

STATUS OF ACRYLIC R&D

September 5, 1990

1 Mechanical:

Progress on the investigation of the mechanical properties of acrylic and bonds has been slow. This is because it has taken longer to establish the infrastructure needed to machine, polish and test the many test specimens of acrylic. This now appears to be in place, the first batch of test specimens is passing through the system. Hopefully things will run more efficiently. Also the creep test machine has completed its check out and now should provide data.

1.1 Bonds:

There are samples of bonded acrylic provided by Reynolds Polymer which are being tested by UNM Engineering Dept., these results will be used to "calibrate" the UNM set up. At the same time, test specimens with different bond widths are being tested to determine bond strength as a function of bond thickness, since it now seems certain that there will be considerable variation in the width of a bond joint. Jerry Stachiw has also provided acrylic samples which have been butt bonded using a commercial adhesive (Cadco PS 30) as another calibration. The report on these results will be available at the beginning of October and will help "debug" the testing system at LANL in preparation for the large amount of testing required to qualify a fabricator and their bonding procedure. If this is unsatisfactory, then we will have to go to a commercial testing facility, (nearest is California or Texas).

1.2 Long term properties:

The most reliable predictions of the longterm mechanical properties of acrylic come from extrapolation of creep and creep-rupture curves. Considerable

data exists for acrylic exposed to air, essentially no data exists for acrylic exposed to water. In an attempt to obtain this data the creep test machine (see attached drawings) has been built. The machine has been shown to be stable to $\pm 0.2^{\circ}\text{C}$ in the range $10^{\circ} \rightarrow 60^{\circ}\text{C}$. It is currently being used to obtain creep-rupture curves for unbonded acrylic samples. There are so many variables in these tests that it is important to set priority on which tests should be performed.

With little modification the machine may be used to study the suspension materials under consideration.

Each test will run between 1,000 to 5,000 hours (6 to 30 weeks). If the data is extrapolated by one order of magnitude (1 to 6 years), the error due to extrapolation is 10 to 35%. In other words, we will not know the properties of acrylic after 15 years, without a large associated error. This places more emphasis on the need to test samples immersed in water throughout the life of the experiment. However, if the deterioration of the acrylic is principally due to the uptake of water, this can be accelerated by preconditioning the sample at an elevated temperature.

1.3 Implosions:

Since the 50cm PMT is no longer under consideration, the problem of damage to the acrylic vessel by an imploding PMT is less severe. Calculations by LANL, Oxford/City University London have supported the findings of the original Swanson implosion study that the implosion of a 20cm PMT will not threaten the vessel. If the walls of the vessel are $\sim 5\text{cm}$ thick, experimental data indicates that the vessel would survive both an impact and implosion of a 20cm PMT against the wall.

Experts point out that an imploding sphere can generate high velocity ($>100\text{ m/sec}$) jets of water. Although these jets would not penetrate to the acrylic wall they may present a hazard to adjacent PMT's. Preliminary studies at Queens suggests this may not be a problem, however, further study is needed before the need to protect individual PMT's against each other is understood.

2 Optical:

With Walter Davidson in Bonn for at least the next two years we have lost our principle source of optical R&D. Since we have to perfect a means of monitoring the optical quality of the acrylic sheets on a production line basis within the next year we have a problem - even if the supplier has some in-house capabilities. In addition, there appears to be a relationship between the thermoforming conditions and the optical performance of the acrylic. Since each potential fabricator has different thermoforming conditions, more research is required into this effect as part of the fabricator selection process. A person/institution to stand in for Walter must be found at the highest priority.

2.1 Crazing:

A study has been completed on the scattering of light in crazed acrylic, the effect is significant between $\pm 40^\circ$ incidence. It would be useful if this empirical behavior could be incorporated into the Monte Carlo in order to determine at what amount of crazing we start to lose the physics. When the stress distributions and levels are available from the current Swanson modeling, we will then know if we have a problem.

3 Summary:

The R&D is proceeding according to schedule, however, the creep tests are very time consuming and priorities have to be set on what answers we need from the apparatus.

