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Relativistic Heavy Ion Collider
Magnet Division Procedure

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REVISION RECORD

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A	1/13/2000		Initial Release.	
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1 Scope:

This procedure describes the method used to assemble the RHIC Helical Magnet Cold Mass Assemblies.

2 Applicable Documents:

Specifications:

RHIC-MAG-Q-1000	Procedure for Control of Measurement Test Equipment
RHIC-MAG-Q-1004	Discrepancy Reporting Procedure
RHIC-MAG-R-7242	RHIC Hypot Testing
RHIC-MAG-R-7227	RHIC Electrical Resistance Measurement
RHIC-MAG-R-7228	RHIC Magnet Coil Inductance and Q Measurement
RHIC-CR-E-4703-0041	Leak Check Specification

Engineering Drawings:

12011050	Cold Mass Assembly – Three Sheets
12011051	BPM and Beam Tube Assembly
12011096	Storage Unit Assembly
12011117	Lower Shell Weldment

3 Requirements:

The helical cold mass assembly shall be welded in accordance with this specification and associated drawings.

The welding assembly operations shall be performed in the Assembly Fixture (A.F.) or Weld Rotator (W.R.). Welding parameters shall be set in accordance with those specified during welding process development and weld procedure qualification. No deviation from these parameters are allowed.

All welding must be performed by welders qualified in accordance with ASME Section IX.

3.1 Materials & Equipment:

25-1747.01-5	Cold Mass Assembly Fixture (AF) – Five Sheets
25-1771.01-5	Rollover Fixture (WR)
25-1764.10-4	Lifting Beam
25-1800.10-5	Helical Shell Uprighting Tool
25-1800.11-5	Helical Shell Lifting Tool
25-1800.12-5	Cold Mass Lifting Scheme
25-1747.11	Cradle Locating Tool
25-1747.10	Cradle Locating Bar
25-1747.56	Cradle Locating Pin
25-1775.01-5	Lead Bending Jig Assembly

3.2 Safety:

3.2.1 Technicians and welders who are part of the staff in the assembly of helical cold masses must adhere to the following safety requirements:

- Wear safety glasses with side shields.
- Wear steel toed safety shoes.
- Wear hard hats when the crane is in operation.
- Abide by the safety requirements as explained in this specification.

3.2.2 All lifting and handling operations requiring overhead crane operations shall be performed by holders of valid safety awareness certificates. They shall also be trained and certified in the use of the appropriate lifting device by the cognizant engineer or technical supervisor.

3.2.3 No welding shall take place unless the weld point of operation is surrounded by welding screens. All personnel not directly involved with the welding process must be outside the screens. Any personnel inside the screens or in any way assisting with the welding process must wear eye protective gear, and be clothed to protect against intense ultra violet light.

3.2.4 The technicians shall be qualified by their cognizant technical supervisor in the operation of the required test equipment and these electrical testing procedures. They shall be familiar with the latest revision of the applicable documents referenced in section 2. In addition, some of these tests require the technician to have special training. A list of qualified personnel shall be maintained with the Training coordinator.

3.2.5 Some of these electrical test procedures have specific safety requirements. The technicians performing these specific tests shall rigorously follow all the safety requirements listed as well as those prescribed by the BNL ES&H standard.

3.2.6 All relief devices and gauges used for pressure tests shall meet the requirements of ES&H standard 1.4.1.

4 Cold Mass Assembly – Model Numbers and Serial Numbers:

4.1 There are three model numbered cold mass assemblies in the helical dipole program for RHIC. (See Dwg. 12011050.). Snake magnets use cold mass assembly 12011050-01 and have serial numbers HRD1xx. Spin Rotators use assemblies 12011050-02 and –03. Assemblies 12011050-02 have serial numbers HRD2xx. Assemblies 1201050-03 have serial numbers HRD3xx. There are four magnet elements (“Storage Units”) in each cold mass assembly. There are four model numbered storage units in the Helical Dipole Program for RHIC. (See Dwg. 12011096.). The right hand, or left hand designation refer to the direction of helicity of the coils in the storage unit.

The snake cold mass assembly – 12011050-01 use four storage unit assemblies.

- 12011096-01 right hand vertical field, leads right with serial numbers starting with HDS-101.
- 12011096-02 right hand vertical field, leads left with serial numbers starting with HSD-201.

The spin rotator cold mass assemblies 12011050-02 and –03 use four storage unit assemblies.

- 12011096-03 right hand horizontal field, leads right with serial numbers starting with HSD301.
- 12011096-04 left hand horizontal field, leads left with serial numbers starting with HSD401.

4.2 This MAP is written for the assembly of the RHIC snake cold mass. Refer to engineering drawing 12011050-01. The spin rotator assembly follows a similar procedure but with different storage unit assemblies used and incorporates four cradles and support posts.

5 Introduction to the Assembly Procedure:

5.1 The procedure for the assembly of the helical cold mass has been planned to be performed in a series of operations. The operations will be performed using one assembly fixture (AF) and one weld rotator fixture (WRF). The two fixtures are located in Bldg. 902 under a fifteen ton crane.

Refer to tooling drawings 25-1747.01-5 for the (AF) - Sheets 1, 2, 3, 4, 5. Refer to tooling drawing 25-1747.23-5, "Fixed Notch Support Grinding". Setup the A.F. before starting to fabricate each cold mass as per this drawing. Remove all, "Notches", items 3&4 and clean all banking surfaces. Check that the four "Notches" that are match marked are placed in their proper position and torque the three bolts per notch to 400 in lb. Torque. Check that the spacing between notches is 9.616 ± .001 before starting a cold mass assembly. If this dimension is incorrect then contact the project engineer. "Do not attempt to correct for errors in the dimensions".

Refer to tooling drawings 25-1771.01-5 for the WRF.

5.2 In the assembly of the three models of cold masses the lead end of the cold mass being built is on the west end of the A.F..

5.3 There are seven major sub assembly operations to be performed in the assembly of the helical cold mass.

5.3.1 Assembly operations:

- Storage Unit Positioning & BPM Section 6
- Shell Assembly And Welding Section 7
- End Plate Assembly And Welding Section 8
- Electro Mechanical Bus Assembly Section 9
- End Volume Assembly And Welding Section 10
- Cradle Assembly Section 11
- Alignment Measuring Section12
- Pressure Leak Checking Section 13

6 Storage Unit Positioning

Refer to drawing 25-1747.01-5 – Sheet 4 – View 1,2,&3.

6.1 Place the respective storage units storage unit "A" and "B" onto the west end of the A.F. The fixture supports each storage unit on four rollers and two corner supports. The angular alignment of the storage unit on the A.F. is obtained by engaging notches in the storage unit, "lead end", end plate with the corner supports of the A.F. Place the storage unit onto the fixture using the overhead crane, supporting the storage unit from slings from the crane hook. Refer to view-1 on drawing 25-1747.01-5. In this operation the storage unit are placed upside down on the fixture. Refer to drawing 12011096, the storage unit assembly. The model number of the storage unit is stamped onto the end plate in the, "Upper", position of the storage unit. In placing the storage unit onto the A.F., the stamped number is to be down. See Appendix SK-1.

