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JOB: X-Spine
PF29-53646 NO. 22325
SHEET NO. 1 OF 18
CALC. BY: DWM DATE: 5/27/2015

## *STRUCTURAL CALCULATIONS FOR:*

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## *X-SPINE*
## *PF 29-53646*

PORTAFAB
Modular Building Systems

| | |
|---|---|
| Project Location: | Miamisburg, OH |
| Building Code: | 2012 IBC |
| Seismic Parameters: | Fa = 1.6, Fv = 2.4, Ss = 0.148, S1 = 0.073 |
| Stud Type: | Ominflex 300+ |

**Unit Geometry:**

Overall Width: $B_o := 30\cdot ft + 4.5\cdot in$

Overall Length: $L_o := 28\cdot ft + 5.75\cdot in$

$L_o := 20\cdot ft + 4.5\cdot in$

Story Heights: $h_o := 10\cdot ft + 0\cdot in$

**Dust Cover Gravity Loads:**

$DL := 5\cdot psf$

$LL := 10\cdot psf$

$WT_{panels} := 5\cdot psf$

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## *DUST COVER DESIGN*

(Ref: SDI Design Specification and Deck Manufacturers Catalog)

DUST COVER PROPERTIES: Dust Cover is: Deck := "1.5B22"

Deck Span: $L_{deck} := 145 \cdot in$

Section Modulus: $S_p := 0.186 \cdot in^3$

Yield Stress: $F_{y\_deck} := 33 \cdot ksi$

Moment of Inertia: $I_{deck} := 0.169 \cdot in^4$

Modulus of Elasticity: $E_{deck} := 29 \cdot 10^6 \cdot psi$

DESIGN:

Uniform Load on Deck: $w_{TL} := (DL + LL) \cdot 1 \cdot ft$ $\quad w_{TL} = 15 \frac{lb}{ft}$

Number of Supports Deck Spans, n: (use either 1, 2 or 3) $\quad n := 1$

Maximum Moment: $M := (\text{if}(n = 3, 0.10, .125)) \cdot w_{TL} \cdot L_{deck}^2$ $\quad M = 274 \cdot lb \cdot ft$

Flexural Stress: $f_b := \frac{M}{S_p}$ $\quad f_b = 17.66 \cdot ksi$

Allowable Flexural Stress: $F_{b\_deck} := 0.60 \cdot F_{y\_deck}$ $\quad F_{b\_deck} = 19.8 \cdot ksi$

Since $F_{b\_deck}$ = 19.8 ksi >= $f_b$ = 17.7 ksi **OK**

Deflection: $$\Delta_{LL} := \frac{\text{if}\left(n = 1, \frac{5}{384}, \text{if}(n = 2, 0.011, \text{if}(n = 3, 0.0059, 0))\right) \cdot LL \cdot 1 \cdot ft \cdot L_{deck}^4}{E_{deck} \cdot I_{deck}}$$ $\Delta_{LL} = 0.979 \cdot in$

Since L / $\Delta_{LL}$ = 148 >= 120 **OK**

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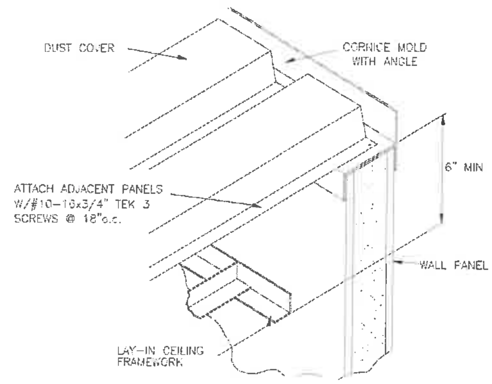
## *CONSIDER CORNICE MOLD*

Tributary width: $b_{cm} := 145 \cdot in \cdot 0.5$ $b_{cm} = 6.04\,ft$




Uniform load on cornice mold $w_{cm}$:

$w_{cm} := (DL + LL) \cdot b_{cm}$ $w_{cm} = 90.62 \frac{lb}{ft}$

Consider cornice mold as 3 span uniformly loaded member:

Cornice mold span: $span_{cm} := 48 \cdot in$

Reaction: $R_{cm} := 1.1 \cdot span_{cm} \cdot w_{cm}$ $R_{cm} = 399\,lb$

Moment: $M_{cm} := 0.1 \cdot span_{cm}^{2} \cdot w_{cm}$ $M_{cm} = 145\,ft \cdot lb$

Cornice mold section modulus: $S_{cm} := 0.28 \cdot in^{3}$

Flexural Stress: $f_b := \frac{M_{cm}}{S_{cm}}$ $f_b = 6.21 \cdot ksi$

Since $F_{b\_allow}$ = 9.5 ksi >= $f_b$ = 6.2 ksi **OK**

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JOB: X-Spine
PF29-53646 NO. 22325
SHEET NO. 4 OF 18
CALC. BY: DWM DATE: 5/27/2015

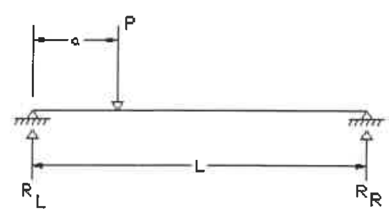
## Beam 1

Member := "W8x10" Material: mat := A992 Span: L := 218·in L = 18.17·ft Unbraced Length: $L_b$ := 54·in

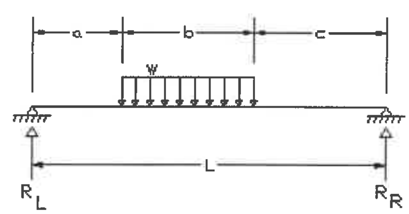
| Selected Member Properties | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Area | $S_x$ | $Z_x$ | $I_x$ | $b_f$ | $F_y$ | E |
| Shape | ($in^2$) | ($in^3$) | ($in^3$) | ($in^4$) | (in) | (ksi) | (ksi) |
| W8x10 | 2.96 | 7.81 | 8.87 | 30.8 | 3.94 | 50 | 29000 |

| Load Factors | |
|---|---|
| DL | LL |
| 1.2 | 1.6 |

| Concentrated Load Data | | | | |
|---|---|---|---|---|
| Number | DL (kips) | LL (kips) | a dist. (ft) | Description |
| P1 | 0.00 | 0.00 | 0.00 | |
| P2 | 0.00 | 0.00 | 0.00 | |
| P3 | 0.00 | 0.00 | 0.00 | |
| P4 | 0.00 | 0.00 | 0.00 | |
| P5 | 0.00 | 0.00 | 0.00 | |




| Uniform Load Data | | | | | | |
|---|---|---|---|---|---|---|
| Number | DL (kip/ft) | LL (kip/ft) | a dist. (ft) | c dist. (ft) | trib. wt. (ft) | Description |
| Self Wt. | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | Beam Dead Load |
| w1 | 0.05 | 0.10 | 0.00 | 0.00 | 10.13 | Dust Cover Load |
| w2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| w3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| w4 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| w5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |




| Reactions | | | | |
|---|---|---|---|---|
| | DL (kips) | LL (kips) | TL (kips) | Factored (kips) |
| Left End | 0.55 | 0.92 | 1.47 | 2.13 |
| Right End | 0.55 | 0.92 | 1.47 | 2.13 |

| Shears, Moments, & Deflections | | |
|---|---|---|
| Max. Factored Shear, Vu (kips) | 2.13 | |
| Design Shear, φVn (kips) | 30.41 | OK |
| Max. Fact. Moment, Mu (kip*ft) | 9.68 | |
| Design Moment, φMn (kip*ft) | 30.19 | OK |
| Max. Dead Load Deflection (in) | 0.166 | L / 1311 |
| Max. Live Load Deflection (in) | 0.278 | L / 785 |
| Max. Total Load Deflection (in) | 0.444 | L / 491 |
| Use: | W8x10 | |

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## *Wall Studs*

Stud Type: Ominflex 300+

(See stud calculations at end)

Height of Studs: $h := h_c$ $\quad k := 1.0 \quad kL := k \cdot h \quad kL = 10\,ft$

Maximum Reaction: $R_{stud} := R_{Beam_1} \quad R_{stud} = 1.47 \cdot kip$

**Allowable axial load for** $kL = 10\,ft$ **and 5psf lateral load** $P_a = 4.3 \cdot kip$ **>** $R_{stud} = 1.47 \cdot kip$ **OK**

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## *Lateral Load Analysis*

### *Seismic Loads*

Overstrength factor: $\Omega_s := 2.5$

Determine Structural Dead Load: Ws

| | | | |
|---|---|---|---|
| Deck Dead Load: | Plan Area: | $A_{plan} := 720 \cdot ft^2$ | $A_{plan} = 720 \cdot ft^2$ |
| | Deck DL: | $W_1 := DL \cdot A_{plan}$ | $W_1 = 3600\,lb$ |
| Wall Dead Load: | Uniform weight of walls: | $WT_{walls} := 4 \cdot psf$ | |
| | Length of walls: | $L_{walls} := 2 \cdot B_o + 2 \cdot L_O$ | $L_{walls} = 117.71 \cdot ft$ |
| | Wall Dead Load: | $W_2 := WT_{walls} \cdot L_{walls} \cdot h_o \cdot 0.5$ | $W_2 = 2354\,lb$ |

Total Structural Dead Load: $W_s$ $W_s := W_1 + W_2$ $W_s = 5.95 \cdot kip$

Use equivalent lateral force procedure for design base shear

$S_{MS} := F_{a\_eq} \cdot S_s$ $S_{MS} = 0.24$ $S_{M1} := F_{v\_eq} \cdot S_1$ $S_{M1} = 0.18$

$S_{DS} := 0.67 \cdot S_{MS}$ $S_{DS} = 0.16$ $S_{D1} := 0.67 \cdot S_{M1}$ $S_{D1} = 0.12$

$R_s := 2$ $I_E := 1.0$ $C_t := 0.020$ $h_n := h_o \cdot ft^{-1}$ $h_n = 10$ $T := C_t \cdot h_n^{0.75}$ $T = 0.11$

$$C_{s\_1} := \frac{S_{DS}}{\left(\frac{R_s}{I_E}\right)} \qquad C_{s\_2} := \frac{S_{D1}}{\left(\frac{R_s}{I_E}\right) \cdot T} \qquad C_{s\_3} := \frac{0.5 \cdot S_1}{\frac{R_s}{I_E}}$$

$C_{s\_1} = 0.079$

$C_{s\_2} = 0.522$

$C_{s\_3} = 0.018$

$$C_s := \max\left[\begin{array}{c} \min\left(\begin{pmatrix} C_{s\_1} \\ C_{s\_2} \end{pmatrix}\right) \\ C_{s\_3} \end{array}\right] \qquad C_s = 0.079 \qquad V := \frac{C_s \cdot W_s \cdot \Omega_s}{1.4}$$

$V = 0.84 \cdot kip$

### *Internal Wind Pressures and Loads*

Using a 5 psf lateral internal wind pressure: $V_{wind} := 5 \cdot psf \cdot \frac{h_o}{2} \cdot B_o$ $V_{wind} = 0.76 \cdot kip$

Seismic governs lateral design

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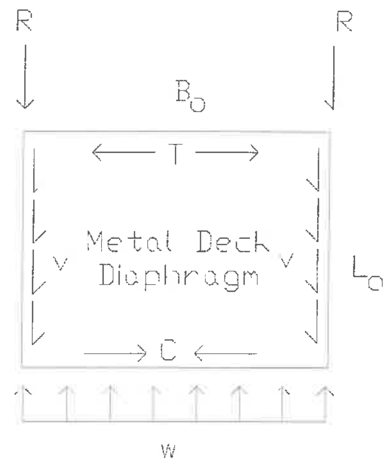
## DUST COVER DIAPHRAGM




Diaphragm Width: $B_o := B_d$

Diaphragm Length: $L_o := L_d$

Equivalent lateral load: $w := \frac{V}{B_o}$ $\quad$ $w = 27.8 \cdot \frac{lb}{ft}$

Strut Reactions: $R := \frac{w \cdot B_o}{2}$ $\quad$ $R = 422\ lb$

Maximum Shear in diaphragm: $v_{max} := \frac{R}{L_o}$ $\quad$ $v_{max} = 21 \frac{lb}{ft}$

Maximum moment in diaphragm: $M_{max} := \frac{w \cdot B_o^{\ 2}}{8}$ $\quad$ $M_{max} = 3202\ ft \cdot lb$

Chord Forces (T = C): $T_{chord} := \frac{M_{max}}{L_o}$ $\quad$ $T_{chord} = 157\ lb$

### Diaphragm and Fasteners Design Strength:

Roof deck: Deck := "1.5B22 Deck"

Fastener layout: Layout := "36/4"

Support fasteners: $Fasteners_{support}$ := "#12 TEK Screws"

Sidelap fasteners: $Fasteners_{sidelap}$ := "#10 TEK Screws"

Number of sidelap fasteners per span: $n_{sidelap} := 1$

Deck span: $deck\_span := 8 \cdot ft$

**For 1.5B22 Deck w/ 8 ft. span & #12 TEK Screws support fasteners w/ 36/4 pattern & 1 - #10 TEK Screws sidelap fastener/span:** $\quad$ $v_{allow} := 100 \cdot \frac{lb}{ft}$

**Since $v_{allow}$ = 100 lb/ft >= $v_{max}$ = 21 lb/ft OK**

### Diaphragm deflection:

$K_1 := 0.306$ $\quad$ $K_2 := 870$ $\quad$ $DB := 2209$

$$G' := \frac{K_2}{3.78 + \frac{0.3 \cdot DB}{deck\_span \cdot ft^{-1}} + 3 \cdot K_1 \cdot deck\_span \cdot ft^{-1}} \cdot \frac{kip}{in} \qquad G' = 9.26 \cdot \frac{kip}{in}$$

$$\Delta_{diaphragm} := \frac{w \cdot B_o^{\ 2}}{8 \cdot L_o \cdot G'} \qquad \Delta_{diaphragm} = 0.017 \cdot in$$

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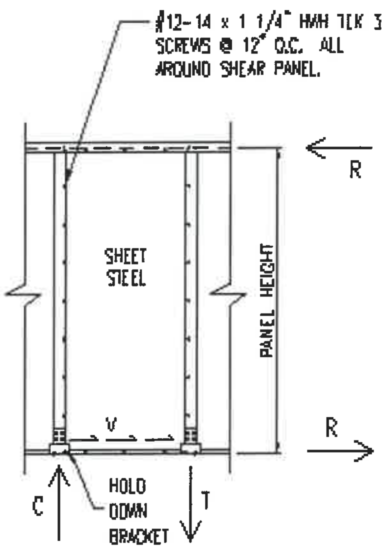
## *SHEAR PANEL DESIGN*




TYPICAL SOLID SHEAR PANEL

### Shear Panel Analysis

Sheet steel conforms to ASTM A653 CS Type B $F_y := 30 \cdot ksi$ $F_u := 55 \cdot ksi$

Screws are #12-14 x 1-1/4" HWH TEK 3

### Determine allowable shear load based on the following criteria:

(Reference: AISI Specification for the Design of Cold-Formed Steel Structural Members)

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Section E4.3.1 Connection Shear

$t_1$ = Thickness of the member in contact with the screw head

$t_2$ = Thickness of the member in not in contact with the screw head

$F_{u1}$ = Tensile strength of member in contact with the screw head

$F_{u2}$ = Tensile strength of member in not in contact with the screw head

$P_{ns}$ = Nominal shear strength per screw

$\Omega$ = Factor of Safety ASD $\Omega := 2.5$

$t_1 := 0.0359 \cdot in$ (Omniflex studs - 20 Ga. Steel) $F_{u1} := F_u$ $F_{u1} = 55 \cdot ksi$

$t_2 := 0.0359 \cdot in$ (Shear panel sheet steel - 20 Ga.) $F_{u2} := F_u$ $F_{u2} = 55 \cdot ksi$

Screw Number Designation: $Screw\_Size := 12$

Nominal screw diameter $d_{screw} = 0.216 \cdot in$

$$\frac{t_2}{t_1} = 1$$

$$P_{ns} := \min\left[\begin{bmatrix} 4.2 \cdot \left(t_2^{\,3} \cdot d_{screw}\right)^{.5} \cdot F_{u2} \\ 2.7 \cdot t_1 \cdot d_{screw} \cdot F_{u1} \\ 2.7 \cdot t_2 \cdot d_{screw} \cdot F_{u2} \end{bmatrix}\right] \qquad P_{ns} = 730\ lb$$

Reference equations E4.3.1-1 thru E4.3.1-3

Allowable shear per screw: $P_a := \frac{P_{ns}}{\Omega}$ $P_a = 292\ lb$

Screws are spaced at 12" c/c along the perimeter of the steel panels, therefore the maximum allowable shear per foot is equal to the allowable shear per screw.

$v_{allow} := P_a$ $v_{allow} = 292\ lb$

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Consider individual shear panels

Total shear in side of wall: R: $R = 0.42 \cdot kip$ (See Diaphragm Reactions)

Number of shear panels in wall: n: $n := 1$

Width at base of shear panel: b $b := 48 \cdot in$

Panel Height: h $h_o = 10 ft$

Shear at top per panel: V $V := \frac{R}{n}$ $V = 0.42 \cdot kip$

Shear per foot of panel: v $v := \frac{V}{b}$ $v = 105 \frac{lb}{ft}$

**Since $v_{allow}$ = 292.1 lb/ft >= v = 105.4 lb/ft OK**

USE 1 SHEAR PANELS PER WALL

SHEAR PANEL ANCHORAGE

Uplift force: T $T := \frac{V \cdot h_o}{b \cdot n}$ $T = 1054\, lb$

See calculations at end of set for anchorage design using Hilti KB TZ

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## SHEAR PANEL HOLD DOWN STRAP

For 1 - #12 screw in 20 gage sheet metal:

$V_{allow} := 292 \cdot lb$

Number of screws required: $N_{screw}$:

$N_{screw} := \frac{T}{V_{allow}}$ $\qquad N_{screw} = 3.61$

**USE** $N_{screw} = 4$ **#12-14 x 1 1/4" HWH TEK 3 SCREWS MINIMUM**

Collector Splice:

$T_{cs} := T_{chord}$ $\qquad T_{cs} = 157 \cdot lb$

Number of screws required: $N_{screw} := \frac{T_{cs}}{V_{allow}}$ $\qquad N_{screw} = 0.54$

Use 2 - #12 TEK screws

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## *Anchorage to Concrete Slab - Tension Capacity*

Reference: ACI 318-05 Appendix D & ESR 1917

Maximum factored tension at anchor location: $N_{u\_max} := T \cdot 1.4 \cdot \frac{R_s}{1.5}$  $N_{u\_max} = 2 \cdot kip$

Anchor type: $Type := 2$  For Cast in Place Anchors - Use Type 1
For Post Installed Anchors - Use Type 2

Cracked Region: $Crack := \text{"YES"}$

Group or single bolt action: $Action := \text{"Group"}$

Number of anchors: $n := 2$

Concrete compressive strength: $f'_c := 3000 \cdot psi$

Minimum specified tensile strength: $f_{uta} := 106 \cdot ksi$

Anchor diameter: $d_{anchor} := 0.5 \cdot in$

Area of anchor: $A_{se} := 0.101 \cdot in^2$

Anchor embedment depth: $h_{ef} := 3.5 \cdot in$

Minimum edge distance (c1): $c_{a1} := 24 \cdot in$

Anchor spacing: $s_1 := 4.5 \cdot in$

Reduction factor: $\phi_{ts} := 0.75$  $\phi_{tc} := 0.70$

Steel Strength of anchor in tension (Section D.5.1):

$N_S := n \cdot A_{se} \cdot f_{uta}$  $N_S = 21.41 \cdot kip$

Concrete Breakout Strength of Anchor in Tension (Section D.5.2):

For a single anchor:

$$A_{Nco} := 9 \cdot h_{ef}^2 \qquad A_{Nco} = 110 \cdot in^2$$

$$A_{Nc} := \min\left[\begin{bmatrix} (c_{a1} + 1.5 \cdot h_{ef}) \cdot (2 \cdot 1.5 \cdot h_{ef}) \\ A_{Nco} \end{bmatrix}\right] \qquad A_{Nc} = 110 \cdot in^2$$

$$\Psi_{edN} := \text{if}\left(c_{a1} \ge 1.5 \cdot h_{ef}, 1, 0.7 + 0.3 \cdot \frac{c_{a1}}{1.5 \cdot h_{ef}}\right) \qquad \Psi_{edN} = 1$$

$$\Psi_{cN} := \text{if}(\text{Type} = 1, 1.25, \text{if}(\text{Type} = 2, 1.4, 0))$$

$$\Psi_{cN} := \text{if}(\text{Crack} = \text{"NO"}, \Psi_{cN}, 1.0) \qquad \Psi_{cN} = 1$$

$$k_{anchor} := \text{if}(\text{Type} = 1, 24, \text{if}(\text{Type} = 2, 17, 0))$$

$$N_b := k_{anchor} \cdot \sqrt{\frac{f'_c}{psi}} \cdot \left(\frac{h_{ef}}{in}\right)^{1.5} \cdot lb \qquad N_b = 6.1 \cdot kip$$

$$N_{cb} := \frac{A_{Nc}}{A_{Nco}} \cdot \Psi_{edN} \cdot \Psi_{cN} \cdot N_b \qquad N_{cb} = 6.1 \cdot kip$$

For a group of anchors: $e'_N := 0 \cdot in$

$$\Psi_{ecN} := \min\left(\begin{pmatrix} 1 \\ \dfrac{1}{1 + \dfrac{2 \cdot e'_N}{3 \cdot h_{ef}}} \end{pmatrix}\right) \qquad \Psi_{ecN} = 1$$

$$A_{Nc} := \min\left[\begin{bmatrix} (c_{a1} + 1.5 \cdot h_{ef}) \cdot (2 \cdot 1.5 \cdot h_{ef} + s_1) \\ n \cdot A_{Nco} \end{bmatrix}\right] \qquad A_{Nc} = 220.5 \cdot in^2$$

$$N_{cbg} := \frac{A_{Nc}}{A_{Nco}} \cdot \Psi_{ecN} \cdot \Psi_{edN} \cdot \Psi_{cN} \cdot N_b \qquad N_{cbg} = 12.19 \cdot kip$$

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Governing Tension Design Strength:

$$\phi N_n := \begin{pmatrix} N_S \cdot n \cdot \phi_{ts} \\ \text{if}(\text{Action} = \text{"Group"}, N_{cbg}, N_{cb}) \cdot \phi_{tc} \end{pmatrix} \qquad \phi N_n = \begin{pmatrix} 32.12 \\ 8.54 \end{pmatrix} \cdot \text{kip}$$

$$\phi N_n := \min(\phi N_n) \qquad \phi N_n = 8.54 \cdot \text{kip}$$

Since $\varphi N_n$ = 8.5 kip >= $N_{u\_max}$ : 2.0 kip **OK**

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## *Anchorage to Concrete Slab - Shear Capacity*

Reference: ACI 318-05 Appendix D

Maximum factored shear at anchor location: $V_{u\_max} := V \cdot 1.4 \cdot \frac{R_s}{1.5}$ $V_{u\_max} = 0.8 \cdot kip$

Anchor type: $Type := 2$ For Cast in Place Anchors - Use Type 1
For Post Installed Anchors - Use Type 2

Cracked Region: $Crack := \text{"YES"}$

Group or single bolt action: $Action := \text{"Group"}$

Number of anchors: $n := 2$

Concrete compressive strength: $f'_c := 3000 \cdot psi$

Minimum specified tensile strength: $f_{uta} := 106 \cdot ksi$

Anchor diameter: $d_{anchor} := 0.5 \cdot in$

Area of headed stud: $A_{se} := 0.101 \cdot in^2$

Anchor embedment depth: $h_{ef} := 3.5 \cdot in$

Minimum edge distance (ca1) & (ca2): $c_{a1} := 24 \cdot in$ $c_{a2} := 24 \cdot in$

Anchor spacing: $s_1 := 4.5 \cdot in$

Reduction factor: $\phi_{vs} := 0.65$ $\phi_{vc} := 0.60$

Steel Strength of anchor in shear (Section D.6.1):

