



LIGO Laboratory

□ California Institute of Technology
MC 18-34, 1200 E. California Blvd.
Pasadena CA 91125 USA
TEL: 617.395.2129
FAX: 617.304.9834
www.ligo.caltech.edu

□ LIGO Livingston Observatory
P.O. Box 940
Livingston LA 70754 USA
TEL: 225.686.3100
FAX: 225.686.7189
www.ligo-la.caltech.edu

□ LIGO Hanford Observatory
P.O. Box 159
Richland WA 99352 USA
TEL: 509.372.8106
FAX: 509.372.8137
www.ligo-wa.caltech.edu

□ Massachusetts Institute of Technology
MIT NW22 – 295, 185 Albany St.
Cambridge MA 02139 USA
TEL: 617.235.4824
FAX: 617.253.7014
www.ligo.mit.edu

Date:	30 October 2008
Refer to:	L080132-00-D
Subject:	Review committee report on the SEI HAM ISI PDR
To:	David Shoemaker
From:	David Shoemaker, Rich Abbott, Dennis Coyne, Matthew Evans, Mick Flanigan, David Nolting, Janeen Romie, Bill Tyler, John Worden
cc:	Ben Abbott, Stephany Foley, Brian Lantz, Jeff Kissel, Ken Mason, Fabrice Matichard, Brian O'Reilly, Andy Stein, Carol Wilkinson, Peter Fritschel

Response to the review committee's report

I accept the recommendations of the review committee. The SEI team should proceed directly to the Final Design phase, and should address the action items as issued by the FDR (or later if indicated).

David Shoemaker
31 October 2008

Recommendations

Proceed with Final Design. The subsystem element is in a very good state.

Background

Documents were posted by 1 October 2008, questions (L080115-00) delivered to the SEI team by the review committee on 8 October when a comprehensive presentation by the SEI team was also made. Responses by the SEI team to the review committee were available on the 24 October, and the committee met to discuss the responses on 29 October. The committee made informal comments on the responses to the team in L080131-00, which form the basis for this formal report.

Documentation for the review is detailed in the Charge M080354-02-D, with these and some additional documents (e.g., the presentations) to be conveniently found on the AdL Wiki at http://ilog.ligo-wa.caltech.edu:7285/advligo/HAM_Preliminary_Design_Review

The review was based on requirements and design documents, as well as results from the two prototype isolators installed at the Observatories.

Findings

The Committee found the design to be suitable for Advanced LIGO and in very good shape to move forward into the Final Design phase. The team showed an excellent understanding of the needs for a production-quality design, and has a good

trajectory for the Final Design. There are, of course, a number of places where further work is needed, and a few places where urgent attention should be directed. These are noted in the Action Items below.

- 1) There remain some performance results to be obtained with the prototype units. The data to date are very promising, meeting or exceeding requirements in most frequency ranges. At low frequencies the servo laws are still being refined (and progress since the review has been promising), and the system is not on a HEPI pre-isolator with the updated support structure that is planned. There are no reasons to believe that the system as constructed will not meet isolation requirements.
- 2) The system is reasonably straightforward to assemble and install, and estimates are that the labor and direct costs are in line with the cost book.
- 3) The system appears to be able to handle the load, in terms of mass, CM, and dynamics.
- 4) The software created for the HAM SEI was not reviewed in any depth, beyond the fact that it functioned enough to collect performance data. There do not appear to be problems with the ability to design and realize control laws which are appropriate.
- 5) The system model is not yet complete, and needs to have noise from ADC and DACs included.
- 6) The committee wants to see a re-evaluation of the approach to the vacuum pods due to concerns about potential failures of the pod vacuum and the difficulty of tracking down one failure among hundreds of pods.
- 7) No quantitative evaluation of the reliability, or the impact on availability, was made for this review. A reliability report is in preparation. This reliability report should be reviewed by the committee as soon as available to allow time for the design team to react to any recommendations in advance of the Final Design Review (FDR).
- 8) The changes proposed for the GS-13 seismometer are well motivated and look practical so far. A critical look at the performance and reliability of the modified instrument is needed on a short time scale (or, the locker option must be left open perhaps through fabrication). The best method to realize changes we choose to adopt (our effort vs. vendor effort) remain to be determined.

