Fermilab

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Title: IPND Scintillator Drain valve selection criteria and options

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Applicable Codes: NONE

Abstract Summary: This document addresses the selection of scintillator (mineral oil and pseudocumene) drain valves for potential installation in the NOvA Integration Prototype and Near Detector (IPND).

The IPND will initially be installed in a surface building, filled, and operated. After the NOvA near detector cavern has been excavated below ground (near the MINOS detector cavern), the IPND will be drained, moved to the new cavern, and re-commissions as the NOvA near detector.

Discussion:

Installation of a drain valve on the vertical modules is one method of removing the scintillator prior to moving the PVC block assembly. Each block when empty of scintillator, weighs less than the MINOS shaft crane capacity. But when filled, the weight exceeds the crane capacity. Therefore, the scintillator needs to be removed prior to moving each block down the MINOS shaft.

Other methods of removing the scintillator exist. For example, a plastic tube could be inserted into each PVC Module and used to draw the scintillator out. While it is likely that the tube can be inserted and removed without damaging the fibers in each module, the fear is that this process damages a fiber rendering a cell 'dead'. To date, this process has not been tried. But even if the tube insertion and scintillator removal were shown to be safe with respect to fiber performance, there is always a small chance that the next attempt could damage a fiber.

Materials:

Commonly used valve materials include brass, steel, stainless steel (300 series), polyvinyl chloride (PVC), polycarbonate (PC), polypropylene (PP), Nylon, and chlorinated polyvinyl chloride CPVC.

Brass material reacts with scintillator and reduces scintillator performance. Therefore, brass (and bronze) is deemed not acceptable.

Steel is the normal valve material used in hydrocarbon service. While not normally used at Fermilab, it is deemed acceptable for this application.

Stainless steel has not been shown to react with scintillator and is deemed acceptable.

Polyvinyl chloride (PVC) is acceptable for use with liquid scintillator. After all, the detector is made from PVC extrusions. But, PVC valves available appear to be gray type I or type II PCV. This material clearly has a different PCV compound than does the NOVA 27 PVC formulation used for the extrusions. Without extensive testing of the gray PVC materials to

demonstrate satisfactory performance with liquid scintillator, this material should not be deemed acceptable.

Polypropylene is not listed as being compatible with pseudocumene in any of the data bases searched. (Pseudocumene is not listed). Therefore, without extensive testing of polypropylene to demonstrate satisfactory performance with liquid scintillator, this material should not be deemed acceptable.

Aluminum is used for some fuel shut off valve applications in the automotive industry and has been shown to be compatible with scintillator. Aluminum is deemed acceptable.

Seat Seal Means:

Two types of seals are typically used in shut off valves.

The first is a metal to metal seat. A metal to metal seat is unlikely to introduce any contamination to the scintillator, but at the expense of some possible seat leakage. A common mitigation to the slight leakage is to cap or plug the other side of the valve.

The second type of seal is a 'bubble tight' seal that uses an elastomer to form the seal at the valve seat. Water faucet valves are common examples of a bubble tight seal. The elastomer provides a leak tight seal, but at the expense of some risk of contamination of the scintillator from coloring agents in the elastomer.

Attachment to Modules:

Extrusion wall thicknesses range from 3 mm to 4.5 mm (0.118 inches to 0.177 inches) nominal thickness.

Required thread engagement for national pipe thread (NPT) profiles are: 1/8 -27 NPT, 3/16 inch engagement; ¼-18 NPT, 3/16 inch engagement; 3/8-18 NPT, ¼ inch engagement.

The above date indicates that even using the finest of pipe threads (1/8 NPT), and the largest extrusion wall thickness, tapping the extrusion for installation of a valve is does not meet the required thread engagement. Such an installation would likely lead to scintillator leaking from the module at the valve connection.

As observed at the module long term hydrostatic test set up at C0, the connection between the threaded fitting and the module cover plate in one of the two extrusions has leaked continuously since filling.

Therefore, to attach a drain valve to the module, a nipple or female threaded boss will have to be glued to the module and the valve attached to this nipple or boss. This will provide sufficient thread engagement to have a reasonable probability of sealing with an acceptable leakage.

Quantity:

Assume 16 vertical planes, each with 2 vertical modules in each block. Assume 6 blocks. Total number of valves would be 16 * 2 * 6 = 192 valves.

Costs:

Stainless steel valves from Swagelok, Parker, and McMaster-Carr are in the $70 per valve range for many sizes (1/8 inch NPT to 3/8 inch NPT).

Carbon steel fuel shut off valves are in the $12 per valve range.

Using the above quantity of 192 units, stainless steel valves will cost approximately $13, 440 while carbon steel valves will cost approximately $2300.