SAMPLE STRUCTURAL CALCULATIONS:

ACUITY BASE FRAME ANCHORAGE
(Design to 2007 CBC)

CLIENT:

Varian Medical Systems
3100 Hansen Way
Building 4A, M/S E-165
Palo Alto, CA 94304-1038

STRUCTURAL ENGINEER:

Rinne & Peterson
1121 San Antonio Road
Suite C200
Palo Alto, California 94303
(650) 428-2860

R&P #M8100

July 3, 2008

Rodney Hartunian, California SE 4438, Expires 12/31/09

These are Sample Calculations for reference only. The individual installations must be engineered by the purchaser based on actual site conditions.

1. SCOPE

The purpose of this report is to provide a sample calculation and seismic anchorage detail for the Acuity to meet the 2007 California Building Code.

2. DESIGN REQUIREMENTS AND ASSUMPTIONS OF SAMPLE CALCULATIONS

A. Analysis for the seismic anchorage is in accordance with 2007 California State Building (CBC) and ASCE 7-05, "Minimum Design Loads for Building and Other Structures".

B. Dimensions, weights and centers of gravity are provided by Varian Medical Systems.

C. When installation is not in California, the engineer of record shall determine the applicability of the following design and modify, as required, following local city and state building codes.

D. Anchorage is into a reinforced normal weight concrete slab (bottom of pit located 7 1/2" below floor level) of 8" minimum thickness for Acuity and f'_c = 3000 psi minimum designed for the applied forces and allowable soil pressure.

E. The location of installation is assumed to be at or below grade in a building assigned to Seismic Design Category F and Site Class D.

F. Sample calculations are based on a mapped MCE short period spectral response acceleration parameter(Ss), value of 2.5 and a Component Importance Factor(Ip), of 1.5.

G. All concrete anchors shall be Hilti Kwik Bolt TZ wedge anchors(ICC ESR-1917) or equivalent and be approved for installation in cracked concrete conditions. Minimum edge distance to a loaded edge is 4".

H. All concrete anchors shall be installed and inspected per the manufacturer's recommendations and respective ICC evaluation report.

I. Each site must submit documentation to the appropriate local or state permitting agencies as required.

J. Due to the location of the machine's Center of Mass, the sample calculation shown considers the bracket design for the location near the stand/gantry end of the Acuity. See drawing on page 4.

3. SUGGESTED PROCEDURE FOR ENGINEERING COMPUTATIONS

A. ASCE 7-05, Section 13.3:

$$F_p = \frac{0.4 a_p S_{DS} W_p}{\left(\frac{R_p}{I_p}\right)}\left(1 + 2\frac{z}{h}\right) \qquad \text{(ASCE 13.3-1)}$$

$$F_{p\,\min} \geq 0.3 S_{DS} I_p W_p \qquad \text{(ASCE 13.3-3)}$$

$a_p = 1.0$ $\quad S_{DS} = 1.667$ $\quad I_p = 1.5$

$R_p = 2.5$ $\quad z = 0$

$$F_P = \frac{0.4(1.0)(1.667)W_P}{\left(\frac{2.5}{1.5}\right)}\left[1+2\left(\frac{0}{h}\right)\right] = 0.400W_P$$

$$F_P = 0.3(1.667)(1.5)W_P = 0.750W_P \quad \text{GOVERNS}$$

Also, design for vertical component per ASCE 13.3.1:

$$F_{pvert} = \pm 0.2 S_{DS} W_P$$

$$F_{pvert} = \pm 0.2(1.667)W_P = \pm 0.333W_P$$

B. Forces on critical connection, based on CBC strength load combination, section 1605.2.1: $0.9D - E$

1. Uplift force, $T = \dfrac{Fp * Z_{CM} - (0.9W_P - F_{pvert}) * d}{X2 + X2}$

   Uplift force to connection, $T_{conn} = \dfrac{T([Y1_{or}Y2] + Y_{CM})}{Y1 + Y2}$

   Uplift Force to connection is based on Center of Mass location.

