Fermilab

Particle Physics Division
Mechanical Department Engineering Note

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Project: NOvA Near Detector

Title: Muon Catcher Weight

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Key Words: NOvA Near Detector Muon Catcher Weight

Abstract: Summary: Calculation of the weight of the detector and steel weights for the NOvA Integration Prototype and Near Detector (IPND)

Applicable Codes: None

Result:

The Muon Catcher Steel Planes weigh about 95 tons total for 10 planes

The Muon Catcher Detector Planes weight about 16,183 pounds for 10 planes

Gross weight of the Muon Catcher (Steel filter planes and detector planes) is about 104 tons.

Calculations:

IPND and Near Detector Scintillator Volume Calculations	Value	Units	Reference or Formula
Cell Interior Width, mm	38.4	mm	see dwg MC-435386
Cell Interior Depth, mm	55.4	mm	see dwg MC-435386
Number of Cells per extrusion	16		see dwg MC-435386
Raw Vertical Extrusion Length, mm	4114.8	mm	see dwg MD-444614
Raw Horizontal Extrusion Length, mm	2794	mm	see dwg VD-444612
Raw Vertical Extrusion Length, inches	162	inches	
Raw Horizontal Extrusion Length, inches	110	inches	
Volume of a RAW vertical extrusion, mm3	150171137	mm3	B3*B4*B5*B6
Volume of a RAW vertical extrusion, m3	0.150	m3	B9/1000/1000/1000
Volume of a RAW vertical extrusion, liters	150.2	liters	B10*1000
Volume of a RAW vertical extrusion, gallons	39.7	gallons	B11/3.785
Volume of a RAW horizontal extrusion, mm3	101968036	mm3	B3*B4*B6*B7
Volume of a RAW horizontal extrusion, m3	0.102	m3	B14/1000/1000/1000
Volume of a RAW horizontal extrusion, liters	102.0	liters	B15*1000
Volume of a RAW horizontal extrusion, gallons	26.9	gallons	B16/3.785
Number of Horizontal planes in a horizontal block	16		see dwg ME-444583
Number of Vertical planes in a horizontal block	15		see dwg ME-444583
Number of Horizontal extrusions in a plane in a horizontal block	8	-	see dwg ME-444583
Number of Vertical extrusions in a plane in a horizontal block	4	-	see dwg ME-444583
Number of Horizontal planes in a vertical block	15		see dwg ME-444096
Number of Vertical planes in a vertical block	16		see dwg ME-444096
Number of Horizontal extrusions in a plane in a vertical block	6		see dwg ME-444096
Number of Vertical extrusions in a plane in a vertical block	4		see dwg ME-444096
Volume of Scintillator in a Horizontal Block, liters	18793.2	liters	B19*B21*B16+B20*B22*B11
Volume of Scintillator in a Vertical Block, liters	15768.1	liters	B24*B26*B16+B25*B27*B11
Volume of Scintillator in a Horizontal Block, gallons	4966.6	gallons	B29/3.785
Volume of Scintillator in a Vertical Block, gallons	4168.8	gallons	B30/3.785
Volume of Scintillator in a Horizontal Block, ft3	663.9	ft3	B29/28.316
Volume of Scintillator in a Vertical Block, ft3	663.5	ft3	B30/28.316

Number of Horizontal blocks in IPND	3		Un-documented, assumed value
Number of vertical blocks in IPND	2		Un-documented, assumed value
Total Scintillator in IPND, liters	11276.8	liters	B38*B34+B39*B30
Total Scintillator in IPND, gallons	2979.9	gallons	B38*B32+B39*B33
Total Scintillator in IPND, ft3	398.2.3	ft3	B38*B35+B39*B36
IPND Secondary Containment Width	15	ft	see dwg ME-444109
IPND Secondary Containment Length	45.25	ft	see dwg ME-444109
IPND Secondary Containment Depth	5.8670571	ft	

MUON CATCHER:

6 planes of horizontals with 3 modules per plane
5 planes of verticals with 2 modules per plane

Weight of a horizontal module (two extrusions + end cap + manifold) is about 125 pounds

Weight of a vertical module (two extrusions + endcap + manifold) is about 255 pounds empty

So, weights of the empty modules:
horizontals: 15 * 125 pounds = 1875 pounds

number of planes	5	
number of modules per plane	3	
weight of one horizontal plane	125	pounds
weight of all horizontal planes:	1875	pounds

verticals: 10 * 255 pounds = 2550 pounds

number of planes	5	
number of modules per plane	2	
weight of one vertical plane	255	pounds
weight of all vertical planes:	2550	pounds

Volume of the cells in one extrusion is:

horizontals	25.9	gallons	from calculation above
vertical	39.7	gallons	from calculation above

Volume of the cells in one module (2 extrusions) is:

horizontals	53.9	gallons	2 times the above number for one extrusion
vertical	79.4	gallons	2 times the above number for one extrusion

Specific Gravity of the scintillator	0.89	
Weight of Water per unit volume	62.4	pounds per cubic foot
Weight of Scintillator per unit volume	7.34	pounds per gallon

Weight of Scintillator:		
Weight of scintillator in one horizontal module	395.5	pounds
number of planes	5	
number of modules per plane	3	
Weight of scintillator in all horizontal modules	5932.7	pounds
Weight of scintillator in one vertical module	582.5	pounds
number of planes	5	
number of modules per plane	2	
Weight of scintillator in all vertical modules	5824.9	pounds
Weight of PVC and Scintillator		
Horizontals:	7,808	pounds
Verticals:	8,375	pounds
Combined Muon Filter Detector Weight:	16,183	pounds
Muon Filter Steel Dimensions:		
Thickness	4	inches
Width	107.5	inches
Height	157.25	inches
Volume:	67,618	in3
Density	0.284	#/in3
Weight of one Filter Steel Plane	19,174	pounds
Number of Filter Steel Planes	10	
Weight of all filter steel planes	191,739	pounds
Weight of all filter steel planes	95.87	tons
Weight of Muon Catcher Steel – Detectors	207,922	pounds
Weight of Muon Catcher Steel – Detectors	103.96	tons