SNO-STR-91-074

Acrylic Vessel - NC Interfaces

-An Update-

2 December, 1991

Peter Doe, LANL

1. Introduction:

This update replaces SNO-STR-90-96, Acrylic Vessel - NC Interfaces. The remaining descrete NC counter options under consideration are 6Li foil based detectors (CRPP/Carleton University) and 3He based detectors (LANL).

Primary interfaces involve design decisions. It is now known that all detector options will be buoyant strings anchored from the bottom of the vessel and that the possible deployment schemes are common to all options. The method of deployment and the question of whether the detectors are passive scintillators or active proportional counters requiring readout lines.presents some up-front design decisions, primarily for the design of the vessel but also for the calibration sources. It should also be remembered that with the designs under consideration, the water cannot be removed without removing the counters which will impact the operating schedules. The major interfaces are considered under four general headings;

1) Installation
2) Access
3) Loads
4) Failure scenarios
5) Calibration

2. Installation:

All detector strings will be anchored to points located on the lower hemisphere of the vessel and positioned at the time of construction of the vessel. The final design of these attachment points may depend on the type of counter and the method of deployment. The detectors will be installed through the neck of the vessel once it is full of heavy water. Two methods of installing the detector strings are under consideration; pulley systems and a remote manipulator arm - these are considered below.

pulley System: The detector strings may be installed by using a system of pulley lines, one for each detector string. These lines run down from the neck of the vessel, through a pulley located at the desired anchor point of each detector string and back up the neck of the vessel. A string is installed by attaching it to the line and pulling it down into the water.

The advantages are conceptual simplicity, immediate availability for use (less down time) and relative low cost. The disadvantages are the the loads on the shell of the vessel are doubled (because of two lines going to one point - this may be overcome at the cost of some increased complexity), the arrangement of the lines (and possibly readout lines) is complicated and there is no way to rectify failures of strings inside the vessel.

A decision must be made by the end of January 1992 as to whether the attachment points are pulleys or simple hooks since this is when detailed design of the attachment points begins and details of any organizational hardware that maintains the lines in the neck is needed for the final design of the vessel.

Remote Manipulator: A simple remote manipulator arm with an "elbow" located at the center of the sphere and mounted from an X-Y-Z-Theta translation table located above the neck of the vessel can reach all anchor locations on the lower hemisphere of the vessel. Once the end of the arm is located at the anchor point, the detector string is deployed by pulling it down a trackway located along the length of the arm.

The advantages are that the system has great flexibility (the possibility of repairing problems), has half the anchor loads of the simple pulley system and when the arm is removed, a minimal radioactive and optical contamination. The disadvantages are that the arm is more complex and expensive than the simple pulley system, it must be designed not to be able to damage the vessel or fail in such a way that it cannot be removed and it must be assembled from subsections.

The decision dates are the same as those for the pulley system, with the additional need for a decision on the overhead clearance before finalizing the cleanroom design, (see below).

3. Access:

This presents interfaces with the vessel design, the deck structure, the cleanroom designers, the calibration group and the scheduling committee.

The interface with the deck structure is most immediate, The current 10 feet clearance places restrictions on the length of the components of the arm, it is recommended that a cupola be incorporated in one quadrant of the cleanroom ceiling to provide 14 feet of vertical clearance above the neck of the vessel.

There are a number of generic interfaces which must be addressed for ant descrete detector system employed; The scheme for deploying the detectors must not effect the purity of the heavy water or undue loss of heavy water. This involves interfaces with component cleaning techniques, cover gas systems, water systems and approval of the general deployment procedures. When a counter string is deployed it will displace the heavy water possibly causing the level to change (a maximum of 0.5 inches for a 3He string). This may result in undue stress on the vessel and requires in interfaces between the vessel design and the water systems.

The cover/glove box which covers the neck of the vessel must satisfy both the installation of the NC counters and the deployment of the calibration sources. It is recommended that the glove box be simply removable for the installation of the NC counters. This should receive the blessings of the cleanroom group in order not to contaminate the heavy water.