$V_S := A_{se} \cdot f_{uta}$ $V_S = 10.71 \cdot kip$

Concrete Breakout Strength of Anchor in Shear (Section D.6.2):

For a single anchor:

$$A_{Vco} := 4.5 \cdot c_{a1}^2 \qquad A_{Vco} = 2592 \cdot in^2$$

$$A_{Vc} := \min\left[\begin{bmatrix} \left[2 \cdot (1.5 \cdot c_{a1}) + s_1\right] \cdot 1.5 \cdot c_{a1} \\ A_{Vco} \end{bmatrix}\right] \qquad A_{Vc} = 2592 \cdot in^2$$

$$V_b := \text{if}(Type = 1, 8, 7) \cdot \left(\frac{h_{ef}}{d_{anchor}}\right)^{0.2} \cdot \sqrt{\frac{d_{anchor}}{in}} \cdot \sqrt{\frac{f'_c}{psi}} \cdot \left(\frac{c_{a1}}{in}\right)^{1.5} \cdot lb \qquad V_b = 47.04 \cdot kip$$

$$\Psi_{edV} := \text{if}\left(c_{a2} \geq 1.5 \cdot c_{a1}, 1, 0.7 + 0.3 \cdot \frac{c_{a2}}{1.5 \cdot c_{a1}}\right) \qquad \Psi_{edV} = 0.9$$

$$\Psi_{cV} := \text{if}(Crack = \text{"NO"}, 1.4, 1.0) \qquad \Psi_{cV} = 1$$

$$V_{cb} := \frac{A_{Vc}}{A_{Vco}} \cdot \Psi_{edV} \cdot \Psi_{cV} \cdot V_b \qquad V_{cb} = 42.34 \cdot kip$$

For a group of anchors:

$$e'_V := 0 \cdot in$$

$$\Psi_{ecV} := \min\left(\begin{pmatrix} 1 \\ \dfrac{1}{1 + \dfrac{2 \cdot e'_V}{3 \cdot c_{a1}}} \end{pmatrix}\right) \qquad \Psi_{ecV} = 1$$

$$A_{Vc} := \min\left[\begin{bmatrix} (2 \cdot 1.5 \cdot c_{a1} + s_1) \cdot 1.5 \cdot c_{a1} \\ n \cdot A_{Vco} \end{bmatrix}\right] \qquad A_{Vc} = 2754 \cdot in^2$$

$$V_{cbg} := \frac{A_{Vc}}{A_{Vco}} \cdot \Psi_{ecV} \cdot \Psi_{edV} \cdot \Psi_{cV} \cdot V_b \qquad V_{cbg} = 44.98 \cdot kip$$

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Governing Shear Design Strength:

$$\phi V_n := \begin{pmatrix} n \cdot V_S \cdot \phi_{vs} \\ \text{if}(\text{Action} = \text{"Group"}, V_{cbg}, V_{cb}) \cdot \phi_{vc} \end{pmatrix} \qquad \phi V_n = \begin{pmatrix} 13.92 \\ 26.99 \end{pmatrix} \cdot \text{kip}$$

$$\phi V_n := \min(\phi V_n) \qquad \phi V_n = 13.92 \cdot \text{kip}$$

| Since | $\varphi V_n$ = | 13.9 | kip | >= | $V_{u\_max}$ | 0.8 | kip | **OK** |
|---|---|---|---|---|---|---|---|---|

Interaction equation: (Per ACI 318 Section D.7)

$$\left(\frac{N_{u\_max}}{0.75 \cdot \phi N_n}\right) + \left(\frac{V_{u\_max}}{0.75 \cdot \phi V_n}\right) = 0.38$$

< 1.2 OK

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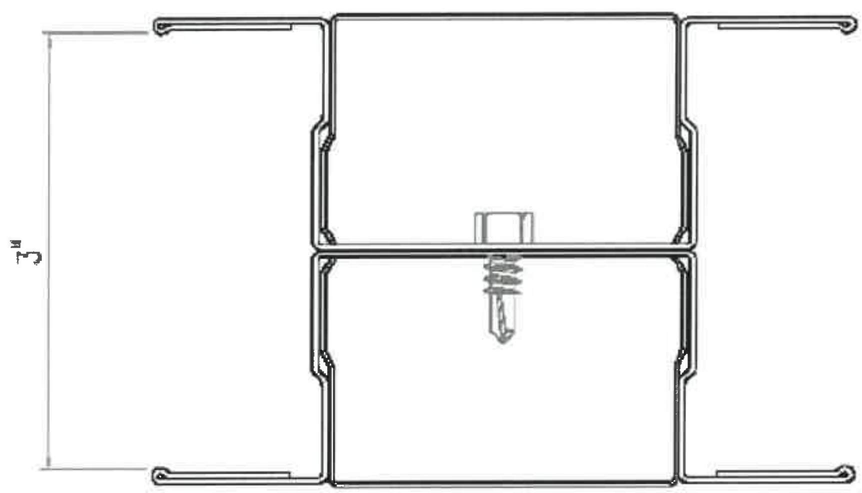
PORTAFAB
Modular Building Systems




OmniFlex 300+
20ga roll-formed steel

| Stud Height (feet) | Maximum allowable axial load (lbs) | Maximum allowable axial load (lbs) with tube insert |
|---|---|---|
| 8 | 5,700 | 6,100 |
| 9 | 5,000 | 6,100 |
| 10 | 4,300 | 6,100 |
| 11 | 3,500 | 5,000 |
| 12 | 3,100 | 4,070 |
| 13 | 2,500 | 3,300 |
| 14 | 2,000 | 2,660 |
| 16 | 1,300 | 1,800 |

Stud load capacities are based upon 48" maximum centers. Loads listed include a 5 p.s.f. lateral combined load.

Maximum deflection limitation of l/120.

The structural capacity of slabs are not considered and should be analyzed independently

Wall studs are to be utilized within PortaFab 3" wall systems.

Tube insert to be HSS 2"x1 1/4"x11ga

# SAM® MicroSound

Clean Rooms International
Designing Flexible Solutions

## Low Profile
## Energy Efficient
## Fine Tuned Air Flow

*SAM* MicroSound Fan Filter Units include a 99.99% efficient HEPA filter, 30% ASHRAE pleated type prefilter, seismic clip suspension points, safety switch which disables the unit while servicing, and solid state variable speed control with RFI suppression, allowing the airflow to be fine tuned.

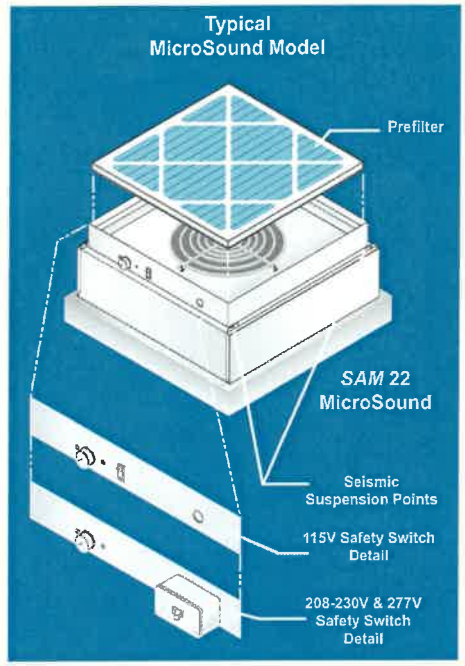
Housings are fabricated from steel with a white powdercoat finish and include seismic clip suspension points.

The energy efficient N310 motor blower is a low watt backward curved impeller, single phase, permanent split capacitor type motor blower assembly with thermal overload protection. Units are available in 115 Volt (60 Hz), 208-230 Volt (50/60 Hz) and 277 Volt (60 Hz).

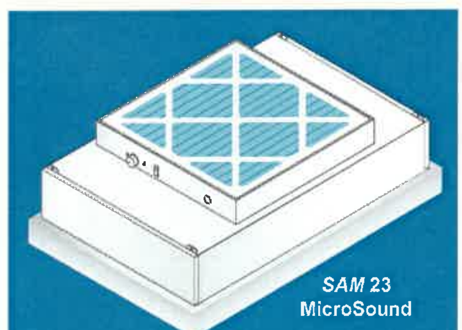
Final filters are protected with a white epoxy diamond pattern grille and are tested according to accepted procedures as described by the Institute of Environmental Sciences (IEST) and/or ISO standards. The standard HEPA filter is 99.99% eff. and an ULPA grade 99.9995% eff. filter is available as an option.

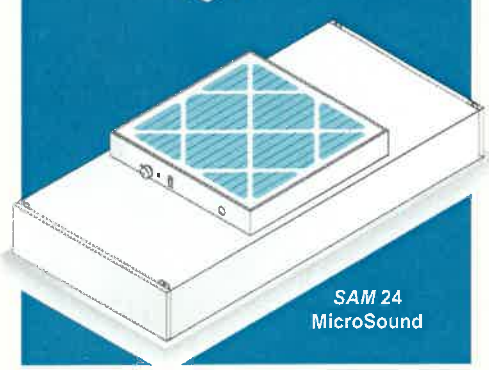
Other popular options include an 8' power cord (110 Volt only), 99.9995% eff. ULPA grade final filter, UL 900 Class 1 filters and duct collar adapters. Refer to the back of this section for more options and accessories.

For horizontal flow applications consult with one of our cleanroom experts in your area, or call the factory for more information.




- **Energy Efficient Motor:** Operating Amps Low As .6 For 277 Volt And 1.6 For 115 Volt
- **Safety Switch:** Disables Unit While Servicing
- **Variable Speed Control:** Allows Air Flow To Be Fine Tuned For Room Requirements




c UL US LISTED

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# Data & Specifications for *SAM*® MicroSound

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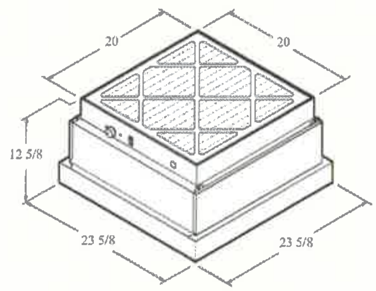
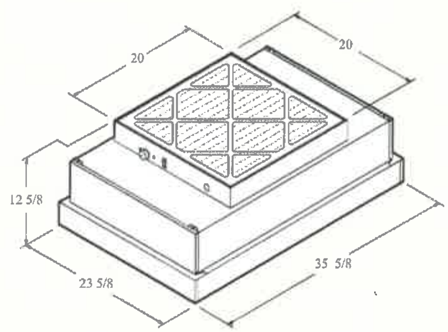
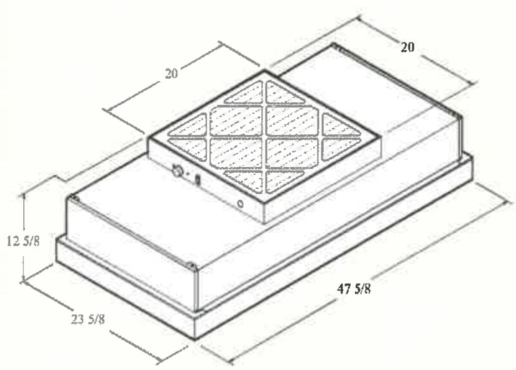



***SAM* 22 MicroSound**




***SAM* 23 MicroSound**




***SAM* 24 MicroSound**

**NCR Style Filter Data:** The HEPA Filters are designed for 90 FPM average face velocity @ initial 0.47 w.g. and have a rated efficiency of 99.99% @ 0.3 micron or larger. An anodized aluminum frame holds the 53mm media which is protected by a diamond pattern white epoxy coated steel grille.

Final filters can be replaced by removing unit from ceiling, placing on a bench, removing and replacing the filter and re-installing unit in ceiling.

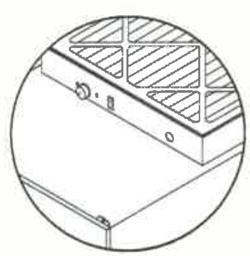
**Low Profile:** All *SAM* MicroSound NCR Style Models are 12-5/8" high.

**Standard Ceiling Size:** All 2' x 4' models are designed to fit a nominal 2' x 4' ceiling grid with a 22.5" x 46.5" standard opening.

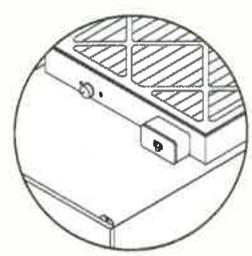
**Air Flow:** Airflow ranges from 400 to 750 CFM for a 2 x 4 unit and 250 to 400 CFM for a 2 x 2 unit. At 90 FPM, CFM is nominal 632 on a 2 x 4 and 300 on a 2 x 2 unit respectively. Airflow for units running at 50 Hz will be about 20% less.

**Sound Level:** At average face velocity of 90 FPM measured 30" from face of filter, sound level is approximately 54 dba with less than 45 dba ambient sound level. Field conditions, voltage and method of testing could produce different results.

**Popular Options:** Refer to next page for a list of popular options.



**Safety Switch Detail**
**115V**



**Safety Switch Detail**
**208-230/277V**

**Motor Data**

| Motor | Voltage | Hz | Watts | Running Amps | Start-Up Amps |
|---|---|---|---|---|---|
| N310 | 115 | 60 | 185 | 1.6 | 4.1 |
| N310 | 208-230 | 50/60 | 165 | 0.8-0.7[1] | 1.5[2] |
| N310 | 277 | 60 | 165 | .6 | 1.5 |
| | | | | | |

(1) Running amps will be less on 50Hz

(2) Line voltage can affect actual start-up amperage

**Replacement Filters**

| Mfg. Code | Description |
|---|---|
| 302070 | 2 x 2 NCR Style HEPA Filter, 99.99% eff. @ 0.3 micron |
| 302071 | 2 x 2 NCR Style ULPA Filter, 99.9995% eff. @ 0.12 micron |
| 302013 | 2 x 3 NCR Style HEPA Filter, 99.99% eff. @ 0.3 micron |
| 302015 | 2 x 3 NCR Style ULPA Filter, 99.9995% eff. @ 0.12 micron |
| 302090 | 2 x 4 NCR Style HEPA Filter, 99.99% eff. @ 0.3 micron |
| 302100 | 2 x 4 NCR Style ULPA Filter, 99.9995% eff. @ 0.12 micron |
| 302190 | Prefilter 20" x 20" x 1", 30% ASHRAE efficient, pleated type |
| | |



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# Ordering Information for *SAM*® MicroSound

## Base Model
### (Ordering Information)

| Mfg. Code | Model or Description | Style | Size | Voltage | Motor | Variable Speed Control | HEPA Filter | Weight |
|---|---|---|---|---|---|---|---|---|
| 12100* | *SAM* 22 MS NCR | NCR | 2 x 2 | 115 | N310 | 703084 | 302070 | 53 lbs. (24.0 kg.) |
| 12101 | *SAM* 22 MS NCR | NCR | 2 x 2 | 208-230 | N310 | 703912 | 302070 | 53 lbs. (24.0 kg.) |
| 12102* | *SAM* 22 MS NCR | NCR | 2 x 2 | 277 | N310 | 703915 | 302070 | 53 lbs. (24.0 kg.) |
| 12150* | *SAM* 23 MS NCR | NCR | 2 x 3 | 115 | N310 | 703084 | 302013 | 57 lbs. (25.9 kg.) |
| 12261* | *SAM* 24 MS NCR | NCR | 2 x 4 | 115 | N310 | 703084 | 302090 | 60 lbs. (27.2 kg.) |
| 12262 | *SAM* 24 MS NCR | NCR | 2 x 4 | 208-230 | N310 | 703912 | 302090 | 60 lbs. (27.2 kg.) |
| 12263* | *SAM* 24 MS NCR | NCR | 2 x 4 | 277 | N310 | 703915 | 302090 | 60 lbs. (27.2 kg.) |
| | | | | | | | | |

* UL Listed
Prefilter and Safety Switch are Standard on all Models

**Popular Options:** (Please choose from the following part numbers when ordering options)

**Final Filters:**

☐302071 2 x 2 NCR ULPA Filter 99.9995% eff.
☐302015 2 x 3 NCR ULPA Filter 99.9995% eff.
☐302100 2 x 4 NCR ULPA Filter 99.9995% eff.
☐308001 2 x 2 NCR HEPA UL 900 Class 1
☐308002 2 x 4 NCR HEPA UL 900 Class 1
☐308005 2 x 4 NCR ULPA UL 900 Class 1
☐308007 2 x 2 NCR ULPA UL 900 Class 1
☐302072 2 x 2 NCR HEPA with Centerboard and Test Port
☐302094 2 x 4 NCR HEPA with Centerboard and Test Port

**Prefilters:**

☐309802 Super Clean Prefilter Suitable for Class 1-100

**Duct Collar Adapters:**

☐19950 10" Duct Collar Adapter
☐19951 12" Duct Collar Adapter
☐19952 Side Load with 10" Duct Collar
☐19953 Side Load with 12" Duct Collar
☐19955 10" Top Load Duct Collar Adapter
☐19956 12" Top Load Duct Collar Adapter

**Air Conditioning Mixing Box:**

☐19958 Slanted Top with 10" Duct Collar
☐19959 Slanted Top with 12" Duct Collar
☐19947 Square with (2) 10" Duct Collars
☐19948 Square with (2) 12" Duct Collars

**Pilot Light:** (Includes Special Order Filters and Speed Control Parts)

☐ 19700 NCR Style Red Pilot Light 110-120 Volt Only (Light Indicates Power to Motor Only)
☐ 19701 NCR Style Red Pilot Light w/Pressure Switch 110-120 Volt Only (Light Indicates Power to Motor Only)

**Radial Diffuser Grille:**

☐ 19300 2 x 2 Radial Diffuser Grille
☐ 19301 2 x 4 Radial Diffuser Grille

**Miscellaneous:**

☐ 703902 8' Power Cord 110-120V Only
☐ 603322 Gasket on Downstream Edge of Unit
☐ Magnehelic Gage: Refer to the Back of this Section

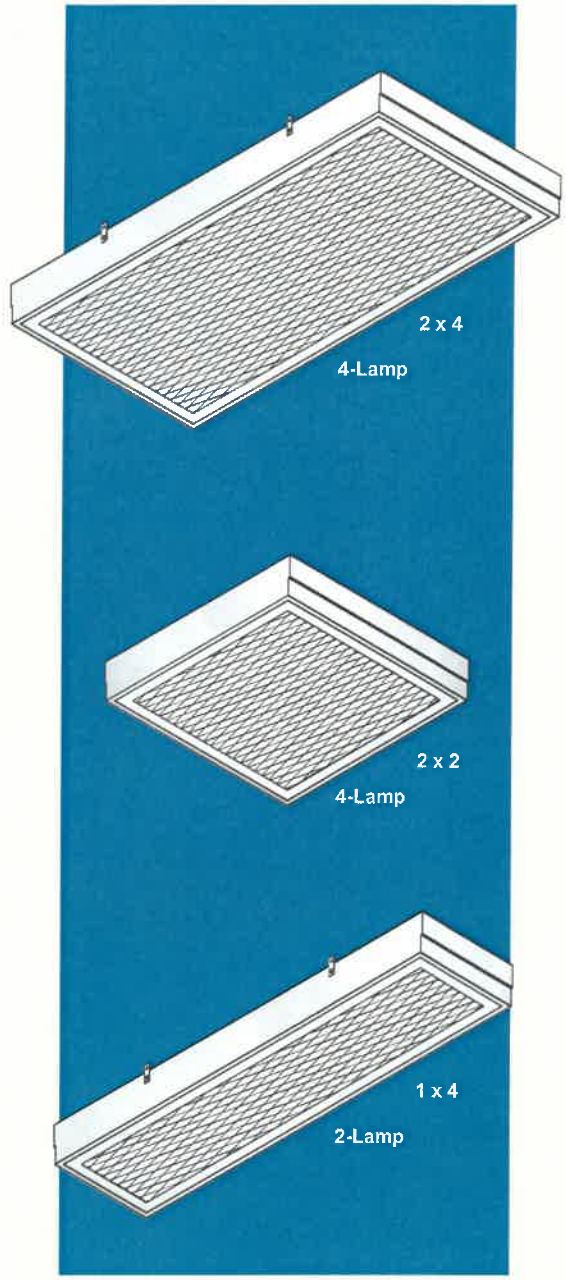
Comments:

*NOTE: Duct collar adapters, air conditioning boxes, pilot lights and adding other electrical components negates UL listing.*

*For more information and illustrations please refer to the back of this section*

## Cleanroom Light Fixtures

Cleanroom Light Fixtures are ideal for general purpose cleanrooms, pharmaceutical cleanrooms and biomedical labs, food processing centers, hospitals and wet locations.




## Sealed Housings Maintain Integrity

Totally sealed housings maintain ceiling integrity and protect against infiltration of particles and airborne bacteria. Housings are painted with a white powdercoat finish and spring loaded latches on each side secure the hinged door lens frame in the closed position. The door frame is removable without the use of tools, permitting re-lamping from roomside without contaminating the clean areas.

## Features of Standard Fixtures

Standard fixtures feature a 120-277 multi-voltage T8 electronic ballast with (4) medium bi-pin lamp receptacles, (lamps not included). The ballast is mounted inside the housing and is removable from roomside, maintaining ceiling integrity.

## Cover for Quick Access

Installation is easy because a gasketed wiring access cover on the top allows quick access for wiring to the building power source.

## Compliance with Federal Standards

These luminaries are UL listed and manufactured in accordance to USDA, FDA, and NSF guidelines. All fixtures have been tested and reported in compliance with Federal Standard 209 and are suitable for Class 1,000 to 100,000 or ISO Class 3 to 9 Cleanrooms. Consult with the factory for Class 100 or ISO Class 1 and 2 applications or hazardous location fixtures.

## Emergency Battery Pak

All models are available with an Emergency Battery Pak. In the event of a power failure, a fixture equipped with this option will illuminate a single lamp, 350-450 lumens for up to 90 minutes.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# Cleanroom Lights

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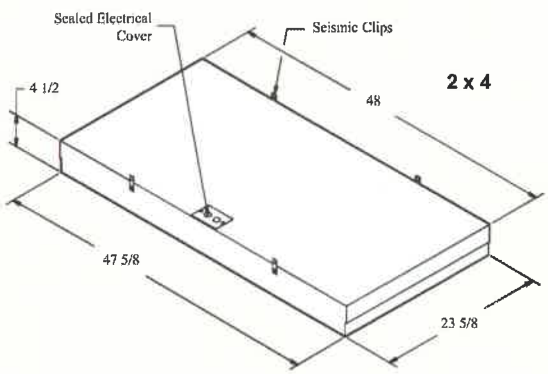
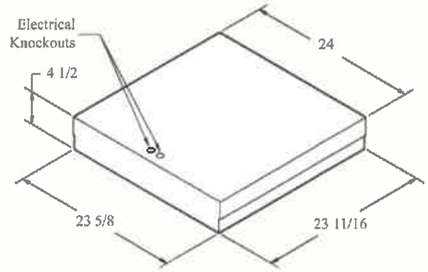
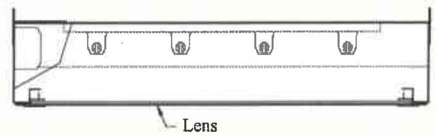



**2 x 4**



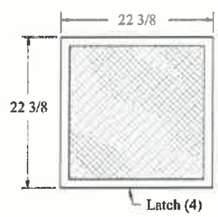

**2 x 2**

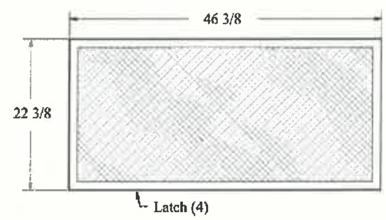



**End View**

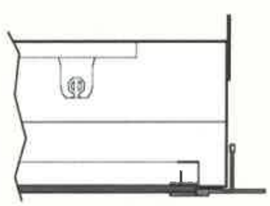
**(Shown with Panel Removed)**

**Door Frame and Lens**

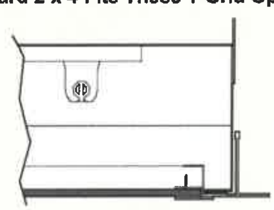


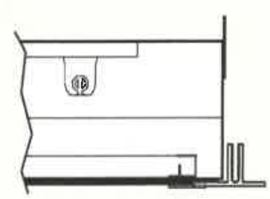

**Standard 2 x 4 Fits These T-Grid Openings**



1-1/2" Cleanroom Grid
24" x 48" o.c.



