FROM: Robert Spero

30 August 1988

SUBJECT: Memo61588–"Pressure Changes...", R. Weiss

TO: Team LIGO

The calculations of diffusion and permeation of Hydrogen provide some reassurance that the required Hydrogen partial pressure will be achievable. The data on welds suggest that measurements to isolate the effect of welds, perhaps by comparing the outgassing from a sample with large weld areas to that from one with minimal welds, and by testing different welding techniques, will be useful.

The suggested measurements of water outgassing could be conducted using the VTF. This would provide model- independent information, as well as measuring the parameters in the model presented in the memo.

The opening paragraph statement

> The pressure changes and the resultant sensitivity change of the gravitational wave interferometers will set a constraint on the temperature stability requirements of the tubes

requires some elucidation. The following observations are based in part on an August 24 phone conversation with Rai, and on a discussion with Ron.

From the perspective of constraints imposed on the conceptual design by environmental effects, the issue is whether temperature fluctuations—in particular diurnal variation—in exposed beam pipes would limit the performance of the LIGO.

Such fluctuations are likely to be much lower in frequency than the search band for periodic sources, and unlikely to interfere with periodic searches. That leaves burst and stochastic sources. The conceptual design as it stands tolerates high gas pressure—especially from water vapor—for the first few years of operation, with the expectation that the initial receivers will not achieve ultimate sensitivity, and will therefore not be limited by pressure effects. However it is possible that the initial receivers will exceed expectations, or (perhaps more likely) that initial vacuum system performance will be poorer than planned . In either case, the residual gas in the pipes would be the dominant source of noise, and one must consider whether fluctuations in this noise source due to temperature fluctuations would limit the scope of experiments to detect burst or stochastic sources.

Consider burst sources. The rate of false bursts might follow the temperature, giving a singles rate that varies diurnally. Several years ago the Maryland-Rome collaboration reported a variation in the coincidence rate for bursts detected with room-temperature bars; the reported variation in rate of detected events was correlated with Earth tides. These data are dubious at best, and require a 12-, not 24- hour period. Still, one might imagine a physical effect that would cause a 24-hour or sidereal (which would be difficult to

separate from pure 24-hour) variation in burst rate. Would such an effect be distinguishable from spurious effects of the vacuum system? Almost certainly, because *first*, there would be a lag of two or three hours between thermal effects at separated sites, compared to a timing resolution for bursts of about 10 milliseconds, and *second*, the midstations would veto signals from gas bursts.

Stochastic searches might be conducted at a single site, in which case the hours-long phase difference between sites would be unavailable as a discriminant. Then a stochastic source could be identified by cross-correlating the outputs from two interferometers at one site—say one mid- and one full-length interferometer—and looking for a peak at zero delay. To first order, such a search would be unaffected by a 24-hour fluctuation in sensitivity. However, one might hope for a sidereal variation in the height of the zero-delay peak: an additional signature, but one that could be masked by a 24-hour periodicity in the sensitivity. This signature could be recovered even in the presence of fluctuating sensitivity by proper calibration of the data run. One approach would be to briefly impose a calibrated amount of broad-band displacement noise on one of the test masses, every hour or so. In this way the inherent sensitivity fluctuation would be tracked, and separated from the galactic (or whatever) signature.