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PRELIMINARY CAVERN ASSEMBLY PROCEDURE (PMT STRUCTURE AND VESSEL)

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Basis for the Procedure

Present plans call for the vessel to be suspended from cables connected to the vessel at its equator; this plan is consistent with this design concept.

Present plans also call for the PMT structure to be made of structural members with the PMTs assembled in honeycomb panels spanning between the members of the structure proper and the procedure is consistent with this concept also. Note that the PMT structure should be equipped with lifting points at its nodes which could serve as points of attachment for hoists to raise the lower honeycomb panels into place.

1. Underground Layout Requirements

i Access to the cavern is provided from the deck for materials and equipment; access for men and tools will also be from the deck using the man hoist mentioned in ii below. If necessary men can also gain access to the deck from the lower access ramp though, for reasons of cleanliness, access from the lower ramp should be limited.

The lower access ramp will also be used for the removal of jigs and scaffolding after the assembly is complete.

ii A pair of beams is installed down the side of the cavern. These are used as guides down which a car is run allowing vessel and PMT system components to be lowered into the work area at the bottom of the cavern (even with the PMT equipment in position). This car will also be used as a man hoist.

iii A polar type crane may be suspended from the underside of the deck structure; whether or not one is installed depends in part upon the stage at which the PMT cables are installed. Note that the design of the crane will permit it to be removed through the deck structure without jeopardizing the PMT structure and the vessel.

iv The ventilation system supplies fresh (and highly filtered) air at top of the cavern; this air is withdrawn at the cavern floor where it can be filtered and re-injected into the cavern or else exhausted into the mine extraction system. It is suggested that any air re-injected into the cavern be injected at the top of the cavern so that there is unidirectional (downward) flow of air in the cavern. This is consistent with clean room

practice.

v it should be noted that the vapours from the bonding process may be explosive in certain concentrations. These vapours will be removed using activated carbon filters in the cavern ventilation system.

vi The last 70 feet or so of the excavation ramp should be finished off and an airlock installed at its cavern end; the purpose here is to allow access to the bottom of the cavern during assembly while preventing the ingress of dust into it. To this end the air lock should have a door or a set of doors at each end. Moreover, the ventilation system design should ensure that the air pressure at the outer end of the airlock is always lower than the pressure in the cavern.

2. Situation before assembly begins.

i The liner and upper deck are in place with only small holes left in the deck. The holes are equipped with temporary covers and with high curbs to protect against tools and equipment being dropped accidentally through the hole. The hole for the hoist car is treated in the same way.

ii A false floor is built above the cavern floor in order to provide a large flat (and solid) working surface. This floor is capable of withstanding the loads of scaffolding etc. and it is at the same elevation as the end of the access ramp.

iii Where necessary, tools and equipment are tied back to their surroundings in order to prevent them falling on men and equipment below.

iv The layout is such as to allow all material entering the cavern to pass through the car wash facility.

3. Assembly Procedure.

i Working from the false floor, start the assembly of the upper hemisphere of the PMT structure. The structure is suspended from the deck and, as the work progresses, the structure is raised up until at least its upper hemisphere (and possibly its upper 60%) has been assembled.

The PMTs and reflectors are mounted in their honeycomb panels; this preassembly work is carried out either on the deck above the cavern or else on the false floor at the bottom of the cavern. The honeycomb panels are mounted on the PMT structure proper as the work progresses. The PMTs are connected to their cables and if

possible tested during the process. The PMT structure will be blocked in position (for reasons of safety) when it was not being hoisted.

ii Once the upper hemisphere of the structure has been completed, raise it up into its final position and suspend it from the deck structure. Suspend protective plastic sheeting across the cavern underneath the PMT structure if cleanliness requires that the PMTs be protected from the vapours which may arise during vessel assembly.

The PMT cabling and its connection to the data acquisition system can be tested during the vessel assembly process described below, if necessary during the third shift when all the lights in the cavern can be turned off.

iii Assemble and bond the vessel chimney and raise it up out of the way.