Interfacing between the acrylic vessel design group and the calibration group is required in order to determine that the calibration sources may be deployed down the neck of the vessel.

If a system of descrete NC counters is chosen, there must be an interaction between the NC group and the acrylic vessel designers in order to develop a mutually satisfactory design for the readout strings/preamplifiers and/or tether lines. This must take place by the end of January 1992 in order to allow the updating of the vessel drawings.

The implementation of any descrete NC counters will impact the schedule. This has to be accommodated by the TMC whenever they feel necessary.

3. Loads:

The loads that must be sustained by the shell of the vessel are not critical. In designing the vessel we have assumed the worst case loads which is that associated with the 3He counters anchored by simple pulleys. There will be some fine tuning of the counter spacing but this is thought to fit within the present conservative envelope. Actual loads will be needed by the time the vessel design receives it's final review on April 1992. This is a question of interfaces between the TMC and the NC group.

4. Failure Scenarios:

Failure scenarios involve the consequences of a detector string breaking loose, the failure of the deployment method and the consequences on the physics program of a general failure of the descrete NC counter system if deployed. This requires that the NC group list all possible failure scenarios and that the TMC make a judgement as to the acceptability of the risk. This interface must take place before a final decision be made on the deployment of descrete NC detectors. It is desirable that the status of the detector strings be monitored, particularly the location, this could perhaps be incorporated with the general monitoring of the vessel.

5. Summary of Interfaces:

The following lists the groups effected by interfaces between the acrylic vessel and the NC counters:

Acrylic Vessel Design - string loads, attachment points, arrangement of lines, water level stress, access through neck during deployment, long term monitoring.

Water Systems - water level management, water loss, contamination during deployment.

Cover gas systems - access through neck, contamination control, heavy water loss, safety.

Calibration - glove box design, deployment down neck and in vessel.

Deck structure - design details of neck penetration of deck, glove box design, cleanroom design and vertical clearance.

Cleanroom - Air quality, vertical clearance, organization of space.

Clean Components - methods of cleaning, handling, exposure to cleanroom air.

TMC - acceptance of program, timescale, risk.

SNO-STR-91-075

The Conformation of Aluminium Petals in ABS Concentrators

P. M. Thornewell N. A. Jelley
Nuclear Physics Department, University of Oxford
Keble Road, Oxford OX1 3RH

December 9, 1991

1 Introduction

The 'petal' concentrator consists of a black plastic (ABS) bowl (made by injection molding) and twenty-four thin, 99.85% pure, aluminium strips which are snapped into the concentrator. The only force holding these strips in is the compressive force provided by the top and bottom lips. Experimentally, a force of ~ 20N/petal (≃ 0.8N/mm) makes the petal conform to within ~ 0.6mm near the bottom of the concentrator and preliminary calculations indicate that such conformity would give satisfactory optical performance.

Increasing the compressive force improves the conformity but leads to certain problems. In order to avoid excessive stress in the top and bottom lips it would be necessary to increase their size, which would in turn reduce the amount of light falling on the concentrator. Also, because of the difference in thermal expansion rates, to allow for a possible temperature drop before instalation the walls must not be too thick. (The increased force due to a drop in temperature is then taken up mainly by the expansion of the walls and does not result in the stresses in the lips becoming too high.) However, due to creep of the ABS plastic, the walls expand over the lifetime of the concentrators leading to a reduction in the compressive force and to lessen this effect would require thickening the walls (or prebending the petals) to lower the stress.

As such the design of the petal concentrator must be a trade off between the optical performance and the mechanical properties of its components. Therefore, it is necessary to compute the petal shape due to various compressive loads.

2 Stress Analysis

It was stated in the introduction that the forces used to conform the petal could not be too large. The following arguments show just how much force can be reasonably applied and why because of creep it is necessary to use actual forces less than this value.

Obviously the places of greatest stress are the top and bottom lips. The bottom lip of the concentrator can be approximated by a short thick cantilever.