-------- Original Message --------
Subject: VRB response to nickel-phosphorous plating issues
Date: Fri, 20 Feb 2009 14:04:49 -0800
From: John Worden <worden_j@ligo-wa.caltech.edu>
To: Dennis Coyne <coyne@ligo.caltech.edu>
CC: Mike Zucker <mike@ligo.mit.edu>, Fred Raab <fjr@ligo-wa.caltech.edu>, Riccardo DeSalvo <desalvo_r@ligo.caltech.edu>, Rainer Weiss <weiss@ligo.mit.edu>, John Worden <worden@ligo.caltech.edu>, Dennis Coyne <coyne@ligo.caltech.edu>
References: <49836C46.6090707@ligo.caltech.edu> <4989E7BF.6040806@ligo.caltech.edu>

This document: L0900024-v1 VRB response to nickel-phosphorous plating issues.

Dennis;

The VRB approves of the use of electroless nickel plating per the procedure outlined below.

John

> John,
> I've drafted the following VRB reply. Does the VRB concur?
>
> Regarding the electroless nickel-plating plating and heat treatment of maraging springs:
>
> Decision: The process (link below) will be re-written to allow for electroless plating after age hardening, but only with the addition of a 330C, 24 hr bake. Age hardening after plating is also acceptable (but not necessary).
>
> Background: The LIGO Vacuum Review Board (VRB) has informally approved the cantilever spring blade process given below (formal approval in a LIGO document will be issued soon; this is in reply to VRB request L0900013-v1). The approved process (see link below; to be written up as a formal LIGO document) calls for the maraging aging heat treatment (435C for 100 hr) after the electroless nickel-phosphorous plating. This bake serves to drive off unbound phosphorous.
>
> Production in the UK has proceeded to the point where 30 cantilever spring blades for the quad have been produced without plating, but have been heat treat aged (hardened). In addition, the SEI margaing blade springs require machining after age hardening for required dimensional accuracy. If we were to repeat the hardening (aging) heat treatment, we would likely compromise the strength. There is a broad strengthening/hardening peak in time at 435C, but the material will become austenitic at ~1000 hrs. Baking at 435C for 200 hrs would likely cause some appreciable reduction in strength. However a small reduction in temperature requires a significant increase in time to achieve the same level of aging; A reduction of 50C requires a factor of 50 increase in time. Consequently a somewhat lower temperature bake (twice room temperature, 600K) for a modest amount of time (say 24 hr) should be sufficient for driving off free phosphorous but not impacting the hardening.
>
> Dennis
>
> Calum Torrie wrote:
>
> **Re: Request of approval of process**
>
> Dennis
>
> Please find at the following wiki address a proposed method of manufacturing cantilever spring blades for Adv LIGO. I am looking for approval of this process. (The process was put together by an updated cantilever committee including Riccardo, Norna, Janeen, Ken Mason, Mike Meyer.)
>
> I have indicted one possible break between vendor and LIGO staff however this could move depending on vendor

chosen. I have also not updated the proposed move to either 300 or 350 series Maraging.

http://lhocds.ligo-wa.caltech.edu:8000/advligo/Suspensions/CantileverBlades#preview

Cheers, Calum

```
John,

I sent an earlier (before noon) e-mail of concurrence, but may have
neglected to use "reply-all".

Fred
```

```
Dennis,
I have used nickel plating in vacuum for years without any problem.
RW
```

John,
It seems that the board has no issue with the proposed use of electroless nickel plating per the defined procedure. The SEI guys are keen to proceed. Do you approve?
Dennis

Dennis Coyne wrote:

> John,
> I forgot to assign a document number to my request. It is L0900013-v1 and can be found here:
> https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?docid=546
> Please refer to this number when you reply on behalf of the VRB.
> Dennis
>
> Dennis Coyne wrote:
>
> > Yes, the parts are serialized. It is required in section 3.2.12 of the Drawing Requirements, E030350-A, that all parts be serialized; The suspension cantilevered 'blade' springs comply.
> > Dennis
> >
> > John Worden wrote:
> >
> > ```
> > Dennis - I assume these parts will be serialized so that we can track them?
> >
> > John
> >
> > Michael Zucker wrote:
> >
> >
> > If I understand it, I don't see a problem as long as there is a bake
> > (e.g., precip hardening/"aging") to essentially
> > remove the phosphorus before it can cross-contaminate a vacuum
> > processing oven.
> >
> > However we then need to uniformly keep to the fab sequence. For
> > example, any post-aging cold work (e.g., shot-peening
> > to correct warped blades) may disrupt the plating; we can't just have
> > it re-plated and put it back in the queue.
> >
> >
> > On Feb 4, 2009, at 4:26 PM, Dennis Coyne wrote:
> > ```

Ric,
Your argument is compelling. The nickel plating is done before a creep "aging" bake (100 hr, 435C, argon) according to the specification given at the link below.
Dennis

Riccardo DeSalvo wrote:

