# SCC 990 Flexible Andon Board
# Structural Design Review & Load Testing
# Of
# Aluminum Frame & Connections

**PREPARED FOR:**
STATIC CONTROLS CORPORATION
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February 29, 2016

Ruby 16-042

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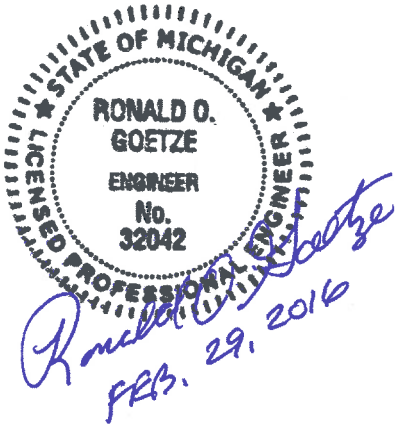


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Client: Static Controls Corporation
Project: Andon Board Design Review

| Table 1: Andon Board - Connection Bolt Strengths | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Joint** | Bolt | Calculated Strength | | | | | Minimum | Applied Force | Minimum Safety Factors | |
| **Mark** | Size | Tension | Shear | Pullout | Slide | Lowest | Tested | @ Connection | Calculated | Min. Test |
| **A** | 1/4 | 2850 | 1425 | 475 | 765 | 475 | 400 | 40 | 11.9 | 10.0 |
| **B** | 1/4 | 2850 | 1425 | 475 | 765 | 475 | 300 | 35 | 13.6 | 8.6 |
| **C** | 1/4 | 2850 | 1425 | 475 | 765 | 475 | 300 | 35 | 13.6 | 8.6 |
| **D** | 1/4 | 2850 | 1425 | 475 | 765 | 475 | 400 | 40 | 11.9 | 10.0 |
| **E** | 1/4 | 2850 | 1425 | 475 | 765 | 475 | 1100 | 40 | 11.9 | 27.5 |
| **F** | 1/4 | 2850 | 1425 | 475 | 765 | 475 | 300 | 35 | 13.6 | 8.6 |
| **G** | 1/4 | 2850 | 1425 | 475 | 765 | 475 | 300 | 35 | 13.6 | 8.6 |
| **H** | 1/4 | 2850 | 1425 | 475 | 765 | 475 | 1100 | 40 | 11.9 | 27.5 |
| **J** | 3/8 | 6975 | 3600 | 1150 | 730 | 730 | 1100 | 116 | 6.3 | 9.5 |
| **K** | 3/8 | 6975 | 3600 | 1150 | 730 | 730 | 1100 | 86 | 8.5 | 12.8 |
| **L** | (2) - 3/8 | 13950 | 7200 | 2300 | 1460 | 1460 | 600 | 185 | 7.9 | 3.2 |

NOTES:

1. For a frame diagram showing joint marks, loads and connection forces, see Appendix A, page A-1.
2. See Table 2 for connection force calculations and allowable force on angles.
3. The minimum safety factor against failure for the bolts, connection angles and aluminum frame is 3.2 for the case of having all the load on the two center mounted safety lugs. Under normal operating condtions, the mininum safety factor is 6.3.

| Table 2: Andon Board - Connection Design Forces/ Angle Strengths | | | | | | |
|---|---|---|---|---|---|---|
| **Joint Mark** | Bolt Size | Connection Angle | Maximum Design Force | | Calculated Allowable Force Applied to Angle | Minimum Calculated Safety Factor |
| | | | Components | Total | | |
| **A** | 1/4 | L1.5x1.5x0.18 | 140/4+5= | 40 | 890 | 22.3 |
| **B** | 1/4 | L1.5x1.5x0.18 | 140/4= | 35 | 890 | 25.4 |
| **C** | 1/4 | L1.5x1.5x0.18 | 140/4= | 35 | 890 | 25.4 |
| **D** | 1/4 | L1.5x1.5x0.18 | 140/4+5= | 40 | 890 | 22.3 |
| **E** | 1/4 | L1.5x1.5x0.18 | 140/4+5= | 40 | 890 | 22.3 |
| **F** | 1/4 | L1.5x1.5x0.18 | 140/4= | 35 | 890 | 25.4 |
| **G** | 1/4 | L1.5x1.5x0.18 | 140/4= | 35 | 890 | 25.4 |
| **H** | 1/4 | L1.5x1.5x0.18 | 140/4+5= | 40 | 890 | 22.3 |
| **J** | 3/8 | L2x2x0.187 | 40+40+6+30= | 116 | 1130 | 9.7 |
| **K** | 3/8 | L2x2x0.187 | 40+40+6= | 86 | 1130 | 13.1 |
| **L** | (2) - 3/8 | (2) L3x1.625x0.132 | 1/2 of Total Wgt | 185 | 1400 | 7.6 |

NOTES:

1. For a frame diagram showing joint marks, loads and connection forces, see Appendix A, page A-1.
2. See Table 1 for connection bolt allowable loads.
3. The minimum safety factor against failure for the bolts, connection angles and aluminum frame is 3.2 for the case of having all the load on the two center mounted safety lugs. Under normal operating condtions, the mininum safety factor is 6.3.

## BOLT STRENGTHS: TENSION & SHEAR

3/8"-16 BOLT

GRADE 5 $F_u$ = 120,000 PSI

TENSILE STRENGTH, $T_u = F_u \cdot A_t$

TENSILE STRESS AREA = 0.0775 $IN^2$ *

$T_u$ = 120,000 (0.0775) = 9300 LBS.

SHEAR STRENGTH, $V_u = 0.6 F_u A_s$

AREA OF MINOR DIA., $A_s$ = 0.0678 *

$V_u$ = 0.6 (120,000)(0.0678) = 4880 LBS.

1/4-20 BOLT

GRADE 5 $F_u$ = 120,000 PSI

$T_u = F_u \cdot A_t$

$A_t$ = 0.0318 $IN^2$ *

$T_u$ = 120,000 (0.0318) = 3800 LBS.

SHEAR STRENGTH, $V_u = 0.6 F_u A_s$

AREA OF MINOR DIA, $A_s$ = 0.0269 $IN^2$ *

$V_u$ = 0.6 (120,000)(0.0269) = 1900 LBS.

APPLY STRENGTH RESISTANCE FACTORS

USE $\phi_T = \phi_S = 0.75$

| | | |
|---|---|---|
| 3/8" BOLTS | $\phi T_u$ = 0.75 × 9300 = | 6975 LBS |
| | $\phi V_u$ = 0.75 × 4880 = | 3600 LBS |
| 1/4" BOLTS | $\phi T_u$ = 0.75 × 3800 = | 2850 LBS |
| | $\phi V_u$ = 0.75 × 1900 = | 1425 LBS |

* PER MACHINERY'S HANDBOOK 23, Table 3a.

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PROJECT: STATIC CONTROL CORP
ANDON BOARD DESIGN REVIEW

TITLE: ALUMINUM FRAME & CONNECTIONS

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## BOLT STRENGTHS: (SLIDE IN T-SLOT)

APPROXIMATE CLAMPING FORCE @ DESIGN BOLT INSTALLATION TORQUE

3/8-16 TORQUE = 10 ft-lbs

= 120 IN-LBS.

$T = KDF$

K = 0.15 LUBRICATED

K = 0.18 ZINC PLATED AND DRY

K = 0.20 PLAIN & DRY

D = DIAMETER OF BOLT

F = CLAMP FORCE

$$F = \frac{T}{KD}$$

WHEN $K = 0.20$, $F = \frac{120}{0.20(.375)} = 1600$ LBS.

COEFFICIENT OF FRICTION (SLIP RESISTANCE)

BETWEEN STEEL & ALUMINUM (DRY, UN LUBRICATED)

$\mu \approx 0.61$ [APPLIED IND. TECH.]

RESISTING SLIP FORCE = $P_n = \mu F$

$P_n = .61(1600) = 970$ LBS.

$\phi P_n = 0.75(970) = 730$ LBS

ACTUAL BOLT HEAD WILL DEFORM ALUMINIMUM AT CONTACT SURFACE INCREASING THE SLIDING RESISTANCE.

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## BOLT STRENGTHS : (SLIDE IN T-SLOT)

1/4-20 BOLTS.

INSTALL TORQUE = 7 FT-LBS = 84 IN-LBS.

FOR $K = 0.20$ (PLAIN & DRY THREADS)

$$F = \frac{T}{KD} = \frac{84}{0.20(.25)} = 1680 \text{ LBS.}$$

RESISTING SLIP FORCE, $P_n = \mu F$

$$P_n = 0.61(1680) = 1020 \text{ LBS}$$

$$\phi P_n = 0.75(1020) = 765 \text{ LBS}$$

ACTUAL BOLT HEAD WILL DEFORM ALUMINUM AT CONTACT SURFACE INCREASING THE SLIDING RESISTANCE.

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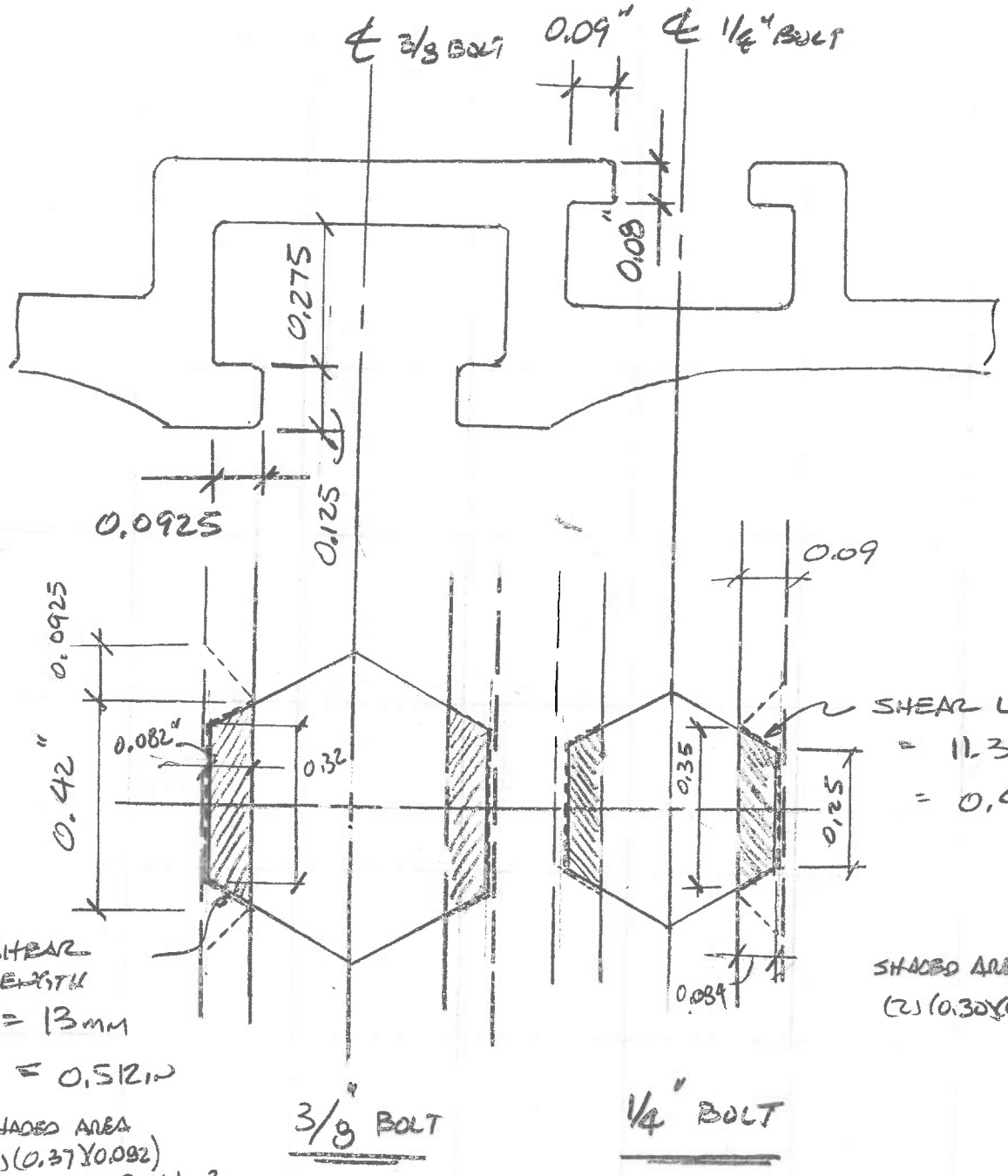
## BOLT STRENGTHS:

PULL-OUT STRENGTH OF ALUMINUM TRACK

3/8" BOLT





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## BOLT STRENGTHS (3/8" PULLOUT)

### SHEAR STRESS IN ALUMINUM

ASSUME BOLT HEAD PULLS THROUGH ALONG OUTER EDGE OF BOLT HEAD

PERIMETER LENGTH = 0.512"

MATERIAL THICKNESS = 0.125"

SHEAR AREA, $A_v$ = (2)(0.512)(0.125)

$$A_v = 0.128 \text{ in}^2$$

$$\sigma_s = \frac{P}{A_v} = \frac{P}{0.128} = 7.81P \quad \text{PSI}$$

### FLEXURAL STRESS IN ALUMINUM.

ASSUME LOAD "P" IS APPLIED AT MIDSPAN OF CANTILEVERS. FORCE ON EACH CANTILEVER = $\frac{P}{2}$

$$M_{MAX} = \left(\frac{P}{2}\right)\frac{L}{2} = \frac{P}{2}\left(\frac{0.0925"}{2}\right)$$

$$M_{MAX} = \frac{P}{43.2}$$

EFFECTIVE BENDING LENGTH = 0.42" + 2(0.0925) = 0.60

$$I = \frac{bh^3}{12} = \frac{0.60\,(0.125)^3}{12} = \frac{1}{10240} \text{ in}^4$$

$$\sigma_b = \frac{Mc}{I} = \frac{(P/43.2)(0.125/2)}{(1/10240)}$$

$$\sigma_b = 14.8P$$

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## BOLT STRENGTHS ( 3/8 POLLOUT )

COMBINED STRESS, MOHR CIRCLE

$$\sigma_{max} = \frac{\sigma_x}{2} + \sqrt{\left(\frac{\sigma_x}{2}\right)^2 + \tau_{xy}^2}$$

$$\sigma_{max} = \left(\frac{14.8\,P}{2}\right) + \sqrt{\left(\frac{14.8\,P}{2}\right)^2 + (7.81\,P)^2}$$

$$\sigma_{max} = 7.4\,P + P\sqrt{\left(\frac{14.8}{2}\right)^2 + (7.81)^2}$$

$$\sigma_{max} = 7.4 + 10.8\,P$$

$$\sigma_{max} = 18.2\,P$$

ALUMINUM, $F_u$ = 28,000 PSI

$$P_u = \frac{F_u}{18.2} = \frac{28{,}000}{18.2} = 1538 \text{ LBS.}$$

$$\phi P_u = 0.75(1538) = \underline{1150 \text{ LBS}}$$

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## BOLT STRENGTHS (1/4" PULL OUT)

### SHEAR STRESS IN ALUMINUM

PERIMETER LENGTH = 0.445"

MATERIAL THICKNESS = 0.08"

SHEAR AREA, $A_v = (2)0.445(0.08) = 0.071\ in^2$

$$\tau_{xy} = \sigma_s = \frac{P}{A_v} = \frac{P}{0.071} = 14.0P$$

### FLEXURAL STRESS IN ALUMINUM

ASSUME LOAD "P" IS APPLIED AT MIDSPAN OF CANTILEVERS, FORCE IN EACH CANTILEVER = $\frac{P}{2}$

$$M_{MAX} = \left(\frac{P}{2}\right)\frac{L}{2} = \left(\frac{P}{2}\right)\left(\frac{0.09}{2}\right) = \frac{P}{44.4}$$

