Fermilab

Particle Physics Division
Mechanical Department Engineering Note

Number: MD-ENG-151 Date: 09 April 2008

Project Internal Reference: None

Project: COUPP

Title: Scintillator Vessel

Author(s): Dave Pushka

Reviewer(s):

Key Words: Scintillator Hydrostatic Pressure

Applicable Codes: n/a

Abstract Summary:

Physicist Mike Crisler and technician Todd Nebel have created a rectangular vessel intended to be filled with liquid scintillator. This analysis was done to evaluate the hydrostatic forces on the vessel.

Vessel is 60.5 inches tall, 12.75 inches wide by 3.75 inches thick. Stiffeners are located 7, 25, and 42 inches above the bottom. Stiffeners are made from 1 by 1 by 1/8 aluminum angle with pin connections at each end.

Image 1 shows the vessel modeled with PVC material (Young's Modulus, E = 400,000 psi), ¼ inch thick subjected to the hydrostatic load of liquid scintillator (density is 54.9 pounds per cubic foot, 0.88 = s.g.). Results indicate that the peak deformation is about 0.003 inches and the peak stress

is 3330 psi in the aluminum angle stiffener and about 700 psi in the PVC wall. While there are no firmly defined allowable values for the PVC (there is no governing code and PVC is subject to creep at room temperature) the 700 psi is similar in magnitude to the value determined to be acceptable for the NOvA detector structural PVC.

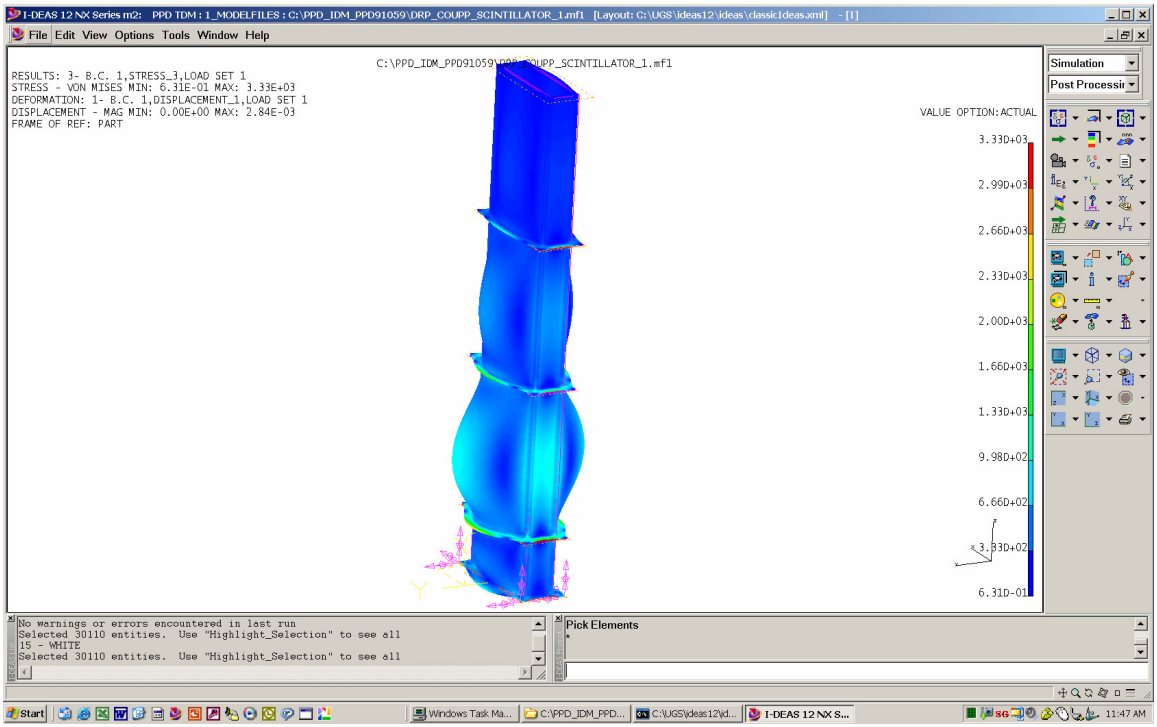

Image 1: Results of a finite element model of the vessel showing the deformations and stress.

Several simplifications were made in the FEA model. First, the stiffeners were modeled as 1/8 inch thick PVC with shear capability between the stiffeners and the walls (not contact resistance) and moment connections at the corners. The effect of the vertical leg of the stiffener angle was neglected as this material was omitted from the model.

Conclusions:

It is safe to fill this vessel with mineral oil or scintillator or water to test the vessel structure. If mineral oil or scintillator is used, the vessel should be placed in a clean secondary containment so that should the vessel leak, the liquid can be easily recovered for re-use.