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CALIFORNIA INSTITUTE OF TECHNOLOGY

Laser Interferometer Gravitational Wave Observatory (LIGO) Project

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Refer to: LIGO-T960123-00-B
Date: July 19, 1996

Subject: Spiral weld outgas measurements

CBI provided spiral weld coupons for our measurements of hydrogen outgassing at the higher weld speeds planned for production. These included six coupons welded at 40 in/min, six welded at 20 in/min, and 48 nonwelded coupons for measurement of base material effects. (For comparison, Tubetec had used weld speeds of 16-18 in/min during the QT). The nonwelded coupons were cut from the same coil, within 100' or so of the spiral weld coupons. These quantities were identical with batches measured during weld wire cleaning evaluation for the beam tube QT.

These coupons were cut from spiral welds made at PRD's Hayward, CA facility, during mill qualification. CBI chose to weld without removing the oxide at the seam, as the wire brush safety guards were not yet completed. This is acceptable structurally, as demonstrated by JPL during their study of welding oxide coated stainless for LIGO.

The table below shows the spiral weld data (PRD) compared with the final QT weld data (Houston, straight seam welded coupons). These readings represent H_2 outgassing flux, in *torr·liter/s*.

Date/ Description	6 Welded PRD 40"/min	6 Welded PRD 20"/min	48 Nonwelded PRD	6 Welded Houston	6 Welded Houston	48 Nonwelded Houston
7/16/96	2.5×10^{-10}	2.0×10^{-10}	11.2×10^{-10}			
7/17/96	2.5×10^{-10}	1.6×10^{-10}	11.2×10^{-10}			
7/18/96	2.5×10^{-10}	1.5×10^{-10}	13.4×10^{-10}			
Average	2.8×10^{-10}	1.7×10^{-10}	11.9×10^{-10}	4.0×10^{-10}	4.1×10^{-10}	9.2×10^{-10}
Sheet Contrib.	1.5×10^{-10}	1.5×10^{-10}	11.9×10^{-10}	1.2×10^{-10}	1.2×10^{-10}	9.2×10^{-10}
Weld Contrib.	1.3×10^{-10}	0.2×10^{-10}	0	2.8×10^{-10}	2.9×10^{-10}	0

The measurement report for this data is attached; data measured on 7/15 was ignored, as it appears to indicate that post-bake temperatures had not stabilized.

The number of coupons in the welded batches contain the equivalent amount of weld that the nonwelded batch surface area would have in a beam tube made from 16" wide skelp. However, they also contain additional outgassing from the six coupon sheets. This was calculated as 1/8 of the average flux reading of the nonwelded batch ("Sheet Contribution"), and subtracted from the average flux of each welded batch to arrive at the "Weld Contribution" numbers.

For the record, the coupons welded at 20 in/min had been splattered with molten residue from a plasma arc cutting process on one side. Since this material could contain substantial hydrogen and this would not be representative of the production material, CBI scraped it off with a sharp blade, causing scratches in the oxide surface. This does not appear to have had a major affect on the data.

It is obvious that the outgassing contributed by the spiral welding is less than the weld contribution measured during the QT. Spiral welding at these speeds is thus qualified for hydrogen outgassing. The practice of welding without oxide removal is qualified, as well. The use of 36" skelp for most of the beam tube will be an added bonus in reduced gas load.

cc:

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H_2 Outgassing from Weld Test Coupons

Jordan Camp, July 19, 1996

Data taken by Steve Vass

Sample:	W1	W2	W3	accum (hrs)	Date
Description:	6 Weld coupons WS - 40	6 Weld coupons WS - 20	48 Nonweld coupons		
Chamber:	LH4-2N	LH4-3N	LH4-4N		
Background, as last measured (torr·l/s·cm^2)					
Area [cm^2]	1,563	1,563	13942		
Outgassing rate [torr·l/s·cm^2]	2 days after pumpdown, before 250 C bake				
	After 250 C bake				
	2.5e-13	1.6e-13	1.2e-13	14	7/15/96
	1.6e-13	1.3e-13	8.0e-14	20	7/16/96
	1.6e-13	1.0e-13	8.0e-14	20	7/17/96
	1.6e-13	9.7e-14	9.6e-14	20	7/18/96