SNO-STR-90-109

To Members of the SNO Collaboration; August 28,1990
>From Philip Cumyn

You will find attached a copy of the Design Criteria document for the acrylic vessel; the purpose of the document is to summarize the design requirements of the acrylic vessel so that the Collaboration as a whole may agree upon the requirements.

The document has already been reviewed by those most involved in the vessel (Peter Doe, Davis Earle, Ken McFarlane and Jerry Stachiw) and all members of the Collaboration are requested to review the document and to comment on it. Your comments can be sent to me or to Peter Doe (before the Collaboration meeting in mid-September please) or else brought to the meeting itself. It is planned to finalize the document the week following the meeting.

You will note that a number of questions of a physics nature have been flagged in the text and these are brought to your particular attention. These are numbered Question 1, Question 2 etc. and they are summarized below.

Question 1 What is the permissible tolerance on vessel radius from a physics point of view? See Section 2.1.3 on page 5.

Question 2 Is the stated allowable leaching rate acceptable? See Section 2.2.2 on page 6.

Question 3 What are allowable material impurity levels beyond r = 345"? See Section 2.3.2 on page 6.

Question 4 What is allowable angular distortion of light? See Section 2.4.2 on page 7.

Question 5 What is the nature of the equipment that may be suspended in the vessel chimney; the information is needed in order to evaluate the practicality of installing a shield under the chimney. See Section

2.5.1 on page 8.

Question 6 What are the minimum elevations above the equator of the vessel of the water inside the vessel? See Section 2.8.2 on page 12.

The document includes two appendices. The first gives the limitations on access to the mine, an Inco document that I have not felt it necessary to have retyped; the second is a drawing of the vessel which I cannot send by bitnet. If you want a copy of the drawing, please let Cathy Reid at Monenco's offices in Rexdale know and she will send one by courier. Cathy can be reached by phone at 416-798-0111 or by bitnet.

Sudbury Neutrino Observatory

Design Criteria DC.17.310.01.C

Revision C

Acrylic Vessel

Prepared by P. B. Cumyn

Reviewed by D. J. Bartle

Approved by A. Farkas

Approved by
for SNO Collaboration

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to come

PRELIMINARY
ACRYLIC VESSEL DESIGN CRITERIA

1. Introduction

The purpose of this document is to describe the design criteria applying to the Acrylic Vessel (hereafter known as the Vessel) of the Sudbury Neutrino Observatory and to indicate the design approach that will be followed during its design.

2. Design Requirements

2.1 Configuration, Dimensions, Location and Tolerances.

2.1.1 Dimensions

The vessel shall be spherical in shape with an inside radius of 237 inches; a chimney with a clear inside diameter of 40 inches extends up from the top of the sphere. The principal dimensions of the vessel are shown on drawing 17.702.6451 appended to this document.

The thickness of the vessel shell shall be a compromise between the demands of low radio-activity and good optical transparency on the one hand and structural integrity, long life and resistance to crazing on the other. In general, the thickness of the vessel shell (that part of it between the heavy water and the PMTs) shall not exceed 2.0" with a thickness of up to 4.0 inches being allowed at the connection of the vessel to its support system. The vessel shell should be thinner if stress levels and elastic stability consider-

ations permit.

Certain (local) areas of the shell of the vessel may be up to 4.0 inches thick; these include the reinforcement at the connection of the shell to the chimney and also at the vessel sump. Local pads are also permitted at the supports of any miscellaneous equipment located in or on the vessel. These areas of increased thickness shall be as small as possible.

2.1.2 Location

The vertical centre line of the vessel and its chimney shall be located within +/- 1.0" of the theoretical vertical centre line of the cavern. In like fashion, the equator of the vessel, when immersed in light water, shall be located within +/- 2.0" of its theoretical elevation. (It is suggested that similar criteria be imposed upon the PMT structure).

