MEPI Assembly and Installation Procedures

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1. SCOPE

The purpose of this document is to provide step-by-step assembly instructions to be used for the installation of the electromagnetic pre-isolator (MEPI) on a HAM chamber.

2. APPLICABLE DOCUMENTS

Listed below are all of the applicable and referenced documents for this task procedure.

D020182	MEPI Top Assembly (HAM)	
D020183	Electromagnetic Actuator Assembly	
D020253	Base Plate	
D972501	LIGO HAM Top Assembly	
D972609	HAM Pier	-
E980268	HAM SEI Installation Procedures	-
-	-	
-	-	
-	-	

3. ASSEMBLY OF ELECTROMAGNETIC ACTUATOR

1. The voice coil actuator is a parts-set consisting of a coil assembly and a permanent magnet assembly. The two parts must be supported and aligned to allow relative movement. In the final assembly, the weight of the stack will be supported by springs, which will then be adjusted to place the optics table into its final aligned position. The electromagnetic actuator must then be placed so it is centered while the optics table is in this final aligned position. Prepare the actuator by placing plastic shims in the gaps between the coil and the magnet. The nominal shims required are:

(2) .04” shims
(2) .125” shims
(2) .250” shims

Additional shims may be required due to the tolerance in the actuator. Care must be taken to prevent the coil winding from rubbing. Shims should be long enough so that they can be removed later on. Rubber bands tied around the ends may be required to prevent the shims from falling out.

Caution: Do not force shims into gaps. Damage to the actuators field or coil may occur.

2. Pre-assemble the position sensor assembly items 8 thru 18 on assembly drawing D020183. Torque 4-40 flat head screws holding the DIT-5200-20N to 5 in-lbs.

3. Mount the base D020253 and flag D020255 to the actuator. Be sure to assemble with face 1 (per D020253) facing down away from the actuator. Assemble 4 units with wires in position ‘A’ for right hand assemblies and 4 units with wires facing position ‘B” for left hand units. Torque ¼-20 screws to 75 in-lbs and 3/8-16 screws to 236 in-lbs.

4. Mount position sensor assembly to push bar D020256 with ¼-20 set screw torqued to 75 in-lbs.

5. Assemble push bar with the position sensor assembly and coil insulators D020264 to actuator. Roughly center the flag between the two position sensors. Torque 3/8-16 bolts with flat washers to 236 in-lbs

6. Carefully store the assemblies in a safe place, being careful not to place stress on the shims placed between the coil and field assemblies.

7. **Cautions and Safeguards**

The sensor faces may be damaged if allowed to strike the target or other hard surface.
Please keep the protective plastic caps in place until you are ready to install the sensors.
The maximum input voltage to the DIT-5200 is +/-15.5V, exceeding this input voltage will cause damage to the DIT-5200.
Caution: The ground pin wiring is the red wire because the color code scheme was in order of the spectrum. Be careful not to connect the ground pin to the supply voltage or you will damage the unit.

4. PREPARATION OF MEPI HOUSING ASSEMBLY

1. Prepare a work area consisting of a workbench of 1000 lb minimum load capacity and 30" wide access on each side.

Caution: Many of the parts used in this installation weigh up to several hundred pounds. Keep fingers out of pinch areas and use extreme caution while lifting heavy objects.

2. Lift the pre-isolator housing D020004 onto the bench with either a crane or a hoist. A protective non-sliding mat should be placed between the housing and the bench.

3. Assemble the rear brace assembly. If a right-handed assembly is being built, assemble rear plate D020279, right brace D020249, and actuator bracket D020277.

4. If a left handed assembly is being built use rear plate D020279, left brace D020276, and actuator bracket D020252.

5. Slide the 3 piece assembly toward the back wall and loosely tighten the (4) 1/2 –20 x 1 ¼ SHCS. These screws will be properly tightened later on.

6. Screw a 1/2- 20 x 2" Hex head screw into the top of D020279. Adjust the screw until the top of the head is 1.00" above the top of the plate.

7. Prepare the boot for assembly to the housing. Assemble the crossbeam attachment plate D020008 with (6) 3/8 –16 x 1.75 long SHCS to the boot D020195. Torque to 236 in-lbs.