6.2 TIG weld beam tube to BPM assembly as per drawing number 12011205. Cold shock weld & vacuum leak check weld.

6.3 Engage alignment pin between BMP and plate/pin assy, then TIG weld plate to beam tube as per drawing number 12011205.

6.4 Refer to view-1 on drawing 25-1747.01-5. Install the NLE beam tube bumper disc. Support the weight of the beam tube/BPM sub assembly on slings from the crane. Carefully thread the beam tube through the bumper disc on storage unit "B" and "A".

6.5 Engage the pin sticking out of the beam tube/BPM sub assembly into the slot in the non lead end laminations of storage unit "B". The signal lead connections should be in the vertical and horizontal angular position of the A.F. See view "A" of drawing 25-1747.01-5.

6.6 Move the sliding carriage of the A.F. eastward to its stop position. Place the respective storage units storage unit "C" and "D" onto the east end of the A.F. Use same procedure as described in section 6.1 and 6.1.1. Refer to view-2 on drawing 25-1747.01-5.

6.7 Install the NLE beam tube bumper disc. Carefully thread the beam tube through the bumper disc on storage unit "C" and "D". Use same procedure as described in Section 6.3.1. Refer to view-2 on drawing 25-1747.01-5 (use beam tube "bullet" to center and guide tube).

6.8 Thread item five, plate, part number 12011127 onto the 3.5 inch diameter end of the beam tube. See drawing number 12011051 for proper positioning.

6.9 Weld the flange (P/N 12011054) to the beam tube. TIG weld as per drawing number 12011051. Cold shock weld and vacuum leak check weld.

6.10 Weld BPM assembly to flange. Refer to drawing 12011051. Cold shock weld.

6.11 Vacuum leak check complete beam tube BMP weldment.

6.12 Weld the plate 12011127 to the beam tube. TIG weld as per drawing 12011051. Locate the plate using items one and four on drawing 12011051.

6.13 Connect the pre assembled, "Signal Cable Loop", sub assembly to the four terminal connections on the BPM housing. Torque the connectors to 7 to 10 inch pounds. Note that the storage units are being assembled upside down thus the signal cables point downward from the BPM.

6.14 Perform a "Time Delay Reflectometry Test" on the signal cable assembly. This is performed by the RHIC Instrumentation Group staff.

6.15 Weld the upper vacuum enclosure 12011137, and the bottom half enclosure, 12011129 to the plates of the BPM vacuum enclosure.

6.16 Clamp with band clamps. Locate the stack tube on the upper vacuum enclosure vertically relative to the base of the AF. Note, this tube will penetrate through a hole in the upper shell. Before setup and welding, check that the pin in the lead end vacuum enclosure plate is engaged with the slot in the yoke laminations of SU B. Remember that the storage units are upside down.

6.17 TIG weld the longitudinal joints at 180^0. Weld both halves together opposite opposed. TIG weld the two circumferential welds in sequence. First weld the lead end, then weld the non lead end.

6.18 Cold shock the welds and vacuum leak check the BPM vacuum enclosure.

6.19 Place a temporary cap on the opening of the enclosure to prevent foreign material from getting in during subsequent operations.

6.20 Return storage units "C" and "D" to their proper location. Check over all length of storage unit assembly prior to wiring.

7 Shell Assembly and Welding

Refer to drawings 25-1747.01-5 – Sheets 4&5 – View 4,5,& 6.

7.1 Partial electrical wiring of warm up heaters. Refer to wiring diagram drawing 12019037, sheet two. Refer to view-3 on drawing 12011050. Do not route the wires so that the dipole or quadrupole bus slots are blocked.

7.2 Wire the heater terminals in the center of the cold mass at the BPM position. Wire heater terminals between SU “B” and “C”. Wire between heaters:

B-NLE-1 to B-NLE-7
B-NLE-2 to B-NLE-8
B-NLE-3 to C-NLE-1
B-NLE-4 to C-NLE-2
B-NLE-5 to C-NLE-7
B-NLE-6 to C-NLE-8
C-NLE-3 to C-NLE-5
C-NLE-4 to C-NLE-6

7.3 Wire the heater terminals at the opposing lead ends of storage unit “A” and “B”, and “C” and “D”. This wiring is only to be done on the bottom of the cold mass. Remember that the storage units are upside down. Wire between heaters:

A-LE-5 to A-LE-7	C-LE-5 to C-LE-7
A-LE-6 to A-LE-8	C-LE-6 to C-LE-8
B-LE-5 to B-LE-7	D-LE-5 to D-LE-7
B-LE-6 to B-LE-8	D-LE-6 to D-LE-8

7.4 Use wire markers to identify the termination of each conductor at a heater with the heater number. Example: A conductor going to heater A-LE-1 will be marked A-LE-1 where it meets the heater.

7.5 Quad Bus Conduit

7.5.1 Install the two-piece Nomex conduit through the four storage units from the non-lead end of the cold mass into the indicated yoke slot. At each gap between adjacent storage units, carefully guide the leading edge of the conduit into the next storage

unit.

7.5.2 In similar fashion install the quad trim and instrumentation conduit into the indicated yoke slot.

7.6 Check the longitudinal alignment of the backup strip slot in the yoke laminations of the four storage units. In the operations, since the laminations have been stacked, some may have become misaligned which may prevent the backup strip fitting in the slot. If alignment is necessary, tap lightly with a hammer and soft tool to rotate the laminations on the outer diameter of the coil assembly.

7.7 Install the weld backup strips, part number 12011062. Locate the backup strips end to end as per drawing 12011050. Refer to SK-2. Center the backup strip in the slot in the lamination. Tack weld the backup strip into the slot at 6 inch intervals, top and bottom of backup strip. Tacks should be 0.25 inches length max. With the weld not to protrude above the O.D. of the laminations.

7.8 Refer to drawing 12011117, “Lower Shell Weldment”. There are two configurations of lower shell weldment, (-01, -02). Part number 12011117-01 is the configuration for snake cold mass. The other is for spin rotator cold masses.

7.9 Lift the lower shell from its shipping crate using slings and lifting tools.

25-1800-11-5 – Helical Shell Lifting Tool

7.10 Lower the shell onto two wood 4 x 4’s placed on the floor. Place shell convex side up. Install the two, “Shell Lifting Tools” – 25-1800.11-5, on each end of the shell.

7.11 Lift the lower shell weldment using the cold mass lifting beam 25-1747.01-4 and lift from both ends. Use the two shell lifting tools. Ref. 25-1800.11.

