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Date:	1st March 2008
Refer to:	L080011-00
Subject:	Comments and Questions on the BOSEM FDR and FRR, and Responses.
To:	BOSEM design team (Stuart Aston, Ken Strain, Alberto Vecchio et al)
From:	BOSEM review committee (Betsy Bland, Doug Cook, Dennis Coyne, Peter Fritschel, Jay Heefner, Richard Mittleman, Janeen Romie, Norna Robertson (chair), Brett Shapiro, Calum Torrie, Bill Tyler)

The review committee for the B-OSEM FDR and FRR met on Feb 15th to discuss the documentation presented, in particular the Design Document and Test Report (T050111-02-K). Our comments and questions on this document and the Assembly Specification and Test Specification Documents (T060233-01-K and T070107-01-K respectively) are given below. These comments/questions are edited from comments received from individuals, and from discussions at our meeting. We will meet with the B-OSEM design team on Feb 29th as planned to discuss the responses to our questions. We thank the design team for putting together and clearly presenting all the documentation for this review, including drawings, drawing tree and 3D CAD model on the Birmingham website at

http://www.sr.bham.ac.uk/dokuwiki/doku.php?id=bal

Revision 01 (21 Feb 2008) Addition of comment on grounding and shielding, 11) a). (NAR)
Revision 02 (24 Feb 2008) Inclusion of design team responses to panel questions/comments, in red. (SMA)
Revision 03 (29 Feb 2008) Inclusion of further responses/comments from review team and from design team at telecon 29 Feb 2008 (NAR)

Noise Prototype OSEM Design Document and Test Report T060233-01-K

The comments are presented in sequential order by document section.

It was noted that committee members could not access reference 1 (E050160) in the DCC, and so some of the comments below may be moot when this document becomes available to them.

Reference [1] - apologies that this document was initially unavailable. The most recent version can now be found on the ICD web page hosted by Dennis Coyne at:-
http://www.ligo.caltech.edu/~coyne/AL/Systems%20Site/ICD.html

1) Title and Section 1.

It was noted that throughout this and other documents being reviewed the design is referred to as the "Noise Prototype OSEM". We assume that what is in fact being presented is the final design for the Advanced LIGO BOSEM. Assuming that is so, Section 1 should be revised accordingly, as should the titles of the documents and references to the design therein.

Agreed. Documentation and drawings to be updated.

2) Section 2

a) Related to the comment on section 1, the second sentence in section 2 says "We intend to further develop this design ... " ; this is similarly confusing as to whether what is presented here is the final design or whether it is a prototype. Please clarify.

Agreed. Sentence will be revised to clarify that this is the final design.

b) 2.1 We commend the use of the "can" style PD and LED assembly for more repeatable assembly than the circuit board style used for iLIGO, and removing the use of Ceramabond.

Agreed.

c) 2.1.2.Figure 2: This shows the SMD2420 photodiode, even though this isn't being used. It should be deleted to avoid confusion. The left panel of fig 2 shows the optics for the emitter; what should be added is a plot of the beam profile (both dimensions) that this forms. The sensitivity shown in the right panel is inconsistent with that shown in fig 22 (see comment/question 7) d) below)

Figure 2 to be removed completely. In its place, a plot of the beam profile in 1-d shall be shown. The orientation of the emitter location tab is constrained when assembling the B-OSEM.

(Plot in other direction difficult to make)

d) Please include much more information on the devices: manufacturer, emitter wavelength & power,operating current, etc, i.e., the most relevant data from their spec sheets.

Agreed. Document to be updated.

e) 2.1.3. Curious about the fit of the devices in their macor sleeves: how tight is the fit? what's the tolerance of the diameters?

IRLED:- 0.180" – 0.186" [4.57 - 4.72]
PD:- 0.179" – 0.189" [4.55 - 4.80]
MACOR sleeve internal aperture is 0.186" ± 0.01

Query on MACOR tolerance and resultant fit: manufacturing tolerance is large for this material. Reply - the fit is snug and no problems encountered.
Variation in signal seen is not due to mechanical slop – see later discussion.

f) 2.2.1. Please include under actuator properties the nominal coil inductance, resistance, max current and other electrical characteristics. It would also be helpful to include the coilformer material (Al) in this section

Agreed. Document to be updated.

g) 2.2.2. How is the PEEK tab held into the coil groove?

