

New Folder Name Diffusion Characteristics

* * * FACSIMILE MESSAGE * * *

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FAX NUMBER IS: 815 439 6010
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DATE: October 4, 1993

TO: Larry Jones
Caltech
Pasadena, CA

FAX NO.: 818/304-9834

FROM: Warren A. Carpenter
Process Design Department
CBI Technical Services Co.

RE: DIFFUSION CALCS
LIGO QUALIFICATION TEST
FACILITY
930212 File #2.2.2

Attached are my calcs of the Calder and Lewin diffusion characteristics. Please note that we do show 2 decades of improvement after the 440° C bake, we were in error this morning. Based on our discussion of this morning, do you know what air bake-out error caused the hydrogen to increase during vacuum bake-out?

Also please note that I have shown Eschbachs diffusion curve along with two curves shown in the Virgo paper. Why do you think Calder and Lewin is more correct?

Regards,

A handwritten signature in cursive script that reads "Warren A. Carpenter".

Warren A. Carpenter
Senior Engineer

DIFFUSION CHARACTERISTICS.
440° BAKE

BASED ON CAROL & LEWIN

$$Q_r = \frac{4 C_0 D}{d} e^{-\left(\frac{\pi^2}{d^2} D t_1\right)}$$

$$d = \frac{1}{8}'' (2.54 \text{ cm}'') = .318 \text{ cm}$$

$$t_1 = 36 \text{ HRS} = 36(3600 \text{ SEC}'') = 1.3 \times 10^5 \text{ SEC}$$

$C_0 =$ USE $0.3 \text{ TL} / \text{cm}^3$ FOR COMMERCIAL

$$D_r = 5 \times 10^{-14} \text{ cm}^2 / \text{SEC}$$

$$D_1 = @ 440^\circ \text{C} = 4 \times 10^{-7} \text{ cm}^2 / \text{SEC}$$

$$Q_r = \frac{4(0.3)(5 \times 10^{-14})}{0.318} e^{-\left[\frac{\pi^2}{.318^2} (4 \times 10^{-7})(1.3 \times 10^5)\right]} = 1.18 \times 10^{-15}$$

$$= \frac{\text{TL cm}^2}{\text{cm}^3 \text{ SEC cm}} = \text{TL} / \text{cm}^2 \text{ SEC}$$

$$Q_r = 1.18 \times 10^{-15} \text{ TL} / \text{cm}^2 \text{ SEC}$$

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140° BAKE (30 DAYS)

$d = .318 \text{ cm}$
 $t_i = 30 \text{ DAYS } (24 \text{ HR/DAY}) (3600 \text{ SEC/HR}) = 2.59 \times 10^6 \text{ SEC}$
 $C_0 = 0.3 \text{ TL/cm}^3$
 $D_r = 5 \times 10^{-14} \text{ cm}^2/\text{SEC}$
 $D_i = 3.1 \times 10^{-10} \text{ cm}^2/\text{SEC}$

$$Q_r = \frac{(4)(0.3)(5 \times 10^{-14})}{0.318} e^{-\left[\frac{\pi^2}{.318^2} (3.1 \times 10^{-10})(2.59 \times 10^6)\right]} = 1.745 \times 10^{-13} \text{ TL/cm}^2 \text{ SEC}$$

250° BAKE (24 HRS)

$t_i = 24(3600) = 8.64 \times 10^4 \text{ SEC}$
 $D_i = 1 \times 10^{-8} \text{ TL/cm}^3$

$$Q_r = \frac{(4)(0.3)(5 \times 10^{-14})}{0.318} e^{-\left[\frac{\pi^2}{.318^2} (1 \times 10^{-8})(8.64 \times 10^4)\right]}$$

