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“Design and analysis of Pressure vessel for DUNE HPgTPC Detector”

Abstract:

A Deep Underground Neutrino Experiment (DUNE) facility is being set up at Fermi National Accelerator Laboratory. DUNE consisting of two massive particle detectors, one at Fermilab known as Near Detector (ND) and a much larger one to be constructed a mile underneath surface at the Sanford Underground Research Facility in South Dakota (Known as 'Far Detector'). In the Near Detector, high-pressure Ar gas (1 MPa) TPC (HPgTPC) is a tracker with an active size approximately 5.7 m in diameter by 6 m in length. HPgTPC is housed inside a pressure vessel, which supports the ECAL detector and is surrounded by a superconducting magnet. Superconducting magnet has its own support structure, but ECAL has to be supported on the pressure vessel. The weight of ECAL is about 300 Ton.

Keeping in view the above requirements, structural design and analysis of pressure vessel are carried out as per ASME code Section VIII Div-I and II. Material of construction has been chosen to minimize radiation length, while complying with the code requirements. The pressure vessel will be kept on saddle supports which have been designed to meet load requirements. Design and analysis include shell thickness calculations for competitive materials as per UG-27 of ASME, design parameters calculations of Ellipsoidal head (Appendix 1). Stresses such as circumferential bending, longitudinal bending, tangential shear, bolt size calculations and flange design have been calculated as per ASME Section VIII Div II, 3D FEM Analysis.

Key Words: DUNE, HPgTPC, Pressure Vessel, ASME, Stress, Deflection

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