SMD
Magnet Division Procedure

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Title: Helical Magnet - Snake & Spin Rotator Cryostat Assembly

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REVISION RECORD

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A	8/29/00		Initial Release	
B	8/28/01		Changes per ECN #MG1233	

1. Scope:

This specification establishes the procedure for Assembly of Helical Magnet Cryostat Assemblies.

2. Applicable Documents:

The following documents, in effect on the date of issue of this specification, form a part of this specification:

RHIC-MAG-M-7422	CQS Multi-Layer Insulation Fabrication
RHIC-MAG-M-7423	Multilayer Insulation Installation
RHIC-MAG-Q-1000	Control of Measurement Test Equipment
RHIC-MAG-Q-1004	Discrepancy Reporting Procedure
RHIC-MAG-R-7242	RHIC Hypot Testing
RHIC-MAG-R-7243	RHIC Continuity Testing
RHIC-MAG-R-7227	RHIC Electrical Resistance Measurement for Individual Coils
RHIC-MAG-R-7408	Magnet Polarity Check

3. Requirements:

3.1 Material/Equipment

Vise Grip Pliers	
Ultrasonic Welder (Portable)	
Weld Machine for Fusion Welding	
Welding Shield (Portable)	
Weld Protection for Insulation Blankets	
Mylar (.01")	
Cold Mass Assembly Fixture	BNL Dwg. 25-1747.01-5
Lifting Beam	BNL Dwg. 25-1764.10-5
Insertion Fixture	BNL Dwg. 25-1773.01-5
Molybdenum Disulfide Lubricant	MIL-M-7866
Power Lead Cap Leak Check fixture	
Power Lead Leak Check Fixture	
Torque Wrench	
Power Lead Installation Tool	25-1833.01-3
Conflat Flange, 2 3/4 inch, Blank	BNL Dwg. 110008
(4)Copper Gasket for 2 ¾” Conflat flange	BNL Dwg. 81015032-02

3.2 Safety Precautions

3.2.1 No welding shall take place unless all welding screens are in place around the welding station, and all personnel not directly involved with the welding process are outside the screens. Any personnel inside the screens shall wear protective gear to prevent eye injury, and shall be clothed to prevent burns caused by intense ultra-violet light.

3.2.2 Operators shall be trained by their cognizant technical supervisor and qualified in the operation of the required welding equipment.

3.2.3 All lifting and handling operations requiring overhead crane operations shall be performed by holders of valid Safety Awareness Certificates. They shall also be trained in the use of the appropriate lifting device by the Cognizant Engineer or Technical Supervisor.

3.2.4 Operators shall be trained by their Cognizant Technical Supervisor in the operation of the Insertion Fixture.

3.2.5 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 by the Training Coordinator.

3.2.6 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.

3.2.7 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 where 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.

3.2.8 Specific steps of this procedure contain electrical and mechanical assembly operations that impact the environment. Prior to performing these steps, personnel shall complete the applicable facility specific environmental training.

4.0 Procedure

4.1 Vacuum Vessel Preparation

4.1.1 Brush and vacuum the interior of the vacuum vessel, if required. Make sure that the threads in the leg surfaces are clean.

4.1.2 Check vacuum vessel leg sealing surfaces for any damages (radial scratches, nicks, etc.).

4.1.3 Install the 6 survey sockets 12065018 using loctite on the threads. Torque to 8-10 foot pounds. On spin rotator assemblies, the fixed post location does not receive survey sockets.

4.1.4 Bolt vacuum vessel onto insertion fixture with six bolts for snake and eight for spin.

4.1.5 Install lower aluminum post-alignment fixtures (loosely).

4.1.6 Slide in aluminum slide plate.

4.1.7 Secure slide plate to post-alignment fixture (lower) with filler piece.

4.1.8 Secure post-alignment fixture to vacuum vessel (lower).

4.1.9 Install slide plate extension.

4.1.10 Position tow-plate with post alignment on insertion fixture (upper).

4.1.11 Position heat shield blankets over tow plate (upper post alignment fixture will extend through post holes in blankets). Outer blanket goes on first, then inner blanket. Note: Be sure that no insulation is between tow plate and post alignment fixtures.

