

Compliance to LIGO Modifications on GS-13

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Feb. 23, 2009

References:

1. **LIGO Project Modifications to the GS-13. LIGO E0900027-v1**, by Brian Lantz, Mick Flanigan, Jeff Kissel, Brian O'Reilly, Feb. 4, 2009.
2. **GS13_tests21** text file emailed to Geotech Instruments on Dec 23, 2008.

Summary:

All relevant internal documentation (part drawings, assembly drawings, assembly procedures, and test procedures) governing compliance to LIGO requests will be reviewed to ensure full compliance to the referenced documents above. The discussion below illustrates our production intent. We have 3D solid Inventor models of the original GS-13, and from that created 2 new models for LIGO horizontal and vertical units. To ensure a mutually agreed upon approach between LIGO and Geotech Instruments, we ask LIGO to review this document for comment and approval. Three issues that we need feedback on are as follows:

- (A) We would like to remove the bubble level from the horizontal LIGO GS-13 per Figure 4,
- (B) We would like to return to the welded case assembly per Figure 6 (not the dip-brazed as in the previous batch). This case was also less problematic for LIGO.
- (C) Please confirm our assumptions made in the "Visual Inspection" section, parts (b), (c) and (e).

Geotech Instruments has taken out two new part numbers to distinguish these two custom GS-13s from standard production per Table 1 below.

Table 1. Part Numbers Reference Table for Custom LIGO GS-13s.

Part Number	Model Number	Comment
990-55400-0102	GS-13	Standard GS-13s previous delivered to LIGO
990-55400-0104	GS-13LH	Custom LIGO Horizontal
990-55400-0105	GS-13LV	Custom LIGO Vertical

Compliance

Both Configurations (Vertical and Horizontal)

- 1) *Setscrews secured with thread-locker.* Figure 1 shows all setscrews used in GS-13 (horizontal units don't have all of those present). All assembly drawings will be reviewed to ensure compliance.
- 2) *Electrical connector orientation.* Final assembly drawings for GS-13LV, and GS-13LH will include view and note of connector orientation to ensure compliance. Figure 2 shows a front view of the GS-13 for reference. Figure 3 shows a front view of the GS-13LV. Figure 4 shows a front view of the GS-13LH.
- 3) *Hole Sealing:* We opt to have customized parts without handle, front horizontal foot, bubble level (GS-13LH only per Figure 4– if agreed), and rear horizontal foot holes. Figure 3, Figure 4, and Figure 6 shows our intent. Figure 5 shows a rear view of the GS-13 for reference.

4) *No Paint.* GS-13LV, and GS-13LH will not have painted cases per Figure 6.

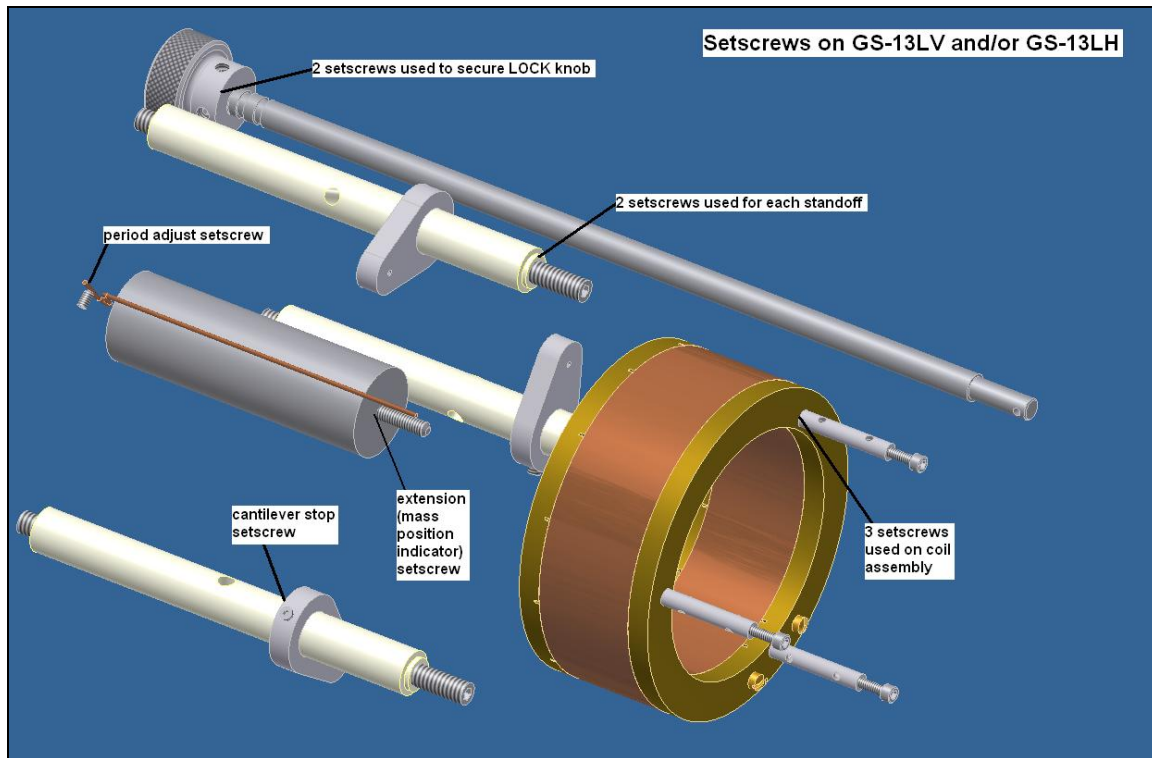


Figure 1. Setscrews Used on GS-13.

