

Subject: Re: VRB Response to Fluorel/Viton O-ring questions

From: Michael Zucker <zucker_m@ligo.mit.edu>

Date: Fri, 12 Oct 2007 14:00:04 -0400

To: John Worden <worden_j@ligo-wa.caltech.edu>

CC: Riccardo DeSalvo <desalvo_r@ligo.caltech.edu>, Dennis Coyne <coyne@ligo.caltech.edu>, John Worden <worden@ligo.caltech.edu>, David Shoemaker <dhs@ligo.mit.edu>, Bill Tyler <tyler_w@ligo.caltech.edu>, Stephany Foley <stephf@ligo.mit.edu>, Rai Weiss <weiss@ligo.mit.edu>, Fred Raab <fjr@ligo-wa.caltech.edu>, Janeen Romie <romie_j@ligo-la.caltech.edu>, Mike Zucker <mike@ligo.mit.edu>, Carol Wilkinson <wilkinson@ligo-wa.caltech.edu>

John-

I think this is adequately conservative, I have no concerns adopting this revision.

As mentioned in an earlier thread the small cross-sections characteristic of seals are easily susceptible to depletion in the bake process. This is a different realm of diffusion times from the bulk springs and spring seats we learned to fear.

Mike

On Oct 12, 2007, at 13:28, John Worden wrote:

Reference LIGO-L070086-00-V
re: L070059-00

I propose that the VRB allow commercial off the shelf Viton or Fluorel o-rings be used in the LIGO vacuum systems provided we obtain material certifications, and that we restrict this to o-ring cross sections equal to or less than the nominal .275 inch vacuum vessel o-rings in use. For O-rings of less than 8 inches in diameter such as those used in viewport mounts and earthquake stops, processing shall be as called out in E960022 (extract below). RGA screening shall be performed post bake. The large diameter o-rings used for vacuum chamber seals and large quantities of smaller o-rings may need to be processed according to E960159-01-V (V049-2-122 PSI doc) if there is concern for contamination of our vacuum ovens. I also propose that we restrict manufacture to Dupont, 3M, Parker and Parco. The documents impacted by these changes would be E960022 and E960050.

Comments? changes?
thanks
John

FROM E960022 - O-ring processing.

D. Fluorel - Viton:

- Seals and O-rings:
 - o Wipe with clean, dry lens tissue or polywipe.
 - o Bake in vacuum for 48 hours at 120 degrees C.
 - At least 24 hours prior to installation, process all Fluorel or Viton seals and O-rings as follows:
 - o Soak 10 minutes in DI water.
 - o Dry with cleanroom wipes.
 - o Place on a class 100 flowbench for 24 hours to dry.
 - o Wrap for transport to the installation.

Michael Zucker wrote:
| this email: **L070084-00-V**

re: **L070059-00**

Yes Dennis that sounds a good policy.

I don't think I'm in the VRB any more, didn't David take my place a while ago?

Just moments ago I forwarded a request by Stephany for clarification on viton (among other things), her search apparently only turned up the pre-Walker spring seat procedure with no cleaning recipe which I flagged as an additional concern.

Mike

On Oct 5, 2007, at 13:47, Dennis Coyne wrote:

To the Vacuum Review Board (VRB):

On several occasions I have sent emails to the VRB to get advice. I think that these interactions should be documented. In the case of the next to most recent inquiry, regarding viton, I sent the question in the form of an email with a DCC number (and posted it into the DCC, L070059-00). I would like the VRB to respond in similar fashion. I suggest that John as the chairman replies (or assigns one of the VRB members to reply) with the majority advice. This response can be in email, but must have a DCC number (let's use L numbers) and if it was prompted by a question, then it must site the L-number of the original question. Sound like a reasonable approach? If so, could you please formally reply to the Viton question; I've recapped my understanding of the consensus reply in the email below.

Thanks,
Dennis

At 08:27 AM 8/15/2007, Dennis Coyne wrote:

Mike,

Your suggestion seems to be the same as Rai's suggestion, except that you stipulate that we "have traceable documentation of the formulation". My interpretation of Rai's comments is that we don't care about the details of the formulation. (Rai even went to far as to say that we can't trust the vendors to apply rigorous compliance with a material certification. I disagree, although to do so will cost some additional amount.) In all cases we must have a successful post-processing RGA screening.

So let me try to interpret your suggestion in my language and in an attempt to be perfectly clear. You, like Rai are confident that a commercial fluoroelastomer is highly likely to pass a post-processing RGA screening. Consequently we should proceed with an order of the Parco o-rings that Janeen has identified and we recognize that there is a small risk that this formulation will subsequently be found to be unacceptable. In addition, you suggest that we (a) capture this new material specification so that we can list it as an acceptable alternative to the specific grades of Viton and Fluorel that we currently have approved, and (b) insist on material certification for the parts (which is, or certainly should be, our standard practice, by the way).

Did I get this correct?
Dennis

At 07:26 AM 8/15/2007, Michael Zucker wrote:

The subject o-rings are 1/16" nominal thickness (.070" actual). Our normal Viton vacuum bake process, developed for components 5-10x thicker, should fully deplete volatile organics present in the bulk. Providing we do have traceable documentation of the formulation, and successful post-process RGA screening, I support waiving the specific formula and using COTS parts.

As I recall the most troublesome ingredient in the PSI o-rings was Carnauba wax. This caused sticking, but (after processing) was apparently neither migratory nor volatile.

Not sure about the details, but I do remember us agreeing to just live with it.

