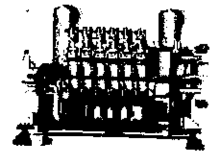


MBX1 FABRICATION TRAVELER

Housing S/N 25I448-1	Plug S/N MB-2

Note: Add S/N at OP 300
See last page for signoffs

OP	AREA	OPERATION DESCRIPTION	REFERENCE PROCEDURE OR DRAWING	NAME	DATE	DR #
10	46	Record I.D. Number of Superconducting Cable: LHC-3-A-N0012 *Include copy of certs in Appendix A*		P.Bish	1/6/03	
20	46	Cut 2 S/C cable pieces to length, tinning ends with Stay-Bright Solder. Cut V notch in both ends, mark thin edge with **Red** marker	Drawing Needed	P.Bish	1/7/03	
30	46	Record I.D. Number of Copper Cable: LHC-NSC37- *Include copy of certs in Appendix A* 0318-KY-1		P.Bish	1/6/03	
40	46	Cut 2 Cu cable pieces to length, tinning ends with Stay-Bright Solder. Mark thick edge with **Blue** marker	Drawing Needed	P.Bish	1/7/03	
50	46	Sepraratety tin areas with 60/40 Sn Pb solder as required. Check that proper solder is used P.B.; check that proper flux is used P.B.	Drawing & Procedure	P.Bish	1/8/03	
60	46	Solder fill area for lambda plug seal with 60/40 Sn Pb solder, check that blue and red marks are together P.B.; check that proper solder is used P.B.; check that proper flux is used P.B.	Drawing & Procedure	P.Bish	1/15/03 1/16/03	
70	46	Join pretinned areas as required.				
80	46	Send cables to plating shop for flux removal and cleaning		P.Bish	1/16/03	
90	46	Bakeout cables at 80 C to remove water		P.Bish	1/17/03	
100	46	Grit blast lambda plug seal area, acetone and alcohol rinse		M. Goli	1/21/03	
110	46	Apply Kapton wrap on each side of plug seal area; check that Kapton film is .002 " thk x 0.315" wide R.H.. Apply two layers, each with 50% overlap.	Drawing needed	P.Bish	1/21/03 1/22/03	
120	46	Hold in clean, dry storage for potting		P.Bish	1/22/03	
130	46					
140	46					
150	46					
160	46					
170	46	Prepare G-10 CR Plug for potting. *Include copy of certs in Appendix A*	Procedure Needed	P.Bish	1/30/03	
180	46	Insert Conductors in G-10 Plug		P.Bish	1/30/03	

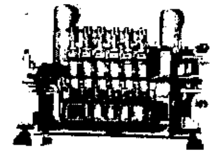
MBX1 FABRICATION TRAVELER

Housing S/N 25I448-1	Plug S/N MB-2

Note: Add S/N at OP 300
See last page for signoffs

OP	AREA	OPERATION DESCRIPTION	REFERENCE PROCEDURE OR DRAWING	NAME	DATE	DR #
190	46	Verify that both S/C cables face the midplane, *witnessed by:* ________		P. Bish	1/30/03	
200	46	Mix 200 g of Stycast 2850MT(blue), 10 g of 24 LV Hardener, 6 drops of Antifoam 88 witnessed by: R.H. *Include copy of certs in Appendix A*		P. Bish	1/30/03	
210	46	Seal conductors per procedure	Procedure Needed	P. Bish	1/30/03	
220	46	Reserve excess epoxy for archival sample. When cured, measure durometer hardness; Durometer = 90	Procedure Needed	P. Bish	1/31/03	
230	46	Prepare for injection in vacuum chamber	Procedure Needed	P. Bish	1/31/03	
240	46	Mix 750 g of Stycast 2850MT(blue), 37.5 g of 24 LV Hardener, 23 drops of Antifoam 88 witnessed by: R.H. *Include copy of certs in Appendix A*		P. Bish	1/31/03	
250	46	Perform injection per procedure	Procedure Needed	P. Bish	1/31/03	
260	46	Reserve excess epoxy for archival sample. When cured, measure durometer hardness; Durometer = 90	Procedure Needed	P. Bish	2/3/03	
270	46	Dunk plug in LN 3 times	Procedure Needed	P. Bish	2/3/03	
280	46	Vacuum leak test after warming and drying; 5x10^{-5} mBar *Leak rate =* 1.2x10^{-9} *atm cc/s* No Leak	Procedure Needed	P. Bish	2/4/03	
290	46	Hipot cond to cond to 5 kV, Passed Hipot? Yes ✓ No ____ *Include data sheet in Appendix B*	Procedure Needed	[illegible signature]	2/6/03	
295	46	Hold for Engineer Approval to Proceed [signature]				
300	46	Prepare SS Housing for potting Enter S/N of housing in Traveler Heading *Include copy of certs in Appendix A*	Procedure Needed	P. Bish	2/11/03	
310	46	Prepare G-10CR plug/bus assembly for potting	Procedure Needed	P. Bish	2/11/03	