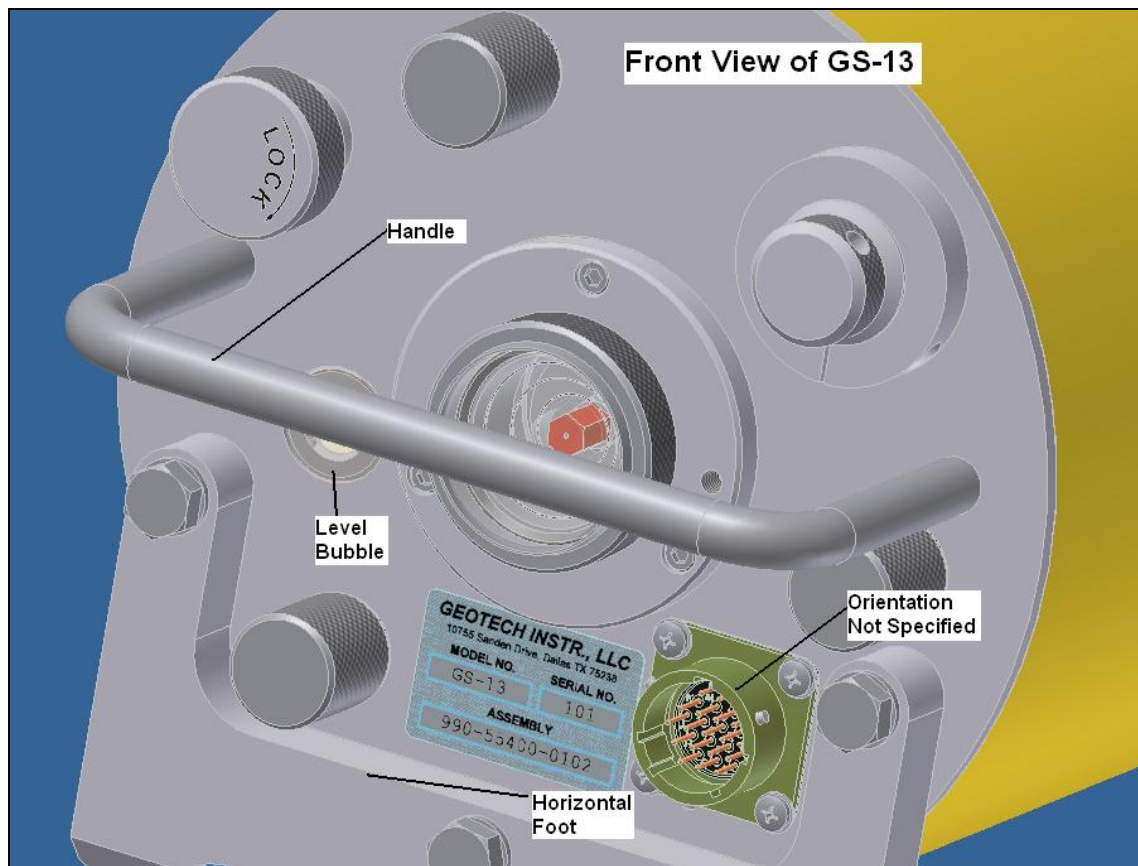


Figure 2. GS-13 Configuration.

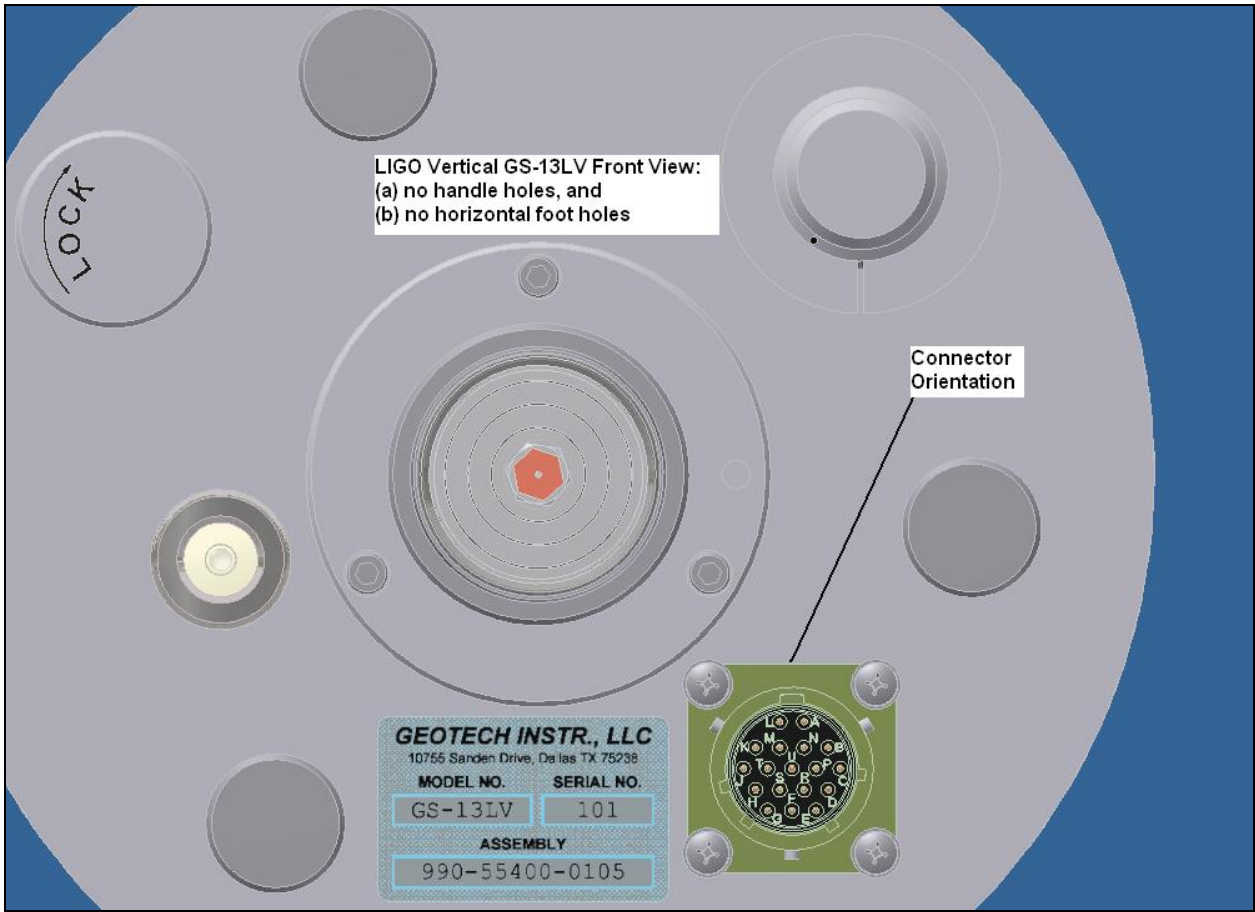


Figure 3. Front View of GS-13LV.