2" Non-Structural Grid
24" x 48" o.c.



2" Structural Grid
24-1/2" x 48-1/2" o.c.

**Consult with factory when using 2" HD Grid on 2'x 4' centers.**

## Ordering Information

| Part No. | Nominal Size | Voltage | Cycle | Lamp | Ballast | Amps | Watts | Weight |
|---|---|---|---|---|---|---|---|---|
| 148050 | 2 x 4 | 120V - 277V | 50/60 Hz | 4 Lamp | T8 Electronic | *1 | 32 / 128 | 35 lbs. (16 kg.) |
| 148053 | 2 x 2 | 120V - 277V | 50/60 Hz | 4 Lamp | T8 Electronic | *2 | 17 / 68 | 23 lbs. (11 kg.) |
| 148066 | 1 x 4 | 120V - 277V | 50/60 Hz | 2 Lamp | T8 Electronic | *3 | 32 / 64 | 25 lbs. (12 kg.) |
| 148513 | Door Frame and Lens | | | | | | | |
| 703902 | Optional 8' Power Cord 110V-120V Only | | | | | | | |
| 148075 | Emergency Battery Pack 120V | | | | | | | |
| 148084 | Emergency Battery Pack 277V (2 x 2 and 2 x 4 Only) | | | | | | | |
| 703754 | Ballast 120V-277V Multi-Voltage | | | | | | | |

*1. 120V = .93 amps, 277V = .40 amps
*2. 120V = .94 amps, 277V = .40 amps
*3. 120V = .50 amps, 277V = .21 amps



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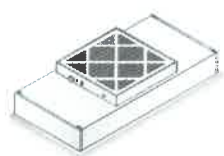
# Clean Rooms International

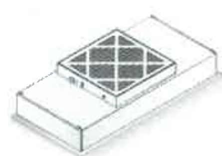
*Designing Flexible Solutions*

## *SAM*® Fan Filter Units

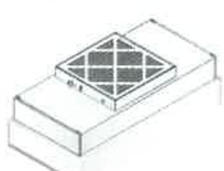
## Installation Operation and Maintenance Instructions



NCR Style



CRF or GS Style



CRF LI or GS LI

Stainless Steel

**READ AND SAVE THESE INSTRUCTIONS**

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**Ph:** 616-452-8700 • **Fx:** 616- 452-2372
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### Table Of Contents



Designers and Manufacturers of *Legend* Modular Hardwall Cleanrooms—*Flexible Solutions* Softwall Cleanrooms— Cleanroom T Grid Systems—Cleanroom Workstations—*SAM* Fan Filter Units and Industrial Air Cleaning Equipment

February 2011

## LIST OF MODELS

Key: MS = MicroSound, MW = MicroWatt, CRF = Ceiling Replaceable Filter, LW = Low Watt, P = Plastic Housing, LC = Low Cost, LI = Lights, GS = Gel Seal , HO = High Output

| MFG Code | Model No. & Description | UL Listed | Size | Volts | Watts | Hz | Motor FLA * | | Housing |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 280 | 310 | |
| *SAM* MicroSound Series | | | | | | | | | |
| 12100 | *SAM* 22 MS | Yes | 2' x 2' | 115V | 185 | 60 | | 1.7 | Metal |
| 12101 | *SAM* 22 MS | No | 2' x 2' | 208-230V | 170 | 50/60 | | 0.8-0.7 | Metal |
| 12102 | *SAM* 22 MS | Yes | 2' x 2' | 277V | 165 | 60 | | 0.6 | Metal |
| 12800 | *SAM* 22 MS GS | Yes | 2' x 2' | 115V | 185 | 60 | | 1.7 | Metal |
| 12801 | *SAM* 22 MS GS | No | 2' x 2' | 208-230V | 170 | 50/60 | | 0.8-0.7 | Metal |
| 12802 | *SAM* 22 MS GS | Yes | 2' x 2' | 277V | 165 | 60 | | 0.6 | Metal |
| 12261 | *SAM* 24 MS | Yes | 2' x 4' | 115V | 185 | 60 | | 1.7 | Metal |
| 12262 | *SAM* 24 MS | No | 2' x 4' | 208-230V | 170 | 50/60 | | 0.8-0.7 | Metal |
| 12263 | *SAM* 24 MS | Yes | 2' x 4' | 277V | 165 | 60 | | 0.6 | Metal |
| 12805 | *SAM* 24 MS GS | Yes | 2' x 4' | 115V | 185 | 60 | | 1.7 | Metal |
| 12806 | *SAM* 24 MS GS | No | 2' x 4' | 208-230V | 170 | 50/60 | | 0.8-0.7 | Metal |
| 12807 | *SAM* 24 MS GS | Yes | 2' x 4' | 277V | 165 | 60 | | 0.6 | Metal |
| *SAM* 24 MicroSound Undersize Units (23 1/8" x 47 1/8") | | | | | | | | | |
| 12240 | *SAM* 24 MS US | Yes | 2' x 4' | 115V | 185 | 60 | | 1.7 | Metal |
| 12241 | *SAM* 24 MS US | No | 2' x 4' | 208-230V | 170 | 50/60 | | 0.8-0.7 | Metal |
| 12242 | *SAM* 24 MS US | Yes | 2' x 4' | 277V | 165 | 60 | | 0.6 | Metal |
| 12243 | *SAM* 24 MS GS US | Yes | 2' x 4' | 115V | 185 | 60 | | 1.7 | Metal |
| 12244 | *SAM* 24 MS GS US | No | 2' x 4' | 208-230V | 170 | 50/60 | | 0.8-0.7 | Metal |
| 12245 | *SAM* 24 MS GS US | Yes | 2' x 4' | 277V | 165 | 60 | | 0.6 | Metal |
| SS *SAM* MicroSound Series with Stainless Steel Housings | | | | | | | | | |
| 12106 | *SAM* 22 MS SS | Yes | 2' x 2' | 115V | 185 | 60 | | 1.7 | Stainless Steel |
| 12108 | *SAM* 22 MS SS | No | 2' x 2' | 208-230V | 170 | 50/60 | | 0.8-0.7 | Stainless Steel |
| 12109 | *SAM* 22 MS SS | Yes | 2' x 2' | 277V | 165 | 60 | | 0.6 | Stainless Steel |
| 12110 | *SAM* 22 MS GS SS | Yes | 2' x 2' | 115V | 185 | 60 | | 1.7 | Stainless Steel |
| 12112 | *SAM* 22 MS GS SS | No | 2' x 2' | 208-230V | 170 | 50/60 | | 0.8-0.7 | Stainless Steel |
| 12113 | *SAM* 22 MS GS SS | Yes | 2' x 2' | 277V | 165 | 60 | | 0.6 | Stainless Steel |
| 12270 | *SAM* 24 MS SS | Yes | 2' x 4' | 115V | 185 | 60 | | 1.7 | Stainless Steel |
| 12271 | *SAM* 24 MS SS | No | 2' x 4' | 208-230V | 170 | 50/60 | | 0.8-0.7 | Stainless Steel |
| 12272 | *SAM* 24 MS SS | Yes | 2' x 4' | 277V | 165 | 60 | | 0.6 | Stainless Steel |
| 12273 | *SAM* 24 MS GS SS | Yes | 2' x 4' | 115V | 185 | 60 | | 1.7 | Stainless Steel |
| 12274 | *SAM* 24 MS GS SS | No | 2' x 4' | 208-230V | 170 | 50/60 | | 0.8-0.7 | Stainless Steel |
| 12275 | *SAM* 24 MS GS SS | Yes | 2' x 4' | 277V | 165 | 60 | | 0.6 | Stainless Steel |
| *SAM* MicroWatt Series | | | | | | | | | |
| 12103 | *SAM* 22 MW | Yes | 2' X 2' | 115V | 115 | 60 | 0.91 | | Metal |
| 12123 | *SAM* 22 MW GS | Yes | 2' x 2' | 115V | 115 | 60 | 0.91 | | Metal |
| 12250 | *SAM* 24 MW | Yes | 2' x 4' | 115V | 115 | 60 | 0.91 | | Metal |
| 12251 | *SAM* 24 MW | No | 2' x 4' | 208-230V | 170 | 50/60 | 0.50-0.46 | | Metal |
| 12252 | *SAM* 24 MW | Yes | 2' x 4' | 277V | 165 | 60 | 1.7 | | Metal |
| 12254 | *SAM* 24 MW GS | Yes | 2' x 4' | 115V | 115 | 60 | 0.91 | | Metal |
| 12255 | *SAM* 24 MW GS | No | 2' x 4' | 208-230V | 170 | 50/60 | 0.50-0.46 | | Metal |
| 12256 | *SAM* 24 MW GS | Yes | 2' x 4' | 277V | 165 | 60 | 1.7 | | Metal |

| MFG Code | Model No. & Description | UL Listed | Size | Volts | Watts | Hz | Motor FLA * | | Housing |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 280 | 310 | |
| *SAM* LC Series | | | | | | | | | |
| 12094 | *SAM* 22 | Yes | 2' x 2' | 115V | 185 | 60 | | 1.7 | Metal |
| 12095 | *SAM* 22 | No | 2' x 2' | 208-230V | 170 | 50/60 | | 0.8-0.7 | Metal |
| 12096 | *SAM* 22 | Yes | 2' x 2' | 277V | 165 | 60 | | 0.6 | Metal |
| 12097 | *SAM* 22 CRF | Yes | 2' x 2' | 115V | 185 | 60 | | 1.7 | Metal |
| 12098 | *SAM* 22 CRF | No | 2' x 2' | 208-230V | 170 | 50/60 | | 0.8-0.7 | Metal |
| 12099 | *SAM* 22 CRF | Yes | 2' x 2' | 277V | 165 | 60 | | 0.6 | Metal |
| 12310 | *SAM* 24 | Yes | 2' x 4' | 115V | 185 | 60 | | 1.7 | Metal |
| 12311 | *SAM* 24 | No | 2' x 4' | 208-230V | 170 | 50/60 | | 0.8-0.7 | Metal |
| 12312 | *SAM* 24 | Yes | 2' x 4' | 277V | 165 | 60 | | 0.6 | Metal |
| 12313 | *SAM* 24 CRF | Yes | 2' x 4' | 115V | 185 | 60 | | 1.7 | Metal |
| 12314 | *SAM* 24 CRF | No | 2' x 4' | 208-230V | 170 | 50/60 | | 0.8-0.7 | Metal |
| 12315 | *SAM* 24 CRF | Yes | 2' x 4' | 277V | 165 | 60 | | 0.6 | Metal |
| *SAM* 26 Series | | | | | | | | | |
| 12600 | *SAM* 26 | Yes | 2' x 6' | 115V | 370 | 60 | | 3.5 | Metal |
| 12601 | *SAM* 26 | No | 2' x 6' | 208-230V | 340 | 50/60 | | 0.8-0.7 | Metal |
| 12602 | *SAM* 26 | Yes | 2' x 6' | 277V | 330 | 60 | | 1.2 | Metal |
| 12603 | *SAM* 26 CRF | Yes | 2' x 6' | 115V | 370 | 60 | | 3.4 | Metal |
| 12604 | *SAM* 26 CRF | No | 2' x 6' | 208-230V | 340 | 50/60 | | 0.8-0.7 | Metal |
| 12605 | *SAM* 26 CRF | Yes | 2' x 6' | 277V | 330 | 60 | | 1.2 | Metal |
| *SAM* CRF/LI Series | | | | | | | | | |
| 12808 | *SAM* 22 CRF LI | No | 2' x 2' | 115V | 185 | 60 | | 2.2 | Metal |
| 12809 | *SAM* 22 CRF LI | No | 2' x 2' | 277V | 165 | 60 | | .8 | Metal |
| 12812 | *SAM* 24 CRF LI | No | 2' x 4' | 115V | 185 | 60 | | 2.7 | Metal |
| 12231 | *SAM* 24 CRF LI | No | 2' x 4' | 208-230V | 170 | 50/60 | | 1.4-1.2 | Metal |
| 12813 | *SAM* 24 CRF LI | No | 2' X 4' | 277V | 165 | 60 | | 1.1 | Metal |
| 12606 | *SAM* 26 CRF LI | No | 2' x 6' | 115V | 370 | 60 | | 5.0 | Metal |
| 12607 | *SAM* 26 CRF LI | No | 2' x 6' | 208-230V | 340 | 50/60 | | 2.7-2.4 | Metal |
| 12608 | *SAM* 26 CRF LI | No | 2' x 6' | 277V | 330 | 60 | | 1.8 | Metal |
| *SAM* HO Series | | | | | | | | | |
| 12500 | *SAM* 24 HO | No | 2' x 4' | 115V | 185 | 60 | | 1.7 | Metal |
| 12501 | *SAM* 24 HO | No | 2' x 4' | 208-230V | 170 | 50/60 | | .8-.7 | Metal |
| 12502 | *SAM* 24 HO | No | 2' x 4' | 277V | 165 | 60 | | .6 | Metal |
| 12503 | *SAM* 24 HO CRF | No | 2' x 4' | 115V | 185 | 60 | | 1.7 | Metal |
| 12504 | *SAM* 24 HO CRF | No | 2' X 4' | 208-230V | 170 | 50/60 | | .8-.7 | Metal |
| 12506 | *SAM* 26 HO CRF | No | 2' x 6' | 277V | 165 | 60 | | .6 | Metal |
| | | | | | | | | | |

* FLA includes ballast draw with standard lamps.
*SAM* 22 (4) F17T8
*SAM* 23 (4) F25T8
*SAM* 24 (4) F32T8
*SAM* 26 (2) F72T12 HO

Notes:
1. Running amps will be less on 50Hz.
2. Line voltage can affect actual start-up amperage.

## READ AND SAVE THESE INSTRUCTIONS

**WARNING-** TO REDUCE THE RISK OF FIRE, ELECTRICAL SHOCK, OR INJURY TO PERSONS, OBSERVE THE FOLLOWING:

Use this unit only in the manner intended by the manufacturer. If you have questions, contact the manufacturer.

Before servicing or cleaning unit, switch power off at service panel and lock the service disconnecting means to prevent power from being switched on accidentally. When the service disconnecting means cannot be locked, securely fasten a prominent warning device, such as a tag, to the service panel.

*SAM* Fan Filter Units are suitable for commercial and industrial use only. They are designed for suspended installation or installation in T-Grid Ceiling Systems for Vertical Flow.

*SAM* Fan Filter Units must never be exposed to rain, ice, snow, or excessive moisture. Do not use this product near water, i.e. near bathtubs, washbowls, whirlpools, etc. If the unit is equipped with a flexible power cord, do not handle with wet hands.

Do not place anything on top of the units. Do not restrict the flow of air into the unit.

## PRE-INSTALLATION INSTRUCTIONS

**WARNING-** TO REDUCE THE RISK OF FIRE, ELECTRICAL SHOCK, OR INJURY TO PERSONS, OBSERVE THE FOLLOWING:

Installation work and electrical wiring must be done by qualified person(s) in accordance with all applicable codes and standards, including fire-rated construction.

*SAM* Fan Filter Units operate on 115 Volts, 208-230 Volts, 277 Volts at 60 Hz., or 208-240 Volts, 50 Hz. Check the label on the front of the unit for voltage, current and frequency of operation. Verify the rating of the branch circuit protector and branch circuit wiring prior to installation and electrical connection to the unit.

Certain models are provided with an optional flexible power cord with plug. Do not use any type of adapter that will allow the unit to be plugged into an outlet that is not grounded.

Do not plug the unit into an outlet that is controlled by an on/off wall switch or by a facility house lighting control switch.

**CAUTION:** To Reduce the risk of injury to persons, install the unit at least 7 feet above grade or in ceiling.

## RECEIVING AND UNPACKING

All shipments are "FOB Ship Point". This means once goods are picked up and signed for by the driver, they are the responsibility of the freight company. When the shipment is delivered and signed for by your receiving personnel, the ownership and responsibility is transferred to the receiving company.

Clean Rooms International, Inc. inspects each product before packaging and does not ship damaged goods. Inspect the incoming shipment with the freight carrier driver present. Note any suspected damage on the receiving papers and immediately inspect the damaged carton(s). Note damages on the receiving documents and file a freight claim with the transportation company. Clean Rooms International does not take responsibility for damages caused by the freight company.

If damage is discovered after the carton is opened, it is the buyer's/receiver's responsibility to file a freight claim. Keep all incoming cartons and the product for inspection. Do not send back to Clean Rooms International.

## INSTALLATION INSTRUCTIONS

**CAUTION -** HEPA and ULPA filter media is fragile and can be damaged easily. Special precautions must be taken during un-packaging and installation of *SAM* Fan Filter Units. To avoid damage to the filter media, touch only the frame.
DO NOT PLACE HANDS OR ANY OTHER OBJECTS ON THE FILTER SURFACE.

**CAUTION:** Commercially available 1" or 1-1/2" T-Grid suspended ceiling systems are not designed to support the weight of any fan powered filter units. Clean Rooms International, Inc. 2" T-Grid systems for softwall and hardwall cleanrooms provide the support for direct mounting of *SAM* Fan Filter Units. If Clean Rooms International, Inc. or equivalent 2" T-Grid system **is not** installed, it is mandatory that *SAM* Fan Filter Units be suspended independently from these suspended ceilings.

**Mechanical Installation of Suspended Vertical Flow Units:** *SAM* Fan Filter Units are equipped with attachment points to make the installation hanging process easy. Units may be supported with flexible or rigid hangers. Use at least 12 gage hanging wire or the equivalent light chain or cable on each corner to support the unit.

**Mechanical Installation of Units in 2" T-Grid Systems:**

Install 2" T-Grid system in accordance with site plan and manufacturers instructions. Install seal gaskets (if provided) in pre-designated locations. Carefully place *SAM* Fan Filter Unit into the grid opening taking care to observe the precautions not to damage the filter media while handling the units.

**Electrical Installation:**

Refer to wiring schematics at the back pages of these instructions.

Provision of electrical branch circuit supply to the appropriate location within close proximity to the *SAM* Fan Filter Units is the responsibility of the customer's electrical installer. If local or national electrical codes or the customer's installation specifications require the provision of metal conduit directly to the unit it is recommended that a Listed flexible metal conduit be provided.

*SAM* Fan Filter Units may be supplied with optional flexible power cord with grounded plug, optional 2"x 4" or 4"x 4" Metallic wiring box with cover, with or without an on-off switch mounted in the wiring box or optionally within the prefilter frame housing. When an on-off switch is provided, field connections are to be made directly to the open supply terminals of the switch. When an on-off switch is not provided, field connections are to be made to the non-connected pigtail leads within the metallic wiring box or pre-filter frame.

**CAUTION:** When making field wiring connections within the Pre-Filter Frame, make sure that all field installed wiring is routed away from moving motor and fan parts and is secured in place to prevent inadvertent damage to wires.

**Start-up Check List—Before Applying Power:**

Check the voltage on the Manufacturer's Name Plate and verify that the power supplied to the unit is the same as that listed on the Name Plate. Remove the prefilter and determine if the fan is free to rotate and has not been misaligned during shipment or installation. Check nuts, bolts, screws and electrical connections for tightness.

**CAUTION:** If the unit is provided with a square perforated metal barrier over the opening to the prefilter frame, it must be re-installed prior to application of power and start-up of the Fan Filter Units.

Apply power and check that the wheel is rotating in the correct direction. Looking through the prefilter frame the fan must be rotating in a clockwise direction.

## OPERATING INSTRUCTIONS

**Principle of Operation:**

*SAM* Fan Filter Units are self-contained, low profile, electric powered, motor-fan driven HEPA or ULPA Filter, air filtering appliances. The units are heavy-duty units suitable for many industrial/commercial applications where clean air is needed. This is accomplished by maintaining a flow of filtered air to remove airborne particles within an enclosed room or chamber. Where manufacturing and assembly processes require Federal Standard 209 or ISO Classification clean rooms, multiple *SAM* Fan Filter units can provide a sufficient number of filtered air changes to maintain a positive pressure of clean air within the controlled environment.

Because of the unique variety of sizes and options offered, *SAM* units can be incorporated into many different areas such as Softwall Cleanrooms, new Hardwall Cleanroom designs, and facility upgrades over conveyors or free standing machinery. They may also be incorporated into custom workbench constructions providing concentrated filtered air to meet critical clean air process requirements.

**Method of Operation:**

Unfiltered air is drawn into the air inlet at the top of the unit through an optional 20x20 Pre-Filter. This air is pulled through the motor/blower assembly into a plenum designed to evenly distribute air over and through the entire receiving surface of the HEPA Filter. Thus, *SAM* Fan Filter Units efficiently and quietly deliver the desired volume of cleaned air to the controlled environment. The volume of air delivered can be adjusted by means of a factory installed variable motor speed controller mounted within the unit.

# *SAM* Maintenance

## Preventive Maintenance

It is the intention of Clean Rooms International, Inc. to deliver a safe and reliable product that will give years of trouble-free service.

To ensure optimum, safe performance and maximum product life a preventative maintenance program must be established.

1. Inspect prefilter and HEPA or ULPA filter after the first three (3) months of operation. Based on the findings, schedule periodic inspections and maintenance for changing prefilter and the HEPA or ULPA Filter.
2. (Fig. 1) Prefilters should be changed at least every six (6) months.
3. Cleaning fan wheel is required to insure smooth quiet operation. Periodic cleaning of all fan equipment is strongly recommended because dirt accumulation on the impeller can cause vibration which greatly increases stress and load on motor bearings.

All services to be performed by a qualified technician.

Order replacement filters and parts from your local CRI distributor or contact CRI Customer Service at (616) 452-8700.

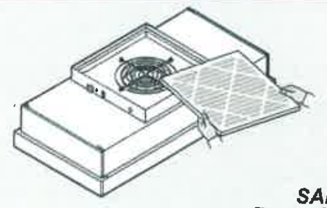


Fig. 1 **_SAM_ Unit Removing Prefilter**

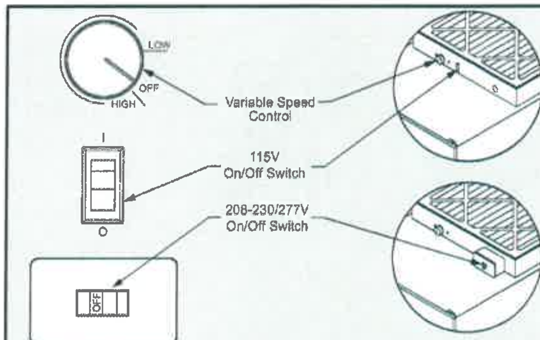



Fig. 2 **Switching _SAM_ Unit Off**

## Servicing *SAM* Units

**WARNING** - REDUCE THE RISK OF FIRE, ELECTRICAL SHOCK, OR INJURY BY OBSERVING THE FOLLOWING:

1. (Fig. 2) Turn the Safety Switch and Variable Speed Control on each unit to the off position.
2. (Fig. 3) To prevent power from being switched on accidentally before servicing, switch power off at service panel and lock the service disconnecting means.
3. If the service disconnecting means cannot be locked, REFER TO YOUR COMPANY OSHA MANDATED LOCK-OUT/TAG-OUT PROCEDURES.
4. (Fig. 4) For units with an optional power cord, unplug unit and tie cord out of reach of receptacle.

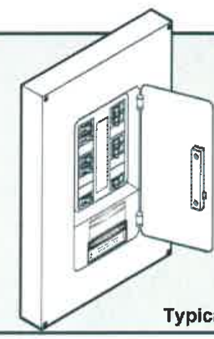


Fig. 3 **Typical Service Panel**

## When to Change the HEPA or ULPA Filter

Static pressure can be measured with a Magnehelic gage or manometer.