EFFECTIVE BENDING LENGTH = 0.35 + (2)0.09

= 0.53

$$I = \frac{bh^3}{12} = \frac{0.53(0.08)^3}{12} = \frac{1}{44200}$$

$$\sigma_x = \sigma_b = \frac{Mc}{I} = \frac{(P/44.4)(0.08/2)}{1/44200} = 39.8P$$

### COMBINED STRESSES

$$\sigma_{MAX} = \frac{\sigma_x}{2} + \sqrt{\left(\frac{\sigma_x}{2}\right)^2 + (\tau_{xy})^2} = \left(\frac{39.8P}{2}\right) + P\sqrt{\left(\frac{39.8}{2}\right)^2 + (14.0)^2}$$

$$\sigma_{MAX} = 19.9P + 24.3P = 44.2P$$

$$P_u = \frac{F_y}{44.2} = \frac{28{,}000}{44.2} = 633\ LBS.$$

$$\phi P_u = 0.75(633) = \underline{475\ LBS}$$


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## EXTRUDED ALUMINUM

MATERIAL 6063-T6

$F_{tu} = 30$ KSI $\quad F_{ty} = 25$ KSI

$F_{cy} = 25$ KSI $\quad F_{su} = 19$ KSI

$E = 10{,}100$ KSI

SECTION PROPERTIES

$A = 1.30\ in^2$

$I_{x-x} = 0.078\ in^4$ $\quad I_{y-y} = 4.036\ in^4$

$c_b = -0.327"$ $\quad c_l = -2.691"$

$c_t = 0.800"$ $\quad c_r = +2.800"$

$$S_x)_b = \frac{I_{x-x}}{c_b} = \frac{0.078}{0.327} = 0.238\ in^3$$

$$S_x)_t = \frac{I_{x-x}}{c_t} = \frac{0.078}{0.80} = 0.097\ in^3 \quad \Leftarrow \text{CONTROLS.}$$

BENDING DESIGN STRESS = $\phi_y F_{ty}$ (GROSS SECTION)

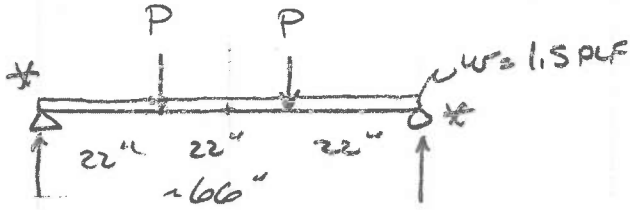
$\phi_y = 0.95$

$$\phi M_n = 0.95(25)(0.097) = 2.3\ \text{K-IN.} = 2300\ \text{LB-IN.}$$

CHECK 65" FRAME W/ 70" LOADS

$P = \frac{140}{2} = 70^{\#}$

$w = 1.5$ PLF




$$M^*_{MAX} \le 22(P) + w\frac{(22^2)}{2.12}$$

$$M_{MAX} \le 22(70) + 1.5\frac{(22)^2}{2.12} = 1570\ \text{LB-IN} < 2300 \quad \text{OK.}$$

* ACTUAL MAXIMUM IS LESS DUE TO "FIXED" MOMENT AT CORNERS.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EXTRUDED ALUMINUM

SHEAR AREA = (2) 1" × 0.12 + (4) 0.52 × 0.12

= 0.73 in²

$\phi V_n = 0.80 (F_{su}) A_v = 0.80 (19)(0.73)$

$\phi V_n$ = 11.1 kips. OK. BY INSPECTION.

TENSILE STRENGTH

$\phi T_n = 0.95 (F_{ty}) A_T$

= 0.95 (25)(1.30) = 30.9 kips OK.

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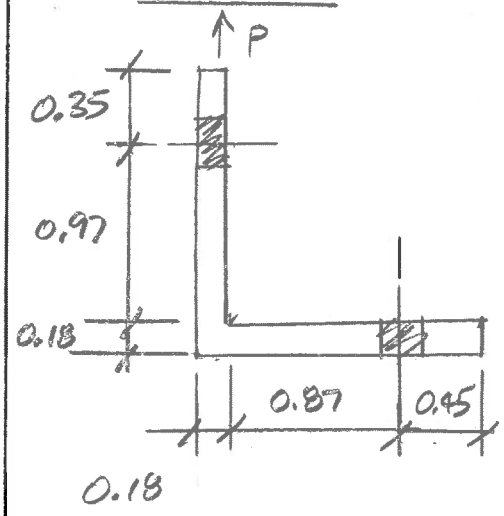
## CONNECTION ANGLES.

CORNER: L 1½ × 1½ × 0.18" × 0'-5⅛




LIMITED STATE: FLEXURAL STRESS

MAXIMUM MOMENT = 0.97 × P

$S = 5.125\,(0.18)^2/6 = 0.028\ in^3$

$\phi M_n = 1.3\,\phi_b (S)(F_{ty})$

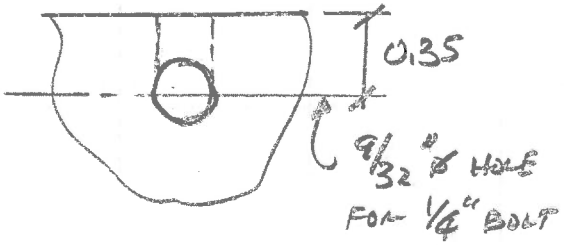
$= 1.3\,(0.95)(0.028)(25)$

$\phi M_n = 0.86\ K\text{-}IN = 860\ LB\text{-}IN$

$P_{max} = \dfrac{\phi M_n}{e} = \dfrac{960}{0.97} = 890\ \#$ ← CONTROLS

LIMITED STATE TENSION ⇒ OK. BY INSPECTION

TEAR OUT (SHEAR FLOW)




$l_v = 2\,(0.35) = 0.70\ in$

$A_v = t \cdot A_v = 0.18\,(0.70) = 0.126\ in^2$

$\phi_v V_n = 0.80\,(F_{su})(A_v)$

$= 0.80\,(19)(0.126)$

$= 1.9\ KIPS = 1900\ LBS.$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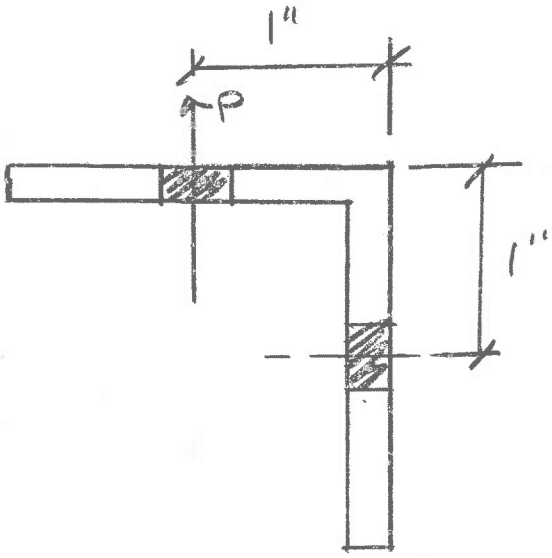
## SIDE ANGLES

L 2x2x0.187" ASTM A36




LIMITED STATE: LEG BENDING.

MAX M. ≤ 1" x P

ASSUME 4" EFFECTIVE ANGLE LENGTH

$Z = bt^2/4$

$Z = 4(0.187)^2/4$

$Z = 0.035\ in^3$

$\phi M_1 = 0.90 F_y Z$

$= 0.90(36)(0.035)$

$= 1.13$ K-IN

$\phi M_1 = 1130$ LB-IN

TEAR OUT → OF. BY INSPECTION. ∴ $P_{allow} = \frac{1130}{1"} = \underline{1130\#}$

LIMIT STATE: SINGLE ANGLE BENDING


$M = \frac{PL}{4} = \frac{P(2')}{4} = 0.5P$ K-FT

FOR P = 400 LBS

$M_{MAX} = 0.4(0.5) = 0.2$ K-FT

$M_u = 1.2 \times 0.2 = 0.24$ K-FT

FROM SINGLE ANGLE CALCULATION (P. 12 to 13)

UNITY = 0.525 ∴ ALLOW. LOAD = $\frac{400}{0.63} = \underline{635\#} > 370\#$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# Single-Angle Member Design

(Load and Resistance Factor Design Specification for Single-Angle Members

Beam Properties:

Units: $ksi := 1000 \cdot \frac{lbf}{in^2}$ $kip := 1000 \cdot lbf$

L2x2x3/1/16 $b := 2 \cdot in$ $t := 0.1875 \cdot in$

Material Properites: $E := 29000 \cdot ksi$ $F_y := 36 \cdot ksi$

$A_g := 0.72 \cdot in^2$ $S_c := 0.188 \cdot in^3$ $r := 0.389$

Strength Reduction Factors: $\phi_b := 0.90$ $\phi_c := 0.90$

Span Information:

Unbraced Length: $l_u := 24 \cdot in$ $K := 2$ $P := 0.0 \cdot kip$ $P_r := 1.6 \cdot P = 0 \cdot kip$

$M_{max}$ = absolute value of maximum moment in the unbraced beam segment
$M_A$ = absolute value of moment at quater point of the unbraced segment
$M_B$ = absolute value of moment at the centerline of the unbraced segment
$M_C$ = absloute value of the moment at the three-quarter point of the unbraced segment

$M_{max} := 1.2 \cdot 0.2 \cdot kip \cdot ft$ $M_A := 1.2 \cdot 0.1 \cdot kip \cdot ft$ $M_B := 1.2 \cdot 0.2 \cdot kip \cdot ft$ $M_C := 1.2 \cdot 0.20 \cdot kip \cdot ft$

COMPRESSION:

Reduction factor for local buckling (Q):

$$Q := \begin{cases} 1.0 & \text{if } \frac{b}{t} \le \sqrt{\frac{E}{F_y}} \\ \left(1.34 - 0.76 \cdot \frac{b}{t} \cdot \sqrt{\frac{F_y}{E}}\right) & \text{if } 0.446 \cdot \sqrt{\frac{E}{F_y}} < \frac{b}{t} \le 0.910 \cdot \frac{b}{t} \cdot \sqrt{\frac{E}{F_y}} \\ \left[0.534 \cdot \frac{E}{F_y \cdot \left(\frac{b}{t}\right)^2}\right] & \text{otherwise} \end{cases}$$

$Q = 1$

Critical compression stress, $F_{cr}$:

$\lambda_c := \frac{K \cdot l_u}{r \cdot \pi} \cdot \sqrt{\frac{F_y}{E}}$ $\lambda_c = 1.384 \cdot in$

$$F_{cr} := \begin{cases} \left[Q \cdot \left[0.658^{Q \cdot \left(\frac{\lambda_c}{in}\right)^2}\right] \cdot F_y\right] & \text{if } \sqrt{Q} \le 1.5 \\ \left[\frac{0.877}{\left(\frac{\lambda_c}{in}\right)^2} \cdot F_y\right] & \text{otherwise} \end{cases}$$

$F_{cr} = 16.151 \cdot ksi$

$\phi P_n := \phi_c \cdot F_{cr} \cdot A_g$ $\phi P_n = 10.466 \cdot kip$

FLEXURE:

Limit state of yielding when the tip of an angle leg is in compression:

$$M_{n1} := \begin{cases} \left(1.5 \cdot F_y \cdot S_c\right) & \text{if } \frac{b}{t} \le 0.54 \cdot \sqrt{\frac{E}{F_y}} \\ \left[F_y \cdot S_c \cdot \left[1.5 - 0.93 \cdot \left[\frac{\frac{b}{t} - 1}{\left(0.54 \cdot \sqrt{\frac{E}{F_y}}\right)}\right] - 1\right]\right] & \text{if } 0.54 \cdot \sqrt{\frac{E}{F_y}} < \frac{b}{t} \le 0.91 \cdot \sqrt{\frac{E}{F_y}} \\ \left(1.34 \cdot Q \cdot F_y \cdot S_c\right) & \text{otherwise} \end{cases}$$

$M_{n1} = 0.846 \cdot kip \cdot ft$

$\phi M_{n1} := \phi_b \cdot M_{n1} = 0.761 \cdot kip \cdot ft$

Limit state of yielding when the tip of an angle leg is in tension:

$M_y := 0.8 \cdot S_c \cdot F_y = 0.451 \cdot kip \cdot ft$ $M_n := 1.5 \cdot M_y = 0.677 \cdot kip \cdot ft$

$$CB := \frac{12.5 \cdot M_{max}}{2.5 \cdot M_{max} + 3 \cdot M_A + 4 \cdot M_B + 3 \cdot M_C}$$

$$C_b := \begin{cases} CB & \text{if } CB < 1.5 \\ 1.5 \end{cases}$$

$C_b = 1.5$

With maximum compression at the angle-leg tips:

$$M_{ob} := \frac{0.66 \cdot E \cdot b^4 \cdot t \cdot C_b}{l_u^2} \cdot \left[\sqrt{1 + 0.78 \cdot \left(\frac{l_u \cdot t}{b^2}\right)^2} - 1\right]$$

$M_{ob} = 5.105 \cdot kip \cdot ft$

For the limit state of lateral-torsional

$$M_{n2} := \begin{cases} \left[\left(0.92 - 0.17 \cdot \frac{M_{ob}}{M_y}\right) \cdot M_{ob}\right] & \text{if } M_{ob} \le M_y \\ \left(1.92 - 1.17 \cdot \sqrt{\frac{M_y}{M_{ob}}}\right) \cdot M_y & \text{otherwise} \end{cases}$$

$$M_{n2} := \begin{cases} M_{n2} & \text{if } M_{n2} \le 1.5 \cdot M_y \\ \left(1.5 \cdot M_y\right) & \text{otherwise} \end{cases}$$

$M_{n2} = 0.677 \cdot kip \cdot ft$

$\phi M_{n2} := \phi_b \cdot M_{n2} = 0.609 \cdot kip \cdot ft$

With maximum tension at the angle-leg tips:

$$M_{ob} := \frac{0.66 \cdot E \cdot b^4 \cdot t \cdot C_b}{l_u^2} \cdot \left[ \sqrt{1 + 0.78 \cdot \left( \frac{l_u \cdot t}{b^2} \right)^2} + 1 \right]$$

$M_{ob} = 30.027 \cdot kip \cdot ft$

For limit state of lateral-torsional buckling:

$$M_{n3} := \begin{cases} \left[ \left( 0.92 - 0.17 \cdot \frac{M_{ob}}{M_y} \right) \cdot M_{ob} \right] & \text{if } M_{ob} \le M_y \\ \left( 1.92 - 1.17 \cdot \sqrt{\frac{M_y}{M_{ob}}} \right) \cdot M_y & \text{otherwise} \end{cases}$$

$$M_{n3} := \begin{cases} M_{n3} & \text{if } M_{n3} \le 1.5 \cdot M_y \\ \left( 1.5 \cdot M_y \right) & \text{otherwise} \end{cases}$$

$M_{n3} = 0.677 \cdot kip \cdot ft$

$\phi M_{n3} := \phi_b \cdot M_{n3} = 0.609 \cdot kip \cdot ft$

$\phi M_n := \min\left( \phi M_{n1}, \phi M_{n2}, \phi M_{n3} \right)$

$\phi M_n = 0.609 \cdot kip \cdot ft$

INTERACTION (UNITY) EQUATION:

$P_c := \phi P_n \qquad M_{rx} := 1.6 \cdot M_{max} \qquad M_{ry} := 0 \cdot kip \cdot ft$

$M_{cx} := \phi M_n \qquad M_{cy} := \phi M_n$

$$U := \begin{cases} \left[ \frac{P_r}{P_c} + \frac{8}{9} \cdot \left( \frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}} \right) \right] & \text{if } \frac{P_r}{P_c} \ge 0.2 \\ \frac{P_r}{2 \cdot P_c} + \left( \frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}} \right) \end{cases}$$

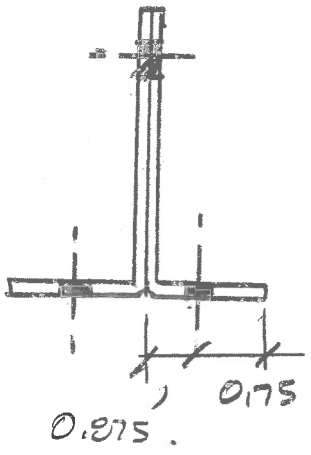
$U = 0.63$

$$Design\_Check := \begin{cases} \text{"OK"} & \text{if } U \le 1 \\ \text{"No Good"} & \text{if } U > 1 \end{cases}$$

Design_Check = "OK"

## SAFETY LUG

(2) L 3 x 1 5/8 x 0.135" x 3½" LG.




