Description:

Liquid Nitrogen is used to precool a warm Cryostat when it is above 100K. The latent heat capacity of Liquid Helium is much lower than Liquid Nitrogen (21 vs. 198 KJ/KG); therefore, precooking with Liquid Nitrogen is more effective, economical and less time consuming.

Since all magnets are shipped from the factory with the Cryostat full of Liquid Helium, there will rarely be any need to precool the Cryostat. Ensure that the temperature check in Section 2-2-3 (Cryostat Cooling/Cryogen Filling Requirements) is above 100K before proceeding with this section. Cryostats with temperatures above 220K will require a gaseous nitrogen purge (Section 3-1) before precooling with Liquid Nitrogen, to prevent the freezing of any latent moisture in the Cryostat. If the Cryostat temperature is lOOK or less, proceed with Liquid Helium Fill, Section 4.

WARNING!

NEVER BRING NITROGEN OR HELIUM DEWARS, GAS CYLINDERS, TOOLS OR EQUIPMENT MADE OF FERROMAGNETIC MATERIAL INTO THE EXAM ROOM WHEN THE MAGNET IS AT FIELD. FERROMAGNETIC OBJECTS BECOME DANGEROUS PROJECTILES IN A STRONG MAGNETIC FIELD.

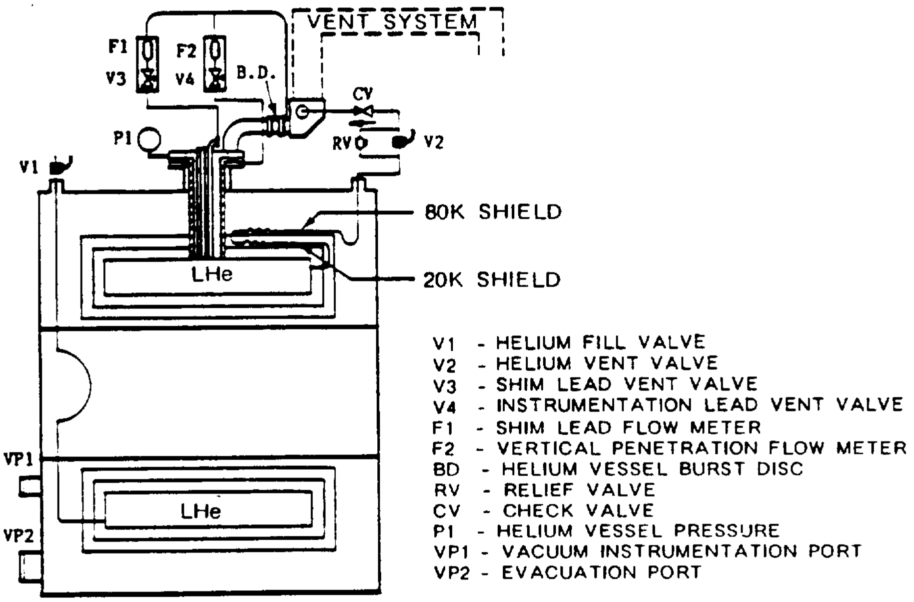
CAUTION

Do not exceed 5 psig Internal Cryostat Pressure at any time during precool and filling with cryogens. Cryostat Pressure Gauge is located between the Flowmeters.

Procedure:

3-1 GASEOUS NITROGEN PURGE

1. Uncap Fill Port and open all valves (VI through V4). See Illustrations 3-1 and 3-2 for valve locations.



CRYOGEN PLUMBING SCHEMATIC
ILLUSTRATION 3-1

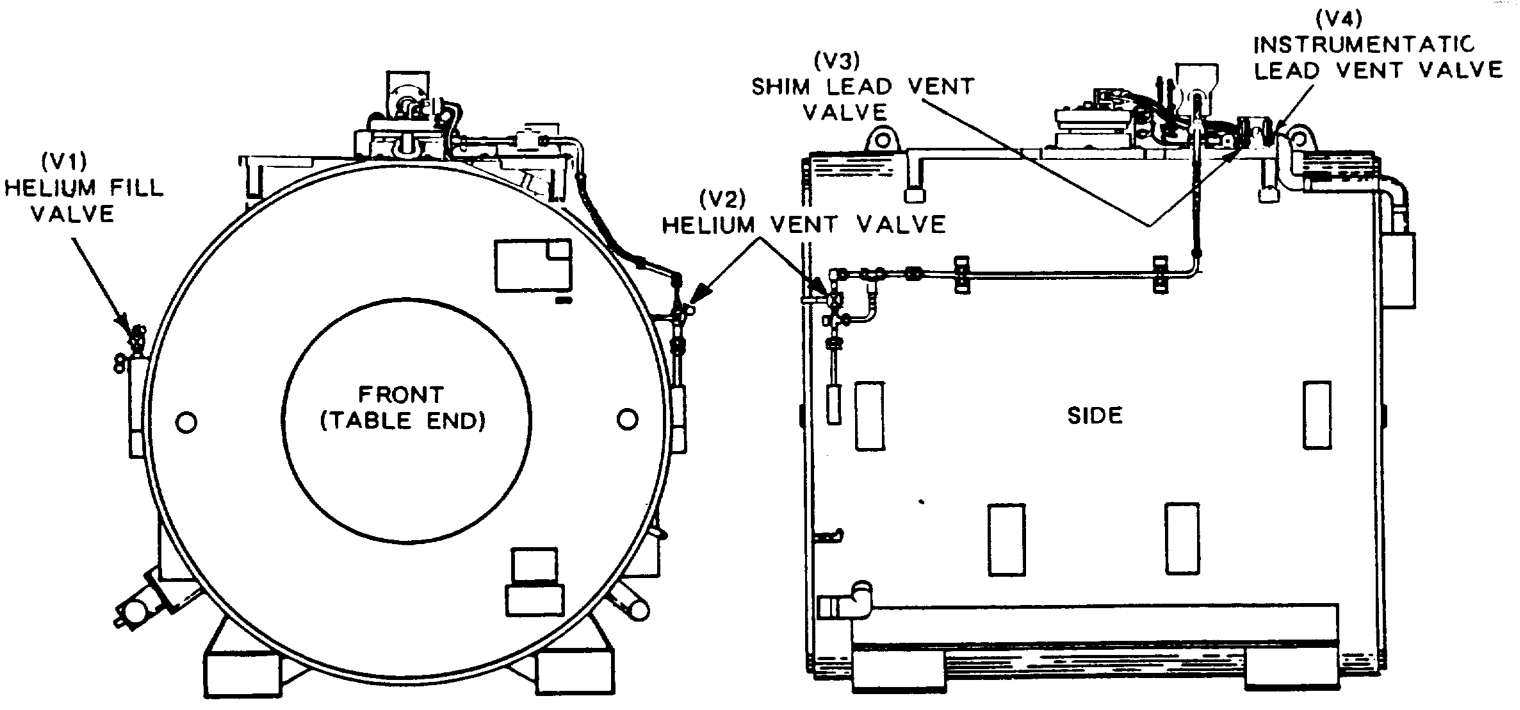


TABLE END FLANGE VALV/VENT LOCATIONS
ILLUSTRATION 3-2

3-1 GASEOUS NITROGEN PURGE (continued)

2. Install Precool Siphon into Helium Fill Port at V1. Tighten Compression Fitting
3. Connect Nitrogen Transfer Line and Pressure Regulator to Gaseous Nitrogen Cylinder and the other end to the Precool Siphon.
4. Open valve on Gaseous Nitrogen Cylinder and adjust regulator to 3–5 psig.
5. Purge Helium Vessel and Shields with one (1) cylinder of gaseous nitrogen (approximately 260 cubic feet) at 3–5 psig.
6. Close Gaseous Nitrogen Cylinder Valve and disconnect Nitrogen Transfer Line upon completion of purge.

3 -2 LIQUID NITROGEN PRECOOL

WARNING!

MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST LARGE AMOUNTS OF ODORLESS AND INVISIBLE NITROGEN GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5-3 OF THE INTRODUCTION (CRYOGEN SAFETY).

SKIN CONTACT WITH LIQUID CRYOGENS WILL CAUSE BURNS. WEAR **PROTECTIVE CLOTHING, GLOVES (NONABSORBENT MATERIAL**) AND **GOGGLES OR FACE SHIELD WHEN TRANSFERRING CRYOGENS.**

SMOKING IS PROHIBITED IN THE MAGNET AND CRYOGEN STORAGE ROOMS. LIQUID CRYOGENS CAN LIQUIFY ATMOSPHERIC OXYGEN, PRODUCING A HIGHLY COMBUSTION SUPPORTING FLUID.

Note

Approximately 2000 to 2500 liters of liquid nitrogen are required to cool the Helium Vessel from room temperature (300K) to 100K.

3-2 LIQUID NITROGEN PRECOOL (continued)

If Gaseous Nitrogen Purge (Set Up and Calibration, Section 3–1) was performed, Steps 1 & 2 are already accomplished.

1. Open all valves (Vl through V4). See Illustrations 3–1 and 3–2 for valve locations.
2. Install Precool Siphon into Helium Fill Port at VI; tighten Compression Fitting.
3. Connect Nitrogen Transfer Line to Liquid Nitrogen Cylinder and the other end to the Precool Siphon. See Set Up and Calibration, Section 3-4 for changing nitrogen cylinders.
4. Open valve on Liquid Nitrogen Cylinder and start LN2 flow into Helium Vessel.
5. Adjust LN2 so pressure in Helium Vessel will not exceed 5 psig at any time during the precool,
6. Connect service readout equipment for the silicon diodes (Lakeshore Cryotonic– DRC80) to the Instrument connector on the Instrumentation Connector Box (MS1 –A3, Al) on the Service End Flange of the magnet. See Set Up and Calibration, Section 2–2–3.
7. Take diode temperature readings at 1 hour intervals.

CAUTION

Do **not cool Cryostat below lOOK with LN2. This will prevent any LN2 from collecting in the Helium Vessel.**

8. Precool with LN2 until lOOK reading is reached on either diode.

Note

It may take in the order of 3 days to precool the Cryostat from room temperature (300K) to lOOK.

9. Close valve on LN2 Cylinder and initiate procedures for N2 purge from the Helium Vessel.

3-3 NITROGEN PURGE FROM HELIUM VESSEL

WARNING!

HELIUM GAS BOTTLE CAPS ARE FERROUS AND MUST BE REMOVED BEFORE BRINGING GAS BOTTLE INTO EXAM ROOM.

1. Ensure LN2 Precool (Set Up and Calibration, Section 3-2) setup is in place and all valves (V1 through V4) are open.

2. Disconnect LN2 Cylinder from Nitrogen Transfer Line and connect Helium Gas Bottle to line

3. Open valve on Helium Gas Bottle and flow gaseous helium through Helium Vessel at 3 psig for approximately 2 hours. Use two 260 cubic foot gas bottles to assure complete nitrogen purge.

4. Close valves (V3 & V4) 15 minutes after starting the purge.

5. Upon completion of nitrogen purge, close valves (V1 & V2) and remove set up equipment.

6. Cap Fill Port.

3-4 CHANGING LIQUID NITROGEN CYLINDERS

1. Close LIQUID and SELF-PRESSURIZING ZING Valves on Liquid Nitrogen Cylinder.

2. Loosen Compression Fitting and raise Nitrogen Transfer Line to clear V1. Close Helium fill Valve (vi).

3. Adjust S ELF-PRESSURIZING Valve on new Liquid Nitrogen Cylinder to stabilize pressure at 8-10 psig.

4. Remove Nitrogen Transfer Line from old Liquid Nitrogen Cylinder and attach to new cylinder

5. Open Helium Fill Valve (VI), insert Nitrogen Transfer Line and tighten Compression Fitting.

6. Open LIQUID Valve on new Liquid Nitrogen Cylinder.

SET UP AND CALIBRATION

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4–3 Liquid Helium Fill 4-4
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SECTION 4- LIQUID HELIUM FILL

The following table should be used for determining minimum cryogen levels. The shaded regions indicate the preferred target levels.

MAGNET TYPE	3 Dewars	2 Dewars	1 Dewar	Emergency	Minimum Ramp Level
Sill	30-38%	50-60%	61 – 85%	25%	**75%**

The "Target Levels'' are established for magnets with normal or"in–spec" boil–off. Magnets with "out-of-spec" boil–off may require emergency fills at Helium levels higher than defined in the table above. Contact your MAC Team Leader or the Magnet Support Team at the Online Center for assistance in determining whether an emergency transfill is required.

DESCRIPTION

This section describes the procedure for filling the superconducting magnet with cryogens. The Helium fills are performed as "BOTTOM FILLS" using the indicated equipment.

4-1 EQUIPMENT

HELIUM FILL EQUIPMENT

Liquid Helium Transfer Line 46-294512P1: 3658 mm (12 feet) or 46–294512P2: 2438 mm (8 feet)

Liquid Helium Cryostat Stinger Assembly with 178 mm (7.00 inch) long stinger 46–294512P3.

Flex Hose 46–271135P1

250 liter / 500 liter Dewar Stinger Assembly 46–294511 P1 / P2

OTHER EQUIPMENT NEEDED

Regulator Kit 46–306734G1
Safety Face Shield Kit 46–271137G1
Nonmagnetic Tools
Heat Gun (TC402274)

1. Select proper cryostat and dewar stinger lengths to be used during the fill. See Illustration 4–1 for appropriate stinger configuration.

4-1 EQUIPMENT (continued)

WARNING!

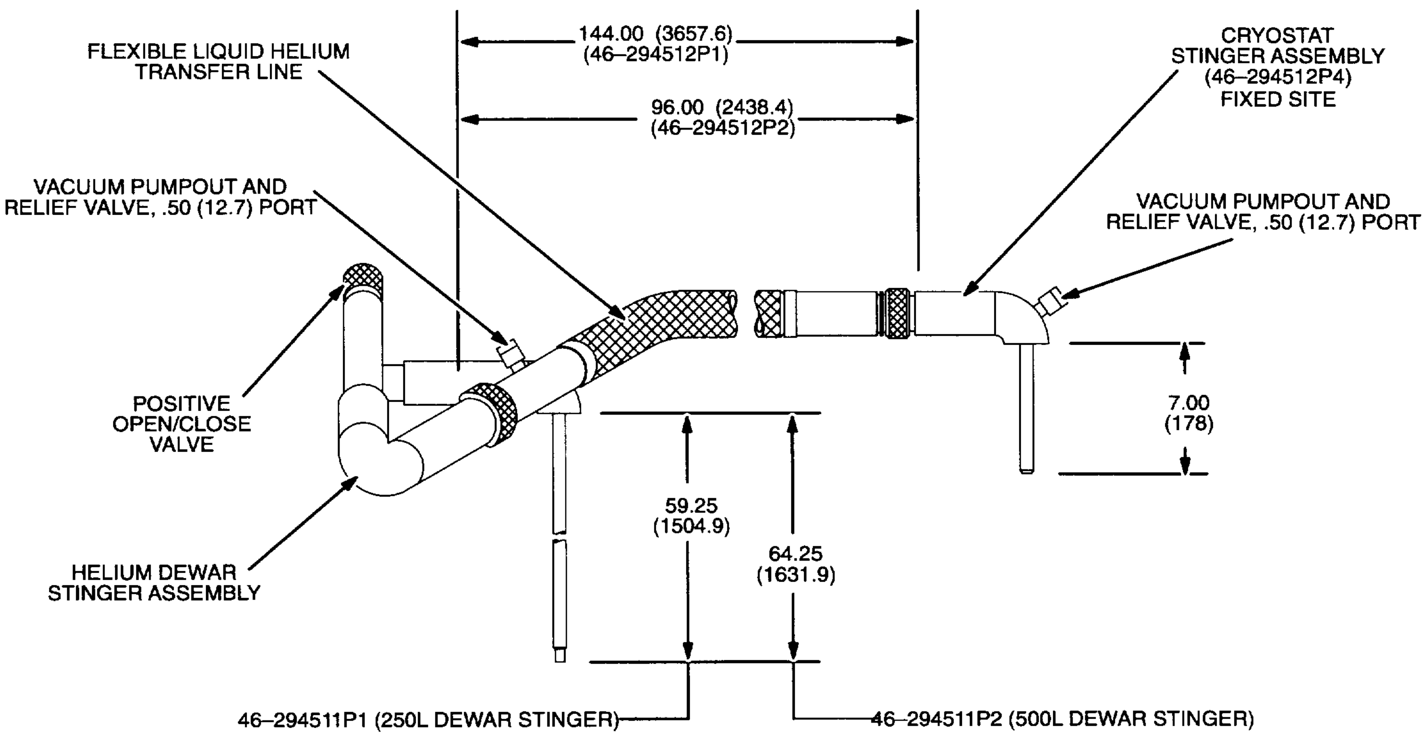
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5-3 OF THE INTRODUCTION (CRYOGEN SAFETY).

NEVER BRING HELIUM DEWARS, OR GAS CYLINDERS THAT ARE MADE FROM FERROMAGNETIC MATERIAL INTO THE MAGNET ROOM. FERROMAGNETIC OBJECTS WILL BECOME DANGEROUS PROJECTILES IN A STRONG MAGNETIC FIELD. MAKE SURE ALL EQUIPMENT AND TOOLS USED IN THE MAGNET ROOM ARE NON–FERROMAGNETIC.

SKIN CONTACT WITH LIQUID CRYOGENS WILL CAUSE BURNS. WEAR PROTECTIVE CLOTHING, GLOVES (NONABSORBENT MATERIAL) AND GOGGLES OR FACE SHIELD WHEN TRANSFERRING CRYOGENS.

SMOKING IS PROHIBITED IN THE MAGNET AND CRYOGEN STORAGE ROOMS. LIQUID CRYOGENS CAN LIQUIFY ATMOSPHERIC OXYGEN THUS PRODUCING A HIGHLY ENRICHED OXYGEN LIQUID.

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



VACUUM JACKETED HELIUM TRANSFER LINE AND DEWAR/CRYOSTAT STINGER ASSEMBLIES
ILLUSTRATION 4–1

4-2 PREPARATION

CAUTION

Make sure the Helium Cryogen Level Meter is callbrated to enable accurate monitoring of LHe fill if any problems are encountered, contact your service representative.

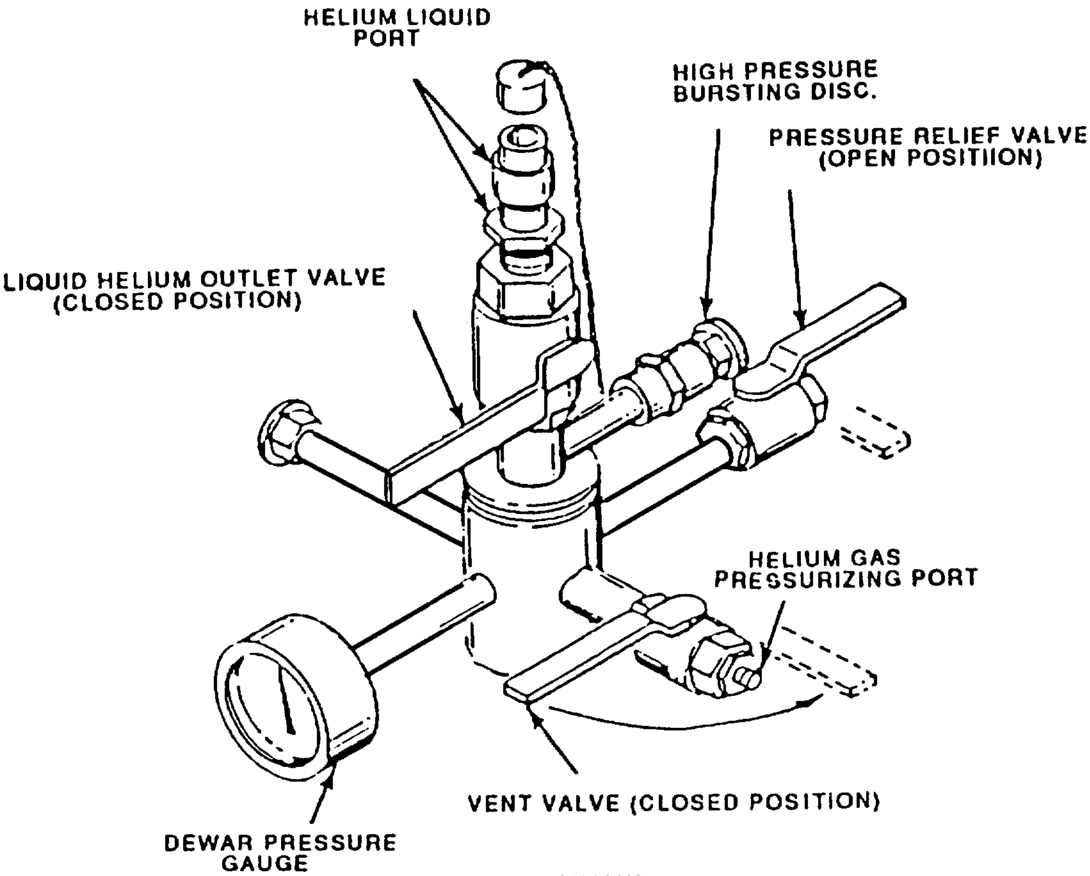
Note

Refer to “Volumetric Conversion Of Liquid Helium Level”, in the Service Manual, to determine approximate quantity of liquid helium required to fill the cryostat. An empty and partially warmed cryostat will require an additional quantity of liquid helium to cool the cryostat down to the 4.3K temperature where liquid helium will begin to collect in the cryostat.

1. if there is helium in magnet, go to step 2. if magnet does not have helium, refer to SET UP AND CALIBRATION section in manual for instruction on checking the shield temperatures. if temperature is greater than 100K, refer to section in the manual for Cryostat Coollng/Fiiling Requirements.

2. Check cryogen meter calibration and record liquid helium level in the Cryostat Performance Log. Make sure cryogen meter sample rate is set to 99.99. Refer to vendor manual for cryogen meter calibration.

3. Obtain full liquid helium dewar. Check dewar pressure gauge. If pressure is above 1 psig, slowly open Dewar Vent Valve and reduce dewar pressure to 1 psig. See illustration 4-2.



DEWAR CONNECTIONS
ILLUSTRATION 4-2

4-2 PREPARATION (continued)

WARNING!

IF DEWAR PRESSURE DOES NOT VENT DOWN TO 1 PSIG, VERIFY THAT DEWAR PRESSURE RELIEF VALVE IS LEFT IN THE OPEN POSITION. CONTACT CRYOGEN SUPPLIER IMMEDIATELY.

Note

The Pressure Relief Valve is normally open during shipping and storage to prevent excessive build up of pressure in the dewar. Therefore, always leave Pressure Relief Valve open after using dewar.

Note

If 99.999% Helium Gas is used, the purity of the gas remaining in the cylinder will degrade as a result of this process (i.e., the purity of the remaining gas will be something less than 99.999%).

4. Obtain 1 full GHe aluminum cylinder (135 SCF) for every 2 liquid helium dewars (250 liter) required.

WARNING!

SECURE CYLINDER BEFORE REMOVING PROTECTIVE VALVE CAP TO PREVENT CYLINDER FROM FALLING, WHICH COULD RESULT IN SHEARING VALVE OUTLET AND CAUSING HAZARDOUS HIGH PRESSURE GAS RELEASE.

5. Connect standard GHe Cylinder Regulator And Hose Assembly to Valve Outlet (CGA 580) on GHe cylinder.
6. Make sure that Regulator Adjusting Handle is fully backed out, then slowly open GHe Cylinder Valve.
7. Observe Regulator High Pressure Gauge. Make sure indicated pressure is approximately 2000 psig indicating full cylinder.
8. Record Cryostat Pressure Gauge reading in Cryostat Performance Log.
9. Vent magnet by temporarily opening Helium Vent Valve as required to obtain 0.3 – 0.5 psig pressure. Record final pressure in Cryostat Performance Log.

4-3 LIQUID HELIUM FILL

1. Verify Dewar Helium Outlet Valve is in the dosed position.
2. Loosen 5/8 inch Locking Collar.

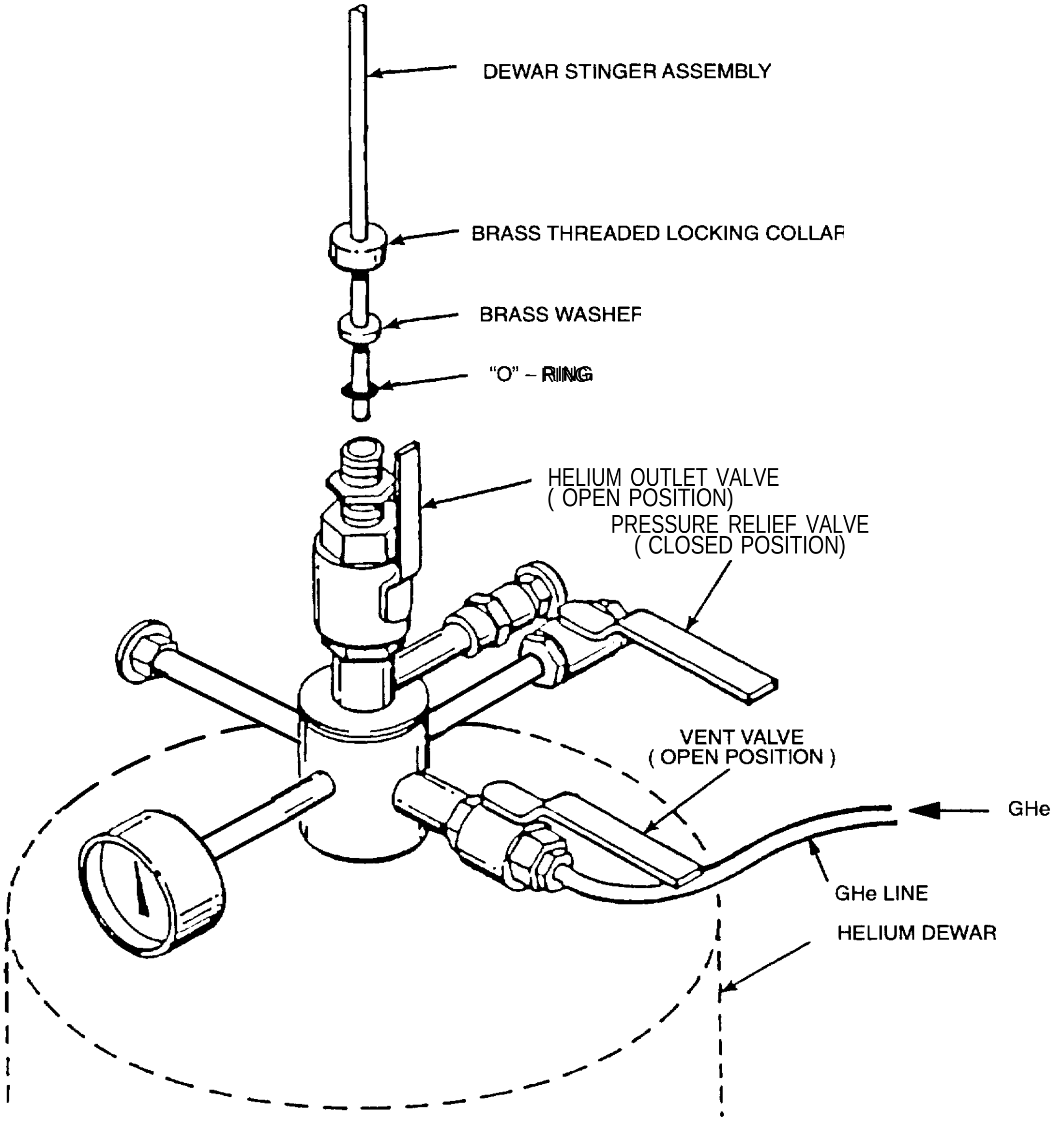
4-3 LIQUID HELIUM FILL (continued)

3. Remove 1/2 inch Cap and Adapters exposing 5/8 inch Brass Locking Collar,

4. Verify that Pressure Relief Valve is in the open position. See Illustration 4–3.

5. Make sure Dewar Stinger Assembly Valve is closed. Insert Dewar Stinger Assembly thru 5/8 inch locking collar until Stinger Tip contacts Helium Outlet Valve. See Illustration 4–3,

6. Open Helium Outlet Valve.



HELIUM DEWAR TRANSFER LINE EXTENSION CONNECTION
ILLUSTRATION 4–3

4–3 LIQUID HELIUM FILL (continued)

7. Slowly insert Dewar Stinger Assembly into dewar until Stinger Tip contacts liquid helium (indicated by pressure increase on Dewar Pressure Gauge and expulsion of gas from Pressure Relief Valve Port).

8. Continue to insert Dewar Stinger Assembly at a rate that maintains a maximum 5 psig reading on the Dewar Pressure Gauge.

9. When Dewar Stinger Assembly contacts bottom of dewar, raise Stinger Assembly 1 inch and securely tighten 5/8” Threaded Locking Collar.

10. When dewar pressure stabilizes at 5 psig, close Pressure Relief Valve.

11, Attach selected Cryostat Stinger Assembly onto Helium Transfer Line,

12. Attach opposite end of Helium Transfer Line onto Dewar Stinger Assembly.

WARNING!

FIRMLY HOLD UNATTACHED END OF HOSE WHILE PURGING REGULATOR AND GAS LINE ASSEMBLY TO PREVENT WHIPPING MOTION.

13. Purge GHe Regulator and Gas Line Assembly by alternately turning Regulator Handle fully in and out 3 times. Upon completion of purge, back Regulator out until minimal flow is felt exiting the Gas Line Assembly.

Note

Open Helium Dewar Vent Valve to allow a small amount of gas flow, Attach purged Gas Line Assembly to Liquid Helium Dewar Gas Pressurizing Port. See Illustration 4–2. This will provide a Helium rich environment for connecting the GHe line to the He Gas Pressurizing Port.

14. Open Helium Vent Valve (V2) on magnet.

15. Partially open Dewar Stinger Assembly Valve allowing liquid helium to purge and precool Transfer Line Assembly until a liquid plume is observed exiting the assembly.

16. While pluming the Cryostat Stinger, remove Fill Porl Plug from fill valve (VI), and slowly open V1 until a plume is present coming out of Fill Port (VI).

17. Insert Cryostat Stinger into Fill Port VI and tighten compression fitting at VI.

Note

If gas is observed escaping from Compression Fitting on Fill Port V1 or on Helium Dewar, use a heat gun to warm Compression Fitting and recheck compression fitting tightness.

18. Fully open Dewar Stinger Assembly Valve.

19, Open Vent Valve at Helium Gas Pressurizing Port on dewar.

20. Verify GHe Cylinder Valve is fully open and adjust GHe Cylinder Regulator to obtain a pressure which is 1,5 psig above the cryostat pressure during the entire fill.

4–3 LIQUID HELIUM FILL (continued)

CAUTION

If the Cryogen Meter is not Increasing, check magnet and fill equipment for frosting or blockage. If it Is decreasing, stop fill immediately and contact service.

WARNING!

MONITOR DEWAR TRANSFER FOR AUDIBLE WHISTLING SOUND INDICATING THAT DEWAR IS EMPTY. DO NOT ALLOW AN EMPTY DEWAR TO BLOW WARM HELIUM GAS INTO RAMPED MAGNET AS A QUENCH COULD OCCUR.

21. Record information for each dewar in Table 3-1 of data sheets or on Magnet Fill Record..
22. When cryostat is full (100\%), or when changing helium dewars, remove cryostat stinger from the fill port and immediately close the fill port valve (Vl).
23. Close valve on dewar stinger assembly, close GHe Cylinder valve, close Dewar Vent Valve, and open Dewar Pressure Relief Valve.
24. If additional dewars are required, change helium dewars in conformance with Section 1-4, “Changing Helium Dewars”, prior to continuing with this procedure.
25. Monitor cryostat pressure. When cryostat pressure drops below 2..0 psig, close Helium Vent Valve V2 on magnet.

Note

A heat gun maybe required to remove frost from the V1 Fill Port assembly before removing Stinger.

CAUTION

Cryostat pressure will Increase during fill. Make sure that 5 pslg cryostat pressure is not exceeded during fill to prevent damage to Cryostat Pressure Gauge or Burst Disc.

If frost Is detected on the transfer line, stop fill immediately to avoid a magnet quench.

Note

Helium Vent Port V2 should be frosting up indicating there is no restriction in venting circuit.

26. Check He Cryogen Meter for increase in the He level and then monitor cryogen level readings, during fill process, every 3 minutes.

4-3 LIQUID HELIUM FILL (continued)

Note

Multiple dewars may be required to achieve 100% fill of magnet cryostat.

27. Replace Fill Plug into Fill Port (V1). Securely tighten Compression Fitting at VI.
28. Disconnect Helium Transfer Line Assembly from Helium Dewar Stinger Assembly.
29. Make sure Helium Dewar is under 1 psi, then remove Helium Dewar Stinger Assembly from helium dewar.
30. Close GHe Cylinder Valve.
31. Disconnect Helium Gas Line from dewar Helium Gas Pressurizing Port.
32. Back off Pressure Regulator Adjusting Handle (CCW) on helium gas cylinder until no resistance is felt.
33. Verify following dewar configuration.
    a. Liquid Helium Outlet Valve closed
    b. Helium Vent Valve closed
    c. Pressure Relief Valve open
    d. Replace all adapters on Liquid Helium Valve Outlet
34. Remove GHe Cylinder Regulator from helium gas cylinder and install protective valve capon cylinder.
35. Check and record cryogen level meter and cryostat pressure readings. Make sure cryostat pressure is at 2.0 psig or less before leaving site.

4-4 CHANGING HELIUM DEWARS

1. Close Helium Vent Valve (V2) on magnet.

Note

If 99.9990/. Helium Gas is used, the purity of the gas remaining in the cylinder will degrade as a result of this process (i.e., the purity of the remaining gas will be something less than 99.9990/').

2. Obtain full liquid helium dewar. Check dewar pressure gauge. If pressure is above 1 psig, slowly open Dewar Vent Valve and reduce dewar pressure to 1 psig. See Illustration 4-3.

WARNING!

IF DEWAR PRESSURE DOES NOT VENT DOWN TO 1 PSIG, VERIFY THAT DEWAR PRESSURE RELIEF VALVE IS LEFT IN THE OPEN POSITION. CONTACT CRYOGEN SUPPLIER IMMEDIATELY.

Note

The Pressure Relief Valve is normally open during shipping and storage to prevent excessive buildup of pressure in the dewar. Therefore, always leave Pressure Relief Valve open after using dewar.

3. Observe GHe Cylinder regulator High Pressure Gauge. Make sure indicated pressure is at least 1000 psig indicating sufficient gas volume for transferring full 250 liter helium dewar.

WARNING!

SECURE CYLINDER BEFORE REMOVING PROTECTIVE VALVE CAP TO PREVENT CYLINDER FROM FALLING, WHICH COULD RESULT IN SHEARING VALVE OUTLET AND CAUSING HAZARDOUS HIGH PRESSURE GAS RELEASE.

4. If new GHe Aluminum Cylinder is required in Step3, connect standard GHe regulator and hose assembly to valve outlet (CGA 580) on GHe cylinder.

5. Make sure that regulator adjusting handle is fully backed out, then slowly open GHe cylinder valve.

6. Refer to equipment in Helium Fill Section for appropriate equipment.

4-4 CHANGING HELIUM DEWARS (continued)

7. Observe cryostat pressure gauge and vent, temporarily opening Helium Vent Valve as required to obtain 1.0psig pressure or below.
8. Verify Helium Outlet Valve is closed on full dewar.
9. Loosen 5/8 inch Locking Collar on full dewar.
10. Remove 1/2 inch cap and adapters exposing 5/8 inch Brass Locking Colliar.
11. Verify that Pressure Relief Valve is in the open position.
12. Verify Dewar Stinger Assembly Valve is in the closed position. Disconnect Helium Transfer Line from Dewar Stinger Assembly.
13. Remove Dewar Stinger Assemblyfrom empty dewar.
14. Wipe off frost or moisture on Dewar Stinger and insert Dewar Stinger Assembly thru 5/8 inch Locking Collar until stinger tip contacts Helium Outlet Valve in full dewar. See illustration 4-3.
15. Open Helium Outlet Valve.
16. Slowly insert Dewar Stinger Assembly into dewar until stinger Tip contacts liquid helium (indicated by pressure increase on dewar pressure gauge and expulsion of gas from pressure relief valve port).
17. Continue to insert Dewar Stinger Assembly at a rate that maintains a maximum 5 psig reading on the Dewar Pressure Gauge.
18. When Dewar Stinger Assembly contacts bottom of dewar, raise Stinger Assembly 1 inch and securely tighten 5/8 inch Threaded Locking Collar.

Note

If ceiling height prohibits insertion of Dewar Stinger Assembly into dewar, dewar must be moved to an area with higher ceiling height and transported back into exam room.

19. When dewar pressure stabilizes at 5 psig, close Pressure Relief Valve.
20. Attach Helium Transfer Line onto Dewar Stinger Assembly.

WARNING!

FIRMLY HOLD UNATTACHED END OF HOSE WHILE PURGING REGULATOR AND GAS LINE ASSEMBLY TO PREVENT WHIPPING MOTION.

4-4 CHANGING HELIUM DEWARS (continued)

21. Disconnect Helium Gas Line from empty dewar. Purge GHe Cylinder Regulator and Gas Line Assembly by alternately turning Regulator Handle fully in and out 3 times. Upon completion of purge, back Regulator out until minimal flow is felt exiting the Gas Line Assembly.

22. Slightly open He Gas Vent Valve to allow for He gas flow from dewar.

23. Attach purged gas line assembly to dewar Helium Gas Pressurizing Port. Fully back out Regulator Adjusting Handle.

24. Prepare empty dewar as follows:

    a. Liquid Helium Outlet Valve — closed

    b. Helium Vent Valve — closed

    c. Pressure Relief Valve — open

    d. Replace all adapters on Liquid Helium Valve Outlet

25. Proceed with "LIQUID HELIUM FILL" , Section 4-3, Step 14.

4-5 CHANGING HELIUM GAS BOTTLES

WARNING!

HELIUM GAS BOTTLE CAPS ARE FERROUS AND MUST BE REMOVED PRIOR TO BRINGING BOTTLE INTO MAGNET ROOM AS THEY CAN BECOME DANGEROUS PROJECTILES IN A MAGNETIC FIELD.

Note

Change the helium gas bottle when bottle pressure drops below 5 psig. Approximately one 235 SCF helium gas bottle is needed to pressurize a 500 liter liquid helium dewar.

1. Close vent valve on dewar and remove gas hose.

2. Close main valve and regulator on helium gas bottle.

3. Bring a full helium gas bottle into the exam room and reconnect the regulator and hoses.

4. Purge hose before reconnecting to dewar.

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	5–6 Teslameter and Probe Mechanical Centering	5–25
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SECTION 5- FIELD MONITORING EQUIPMENT SET-UP & OPERATION

Description:

The Field Mapping Fixture, capable of providing three axis positioning (radial, angular and axial) for the Teslameter Probe, is used to position the probe at specific points within the magnet bore in order to determine the magnetic field inhomogeneity.

This section covers magnet access for mounting field monitoring equipment, mapping fixture assembly and mounting, probe positioning and the set up and use of the Teslameter.

At installation, the Enclosure Frame, Brackets, RF and Gradient Coils and Cone should be assembled prior to setting up the field monitoring equipment and ramping the magnet. This permits the use of steel (magnetic) tools.

5-1 MAGNET ACCESS

1. Remove Magnet Side Covers.
2. Bring Head Coil Carriage and Cradle to Table End of magnet, using IN/OUT Button, and unlatch Cradle.
3. Run Head Coil Carriage to rear of magnet.
4. Pull Cradle back and lock on Table.
5. Unlock Table and move to the side.
6. Unlatch the Rubber Latch Cords securing the Front Cover and pull the Front Cover out to expose the Magnet Interface Ring.
7. Remove Top Alignment Light Assembly.
8. Disconnect Head Coil Carriage Top Assembly (remove the four mounting screws, slide assembly forward and lift) disconnect cables and move assembly out of the bore.
9. Repeat Step 6 for Rear Cover.
10. Remove the Top Bracket on the Rear Interface Ring (four bolts).

Note

The Magnet Interface Rings should now be exposed and the Magnet Bore clear for mounting and operating the Field Mapping Fixture.

5-2 FIELD MAPPING FIXTURE SET-UP (MODEL #4G209988G3)

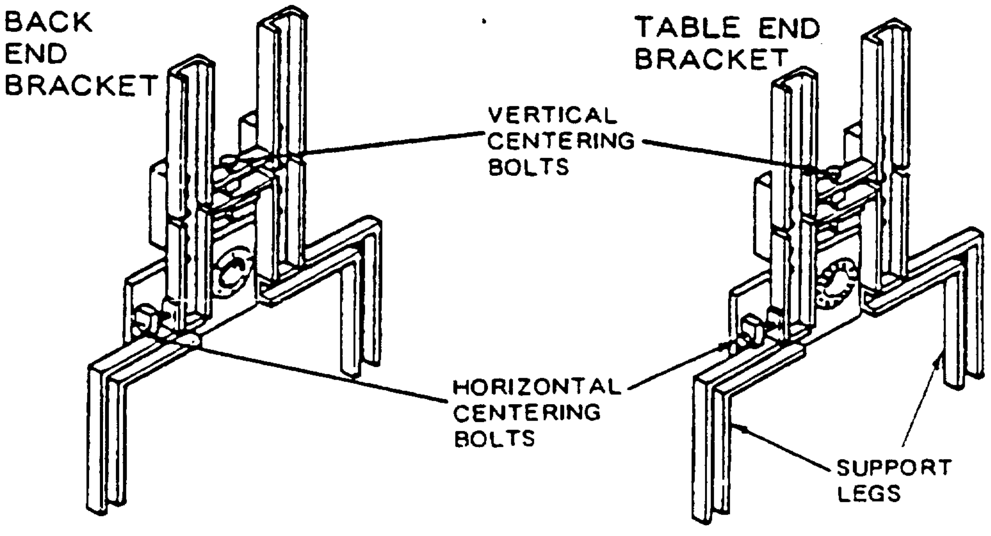
Note
Field mapping is performed from the Table End of the magnet.

CAUTION

Do not use any ferromagnetic material or hardware In the assembly of the mapping fixture as It will affect shimming.

Procedure:

1. Lay the Back and Table End Support Brackets on the floor and position the Support Legs (2 for each bracket) with the slots over the threaded holes in the Support Bracket. See Illustration 5-1.

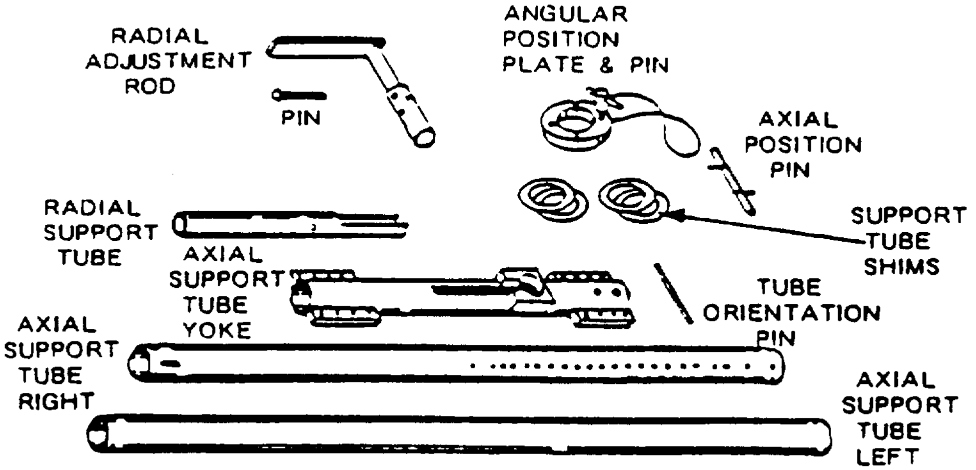


END SUPPORT BRACKETS
ILLUSTRATIONS 5-1

5-2 FIELD MAPPING FIXTURE SET-UP (MODEL #46-209988G3) (continued)

2. Insert the shorter brass bolts provided in the kit through the slots and into the threaded holes of the Support Bracket, hand tighten.