It is time to change the HEPA or ULPA filter when the pressure drop across the filter reaches two (2) times the original resistance.

Tools Required for NCR Style:
1. Power driver, 1/4" socket bit. Or,
2. Standard slotted screw driver.

Tools Required for CRF, CRF LI, GS and GS LI Style:
1. Standard phillips head screw driver.
2. 5/32" allen wrench.
3. (2) persons, if installing from roomside. To hold the filter in place and to position the filter clamps correctly.
4. (1) person, if installing on a bench with housing upside down.

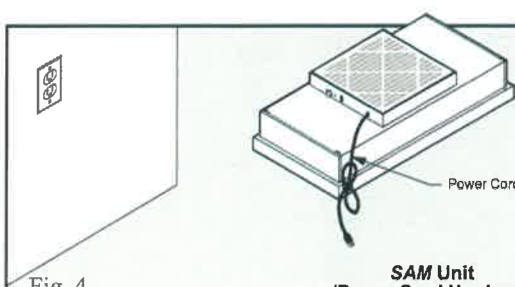



Fig. 4 **_SAM_ Unit w/Power Cord Unplugged**

## NCR Style units with HEPA or ULPA Filter (are not replaceable from roomside)

### How to Change the HEPA or ULPA Filter

**CAUTION:** Do not touch either side of the HEPA or ULPA filter surface while installing or removing the filter.

1. Remove *SAM* Unit from ceiling, and place on solid surface.
2. (Fig. 5) Using a power driver and 1/4" socket bit or, phillips head screwdriver, remove twelve Self-Piercing Screws(A) located on plenum flange.
3. Separate plenum hood assembly from filter.
4. Clean plenum flange surface.
5. Place plenum hood assembly on top of replacement filter.

   Note: Gasketed surface of filter should mate with plenum.
6. Install all Self-Piercing Screws.
7. Replace *SAM* unit back into ceiling.

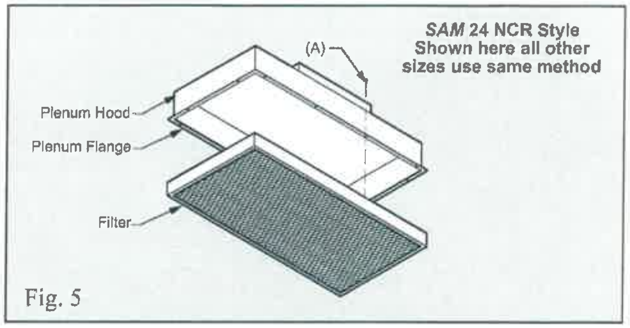


Fig. 5

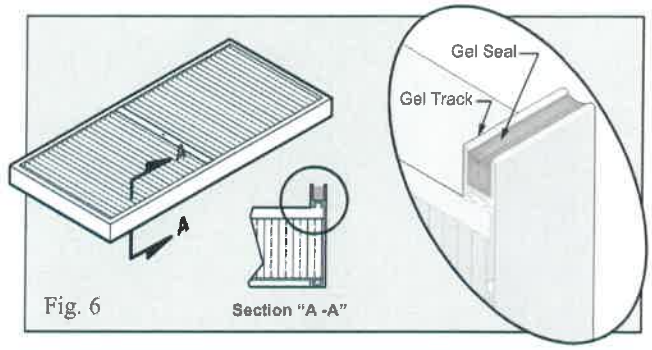


Fig. 6

## CRF, CRF LI, GS and GS LI Style units with HEPA or ULPA Filter (are replaceable from roomside)

### How to Change the HEPA or ULPA Filter

Note: For the purposes of this manual it is understood that changing/installation (for CRF, CRF LI, GS and GS LI styles) is being performed from roomside.

**CAUTION:** Do not touch either side of the HEPA or ULPA filter surface while installing or removing the filter. For Gel Seal units, do not touch gel. Do not allow gel to collect dirt or dust. Inspect gel track on filters to:

1. (Fig. 6) Insure adequate gel depth, (within 1/16" from top of gel track).
2. Check for consistency and color for uniformity.

Removal of unit from ceiling grid is not required.

1. (Fig. 7 and Fig. 8) Using a standard phillips head screw driver, remove (2) Phillips screws (B) from the grille assembly, lower grille. Proceed to Step 3 for CRF or GS series units without lights.

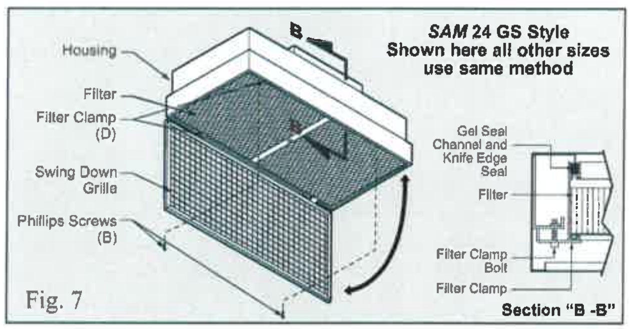


Fig. 7

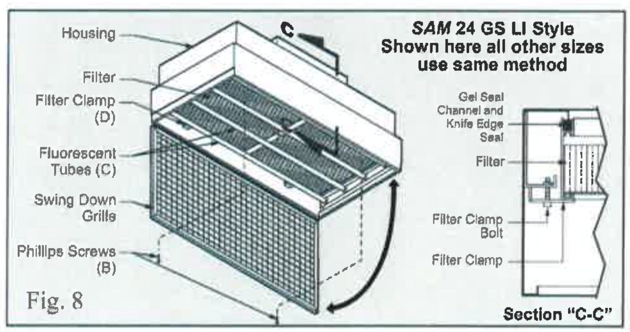


Fig. 8

2. (Fig. 9) To remove fluorescent tubes (C) from the housing:
   - Carefully grasp one of the fluorescent tubes with both hands.
   - Rotate the fluorescent tube 1/4 turn in either direction until the pins line up with the slot in the lamp holder.
   - Then gently pull down on one end. The other end will pull out easily once this is done.
   - Repeat this procedure for all remaining fluorescent tubes.

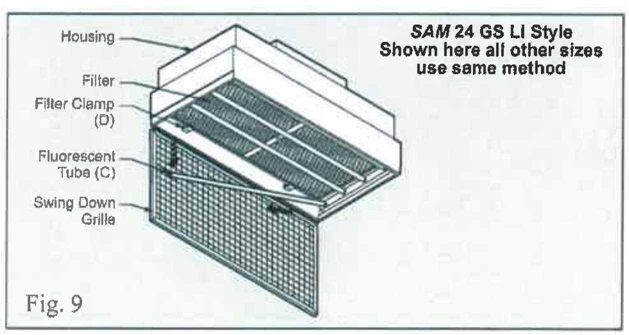


Fig. 9

3. (Fig. 10) With a 5/32" allen wrench, remove the (4) filter clamp bolts and (4) filter clamps (D) from housing.

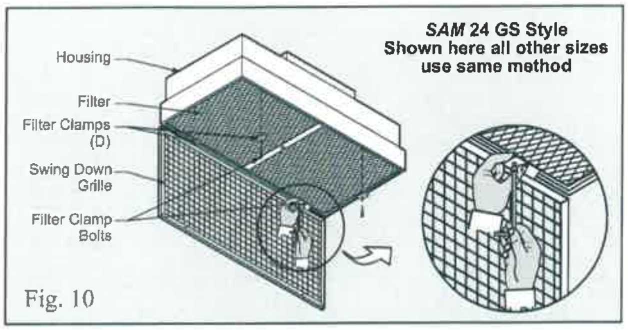


Fig. 10

4. (Fig. 11) Pull down on the HEPA or ULPA filter to break the seal, then lower the filter straight down through the housing. Discard the filter.

   Note: (Fig. 12) For CRF units insure that the knife edge is free of any and all debris. Paying special attention to the (4) corners of the unit, as these are the areas that would be most susceptible to debris/glue fragments, after removal of the filter.

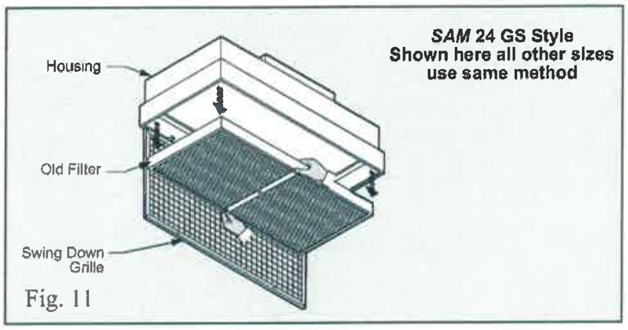


Fig. 11

5. (Fig. 12) With the assistance of another person, center the new HEPA or ULPA filter in the housing with equal clearance on all four sides between the filter and the housing guides. Then carefully install the new filter into the housing.

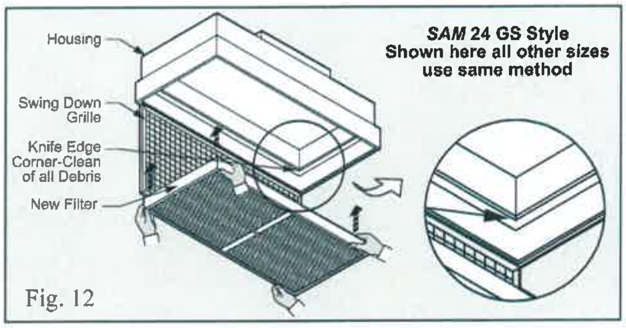


Fig. 12

6. (Fig. 13) With the assistance of another person (to hold the new filter in place), replace the (4) filter clamps and the (4) filter clamp bolts. Using a 5/32" allen wrench hand tighten firmly. Proceed to Step 8 for CRF or GS series units without lights.

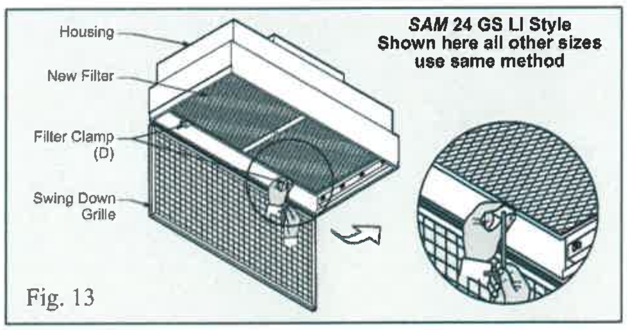


Fig. 13

7. (Fig. 14) To replace fluorescent tubes (C) in the in the CRF LI or GS LI housing:
   - Carefully grasp one of the fluorescent tubes with both hands.
   - Gently insert one end of the fluorescent tube into the lamp holder.
   - Then align the pins on the other end, with the slot in the lamp holder.
   - Gently insert into the lamp holder. Rotate the fluorescent tube 1/4 turn in either direction until the pins are firmly locked in place.
   - Repeat this procedure for all remaining fluorescent tubes.

8. (Fig. 14) Replace the grille assembly and fasten with the remaining (2) Phillips screws (B).

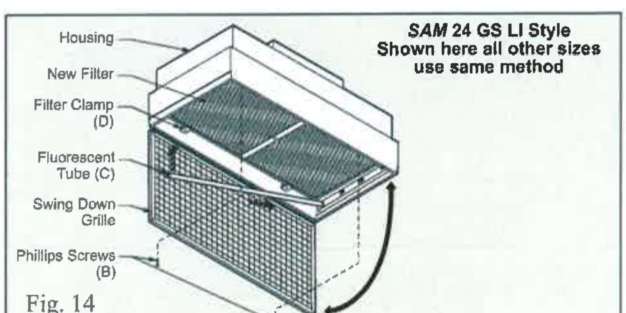


Fig. 14

## Gel Seal Filters:

9. Refer to the following pages for more information.

## Gel Filter Replacement

Polyurethane and Silicone Gel are often used in systems where HEPA filters are installed into grids or housing and where ease of installation and removal of the filter is desirable.

Both Silicone and Polyurethane base Gel offer properties that are suitable for a wide variety of HEPA filter sealing applications. These applications consist of two mating structures
One side of the seal consists of a channel or track containing the gel. The other side of the seal consists of a "knife edge" which penetrates into the gel. Modern systems often feature a knife edge on the housing or grid and the gel is in a track integral to the filter, but the reverse construction is also common and just as effective.

Gel can become damaged from a variety of factors including age, exposure to chemicals, cutting and abrasion due to over-stressing the gel (sharp knife edges, excessive penetration, shearing, etc.) and tearing due to too rapid removal of the knife edge from the gel.

In situations where a filter is removed from the system and re-installed, the question often arises, "Is the condition of the gel satisfactory for reinstallation of the filter, or does the gel need to be replaced?"

Due to the nature of gel and the wide variety of circumstances that can exist in actual installations, no "hard and fast" criteria exist.

It is the purpose of this guideline to discuss various possible conditions of the gel and to assist the end user in making rational decisions of when to replace the gel.

For the purpose of this guideline, gel damage may be divided into two categories; chemical damage and physical damage.

### Chemical Damage to Gel

Chemical damage to gel may be due to the presence of external or internal substances or conditions that result in a chemical change to the gel. These include:

1. Reversion (degradation) of the gel into liquid state.

2. Chemical attach (usually by oxidizing agents like those used for sanitizing clean rooms.) This usually results in a loss of surface tack the formation of a skin or blisters on the surface of the gel.
3. Ultra Violet degradation which usually results in surface crazing, cracking, skinning and may also result in liquefication of the gel.
4. Thermal degradation, which usually results in a loss in elasticity, surface tack and increase in hardness of the gel.

Chemical damage can be separated into two groups; mild and severe.

Mild chemical attack results in slight changes in the physical characteristics of the gel.
These include:

1. Change or loss in color that does not have measurable effects on gel hardness or elasticity.
2. Formation of a slight skin, noticeable only when the gel is "pinched" between the fingers.
3. Some loss of surface tack.

Sever chemical attack results major and significant changes in the physical characteristics of the gel.
These include:

1. Significant change in hardness or elasticity.

2. Complete loss of surface tack.

3. Formation of thick Skin.

4. Formation of wet areas on or in the gel. Dripping of the gel.

Filters may be re-installed into gel showing mild chemical attack. Reinstalled filters will likely continue to seal and perform without any problem. In any case a scan test to verify and confirm the integrity of the filter and seal system upon re-installation of the filter is necessary and should always be performed. If the filter is found to be leaking at the gel seal during the test, the filter should be removed and the gel should be replaced prior to reinstallation and testing.

Gel exhibiting severe chemical attack must be completely removed and replaced prior to reinstallation of the filter and subsequent scan testing for filter and seal integrity.

### Physical Damage to Gel

Physical damage to gel is the most common type of gel damage experienced and is the result of subjecting the gel to forces that result in stress greater than the strength of the gel. Physical damage to the gel can range from very mild to severe. Most often, physical damage to the gel is caused by too rapid removal of an object inserted into the gel. The most common causes of physical damage are:

1. Too rapid removal of the knife edge from the gel. The knife edge must be removed slowly, working from one corner and slowly removing the filter allowing the gel to peel off of the knife edge at its own rate.

2. Too deeply inserting the knife edge into the gel. If the knife edge is allowed to penetrate too deeply, the force exerted on the gel will be sufficient to cut the gel or split the gel. We recommend that the knife edge clearance to the bottom of the gel channel be not less than 0.10 inches (2.4 mm). We recommend that the maximum penetration of the knife edge into the gel be not greater than a depth equal to 70% the inside width of the gel channel.

3. Abrasion of the gel surface by dragging the knife edge or other object, including fingers across the surface of the gel.

4. Cutting the gel by using a knife edge that is too sharp at the corners or at the tip.

5. Careless removal of the plastic bag from the filter during unpacking can cause the gel to adhere to the bag.
If the bag adheres to the gel during shipping, the bag can be slowly peeled out of the gel. Slight surface disruption to the gel due to the plastic bag are insignificant.

Physical damage to the gel can be divided into two groups; mild and severe.

1. Mild physical damage in most cases will not interfere with the proper sealing of the knife edge to the gel since the surface disruption of the gel is less than the penetration distance of the knife edge. Mild damage includes small ripples, lines or rough spots that leave a pattern in the gel but do not penetrate into the gel by more than 0.25 inches (6mm). Please refer to figure 15 and 16 for examples of mild physical damage to gel. Figure 15 is of nearly new condition gel with the knife edge removed once. Figure 16 is of gel experiencing multiple but careful knife edge removal and re-installation.
2. Severe physical damage results in a good probability that the proper sealing of the knife edge to the gel will be compromised since the damage may extend under a fully seated knife edge. Severe includes large deep cuts, splits or craters in the gel surface that penetrate the gel by more than 0.25 inches (6mm). Please refer to figures 17 and 18 for examples of severe physical damage to gel. Figure 17 is of gel that was cut too sharp knife edge and one that was also inserted too deeply. Figure 18 is of gel that was subject to too rapid removal of the knife edge numerous times.

Filters may be re-installed into gel showing mild physical damage. Reinstalled filters will likely continue to seal and perform without any problem. In any case, a scan test to verify and confirm the integrity of the filter and seal system upon re-installation of the filter is necessary and should always be performed.


*Origination Credit to Camfil Farr © 2005 Camfil Farr*

If the filter is found to be leaking at the gel seal during the test, the filter should be removed and the gel should be replaced prior to re-installation and testing.
Gel exhibiting severe physical damage must be completely removed and replaced prior to reinstallation of the filter and subsequent scan testing for filter and seal integrity.

In all cases where gel is to be repaired it must be completely removed from the gel channel and the channel must be completely cleaned so that residual gel is removed. Open joints in the channel must be re-sealed to prevent gel from leaking out.
Gel must be mixed well and on ratio according to manufacturers instructions and adequate time must be allowed for the gel to fully cure before re-installation of filters. In no case is it permissible to "touch-up" the gel by pouring new gel over defects in old gel. This practice is to be avoided because the new gel will not adhere to the old gel and problems will be encountered when the filters are installed or when they are removed in the future.

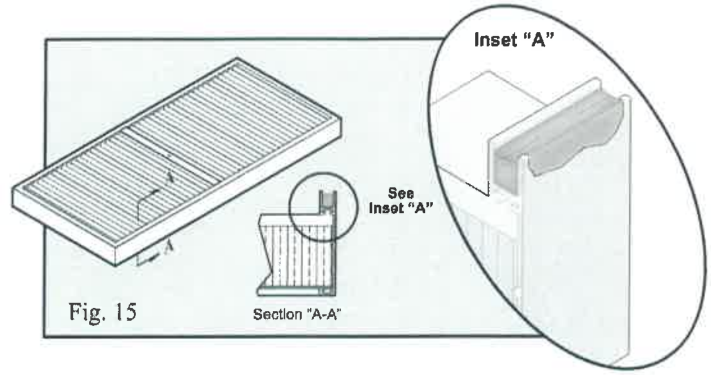


Fig. 15

(Fig. 15) Nearly new condition gel with the knife edge removed once.

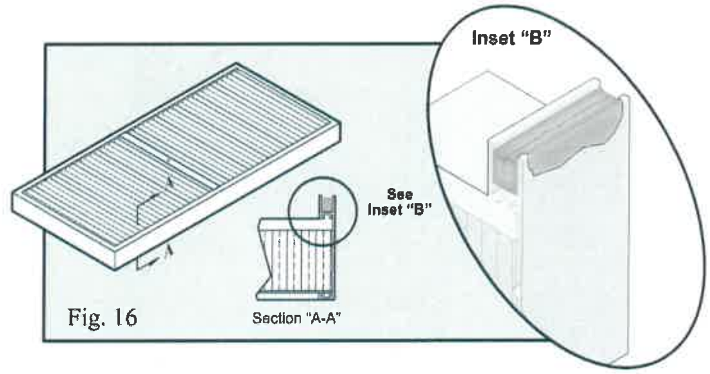


Fig. 16

(Fig. 16) Gel experiencing multiple but careful knife edge removal and re-installation

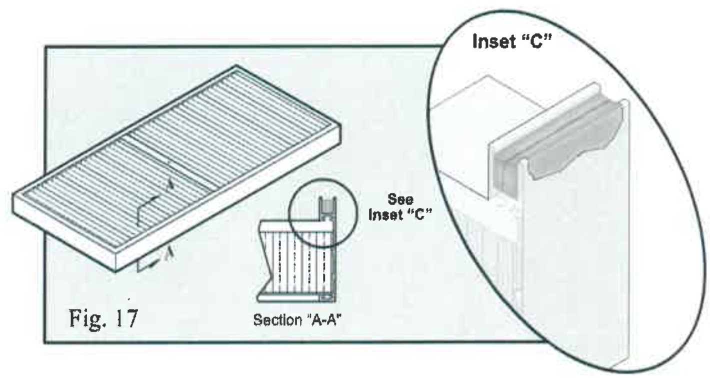


Fig. 17

(Fig. 17) Gel that was cut by a too sharp knife edge and one that was also inserted too deeply.

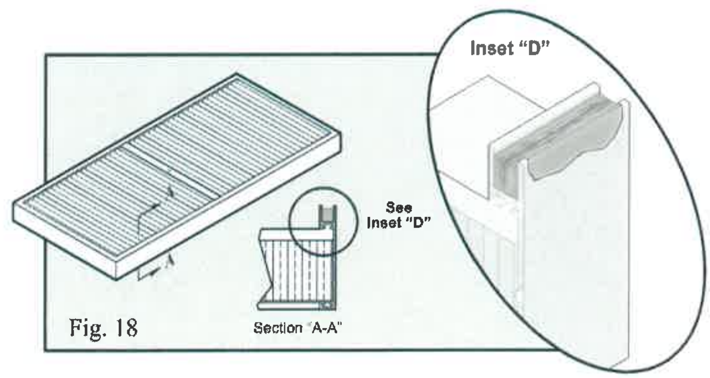
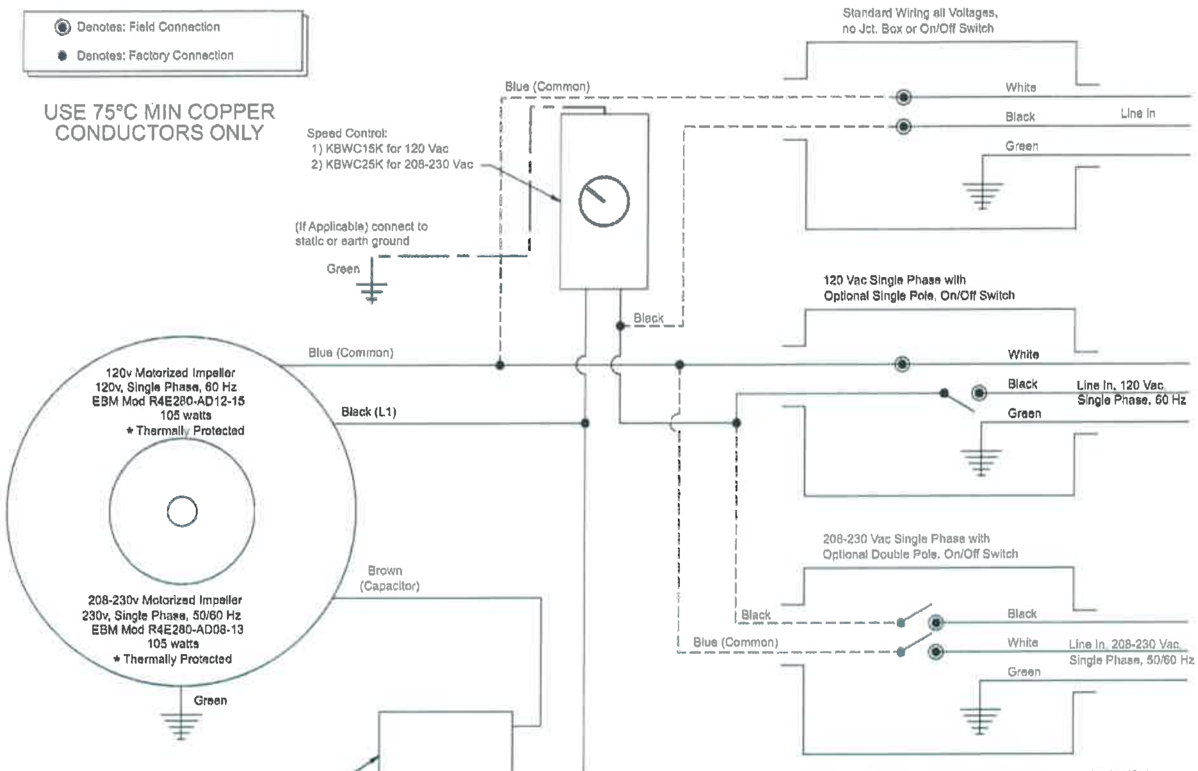


Fig. 18

(Fig. 18) Gel that was subject to too rapid removal of the knife edge numerous times.