LIMIT STATE: FLEXURE (SHORT LEG)

$Z = 3.5(0.135)^2/4$
$= 0.016\ in^3$

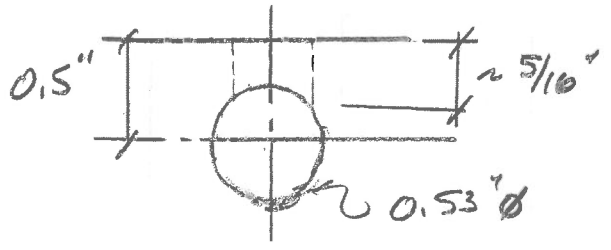
$\phi M_n = 0.90(F_y)Z$
$= 0.90(36)(0.016)$
$\phi M_n = 0.518$ K-IN / LEG.
x 2
1.04 K-IN

$M = (0.875 - 0.135)P = 0.74P$

$P_{allow} = \frac{1.04 \times 1000}{0.74} = 1400$ LBS.
↑ CONTROLS.

$\phi V_n = 0.90(0.6)(F_y)A_w$
$= 0.90(0.6)(36)(.9135)(3.5)(2) = 18.3$ KIPS.
OK.

TEAR OUT @ TOP HOLE:




$l_w = 0.3125$
$L_v = 2(.3125) = 0.625$
$A_w = 2(.625)(.135) = 0.17\ in^2$
$\phi V_n = 0.90(0.6)(36)(0.17)$
$= 3.3$ KIPS = 3300 LBS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| | |
|---|---|
| PROJECT | STATIC CONTROL CORP<br>ANDON BOARD DESIGN REVIEW |
| TITLE | ALUMINUM FRAME &<br>CONNECTIONS |

| | |
|---|---|
| BY: RG | SHEET: 15 |
| CHKD: RA | PROJECT NO: 16-042 |
| DATE: 02/29/16 | PAGE: 17 |

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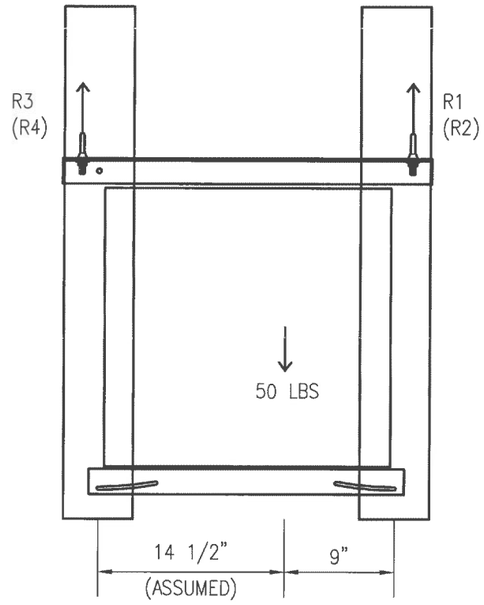
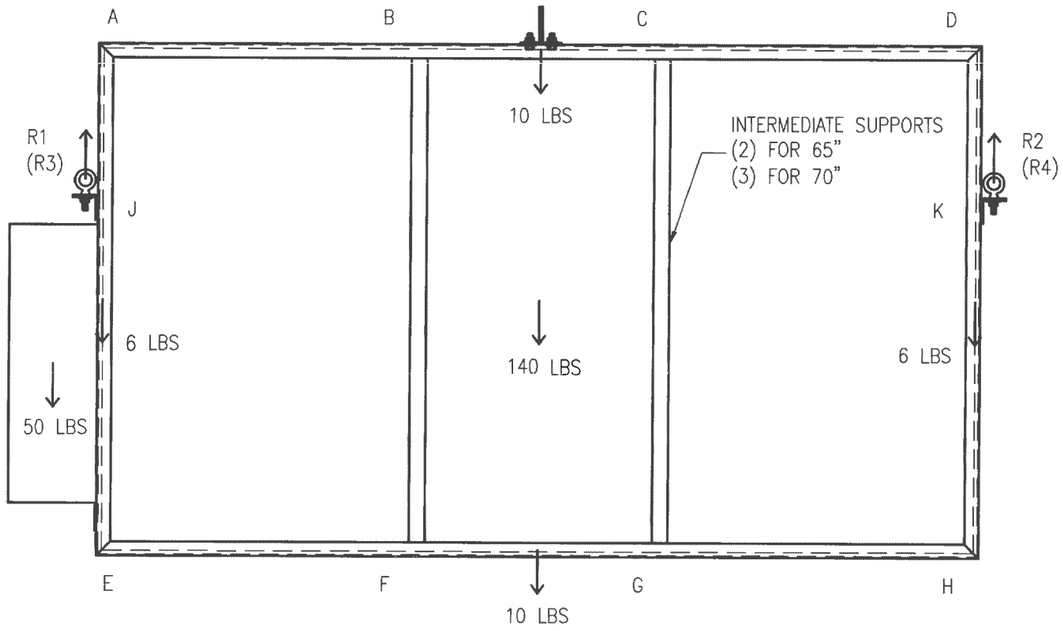
# Appendix A
## (Frame Loads & Properties)



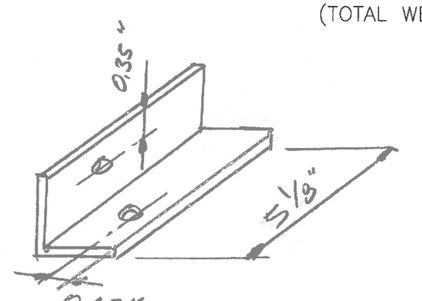

LEFT SIDE VIEW

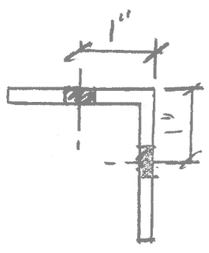


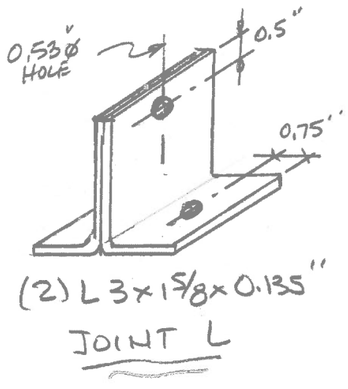

MONITOR VIEW

# 65"/70" DS LCD MONITOR, W/ CONTROL BOX (+MUSIC)

(TOTAL WEIGHT = 370 LBS)




ANGLE DETAILS

NOTES:

1. CONSERVATIVELY APPLY HEAVIER 370 POUND LOAD OF 70" DISPLAY TO 65" FRAME WHICH HAS ONE LESS INTERMEDIATE SUPPORT THAT DIRECTLY RESISTS THE LCD DISPLAY WEIGHT.
2. LOADS/FORCES SHOWN OCCUR ON EACH FRAME EXCEPT FOR THE 50 POUND CONTROLLER WHICH IS SHARED (ASSUMED 60%/40% SPLIT) BETWEEN THE TWO FRAMES.

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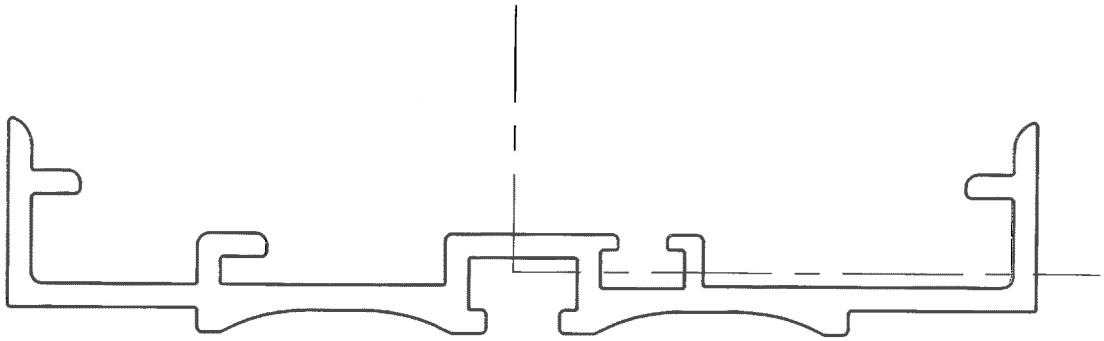
PROJECT
STATIC CONTROLS CORPORATION
ANDON BOARD CONNECTION REVIEW

TITLE
65"/70" DS LCD MONITOR FRAMES
LOADS/FORCES ON FRAME CONNECTIONS

DESIGN BY: RG
DRN BY: RG
DATE: 02/16/16
PROJECT NO. 16-042
SHEET NO. A-1
REVISION



---------- REGIONS ----------

WEIGHT
A x 1.18 LB/IN² = 1.53 PCF
F1

Area: 1.3002 sq in
Perimeter: 19.1976 in
Bounding box: X: -2.6915 -- 2.7991 in
Y: -0.3266 -- 0.8005 in
Centroid: X: 0.0000 in
Y: 0.0000 in
Moments of inertia: X: 0.0777 sq in sq in
Y: 4.0364 sq in sq in
Product of inertia: XY: -0.0061 sq in sq in
Radii of gyration: X: 0.2444 in
Y: 1.7620 in
Principol moments (sq in sq in) and X-Y directions obout centroid:
I: 0.0777 olong [1.0000 -0.0015]
J: 4.0364 along [0.0015 1.0000]

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PROJECT
STATIC CONTROLS CORP.
ANDON BOARD REVIEW

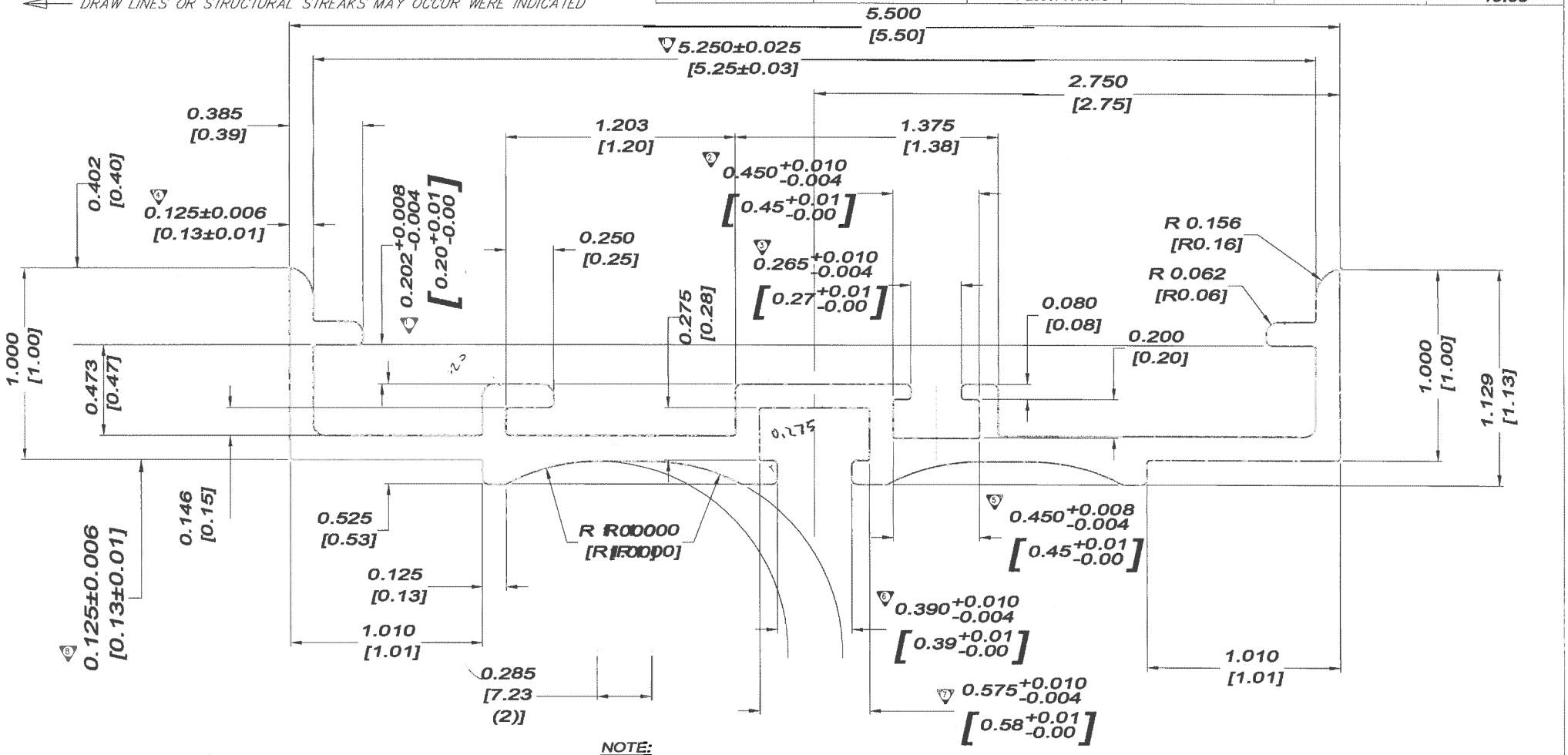
TITLE
ALUM. FRAME PROPERTIES

| DRN BY: | DATE: |
|---|---|
| SCC | 2/16/16 |
| DESIGN BY: | PROJECT NO. |
| SCC | 16-042 |
| SHEET NO. | REVISION |
| A-2 | |

ALUMINUM ASSOCIATION STANDARD TOLERANCES WILL APPLY UNLESS OTHERWISE SPECIFIED

DRAW LINES OR STRUCTURAL STREAKS MAY OCCUR WERE INDICATED

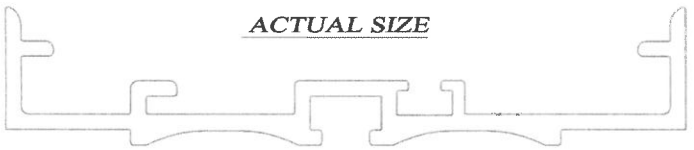
| LENGTH OF BILLET | PRESS NO. 1650 | BACKER 7-29017 X 88.90 | BOLSTER 15-22 | NO. CAV. 1 | DIA. 278.81 X 139.70 |
|---|---|---|---|---|---|
| | | PLATE 7-29017 X 50.80 | FEEDER ——— | | POCKET 19.05 |




NOTE:

1. ALL DIMENSIONS IN "INCHES"
   METRIC "mm"
2. NO EXPOSED SURFACES

ACTUAL SIZE



RUNOUT PLANE

DAICOR Aluminum Ltd.
155 IRWIN STREET
CHATHAM, ONT. N7M-5J5
Web Site: www.daicor.com

| DENOTES DIMENSIONS TO BE CHECKED | | | | | | CUSTOMER | STATIC CONTROLS | | |
|---|---|---|---|---|---|---|---|---|---|
| BREAK SHARP CORNERS .010 [0.25] RADII UNLESS OTHERWISE SPECIFIED | | | | | | CUSTOMER'S DWG. NO. | 5.50" 990 - SIGN FRAME | | |
| UNSPECIFIED WALL THICKNESS 0.125±0.006 [3.18±0.15] | | | | | | MATERIAL 6063-T6 | SCALE 2:1 | DIE TYPE | |
| | LETTER | REVISION | | | DATE | DWN. IAN COLQUHOUN | DATE 11-13-2014 | SOLID | ☒ |
| VIS QUOTE NO. 0000-00 | AREA SQ.INS. 1.306 | LBS/FT 1.541 | TOTAL PERIM. 19.235 (488.564) | FACTOR 12 (213) | | | | PORTHOLE | ☐ |
| VIS PART NO. 00000000 | AREA SQ.CM 8.429 | KG/M 2.297 | ANOD.PERIM. | EXTRUSION RATIO 29 | | DWG. NO. 7-29017 | CHKD. | SEMI-PORT | ☐ |
| | | | | | | | | SPECIAL | ☐ |