7.12 Place the lower shell weldment on the Set-Up table in a position that allows access to the elbows on the shell from the inside of the shell.

7.13 Weld two pipe anchors 12011458 to the lower half shell and weld two pipe assemblies 12011466 with disc 12011118 to the half shell.

7.14 Attach pipe assemblies to anchors using MS35307-312 screws, AN960-C416 washers, MS35338-139 lock washers AND MS35649-2254 hex nuts.

7.15 Weld the two elbows from the inside of the shell. Leave two 0.3 gaps in the weld as shown on drawing 12011117.

7.16 Leak check the welds from the inside of the shell to the end of Power lead flex line. Leak check the welds to 2 x 10^{-10} cc. He/sec. on both power lead flex lines.

7.17 Insert the power lead assembly 12011282 into the flex line.

7.18 Thread the power lead assembly into the flex line from inside of The shell. The end of the power lead assembly that connects to the storage units must be 10.3 +0/-0.2 inches inside the inner radius of the shell.

7.19 Hypot the power leads and voltage Tap wiring to themselves and to ground.

CAUTION

This testing poses a Class "C" electrocution hazard. At least two Properly trained technicians must be present to perform this testing. When testing, a trained technician shall be stationed at any point the item under test is accessible to unauthorized people, and barriers shall be set up. Signs shall be posted reading "DANGER HIGH VOLTAGE" and warning lights shall be turned on.

CAUTION

Be sure the "Hypot" is grounded at all times. Failure To observe this caution may result in electrocution.

7.19.1 5 kV voltage standoff required for all conductors to each other and to ground. Max leakage 10μA.

7.19.2 Lift the shell and move it to a position where the shell is poised above the four storage units which are on the A.F.

7.20 Carefully line up the shell so that it can be slowly lowered onto the four storage units. Slowly lower the shell with the crane. At least three technicians aside from the crane operator should be watching this operation. One technician on each end of the cold mass and the third technician at the center of the shell. Be careful that the shell lifting tools on each end of the shell do not crush the protruding warm up heaters. Center the shell equally about the storage unit length within .06 inches. Center the shell circumferentially about the yoke laminations. Remove all fixturing and the handling tooling.

7.21 In this case, carefully lower the shell weldment onto the storage units being aware of

the power leads inside the shell. Guide the end of the power leads in between the storage unit wiring boards behind the cover board screws. This operation will require hand work by two technicians one at each power lead.

CAUTION

The crane cannot be in operation while the hands of technicians are guiding the power leads into position. Movement of the crane with the lower shell suspended over the storage units is not allowed until all technicians are clear in all respects of the shell/storage unit interface.

7.22 With the power lead ends in their guided position, slowly lower the shell weldment into position on the storage units. Check that the power leads have not been pinched or have they in any way interfered with the wiring on the ends of the storage units. Align the shell weldment on the storage units.

7.23 Rotate the storage units and half shell 180^0.

7.24 Clamp the lower shell to the storage unit using the ten 180^0 chain clamps. See SK-4. In between the 180^0 clamps at the center of each storage unit place a 360^0 roller chain clamp (if necessary). If the shells do not pull down to the backup strip at the point where the root pass will occur, "C" clamps may be used. Check the alignment of the shell longitudinally and circumferentially. Check the alignment of the shell at the eight 1.28 holes that expose the notches in the end plates. The holes must allow the seating of the A.F. into the end plate notches.

7.25 Tack weld the half shell to the backup strips using type 12010441-03 wire. A "C" clamp may be used to squeeze in the edges of the shell when tacking. Tacks shall be 0.5 inch long spaced at a 6 inch pitch end to end. Use two welders operating simultaneously, with one on each side of the cold mass progressing in step along the length. Leave the last three inches at each end unwelded.

7.26 When the welds have cooled, remove any "C" clamps and all of the 180^0 and 360^0 roller chain clamps.

7.27 Tape the outer ends of the two flex line assemblies to the outside of the shell weldment. Use generous amounts of duct tape to hold the flex line assembly to the shell. Tape and flex line assembly should be clear of the point of operation of the longitudinal shell weld by at least six inches.

7.28 Lift the integral four storage units and lower shell off the A.F. and place it on the (W.R.). Use lifting scheme 1 from appendix A.

7.29 Clear all personnel from around the W.R. Rotate the storage units and half shell 180^0 with the W.R.

7.30 Lift the storage units and half shell from the W.R. and return it to The A.F. Lower the integral four storage units and lower shell carefully onto the A.F. Guide the assembly on the crane so that it sits on the A.F. resting on the eight corner supports of the A.F. and rollers. Corner supports on north side are first loosened and slid back approximately 3/16" to allow for lower shell and storage unit to be installed without interference. They are to be re-tightened and re-set to proper position after installation. Each support point must protrude through holes in the lower shell. Slowly lower the assembly with the crane. At least three technicians aside from the crane operator should be watching this operation. One technician at the location of each of the four corner supports and one technician observing the roller supports.

CAUTION

Movement of the crane with the assembly over the A.F. is not allowed until all three technicians or any other person(s) are clear in all respects of the assembly/A.F. interface.

7.31 Remove all handling tooling and move the lifting beam away from the A.F. area.

7.32 Connecting Power Lead Assemblies To The Four Storage Units.

Refer to drawings 12011050, 12011096, and 12019037.

7.32.1 Remove the two .25-20 x .50 LG. Hex socket head cap screws, (item 21 of drawing 12011096), from the pivoting cover of the “A” storage unit. Carefully pivot the cover outward. The cover pivots on one shoulder screw, item 18 of drawing 12011096. Be careful not to snag the wiring on the pivoting cover with any projections from the wiring board next to the cover.

7.32.2 The power lead assembly comes through the lower half shell and is below the pivoted cover. It has nine pairs of insulated No. 10 AWG copper conductors and two jacketed, triple wired No. 28 AWG copper conductors for voltage taps.

7.32.3 One No. 10 AWG pair of conductors (part No. 12100031) is used to power the warmup heaters in storage units “A” and “B”.

7.32.4 Four No. 10 AWG pair of conductors (part No. 12100031) is used to power the coils in storage unit “A”. (Part No. 12101096-01).

7.32.5 Four No. 10 AWG pair of conductors (part No. 12100031) is used to power the coils in storage unit “B”. (Part No. 12011096-02).

7.32.6 One triple wired No. 28 AWG conductor is used for voltage taps on storage unit “A”.

7.32.7 One triple wired No. 28 AWG conductor is used for voltage taps on storage unit “B”.

7.32.8 If above conductors require shortening, it should be kept to an absolute minimum.

7.32.9 Connect one No. 10 AWG conductor of the pair chosen to power the warm up heaters to the lone solder lug on the cover. From the solder lug and a No. 10 AWG conductor to terminal “A-LE-3” of warm up heater “No. 3”. See drawing 12019037. This conductor must be routed so that it allows the pivoting cover to return to its fixed position, does not interfere with the main wiring board, and does not block the eventual passage of the dipole bus through the space between storage units. Use wire markers to identify the termination of the conductor at the heater and at the solder lug on the pivoting cover. Mark this conductor “A-Le-3”. Mark the same conductor “CKT-1” at the far end of the lead assembly.

