interoffice memorandum

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Gravitational Physics

To: Bill **Date:** March 2, 1989
From: Robert Spero Extension 4437 Mail Code 130-33
Subject: Comments on LIGO Electrical Power Study; 2 Dec 1988 Edition

I'm all for the extra lighting called for around the chambers and lasers. The CES control room is plenty bright, with 1600 W of fluorescents and 1200 W of incandescents distributed over 470 ft^2. Using the conversions implied in the memo (25 ft-c/W/ft^2 for fluorescents and 6 ft-c/W/ft^2 for incandescents) the control room lighting comes to 85 ft-c of fluorescents, and 15 ft-c of incandescents. By this measure, the 120 ft-c illumination called for in the chamber and laser table areas is adequate.

We have found no RFI in the 40-m lab from fluorescents, but it is a convenience to have the option of choosing between bright fluorescent and fairly dim incandescent lighting. Perhaps the spec for lighting can include the option of switching a small fraction of the lights, or of dimming the whole bank.

Similarly, the area above the central chamber in CES has 55 ft-c of fluorescents and 11 ft-c of incandescents. A small question: doesn't the lighting depend on the height of the fixtures? I would guess that without special lenses, a lot of light from high fluorescents might be wasted on the walls.

The lighting called for in offices and public areas, 2 W/ft^2 of fluorescents, is just adequate. My office has enough fixtures for 4 W/ft^2 or 100 ft-c, though only half of them are active.

The "safety lighting" called for—3 ft-c of incandescent lighting—is indeed very dim. This compares to about 15 ft-c along the arms of the 40-meter interferometer, split evenly (in terms of ft-c) between incandescents and fluorescents. If the same power were used for fluorescents instead of incandescents as described in the memo, the lighting would be O.K.

A physics footnote to the estimate of electricity charges for pumping out the tubes is an estimate of the P·V energy stored in the evacuated tubes (as might be released by a catastrophic collapse of the vacuum system). It comes to 9×10^8 J, or 250 kWh (compared to an electricity consumption of 4×10^5 kWh). This is equivalent to something like 100 kg of TNT.

There is no explicit mention in the memo of the reliability required of

the electrical power, except perhaps for TBD item 12. A reliability spec might take the form

The mean time between interruptions lasting more than t1 should be at least m1, and the mean time between interruptions lasting more than t2 should be at least m2. The maximum time to restore power in the event of failure should be t3.

The sort of parameters I have in mind are t1 = 5 milliseconds, m1 = 15 days, t2 = 10 minutes, m2 = 6 months, t3 = 6 hours.

The quality spec (TBD item 10) might specify waveform purity, frequency stability, and daily and long-term amplitude stability. I would guess there is standard language in the power industry to cover this spec (a complete description would be contained in the required power spectral density, but I wouldn't know how to precisely set the requirements).

The three largest items in the power budget—air conditioning of the high-bay area, lasers, and beam tube roughing—are among the poorest known. The air conditioning power requirement will probably depend on the spec for the thermal stability of the building; I propose here (without rationale) a spec of +/- 1 degree C.

Evaluation of the power requirements for vacuum pumps requires detailed information on the vacuum system, presumably now in preparation. For example, there is no mention in the memo of cryopumps, which have worked very well in the prototype. Allowing the option of using power-hungry cryopumps will increase the power requirement.

Settling on the laser power requirement awaits definition of the operations scenario. My only observation for now is that the memo requires that the laser power be available for occasional use of roughing pumps and bakeout apparatus, but it does not specify how the switch will be done. Do the pumps and bakeout heaters use the same voltage level as the lasers (I assume everything is 3-phase)? If not, how much expense and delay is involved in switching the transformers?

The list of electronic equipment (Table III) seems adequate, but I balk at accepting this as a specification for the needs over the next twenty years. Here a good case can be made for reserves. The meaning of "interferometer", used in the Table, should be standardized. I believe the table intends the term to refer to a system built from a single pair of test masses, while it more conventionally refers to two pairs.

I would add to Table IV a small lathe and milling machine, and a healthy reserve.