A-3

Rust
16.042

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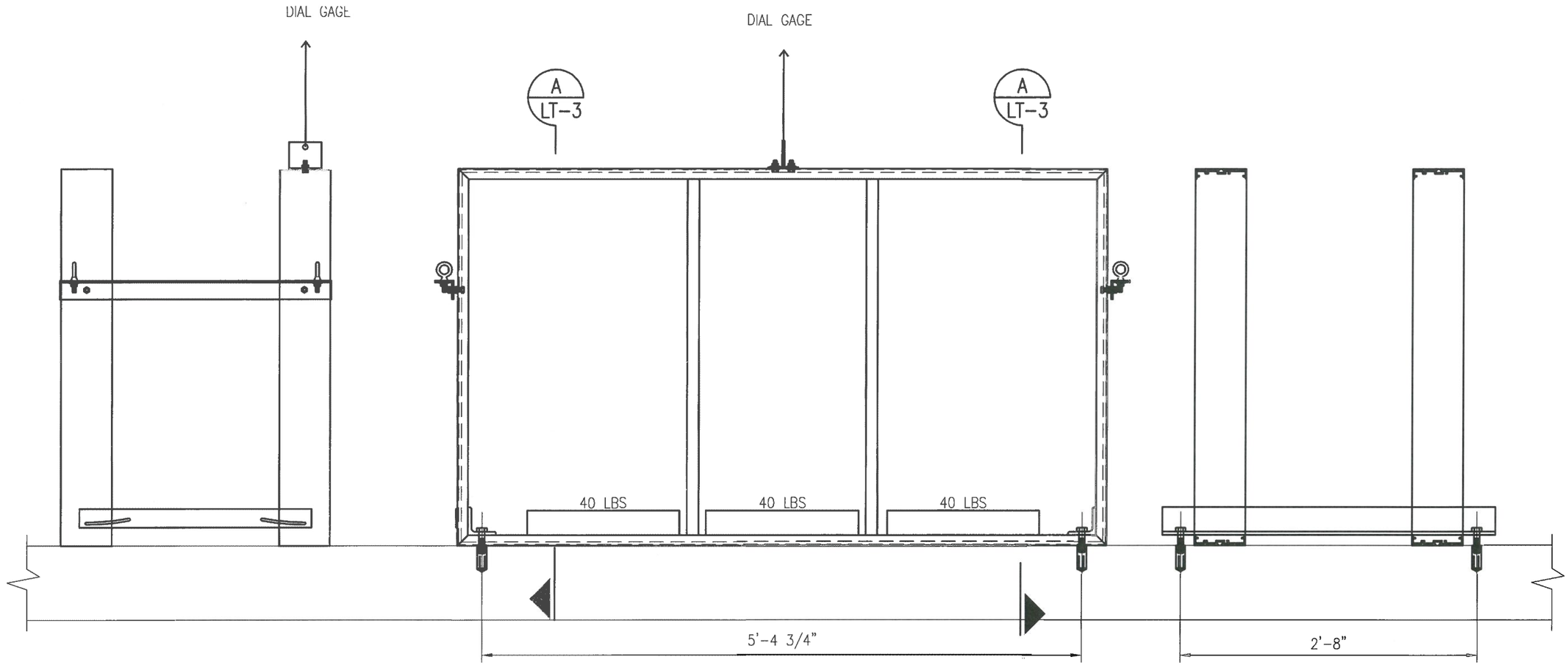
# Appendix B
## (Load Tests)




HOLD DOWN SUPPORT:
L3 x 3 x 3/8 or HSS x 3'-0" LONG
+ (2) 5/8" DIA. HILTI HDI DROP-IN ANCHORS
(INSTALLED PER MANUFACTURER'S INSTRUCTIONS)
+ (2) 5/8" DIA. X 2 1/4 GRADE 5 BOLTS

SECTION A LT-1
1"=1'-0"

# 65"/70" DS LCD MONITOR, TEST SETUP 1

SAFETY CABLE LUG/CENTER STRUT CONNECTIONS

DATE OF TEST: FEB. 23, 2016
TESTED TO: 600 LBS
OBSERVATIONS: VERTICAL FRAME DEFLECTION ~ 1.5"
NO FAILURES

WITNESS: Ronald O Goetze
Ronald Goetze, PE

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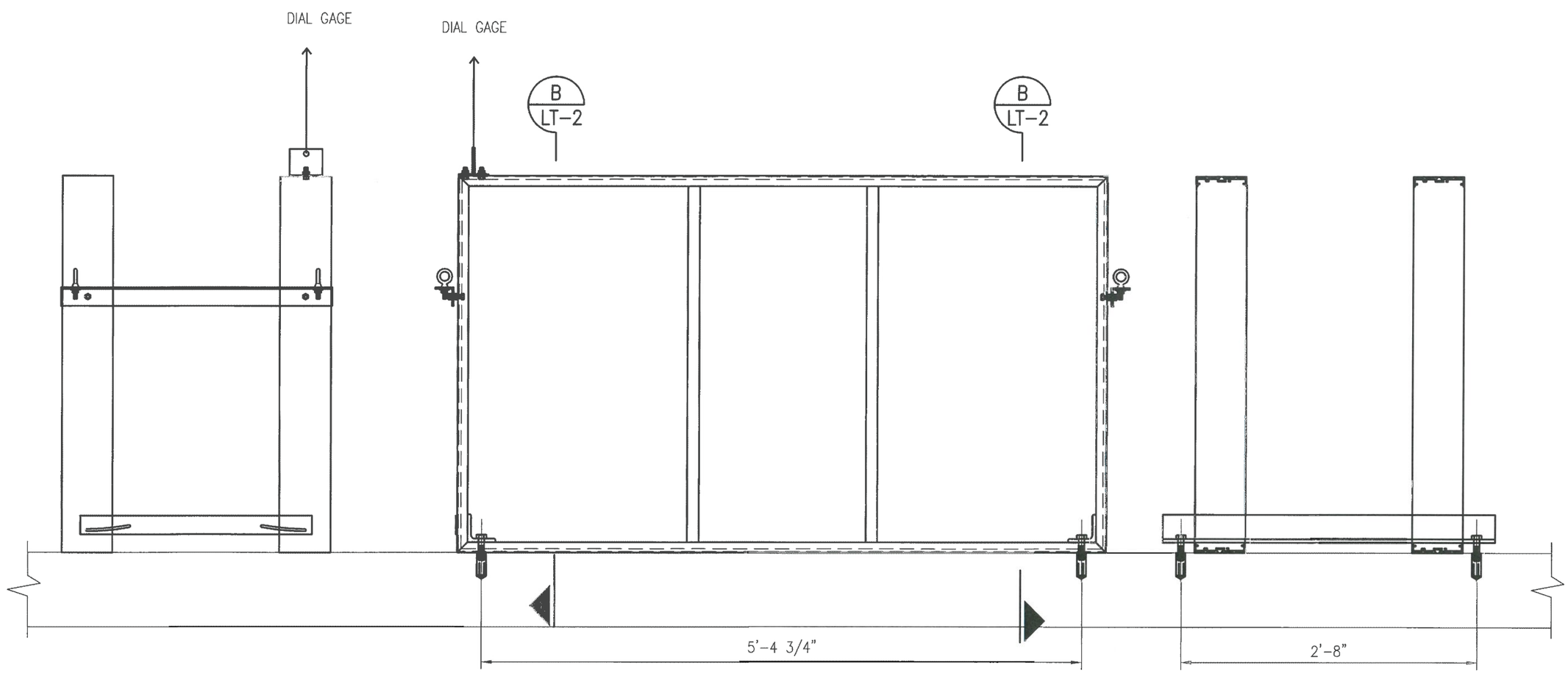
PROJECT
STATIC CONTROLS CORPORATION
ANDON BOARD CONNECTION REVIEW

TITLE
65"/70" DS LCD MONITOR FRAMES
CENTER SAFETY LUG TEST

DESIGN BY: RG
DRN BY: RG
DATE: 02/16/16
PROJECT NO. 16-042
SHEET NO. LT-1
REVISION

B-1




HOLD DOWN SUPPORT:
L3 x 3 x 3/8 or HSS x 3'-0" LONG
+ (2) 5/8" DIA. HILTI HDI DROP-IN ANCHORS
(INSTALLED PER MANUFACTURER'S INSTRUCTIONS)
+ (2) 5/8" DIA. X 2 1/4 GRADE 5 BOLTS

SECTION B LT-2
1"=1'-0"

# 65"/70" DS LCD MONITOR, TEST SETUP 2

SIDE FRAME/SAFETY CABLE LUG CONNECTIONS

DATE OF TEST: FEB. 23, 2016
TESTED TO: 500 LBS
OBSERVATIONS: SLIGHT FRAME DESTORTION
NO FAILURES

WITNESS: Ronald O Goetze
Ronald Goetze, PE

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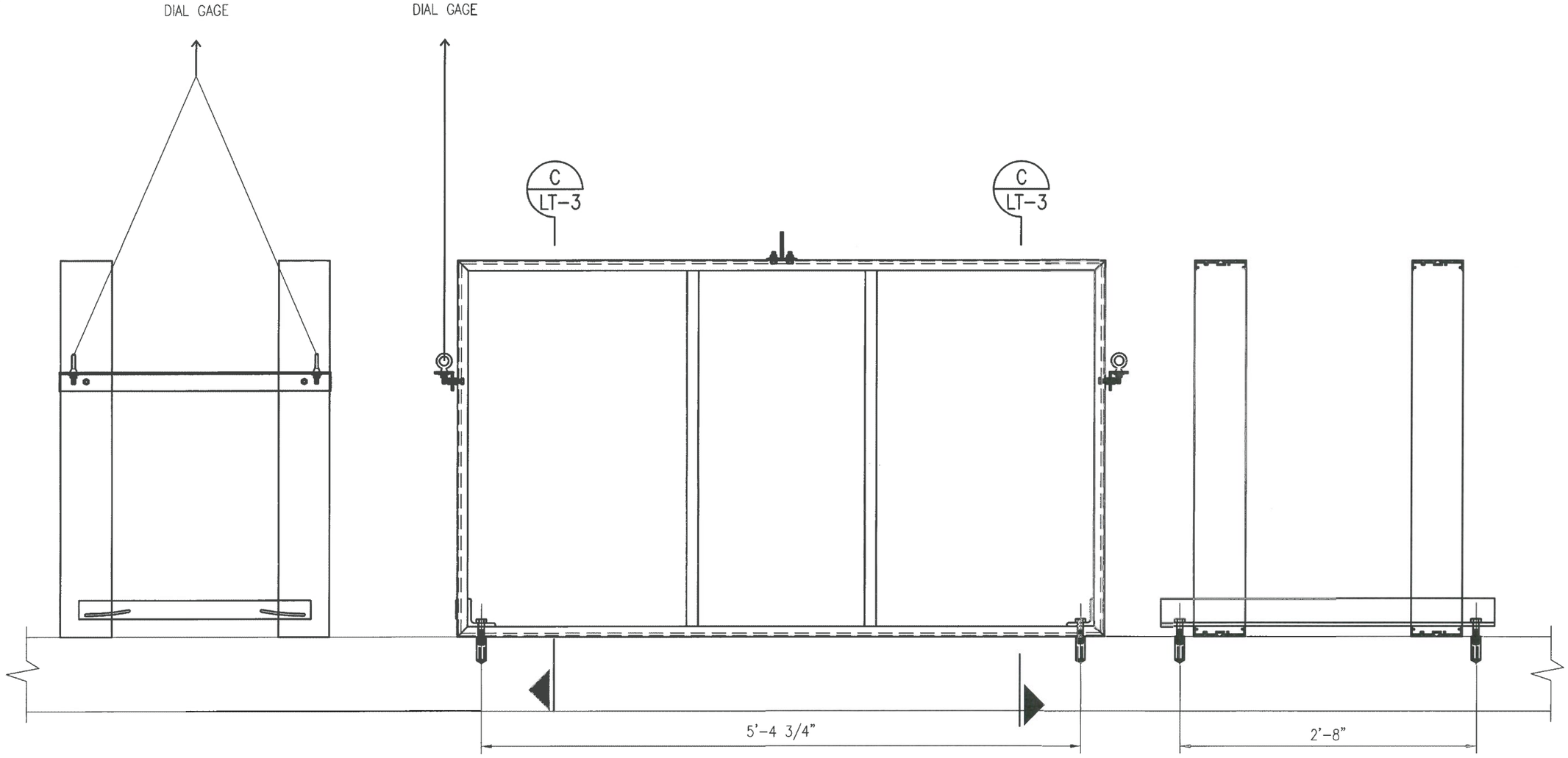
PROJECT
STATIC CONTROLS CORPORATION
ANDON BOARD CONNECTION REVIEW

TITLE
65"/70" DS LCD MONITOR FRAMES
SIDE FRAME CONNECTION TEST

DESIGN BY: RG
DRN BY: RG
DATE: 02/16/16
PROJECT NO. 16-042
SHEET NO. LT-2
REVISION

B-2




HOLD DOWN SUPPORT:
L3 x 3 x 3/8 or HSS x 3'-0" LONG
+ (2) 5/8" DIA. HILTI HDI DROP-IN ANCHORS
(INSTALLED PER MANUFACTURER'S INSTRUCTIONS)
+ (2) 5/8" DIA. X 2 1/4 GRADE 5 BOLTS

SECTION C LT-3
1"=1'-0"

# 65"/70" DS LCD MONITOR, TEST SETUP 3

MAIN LUG CONNECTION

DATE OF TEST: FEB. 23, 2016
TESTED TO: 800 LBS
OBSERVATIONS: VERTICAL FRAME DEFLECTION ≈ 1.5"
NO FAILURES

WITNESS: Ronald O Goetze
Ronald Goetze, PE

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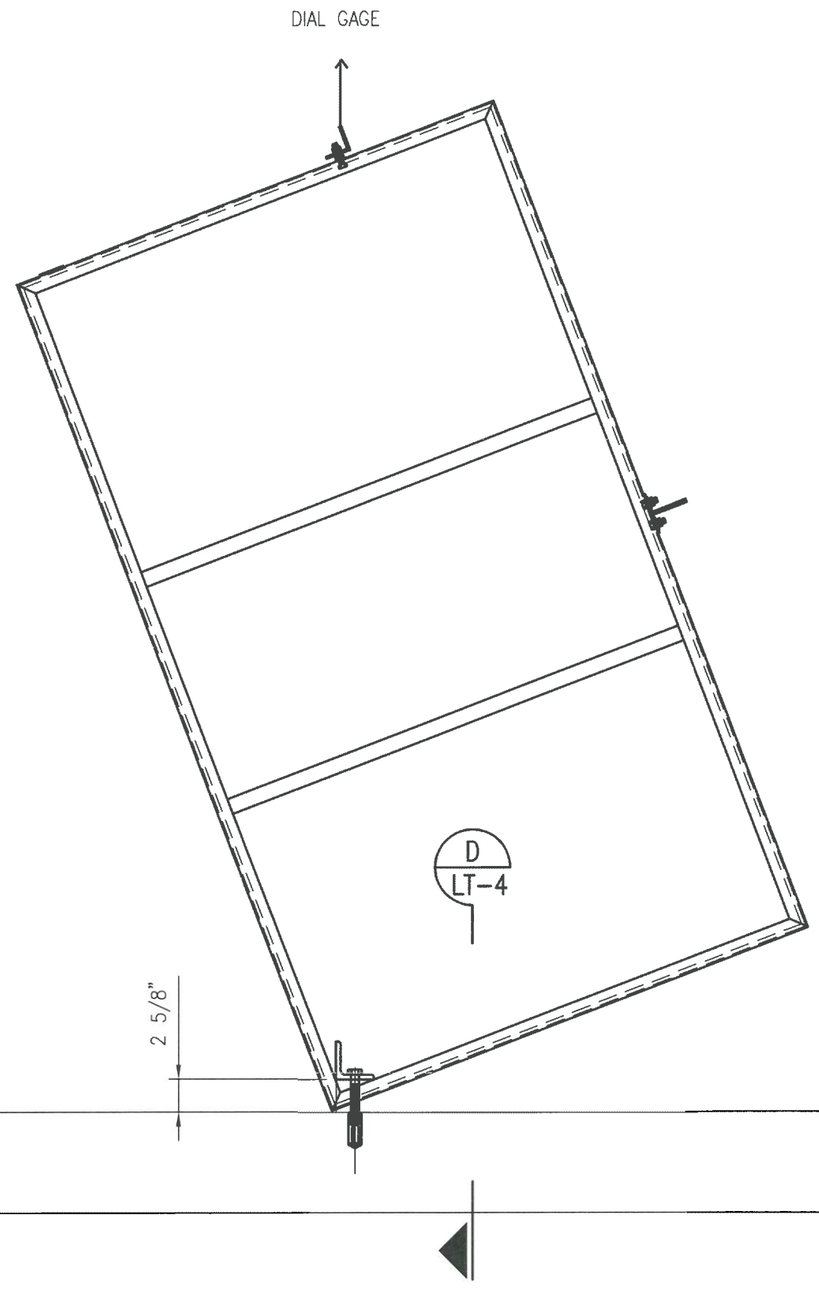
PROJECT
65"/ ANDON BOARD CONNECTION REVIEW

