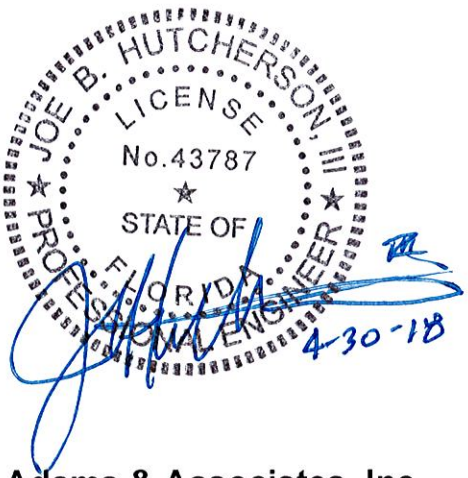
Roof Curb Clip Calculations
for
Lennox RTUs
2017 Florida Building Code

For:

Curbs Plus, Inc.
8767 Alabama Hwy (GA Hwy 151)
Ringgold, GA 30736

March 2018



March Adams & Associates, Inc.
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Chattanooga, Tennessee 37404
Job #: 18-098

Clip capacity Information for use by Design Professionals in determining the number and location of the clips required to secure mechanical equipment to the roof curb - maximum wind speed 175 mph.

CALCULATIONS per the 2017 Florida Building Code

Notes:
1) All page and section references in this calculation to wind loads are to the referenced Building Code, U.N.
2) All references for Cold Form Steel Calculations are to the *North American Specification for the Design of Cold-Formed Steel Structural Members* - 2001 Edition

Design Note: The 14 ga clips were checked for different types of units and were found to be adequate for equipment hold down. Clips are to be installed as shown on the Hold Down Clip Locations sketch and attached using (4) #14 Teks to the curb and to the unit.

Wind Forces per Section 1609

$Wind\_Code = \text{"ASCE 7-10"}$ <---per Section 1609.1.1 of 2017 Florida Building Code

$Risk_{Category} = \text{"II"}$ <---per Table 1.5-1 of ASCE 7-10

$V_W = 175 \cdot mph$ <---basic wind speed, ASCE 7-10 Figures 26.5-1A, 26.5-1B and 26.5-1C dependent on Risk Catagory

$K_d := 0.9$ <---wind directional factor, see ASCE 7-10 Section 26.6 and Table 26.6-1

$Exposure = \text{"C"}$ <---exposure category, see ASCE 7-10 Section 26.7.3

$\alpha = 9.5$ <---Table 26.9-1, 3-second gust speed power law exponent

$z_g = 900\,ft$ <---Table 26.9-1, nominal height of the atmospheric boundary layer

$z_{min} = 15\,ft$ <---Table 2614, exposure constant

$H_R = 30\,ft$ <---roof height

$z := \max(z_{min}, H_R)$ $z = 30\,ft$ <---mean roof height or min, used in calcs for MWFRS and Comp and Cladding

$K_z := 2.01\left(\frac{z}{z_g}\right)^{\frac{2}{\alpha}}$ $K_z = 0.98$ <---Velocity pressure exposure coefficient, Table 27.3-1 ASCE 7-10

$K_{zt} = 1$ <---topographic factor, see ASCE 7-10 Section 26.8.2

$q_z := 0.00256 \cdot K_z \cdot K_{zt} \cdot K_d \left(\frac{V_W}{mph}\right)^2 \cdot psf$ <---basic velocity pressure, ASCE 7-10, Section30.3.2 and Eq. 30.3-1

$q_z = 69.3 \cdot psf$ $q_h := q_z$

Clip Values

Assume unit gauge and material match clip

$F_u = 54 \cdot ksi$ <---tensile strength of steel

$\Omega_{screw} := 3$ <---safety factor for screw connections, see Section E4

$Ga_{clip} = 14$ <---gauge of clip

$L_{clip} = 6 \cdot in$ <---length of clip

$t_c = 0.0713 \cdot in$ <---thickness of clip

$$P_{ns} := \left| \begin{array}{l} E_{4.3.1\_1} \leftarrow 4.2 \cdot \left(t_c^{\,3} \cdot d_{14}\right)^{\frac{1}{2}} \cdot F_u \\ E_{4.3.1\_2} \leftarrow 2.7 \cdot t_c \cdot d_{14} \cdot F_u \\ \min\left(E_{4.3.1\_1}, E_{4.3.1\_2}\right) \end{array} \right.$$

$P_{ns} = 2158.97 \cdot lbf$ <---nominal shear strength, per screw- *Eq.* E4.3.1-1 and E4.3.1-2

$P_{as} := \frac{P_{ns}}{\Omega_{screw}}$ $P_{as} = 719.66 \cdot lbf$ <---allowable shear on material, per screw