The actuator wire is wrapped through holes in this part a number of times securing it in place. This feature is not present in the model and therefore can not be seen in figure 8. This part is now part of the B-OSEM assembly tooling and is manufactured from PFA 440HP (not PEEK). Document to be updated.

This tab is only used in tooling during assembly to stop coil from unwinding. It gets removed when flex-rigid circuit is put one and wires soldered in place.

It was suggested that a picture be put in here to illustrate.

h) 2.3 Has the 'sweet spot' been determined? It would be good to include in this doc a plot of force vs axial position.

The 'sweet spot' has been determined, using the refined coil geometry in Mark Barton's Mathematica model. The document will be updated to include the plot.

It will be checked that correct geometry has been used.

i) Flag-magnet connection: experience at LASTI has shown that the mounting of the flag on the magnet is not sufficiently 'kinematic' -- how has this been redesigned to improve this? Also there were problems with baking – are the procedures resolved?

Flags and magnets are not within the scope of Birmingham deliverables. Birmingham has provided input to the design (e.g. by specifying flag dimensions etc). However, the final design and fabrication is a RAL responsibility. Therefore we recommend that these parts should therefore be covered in the forthcoming Mechanical FRR / FDR.

We agreed this will be covered in the Mechanical review (and it was noted that the issues have been addressed by RAL).

j) 2.4 Are we to review the design for transverse positioning here? (or is it regarded as part of the quad mechanical review?)

The transverse positioning afforded by the B-OSEM is superseded by the adjustment available on parts of the mechanical structure (e.g. tablecloth). Hence, I believe this should be covered in the scope of the forthcoming Mechanical FRR / FDR.

k) What are the positioning tolerances?

See answer to (j) above. The B-OSEM traverse positioning range is given in section 1.1.1.1.3 of reference [1].

Outcome after discussion – it is believed measurements on sensitivity to transverse flag motion were carried out and used in providing tolerance info to the mechanical design, to be confirmed and referenced.

l) We note from experience at LASTI and with the OMC-SUS that there is small clearance around the magnets. This is not a problem per se but makes setting up and alignment more difficult. Has there been a change in the design from the first prototypes? Can the inner diameter of the coil former be increased? Or should we consider a smaller diameter longer magnet?

Dimensions of the magnet aperture within the coilformer have remained the same, from early prototypes to the final B-OSEM design. It's likely that if the revised magnet-flag holders are being used, then these parts exceed the 10mm diameter of the magnets; thus reducing the clearance and alignment visibility. There is the potential in the current B-OSEM coilformer design to improve the clearance situation marginally. However, any changes in this dimension would require us to re-fabricate some of our assembly tooling.

It was commented by several people who had hands-on experience that the alignment was tight. During discussion it was realised that the clearance is less than originally designed. The original had the flag vacsealed to the magnet and spacer. The attachment is now done magnetically, with a "cup", whose outer dimension is larger than the magnet diameter. Internal diameter of OSEM bore is 12.7 mm. Original OD of flag assembly was 10 mm. It is now 10.5 mm with the cup. We recommend that the design is looked at to see if we can win back the 0.5 mm (or more is possible) on the OSEM bore. An alternative might be to go for smaller diameter magnets but 9 mm probably would not be off-the-shelf.

m) The third paragraph refers to a two screw design that could be pursued. Will it? What will AdL have? If this is not what is being supplied then there should be a figure showing the 4 screw design and adjustment procedure.

The two screw adjustment scheme has been adopted for the final design B-OSEM. The document is to be updated to clarify this.

n) Please comment on the choice of axial range (11mm) – is this range needed, is it sufficient?

No traceable requirement has been located detailing the axial range. However, the Controls Prototype "Hybrid-OSEM" had ~7mm axial range available. In designing the B-OSEM, a 50% safety margin was added to this axial range. We are not aware of any OSEM axial range issues associated with the CP Quad assembly and alignment. The B-OSEM axial range maybe in excess of what is required, but it does not encumber the design and is thus an appealing feature to retain.