MBX1 FABRICATION TRAVELER



Housing S/N 25I448-1	Plug S/N MB-2

Note: Add S/N at OP 300
See last page for signoffs

OP	AREA	OPERATION DESCRIPTION	REFERENCE PROCEDURE OR DRAWING	NAME	DATE	DR #
320	46	Insert Plug into housing in vacuum chamber to allow magnet side (pipe end) potting		P. Bish	2/12/03	
330	46	Mix 200 g of Stycast 2850MT(blue), 10 g of 24 LV Hardener, 6 drops of Antifoam 88 witnessed by: R.H. *Include copy of certs in Appendix A*		P. Bish	2/13/03	
340	46	Pot per procedure	Procedure Needed	P. Bish	2/13/03	
350	46	Reserve excess epoxy for archival sample. When cured, measure durometer hardness; Durometer = 75		P. Bish	2/14/03	
360	46	Position assembly in vacuum chamber for potting the DFBX side (flange end)		P. Bish	3/12/03	
370	46	Mix 300 g of Stycast 2850MT(blue), 15 g of 24 LV Hardener, 9 drops of Antifoam 88 witnessed by: R.H. *Include copy of certs in Appendix A*		P. Bish	3/12/03	
380	46	Pot per procedure		P. Bish	3/12/03	
390	46	Reserve excess epoxy for archival sample. When cured, measure durometer hardness; Durometer = 90		P. Bish	3/13/03	
400	46	Dunk plug in LN 3 times	Procedure Needed	P. Bish	3/17/03	
405	46	Apply final Kapton wrap to box end of cables				
410	46	Vacuum leak test after warming and drying, using Cable Protection Assembly 25M934 5×10^{-5} mbar Leak rate = 1×10^{-9} atm cc/s	No helium Procedure Needed Detected	P. Bish	3/17/03	
405	46	Hold for Engineer Approval to Proceed Jon Zbasnik		Jon Zbasnik	3/18/03	
420	46	Package and ship to B77, include traveler for work completed thus far				

Author
Doyle Byford and Jon Zbasnik

Department
Mechanical Engineering

Date
4 February 2003

2/6/2003
0925 Hrs.

Equipment check | 100 x10⁶ Resistor

1.008 KV = 99.9mV @ 100nA/mV
= 9.99 nA
R calc = 1.008 KV / 9.99 nA ≅ 100 x10⁶ Ω

~~Trips at 8nA on 10μA scale~~

VI. DATA SHEET FOR OPERATION 290 TEST

Trips at 8 nA on 10 μA scale. ∴ Resistor 3751 is OK
note at 0KV meter reads 0.2mV

Data sheet for operation 290 test.
Plug S/N MB2

Conductor	Leakage Current, micro amps or .01 = 0.1mV Trip Voltage
M1 *	0.2mV @ .10nA/mV ∴ = 10nA
M2 **	0.5 @ 100nA/mV = 50nA

0948 Hrs.

Signed [signature] Date 2/6/2003

* at end meter reading 0.1mV at 0KV

** " " " " 0.0mV at 0KV

MBX1 FABRICATION TRAVELER

Housing S/N 25I448-1	Plug S/N MB-2

Note: Add S/N at OP 300
See last page for signoffs

OP	AREA	OPERATION DESCRIPTION	REFERENCE PROCEDURE OR DRAWING	NAME	DATE	DR #
430	77	Remove Protective Assembly 25M905 from conductors and install the lambda plate housing in the assembly fixture		C. Z[illegible] A. Pekedis	5/1/03	
440	77	Rotate lambda plug to proper orientation		A. Pekedis	5/1/03	
450	77	install bending fixture		A. Pekedis	5/1/03	
460	77	Make bend 1 of the first bus		A. Pekedis	5/1/03	
470	77	Make bend 1 of the second bus		A. Pekedis	5/1/03	
480	77	Slip a short radius elbow, with backing rings attached, into position. Clamp into position. *Include copy of certs in Appendix A*				
490	77	Make the 5-inch-long solder joints between the adjacent Cu and S/C cables. Verify that 60/40 Sn/Pb solder is used. Yes A.P. Verify that rosin-type flux is used. Yes A.P. Clean any flux residue after soldering.		A. Pekedis C. Z[illegible]	5/1/03 5/1/03	
500	77	Apply Kapton wrap on <u>first</u> bus, overlapping existing Kapton wrap by at least 1.5 inch; on bends use Kapton film .002 " thk x 0.315" wide ________. Apply two layers, each with 50% overlap. On straight sections use a cigarette- paper-type wrap of wide Kapton film		A. Pekedis C. Z[illegible]	5/1/03 5/1/03	
510	77	Apply Kapton wrap on ~~first bus~~, SECOND overlapping existing Kapton wrap by at least 1.5 inch; on bends use Kapton film .002 " thk x 0.315" wide Yes A.P. Apply two layers, each with 50% overlap. On straight sections use a cigarette- paper-type wrap of wide Kapton film		A. Pekedis C. Z[illegible]	5/1/03 5/1/03	
520	77	Install a 0.060 inch thick G-10 spacer beween busses in the straight section.		A. Pekedis C. Z[illegible]	5/1/03 5/1/03	
530	77					