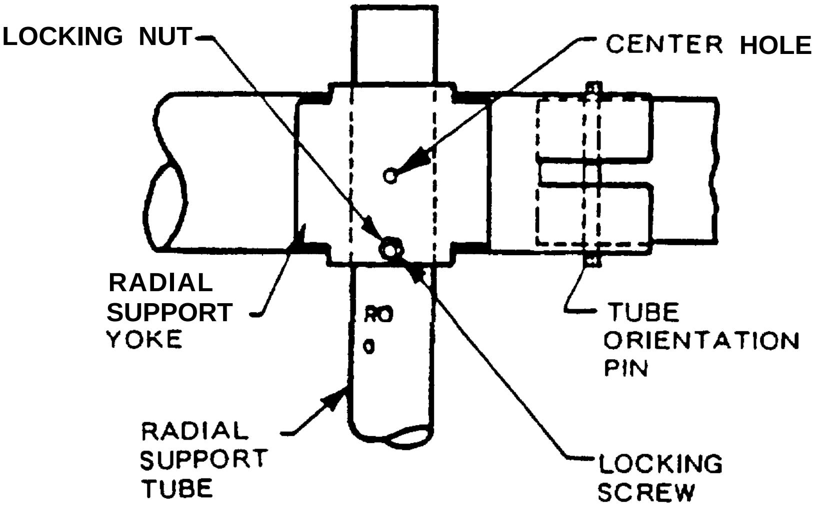
Note
See illustration 5-2 for the definition and identification of components covered in the following steps.



PROBE POSITIONING SUPPORT TUBE COMPONENTS
ILLUSTRATION 5-2

3. Insert the Axial Support Tube Left into the end of the Support Tube Yoke without Orientation Holes.
4. Insert the Axial Support Tube Right (end with alignment slot) Into the other end of the Supped Tube Yoke.
5. Align the Axial Support Tube Right In the Support Tube Yoke by Inserting the Orientation Pin through the alignment holes of the yoke and slot of the Support Tube. Insert Cotter Pin at end of Orientation Pin.
6. Insert the Radial Support Tube through the hole in the built up area of the Support Tube Yoke. See Illustration 5-3.

5-2 FIELD MAPPING FIXTURE SET-UP (MODEL #46-209988G3) (continued)



RADIAL SUPPORT TUBE ALIGNMENT
ILLUSTRATION 5–3

7. Align the Radial Support Tube so that the slotted end is lined up with the slot in the Support Tube Yoke.
8. Align the center hole of the Radial Support Tube with the center hole of the Support Tube Yoke.
9. Secure the Radial Support Tube with the Locking Screw threaded through the Support Tube Yoke.

Note

End Support Brackets are attached to the End Flanges of the Magnet by removing the applicable Cone Retaining Bolts and using those bolt holes for the attaching bolts found in the kit. See Illustration 5–4 and 5–5. Use the 3/4 inch stainless steel bolts provided with the Mapping Fixture Kit.

10. Attach the Table End Support Bracket to the Table End Flange of the magnet.

Note

Steps 11 through 14 require two persons.

11. Insert the "composite" Axial Support Tube through the Magnet Bore with the end of the Support Tube Right at the Table End of the magnet.
12. Slide the Back End Support Bracket onto the end of the Axial Support Tube Left.

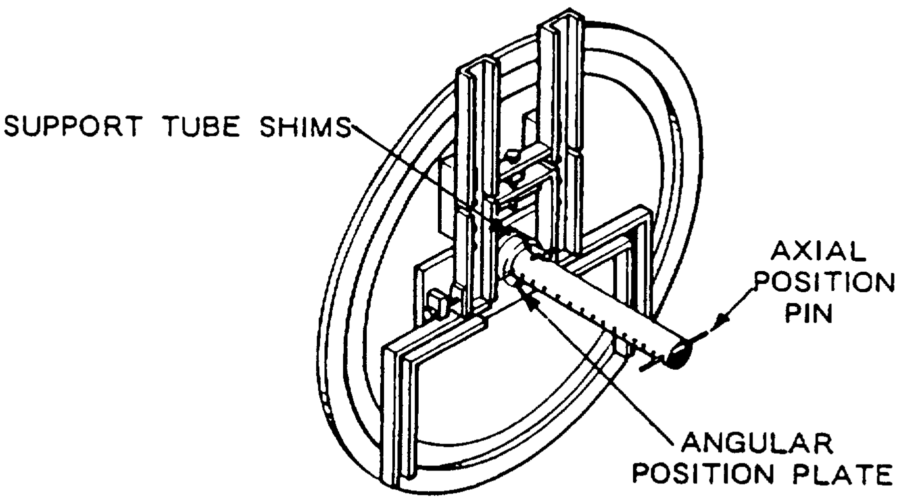
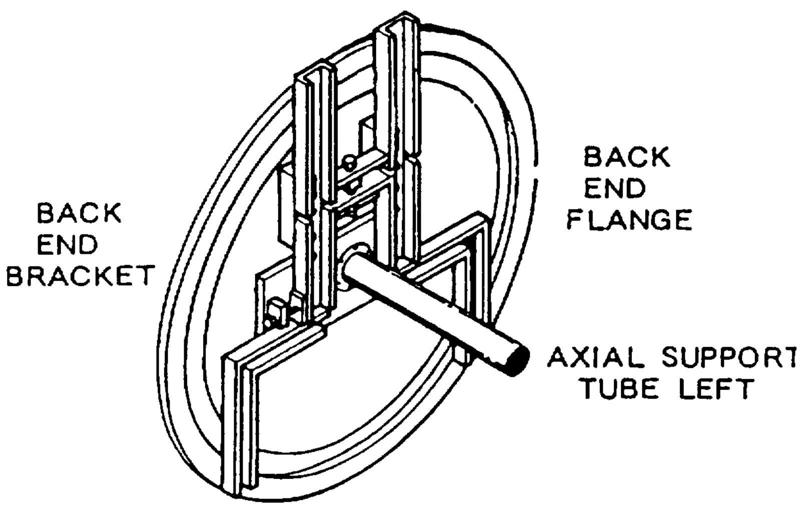


TABLE END SUPPORT BRACKET
(WITH SUPPORT TUBE IN PLACE)
ILLUSTRATION 5-4



BACK END BRACKET
ILLUSTRATION 5-5

5-2 FIELD MAPPING FIXTURE SET–UP (MODEL #46-209988G3) (continued)

13. With one person on either end of the magnet, lift the “composite” Axial Support Tube with the Back End Support Bracket mounted on it and insert the end of the Axial Support Tube Right into the bushing on the Table End Support Bracket.

14. With both persons at the Back End of the magnet, support the Back End Support Bracket against the Back End Flange of the magnet and insert and tighten the supporting bolts into the End Flange Bolt holes.

15. Assemble half of the Support Tube Shims provided with the Mapping Fixture and the Angular Position Plate and Pin. See Illustration 5-4.

16. Assemble the Radial Adjustment Rod and Locating Pin in the Radial Support Tube. See Illustration 5-6

17. Center the “composite” Support Tube Axis, coaxial within a .06 inch (1 .5mm) radius to the Magnet Bore Axis using the horizontal and vertical centering bolts shown in Illustration 5-1.

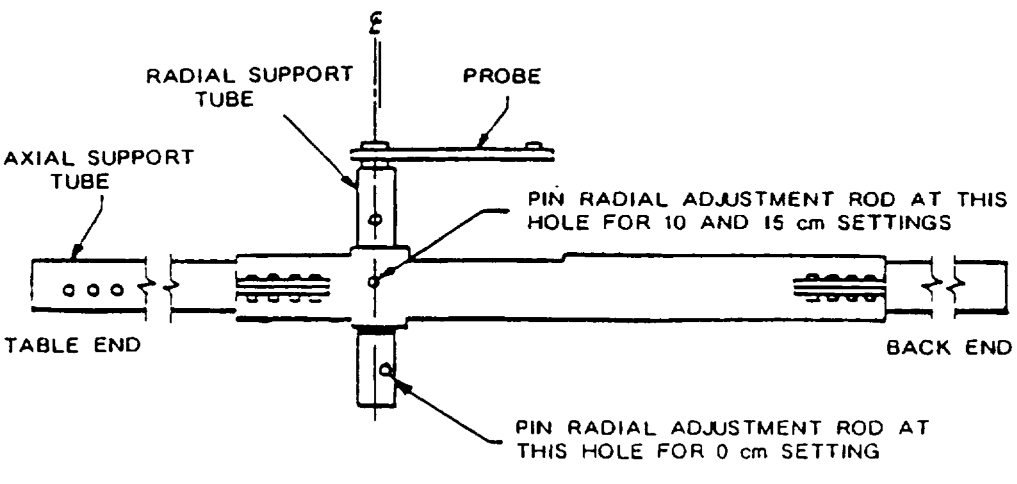
Note

Use Retaining Ring Bolts on both ends of the magnet as reference position measurements to the “composite” Support Tube Axis in both the horizontal and vertical plane.

18.Tighten all hardware.

Note

Mapping Fixture Set Up in Section 5-2 will result in the probe being at the physical center of the magnet when set to (R= O, Z = O).



RADIAL POSITION (REFERENCE) ADJUSTMENT
ILLUSTRATION 5-6

5-3 FIELD MAPPING FIXTURE SET UP (MODEL #46-281420G2)

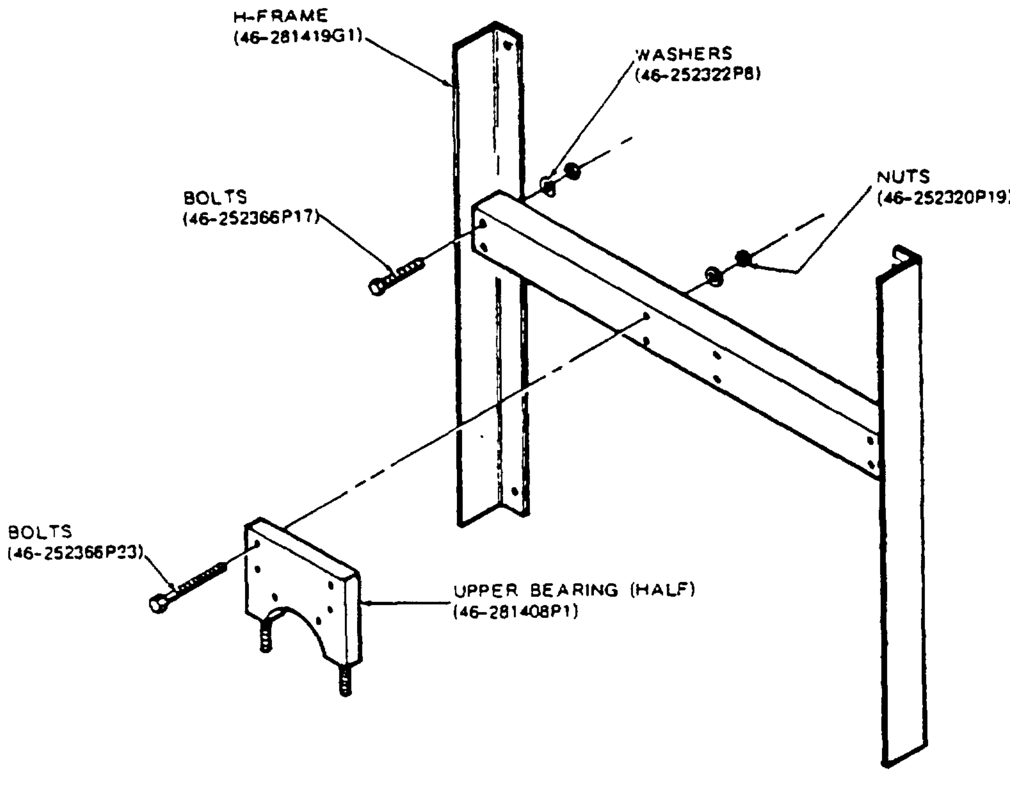
Note

Field mapping is performed from the Table End of the magnet.

CAUTION

Do not use any ferromagnetic material or hardware in the assembly of the mapping fixture as it will affect shimming.

. Assemble H–Frames using 2.75 inch long 3/8– 16 brass bolts, washers, and nuts. See Illustration 5–7.

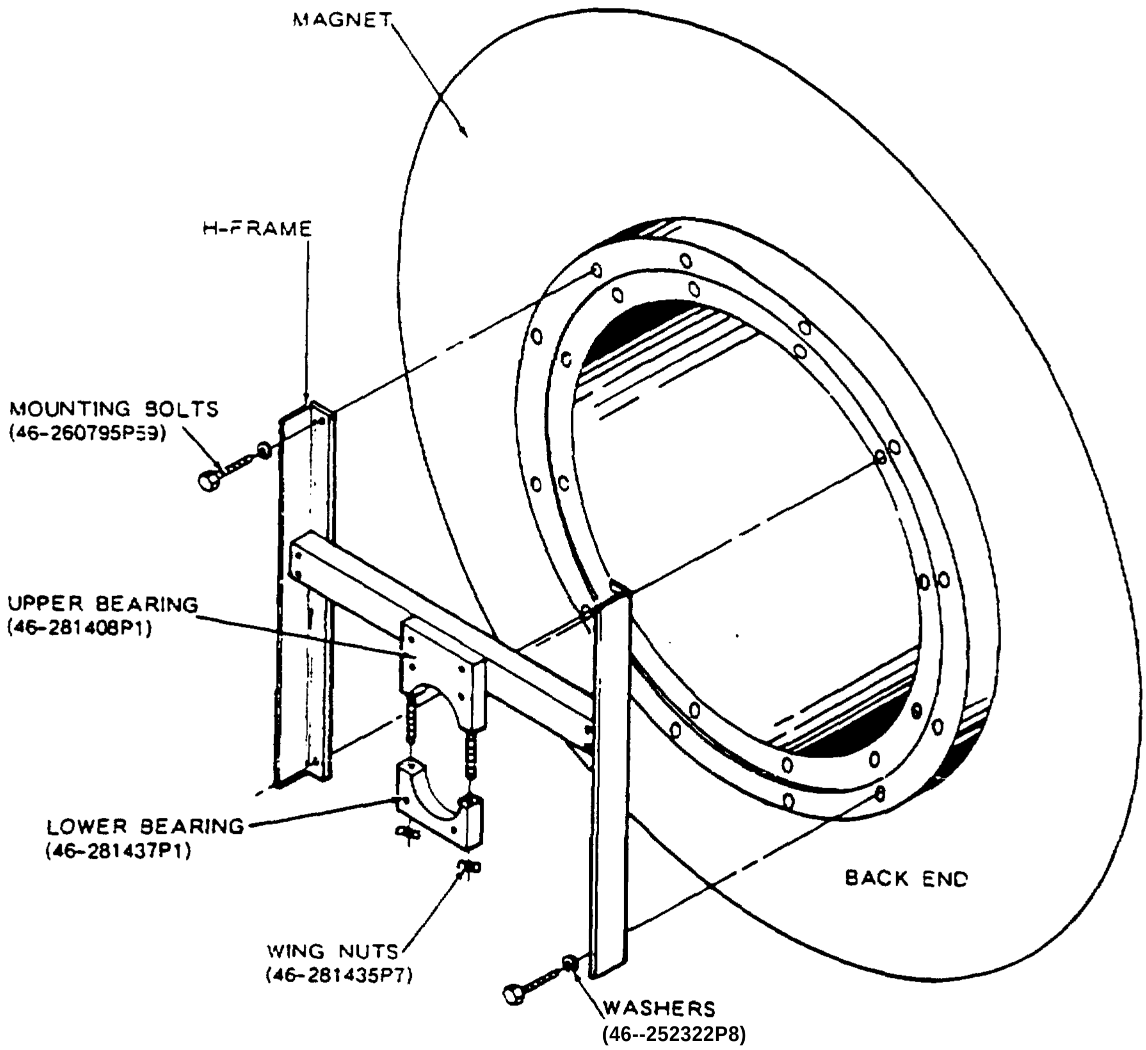


Attachment OF UPPER BEARING (HALF)/ASSEMBLY OF H-FRAME
ILLUSTRATION 5-7

2. Attach the H-Frames to the Interface Ring on each end of the magnet with four 0.5 inch long 3/8–16 brass bolts, at the 45 degree positions. See Illustration 5-8.

3. Attach the upper bearing to the H-Frames cross beam on the Back End of the magnet using 3.75 inch long cap screws, washers, and nuts.

5-3 FIELD MAPPING FIXTURE SETUP (MODEL #46-281420G2) (continued)



H-FRAME MOUNTING & LOWER HALF BEARING ATTACHMENTt

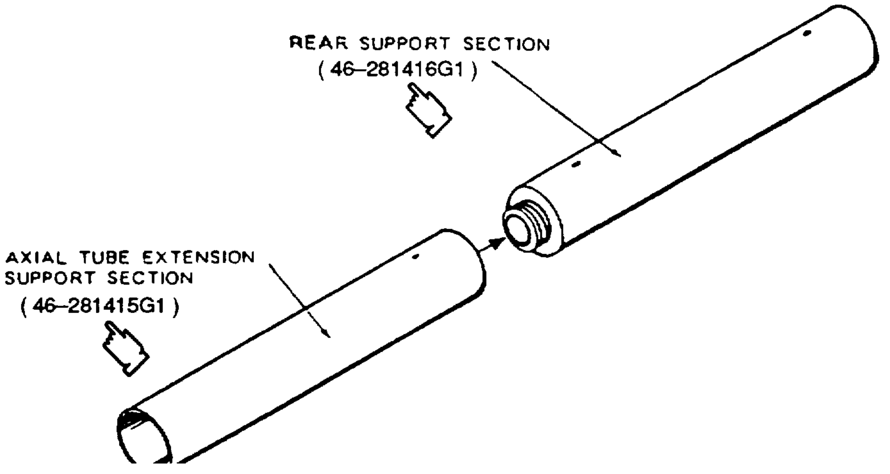
ILLUSTRATION 5-8

4. Loosely attach the lower half of the bearing to the upper half of the bearing on the Back End of the magnet. Slide the lower bearing half on the two threaded rods until it is within 1 to 2 inches of the upper half. Use the Wing Nuts to support the lower half of the bearing. See Illustration 5-8.

- Note that a small amount of lubricant on the axial tube threads will aid in assembly and disassembly of tube segments.

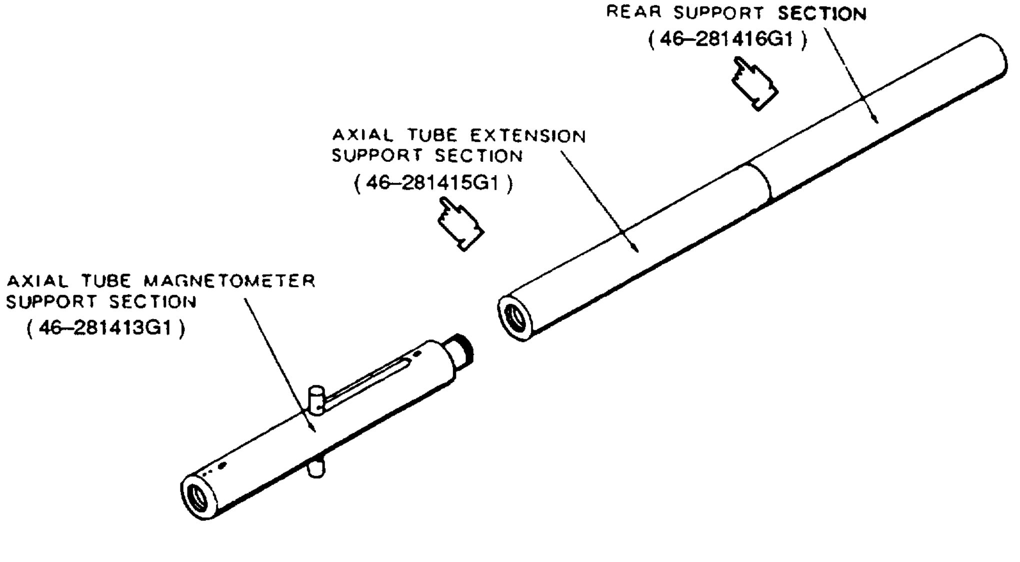
5-3 FIELD MAPPING FIXTURE SET UP (MODEL #46-281420G2) (continued)

5. Thread the Axial Tube Extension Support section into the Rear Support section. Twist them together as tightly as possible by hand then use a torquing bar (46-294019P1) through the holes near each joint as leverage to tighten the joint. See Illustration 5-9.



Attachment OF THE AXIAL TUBE EXTENSION SUPPORT SECTION TO THE REAR SUPPORT SECTION
ILLUSTRATION 5-9

6. Thread the Axial Tube Magnetometer Support section onto the Axial Tube Extension Support section. Tighten joint in same fashion as Step 5. See Illustration 5-10.



Attachment OF THE AXIAL TUBE MAGNETOMETER SUPPORT SECTION TO THE REAR SUPPORT SECTION AND THE AXIAL TUBE EXTENSION SUPPORT
ILLUSTRATION 5-10

5-3 FIELD MAPPING FIXTURE SET UP (MODEL #46-281420G2) (continued)

7. Join the Axial Positioning Tube (46-281414G1) to the other assembled tubes as described below:.

o Thread the Axial Positioning Tube onto the Magnetometer Support Tube Section. See Illustration 5-11.

o Threads and the Aluminum edges of the tubes need lubrication to prevent galling during assembly., NOALOX compound lubricant (46-252065P65) is recommended, but any mechanical grease is better than none. For grease placement, see Illustration 5-12.

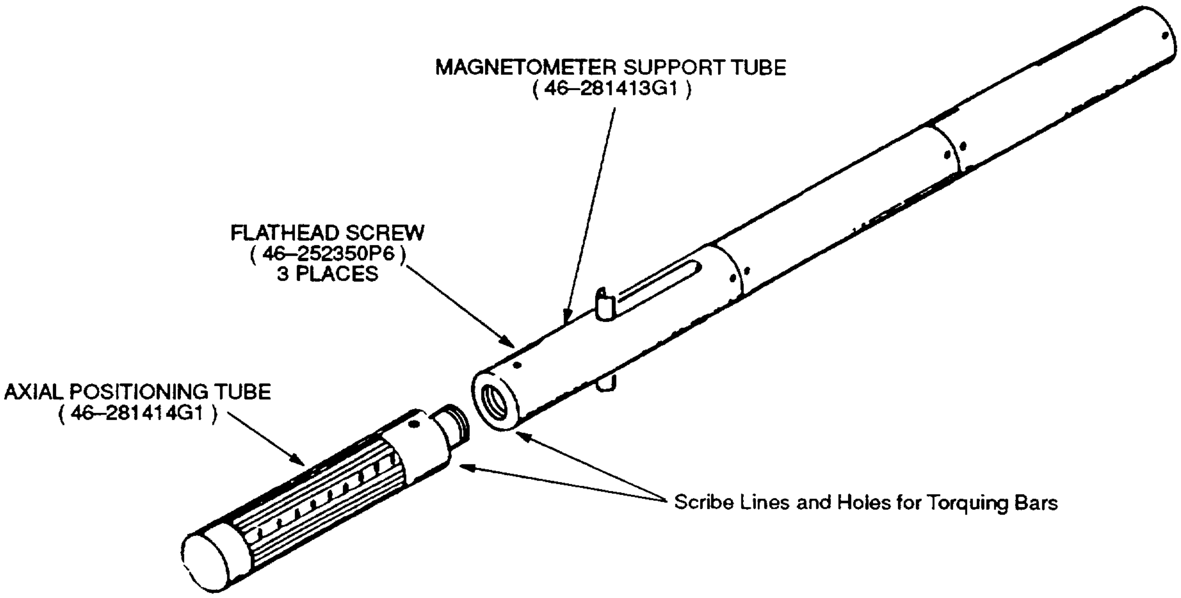
o Tighten the tubes until the Scribe Lines are lined up. These lines must be matches up for proper mapping.

o If it is difficult to align the tubes by hand, then use Torquing Bars as follows: All 4 tubes have a pair of 3/4" diameter holes near each end. These holes should be used to insert Torquing Bars for leverage when torquing the tubes together. See Illustration 5-12.

CAUTION

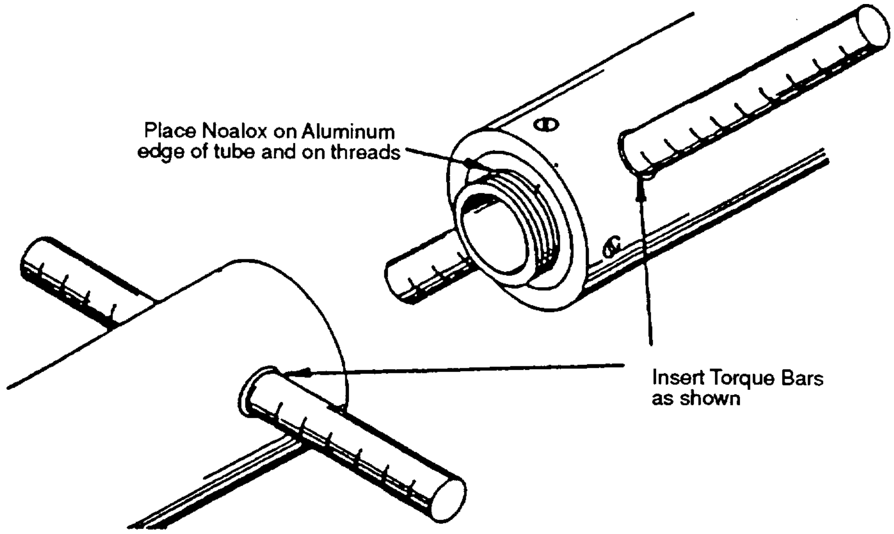
Stainless Steel Torquing Bars may be slightly magnetic. Do not use near the magnet bore.

o Secure the joint and prevent its motion with three #10-24 brass flathead screws. See Illustration 5-12.



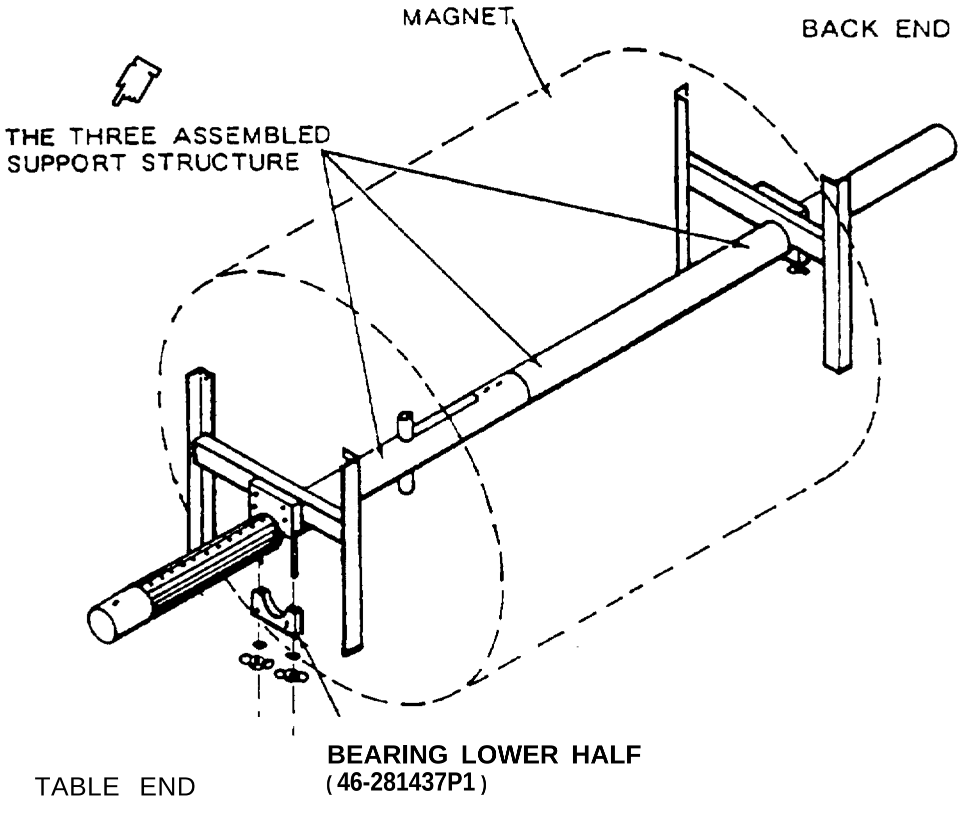
ATTACHMENT OF AXIAL POSITIONING TUBE
ILLUSTRATION 5-11

5-3 FIELD MAPPING FIXTURE SET UP (MODEL #46-281420G2) (continued)



LUBRICATION POINTS
ILLUSTRATION 5-12

8. **Place the four–piece tube assembly into the bore of the magnet. entering from the Table End of the magnet with the Rear Support section. Insert the Rear Support section into the open bearing at the Back End of the magnet. See Illustration 5–13.**



INSERTION OF THE THREE ASSEMBLED SUPPORT TUBES
ILLUSTRATION 5-13

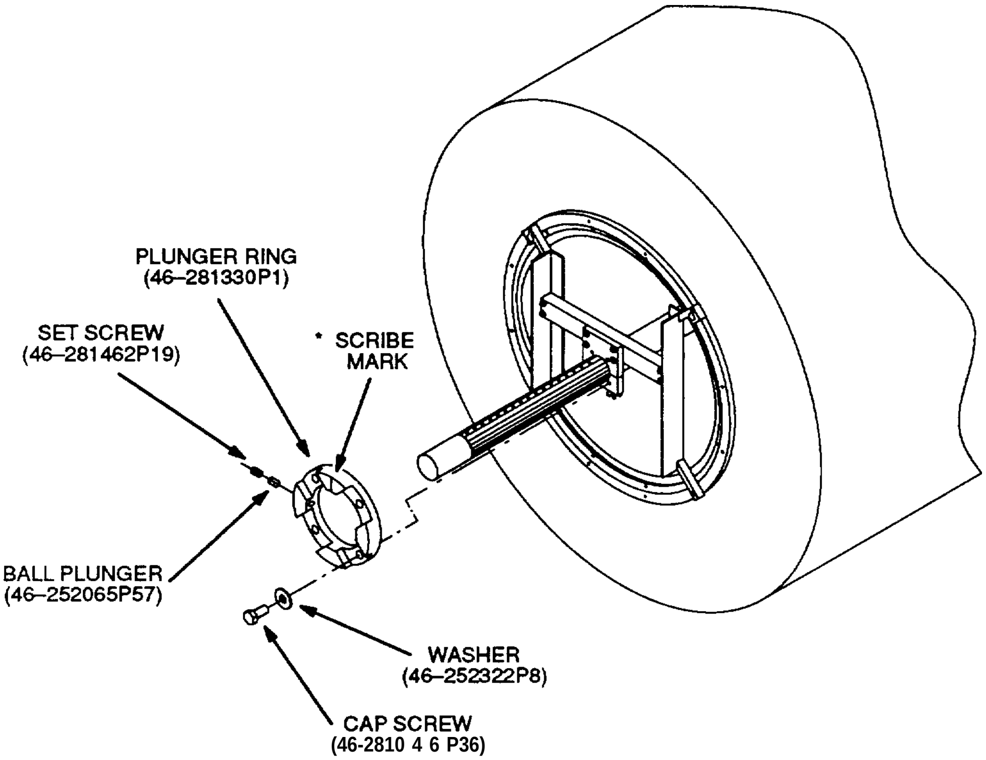
5-3 FIELD MAPPING FIXTURE SET UP (MODEL #46281420G2) (continued)

9. Place the Axial Tube Magnetometer Support section against the upper bearing at the Table End and hold in place.

10. Loosely attach the lower half-bearing to the H-Frame on the Table End of the magnet.

11. Tghten, with the wing nuts on both half bearings, hand tight.

12. Slide the Plunger Ring onto the Axial Positioning Tube and secure it to the bearing with four 1.5 inch long 3/8-16 cap screws. Back out the Set Screw and Ball Plunger if it interferes with this process. See Illustration 5-14

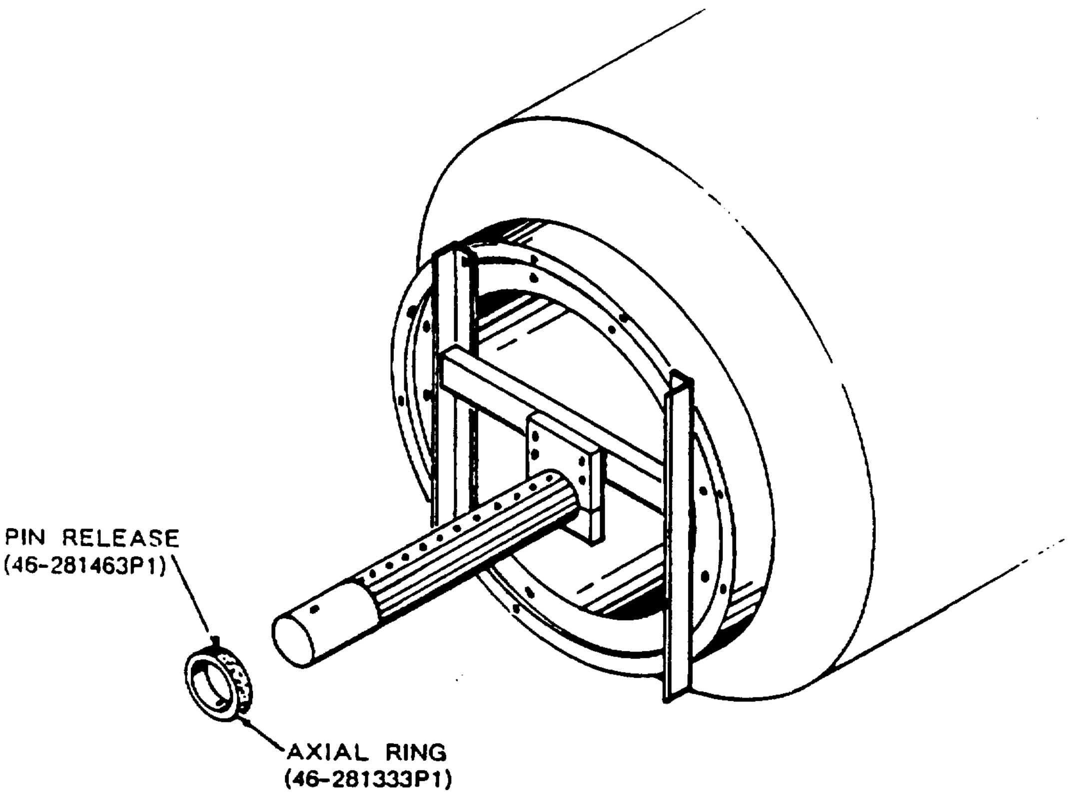


" SCRIBE MARK TO BE AT TOP, O DEG. POSITION

ATTACHMENT OF THE PLUNGER RING
ILLUSTRATION 5-14

5-3 FIELD MAPPING FtXTURE SETUP (MODEL #46-281420G2 (continued)

13. Slide the Axial Positioning Ring on the Axial Positioning Tube. Pin it at a convenient axial position. See Illustration 5-15. Make sure Axial Positioning Ring is oriented with degree numbers advancing in a clockwise direction. See Illustration 5-28.



ATTACHMENT OF AXIAL POSITIONING RING
ILLUSTRATION 5-15

5-3 FIELD MAPPING FIXTURE SET UP (MODEL #46-281420G2) (continued)

14. Attach the Handles to the Axial Positioning Tube. See Illustration 6-16.

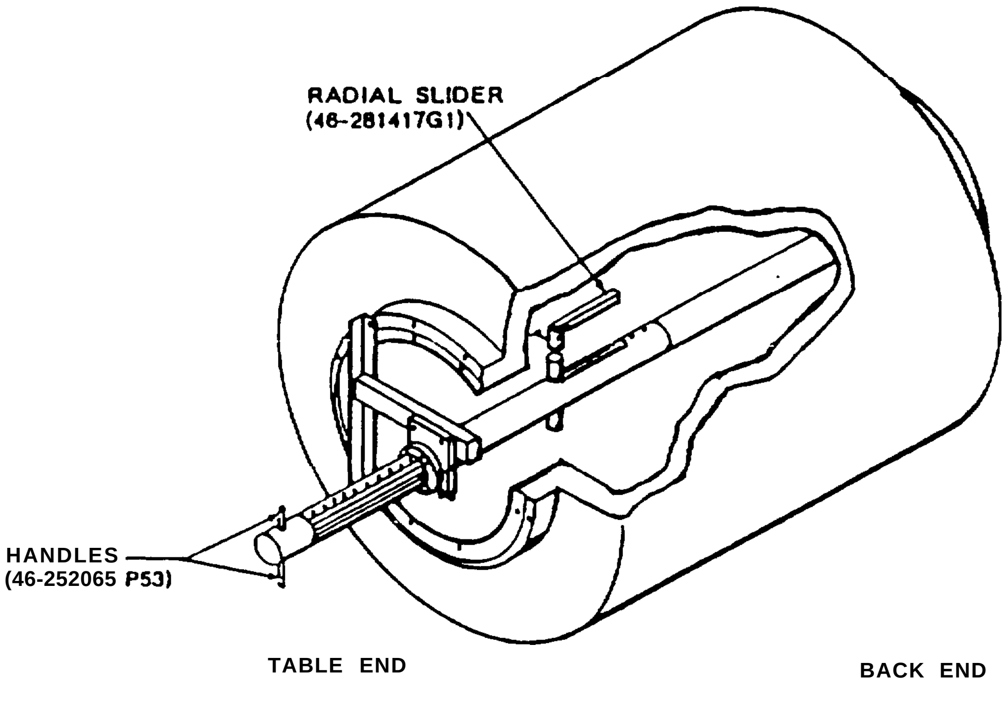
CAUTION

Do not overtighten Ball Plunger as damage could result. Back set screw out as far as possible to still maintaln "detent action".

15. Adjust the Ball Plunger. Move the fixture circumferentially to establish sufficient Plunger pressure to "click" in detent without binding. Put the Plunger Set Screw in place to maintain the Plunger at the proper pressure..

    - Note that a dry silicon lubricant may be used to improve axial and circunferential fixture action.

16. Draw the Mapping Fixture out and insert the Radial Slider with its Magnetometer Support Table into the Slider Support Tube. Pin the Radial Slider at a convenient position for attachment of the Magnetometer Probe to the Magnetometer Probe Support.



INSERTION OF THE RADIAL SLIDER AND ATTACHMENT OF HANDLES
ILLUSTRATION 5-16

5-4 SERVICE TOOL MAPPING FIXTURE SETUP (MODEL #46-294060G2)

Note

The Magnet Interface Rings should now be exposed and the Magnet Bore clear for mounting and operating the Field Mapping Fixture.

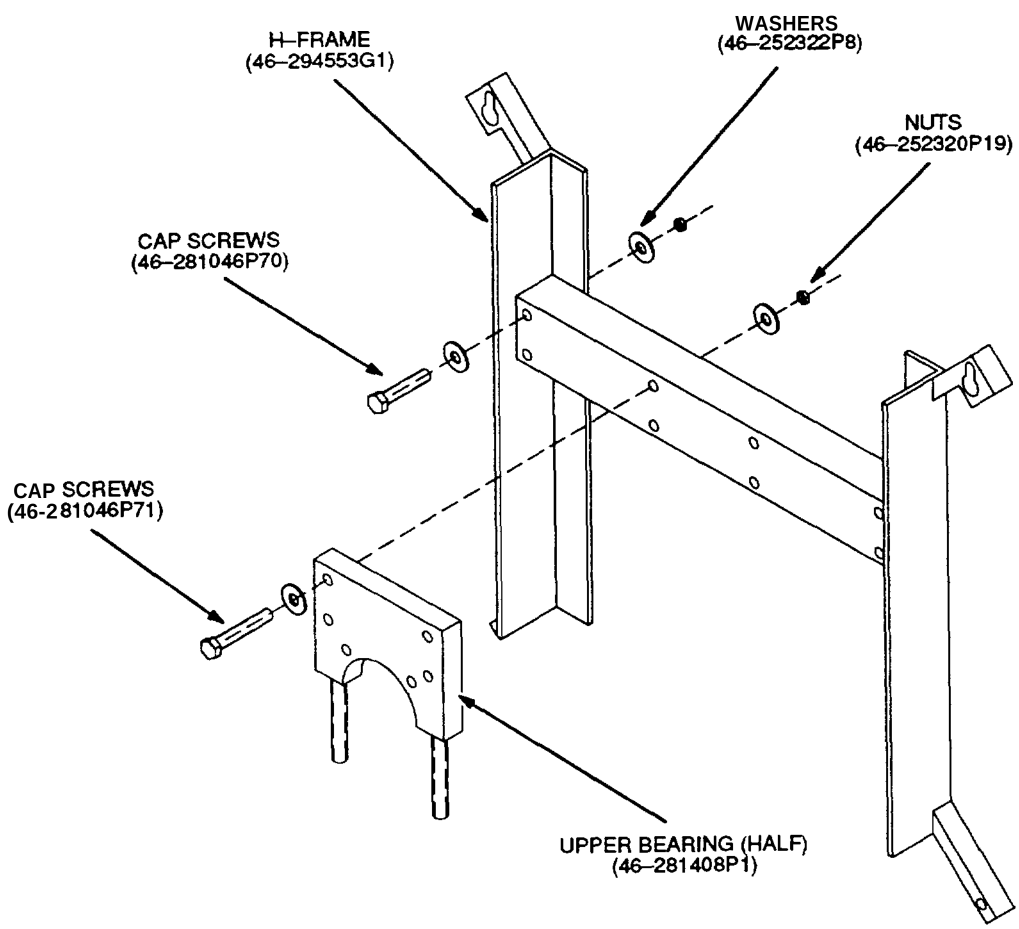
Note

Field mapping is performed from the Table End of the magnet.

CAUTION

Do not use any ferromagnetic material or hardware in the assembly of the mapping fixture as it will affect shimming.

1. Assemble H–Frames using 2.75 inch long 3/8– 16 brass bolts, washers, and nuts. See Illustration 5–17.

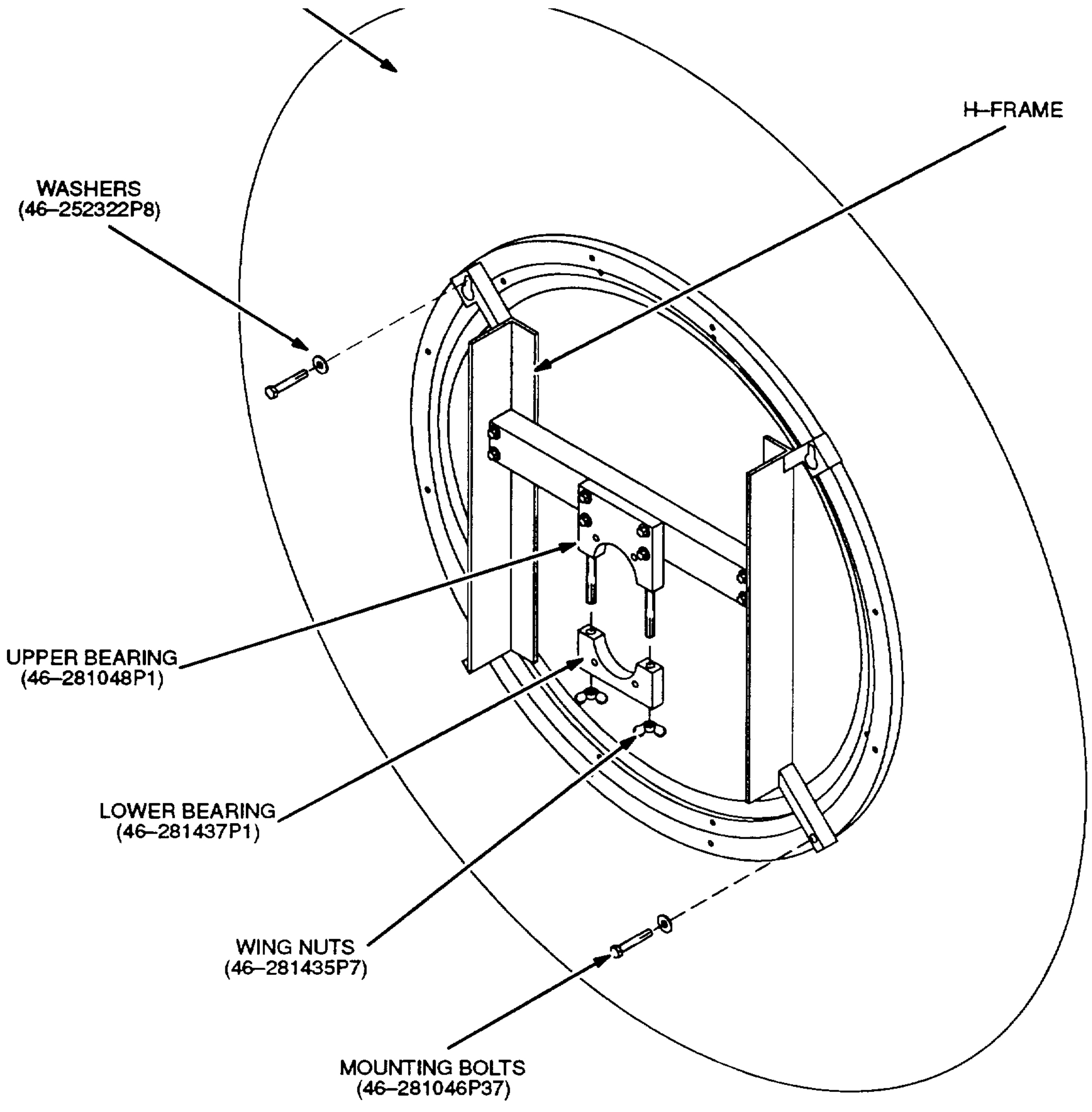


ATTACHMENT OF UPPER BEARING (HALF)IASSEMBLY OF H-FRAME
ILLUSTRATION 5-17

5-4 SERVICE TOOL MAPPING FIXTURE SETUP (MODEL #46-294060G2) (continued)

2. Attach the upper bearings to the H–Frame cross beams using 3.5 inch long cap screws, washers, and nuts. See Illustration 5-17.