8. Assemble the L4C kinematic plates D020258 to the side and bottom of the boot D020195 with 1/4-20 x .75 SHCS. Torque to 75 in-lbs.

9. Assemble the L4C tube mount D020259 to the kinematic plates. The side mount has the 1.0" diameter hole facing down. Hands tighten the (3) 1/2-20 x 1.25 SHCS. Screw (3) ball tipped screws with compression spring (item 42 on D020182) into each tube mount until contact is made with the hardened grooves.

10. Assemble (2) vertical actuator arms D020261 to the bottom of the boot with (4) 3/8- 16 x 1.0 SHCS hand tight.

11. Lift the crossbeam boot now partially assembled using lift plate DXXXXXX, eyehooks and a lift chain. Place it in position slightly above the 1/2- 20 hex head bolt.

12. Screw a 1/2-20 x 2" hex head cap screw into the top of D020250 and assemble to the front braces with 1/2-13 x 1.0" SHCS.

13. Screw in the (7) 1/2-20 x 2" SHCS into the front, rear and side braces until they are approximately .06" from the boot. These are used to adjust the boot position and to tie down the boot.

14. Lower the boot until it rests on the 2 hex head bolts. Tighten the (7) side bolts to secure the boot.

15. Remove the lift chain, eyehooks and lift plate.

16. Place gauge block DXXXXXX between the back wall and the boot. Slide the boot using the (4) 1/2-20 x 2.0" SHCS in the front and rear plates until the boot is spaced 5.540" from the back wall. Adjust the three side stops until the boot is centered.

17. Adjust the (9) ½-20 adjustment screws until the top plate is parallel to the top of the base plate and at a distance of 22.562 +/- .015.

18. Repeat the steps above for two right and two left MEPI assemblies.

19. The remaining assembly and alignment will be done with the housing assembly installed on the HAM.

5. PREPARATION FOR INSTALLATION

1. Procure the following special equipment for this task:
a. Load cell (dynamometer) for crane, with 6000 lb maximum range and 10 lb gradations (Eilon Engineering, RON 2000 Shackle Type, Catalog no. S-03)
b. Overhead HAM Crossbeam Bracket, with Shims, Eyebolt, Fasteners and Washer
c. Transfer table, for transferring equipment between the fork lift platform and the top of the Scissors Table
d. Shim blocks and crowbars for separating pinned pier stack components (if needed).

2. Coordinate task schedule with the Detector Commissioning Manager (if commissioning is occurring; otherwise, coordinate with Observatory Manager).

3. Confirm shackle/clevis fit has been checked, and machine screw jack has been reworked, as called out in the Notes of drawing D020280.

4. Confirm all equipment to be used for this task fits and is fully functional. Confirm that the transfer table is securely attached to the forklift platform, and that the forklift platform is securely attached to the forklift.

5. Setup beam monitors as appropriate to monitor possible shifting of the optic(s) in the BSC being worked on.

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6. Setup dial indicators at each crossbeam end for monitoring movement in all three directions: X, Y and Z. Record direction of positive indication and zero all dials (use compass directions for Pier ID reference and direction reference). **Caution: Throughout this task, take care to not disturb the Dial Indicator mounting hardware! Take great care to not apply force or torque to the Crossbeams or anything rigidly attached to them. Do not push them, lean on or stand on them (or anything connected to them)! It is very important that the current optical alignment is not disturbed! Refer to Drawing D020280 for an illustration of the hardware for the steps to follow.**

Direction of positive indication for Dial Indicators:

Pier ID: _____ X: _____ Y: _____ Z: _____

Pier ID: _____ X: _____ Y: _____ Z: _____

Pier ID: _____ X: _____ Y: _____ Z: _____

Pier ID: _____ X: _____ Y: _____ Z: _____

Confirmation of Zeros:

Pier ID: _____ X: _____ Y: _____ Z: _____

Pier ID: _____ X: _____ Y: _____ Z: _____

Pier ID: _____ X: _____ Y: _____ Z: _____

Pier ID: _____ X: _____ Y: _____ Z: _____

8. Install eyebolt and shackle on screw jack. Bring crane directly over screw jack. Use a plumb bob to ensure this location.

9. Connect the shackle to the crane and lift to remove excess length. Stop if you see any load being transferred to the load cell.