2.1.3 Tolerances on Dimensions

As far as physics requirements are concerned, when full of water (light or heavy), the radius from the theoretical centre of the vessel to any point on its surface may vary locally by +/- 3.0" from its theoretical value. Question 1 (Note that vessel stress and elastic stability questions may require that the tolerances on these dimensions be maintained within stricter limits).

Once specified, the volume of the vessel shall not exceed the specified volume by more than 307 cubic feet (8.7 cubic metres); this is equivalent to an overall increase in radius of .75 inches and it is imposed for reasons of heavy water inventory. This requirement will also have an effect on the permissible variation on vessel dimensions.

2.2 Vessel Material and Its Properties.

2.2.1 Vessel Material

The vessel proper shall be fabricated from virgin non crosslinked polymerized methyl methacrylate (acrylic). The material shall conform to the requirements of Section 2.3 (Considerations of Radio-Activity) and its optical properties shall conform to the requirements of Section 2.4, Optical Properties.

2.2.2 Other Materials

Other materials may be used in the vessel and its support system provided that:

they conform to the requirements of Section 2.3, Considerations of Radio-Activity;

they do not promote biological growth;

they are acceptable to the members of the SNO Collaboration.

The leaching rate of the materials used in the vessel components located in contact with water must not exceed that of passivated type 304 stainless steel. Question 2

2.3 Considerations of Radio-Activity

2.3.1 Radio-Activity in Acrylic Material

The amount of thorium, uranium and their daughter products in the acrylic material when measured in a five kg. sample shall not exceed the following limits:

thorium	5.0 pg/gm (pico-grams per gram)
uranium	15.0 pg/gm.
daughter products	equivalent to 5.0 pg/gm of the parent Th232 and U238 in equilibrium.

2.3.2 Radio-Activity in other materials

The total amount of thorium and uranium used in non-acrylic components of the vessel located within the sphere defined by the PMT structure (at radius 345 inches) shall not exceed 2.0 ng/gm; (nanograms per gram). Such components include non-acrylic piping, miscellaneous hardware including hardware of the neutral current detector system and components of the support system.

The amount of thorium and uranium used in vessel components (including the support system components) located beyond radius 345 inches must not exceed ??? ng/gm. (Question 3)

2.4 Optical Properties

2.4.1 Light Absorption Properties

The light absorption coefficient (ac) of the vessel material, once fabricated and installed, shall not exceed:

.40 per cm	for 300 nm light
.20 per cm	for 320 nm light
.08 per cm	for 350 nm light and
.02 per cm	for light with a wave length greater than 400 nm.

Bubbles and inclusions in the vessel wall shall not increase the absorption coefficient by more than 1% when the absorption coefficient is measured at the surface of the vessel and integrated over an area 25 mm by 25 mm.

The light transmission coefficient of the vessel wall is

$(1-ac)^t$ where t is the vessel wall thickness expressed in cm.

The transmission coefficient at the bond joints between the acrylic panels may be half the acceptable values at vessel acceptance and the expected values of the transmission coefficient when the vessel has been in service 10 years may be one quarter the acceptable value at vessel acceptance.

2.4.2 Light Distortion

The angular distortion of light which originates inside the vessel and which strikes the vessel wall in a radial direction shall not exceed X (10 ?) degrees when the vessel is immersed in water. Question 4 Local angular distortion at the splices between acrylic panels and at major changes in thickness such as at the connection of the vessel to its chimney and to its support may be greater than the above value and shall be disregarded.

In general, polishing the surface of the acrylic material is neither necessary nor desirable. It cuts down the optical transmittance of the material and, from an optical point of view, is unnecessary given the fact that the indices of refraction of water and acrylic are very close in value.