3. Attach one of the H-Frames to the Interface Ring on Back End of the magnet with four 1.5 inch long 3/8-16 brass bolts, at the 45 degree positions. See Illustration 5-18.

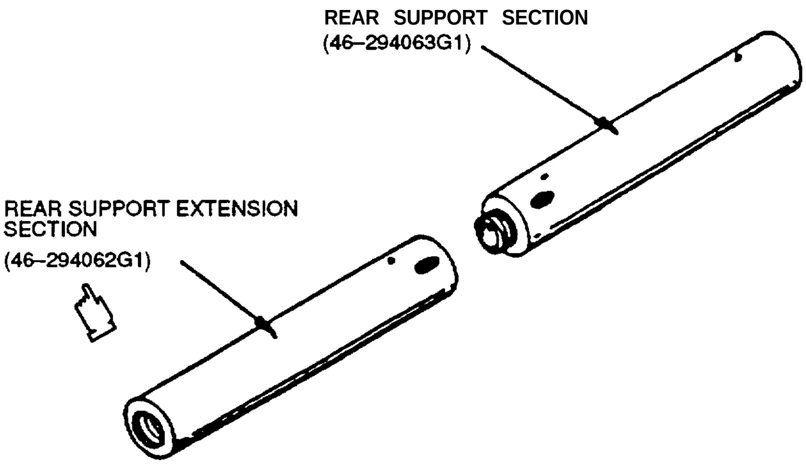


H-FRAME MOUNTING & LOWER HALF BEARING Attachment
ILLUSTRATION 5-18

5-4 SERVICE TOOL MAPPING FIXTURE SETUP (MODEL #46-294060G2) (continued)

4. Loosely attach the lower half of the bearing to the upper half of the bearing on both H – Frames. Use the Wing Nuts to support the lower half of the bearing. See Illustration 5-18.

5. Thread the Rear Support Extension Section into the Rear Support section. Twist them together as tightly as possible by hand then use a torquing bar (46-294019P1) through the holes near each joint as leverage to tighten the joint. See Illustration 5-19.



Attachment OF THE AXIAL TUBE EXTENSION SUPPORT SECTION
TO THE REAR SUPPORT SECTION
ILLUSTRATION 5-19

Note

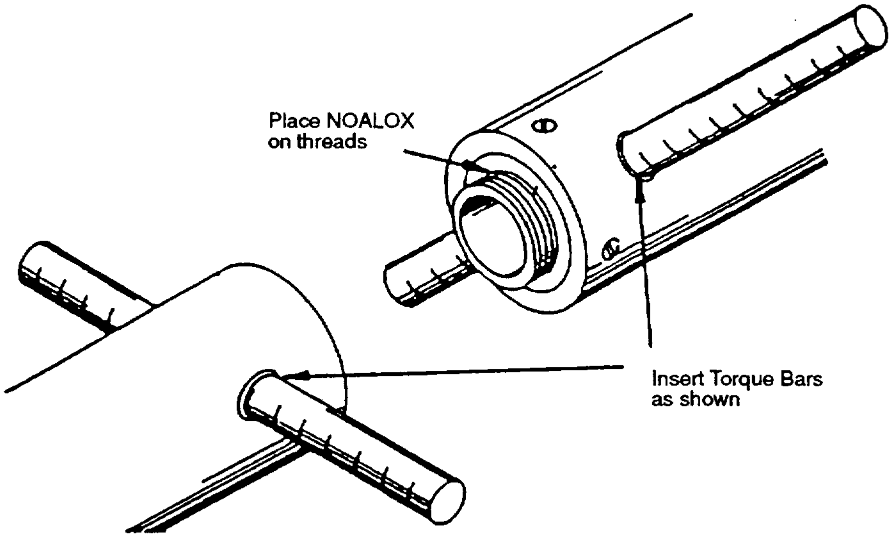
Threads and the Aluminum edges of the tubes need lubrication to prevent galling during assembly. NOALOX compound lubricant (46-252065P65) is recommended, but any mechanical grease is better than none. For grease placement, see Illustration 5-20.

If it is difficult to align the tubes by hand, then use Torquing Bars as follows: All tubes have a pair of 3/4 inch diameter holes near each end. These holes should be used to insert Torquing Bars for leverage when torquing the tubes together. See Illustration 5-20.

CAUTION

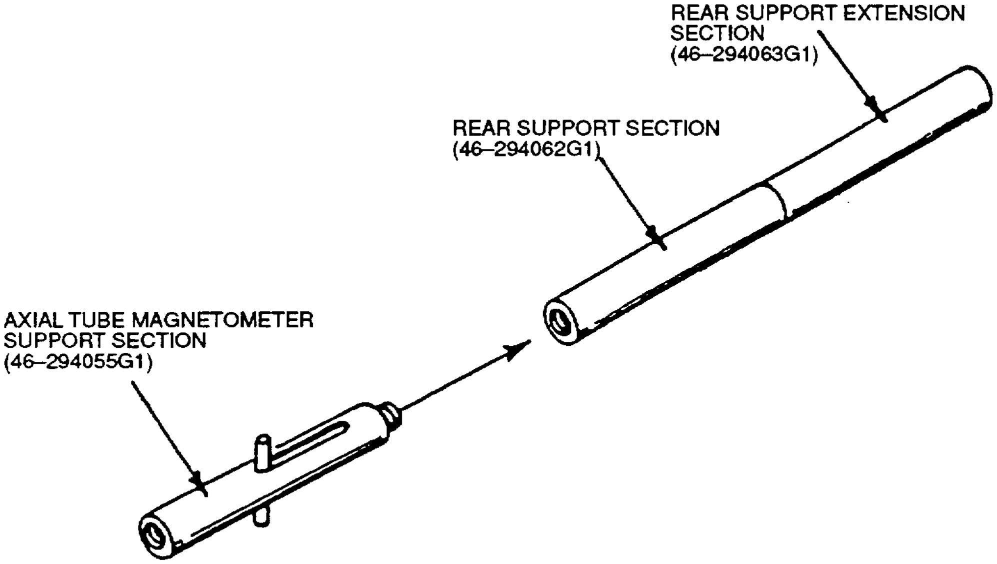
Stainless Steel Torqulng Bars maybe slightly magnetic. Do not use near the magnet bore.

5-4 SERVICE TOOL MAPPING FIXTURE SETUP (MODEL #46-294060G2) (continued)



LUBRICATION POINTS
ILLUSTRATION 5-20

6. Thread the Axial Tube Magnetometer Support Section into the Rear Support Section. Tighten joint in same fashion as Step 5. See Illustration 5-21.



ATTACHMENT OF THE AXIAL TUBE MAGNETOMETER SUPPORT SECTION
TO THE REAR SUPPORT SECTION AND THE REAR SUPPORT SECTION EXTENSION
ILLUSTRATION 21

5-4 SERVICE TOOL MAPPING FIXTURE SETUP (MODEL #46-294060G2) (continued)

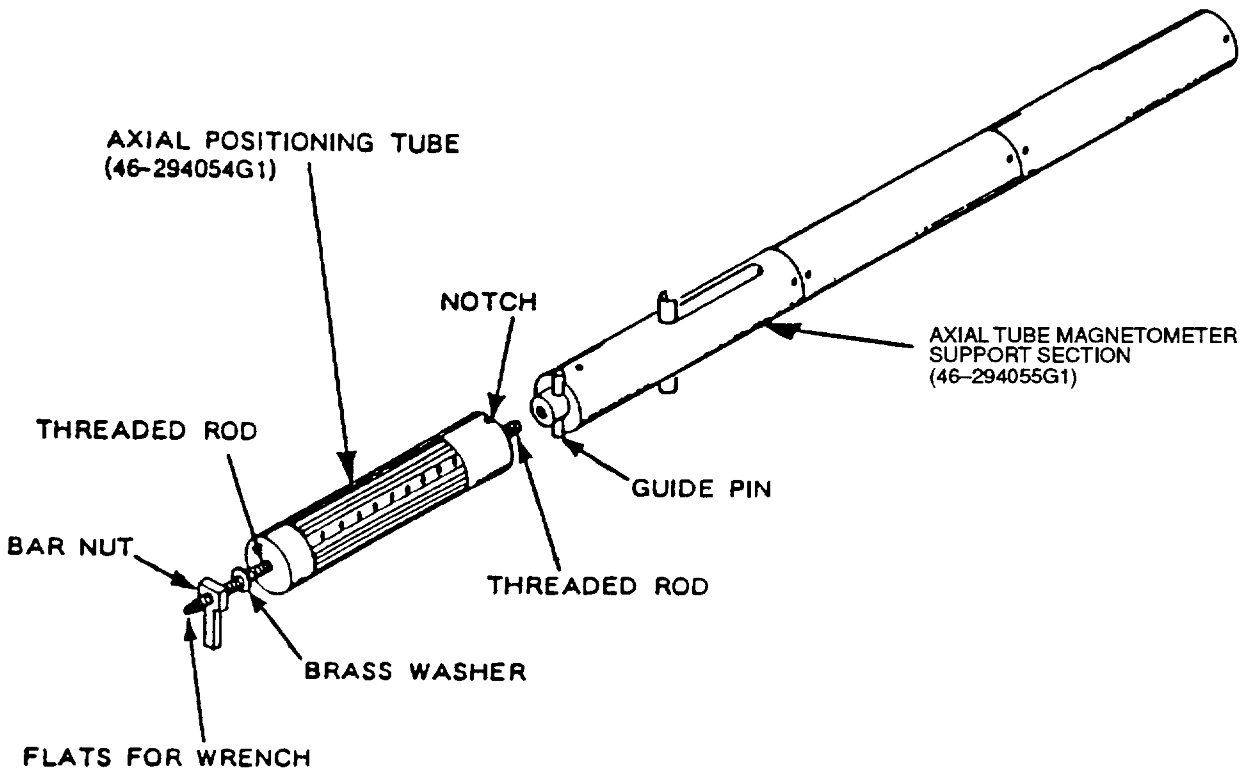
7. Join the Axial Positioning Tube (46-294054G1) to the other assembled tubes as described below:

   • Line up the notch in the Axial Positioning Tube with the pin in the front of the Magnetometer Support Tube and slide the tubes together.

   • Using a 9/16 inch wrench on the “Flats” of the threaded brass rod, turn the rod until it engages the Magnetometer SupportTube (at least 4 turns).

   Ž Turn the Bar Nut (46-294072P1) to snug the two tubes firmly against each other.

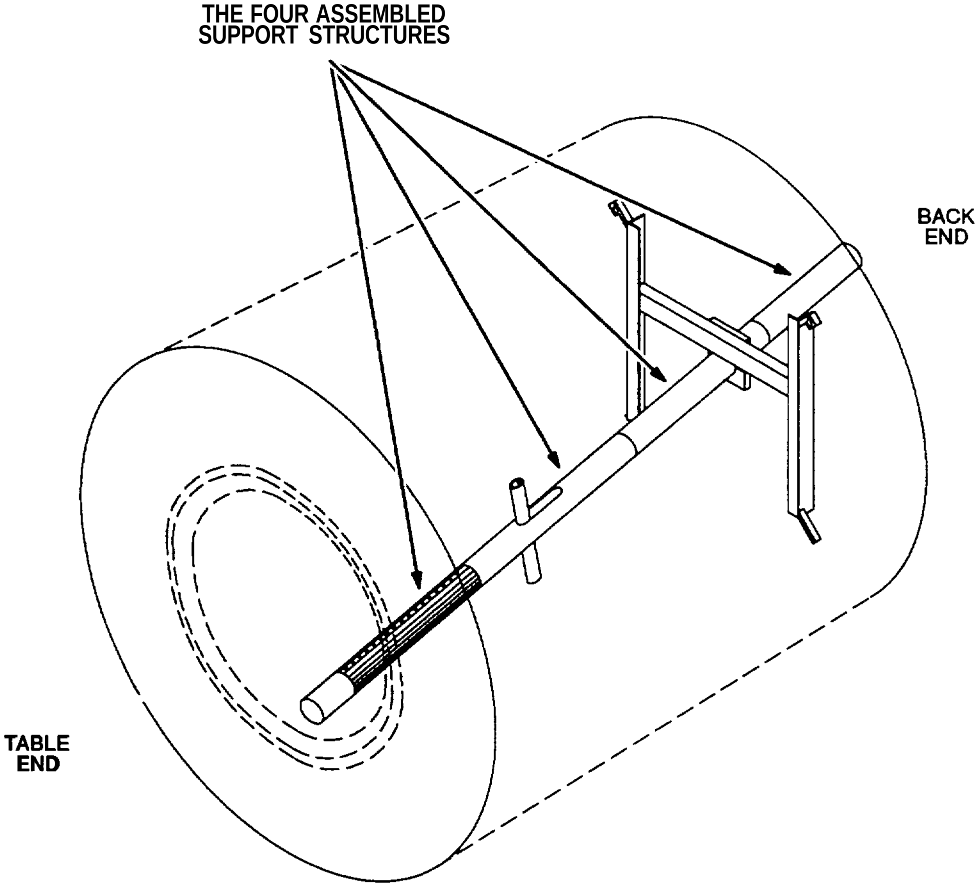
   Ž See Illustration 5-22.



Attachment OF AXIAL POSITIONING TUBE
ILLUSTRATION 5-22

5-4 SERVICE TOOL MAPPING FIXTURE SETUP (MODEL #46-294060G2) (continued)

8. Place the four-piece tube assembly into the bore of the magnet, entering from the Table End of the magnet with the Rear Support Section. Insert the Rear Support Section into the open bearing at the Back End of the magnet and slide the tube assembly through until the tube assembly at the Table End is even with the front of the magnet. See Illustration 5-23.



INSERTION OF THE FOUR ASSEMBLED SUPPORT TUBES
ILLUSTRATION 5-23

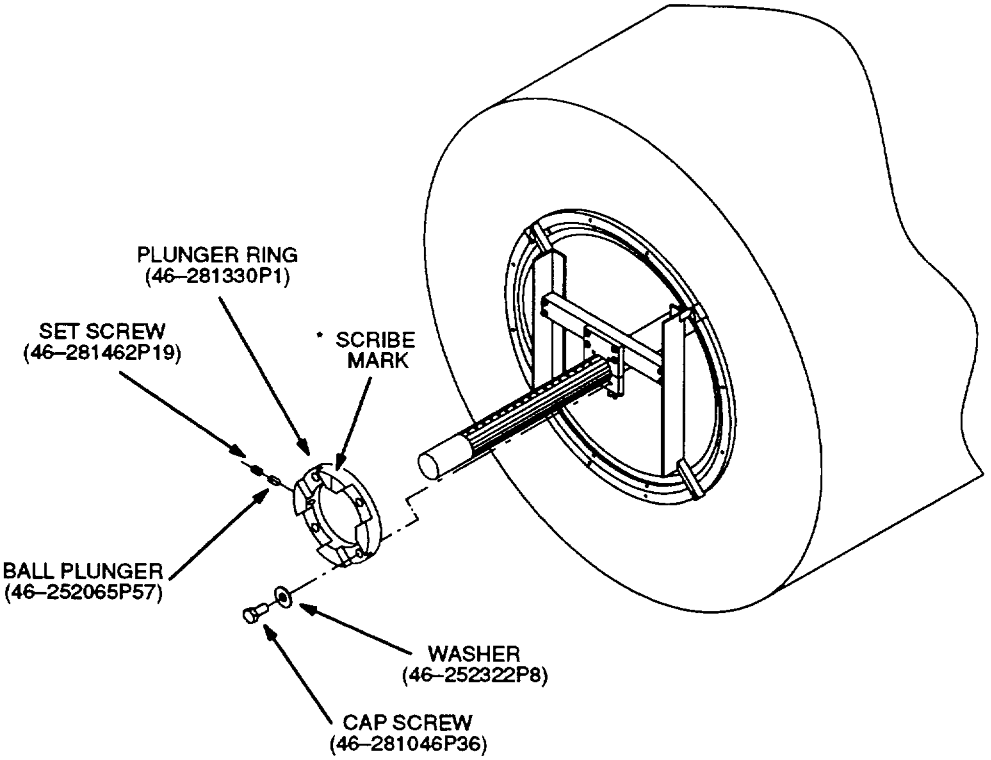
9. Attach the remaining H-Frame to the Table End of the magnet.

10. Lift and pull the tube assembly through the Table End bearing hole until the tube assembly is supported by the H-Frames. See Illustration 5-24.

11. Tighten the wing nuts, on both Lower Bearings, hand tight.

12. Slide the Plunger Ring onto the Axial Positioning Tube and secure it to the bearing with four 1.5 inch long 3/8–16 cap screws. Back out the Set Screw and Ball Plunger if it interferes with this process. See Illustration 5-24.

5-4 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46-294060G2) (continued)

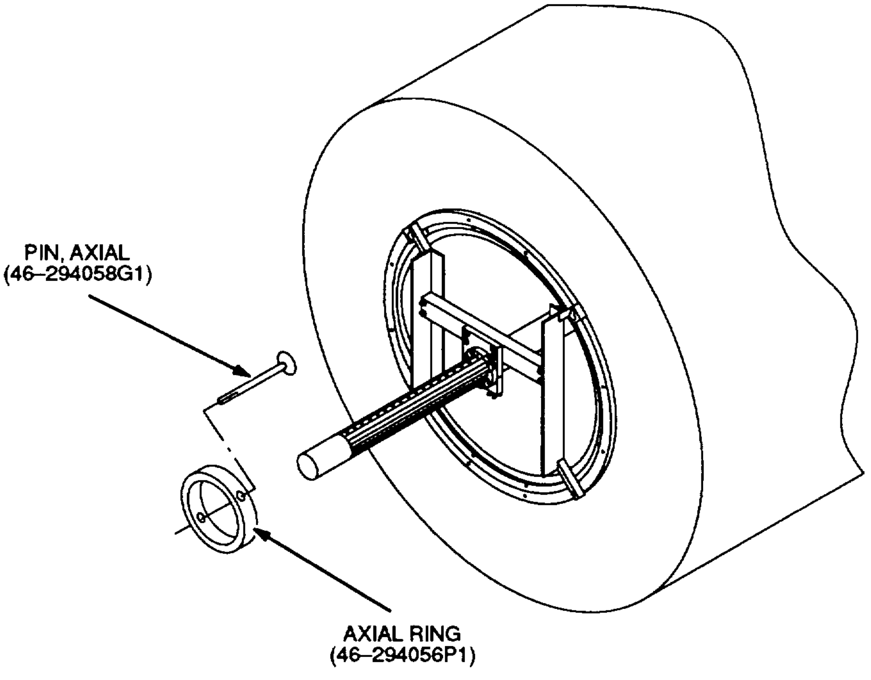


* SCRIBE MARK TO BE AT TOP, 0 DEG. POSITION

ATTACHMENT OF THE PLUNGER RING
ILLUSTRATION 5–24

13. Slide the Axial Positioning Ring on the Axial Positioning Tube. Pin it at a convenient axial position. Make sure the Axial Positioning Ring is oriented with degree numbers advancing in a clockwise direction. See Illustration 5-25.

5-4 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46-294060G2) (continued)



Attachment OF AXIAL POSITIONING RING
ILLUSTRATION 5-26

5-4 SERVICE TOOL MAPPING FIXTURE SETUP (MODEL #46-294060G2) (continued)

14. Attach the Handles to the Axial Positioning Tube. See Illustration 5-26.

CAUTION

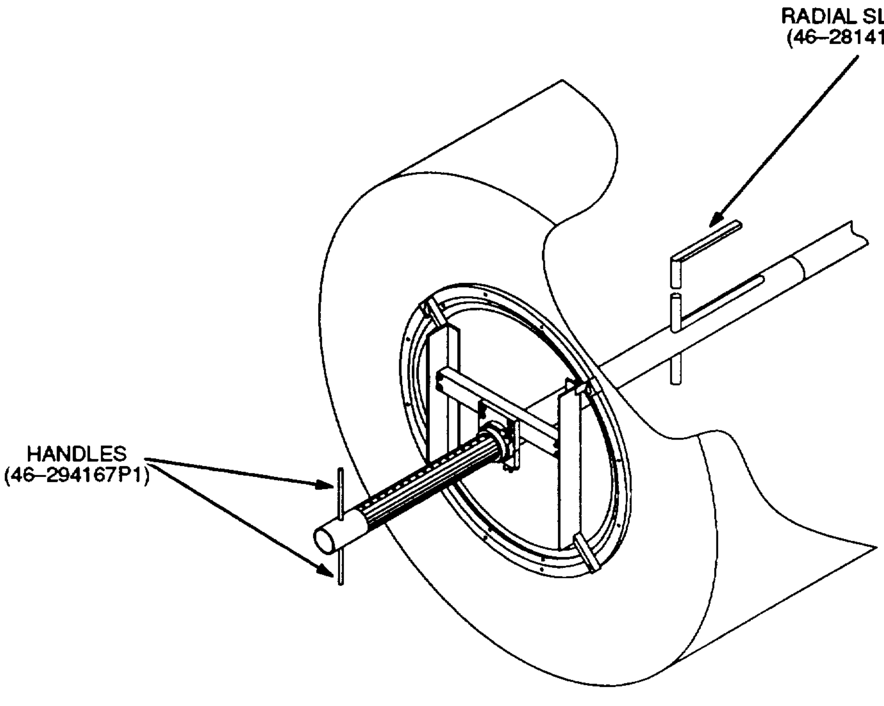
Do not overtighten Ball Plunger as damage could result. Back Set Screw out as far as possible to still maintain "detent action".

15. Adjust the Ball Plunger. Move the fixture circumferentially to establish sufficient Plunger pressure to "clicK' in detent without binding. Adjust the Set Screw to maintain the Plunger at the proper pressure.

Note

A dry silicon lubricant may be used to improve axial and circumferential fixture action.

16. Draw the Mapping Fixture out and insert the Radial Slider with its Magnetometer Support Table into the Slider Support Tube. Pin the Radial Slider at a convenient position for attachment of the Magnetometer Probe to the Magnetometer Probe Support.



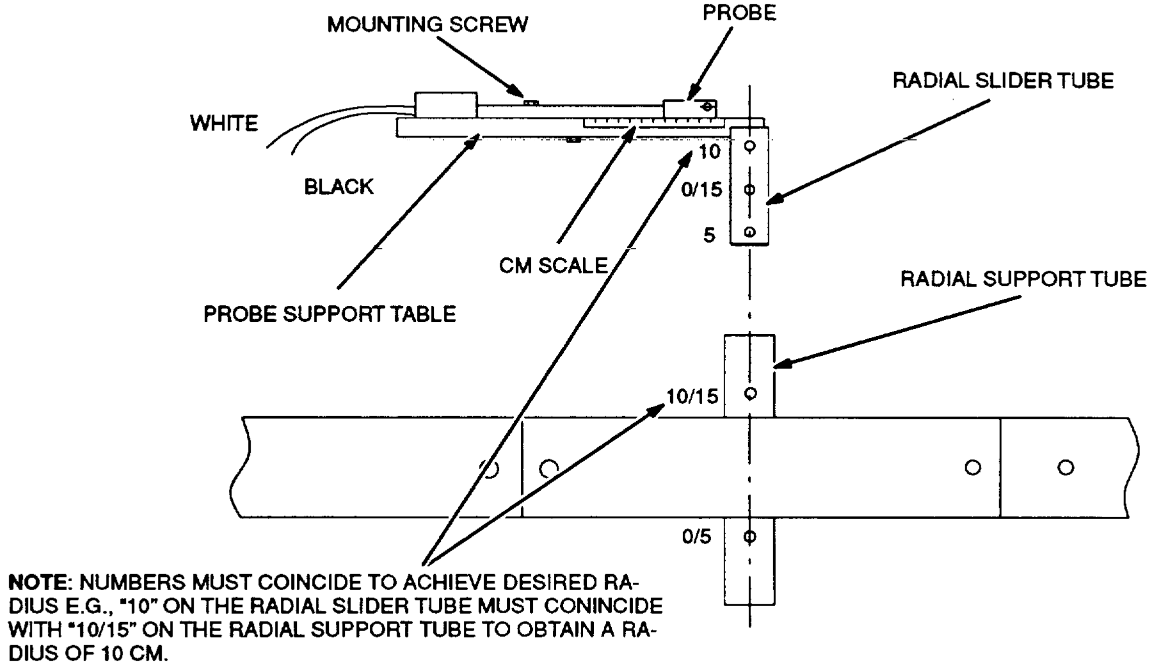
INSERTION OF THE RADIAL SLIDER AND ATTACHMENT OF HANDLES
ILLUSTRATION 5-26

5-5 PROBE POSITION REFERENCE ADJUSTMENTS(RADIAL, ANGUIAR & AXIAL)

Magnetic field mapping is accomplished by the three separate adjustments referenced in Steps 1, 2 and 3 below:

MODEL #46-294060G2

1. Radial Positioning: Adjust the Radial Slider Tube in the Radial Support Tube and pin through the desired position holes. See Illustration 5-27.

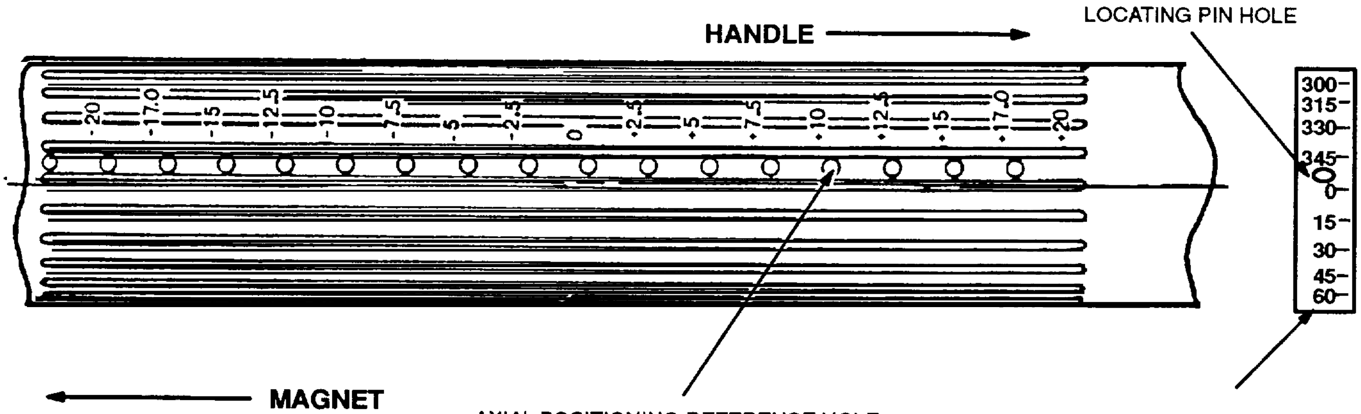


RADIAL POSITIONING HOLES
ILLUSTRATION 5-27

5-5 PROBE POSITION REFERENCE ADJUSTMENTS (RADIAL, ANGULAR & AXIAL) (continued)

2. Angular Positioning: Angular positions are obtained by rotating the Axial Positioning Tube through the specific 15 degree detent positions, shown on the tube. The angular markings on the Axial Positioning Ring will display the specific angle at the top (90 degree vertical position) when the Ball Plunger is seated Into the detent on the Axial Positioning Tube. See Illustration 5-28.

3. Axial Positioning: Slide the Axial Positioning Tube along the bore of the magnet and insert Locating Pin through the desired axial position reference hole. See Illustration 5-28.



ANGULAR/AXIAL POSITIONING
ILLUSTRATION 5-28

5-6 TESLAMETER AND PROBE MECHANICAL CENTERING

Description:

Precise magnetic field measurements are made with the Teslameter and Magnetometer Probe when properly setup and positioned in the Magnet Bore.

The Magnetometer Probe is centered physically at the bore center In this procedure, it will be centered magnetically at the beginning of the shimming procedure.

Ensure alignment of red lines, on the connectors, when connecting the cables. Never force or twist the connectors as damage may result.

5-6 TESLAMETER AND PROBE MECHANICAL CENTERING (continued)

Procedure:

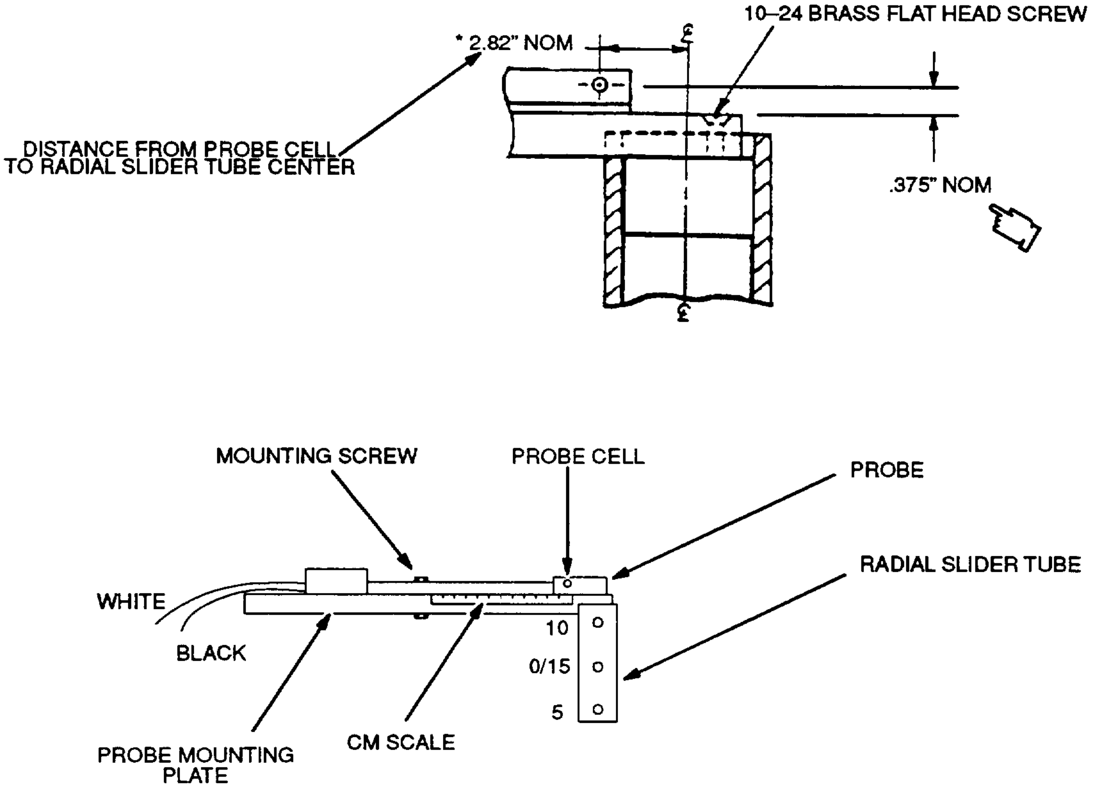
1. Attach the Magnetometer Probe to the probe mounting plate with brass machine screws as shown in Illustration 5-29.

Note

To get proper radial spacing of the probe (.375 inches from the top of the Probe Mounting Plate), Nylon Spacers (46-294059P1 and P2) are included with the Service Tool Mapping Fixture (46-294060G2). These Shims should only be needed with the Metrolab Probe.

2. Loosen Probe Mounting Screw and set the Probe Cell 2.82 inches from the center of the Radial Slider Tube. See Illustration 5-29.

3. Install Shims, if necessary, to bring Probe height to .375 inches; measured from the center of the Probe Cell to the top of the Radial Slider Tube. See Illustration 5-29.



* Loosen Mounting Screw to Adjust Probe to Magnet Center.

AXIAL MECHANICAL CENTERING OF MAGNETOMETER PROBE
ILLUSTRATION 5–29

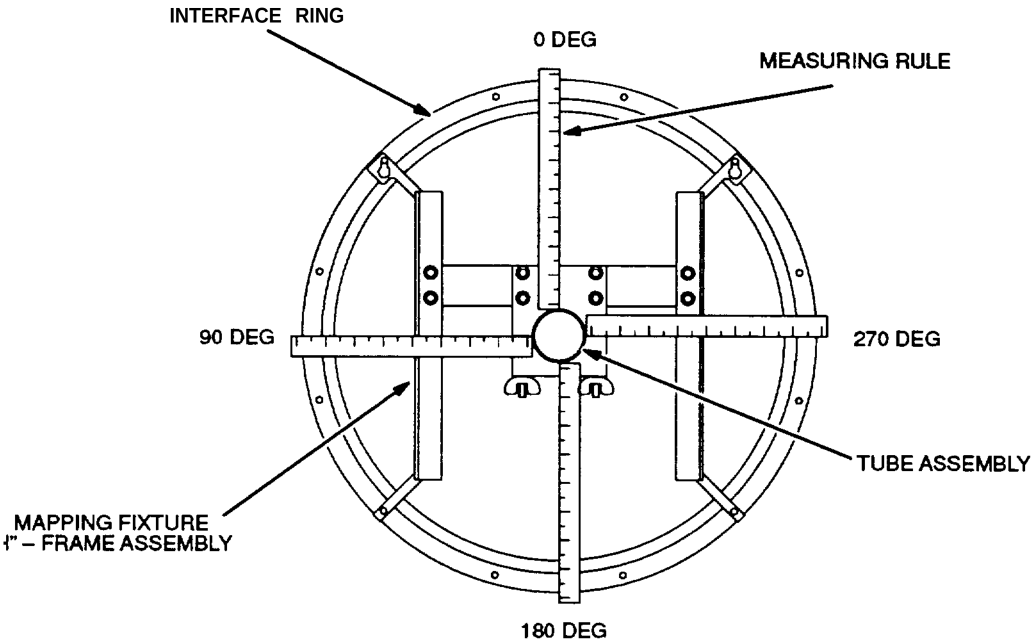
5-6 TESLAMETER AND PROBE MECHANICAL CENTERING (continued)

4. Measure the distance from the outside of the Interlace Ring to the 0°, 180°, 90°, and 270° points on the Tube Assembly, using a rulie capable of measuring to within 1 mm. See illustration 5-30.

5. Check the distances between 0 degrees(top) and 180 degrees (bottom), 90 degrees (right) and 270 degrees (left). The two distances should be equal within* 1 mm (0.04 in).

6. Loosen the four bolts on the appropriate H–Frame slightly and adjust the H-Frame in the appropriate direction to bring the distances within the ± 1 mm tolerance.

7. Repeat Steps 3 through 5 for both sides of the Mapping fixture,



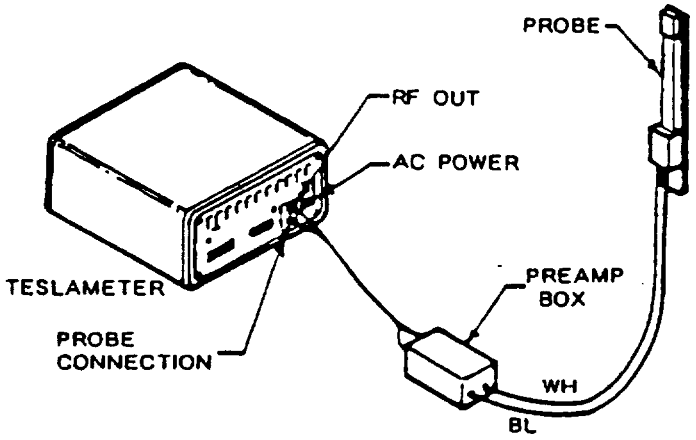
TRANSVERSE MECHANICAL CENTERING OF MAPPING FIXTURE
ILLUSTRATION 5-30

8. Connect the Probe Output Cables to the Preamp Box. See illustration 5-31.

9. Connect the preamp box to the two probe connection input plug on the Teslameter.

5-6 TESLAMETER AND PROBE MECHANICAL CENTERING (continued)

10. Position the Magnetometer probe at physical center of the bore (R= O, Z = O).



TESLAMETER INTERCONNECTIONS
ILLUSTRATION 5-31

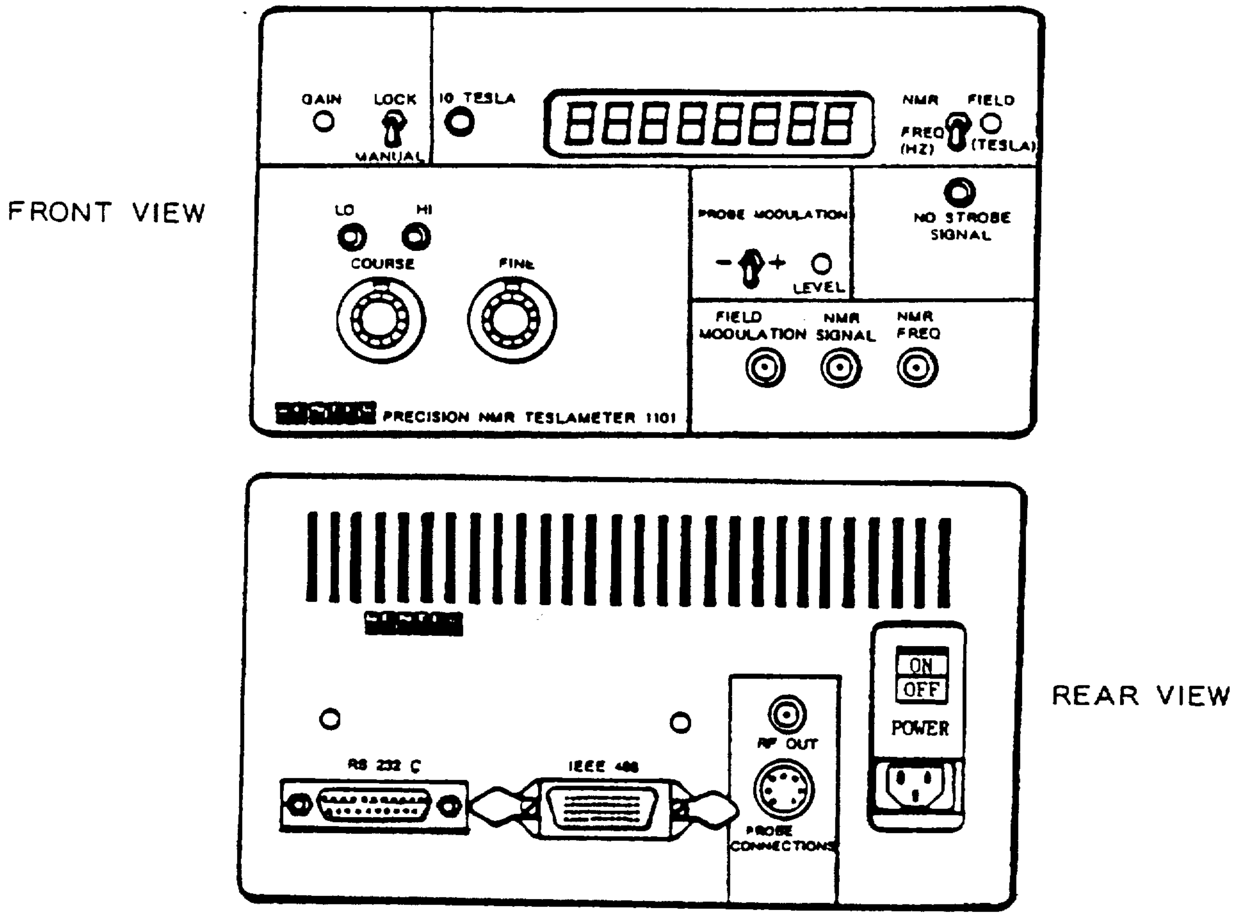
11. Turn on AC power to the meter. See Illustration 5-32 rear view.

12. Place the “LOCK/MANUAL” switch in the MANUAL position.

CAUTION

If “LOCK/MANUAL” switch is not In MANUAL at start of field search during ramping, Its sweep will be in the +/-10,000 gauss range and the system could lock on to the mechanical oscillation harmonic of the Shield Cooler Cold Head and result in an erroneous reading.

5-6 TESLAMETER AND PROBE SET–UP (continued)



TESLAMETER
ILLUSTRATION 5-32

Note
These switches must be pulled before repositioning.

13. Set the COARSE and FINE control knobs fully counterclockwise (CCW).

14. Set the “NMR FREQ/FIELD” switch to the FIELD position.

The Teslameter is now set up and prepared to start monitoring the field when ramping commences.

Note
The Teslameter will not lock in on a probe signal until magnetic field is approximately 7000 gauss.

5-7 TESLAMETER ADJUSTMENT(RAMP UP)

1. Once ramping has started, monitor the power supply current meter until an indication of approximately 350 amps is approached. At this time, start monitoring the teslameter.

2. As the developing field approaches the lower limit of the teslameter probe (approximately 7000 gauss), the “NO STROBE SIGNAL” LED will start blinking. Observe when the LED goes out.

3. When the “NO STROBE SIGNAL” LED is out, change the “LOCK/MANUAL” switch to the LOCK position. See Illustration NO TAG.

Note

If the signal does not lock in, change the position of the PROBE MODULATION switch.

4. As the field continues to increase, note when the ‘HI” LED to the right of the COARSE control begins to light. Turn the COARSE control clockwise (towards the lighted LED) until the LED is extinguished.

Note

As the magnetic field Increases, the probe sample resonant frequency will increase above the range setting of the teslameter. Therefore, increase the setting of the COARSE knob periodically to keep the teslameter locked on the probe sample.

Note

The FINE knob does not function when the “LOCK/MANUAL” switch Is in the LOCKED position.

5-8 TESLAMETER ADJUSTMENT (RAMP DOWN)

1. Increase the COARSE control knob until afield reading of approximately 15,000 gauss is obtained. You should be near but slightly below the actual field.

2. Slowly start increasing the FINE control knob while watching the “NO STROBE SIGNAL” LED. When the LED stops blinking and remains out, reposition the “LOCK/MANUAL” switch to the LOCK position.

Note

If the signal will not lock on, change the position of the PROBE MODULATION switch.

3. Now that the teslameter is locked on the field, note that either the LO or HI LED is lighted. Turn the COARSE control in the direction of whichever LED is on. Slowly it will go out and stay out.

4. As the magnetic field decreases, the probe sample resonant frequency will decrease below the present setting of the teslameter. Therefore, decrease the setting of the COARSE control knob to keep the teslameter locked on the probe sample.

Note

The FINE control does not function when the “LOCK/MANUAL” switch is in the LOCKED position.

5-9 TESLAMETER RESYNCHRONIZATION.

If the teslameter should go out of sync while ramping the magnet up (or down), it can easily be desynchronized by the following procedure.

Manual Resynchronization

1. Reposition the “LOCK/MANUAL” switch to MANUAL.

Note

The “NO STROBE” SIGNAL will be on; the LO/Hi LEDs will be oscillating, indicating a search mode.

2. Note the present current reading on the Main Power Supply Current Meter.
3. Multiply the current times 20 gauss (approximately 20 gauss/amp). The meter should be set at the resultant gauss level.
4. Slowly start Increasing (if ramping up) the COARSE and/or FINE control knob while monitoring the “NO STROBE SIGNAL” LED.
5. Once the LED extinguishes, quickly place the “LOCK/MANUAL” switch to the LOCK position. The meter will now be “SYNCHRONIZED”.