Figure 4. Front View of GS-13LH.

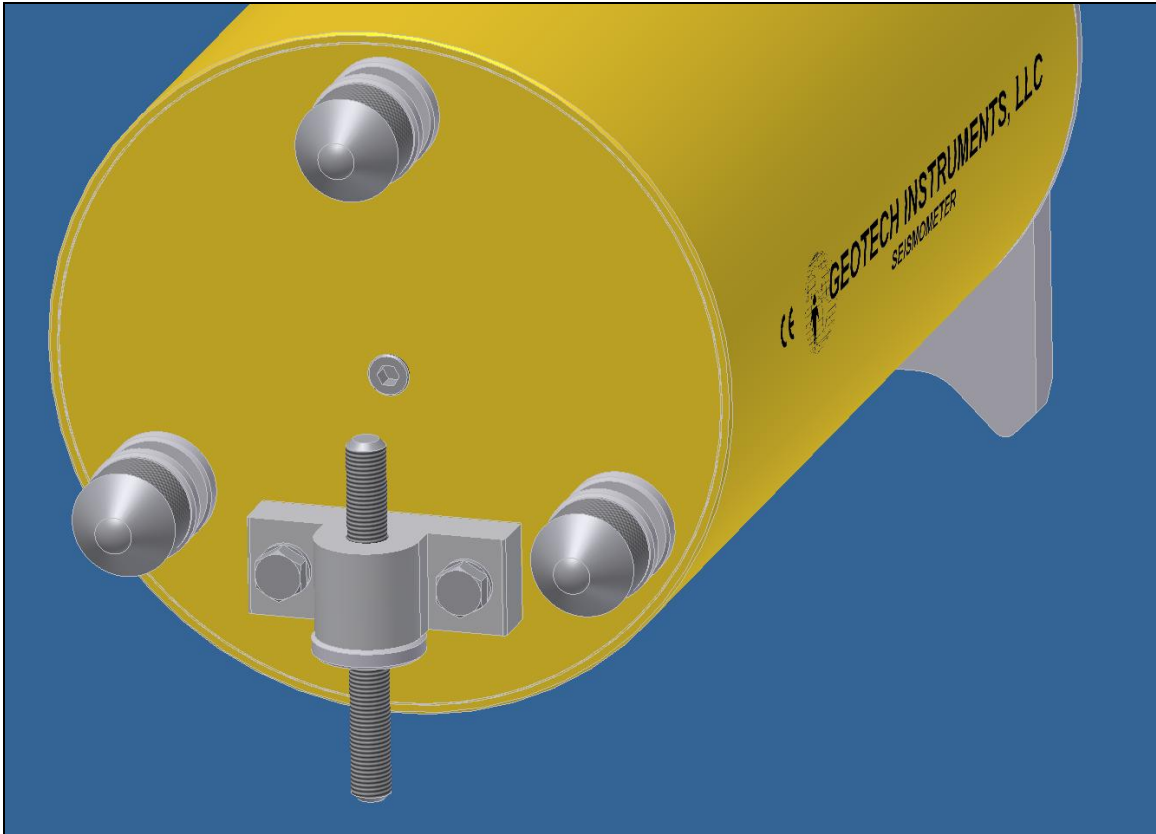


Figure 5. Rear View of GS-13.