3) Section 3

a) 3.1.1 Please include the connector pin-out in this document, and the mating connector part number for the GlenAir micro D.

Agreed. Document to be updated.

b) 3.1.2 What is the adhesive used in the flexi-circuit? (include name)

Pyralux® LF Sheet Adhesive. Part Number LF0100. Datasheet is available via the following link:- http://www2.dupont.com/Pyralux/en_US/assets/downloads/pdf/LFadhesive_H-73246.pdf

c) 3.2 We think that the cable harness section should be removed from this review and covered elsewhere along with other cable types etc.

(Note: When the harnessing gets reviewed elsewhere, some amendments are needed to 3.2.3.2, 3.2.3.5 and 3.2.3.6:
3.2.3.2Title should be OMC Double suspensions and remove both the penultimate mass and bottom mass entries (there are only OSEMs on the top mass)
3.2.3.5 and 3.2.3.6 should be merged. The BS and FM designs are identical. Also they are triples not quads.)

Harnesses are discussed in the design document because they fall within the Birmingham scope and are an in-vacuum deliverable. Document to be updated as determined necessary.

It was agreed that the harnessing should be included in the Mechanical review. Rich Abbott should be involved. It was noted that Birmingham only supplies the harnessing for the quads, not for HAM suspensions. Alberto agreed that delaying this review is OK for their schedule.

4) Section 4

a) Should include here (or earlier) information on sensing tolerance on x and y position. How well aligned does the flag need to be? Please also include information on cross-coupling.

Agreed. We shall incorporate details on sensing tolerance into the document. Unfortunately, I have not been able to locate cross-coupling information from Birmingham / Strathclyde documentation. However, we are aware of measurements that have taken place for the OMC work. Have these results been documented and are they available on the DCC?

Norna confirmed some measurements were made by Caltech SURF student. These are on the wiki at

http://ilog.ligo-wa.caltech.edu:7285/advligo/OMC_Presentations

under Campos_report.doc. This document will be put on the DCC.
Stuart is pursuing whether other measurements have been made in the UK – they may need to be taken again.

b) 4.1. How did you arrive at a max magnetic force of 5 mN? What is the force for the actual separation of 28.6 mm?

The coupling force was not measured at this range.

Original requirement was set to be such that coupling force was no larger than 10% of the range of actuator force. This gave a number for the flag length. The design is now such that coupling force is only 1% of the peak actuation force.

c) 4.2 What is the motivation for this? Would it help to drop this provision? (Does it encumber the design?) Correction: iLIGO magnets are 2mm diameter.

There was a request from David Shoemaker to include provision for this feature. It does not encumber the design and only requires 3 tapped holes in the backplate (D060107). We have not designed, nor do we provide, the screw and magnet assembly, just mounting holes.

d) If PAMs are added to the pitch UI mass can we access them easily?

No. The B-OSEMs are installed onto the Quad UI mass without the backplate (D060107) and consequently have no PAM mounting holes. In addition, the following B-OSEM parts are also not install in the UI mass locations:- Clamp (D060108), Adjuster Shafts (D060109) and the Adjuster Nuts (D060110). Instead the B-OSEM coilformer is directly mounted onto an adjustable bracket which should fall within the scope of the forthcoming Mechanical FRR / FDR.

Outcome of discussion of c) and d) – leave the holes there in case needed. Could think of a ring geometry so as not to occlude view if ever needed.

e) 4.3 What is the eddy current damping coefficient for these OSEMs?

This has not been measured at Birmingham. However, some measurements have been taken by Bram Slagmolen at ANU. A damping coefficient of 0.377 kg/s was reported, see:-
http://150.203.48.157:7473/CGP/110

It should be confirmed if this figure is for 1 or 4 OSEMs.

f) The final sentence of this section appears out of place. Also the RODA does not say that sensors will not be fitted – rather that experiments at LASTI will establish whether they are useful/necessary

Agreed. Document to be updated.

g) 4.4.1. What are the acceptance criteria for the burn-in process?