Note

If the HI LED is lit, the COARSE control knob will have to be turned in the HI direction until the LED goes out. Repeat this adjustment as required until the parking field Is reached.

Manual Resynchronization (with scope)

An oscilloscope can be set up near the teslameter to display and trigger on the “FIELD MODULATION” signal from a jack on the teslameter front panel. Adjust the time base to display one or two ramp wave forms. On the second channel, display the “NMR SIGNAL” from the front panel of the teslameter.

1. Leave the teslameter in the “LOCKED” position.
2. Slowly turn the COARSE control knob in the direction the field is going; i.e., if ramping up, turn the control knob up to the higher numbers.
3. As the meter is approaching the actual field, the baseline of the "FID” display will start to wander. Once the meter is in range of the field, the “FID” will appear on the scope trace as the meter locks on.
4. Again, when locked on, the “NO STROBE SIGNAL” LED will be out; readjust ,slightly, the COARSE control knob in the direction of the lighted LO/Hi LED until that LED goes out.
5. Maintain tracking through end of ramp sequence.

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6 POWER SUPPLY CONNECTIONS 6–1
6-1 Superconducting Shim Coil Power Supply Connections 6–1
6-2 Main Coil Power Supply Connections 6-4

SECTION 6 - POWER SUPPLY CONNECTIONS

Description:

Main and Superconducting Shim Power Supply lnput/Output Connections have the same (P/J) designations, used in this procedure, for both the Service and Phase Ill Power Supply Units.

Ensure that the Power Supply Cabinets are installed and checked out in conformance with the vendor manual, supplied with the unit, before making any power supply connections to the magnet. See Introduction, Section 2 (Vendor Manuals) for vendor manual numbers.

Schematics/Interconnects, Section 1–1 (Magnet interconnect Diagram) shows the Cable Numbers, Run Numbers and Interconnect Pattern covered in this section.

The Main Coil Power Cables, Superconducting Shim Coil Wire Harness, Heater Wire Harness and Volt Sense Leads are located in the Magnet Cable Trough.

Procedure:

6-1 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS

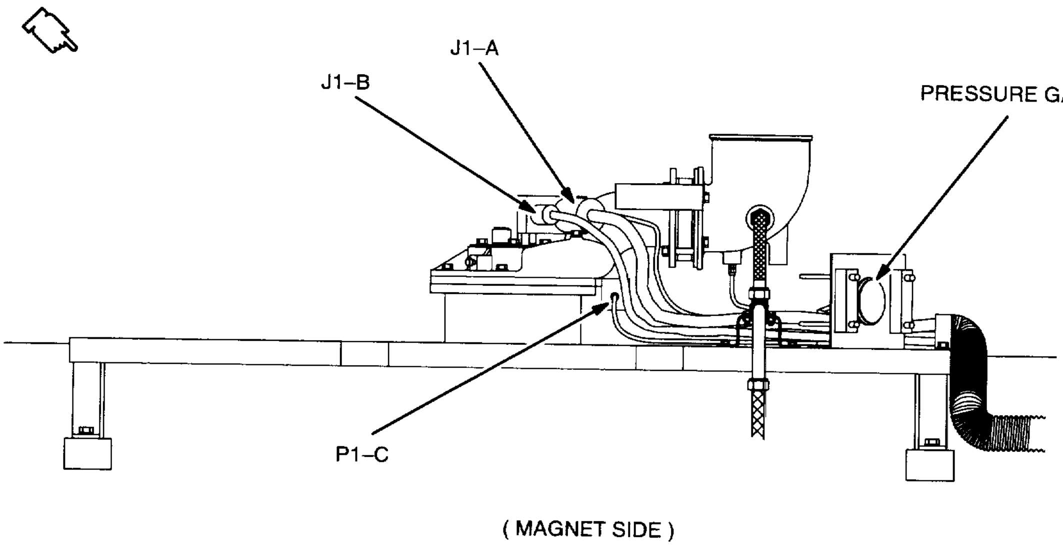
1. Verify that input power to the Superconducting Shim Coil Power Supply is disconnected.

WARNING!

DO NOT CONNECT INPUT POWER TO OR TURN ON SUPERCONDUCTING SHIM COIL POWER SUPPLY UNTIL IT IS VERIFIED THAT ALL CURRENT CONTROLS ARE SET AT ZERO, FULLY COUNTERCLOCKWISE.

2. Verify that all connectors (J1–A, J1–B, P1–C) are mated on the top of the magnet. See Illustration 6–1.

6-1 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS (continued)



MAGNET ELECTRICAL CONNECTIONS
ILLUSTRATION 6–1

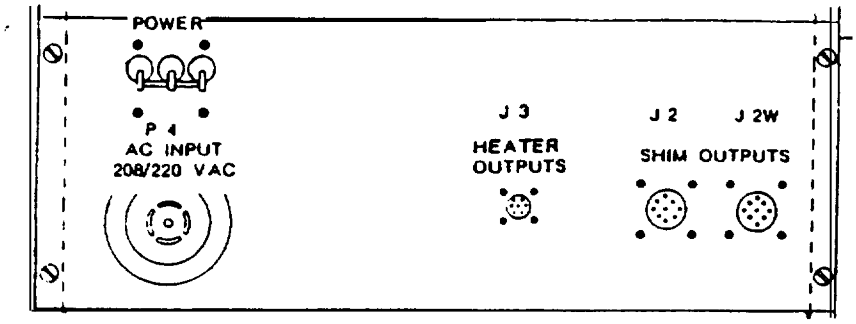
3. Connect (P2 & P2–W) of the Superconducting Shim Coil Wire Harness (RUN #603) to (J2 & J2–W) Shim Outputs on the rear of the Superconducting Shim Coil Power Supply Cabinet (MS7–A1). See Illustration 6–2.

4. Connect (J2 & J2–W) of the Superconducting Shim Coil Wire Harness (RUN #603) to (P2 & P2–W) on the Magnet Harness Terminal Box (MS 1–A3,A1). See Illustration 6–3.

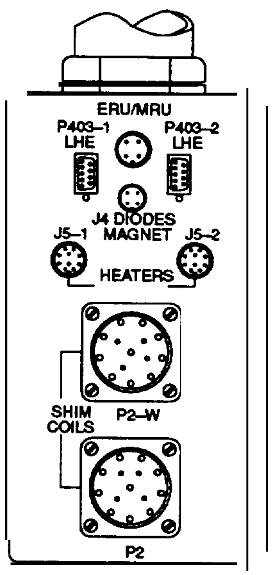
WARNING!

CONNECTING THE SUPERCONDUCTING SHIM COIL HARNESS TO THE MAGNET WHEN THE SUPERCONDUCTING SHIM COIL POWER SUPPLY IS ON MAY CAUSE IRREPARABLE DAMAGE TO THE VAPOR COOLED SHIM LEADS.

Note
Vapor Cooled Shim Leads are field replacement items, see Replacement / Maintenance, Section 8,



SHIM POWER SUPPLY OUTPUT CONNECTIONS
ILLUSTRATION 6-2



• MAGNET HARNESS TERMINAL BOX
ILLUSTRATION 6-3

6-2 MAIN COIL POWER SUPPLY CONNECTIONS

1. Verify that the input power to the Main Coil Power Supply is disconnected.

2. Verify that all connectors (J1 -A, J1-B, P1-C) are mated on the top of the magnet. See Illustration 6-1.

3. Connect (P703) on Heater Wire Harness (RUN #604) to Heater Outputs (J3) on the rear of the Main Coil Power Supply Cabinet (M S6-A1). See Illustration 6-4.

4. Connect (P5) on Heater Wire Harness (RUN #604) to (J5-1 or J5-2) on the Magnet Harness Terminal Box (MS1-A3, A1). See Illustration 6-3.

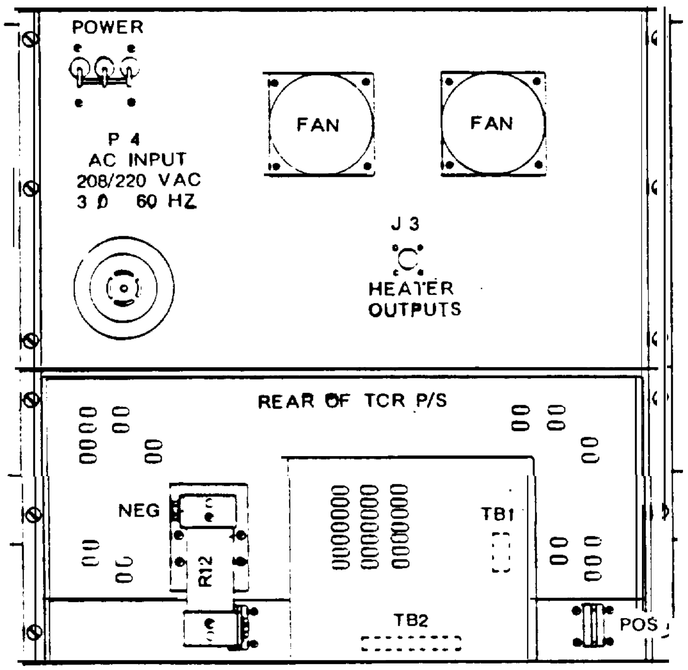
5. Connect the Main Coil I Power Cables (RUN #601 & #602) to the Main Power Buss Bars with the Brass Nuts and Bolts provided in the service kit.

Note

Ensure that the nuts are tightened sufficiently to prevent a high resistance contact. Connect (Red) Cables to the (+) Buss Bar and (Black) Cables to the (-) Buss Bar. Two Red and two Black Cables are connected in parallel to the Buss Bars.

6. Place the other end of the Main Power Cables on the Service Platform (MS1-A5,A3). Allow for 3 feet (1 meter) of slack there.

7. Check Cryostat Pressure Gauge. If the pressure is above 0.25 psi, slowly open Helium Vent Valve (V2) and allow pressure to drop to 0.25 psi. Then close valve (V2).



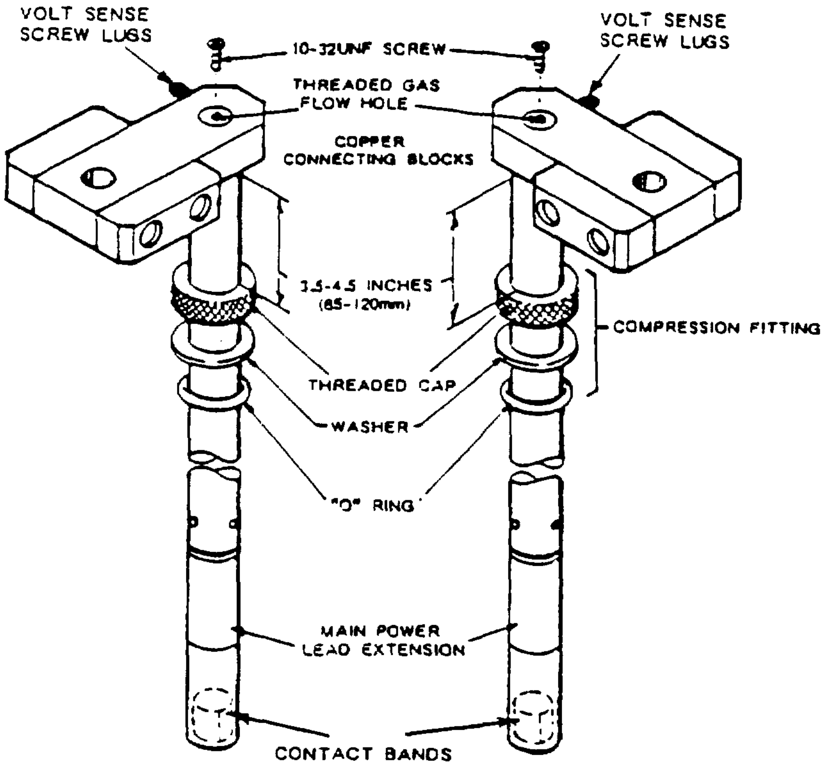
MAGNET POWER SUPPLY OUTPUT CONNECTIONS
ILLUSTRATION 6-4

6-2 MAIN COIL POWER SUPPLY CONNECTIONS (continued)

8. Replace Contact Bands on Main Power Lead Extensions. Ensure gas flow holes are not blocked. See Replacement/Maintenance, Section 1 1.

Note
Use a new set of Contact Bands for each ramp performed.

9. Remove the Threaded Caps, Washers and “0” Rings (46–294104P1, 46-294105P1 & 46–260389PI) from the plastic bag, provided with the magnet accessory components and mount them on the Main Power Lead Extensions. See Illustration 6–5.



COMPRESSION FITTING MOUNTING ON MAIN POWER LEAD EXTENSION
ILLUSTRATION 6–5

6-2 MAIN COIL POWER SUPPLY CONNECTIONS (continued)

WARNING!

MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5-3 OF THE INTRODUCTION (CRYOGEN SAFETY).

A SUPERCONDUCTING MAGNET AT FIELD IS A HIGH ENERGY STORAGE DEVICE CAPABLE OF DISCHARGING RAPIDLY. DO NOT TOUCH THE MAIN LEAD EXTENSIONS SIMULTANEOUSLY OR ALLOW THEM TO COME IN CONTACT WITH EACH OTHER WHEN THE MAGNET IS BEING RAMPED OR AT FIELD AS A RAPID DISCHARGE WOULD RESULT THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER BECOMES ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS.

IF THE MAGNET IS RAMPED UP, WAIT FOR THE LEAD EXTENSIONS TO COOL SUFFICIENTLY (A FOG OR WATER VAPOR FORMS AROUND THE LEAD EXTENSIONS) BEFORE FULLY ENGAGING THEM TO PREVENT THE RISK OF QUENCHING THE MAGNET.

10. Remove the cap on one of the Main Power Lead Extension Receptacles located on the vertical stack of the magnet. Make sure that the gasket inside of the cap does not get lost.

11. Quickly insert one Main Power Lead Extension into the open receptacle with 3.5– 4.5 inches (85 – 120 mm) of Lead Extension exposed, Tighten the Compression Fitting.

CAUTION

Ensure gas flow holes in lead Extension are not blocked and GHe is exiting holes.

12. Repeat Steps 9 through 11 for the other Lead Extension.

13. When the Lead Extensions are sufficiently cooled, or if the magnet is not ramped up, loosen the Compression Fittings and fully engage the Lead Extensions. Tighten the Compression Fittings.

6–2 MAIN COIL POWER SUPPLY CONNECTIONS (continued)

Note

Lead Extensions will depress approximately 1 inch (25mm) from the point of contact to the fully engaged position. A firm contact will be felt when fully engaged. Do not rotate Lead Extensions excessively when in the engaged position as internal contact wear could result.

14. Connect the other end of the Main Power Cables to the engaged Main Power Lead Extensions with the 1 inch (25mm) Brass Nuts and Bolts provided. Ensure that the connection polarities are in conformance with the lead markings (Red to +, Black to –). Tighten the leads sufficiently to ensure a good contact.

Note

As you face the magnet from the table end, the right hand terminal on top of the magnet is (+) and the left is (–). Z– field is at Table End and Z+ field is at Back End.

Note

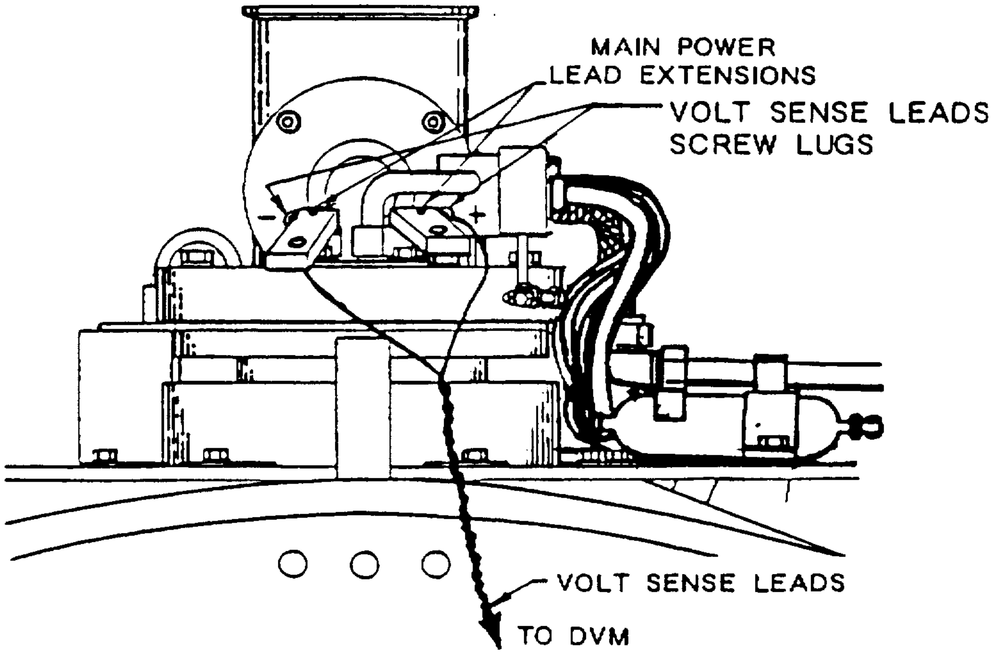
A heat gun and/or wire brush may be required to remove ice from the Copper Connecting Blocks, prior to connecting the Main Power Cables, to ensure a good connection. If necessary, close off the gas flow in the lead by temporarily threading the 10–32 screw provided into the threaded Gas Flow Hole at the top of the Lead Extension and thaw the Copper Block, Bolt and Cables with a heat gun. Remove the 10–32 screw after the connection is made. See Illustration 6–5.

WARNING!

CONNECTION POLARITIES MUST BE NOTED AND RECORDED IN FUNCTIONAL CHECKS, TABLE 8-4 TO PREVENT THE POSSIBILITY OF MIS-WIRING AND A RESULTANT QUENCH DURING FUTURE RAMPING OF THE MAGNET.

15. Connect the volt sense leads to the Main Power Lead Extensions by clamping the Spade Lugs on the Volt Sense Leads to the Main Lead Extensions with the screw lugs provided on the side of the Lead Bus Bar. Terminate other end of volt sense leads to a DVM or VOM placed near to Main Coil Power Supply. See Illustration 6–6,

6–2 MAIN COIL POWER SUPPLY CONNECTIONS (continued)



(MAGNET TABLE END)

VOLT SENSE LEAD CONNECTIONS
ILLUSTRATION 6-6

Note

During ramping, high currents in the power cables may cause movement of the cables due to magnetic forces, Excess motion may disrupt contact between the ramp probes and their contact pins causing a quench. Take the following steps to prevent lead motion.

16, After installing the ramp leads, secure the main power cables using plastic twist ties. The cables should be secured to each other and to convenient fixed points, such as the shroud rails or the magnet lifting rings, to prevent their movement,

17. A Ramp Lead Hold Down Tool (46–323015G1) is an optional tool which will minimize lead motion and aid in getting good contact resistance. Install the tool as follows: Remove two bolts from the Shim Lead Base Plate on top of the magnet (save these bolts to be put back later). Screw the Mounting Bolts of the Hold Down Tool into these mounting holds. See Illustration 6–7.

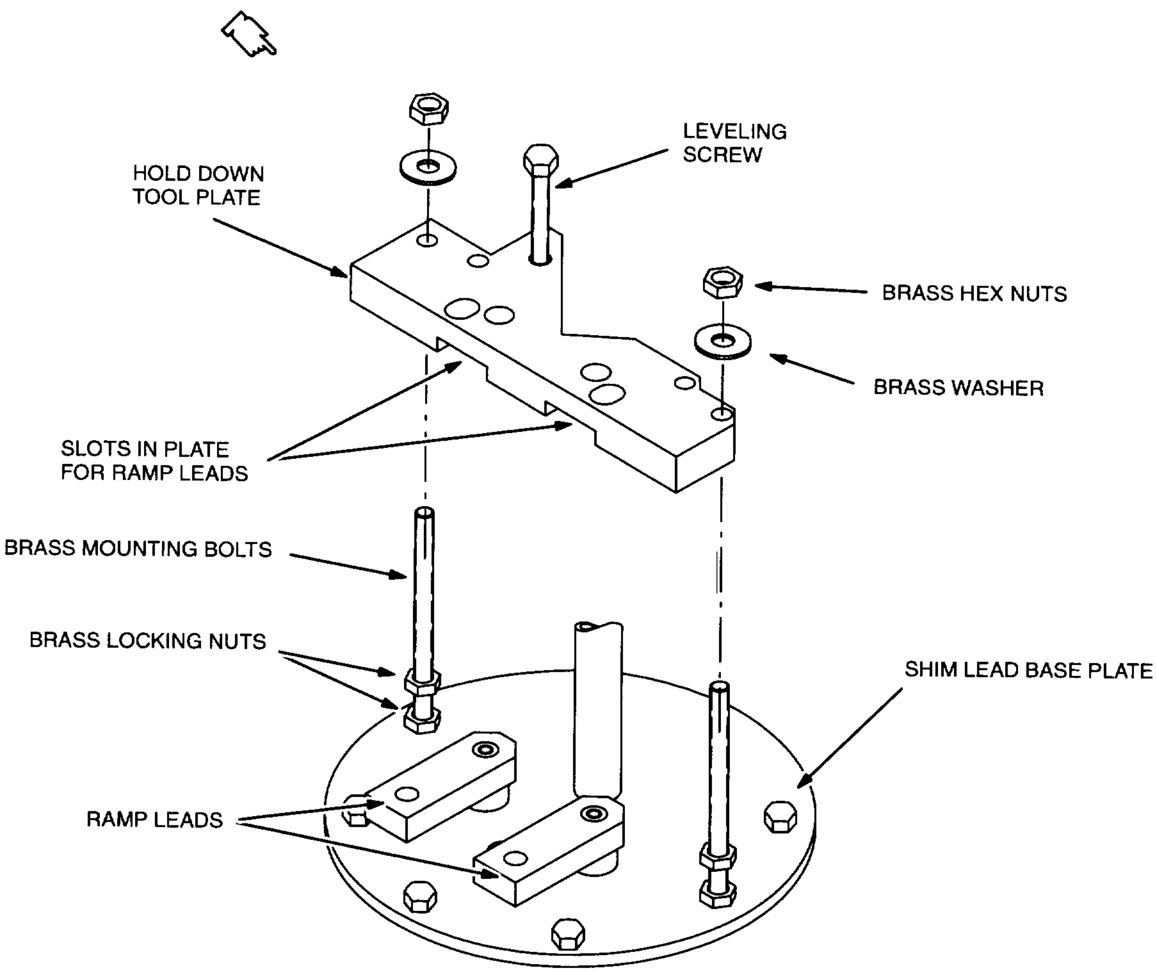
18. Install the Hold Down Tool Plate onto the mounting bolts. Ensure that the ramp leads fit into the slots on the plate. See Illustration 6–7.

CAUTION

Ensure that the vent holds in the ramp leads are not blocked.

6-2 MAIN COIL POWER SUPPLY CONNECTIONS (continued)

19. Tighten the nuts on top of the Hold Down Tool Plate to lock the plate firmly in place and prevent lead motion. While tightening the plate nuts, adjust the leveling screw to keep the plate level, See Illustration 6–7.



HOLD DOWN TOOL INSTALLATION
ILLUSTRATION 6–7

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7–1 Preparation 7–1
7–2 Resistance Checks 7–2
7–3 Ramping 7-4

SECTION 7- MAGNET RAMPING

WARNING!

THE FOLLOWING REQUIRED SAFETY ACTIONS MUST BE TAKEN PRIOR TO RAM PiNG THE MAGNET:

1. **MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5-3 OF THE INTRODUCTION (CRYOGEN SAFETY).**
2. **NOTIFY SITE ADMINISTRATION BEFORE RAMPING THE MAGNET THAT ALL MAGNETIC SAFETY PRECAUTIONS MUST BE TAKEN.**
3. **POST WARNING SIGNS OUTSIDE THE 5 GAUSS ZONE TO ALERT PERSONNEL WITH CARDIAC PACEMAKERS, NEUROSTIMULATORS AND OTHER BIOSTIMULATION DEVICES NOT TO PROCEED INTO THE DESIGNATED AREA. POST THESE SIGNS ON THE MAGNET ROOM LEVEL AS WELL AS AREAS BELOW THE MAGNET TO WHICH THE 5 GAUSS ZONE EXTENDS. SEE INTRODUCTION, SECTION 5.**
4. **POST "RAMPED MAGNET" WARNING SIGN AT THE MAGNET ROOM ENTRANCE PRIOR TO RAMPING THE MAGNET. WARNING TO ALERT PERSONNEL THAT NO FERROMAGNETIC MATERIAL OR INDIVIDUALS WITH CARDIAC PACEMAKERS, NEUROSTIMULATORS OR STEEL PLATES ARE ALLOWED IN THE MAGNET ROOM WHEN THE MAGNET IS RAMPED.**
5. **REMOVE ALL LOOSE FERROMAGNETIC MATERIAL FROM THE MAGNET ROOM. PULL THE POWER SUPPLIES AS FAR AWAY FROM THE MAGNET AS THE CABLES AND SITE GEOMETRY ALLOW. METAL OBJECTS CAN BECOME DANGEROUS PROJECTILES IN A MAGNETIC FIELD.**
6. **MAKE SURE THAT THE EMERGENCY/ MAGNET RUNDOWN UNIT IS INSTALLED AND OPERATIONAL TO ENABLE THE MAGNETIC FIELD TO BE QUICKLY DISCHARGED IN CASE OF AN EMERGENCY. SEE SET UP AND CALIBRATION, SECTION 1-4 AND 1-6.**
7. **MAKE SURE THAT THE MAGNET IS AT LEAST 75% FULL OF LIQUID HELIUM TO PREVENT THE LIQUID HELIUM LEVEL FROM DROPPING TO A POINT, DURING RAMPING, WHERE A QUENCH MAY OCCUR.**

7.1 PREPARATION

1. Set up the field monitoring equipment Probe and Teslameter in accordance with Set Up and Calibration, Section 5.
2. Make sure that the Magnet Power Supply is installed, checked and adjusted in accordance with the Vendor Manual (Sections 1 through 4) supplied with the unit. Verify Main Switch Heater Power Supply set for 815 ± 5 mA.

7–1 PREPARATION (continued)

3. Make sure that the Input Power Cable for the Power Supply is disconnected.
4. Connect the Power Supply to the magnet by making all cable connections in accordance with Set Up and Calibration, Section 6.
5. Record the Main Coil connection polarity In Functional Checks, Table 8-4.
6. Set all heater switches to the “OFF” position. Set “CURRENT CONTROL” and “VOLTAGE CONTROL” to 0 (full CCw).
7. Connect the Input Power Cable for the Main Power Supply.

7–2 RESISTANCE CHECKS

1. Check Switch Heater resistances in accordance with Functional Checks, Section 2.
2. Make sure “CURRENT CONTROL” and “VOLTAGE CONTROL” on the Main Power Supply are off (full ccw). Turn on Power Supply Input Power.
3. Turn on Axial Shim Heaters and observe current rise in ammeter (800–820 mA) to ensure circuit continuity, Make sure Main Heater Switch is off.

WARNING!

AXIAL SHIM SWITCH HEATERS MUST REMAIN ON DURING THE ENTIRE RAMPING PROCESS TO PREVENT IRREPARABLE SHIM COIL DAMAGE AND MAGNET QUENCH DURING RAMPING. THE POWER SUPPLY WILL NOT PASS CURRENT IN THE MAIN POWER LEAD CIRCUIT WITH THE AXIAL SHIM HEATERS OFF.

4. Connect a Digital Volt Meter (DVM) to the end of the Voltage Sense Leads terminated at the power supply.
5. Set “VOLTAGE CONTROL” on power supply to maximum (full CW).
6. Observe the Main Power Supply Ammeter and slowly turn the “CURRENT CONTROL” (CW) to set 500A current through the Main Power Leads, Lead Extensions and persistent Main Switch.
7. Record the voltage reading on the (DVM) ____________ mV.

7-2 RESISTANCE CHECKS (continued)

8. A voltage reading less than 150 mV at 500 Amps indicates acceptable internal contact resistance of the Lead Extensions. Higher resistances will add more heat to the magnet increasing boil-off and possibly causing a quench during ramping.

   If the voltage reading is greater than 150 mV, then wait approximately 1 minute with the current running, reading may drop as the leads cool. If this fails, tighten the plate nuts on the Ramp Lead Hold Down Tool to move the leads slightly. Observe the effect on the voltage reading.

   if the reading still exceeds 150 mV, then turn the "CURRENT CC W), turn off input power, and check/tighten the bolts securing Cables to the Power Supply and Ramp Leads. Lift and re-seat the Ramp Leads Repeat Steps 1 - 7.

   Note

   Repeated failing of the contact resistance check indicates a need to replace the lead Contact Bands. See Replacment/Maintenance, Section 11, or damaged Ramp Leads.

Upon passing the internal resistance check, continue with Step 9.

9. Set the Power Supply Voltmeter to read voltage across the Power Supply Output Lugs (read on Power Supply Voltmeter with toggle switch in Main Power Supply position).

10. Gradually increase the "CURRENT CONTROL" (CW) to pass 735A through the IMain Power I-cads, I-cad Extensions and persistent Main Switch while observing the Power Supply Voltmeter. If the voltage exceeds 2.2V, discontinue the test.

    Note

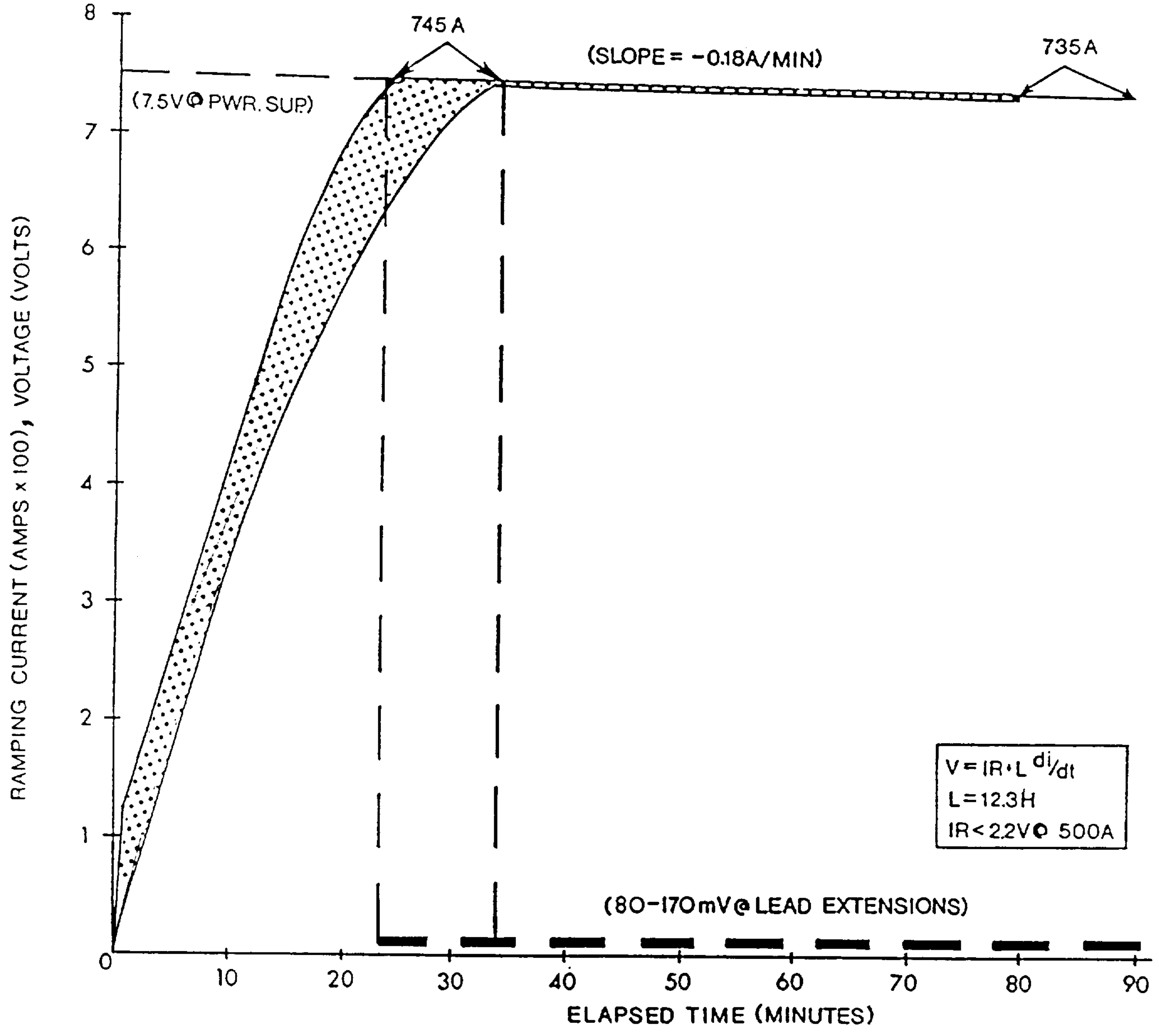
    A voltage less than 2.2V at 735A indicates acceptable system resistance. If the voltage exceeds 2.2V during the test, follow the procedures in Step 8 for adjusting contact resistance.

11. Upon passing Step 10, turn the "CURRENT CONTROL" and "VOLTAGE CONTROL" off (full CCW) and continue with the ramping procedure.

7-3 RAMPING

Description:

The Ramping Procedure covered here provides for a rapid ramping slightly above field with a gradual reduction to field (1 .5 T). This method has resulted in the fastest "settling" time. See Illustration 7-1.



MAGNET RAMPING PROFILE
ILLUSTRATION 7-1

7-3 RAMPING (continued)

Procedure:

CAUTION

If a Quench occurs during ramping, immediately turn “VOLTAGE CONTROL” and “CURRENT CONTROL" of the Main Coil Power Supply to zero (fully CCW). A quench is a rapid discharge of the magnetic field which will result in the rapid generation and expulsion or helium gas, rupturing the Burst Disc In the Vent System.

WARNING!

MAKE SURE THAT THE AXIAL SHIM SWITCH HEATERS ARE ON DURING RAMPING TO PREVENT COIL DAMAGE AND MAGNET QUENCH. GE POWER SUPPLIES HAVE PROTECTIVE CIRCUITRY TO PREVENT RAMPING VOLTAGE WITH THE AXIAL HEATER SWITCH IN THE “OFF” POSITION.

1. Make sure Valve (V2) is closed.
2. Make sure “VOLTAGE CONTROL’’ and “CURRENT CONTROL” is at zero (full CCW).
3. Engage “SET POINT” button (depress and hold until current set) and set “CURRENT CONTROL” for a reading of 745A. This sets the maximum current output of the Power Supply.
4. Turn on Main Switch Heater, leave Axial Shim Switch Heater on. Wait 3 minutes.
5. Check that Main Switch Heater current is 815 ± 5 mA.
6. Turn “VOLTAGE CONTROL” on Main Power Supply to maximum (full CW).
7. Estimate the system inductance by measuring current change over a 10 second ramping interval:

   L (inductance) = 10 x Voltage/ Current Change

Note
This method will give inaccurate values of inductance when the current is less than 200 Amps.

7-3 RAMPING (continued)

Note

Measured inductance should be approximately 12.3H (henry), if the calculated value is between 11 – 13.5H continue with the procedure. If the calculated value is outside this range, discontinue ramping and “troubleshoot” the system. Measure Main Coil Resistance (see Functional Checks, Section 2) and contact the Region Magnet Support Engineer.

8. Observe the voltage profile across the Magnet Voltage Taps (Power Supply Voltage Switch set to Main Coil) as the ramping current approaches 745A.
9. When current reaches 745A, start decreasing current by turning “CURRENT CONTROL” (CCW).
10. Decrease current at a rate of approximately 0.18 amp/min. to 735A and allow to stabilize.

Note

Voltage will go negative as current decreases.

11. Check Teslameter and adjust current as required, to bring magnetic field to within (63.87– 63.88 MHz) (15000.$ 15002.0 gauss) range. Allow final current to stabilize. Voltage should read less than 30mV.
12. Maintain current at final setting until the Main Switch goes into the “persistent” mode in Step 13.
13. Turn off Main Switch Heater. Wait a minimum of 7 minutes for the switch to fully cool and go “persistent”.

Note

Observe voltage (read on Power Supply Voltmeter with toggle switch in Main Coil Position). When the switch goes “persistent” the voltage across the magnet terminals will drop to approximately 0.00V. This sudden voltage drop will indicate that the switch has gone into the persistent mode.

14. When the switch goes “persistent", slowly turn the power supply “CURRENT CONTROL” to zero over a one minute period (Full CCW).

Note

Check that Teslameter does not decrease as current knob is turned. If it does, switch is not persistent.

15. Record current value at which the switch went “persistent” in Functional Checks, Table 8-4.

7-3 Ramping (continued)

WARNING!

ASSURE THAT THE CONNECTION POLARITY AND FINAL RAMPING CURRENT ARE RECORDED IN FUNCTIONAL CHECKS, TABLE 8-4. THIS INFORMATION IS ESSENTIAL FOR LATER CHANGING OF THE MAGNETIC FIELD. THE MAIN POWER SUPPLY MUST BE SET TO THE SAME CURRENT AND POLARITY IN THE MAIN COILS TO AVOID A QUENCH WHEN TURNING ON THE MAIN SWITCH.

16. Gradually turn the “VOLTAGE CONTROL” to zero (over a one minute period) and turn the power supply off.
17. Turn off the Axial Shim Heaters.
18. Disconnect Input Power Cable from the Main Power Supply.
19. Slowly open valve (V2) while observing Pressure Gauge to repressurize the Cryostat. When pressure reaches 0.3 psig, close valve (V2).
20. Remove the Hold Down Tool. Disconnect the Main Power Leads, Volt Sense Leads and remove Main Power Lead Extensions on the top of the magnet. Immediately replace the caps onto the Main Power Lead Extension Receptacles.

CAUTION

Cryostat exhaust flow rates and pressure must be checked and adjusted as required after magnet installation, ramping and shimming to ensure that proper cooling conditions are maintained and no leaks are present in the Helium Exhaust System or Vent Valve (V2).

21. Open Vent Valve (V2) to de-pressurize the Cryostat to 0.25 psig. Close V2.

Note

Read all flow rates from the bottom of the float (ball) on the flowmeters.

Note

Flow rates may be temporarily elevated after ramping. Do not adjust them until after the magnet has had time to stabilize (at least one day).

7-3 Ramping (continued)

22. Set Flowmeter (Fl) between 0.4 - 0.6 SCFH.

23. Set Flowmeter (F2) between 1.5 - 2.0 SCFH to maintain a Cryostat Pressure Gauge reading between 0.25 - 0.50 psig.

24. Ensure flow rate through F2 is equal or greater than 1.5 SCFH.

25. If flow rate through F2 is less than 1.5 SCFH or the pressure gauge reads less than 0.25 psig, pressurize the vessel and "bubble test" all exhaust plumbing joints, relief valve and Shim Lead Connector. Ensure V2 is fully closed. Repair any leaks. If a 1.5 SCFH flow rate through F2 cannot be achieved, under the above conditions, contact your Region Magnet Service Engineer.

26. Ensure the following conditions are maintained. Re-check settings in three days and again after one week:

    FLOWMETER (Fl) = 0.4 - 0.6 SCFH
    FLOWMETER (F2) > 1.5 - 2.0 SCFH
    CRYOSTAT GAUGE PRESSURE - 0.25 - 0.50 psig

27. Proceed to Set Up and Calibration, Section 8 (Shimming Preparation/Field Stabilization).

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8-1 Superconducting Shim Coil Power Supply Connections 8-1
8-2 Magnet Stability Check 8-4

SECTION 8 - SHIMMING PREPARATION/FIELD STABILIZATION

Description

The preparations, covered in this procedure, are required prior to shimming the magnet. Allow the magnet to stabilize to < 0.1 ppm/hr (6.3 Hz / hr) main field drift before shimming. This will take from 4 to 12 hours. Other commissioning functions can be performed during this time.

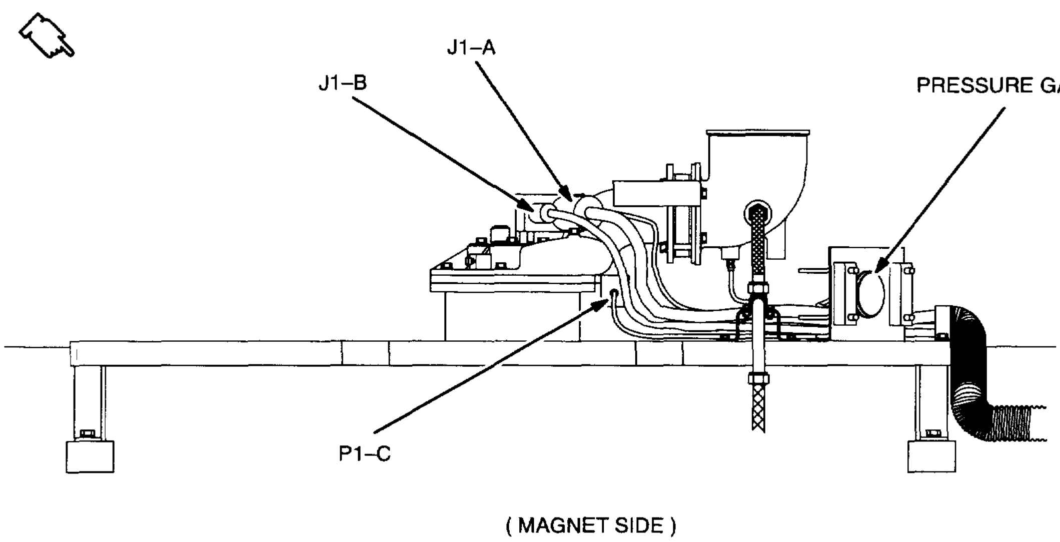
Procedure:

CAUTION

Moving articles or equipment in the Exam Room may affect field readings.

8-1 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS

1. Verify that connectors (J1–A, J1–B, P1–C) on the top of the magnet are mated. See Illustration 8–1.



MAGNET ELECTRICAL CONNECTIONS
ILLUSTRATION 8–1

8–1 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS (continued)

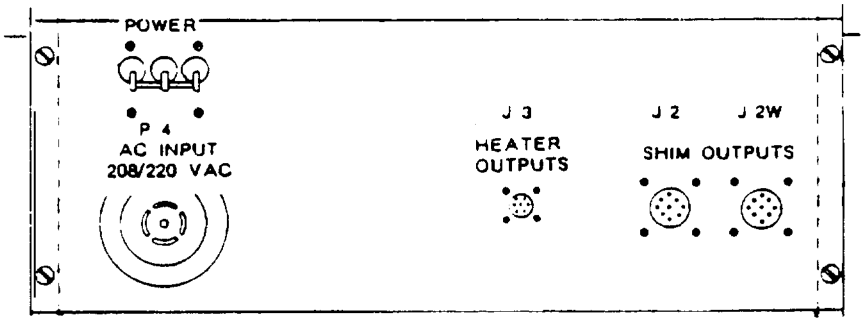
2.Connect power to Superconducting Shim Coil Power Supply and set Shim Heater Currents (Axial, T1, T2) at 810 mA, See Vendor Service Manual, Section 4 for details,

3. Disconnect the input power to the Superconducting Shim Coil Power Supply.

WARNING!

DO NOT CONNECT THE INPUT POWER TO OR TURN ON THE SUPERCONDUCTING SHIM COIL POWER SUPPLY UNTIL IT IS VERIFIED THAT ALL CURRENT CONTROLS ARE SET AT ZERO, FULLY COUNTERCLOCKWISE. TURNING THE SUPERCONDUCTING SHIM COIL POWER SUPPLY WHEN THE CURRENT CONTROLS ARE NOT AT ZERO MAY CAUSE IRREPARABLE DAMAGE TO THE VAPOR COOLED SHIM COIL LEADS.