Wed. April 18

9:30 - 12:30	Room F443	Acrylic Group Meeting	(P. Doe)
10:30 - 12:30	Room F441	SNO Management Committee	(G. Ewan)
14:00	Room F441	Welcome to Laurentian	
14:15		Recent Physics results	(E. Beier)
14:45	Room F441	Session on the SNO Institute	(A. McDonald)
		Report by Director	(A. McDonald)
		Introduction of Project Management and Design Team	(A. McDonald)
	Status of action items from the Los Alamos Meeting	(D. Earle)	
		Critical path items	(D. Hepburn)
19:30	Room F443 Acrylic Radioactivity Group Meeting	(D. Earle)	
19:30	Room F441	Software Group Meeting	(G. Buehler)

2.4.3 Crazing

The design must be such as to minimize crazing in the shell of the vessel proper with a view to having no more than 3% of the surface of the vessel shell in a crazed condition at the end of the 10 year life time. Refer also to Section 2.7, Design Life.

2.4.4 Influence of Optical Requirements on Stress Levels

The above values indicate the physics restrictions on crazing, inclusions, bubbles, abrupt changes in section and surface finish. Stress and other considerations may require that these values be further limited.

2.5 Vessel Details

2.5.1 Vessel Chimney

The vessel shall be equipped with a chimney as shown on the drawing. The upper end of the chimney shall be connected to an enlarged "glove" box located on the main deck. The connection between chimney and glove box shall be gas tight in order to contain the cover gas within the vessel.

The chimney shall be supported; the design of the support system shall cater to the relevant loads and displacements; these shall include loads and displacements caused by seismic effects (including rock bursts) as well as by gravity and hydrostatic effects. The support design shall minimize tensile stresses (particularly long term ones), shall minimize the risks of crazing and shall prevent unacceptable loads and stresses being imposed upon the vessel.

Acrylic rubbing rings (or pulleys) shall be provided at the lower end of the chimney in order to protect it and the vessel proper from equipment and its tethering cables located within the vessel.

If at all possible, an acrylic shield shall be suspended in the chimney. Possible locations for it include at the intersection of the chimney and the vessel shell and at the top of the chimney. This shield shall be equipped with a raised rim and shall be removable. The purpose of this shield is to catch any component or instrument allowed to drop down the chimney. The design of the shield shall cater to the piping and components suspended in the chimney; a second and

smaller shield shall be provided if the decision is made to install the neutral current counters. Question 5

2.5.2 D2O Circulation System and Pipe Connections to the Vessel

The water in the vessel is recirculated through a closed loop purification system and all piping connections to the vessel shall be made through the glove box above the chimney. The design of the piping in the vessel shall allow the water to be drawn out of the vessel from its surface and returned to the vessel through a sparge ring mounted above the vessel floor. The design of the sparge ring shall ensure a uniform temperature and flow distribution within the vessel.

Piping in the vessel shall be made of acrylic pipe; alternatively it may be made of another material (such as hose) providing that it is transparent and respects the requirements of section 2.2, Vessel Materials and its Properties. The design of the piping and its supports shall be suitable for the dynamic effects specified in section 2.8.4, Dynamic Effects.

2.5.3 Provisions for emptying the vessel

A shallow depression (sump) shall be thermoformed in the panel at the centre of the floor of the vessel. The design of the depression in the vessel floor shall allow the vessel to be emptied leaving no more than 5 litres of water in it when the depth of water in the sump is 0.5 inches.

2.5.4 Provisions for a Bladder

It may be desired (or necessary) to install a leak proof bladder in the vessel. The bladder will, when fully expanded, fill the vessel and chimney. Equipment, including piping, located in the vessel shall either be removable (from the deck) or else its design shall neither impede the installation of the bladder nor present any sharp edges or other details which might damage the bladder.