Only the total current draw is monitored throughout the process. We are initially looking to identify any IRLED device that fails completely within the 50 hour burn-in process. Hence, an observed change in current draw of ≥100mA would indicate failure of a device (or a number of devices). A visual inspection of the optical output of all the devices is then conducted using a CCD camera to identify any failed devices.

n.b. throughout this burn-in process the optical output of the IRLEDs is not measured. This is carried out in a later screening procedure – see item (i) below.

h) is there any data on long term degradation?

Long term data is being taken in an ongoing MTBF test based at the University of Strathclyde (Nick Lockerbie). The document can be updated with the latest degradation plots.

No failures yet.

i) 4.4.2. What are the acceptance criteria for the LED screening test?

See revised test / acceptance procedure (k) below.

j) The stated LED intensity 2-6mW/cm²@ an IR wavelength at the output is probably not eye safe especially with a focusing lens. This should be looked into especially when testing the units away from final installations

Has this concern been raised with respect rt the IRLED burn-in or screening process? It is assumed that this is not an operational safety concern for the B-OSEM? It should be noted that the 2-6mW/cm²@ an IR rating is at maximum forward current of 100mA. During screening, the devices are de-rated to 35mA.

It was noted that beam diverges at 18 degrees. A note in the assembly/test procedure re safety should be included.

k) We have observed a relatively large spread in the open-light current of the osems used so far. They vary anywhere from 50uA to 90uA. Is this expected? Do we know the cause? Should here be a tighter acceptance? What is done with the screening info data described in this section? Is there a screening process for the PDs? How does this affect the sensitivity? How does it affect the noise? Is there a plan to resolve this?

The original screening process (detailed in T050111) was carried out using a clear aperture with the PD & IRLED located at either end. The PD remained the same whilst the IRLEDs were swapped in and out. The orientation of the location tab of the devices was consistent for all devices. The IRLED was driven at 35mA. IRLEDs were sorted into 10% bins.

However, the spread seen in the open-light current was larger than we had expected and did not become evident until we had characterized and shipped a number of B-OSEMs. Bench tests were repeated using IRLEDs that had gone through the original screening process, using an actual B-OSEM assembly (i.e. optical configuration). Results obtained showed a spread in open-light currents equivalent to what had been observed with the shipped B-OSEMs. This demonstrated that it was the original screening process that had proved ineffective. It's likely that the original screening process did no screen the optical output of the device, but instead manufacturing tolerances on the package & location of the integrated lens.

To rectify this issue, the new screening process utilizes a production B-OSEM and sensor assembly for screening IRLEDs. Again, the PD is to remain the same, whilst the IRLEDs are swapped in and out. We are aiming for a nominal PD current around 60uA, with the devices being sorted into 1uA bins.

The final delivery of B-OSEMs for Noise Prototype work will be cleaned, baked and assembled using IRLEDs that have gone through this revised screening process. B-OSEM testing prior to shipping will enable to confirm that the spread in open-light current is what we would expect.

Document to be updated with the details of the revised screening process.

More background info: Birmingham originally approached manufacturer for grading, but they were not prepared to do this. The OSEMs already delivered have wide variation. The screening procedure will be revised as described above.
Fraction within 1uA is ~ 5 to 10%.
~2000 to be screened. Cost of device is negligible compared to cost of screening.

l) 4.4.3. Is the coil winding burn-in test part of the procedure? We think such a test is advisable, at level of ~ 200V.

Such tests have not been conducted so far, but could be implemented as part of the final B-OSEM test procedure prior to shipping.

However, are there any outguessing issues associated with conducting these tests? Have similar tests been carried out on previous OSEMs? It should be noted that we are using the QML grade insulation, whereby it's understood that previous OSEMs used the HML grade.

