

Fermilab

**Particle Physics Division
Mechanical Department Engineering Note**

Number: MD-ENG-111

Date: 23 October 2006

Project Internal Reference: See Nova Docdb document number 1096

Project: NOvA

Title: Calculation of the PVC extrusion areas (area of PVC and area open for scintillator).

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Reviewer(s):

Key Words: PVC, extrusions, scintillator, detector active area

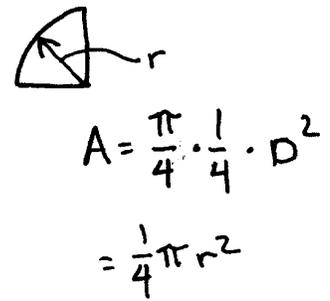
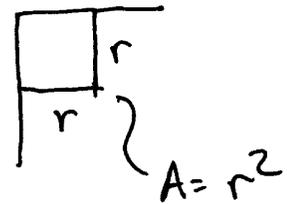
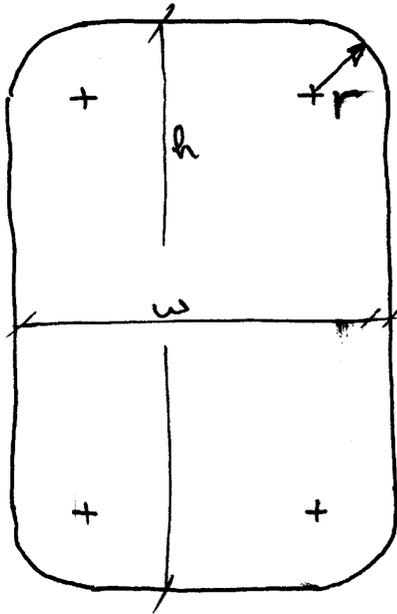
Applicable Codes: none

Abstract Summary:

Based on the sixteen cell PVC extrusion shown on drawing 9219.000-MC-435388 Revision C, I calculate the PVC area and the open area (which will be filled with scintillator oil). Since the mechanical tolerances shown on this drawing are a significant fraction of the total area, the area calculations were repeated for the extrusion wall thickness at the maximum and minimum material conditions and for the corner radii at the minimum and maximum values.