7.32.10 Connect two pair of No. 10 AWG conductor to the red color cable on the pivoting cover. Use two barrel splices (part No. 12011252). One pair of No. 10 AWG conductors (part No. 12100031) from the power lead assembly. Connect to two conductors in the red cable on the cover with one barrel splice. Repeat this twice. Mark this conductor, “R-01”, at the splice on the cover and on the far end of the lead assembly.

7.32.11 Connect two pair of No. 10 AWG conductor to the brown color cable on the pivoting cover. Use the same procedure as described above. Mark this conductor, “B-01”, at the splice on the cover and on the far end of the lead assembly.

7.32.12 Connect the triple No. 28 AWG cable to the three solder lugs on the pivoting cover. These three conductors are color coded red, yellow, and black and correspond to the color code of the conductor going into each solder lug on the board. Mark this conductor, “VT-01”, at the solder lug, and on the far end of the lead assembly.

7.32.13 Solder all connections.

7.32.14 Lace all of the conductors from the power lead assembly to the pivoting cover through the holes provided in the cover with lacing cord. Use lacing cord, item 7, on drawing 12011096. Apply epoxy to knots.

7.32.15 Ring out all of the connections made from the far end of the power lead assembly to

the connection on the pivoting cover checking for continuity.

7.32.16 Carefully pivot the cover and connected leads inward into the storage unit. Be careful that no damage to the board or other conductors occurs.

7.32.17 Replace the two .25-20 x .50 long Hex socket head cap screws that hold the pivoting cover to the storage unit. Use Loctite, item No. 25 and drawing 12011096, to lock these screws.

7.32.18 Repeat operations 7.32.1 to 7.32.17 for the "B" storage units, part No. 12011096-02 with the following changes:

- Change 7.32.9 as follows: terminal "A-LE-3" of warm up heater "No. 3" becomes terminal "B-LE-1" of warm up heater "No. 1".
- Change 7.32.10 as follows: Conductor R-01 becomes conductor R-02.
- Change 7.32.11 as follows: Conductor B-01 becomes conductor B-02.
- Change 7.32.12 as follows: Conductor VT-01 becomes VT-02.

7.32.19 Repeat operations 7.32.1 to 7.32.17 for the "C" storage unit, part No. 12011096-01 with the following changes:

- Change 7.32.9 as follows: Terminal "A-LE-3" of warm up heater "No. 3" becomes "C-LE-4 of warm up heater "No. 4". "CKT-1" becomes "CKT-2".

7.32.20 Repeat operations 7.32.1 to 7.32.17 for the "D" storage unit, part No. 12011096-02 with the following changes:

- Change 7.32.9 as follows: Terminal "A-LE-3" of warm up heater "No. 3" becomes "D-LE-2" of warm up heater "No. 2". "CKT-1" becomes "CKT-2".

7.33 Electrical Testing Of Power Leads and Voltage Taps.

7.33.1 Re-check for electrical continuity from the end of the power lead assembly to each coil power lead. Test @ 1 AMP

"B01 to R01" Storage Unit-A
"B02 to R02" Storage Unit-B
"B01 to R01" Storage Unit-C
"B02 to R02" Storage Unit-D

7.33.2 Measure the resistance from the end of the power lead assembly to each voltage tap lead. Record this value in the traveler for each storage unit.

VT-01 R
VT-01 Y } Storage Unit-A
VT-01 B

VT-02 R
VT-02 Y } Storage Unit-B
VT-02 B

VT-01 R
VT-01 Y } Storage Unit-C
VT-01 B

VT-02 R
VT-02 Y } Storage Unit-D
VT-02 B

The resistance value should be 190-210 ohms in each case.

7.33.3 Perform hypot insulation test of the individual power leads and voltage taps for each storage unit. Ground the other power leads.

CAUTION

This testing poses a Class "C" electrocution hazard. At least two properly trained technicians must be present to perform this testing. When testing, a trained technician shall be stationed at any point the item under test is accessible to unauthorized people, and barriers shall be set up. Signs shall be posted reading "DANGER HIGH VOLTAGE" and warning lights shall be turned on.

CAUTION

Be sure the "Hypot" is grounded at all times. Failure to observe this caution may result in electrocution.

Hypot at 500 volts to ground with the voltage tap leads and brown leads floating. Max leakage 50 μA.

7.34 Perform partial electric wiring of warm up heaters. Refer to wiring diagram, drawing 12019037, sheet two. Wire the balance of heater terminals at the opposing lead ends of (S.U.) "A" and "B", and (S.U.) "C" and "D".

Wire Between Heaters:

A-LE-1	to	B-LE-3
A-LE-2	to	B-LE-4
A-LE-4	to	B-LE-2
C-LE-1	to	D-LE-3
C-LE-2	to	D-LE-4
C-LE-3	to	D-LE-1

7.35 Dipole Bus Conduit

7.35.1 Install the two-piece Nomex conduit through the four storage units from the non-lead end of the cold mass into the indicated yoke slot. At each gap between adjacent storage unit, carefully guide the leading edge of the conduit into the next storage unit.

7.35.2 In similar fashion install the dipole trim and instrumentation conduit into the indicated yoke slot.

7.36 Install the Upper Half Shell – Part No. 12011109.

7.36.1 Lift the upper shell from its shipping apparatus using slings and lifting tools.

25-1800-11-5 - Helical Shell Lifting Tool

7.36.2 Lift the shell and move it to a position where the shell is poised above the four storage units which are on the A.F. Use two slings and lifting tools.

7.36.3 Carefully line up the shell so that it can be slowly lowered onto the four storage units. The 3.94 dia. Hole in the upper half shell rough positions the shell relative to the four storage units. The BPM stack tube fits through this hole. Slowly lower the shell with the crane. At least three technicians aside from the crane operator should be watching this operation. One technician on each end of the cold mass and the third technician at the center of the shell. Be careful that the shell lifting tools on each end of the shell do not crush the protruding warm up heaters. The shell is nominally 431 inches long, and the length of the storage units end to end on the A.F. is nominally 429 inches long. Center the shell equally about the storage unit length within .06 inches. Center the shell circumferentially about the yoke laminations. Remove all fixturing and the handling tooling.

7.36.4 Gradually clamp the upper half shell to the yoke using the ten 180^0 chain clamps. In between the 180^0 clamps at the center of each storage unit place a 360^0 roller chain clamp. Slowly pull up on the four 360^0 clamps. With this condition the shells want to be in intimate contact with the yoke laminations throughout each storage unit. Check this at each penetration hole in the shell with feeler gages. It may be necessary to remove the upper shell and grind some material off the edge of the weld prep to achieve the above condition.