4.2 Cold mass Build Up

4.2.1 Place cold mass on rollover fixture using the lifting beam (25-1764.10-5). The cold mass must be in its proper orientation centered lengthwise on fixture, lead end west. Remove stick-on labels and clean outside of cold mass using alcohol or acetone.

4.2.2 Rotate the cold mass upside down.

4.2.3 Insulate the power leads, using insulation blankets 34045047. Wrap blankets around the power leads lengthwise. Tape using transparent tape 12100072 and tie with lacing cord 12010236 every 3" down the length of power lead.

4.2.4 Install posts. Remove lower steel ring from lower posts. Apply Molybdenum Disulfide to top flange of each sliding post 12105093 before attaching to the cradle. Install spring blocks 12105145 to each sliding post, applying Molybdenum Disulfide to their contact surfaces. Assemble the post to the cradle using guide pin sleeve and proper hardware. Check assembly drawing for proper guide pin sleeve location. Torque to 30 foot pounds.

Note

Make sure guide pin is installed in proper orientation. Arrow points towards nearest end of magnet.

Note

There are 3 sliding posts for spin rotator assemblies. Refer to Figure 1.

4.2.5 Install 2 post spacers 12100020 and 2 post clamps 12100018 to each sliding cradle using 6 MS35338-141 lock washers and 6 MS35308-365 screws. Apply anti-seize to the screw threads. Torque screws to 20 foot-pounds. Install fixed post to fixed cradle with bolts and torque to 30 foot-pounds.

4.2.6 Mark lower post halves as follows: LE, CTR.,NLE (and SR for post assembly used on spin rotators). Refer to Figure 1. Apply unique witness marks across post halves to allow same rotational positioning when bottom halves are reinstalled later.

4.2.7 Rotate cold mass to upright position and move to set-up table.

4.2.8 Measure height from table to top of lower post flange in four places, 90 degrees apart, to nearest .001. Record readings in traveler and calculate average.

4.2.9 Mark heat shield mounting plates, LE,CTR,NLE,(SR). Measure thickness in four places, near I.D. 90 degrees apart, to the nearest .001. Record readings in traveler and calculate average.

4.2.10 Mark post spacers LE,CTR,NLE,(SR). Measure to nearest .001, 90 degrees apart, four places near I.D. Record readings in traveler and calculate average.

4.2.11 Calculate the shim thickness required, record on traveler, make up shim packs and identify as LE,CTR, NLE, (SR).

4.2.12 Lift cold mass and remove lower posts. Place cold mass on set-up table.

4.2.13 Insulate cold mass.

4.2.14 Lift cold mass and place on assembly fixture pedestals.

4.2.15 Bolt the Helium Return pipe to the "fixed" cradle. Note that the six pipe supports must be properly positioned along the pipe length prior to bolting to the "fixed" cradle. Refer to drawing 12011395 for call-out of proper hardware and insulating spacers.

4.2.16 Verify that the return pipe is in its correct position.

4.2.17 Fasten the Supply and Utility pipe assembly to the "fixed" cradle. Note that the pipe supports must be properly positioned along the pipe length prior to bolting to the "fixed" cradle. Refer to drawing 12011395 for call-out of proper hardware and insulating spacers.

4.2.18 Position the lower heat shield with lower heat shield mounting plates on set up table and secure with tie rods. Match mounting plates as marked with correct positions on table.

4.2.19 Position both rush line blankets over lower heat shield. Align post holes outer blanket first, inner second.

4.2.20 Lift cold mass and position cold mass over lower heat shield 1/8” from lower heat shield (Posts extend through holes in blankets).

4.2.21 Attach lower heat shield to upper posts (loosely) with (2) .250-20 screws per post. Assure that no insulation is between posts and lower heat shield.

4.2.22 Lower the cold mass to contact lower heat shield and secure to upper posts by tightening the (2) .250-20 screws per post.