INTERIOR CELL DIMENSIONS

SEE CELLS B 69 TO B 133 for HORIZONTAL EXTRUSIONS
 " " B 158 TO B 222 for VERTICAL EXTRUSIONS



AREA OF A CELL = A_{CELL}

$$A_{CELL} = h * w - 4r^2 + 4 * \frac{1}{4} \pi r^2$$

$$= h * w - r^2(4 - \frac{\pi}{1})$$

FOR NOMINAL SIZE $h = 59.4$, $w = 38.4$, $r = 9.7$

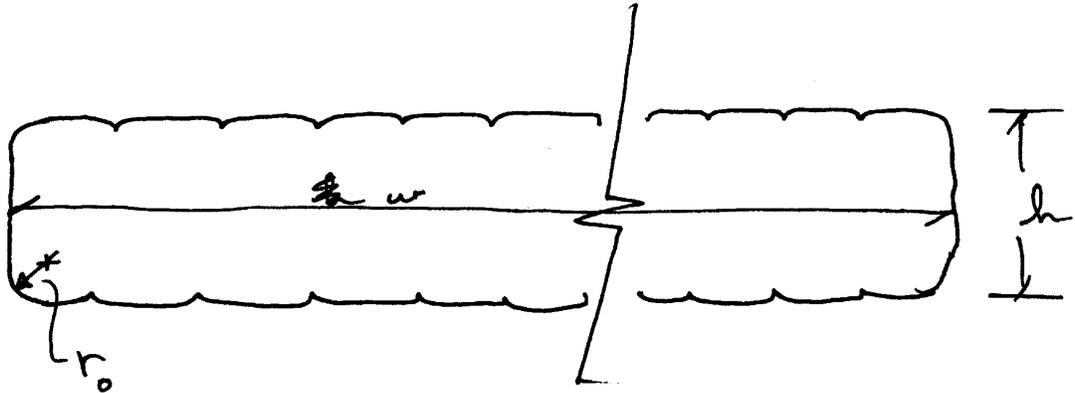
$A = 2200.19 \text{ mm}^2$

Spread sheet gets 2199.1 In cell B69 BECAUSE $w = 38.38125$ AND NOT EXACTLY 38.4

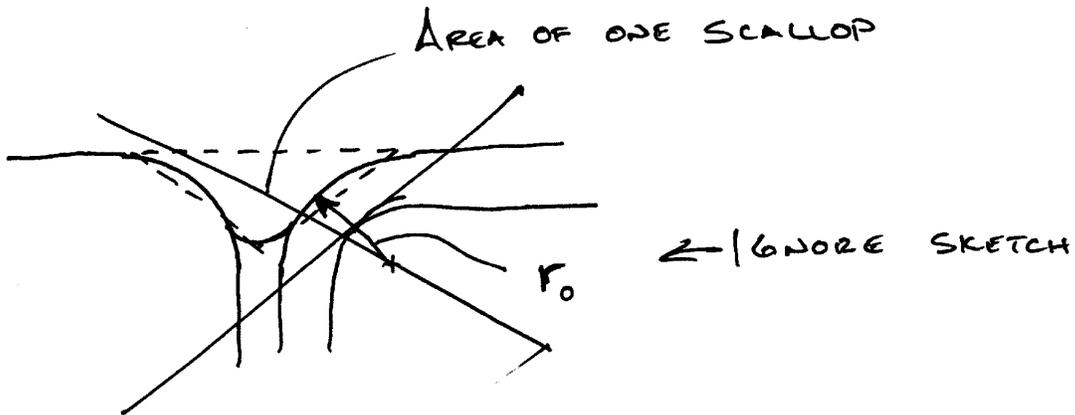
10-111 SHEETS
10-112 SHEETS
10-113 SHEETS



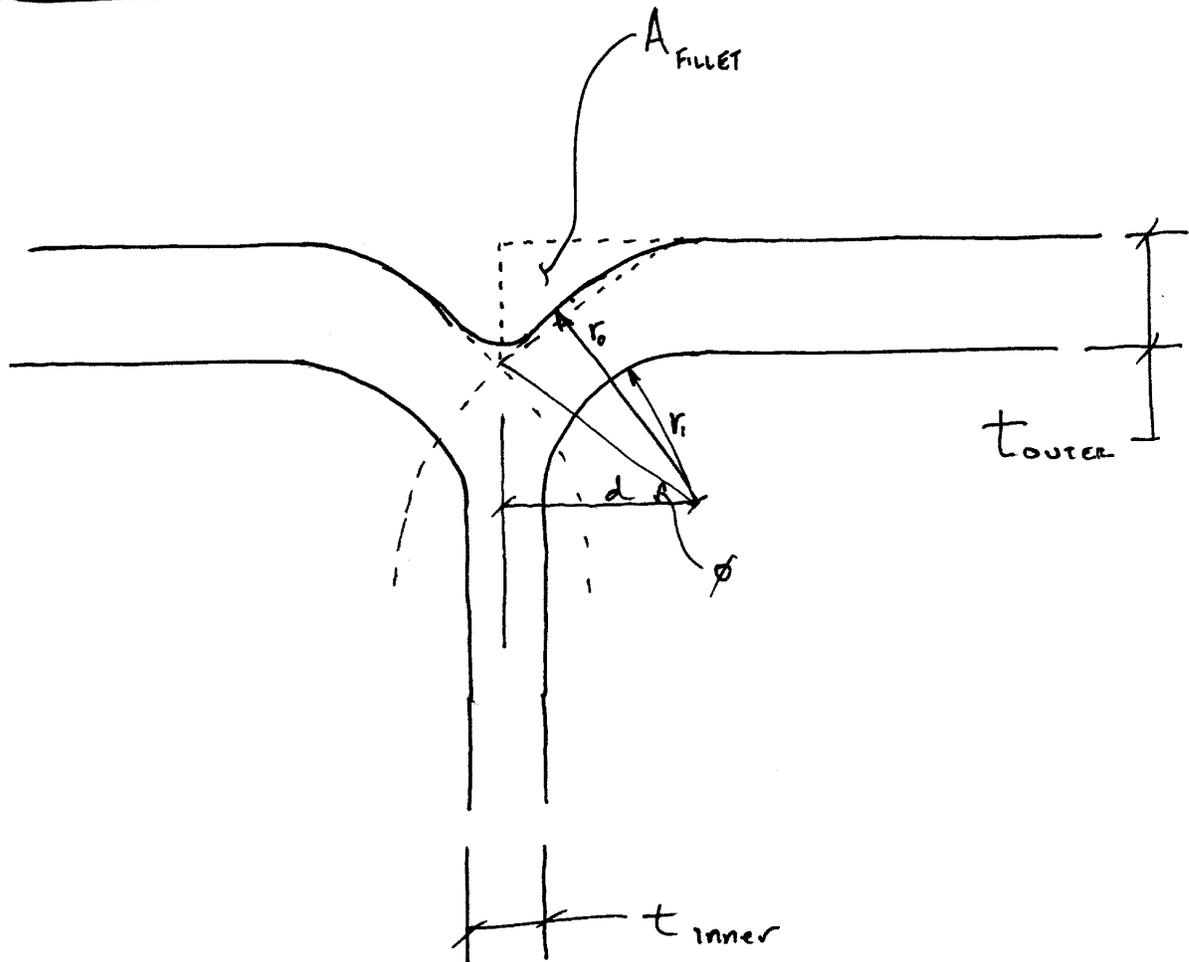
EXTERIOR GROSS VOLUME - 16 CELL EXTRUSIONS
(BOTH H & V)
See cells B33 to B45