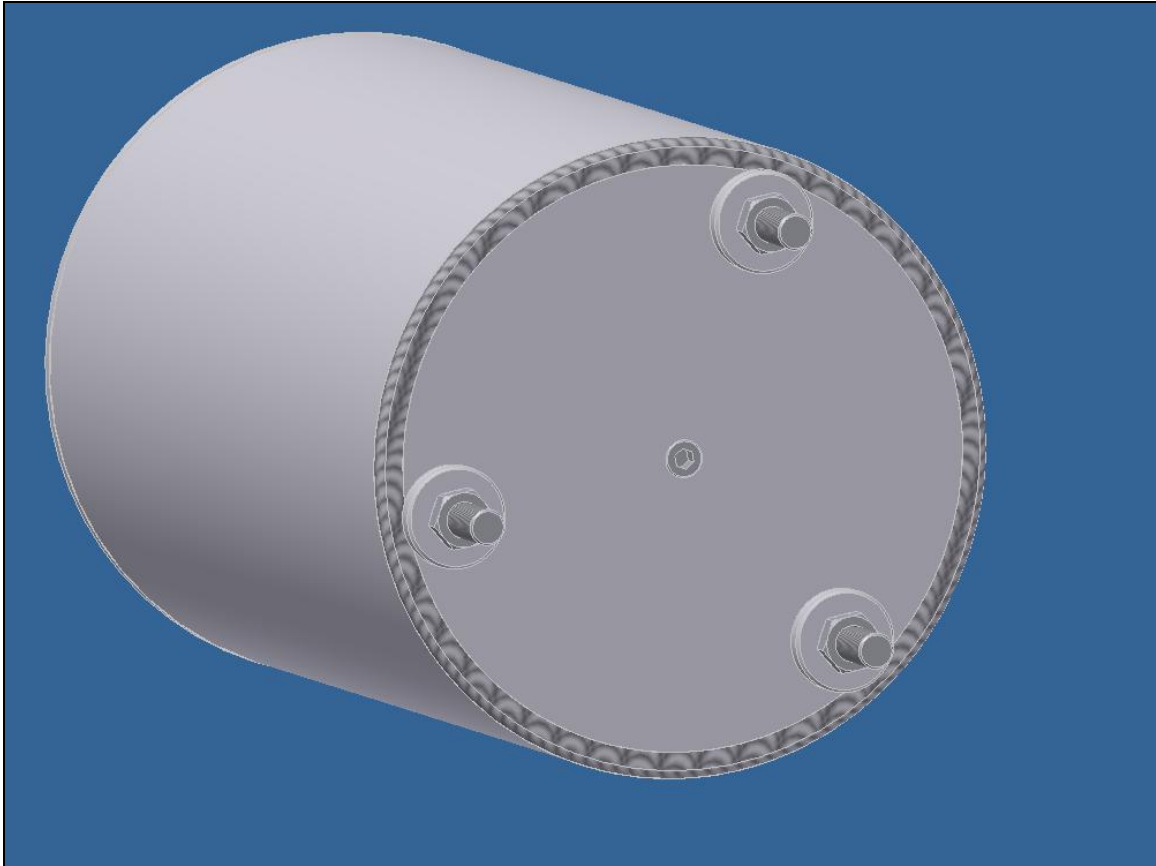


Figure 6. Rear Views of GS-13LV and GS-13LH are the Same.

5) *Additional modifications.*

Vertical Configuration:

- (a) *Remove calibration coil and cap.* Figure 7 shows a section view of the GS-13 for reference. Figure 8 shows a section view of the GS-13LV calibration magnet assembly area. For both the GS-13LV and GS-13LH (Figure 11), the calibration coil and cap are removed.

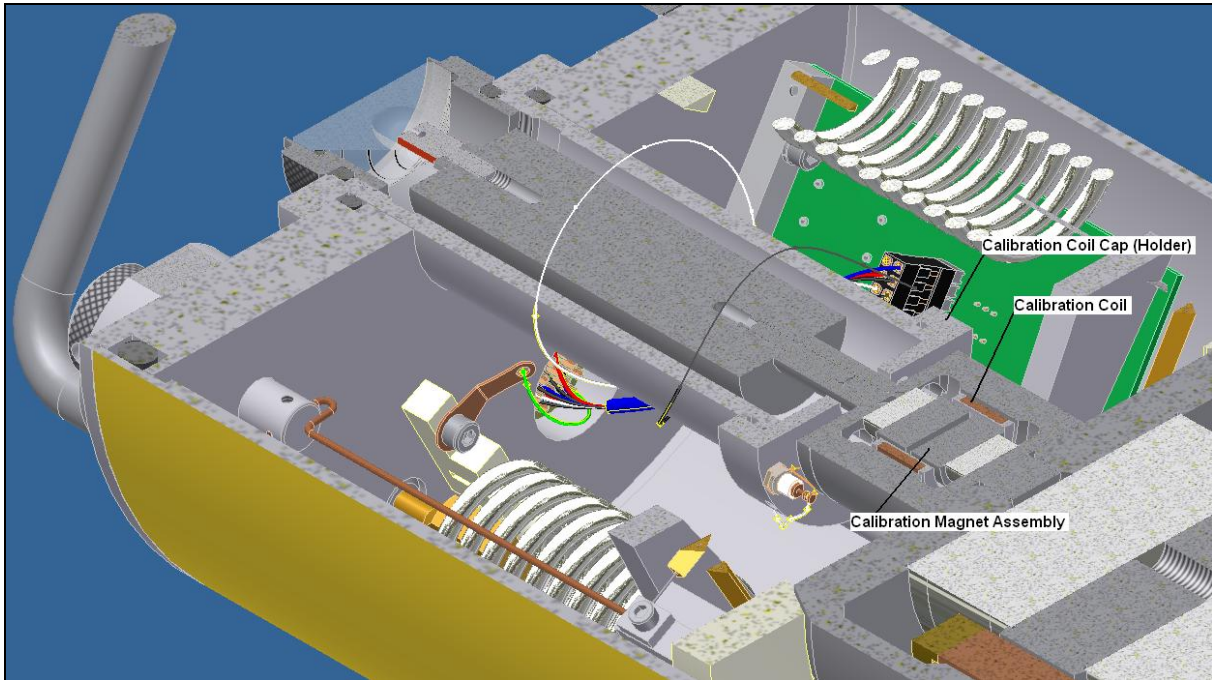


Figure 7. GS-13 Calibration Coil, Holder, and Magnet Assembly.

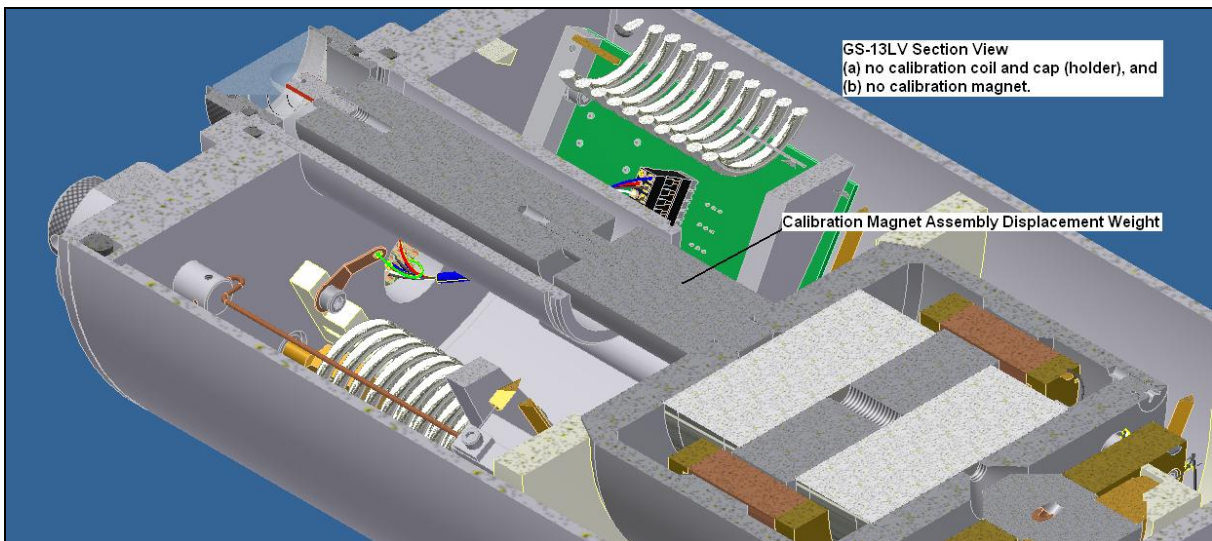


Figure 8. GS-13LV Section View of Previous Calibration Coil and Magnet Area.