2.5.5 Provisions For Neutral Current Detectors

The design of the vessel shall allow for the installation of approximately 100 Neutral Current detectors (though it is

Thursday April 19

8:00		Underground visit to Creighton mine	
11:00		Project launching ceremony	
12:30		Reception	
15:00-	Room	Session on Acrylic Vessel	(P. Doe)
17:30	F441		
		Design	(P. Doe/J. Stachiew)
		Radioactivity	(D. Earle)
		Quality Control	
		a) Mech. and Optical	(P. Doe)
		b) Radioactivity	(J. Simpson)
		Operational lifetime	(P. Doe)
		New ideas	(J. Simpson and R. Schubank)

not certain that these detectors will be installed).

Preliminary data on the detectors indicate that they will be in the form of 25 mm diameter by 1000 mm long tubes. They may be buoyant in which case they will be tethered to the bottom of the vessel using pulleys with the tethering ropes being collected at the chimney. They may also be heavier than water in which case they will be suspended from the underside of the upper hemisphere of the vessel. In any case, the pulleys shall be placed so that the detectors are located on a 40 inch by 40 inch grid with the outermost detectors being no more than 30 inches from the vessel wall. The vessel and the connections of the pulleys to the shell shall be designed for the forces involved, currently estimated to be 30 Newtons per detector unit or a maximum of 400 Newtons per string when number of units per string are considered. The requirements stated in section 2.2, Vessel Material and its Properties, apply to the pulleys, their hardware and the tethering cables.

2.6 Vessel Supports

The vessel and its chimney shall be supported from the cavern deck. The design of the support system shall:

support the vessel and its chimney against all loading conditions;

ensure that the loads on the vessel from the support system are equally distributed;

minimize stress in the acrylic material, keeping them within the limits given in section 2.10, Allowable Stresses;

minimize the likelihood of a leak developing at the intersections of the vessel with the support system or with the chimney;

minimize the risk of crazing in the vessel shell. Note that crazing per se in the support material is acceptable providing that it does not weaken the material unacceptably nor interfere with the optical performance of the vessel;

minimize the interference of the supports with the PMT structure.

Friday April 20

8:30	Room F441	Radioactivity Quality Control Group Meeting AND additional group meetings if requested	(J. Simpson)
10:30	Room F441	Session on Laboratory	(H. Evans)
		Laboratory construction and services	(L. Van Eyck/ H. Evans)
		Background and shielding	(B. Robertson)
		Surface Facility	(D. Hallman)
		Geotechnical Calculations	(P. Oliver)
12:30		LUNCHEON hosted by Laurentian University	
14:00	Room F441	Session on PMTs, reflectors, etc.	(E. Beier)
	Short reports on	PMTs	(H. Robertson)
	reflectors		(N. Tanner/C. Waltham)
	support structure		(K. Lesko)
	electronics		(R. Van Berg)
	software		(G. Buehler)
15:30	Room F441	Session on SNO Collaboration Administration	(G. Ewan)
		Relationship to Project Management Firm	(A. McDonald)
		Memo of Understanding	(A. McDonald)
		Role of SNO Management Committee	(G. Ewan)
		Future Meetings	(G. Ewan)

The materials used in the support system shall conform to the requirements stated in section 2.2, Vessel Material and its Properties.

2.7 Design Life

The vessel shall be designed for a life of at least 10 years. The effects of a 15 year design life on optical transmittance, crazing, radio-activity, strength, creep and elastic stability shall be evaluated and an optimization study of life versus performance prepared and presented to the Collaboration.

The vessel shall be designed for 8 months in the empty condition, 18 months full of light water 4 months empty and the remainder of its life full of heavy water, to which must be added one additional emptying and refilling cycle. The vessel shall also be designed for the load changes that it will see due to seismic effects.

2.8 Loads and Loading Conditions

2.8.1 General

The loads imposed upon the vessel and its support system include gravity loads, hydrostatic and other pressure loads, the effects of differential temperature, seismic loads including loads due to rock bursts, loads due to the neutral current detectors and loads due to the implosion of a PMT. Loading conditions evaluated shall include those when the vessel is full, be it full of light water or heavy water, as well as those occurring during the filling and emptying cycles.