It is also necessary that the eight 1.28 dia. holes in the upper shell be centered on the eight end plate notches in the storage units. It may also be necessary to use “C” clamps to squeeze in the edges of the shell into the backup strip before proceeding to tack weld.

7.37 Tack Weld the Upper Shell to the Backup Strip Using Filler Wire Part No. 12010441-3.

7.37.1 A “C” clamp may be used to squeeze in the edges of the shell when tacking. Tacks shall be 0.5 inch long spaced at a 6 inch pitch end to end. Use two welders operating simultaneously with one on each side of the cold mass progressing in step along the length. Tacks shall be in the same location as on the bottom shell. Start at the center and work out first to the lead end then to the non lead end. Leave the last three inches at each end unwelded.

7.37.2 TIG root pass the longitudinal shell seams using filler wire part No. 12010441-03. Use two welders operating simultaneously with one on each side of the cold mass progressing in step along the length. Weld in from each end to the quarter points, then out from the center to the quarter points. Leave the last three inches at each end unwelded. Remove the chain clamps as weld approaches each clamp and re-apply the clamps behind the weld.

7.37.3 Make a filler pass on the longitudinal shell seams by MIG welding using MIG guns and filler wire part No. 12010441-02. Use two welders operating simultaneously with one on each side of the cold mass progressing in step along the length. Weld in from each end to the quarter points, then out from the center to the quarter points. Leave the last three inches at each end unwelded in order to fit the end plate inside the shells. Allow the welds to cool.

NOTE

Inspection of welds to be done later.

7.37.4 Remove all the chain clamps from the welded assembly.

7.38 Welding the BPM Stack Tube to the Upper Shell.

7.38.1 Place the, BPM disc, part No. 12011133 over the stack tube, down into contact with the shell. Tack weld the, BPM disc, in four places to the upper shell.

7.38.2 Tack weld the BPM stack tube to the BPM disc in four places.

7.38.3 Fillet weld the BPM disc to the upper shell, all around the disc. This is a 0.20 fillet weld.

7.38.4 Fillet weld the stack tube to the welded BPM disc, all around the stack tube. This is a 0.20 fillet weld.

8 End Plate Assembly and Welding

Refer to drawings: 12011050 – sheet 1
25-1747.01-5 – sheet 5 view 6 and 7
25-1747.44-5

8.1 Use a 50 foot steel tape to measure the actual length of the two welded shells. Record this length in the traveler. (The length of the shells as purchased was 431.0 ± .12 inches).

8.2 The distance from end plate face to end plate face is shown on dwg. 12011050. To allow for weld shrinkage, add .13 inches to this length. Subtract the resulting total from the maximum shell length recorded in step 8.1. Divide by 2 to obtain the offset for each end plate from the shell. Record offset.

$$\frac{\text{MAX SHELL LENGTH} - (\text{END PLATE LENGTH} + .13)}{2} = \text{offset}$$

8.3 Mount the cold mass end plate onto the end plate installation tool, part No. 2501747.44-5. Use end plate part No. 12011185-01. This end plate mounts onto the cold mass as per drawing No. 12011050, view of –01 shown.

8.4 Using the fixture, push the end plate into the shell until the measured offset from the end of the shell to the face of the end plate is equal to the calculated offset just recorded. Align the end plate with the top and bottom (.58 x 1.66 inch) slots in the end plate and laminations. In mounting the end plate be careful not to damage the dipole and quadrupole bus and warm up heater ends which thread through slots in the end plate.

8.5 Tack weld the end plate to the shells in six places, using 0.5 inch tacks. Tack weld the upper and lower shells approximately two inches from the top or bottom of the backup strip. Use a criss-cross tacking pattern to minimize cocking of the end plate. Then tack weld the upper shell to the end plate at the top of the end plate.

8.6 Remove the, “End Plate Installation Tool” and with the overhead crane, move it to the non lead end of the A.F. Repeat procedure 8.2 on the non lead end of the cold mass using end plate part No. 12011185-02.

8.7 Before tacking the non-lead end, check the overall length of the cold mass from the outside of each end plate. Use the same 50 foot steel tape that was used to measure the shells. The measured length shall be within ± .12 inches of the drawing dimension.

8.8 The non lead end plate should still be connected to the. “End Plate Installation Tool”.

Lock the fixture from movement and repeat welding per section 8.5.

8.9 Lift the cold mass assembly off the A.F. and place it on the W.R. Use lifting scheme from appendix A.

9 Electro-Mechanical Bus Assembly

9.1 Refer to drawing 12011050 – Sheets One and Three.

9.2 Bus Installation.

9.2.1 Fasten the bus conduits to the lead end endplate. Use washer plate 12011274 and screws item 46 on drawing 12011050. Perform this on the dipole and quadrupole bus conduits, and on the trim & instrumentation conduits.

9.2.2 Slide strips of .030 inch thick G-10 into the slots that have warm up heaters. Slip these strips into the slots between the heater and the weld to insulate the parts from the heat of the weld.

9.2.3 Complete the longitudinal seam welding of the shells in the three inch length adjacent to the end plates.

9.2.4 Setup the circumferential MIG weld head at the lead end plate weld prep.

9.2.5 Complete the welding of the end plate using MIG with filler wire 12010441-01. Allow 15 minutes after end plate welding for cooling before end volume welding.

9.2.6 Install the dipole and quadrupole power buses into their conduits. Install the trim & instrumentation cables into their conduits.

9.2.7 Perform hypot insulation test of the quadrupole and dipole bus to the cold mass. Hypot to 5kV. Max leakage 10 μA. This testing poses a Class “C”. electrocution hazard. At least two properly trained technicians must be present to perform this testing. When testing, a trained technician shall be stationed at any point the item under test is accessible to unauthorized people, and barriers shall be set up. Signs shall be posted reading “DANGER HIGH VOLTAGE” and warning lights shall be turned on.

9.2.8 Perform continuity and 5Kv hypot insulation test on Dipole and Quad instrumentation cable, trim bus cable and V-Tap cable.

CAUTION

Be sure the "Hypot" is grounded at all times. Failure to observe this caution may result in electrocution.

9.3 Installation of NLE Quadrupole Bus Extensions

9.3.1 Clean non-lead ends of bus bars and extension bars using alcohol first, then emery cloth, removing oils and oxides in that order in preparation for soldering.

9.3.2 Apply a thin film of soldering paste to the mating surfaces. Clean and coat copper screws similarly.

9.3.3 Fasten the upper and lower quad bus extension bars, part numbers 12011068 and 12011069, to the bus ends using screws. Tighten the screws.