The production line for fabrication, polishing and testing of samples is in place and undergoing its first test. If it doesn't perform to specs. we will go out to commercial testers.

We need to identify a lead person/institute ASAP for the optical properties of acrylic.

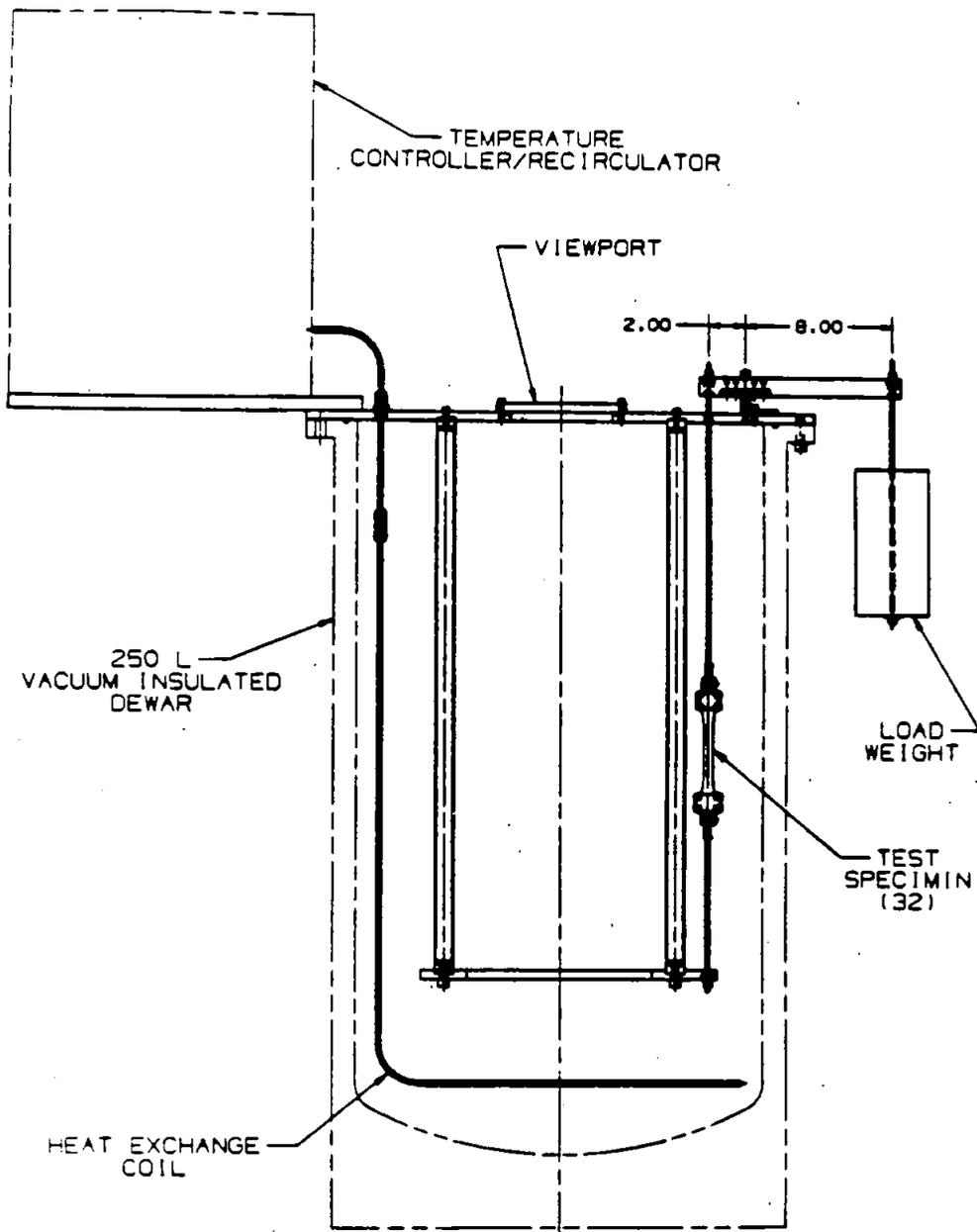


Figure 1: Cross section of creep test apparatus.