The designer shall specify the relationship between water levels inside and outside the vessel during cavern filling and emptying, the goal being to minimize stresses and to minimize the tendency for the vessel to buckle. It shall be assumed that actual relationship between the two levels may vary from that specified by +/- 2.0" (+/- 1.0" for each water level) and the vessel shall be designed for the resulting stresses.

2.8.2 Operating Pressures

The free surface of the liquids inside and outside the vessel will be at atmospheric pressure, 18.1 psi in the present case. Both the liquid inside the vessel and outside

will be covered with a cover gas. The nominal pressures of the cover gasses will be atmospheric and the pressures of the two gasses will not deviate from atmospheric by more than (+1.0 - 0.0" of water). The design of the vessel shall allow for the full range of cover gas differential pressures.

For reasons of shielding, the water outside the vessel must extend at least 481 inches above the vessel equator. Similarly, the surface of the water inside the vessel must be at least XXX inches above its equator. These figures are valid be the vessel full of heavy water or light water. Question 6

The design water levels shall be chosen by the vessel designer in order to minimize tensile stresses in the vessel and the tendency for it to buckle. In principle, this will be achieved by having a small differential pressure across the vessel at its bottom with the pressure on the outside of the vessel being larger than that inside it. Given the difference in density between light and heavy water, the design level of the water in the vessel will vary depending upon whether the vessel be full of light or heavy water.

The level control loops of the two water systems shall be designed to maintain the water levels within +/- 1.0" of the specified water level and once the nominal design water levels have been chosen, the vessel shall be designed to cater to any combination of water levels within the specified ranges.

2.8.3 Operating Temperatures

The temperature of the water inside and outside the vessel will vary between 5 and 20 C. The difference between the average temperature in each of the two volumes of water will not exceed 3 C and the vessel shall be designed for the worst possible combination of temperatures.

2.8.4 Dynamic Effects

The vessel shall be designed to withstand loads due to seismic effects including rock bursts, actual loads and displacements being derived from the appropriate project documentation. Seismic effects may in turn cause the water inside and outside the vessel to "slosh about", an effect which shall also be considered. Note that loads due to earthquakes and due to rock burst need not be considered to act simultaneously.

Status Report

Firmware Revision 2.3

PCU Rom Revision G

Lifetime Information

Photoconductor Cartridge Count: 350
Developer Cartridge Count: 350
Total Pages: 459

PostScript Version: 52.1 Rev: 0

Printername: LaserPrinter

Memory Status

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Xon/Xoff-RbstOff
Tray 1

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Xon/Xoff-RbstOff
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Portrait
60 Lines/Page
COURIER 10 PC-8

3: HPII
Std Parallel
Tray 1
Portrait
60 Lines/Page
COURIER 10 PC-8

4: HPII
Std Parallel
Tray 1
Portrait
60 Lines/Page
COURIER 10 PC-8

Controller Configuration

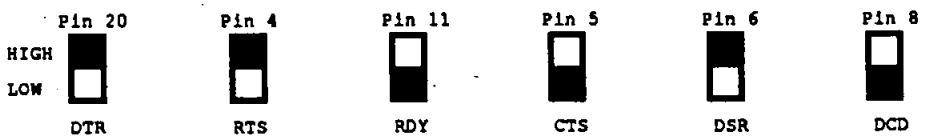
Communication Board Installed
RS232 Option Available

Expansion ROM Board Installed
RAM Module 1 Installed - 1 MEG Size
RAM Module 2 Installed - 1 MEG Size

64k Band RAM

ASIC 1 Version : A

Serial Status Signals



A users manual for mg is available on request (40 pages)

The vessel shall be designed to withstand, without failure, the effect of the implosion of a PMT whatever its position in the PMT structure and whatever the water levels at the time of the event.

The vessel must also be able to withstand the effect of a PMT failure with the tube in contact with the vessel and the failure of a more than one PMT at once unless it can be shown that the likelihood of either of these events occurring is less than 1 event per thousand years.