MBX1 FABRICATION TRAVELER

Housing S/N 25T448-1 | **Plug S/N** MB-2

Note: Add S/N at OP 300
See last page for signoffs

OP	AREA	OPERATION DESCRIPTION	REFERENCE PROCEDURE OR DRAWING	NAME	DATE	DR #
540	77	Apply Kapton ground wrap over the bus assembly straight section and first bend; In the bend region use Kapton film .002 " thk x 0.315" wide A.P. Apply two layers, each with 50% overlap, and in the straight section use a cigarette-paper-type wrap of wide Kapton film		A.P.	5/2/03	
550	77	Apply spiral wrap of Kevlar tape over the Kapton ground wrap. 1/4 inch pitch. Epoxy the starting and stopping knots.		A.P.	5/2/03	
560	77	Install 2 G-10 spiders, 25M948, in the straight section as shown on 25M859. Apply a wrapping of fiberglass tape, soaked with epoxy, on either side of the spiders to keep them in position.		A.P.	5/5/03	
570	77	Install Vertical pipe assembly 25M911. ***Note: this subassembly must have previously been thermally shocked and leak checked.*** Include a copy of the testing report in Appendix B.		A.P.	5/5/03	
580	77	Bend the conductors to form the second bend and clamp in position.		A.P	5/6/03	
590	77	Slip the small radius elbow, with backing rings attached, into position. Clamp into position		A-P	5/6/03	
600	77	Install a 6 inch long, 0.06 inch thick G-10 spacer between busses in the horizontal section.		A.P	5/6/03	
610	77	Apply Kapton ground wrap over the 6-inch long section with G-10 spacer; check that Kapton film is .002 " thk x 0.315" wide Key A.P. Apply two layers, each with 50% overlap.		C L A.P.	5/7/03	
620	77	Apply spiral wrap of Kevlar tape over the Kapton ground wrap. 1/4 inch pitch. Epoxy the starting and stopping knots.		C.L	5/8/03	
630	77	Install 1 G-10 spider as shown on 25M859. Apply a wrapping of fiberglass tape, soaked with epoxy, on either side of the spider to keep it in position.	use epoxy ver samaid	CL.	5/8/03	

MBX1 FABRICATION TRAVELER

Housing S/N 25I448-1	Plug S/N MB-2

Note: Add S/N at OP 300
See last page for signoffs

OP	AREA	OPERATION DESCRIPTION	REFERENCE PROCEDURE OR DRAWING	NAME	DATE	DR #
640	77	Install Horizontal assembly 25M912 and clamp in place. ~~***Note: this subassembly must have previously been thermally shocked, pressure tested and leak checked.*** Include a copy of the testing report in Appendix B.~~	No test needed due to redesign Jon Z.		5/	
645	77	Hold for Lead Enginner Signoff before proceeding. Jon Zbasnik				
650	77	Trim conductors to 7.5 inch overhang out of Horizontal assembly 25M912. Make sure the cable end is tinned with Stay Bright solder before cutting to prevent the cable from unravelling.		A.P.		
660	77	Place teflon tubes over the individual conductors to prevent end flashover during hipot testing. Teflon tubes to extend from the section with G-10 insulators 1.5 inch past the end. Wrap with mylar tape to hold the tubes in place.		A.P.		
665	77	Install spacer 25M949 at location shown on 25M859.		[illegible]	6/16/03	
670	77	Install Test Cap 25M913. ***Note: this subassembly must have previously been thermally shocked and leak checked.*** Include a copy of the testing report in Appendix B.		A.P.		
680	77	Perform closeout welding. Use GTAW process, with a skipping technique and intermediate cooling with "cool gun" to minimize heat input. Fill out weld log and include in Appendix C.	Welds performed by Tim Williams Jon Z.			
690	77	Dimensional Check of Bus Duct Piping within tolerance? Yes X No ___				
700	77	Leak check closeout welds. Connect to ISO flange on 25M911. Leak rate less than 1×10^{-9} atm cc/s (helium) ? Yes X		A.P.	5/28/03	
710	77	Dunk assembly in LN 2 times to thermally shock closeout welds. Use dry Ne gas inside piping.		A.P.		

MBX1 FABRICATION TRAVELER

Housing S/N 25I446-1 **Plug S/N** M-B-2

Note: Add S/N at OP 300
See last page for signoffs

OP	AREA	OPERATION DESCRIPTION	REFERENCE PROCEDURE OR DRAWING	NAME	DATE	DR #
720	77	Pressure test closeout welds & lambda plug at room temperature to 370 psig with dry N_2. *Include data sheet in Appendix B.*	Procedure needed	A.P.	5/28/03	
730	77	Leak check closeout welds. Leak rate less than 1 x 10^{-9} atm cc/s (helium) ? Yes X		A.P.	6/25	
740	77	Pressure test closeout welds and lambda plug at LN temperature to 370 psig with dry Ne. *Include data sheet in Appendix B.*	Procedure needed	A.P.	6/26	
750	77	Leak check closeout welds. Leak rate less than 1 x 10^{-9} atm cc/s (helium) ? Yes X		A.P.	6/26	
760	77	Determine leak rate or rate of rise across lambda plug from flange side to pipe side. Leak rate less than 0.1 atm cc/s? Yes X		A.P.	6/27	
770	77	Determine leak rate or rate of rise across lambda plug from pipe side to flange side. Leak rate less than 0.1 atm cc/s? Yes X	Not Done.	~~A.P.~~		
780	77	Attach "pressure-tested" label to magnet end of the assembly		A.P.	1/25/03	
790	77					
800	77	Hipot cond to cond to 5 kV in air, Passed Hipot? Yes ✓ No ___ *Include data sheet in Appendix B* 0.0 µA		D.B. Byford	7/24/2003	
810	77	~~Hipot cond to cond to 2 kV in He, Passed Hipot? Yes ___ No ___ Include data sheet in Appendix B~~	Not Done JonZ			
820	77	Ring out conductors and attach labels to conductors. *Include data sheet in Appendix B*	Done by Byford 7/24/03			
830	77	Cover the busses with a close-fitting teflon tube. Attach spacer 25M949 as shown on 25M859 to prevent the bundle from movement inside the tube.		A.P.		