$$A_{\text{Gross}} = h \cdot w - 4r_0^2 + \pi r_0^2 - \text{AREA OF SCALLOPS}$$



EXTERIOR GROSS VOLUME - CONTINUED



$$r_i = 9.7 \text{ mm}$$

$$d = r_i + \frac{t_{inner}}{2}$$

$$\cos \phi = \frac{d}{r_0}$$

$$\text{for } t_{inner} = 2.3 \text{ mm}$$

$$t_{outer} = 3.3 \text{ mm}$$

$$d = 9.7 + \frac{2.3}{2} = 10.85 \text{ mm}$$

$$\phi = \cos^{-1} \frac{10.85}{13.0}$$

$$\phi = 33.4^\circ$$

$$A_{FILLET} = \frac{1}{2} * d * (r_0 - r_0 \sin \phi) = \frac{1}{2} * 10.85 * (13 - 13 \sin 33.4^\circ)$$

$$A_{FILLET} = 31.6 \text{ mm}^2$$

EXTERIOR GROSS AREA - CONTINUED

$$A_{\text{GROSS}} = h * w - r_0^2 (4 + \pi) - A_{\text{SCALLOPS}}$$

$$\begin{aligned} A_{\text{SCALLOPS}} &= (\# \text{ SCALLOPS}) A_{\text{FILLET}} * 2 \\ &= (30) 31.6 * 2 \end{aligned}$$

SINCE THE CALCULATION OF THE FILLET IS AN APPROXIMATION ONLY, I APPLIED A CORRECTION OR FUDGE FACTOR. THE AREA CALCULATED BY IDEAS