9.3.4 Heat the joints and add solder as required. Re-tighten the screw as necessary before the solder hardens.

9.3.5 Clean off the soldered joint with alcohol to remove any excess soldering paste.

9.3.6 Apply a thin film of soldering paste to the extension bars and superconducting cable at the mating surface where they are to be soldered.

9.3.7 Solder the superconducting cable to the balance of the bus and the extension bar for the entire unsoldered length.

9.3.8 Clean off the soldered joint with alcohol to remove all of the excess soldering paste.

9.4 Installation of NLE Dipole Bus Extensions

9.4.1 Repeat the procedure in 9.3 to install the dipole bus bars and extension bars, part numbers 12011066 and 12011067.

9.5 Insulating Quadrupole Bus Extensions.

9.5.1 Wrap the individual quadrupole extensions with Kapton insulation. Wrap the bus and the extension bars with part number 12010181-07. Overlap the bus insulation by one inch and wrap each extension bar out to within 0.5 inches of the splice fastening hole. Wrap single pass half overlap. Secure ends of Kapton with half mil adhesive backed Kapton.

9.5.2 Place a piece of .030 thick x .62 width Nomex between the two extension bars where they converge. The Nomex is to start at point "A" (see drawing 12011050, sheet 3)

and go to within 0.5 inches of the splice fastening hole.

9.5.3 Overwrap the two extension bars together with the .030 thick Nomex sandwiched between using Kapton, part number 12010181-07. Overwrap the length of the Nomex. Wrap single pass half overlap. Wrap with fiberglass tape, 50% overlap.

9.6 Insulating Dipole Bus Extensions.

9.6.1 Repeat the procedure in 9.5 to insulate the dipole extension bars.

9.7 Installation of LE Quadrupole and Dipole Bus Extensions

9.7.1 Route instrumentation wire in separate loops for quad and dipole out through bus conduits.

9.7.2 Repeat the procedure in 9.4 using part numbers 12011071 and 12011072 for quad bus, and 12011076 and 12011080 for dipole bus.

9.8 Insulating LE Quadrupole and Dipole Bus Extensions

9.8.1 Repeat the procedure in 9.5 to insulate the quad and dipole extensions.

9.9 Installation of Quadrupole Flex Joint.

9.9.1 Install G-10 support bracket.

9.9.2 Assemble the quadrupole flex joint assembly, part number 12011126, and solder to the quadrupole extension bars.

9.9.3 Install clamp splice, part number 01025100, after soldering joint (solder to flex joint and extension bars).

9.9.4 Wrap the quadrupole extension bars and the balance of the bus with Kapton, part number 12010181-07. Overlap the bus insulation by one inch and wrap complete extension bar out to one inch beyond the insulation on the flex joint assembly. Wrap single pass half overlap. Secure ends of Kapton with lacing cord. Tie knot and secure with epoxy. Wrap with fiberglass tape, 50% overlap.

9.10 Installation of Dipole Flex Joint.

9.10.1 Install the dipole flex joint support bracket. Mount the flex joint to the bracket.

9.10.2 Repeat procedure in 9.9 to attach the dipole flex assembly to the extensions at the lead end of the cold mass.

9.10.3 Route instrumentation cables for quad and dipole around each flex joint. Secure and install through bus conduit.

9.11 Perform hypot insulation test of the quadrupole bus and dipole bus to the cold mass. Test bus to bus, and bus to ground. Hypot 5kV to ground. Max leakage current allowed is10 μA.

CAUTION

This testing poses a Class "C" electrocution hazard. At least two properly trained technicians must be present to perform this testing. When testing, a trained technician shall be stationed at any point the item under test is accessible to unauthorized people, and barriers shall be set up. Signs shall be posted reading "DANGER HIGH VOLTAGE" and warning lights shall be turned on.

CAUTION

Be sure the "Hypot" is grounded at all times. Failure to observe this caution may result in electrocution.

9.12 Wiring of Warm Up Heaters, Ends of Cold Mass Only.

9.12.1 Refer to wiring diagram, drawing 12019037, sheet two.

9.12.2 Wire the heater terminals on the lead end of the cold mass. NOTE: This is the NON-LEAD end of storage unit “A"

Wire Between Heaters:

A-NLE-1	to	A-NLE-7
A-NLE-2	to	A-NLE-8
A-NLE-3	to	A-NLE-5
A-NLE-4	to	A-NLE-6

9.12.3 Wire the heater terminals on the non-lead end of the cold mass. This is the non- lead end of storage unit “D”

Wire Between Heaters:

D-NLE-1	to	D-NLE-7
D-NLE-2	to	D-NLE-8
D-NLE-3	to	D-NLE-5
D-NLE-4	to	D-NLE-6

9.13 Insulation Tests

CAUTION

This testing poses a Class “C” electrocution hazard. At least two properly trained technicians must be present to perform this testing. When testing, a trained technician shall be stationed at any point the item under test is accessible to unauthorized people, and barriers shall be set up. Signs shall be posted reading “DANGER HIGH VOLTAGE” and warning lights shall be turned on.

CAUTION

Be sure the “Hypot” is grounded at all times. Failure to observe this caution may result in electrocution.

9.13.1 Ground circuit number 2. Hypot circuit number 1 to ground at 2kV. Max leakage 50 μA.

9.13.2 Ground circuit number 1. Hypot circuit number 2 to ground at 2kV. Max leakage 50 μA.

9.13.3 Perform D.C. resistance measurements on warm up heater circuit number 1 by

applying a current of one ampere to the circuit and checking the D.C. resistance of the circuit.

9.13.4 Perform D.C. resistance measurements on warm up heater circuit number 2 by applying a current of one ampere to the circuit and checking the D.C. resistance of the circuit.

10 End Volume Assembly and Welding

Refer to drawings:

12011050 – sheet 1
15-1747.01-5 – sheet 2 of 5
25-1747.01-5 – sheet 5 of 5; views 6 and 7
25-1747.44-5

10.1 Return cold mass to A.F., with the lower shell down, BPM stack tube up. The, "End Plate Installation Fixture", should be on the lead end of the A.F. It is positioned to hold an end plate. Lift this fixture off the A.F. with the overhead crane, rotate it 180^0 with the crane and lower it onto the A.F. It will then be positioned to hold the end volume. Re-configure the End Plate Installation Fixture for the loading of end volumes.

10.2 Mount the first end volume onto the, "End Plate Installation Fixture". Align buses and cables with end volume tubes. Using the fixture, push the end volume onto the end plate, threading buses through end volume, until it banks against the shoulder of the end plate. If the alignment of the end volume is correct, then proceed.

10.3 Tack weld the end volume sleeve to the end plate in six places. Use 0.5 inch tacks. Use a criss cross-tacking pattern to minimize cocking of the end volume. Equally space the tacks around the circumference of the end plate @ 60^0. Disconnect the, "End Plate Installation Fixture", from the end volume and with the overhead crane move it to the other end.