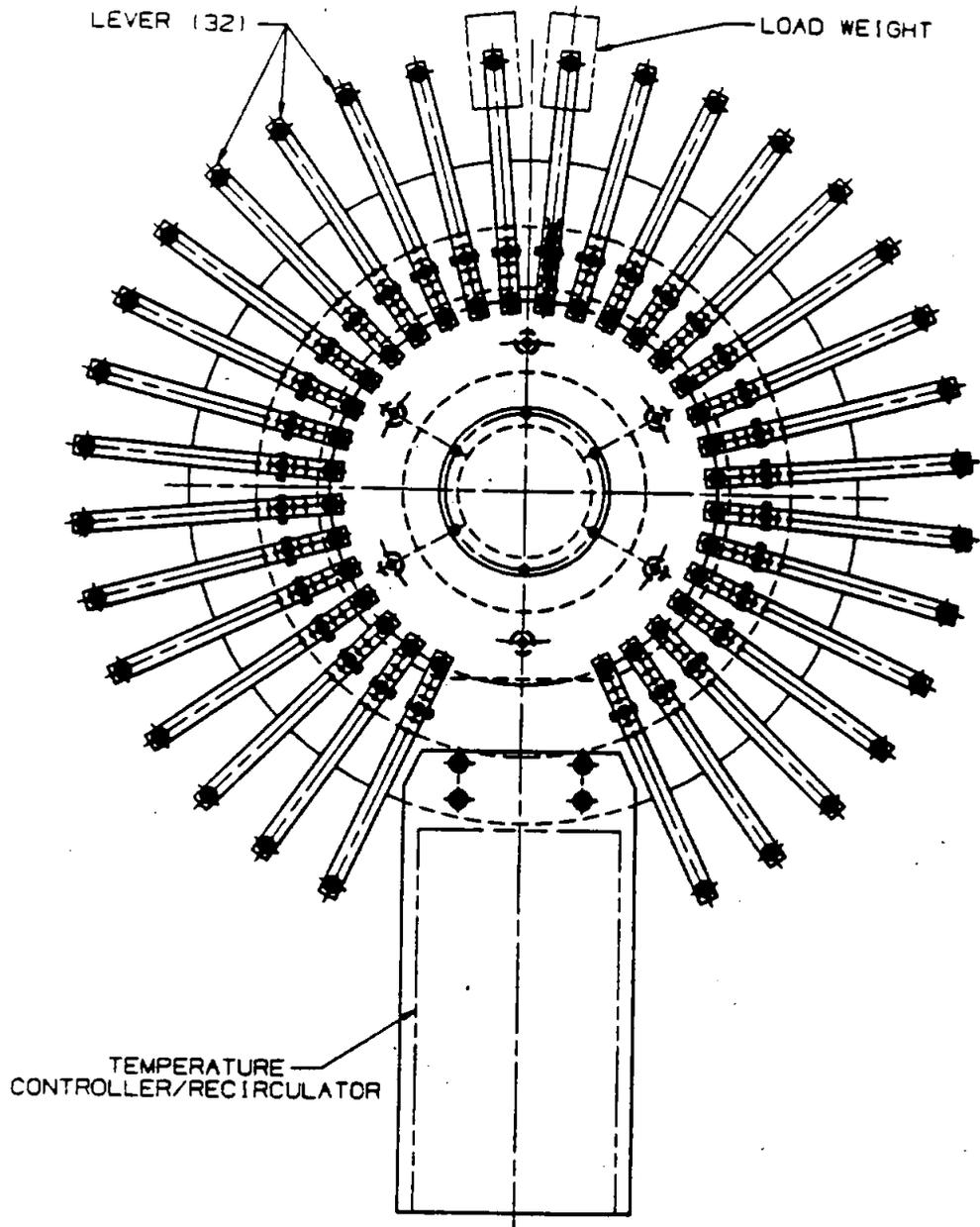


Figure 2: Plan view of creep test apparatus.