2.9 Analysis Requirements

The vessel shall be stress analyzed using finite element methods in order to determine the stresses in it; a buckling analysis of the vessel shall also be prepared. Stresses in the vessel shall not exceed those of section 2.10, Allowable Stresses and the real factor of safety against buckling shall be at least 5.

The analyses shall consider the vessel in the following operating conditions:

i vessel hanging empty;

ii vessel during the light water filling process;

iii vessel full of light water and suspended in light water;

iv vessel during the heavy water filling process;

v vessel full of heavy water and suspended in light water;

vi vessel full of heavy water, suspended in light water with one of the supports failed.

The effect of a seismic event and of the failure of a PMT tube shall be considered for each one of the above operating conditions. The consequences of a PMT failing whilst one of the vessel support cables has failed or during a seismic event shall be evaluated but the design need not be capable of resisting these combinations of conditions at normal stress levels.

The analyses (both stress and buckling) shall study the following:

a the effect of the variation of Young's Modulus with time and/or with immersion of the acrylic in water;

b the effect of out of roundness of the vessel in order to establish acceptable out of roundness limits;

c the consequences of he failure of one of the vessel supports;

d the need for lateral support of the vessel shall be established and if required, lateral supports shall be provided. The effect of these supports on the vessel stresses shall be established;

e the stresses in the chimney as well as those that the chimney induces in the shell of the vessel. The analyses shall consider the effect of lateral acceleration and the displacement of the chimney with respect to the vessel;

f the consequences of tethering the neutral current counter cables to the vessel. The analysis of the vessel as a whole shall consider the net vertical forces on the vessel; the individual pulley supports shall be designed for 5 times the normal force on the support to allow for freeing a jammed tethering cable.

2.10 Allowable Stresses

Maximum allowable stresses are a function of type of stress (compression, tension and shear), their duration (long term in the case of static loads and short term in the case of dynamic and temporary loads) and their location. Table I gives the basic allowable stress of each type for long term loading conditions. These stresses must be multiplied by one or more of factors F1, F2 and F3 as appropriate to take into account the reduction in allowable stress at the bond joints, the increase in allowable stresses permitted when loads are due to short term effects and the relaxation of requirements where the optical problems caused by crazing are not a concern. The latter situation arises in the chimney, and in the supports for the neutral current detectors.

TABLE I

The Linear Response of Extended Systems as an Equation of State

Applications in liquid ^{4}He and nuclear matter

Avraham S. Rinat
Weizmann Institute, Rehovot Israel

Thursday August 16, 2:00 pm
Rm. 201

The first of two talks to be given on the calculation of the linear response function for many-body systems.

Allowable Stress Levels

	Compressive	Tensile	Shear
Basic allowable stress	1200 psi	600 psi	600 psi
Factor F1 * (at bond joints)	1.0	.5	.5
Factor F2 (for dynamic and short term loads)	2.0	2.0	2.0
Factor F3 (non-optical applications)	1.0	1.2	1.0

* Note that the project is presently preparing a failure envelope for bond joints immersed in water and factor F1 may be modified to suit.

2.11 Code Requirements

To the extent that it applies and can be applied to this vessel and to the extent that it is not superseded by the requirements of this Design Criteria, the vessel shall be designed and fabricated in conformance with the requirements of the ASME Code for Pressure Vessels for Human Occupancy, (PVHO).

The vessel shall be leak tight and shall be tested for leaks. A pressure test of the vessel may be carried out on the vessel as a whole if it can be done safely. If it is decided to carry out such a test, the stresses during the test shall be considered to be of short duration (Factor F2).

2.12 Shop Fabrication and Field Erection

All processes used in the fabrication and erection of the vessel shall be developed and qualified (by the Fabricator) and procedures for them written, tested, submitted for approval and approved. Where necessary, the labourers carrying out the work shall qualified for the process in question.