On Aug 14, 2007, at 23:27, Dennis Coyne wrote:

Reference LIGO-L070059-00

To the Vacuum Review Board (VRB):
I have two urgent questions for which I need answers from the VRB:

1) Mold release agents are a source of much of the hydrocarbon outgassing from viton or flourel parts. For advanced LIGO, I think we should not accept parts with mold release agent(s) mixed into the formulation (only permitted on the surface of the mold); The 200C vacuum bake out with a cold trap seems effective at removing any remaining trace of the mold release agent.

However, for Enhanced LIGO, we already have a precedent of using flourel and viton supplied from PSI without a material specification which eliminates or precludes mold release (specification cited below). Consequently I propose to the Vacuum Review Board (VRB) that we accept commercial o-ring parts for use in the revised earthquake stop design (used as a mechanical spring & damper and is not in contact with the fused silica optic -- only the fused silica tip contacts the optic). These commercial parts almost certainly have cure system components and a mold release agent mixed into the material. (One supplier indicated that their formulation contains a wax process aid (internal mold release agent) and that additionally mold release is used in production (presumably on the mold surface as well)). Does the VRB concur?

2) The LIGO Vacuum Compatible Materials list (E960060-B) lists only the following formulations for viton and flourel:

a) 3M/Dyneon Fluorel FC2180 (or FE5641) as processed per E970130-A [used for seismic isolation system coil spring seats; see also T970168-00, C972528-B]

b) Parker Fluorel V747-75 as specified in C990061-00 [PSI-V049-2-210, Rev. 0, attached]

[used for LLO mid-point gate valve o-rings]

c) Dupont Viton E-60C as specified per E960085-06-V (copy appears to be missing from the DCC; also known as PSI-V049-2-045, attached as rev. 0)

[used for vacuum equipment o-ring seals]

d) Dupont Viton A500 as specified per C961792-06 (reference seems incorrect)

[used for vacuum equipment o-ring seals]

It would be expedient, for schedule and cost reasons, to purchase commercial off the shelf o-rings for the Enhanced LIGO revised earthquake stops. Janeen can find a supplier that provides appropriate sized o-rings comprised of Parco 9009-75 material which is "equal to" Parker V747-75 material. This is almost entirely consistent with PSI specification V049-2-210, rev. 0 which stipulates Parker Fluorel material with physical properties similar to V747-75. However, there is no guarantee that the Parco material 9009-75 has the same chemical composition as the Parker Fluorel. Is this acceptable for use in Enhanced LIGO? ... for use in Advanced LIGO?

Note that the typical formulation for o-rings (see for example this Wiley InterScience Encyclopedia entry on Fluoroelastomers) is:

Poly(vinylidene fluoride-co-hexafluoropropylene) 100 parts

Hexafluoroisopropylidenediphenol 2.1 parts

Triphenylbenzylphosphonium chloride 0.45 parts

Magnesium oxide 3 parts

Calcium hydroxide 6 parts

MT Black (N-990) 30 parts
 The special UHV formulation of Fluorel called out in E970130-A is:
 Fluorel FC2180 (or FE5641), 100 parts
 Magnesium oxide (maglite), 3 parts
 Calcium hydroxide, 6 parts
 Calcium oxide, 3 parts
 MT Black (N990), 20 parts
 no other additives or mold release agent
 Fluorel FC2180 (from Dyneon LLC, a division of 3M) is a di-polymer of vinylidene flouride (PVF2) and hexafluoropropylene (HFP). It does not contain cure system components such as Hexafluoroisopropylidenediphenol and Triphenylbenzylphosphonium.

Some background notes on the source specifications:

LIGO-E960085-00-V is the LIGO Lab designation for PSI document PSI-V049-2-045, rev 0 (dated 12/27/1996). It is found in:

LIGO Vacuum Equipment Final Design Report, Vol. II, Attachment 5: Specifications/Misc., section 6. [This 4 volume compendium, which fills a shelf in my office, is designated as a set in the LIGO system as LIGO-C961160-00-V. You can likely find a copy in the LIGO library/conference room at each LIGO site.]

I've attached a copy of LIGO-E960085-00-V (aka PSI-V049-2-045, rev 0). This spec calls for Dupont Viton E-60C suitable for UHV use, handled and packaged for consistent with clean room class 100 standards, then baked by PSI (or us) per v049-2-122 (see below).

LIGO-C961792-02-V is the LIGO Lab designation for PSI document PSI-V049-2-045, rev 2, dated 8/22/1996 (it should not have double designations in the LIGO Lab system, but it does).

There is also a LIGO-E960085-06-V (aka V049-2-045, Rev. 6), dated 6/23/1998 logged into the DCC. This appears to be the latest version. I tried to identify the source document (likely a compendium of many documents), but failed.

I did find a related document, PSI-V049-2-210, rev. 0, which is an o-ring specification for the LLO mid-station gate valve. It calls out a TBD material with properties identical to Parker Fluorel V747-75.

A related specification is the viton vacuum bakeout specification. The version included in

LIGO Vacuum Equipment Final Design Report, Vol. II, Attachment 5: Specifications/Misc., section 6.

is PSI-V049-2-122, Rev. 0. (dated 5/4/1996). There is newer revision, PSI-V049-2-122, Rev. 1 (aka LIGO-E960159-01-V), dated 12/18/1996, but I couldn't find it. The Rev. 0 specification calls for a 150C vacuum bake.

Dennis
 <v049-2-45-rev0.pdf><v049-2-210-rev0.pdf>

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