> According to this table, phosphor of all forms (red and white) have such an high vapour pressure at 425oC that it whatever is not strongly chemically bound it will be all gone at the end of the 100 hour precipitation bake.
> I have recommended that the nickel plating is done before precipitation.
> If that recommendation was accepted the issue seems moot to me.
> Riccardo
>
> On Feb 4, 2009, at 11:08 AM, Dennis Coyne wrote:
>
> > Vacuum Review Board Members (John, Rai, Mike, Fred & Ric):
> >
> > In accordance with the VRB guidance on limits to high vapor pressure elements in alloys, L080072-00, we are requesting approval for an electroless nickel/phosphorous plating (5% phosphorous). This plating is only intended for use on the maraging steel, cantilevered springs used in the suspension systems. A plating is required to prevent corrosion while in storage prior to installation in the vacuum system. The chosen plating has been used by the Virgo project.
> >
> > LIGO has tested the plating for sufficient ductility to sustain the spring deflection without peeling or crazing.
> >
> > Vacuum outgassing of some sample plated maraging steel springs (7 springs totaling 1230 cm^2) has also been measured at room temperature. The outgassing of P (AMU 31) was background limited (2E-11 torr-liter/sec).
> >
> > Does the VRB accept the proposed electroless nickel plating?
> > Dennis
> >
> > Calum Torrie wrote:
> >
> > > **Re: Request of approval of process**
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> > > Dennis
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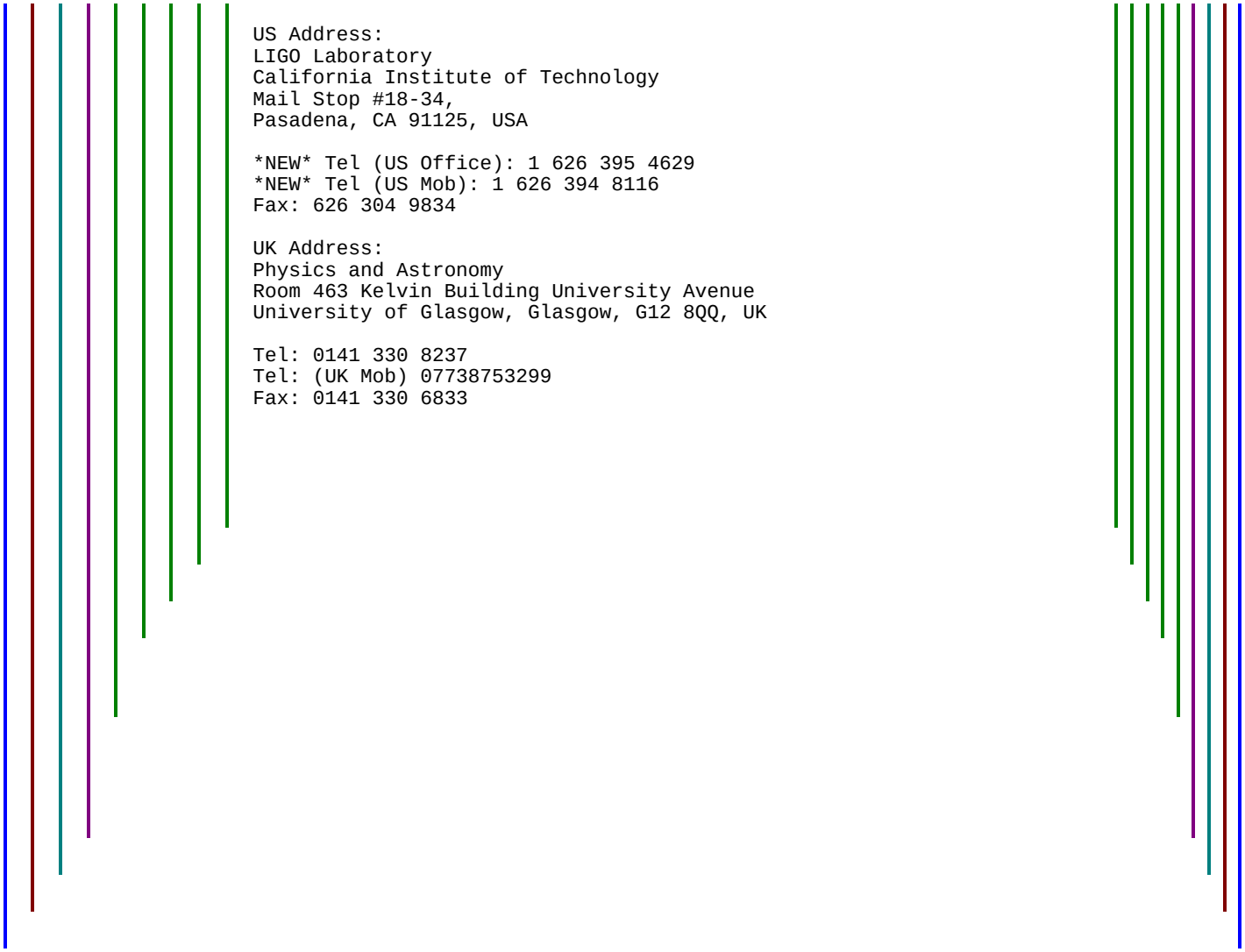
> > > http://lhocds.ligo-wa.caltech.edu:8000/advligo/Suspensions/CantileverBlades#preview
> > >
> > > Cheers, Calum
> > >
> > > --
> > > Dr. Calum I. Torrie



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