## WIRING DIAGRAM FOR ALL *SAM* MICROWATT MODELS WITH 280 LW or MW MOTORS and 2-WIRE SPEED CONTROLS

See following pages for *SAM* Models with 310 Motors

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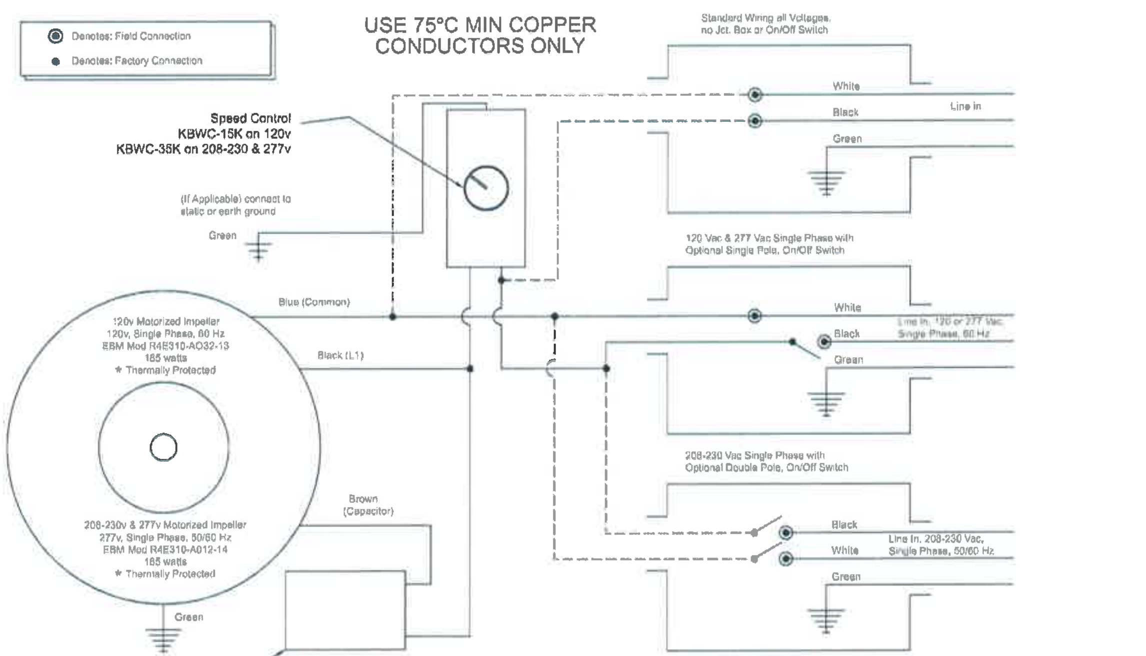
DRAWING No.
1450-6

## WIRING DIAGRAM FOR ALL *SAM* LC MODELS and *SAM* Models with 208-230 VOLT and 277 VOLT N310 MOTORS and 2- WIRE SPEED CONTROLS

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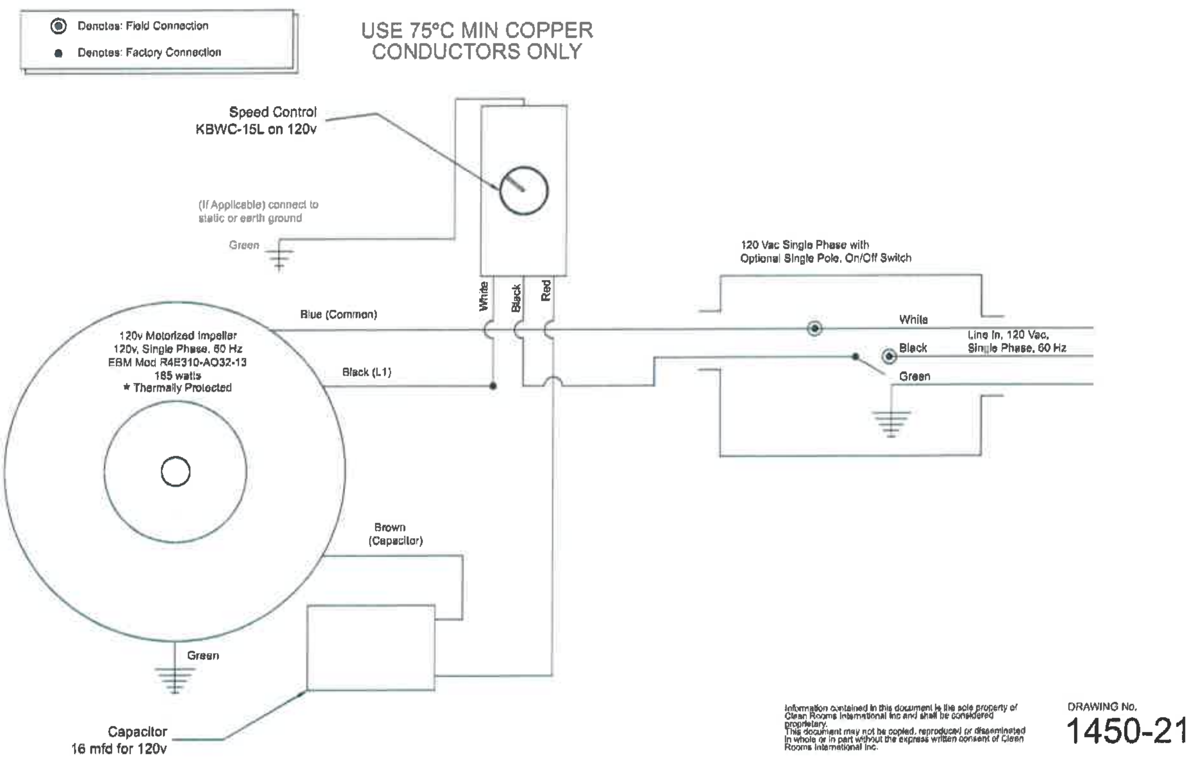
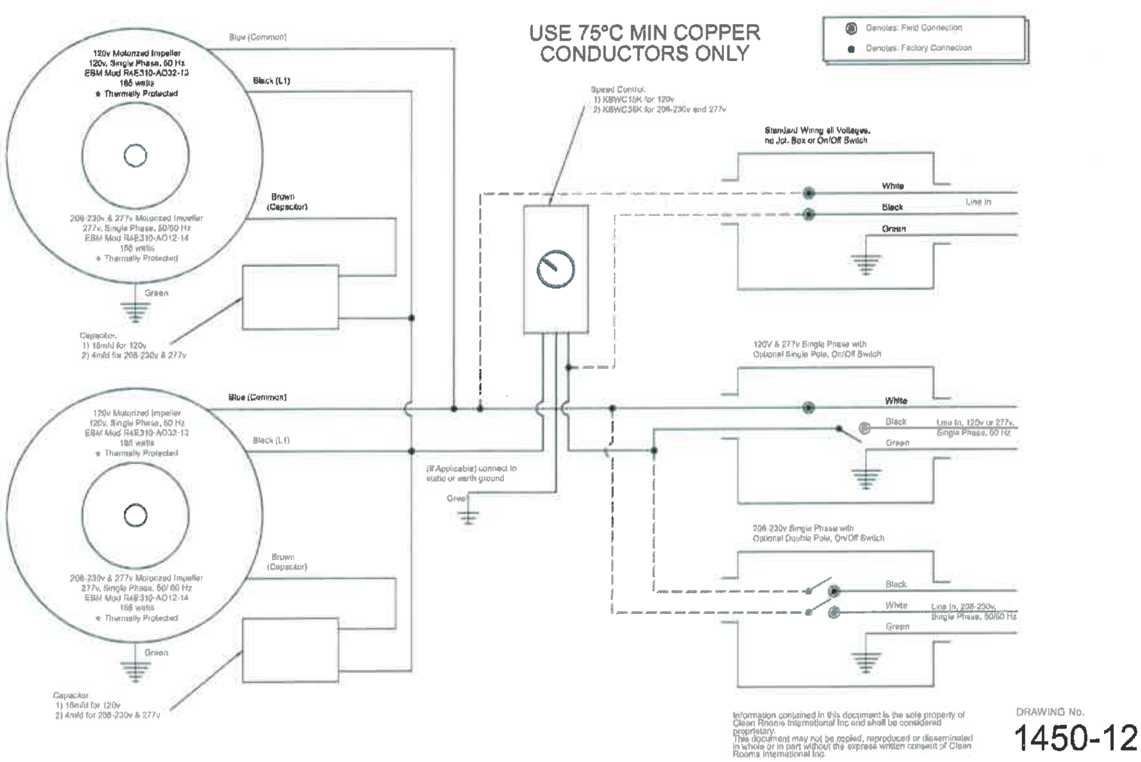
DRAWING No.
1450-11

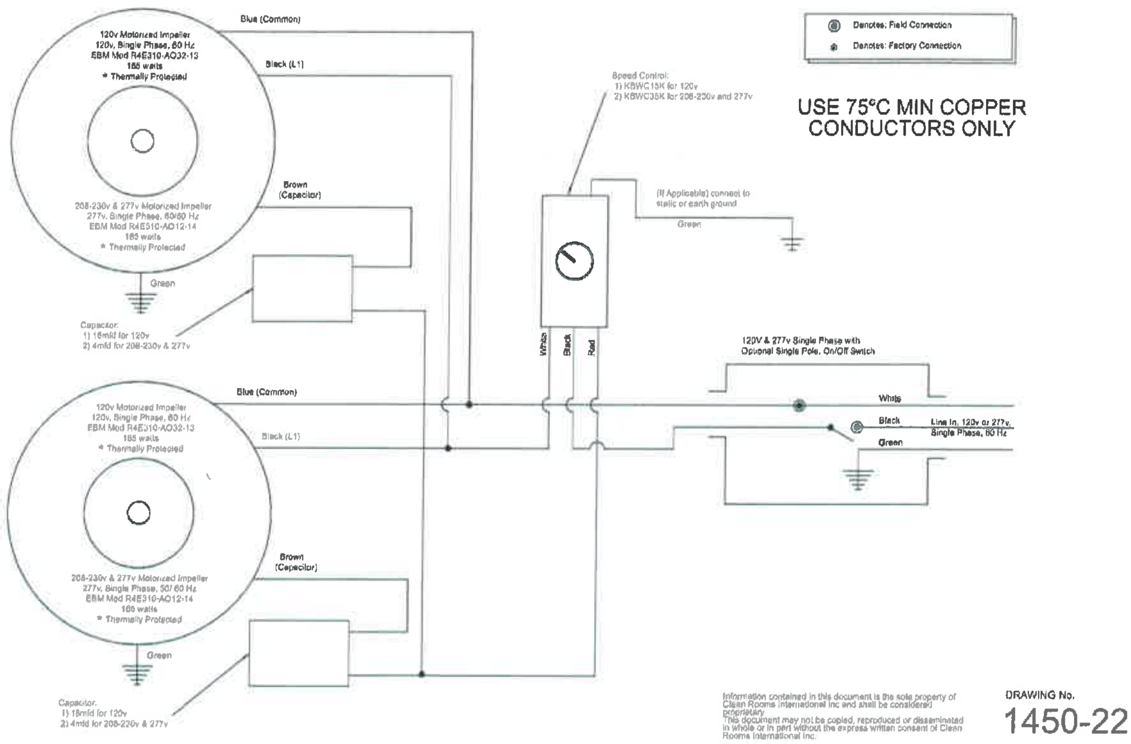
**WIRING DIAGRAM FOR ALL *SAM* MICROSOUND MODELS with 115 VOLT N310 MOTOR and 3- WIRE SPEED CONTROLS**




**WIRING DIAGRAM FOR ALL *SAM* 26 MODELS with (2) N310 MOTORS and 2- WIRE SPEED CONTROLS**



**WIRING DIAGRAM FOR ALL *SAM* 26 MODELS with (2) N310 MOTORS and 3- WIRE SPEED CONTROLS**




## Troubleshooting Guide

**Problem:** Blower does not run:

**Possible Solution :**

1. Make sure the unit is properly connected to the power source.
2. Make sure switch is in the On position.
3. Make sure the speed control is in an On position.
4. Verify power to the outlet.
5. Check capacitor for loose connection.

**Problem :** Blower is running but no or very little air flow:

**Possible Solution:**

1. Make sure the blower is running clockwise as viewed thru the prefilter frame and blower opening.
2. Prefilter is dirty and should be replaced.
3. HEPA filter is dirty and should be replaced.

## Clean Rooms International Product Warranty

The manufacturer warrants this equipment to be free from defects in material and workmanship for a period of one (1) year from date of purchase.

No other warranty is herein expressed and none shall be implied.

If failure appears within one (1) year from date of purchase, the buyer must notify the Company immediately. Documentary proof of length of service (which shall include date of purchase) must be furnished to Company if the date of manufacture was more than one (1) year prior to the date of alleged failure. Defective product may be delivered freight prepaid to the nearest Company authorized location. Company shall, at its option, correct the defect, or supply a replacement.

The liability of Company shall not in any case exceed either the cost of correcting defects in the product or supplying a replacement for that, whichever shall be less, and upon the expiration of one (1) year from date of purchase of product by customer all such liability shall terminate.

Company is not responsible for damage to product due to abuse, improper installation, use other than for which originally sold, or through operation above rated load, either intentionally or otherwise of any product or party. Under no circumstances will manufacturer be responsible for any freight (in or out), installation, or removal costs.

The foregoing warranty is in lieu of all other warranties, express or implied, with respect to the product, including any implied or statutory warranty of merchantability or fitness for purpose. Company shall not be liable by virtue of this warranty, or otherwise, for any consequential, incidental or special loss or damage resulting from the use or loss of use of the product.

## CRI JOB NUMBER: 22206 - Vernick & Assoc.

| * SAM FFU Serial # | filter part # | filter serial # | filter style: | filter type: | size: |
|---|---|---|---|---|---|
| UL 77523 | 302090 / CF-855027341 | E998614_334 | NCR | HEPA | 2x4 |
| UL 77524 | 302090 / CF-855027341 | E998614_352 | NCR | HEPA | 2x4 |
| UL 77525 | 302090 / CF-855027341 | E998614_305 | NCR | HEPA | 2x4 |
| UL 77526 | 302090 / CF-855027341 | E998614_359 | NCR | HEPA | 2x4 |
| UL 77527 | 302090 / CF-855027341 | E998614_338 | NCR | HEPA | 2x4 |
| | | | | | |
| UL 77528 | 302090 / CF-855027341 | E998613_026 | NCR | HEPA | 2x4 |
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* For record keeping purposes, Customer may use this form to manually record SAM Fan Filter Unit Serial # to corresponding Filter Serial #.

## CRI JOB NUMBER: 22312 - Vernick LLC

| * SAM FFU Serial # | filter part # | filter serial # | filter style: | filter type: | size: |
|---|---|---|---|---|---|
| | 302090 / CF-855027341 | F031795_004 | NCR | HEPA | 2x4 |
| | | | | | |
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## *STRUCTURAL CALCULATIONS FOR:*

## *X-SPINE*
## *PF 29-53646*

PORTAFAB
Modular Building Systems

| | |
|---|---|
| Project Location: | Miamisburg, OH |
| Building Code: | 2012 IBC |
| Seismic Parameters: | Fa = 1.6, Fv = 2.4, Ss = 0.148, S1 = 0.073 |
| Stud Type: | Ominflex 300+ |

Unit Geometry:

Overall Width: $B_o := 30 \cdot ft + 4.5 \cdot in$

Overall Length: $L_O := 28 \cdot ft + 5.75 \cdot in$

$L_o := 20 \cdot ft + 4.5 \cdot in$

Story Heights: $h_o := 10 \cdot ft + 0 \cdot in$

Dust Cover Gravity Loads:

$DL := 5 \cdot psf$

$LL := 10 \cdot psf$

$WT_{panels} := 5 \cdot psf$

STATE OF OHIO
DANIEL W. McGINNIS
E-67996
REGISTERED PROFESSIONAL ENGINEER
6/5/2015

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## *DUST COVER DESIGN*

(Ref: SDI Design Specification and Deck Manufacturers Catalog)

DUST COVER PROPERTIES: Dust Cover is: Deck := "1.5B22" Deck Span: $L_{deck} := 145 \cdot in$

Section Modulus: $S_p := 0.186 \cdot in^3$ Yield Stress: $F_{y\_deck} := 33 \cdot ksi$

Moment of Inertia: $I_{deck} := 0.169 \cdot in^4$ Modulus of Elasticity: $E_{deck} := 29 \cdot 10^6 \cdot psi$

DESIGN:

Uniform Load on Deck: $w_{TL} := (DL + LL) \cdot 1 \cdot ft$ $w_{TL} = 15 \frac{lb}{ft}$

Number of Supports Deck Spans, n: (use either 1, 2 or 3) $n := 1$

Maximum Moment: $M := (if(n = 3, 0.10, .125)) \cdot w_{TL} \cdot L_{deck}^2$ $M = 274 \cdot lb \cdot ft$

Flexural Stress: $f_b := \frac{M}{S_p}$ $f_b = 17.66 \cdot ksi$

Allowable Flexural Stress: $F_{b\_deck} := 0.60 \cdot F_{y\_deck}$ $F_{b\_deck} = 19.8 \cdot ksi$

Since $F_{b\_deck}$ = 19.8 ksi >= $f_b$ = 17.7 ksi **OK**

Deflection: $$\Delta_{LL} := \frac{if\left(n = 1, \frac{5}{384}, if(n = 2, 0.011, if(n = 3, 0.0059, 0))\right) \cdot LL \cdot 1 \cdot ft \cdot L_{deck}^4}{E_{deck} \cdot I_{deck}}$$ $\Delta_{LL} = 0.979 \cdot in$

Since L / $\Delta_{LL}$ = 148 >= 120 **OK**

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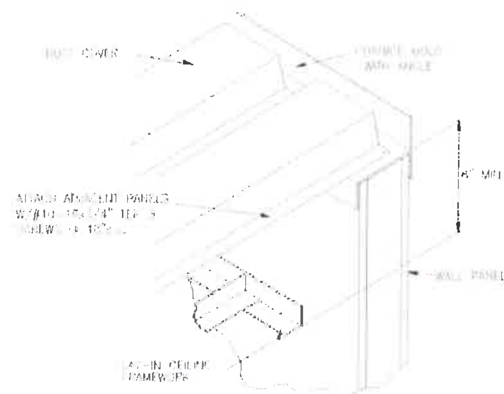
## *CONSIDER CORNICE MOLD*

Tributary width: $b_{cm} := 145 \cdot in \cdot 0.5$ $b_{cm} = 6.04\,ft$




Uniform load on cornice mold $w_{cm}$:

$w_{cm} := (DL + LL) \cdot b_{cm}$ $w_{cm} = 90.62\,\dfrac{lb}{ft}$

Consider cornice mold as 3 span uniformly loaded member:

Cornice mold span: $span_{cm} := 48 \cdot in$

Reaction: $R_{cm} := 1.1 \cdot span_{cm} \cdot w_{cm}$ $R_{cm} = 399\,lb$

Moment: $M_{cm} := 0.1 \cdot span_{cm}^{\,2} \cdot w_{cm}$ $M_{cm} = 145\,ft \cdot lb$

Cornice mold section modulus: $S_{cm} := 0.28 \cdot in^3$

Flexural Stress: $f_b := \dfrac{M_{cm}}{S_{cm}}$ $f_b = 6.21 \cdot ksi$

| Since | $F_{b\_allow}$ = | 9.5 | ksi | >= | $f_b$ = | 6.2 | ksi | OK |
|---|---|---|---|---|---|---|---|---|

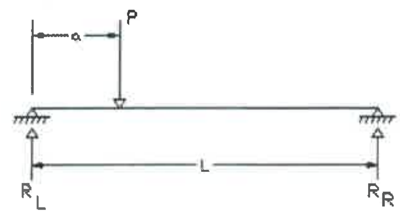
## *Beam 1*

Member := "W8x10" Material: mat := A992 Span: L := 218·in L = 18.17·ft Unbraced Length: $L_b$ := 54·in

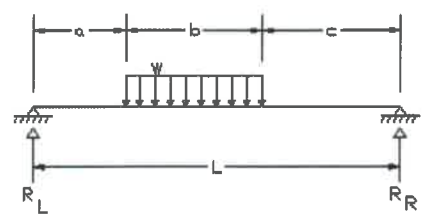
| Selected Member Properties | | | | | | | |
|---|---|---|---|---|---|---|---|
| Shape | Area ($in^2$) | $S_x$ ($in^3$) | $Z_x$ ($in^3$) | $I_x$ ($in^4$) | $b_f$ (in) | $F_y$ (ksi) | E (ksi) |
| W8x10 | 2.96 | 7.81 | 8.87 | 30.8 | 3.94 | 50 | 29000 |

| Load Factors | |
|---|---|
| DL | LL |
| 1.2 | 1.6 |

| Concentrated Load Data | | | | |
|---|---|---|---|---|
| Number | DL (kips) | LL (kips) | a dist. (ft) | Description |
| P1 | 0.00 | 0.00 | 0.00 | |
| P2 | 0.00 | 0.00 | 0.00 | |
| P3 | 0.00 | 0.00 | 0.00 | |
| P4 | 0.00 | 0.00 | 0.00 | |
| P5 | 0.00 | 0.00 | 0.00 | |




| Uniform Load Data | | | | | | |
|---|---|---|---|---|---|---|
| Number | DL (kip/ft) | LL (kip/ft) | a dist. (ft) | c dist. (ft) | trib. wt. (ft) | Description |
| Self Wt. | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | Beam Dead Load |
| w1 | 0.05 | 0.10 | 0.00 | 0.00 | 10.13 | Dust Cover Load |
| w2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| w3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| w4 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| w5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |




| Reactions | | | | |
|---|---|---|---|---|
| | DL (kips) | LL (kips) | TL (kips) | Factored (kips) |
| Left End | 0.55 | 0.92 | 1.47 | 2.13 |
| Right End | 0.55 | 0.92 | 1.47 | 2.13 |

| Shears, Moments, & Deflections | | |
|---|---|---|
| Max. Factored Shear, Vu (kips) | 2.13 | |
| Design Shear, φVn (kips) | 30.41 | OK |
| Max. Fact. Moment, Mu (kip*ft) | 9.68 | |
| Design Moment, φMn (kip*ft) | 30.19 | OK |
| Max. Dead Load Deflection (in) | 0.166 | L / 1311 |
| Max. Live Load Deflection (in) | 0.278 | L / 785 |
| Max. Total Load Deflection (in) | 0.444 | L / 491 |
| Use: | **W8x10** | |

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***Wall Studs***

Stud Type: Ominflex 300+

(See stud calculations at end)

Height of Studs: $h := h_d$ $k := 1.0$ $kL := k \cdot h$ $kL = 10\,ft$

Maximum Reaction: $R_{stud} := R_{Beam_1}$ $R_{stud} = 1.47 \cdot kip$

**Allowable axial load for** $kL = 10\,ft$ **and 5psf lateral load** $P_a = 4.3 \cdot kip$ **>** $R_{stud} = 1.47 \cdot kip$ **OK**