- (b) *Remove calibration magnet.* Refer to Figure 8 for compliance.
(c) *Remove the handle.* Refer to Figure 3 for compliance.
(d) *Remove the front horizontal foot.* Refer to Figure 3 for compliance.
(e) *Remove the rear horizontal foot.* Refer to Figure 6 for compliance.
(f) *Remove adjustable feet.* Refer to Figure 6 for compliance.

(g) *Install o-ring on spring assembly.* Refer to Figure 9 for compliance.

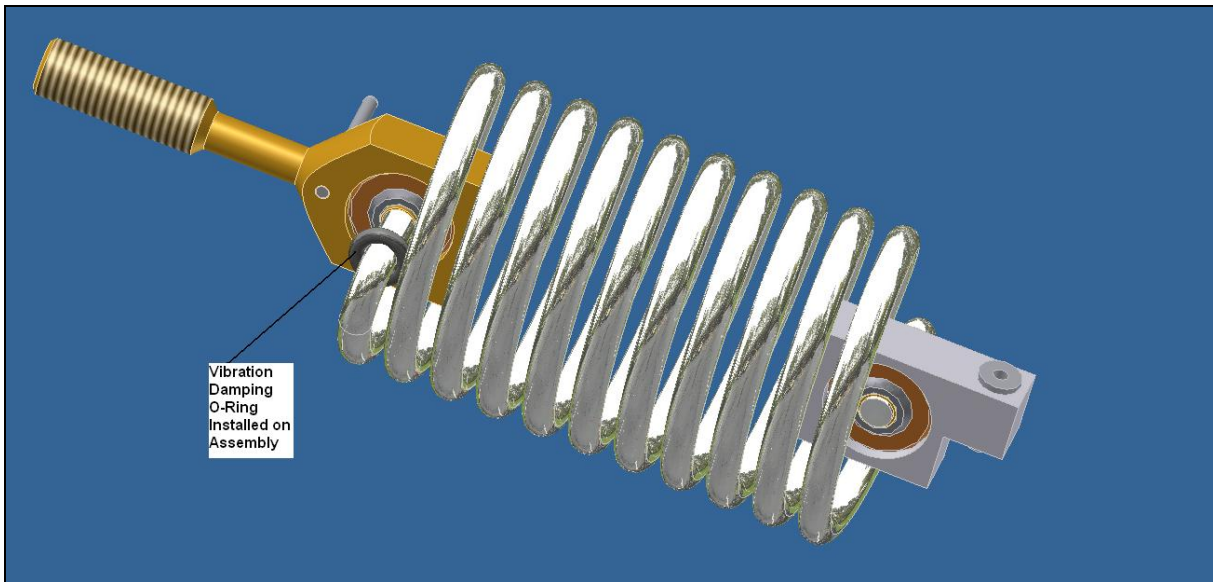


Figure 9. Vibration Damping O-Ring.

(h) *Seal holes.* Refer to Figure 3 and Figure 6 for compliance.

(i) *Calibration Magnet Assembly Displacement Mass.* Refer to Figure 10 for view of design.

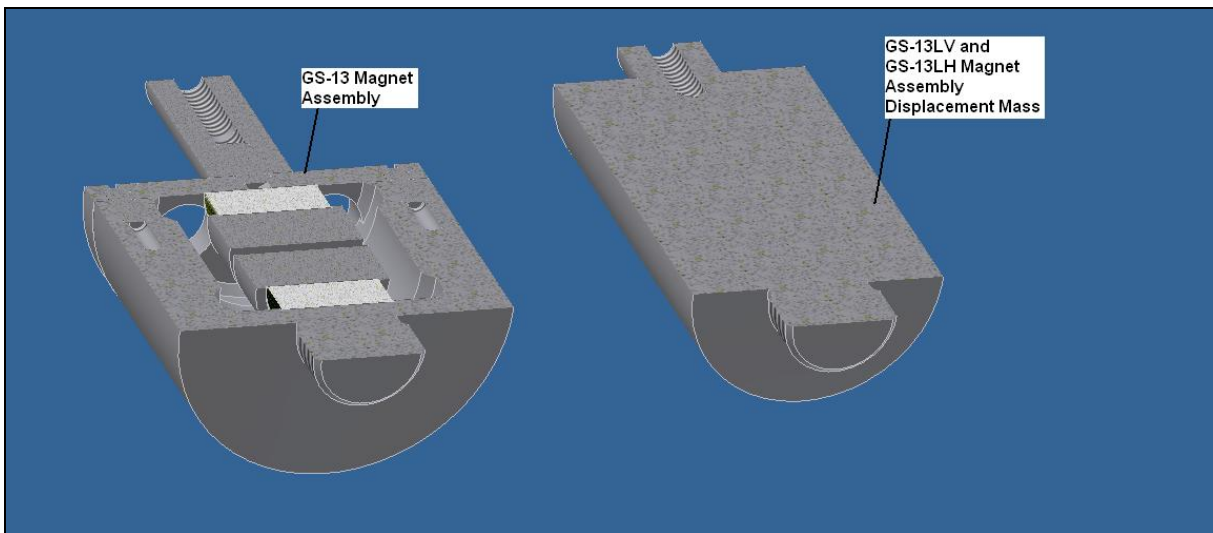


Figure 10. GS-13 Magnet Assembly and GS-13LV / LH Displacement Mass.

Horizontal Configuration:

- (a) *Remove calibration coil and cap.* Figure 11 shows a section view of GS-13LH for compliance.
- (b) *Remove calibration magnet.* Refer to Figure 11.
- (c) *Remove the handle.* Refer to Figure 4.
- (d) *Remove the front horizontal foot.* Refer to Figure 4.
- (e) *Remove the rear horizontal foot assembly.* Refer to Figure 6.
- (f) *Remove the adjustable feet.* Refer to Figure 6.