MBX1 FABRICATION TRAVELER

Housing S/N 25I448-1	Plug S/N MB-2

Note: Add S/N at OP 300
See last page for signoffs

OP	AREA	OPERATION DESCRIPTION	REFERENCE PROCEDURE OR DRAWING	NAME	DATE	DR #
840	77	Install protective tube assembly. Flush both sides of lambda plug with dry N_2 gas and cap for shipment to DFBX vendor.		A.P.	~~11/17/03~~ 11/24/03	
850	77	Package for shipment to DFBX vendor. Include a copy of the assembly's traveler in the shipping container.		A.P.	11/26/03	

Traveler Entries Reviewed by: Jon Zbasnik (signature) Jon Zbasnik Date 11/26/03

Traveler Approved by: Joseph Rasson (signature) Joseph Rasson Date 12/02/03

11

Author
Jon Zbasnik

Department
Mechanical Engineering

Date
6 June 2003

Project: LHC I.R. Feedboxes

Title: Pressure and Leak Testing of MBX1 and MQX1 Bus Ducts

Part Serial Number 25I448-1

I. Description

We present the thermal cycling and subsequent pressure and leak test of MBX1 and MQX1 Bus Ducts fabricated at LBNL. These assemblies contain superconducting busses that allow the superconducting inner triplet magnets and corrector magnets to be supplied with current. A barrier between the 1.8K, 1 bar superfluid helium magnet bath and the 4.3K, 1.3 bar liquid helium bath in the DFBX (lambda plug) is integral to the bus duct assembly.

Isometric views of MBX1 and MQX1 are shown in Figures 1 and 2, respectively.

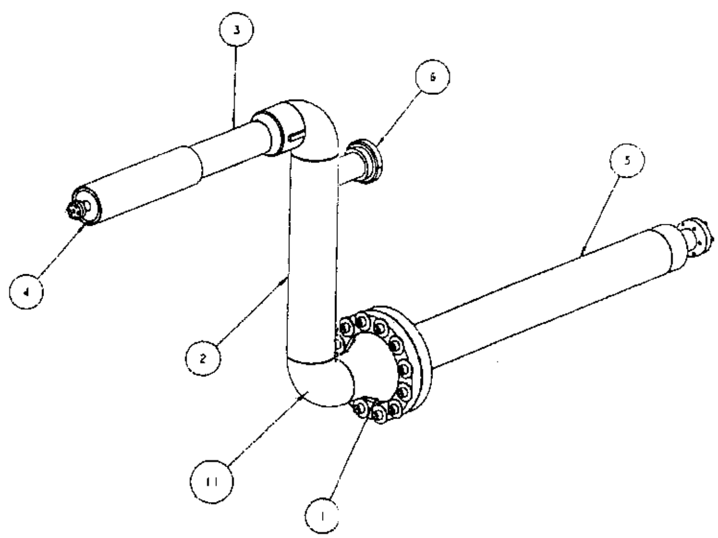


Figure 1. Isometric view of MBX1. 1-Housing with Lambda Plug; 2-Vertical Pipe Section; 3-Horizontal Section (this connects to magnet); 4-test Cap (this is removed for tunnel installation); 5-Conductor Protection Tube (this is removed for attachment to DFBX); 6-Helicoflex Sealing system; 11-Short Radius 3 IPS Weld Elbow.

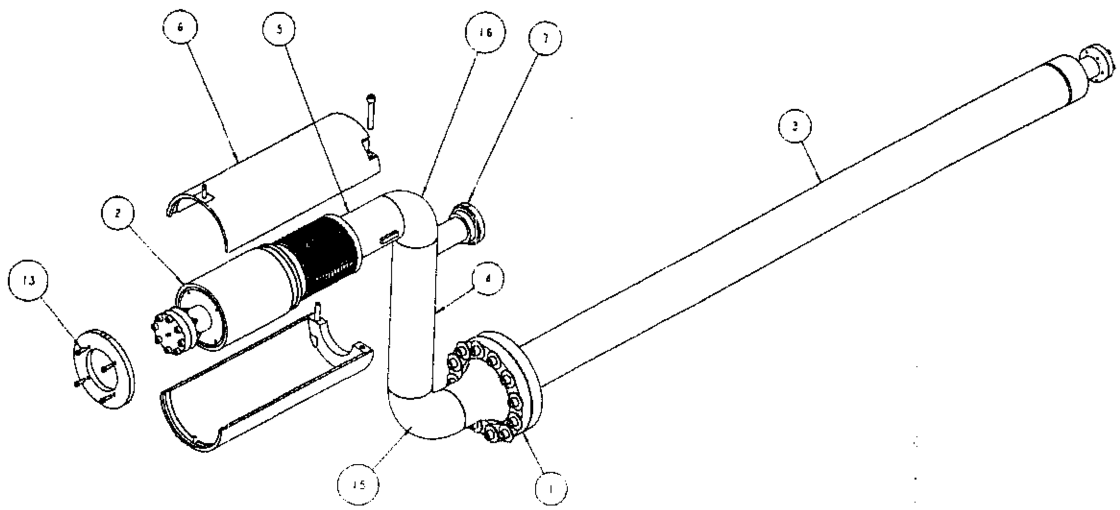


Figure 2. Isometric View of MQX1. 1 - Housing with Lambda Plug; 2 - Test Cap (this is removed for tunnel installation); 3 - Conductor Protection Tube (this is removed for attachment to DFBX); 4 - Vertical Pipe Section; 5 - Horizontal Section (this connects to magnet); 6 & 13 - Bellows Restraint (this is removed for tunnel installation); 7 - Helicoflex Sealing System; 15 - Long Radius 3 IPS Weld Elbow; 16 - Short Radius 3 IPS Weld Elbow.