$e_{min} := \frac{P_{ns}}{t_c \cdot F_u}$ $e_{min} = 0.56 \cdot in$ <---minimum end distance, E4.2 and E4.3.2

$sp_{min} := 3 \cdot d_{14}$ $sp_{min} = 0.75 \cdot in$ <---minimum screw spacing, E4.1

$edge_{min} := 1.5 d_{14}$ $edge_{min} = 0.38 \cdot in$ <---minimum edge distance, E4.2

Screw Values

$N_{screws} = 4$ <---number of screws per clip

$V14_{ult} = 2584 \cdot lbf$ <---ultimate shear value on 1/4" Tek screw

$V14_{all} := \frac{0.8 V14_{ult}}{\Omega_{screw}}$ $V14_{all} = 689 \cdot lbf$ <---allowable shear, E4.3.3

$V_{clip} := \min\left(V14_{all}, P_{as}\right) \cdot N_{screws}$ <---total allowable shear on clip

$V_{clip} = 2756.27 \cdot lbf$

Bending

$\Omega_b := 1.67$ <---safety factor for bending, C3.1.1

$F_y = 38 \cdot ksi$ <---yield stress of steel

$S_e := \frac{t_c \cdot L_{clip}^2}{6}$ $S_e = 0.43 \cdot in^3$ <---effective section modulus

$M_n := S_e \cdot F_y$ <---effective yield moment, Eq C3.1.1-1

$M_a := \frac{M_n}{\Omega_b}$ <---allowable bending in clip

$M_a = 9.73 \cdot kip \cdot in$

Equipment: Lennox
Models: KCA, KGA, KHA 024-072 and LCH, LGH 036-072 (Worst Case)
for use with Curbs Plus Curb #:
LENNOX T/K-SERIES/LGH-LCH 024-072

$sub_{matrix1}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"KCA-024"	83.25	45	35.38	18	495	79.13	40.88
"KCA-030"	83.25	45	35.38	18	496	79.13	40.88
"KCA-036"	83.25	45	35.38	18	499	79.13	40.88
"KCA-048"	83.25	45	35.38	18	535	79.13	40.88
"KCA-060"	83.25	45	35.38	18	565	79.13	40.88
"KCA-072"	83.25	45	35.38	18	664	79.13	40.88

$sub_{matrix2}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"KGA-024"	83.25	45	35.38	18	532	79.13	40.88
"KGA-030"	83.25	45	35.38	18	533	79.13	40.88
"KGA-036"	83.25	45	35.38	18	534	79.13	40.88
"KGA-048"	83.25	45	35.38	18	571	79.13	40.88
"KGA-060"	83.25	45	35.38	18	600	79.13	40.88
"KGA-072"	83.25	45	35.38	18	700	79.13	40.88

$sub_{matrix3}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"KHA-024"	83.25	45	35.38	18	532	79.13	40.88
"KHA-030"	83.25	45	35.38	18	533	79.13	40.88
"KHA-036"	83.25	45	35.38	18	535	79.13	40.88
"KHA-048"	83.25	45	35.38	18	556	79.13	40.88
"KHA-060"	83.25	45	43.38	18	647	79.13	40.88
"KHA-072"	96.25	45	43.38	20.5	780	79.13	40.88

$sub_{matrix4}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"LCH-036"	83.25	45	35.38	18	532	79.13	40.88
"LCH-048"	83.25	45	35.38	18	562	79.13	40.88
"LCH-060"	83.25	45	43.38	18	648	79.13	40.88
"LCH-072"	83.25	45	43.38	18	726	79.13	40.88
"LGH-036"	83.25	45	35.38	18	567	79.13	40.88
"LGH-048"	83.25	45	35.38	18	599	79.13	40.88
"LGH-060"	83.25	45	43.38	18	685	79.13	40.88
"LGH-072"	83.25	45	43.38	18	762	79.13	40.88

Max Unit Data (see shop drawings in Appendix)

$L_{u\_max} = 96.25 \cdot in$ <---outside length of unit

$W_{u\_max} = 45 \cdot in$ <---outside width of unit

$H_{u\_max} = 43.38 \cdot in$ <---height of unit from top of curb

Cross_Section = "Square"

$Weight_{max} = 780\,lbf$ <---installation weight of mechanical unit.