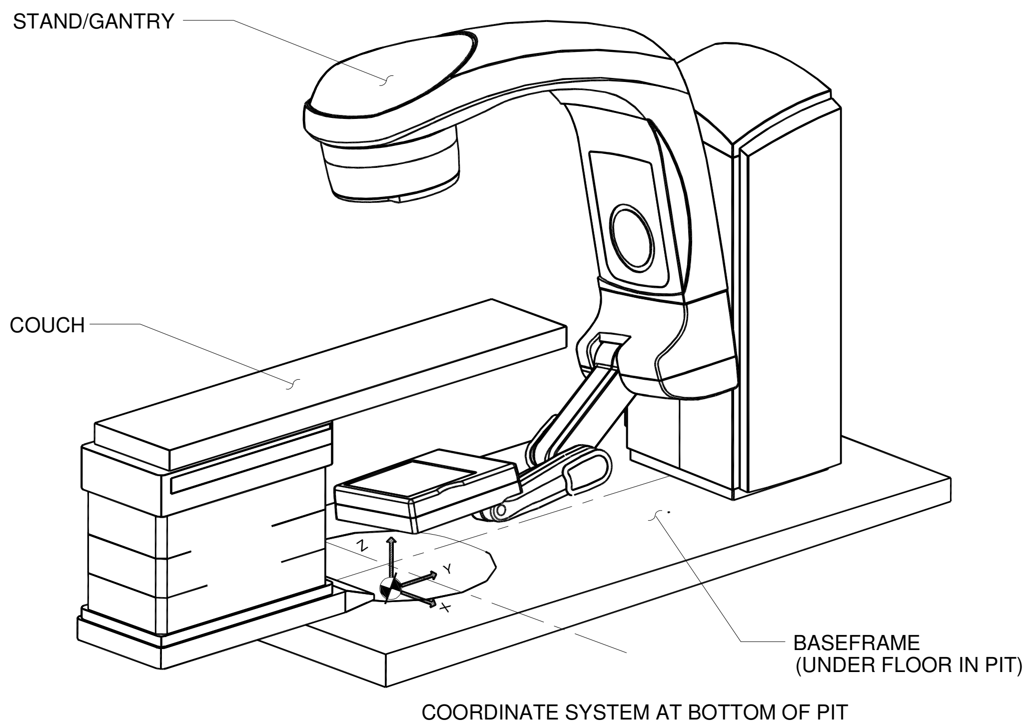
2. Shear force to connection, $V_{conn} = \sqrt{(Vx)^2 + (Vy)^2}$

   $$Vx = \frac{F_P}{4} + \frac{(F_P * e)(Y2 - Y_{CR})}{I_{conn}} \qquad Vy = \frac{(F_P * e)(X2 - X_{CR})}{I_{conn}}$$