The bus duct design pressure is 20 bar applied to the magnet side and 3.5 bar applied to the DFBX side. The duct would probably be damaged with hydrostatic testing using water since the electrical insulation would be compromised, so it will be tested pneumatically with dry nitrogen or helium. In accordance with Pub 3000, the magnet-side piping will be pressure tested to 25 bar (370 psig).

The magnet-side piping is 3 IPS (3.5 inch outer diameter) schedule 10, type 304L stainless steel pipe and weld elbows. The Lambda Plug housing is machined from a forged 304L stainless steel special weldneck flange. Welding was performed by LBNL welders using the GTAW process with ER316L filler wire. The assembly of NEMA G-10CR and conductors potted into the housing completes the pressure boundary of the magnet-side piping.

II. Pressure Test Hazards

The chief hazard in this test is the stored energy in the pressurized gas providing a driving force that could eject the potted plug out of the housing.

The stored energy is given by:

$$U = \frac{P_h V_h}{\gamma - 1}\left[1 - \left(\frac{P_l}{P_h}\right)^{\frac{\gamma-1}{\gamma}}\right],$$

where U = stored energy in N-m (J)
P_h = Initial Vessel Pressure (absolute) in N/m^2 (Pa) = 25 bar = 2.5 MPa
P_l = Final Vessel Pressure (absolute) in N/m^2 (Pa) = 0.1 MPa
V_h = Vessel Volume in m^3 = 442 in^3 = 7.2 x 10^{-3} m^3
γ = specific heat ratio, C_P/C_V, = 1.67 for helium and 1.4 for nitrogen.

If we test with dry nitrogen,

$$U = \frac{3.0x10^6 * 7.2x10^{-3}}{1.4 - 1}\left[1 - \left(\frac{.1}{2.5}\right)^{\frac{1.4-1}{1.4}}\right]$$

$$U = 5.4x10^4\left[1 - (.04)^{.286}\right]$$

$$U = 3.25 \text{ x } 10^4 \text{ N-m or 32 kJ}$$

The stored energy is quite low, and is equivalent to about 7.9 g of TNT.

If we test with helium,

$$U = \frac{3.0x10^6 * 7.2x10^{-3}}{1.67 - 1}\left[1 - \left(\frac{.1}{2.5}\right)^{\frac{1.67-1}{1.67}}\right]$$

$$U = 3.22x10^4\left[1 - (.04)^{.401}\right]$$

$$U = 2.3 \text{ x } 10^4 \text{ N-m or 23 kJ}$$

The stored energy is quite low, and is equivalent to about 5.8 g of TNT.

In spite of the rather low stored energies, the part should be tested behind a protective barricade such as inside a 1-inch-thick plywood box. The box should be large enough to accommodate the styrofoam dewar for cold pressure testing. The corners should be reinforced with 2 inch Al angle. The top should be easily removable to allow the part to be placed inside. The high pressure line and LN fill tube can also penetrate through the top.

III. Calculations

Allowable pressure in 3 inch pipe, fittings, and welds.

Assume full penetration welds, without Radiographic Testing. The allowable pressure in psi is given by:

$$P = \frac{SEt}{R + .6t},$$

where S = allowable stress (psi) = 16,500 psi
E = Joint Efficiency =.65 because of the welds
R= inner radius = 1.63
t = wall thickness (inch) = .12 inch

$P_{allowable}$ = 756 psig

The test pressure of 370 psig is considerably below the allowable pressure of 756 psig.

Shear Stress in Stycast 2850MT bond between 304 Stainless Steel and the G-10CR Insulator block.

We take the limiting case that the entire pressure load is carried by the Stycast epoxy bond between the stainless housing and the G-10CR insulator block,

$$\tau_{shear} = \frac{PA_{pipe}}{A_{shear}}$$

$$\tau_{epoxy} = P\frac{\pi r_i^2}{2\pi r_{G-10} l_{epoxy}},$$

where P = test pressure = 370 psig
r_i = inner radius of piping = 1.63 inch
r_{G-10} = outer radius of G-10CR insulator = 1.35 inch
l_{epoxy} = length of epoxy bond = 1.75 inch

$$\tau_{epoxy} = 370x\frac{1.63^2}{2*1.35*1.75}$$

$$\tau_{epoxy} = 208 psi$$

Shear Stress in NEMA G-10CR Plug

In this case we have the limiting case in which the pressure load is carried by a shear load in the end of the G-10 insulator block.

$$\tau_{G-10} = P \frac{\pi r_i^2}{2\pi r_{G-10*} l_{G-10}}$$

where P = test pressure = 370 psig
r_i = inner radius of piping = 1.63 inch
r_{G-10*} = outer radius of G-10CR insulator joint = 1.1 inch
l_{G-10} = shear length of G-10CR = .25 inch

$$\tau_{G-10} = 370 \frac{1.63^2}{2*1.1*.25}$$

$$\tau_{G-10} = 1787\,psi$$

These shears are very low and are well within the materials' capability.

