SNO-STR-90-145

ACRYLIC VESSEL ACTIVITIES

September - October, 1990

1 SUMMARY:

The acrylic program is making satisfactory progress. The design criteria document has been reviewed and a final(?) version will be compiled in late November. A design study of the vessel suspended from ropes has been initiated and results expected in December will allow comparison to the existing design suspended from an acrylic collar. An engineering drawing of this design has been produced which incorporates changes to the vessel, i.e. wall thickness, neck diameter. A general study of "sloshing" in the cavity as a result of seismic activity has been initiated.

A plan for the selection of the vessel fabricator is being developed, this includes a section on qualification of the fabricator - an item which *may* have an impact on schedule and cost. A number of schemes have been documented on how the vessel will be bonded together, some of these *may* have optical consequences.

Radioactivity R&D continues to make steady progress. LANL has produced "spiked" acrylic samples which when measured gives consistent results. These samples are being distributed to other radioactivity centers. CRL has become the center for optical studies of acrylic. The mechanical properties R&D is slow, largely because the production of test samples is behind schedule.

The formerly carefree, can do, acrylic group is being "organized". An acrylic vessel committee has been established which meets every two weeks. Document files on acrylic are kept in accordance with the Monenco filing system. Note, this does not automatically guaranty the success of the project, only the amount of paper produced.

2 DESIGN STATUS:

Phil Cumyn has produced a drawing (# 17 702 6151) of the vessel suspended from ropes. This drawing includes some dimensional changes;

Internal Radius of Sphere	236 inches
Shell Thickness	2 inches (nominal), 1.75 minimum
Shell Thickness at Equator	4 inches
Neck Diameter	60 inches

We appologize for the units. Details can be found in the Design Criteria document produced by Cumyn. Comments on this document are currently being edited by Doe and a final version will be avaliable in December and will be submitted to AECL for discussion prior to the main and formal review.

A contract has been established with Swanson Service Corp. to carry out a finite element analysis of the vessel suspended from ropes. This design will also provide some "fine tuning", including the shell thickness at the equator of the vessel where the suspension ropes attach, optimisation of the stress at the rope attachment and stabalization of the chimney against seismic effects. Details of this work were discussed with Swanson during a visit of the Vessel Committee to California on 1-2 October. Not suprizingly, Swansons main concern is the accuracy of the buckling culculations - critical, now that the vessel will be operated in compression. Swanson proposes to use the BOSOR-4 code which is recommended for buckling analysis and to request that its designer, David Bushnell of Lockheed Missile and Space Corp., review Swansons findings. Preliminary results from the Swanson study will be avaliable late December. Given the importance of buckling, the geometry for the vessel suspended from ropes has been set up at LANL by Tom Butler of MEE-13 Division. They use the ABAQUAS finite element code, which will be used to cross check BOSOR-4. The model has been checked and shown to function correctly. A report of their preliminary findings is avaliable.

In addition, Swanson will produce an estimate of time and cost required to address some outstanding question on the existing design supported from an acrylic collar. This will allow a fair comparison between the two designs,

and a decision made.

Stachiw, Comyn and informaly Reynolds Polymer Technology have all made statements on the question of segmenting the vessel in two using either a flexable membrane or a rigid wall. It appears possible, but has a high price in terms of complexity, reliability and access for neutral current counter options. Their recommendations are that the vessel should not be divided unless there is some very compelling physics reason.

During the October California trip, the Vessel Committee visited Quest Structures Inc., who are modeling sloshing of water in the cavity due to seismic activity. Their report will include wave shape, frequency and stress in an acrylic vessel suspended from ropes. It was felt that the presence of the PMT support structure would only damp the effects of sloshing and a decision to model it will be made after the preliminary results are avaliable. Bartle has suggested, and Comyn has sketched, the possible use of a stainless steel collar which surrounds the vessel and dampens seismic waves. This is a simple structure and should not impact other design considerations much.

The increase in the diameter of the acrylic chimney was largely in response to the Neutral Current team. Skensved, Robertson and Earle have cross checked the effect of a larger chimney on the flux of neutrons entering the D_2O. A 1.5 meter diameter nck, 4.5 meters long results in a neutron flux of 0.023 neutrons per day and therefore neutrons are not a problem. however, they point out that a larger diameter would probably require a plug. Three possible NC deployment schemes are being evaluated (tethers, remote vehicules and robotic arms), none of these are felt to have any significant impact on the basic configuration of the vessel now that the chimney has been widened. Also, the worst case load envelope provided by the NC team is sufficient to enable the vessel design to continue.

3 R&D STATUS:

The radioactivity R&D is progressing steadily and is reported below. The same cannot be said for the mechanical properties. A major bottle neck

is getting the acrylic test samples polished. The problem being that this small shop has an obligation to provide priority to those experiments receiving beam. An alternative solution is to have a commercial shop polish them, Reynolds Polymer has indicated their willingness to undertake this. The basic information on creep will be avaliable for the final engineering design, however, qualification of the fabricator will require a fast turn round on test samples, and the LAMPF polishing solution will not work. Likewize, progress on the properties of suspension ropes is stalled for lack of samples. A firm decision on the possibility of suspending the vessel should be made early in 1991, and information on leaching, longevity etc. will be required by then, as well as the standard information avaliable from the manufacturers.