10. Remove the (4) 1/2-13 SHCS connecting the crossbeam to the air-bearing adapter.

11. Using the machine screw jack, apply load to the crane hook. As you lift, watch the dial indicator at the support tube closest to the pier you are lifting. As you raise the crossbeam you will notice the dial indicator reading lower then begin to rise. Continue to lift the crossbeam until the dial indicator reaches 0.000.

Record load cell _____lb

Record all dial indicator positions:

Pier ID: _____ X: _____ Y: _____ Z: _____

Pier ID: _____ X: _____ Y: _____ Z: _____

Pier ID: _____ X: _____ Y: _____ Z: _____

Pier ID: _____ X: _____ Y: _____ Z: _____

12. Remove the coarse stage adapter D972107, the scissor table adapter D972145, the pier plate adapter D972904, and the HAM pier D972609.

13. Clean the grout plate top surface of any dirt particles.

14. Position the pre-isolator pier D020126 onto the pier grout plate D972126.

15. Check the pier level with a surveyors level, scale, and stand. If out of level by more than .01 over the width of the pier, remove the pier and check again for any obstructions that are preventing the pier from sitting level.

16. Set yaw of pier by laying a flat edge across the flat on the pier to the flat on an adjacent pier.

17. Replace the ¾ " flange nuts and torque to 100 ft-lbs.
Caution: Take great care to not apply force or torque to the Crossbeams or anything rigidly attached to them. Do not push them, lean on or stand on them (or anything connected to them)! It is very important that the current optical alignment is not disturbed.

6. INSTALLATION OF MEPI HOUSING ASSEMBLY TO THE PIER

1. Place a .06" thick sheet of Teflon onto the lift table and place a completed MEPI housing onto the lift. Be sure to select the correct assembly. The MEPI actuators always face away from the chamber.

2. Place a .06" thick sheet of Teflon on the pier surface, with the lift aligned to the height of the pier slide the housing until the (4) holes in the crossbeam top plate line up to the crossbeam. Remove the Teflon sheets.

3. Install (4) pneumatic lift assemblies D020375 to the housing. Add the manifold, gauge, and pneumatic tubing.

4. Install (2) double clamps D020269, (1) offset clamp D020270, and (1) straight clamp D020271. Screw (2) ½-20 x 1" long set screws into each clamp. Tighten so that they touch the MEPI housing then back off ½ turn.

5. Measure the gaps at the four corners between the MEPI top plate D020008 and the crossbeam D972612 with shims or a feeler gage and record.

Inner right gap _____
Inner left gap _____
Outer right gap _____
Outer left gap _____

6. Gap the (4) vertical setscrews in the clamps by the smallest gap setting obtained in the previous step.

7. Slowly raise the pressure of the air to the pneumatic lift assemblies. Stop when a .001" shim will not fit between the housing base and the setscrew. **Important: Keep the air pressure to a minimum.**
8. With the (6) horizontal set screws in the clamps, slide the MEPI assembly until all (4) ½-20 screws can be started attaching the crossbeam to the MEPI top plate.

9. Check the level of the MEPI top plate with a precision cross level. Adjust the (4) vertical ½-20 set screws in the clamps until the top plate is level 40 seconds.

10. Place shims in the gaps between the cross beam and the top plate. Tighten the (4) ½-20 screws to 45 ft-lbs.

11. Place shims in the gaps between the pier and the bottom of the MEPI housing. Tighten down all vertical and horizontal setscrews in the clamps to prevent movement of the MEPI assembly.

12. Check that all ½-20 screws holding the boot in position are tight then start transferring the load of the crossbeam from the crane and load cell to the MEPI housing.

13. Remove the load cell, shackle, eyebolt, and HAM cross beam bracket.

14. Repeat the above procedure for the remaining corners of the HAM.

7. SPRING INSTALLATION

1. Place a jam nut D020009-2 on one end of the (2) machined springs D010229 2.25" from the end of the spring.

2. Slide a spherical washer (item 42 D020182) onto the end of the spring with the jam nut and slide the spring down the tube in the housing and thru the .88" dia. Hole in the boot. This will take two people to hold the spherical washer in place. Attach a full nut D02009-1 finger tight.