10.4 Repeat steps 10.2 and 10.3 on other end.

10.5 Lift the cold mass assembly off the A.F. and place it on the W.R. Use lifting scheme from Appendix A.

10.6 Complete the welding of the end volume using MIG with filler wire 12010441-01.

10.7 Move the circumferential MIG weld head and stand from the lead end to the non lead

end of the cold mass.

10.8 Repeat on the non-lead end plate and end volume.

10.9 Fillet weld the beam tube to the end volume at both lead and non lead end.

10.10 Electrical Checks

CAUTION

This testing poses a Class "C" electrocution hazard. At least two properly trained technicians must be present to perform this testing. When testing, a trained technician shall be stationed at any point the item under test is accessible to unauthorized people, and barriers shall be set up. Signs shall be posted reading "DANGER HIGH VOLTAGE" and warning lights shall be turned on.

CAUTION

Be sure the "Hypot" is grounded at all times. Failure to observe this caution may result in electrocution.

10.10.1 Ground circuit number 2. Hypot circuit number 1 to ground at 2kV. Max leakage 50 μA.

10.10.2 Ground circuit number 1. Hypot circuit number 2 to ground at 2kV. Max leakage 50 μA.

10.10.3 Perform D.C. resistance measurements on warm up heater circuit number 1 by applying a current of one ampere to the circuit and checking the D.C. resistance of the circuit.

10.10.4 Perform D.C. resistance measurements on warm up heater circuit number 2 by applying a current of one ampere to the circuit and checking the D.C. resistance of the circuit.

10.10.5 Perform hypot insulation test of the quadrupole bus and dipole bus to the cold mass. Test bus to bus, and bus to ground. Hypot 5kV to ground. Max leakage current allowed is10 μA.

10.10.6 Perform continuity and 5Kv Hypot insulation test on Dipole and Quad instrumentation cable, trim bus cable and V-Tap cable.

CAUTION

Be sure the "Hypot" is grounded at all times. Failure to observe this caution may result in electrocution.

10.11 Clear all personnel from around the W.R. rotate the cold mass assembly 180^0 with the W.R..

10.12 Place the cold mass on the A.F. with the top facing up. Verify engagement of the end plate notches with the fixture keys. Measure and record any gaps on the traveler data sheet.

10.13 Calibrate the (CLT) on a known level surface and record the inclinometer reading at this known “zero”.

10.14 Measure and record the twist defined by the four sets of end plate notches at the quarter points.

10.15 Move cold mass back to W.R. Use lifting scheme from Appendix A. Rotate the cold mass 180^0 – The cold mass is now upside down.

11 Cradle and Cover Patch Welding

Refer to drawing 25-1747.01-5 – sheet 5 view 8 & 9; and cradle support drawings 25-1747.34-5, 25-1747.35-5, 25-1747.36-5, and 25-1747.37-5. See drawing 25-1747.01-5 for location of cradle supports.

CAUTION

Refer to drawing 25-1747.23-5 and 25-17477.32.S. The “Notch” parts shown on this drawing must be removed from the (A.F.) for the operations of cradle assembly.

11.1 Place cradles on cold mass with alignment bar and tack weld two axial restraints per cradle on east end of each cradle (partial installation of axial restraints.).

11.2 Mount the cradle supports pedestals on the A.F. See drawing 25-1747.001-5 – sheets 1 and 2 for locating the supports. In mounting these supports, clean the mating surfaces carefully assuring no grit or chips are present to throw off the alignment of

the supports.

11.3 Clean the top surface of the three cradle supports and the bottom of the 3 cold mass cradles. Mount the three cradles on the supports, engaging the pins in the outboard cradles into the clearance holes in the mating cradle supports. Remember that each cradle has identifiable stampings on it that designate its location on the cold mass. See 7.3.7.2.1, and of this procedure. The cradles must be positioned in the same location that they were originally located at during partial cradle axial restraint welding

11.4 Lift the cold mass assembly off the W.R. and place it into the cradles (3 for snakes, 4 for spin rotators) on the A.F., touching the axial restraints. They must engage the axial restraints (two per cradle) as the cold mass is lowered. Use lifting scheme from Appendix A.

11.5 Calibrate the (CLT) and record the inclinometer offset.

11.6 Place the (CLT) onto the end plate notches of the “B” storage unit. Read the inclinometer to determine how far away from the previous “B” reading it is (Step 10.12) and in what direction the twist is.

11.7 Attach the band clamps at the “B” quarter points. Using a hydraulic jack against one boss of the clamp rotate the cold mass within the cradle to bring the inclinometer reading in agreement with the previous (Step 10.12) reading at the “B” notches. The cradle must be located to within 1.0 mrad absolute of the twist-free condition of the cold mass.

11.8 Repeat steps 11.6 and 11.7 as required at the other quarter point using “C” storage unit notches. Remove the band clamps after the best compromise has been attained between the ”B” and “C” readings.

11.9 Position and weld the remaining eight axial restraints at each of the three cradle locations (four cradle locations for spin rotators) so that all restraints are in contact with the sides of the cradles. There are 0.1 x 0.1 inch x .2 inch long fillet welds that attach each cradle to the axial restraints on the lower half shell. See drawing 12011050. Perform the welding on all cradles, first tacking and then building up the weld to its final size in SMALL additions to prevent as much shrinkage distortion as possible. Welding must be done by alternately welding one side of one cradle, then the opposite side of the next cradle, etc., moving back and forth along the length of the cold mass. The (CLT) should be used during the welding to help determine where the next weld should be made to limit distortion. Place the (CLT) across the set of end plate notches closest to the cradle being welded.

11.10 Perform a final inspection of cradle twist with respect to each other using the CLT and feeler gauges between the cradles and cradle supports. Record the data in the traveler.

11.11 Remove the cold mass from the A.F. and position it in the WR. Use lifting scheme from Appendix A.

11.12 Weld the cover patches over all the holes, both top and bottom, except for the ones over the 4 notches on top at the “b” and ”c” Storage units. These must remain open to be used in subsequent steps to determine the x,y positions of the fiducials on the end volumes relative to the transverse center of the storage units.

11.13 Inspect Welds - To be performed by qualified weld inspector:

- Cold Mass Longitudinal Joints
- End Plate and End Volume Circumferential Joints
- Cover Patch Welds
- Beam Tube Welds.

12 Twist/Straightness Check and Fiducial Survey

12.1 Move the cold mass from the W.R. to the A.F. The cold mass will sit on the cradle supports. Use lifting scheme from Appendix A.

12.2 Establish the offset reading for the (CLT) on a known level surface.

12.3 Measure and record the twist at the two sets of end plate notches. The measurements must be within 1.0 mrad of each other total deviation.