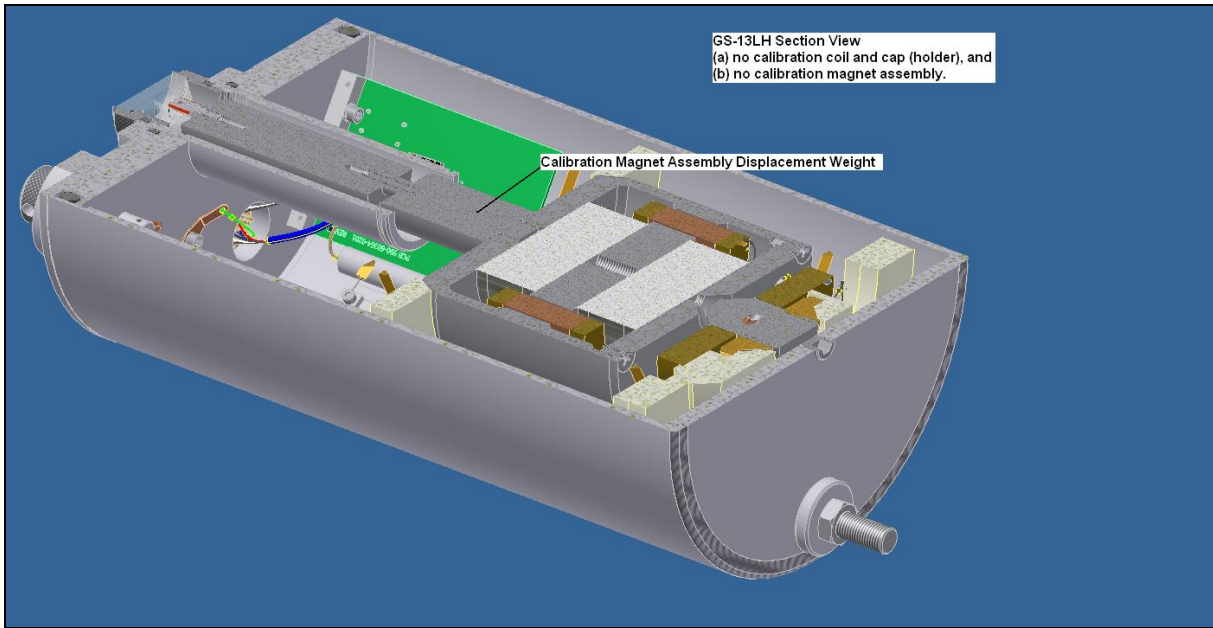


Figure 11. GS-13LH Section View of Previous Calibration Coil Area.

- (g) Remove the 3 vertical offload springs. Refer to Figure 11 for section view. Figure 12 shows details of the top end of spring (now removed), and Figure 13 shows the bottom end of spring (now removed).

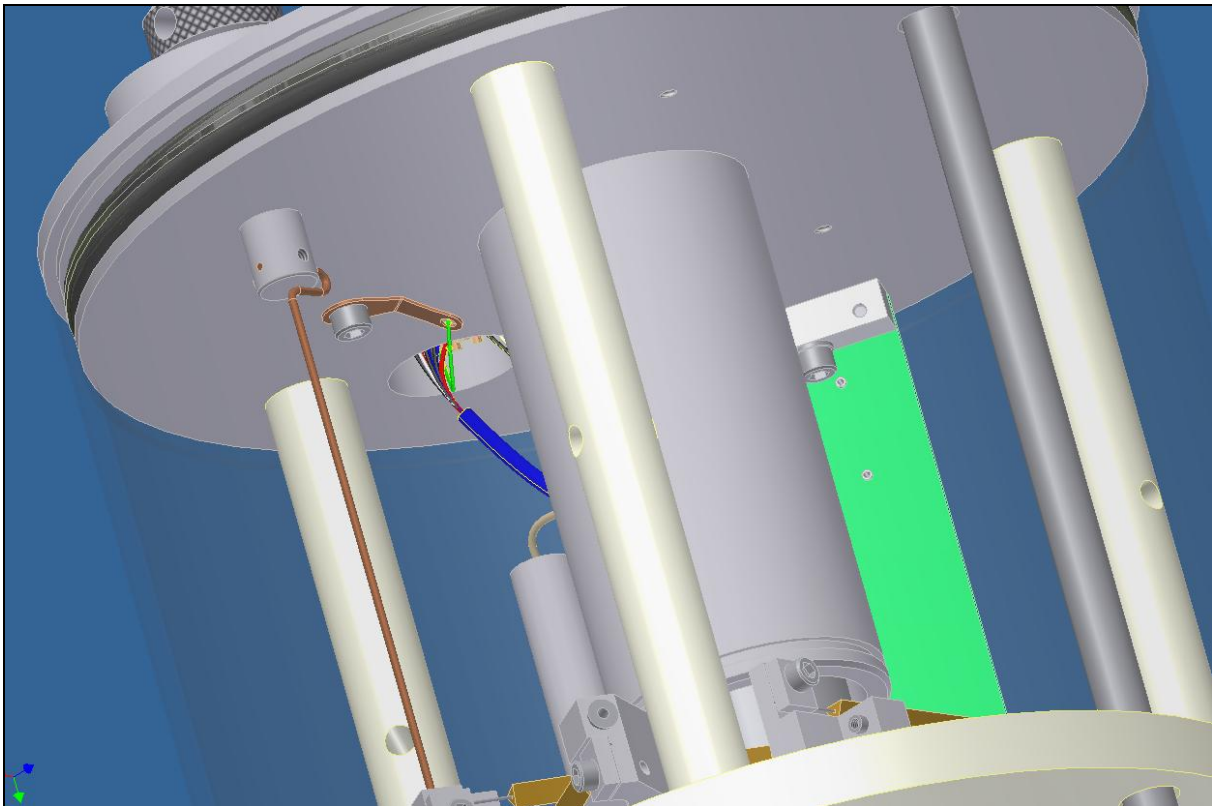


Figure 12. Inside Front View of GS-13LH Showing Top End of Spring Assembly (now Removed).