4.2.23 Tie inner heat shield blankets up and out of the way.

4.2.24 Lift cold mass with lower heat shield and inner heatshield blankets and place on slide plate on insertion fixture.

4.2.25 Ultrasonic weld inner and outer rush line blankets by interleaving every five or six layers of insulation. Be sure to use a stainless steel strip to back-up when making ultrasonic welds. During the welding of the last layer, spacer material 12060093-17 must be put on top of the outer layer of aluminized mylar to reinforce welds. With Kevlar cord, tie blankets up to pull insulation away from lower heat shield. Slit the magnet Outer #1 and #2 blankets through the heat shield power lead hole, two places, to allow the power lead flex hose and BPM leads to pass through the blankets easily.

4.2.26 Install the upper heat shield on top of the lower, sure that the upper heat shield is even on both ends with the lower heat shield. Make sure that the penetrations in the heat shield are in their correct positions in accordance with the model number of the magnet that is being assembled (see assembly drawing), Make sure BPM leads are visible and both power leads pull cords are located in their proper penetrations in the upper heat shield.

4.2.27 Fusion weld both sides of the heat shield and allow to cool. Make sure that the weld blanket tool is used with vise grip pliers as needed. Make sure weld screen is in place during welding operation to avoid injury.

4.2.28 Interleave and ultrasonic weld approximately every ten layers of the inner heat shield blanket. Use a stainless steel backing strip when welding. Slit the heat shield inner blanket for the power lead hole, two places, to allow the power lead flex hose and BPM leads to pass.

4.2.29 Interleave and ultrasonic weld approximately every ten layers of the outer heat shield blanket. Spacer material 12060093-17 must be used on top of the last layer to reinforce welds. Use stainless backing strip when welding. Slit the heat shield outer blanket for the power lead hole, two places, to allow the power lead flex hose and BPM leads to pass.

4.2.30 Wrap the temporary .010 mylar shield around the outside of the insulation blankets and tape into position at the end volumes.

4.3 Cold Mass Installation

4.3.1. Winch the cold mass assembly into the vacuum vessel. Align the center upper post on the cold mass with the corresponding vacuum vessel post hole center using the post alignment fixture. **Watch for interference during pull-in**.

4.3.2 Remove mylar.

4.3.3 Place spacer, shims and lower post over center lifting mechanism. Lift cold mass with two A-frame gantries and center hydraulic lift mechanism.

4.3.4 Remove aluminum extension filler piece and tow-plate.

4.3.5 Remove slide plate and post upper alignment fixtures.

4.3.6 Loosely install lower posts with spacers and shims to remaining upper posts with the correct bolts and lock washers. Use anti-seize compound 12010109 on bolts.

4.3.7 Attach lower posts, with correct hardware, (capturing the laminated shim and spacer 12011399) to vacuum vessel, torque bolts to 45 foot pounds.

4.3.8 Lower cold mass and remove lifting tooling.

4.3.9 Tighten post bolts to 45 foot-pounds.

4.3.10 Install baffle assemblies (12065070) into post assemblies.

4.3.11 Install port covers (12065091) with spacers (12011398) and greased “O” rings (NAS1593-453) with Apiezon “M” grease and torque bolts to 25 foot pounds.

4.3.12 Route cold mass power lead flex lines and BPM leads through the vacuum vessel turrets.

4.3.13 Remove vacuum vessel hold down bolts and move assembly to cold mass assembly station.

4.4 Vacuum Leak Check and Power Lead Welding

4.4.1 Feed the flex line through the stack until it extends above the top of the cryostat. Fuse-weld (no filler wire) the flex line to the mounting flange. Make sure the cup welded to the flex line seats in the flat on the underside of the mounting flange and the power lead wires do not touch the ID of the flex line near the point of welding.