Action Items

To be completed by the time of the FDR unless otherwise noted:

- 1) Create a snapshot of the review Wiki Page and archive in the DCC
- 2) (when convenient) Create a document for the responses to the DRR Actions (M60062) and archive
- 3) Update the estimates for assembly and installation hours in our planning documents, and check/modify the master schedule plan for the phases to come for the HAM ISI
- 4) Complete a model suitable for predicting the controls and noise performance
- 5) Confirm that practical shipping containers and trucks can deliver the shock load specifications and maintain a low-humidity environment for the parts for transport and storage
- 6) Work with the VRB (Worden) and Systems (Coyne) to assess the approach to vacuum pods. Consider running them at vacuum rather than with a tracer gas; consider adding a gauge; consider adding feedthrough pins to allow other instrumentation
- 7) Contact SUS (Mike Myers) for potential Solidworks tools for cable routing
- 8) Consider means to remotely operate platform lockers on one side of HAM; there is a strong incentive from the operational side to be able to work on the HAM optical table with removal of one HAM door only. Consider the use of mechanical linkages (similar to aircraft design; Worden); contact SUS (Romie) for information on in-vacuum stepper motor solutions. Perform a test in eLIGO with work on the table unlocked if wise, or drop as option if not.
- 9) Request official HAM ISI load upper limit from Systems (Torrle)
- 10) Present data for new AND old crossbeam resonances from LASTI test to allow the influence on the HAM ISI performance to be estimated.
- 11) (when convenient) Update the documentation to note explicitly the calculations, recommendations, etc. that led to the 30% stress level in the springs.
- 12) Investigate having the seismometer vendor undertake modifications of the GS-13. Prepare and execute a test plan for shake-testing GS-13s with modified flexures to ensure that system can be shipped and integrated unlocked. Satisfy QA needs for reliability, reproducibility. If adequate progress on this front by the FDR is impractical, address options for deferred decisions and fallback plans; a pre-procurement review of the final approach will be needed.
- 13) Document adequately the cleaning procedure used for the large parts (detailing differences from E960022).
- 14) Request via SYS (Coyne) optical contamination testing of the PI-2525 Resin

- 15) Make an estimate of the number of hours, and the number of man-hours, for replacement of (at least) the most difficult-to-reach instrumentation pods. Make an estimate with QA (Flanigan) for the MTBF for the pods and their payload. Repeat for the capacitive sensors, and the electromagnetic motors. Combine to form an estimate of the impact on availability of the Advanced LIGO interferometer from these sources.
- 16) Make an estimate with QA (Flanigan) for the in-process, installation, and infant mortality rates for the sensors and actuators used in HAM ISI, and update numbers for numbers of units to procure. For these items, a generic percentage is probably not appropriate.
- 17) (Completion by time of each RFQ for review by SYS (Coyne)) Work on vendor QA/test requirements, and incoming inspection plans, for the HAM ISI elements. Consider carefully the trade of work in house vs. by vendors – if they do the tests, it is their responsibility to fix the problem themselves, which is worth time and money to LIGO.
- 18) (by FDR if feasible; can be delayed if needed) Work with DAQ (Bork) to determine what software is specifically the responsibility of the SEI team, and work with DAQ and QA to develop a plan for acceptance of the software and an appropriate timeline.
- 19) Work with QA (Flanigan) to develop a list of needed tests/diagnostics and documentation, and appropriate milestones for completion of the substance of the plans. This includes SEI-specific software.
- 20) (schedule to be agreed upon with Safety/QA) Work with Safety (Nolting) and QA (Flanigan) to produce an FMEA for HAM ISI.

Additional Comments

Please refer to L080131, Comments on Responses to AdL HAM ISI Review Committee, for additional suggestions. All critical Actions have (however) been brought forward to this Report.