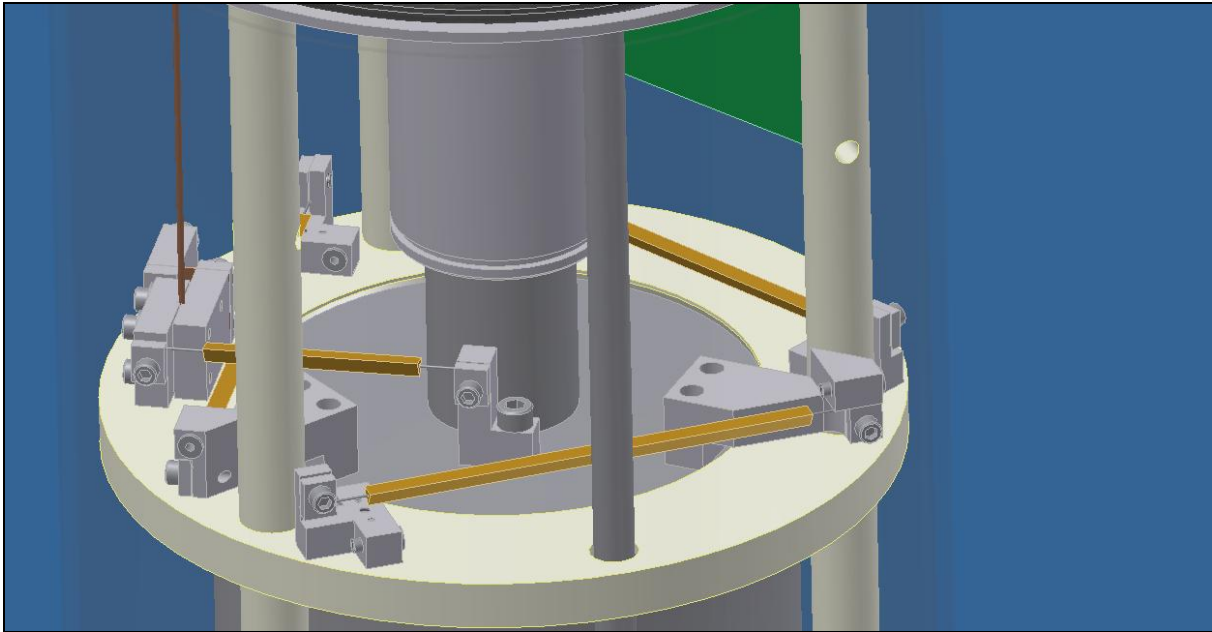


Figure 13. Inside View of GS-13LH Showing Bottom End of Spring Assembly (now Removed).

- (h) *Remove mechanisms associated with vertical offload springs.* Refer to Figure 14 for pictorial view of difference between GS-13LV and GS-13LH.
- *spring tension adjust knobs, screws, bushings, etc..* All items are removed. Refer to Figure 4, and Figure 12.
 - *cantilever assemblies which connect spring to mass.* Refer to Figure 13.
 - *flexures for the spring and cantilevers.* Refer to Figure 13.
 - *cantilever stops.* Refer to Figure 13.
 - *spring guides.* Refer to Figure 12.
 - *list for approval.* See Table 2 for a list of parts shown in Figure 14.

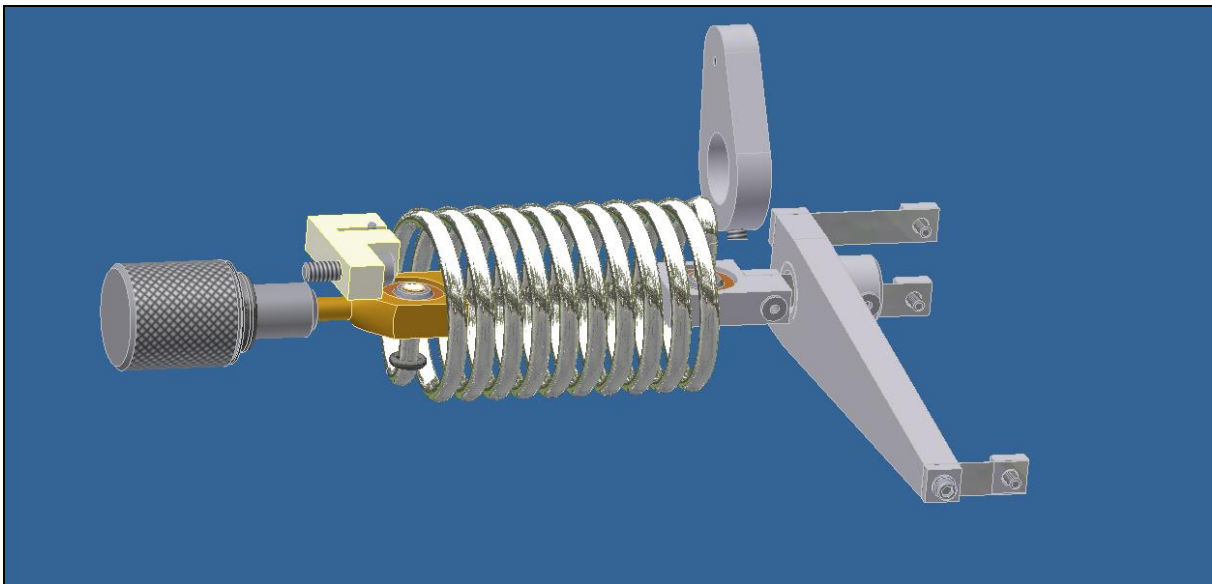


Figure 14. Spring Assembly Parts: Difference between GS-13LV and GS-13LH.

Table 2. Spring Assembly Parts used on GS-13LV, but not on GS-13LH.