## *Lateral Load Analysis*

### *Seismic Loads*

Overstrength factor: $\Omega_s := 2.5$

Determine Structural Dead Load: Ws

| | | | |
|---|---|---|---|
| Deck Dead Load: Plan Area: | | $A_{plan} := 720 \cdot ft^2$ | $A_{plan} = 720 \cdot ft^2$ |
| Deck DL: | | $W_1 := DL \cdot A_{plan}$ | $W_1 = 3600\ lb$ |
| Wall Dead Load: Uniform weight of walls: | | $WT_{walls} := 4 \cdot psf$ | |
| Length of walls: | | $L_{walls} := 2 \cdot B_o + 2 \cdot L_O$ | $L_{walls} = 117.71 \cdot ft$ |
| Wall Dead Load: | | $W_2 := WT_{walls} \cdot L_{walls} \cdot h_o \cdot 0.5$ | $W_2 = 2354\ lb$ |

Total Structural Dead Load: $W_s$ $\quad W_s := W_1 + W_2 \quad W_s = 5.95 \cdot kip$

Use equivalent lateral force procedure for design base shear

$S_{MS} := F_{a\_eq} \cdot S_s \quad S_{MS} = 0.24 \quad S_{M1} := F_{v\_eq} \cdot S_1 \quad S_{M1} = 0.18$

$S_{DS} := 0.67 \cdot S_{MS} \quad S_{DS} = 0.16 \quad S_{D1} := 0.67 \cdot S_{M1} \quad S_{D1} = 0.12$

$R_s := 2 \quad I_E := 1.0 \quad C_t := 0.020 \quad h_n := h_o \cdot ft^{-1} \quad h_n = 10 \quad T := C_t \cdot h_n^{0.75} \quad T = 0.11$

$$C_{s\_1} := \frac{S_{DS}}{\left(\frac{R_s}{I_E}\right)} \qquad C_{s\_2} := \frac{S_{D1}}{\left(\frac{R_s}{I_E}\right) \cdot T} \qquad C_{s\_3} := \frac{0.5 \cdot S_1}{\frac{R_s}{I_E}}$$

$C_{s\_1} = 0.079$

$C_{s\_2} = 0.522$

$C_{s\_3} = 0.018$

$$C_s := \max\left[\left[\begin{matrix} \min\left(\left(\begin{matrix} C_{s\_1} \\ C_{s\_2} \end{matrix}\right)\right) \\ C_{s\_3} \end{matrix}\right]\right] \qquad C_s = 0.079 \qquad V := \frac{C_s \cdot W_s \cdot \Omega_s}{1.4} \qquad V = 0.84 \cdot kip$$

## *Internal Wind Pressures and Loads*

Using a 5 psf lateral internal wind pressure: $V_{wind} := 5 \cdot psf \cdot \frac{h_o}{2} \cdot B_o \quad V_{wind} = 0.76 \cdot kip$

Seismic governs lateral design

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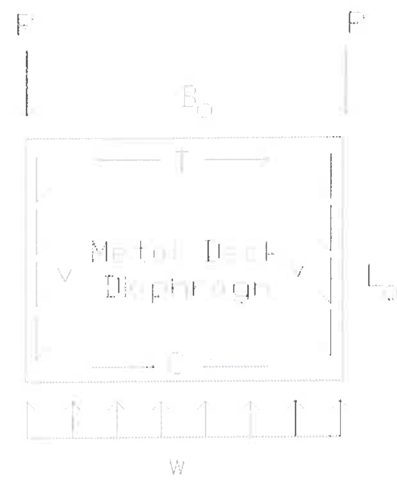
## DUST COVER DIAPHRAGM




Diaphragm Width: $B_o := B_o$

Diaphragm Length: $L_o := L_o$

Equivalent lateral load: $w := \frac{V}{B_o}$ $\quad w = 27.8 \cdot \frac{lb}{ft}$

Strut Reactions: $R := \frac{w \cdot B_o}{2}$ $\quad R = 422\ lb$

Maximum Shear in diaphragm: $v_{max} := \frac{R}{L_o}$ $\quad v_{max} = 21 \frac{lb}{ft}$

Maximum moment in diaphragm: $M_{max} := \frac{w \cdot B_o^2}{8}$ $\quad M_{max} = 3202\ ft \cdot lb$

Chord Forces (T = C): $T_{chord} := \frac{M_{max}}{L_o}$ $\quad T_{chord} = 157\ lb$

### Diaphragm and Fasteners Design Strength:

Roof deck: Deck := "1.5B22 Deck"

Fastener layout: Layout := "36/4"

Support fasteners: $Fasteners_{support}$ := "#12 TEK Screws"

Sidelap fasteners: $Fasteners_{sidelap}$ := "#10 TEK Screws"

Number of sidelap fasteners per span: $n_{sidelap} := 1$

Deck span: deck_span := 8·ft

For 1.5B22 Deck w/ 8 ft. span & #12 TEK Screws support fasteners w/ 36/4 pattern & 1 - #10 TEK Screws sidelap fastener/span:

$v_{allow} := 100 \cdot \frac{lb}{ft}$

| Since | $v_{allow}$ = | 100 | lb/ft | >= | $v_{max}$ = | 21 | lb/ft | OK |
|---|---|---|---|---|---|---|---|---|

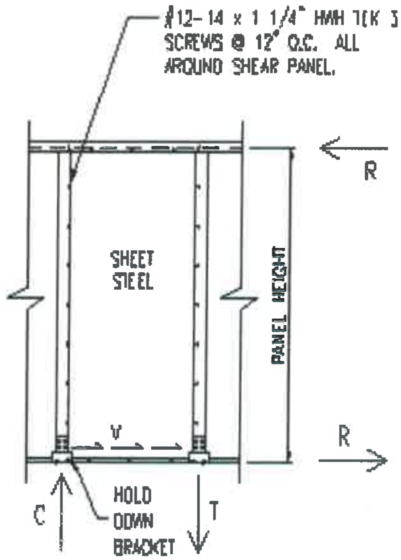
### Diaphragm deflection:

$K_1 := 0.306 \quad K_2 := 870 \quad DB := 2209$

$$G' := \frac{K_2}{3.78 + \frac{0.3 \cdot DB}{deck\_span \cdot ft^{-1}} + 3 \cdot K_1 \cdot deck\_span \cdot ft^{-1}} \cdot \frac{kip}{in} \qquad G' = 9.26 \cdot \frac{kip}{in}$$

$$\Delta_{diaphragm} := \frac{w \cdot B_o^2}{8 \cdot L_o \cdot G'} \qquad \Delta_{diaphragm} = 0.017 \cdot in$$

## *SHEAR PANEL DESIGN*




TYPICAL SOLID SHEAR PANEL

Shear Panel Analysis

Sheet steel conforms to ASTM A653 CS Type B $F_y := 30 \cdot ksi$ $F_u := 55 \cdot ksi$

Screws are #12-14 x 1-1/4" HWH TEK 3

Determine allowable shear load based on the following criteria:

(Reference: AISI Specification for the Design of Cold-Formed Steel Structural Members)

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## Section E4.3.1 Connection Shear

$t_1$ = Thickness of the member in contact with the screw head

$t_2$ = Thickness of the member in not in contact with the screw head

$F_{u1}$ = Tensile strength of member in contact with the screw head

$F_{u2}$ = Tensile strength of member in not in contact with the screw head

$P_{ns}$ = Nominal shear strength per screw

$\Omega$ = Factor of Safety ASD $\quad \Omega := 2.5$

$t_1 := 0.0359 \cdot in$ (Omniflex studs - 20 Ga. Steel) $\quad F_{u1} := F_u \quad F_{u1} = 55 \cdot ksi$

$t_2 := 0.0359 \cdot in$ (Shear panel sheet steel - 20 Ga.) $\quad F_{u2} := F_u \quad F_{u2} = 55 \cdot ksi$

Screw Number Designation: $\quad Screw\_Size := 12$

Nominal screw diameter $\quad d_{screw} = 0.216 \cdot in$

$$\frac{t_2}{t_1} = 1$$

$$P_{ns} := \min\begin{bmatrix} 4.2 \cdot \left(t_2^{\,3} \cdot d_{screw}\right)^{.5} \cdot F_{u2} \\ 2.7 \cdot t_1 \cdot d_{screw} \cdot F_{u1} \\ 2.7 \cdot t_2 \cdot d_{screw} \cdot F_{u2} \end{bmatrix} \qquad P_{ns} = 730\ lb$$

Reference equations E4.3.1-1 thru E4.3.1-3

Allowable shear per screw: $\quad P_a := \frac{P_{ns}}{\Omega} \qquad P_a = 292\ lb$

Screws are spaced at 12" c/c along the perimeter of the steel panels, therefore the maximum allowable shear per foot is equal to the allowable shear per screw.

$$v_{allow} := P_a \qquad v_{allow} = 292\ lb$$

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Consider individual shear panels

Total shear in side of wall: R: $R = 0.42 \cdot kip$ (See Diaphragm Reactions)

Number of shear panels in wall: n: $n := 1$

Width at base of shear panel: b $b := 48 \cdot in$

Panel Height: h $h_o = 10\,ft$

Shear at top per panel: V $V := \frac{R}{n}$ $V = 0.42 \cdot kip$

Shear per foot of panel: v $v := \frac{V}{b}$ $v = 105 \frac{lb}{ft}$

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Since | $v_{allow}$ = | 292.1 | lb/ft | >= | v = | 105.4 | lb/ft | **OK** |

USE 1 SHEAR PANELS PER WALL

SHEAR PANEL ANCHORAGE

Uplift force: T $T := \frac{V \cdot h_o}{b \cdot n}$ $T = 1054\,lb$

See calculations at end of set for anchorage design using Hilti KB TZ

SHEAR PANEL HOLD DOWN STRAP

For 1 - #12 screw in 20 gage sheet metal:

$V_{allow} := 292 \cdot lb$

Number of screws required: $N_{screw}$:

$N_{screw} := \frac{T}{V_{allow}}$ $N_{screw} = 3.61$

**USE** $N_{screw} = 4$ **#12-14 x 1 1/4" HWH TEK 3 SCREWS MINIMUM**

Collector Splice:

$T_{cs} := T_{chord}$ $T_{cs} = 157 \cdot lb$

Number of screws required: $N_{screw} := \frac{T_{cs}}{V_{allow}}$ $N_{screw} = 0.54$

Use 2 - #12 TEK screws

## *Anchorage to Concrete Slab - Tension Capacity*

Reference: ACI 318-05 Appendix D & ESR 1917

Maximum factored tension at anchor location: $N_{u\_max} := T \cdot 1.4 \cdot \frac{R_s}{1.5}$ $N_{u\_max} = 2 \cdot kip$

Anchor type: $Type := 2$

For Cast in Place Anchors - Use Type 1
For Post Installed Anchors - Use Type 2

Cracked Region: Crack := "YES"

Group or single bolt action: Action := "Group"

Number of anchors: $n := 2$

Concrete compressive strength: $f'_c := 3000 \cdot psi$

Minimum specified tensile strength: $f_{uta} := 106 \cdot ksi$

Anchor diameter: $d_{anchor} := 0.5 \cdot in$

Area of anchor: $A_{se} := 0.101 \cdot in^2$

Anchor embedment depth: $h_{ef} := 3.5 \cdot in$

Minimum edge distance (c1): $c_{a1} := 24 \cdot in$

Anchor spacing: $s_1 := 4.5 \cdot in$

Reduction factor: $\phi_{ts} := 0.75$ $\phi_{tc} := 0.70$

Steel Strength of anchor in tension (Section D.5.1):

$N_S := n \cdot A_{se} \cdot f_{uta}$ $N_S = 21.41 \cdot kip$

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1110 Westmark Drive
St. Louis, Missouri 63131
(314) 835-1224 Fax: (314) 984-0561



Concrete Breakout Strength of Anchor in Tension (Section D.5.2):

For a single anchor:

$A_{Nco} := 9 \cdot h_{ef}^2$ $\quad A_{Nco} = 110 \cdot in^2$

$A_{Nc} := \min\left[\begin{bmatrix} (c_{a1} + 1.5 \cdot h_{ef}) \cdot (2 \cdot 1.5 \cdot h_{ef}) \\ A_{Nco} \end{bmatrix}\right]$ $\quad A_{Nc} = 110 \cdot in^2$

$\Psi_{edN} := \text{if}\left(c_{a1} \geq 1.5 \cdot h_{ef}, 1, 0.7 + 0.3 \cdot \dfrac{c_{a1}}{1.5 \cdot h_{ef}}\right)$ $\quad \Psi_{edN} = 1$

$\Psi_{cN} := \text{if}(Type = 1, 1.25, \text{if}(Type = 2, 1.4, 0))$

$\Psi_{cN} := \text{if}(Crack = \text{"NO"}, \Psi_{cN}, 1.0)$ $\quad \Psi_{cN} = 1$

$k_{anchor} := \text{if}(Type = 1, 24, \text{if}(Type = 2, 17, 0))$

$N_b := k_{anchor} \cdot \sqrt{\dfrac{f'_c}{psi}} \cdot \left(\dfrac{h_{ef}}{in}\right)^{1.5} \cdot lb$ $\quad N_b = 6.1 \cdot kip$

$N_{cb} := \dfrac{A_{Nc}}{A_{Nco}} \cdot \Psi_{edN} \cdot \Psi_{cN} \cdot N_b$ $\quad N_{cb} = 6.1 \cdot kip$

For a group of anchors: $\quad e'_N := 0 \cdot in$

$\Psi_{ecN} := \min\left(\begin{pmatrix} 1 \\ \dfrac{1}{1 + \dfrac{2 \cdot e'_N}{3 \cdot h_{ef}}} \end{pmatrix}\right)$ $\quad \Psi_{ecN} = 1$

$A_{Nc} := \min\left[\begin{bmatrix} (c_{a1} + 1.5 \cdot h_{ef}) \cdot (2 \cdot 1.5 \cdot h_{ef} + s_1) \\ n \cdot A_{Nco} \end{bmatrix}\right]$ $\quad A_{Nc} = 220.5 \cdot in^2$

$N_{cbg} := \dfrac{A_{Nc}}{A_{Nco}} \cdot \Psi_{ecN} \cdot \Psi_{edN} \cdot \Psi_{cN} \cdot N_b$ $\quad N_{cbg} = 12.19 \cdot kip$

Governing Tension Design Strength:

$$\phi N_n := \begin{pmatrix} N_S \cdot n \cdot \phi_{ts} \\ \text{if}(\text{Action} = \text{"Group"}, N_{cbg}, N_{cb}) \cdot \phi_{tc} \end{pmatrix} \qquad \phi N_n = \begin{pmatrix} 32.12 \\ 8.54 \end{pmatrix} \cdot \text{kip}$$

$$\phi N_n := \min(\phi N_n) \qquad \phi N_n = 8.54 \cdot \text{kip}$$

| Since | $\varphi N_n$ = | 8.5 | kip | >= | $N_{u\_max}$ | 2.0 | kip | OK |
|---|---|---|---|---|---|---|---|---|

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(314) 835-1224 Fax: (314) 984-0561



## *Anchorage to Concrete Slab - Shear Capacity*

Reference: ACI 318-05 Appendix D

Maximum factored shear at anchor location: $V_{u\_max} := V \cdot 1.4 \cdot \frac{R_s}{1.5}$ $V_{u\_max} = 0.8 \cdot kip$

Anchor type: $Type := 2$

For Cast in Place Anchors - Use Type 1
For Post Installed Anchors - Use Type 2

Cracked Region: $Crack := \text{"YES"}$

Group or single bolt action: $Action := \text{"Group"}$

Number of anchors: $n := 2$

Concrete compressive strength: $f'_c := 3000 \cdot psi$

Minimum specified tensile strength: $f_{uta} := 106 \cdot ksi$

Anchor diameter: $d_{anchor} := 0.5 \cdot in$

Area of headed stud: $A_{se} := 0.101 \cdot in^2$

Anchor embedment depth: $h_{ef} := 3.5 \cdot in$

Minimum edge distance (ca1) & (ca2): $c_{a1} := 24 \cdot in$ $c_{a2} := 24 \cdot in$

Anchor spacing: $s_1 := 4.5 \cdot in$

Reduction factor: $\phi_{vs} := 0.65$ $\phi_{vc} := 0.60$

Steel Strength of anchor in shear (Section D.6.1):

$V_S := A_{se} \cdot f_{uta}$ $V_S = 10.71 \cdot kip$

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Concrete Breakout Strength of Anchor in Shear (Section D.6.2):

For a single anchor:

$$A_{Vco} := 4.5 \cdot c_{a1}^2 \qquad A_{Vco} = 2592 \cdot in^2$$

$$A_{Vc} := \min\left[\begin{bmatrix} \left[2 \cdot (1.5 \cdot c_{a1}) + s_1\right] \cdot 1.5 \cdot c_{a1} \\ A_{Vco} \end{bmatrix}\right] \qquad A_{Vc} = 2592 \cdot in^2$$

$$V_b := \text{if}(\text{Type} = 1, 8, 7) \cdot \left(\frac{h_{ef}}{d_{anchor}}\right)^{0.2} \cdot \sqrt{\frac{d_{anchor}}{in}} \cdot \sqrt{\frac{f'_c}{psi}} \cdot \left(\frac{c_{a1}}{in}\right)^{1.5} \cdot lb \qquad V_b = 47.04 \cdot kip$$

$$\Psi_{edV} := \text{if}\left(c_{a2} \geq 1.5 \cdot c_{a1}, 1, 0.7 + 0.3 \cdot \frac{c_{a2}}{1.5 \cdot c_{a1}}\right) \qquad \Psi_{edV} = 0.9$$

$$\Psi_{cV} := \text{if}(\text{Crack} = \text{"NO"}, 1.4, 1.0) \qquad \Psi_{cV} = 1$$

$$V_{cb} := \frac{A_{Vc}}{A_{Vco}} \cdot \Psi_{edV} \cdot \Psi_{cV} \cdot V_b \qquad V_{cb} = 42.34 \cdot kip$$

For a group of anchors:

$$e'_V := 0 \cdot in$$

$$\Psi_{ecV} := \min\left(\begin{pmatrix} 1 \\ \dfrac{1}{1 + \dfrac{2 \cdot e'_V}{3 \cdot c_{a1}}} \end{pmatrix}\right) \qquad \Psi_{ecV} = 1$$

$$A_{Vc} := \min\left[\begin{bmatrix} (2 \cdot 1.5 \cdot c_{a1} + s_1) \cdot 1.5 \cdot c_{a1} \\ n \cdot A_{Vco} \end{bmatrix}\right] \qquad A_{Vc} = 2754 \cdot in^2$$

$$V_{cbg} := \frac{A_{Vc}}{A_{Vco}} \cdot \Psi_{ecV} \cdot \Psi_{edV} \cdot \Psi_{cV} \cdot V_b \qquad V_{cbg} = 44.98 \cdot kip$$

Governing Shear Design Strength:

$$\phi V_n := \begin{pmatrix} n \cdot V_S \cdot \phi_{vs} \\ \text{if}(\text{Action} = \text{"Group"}, V_{cbg}, V_{cb}) \cdot \phi_{vc} \end{pmatrix} \qquad \phi V_n = \begin{pmatrix} 13.92 \\ 26.99 \end{pmatrix} \cdot \text{kip}$$

$$\phi V_n := \min(\phi V_n) \qquad \phi V_n = 13.92 \cdot \text{kip}$$

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Since | $\varphi V_n$ = | 13.9 | kip | >= | $V_{u\_max}$ | 0.8 | kip | **OK** |

Interaction equation: (Per ACI 318 Section D.7)

$$\left(\frac{N_{u\_max}}{0.75 \cdot \phi N_n}\right) + \left(\frac{V_{u\_max}}{0.75 \cdot \phi V_n}\right) = 0.38$$

< 1.2 OK

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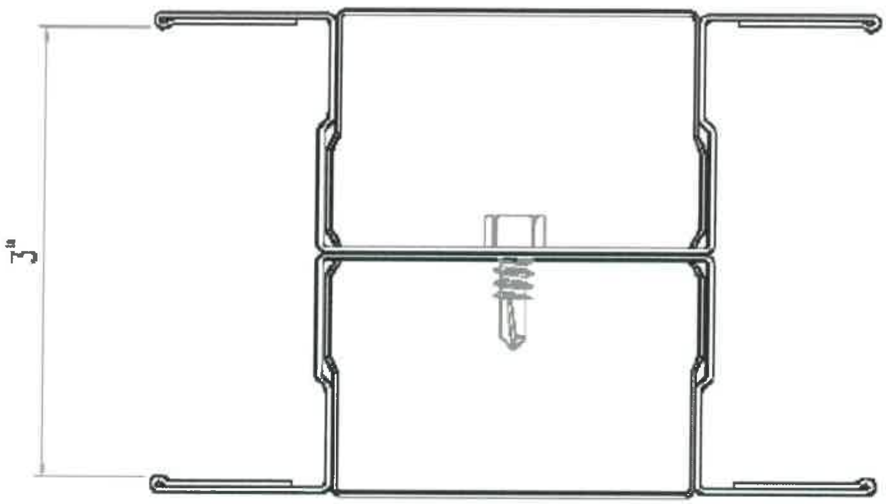
PORTAFAB
Modular Building Systems




OmniFlex 300+
20ga roll-formed steel

| Stud Height (feet) | Maximum allowable axial load (lbs) | Maximum allowable axial load (lbs) with tube insert |
|---|---|---|
| 8 | 5,700 | 6,100 |
| 9 | 5,000 | 6,100 |
| 10 | 4,300 | 6,100 |
| 11 | 3,500 | 5,000 |
| 12 | 3,100 | 4,070 |
| 13 | 2,500 | 3,300 |
| 14 | 2,000 | 2,660 |
| 16 | 1,300 | 1,800 |

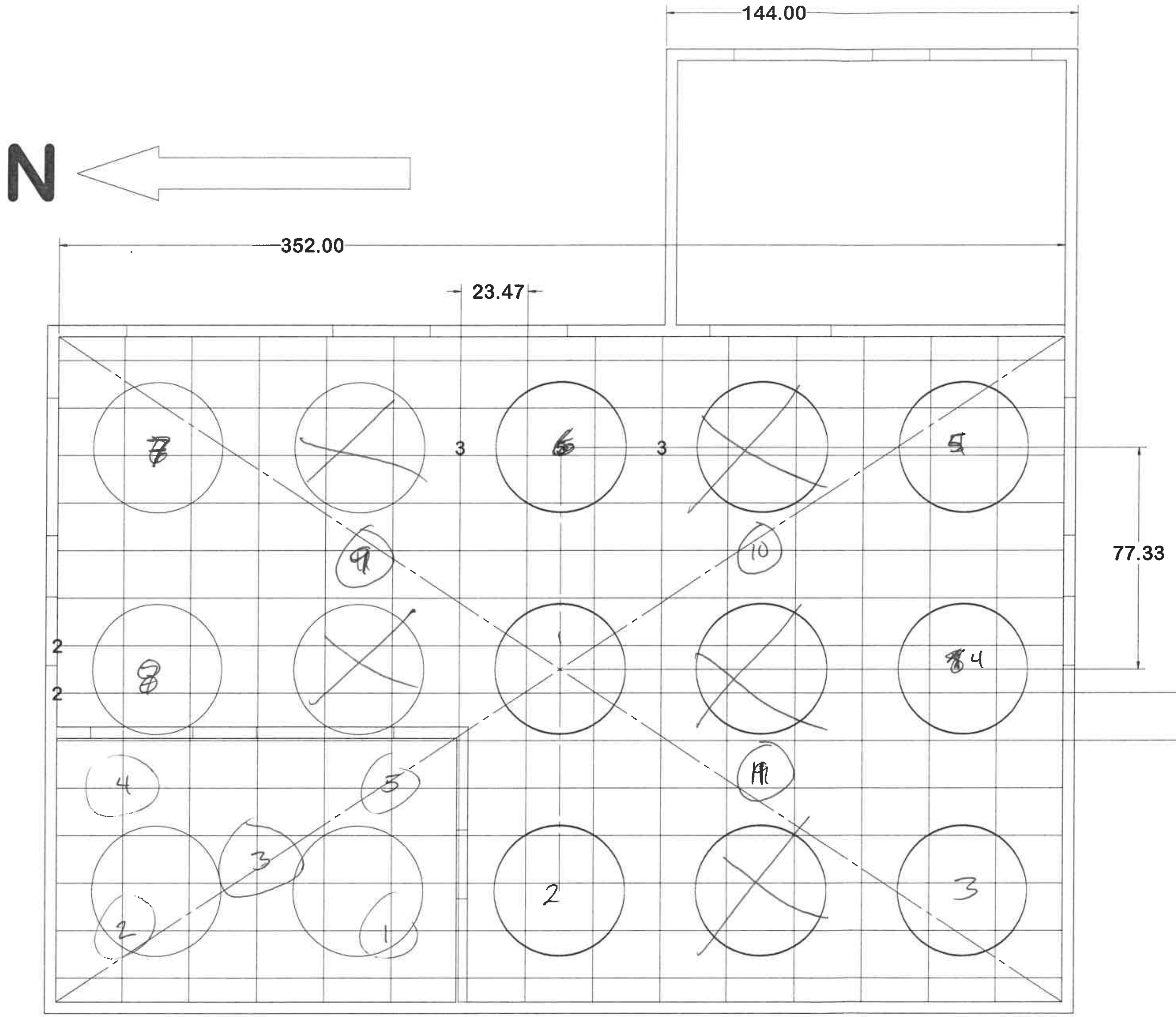
Stud load capacities are based upon 48" maximum centers. Loads listed include a 5 p.s.f. lateral combined load.

