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Date:	8 Sep 2008	Refer to:	L080097-00
Subject:	Review Committee Charge: Final Design and Fabrication Readiness Review (FDR/FRR) of the mechanical elements of the Beamsplitter (BS) / Fold Mirror (FM) suspensions		
To:	Review Committee: Betsy Bland, Doug Cook, Mick Flanigan, Brian Lantz, Richard Mittleman, David Nolting, Norna Robertson, Janeen Romie, Bret Shapiro, Calum Torrie		
From:	Name: Dennis Coyne (review chairman)	Tel: 626-395-2034	
cc:	Mark Barton, Amanda Brummitt, Matt Evans, Peter Fritschel, Justin Greenhalgh, Joe O'Dell, David Shoemaker, Bill Tyler, Carol Wilkinson		

A Final Design Review (FDR) and Fabrication Readiness Review (FRR) for the mechanical elements of the advanced LIGO Suspension assemblies for the Beamplitter (BS) and Fold Mirror (FM) component is underway. As review committee members you should be aware of the following planned dates:

- Questions from the committee for the design team to be emailed to all committee members (or posted to the review wiki page, [http://lhocds.ligo-wa.caltech.edu:8000/advligo/BS\\_Suspension](http://lhocds.ligo-wa.caltech.edu:8000/advligo/BS_Suspension) ) by early 9/12 a.m. US-PT.
- Questions to be discussed in a committee teleconference on Friday 9/12 from 8:00 – 9:30 am US-PT. Design team members encouraged to attend as well.
- Answers from the design team by 9/17.
- A teleconference between the committee and the design team Friday 9/19 from 8:00 – 9:30 am US-PT.

Note that this optimistic and compressed schedule presumes that there will not be any significant issues brought to light in the review or any late documentation; If significant issues arise, then we will re-evaluate the schedule with the SUS team.

The documentation under review was posted at this web site on 8 Sep:

[http://www.eng-external.rl.ac.uk/advligo/Reviews/bs\\_review.htm](http://www.eng-external.rl.ac.uk/advligo/Reviews/bs_review.htm)

and consists of the review documents in the following table, plus the referenced documents given in the second table below.

#	Review Documents	Document No
1	BS/FM FDD (Final design document)	<a href="#">T080218-00-K</a>
2	BS/FM Compliance matrix	<a href="#">T080220-00-K</a>
3	BS/FM component List	<a href="#">T080221-00-K Excel</a> <a href="#">T080221-00-K PDF</a>
4	Measured Parameters document	<a href="#">T080222-00-K Excel</a> <a href="#">T080222-00-K PDF</a>
5	Production Plans	<a href="#">T080223-00-K</a>
6	Fabrication, delivery and test schedule	<a href="#">M080102-00-K</a>
7	BS prototype suspension trial at RAL (photos)	<a href="#">T080224-00-K</a>
8	BS combined envelope and assembly drawing	<a href="#">D080536-00-K</a>
9	BS envelope drawing	<a href="#">D080537-00-K</a>
10	FM combined envelope drawing (Note: in this drawing, the structures are shown with minimum clearance. This means that the structure separation is at its inner limit of adjustment range. Any adjustment needed will increase the nominal distance between the two structures)	<a href="#">D080538-00-K</a>
11	Part Drawings:	
	Upper Structure	<a href="#">All</a> <a href="#">Individual</a>
	Lower Structure	<a href="#">All</a> <a href="#">Individual</a>
	Top Stage	<a href="#">All</a> <a href="#">Individual</a>
	Top Mass	<a href="#">All</a> <a href="#">Individual</a>
	Penultimate mass	<a href="#">All</a> <a href="#">Individual</a>
	Top Tablecloth	<a href="#">All</a> <a href="#">Individual</a>
	Bottom Tablecloth	<a href="#">All</a> <a href="#">Individual</a>

Note that cost, schedule, long lead procurement, and procurement strategies are not part of this review, since they have been handled separately by RAL management. Similarly, production plans: for acquisition of parts, components, and materials needed for fabrication are a "UK problem" and are not in the scope of this review. In addition, separate mechanisms are already in place to ensure compatibility of schedules for fabrication, delivery, training, assembly and test, and are not part of this review.

#	Reference Documents	Document No
12	<b>BS Finite Element Analysis (FEA) Documents:</b>	
	Finite Element Analysis of the face plate design for the beam splitter and folding mirror structures	<a href="#">T070033-00-K</a>
	Preliminary finite element analysis of the beam splitter design	<a href="#">T070160-00-K</a>
	Preliminary finite element analysis of the beam splitter design	<a href="#">T070160-02-K</a>
	Finite element analysis of the stay design for the beam splitter structure	<a href="#">T070161-00-K</a>
	BS shear plate study and justification	<a href="#">T080204-00-K</a>
13	<b>BS conceptual documents</b>	
	Conceptual Design of Beamsplitter Suspension for Advanced LIGO	<a href="#">T040027-03-R</a>
	Pendulum parameter descriptions and naming convention	<a href="#">T040072-01-R</a>
	<b>Other documents referenced in T080220-00-K (compliance matrix):</b>	
14	Generic Requirements and Standards for Detector Subsystems	<a href="#">E010613-01-D</a>
15	Drawing requirements	<a href="#">E030350-A</a>
16	Seismic isolation system (SEI) payload mass properties	<a href="#">E040136-00</a>
17	Advanced LIGO Quadruple Pendulum Suspension Failure Modes and Subsequent Repair Approaches	<a href="#">E040329-03</a>
18	Universal Suspension Subsystem Design Requirements Document	<a href="#">T000053-04-D</a>
19	Advanced LIGO, Cavity Optics Suspension Subsystem Design Requirements Document	<a href="#">T010007-03-D</a>
20	Conceptual Design of Beamsplitter Suspension for Advanced LIGO	<a href="#">T040027-03-R</a>
21	Blade, Wire and Clamp Process Specification	<a href="#">T040108-03-K</a>
22	Noise Prototype Assembly Procedure	<a href="#">T060040-04-K</a>
23	BSC Suspension Thermal Budget	<a href="#">T060115-01-K</a>
24	BSC Suspension Failure Effects and Modes - Initial Study	<a href="#">T060116-00-K</a>
25	Quad Noise Prototype PDR-3 Overview	<a href="#">T060142-00-K</a>
26	Check on beam splitter suspension blade springs	<a href="#">T080133-01-K</a>
27	Collected Comments from UK Team on ICDs and DRDs	<a href="#">M050438-01-K</a>