TITLE
70" DS LCD MONITOR FRAMES
SIDE ANGLE TEST 1

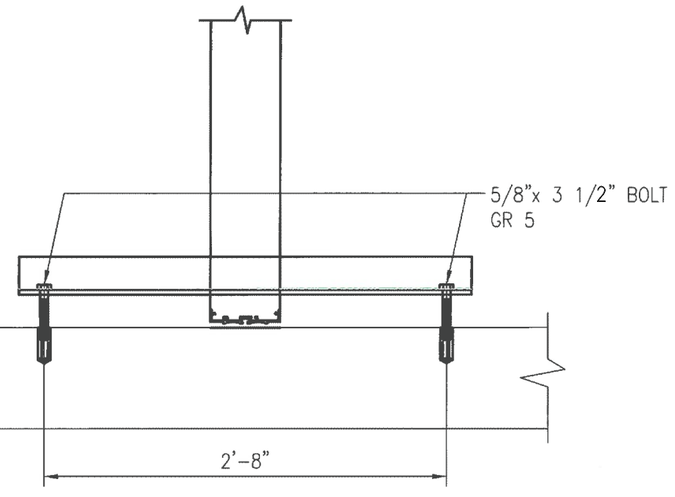
DESIGN BY: RG
DRN BY: RG
DATE: 02/16/16
PROJECT NO. 16-042
SHEET NO. LT-3
REVISION

B-3




DATE OF TEST: FEB. 23, 2016
TESTED TO: 500 LBS
OBSERVATIONS: FRAME DISTORTION, NO FAILURES

WITNESS: Ronald O Goetze
Ronald Goetze, PE




# 65"/70" DS LCD MONITOR, TEST SETUP 4

FRAME & CONNECTIONS WHEN LOAD ON END SAFETY CABLE

SECTION D LT-4
1"=1'-0"

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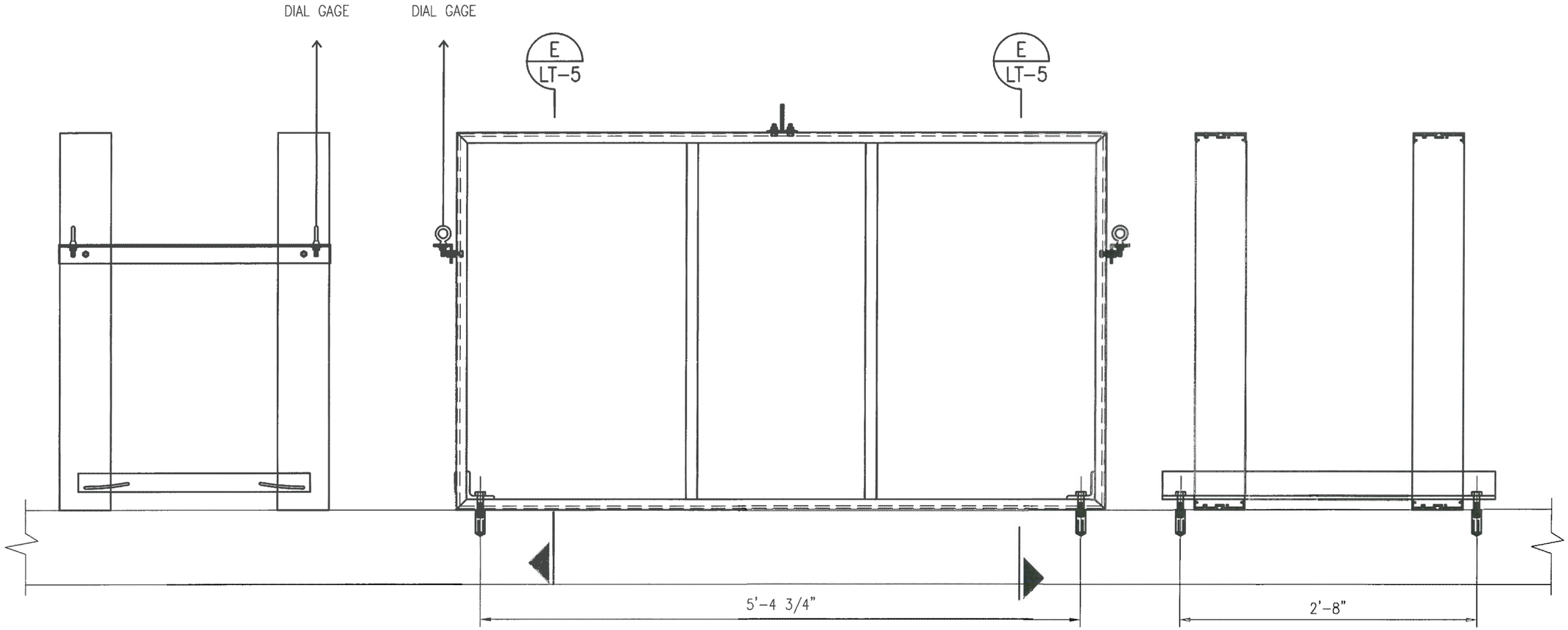
PROJECT
STATIC CONTROLS CORPORATION
ANDON BOARD CONNECTION REVIEW

TITLE
65"/70" DS LCD MONITOR FRAMES
SIDE ANGLE TEST 2 (SIMULATE SAFETY CABLE ONLY)

DESIGN BY: RG
DRN BY: RG
DATE: 02/16/16
PROJECT NO. 16-042
SHEET NO. LT-4
REVISION

B-4




HOLD DOWN SUPPORT:
L3 x 3 x 3/8 or HSS x 3'-0" LONG
+ (2) 5/8" DIA. HILTI HDI DROP-IN ANCHORS
(INSTALLED PER MANUFACTURER'S INSTRUCTIONS)
+ (2) 5/8" DIA. X 2 1/4 GRADE 5 BOLTS

SECTION E LT-5
1"=1'-0"

# 65"/70" DS LCD MONITOR, TEST SETUP 5

MAIN LUG CONNECTION

DATE OF TEST: FEB. 23, 2016
TESTED TO: 1100 LBS
OBSERVATIONS: CORNER CONNECTION SLIPPED
NO FAILURES

WITNESS: Ronald O Goetze
Ronald Goetze, PE

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PROJECT
65"/ ANDON BOARD CONNECTION REVIEW

TITLE
70" DS LCD MONITOR FRAMES
SIDE ANGLE TEST 3

DESIGN BY: RG
DRN BY: RG
DATE: 02/16/16
PROJECT NO. 16-042
SHEET NO. LT-5
REVISION

B-5

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# Appendix C
## (Load Test Pictures)

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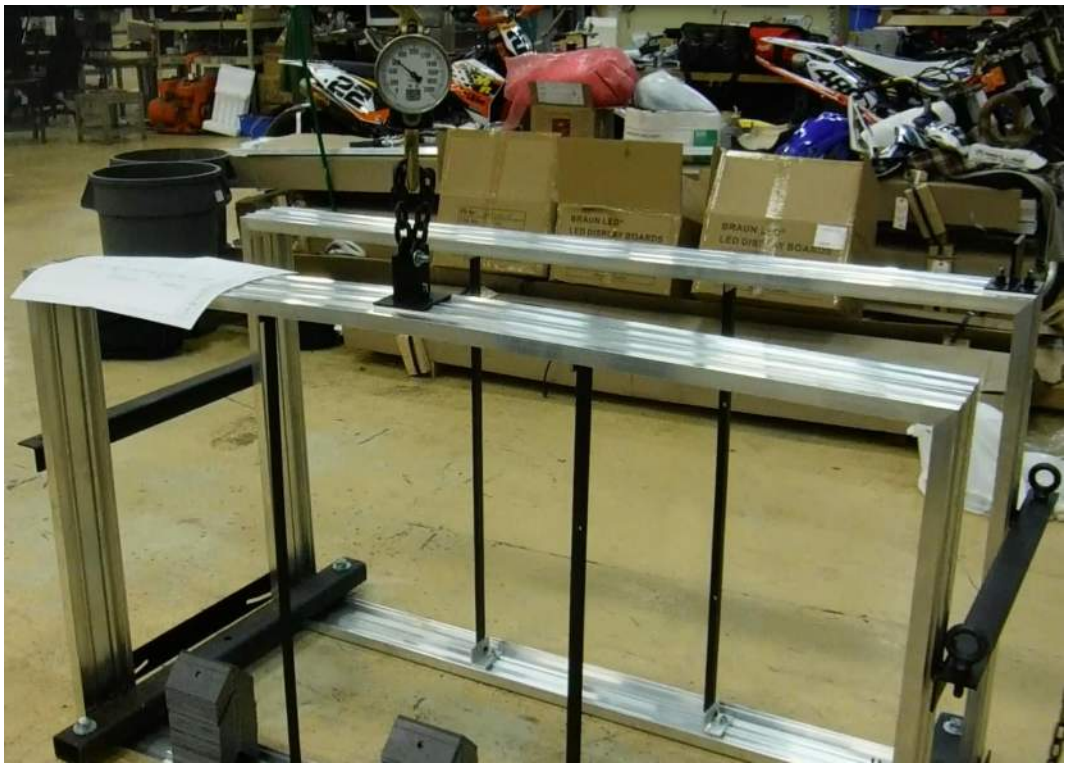

Photo 1: Test LT-1, Center Safety Lug [600 LBS]

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Photo 2: Test LT-2, Side Frame Connection Test [400 LBS]

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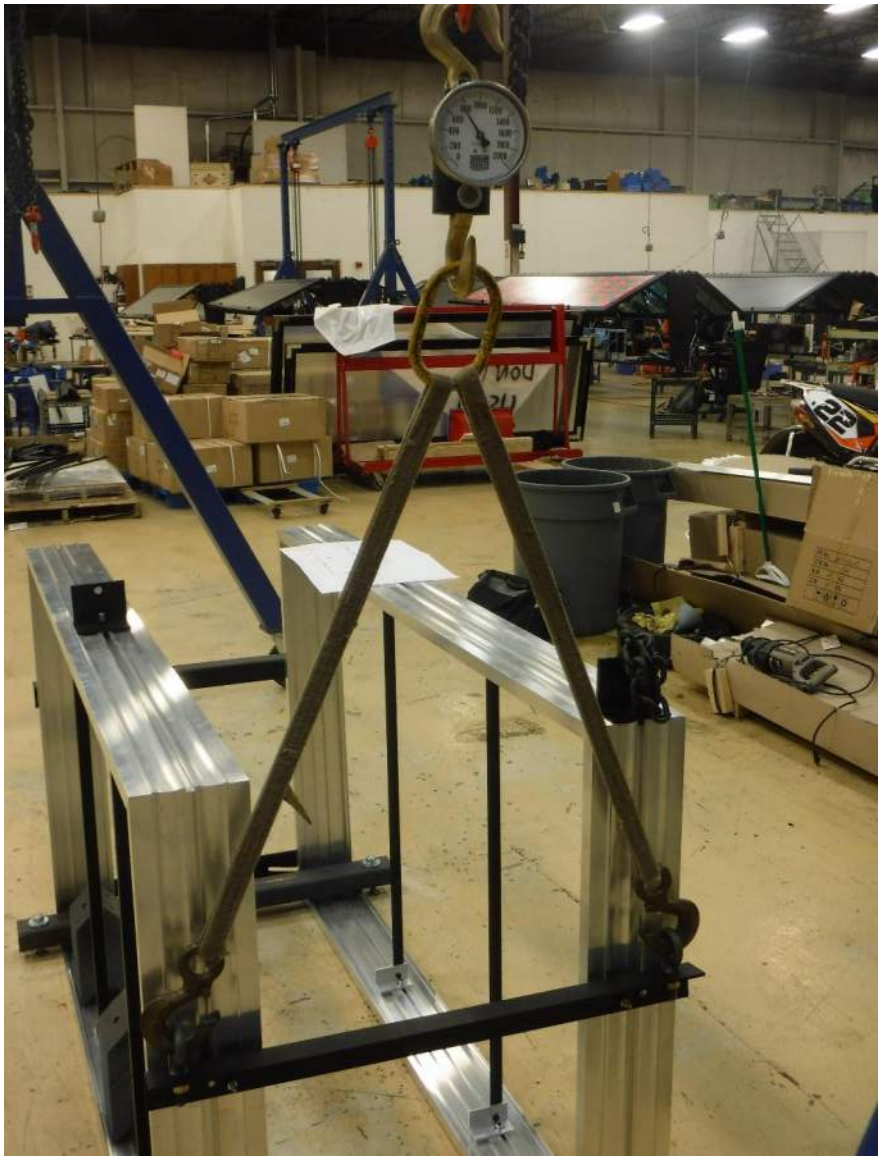

Photo 3: Test LT-3, Side Angle Test [800 LBS]

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Photo 4: Test LT-4, Side Angle Test 2 [600 LBS]

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Photo 5: Side Angle Test 2 [600 LBS]