IV. Pressure & Leak Testing

a. OP 700 (MBX1), OP xxx (MQX1): Post-Weld Leak Check

Connect a calibrated helium mass spectrometer leak detector to Item 6, Figure 1 for the MBX1 or to Item 7, Figure 2 for the MQX1 and leak check the closeout welds using a tracer probe method in which helium in sprayed over the weld joints. The leak rate should be less than $1x10^{-9}$ atm cc/sec (helium).

The maximum acceptable room temperature helium leak rate for the lambda plug is 0.1 atm cc/sec (helium), which exceeds the maximum leak rate that can be measured with a conventional helium mass-spectrometer type leak detector. If the lambda plug leak rate is too high for the leak detector, pump in parallel on the Conductor Protection Tube to allow the leak detector to be used.

Date: 5/28/03 Helium Leak Rate: 3.0 x 10-10 cc/sec He Signed: [signature]

Parallel Pumping on Conductor Protection Tube? Yes ________ No X

Witnessed: ______________________

b. OP 710 (MBX1), OP xxx (MQX1): Thermal Shock to LN Temperature

Make sure a teflon Oring is used to seal the Protection tube to the Lambda Plug Housing.
Pressurize both sides of the assembly shown in Figure 1 or Figure 2 to 20 psig with pure neon gas, valve the gas supply off and submerge the assembly in a bath of Liquid Nitrogen.
Hold in the LN bath for at least 1 hour to allow the part to reach LN temperature.
Remove from Liquid Nitrogen bath and allow the part to reach room temperature. Set up a fan to circulate a flow of air over the part and speed the warmup. Allow sufficient time for the part to defrost and become dry.
Repeat the process to obtain 2 thermal cycles.

Signed: ____________

Witnessed: ____________

c. OP 720 (MBX1), OP xxx (MQX1): Room Temperature Pressure Test

The pressure test is to be performed using dry nitrogen gas.

Hook up dry nitrogen gas source to the magnet side piping as indicated in Figure 3.

Use pressure safety manifold M8104-6 with a relief valve set to 500 psig.

Allow any leakage across the lambda plate to be vented out the Conductor Protection Tube.

Place the part in the protective barrier described above.

Raise the pressure to 370 psig in steps of about 50 psi. Pause at each step for 60 sec. When 370 psig is attained, close the shutoff valve and record the test gauge reading for 10 minutes at 1 minute intervals.

Reduce pressure to 0 psig.

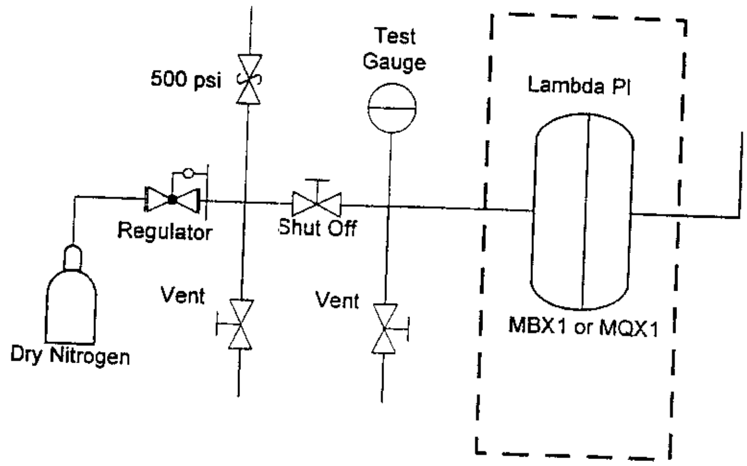


Figure 3. Pressure Test Setup.

Date: 6/25/03

Time: 12:55	Pressure: 370
Time: 12:56	Pressure: 370
Time: 12:57	Pressure: 370
Time: 12:58	Pressure: 370
Time: 12:59	Pressure: 369
Time: 1:00	Pressure: 368
Time: 1:01	Pressure: 367
Time: 1:02	Pressure: 367
Time: 1:03	Pressure: 367
Time: 1:04 PM	Pressure: 367
Time:	Pressure:
Time:	Pressure:
Time:	Pressure:
Time:	Pressure:
Time:	Pressure:

Signed: [signature]

Witnessed: [signature]

d. OP 730 (MBX1), OP xxx (MQX1): Leak Check after Room Temperature Pressure Test

Connect a calibrated helium mass spectrometer leak detector to Item 6, Figure 1 for the MBX1 or to Item 7, Figure 2 for the MQX1 and leak check the closeout welds using a tracer probe method in which helium in sprayed over the weld joints. The leak rate should be less than 1×10^{-9} atm cc/sec (helium).

The maximum acceptable room temperature helium leak rate for the lambda plug is 0.1 atm cc/sec (helium), which exceeds the maximum leak rate that can be measured with a conventional helium mass-spectrometer type leak detector. If the lambda plug leak rate is too high for the leak detector, pump in parallel on the Conductor Protection Tube to allow the leak detector to be used.

Date: 6/26/03 Helium Leak Rate: 2.8 x 10⁻¹⁰ cc/sec He Signed: [signature]

Parallel Pumping on Conductor Protection Tube? Yes ______ No X

Witnessed: [signature]

e. OP 740 (MBX1), OP xxx (MQX1): Pressure Test at LN Temperature

The pressure test is to be performed using neon gas.

Hook up the neon gas source to the Assembly as indicated in Figure 4.