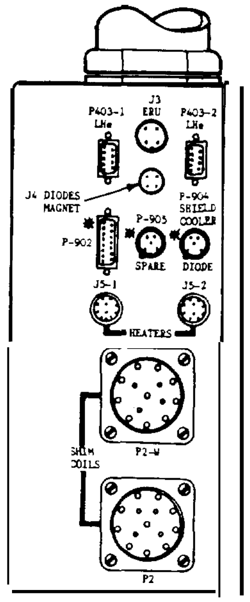
4. Verify that (P2 & P2W) on the Superconducting Shim Coil Wire Harness (RUN #603) are connected to (J2 & J 2-W) Shim Output Connectors on the back of the Power Supply Cabinet (MS7-A1), See Illustration 8–2.



SHIM POWER SUPPLY OUTPUT CONNECTIONS
ILLUSTRATION 8–2

5. Verify that (J2 & J2–W) on the other end of the Superconducting Shim Coil Wire Harness (RUN #603) are connected to (P2 & P2–W) on the Magnet Harness Terminal Box (MS1–A3, Al). See Illustration 8–3.

8-1 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS (continued)



* NOT PRESENT ON SOME UNITS

MAGNET HARNESS TERMINAL BOX
ILLUSTRATION 8-3

6. Disconnect (P703) on Heater Wire Harness (RUN #604) from connector (J3) on the back of the Main Coil Power Supply Cabinet (MS6-A1) and connect (P703) to connector (J3) on the back of the Superconducting Shim Coil Power Supply Cabinet (MS7-AI).

7. Verify that connector (P5) on Heater Wire Harness (RUN #604) is connected to (J5-1 or J5-2) on the Magnet Harness Terminal Box (MS1- A3,A1 **).**

CAUTION

Only one Heater Wire Harness is to be connected to the Magnet Harness Terminal Box.

8-2 MAGNET STABILITY CHECK

1. Maintain probe setting at magnet physical center (R = **o, z = o).**

Note
Wait one hour before performing the following steps.

WARNING!

BEFORE TURNING ON SUPERCONDUCTING SHIM COIL POWER SUPPLY, ENSURE THAT ALL CURRENT CONTROLS ARE SET TO ZERO, FULL COUNTERCLOCKWISE.

2. Connect input power on Superconducting Shim Coil Power Supply and turn on all Shim Coil Switch Heaters for one minute to dump any residual Shim Currents.

3. Turn off the Switch Heaters, Shim Coil Power Supply and disconnect input power and Shim Cable.

4. Monitor the magnetic field (center frequency) at one hour intervals until the magnet has stabilized within 0.1 ppm/hr (frequency change between hour readings is wi~in 62 Hz).

5. Disconnect input power to Superconducting Shim Power Supply.

6. Begin magnet shimming.

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SECTION 9- SUPERCONDUCTING SHIMMING

Description:

Superconducting Shimming is performed after the magnet has been brought up to field and stabilized in conformance with Set Up and Calibration, Section 8, or when environmental changes greatly reduce the homogeneity of the magnet. An overview of the shimming procedure is shown in Illustration 9–1 (Shimming Flow Diagram). Shim the magnet over the specified volume, 30 cm diameter by 40 cm long cylinder (C6) using this process. Iterations of mechanical shimming should be performed until 6 parts per million (ppm) inhomogeneity, less than 380 Hz frequency spread, is achieved.

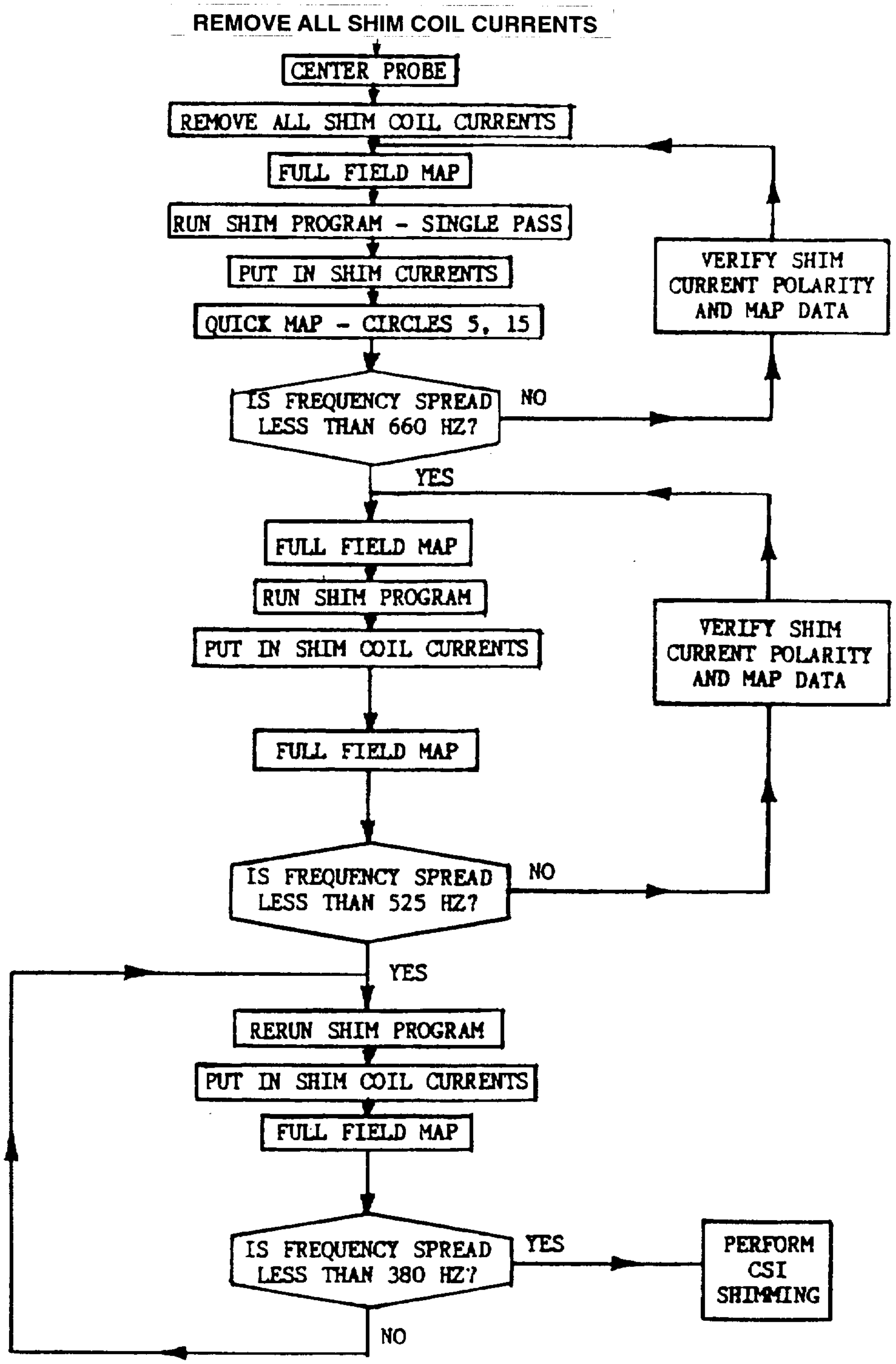
“Shimming” is the process of measuring the spatial dependence of the magnetic field and having a program compute currents which, when set in the Superconducting (S/C) Shim Coils, will render the field uniform over the volume mapped.

The program for point by point shimming is selected from the utilities menu of the S–n System Software,

The self-contained NMR Probe and Field Mapping Fixture is used to obtain “point data” during installation because of the limited bandwidth of the imaging system. Unshimmed magnets often have field variability greater than this bandwidth.

WARNING!

MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5-3 OF THE INTRODUCTION (CRYOGEN SAFETY).



NOTE – CIRCLES 5,15 ARE AT R = 15, Z = ±2O cm

SHIMMING FLOW DIAGRAM
ILLUSTRATION 9–1

SECTION 9- SUPERCONDUCTING SHIMMING (continued)

Procedure:

9-1 Centering Probe to Magnetic Center

To minimize the number of iterations required to shim the magnet, center the probe on the Field Mapping Fixture at the magnetic center of the Superconducting Coils (R = 0, Z = 0). if the Field Mapping Fixture is adjusted so that the centerline of the radial arm is on the mechanical centerline of the Cryostat, only minor adjustments should be required, if any, during magnetic centering.

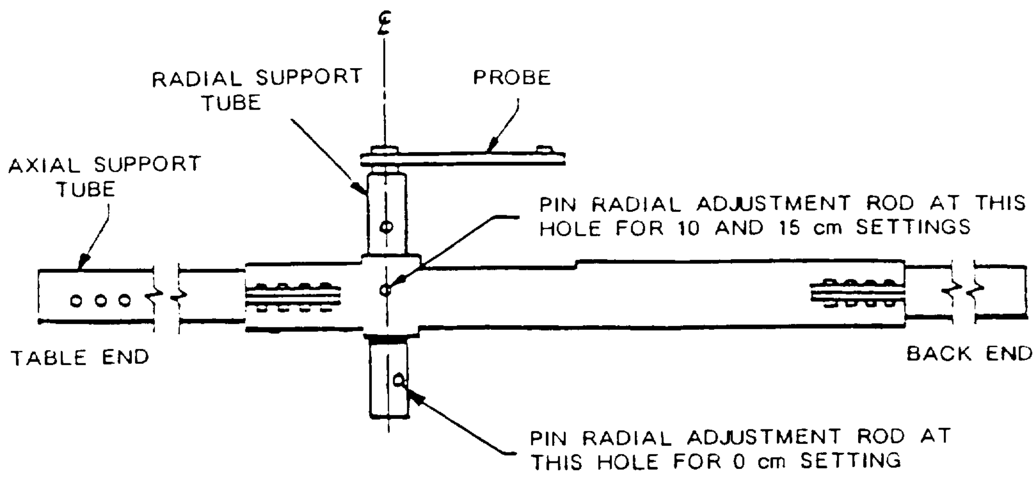
Axial Probe Centering:

1. Verify that the probe and mapping fixture are installed in conformance with Set Up and Calibration, Section 5 (Field Monitoring Equipment Set Up and Calibration).
2. Verify that the Superconducting Shim Coil Cables, Heater Cable and Power Supply are connected in conformance with Set Up and Calibration, Section 8-1.
3. Set the probe to 0cm radius and move it to the center of the magnet (i.e., axial = 0 cm and 0 degree rotation). See Illustration 9-2.

WARNING!

TURN ON SHIM COIL
CONTROLS TO ZERO
VAPOR COOLED SHIM

LEADS MAY OCCUR.



AXIAL SUPPORT TUBE ASSEMBLY
ILLUSTRATION 9-2

9-1 CENTERING PROBE TO MAGNETIC CENTER (continued)

4. Ensure Shim Power Supply is turned off and “CURRENT CONTROLS” are at 0 (full CCW). Connect input power to and turn on Shim Power Supply.

5. Remove the capon the Shim Lead Vent to vent Shim Leads. To vent models without cap, disconnect copper tube from Shim Lead. Turn on the Axial and Transverse Switch Heaters and allow the heaters to warm up for 2 minutes to dump any induced currents in the S/C Shim Coils.

CAUTION

Save Shim Lead Vent Cap for replacement In Step 15 in Transverse Probe Centering. Do not leave cap off for extended period of tlme to allow Cryostat to repressurize below 0.2 psig.

WARNING!

DO NOT TURN ON THE MAIN MAGNET SWITCH HEATER. ACTIVATING THE MAIN MAGNET SWITCH HEATER WHILE THE MAGNET IS AT FIELD WILL CAUSE AN EMERGENCY RUNDOWN.

6. Turn off the Axial and Transverse Switch Heaters. Allow the heaters to cool for 2 minutes.

Note
If the heater switches are persistent (cooled), the magnetic field should not change by more than 10 Hz over a 2 minute period.

7. Record the virgin field value (in gauss) at the center of the magnet and at +20cm along Z axis in Table 9-1.

TABLE 9-1
AXIAL PROBE CENTERING

S/C COIL STATUS	GAUSS READING (150xx.xx) AT Z AXIS POSITION	
	+20 cm	0 cm
Virgin Plot		
Axial 1 (10 amps)		
Peak Difference	△	△

9-1 CENTERING PROBE TO MAGNETIC CENTER (continued)

8. Turn all Shim Power Supply switches on the front of the Power Supply Cabinet to the positive position.

9. Turn on the Axial Switch Heater. Allow the heater to warm up for 2 minutes.

WARNING!

ENSURE VAPOR COOLED LEADS ARE FROSTED BEFORE SETTING POWER SUPPLY CURRENTS TO PREVENT IRREPARABLE DAMAGE TO VAPOR COOLED LEADS.

10. Turn on the Axial 1 on Shim Power Supply and adjust It to 10.0A.

11. Record the field (In gauss) at the center of the magnet and at +20 cm in Table 9-1

12. Ensure field at +20 cm has changed by at least 3 gauss from the virgin field value at +20 cm. If the field has not changed from virgin field (at +20 cm), no current is being supplied to axial 1. Check connections.

Note

If the probe on the Mapping Fixture Is "magnetically" centered in the axial direction, the difference between the virgin field reading in Step7 and the field reading with 10A In Axial #l In Step 11 will be less than 40 milligauss atthecenter(0 cm). If the field in Step 11 is greater than the virgin field, the probe is too close to the Back End of the magnet. If the field in Step 11 is less than the virgin field, the probe is too cfose to the Table End of the magnet. See Axial #1 plot in Illustration 10-1.

13. Calculate the distance the probe must be moved axially In Step 14 or 15, when A gauss in Table 9-1 (0 cm position) exceeds 40 milligauss, by using the following formula:

$$\text{DISTANCE (cm)} = \frac{\text{A gauss}}{0.16\ \text{gauss/cm}} \qquad \text{(10 A in Axial \#1)}$$

14. For Mapping Fixture Model #46-209988G3, add (to move probe toward Table End of magnet) or remove (to move probe toward Back End of magnet) the appropriate number of Nylon Shims between the Table End Support Assembly and the Guide Disc. See Illustration 9-3.

9-1 CENTERING PROBE TO MAGNETIC CENTER (continued)

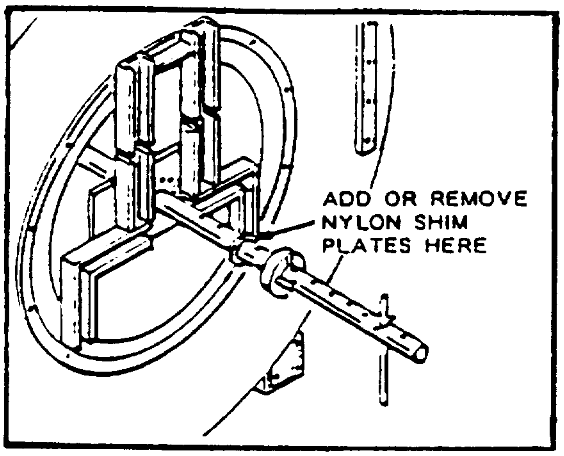
15. For Mapping Fixture Model #46-281420G2 and #46-294060G2, loosen the Probe Mounting Screw and slide the probe the appropriate length on the Probe Support Table using the scale on the side of the Probe Support Table as a reference. See Illustration 9-3.

16. If probe was moved, retake virgin field reading.

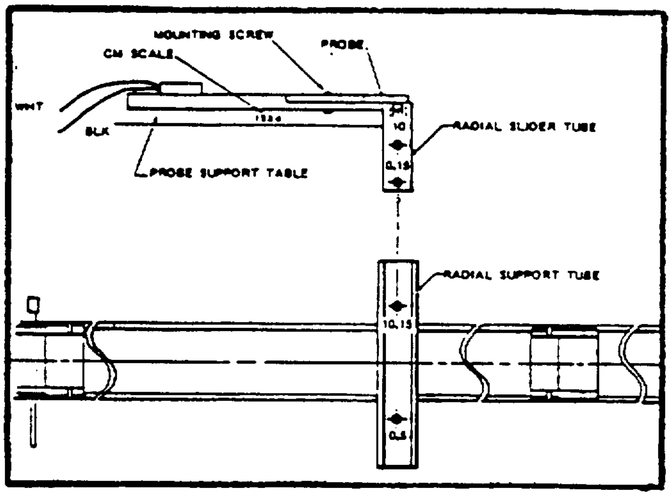
17. Check probe reading at 10 A after adjustment In Step 14 or 15 to ensure the reading is within 40 milligauss of the virgin field.

18. Ramp down the Axial1Shim Power Supply and then turn supply off.

19. Turn off the Axial Switch Heater.



MODEL 46-209988G3



MODEL 46-281420G 2

AXIAL ADJUSTMENT OF MAPPING FIXTURE
ILLUSTRATION 9-3

9-1 CENTERING PROBE TO MAGNETIC CENTER (continued)

Tranverse Probe Centering

Note

Matching S/C – Shim Coil designations are shown in brackets after the Transverse Power Supply "T", Channel Numbers.

1. Adjust the probe radius to 15 cm (fully extended).
2. Move the probe positioner to -20 cm axially (towards the Table End of the magnet).

WARNING!

ENSURE ALL SHIM POWER SUPPLY CHANNELS ARE TURNED OFF (FULL CCW) BEFORE TURNING ON THE SWITCH HEATERS.

3. Turn on both Transverse Switch Heaters and Axial Switch Heater for 2 minutes to dump any induced current in the S/C Shim Coils. Turn the Switch Heaters off and allow the heaters to cool for 2 minutes.

Note

Make sure all Shim Power Supply Channels are turned off (full CCW) before turning on the Switch Heaters.

4. Rotate the probe positioner clockwise (as viewed from the Table End of magnet). Record the virgin field values (in gauss) at 0, 90, 180 and 270 degrees in Table 9-2.
5. Move the probe positioner to +20 cm axially.
6. Rotate the probe positioner clockwise and record the gauss field at 0, 90, 180 and 270 degrees in Table 9-2.
7. Turn on Axial and Transverse Switoh Heaters, AX, T1 & T2, for 2 minutes each. Turn off Axial Heaters only.
8. Ramp the T1-3 (C22+) Power Supply to 10A and the T1-5 (C22–) Power Supply to 5A.
9. Rotate the probe positioner clockwise (as viewed from the Table End of the magnet). Record field values at 0, 90, 180 and 270 degrees in Table 9-2. These field values should be measured at both +20 and –20 cm axially.

9-1 CENTERING PROBE TO MAGNETIC CENTER (continued)

10. Calculate the peak difference between the virgin field values and the field values when current was supplied to the (C22+, -) Coils. Use Table 9-2.

Note

See Set Up and Callbration Section 10 for the graphs of the magnetic fields produced by the various S/C Coils.

11. If the difference between the 0 and 180 degree or 90 and 270 degree peaks is greater than 30 milligauss, adjust the probe positioner, moving it towards the lowest peak, by using the horizontal and vertical centering boits on the Mapping Fixture for Model 46-209988G3.

Note

Mapping Fixture Model #46-281420G2 and #46-294060G2 are factory set for X and Y center (not field adjustable). If peak difference should exceed 30 milligauss (in an isolated case) with this fixture, record peak difference for reference during shimming.

Table 9-2
TRANSVERSE PROBE CENTERING

S/C COIL STATUS	Z-AXIS	GAUSS READING (50xx.xx) AT			
		0 degrees	90 degrees	180 degrees	270 degrees
VIRGIN PLOT	+20 cm				
C22+(10A), C22-(5A)	+20 cm				
(peak difference)		△	△	△	△
VIRGIN PLOT	-20 cm				
C22+(10A), C22-(5A)	-20 cm				
(peak difference)		△	△	△	△

Note

If the probe is centered in the transverse direction (at either +20 cm or–30 cm), the maximum difference between the O and 180 degree or 90 and 270 degree “peeks” must not exceed 30 mG at r = 15cm, Peaks are calculated by taking the difference between the virgin field gauss valves and those gauss values when current is supplied to the (C22+) and (C22–) S/C Shim Coils. Seethe sample calculations in Illustration 9-4.

9-1 CENTERING PROBE TO MAGNETIC CENTER (continued)

MAXIMUM PEAK Difference IS
(0.08 -0.04) = 40 MILLIGAUSS

S/C COIL STATUS	Z-AXIS	GAUSS READING (50xx.xx) AT			
		0 degrees	90 degrees	180 degrees	270 degrees
VIRGIN PLOT	+20cm	10.21	10.22	10.16	10.11
C22+(10A), C22-(5A)	+20cm	10.25	10.28	10.08	10.19
(peak difference)		△0.04	△0.06	△0.08	△0.08
VIRGIN PLOT	-20cm	10.24	10.38	10.20	10.18
C22+(10A), C22-(5A)	-20cm	10.20	10.19	10.24	10.17
(peak difference)		△0.04	△0.19	△0.04	△0.01

MAXIMUM PEAK DIFFERENCE IS (0.19 -0.01) = 180 MILLIGAUSS
THEREFORE MOVE PROBE TOWARDS 270 DEGREE DIRECTION
AT THE FRONT END

SAMPLE TRANSVERSE PROBE CENTERING
ILLUSTRATION 9--4

12. Repeat Steps 9 through 11 until there is less than a 30 milligauss difference between the 0 and 180 degree or 90 and 270 degree peaks calculated at the –20 cm or +20 cm axial position for Model 46-209988G3.
13. Ramp down the T1–3(C22+) and TI-5(C22-) Power Suppliies.
14. Turn off the Transverse Switch Heaters and the Shim Coil Power Supply.
15. Remove frost and replace Shim Lead Vent Cap.

CAUTION

Make sure cap is tight and does not leak when warm.

9-2 FIELD MAPPING (314 POINT, C6 VOLUME)

Description:

The first iteration, 314 point plot is called the virgin map since there is no current (thus, no magnetic field produced) in the Superconducting Shim Coils. Subsequent maps are taken with current set in the Shim Coils. Obtain the 314 points by taking two data points along the Z axis at -20cm (Table End) and +20cm (Back End). Obtain the remaining 312 data points by taking 24 data points (at 15 degree increments about a circle) on 13 different planes. Refer to Illustration 9-5 for the location of the 13 planes and 2 data points along the z axis for the shim volume (ie., 30 cm dia by 40 cm long cylinder, C6).

Procedure:

1. Use the field monitoring equipment with the probe centered in Set Up and Calibration, Section 9-1.
2. Turn off gradient amplifiers at rear of gradient cabinet and resistive shim power supplies when equipped with system.
3. Turn on all three (Axial and Transverse) Switch Heaters for 2 minutes immediately before beginning the virgin map. Monitor the Teslameter and verify that the field is stable before performing Step 4.

Note

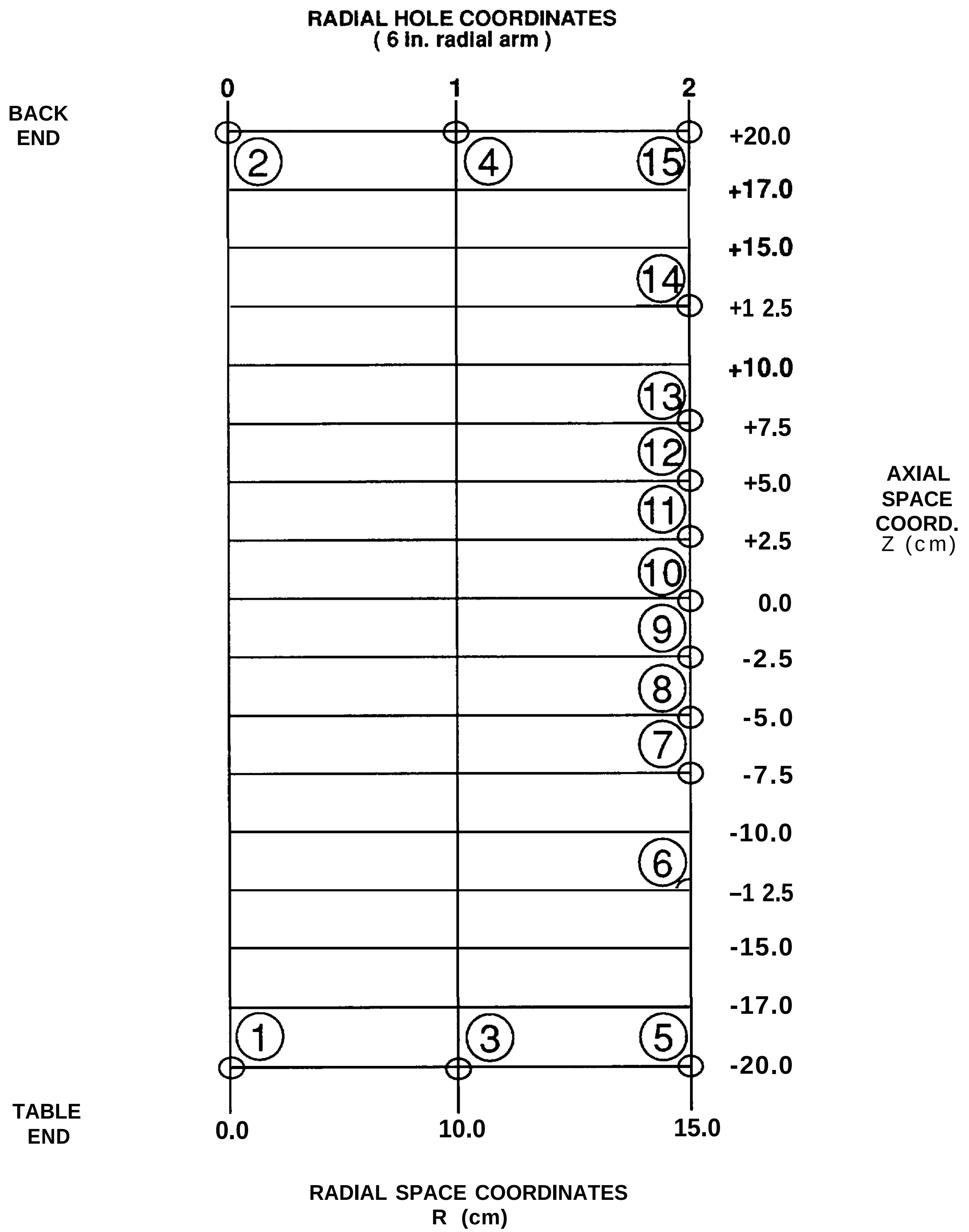
This step ensures there are no persistent currents in the S/C Correction Coils for the Virgin Map. Do not perform Steps 3 and 4 for subsequent maps with current set in the Shim Coils.

4. Turn off the Transverse and Axial Switch Heaters.
5. Plot the 314 pt map by recording in Table 9-3 the frequency at the two end points (–20cm and +20cm) and the 13 planes specified in Illustration 9-5. Plot the planes sequentially. Record the frequency values accurate to the tens place (i.e., round off 63987654 MHz to 63987650 MHz). Make sure the reading has stabilized before recording it.

Note

Take two points on the Zaxis at-20cmand +20cm first. Next, obtain the data for the remaining 13 planes by rotating the probe positioner Clockwise (as viewed from Table End of the magnet) at 15 degree increments, starting at the top (12 o'clock).

6. After collecting all 314 points, check the data for errors (i e,, all points should lie within a 500 KHz range). If a frequency value is suspect, adjust the probe positioner to the appropriate radius and axial coordinates and recheck the frequency value.



PROBE POSITIONER LOCATIONS -30 CM DIA. BY 40 CM LONG CYLINDER (C6)
ILLUSTRATION 9-5

DATE:__________ MAGNET:__________ LOCATION:__________ PLOT#:__________

POINT 1 (R = 0, Z = –20cm):__________ POINT 2 (R = 0, Z = +20cm):__________ BASE FREQ:__________

ROTATION COORD. (DEGREES)	PLANE												
	3	4	5	6	7	8	9	10	11	12	13	14	15
0°													
15°													
30°													
45°													
60°													
75°													
90°													
105°													
120°													
135°													
150°													
165°													
180°													
195°													
210°													
225°													
240°													
255°													
270°													
285°													
300°													
315°													
330°													
345°													

FREQUENCY – 63,xxxxx0 Hz (Round Off To Nearest 10 Hz)

SHIM PLOT DATA
TABLE 9–3

DATE:______ MAGNET:______ LOCATION:______ PLOT#:______

POINT 1 (R = 0, Z = −20cm):______ POINT 2 (R = 0, Z = +20cm):______ BASE FREQ:______

PLANE \ ROTATION COORD. (DEGREES)	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180°	195°	210°	225°	240°	255°	270°	285°	300°	315°	330°	345°
3																								
4																								
5																								
6																								
7																								
8																								
9																								
10																								
11																								
12																								
13																								
14																								
15																								

FREQUENCY – 63,xxxx0 Hz (Round Off To Nearest 10 Hz)

SHIM PLOT DATA
TABLE 9–3

DATE:______ MAGNET:______ LOCATION:______ PLOT#:______

POINT 1 (R = 0, Z = –20cm):______ POINT 2 (R = 0, Z = +20cm):______ BASE FREQ:______

ROTATION COORD. (DEGREES)	PLANE												
	3	4	5	6	7	8	9	10	11	12	13	14	15
0°													
15°													
30°													
45°													
60°													
75°													
90°													
105°													
120°													
135°													
150°													
165°													
180°													
195°													
210°													
225°													
240°													
255°													
270°													
285°													
300°													
315°													
330°													
345°													

FREQUENCY – 63,xxxxx0 Hz (Round Off To Nearest 10 Hz)

SHIM PLOT DATA
TABLE 9–3

DATE:__________ MAGNET:__________ LOCATION:__________ PLOT#:__________

POINT 1 (R = 0, Z = –20cm):__________ POINT 2 (R = 0, Z = +20cm):__________ BASE FREQ:__________

ROTATION COORD. (DEGREES)	PLANE												
	3	4	5	6	7	8	9	10	11	12	13	14	15
0°													
15°													
30°													
45°													
60°													
75°													
90°													
105°													
120°													
135°													
150°													
165°													
180°													
195°													
210°													
225°													
240°													
255°													
270°													
285°													
300°													
315°													
330°													
345°													

FREQUENCY – 63,xxxxx0 Hz (Round Off To Nearest 10 Hz)

SHIM PLOT DATA
TABLE 9–3

DATE:________ MAGNET:________ LOCATION:________ PLOT#:________

POINT 1 (R = 0, Z = –20cm):________ POINT 2 (R = 0, Z = +20cm):________ BASE FREQ:________

ROTATION COORD. (DEGREES)	PLANE												
	3	4	5	6	7	8	9	10	11	12	13	14	15
0°													
15°													
30°													
45°													
60°													
75°													
90°													
105°													
120°													
135°													
150°													
165°													
180°													
195°													
210°													
225°													
240°													
255°													
270°													
285°													
300°													
315°													
330°													
345°													

FREQUENCY – 63,xxxxx0 Hz (Round Off To Nearest 10 Hz)

SHIM PLOT DATA
TABLE 9–3

DATE:____________ MAGNET:____________ LOCATION:____________ PLOT#:____________

POINT 1 (R = 0, Z = –20cm):____________ POINT 2 (R = 0, Z = +20cm):____________ BASE FREQ:____________

ROTATION COORD. (DEGREES)	PLANE												
	3	4	5	6	7	8	9	10	11	12	13	14	15
0°													
15°													
30°													
45°													
60°													
75°													
90°													
105°													
120°													
135°													
150°													
165°													
180°													
195°													
210°													
225°													
240°													
255°													
270°													
285°													
300°													
315°													
330°													
345°													

FREQUENCY – 63,xxxxx0 Hz (Round Off To Nearest 10 Hz)

SHIM PLOT DATA
TABLE 9–3

9–3 LOADING FIELD DATA INTO SOFITWARE PROGRAM (THRU 4X SYSTEMS)

9-3-1 Loading Field Data

Procedure:

1. Bring up software if not already running.

2. At operator console display panel, touch [UTILITIES] then [TOOLS].

3. Select, GE SHIM – GE Mechanical Shim, [CR].

SHIM DATA EDITOR FOR GE MAGNETS

H - help	P – prompt for data
L– load an existing data file	S – save current data file
M – modify plane degree value	X– execute shim algorithm
B - display and/or edit base frequency	E - exit shim data editor
D – display planes	

4. Select,B– display and/or edit base freq. [CR].

This is the option to modify base freq.
Range of freq is between 10000000Hz
90000000 Hz.
Enter the new base frequency or minus 1 to
without changing the base frequency.
value is:0
value: 6<u>3kkkk0</u> [CR]

Notes: "k" is 0 if digit place frequency not common to all 314 data points. For all digits not common, enter 0 in Valid base freq. For example, and if the lowest frequency is Enter 6380123 and the highest exit frequency is <u>6380</u>133, Current enter <u>6380</u>100 for base Enter new frequency.

5. Exit B and Select, P – prompt for data, [CR].

This is the option to prompt for all plan~degree data values. Valid range for data is between 0 and 9.

kkkkk is freq. data obtained with mapping fixture. The number of digits to enter for 'k" depends on string of zeros in base freq. The base frequency must have enough 0's to accommodate the minimum and maximum values in Table 9-3. If base freq. is 6380100 enter a two digit value (kk) for each input.

<u>Do not include a "0" in the 1 Hz unit place as all entries are multiplied by 10.</u>

9-3-1 Loading Field Data (continued)

Enter minus 1 for any value to exit.

Plane 1 Degree0: **kkkkk [CR]**
Plane 2 Degree0 **kkkkk [CR]**
Plane 3 Degree0: **kkkkk [CR]**
Plane 3 Degree 15: **kkkkk [CR]**
Plane 3 Degree 30: **kkkkk [CR]**
Plane 3 Degree 45: **kkkkk [CR]**
Plane 3 Degree 60: **kkkkk [CR]**
Plane 3 Degree 75: **kkkkk [CR]**
Plane 3 Degree 90: **kkkkk [CR]**
Plane 3 Degree 105: **kkkkk [CR]**

Continue to enter data for 314 points. If an erroneous value is entered, it can be corrected after the initial data file is completed by using the "DISPLAY and then the "MODIFY" prompts.

Plane 3 Degree 315: **kkkkk [CR]**
Plane 3 Degree 330: **kkkkk [CR]**
Plane 3 Degree 345: **kkkkk [CR]**
Plane 4 Degree **0:kkkkk [CR]**
Plane 4 Degree 15: **kkkkk [CR]**

Plane 15 Degree 330: **kkkkk [CR]**
Plane 15 Degree 345: **kkkkk [CR]**

6. To review any plane select, D-Display Plane.

This option displays the values for a given plane.

7. Enter minus 1 to any plane to Exit.
8. Enter Plane1 to 15:_______ [CR].
9. If any data points need to be modified, select M – Modify Plane degree value, [CR].

   Enter Plane. _________ **[CR].**
   Enter Degree: _________ **[CR].**
   Current Value is: _________ **[CR].**
   Enter new Value:__________ **[CR].**

10. Select, S - save current data file, **[CR].**

Ensure File Is Saved.
If current file not saved prior to exiting GE Mechanical Shim program, all data loaded in will be **DUMPED!**

9-3-1 Loading Field Data (continued)

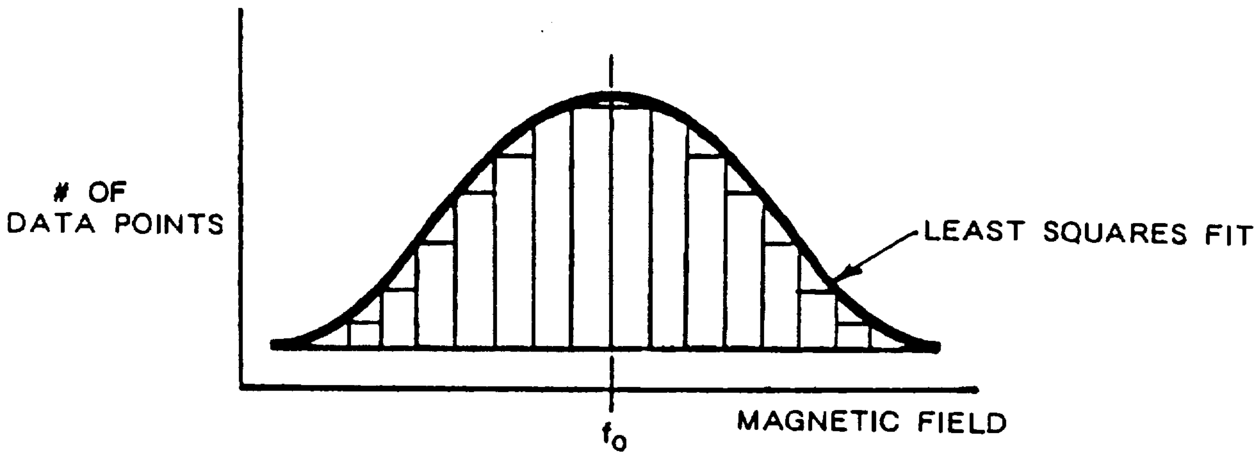
This is the option to save data in a file.
Enter the name of the destination file or NEWLINE to exit
Enter filename: <u>Plotx.dat </u>[CR].

Where; x = 1 for first plot, 2 for second plot, . . .

9-3-2 Executing GE Shim Algorlthm

Description:

The Shim Algorithm consists of a Least Squares Fit (Yields Normal Distribution Curve).



Record shim currents in Table 9-4.

Procedure:

Notes:

1. Type X to execute algorithm.

2. Load following input:

Date is: dd/mm/yy
Time is: tt:tt:tt

What is magnet serial number? [xxxxxx]:
<u>xxxxxx</u> [CR].

What is file name which contains number of shim coils and coefficents, e.g. [SIIC6.dat] ?

9-3-2 Executing GE Shim Algorithm (continued)

What is name of file containing field data? **Plotx.dat [CR].**	Saved in previous Section.
What name do you want to use for output file? **OPlotx.dat [CR].**	
Is the magnet ramped normal (red–red, blk–blk)? (y/n]: **Y or N [CR].**	Normal: red cable to red terminal on pwr supply. Other end of red cable connected to ramp lead on right side of magnet (as viewed from service end).
Magnet location? [max 30 characters]_______ **[CR].**	
Is this a virgin plot? [**y / n] Y or N [CR].**	
Name of file with previous currents? **OPlotx.dat [CR].**	Last output file used. Prompt does not appear if virgin plot.
Do you want Stochastic Shimming? [y / n] N [CR],	
Do you want to include statistics with output? [y / n]: **Y [CR].**	

WORKING
(Program calculates then displays inhomogeneity and correction currents).

3. Record correction current and ppm values in Table 9-4.

4. Change the currents in the S/C power supplies to the Recommended Total Current values calculated by the program. Use the (adjusting S/C Shim Coil Power Supply Currents) procedure in Set Up and Calibration, Section 9–5 for all S/C Shim Coil Current Settings/ Changes.

Note

If problems encountered during shimming, go to Set Up and Calibration, Section 10 (Polarity& Functional Checks).

5. Replot magnetic field, load new data, then rerun shim program and adjust shim currents until magnet shimmed to less than 6 ppm over the C6 volume (30 cm dia by 40 cm long cylinder).

6. When shimming is completed, go to Set Up and Calibration, Section 11.

9-4 LOADING FIELD DATA INTO SOFTWARE PROGRAM (5X, SIGNA ADVANTAGE SYSTEMS)

9-4-1 Loading Field Data

Procedure:

CONVENTIONS

Text inside the symbol [ ] means that the command is issued by manually touching the Operator Console Display. Text within the symbol < > indicates a “function” key on a keyboard (e.g. <RETURN>). Bold type within text indicates user inputs (e.g. Select B – display base frequency). Italicized type indicates variable user input.

1. Bring up software if not already running.

2. At operator console display panel, touch [UTILITIES].

3 Press [1], [2], and [3], in numerical order, for software acknowledgment.

4. Press [MR Tools] at tool menu

5. Press [Shim].

6. Press [C6 Data Editor].

Note

The screen will display as shown below.

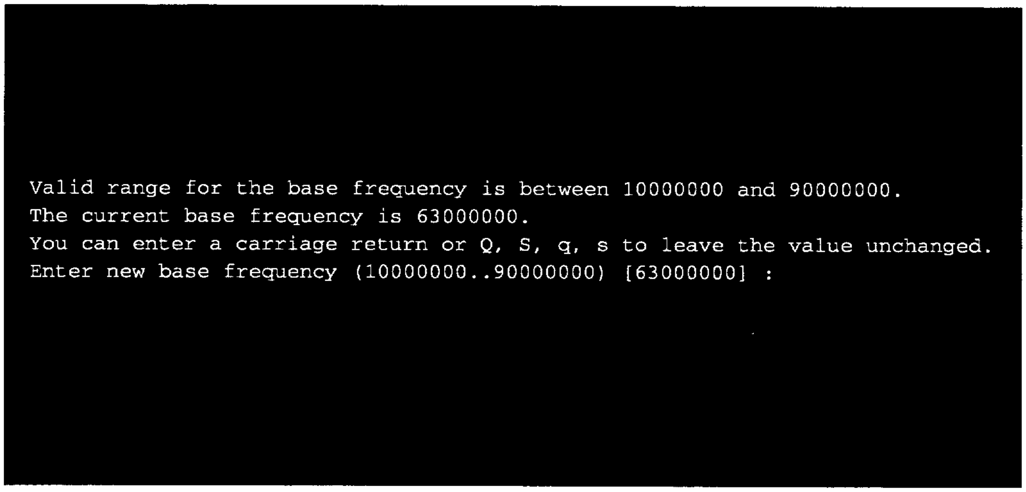
```
Shim Data Editor Main Menu

 L  - Load an existing datafile from disk for editing
 M  - Modify individual plane degree values
 B  - Display and/or edit the base frequency
 D  - Display all the values for a given plane
 P  - Prompt for all plane-degree values in sequence
 K  - save (Keep) data to disk

 Q,S - exit shim data editor (does not save data!)

Enter Selection [L]:
```

9-4-1 Loading Field Data (continued)

7. Select “B” from the main menu by typing B followed by <ENTER>, This provides the screen for inputting or changing the Base Frequency. After selecting “B”, perform Step a below.

Note

After selecting “B”, the following information will appear, under the main menu, with range in parenthesis and default values in brackets.



Note

The Base Frequency is obtained by finding the lowest and highest frequency values on the Shim Plot and taking the common most significant digits; then adding zeroes for the remainder of the digit positions (e.g., if the lowest frequency is 6386123 and the highest frequency is 6386133, enter 6386100 for new Base Frequency).

a. Enter new base frequency (10000000 to 90000000) [63000000] :

Note

You can enter a carriage return to leave the value unchanged or type Q, S, q ,ors, followed by <ENTER>, to return to the Main Menu .

8. After entering Base Frequency, Select “P” from the Shim Data Editor Main Menu by typing **P** followed by<ENTER>. This provides the screen for entering all Plane – Degree values in sequence. After selecting “P”, perform Step a below.

9-4-1 Loading Field Data (continued)

Note

After selecting “P”, the following information will appear, under the main menu, with range in parenthesis and default values in brackets.

```
Valid range for data is between 0 and 99999.
Every prompt shows the range in parentheses and the default in square brackets.
You can enter Q, S, q or s at any prompt to return to the main menu.
Entering any of these quit characters will leave the database value unchanged.
NOTE:  The value you enter will be automatically multiplied by ten.
The current value for plane 1 and degree 0 is 0.
Please enter new value (carriage return to leave unchanged) (0..99999) [0] :
```

Note

The value you enter will be automatically multiplied by ten.

Note

If a mistake is made during the following step, it can be corrected after all other data is input by selecting “M” at the Shim Data Editor Main Menu. If you are not sure about a value, you can view data for any given plane by selecting “D” at the Shim Data Editor Menu.

Note

You can enter Q, S, q, ors at any prompt to return to the main menu. Entering any of these “Quit” characters will leave the database value unchanged,

a. Type in new value followed by <ENTER>, or just <ENTER> to leave value unchanged,

Note

The program will prompt you for all 314 data points in succession.

Plane 1 Degree 0: **kkkkk < RETURN >**
Plane 2 Degree 0: **kkkkk < RETURN >**
Plane 3 Degree 0 **kkkkk** < RETURN >
Plane 3 Degree 15: **kkkkk < RETURN >**
Plane 3 Degree 30:* **kkkkk** < RETURN >

Plane 15 Degree 330: **kkkkk** c RETURN >
Plane 15 Degree 345: **kkkkk < RETURN >**

* Successive Data Points (Planes 3 through 15 at 15° increments).

9-4–1 Loading Field Data (continued)

9. Select “K” from Shim Data Editor Main Menu by typing K followed by <ENTER>. This will provide the screen for saving the data. After selecting “K”, perform Step a below.

Note
After selecting “K”, the following screen will appear.