FOR THE 16 cell EXTRUSION GIVES AN AREA OF 6860 mm²

BY SETTING MY FUDGE FACTOR TO 0.55395, MY AREA IS THE SAME. SEE CELLS B6 TO B13

PVC AREA

$$A_{PVC} = \text{EXTERIOR GROSS AREA} - 16 * A_{CELL}$$

SCINTILLATOR AREA

$$A_{SCINTILLATOR} = 16 * A_{CELL}$$

10-142 50 SHEETS
22-142 100 SHEETS
20-142 200 SHEETS



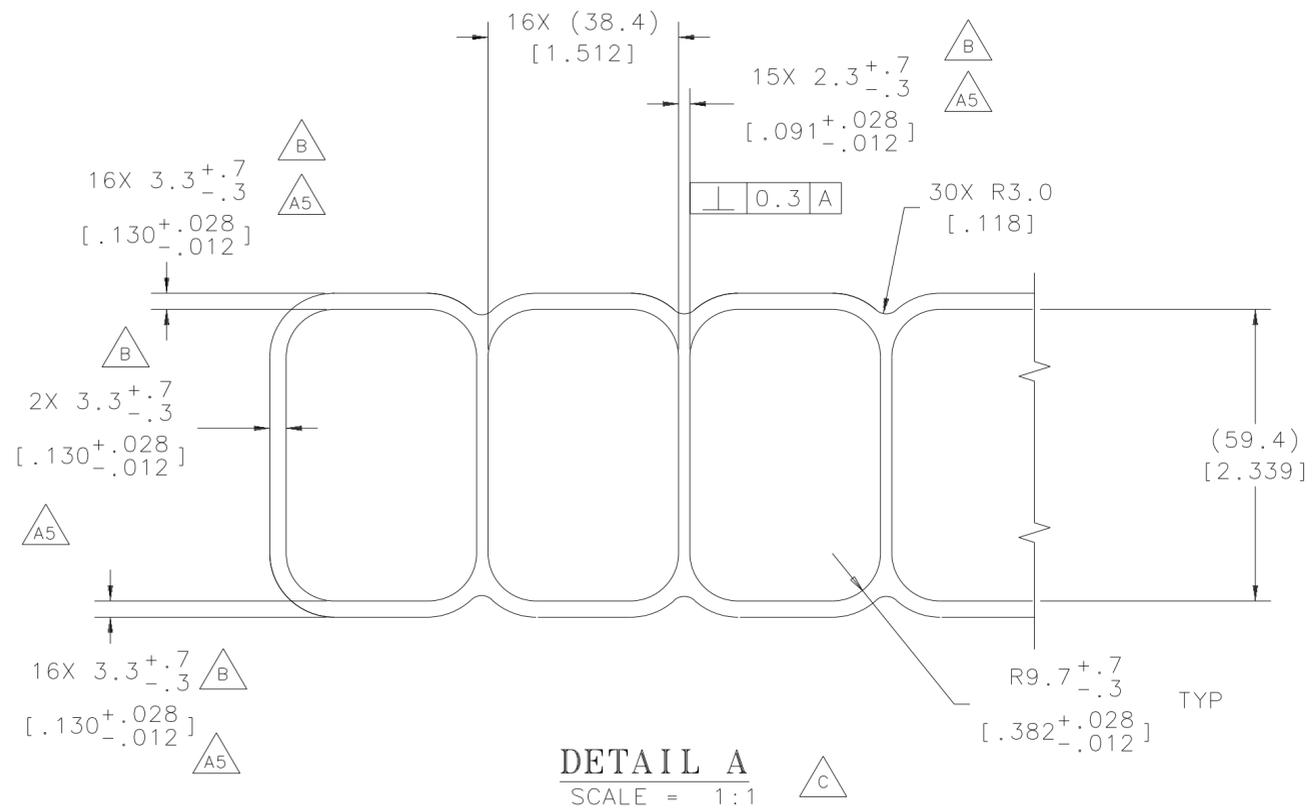
4

3

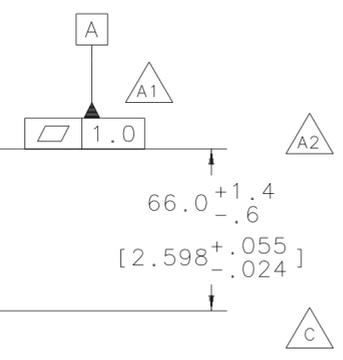
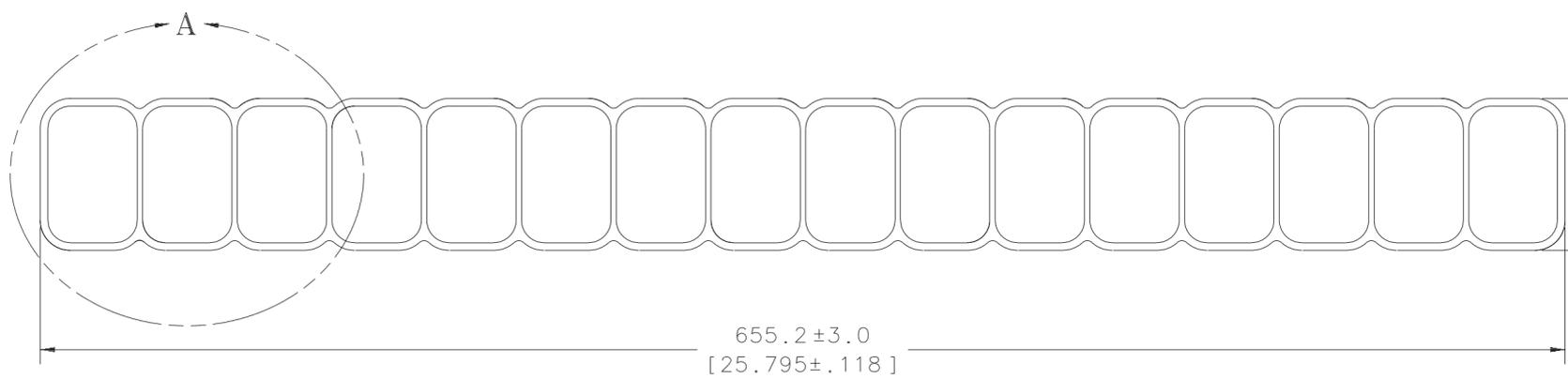
2

1

REV	DESCRIPTION	DRAWN	DATE
		APPROVED	DATE
A	1. CHNG'D TOLERANCES FROM 1.0 [0.39] TO 3.0 [.118] AND 0.2 TO 1.0. 2. ADDED TOLERANCE OF 1.0 [0.39] TO 66.0 DIMENSION. 3. CHG'D NOTE 1 TOLERANCE FROM .25mm TO 1.5mm AND .010 TO .049. 4. CHG'D TOLERANCE BLOCK .X TOLERANCE FROM .1 TO .5 5. ADDED TOLERANCE OF +.1 [+0.04] AND -.0 [-.000] TO 3 DIM'S.	D. FRIEND	07-OCT-2005
		C. GROZIS	07-OCT-2005
		D. PUSHKA	07-OCT-2005
B	CHANGED TOLERANCE FROM .1 [.004] TO 1.0 [.039], 4-PLACES.	B. CYKO	14-OCT-2005
		C. GROZIS D. PUSHKA	14-OCT-2005
C	CHG'D CELL DIMENSIONS TO AGREE WITH VENDOR TOOLING DIMENSIONS. CHG'D NOTE 2 FOR NEW CROSS SECTIONAL AREA.	D. FRIEND	04-JAN-2006
