New Folder Name Cleaning Summary

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LIGO PROJECT

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FACSIMILE COVER SHEET

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TO	Marty Tellalian CBITSC	DATE FAX NUMBER OFFICE NUMBER	November 2, 1994

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A copy of Rai's notes from last week's visit.

From weiss@tristan.mit.edu Sun Oct 30 20:49:56 1994
To: gerry@ligo.caltech.edu, ljones@ligo.caltech.edu, sanders@ligo.caltech.edu, weiss@ligo.caltech.edu
Subject: summary of cleaning issues at CBI

file:qtcln103094.txt
to: L. Jones
from: R. Weiss October 30, 1994
concerning: Summary of information and recommendations on the beam tube cleaning following visit to CBI and some new research on Saturday.

OBSERVATIONS AND DATA
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1) The tube 22A cleaned by steam alone was treated by:

a) steam: at 130psi (at output of steam generator),

b) surface temperature of the tube: 137 to 150 F

c) cleaning rate: 6 inches/minute

After cleaning the tube has the following properties:

a) Is not visually clean - patches of contamination are visible on the surface

b) Does not pass the water surface adhesion test - water prefers to stick to itself rather than the surface, indicating a surface film.

c) The surface is covered with dislodged particles of oxide not washed away by the cleaning.

d) Fluorescence under UV is seen in a channel along the bottom of the tube even without the aid of solvent.

e) Point sources of fluorescence with the aid of solvent exist over the wall where there is oxide and not at places where the oxide has been removed. The surface density of the points is close to 20 - 25 per square foot

2) The 8ft (so called virgin) tube was cleaned by:

a) steam and 3% solution of Mirachem 500 (surfactant) at 130 psi (at output of steam generator)

b) cleaning rate: 6 inches/minute

c) steam alone flush

d) flushing rate: 12 inches/minute

After cleaning the tube has the following properties:

a) Is visually clean

b) Passes the water surface adhesion in those places tried

c) The surface is not covered by dislodged particles

d) Fluorescence under UV is still seen in a channel along the bottom of the tube but only with the aid of solvent.

e) Point sources of fluorescence with the aid of solvent exist over the the wall where there is oxide and not at places where the oxide has been removed. The surface density is less than 10 per square foot and the efflux is qualitatively smaller than in 22A

3) Other cleaning tests

a) Unoxidized stainless steel with a cold rolled surface finish does not show point sources of fluorescence with solvent.

b) All tests with oxide coating whether stored in offices, outside or in the CBI basement are now suspected of showing point sources of fluorescences with solvent. Earlier reports cannot be trusted since they were done by different people and under varying circumstances. The fluorescence technique is unfortunately both subjective and unquantifiable.

4) Data on the point sources

a) Are associated with the oxide

b) The sources are regions of the oxide which are usually black under a 30 power microscope and in all cases looked at (8 regions) are associated with depressions on the surface about 1/4 of a millimeter in linear dimension. The fractional surface coverage is close to 10^-5.

c) The contaminant that emanates from the sources in the solvent appears to be mostly in suspension and not in solution. The efflux gathers at the edges of the meniscus in the solvent and after sufficient concentration can be seen as a discontinuity visually when the solvent evporates.

d) The contaminant does not show color in a standard flame test, nor is it visible in a spark spectrum by eye.

5) Analysis to be performed this week

The major effort is to establish if the contaminant is organic or inorganic. The fluorescence technique used by CBI is not specific nor quantifiable. Furthermore, the fluorescence technique on oxide coated surface is unfamiliar to CBI (as it is to Fred Dylla who urges surface analysis and will help with the analysis of the data when it becomes available mid week)

a) Auger and ESCA (XPS) surface analysis with scanning electron micrsocopy to determine: the morphlogy of the point sources, the elemental abundance in the point sources, the elemental carbon and associated carbon by line width measurements. The technique provide some of the information to establish if the contamination seen in the fluorescence is organic or inorganic.

b) Fourier Transform Infrared Spectroscopy in the 1 to 20 micron band to establish the type of organic compounds (and if they are indeed organic)

in the efflux from the point sources. Concentrated samples gathered by hyperdermic syringe at the point source when immersed in solvent will be referenced to the solvent alone.

c) Filter paper samples of the efflux of the cleaning of the 8 ft virgin tube will be analysed by Fourier Transform Infrared Spectrometry to establish if the general collected material is similar to that from the point source samples.

6) Guesses, hunches and suggestions

a) Place bets that the contaminant is organic and that the efflux from the point sources is no different than the general contaminantion taken out by the cleaning on the average surface. The difference is the surface tension of the cleaning fluid and the inability for the process to enter small depressions. The solvent has 1/3 the surface tension of water. The surfactant reduces the surface tension of the water and succeeds better than water alone.

b) An ancillary and simple test to perform is to measure the surface tension of various ratios of Mirachem 500 to water. If CBI cannot do this, I will ask CBI to Fedex some Mirachem to MIT, the measurement (since it is relative) is easy to perform with a good chemical balance. If there is an optimum, it is worth trying a cleaning with this mixture as a means to avoid the current guess at the next best solution should the contaminant be organic, which is a solvent

cleaning.

7) Recommendations and Options

a) The data should be together be Friday Nov 4, the options that will be discussed and open to us without major disruptions in the QT and later in the installation are:

1) Continue the QT cleaning with steam alone

2) Continue the QT cleaning with an optimized Mirachem mixture followed by a steam flush

3) 1) followed by a solvent cleaning

4) 2) followed by a solvent cleaning

Alternate options such as a different surfactant than Mirachem do not hold large gains unless the chemical analysis shows a specific contaminant.

Removal of the oxide by acid etches to reduce the surface to a standard stainless steel is a major change and would require additional treatment of the surface to maintain the optical properties of the tube.

Another key consideration is the field applicability and cost of the cleaning technique.

b) Whatever option is chosen a baseline be established for quantitative analysis of the method by surface and chemical analysis. This is particularly important for quality assurance in the installation phase, especially, if the hydrocarbon outgassing of the QT after bake passes the LIGO requirements.

c) As part of the Q&A for the installation, coupons should be taken of the steel before it goes into the annealing furnace which reduces the hydrogen outgassing. A worry shared by Fred and me is that the surface of the steel is oily before it enters the furnace and that there is a competition between the carbeurization of the oil and the oxide growth. If the competition is in favor of the oxide growth, it could happen that the surface under the oxide remains a source of hydrocarbons through the many holes in the oxide layer.

d) The project should seriously consider a parallel effort to establish a vacuum test facility to measure the hydrocarbon outgassing of cleaned surfaces after a 140C bake. It is one method of insurance should the QT hydrocarbon outgassing fail.