4.4.2 Prepare for Leak and Pressure Detection Procedure.

4.4.3 Attach power lead cap leak check fixture to mounting flange.

4.4.4 Calibrate the leak detector.

4.4.5 Connect and start leak detector.

4.4.6 Using compressed helium gas, spray helium on weld.

4.4.7 Verify no leaks greater than 2.0×10^{-10} Atm. cc./sec helium, vent vacuum, and remove the fixtures.

4.4.8 Feed the flex line back into the cryostat until the mounting flange sits on top of the five-inch turret.

4.4.9 Weld mounting flange to the cryostat stack as per Dwg. Use 308L filler rod.

CAUTION

During installation care must be taken to avoid putting dents and flat spots in the flexible hose sections of the conduit. If flattening of the flex-hose does occur notify the RHIC Vacuum Group supervisor prior to welding of the conduit weld plate to the cryostat.

CAUTION

Make sure weld screen is in place.

4.5 BPM Signal Cables

4.5.1 Mount the BPM leads as shown in figure 2.

4.5.2 Facing lead end of magnet, the “horizontal” BPM leads (3 & 9) will come out of left side flange. “Vertical” leads (6 & 12) will come out of right side flange. See Figure 2 and view A-A.

4.5.3 Weld Feedthru to Center Turret in orientation as shown on assembly drawing

CAUTION

Make sure weld screen is in place.

4.6 Blank Turrets and Flanges

4.6.1 Weld two blank cover plates to unused vacuum vessel turrets.

4.6.2 Weld rolled flanges to both pipes on end volumes.

4.6.3 Weld beam tube flanges to both ends of the beam tube.

CAUTION

Make sure weld screen is in place.

4.7 Helical Magnet Power Leads

4.7.1 Label all power leads and V taps. The power leads should be (8) to (9) inches long from top of lower flange. (Do not cut).

4.7.2 Cover the two aluminum stand-offs with Tefzel heat shrink tubing (3/4 x 6-1/2). Bend over at end to cover end.

4.7.3 Trim wire sets (B+, B-, A+, A-) equal lengths. Strip to 1.125 inch. Apply flux to wire; slip lug over (4) wires leaving .125 inch of each wire free of lug for soldering.

4.7.4 Slide Tefzel heat shrink tubing (3/4 x5) over each set of wires.

4.7.5 Crimp each lug in two spots near each other toward the end of the lug with a Green T&B lug crimper.

4.7.6 Mount the two aluminum stand offs in their proper location.

4.7.7 Mount the assembly tool to hold the feedthru in place for further assembly.

4.7.8 Slide the crimped lugs over the ceramic power lead of the feedthru. (Be sure to apply flux to connection).

4.8 Power Leads

4.8.1 Solder the four power leads to ceramic feedthru. (Clean off flux).

NOTE

Ensure unused solder is recycled or disposed of properly.

4.8.2 Slide 1/8 dia. heat shrink up over all leads. Heat upper side first so that it will slide in between the copper and ceramic.

4.9 Heater Wires

4.9.1 Crimp lug to wire; slip Tefzel heat shrink tubing over wire and lug (1/4 x 3). (Do not shrink).

4.9.2 Crimp wire and lug to feedthru then solder.

4.9.3 Slide heat shrink over ceramic (1/4) then heat.

4.10 Voltage Taps

4.10.1 Strip 1.125 inch of wire. Tin end of wire lightly. (Be sure to leave a service loop). Wrap the wire around itself to obtain proper shape. Tack end to hold wire together.

4.10.2 Slide the Tefzel heat shrink tubing up and over the V-tap wire (1/4 x 2). Slide the wire over the proper feedthru lug and solder.

4.10.3 Slide 3/16 dia. heat shrink up and over the connection, then heat.

4.10.4 Remove Assembly Fixture.

4.10.5 Slide can over feedthru assembly and tack into place.

4.10.6 Assemble the (4) .312-18 threaded rod to the (4) .312-18 holes in the feedthru (12011385) with (4) .312-18 nuts. Tighten nuts. Place (4) .312-18 nuts onto the threaded rod approximately 5.25 inches from the face of feedthru (12011385) to the top of each nut.