Note
You can enter Q, S, q, or s at any prompt to return to the Shim Data Editor Main Menu, Entering any of these “Quit” characters will leave the database value unchanged.

Note
In the following step, “X’ is any iteration a through z except for “v’’which is reserved for the virgin plot.

Note
If entering a filename that already exists, the following message will appear:
“File /usr/g/caldir/gemech-D384–v.plot exists, overwrite (Y / N) :“
If “Y” is entered, the existing file is overwritten which deletes original content.

a. Enter filename by typing in: **gemech** _serial *#_X.* **plot.** followed by <ENTER>.

EXAMPLE: gemech_D384_v.plot<ENTER>.

10. At the Shim Data Editor Main Menu, type in Q, S, q, ors to return to "‘MR Tools” Menu.

9-4-2 Executing GE Shim Algorithm

Description:

The Shim Algorithm calculates shim coil currents based on a least squares approach that maximizes homogeneity of each iteration,

Procedure:

Note

Record shim currents in DATA SHEETS, Table 9–3.

1. Select GE Mechanical Shim from the "MR Tools" Menu by touching [Mech Shim] on the screen.

2. Answer questions "a" through "g" below,

   A. Enter magnet location (site name).

   B. Enter magnet type (e.g., s1, s2, s3, s4, v6 ...).

   C. Enter the magnet serial number,

   D. Enter "Y" if virgin plot, otherwise enter "N",

   E. Enter "Y" if displayed file is to be overwritten with a new file, otherwise enter "N".

   F. Enter "Y" if the magnet is ramped normal (power supply positive to magnet positive),

   G. Enter "Y" if you want statistics with the output.

Note

The screen displays "Working... " and then shows the information below.

```
                  Results of GeMechShim

      Date and Time         : Tue Oct  1 11:01:12 1991

      Magnet Type           : S3
      Magnet Serial #       : D384
      Magnet Polarity       : Normal
      Site Name             : b15

      Coils File            : /w/config//shim_sIIIc6.coils
      Coefficient File      : /w/config//shim_sIIIc6.coeff
      Plot Data File        : /usr/g/caldir//gemech_D384_v.plot
      Output Currents File  : /usr/g/caldir//gemech_D384_v.curr
      Prev. Currents File   : None

   Please  press  carriage  return  to  continue  ...  [  ]  :
```

9-4-2 Executing GE Shim Algorithm (continued)

3. Press cENTER> to continue after the screen displays the above information, The screen will then display as shown below.

```
                                              Delta Current  Recommended
Supply Name  Present Current (A)    Change (A)     Total Current (A)
-----------  -------------------    -------------  -----------------
  T1_1             0.000         :     -0.016          -0.016
  T1_2             0.000         :      0.007           0.007
  T1_3             0.000         :     -0.035          -0.035
  T1_4             0.000         :     -0.002          -0.002
  T1_5             0.000         :      0.039           0.039
  T1_6             0.000         :     -4.168          -4.168
  T2_1             0.000         :      0.125           0.125
  T2_2             0.000         :     -0.021          -0.021
  T2_3             0.000         :      0.011           0.011
  T2_4             0.000         :     -0.003          -0.003
  T2_5             0.000         :     -0.028          -0.028
  T2_6             0.000         :      1.365           1.365
  AX_1             0.000         :      1.614           1.614
  AX_2             0.000         :      1.662           1.662
  AX_3             0.000         :     -1.000          -1.000
  AX_4             0.000         :      3.001           3.001
  AX_5             0.000         :      0.212           0.212
  AX_6             0.000         :      1.349           1.349




  Present ppm  =  36.13 (ppm)    :   Predicted ppm =    44.35  (ppm)

Data points in acquired field map  =     314
Average Field Strength             =    14999.72  (Gauss)

Please press carriage return to continue ... [ ]  :
```

4. Record Delta Current Delta Current Change and ppm values in Table 9-4 of DATA SHEETS.

5. Press cENTER> to continue after the screen displays the above information. The screen will then display as shown below.

```
Average Deviation              =      8.07  (ppm)
Maximum Deviation              =     23.15  (ppm)
Chi-squared  / DFD             =    119.89  (D = ppm)
Statistical Error              =    233.08  (Hertz)

Please press carriage return to continue ... [ ] :
```

9–4-2 Executing GE Shim Algorithm (continued)

6. Press <ENTER> to continue after the screen displays the above information. The screen will then display as shown below.

```
              GE Mechanical Shim
              ------------------

     The following parameters are currently set:

          Site Name             : b15b
          Magnet Type           : S3
          Magnet Serial #       : D384
          Magnet Polarity       : Normal
          Statistics will be included with the output.

              Selection Menu
              --------------
     C - Run GE Mechanical Shim with the current parameters
     N - Run GE Mechanical Shim with new parameters
         or enter Q, S, q, or s to quit.

     Enter selection (C, N, or a quit character) [C] :
```

7. Choose one of the following:

   A. Select C to run GE Mechanical Shim with the current parameters

   B. Select N to run GE Mechanical Shim with new parameters.

   C. Select Q, S, q, ors to exit GE Mechanical Shim.

8. Load Correction Currents recorded in Step 3. Use the “Adjusting S/C Shim Coil Power Supply Currents” procedure in SET UP AND CALIBRATION, Section 9-4 for all S/C Shim Coil Current settings/changes.

9. Re–map the Magnet.

10. Enter Data from new map in Section 9-4, Step 8. Continue to re–map magnetic field, load new data, run shim program, and adjust shim currents until magnet is shimmed to lowest possible inhomogeneity (Specification is <6,3ppm).

11. Make sure Center Frequency (R = O, Z = O) is within specification at the completion of shimming. If necessary, adjust Center Frequency to specification in conformance with SET UP AND CALIBRATION, Section 12 (Field Adjustment after Shimming).

DATE:________ MAGNET SERIAL #:________ PLOT #:________ OUTPUT FILE:________

POWER SUPPLY # (NAME)	TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)	= TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)	= TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)
T1–1(C31)						
T1–2(C11+)						
T1–3(C22+)						
T1–4(C11–)						
T1–5(C22–)						
T1–6(C33)						
T2–1(S31)						
T2–2(S11+)						
T2–3(S22+)						
T2–4(S11–)						
T2–5(S22–)						
T2–6(S33)						
AX1						
AX2						
AX3						
AX4						
AX5						
AX6						
GRADIENT OFFSETS						
X						
Y						
Z						
PREDICTED						
INHOMOGENEITY						

CALCULATED CORRECTION CURRENTS FOR S/C SHIM COILS
TABLE 9–4

DATE:____________ MAGNET SERIAL#:____________ PLOT#:____________ OUTPUT FILE:____________

POWER SUPPLY # (NAME)	TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)	= TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)	= TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)
T1–1(C31)						
T1–2(C11+)						
T1–3(C22+)						
T1–4(C11–)						
T1–5(C22–)						
T1–6(C33)						
T2–1(S31)						
T2–2(S11+)						
T2–3(S22+)						
T2–4(S11–)						
T2–5(S22–)						
T2–6(S33)						
AX1						
AX2						
AX3						
AX4						
AX5						
AX6						
GRADIENT OFFSETS						
X						
Y						
Z						
PREDICTED						
INHOMOGENEITY						

CALCULATED CORRECTION CURRENTS FOR S/C SHIM COILS
TABLE 9–4

DATE:______________ MAGNET SERIAL#:______________ PLOT#:______________ OUTPUT FILE:______________

POWER SUPPLY # (NAME)	TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)	= TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)	= TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)
T1–1(C31)						
T1–2(C11+)						
T1–3(C22+)						
T1–4(C11–)						
T1–5(C22–)						
T1–6(C33)						
T2–1(S31)						
T2–2(S11+)						
T2–3(S22+)						
T2–4(S11–)						
T2–5(S22–)						
T2–6(S33)						
AX1						
AX2						
AX3						
AX4						
AX5						
AX6						
GRADIENT OFFSETS						
X						
Y						
Z						
PREDICTED						
NHOMOGENEITY						

CALCULATED CORRECTION CURRENTS FOR S/C SHIM COILS
TABLE 9–4

DATE:________ MAGNET SERIAL #:________ PLOT #:________ OUTPUT FILE:________

POWER SUPPLY # (NAME)	TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)	= TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)	= TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)
T1–1(C31)						
T1–2(C11+)						
T1–3(C22+)						
T1–4(C11–)						
T1–5(C22–)						
T1–6(C33)						
T2–1(S31)						
T2–2(S11+)						
T2–3(S22+)						
T2–4(S11–)						
T2–5(S22–)						
T2–6(S33)						
AX1						
AX2						
AX3						
AX4						
AX5						
AX6						
GRADIENT OFFSETS						
X						
Y						
Z						
PREDICTED						
INHOMOGENEITY						

CALCULATED CORRECTION CURRENTS FOR S/C SHIM COILS
TABLE 9–4

9-5 ADJUSTING S/C SHIM COIL POWER SUPPLY CURRENTS FOR MAGNET SHIMMING

Description:

The RECOMMENDED TOTAL CURRENT (see Table 9-4) values calculated by the shim program must be entered into the S/C Correction Coils before performing an additional 314 point plot. The S/C Correction Coils are divided into the following groups:

0 Axial 1 through 6
0 Transverse Odd: (C31, C11+, C22+, C11-, C22–, C33)
0 Transverse Even: (S31, S11+, S22+, S11–, S22-, S33)

Each group is connected together on one heater circuit. For example, when the Axial Switch Heater is on, the current in all of the Axial Coils (1 through 6) is dumped. Therefore, if the only current change was in the Axial 2 Coil, the complete Axial Set (1 through 6) would have to be dumped and the appropriate currents adjusted for each.

Procedure:

WARNING!

BEFORE TURNING ON SHIM COIL POWER SUPPLY AND APPLYING SHIM CURRENTS, ENSURE THAT THE FOLLOWING CONDITIONS EXIST TO PREVENT IRREPARABLE DAMAGE TO THE VAPOR COOLED SHIM LEADS:

0 THE CAPON THE SHIM LEAD VENT IS REMOVED.
0 THE THE SHIM LEAD EXTENSION IS FROSTED.
0 THE POWER SUPPLY CURRENT CONTROLS ARE SET TO ZERO (FULL CCW).

1. Remove Shim Lead Vent Cap. To vent models without a vent cap, remove the copper tubing where it screws into the Shim Lead. Do not proceed with adding currents until the escaping vapor has frosted the Shim Lead.

2. It is recommended that the Shim Currents be input in the following order:

   Transverse 1
   Transverse 2
   Axials

   For each of these groups, follow the instructions below:

3. Set the Shim Group Select Switch to the appropriate group (T1, T2, or Axial),

9–5 ADJUSTING S/C SHIM COIL POWER SUPPLY CURRENTS FOR MAGNET SHIMMING (continued)

4. Match the existing current in these Shim Coils with the knobs on the Shim Power Supply as follows:

   FIRST ITERATION – there are no currents in the Shim Coils –Set the power supply knobs to zero amps (full CCW).

   SUBSEQUENT ITERATIONS - adjust the polarlty toggle switches as required for positive or negative current. Then set the power supply coarse and fine control knobs to the current level existing in the coils.

CAUTION

When the Switch Heaters are turned on, any currents existing in the Shim Coils wlll be discharged Into the power supply. To prevent dumping excessive currents through the Shim Leads, match the existing shim currents with the power supply before turning on the heaters. The current will then be adjusted to the required new levels after the heaters are activated.

5. Turn on theappropriate Switch Heater. Verify that the heater current is 810± 10mA. If it is not correct, adjust it with the adjustment screw located on the rear of the Shim Power Supply. Allow 5 minutes for the heater to drive the switches resistive. Make sure Shim Lead Extension is frosted.

6. Adjust the appropriate Shim Power Suppiles to the RECOMMENDED TOTAL CURRENT values listed by the shim program, (Table 9-4).

7. After all the Correction Coil currents have been set, make sure each power supply is delivering the appropriate amount of current at the correct polarity.

Note

If repeated iterations of shim program call for same current in a shim roil, indicating Shim Switch not going resistive, set 20A in coil then lower current to required value, driving switch resistive.

Note

Adjust slightly as required. 1mA high is better than 1mA low.

Note

Failure to accurately set the power supply currents and polarity can greatly increase the number of plotting iterations (i.e., time to shim the magnet).

9–5 ADJUSTING S/C SHIM COIL POWER SUPPLY CURRENTS FOR MAGNET SHIMMING (continued)

8. Check the frequency reading on the Teslameter to make sure the Correction Coils are stable (i.e., there is no more than a 20 Hz change in the total magnetic field over a two minute period).

9. Once the field is stable (see Step 8), turn off Switch Heater and a flow the heater to cool for 5 minutes.

10. Turn all the Shim Power Supplies back down to zero amperes (full CCW).

11. Repeat Steps 1 through 10 for Transverse 2 then Axial Coil Groups.

12. Make a quick check of the circles at r = 15cm, z =±20 cm to determine if homogeneity has improved. If homogeneity has not improved, troubleshoot. Refer to Set Up and Calibration, Section 10 (Polarity & Functional Checks).

13. When all currents are set, turn off the power supply, then disconnect all leads between the magnet and Shim Power supply.

14. Replace the capon the Shim Lead Vent.

CAUTION

Ensure that the cap Is replace and does not leak.

15. Turn off input power to the Shim Power Supply and disconnet input power cable.

CAUTION

Ensure that the Shim Power Supply Is not connected to the magnet.

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SECTION	TITLE	PAGE
10	POLARITY AND FUNCTIONAL CHECKS	10–1
	10-1 Axial Correction Coil	10–1
	10-2 Transverse Correction Coils	10-6

SECTION 10- POLARITY AND FUNCTIONAL CHECKS

Description:

Follow the procedures below if problems are encountered in shimming the magnet with the Super conducting Shim Coils. These procedures will help to identify: Shim Cable wiring error; Shim Coil Switch malfunction; Switch Heater malfunction; defective or misaligned S/C Shim Coil. See SCHEMATICS/INTERCONNECTS, illustrations 2-1 ("Magnet System Wiring Diagram") and FUNCTIONAL CHECKS, Section 2 ("Magnet Electrical Checks") for trouble shooting if problems are encountered.

Note

if wiring problems are suspect, make sure the Shim Cables are not miswired before changing leads in the Magnet Connector Box.

10-1 AXIAL CORRECTION COIL

1. Connect the Superconducting Shim Power Supply and Cable in conformance with SET UP AND Calibration, Section 8-1.
2. Make sure the Field Monitoring Equipment is installed and aligned. See SET UP AND Calibration, Section 5 and 9-1.
3. Turn on all Switch Heaters for 2 minutes, then turn heaters off to produce a virgin field.
4. Set the Teslameter probe to 0 cm radius and move it to the center of the magnet (i.e., axial = 0 cm and 0degree rotation).
5. Record the virgin magnetic field at the magnet center (Z= 0cm) in Table 10-1.
6. Move the probe along the z-axis and record the virgin magnetic field at –20 cm and +20 cm.
7. Turn on the Axial and Transverse Switch Heaters. Allow the heaters to warm up for 2 minutes.

10-1 **POLARITY AND FUNCTIONAL CHECKS (continued)**

TABLE 10–1
AXIAL COIL DATA

S/C COIL	GAUSS READING (15.XXX.X)		
	Z = –20CM (TABLE END)	Z = 0CM (CENTER)	Z = +20CM (BACK END)
VIRGIN MAP			
AXIAL 1			
AXIAL 2			
AXIAL 3			
AXIAL 4			
AXIAL 5			
AXIAL 6			

WARNING!

DO NOT TURN ON THE MAIN MAGNET SWITCH HEATER. ACTIVATING THE MAIN MAGNET SWITCH HEATER WHILE THE MAGNET IS UP TO FIELD WILL RESULT IN A QUENCH.

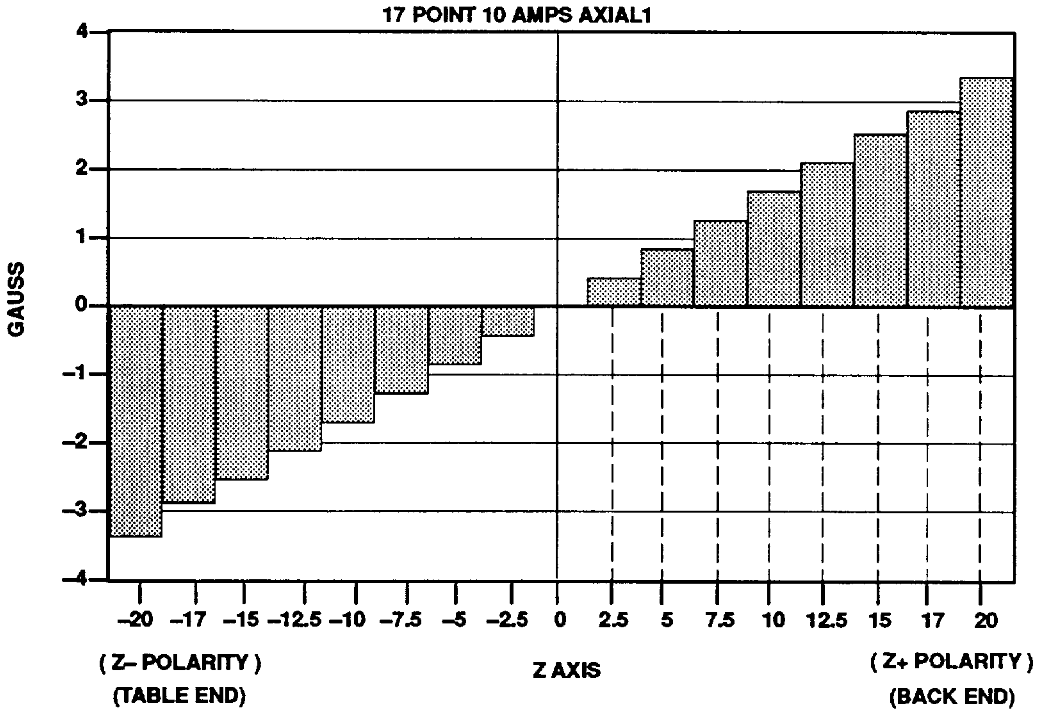
8. Apply 10 A to the Axial–1 coil (i.e set Axial–1 Power Supply to 10 A).
9. Turn off the Axial and Transverse S/C Switch Heaters. Allow the heaters to cool for 2 minutes.
10. Ramp the Axial – 1 S/C Power Supply to 0 A after the Switch Heaters have cooled down for 2 minutes.
11. Move the probe to the –20 cm, 0 cm and +20 cm axial locations. Record the gauss values in Table 10–1.
12. Take the Axial 1 readings at –20 cm, 0 cm and +20 cm and subtract the corresponding point of the virgin map values from each.
13. Compare the gauss **difference** with the coil maps In Illustration 10–1.

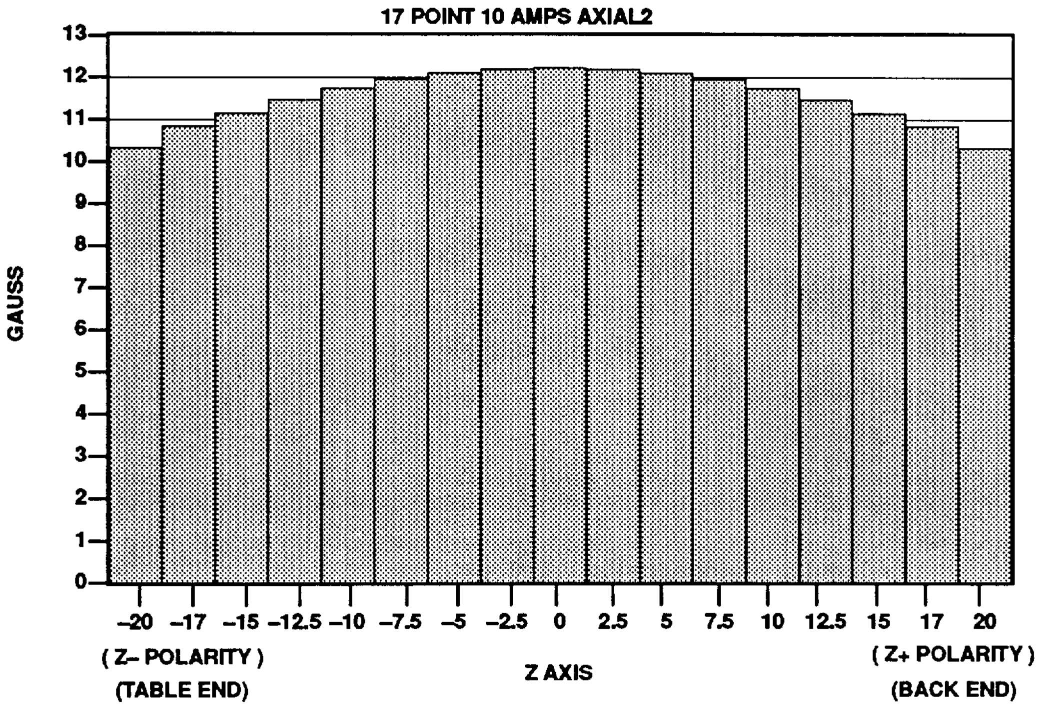
Note

If the polarity is correct for the Axial–1 Coil, the gauss value at the Table End (–20cm) will be approximately 4 gauss less than the –20cm virgin map value. However, the gauss value at +20cm along the Z–axis is approximately 4 gauss greater than the +20cm virgin value.

14. Repeat Steps 6 through 13 for each of the Axial S/C Coils (Axial–2 through Axial–6). Compare the gauss differences with the plots in Illustration 10–1. Rewire connectors on the Magnet Terminal Box (MS1–A3,A1) or change the Polarity Switch on the particular power supply as appropriate (ie., when the collected data is opposite that in Illustration 10–1.

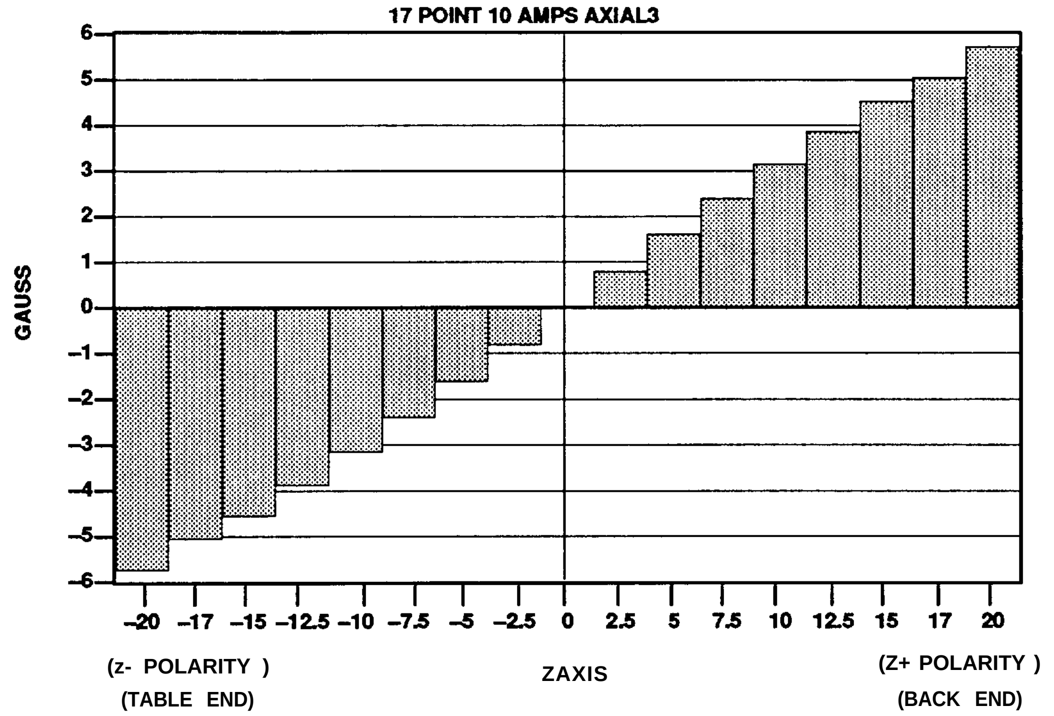
NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITVE SHIM COIL CURRENTS.

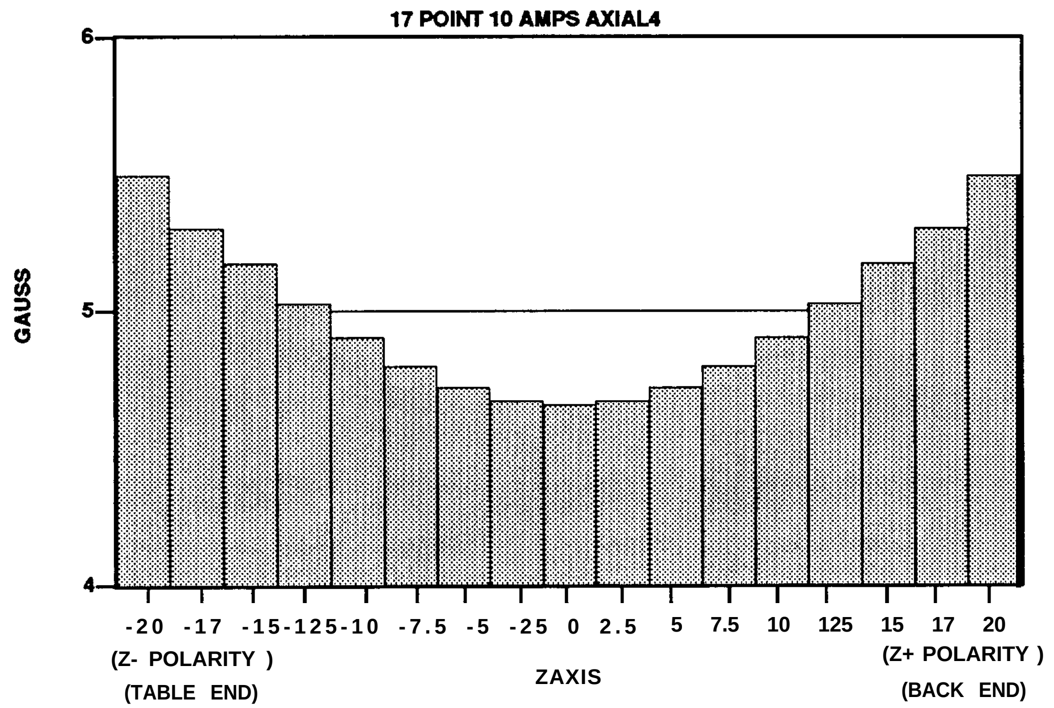




AXIAL 1 AND AXIAL 2 CORRECTION COIL PLOTS
ILLUSTRATION 10-1

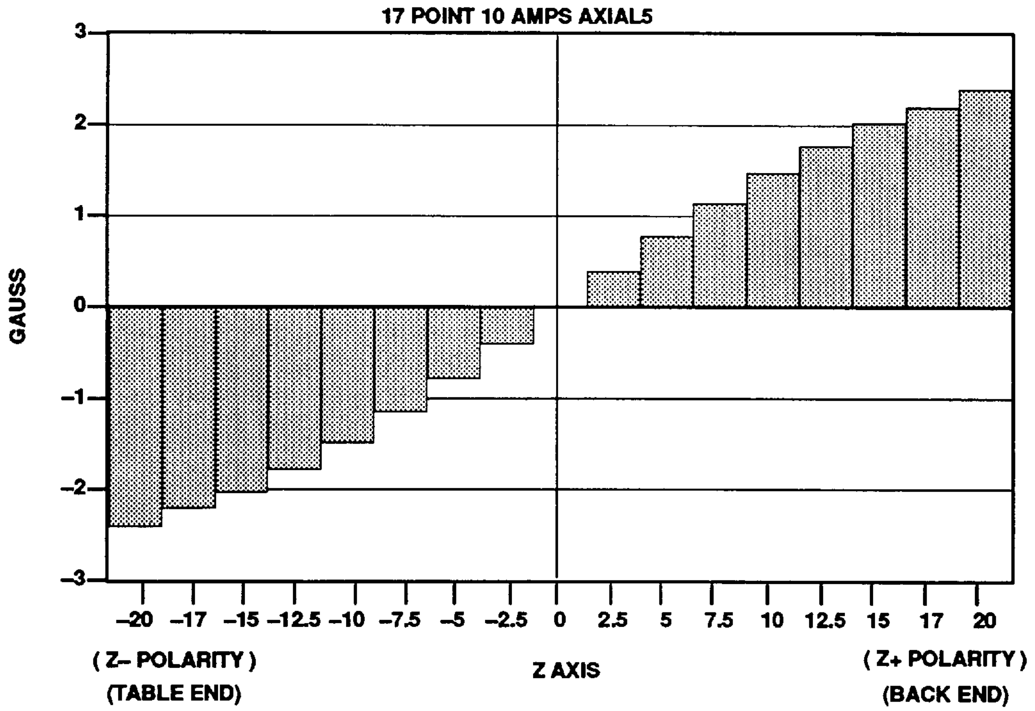
NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.

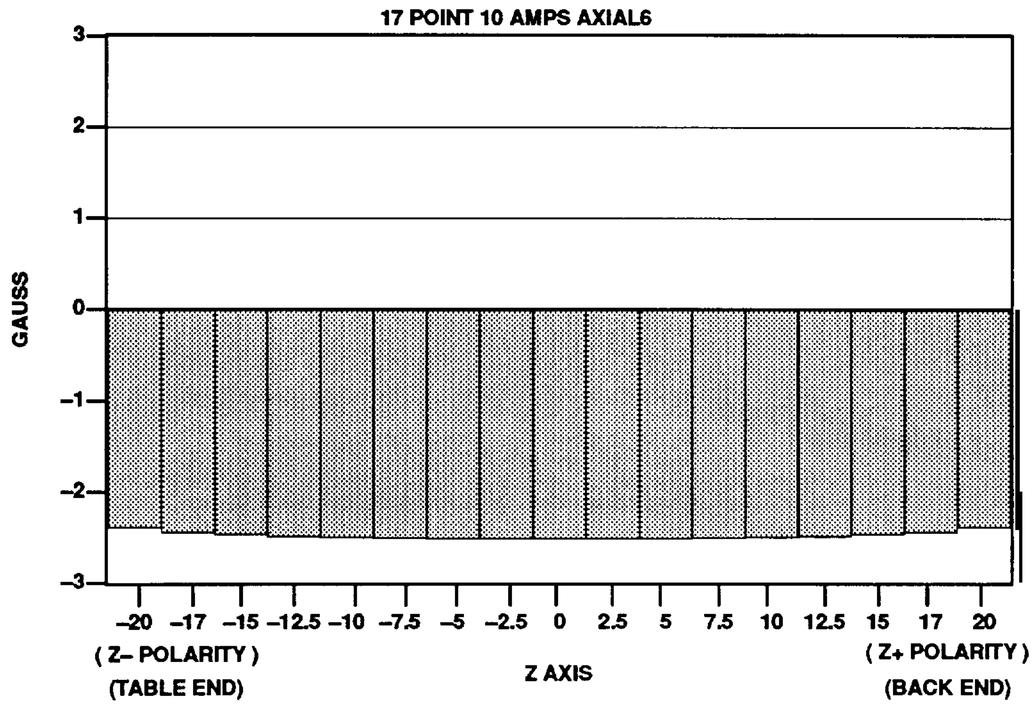




AXIAL 3 AND AXIAL 4 Correction COIL PLOTS
ILLUSTRATION 10-1 (CONTINUED)

NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.





AXIAL 5 AND AXIAL 6 CORRECTION COIL PLOTS
ILLUSTRATION 10–1 (CONTINUED)

10-2 TRANSVERSE CORRECTION COILS

1. After completing the Axial Coil Checks, dump any remaining current in the Correction Coils by turning on both the Axial and Transverse Switch Heaters for one minute.

2. Adjust the probe to the 15cm radius position.

3. Move the probe positioner to–20cm (towards the Table End). Rotate the probe plotter clockwise (as viewed from the Table End). Record the virgin field values at 0, 45, 90, 135, 180, 225, 270 and 315 degrees. Record the data in Table 10-2.

4. Move the probe positioner to 0 cm. Obtain and record the virgin field values at 0,45,90, 135, 180,225,270 and 315 degrees.

5. Move the probe positioner to +20 cm. Obtain and record the virgin field values at 0,45,90, 136, 180,225,270 and 315 degrees.

6. After all virgin HeId data in three planes (-20,0 and +20cm) has been taken, turn-on the Transverse and Axial Switch Heaters.

7. Allow the heaters to warm up for two minutes.

8. Ramp the T1–2 (C11 +) Power Supply to 10A and the T1-4 (C11-) supply to 6A.

9. Turn off the Axial and Transverse Odd and Even Switch Heaters. Allow the heaters to cool two minutes.

10. Ramp down the T1–2 (C11 +) and T1-4 (C11-) Power Supplies to **0** amps.

11. Move the probe (set to 15cm radius) to the -20cm axial location (Table End) and record data points at 0, 45, 90, 135, 180,55,270 and 315 degrees in Table 10-2.

12. Record the data at the same rotational degrees recorded in Step 11, with the probe at 0cm and then at +20cm along the Z-axis.

13. Take the data collected at each of these points (i.e., 0,45,90, 135, 180,225,270 and 315 degrees) and subtract the corresponding virgin field value from each point.

14. Compare the gauss differences with the plots in Illustrations 10-2.

Note

The lead connections for any individual coil could be reversed or could be interchanged with another coil. See Illustrations 1&7 and 10-8 for determining where wiring problems could occur.

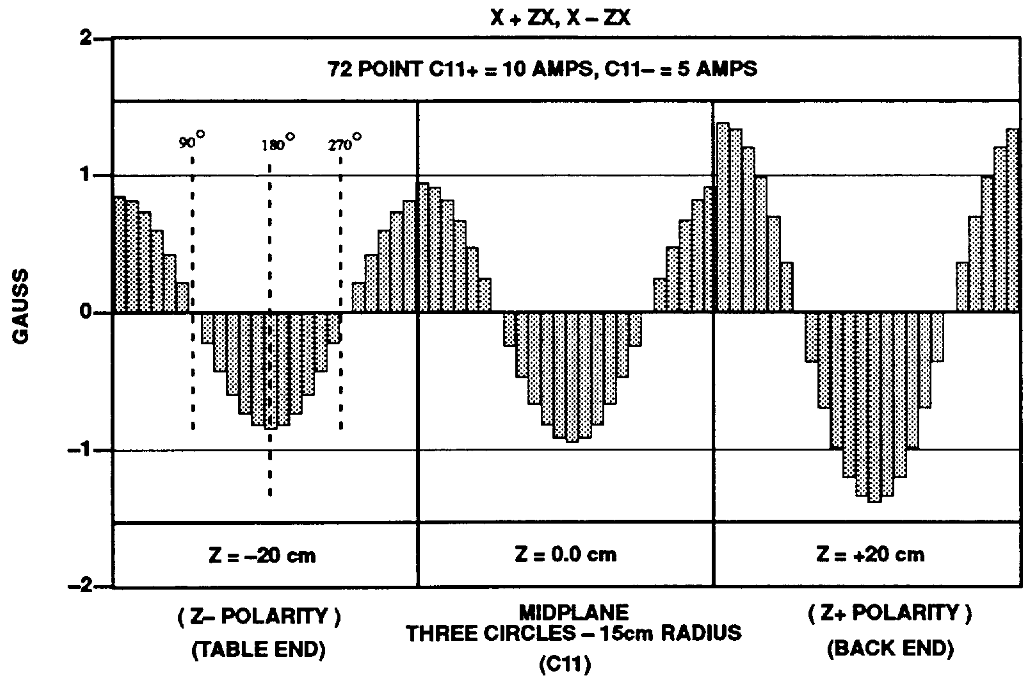
15. Turn on both the Axial and Transverse Switch Heaters and allow the heaters to warm up for 2 minutes.

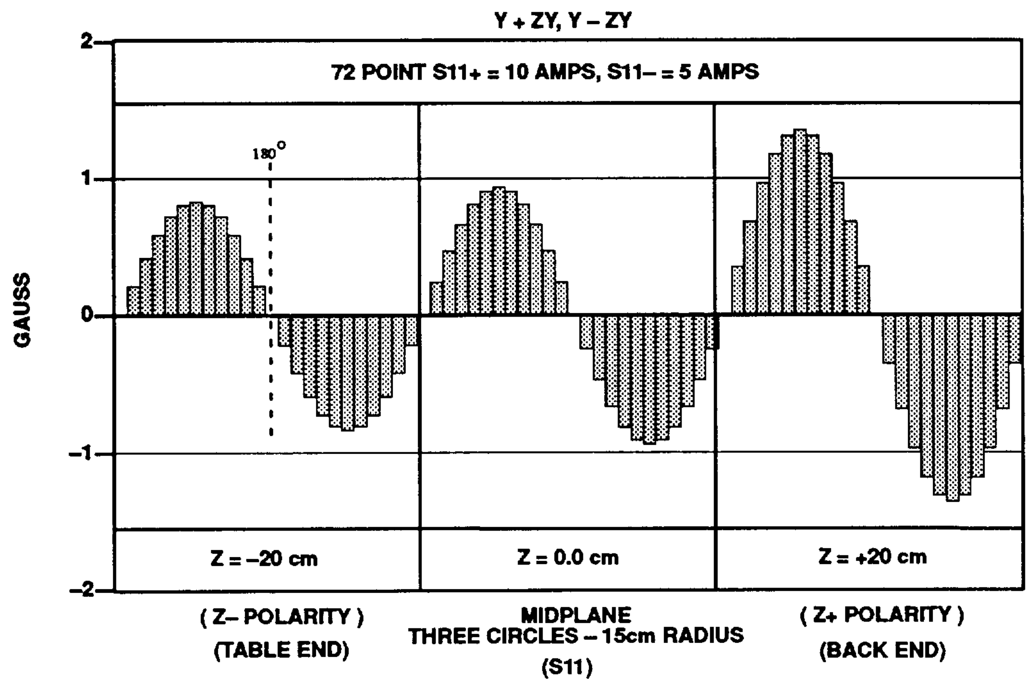
16. Repeat steps 8 – 15 for each of the Correction Coil configurations. Use the ampere values in Table 10-2.

TABLE 10-2
TRANSVERSE COIL DATA

CORRECTION COIL (CURRENT INPUT)	Z–AXIS	GAUSS READING (15.XXX.X)							
		0	45	90	135	180	225	270	315
VIRGIN	+20cm								
(0AMPS)	0cm								
	–20cm								
T1–2(C11+) = 10 AMPS	+20cm								
	0cm								
T1–4(C11–) = 5 AMPS	–20cm								
T2–2(S11+) = 10 AMPS	+20cm								
	0cm								
T2–4(S11–) = 5 AMPS	–20cm								
T1–3(C22+) = 10 AMPS	+20cm								
	0cm								
T1–5(C22–) = 5 AMPS	–20cm								
T2–3(S22+) = 10 AMPS	+20cm								
	0cm								
T2–5(S22–) = 5 AMPS	–20cm								
	+20cm								
T1–1(C31) = 10 AMPS	0cm								
	–20cm								
	+20cm								
T2–1(S31) = 10 AMPS	0cm								
	–20cm								
	+20cm								
T1–6(C33) = 10 AMPS	0cm								
	–20cm								
	+20cm								
T2–6(S33) = 10 AMPS	0cm								
	–20cm								

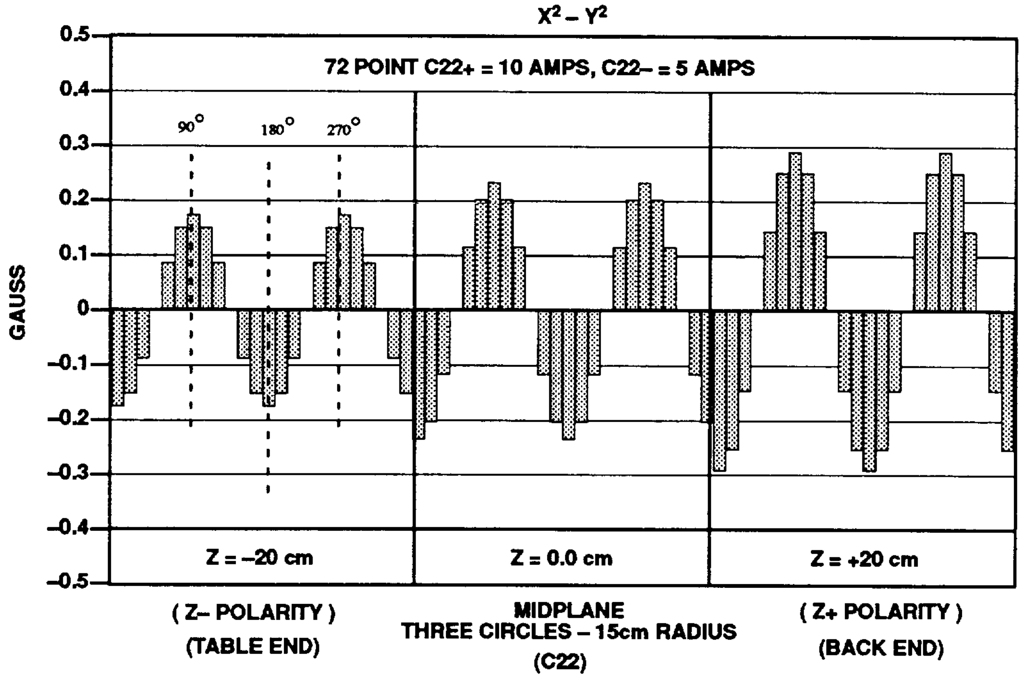
NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.