2.13 Quality Assurance

The vessel shall be designed, fabricated, erected and tested following the requirements of the project Quality Assurance Programme.

2.14 Special Considerations

The vessel will be erected in an underground mine and its design shall cater to the special requirements that this involves. These include (and are not necessarily limited to) the following:

there are limitations on the size of crate that can be handled in the mine hoist and on the cars in the mine drift, the requirements are given in Appendix I;

approval is required for all substances used underground. These substances include, amongst others, solvents, adhesives, cleaning agents and leak test fluids as well as any fluid which may be used in the bonding process. (The concerns include health hazards, fire and explosive mixtures of dusts and vapours);

special cleanliness precautions are required for underground work (particularly in the bonding process) and site cleanliness requirements and precautions shall be specified;

special requirements may be imposed upon the ventilating system of the assembly cavern;

there are special codes and regulations governing work underground to which the project must conform.

2.15 Vessel Instrumentation

Vessel instrumentation shall be provided; the purpose of this instrumentation is to monitor the state of the vessel and to detect problems as early as possible. Such instrumentation may include vessel position detectors and strain gauges; it may also include sound detectors if it can be shown that these can detect signs of incipient failure. Protective instrumentation shall also be provided in the support system to monitor its state.

Status Report

Firmware Revision 2.3

PCU Rom Revision G

Lifetime Information

Photoconductor Cartridge Count: 3387
Developer Cartridge Count: 3387
Total Pages: 3496

PostScript Version: 52.1 Rev: 0

Printername: LaserPrinter

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Personal Printer Configurations

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Xon/Xoff-RbstOff
Tray 1

2: HPII
RS 232 9600,8,1,None,
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Tray 1
Portrait
60 Lines/Page
COURIER 10 PC-8

3: HPII
Std Parallel
Tray 1
Portrait
60 Lines/Page
COURIER 10 PC-8

4: HPII
Std Parallel
Tray 1
Portrait
60 Lines/Page
COURIER 10 PC-8

Controller Configuration

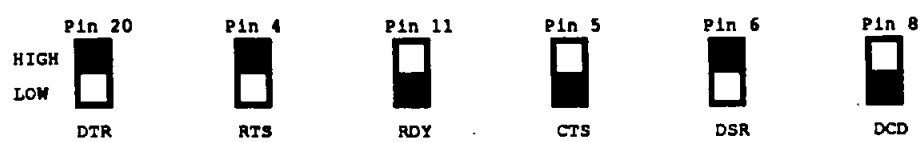
Communication Board Installed
RS232 Option Available

Expansion ROM Board Installed
RAM Module 1 Installed - 1 MEG Size
RAM Module 2 Installed - 1 MEG Size

64k Band RAM

ASIC 1 Version : A

Serial Status Signals



Detectors shall be provided to monitor the temperature of the water inside and outside of the vessel.

All instrumentation cabling for instruments located within the vessel shall enter the vessel through its neck; no other penetrations shall be made through the shell of the vessel.

Test specimens suitable for subsequent testing shall be prepared, loaded and kept under conditions as close as possible to those which the actual materials and components see in service. The specimens will be tested over the life of the Observatory in order to have the best possible idea of the variation of material properties with time. Such specimens shall include (but not be limited to) bulk acrylic material, bonded joints, vessel suspension materials and other material as may be appropriate. These test specimens shall be prepared during both the vessel fabricating process (in the Fabricator's shop) and also during field erection.

3. Design Approach

3.1 Vessel Description

Preliminary studies indicate that the vessel will be made up from sections of thermo-formed acrylic sheet 1.5 inches thick with 2.5 inch thick material being used at the connection of the vessel to the vessel supports. It also appears that the vessel will be hung from 12 non-metallic ropes and that both ends of the ropes will be dead ended at the deck structure from which the vessel will be supported. Final thicknesses of the vessel material and the final number of support ropes will determined during the stress analysis of the vessel.