4.10.7 Assemble G-10 mounting plate (12011416) with (2) hypertronic connectors and (2) connectors with .250-20 bolts.

4.10.8 Place the G-10 mounting plate (12011416) over the (4) .312-18 threaded rods until it rests on the (4) .312-18 nuts. Mount the mounting plate (12011416) with (4) .312-18 nuts.

4.10.9 Wire V-tap connectors.

4.10.10 Place heat shrink over each wire.

4.10.11 Wire J1-J4 as per drawing 12019037.

4.10.12 Heat shrink all wires. Be sure to leave service loop in wire. (Heat shrink with ¼ inch lug on one side and No. 22 wire on other side).

4.10.13 Mounting Feedthru Cables.

4.10.13.1 Mount (8) terminal support angles (12011417) to G-10 mounting plate with (16) .250-20x socket head cap screws.

4.10.13.2 Bolt (4) terminal blocks (12011414) of power lead assembly (12011464) to G-10 mounting plate with (8) .250-20x socket head cap screws.

4.10.13.3 Clean (4) .500 dia. power leads on feedthru (12011385) and coat with Penetrox E (thin coat).

4.10.13.4 Slide copper terminal (12011413) of power lead assembly (12011464) over each lead.

CAUTION

Do not exert any unnecessary force on the ceramic feedthru leads. Leak tightness can be ruined.

4.10.13.5 Apply dry moly to all bolts. Place the following hardware in each of the terminal blocks (12011413) of the power lead assembly (12011464) (3) .250–20 x 1-1/2; (3) ¼ washers under each bolt head; (9) bellville washers (3) over each bolt in the same direction; (3) .250–20 hex nuts. Place the resistor lug under the head of the top bolt. Finger tighten all three nuts.

4.10.13.6 Using hydraulic assembly tool No. 25-1833.01, starting from the top bolt going down 1, 2 & 3, apply the following pressure and tighten bolt slightly.

Apply (1) 2000 psig then (1) 1800 psig
(2) 1500 psig then (2) 1200 psig
(3) 1000 psig then (3) 800 psig

4.11 Perform Electrical Tests

4.11.1 Perform resistance check of voltage taps following RHIC-MAG-R-7227

4.11.2 Perform resistance check & Hypot of warm-up heaters following RHIC-MAG-R-7227 & RHIC-MAG-R-7242.

4.11.3 Perform resistance check of 4 individual coil assemblies A through D following RHIC-MAG-R-7227.

4.11.4 Hypot individual coils to each other and to ground following RHIC-MAG-R-7242. Use 500 Volts maximum test for all coils.

4.11.5 Hand assemble power lead assembly hardware to angle and terminal block assembly (2) .500 – 13 x 25 hex head bolts; (4) .500 washers; (2) .500 lock washers; (2) .500 – 13 nuts.

4.11.6 Weld can to cap (12011383) and feedthru (12011385).

4.11.7 Assemble (2) half shells (12011420) with vent ports with (2) .250-20 x .625 hex head bolts; (2) .250 washers; (2) .250 lock washers and (2) .250-20 nuts.

4.11.8 Tighten (4) .312-16 nuts on G-10 mounting plate (12011416) until tight.

4.11.9 Place (4) G-10 covers to bottom of G-10 mounting plate (12011416) with (8) .250-20 x .5 socket head cap screws.

4.11.10 Attach (4) dust covers to G-10 mounting plate (12011416) for assembly in field.

4.11.11 Assembly cover assembly to G-10 mounting plate (12011416) with (7) .250-20 x .500 and (7) .250 washers.

4.12 Final Survey

4.12.1 Place magnet on assembly stands.

4.12.2 Establish the “zero” reading for the (CLT) on a known level surface.

4.12.3 Take the readings of the end volume fiducials at both ends.

4.12.4 Take the readings of the six fiducial sockets, three on each side.

4.12.5 Insert a rolling target into the beam tube. Check tube straightness from each end to the BPM at the center. Record sag at end points and center points using the end volume fiducials to establish a datum plane. Compare with cold mass data taken.