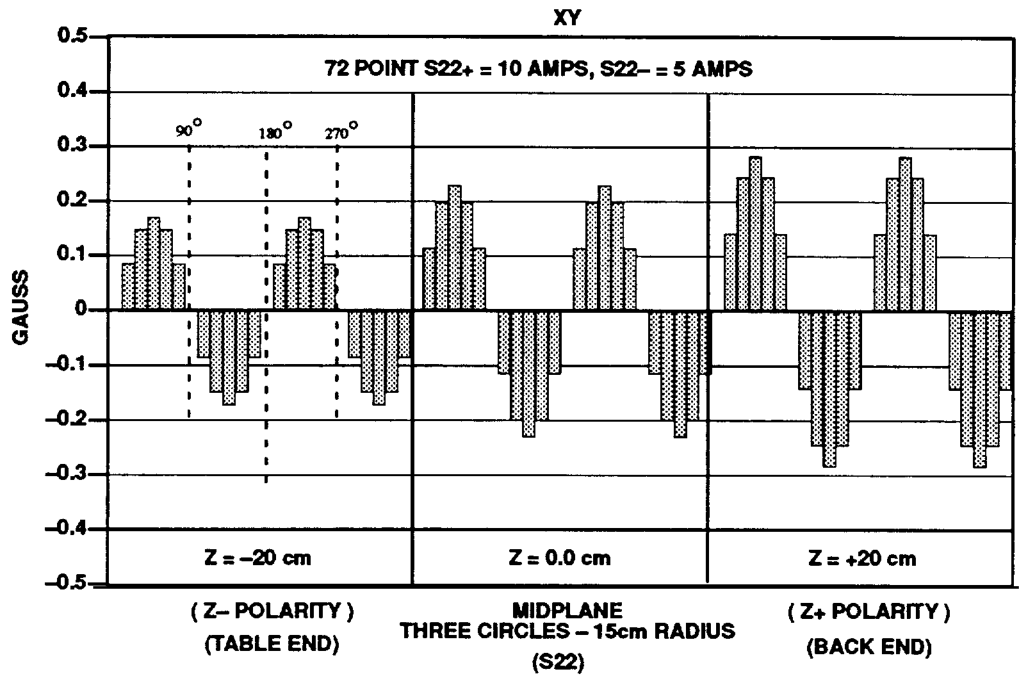




TRANSVERSE CORRECTION COIL PLOTS c11 AND S11
ILLUSTRATION 10-2

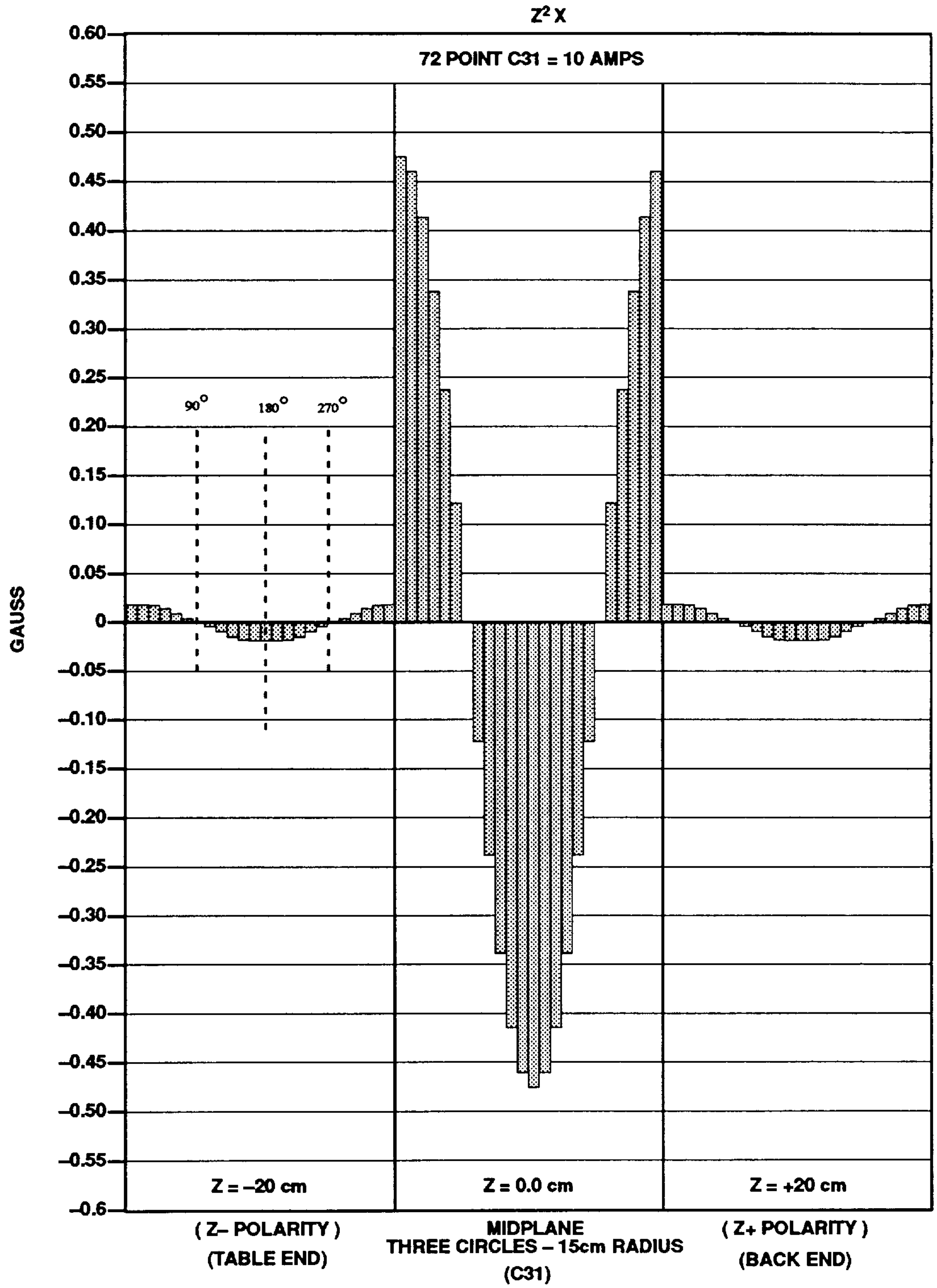
NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.





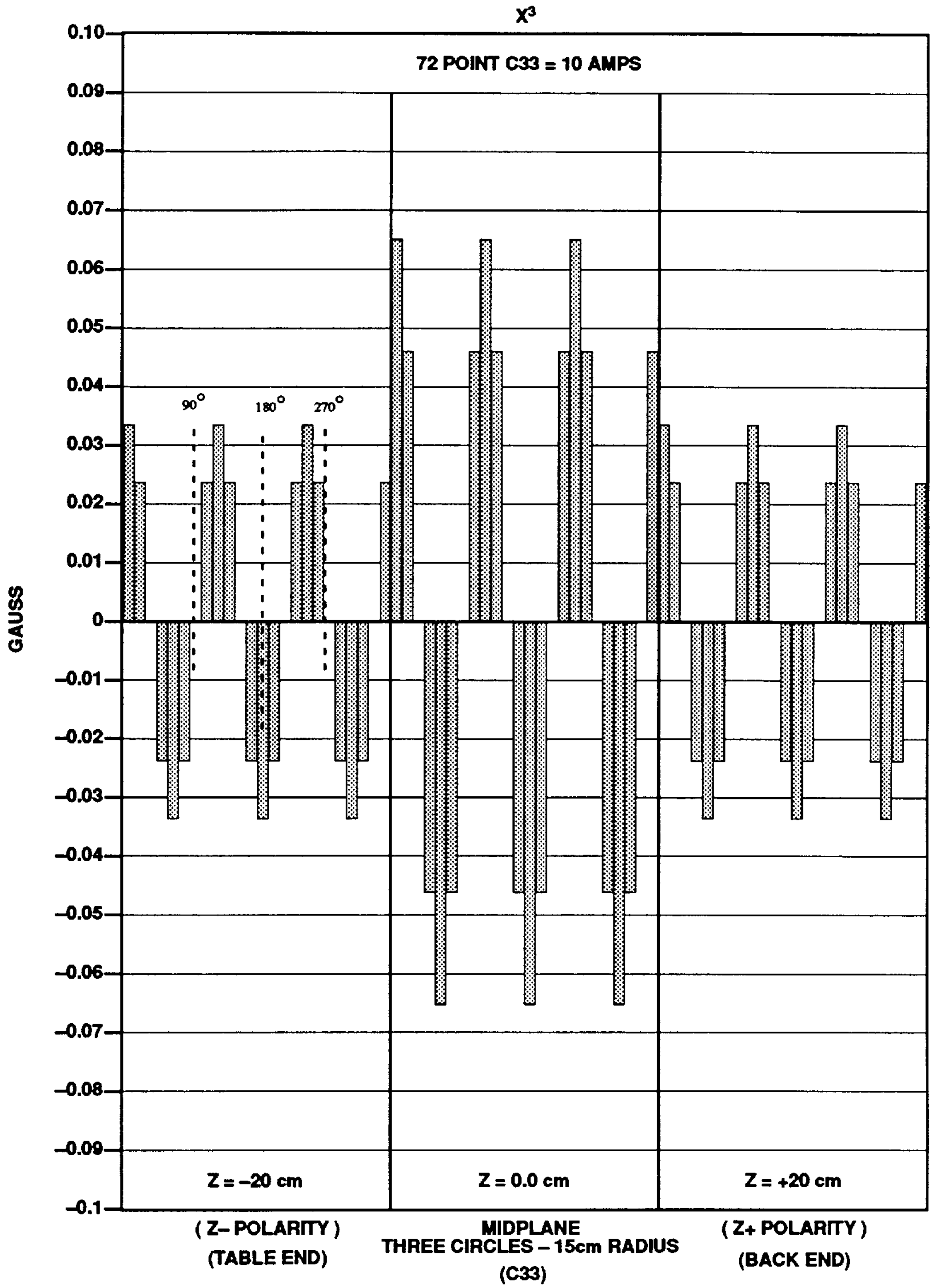
TRANSVERSE CORRECTION COIL PLOTS C22 AND S22
ILLUSTRATION 10-2 (CONTINUED)

NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.



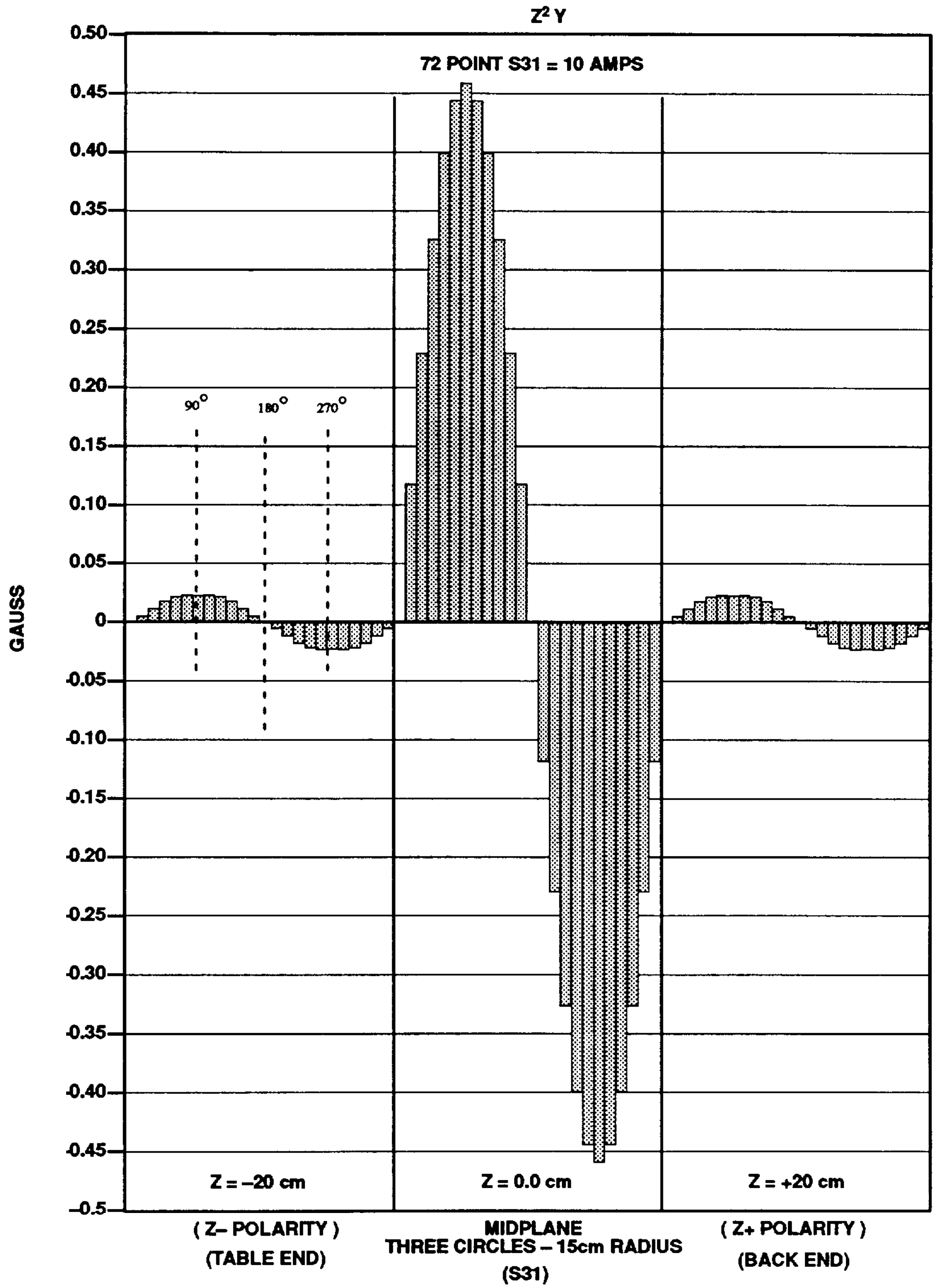
TRANSVERSE CORRECTION COIL PLOT C31
ILLUSTRATION 10-2 (CONTINUED)

NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.



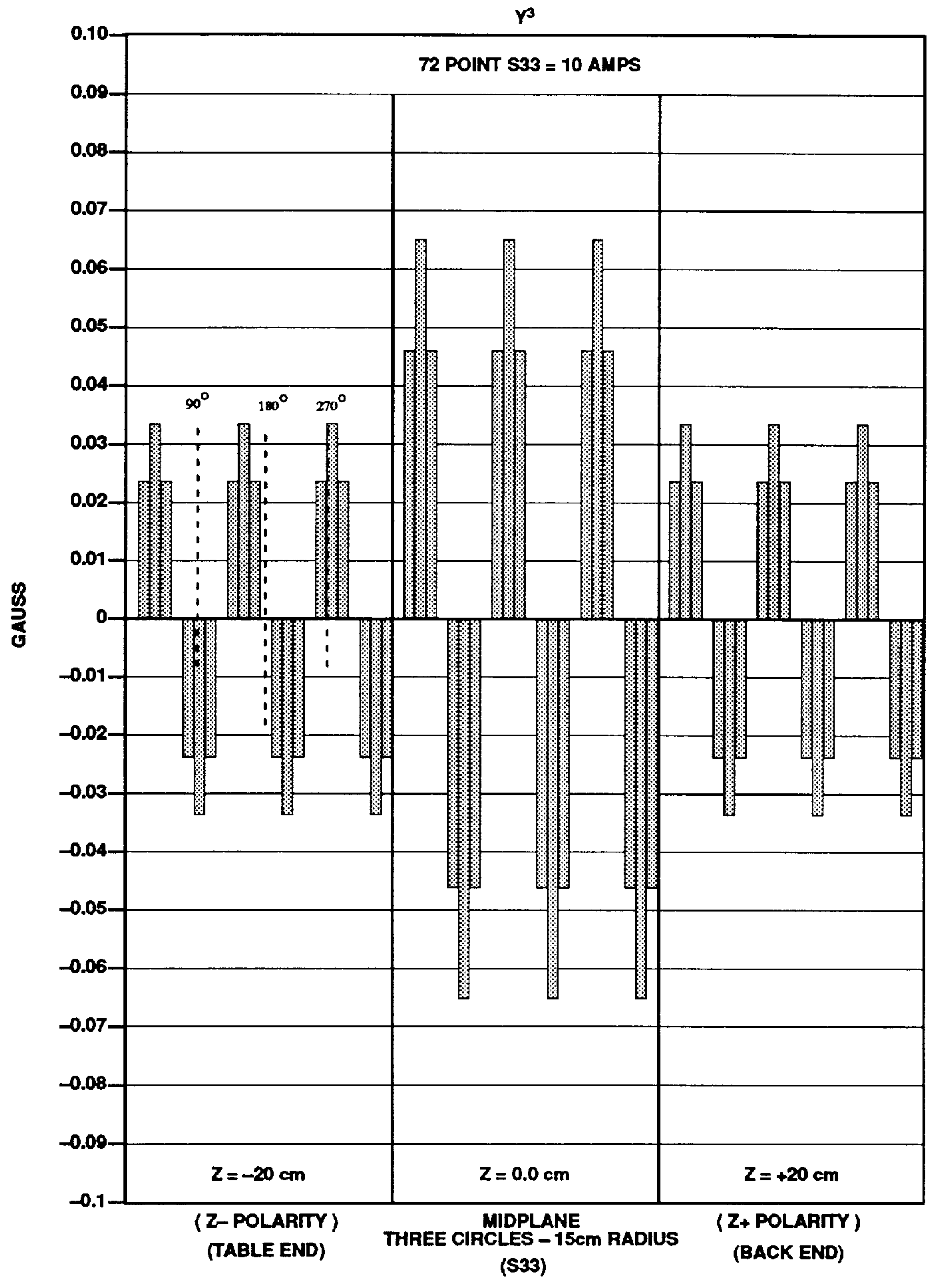
TRANSVERSE CORRECTION COIL PLOT C33
ILLUSTRATION 10-2 (CONTINUED)

NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.



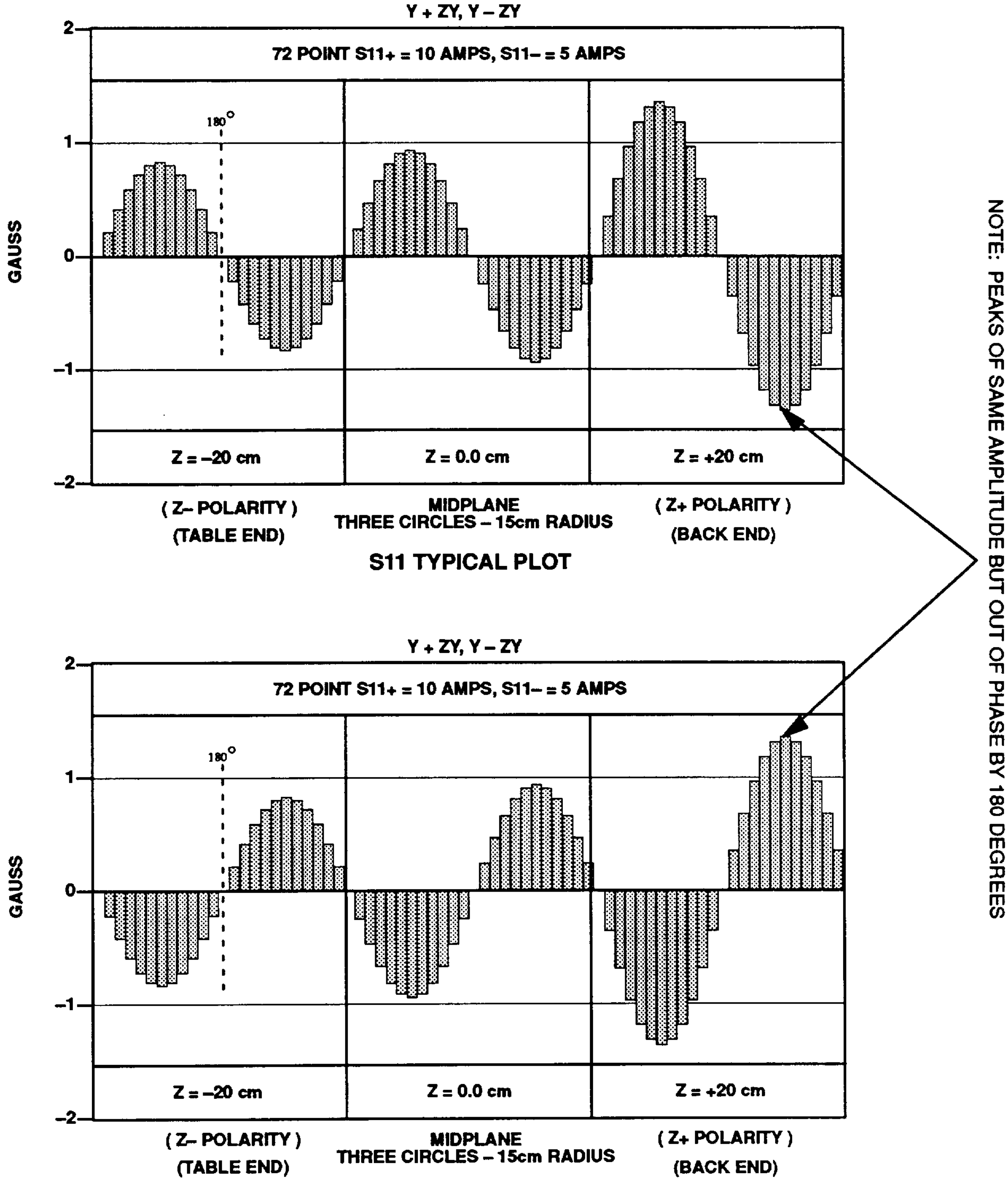
TRANSVERSE CORRECTION COIL PLOT S31
ILLUSTRATION 10-2 (CONTINUED)

NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.



TRANSVERSE CORRECTION COIL PLOT S33
ILLUSTRATION 10–2 (CONTINUED)

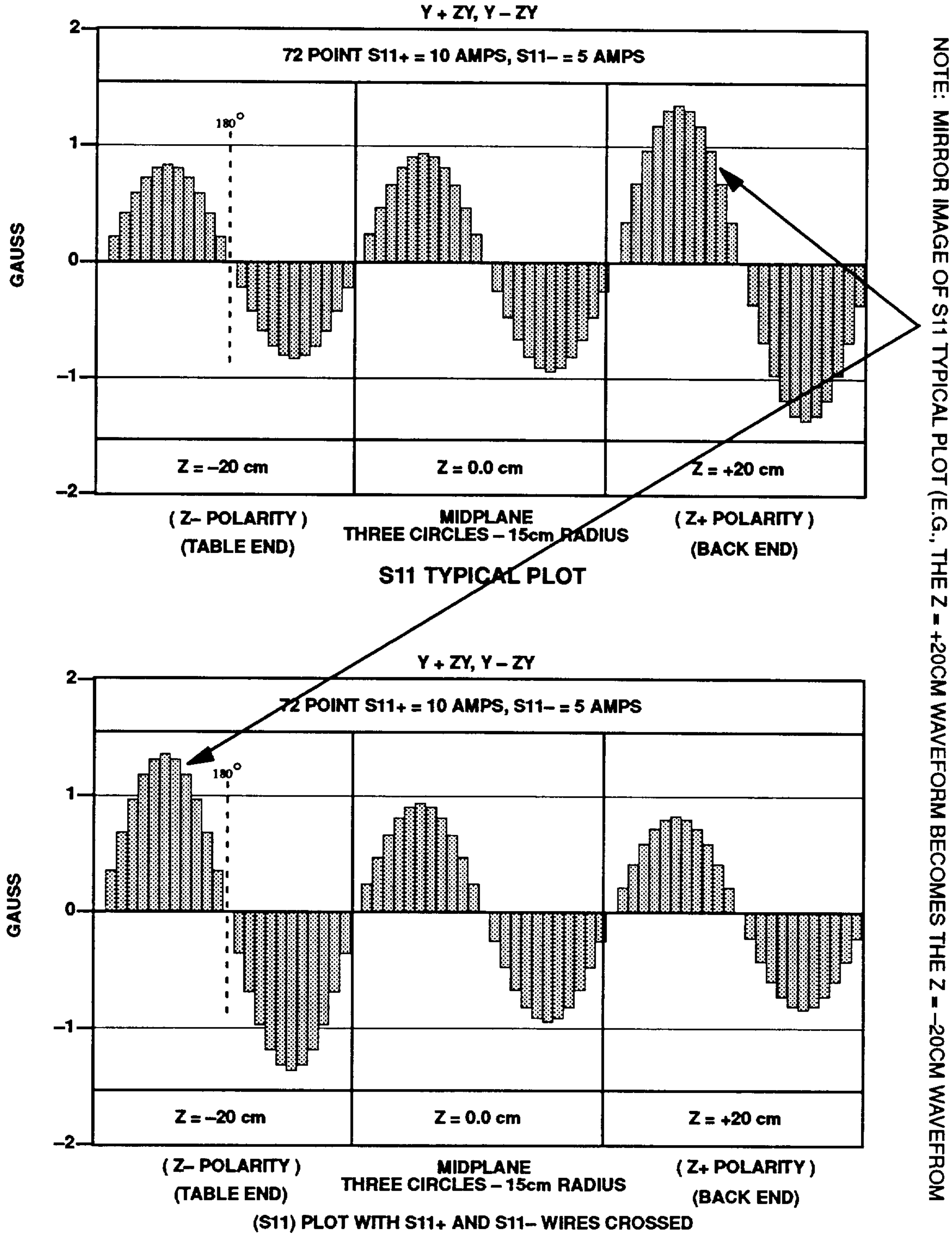
NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.



(S11) PLOT WITH REVERSED POLARITY (SOLUTION: SWAP + AND – COIL LEADS)

CORRECTION COIL WIRING PROBLEMS
ILLUSTRATION 10–3

NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.



CORRECTION COIL WIRING PROBLEMS
ILLUSTRATION 10–3 (CONTINUED)

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SECTION	TITLE	PAGE

11 FIELD ADJUSTMENT AFTER SHIMMING 11–1

SECTION 11- FIELD ADJUSTMENT AFTER SHIMMING

Note

If the magnetic field is outside the range of (5000.0–5002.0) Gauss (63.866-63.874 MHz) after the first shimming of the magnet, the following field adjustment is required. If the field is in the specified range, adjust flow rates in conformance with Steps 27 through 32 of this procedure.

WARNING!

A SUPERCONDUCTING MAGNET IS AN ENERGY STORAGE DEVICE CAPABLE OF DISCHARGING RAPIDLY DURING A QUENCH AND CREATING A VOLTAGE OF 100V OR MORE ACROSS THE MAIN LEADS AND EXTENSIONS.

ENSURE INPUT POWER TO THE MAIN POWER SUPPLY IS DISCONNECTED WHEN CONNECTING MAIN POWER LEADS AND THE POSITIVE AND NEGATIVE POWER LUGS DO NOT MAKE CONTACT.

1. **Calculate final field current required for the specified magnetic field in the above note. Base calculation on observed field after shimming and a change rate of 20 Gauss per 1.0 amp. ____________________ Final Field Current.**
2. **Connect the Main Power Supply to the magnet in conformance to Set Up and Calibration, Section 6.**
3. **Set Axial Shim Coil Currents in power supply to match currents in Axial Shims. See Table M in Set-Up and Calibration.**
4. **Turn on Axial Heater, verify heater current is 810+/-10mA. Allow two minutes for the heater to drive the switches resistive, then slowly reduce all axial shim currents to zero. Leave Axial Heater on.**
5. **Retrieve the latest magnet "PARKING CURRENT and "CONNECTION POLARITY" from Functional Checks, Table 8-4.**

SECTION 11 - FIELD ADJUSTMENT AFTER SHIMMING (continued)

6. Ensure “CURRENT” and “VOLTAGE” Controls are off (full CCW) and turn on Main **Power Supply.**

CAUTION

Axial Heaters must remain on during entire field adjustment procedure to prevent damage to Shim Coils.

7. **Perform the resistance check in Set Up and Calibration, Section 7-2.**

CAUTION

If a Quench occurs during change of magnetic field, Immediately turn “VOLTAGE CONTROL” and "CURRENT CONTROL" to zero.

8. Turn "VOLTAGE CONTROL" on Main Power Supply to maximum.

WARNING!

ENSURE THAT THE CONNECTION POLARITY AND CURRENT SET ARE THE SAME AS THE LAST RECORD IN TABLE 8–4 OF FUNCTIONAL CHECKS. THE MAIN POWER SUPPLY MUST BE SET TO THE SAME CURRENT AND POLARITY IN THE MAIN COILS TO AVOID A QUENCH WHEN TURNING ON THE MAIN SWITCH.

9. Engage "SET POINT" button and set "CURRENT CONTROL" to pass the same current as retrieved in Replacement/Maintenance, Section 3–1, Step 4, through the persistent Main Switch.
10. Turn on Main Switch Heater. Leave the Axial Shim Switch Heater Supply on.
11. Allow approximately 1 minute for the Main Switch to go normal.
12. When the Main Switch is normal, gradually turn the "CURRENT CONTROL" to obtain final field calculated in Step 1.
13. Turn off the Main Switch Heater.
14. Wait 7 minutes for the Main Switch to fully cool before touching the “CURRENT CONTROL”.
15. Record the current value at which the switch went “persistent” in Functional Checks, Table 8–4.

SECTION 11 - FIELD ADJUSTMENT AFTER SHIMMING (continued)

16. Turn the “CURRENT CONTROL” (CCW) gradually to 0, over 1 minute. Turn off Axial Heaters and Power Supply. Disconnect input power.

17. Turn the “VOLTAGE CONTROL” (CCW) to 0.

18. Connect Shim Power Supply to the magnet in conformance with Set Up and Calibration, Section 6.

CAUTION

Ensure Shim Leads are vented and frosted before setting final Axial Shim Currents in Step 19.

19. Turn on Axial Shim Heaters, remove Shim Lead Vent Cap and set the final Axial Shim Currents from the Shim Program.

20. Turn off Axial Shim Heaters.

21. Wait 2 minutes and turn Axial Shim Current Controls on the Shim Coil Power Supply gradually to 0 (CCW).

22. Turn off Shim Coil Power Supply.

23. Disconnect Input Power to Shim Coil Power Supply.

24. Disconnect all leads from Power Supplies and magnet.

CAUTION

Ensure that the Shim Power Supply Is not connected to the magnet.

25. Remove Power Lug Extensions on magnet and replace plugs and Shim Lead Vent Cap. Leak Check Plugs and cap to ensure no leaks are present.

26. Check final field and remap magnet to check shimming.

CAUTION

Cryostat exhaust flow rates and pressure must be checked and adjusted as required after magnet Installation, ramping and shimming to ensure that proper cooling conditions are maintained and no leaks are present in the Helium Exhaust System or Vent Valve (V2).

27. Open Vent Valve (V2) to de-pressurize the Cryostat to 0.25 psig. Close V2.

SECTION 11 - FIELD ADJUSTMENT AFTER SHIMMING (continued)

Note

Read all flow rates from the bottom of the float (ball) on the flow meters.

Note

Flow rates may be temporarily elevated after ramping/shimming. Allow the magnet time to stabilize before adjusting them.

28. Set Flowmeter (F1) between 0.4-0.6 SCFH.
29. Set Flowmeter (F2) between 1.5–2.0 SCFH to maintain a Cryostat Pressure Gauge reading between 0.25 – 0.50 psig.
30. Ensure flow rate through F2 is equal or greater than 1.5 SCFH.
31. If flow rate through F2 is less than 1.5 SCFH or the pressure gauge reads less than 0.25 psig, pressurize the vessel and “bubble test” all exhaust plumbing joints, relief valve and Shim Lead Connector. Ensure V2 is fully closed. Repair any leaks. If a 1.5 SCFH flow rate through F2 cannot reachieved, under the above conditions, contact your Region Magnet Service Engineer.
32. Ensure the following conditions are maintained. Re-check settings in three days and again after one week:

    FLOW METER (F1) = 0.4–0.6 SCFH
    FLOW METER (F2) > 1.5–2.0 SCFH
    CRYOSTAT GAUGE PRESSURE - 0.25-0.50 psig.

GE MAGNET RIGGING

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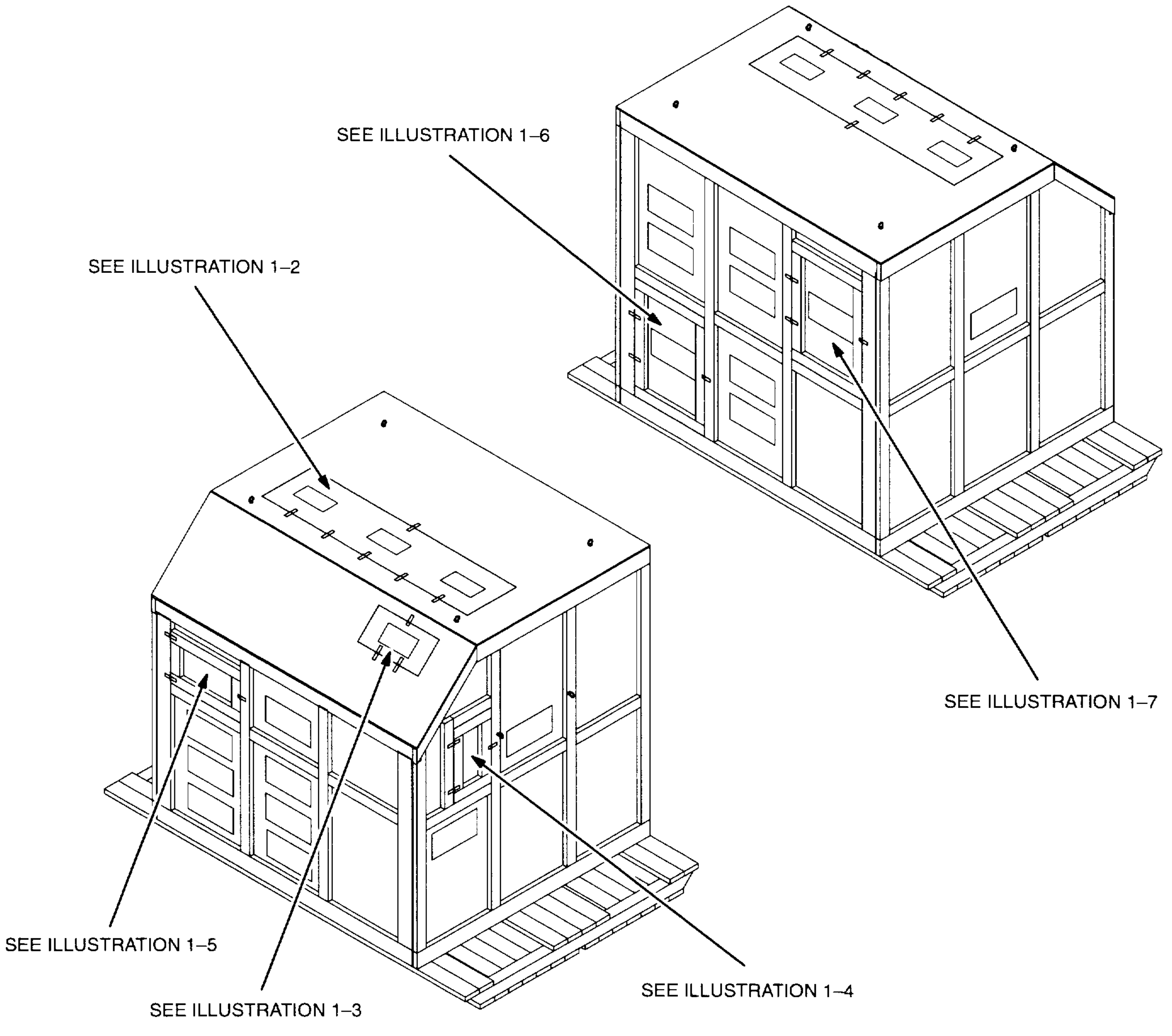
	1–1 INTRANSIT SERVICE	1–1
	1–2 SHIPPING / HANDLING	1–5
	1–3 UNLOADING / LOADING MAGNET AND CRATE	1–6
	1-4 PRE–DELIVERY INSTRUCTIONS	1–8

SECTION 1 – SHIPPING/ DELIVERY INSTRUCTIONS

1–1 INTRANSIT SERVICE

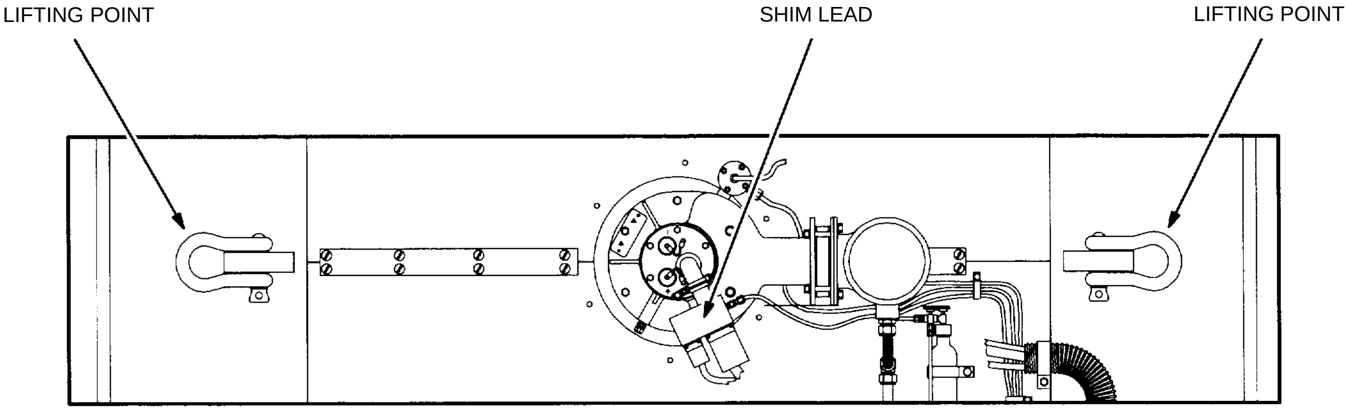
Note

The following information outlines provisions for filling and electrical / temperature checks while magnet is still in shipping crate. This will enable required service to be performed in transit based upon magnet shipping date. The following Illustrations (1–1 through 1–7) show the magnet configuration behind each shipping crate access door, Access doors and hinges not shown for clarity.

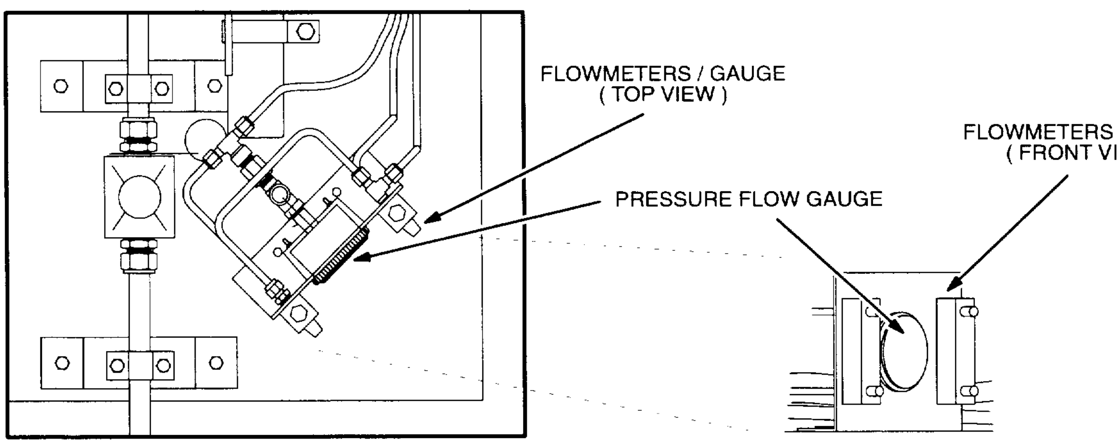


ACCESS DOOR LABELING ON CRATE
ILLUSTRATION 1–1

1-1 INTRANSIT SERVICE (continued)

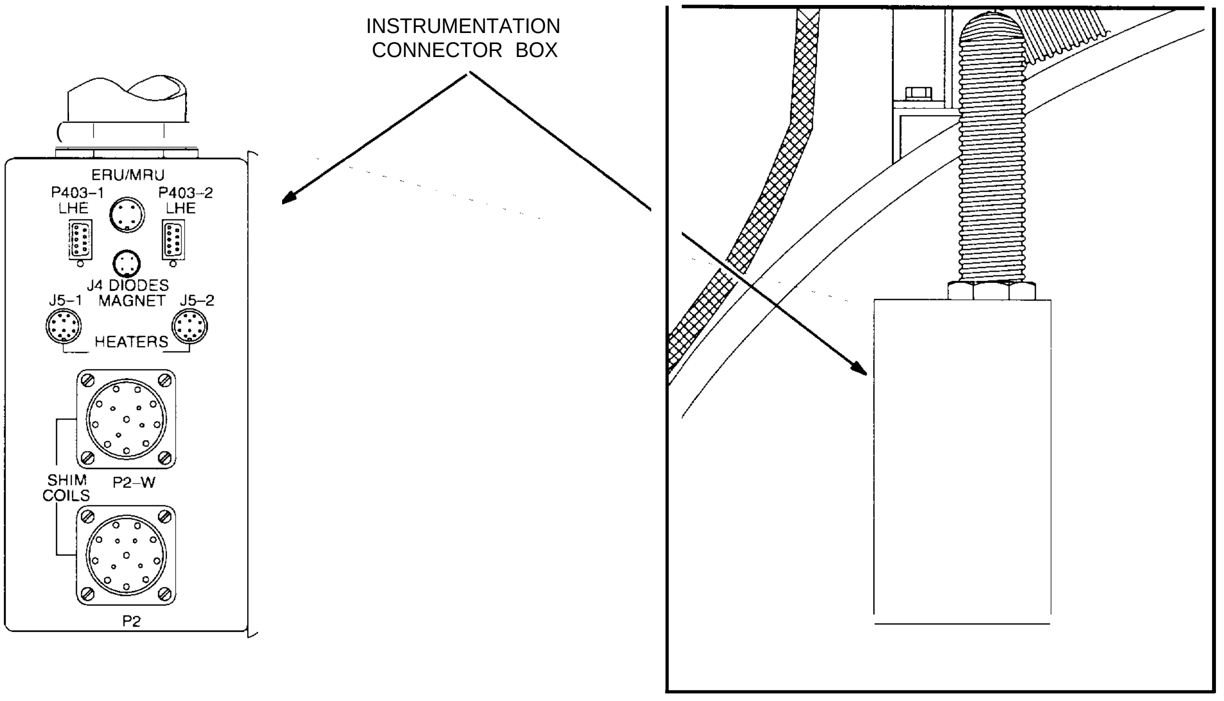


TOP ACCESS DOOR LABELED "LIFTING POINT" AND "SHIM LEAD ACCESS"
ILLUSTRATION 1–2

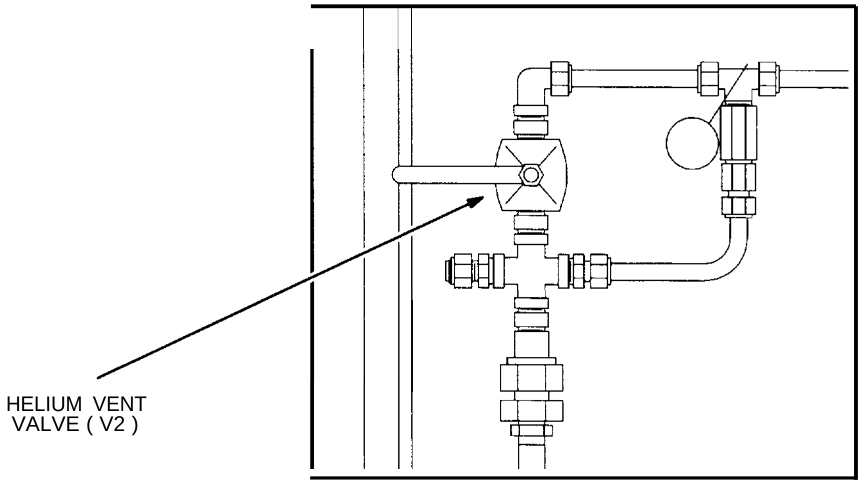


TOP ACCESS DOOR LABELED "PRESSURE FLOW GAUGE ACCESS"
ILLUSTRATION 1–3

1-1 INTRANSIT SERVICE (continued)

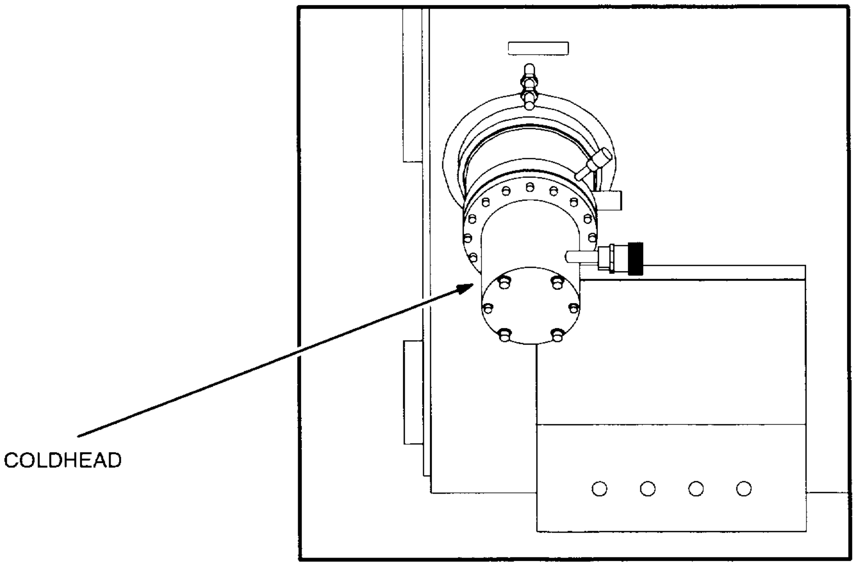


FRONT ACCESS DOOR LABELED “INSTRUMENT CONNECTOR”
ILLUSTRATION 1-4

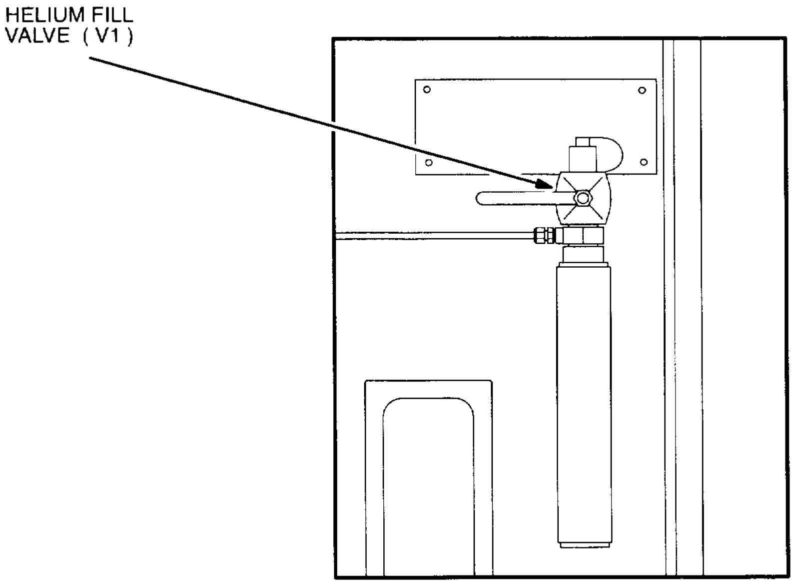


RIGHT SIDE ACCESS DOOR LABELED “V2 VENT PORT”
ILLUSTRATION 1–5

INTRANSIT SERVICE (continued)



LEFT SIDE ACCESS DOOR LABELED "COLD HEAD ACCESS"
ILLUSTRATION 1–6



LEFT SIDE ACCESS DOOR LABELED "VI HELIUM FILL ACCESS"
ILLUSTRATION 1–7

1–2 SHIPPING / HANDLING

CAUTION

Shipping and handling guidelines are provided in Table 1.