CRL is now the center for optical studies, with Earle as the contact person. Some interesting data was received from Rohm concerning the effect of temperature on transmission. This is important in selecting fabricators for the vessel, since they all tend to use a different thermoforming temperature. Doe has written to Dr. Fischer thanking him for the information and suggesting further studies. It should be remembered that the Polycast material may behave completely differently from that of Rohm and that independent tests should be carried out as part of the criterial for selecting a supplier of the acrylic.

Doe has written a summary of the current status of the R&D for the acrylic vessel and what remains to be done. This is appended.

4 CONSTRUCTION:

A major activity on the construction front has been the outlining by Cumyn and Stachiw of plans to make a preliminary selection and final qualification of the fabricators of the vessel, their reports are avaliable. A list of points on which to pre-screen the potential fabricators has been drawn up and needs commenting on. Succesful candidates from this list can then be considered for qualifying as fabricators. This involves thermoforming and bonding several panels under representative conditions and developing techniques to produce bonds that satisfy the SNO quality assurence criteria. This can be considered

as both qualification and R&D, it is likely to be time consuming (estimate 6 months) and costly (estimate $250K), it therefore may have both scheduling and budget implications. Idealy, this work would be carried out by two potential manufacturers, in case one drops out, a decision on this should be made soon.

Stachiw and Comyn have produced memos on recommended installation proceedures for the vessel. These were presented to Reynolds Polymer for comment during the visit to California by the Vessel Committee. No major objections were raised.

R.G.H.Robertson, Stachiw and Cumyn have produced memos on how to bond the complex acrylic panels underground - the conventional way (taped joints while panels are horizontal) will not work well for SNO where the bonds run verticaly and can have a large hydrostatic head. A simple solution is to use acrylic overlays in place of tape (Stachiw) but this has problems due to the variation in thickness of the panels and optical interference (they cannot be machined off). Skensved had been appraised of this possible optical interference. An alternative would be to replace the tape by rubber sheets held in place by vacuum (Robertson, Cumyn), but this is untried and could be the subject of R&D in the qualification of the fabricator(s).

5 RADIOACTIVITY:

The following is a brief summary of the radioactivity situation, Details can be found in the report by Earle, November 1, 1990.

At Guelph, measurements have been made on a number of rope samples and on the Polycast "candle" material (samples taken from the core of the sheets).

At LANL, acrylic samples spiked with ^{232}Th have been made. They have confirmed their high recovery efficiencies and precise Th determination by NAA. Spiked samples have been distributed to CRL and eventually to Guelph (via CRL) for verification of their procedures.

At CRL, the confidence in the reliability of the TIMS results continues to be high and our confidence in the NAA results has much improved during the last period. There is now good evidence that the Polycast monomer and acrylic sheet cores are low in Th (3 ppt). The high values observed in many samples over the years may be due to Th concentrated on or near the surfaces of the sheets. The Th in the kevlar rope is higher than we would like it to be if it is to be used to support the vessel.

6 REPORTS & MEMOS:

Copies of the following reports and memo's can be obtained from SNO Institute, Queens University, Peter Doe, LANL or Phil Cumyn, Monenco. A Monenco approved filing system has been implemented for all acrylic documentation.

1. "Thoughts about the Qualification Program for Prospective Sphere Fabricators", J. Stachiw, October 21, 1990.

2. "Vessel Fabricator Qualification", P. Cumyn, October 11, 1990.

3. "Cavern Assembly Proceedure", P. Cumyn, September 5, 1990.

4. "Technical Position Paper on Internal Partitioning of Acrylic Sphere", J.Stachiw, October 7, 1990.

5. "Internal Partitioning of Vessel", P. Cumyn, October 12, 1990.

6. "Support of Chimney", P. Cumyn, October 21, 1990.

7. "Cylinder Around the Chimney", P. Cumyn, October 10, 1990.

8. "Neutron Leakage Down the Acrylic neck", E.D. Earle, October 17, 1990. and B. Robertson, P. Skensved, September 26, 1990.

9. "Optica lPerformance of Bonded Joints on Acrylic Sphere", J. Stachiw, October 14, 1990.

10. "Fabrication of Panel Joits for Acrylic Vessel", R.J.H. Robertson, October 18, 1990.

11. "Bonding Process and Equipment", P. Cumyn, October 24, 1990.

12. "Connection of NCD's to the Vessel", P. Cumyn, October 15, 1990.

13. "Culculated Buckling Loads for the SNO Vesel", T. Butler, MEE-13, LANL, September 17, 1990.

14. "Preliminary SNO Vessel Arrangement", J. Stachiw, September 15, 1990.

15. "Vessel Committee Conference Call - Notes", September 28, October 11, October 23, 1990.

16. "Vessel Coordination Committe - Trip Report - California", October 1, 1990.