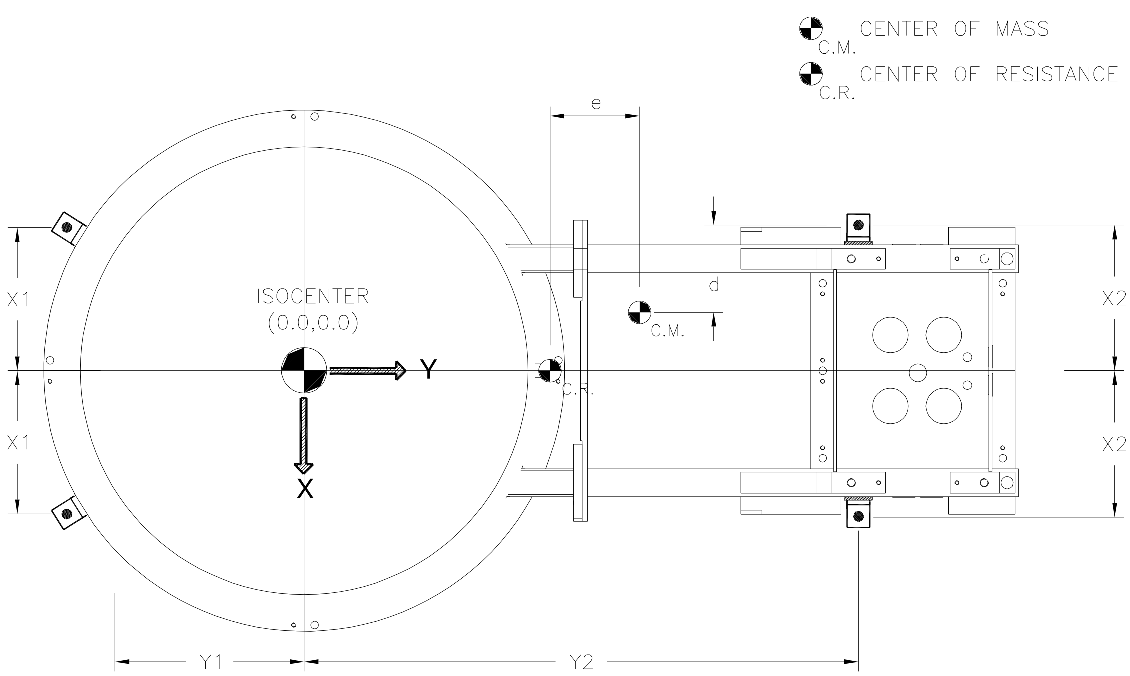
   I_{conn} = Connection group moment of inertia

3. Design of base angle based on AISC "Steel Construction Manual", 13th edition.

4. Design of concrete anchors based on ACI 318, Appendix D and ASCE 7-05 Sect. 13.4.2. Note: Per 2007 CBC Section 1908A.1.47, a ductile failure in the steel element is not required in nonstructural component design regardless of Rp used.



GENERAL EQUIPMENT LAYOUT



BASE FRAME PLAN: GENERAL RELATION OF ANCHORS

Acuity Base Frame Anchorage
July 3, 2008

See drawings SK-1 and SK-2 for seismic anchor layout and details.

Acuity			
Weight(lbs) & Center of Mass(in)		Couch in Y axis	Couch in X axis
Gantry/Stand	**W**	3080	3080
	X	0	0
	Y	50.2	50.2
	Z	52.3	52.3
Couch	**W**	1357	1357
	X	0	51.5
	Y	-51.5	0
	Z	30.2	30.2
Base	**W**	1133	1133
	X	0	0
	Y	14.4	14.4
	Z	4.6	4.6
Total Wt.(lbs)	**W_p**	5570	5570
Center of Mass(in)	**X_{CM}**	0	12.5
	Y_{CM}	18.1	30.7
	Z_{CM}	37.2	37.2
Bracket Locations & Center of Resistance	**X1**	15.1	15.1
	X2	15.1	15.1
	Y1	22.6	22.6
	Y2	65.0	65.0
	X_{CR}	0.0	0.0
	Y_{CR}	21.2	21.2
	e	-3.1	9.5
	d	15.1	2.6
	Iconn	8586	8586
Sample Calculation			
	Fp	4178	4178
Tension	**Fpvert**	1855	1855
	T	3569	4881
	Tconn	1909	2969
Shear			
	Vx	979	1247
	Vy	-22	70
	Vconn	979	1249
Summary			
	Tconn	1909	2969
	Vconn	979	1249
x1.3 for expansion bolt	**Tconn**	2482	3860
	Vconn	1273	1623
3/4"ϕ Kwik Bolt TZ anchor (emb=5 3/8")			Governs
ACI 318 Appendix D (Refer to ICC report for product specific design parameters required for Appendix D)	**ϕNsa**	14078	
	ϕNcb	4699	Governs
	ϕNpn	NA	
	ϕVsa	6944	
	ϕVcb	5675	Governs
	ϕVcp	10121	
Interaction:			

$$\frac{3860}{4699} + \frac{1623}{5675} = 1.11 < 1.2 \quad \textbf{OK}$$

Acuity Holdown Angles:

From calculation summary:

Tconn = 2,969 lbs
Vconn = 1,249 lbs

Design angle/weld for eccentricity between frame and anchor bolt reaction.