This is a breakdown test. Birmingham already do a low voltage test.
It is good practice to "stress" at level above the rail limits (+/-15 V for the quad application) – say by factor of 2 to 3. We will recommend this is done.

m) 4.5. From the table, is it correct to infer that 0.833 W is dissipated in the coil at 0.15 amp? (corresponds to a coil resistance of 36 ohm)

Agreed. Nominal coil resistance shall be included explicitly in the document as agreed in section 2, item (f).

n) Thermal Considerations- What is the max coil current and for how long for the osem?
With reference to T060067-00-C - "Coil Driver Design Requirements" J. Heefner. DCC link:-
http://www.ligo.caltech.edu/docs/T/T060067-00.pdf
Max continuous coil current (at top-stage) is 200mA.
Peak current requirement is 400mA during acquisition.

This issue led to much discussion. Some points:
400mA is for actuation on penultimate stage and is not continuous.
Justin noted calculation he has done gives 5.6K per W temperature increase on tablecloth when attached to the structure. This is different from the conditions used to produce the numbers shown in table 7.4.3.1 in T050111-02-K where larger temperature rises are recorded. It was agreed it would be a

good idea to include numbers on internal rise and surface rise in operating conditions in the design document. The temp rise would be of order 10K not 50K.
Outgassing – We could make measurements at Caltech doing RGA scans as the devices cool after baking. We will take opportunity to do this when next batch of noise prototype OSEMs are sent (likely to be late March.)

5) Section 5

a) 5.1 We note that some of the non-standard materials listed should be looked at for UHV compatibility e.g. phosphor bronze, hysol epoxy, LCP. Dennis has taken an action to check on the OSEM results. An RGA test capture here would be good – we will provide

Agreed.

b) Why is titanium used? (and what is the adjustment assembly?)

The adjuster nuts (D060110) and adjuster shafts (D060109) comprise the adjustment assembly. In our initial designs all parts were aluminum, which was susceptible to galling. So the adjuster shafts were switched to titanium. We have since settled on PEEK for the adjuster nuts, so the adjuster shafts could be switched back to aluminum. Drawing D060109 can be updated.

The possible use of aluminium raised concerns due to wearing – the adjusters get used a lot. Recommend keep to titanium.

c) Include peek in the list of materials

Agreed. Document to be updated.

d) 5.2 The pre-assembly bake of all parts at 125 C is inconsistent with the 80 C limit for the magnets given later. With reference to this we note we may make a global change to SmCo magnets from NdFeB.

It is not within Birmingham's scope to supply magnets (can be considered as part of the structure) i.e. no cleaning or bake-out of these parts will be conducted at Birmingham. Section 5.2 of the document can be revised to clarify this.

6) Section 6
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7) Section 7

a) 7.2 What is the scaled estimate for the emitter MTBF?

See section 4 item (h). Document to be updated.

b) Will we batch sort OSEMs into sets according to their test results?

This should not be necessary. What parameter would be potentially used to sort B-OSEMs?

It was noted that in LIGO 1 properties of OSEMS were all recorded and they were grouped with similar properties. Useful when replacements need to be done.

c) 7.4.1 Sensitivity range appears to be defined by those points at which the sensitivity drops to half the max value ... correct?

Agreed.

d) 7.4.2. For the noise spectrum, there should be a plot calibrated in m/ rtHz on the vertical axis, and with a log x-axis that extends from 0.1-10 Hz (or higher). The data shown in Fig 22 is significantly noisier than a plot we received in Feb 2006 from Nick Lockerbie (in fact the plot shown in Fig 2), where the noise is 9.9e-11 m/rtHz at 1 Hz, versus 3e-10 m/rtHz shown here. Please explain. Were either of these measured in-vacuum, with the appropriate preamp?

These measurements have not been made in-vacuum. Appropriate front-end electronics was used in each case. The performance <1Hz is driven by thermal effects. The sensor prototype (shown in Fig 2) had a good thermal link to the metal package of the IRLED. The final article B-OSEM uses a Macor sleeve to insulate the PD and IRLED packages from the OSEM body.

The noise performance led to some discussion. The factor of three worse performance between the original measurements from Feb 2006 and more recent ones are attributed to the lack of good thermal link from the IRLED which is getting warm (previous measurements made with Al link, now macor). It was pointed out that the new noise figures meet requirements. However the better (older) measurements have been used by several people in modeling, and it would be good if the factor could be regained.
Subsequent to the telecon, Peter F sent round a note suggesting alumina might be better than macor
Conductivity: Macor: 1.46 W/mK, Alumina, 99.5%: 35 W/mK

e) 7.4.3. What's the plan for doing measurements of outgassing versus current? Are there plans to test/quantify the level of out-gassing from the coil at 250mA rms drive current? Is the 150 mA current given in section 4.5 a placeholder until these tests are done?