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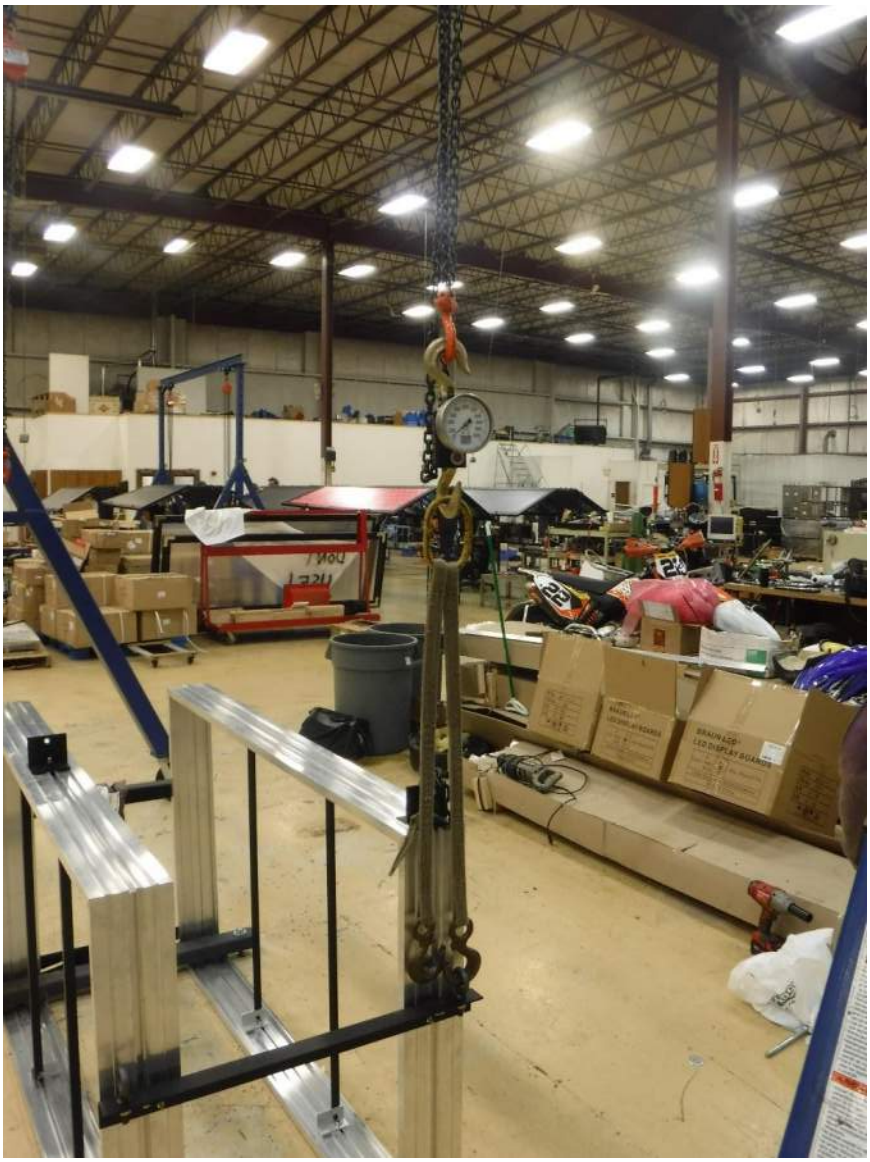

Photo 6: Test LT-5, Side Angle Test 3 [1100 LBS]

ruby+associates
STRUCTURAL ENGINEERS

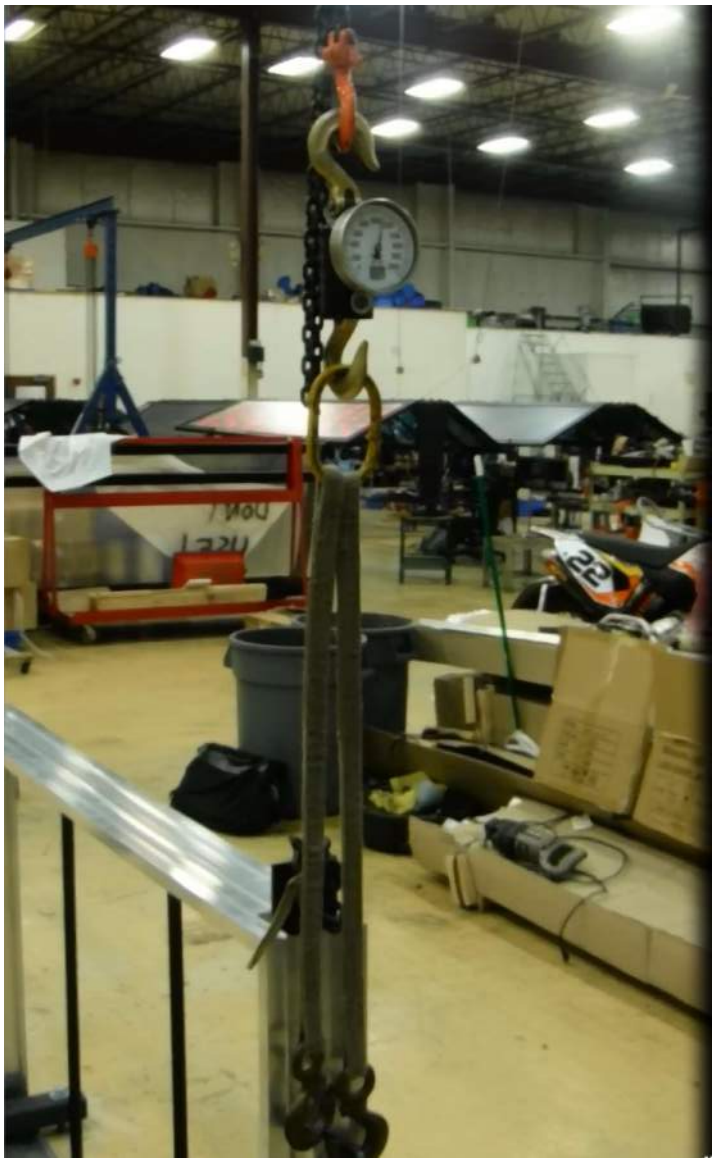

Photo 7: Test LT-5, Side Angle Test 3 [1100 LBS]

ruby+associates
STRUCTURAL ENGINEERS

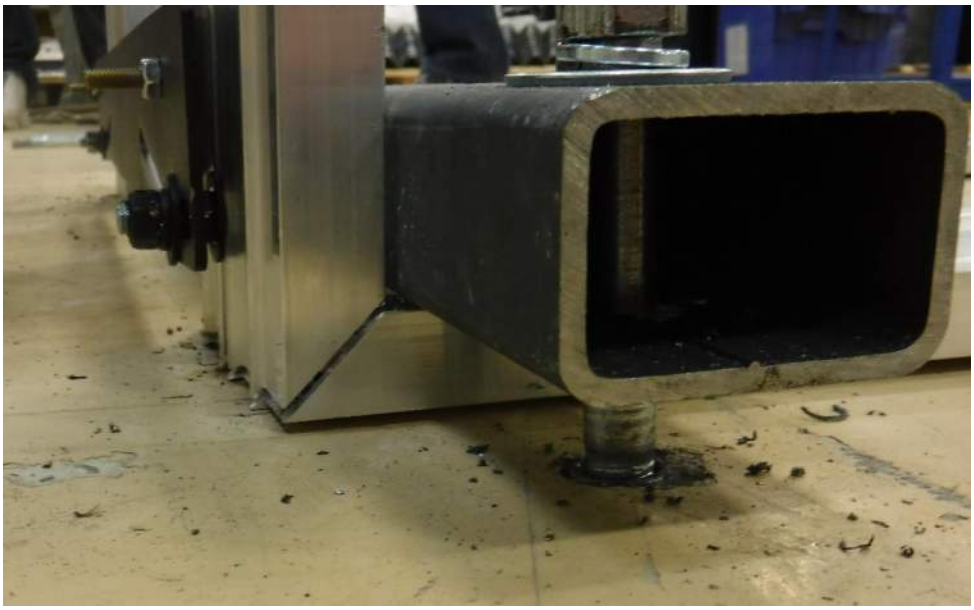

Photo 8: Test LT-5, Side Angle Test 3 [1100 LBS]

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Photo 9: Test LT-5, Side Angle Test 3 [1100 LBS]

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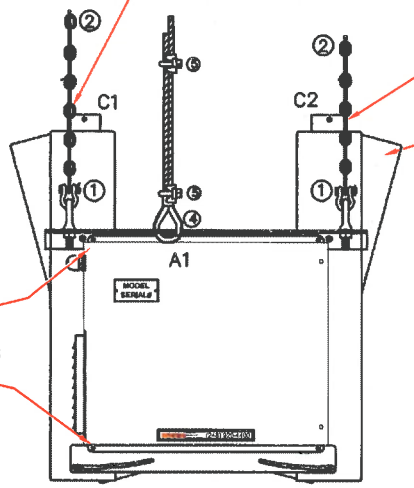
STRUCTURAL ENGINEERS

# Appendix D
## (Andon Board Drawings)

| SYM | REVISION | APP | DATE |
|---|---|---|---|
| A | ADDED SAFETY CABLE NOTE CHANGED TORQUE ON CONTROL BOX NUT. | BG | 01/28/16 |
| | | | |
| | | | |

CHAIN AND UPPER AND LOWER SHACKLES SHALL BE OF CORROSION RESISTANT MATERIAL AND BE RATED FOR OVERHEAD LIFTING WITH A WORKING LOAD LIMIT OF 3000 LBS. VERTICAL CHAIN LOADING ONLY.

5/16" GRADE 80 CHAIN WITH (2 TOP & BOTTOM) 3/8" GALV BOLT NUT & COTTER ANCHOR SHACKLE–(3000 LB WLL)




SUPPORT FROM EACH EYEBOLT WITH EQUAL CHAIN LENGTHS.

(2) SAFETY CABLES REQUIRED FOR EACH DISPLAY. LOOP AROUND BUILDING STEEL. (2) CROSBY CLAMPS AT EACH CONNECTION. CABLE SHALL NOT BE ROUTED OVER SHARP EDGES.
NOTE: DO NOT LEAVE MORE THAN 2" OF SLACK IN SAFETY CABLE.

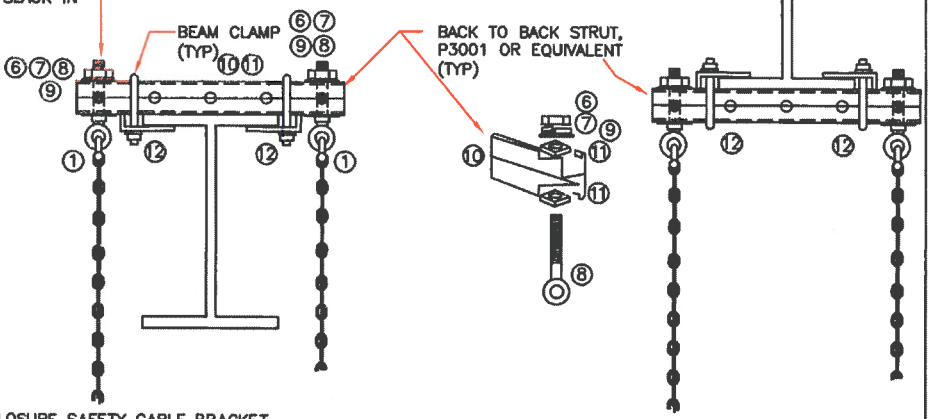
CONTROL BOX ATTACHMENT NUTS. TORQUE TO 7 FT LBS (TYP)

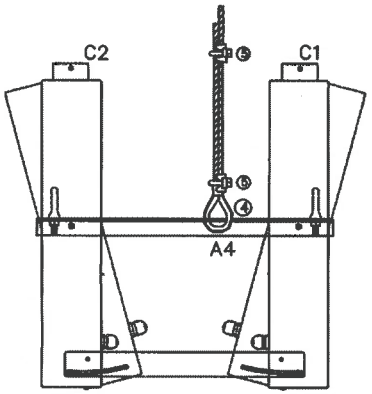
SYSTEM LEFT SIDE VIEW

MINIMUM CLEARANCES BETWEEN BOARD AND NEARBY SURFACES:
TOP: 6"
BOTTOM: 12"
SIDES: 36"
FACE: 36"

DO NOT MOUNT BOARD ABOVE EQUIPMENT WHICH GENERATES HEAT.

1/2" THREAD DIA. SHOULDER EYEBOLT, WASHERS, LOCK WASHER, NUT, WORKING LOAD LIMIT MIN. 2200 LBS. (TYP)




SYSTEM RIGHT SIDE VIEW

DISPLAY ENCLOSURE SAFETY CABLE BRACKET "C1 AND C2". TORQUE NYLOC NUTS TO 20 FT LBS.

CLOSE UP VIEW OF OUTER NUT. TORQUE TO 20 FT LBS (TYP)

FRONT VIEW OF LCD DISPLAY

HOW TO ADJUST ENCLOSURE TILT.

LOOSEN OUTER NUT ON BOTH ENDS OF BRACKET AND ADJUST MONITOR TO DESIRED ANGLE. TIGHTEN 4 NUTS TO HOLD MONITOR IN POSITION. TORQUE TO 20 FT LBS.

MONITOR FRONT VIEW TYP. PER SIDE

## TYPICAL ATTACHMENT OF BOARD SUPPORT CHAIN TO BUILDING STEEL

## STATIC CONTROLS 990 FLEXIBLE ANDON BOARD MOUNTING

(NOT TO SCALE)

1. LOCATION AND ELEVATION OF EACH UNIT TO BE DETERMINED IN FIELD PER SKETCH PROVIDED BY THE GM PROJECT ENGINEER.

2. MOUNTING METHOD(S) SHOWN ARE FOR REFERENCE ONLY. FINAL MOUNTING METHOD SHALL BE APPROVED BY CCRW AND PLANT ENGINEERING REPRESENTATIVES.

| DB Size | System Foot Print Size | MAX (AMPS) | Weight (LBS) |
|---|---|---|---|
| 70" SS LCD Monitor, with Control Box w/Music | 40.5"H x 76"W x 29"D | 7 | 210 |
| 70" DS LCD Monitor, with Control Box w/Music | 40.5"H x 76"W x 29"D | 10 | 370 |
| 65" SS LCD Monitor, with Control Box w/Music | 37.5"H x 71"W x 29"D | 7 | 170 |
| 65" DS LCD Monitor, with Control Box w/Music | 37.5"H x 71"W x 29"D | 10 | 290 |
| 55" SS LCD Monitor, with Control Box w/Music | 31.5"H x 61"W x 29"D | 6 | 150 |
| 55" DS LCD Monitor, with Control Box w/Music | 31.5"H x 61"W x 29"D | 9 | 250 |
| 42" SS LCD Monitor, with Control Box w/Music | 26"H x 51"W x 29"D | 5 | 130 |
| 42" DS LCD Monitor, with Control Box w/Music | 26"H x 51"W x 29"D | 8 | 210 |
| Stand alone Control Box w/Music | 19.5"H x 22.5"W x 8.6"D | 3 | 50 |

**Installation contractor responsible for all local practices/codes and structural load verification**

16-042 P-1


Static Controls Corporation
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Customer Approval | By | Released for Prod. | Material Tolerances ± 0.005 on 2 Place Decimal ± 0.010 on 3 Place Decimal

Dr MT | App | Date 01/28/2016 | Scale N/A

Title: FLEXIBLE ANDON BOARD INSTALLATION DRAWING VERSION W

Part # SCC 990 | Layer 1 | File #990W_INST_V1.DWG | Page # 1 of 3 | DWG # 990W-INST-SCC

| SYM | REVISION | APP | DATE |
|---|---|---|---|
| A | | | |
| | | | |
| | | | |
| | | | |

## Install of one SCC 990 Flexible Andon Board & 8 Speaker Installation Hardware

| # | Description: | Manufacture | Part/Model Number | Unit of Measure | Purchase Quantity |
|---|---|---|---|---|---|
| 1 | 3/8" 3000lb-WLL Galvanized Bolt Nut & Cotter Anchor Shackle | Fastenal Pricing | 0504876 | each | 8 |
| 2 | 5/16" Grade 80 Chain 500 foot drum | Fastenal Pricing | 45034 | per foot | 80 |
| 3 | 1/4" Class 6 x 19 Fiber Core Wire Rope 500 foot need about 80 per board | Fastenal Pricing | 45576 | per foot | 80 |
| 4 | 1/4" Closed Galvanized Wire Rope Thimble | Fastenal Pricing | 43443 | each | 4 |
| 5 | 1/4" Drop Forged Wire Rope Clip | Fastenal Pricing | 43423 | each | 8 |
| 6 | 1/2" High Strength Nut (Furnished with item 8) | Fastenal Pricing | | each | 4 |
| 7 | 1/2" Heavy Lock Washer | Fastenal Pricing | 33895 | each | 4 |
| 8 | 1/2"-13 x 4-1/2" Shank Length Hot Dipped Galvanized Drop Forged Eye Bolt | Fastenal Pricing | 42445 | each | 4 |
| 9 | 1/2" High Strength Flat Washer | Fastenal Pricing | 33847 | each | 4 |
| 10 | Unistrut Channel: 1-5/8" x 2 3/4", 12 Gage, Back-to-Back, Slotted Holes P3001SH | Unistrut (Atkore) | P3001SH | 1' (10' sticks) | 1 |
| 11 | Unistrut Flat Plate Fitting: Width 1-5/8" x 1-5/8", Thickness 1/4" P1064 | Unistrut (Atkore) | P1064 | each | 8 |
| 12 | Unistrut Beam Clamp: 1-5/8" x 5" P2786 | Unistrut (Atkore) | P2786 | each | 4 |
| 13 | Andon Speaker, SPEAKER STATIC CNTRL 977-SPKR-R EXTERNAL | SCC | 1032-006X | each | 8 |
| 14 | 1/4" Beam Clamp: Speaker Installation | Appleton | BH-500 | each | 100 |
| 15 | Speaker Cable/Wire: Order in 1,000' spools | Belden | 8471 | per foot | 1,000 |
| 16 | Bridle Rings and Saddles: 1/4"-20 x 7/8" 2 Boxes (50/Box) | B-Line | each | BRS-32A | 60 |
| 17 | Cat5e Cable: General Cable GenSPEED® 5000, 1,000 ft. Pull-Pac® II, Non-Plenum, Blue For one board using 333feet of 1000foot roll | General Cable | each | 5133299E | 333 |
| 18 | Wire Nuts: For Speaker Terminations | | each | | 16 |

Installation contractor responsible for all local practices/codes and structural load verification

Static Controls Corporation
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FAX (248) 926-4412

Customer Approval | By | Released for Prod.