Mangle $= \dfrac{2{,}969(2.50'') - 1{,}249(1'')}{1000} = 6.17$ in-kips

For a L3x3x5/8" x 3" long angle, $\phi \mathrm{Mn} = \phi ZFy = .9\left(\dfrac{3(.625)^2}{4}\right)36 = 9.49$ in-kips > 6.17 **OK**

Weld connection to frame:

Provide fillet weld on 3 sides of L3x3 to frame attachment point

Stop = $\dfrac{2bd + d^2}{3}$ Sbot = $\dfrac{d^2(2b+d)}{3(b+d)}$ b~2.5" d~1.5"

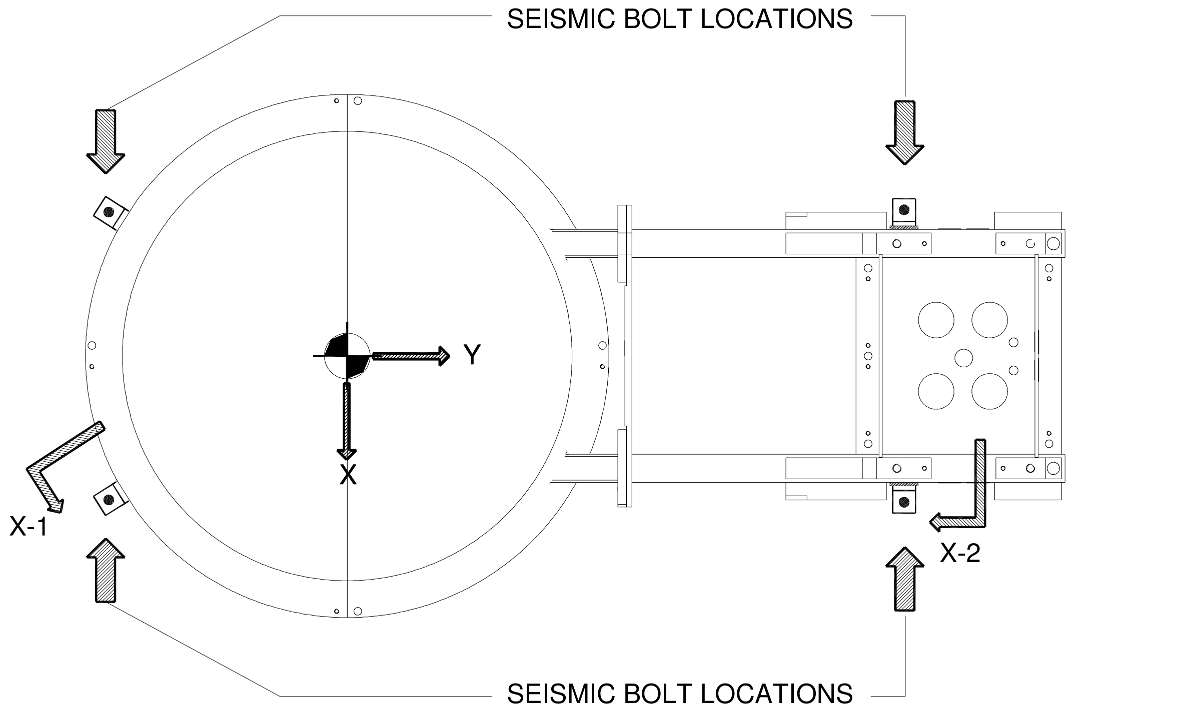
Stop = 3.25 Sbot = 1.22

$$q_x = \frac{V_{conn}}{L_{weld}} + \frac{M_{weld}}{S} = \frac{1.249}{2.5 + 2(1.5)} + \frac{6.17}{1.22} = 5.28 \text{ kips/in.}$$