Use pressure safety manifold M8104-6 with a relief valve set to 500 psig.

Allow any leakage across the lambda plate to be vented out the Conductor Protection Tube through a relief valve set to 30 psig The relief valve is at room temperature.

Place the part in the protective barrier described above.

Raise the pressure to 370 psig in steps of about 50 psi. Pause at each step for 60 sec. Maintain at 370 psig for 10 minutes.

Reduce pressure to 0 psig.

Allow the assembly to reach room temperature

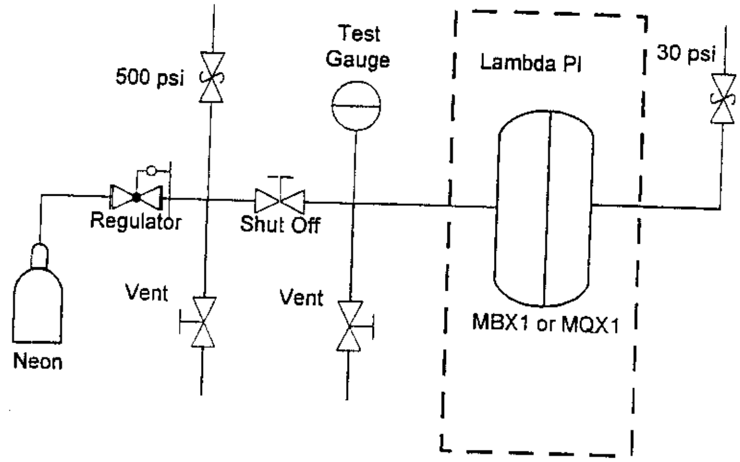


Figure 4. LN Temperature Pressure Test Setup.

Date: 6/26/03

Time: 10:45 Am Pressure at 370 psig
Time:__________ Pressure released to 0 psig

Signed: [signature]

Witnessed: [signature]

f. OP 750 (MBX1), OP xxx (MQX1): Leak Check after LN Temperature Pressure Test

Connect a calibrated helium mass spectrometer leak detector to Item 6, Figure 1 for the MBX1 or to Item 7, Figure 2 for the MQX1 and leak check the closeout welds using a tracer probe method in which helium in sprayed over the weld joints. The leak rate should be less than $1x10^{-9}$ atm cc/sec (helium).

The maximum acceptable room temperature helium leak rate for the lambda plug is 0.1 atm cc/sec (helium), which exceeds the maximum leak rate that can be measured with a conventional helium mass-spectrometer type leak detector. If the lambda plug leak rate is too high for the leak detector, pump in parallel on the Conductor Protection Tube to allow the leak detector to be used.

Date: 6/27/03 Helium Leak Rate: 3.4x10-10 cc/sec. He Signed: Ahmet Pekedis

Parallel Pumping on Conductor Protection Tube? Yes ______ No X

Witnessed: [signature]

g. OP 760 (MBX1), OP xxx (MQX1): Lambda Plug Leak Check after LN Temperature Pressure Test

The maximum acceptable helium leak rate for the lambda plug is 0.1 atm cc/sec (helium), which exceeds the maximum leak rate that can be measured with a conventional helium mass-spectrometer type leak detector. Follow the steps in g.1 if the leak rate can be measured with a conventional leak detector. If the leak rate cannot be measured with a mass spectrometer, perform a rate of rise measurement in g.2.

g.1 Leak Detector Method

Remove the Conductor Protection Tube and connect a helium mass spectrometer leak detector to the assembly as in part IV-a above. Apply a spray of Helium gas to the exposed conductors. Measure and record the room temperature leak rate.

Date: 6/27/03 Helium Leak Rate: 3.4x10-10 cc/sec. He Signed: Ahmet Pekedis

Witnessed: [signature]

g.2 Rate of Pressure Rise Method

Install a "Rad-Lab" Tee to the Helicoflex Seal Flange. Connect one leg of the Tee to a pumping station through a Veeco-style vacuum valve and install a Convectron vacuum gauge on the other leg.
Make sure the Conductor Protection Tube is opened to the atmosphere.
Evacuate the piping to about 20 mTorr.
Close the Veeco valve and record the reading of the convectron gage every 60 sec.
Allow the pressure to rise to about 10 Torr.
Note: The trapped volume is 7.2 liter, so the rate of pressure rise must be less than 3.8 mTorr/sec.

Date: __________

Time: __________ Pressure: __________
Time: __________ Pressure: __________
Time: __________ Pressure: __________
Time: __________ Pressure: __________
Time: __________ Pressure: __________

Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________

Signed: ____________________

Witnessed: ____________________

h. OP 770 (MBX1), OP xxx (MQX1): Lambda Plug Leak Check after LN Temperature Pressure Test

Install a "Rad-Lab" Tee to the Conflat Flange on the end of thje Conductor Protection Tube.

Connect one leg of the Tee to a pumping station through a Veeco-style vacuum valve and install a Convectron vacuum gauge on the other leg.

Make sure the Helicoflex flnage is opened to the atmosphere.
Evacuate the Conductor Protection Tube to about 20 mTorr.
Close the Veeco valve and record the reading of the convectron gage every 60 sec.
Allow the pressure to rise to about 10 Torr.
Note: The trapped volume for MBX1 is 4.3 liter, so the rate of pressure rise must be less than 6.5 mTorr/sec, and the trapped volume for MQX1 is 8.3 liter, so the rate of pressure rise must be less than 3.4 mTorr/sec.