Item	Part Number	Description	1/3rd of Qty
1	035-01007-0400	Socket Head Cap Screw, Stainless Steel, 2-56 x 1/4"	4
2	035-01007-0600	Socket Head Cap Screw, Stainless Steel, 2-56 x 3/8"	4
3	035-01018-0800	Socket Head Cap Screw, Stainless Steel, 6-32 x 1/2"	1
4	035-47018-0400	Socket Head Setscrew, Stainless Steel, 6-32 x 1/4"	1
5	038-56106-0000	No. 2 Internal Lock Washer	8
6	042-11110-6747	O-ring, 3/8" ID x 3/32" Wide	1
7	990-19952-0101	Spring Tension Adjust Nut	1
8	990-19965-0101	Flexure Clamp	8
9	990-19971-0101	Cantilever to Base Flexure	2
10	990-19973-0101	Cantilever to Mass Flexure	1
11	990-19974-0101	Cantilever to Spring Flexure	1
12	990-20347-0102	Spring Assembly with O-Ring Damper	1
13	990-20571-0101	Spring Guide	1
14	990-20572-0102	Cantilever Assembly	1
15	990-20659-0101	Cantilever Stop	1
16	990-20857-0101	Washer	1

- (i) *Seal holes.* Refer to Figure 4 and Figure 6.
- (j) *Calibration Magnet Assembly Displacement Mass.* Refer to Figure 10 for view of design.

GS13_tests21 Text File Compliance

Visual Inspection:

- (a) *Inspect the delta rod.* Seven delta rods will be inspected as shown in Figure 15.
- (b) *Inspect tension rod.* **It is assumed** this is the same as the torsion bar shown in Figure 15.
- (c) *Inspect spring tabs.* **It is assumed** that the locations of these particular tabs, as shown in Figure 15, are correct.
- (d) *Inspect wiring interference.* Notes will be added to assembly drawings as required and assemblers briefed on this.
- (e) *Inspect vertical-to-horizontal cantilever flexure tab.* **It is assumed** that this requirement is no longer applicable, since vertical units will not be converted into horizontal ones. Refer to Figure 15 for location of this tab.
- (f) *Check proper unlocking.* Assembly and test documentation will be reviewed to ensure compliance. Notes will be added to assembly drawing to ensure oil-free (non-sticky) contact surfaces during assembly.

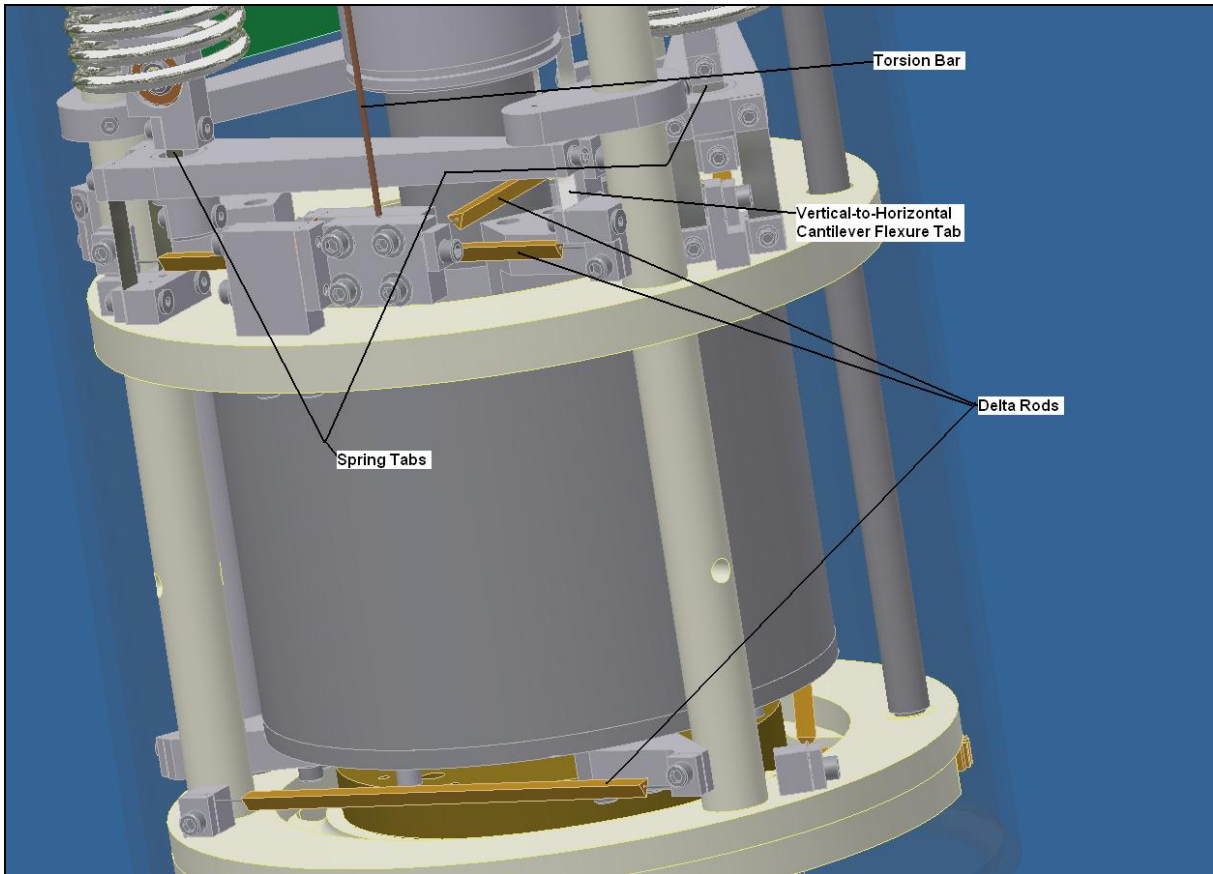


Figure 15. Visual Inspection Parts.

Huddle Test:

Items (a)—(d) will be done prior to shipping any instruments to LIGO. Test procedure will be referenced on final assembly documentation for the GS-13LV, and GS-13LH. Geotech Instruments will establish its own reference horizontal and vertical units through sharing huddle test data with LIGO for approval.