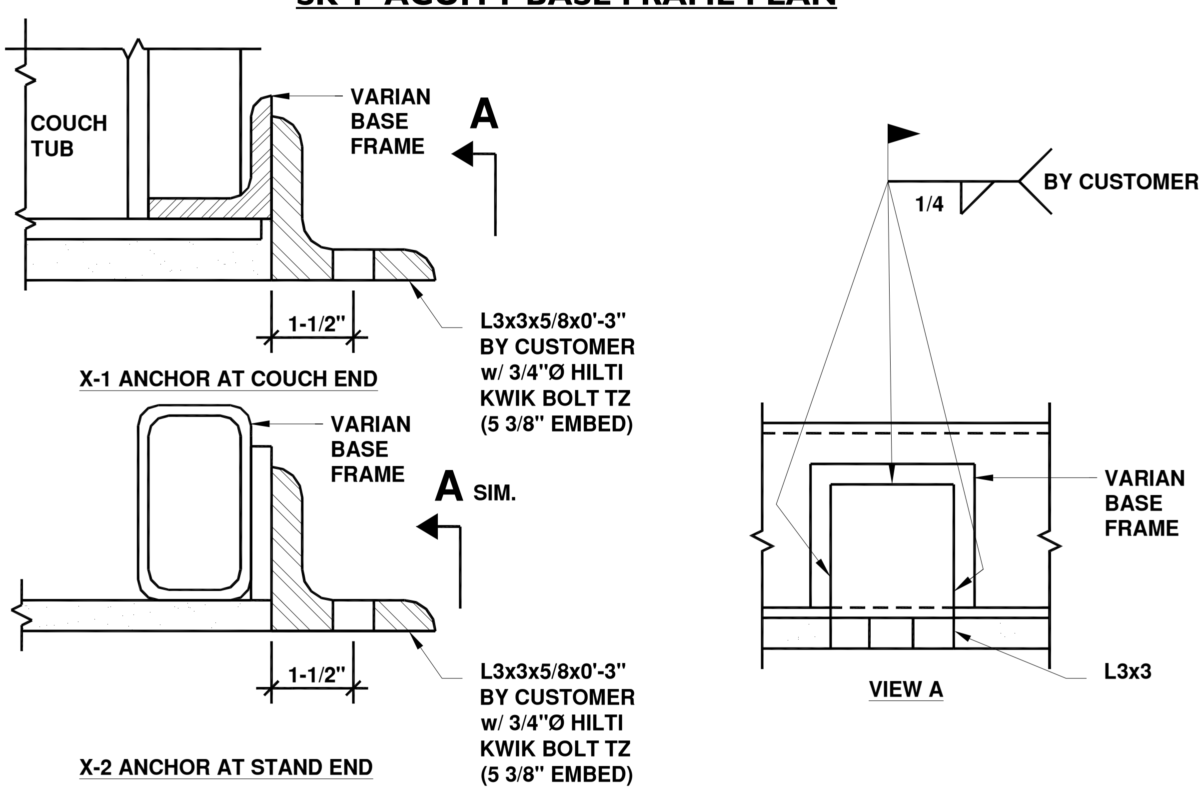
$$q_z = \frac{T_{conn}}{L_{weld}} = \frac{2.969}{2.5 + 2(1.5)} = 0.54 \text{ kips/in.}$$

$$q_{weld} = \sqrt{q_x^2 + q_z^2} = \sqrt{5.28^2 + .54^2} = 5.31 \text{ kips/in.}$$

Thickness required: $\dfrac{5.31}{1.392} = 3.8$ 16ths. **Use 1/4" fillet weld**



SK-1 ACUITY BASE FRAME PLAN



SK-2 ACUITY BASE FRAME ANCHORAGE DETAILS