12.4 To correct for an out of tolerance condition, a plan must be devised with the

cognizant engineer and the welders experienced in repairing twist in CQS cold masses. The plan should describe how the pattern of weld on the outside of the shell should be laid down to remove enough twist to bring the readings within tolerance. Perform the correction welding according to the plan.

12.5 Record initial sag and straightness values in traveler. The cold mass sag at the end volumes must be within .02 inches as compared to the quarter points. Straightness as measured by a taut wire must be within 0.04 inches between cold mass end plates. Correct sag and straightness to within these limits if required by devising a plan with the cognizant engineer and the welders that will consist of adding transverse weld stripes across the shell.

NOTE

Sag correction calculations should take into account the additional "correction" expected from welding of the final four cover patches after survey.

12.6 If corrections are required, re-measure sag, straightness, and twist values. Allowable limits are same as those used before correction.

12.7 For this next procedure, the “MANCAT” laser computer measuring system must be set up around the A.F. The pedestals for the instruments can be positioned in the same location that was used to check alignment of the A.F.

12.8 Clean the notches at “A” and “B” and install precision ground temporary fiducial sockets in the notches using cyanoacrylate adhesive. The four temporary fiducial sockets must be identical to each other and symmetric about their bore axes. Install tooling balls in the fiducial sockets at the quarter points and on the end volumes. There are eight fiducial sockets.

12.9 Zero the “MANCAT” unit.

12.10 Take “X”, “Y”, and “Z” position readings of the center of the tooling balls located in each fiducial socket. Record the “X”, “Y” and “Z” position in the traveler for each location. Use the fiducial measurements at the quarter points to establish a datum based on a “least squares” analysis. Make four center punch marks approximately 3 inches away from each quarter point fiducial. Measure these positions also, and record.

NOTE

The cold mass will be installed in its position in the ring using the four "X", "Y", and "Z" position readings taken at the end volumes.

12.11 Insert a rolling target into beam tube. Check tube straightness from each end to the BPM at the center. Record sag at end points and center points using the quarter points to establish a datum plane. Compare w/cold mass.

12.12 Remove the TEMPORARY fiducial sockets ONLY; those on the end volumes must remain.

12.13 Using a height gage, measure the vertical position of each of the four fiducials on the end volumes relative to the table surface, and record the readings.

12.14 Weld on the four small discs 12011110 over the remaining notch holes. Weld the discs over storage units using a crisscross pattern similar to cradle welding. Use the same pattern from cold mass to cold mass.

12.15 Re-measure cold mass sag at the end volumes by re-measuring the fiducials with the height gage. Record data in the traveler and verify that it is still within .02 inches.

12.16 Check that the cold mass straightness is still within 0.04 inches using the taut wire. Record data in the traveler.

12.17 Perform a second survey as described in 12.7-12.12, re-establishing the datum based on a "least squares" analysis of the center punch marks. Any proposed corrections in cold mass twist or sag at this point must be approved by the cognizant engineer before being attempted.

13 Pressure Test Procedure

Refer to Drawings 25-1762.01-5 – sheets 1, 2, & 3

The Pressure Test Facility is an assembly depicted on the above assembly drawings. Its main components are a vacuum vessel with sealing end plates, support dollies, and rails for the support dollies to roll on. The cold mass sits on the support dollies and is allowed to roll into and out of the vacuum vessel. During the pressure test, a cold mass sitting on the dollies is in the vacuum vessel. The ends of the vacuum vessel are sealed. The inside of the cold mass is pressurized with Helium and the inside of the vacuum vessel is evacuated.

CAUTION

Take care not to damage the Power Lead and Instrumentation Wiring that must be rolled back on itself to fit into the can. Call for electronics assistance if you suspect any problems.

13.1 Install the two wire canisters, part number 25-1762.13 on the flex leads package of the cold mass.

13.2 Install the one conduit cap weldment on the non lead end of the cold mass to cover the protruding quad bus.

13.3 Install the three conduit cap weldments on the balance of protruding quad or dipole bus.

13.4 Install the beam tube flange caps to the lead and non-lead end of the beam tube.

13.5 Lift the cold mass with the overhead crane using lifting scheme from Appendix A and place it onto the three trolley frames.

13.6 Connect the winch chain from the vacuum tank end to the tow rod. Winch the Cold Mass into the vacuum vessel until the ends of the conduit cap weldments are a few inches away from the bolted and sealed end plate of the vacuum vessel.

13.7 Disconnect the winch chain from the tow rod and pull the chain completely out of the vacuum tank.

13.8 Mount the port hole cover with sealing “O” ring onto the end plate.

13.9 Lift the loose end plate, part number 25-1762.29 with the crane up to a position a few inches away from its bolted location on the vacuum vessel.

13.10 Reach into the vacuum vessel and extract the non connected end of the hose weldment. Connect this end to the sealing adapter on the end plate.

13.11 Mount the end plate with its sealing “O” ring onto the end of the vacuum vessel.

13.12 Connect the pressure port swage lock fitting to a helium bottle with a flex hose capable of 500 psi operating pressure through a regulator and gauge.

CAUTION

Move all operating persons away from the end plates of the vacuum tank end plates and the connection to the helium bottle.

13.13 Connect the vacuum pump line to the cover and start the mechanical pump. At 60 microns (60 x 10^{-3} Torr) start the turbo pump and valve it into the test loop. Close valve to the mechanical pump and turn off.

13.14 Calibrate the leak detector.

13.15 Allow to pump to approximately 10 microns before leak check is started.

13.16 Pressurize the Cold Mass to 330 psig in the vacuum environment with He and monitor the leak detector for 15 minutes.

13.17 The maximum acceptable leak rate at 330 psig is 4.7 x 10^{-9} cc He/Sec. This is equivalent to a leak rate of 2 x 10^{-10} Atm cc He /Sec.

13.18 Bleed the He pressure from the Cold Mass into the He return gas system and vent the vacuum system with nitrogen.

13.19 Remove the vacuum vessel cover from the vacuum vessel, disconnect the plumbing & tow the Cold Mass out of the vacuum vessel.

13.20 After successful completion of testing, sign and date a "*PASSED LEAK CHECK"* decal and apply to the Cold Mass.

14 Quality Assurance Provisions

14.1 The Quality Assurance provisions of this procedure require that the technician shall be responsible for performing all assembly operations in compliance with the procedural instructions contained herein and the recording of the results on the production traveler.

14.2 The technician is responsible for notifying the technical supervisor and/or the cognizant engineer of any discrepancies occurring during the performance of this procedure. All discrepancies shall be identified and reported in accordance with RHIC-MAG-Q-1004.

14.3 Measuring and test equipment used for this procedure shall contain a valid calibration label in accordance with RHIC-MAG-Q-1000.

15 Preparation for Delivery:

N/A

Appendix A

Lifting Scheme

Use the lifting beam (25-1765.10-4) with 8 shackles and short slings. Refer to lifting layout drawing number 25-1800.12.