		C. GROZIS D. FRIEND	04-JAN-2006



DETAIL A
SCALE = 1:1

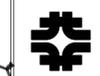


3. THIS DRAWING WAS REFERENCED FROM ARGONNE NATIONAL LABORATORY DWG. #NOVA100-2.
2. EXTRUSION CROSS SECTIONAL AREA IS 6860.0 sq/mm (10.63 sq/in)
1. EXTRUSIONS SHALL BE STRAIGHT WITHIN 1.5mm PER 1M (.049 PER 3.28 FT)

NOTES:

NOTICE: IMAGE OBTAINED FROM FERMILAB WEB SITE
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UNLESS OTHERWISE SPECIFIED			ORIGINATOR	V. GUARINO	25-AUG-2005
.X	.XX	ANGLES	DRAWN	D. FRIEND	25-AUG-2005
± .5	± ---	± 1°	CHECKED	V. GUARINO	25-AUG-2005
1. BREAK ALL SHARP EDGES .4 MAX.			APPROVED	J. COOPER	25-AUG-2005
2. DO NOT SCALE DRAWING. DIMENSIONS BASED UPON ASME Y14.5M-1994			USED ON		
3. MAX. ALL MACH. SURFACES 3.2			MATERIAL		
4. DRAWING UNITS: mm			PVC		



FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

**NOVA
EXTRUSION PROFILE
16 CELL PROFILE**

SCALE	DRAWING NUMBER	SHEET	REV
1:2 AS NOTED	9219.000-MC-435388	1 OF 1	C

CREATED WITH : Ideas11NXSeries GROUP: PPD/MECHANICAL DEPARTMENT