The vessel chimney will have a minimum inside diameter of 42 inches with a 2 inch high by 40 inch inside diameter wear ring being provided at the lower end of the chimney to protect the vessel from wear caused by equipment and its tethering cables located in the vessel. The diameter of the chimney may be enlarged if stress considerations require it.

The details of the vessel, to the extent that they have now been worked out, are shown on drawing 17.602.6451.

3.2 Vessel Analysis

AGENDA] OR SUDBURY MEETING
Laurentian U niversity, April 18 - April 21

Wed. April 18			
9:30 - 12:30	Room F443	Acrylic Group Meeting	(P. Doe)
10:30 - 12:30	Room F441	SNO Management Committee	(G. Ewar
14:00	Room F441	Welcome to Laurentian	
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		Report by Director	(A. McD
		Introduction of Project Management and Design Team	(A. McD
		Status of action items from the Los Alamos Meeting	(D. Ear
		Critical path items	(D. [redacted]
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Thursday April 19			
8:00		Underground visit to Creighton mine	
11:00		Project launching ceremony	
12:30		Reception	
15:00-17:30	Room F441	Session on Acrylic Vessel	(P. Doe)
		Design	(P. Stachiew
		Radioactivity	(D. Earle
		Quality Control	
		a) Mech. and Optical	(P. Doe)
		b) Radioactivity	(J. Simps
		Operational lifetime	(P. Doe)
		New ideas	(J. Simps R. Schub

APPENDIX II

DRAWINGS

Friday April 20			
8:30	Room F441	Radioactivity Quality Control Group Meeting	(J. Simps
		AND additional group meetings if requested	
10:30	Room F441	Session on Laboratory	(H. Evan
		Laboratory construction and services	(L. Van H. Evans
		Background and shielding	(B. Robe
		Surface Facility	(D. Halln
		Geotechnical Calculations	(P. Olive
12:30		LUNCHEON hosted by Laurentian University	
14:00	Room F441	Session on PMTs, reflectors, etc.	(E. Beier
		Short reports on:	
		PMTs	(H.
		reflectors	(N. Waltham
		support structure	(K. Lesk
		electronics	(R. Van
		software	(G. Bueh
15:30	Room F441	Session on SNO Collaboration Administration	(G. Ewar
		Relationship to Project Management Firm	(A. McD
		Memo of Understanding	(A. McD
		Role of SNO Management Committee	(G. Ewar
		Future Meetings	(G. Ewar

Sat April 21			
9:00	Room F441	Report on Water Treatment Workshop	(D. Sincl
		Report on Facilities for radioactivity quality control	(J. Simps
		Report on PMT measurements	(H.-B. M
		Any Additional Reports	
13:00-17:00	Room F441	Review of critical path items	
		Recommendations for Action	
		Date and place of next meeting	

The vessel will be analyzed using finite element methods; preliminary analyses have been carried out using Ansys and there does not seem to be any reason not to continue using this code for the main analysis of the vessel.

3.3 Design Process

Present plans call for Monenco/Canatom to prepare a preliminary design of the vessel and to analyze it or have it analyzed. In parallel with carrying out the analysis, Monenco-Canatom will forward copies of the design drawings to Stachiw Associates, a consultant whose services the project has retained. Copies of the drawings and other preliminary documentation will also be forwarded to selected fabricators who have expressed an interest in fabricating the vessel. The comments of these organizations will be incorporated into the design where they are considered relevant; the design will also be brought into line with the results of the stress analysis and the process repeated as necessary.

The design will then be presented to the members of the Collaboration and to Candu Ops for final comment.

Tendering documents will be prepared in parallel with this work.

APPENDIX I

LIMITING DIMENSIONS & WEIGHTS

FOR MATERIAL TRANSPORT

UNDERGROUND AT CREIGHTON No.9 MINE