At present we do not have plans to carry out these tests at Birmingham.

See 4) n) above

f) Additional topic: A portable OSEM test box should be developed that allows one to test and readout the OSEMs in-situ. This should allow to test the coil inductance, and resistance, PD current, and test for electrical shorts. This would allow OSEM alignment to be done without having to read off a computer screen. In iLIGO a similar test box was used and the results were recorded by serial number and group by similar performances. Also having a satellite box with a breakout port accessible at the chamber is very useful during alignments and trouble shooting etc.

Would a portable test box be required to connect to UHV ‘clean’ OSEMs? Or could it interface to the satellite box monitor ports outside the chamber, would this be sufficiently local? Could any existing test equipment be employed in this role? For example, a modified harness would allow the B-OSEM to be interfaced with the MIT OSEM test box.

Birmingham plan to deliver two Automated Test Equipment (ATE) units – one for each site. These are bulky (not portable) and for use before installation.
After installation the satellite module port can be used with an "octopus" cable.
It was noted that having something portable which one person could view while making adjustments would be a good idea, and we might be doing this procedure when satellite module is not in place. This will be discussed further and a recommendation made.

8) Noise Prototype OSEM Test Specification Document, T070107-01-K

a) Section 2. It is not clear when the Stage 1 tests are to be performed and when the Stage 2 tests are to be performed with respect to cleaning and baking. For info, we perform a Stage 2-type test before and after the 2nd bake process, and after shipping to a sites (at a minimum), for initial LIGO osems.

Stage 1 & Stage 2 tests will be conducted on assembled B-OSEMs, after all the parts have been cleaned and baked at Birmingham. Stage 2 type tests can then be repeated after shipping cleaning/baking in the US. Document will be updated to clarify this.

b) The test set-up noted on page 5 is sounds good, but are we going to receive one or procure it?

Anticipate delivering a single ATE (Automated Test Equipment) set-up, to each observatory site.

c) The acceptable test parameters on page 7 need to be fleshed out soon.

Agreed. This is a work in progress. Document to be updated.

d) In the OSEM test log, it may be useful to explicitly list the nominal values and tolerances for the coil resistance, resistance to body, etc. Maybe there should also be a pass/fail column?

Agreed. Document to be updated.

e) The ATE generates data files for the osems. Will these files be sent to LIGO or are they maintained by the UK? Will osems be tracked over their lifetimes by the UK or by LIGO?

ASCII data files would be available to LIGO upon request. We can provide LIGO with the capability to monitor B-OSEM characteristics over the lifetime of the units. See item (b) above.

9) Noise Prototype OSEM Assembly Specification Document, T060233-01-K

a) Reference 7-update to version -01

Agreed. Reference to be updated.

b) 3.5 IRLED and PD cleaning. The description of the cleaning process is unclear. Are agitated soaks being advocated over ultrasonic cleaning? And the word "required" suggests a requirement is written down somewhere - is that the case? Reference? See also comment on section 5 below.

There had been some initial (unfounded) concerns about potential damage that could be caused to the PD & IRLED devices if cleaned in ultrasonic-baths. These parts can withstand this process, so references to agitated soaks will be removed and the document updated.

c) 4.2.1 Does the coil winding machine require to be cleaned before it gets used? What procedure is used for that?

The winding machine is cleaned to class B. Whereas PFA 440HP fixtures and jigs used to mount the OSEM onto the coil winding machine are cleaned as class A

d) 4.3.1 Somewhere it should be made clear which is the "back" of the OSEM e.g. label a nearby figure and reference

Agreed. Document to be updated.

e) 5. Why is it Ok to ultrasonic the complete assembly when it was not Ok to do individual parts?

See item (b) above. All parts and the completed assembly can be placed in ultrasonic bath. Document to be updated.