Dr MT | App | Date 01/29/2016 | Scale N/A

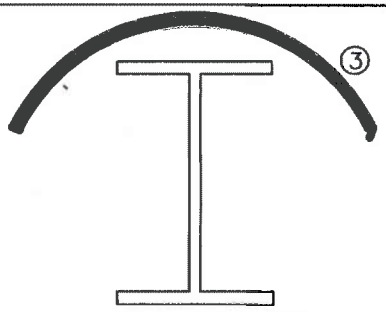
Title FLEXIBLE ANDON BOARD INSTALLATION DRAWING VERSION W

Part # SCC 990 | Layer 1 | File # 990W_INST_PR.DWG | Page # 2 of 3

DWG # 990W-INST-SCC

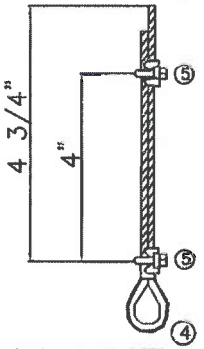
16-042 D-2

| SYM | REVISION | APP | DATE |
|---|---|---|---|
| A | ADDED SAFETY CABLE NOTE CHANGED TORQUE ON CONTROL BOX NUT. | BG | 01/25/18 |
| | | | |
| | | | |




I – BEAM OF BUILDING STEEL

(2) SAFETY CABLES REQUIRED FOR EACH DISPLAY BOARD SYSTEM. LOOP AROUND BUILDING STEEL.
(2) CROSBY CLAMPS AT EACH CONNECTION. CABLE SHALL NOT BE ROUTED OVER SHARP EDGES.
NOTE: DO NOT LEAVE MORE THAN 2" OF SLACK IN SAFETY CABLE.




TYPICAL FOR ALL SAFETY CABLES WITH CROSBY CLAMPS.

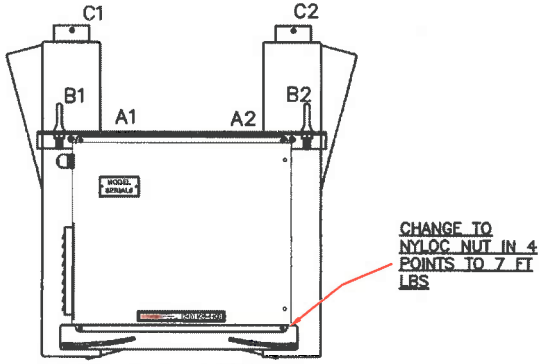
**RIGGING POINTS - A1, A2, A3, A4 WITH INSTALLATION CONTRACTORS HARDWARE. HOLE SIZED FOR 1/2" HARDWARE (0.53").**

**MOUNTING POINTS - B1, B2, B3, B4 WITH CHAIN AS SHOWN ON PAGE 1.**

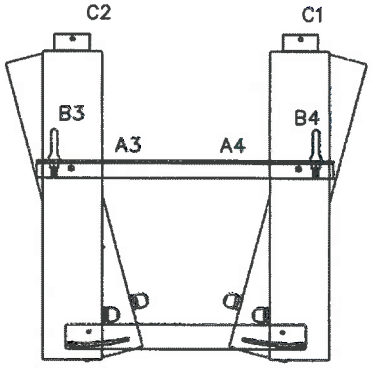
**SAFETY CABLE POINTS - A1 TO A4, AND C1 TO C2**
**NOTE: DO NOT LEAVE MORE THAN 2" OF SLACK IN SAFETY CABLE.**

SAFETY CABLE BRACKET C1 AND C2

SIDE VIEW FRONT VIEW

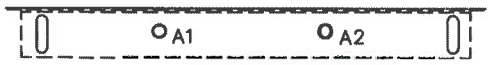



SYSTEM LEFT SIDE VIEW –CONTRDL BOX SIDE




SYSTEM RIGHT SIDE VIEW NON CONTROL BOX SIDE

TOP VIEW ANGLE BRACKET CONTROL BOX SIDE




TOP VIEW ANGLE BRACKET NON CONTROL BOX SIDE



SIDE VIEW ANGLE BRACKET CONTROL BOX SIDE


SIDE VIEW ANGLE BRACKET NON CONTROL BOX SIDE

## BARRICADE PERIMETER TAPE

RED DANGER TAPE (INDICATES HAZARD TO PEOPLE):
CROSSING THIS BARRICADE COULD LEAD TO INJURY. NEVER CROSS RED BARRICADE TAPE UNLESS GRANTED PERMISSION BY AN AUTHORIZED EMPLOYEE.

## SOME EXAMPLES INCLUDE:

- OVERHEAD WORK, ARIAL LIFT, MOBILE CRANE, ETC.
- RIGGING APPLICATIONS


## SEE WEB LINKS FOR MORE INFO.

http://www.constructionsafety.oq/toolbox/documents/wireropecableclipe_000.pdf
http://www.fdlake.com/wrclipe.html
http://www.safteng.net/index.php?option=com_content&view=article&id=662&Itemid=178

## WARNINGS AND APPLICATION INSTRUCTIONS.

THIS APPLICATION REQUIRES TWO CROSBY WIRE ROPE CLAMPS – INSTALLATION INSTRUCTIONS

- 1st CLAMP APPLY APPROXIMATELY 3/4" FROM DEAD END UBOLT IS PLACED OVER DEAD END OF 1/4" WIRE ROPE. LIVE END REST IN THE SADDLE.
- 2ND CLAMP APPLY NEAR THE THIMBLE.
  NOTE: ALL NUTS TIGHTEN EVENLY, ALTERNATING TURNS.

Installation contractor responsible for all local practices/codes and structural load verification


Static Controls Corporation
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| | |
|---|---|
| Customer Approval | |
| By | |
| Released for Prod. | |
| Mechanical Tolerance ± 0.030 on 2 Place Decimal ± 0.010 on 3 Place Decimal | |
| Dr MT | |
| App | |
| Date 01/29/2018 | |
| Scale N/A | |

Title: FLEXIBLE ANDON BOARD INSTALLATION DRAWING VERSION W

Part # SCC 990 Layer 1

File # 990W_INST_SCC.DWG Page # 5 of 5

Dwg # 990W-INST-SCC

16-042 D-3

# MODIFICATIONS REQUIRED TO ACCOMMODATE NEW GM SAFETY CABLE REQUIREMENTS

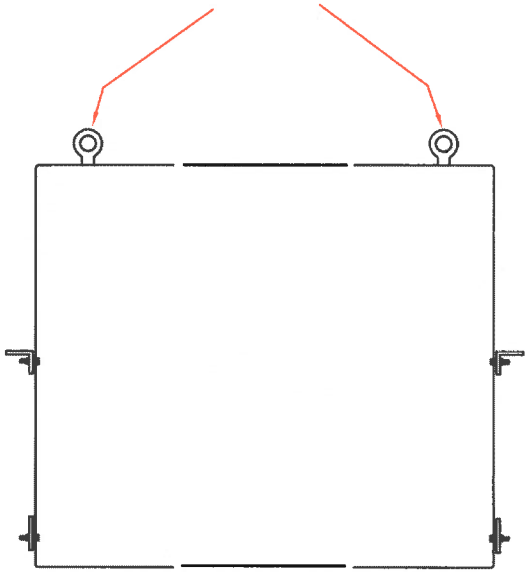
## PERFORM ALL MODIFICATIONS WITH 990 SYSTEM ON THE GROUND

| SYM | REVISION | APP | DATE |
|---|---|---|---|
| A | ADDED SAFETY CABLE NOTE CHANGED TORQUE ON CONTROL BOX NUT. | BG | 01/22/10 |
| B | ITEMS MOVED TO PAGES 2,3,4,5 | BG | 02/03/10 |

SAFETY CABLE BRACKET C1 AND C2

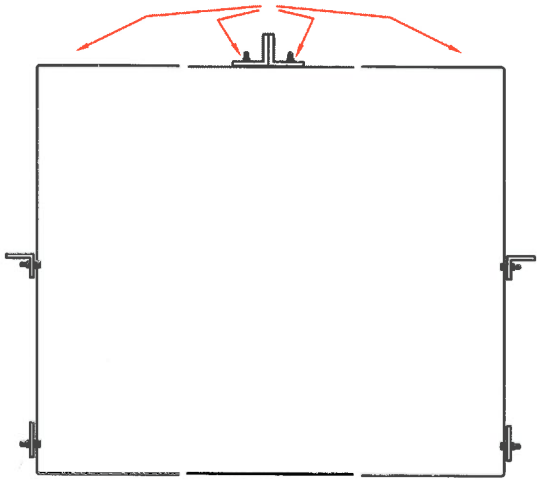
SIDE VIEW FRONT VIEW

STEP 1 - REMOVE EYE NUTS ON TOP OF DISPLAY (2 PER DISPLAY)



MONITOR FRONT VIEW

STEP 2 - USE EXISTING BOLTS AND WASHERS, SLIDE TO THE CENTER OF DISPLAY TO MOUNT C1 (BACK DISPLAY) AND C2 (FRONT DISPLAY) BRACKET USING NYLOC NUTS AT 10 FT LBS OF TORQUE.



MONITOR FRONT VIEW

Installation contractor responsible for all local practices/codes and structural load verification

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Customer Approval By | Released for Prod. | Mechanical Tolerances ± 0.030 on 2 Place Decimal ± 0.005 on 3 Place Decimal

Dr MT | App | Date 01/20/2010 | Scale N/A

Title FLEXIBLE ANDON BOARD SAFETY CABLE MODIFICATION DRAWING

Part # SCC 990 Layer 1

File # 990INST_MOD.DWG Page # 1 of 5

DWG # 990INST MOD

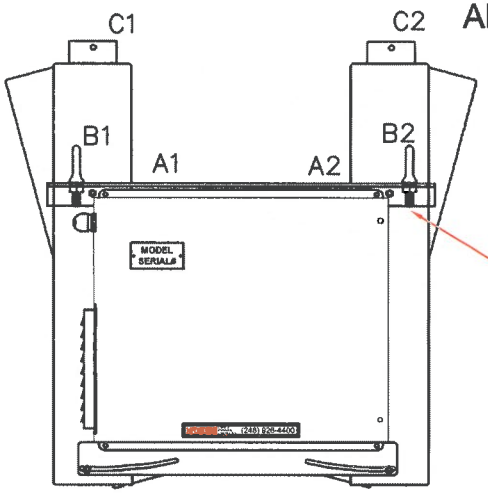
16-042 p-4

# MODIFICATIONS REQUIRED TO ACCOMMODATE NEW GM SAFETY CABLE REQUIREMENTS

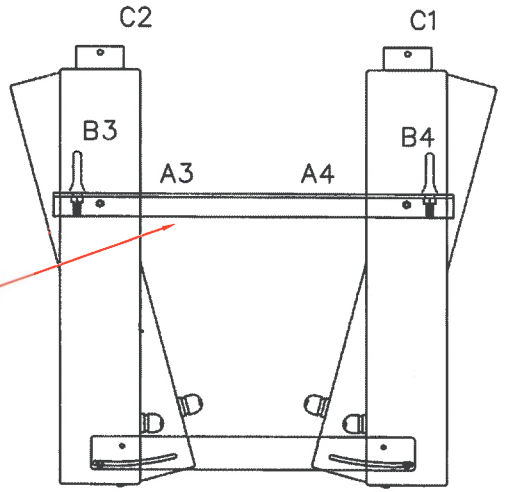
## PERFORM ALL MODIFICATIONS WITH 990 SYSTEM ON THE GROUND

| SYM | REVISION | APP | DATE |
|---|---|---|---|
| A | ADDED SAFETY CABLE NOTE CHANGED TORQUE ON CONTROL BOX NUT. | BG | 01/28/10 |
| B | ITEMS MOVE TO PAGES 3,4,5 | BG | 02/03/10 |
| | | | |

## STEP 3 - DRILL 9/16" HOLE FOR A1, A2, A3, AND A4.

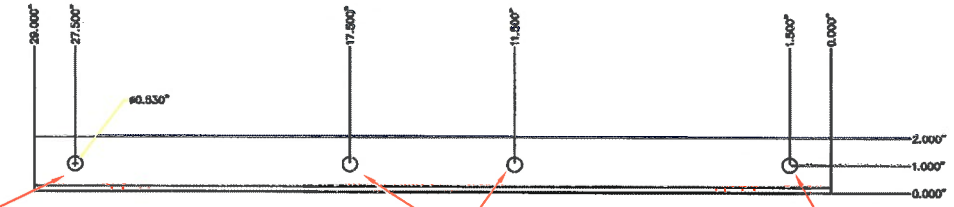



SYSTEM LEFT SIDE VIEW –CONTROL BOX SIDE




SYSTEM RIGHT SIDE VIEW NON CONTROL BOX SIDE

STEP 3 – DRILL TWO 9/16" HOLES IN EACH SIDE HANGING BRACKET FOR A1, A2, A3, AND A4.