4.13 Final Preparation

4.13.1 Check paint finish and touch up with siliconized paint 12010237 as required.

4.13.2 Apply labels Verify that the information on the labels agrees with the magnet traveler.

4.13.3 Apply tape stripes yellow or blue 12100042 as required Inspect the beam tube and He lines for foreign matter. Clean the He lines by using clean, dry nitrogen gas to force a close-fitting ball of aluminum foil wrapped with several layers of lint-free cloth saturated with ethyl alcohol through the He lines. Continue the procedure until no foreign matter is seen on the lint-free cloth. Do NOT clean the beam tube by forcing the cleaning ball through the BPM, cleaning ball may be caught inside. Beam tube can only be cleaned from both sides since BPM is in center.

4.13.4 Enclose the ends of the magnet vacuum vessel with plastic sheet by taping the sheet to the vacuum vessel at each end. The Helical Magnet is now ready to ship to the RHIC ring.

5 Quality Assurance Provisions:

5.1 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.

5.2 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.

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

6 Preparation for Delivery:

N/A

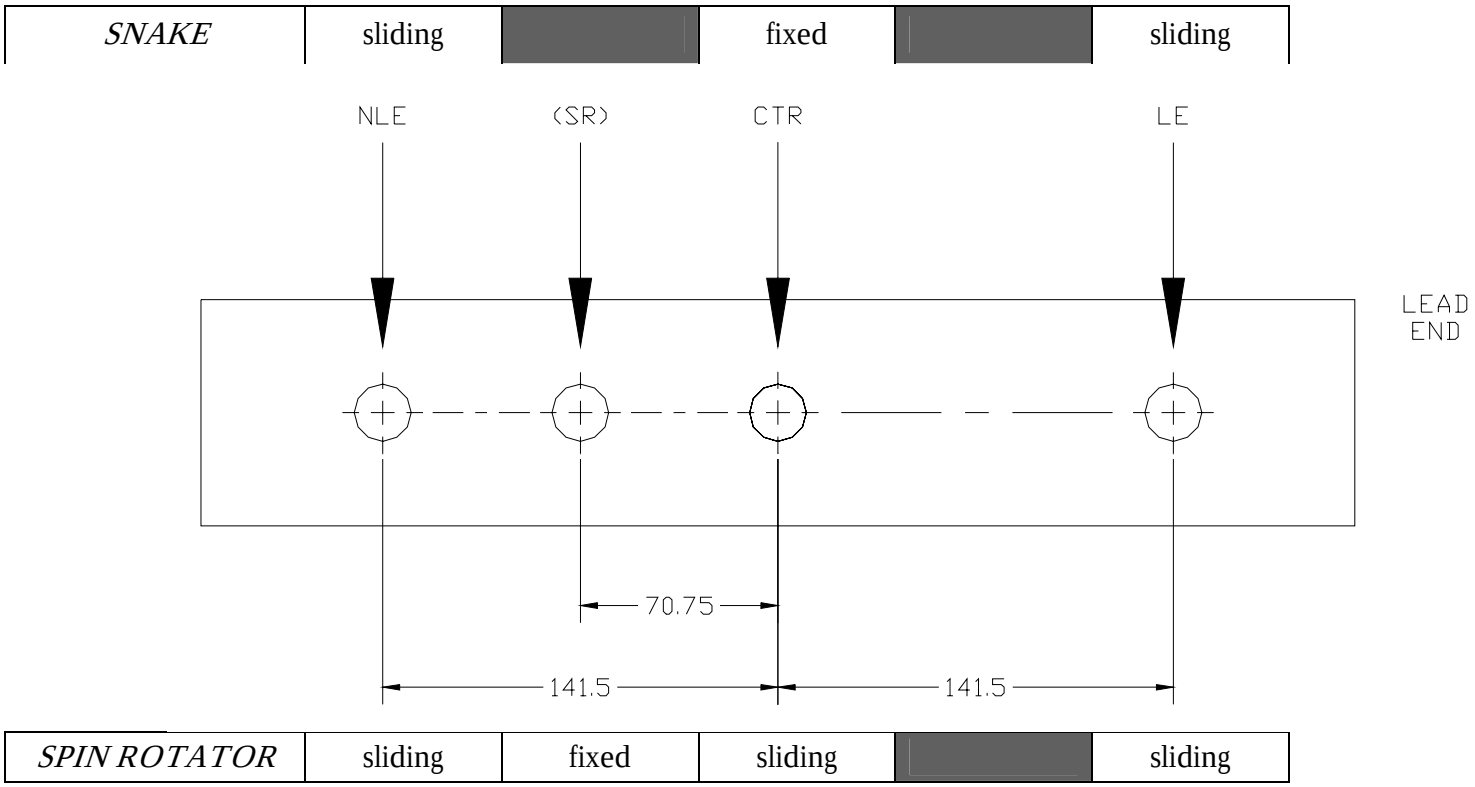

Figure 1

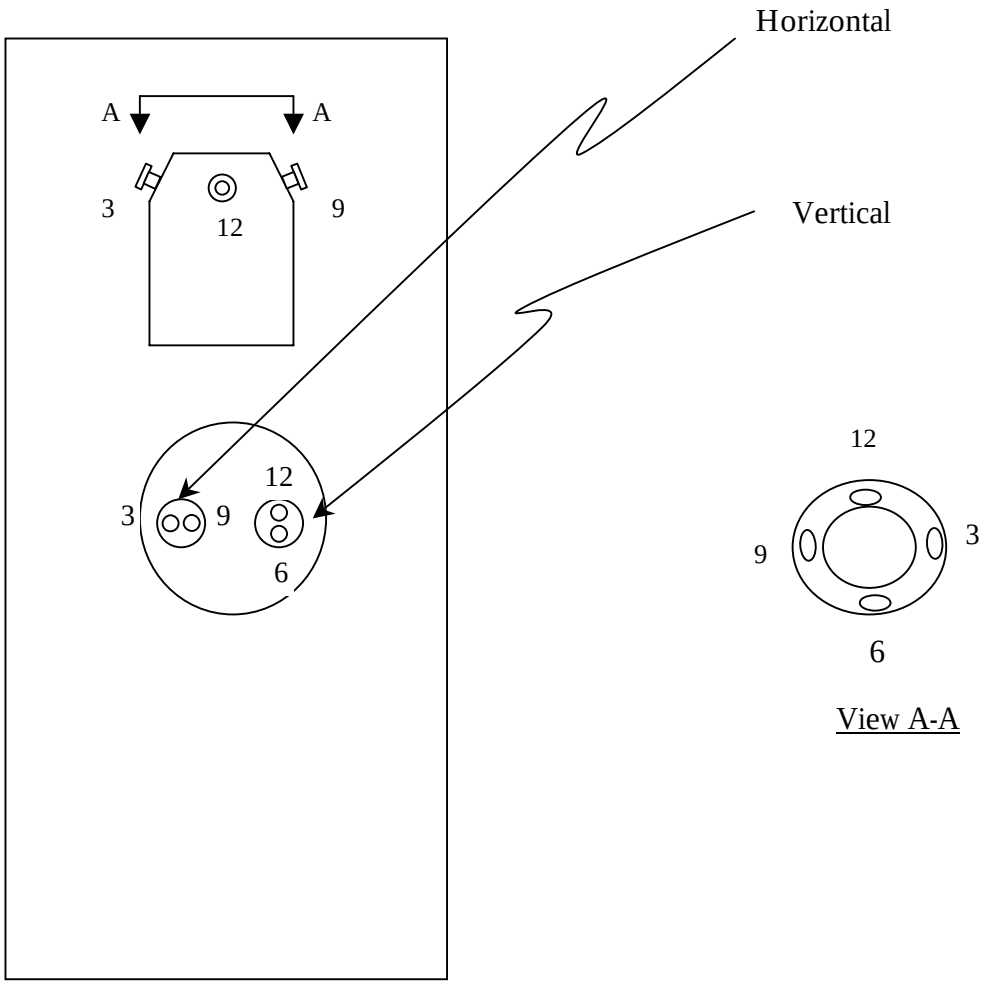

Figure 2