The following review committee charge has been developed with the [Guidelines for AdL Construction Activities \(M050220-09\)](#) in mind, but tailored to this review:

1) There are two requirements documents which apply to the BS/FM suspension: (a) Cavity Optics Suspension Subsystem Design Requirements Document, T010007, and (b) the Universal Suspension Subsystem Design Requirements Document, T000053.

a) Has the Design Requirements Document (DRD) been completed by quantifying all "TBD" items (related to the BS & FM), incorporating relevant changes adopted from the DRR, and updated to be consistent with Peter Fritschel's recent technical memorandum, T080192, on displacement noise in ALIGO triples (at least in regard to the BS & FM<sup>♦</sup>)?

<sup>♦</sup> Note that T010007 needs a lot of updating - the mode cleaner (MC) and recycling mirror (RM) sections are also now out of date and there may be material in the introductory and

b) Is the Universal Suspension Subsystem Design Requirements Document still appropriate, applicable and complete?

2) Review the Compliance Matrix Document, T080220-00, to determine if all requirements are adequately covered or addressed in the design, analysis and testing to date. Pay particular attention to interfaces between the U.K. and U.S. responsibilities for the BS/FM suspension and between the BS/FM suspension and other subsystems.

3) Does the Final Design Document (FDD) summarize the design, analysis and prototype testing (and lessons learned) in a single integrated (stand alone) document (with pointers to other supporting documents if/as needed)? This document should include the checklist from the Review Guidelines document, M050220-09, with responses to each item, or pointers to other documents which satisfy the checklist.

4) Has supporting design analysis and engineering test data been presented which adequately supports the BS/FM design (can be incorporated into the FDD if appropriate)? This must include a revised Matlab model and simulation document.

5) Have detailed and sufficient engineering specifications and drawings been provided and are they ready to go into configuration control? Are these drawings (and underlying CAD model) consistent with the key parameter set used in the Matlab model/simulation of the expected performance of the BS/FM suspension?

6) Has a final parts list (mechanical only) been provided and filed as an E-document (in excel & pdf formats) per E030350-A, section 3.1.8?

7) Are the interface control documents complete and final [for the mechanical aspects only]? This interface definition includes the combined envelope and assembly drawing, but also the ICDs, E050160, -169, -168, -159, -176 (see the compliance matrix for the list). In addition to physical interfaces, this interface definition must define the assembly & test responsibilities (US vs UK) for tooling, training, etc.

8) The BS/FM suspension will be subject to standard Rutherford Appleton Laboratory (RAL) inspection plans/procedures. Are these standard procedures and the resulting data adequate?

9) A test assembly of the BS has been performed at RAL, and lessons learned applied to the drawings. The SUS group have not identified any test plans/procedures for the production BS/FM assemblies. Is there any testing which should be planned for each assembly, as a means of checking fit and function? e.g. suspension damping to check that nothing is rubbing, measurement of clearances, measurement of frequencies?

10) RAL has carried out a BS assembly as proof of assembly concept using similar techniques to those of the quad. The BS assembly is considerably simpler than the E/ITM

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quad sections that also needs revision. However these items are beyond the scope of the current review.

(quad) assembly, because there are no fibers, and no reaction chain. The SUS group does not propose to produce an assembly document for the review; this will be developed in conjunction with the BS assembly training on the first article. The heritage of the E/ITM quad, the BS prototype assembly experience and the simplicity of a single wire suspension chain are used as arguments for deferral of detailed integration plans/procedures. Is this sufficient justification, or is there significant risk in proceeding with production?

11) Have all of the relevant action items from the DRR/CDR (Design Requirements and Conceptual Design Review) been resolved satisfactorily?

12) Have relevant RODAs (Records Of Decision and Agreement) been addressed in the design?

13) Are there any scope compatibility issues with the RAL work plan (any deviations in work scope or delivery quantities noted)?

14) Are there any known problems, risks or concerns which have not been addressed adequately?

All review committee members are encouraged to review all of the material that they can and have an interest in pursuing. However, since there is little time and much to review, I propose that committee members concentrate on the following documents and charge items:

<b>Committee Member</b>	<b>Charge Items</b>	<b>Document Numbers</b>
<i>Everyone</i>	2, 3, 14	1, 2, 5, 7, 8, 9, 10
Betsy Bland	1b, 9, 10	18, 22
Doug Cook	1b, 9, 10	18, 22
Dennis Coyne	7, 11, 12	12, 27
Mick Flanigan	8, 9 (QA)	17, 24
Brian Lantz	(SEI interface compatibility)	12
Richard Mittleman	9, 10	
David Nolting	(safety)	24
Norna Robertson	1a, 4, 9, 11 (performance)	4, 19
Janeen Romie	5, 6, 7, 13	4, 11, 18, 26
Bret Shapiro	9, 10	22
Calum Torrie	4, 5, 6, 7	3, 11, 12, 19