10) General QA questions and comments

a) One item that sometimes is of concern is specifying and having an agreement with vendors about applicable "workmanship standards". This is particularly important for electronic assemblies (soldering and welding). Also applies to fabricated parts/components.

Agreed. It may be necessary for us to visit vendor’s sites to ensure that the same “workmanship standards” apply to the larger quantities of parts we will place on order for the full production run.

b) Another important requirement to impose on suppliers and vendors is for them to provide "certification of acceptance" (compared to requirements), material and process certifications, traceability data (i.e., lot and/or batch identification) and an "as-built-list"

Agreed.

c) Document/record test set-ups (schematics, photos, etc.) and equipment identification (mfgr. model no., S/N, P/N,) and calibration data. Automated test set-ups should also include periodic "end-to-end" check-out and calibration tests.

Agreed. Equipment identification information is to be included in our test documentation.

d) Customer should always attempt to review and approve vendor's final inspection and test data prior to vendor shipping the product.

Agreed.

e) Ask vendor/supplier for information about decrepit hardware or material or test results and disposition (MRB actions).

Agreed.

f) There is a statement regard a hermetically sealed assembly, how is this tested and verified to be true ?

The PD and IRLED are specified as being hermetically sealed devices. However, the devices are not required to be hermetically sealed and I believe have been qualified for LIGO UHV use in both hermetically sealed and vented states. Can Dennis Coyne confirm?

Dennis has taken action to check with Bob Taylor on what has been done.

g) When installing fasteners (screws), should torque values be specified and verified at installation?

No critical fixing screw torques are required throughout the B-OSEM assembly. “Finger tight” for all fixings screws will suffice.

h) An assembly record or Traveler is required for all assembly activities ?

Agreed. We shall implement travelers for final production units.

i) Is measuring and recording the final assembly mass (weight) useful ?

We do not presently measure the mass of shipped B-OSEMs. However, the measurement may be of limited value given that B-OSEMs can be installed in different configurations. For example, no backplate, no adjuster assembly etc.

j) The coil insulation "short" test voltage should be carefully selected to avoid "over-stressing" the wire insulation.

Agreed. Are there any out-gassing concerns associated with this process?

11) Comments on grounding and shielding

a) Please address the comments in the following e-mail from Rich Abbott.

In designing the LIGO in-vacuum wiring harnesses, we set goals to achieve, mechanical robustness , vacuum compatibility, and electro-magnetic shielding effectivity.

In the current design of the B-OSEM, microminiature Sub-D connectors are used to interface to the vacuum wiring harness. We noticed that these connectors have a direct galvanic connection to the metal body of the OSEM. In order to avoid connecting our cable shields to ground through the mating cable's metal backshell, we had to break the cable shield prior to attaching the vacuum cable harness to the OSEM. This compromises the mechanical and electrical properties of the cable assembly.

There are several options for fixing this that use PEEK plastic connectors. During our research into vacuum cabling and shielding, we developed custom PEEK versions of standard connectors. We applied metal coatings in the form of Electroless-nickel that are vacuum compatible, and can be masked to achieve complex geometries.

The current mate to the B-OSEM microminiature Sub-D is purchased from Glenair Vacuum Company. We could prepare a similarly priced PEEK version with a custom stainless steel backshell like we did for the larger 25 pin Sub-Ds.

It is yet to be determined if shielding of B-OSEM harnesses is a requirement. So far, due to stiffness concerns, the harnesses we have provided for the Noise Prototype Quad Suspension have not incorporated an overall braided shield. So direct galvanic connection has been avoided.

However, if later measurements demonstrate significant levels of cross-coupling between the ESD and B-OSEMs, then we shall look into adopting an approach similar to that outlined above.

Baseline is no shielding to check for the cross-coupling referred to above. We may want shielding but not connected to the coil form. Rich’s note gives guidance how this can be done.

Other notes.

A) Outgassing
Dennis sent out information by e-mail on outgassing measurements which have been done already. He will put the info into a technical memo,

B) Peter reminded us about concerns on using phosphor bronze. Dennis took an action to think about this.