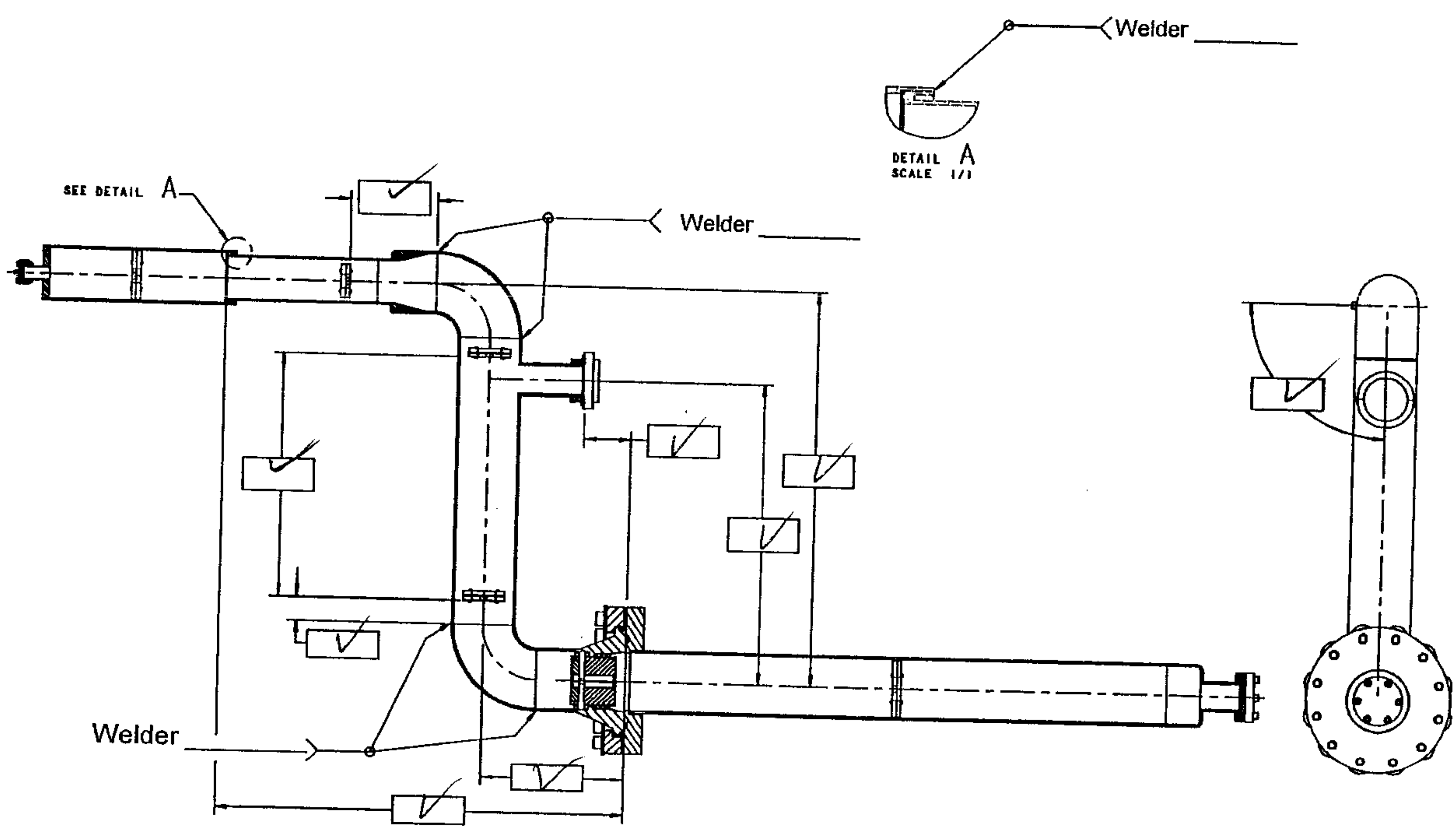
Date: __________

Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________

MBX1 S/N 25IL48-1
Inspection Form

(Check if within tolerance
If out of tolerance, state the deviation)

Signed A. Pokedi **Date** 6/27/03



Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________
Time:__________ Pressure: __________

Signed: ____________________

Witnessed: ____________________

IX. DATA SHEETS FOR OPERATION 800 AND 810 TESTS

Data sheet for operation 800 test
Assembly S/N ZSI 448-1

Conductor	Leakage Current, micro amps or Trip Voltage
LEAD A	0.0 uA leakage
LEAD B	0.0 uA

Signed [signature] Date 7/24/2003

Data sheet for operation 810 test
Assembly S/N ________

Conductor	Leakage Current, micro amps or Trip Voltage
LEAD A	
LEAD B	

Signed ____________________ Date ________________

Date	Time	Test Type	Memory	Step	Pass/Fail	Test Result	Timer	Parameter 1	Parameter 2	Serial Number	Test Model #	Test Serial #	Calibration Due Date	Model Number
7/24/2003	10:35:53 AM	DC Withstand	2	1	Pass	Pass	60.0s	5.00KV	0.0microamps	251448-1	7550DT	9111100	1/31/2004	MBX
7/24/2003	10:35:53 AM	DC Withstand	2	2	Pass	Pass	60.0s	5.00KV	0.0microamps	251448-1	7550DT	9111100	1/31/2004	MBX

Done by Doyle Byford.