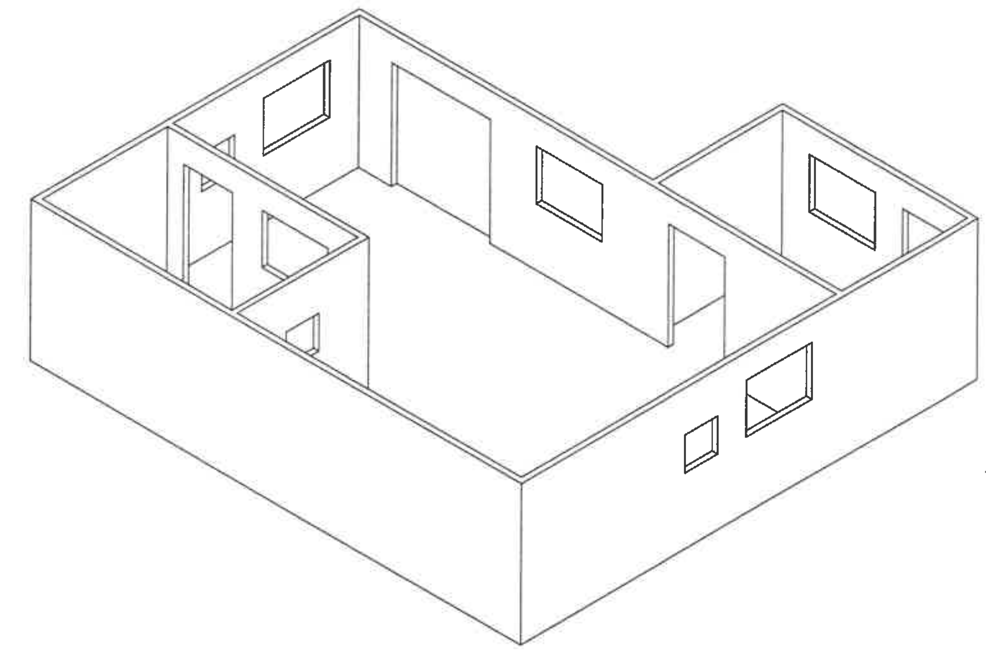
Maximum deflection limitation of l/120.

The structural capacity of slabs are not considered and should be analyzed independently

Wall studs are to be utilized within PortaFab 3" wall systems.

Tube insert to be HSS 2"x1 1/4"x11ga



(5) WINDOWS 36 X 48
(3) PASS THROUGHS 24 X 24
(2) WALK THROUGH DOORS 36 X 78
(1) SLIDING DOOR 36 X 78

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452 Alexandersville Rd.
Miamisburg, OH 45342
Telephone: 937-847-8400
Fax: 937-847-8410
www.x-spine.com

| | |
|---|---|
| TOLERANCES UNLESS OTHERWISE SPECIFIED: X ±.1, XX ±.01, XXX ±.005, XXXX ±.0005, ANGLES ± 1. | MODEL BY: MAA DATE: 3.23.15 |
| | DRAWN BY: MAA DATE: 3.23.15 |
| | CHECKED BY: DATE: |
| TOLERANCING | DO NOT SCALE DRAWING |
| | UNITS: IPS / SHEET SIZE: D |
| THIRD ANGLE PROJECTION | SCALE: 1:48 / SHEET: 1 OF 1 |

TITLE: CLEAN ROOM

DRAWING# ROOM LAYOUT — REV: 02

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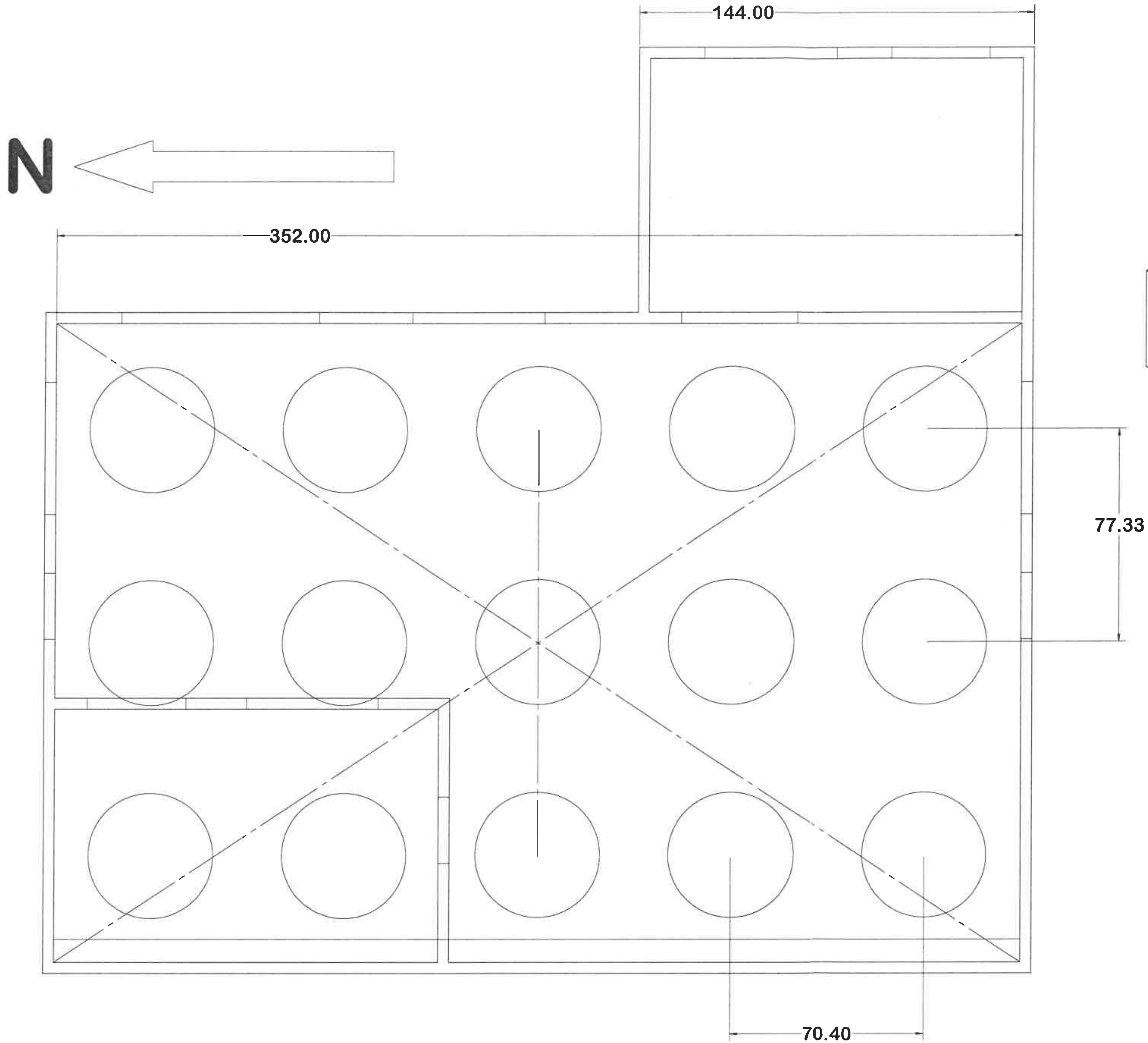


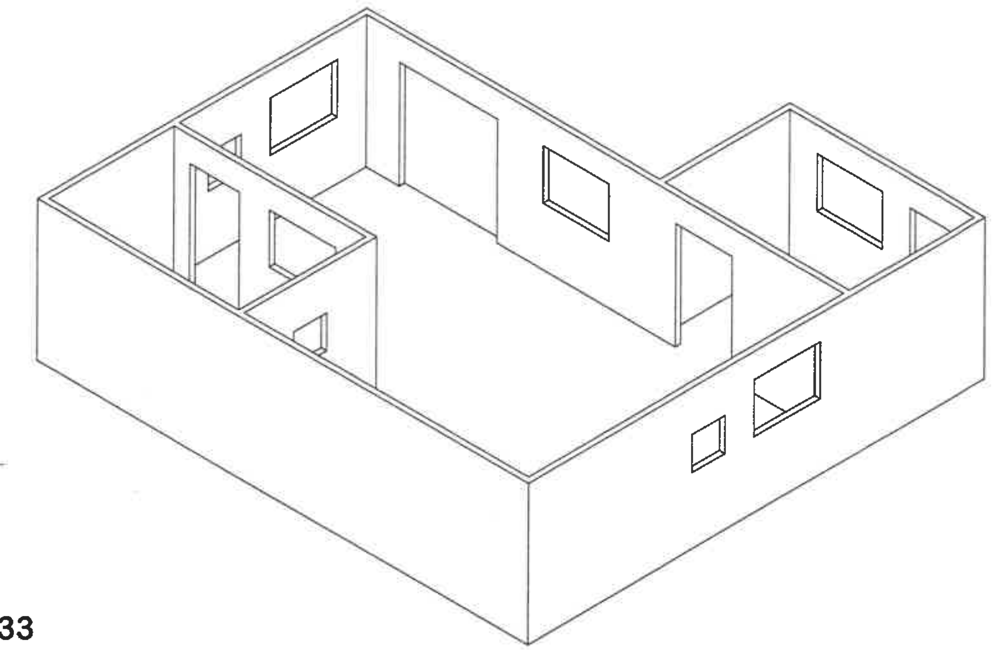

(5) WINDOWS 36 X 48
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|---|---|---|---|
| TOLERANCES UNLESS OTHERWISE SPECIFIED: X ±.1, XX ±.01, XXX ±.005, XXXX ±.0005, ANGLES ± 1. | MODEL BY: MAA | DATE: 3.23.15 | |
| | DRAWN BY: MAA | DATE: 3.23.15 | |
| | CHECKED BY: | DATE: | |
| DIMENSIONING AND TOLERANCING PER ASME Y14.5M-2009 | DO NOT SCALE DRAWING | | |
| THIRD ANGLE PROJECTION | UNITS: IPS | SHEET SIZE: D | |
| | SCALE: 1:48 | SHEET: 1 OF 1 | |

TITLE: CLEAN ROOM

DRAWING# ROOM LAYOUT — REV: 02

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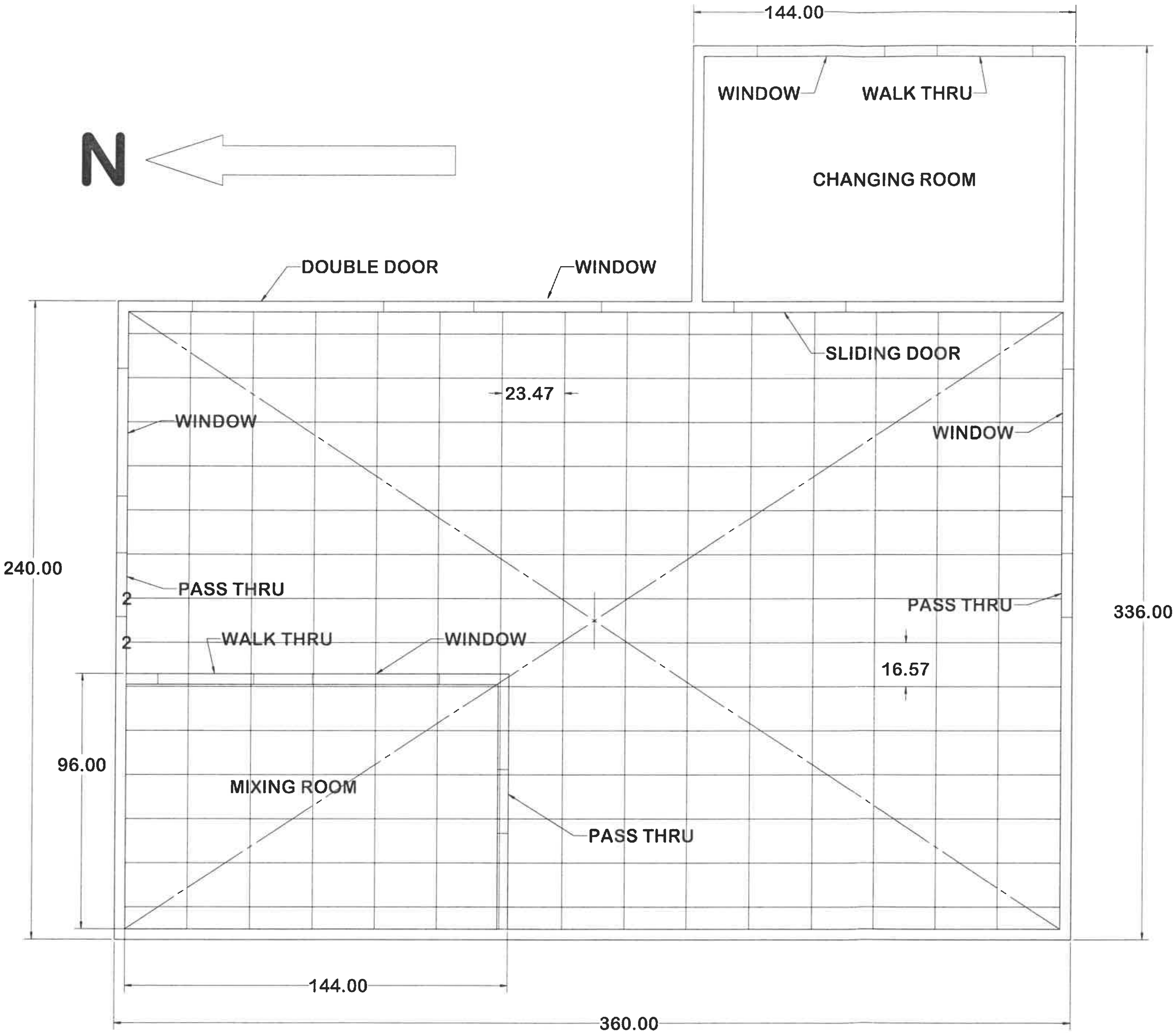


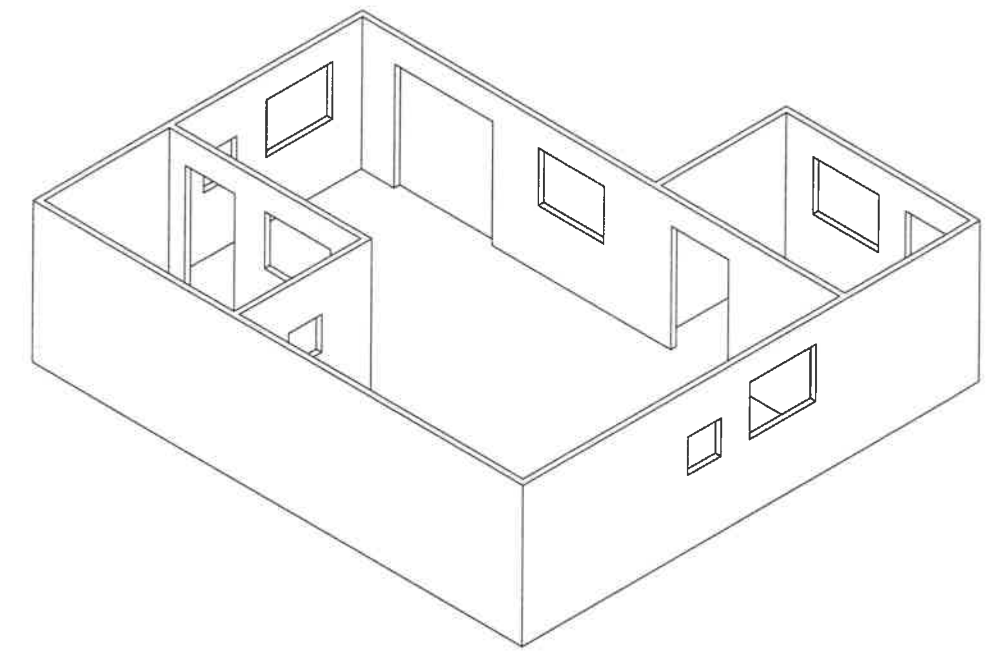

(5) WINDOWS 36 X 48
(3) PASS THROUGHS 24 X 24
(2) WALK THROUGH DOORS 36 X 78
(1) SLIDING DOOR 36 X 78

| | |
|---|---|
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| TOLERANCES UNLESS OTHERWISE SPECIFIED: X ±.1, XX ±.01, XXX ±.005, XXXX ±.0005, ANGLES ± 1. | MODEL BY: MAA DATE: 3.23.15 |
| | DRAWN BY: MAA DATE: 3.23.15 |
| | CHECKED BY: DATE: |
| DIMENSIONING AND TOLERANCING PER ASME Y14.5M | DO NOT SCALE DRAWING |
| THIRD ANGLE PROJECTION | UNITS: IPS — SHEET SIZE: D |
| | SCALE: 1:48 — SHEET: 1 OF 1 |
| TITLE: CLEAN ROOM | |
| DRAWING# ROOM LAYOUT | REV: 02 |

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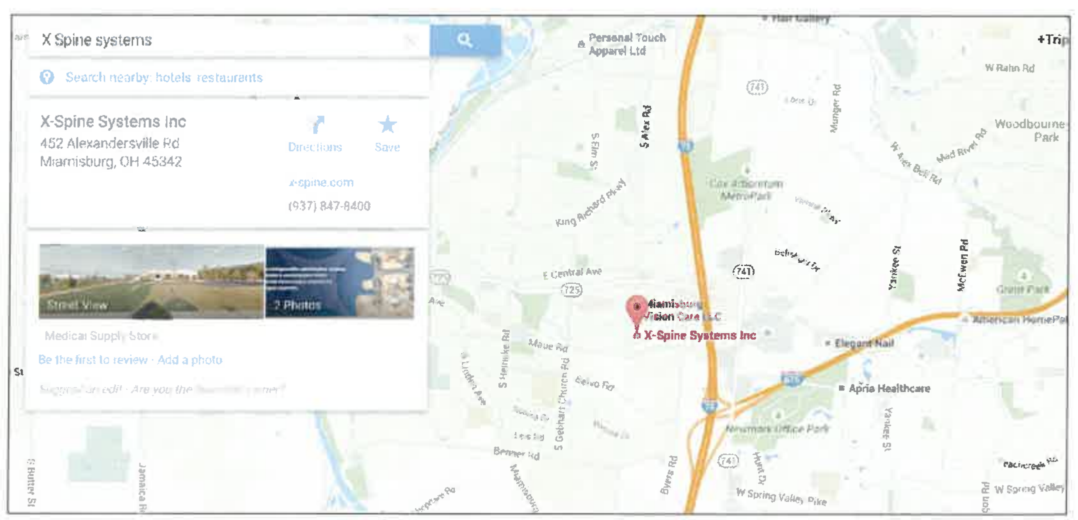
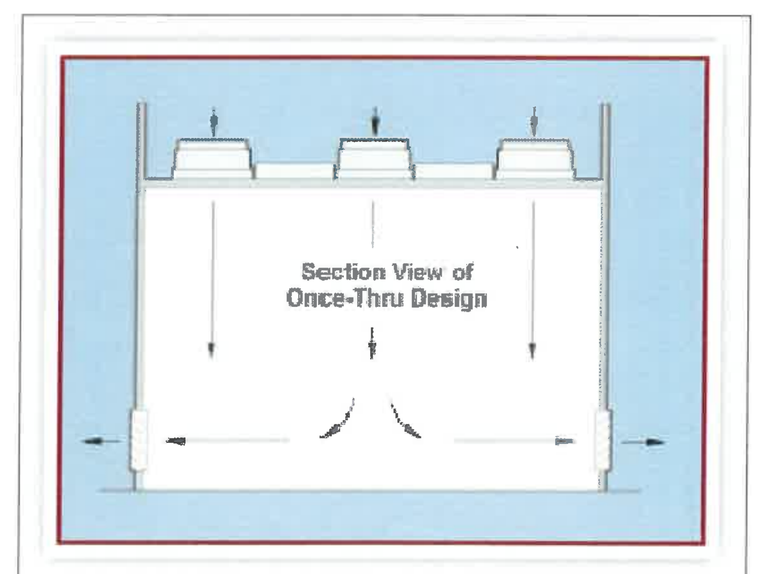
INDEX:
T1 Title Page
A1 Floor Plan
A2 Details
E1 Electrical.
(No Plumbing Work)
(No HVAC work)

ISO 8 Once-Thru Cleanroom




Cleanroom Design Schematic.
(Uses existing building HVAC)




General Notes

2401 Train Ave - Suite B - Cleveland, Ohio 44113
C: 216-536-7717

VERNICK & ASSOCIATES
CLEANROOM & CONTROLLED ENVIRONMENTS
DESIGN BUILD SERVICES

| No. | Revision/Issue | Date |
|---|---|---|
| 6/1/15 | Permit Set | |

Firm Name and Address

Vernick and Associates
2401 Train Ave.
Cleveland, OH 44113

Project Name and Address

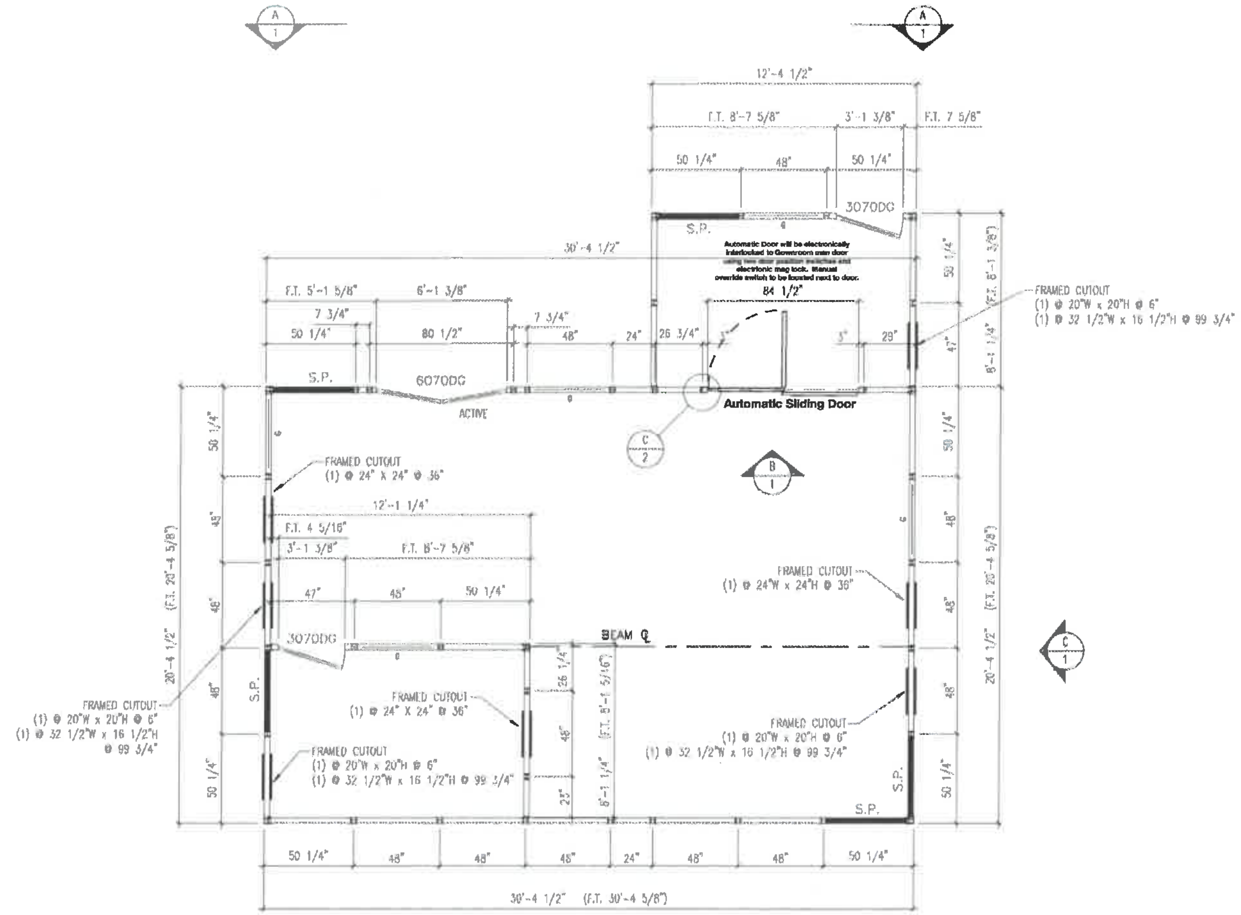
X-Spine Systems Inc
452 Alexandersville Rd
Miamisburg, OH 45342