EXISTING EYBOLT HOLE

NEW 9/16" HOLE LOCATIONS

EXISTING EYBOLT HOLE

**RIGGING POINTS - A1, A2, A3, A4 WITH INSTALLATION CONTRACTORS HARDWARE.**

**SAFETY CABLE POINTS - A1 TO A4, AND C1 TO C2.**

Installation contractor responsible for all local practices/codes and structural load verification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30480 WIXOM ROAD
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Customer Approval | By | Released for Prod. | Material Minimum .040 on 2 Plate Bonded .060 on 3 Plate Bonded

Dr MT | App | Date 01/29/2010 | Scale N/A

Title: FLEXIBLE ANDON BOARD SAFETY CABLE MODIFICATION DRAWING

Part # SCC 990 | Layer 1 | File # 990INST_MOD.DWG | Page # 2 of 5

DWG # 990INST MOD

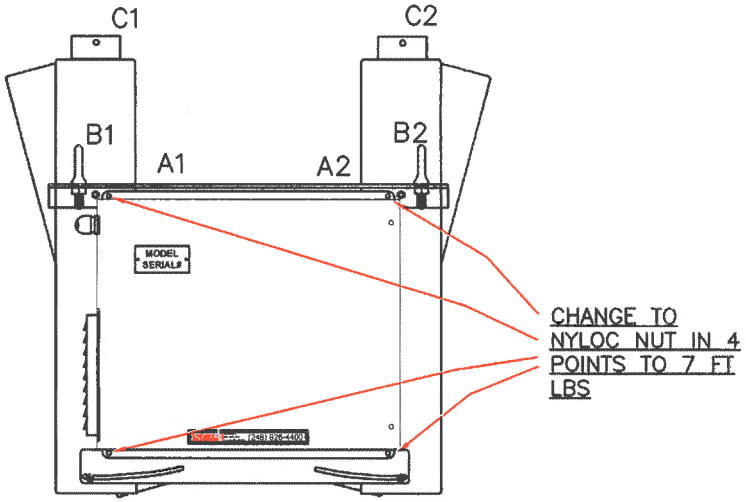
16-042 S-5

# MODIFICATIONS REQUIRED TO ACCOMMODATE NEW GM SAFETY CABLE REQUIREMENTS

## PERFORM ALL MODIFICATIONS WITH 990 SYSTEM ON THE GROUND

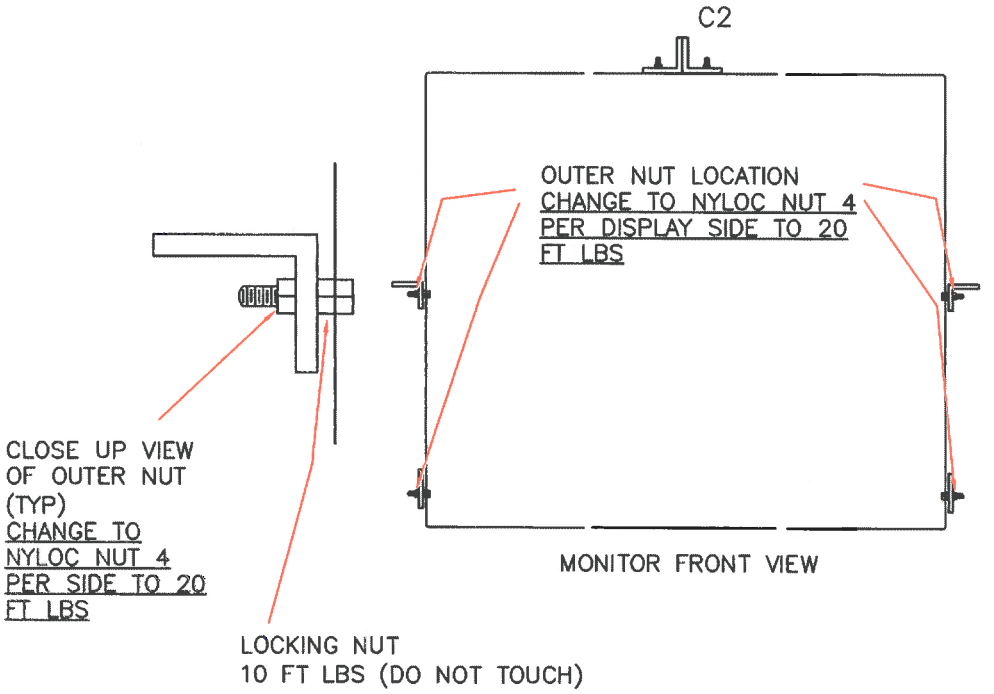
| SYM | REVISION | APP | DATE |
|---|---|---|---|
| A | ADDED SAFETY CABLE NOTE CHANGED TORQUE ON CONTROL BOX NUT. | BG | 01/25/16 |
| B | PAGE ADDED | BG | 02/03/16 |
| | | | |

**STEP 4 - REPLACE (4) HOLDING NUTS ON CONTROL BOX WITH NYLOC NUTS. TORQUE TO 7 FT LBS.**




SYSTEM LEFT SIDE VIEW –CONTROL BOX SIDE

**STEP 5 - REPLACE OUTER NUTS (4) PER DISPLAY ON SIDE BRACKETS WITH NYLOC NUTS. TORQUE TO 20 FT LBS.**




MONITOR FRONT VIEW

Installation contractor responsible for all local practices/codes and structural load verification


Static Controls Corporation
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FAX (248) 926-4412


Customer Approval
By
Dr MT
App
Released for Prod.
Date 01/25/2016
Material Tolerance ± 0.005 on 2 Place Decimal ± 0.005 on 3 Place Decimal
Scale N/A

Title: FLEXIBLE ANDON BOARD SAFETY CABLE MODIFICATION DRAWING
Part # SCC 990 Layer 1
File # 990INST_MOD.DWG Page # 5 of 6
DWG # 990INST MOD

16-042 D-6

# MODIFICATIONS REQUIRED TO ACCOMMODATE NEW GM SAFETY CABLE REQUIREMENTS

## PERFORM ALL MODIFICATIONS WITH 990 SYSTEM ON THE GROUND

| SYM | REVISION | APP | DATE |
|---|---|---|---|
| A | ADDED SAFETY CABLE NOTE CHANGED TORQUE ON CONTROL BOX NUT. | BG | 01/25/16 |
| B | PAGE ADDED | BG | 02/03/16 |
| | | | |

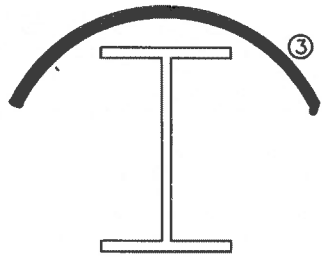
**RIGGING POINTS - A1, A2, A3, A4 WITH INSTALLATION CONTRACTORS HARDWARE.**

**MOUNTING POINTS - B1, B2, B3, B4 WITH CHAIN AS SHOWN ON PAGE 5.**

**SAFETY CABLE POINTS - A1 AROUND BUILDING STEEL TO A4, AND C1 AROUND BUILDING STEEL TO C2**
**NOTE: DO NOT LEAVE MORE THAN 2" OF SLACK IN SAFETY CABLE.**

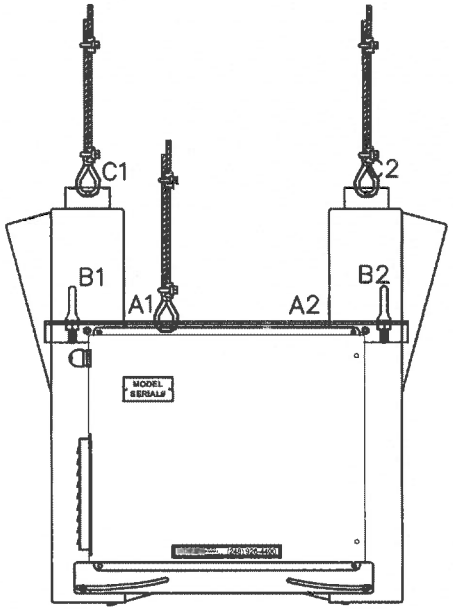
SCC TESTING ( VERTICAL LOAD)

B1, B2, B3, OR B4 - SUCCESSFUL AT 1400 LBS PER POINT
C1, OR C2 - SUCCESSFUL AT 1400 LBS PER POINT

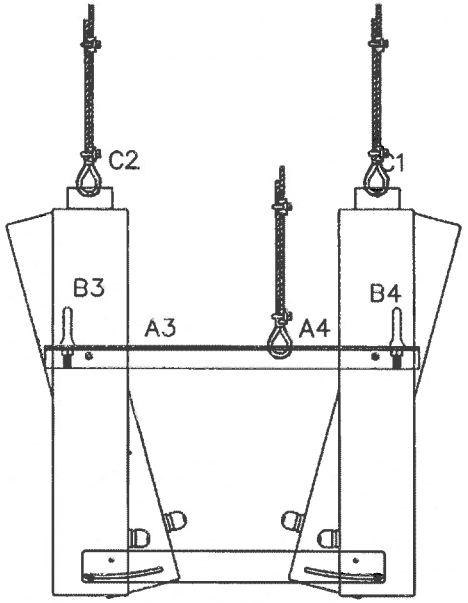


I – BEAM OF BUILDING STEEL

(2) SAFETY CABLES REQUIRED FOR EACH DISPLAY BOARD SYSTEM. LOOP AROUND BUILDING STEEL.
(2) CROSBY CLAMPS AT EACH CONNECTION. CABLE SHALL NOT BE ROUTED OVER SHARP EDGES.
NOTE: DO NOT LEAVE MORE THAN 2" OF SLACK IN SAFETY CABLE.



SYSTEM LEFT SIDE VIEW –CONTROL BOX SIDE



SYSTEM RIGHT SIDE VIEW NON CONTROL BOX SIDE

Installation contractor responsible for all local practices/codes and structural load verification

Static Controls Corporation
30460 WIXOM ROAD
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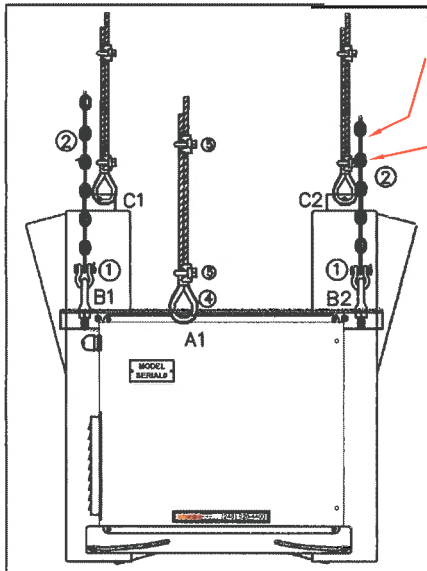
FAX (248) 926-4412

Customer Approval
By
Released for Prod.
Dr MT
App
Date 01/29/2016
Scale N/A

Title FLEXIBLE ANDON BOARD SAFETY CABLE MODIFICATION DRAWING
Part # SCC 990 Layer 1
File # 990INST_MOD.DWG Page # 4 of 5
DWG # 990INST MOD

16-042 D-7

| SYM | REVISION | APP | DATE |
|---|---|---|---|
| A | ADDED SAFETY CABLE NOTE CHANGED TORQUE ON CONTROL BOX NUT. | BG | 01/22/16 |
| B | PAGE ADDED | BG | 02/03/16 |
| | | | |




SYSTEM LEFT SIDE VIEW

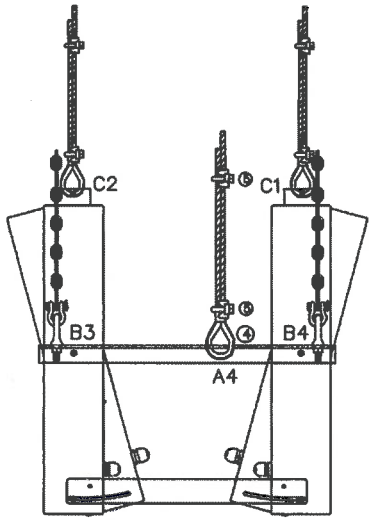
5/16" GRADE 80 CHAIN WITH (2 TOP & BOTTOM) 3/8" GALV BOLT NUT & COTTER ANCHOR SHACKLE–(3000 LB WLL)

SUPPORT FROM EACH EYEBOLT WITH EQUAL CHAIN LENGTHS.

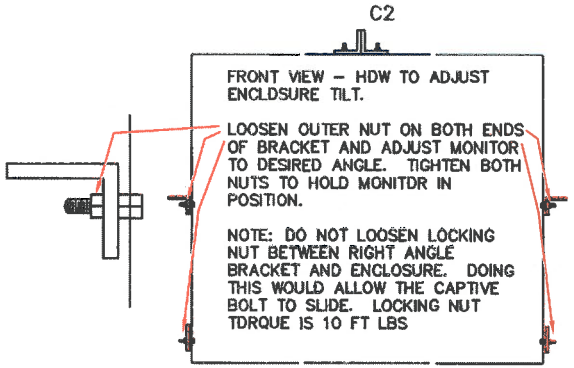
CHAIN AND UPPER AND LOWER SHACKLES SHALL BE OF CORROSION RESISTANT MATERIAL AND BE RATED FOR OVERHEAD LIFTING WITH A WORKING LOAD LIMIT OF 3000 LBS. VERTICAL CHAIN LOADING ONLY.

MINIMUM CLEARANCES BETWEEN BOARD AND NEARBY SURFACES:
TDP: 6"
BOTTOM: 12"
SIDES: 36"
FACE: 36"

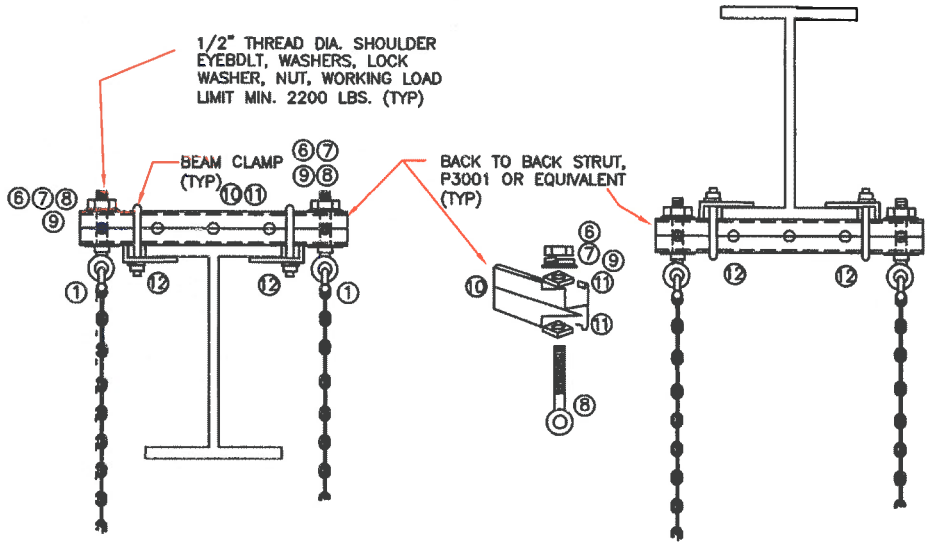
DO NOT MOUNT BOARD ABOVE EQUIPMENT WHICH GENERATES HEAT.




SYSTEM RIGHT SIDE VIEW




MDNITOR FRONT VIEW




TYPICAL ATTACHMENT OF BOARD SUPPORT CHAIN TO BUILDING STEEL

| DB Size | System Foot Print Size | MAX (AMPS) | Weight (LBS) |
|---|---|---|---|
| 70" SS LCD Monitor, with Control Box w/Music | 40.5"H x 76"W x 29"D | 7 | 210 |
| 70" DS LCD Monitor, with Control Box w/Music | 40.5"H x 76"W x 29"D | 10 | 370 |
| 65" SS LCD Monitor, with Control Box w/Music | 37.5"H x 71"W x 29"D | 7 | 170 |
| 65" DS LCD Monitor, with Control Box w/Music | 37.5"H x 71"W x 29"D | 10 | 290 |
| 55" SS LCD Monitor, with Control Box w/Music | 31.5"H x 61"W x 29"D | 6 | 150 |
| 55" DS LCD Monitor, with Control Box w/Music | 31.5"H x 61"W x 29"D | 9 | 250 |
| 42" SS LCD Monitor, with Control Box w/Music | 26"H x 51"W x 29"D | 5 | 130 |
| 42" DS LCD Monitor, with Control Box w/Music | 26"H x 51"W x 29"D | 8 | 210 |
| Stand alone Control Box w/Music | 19.5"H x 22.5"W x 8.6"D | 3 | 50 |

STATIC CONTROLS 990 FLEXIBLE ANDON BOARD MOUNTING

(NOT TO SCALE)

1. LOCATION AND ELEVATION OF EACH UNIT TO BE DETERMINED IN FIELD PER SKETCH PROVIDED BY THE GM PROJECT ENGINEER.

2. MOUNTING METHOD(S) SHOWN ARE FOR REFERENCE ONLY. FINAL MOUNTING METHOD SHALL BE APPROVED BY CCRW AND PLANT ENGINEERING REPRESENTATIVES.

Installation contractor responsible for all local practices/codes and structural load verification


SCC Static Controls Corporation
30460 WIXOM ROAD
WIXOM, MI. 48393
(248) 926-4400
FAX (248) 926-4412


Customer Approval | By | Released for Prod. | Dr MT | App | Date 01/20/2015 | Scale N/A

Title: FLEXIBLE ANDON BOARD SAFETY CABLE MODIFICATION DRAWING

Part # SCC 990 | Layer 1 | File # | Page # 5 of 6

Dwg # 990-INST-MOD

16-042 08