SNO-STR-90-96

ACRYLIC VESSEL - NC INTERFACES

31 August, 1990

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1 OVERVIEW:

Assuming that neutral current detection will be accomplished in SNO by the use of descrete counters rather than an additive dissolved in the D_2O, then there are three major interfaces between the acrylic vessel and the neutral current detectors, these are;

1. Installation
2. Loads
3. Failure Scenarios

The counters are most likely to consist of vertical strings arranged on a uniform grid. If the counters are buoyant, they will be attached to the lower hemisphere of the vessel, with guide lines attached to the upper hemisphere to support the counters in the event of the D_2O being removed. If they are denser than D_2O they need only be suspended from the upper hemisphere of the vessel.
Two detector types are currently under consideration, scintillation and gas proportional; these can have widely different readout/supplies of varying

degrees of complexity which may further impact the acrylic vessel. The simplest configuration consists of hanging strings of solid scintillator material, the scintillation light being detected by the main PMT array. A more complicated arrangement would employ light pipes (which may also double as tethers for the strings) · carry the light from individual strings outside the vessel. If the scintillator/neutron capture medium is gaseous, then the strings may be buoyant and require tethering at both the top and bottom of the vessel. Gas proportional counters also have this complication that they will probably be buoyant, and in addition they require high voltage/signal readout lines. It is assumed that all gaseous detectors are sealed and do not require gas flow lines.

2 INSTALLATION:

Currently two methods of installation are under consideration, these are;

1. **Tether Lines:** At the time of installation of the vessel, attachment points for each counter string will be fixed to the inner wall of the vessel. These attachment points (which may incorperate pully wheels) allow a tether loop to run from the top of the vessel neck to the point of attachment and back out the vessel neck. To install the counter string it is attached to the tether loop which is then used to pull the counter into position. If the tether loop remains in place, it is possible that it can be used to recover and replace a failed counter. Difficalties will arise in locating the tether loops and possible readout linesin the region where they pass through the neck. Currently, the circumference of the neck of the vessel is 320cm, since there could be several hundred counter strings, this will not leave much room for each tether line and will become even more difficult if readout lines are required.

2. **Robotic Arm:** Another installation scheme involves the use of a robotic arm which enters the vessel via the neck and is used to position or retrieve individual counters. The "reach" of the arm must be at least 20 meters while the location of the end of the arm must be known to within 1cm. The arm must be articulated in at least on place

(i.e. elbow) and be broken down into four sections to allow it to be inserted through the neck of the vessel (this arises due to the height of the cavity ceiling). This arm could turn out to be a complicated device. Difficulties arise due to the restriction of the neck, which could be damaged during insertion/assembly of the arm. Due to the similar refractive index of acrylic and D_2O, the wall of the vessel will be hard to see which may result in the arm being driven into the wall, causing damage.

Questions: How many counters?
Will there be tethers and readout lines?
What diameter of neck is required?

3 LOADS:

Culculations have been carried out for 110 counter strings placed on a 1 meter grid, each string exerting a force of 40Kg. Applying the load to points on the vessel did not induce "knuckle" buckling and an attachment pad of a few square inches will keep the stress level below that which would initiate long term crazing. However these culculations assumed a vessel under tension, where the bouyancy loads of the counters tend to offset the tensile forces. The current design under consideration will have the whole vessel under compression and the counter loads (whether positive or negative bouyancy) will increase the compressive loads, reducing the safety margin against buckling. This new situation will require modeling.

Questions: How many counters?
What is the load per string (either positive or negative)?
What is the spacing of the counters?

4 FAILURE SCENARIOS:

Assuming that the counters are not neutrally buoyant then a failure of the counter string tether or anchor would result in the counter striking the wall of the vessel. Considerable data exists on the impact resistance of acrylic which would allow worst case modeling once the forces on the counter are known.

Presumably some redundancy of the counter strings exist but at some level of failure it will be neccessary to replace the defective counters. It would be useful to know how many failures of counters can be tolerated, what time scale is needed to replace them, what level of threat does this subject the vessel to, if any (i.e. operation of possible robot arm) and would this threat suggest removal of the D_2O?

Questions: What is the positive/negative buoyancy of a counter string?

5 CONCLUSIONS:

The primary answeres needed for the design of the acrylic vessel are *worst case estimates of the number of counters, their location and the load exerted by each string.* This input will be needed in approximately a month, when the buckling studies are underway for the vessel. In a similar time scale it is also required to know if a large diameter neck will be needed to accomodate the number of tethers and readout lines and the possible use of a robotic arm. Increasing the width of the neck to 1.5 meters requires an additional ~10 tonnes of D_2O and consideration of the neutron backgrounds. It may be that the neck of the vessel will have to be widened to give it sufficient stability.