3. Assemble the spring adjust plate D020001 and spring mount plate D020002 per assembly drawing D020182. Gap the two plates .500".

4. Add the spherical washer, load cell and flat washer. Screw a full nut D020009-1 until it just touches the flat washer.

5. Torque the lower nut to 100 ft-lbs.

6. Repeat the above steps for all remaining piers.

7. Install digital readout boxes to all eight load cells. Calibrate the readout to the load cell per the manufacturers directions using calibration data supplied with each load cell.

8. Begin tightening both springs at one of the piers. Tighten the nuts simultaneously, maintaining an equal load on each of the load cells.

9. Once you have reached 500 lbs on each of the load cells back off on the 7 horizontal stops. Continue to tighten until you see a .002" to .003" rise on the z-height dial indicators or until the screw heads of the vertical stops become loose.

10. Lower the two vertical stops by .060".

11. Repeat steps 8-10 above for each of the remaining piers.

12. Starting with pier 1, increase or decrease the loads equally on the springs until the dial indicators return to a z-height of 0.000. Follow a figure 8 pattern going from pier 1, pier 3, pier 4, and pier 2 then back to pier 1. Several times around may be required to bring each dial indicator to +/- .001 from 0.000.

13. Hand tighten all horizontal and vertical stops to secure the boot.

14. Place a .005" shim between each of the vertical stops in the clamps and gradually increase the air pressure in the course actuation system until all 4 piers rise against these stops.

15. Adjust the ½-20 pushers in each clamp to return the x and y dial indicators to their original position and the optical lever returns to its original position. Release air pressure to lower the housing and tighten all ½-20 set screws in the clamps.

8. ACTUATOR INSTALLATION

1. Remove the front vertical arm D020261.

2. Slide a vertical L4C geophone with its cable attached up into the L4C tube mount D020259. Pull the cable up and through the horizontal tube mount.

3. Push the L4C flush with the bottom of the tube mount. Insert a ¼-20 x .88 brass tipped setscrew into the tube mount and torque to 35 in-lbs.

4. Slide the horizontal L4C geophone (with cable facing outward) into the horizontal tube mount until the large diameter face of the geophone is flush with the tube mount.

5. Insert a ¼-20 x .88 brass tipped setscrew into the tube mount and torque to 35 in-lbs.

6. Mount one of the actuators assembled in step 3 to the vertical actuator mount D020251. Be sure to use the set of tapped holes, which centers the actuator in the mount. Leave the 4 screws loose.

7. Slide the actuator and mount onto the housing base with all mounting screws loose. Move the actuator into position and tighten the (8) screws holding the actuator to the boot. Tighten the 4 screws holding the field and insulator to the mount and the 3 screws holding the mount to the housing.
Caution: Be certain no stress is being placed on the plastic shims, which maintain the gaps between the coil and field of the actuator.

8. Loosen the 2 screws holding the rear brace D020276 and the 3 screws holding the horizontal actuator bracket D020252.

9. Attach the horizontal actuator and insulator to the horizontal actuator bracket and to the boot. Wires should extend upward. Move the actuator assembly into position then tighten all mounting screws.

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7. FINAL ASSEMBLY AND ALIGNMENT

1. Remove the shims in each of the horizontal and vertical actuators. If any shims are tight, loosen the actuator mounting screws and adjust the field assembly until it is centered to the coil. Once centered torque the ¼-20 screws to 75 in-lbs, 3/8-16 screws to 235 in-lbs, and the ½-13 screws to 43 ft-lbs.

2. Mount the pier pre-amp box and the Kaman junction box to the blank-off plate D020128 with cable connections facing down. Mount the blank off plate to the housing assembly and connect the geophone and position sensor cables.

3. Connect the position sensor breakout box between the pier pre-amp box and the rack connection using the 15 pin connectors. Attach a voltmeter to the breakout box.

4. Adjust the micrometer on the position sensor until you see +/- 8 volts. If this range is not attainable move the position switches. Caution: Remove the flag D020255.

5.Attach the horizontal and vertical heat fins to the field assemblies. Place a Co-Thermal heat conductive pad between the actuator and the heat fin. Connect power cables to the electromagnetic actuators.

6. Attach stiffening brackets D020329 and D020330 to housing assembly.