Project

Date 6-01-15

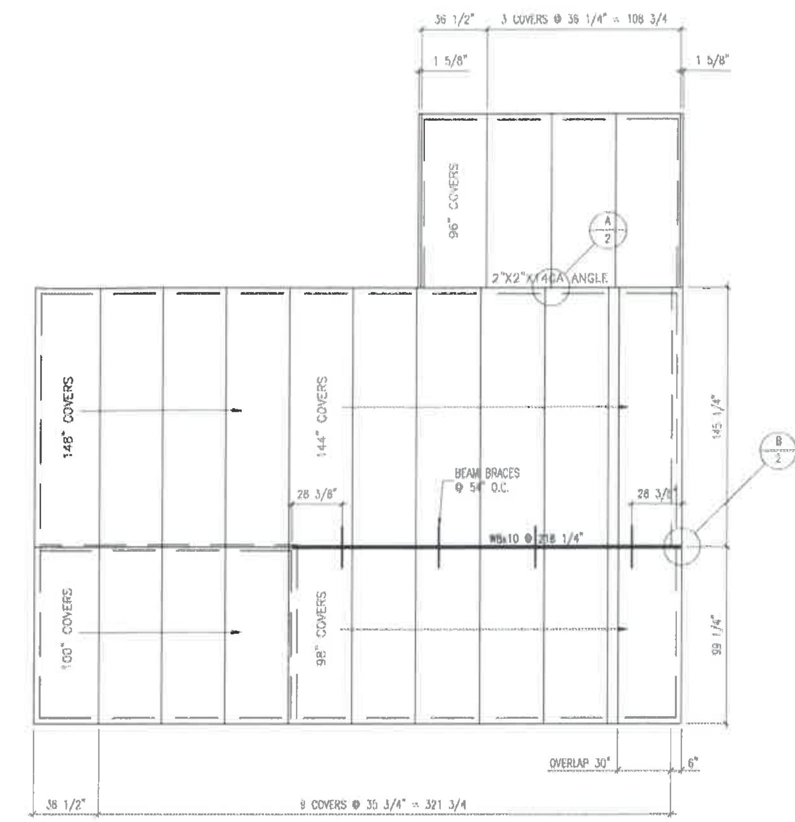
Scale

Sheet T1




## FLOOR PLAN

HOLD CENTERLINE DIMENSIONS OF STUDS AS SHOWN ON PRINT TO ELIMINATE ANY GROWTH OR SHRINKAGE TO THE REQUIRED WALL LENGTH




## DUST COVER LAYOUT

NON LOAD BEARING
MAXIMUM POST REACTION = 1,500 POUNDS

GENERAL NOTES:

1) DOORS AND FRAMES ARE PAINTED ?. EXTRUSIONS ARE ? AND VINYL BASE IS ?. (VERIFY PANEL COLOR)

2) DUST COVER SUPPORT ANGLE MUST BE SECURELY ATTACHED TO WIRING STUD LEGS (NOT COVERS) W/#10-16x3/4" TEK 3 SCREWS.

3) ALL GLASS IS 1/4" CLEAR TEMPERED.

4) H-STUDS, CORNICE MOLD AND FLOOR TRACK SHIP FULL LENGTH. 90 DEGREE OUTSIDE CORNICE MOLD CORNERS ARE PROVIDED FACTORY MITERED. FIELD CUT/MITRE MATERIALS AS REQUIRED.

5) DOORS ARE SUPPLIED W/DESIGN HARDWARE LEVER HANDLE LOCKSETS (#V-82-F-US26D 2 3/4"x ASA x ADA), NATIONAL GUARD AUTOMATIC DOOR BOTTOM (#220 NA), AND PARKER CLOSERS (#953ALX611AL).

STRUCTURAL NOTES:

1) SP INDICATES THE LOCATION OF A SHEAR PANEL.

2) ALL TUBE STEEL TO BE ASTM A500 GRADE "B"

3) ALL BEAMS TO BE A992. ALL ANGLES, PLATES & THREADED RODS TO BE ASTM A36.

4) ALL BOLTS TO BE A325. BOLTS TO BE SNUG-TIGHT (ALL PLIES OF THE CONNECTION IN FULL CONTACT).

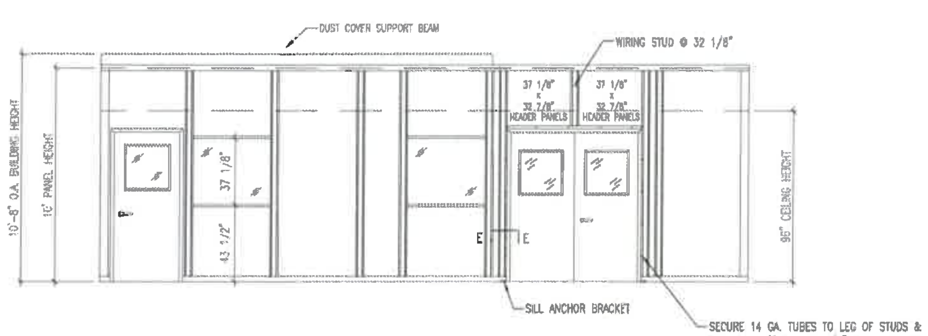
5) ALL SHEAR PANEL ANCHOR BOLTS TO BE MINIMUM 1/2"φ EXPANSION ANCHORS (HILTI ICC ESR 1917 APPROVED) W/3 1/2" MIN. EMBEDMENT.

6) THE END USER IS RESPONSIBLE TO PROVIDE ADEQUATE FOUNDATIONS TO SUPPORT THE COLUMNS & STUD LOADS SHOWN ON THE PLAN.

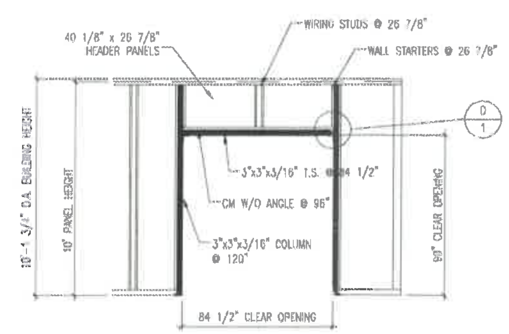
7) ALL WELDING TO CONFORM TO THE AMERICAN WELDING SOCIETY "STRUCTURAL WELDING CODE -- STEEL, ANSI/AWS D1.1-98"

8) LOCATION: MIAMISBURG, OH 45342

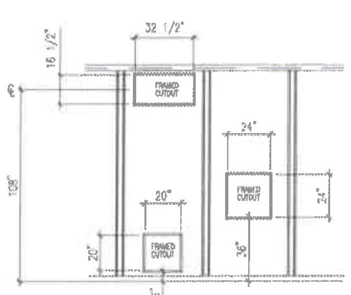
STATE OF OHIO
DANIEL W. McGINNIS
E-67996
REGISTERED PROFESSIONAL ENGINEER
6/5/2015



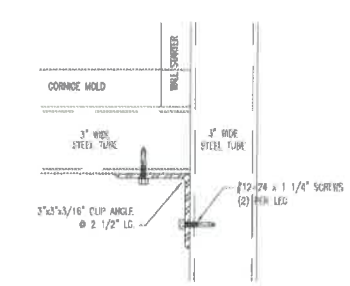

A/1 WALL ELEVATION



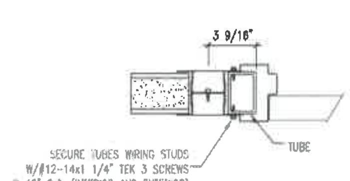

B/1 FRAMED OPENING



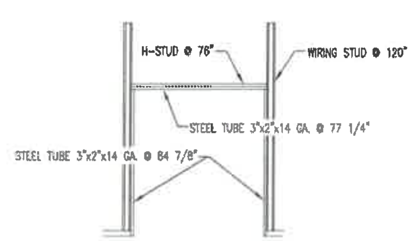

C/1 WALL ELEVATION




D/1 CLIP ANGLE DETAIL




E/1 6070 DOOR SECTION




6070 DOOR FRAMING

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ST. LOUIS, MISSOURI 63131
314-835-1224

VERNICK LLC
X-SPINE
P.O. 15-006-1

OMNIFLEX 300 + F&S
PANEL HEIGHT: 10'-0"

FINISH:
INT: TBD
EXT: TBD

PANEL CONSTRUCTION:
INT: 1/2" VINYL GYPSUM
2" POLYSTYRENE
EXT: 1/2" VINYL GYPSUM

| DRAWN BY: DM | DATE: 5/18/2015 |
|---|---|
| CHECKED BY: | SHIP DATE: OFA |
| SCALE: 1/4" = 1' | REVISED: |

ORDER NO. 29-53646

SHEET NO. 1OF 2

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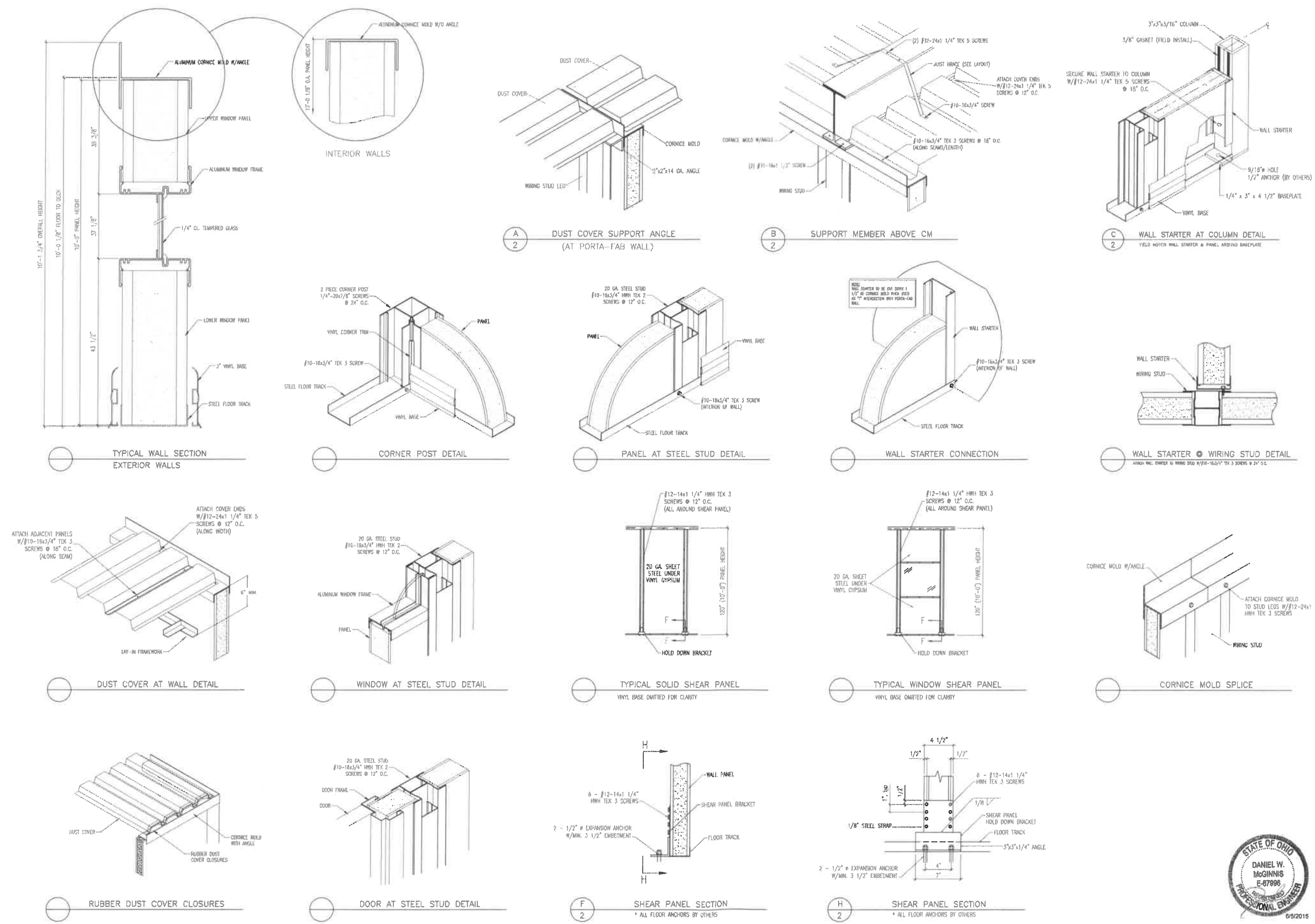


STATE OF OHIO
DANIEL W. McGINNIS
E-67996
REGISTERED PROFESSIONAL ENGINEER
6/5/2015

| REV. | DESCRIPTION | DATE |
|---|---|---|

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X-SPINE
P.O. 15-008-1

OMNIFLEX 300 + F&S
PANEL HEIGHT: 10'-0"

FINISH:
INT: TBD
EXT: TBD

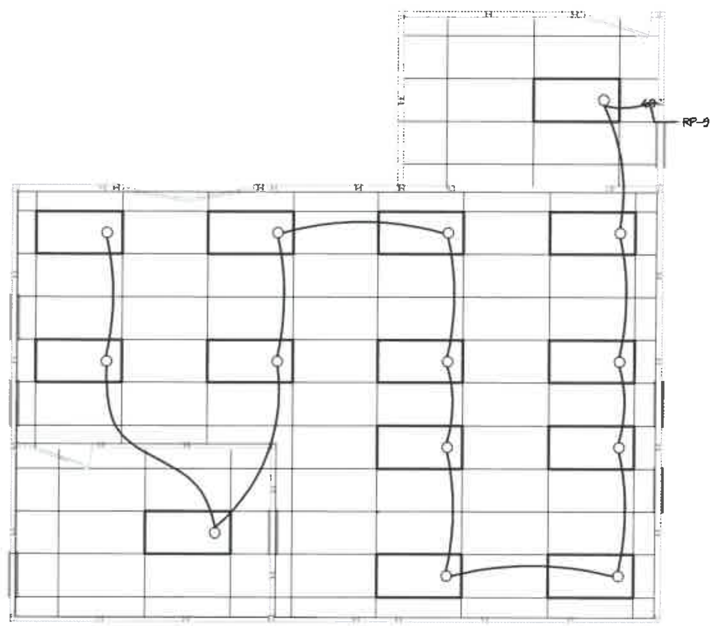
PANEL CONSTRUCTION:
INT: 1/2" VINYL GYPSUM
2" POLYSTYRENE
EXT: 1/2" VINYL GYPSUM

| | |
|---|---|
| DRAWN BY: DM | DATE: 5/18/2015 |
| CHECKED BY: | SHIP DATE: OFA |
| SCALE: 1/4" = 1' | REVISED: |

ORDER NO. 29-53646

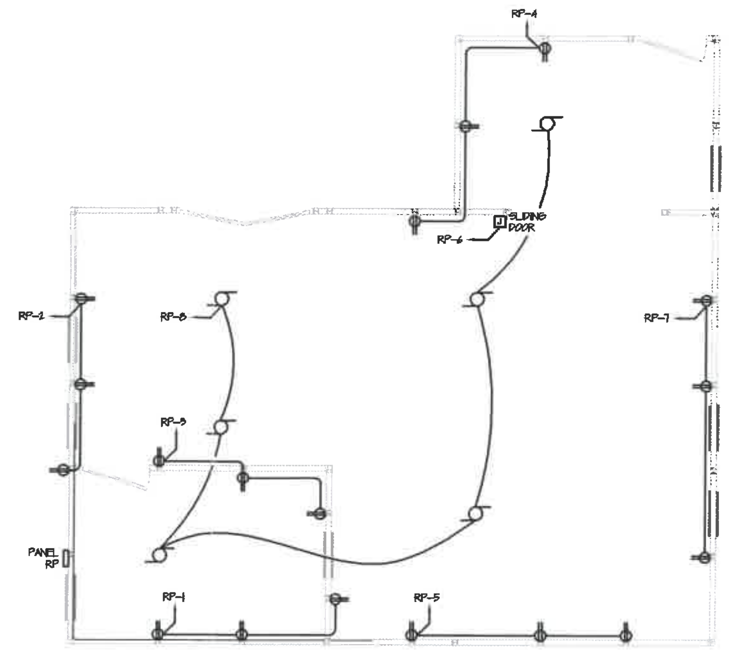
SHEET NO. 2 OF 2

SUPPLIER MAKES NO REPRESENTATION THAT THE BUILDING OR COMPONENT DEPICTED HEREIN COMPLIES WITH APPLICABLE CODE OR ORDINANCES; PURCHASER SHOULD VERIFY COMPLIANCE WITH SUCH CODES AND ORDINANCES.




## LIGHTING PLAN

SCALE: 1/4" = 1'-0"




## POWER PLAN

SCALE: 1/4" = 1'-0"

## PANEL SCHEDULE

PANEL: RP | PANEL LOCATION: Clean room | FED FROM:
SERVICE: 208V/120 VAC, 3P, 4W | MAINS: MCB 100 amp | BUS: | MOUNTING: PP

| CKT No. | AMP | LOAD SERVED | | VA/PHASE A | VA/PHASE B | VA/PHASE C | VA/PHASE A | VA/PHASE B | VA/PHASE C | LOAD SERVED | | AMP | CKT No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 20 | Clean room receptacles | NC | 540 | | | 540 | | | Receptacles clean room | NC | 20 | 2 |
| 3 | 20 | Clean room receptacles | NC | | 540 | | | 540 | | Receptacles clean room | NC | 20 | 4 |
| 5 | 20 | Clean room receptacles | NC | | | 540 | | | 500 | Sliding door operater | NC | 20 | 6 |
| 7 | 20 | Clean room receptacles | NC | 540 | | | 1,152 | | | Clean room filter fans | C | 20 | 8 |
| 9 | 20 | Clean room lighting | C | | 1,792 | | | | | | C | 20 | 10 |
| 11 | 20 | | C | | | | | | | | C | 20 | 12 |
| 13 | 20 | | C | | | | | | | | C | 20 | 14 |
| 15 | | | C | | | | | | | | C | 20 | 16 |
| 17 | | | C | | | | | | | | C | | 18 |
| 19 | | | C | | | | | | | | C | | 20 |
| 21 | | | C | | | | | | | | C | | 22 |
| 23 | | | C | | | | | | | | C | | 24 |
| 25 | | | C | | | | | | | | C | | 26 |
| 27 | | | C | | | | | | | | C | | 28 |
| 29 | | | C | | | | | | | | C | | 30 |
| 31 | | | C | | | | | | | | C | | 32 |
| 33 | | | C | | | | | | | | C | | 34 |
| 35 | | | C | | | | | | | | C | | 36 |
| 37 | | | NC | | | | | | | | C | | 38 |
| 39 | | | NC | | | | | | | | C | | 40 |
| 41 | | | NC | | | | | | | | C | | 42 |
| | | SUBTOTAL (VA/PHASE) | | 1080 | 2332 | 540 | 1692 | 540 | 500 | SUBTOTAL (VA/PHASE) | | | |

| | |
|---|---|
| 6,684 | TOTAL CONNECTED LOAD (VA.) |
| 2,944 | CONTINUOUS LOAD (VA.) |
| 0 | RECEPTACLE LOAD (VA.) |
| 0 | NEC TABLE 220.44: 10KVA + 0.5 (RECPT. LOAD-10KVA) |
| 3,740 | OTHER NON-CONTINUOUS LOAD (VA.) |
| 7,420 | 125% CONT. + NEC TABLE 220.44 + 100% NON-CONT. |
| 20.60 | AMPS PER NEC |

## GENERAL NOTES:

1. ALL WIRING METHODS WILL BE MC CABLE INSIDE CLEAN ROOM

## SYMBOL LEGEND:

- 2X4 LAY-IN FLUORESCENT LIGHT FIXTURE
- STANDARD DUPLEX RECEPTACLE
- IN-CEILING FAN

| # | DATE | REVISION |
|---|---|---|
| 1 | 6/4/15 | RELEASED FOR PERMIT |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

Associated Builders and Contractors, Inc.

Reddy ELECTRIC CO.
1145 BELLBROOK AVE. XENIA, OHIO 45385
OFFICE: 937-372-8205 FAX: 937-372-1556
OH LICENSE NUMBER: 18569

X-SPINE SYSTEMS INC.
CLEAN ROOM ADDITION
452 ALEXANDERSVILLE RD.
MIAMISBURG, OHIO 45342

ENGINEER'S SEAL
STATE OF OHIO — BARRY L. VENEY — REGISTERED PROFESSIONAL ENGINEER

CHECKED BY: T. NICHOLSON
DRAWN BY: S. SANNON
DESIGNED BY: B. VENEY
DATE: 6/2/15
REDDY JOB #
SHEET NO. E1

| Wednesday, April 22, 2015 | PortaFab | Precision Environment | Clean Air Tech | Gerbig one-pass | Gerbig recirculating |
|---|---|---|---|---|---|
| Sq Ft | 696 | 696 | 696 | 696 | 696 |
| lead time | 10 weeks | 12 weeks | 12-15 weeks | | |
| type | one way air | one way air | recirculating air | one way air | recirculating air |
| mixing room | 8X12/10 | 8x12X8 | 8x12X8 | 8x12X8 | |
| gowning room | 8X12/10 | 8x12X8 | 8x12X8 | 8x12X8 | |
| Air changes per hour | 30 | 20 | 30 | 30 | 30 |
| Monitoring system for temp, pressure | yes | yes | Yes | Yes | Yes |
| Modular construction | yes | yes | yes | yes | yes |
| epoxy floor | yes | yes | yes | No | No |
| Cover base at floor | yes | yes | yes | Yes | Yes |
| interlocks gowning room | yes | yes | yes | yes | yes |
| Automatic door into room - sliding door | yes | yes | yes | yes | yes |
| Double door | 1 | 1 | 1 | 1 | 1 |
| Std door | 2 | 2 | 2 | 3 | 3 |
| windows | 5 | 5 | 5 | 5 | 5 |
| pass thru's | 3 | 3 | 3 | 3 | 3 |
| wet sprinkler system | yes | yes | yes | No | No |
| vacuum system | yes | yes | yes | no | no |
| tied into electrical system | yes | yes | yes | No | No |
| electical | 14-120V 3-220V | 12 - 120V | 14-120V 3-220V | No | No |
| Drawings | $ 2,570 | | included | | |
| Quote | $ 132,615 | $ 193,000 | $ 209,500 | $ 131,165 | $ 169,909 |
| | $ 44,900 | $ 44,900 | $ 44,900 | $ 44,900 | $ 44,900 |
| | $ 177,515 | $ 237,900 | $ 254,400 | $ 176,065 | $ 214,809 |