

88/11/20  
15:48:56

L190-T880040

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# 27R1

List of 3/1/89

From wea Sun Nov 20 12:50:39 1988  
To: alex  
Subject: pressure specification draft  
Cc: fjr

Minor corrections/comments/suggestions:

page 1: definition of v naught: change "the mean square speed..."  
to "the rms speed..."

page 2: integration variable dz missing from eq. 2

page 2: "For two arms, the amount of noise doubles, but the signal powers quadruples, so..." -- do you mean 'the signal quadruples..' ?

page 2: footnote: change "...one has to take the average..."  
to "... one may take the average ..." (there are clearly other ways to solve the problem...)

page 3: table 1: suggest re-ordering as below and adding two columns:  
p(allowable)/p(allowable for hydrogen) for tubes and for chambers:

| gas | M  | (n.. | tubes                     | chambers                  |
|-----|----|------|---------------------------|---------------------------|
|     |    |      | p(allow<br>-----<br>p(h2) | p(allow<br>-----<br>p(h2) |
| He  | 4  | 0.51 | 10.5                      | .71                       |
| H2  | 2  | 1.66 | 1                         | 1                         |
| H2O | 18 | 5.15 | .104                      | .33                       |
| O2  | 32 | 6.66 | .062                      | .25                       |
| N2  | 28 | 6.90 | .058                      | .27                       |
| Ar  | 40 | 7.04 | .056                      | .22                       |
| CO  | 28 | 7.82 | .045                      | .27                       |
| CO2 | 44 | 11.6 | .021                      | .21                       |

page 3: to implement the new column in table 1, suggest adding eq. 6a:

$p(\text{allowable}) = 1.49 \times 10^{41} (h \text{ sub } d)^2 / \text{delta } f$  for hydrogen;  
allowable partial pressures for other constituents are obtained  
by multiplying the hydrogen allowable pressure by the factor given  
in table 1 (clumsy words, but you get the drift...)

page 4: the square root of 15 is 3.87

page 4: 1st paragraph of 2.1: cross sectional area ... don't you mean total surface area?

page 5: replace "hidrogen" with 'hydrogen' (2 places)

page 5: (summary): replace 'hydrogen' and 'water' statements with one statement on (total) pressure expressed as "hydrogen-equivalent pressure"; table 1 tells us how to apportion this among various constituents.

With these minor corrections and additions (the suggestions, of course, are optional), give it a title ("Pressure Specification for the LIGO" would be fine), incorporate the Whitcomb paper as Appendix I, and send it to Ernie for circulation and comments. This should be easy to accomplish by Monday afternoon (11/21).

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Now for some comments; some of these may be eventually incorporated, but I don't want to hold up immediate circulation of this draft.

First, section 1 is just what we need. Given a policy decision on sensitivity as a function of time, I know exactly how to specify tube pressure performance.

2nd, I think that section 2 needs more work; if i follow the physics correctly, I would suggest two things:

1. carry eq. 10 one more step: approximately carry out the integration (referred to in 2.2-3) and evaluate for a 1 Hz bandwidth by replacing  $1/f^4$  with  $1/(3*f(\min)^3)$ , and solve for p:

$$p(\text{allowable}) = 6.1 \times 10^{37} h(f(\min))^2 * f(\min)^3 \text{ for hydrogen}$$

of course, maybe this is wrong; it doesn't give the numerical result you get on page 5....

2. keep the mass, surface area (if I'm correct in this) and suspension pendulum frequency of the test mass as parameters of the result, so we can evaluate the result for smaller test masses (and other optical components)

Third, the summary should evaluate hydrogen-equivalent pressures (you have already taken care of other constituents in table 1) for three cases: "possible early LIGO detectors", "possible advanced LIGO detectors" (the one case you do evaluate), and one (or more) arbitrarily but realistically chosen intermediate cases...

Meanwhile, I already know a lot more about this subject than I did a week ago.