(It has been suggested that the whole of the PMT structure be assembled and the upper 50 to 60 percent of the PMTs be installed on it before proceeding with the assembly of the vessel. The lower half of the structure would be "hidden" below the false floor with a few members of the structure being removed to allow access for the assembly of the vessel within the skeleton of the structure. The advantage of such an assembly method is that it would reduce the problems inherent in closing off the PMT structure; on the other hand it would limit access to the vessel during its assembly. The benefits and drawbacks of such a procedure will be investigated when the details of the PMT structure are better defined).

iv Construct a hemispherical jig on which the top half of the vessel can be supported. The jig is mounted on the false floor and its surfaces in contact with the acrylic material are covered with suitable padding. The jig's design would be such that it did not interfere with the assembly of the vessel nor with the vessel bonding, inspection and testing processes. The equator of the jig would be 5 to 8 feet above the false floor to allow access to the inside and outside of the vessel during assembly.

v Assemble the ring around the equator of the vessel and bond it together with the jig holding it circular and flat.

vi Assemble the top half of the vessel on the jig with (if necessary) spacers provided to separate the panels. Clamp the panels to the jig.

vii Bond the sections of the vessel together. This could start either at the vessel's equatorial ring or at the vessel's connection to the chimney. (Probably the best process is to bond the vessel together a ring at a time and then bond the completed ring to the ring below it. Then bond the lower end of the chimney to the vessel; some adjustment of the chimney flange's outside diameter may be required. However, the process cannot be chosen finally until the behaviour of the joints during bonding has been established).

viii Inspect and test vessel joints and, where necessary, repair them. This will be an ongoing process as the assembly progresses.

ix Install vessel suspension system and adjust it so that it carries the weight of the vessel. Remove the jig supporting the vessel and raise the vessel using its suspension system.

x Install a second jig assembly; this one would be located outside and underneath the vessel and, other than that, would be similar to the first jig.

xi Assemble the lower half of the vessel on the framework, again with spacers provided to separate the various panels. Provide temporary scaffolding inside the vessel to allow access to the inside surface of the lower half of the vessel.

xii Bond the panels together starting at the equator and moving down to the bottom of the vessel. Inspect and test the vessel joints, cleaning the inside of the vessel and removing the temporary scaffolding as the work progresses. Do not install the bottom central panel at this time.

xiii Carry out any remaining operations in the vessel; cleaning, checking etc. and install and bond the vessel bottom plate to the vessel assembly. This panel may need adjustment in the field.

xiv Raise vessel into final position and remove jig.

xv Assemble the lower half of the PMT structure, starting at its equator. As the work progresses, raise the structure. Once the lower half of the structure is fully assembled with all its PMTs installed and tested, raise the structure fully and connect it to its upper half.

xvi Complete remaining cleaning and checking operations.

xvii Close off the liner opening in the bottom of the cavern..

4. Comments on the procedure

Its benefits include:

i The great majority of the work is done from the bottom of the cavern and the maximum height of the scaffolding needed is never more than 25 feet.

ii The acrylic panels are properly located and supported during the assembly and bonding processes.

iii There is little if any work done above assembled components. Tools or materials which drop to the floor will not be in a position to damage the vessel or the PMTs and structure below them.

iv The PMTs on the upper hemisphere can be tested in parallel with the assembly of the vessel.

Its drawbacks include:

i It is possible that the constructing the upper hemisphere of the PMT assembly, the vessel and then the lower hemisphere of the PMT assembly may cause scheduling and manpower difficulties. On the other hand it may reduce them.

ii The procedure requires that the end of the lower access to the cavern be clean (ie lined). Note that closing the cavern bottom access off with the vessel in place is not considered to be a problem; this can be done from the lower access itself so as not to run the risk of contaminating the cavern and its equipment with welding "smoke".

Other Comments

i The assembly and bonding procedures are outlines.

ii Minor adjustments to the PMTs and related equipment that were required after completion of assembly would be carried out from temporary and local scaffolding mounted on the PMT structure. Every attempt should be made to minimize this work.

iii The maximum size of component may be limited by the size of the passage and car down to the bottom of the cavern. Final details will not be known until the PMT structure is designed.

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