These guidelines must be followed to prevent any potential damage to the magnet during shipping and handling.

Review guidelines with Shipper / Riggers prior to transporting magnet.

TABLE 1
MAGNET SHIPPING AND HANDLING INFORMATION

MAGNET	MAXIMUM WEIGHT	*** MAXIMUM TILT	(1) ALLOWABLE SHIPPING MODES	(2) FORKLIFT CAPABILITY
SII & SIII	*SII = 21,000 lbs. **SIII = 18,300 lbs.	30 deg.	A, T, Tr, B	Yes

MAGNET	SHIPPING CAPABILITY	(3) MAXIMUM TRANSIT TIME	MAXIMUM SHOCK LOADS	COMMENTS
SII & SIII	Cold	21 days	2 G's	See Notes

* Includes weight of Shipping Crate (2,200 lbs.)

** Includes weight of Shipping Crate (2,200 lbs.) and Gradient Coil (900 lbs.)

*** Tilt allowed when suspended by Lifting Shackles.

Notes:

1. Key for Shipping mode symbols:
   "A" Airplane (including any plane that has fuselage openings large enough to accept a magnet)
   "T" Air ride Trailer (Any magnet transported on a non–air ride trailer must be identified and never used in a Mobile trailer.)
   "Tr" Train
   "B" Boat or ocean going ship

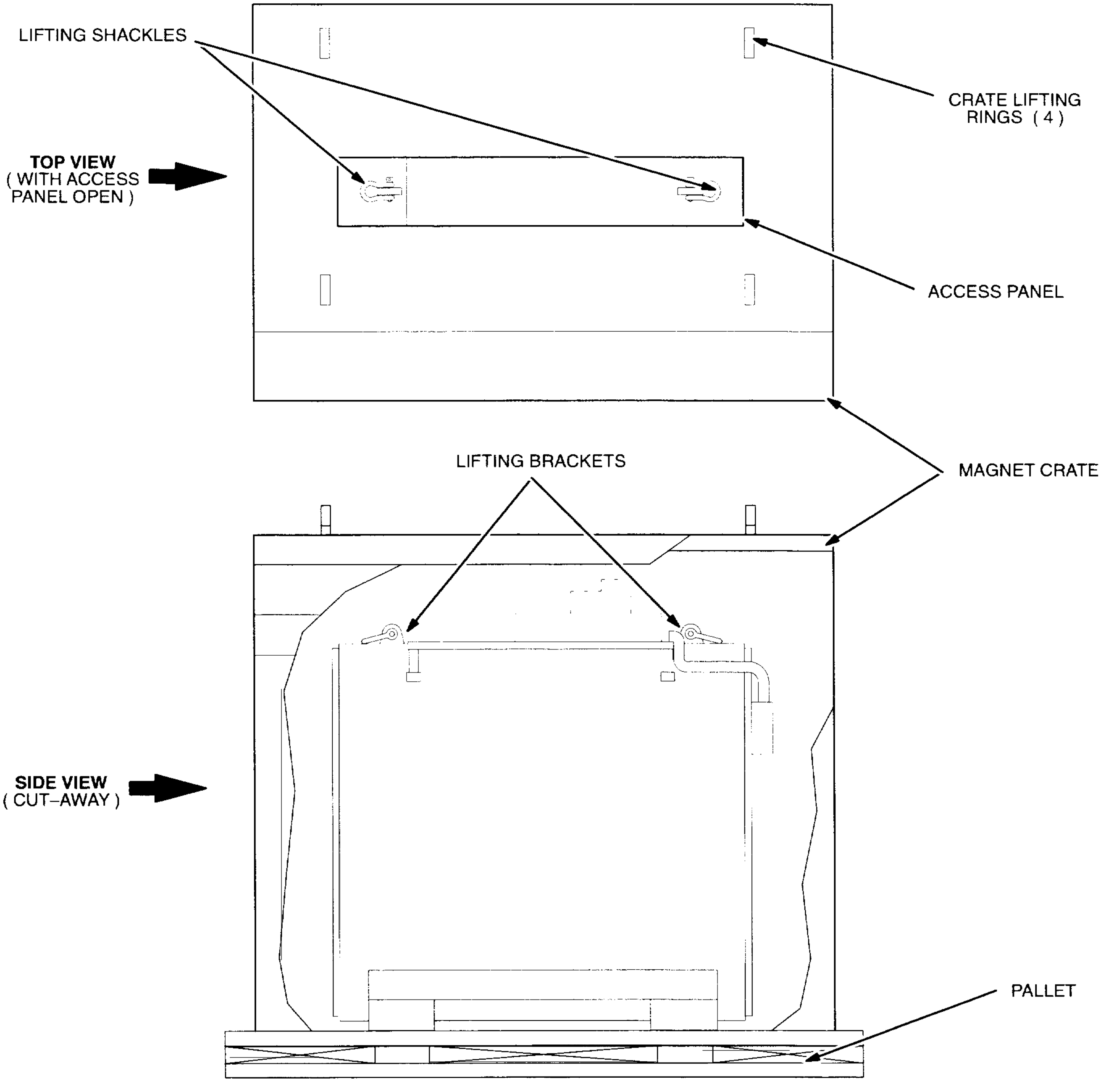
2. Extreme care must be exercised during forklift operations. The magnet pallet / crate must be picked up from the sides only. The forks MUST be placed directly under the four (4) feet of the magnet. The magnet feet can be identified by the steel plates attached to the pallet.

3. The elapsed time begins when the magnet leaves the Florence loading dock.

1–3 UNLOADING / LOADING MAGNET AND CRATE

Note

Lifting Shackles and Brackets are provided for magnet unloading / loading. See Illustration 1–8. Shackle / Bracket access panel is provided, as shown in Illustration 1–8, for crated magnets.

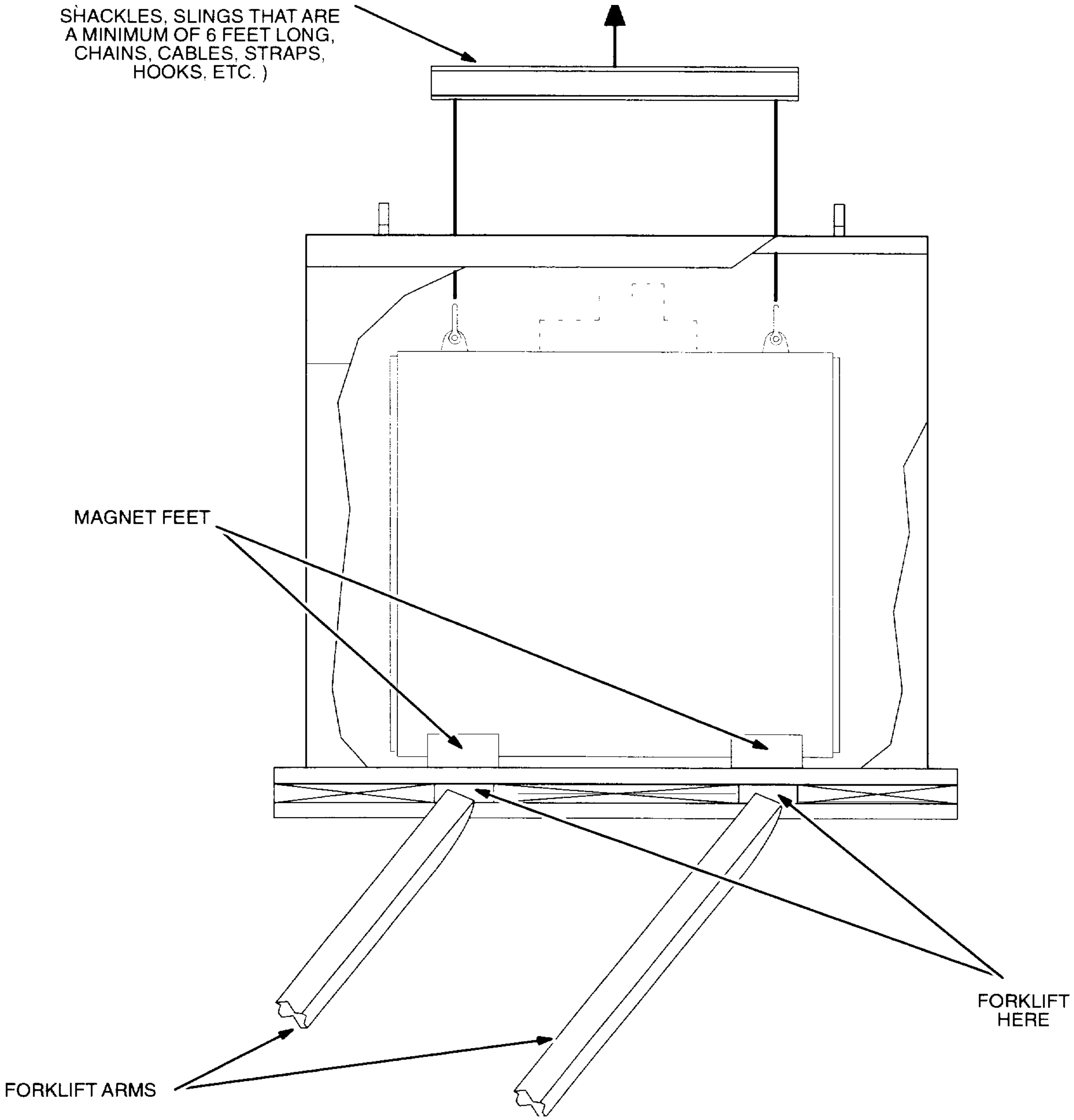


ACCESS PANEL, SHACKLE AND BRACKET LOCATIONS
ILLUSTRATION 1–8

1–3 UNLOADING / LOADING MAGNET AND CRATE (continued)

CAUTION

Extreme care must be exercised during forklift operations. The magnet crate must be picked up from the sides only. The forks MUST be placed directly under the four (4) feet of the magnet. The magnet feet can be identified by the steel plates attached to the pallet. Do not lift crate with straps fed through the pallet. This will crush the crate.



FORKLIFT / CRANE LIFTING OPERATIONS
ILLUSTRATION 1–9

1–3 UNLOADING / LOADING MAGNET AND CRATE (continued)

1. Position the Crane Hook centrally over the crated magnet to ensure a vertical lift force on the Lifting Brackets.

CAUTION

It is important to lift the magnet smoothly to avoid impact or jolts to the system which may damage the magnet.

2. Attach the rigging to the lifting shackles at each end of the crated magnet.

Note

Any combination of spreader beam, shackles and / or slings, 6 foot (1829 mm) minimum length, which can support a minimum of 21,000 pounds (9,938 Kg) for SII or 18,300 pounds (8,301 Kg for SIII may be used.

3. Lift crated magnet with crane to clear trailer.
4. Lower the crated magnet onto a flat surface.

1–4 PRE–DELIVERY INSTRUCTIONS

CAUTION

Make sure ALL site requirements / conditions, identified for the magnet in the site planning manual, are met before scheduling magnet delivery.

This will prevent installation delays, cryogen loss and resultant ongoing magnet quenches, potential damage, environmentally related problems and increased costs.

WARNING!

MAKE SURE BOTH MAGNET AND ROOM VENTING SYSTEMS ARE INSTALLED IN THE MAGNET ROOM, IN CONFORMANCE WITH THE SITE PLANNING MANUAL (REV. 4 AND ABOVE), PRIOR TO BRINGING THE MAGNET INTO THE ROOM. LARGE QUANTITIES OF GASEOUS HELIUM ARE DISCHARGED FROM THE MAGNET DURING INSTALLATION AND COMMISSIONING ACTIVITIES, WHICH WILL REQUIRE EXHAUSTING TO PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5-3 OF THE INTRODUCTION (CRYOGEN SAFETY).

1. Visit magnet site with rigging foreman before magnet delivery to plan the move.
2. Caution rigger that the magnet is extremely fragile. Sudden jolts can damage the magnet. Riggers aware of the cost of a magnet and its replacement usually use more care while handling magnet.
3. Ensure all roads and paths leading to exam room are level and free from obstacles and holes. Rigger will be required to construct platforms where needed.
4. If Roller Skids are to be used, have rigger bring eight steel plates, 36 in. x 12 in. x 0.25 in. (915 mm x 305 mm x 6.4 mm), to place along delivery route.
5. Mark the magnet location on the floor before delivery. Refer to architectural drawings.

GE MAGNET RIGGING

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SECTION	TITLE	PAGE
2	UNCRATING MAGNET SYSTEM	2–1

SECTION 2 – UNCRATING MAGNET SYSTEM

Note

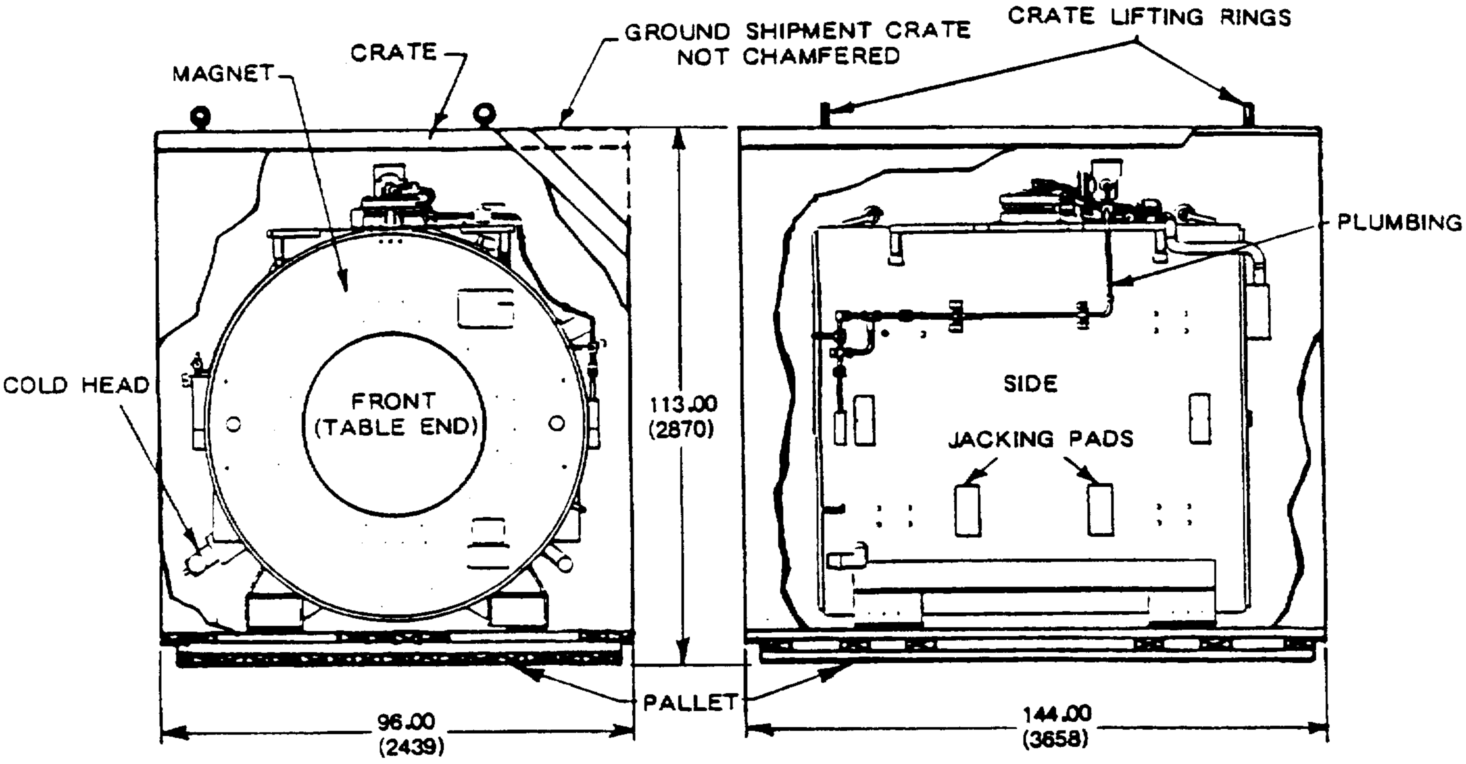
Magnet shipments within the USA have a protective wrap and tarpolian cover in place of a crate. Disregard Section 2 and remove cover for magnet shipments within the USA.

1. Remove all subsystem crates from low–boy trailer using a crane or forklift. Inspect all crates for visible damage.
2. Move subsystem crates to a receiving location protected from the weather, preferably in proximity of the examination room and on the same level.
3. Inspect the crate containing the magnet and identify the crate side marked, “ REMOVE THIS SIDE FIRST” This designated side is to be removed first. See Illustration 2–1 for crate dimensions.
4. Position crane centrally over this designated crate side,
5. Connect crane to the two lifting rings located near the top of the crate side marked “Remove This Side First” using a sling and shackles supplied by riggers. Tighten the sling snug, See Illustration 2–2.
6. Remove lag screws securing the face of the crate marked “REMOVE THIS SIDE FIRST” . See Illustration 2–2.
7. Lift crate side with crane and clear from the area.
8. Secure four one ton (900 Kg) working load slings, minimum 6 foot length (1829 mm), to four lifting rings assembled to the top corners of crate, Using one ton (900 Kg) anchor shackles,
9. Position crane centrally over top section of the crate and attach slings to crane hook.
10. Remove lag screws only from the bottom portions of the three remaining crate sides. See Illustration 2–3.
11. Lift crate carefully using crane and clear crate from shipping skid containing magnet.

CAUTION

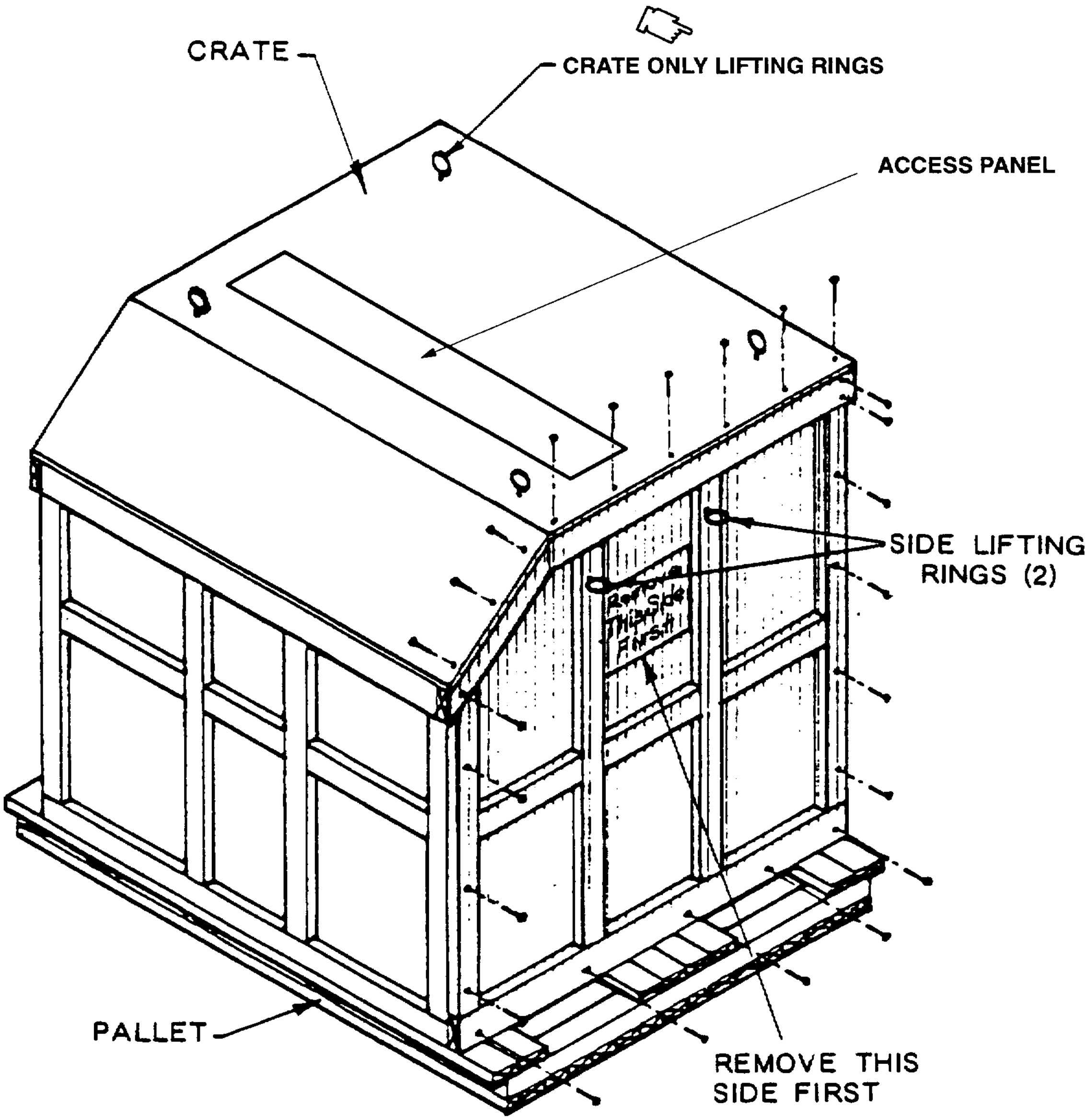
Make sure that the crate does not swing and hit the Magnet Cold Head or Plumbing during the lifting process.

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)

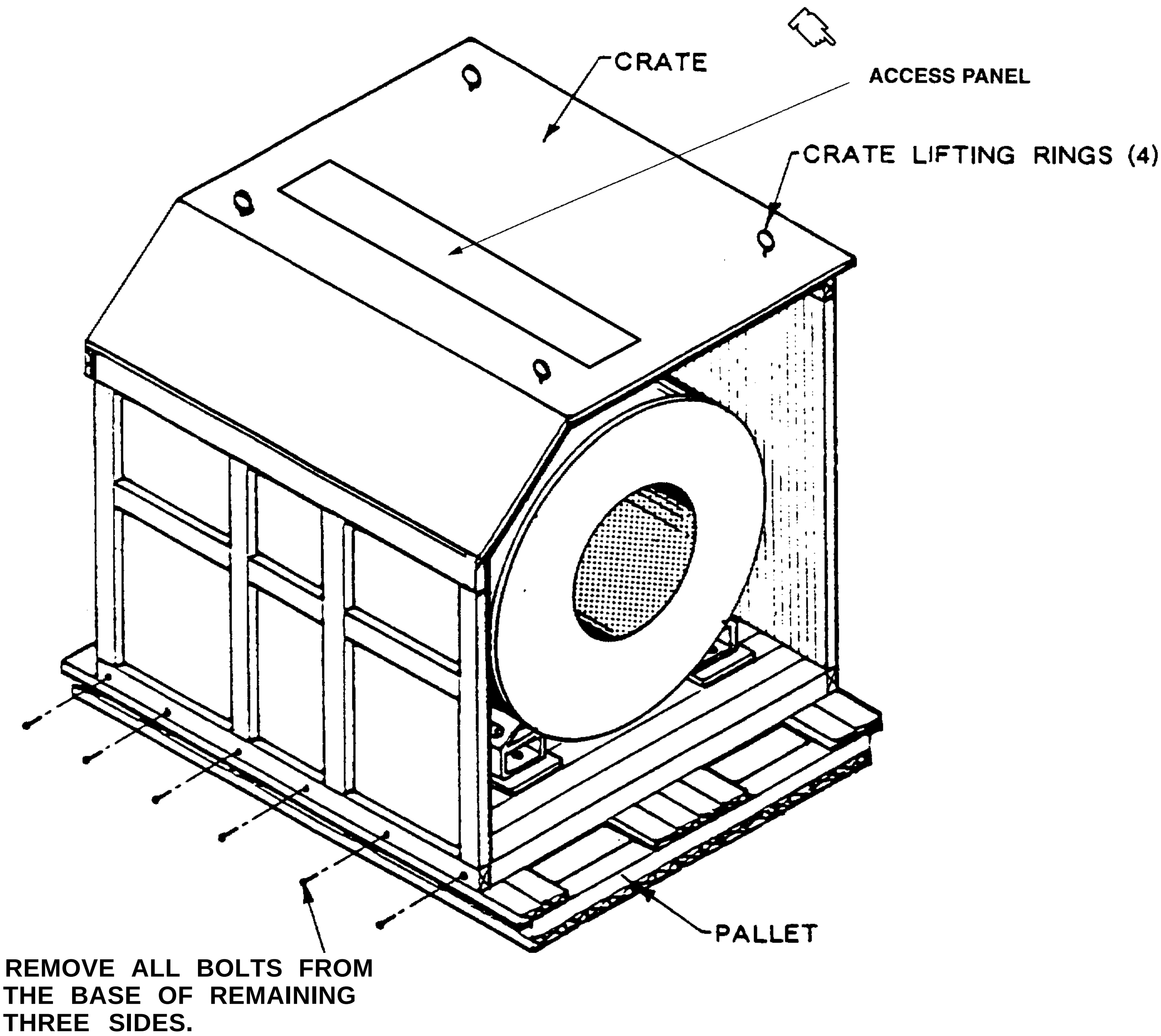


MAGNET CRATE
ILLUSTRATION 2–1

NOTE:
MAGNET LIFTING SHACKLES ARE LOCATED UNDER THE ACCESS PANEL DOOR



MAGNET CRATE FACE LAG SCREW REMOVAL
ILLUSTRATION 2–2



MAGNET CRATE FACE LAG SCREW REMOVAL
ILLUSTRATION 2–3

GE MAGNET RIGGING

TABLE OF CONTENTS

SECTION	TITLE	PAGE

3 MAGNET SYSTEM COMPONENT CHECK 3–1

SECTION 3- MAGNET SYSTEM COMPONENT CHECK

CAUTION

It Is important to establish If any damage was sustained by the magnet or Its system components during delivery or if any components are missing. This will result In the fast, proper follow-up of any problems and a timely installation.

1. Locate the Pre-Delivery Information Package shipped with the magnet which contains the (Bill of Material) for the magnet system delivered. Cheek that all boxes indicated are present.
2. Check the contents of each box against its packing list when the boxes are brought into the MR Site.
3. Inspect the magnet for damage and condensation / icing.
4. Perform the Magnet Circuits Resistance Checks identified in Table 3-1, “MAGNET CIRCUITS RESISTANCE CHECK COLD (4.2K)“ and Table 3-2“ SHIM LEAD CHECKS”.
5. If any magnet problems found, check Liquid Helium Level of the magnet.
6. Report any damage found in compliance with the “Damage In Transportation” note on the back side of the Service Manual Title Page.
7. Report all problems found to the Regional Magnet& Cryogenics (MAC) Team Leader. Report all missing components to the person identified on the Magnet Component Bill of Material.

TABLE 3-1
MAGNET CIRCUITS RESISTANCE CHECK COLD (4.2 K)

			RESISTANCE (OHMS)	
FUNCTION	CONNECTOR	PIN #	ACCEPT. RANGE	MEASURED
MAIN COIL	MAIN COIL PWR LUGS	+ –	0 – 0.5	
SUPERCONDUCTING SHIM COILS	CANNON (P1A) AT MGT. VERT. STACK		0 – 0.5	
Z1		1, 19		
Z2		2, 20		
Z3		3, 21		
Z4		4, 22		
Z5		5, 23		
Z6		6, 24		
C11+		16, 19		
C11–		17, 20		
C22+		14, 21		
C22–		15, 22		
S11+		9, 19		
S11–		10, 20		
S22+		7, 21		
S22–		8, 22		
C31		13, 23		
S31		11, 23		
C33		18, 24		
S33		12, 24		
SUPERCONDUCTING SWITCH HEATERS MAIN SWITCH	J 5–1 & J 5–2 ON MGT. TERMINAL BOX (MS1–A3, A1)	1, 2	5.9 – 8.0 or 20.5 – 25.0	
AXIAL SHIMS		5, 6	* 25.5 – 31.0	
TRANSVERSE 1		7, 6	6.1 – 8.0	
TRANSVERSE 2		8, 6	6.1 – 8.0	

• Early units have switch heaters resistance values of 19.0 -25.0 ohms.

TABLE 3-2

SHIM LEAD CHECKS

LEAD TO LEAD SHORTS

PINS PI A Connector Vertical Stack	ACCEPTABLE RANGE	MEASURED
19 to 20	Greater Than 16 Kilo ohms	
19 to 21	↓	
19 to 22		
19 to 23		
19 to 24		
20 to 21		
20 to 22		
20 to 23		
20 to 24		
21 to 22		
21 to 23		
21 to 24		
22 to 23		
22 to 24		
23 to 24	Greater Than 16 Kilo ohms	

LEAD TO GROUND SHORTS

PINS P1 A Connector Vertical Stack	ACCEPTABLE RANGE	MEASURED
19 to ● GROUND	Greater Than 16 Kilo ohms	
20 to ● GROUND	↓	
21 to ● GROUND		
22 to ● GROUND		
23 to ● GROUND		
24 to ● GROUND	Greater Than 16 Kilo ohms	

● GROUND DEFINED AS SHIM LEAD COVER

GE MAGNET RIGGING

TABLE OF CONTENTS

SECTION	TITLE	PAGE
4	REMOVING THE MAGNET FROM THE SHIPPING SKID	4–1

SECTION 4 – REMOVING THE MAGNET FROM THE SHIPPING SKID

Note

Magnet shipments within the USA do not have shipping skid attached. Section 4 applies only for international shipments.

1. Unbolt and remove the four 1 inch bolts which secure the base frame to the magnet. See Illustration 4–1.
2. Position the Crane Hook centrally over the magnet to ensure a vertical lift force on the Lifting Brackets.

CAUTION

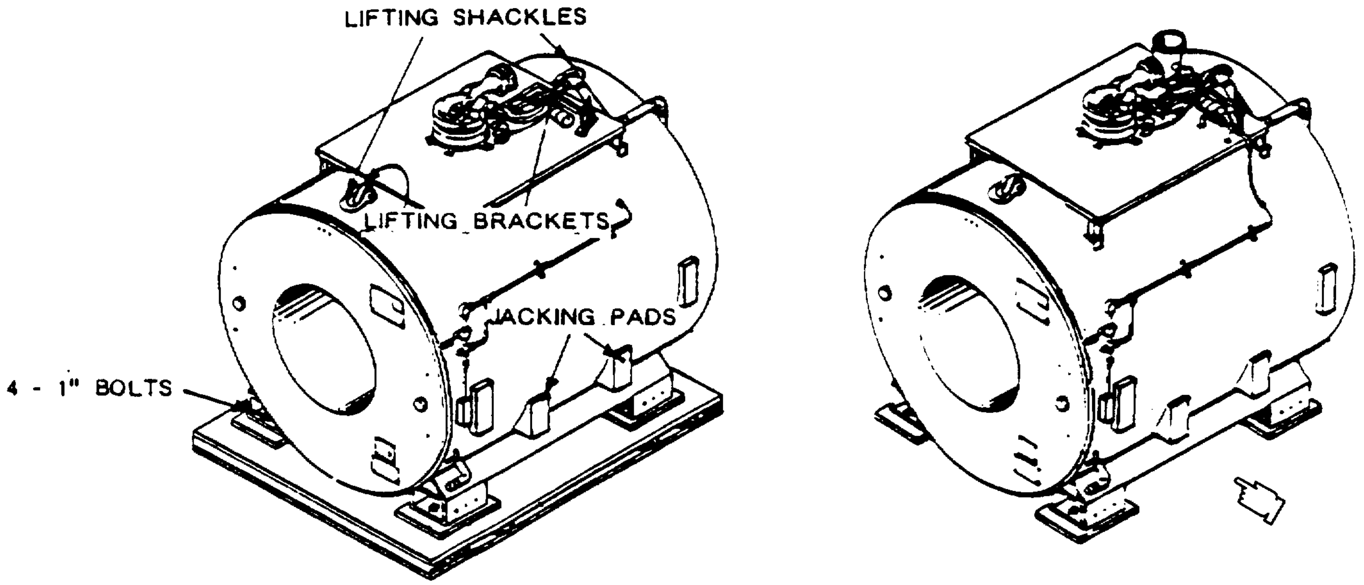
It is important to lift the Magnet smoothly to avoid impact or jolts to the system which may damage the Magnet. The magnet cannot be tipped by more than 30 degrees during any lifting operation using the lifting shackles / brackets.

3. Attach the rigging to the lifting shackles at each end of the magnet.

Note

Any combination of spreader beam, shackles and/or slings, 6 foot (1829 mm) minimum length, which can support a minimum of 21,900 pounds (9,938 Kg) for SII or 18,300 pounds (8,301 Kg) for Sill may be used.

4. Lift magnet with crane to clear shipping skid and trailer.
5. Lower the magnet onto a flat surface.



(AIR SHIPMENT) (GROUND SHIPMENT)

MAGNET MOUNTING ON PALLET
ILLUSTRATION 4–1

GE MAGNET RIGGING

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SECTION **TITLE** **PAGE**

5 MOVING MAGNET TO EXAM ROOM 5–1

SECTION 5- MOVING MAGNET TO EXAM ROOM

CAUTION

Coldhead or any other appendage on magnet should NEVER be used as a step. Coldhead, Instrumentation or Vacuum Ports are NOT to be used as positioning fixtures by directly pushing /pulling on them or attaching anything to them for the purpose of positioning /moving the magnet. Serious damage to magnet could occur. See Illustration 5-1.

Note

Roller Skids are recommended for moving magnet into the examination room as shown in Illustration 5–1. If Roller Skids are used, place steel floor plates along the magnet delivery route.

CAUTION

Use the jacking pads located on the magnet to raise the magnet for Roller Skid installation.

Use shims when rolling magnet with Roller Skid over door thresholds and other inclines.

Note

The magnet location in the examination room must be marked. Use tape to mark the four corners of magnet on the examination room floor. Refer to architectural drawings to determine the exact location of magnet within the examination room.

1. Push magnet to exam room. If using a motorized tow vehicle, attach chains around the magnet base support pads and pull magnet.
2. If there are turns in the delivery route, adjust Roller Skids to appropriate positions to negotiate turns.
3. Position magnet on the examination room floor.

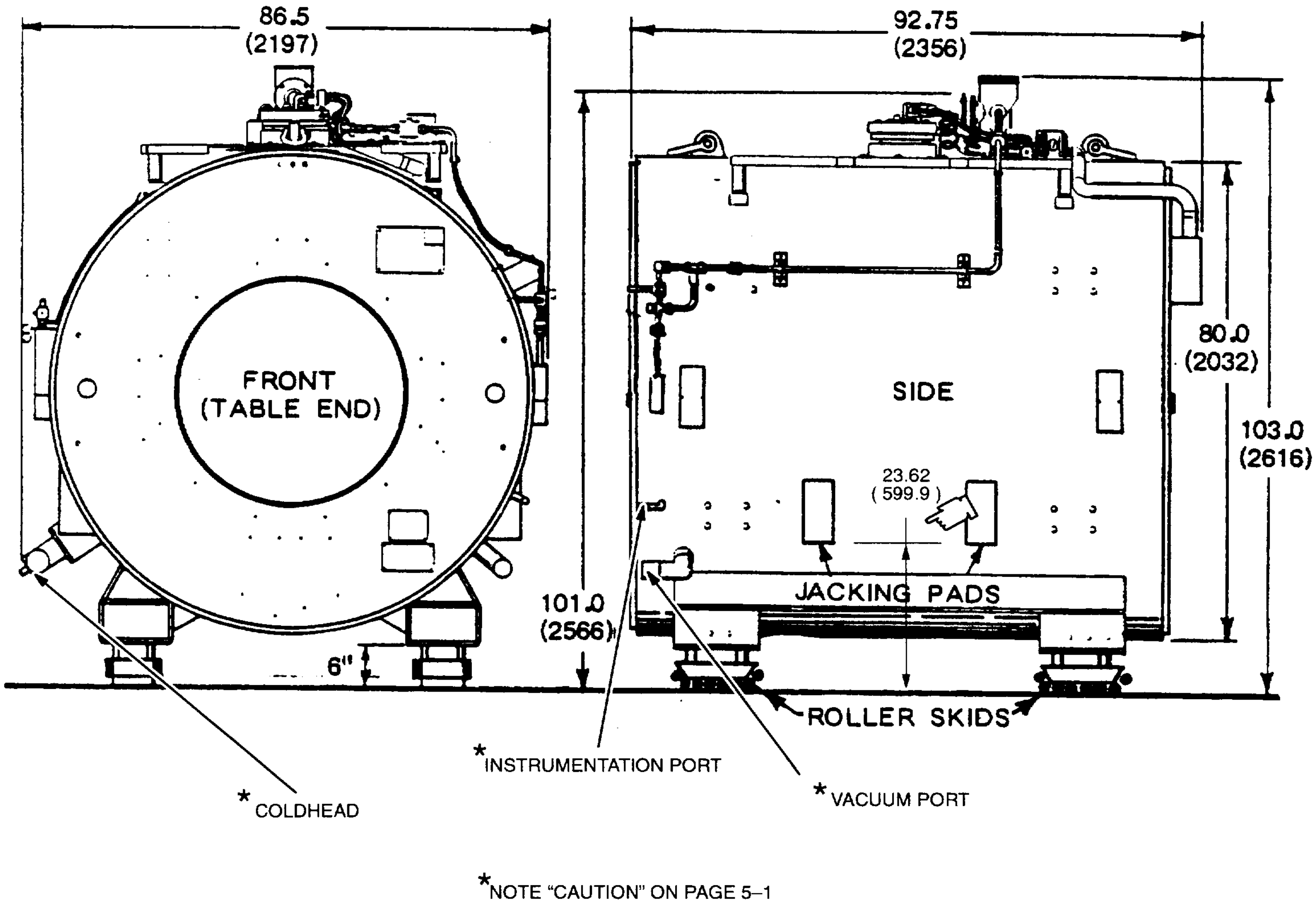
Note

Table end of magnet (See Introduction, Illustration 4–1)must be oriented away from rear wall of exam room.

CAUTION

Keep magnet level at all times. Uneven jacking of corners could result in shifting of magnet on jacks.

4. Jack the magnet up sufficiently, at the 4 jacking pads, and remove the 4 Roller Skids.
5. Slowly lower magnet onto the exam room floor.



MAGNET WITH ROLLER SKIDS ATTACHED
ILLUSTRATION 5–1

GE MAGNET RIGGING

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SECTION	TITLE	PAGE
6	LEVELING MAGNET	6–1

SECTION 6 - LEVELING MAGNET

1. Fill a 25 foot (7.6m) x 0.5 inch (12.7 mm) section of transparent tubing 3/4 full with water.

2. Position the ends of the tube adjacent to the 3mm deep grooves, located on the end flanges of the magnet, at the horizontal center. Assure that there is sufficient water in the tube so that the water level is above the groove height. See Illustration 6-1.

3. Measure the difference between the groove and water level height in the tube. There should be no more than 0.04 inch (1 mm) difference between any of the four measurements (four corners of the magnet).

4. If there is more than a 0.04 inch (1 mm) difference, jack up magnet and insert an aluminum shim plate under the appropriate corner of the Magnet Base Frame.

Note

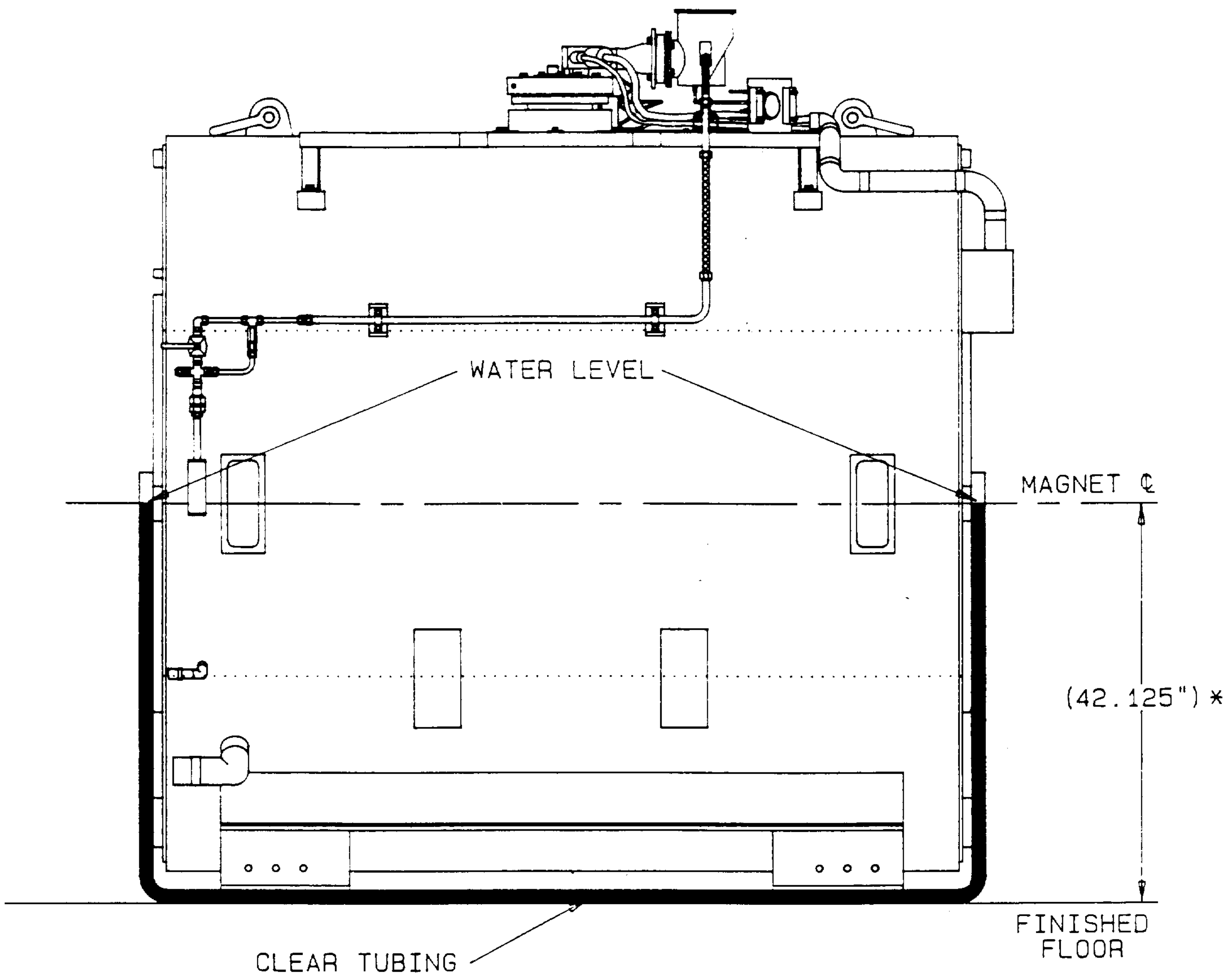
A Magnet Leveling Kit (46-260888G1), containing 12 - 0.062 inch (1.57 mm) and 8 - 0.020 inch (0.5 mm) shim plates, is shipped with the magnet.

5. Lower magnet onto shim plate and recheck the level.

Note

Repeat Steps 2 through 5 until the magnet is level (ie., there is no more than a 0.04 inch (1 mm) difference between any of the four measurements.

6. Allow magnet to settle on exam room floor for approximately 12 hours and recheck magnet level.



* MINIMUM DISTANCE BETWEEN MAGNET CENTERLINE AND FINISHED FLOOR IS 42.125" FOR FRONT AND REAR SHROUD CLEARANCE.

CHECKING MAGNET LEVEL
ILLUSTRATION 6-1