$$Q_r = 1.73 \times 10^{-13} \text{ TL/cm}^2 \text{ SEC}$$

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DIFFUSION CURVES

MODEL

DATE

10^{-4}

10^{-5}

10^{-6}

10^{-7}

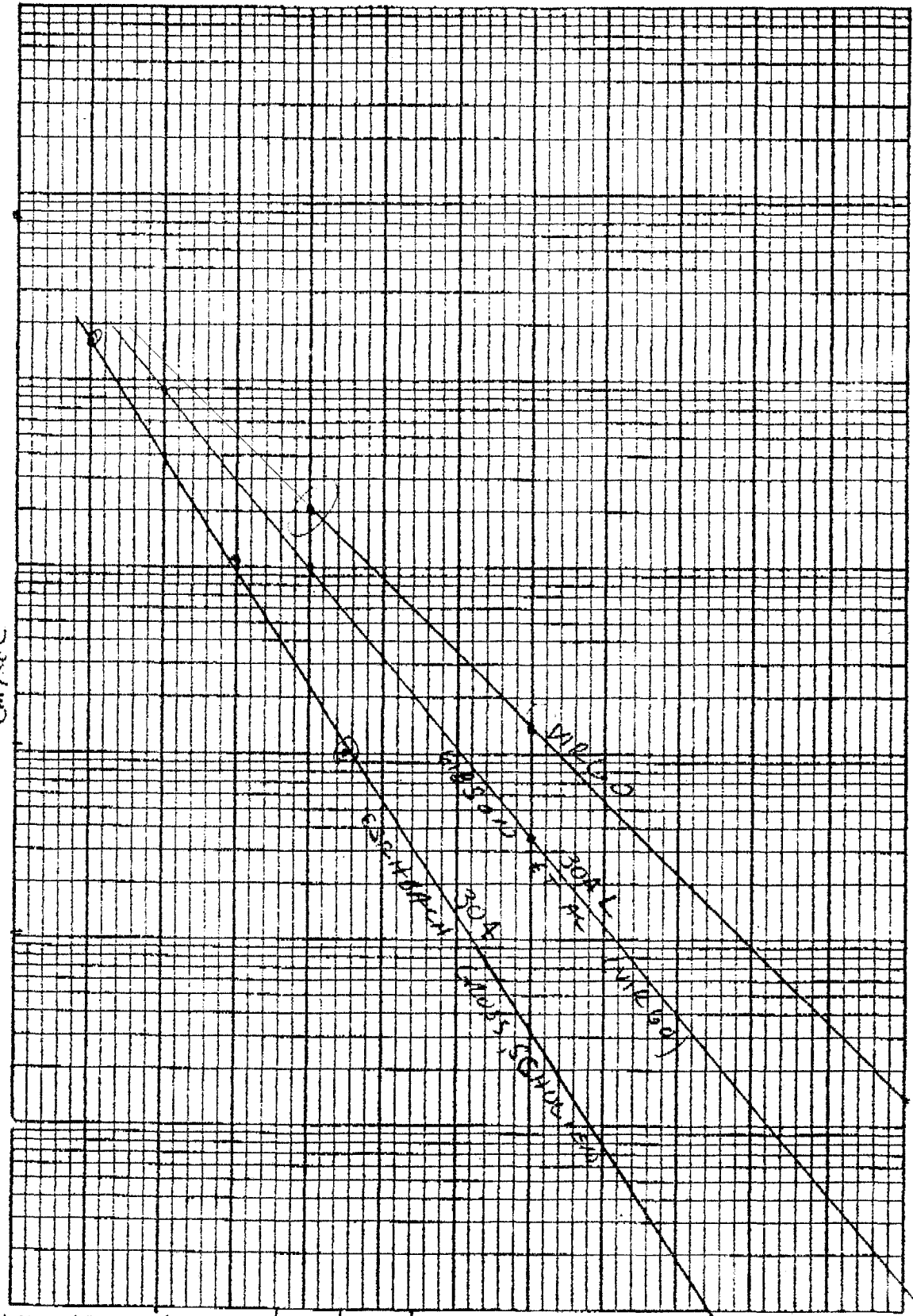
10^{-8}

10^{-9}

10^{-10}

10^{-11}

D
cm²/SEC



$1.0 \quad 1.2 \quad 1.4 \quad 1.6 \quad 1.8 \quad 2.0 \quad 2.2 \quad 2.4 \quad 2.6 \quad 2.8 \quad 3.0 \quad 3.2 \quad 3.4$
 $440^{\circ}\text{C} \quad 300^{\circ}\text{C} \quad 250^{\circ}\text{C} \quad 200^{\circ}\text{C} \quad 140^{\circ}\text{C} \quad 21^{\circ}\text{C}$
 $1000/T \text{ (K)}$

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