Design Forces

Dead Forces

$P_{dead} := \frac{Weight_{max} \cdot L_{cg\_max}}{W_{u\_max}} = 355.33\,lbf$ <---minimum dead load per linear foot acting vertically on curb. Lcg (distance to center of gravity assumed at mid point)

Wind Forces

Wind blowing on Long side (Length) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_max} \cdot \max(L_{u\_max}, W_{u\_max})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 3817.8\,lbf$

Wind uplift on unit

$GC_r := 1.5$ <---factor for rooftop structures and equipment with Ar less than 0.1BL, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_r := W_{u\_max} \cdot L_{u\_max}$ <---horizontal projected area of the rooftop unit, ASCE 7-10

$F_v := q_h \cdot (GC_r) \cdot A_r$ <---vertical uplift force on rooftop unit, Eq. 29.5-3 ASCE 7-10

$F_v = 3126.97\,lbf$

$P_{vLwind} := \frac{F_h \cdot \frac{H_{u\_max}}{2}}{W_{u\_max}}$ $P_{vLwind} = 1840 \cdot lbf$ <---vertical wind force on curb

$N_{clipsL} = 2$ <---number of clips on long side (Length) of unit

$Uplift_L := \max\left(0lbf, \frac{P_{vLwind} - 0.6P_{dead}}{N_{clipsL}}\right)$ <---uplift per clip

$Uplift_L = 813.38 \cdot lbf$

Design Forces (continued_

Wind Forces (continued)

Wind blowing on short side (Width) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_max} \cdot \min(L_{u\_max}, W_{u\_max})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 1784.95\,lbf$

$$P_{vWwind} := \frac{F_h \cdot \frac{H_{u\_max}}{2}}{L_{u\_max}} = 402.19\,lbf$$ <---vertical wind force on curb

$N_{clipsW} = 1$ <---number of clips on long side (Length) of unit

$$Uplift_W := \max\left(0lbf, \frac{P_{vWwind} - 0.6P_{dead}}{N_{clipsW}}\right)$$ <---uplift per clip

$Uplift_W = 188.99 \cdot lbf$

$$Uplift := \max\left[Uplift_L, Uplift_W, \frac{F_v - 0.6 \cdot P_{dead}}{2 \cdot (N_{clipsW} + N_{clipsL})}\right]$$ $Uplift = 813.38 \cdot lbf$

Check Clip

Shear

$v_{clip} := Uplift$ $v_{clip} = 813 \cdot lbf$ <---actual shear on clip

$V_{clip} = 2756 \cdot lbf$ <---allowable shear on clip

Bending

$e_{force} = 4.63 \cdot in$ <---moment arm

$m_{clip} := e_{force} \cdot Uplift$ $m_{clip} = 3.76 \cdot kip \cdot in$ <---actual bending moment in clip

$M_a = 9.73 \cdot kip \cdot in$ <---allowable bending in clip

Interaction

$$Interaction := \left(\frac{v_{clip}}{V_{clip}}\right)^2 + \left(\frac{m_{clip}}{M_a}\right)^2 = 0.24$$ <---interaction for bendng and shear, Section C3.3 - Must be less than 1.0

Minimum Unit Data (see shop drawings in Appendix)

$L_{u\_min} = 83.25 \cdot in$ <---outside length of unit

$W_{u\_min} = 45 \cdot in$ <---outside width of unit

$H_{u\_min} = 35.38 \cdot in$ <---height of unit from top of curb

Cross Section = "Square"

$Weight_{min} = 495 \cdot lbf$ <---installation weight of mechanical unit.

Design Forces

Dead Forces

$$P_{dead} := \frac{Weight_{min} \cdot L_{cg\_min}}{W_{u\_min}}$$

<---minimum dead load per linear foot acting vertically on curb. Lcg (distance to center of gravity assumed at mid point)

Wind Forces

Wind blowing on Long side (Length) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_min} \cdot \max(L_{u\_min}, W_{u\_min})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 2693.11\ lbf$

Wind uplift on unit

$GC_r := 1.5$ <---factor for rooftop structures and equipment with Ar less than 0.1BL, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_r := W_{u\_min} \cdot L_{u\_min}$ <---horizontal projected area of the rooftop unit, ASCE 7-10

$F_v := q_h \cdot (GC_r) \cdot A_r$ <---vertical uplift force on rooftop unit, Eq. 29.5-3 ASCE 7-10

$F_v = 2704.63\ lbf$

$$P_{vLwind} := \frac{F_h \cdot \frac{H_{u\_min}}{2}}{W_{u\_min}} \quad P_{vLwind} = 1059 \cdot lbf$$

<---vertical wind force on curb

$N_{clipsL} = 2$ <---number of clips on long side (Length) of unit

$$Uplift_L := \max\left(0lbf, \frac{P_{vLwind} - 0.6P_{dead}}{N_{clipsL}}\right)$$

<---uplift per clip

$Uplift_L = 469.87 \cdot lbf$

Design Forces (continued_

Wind Forces (continued)

Wind blowing on short side (Width) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_min} \cdot \min(L_{u\_min}, W_{u\_min})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 1455.73\ lbf$

$$P_{vWwind} := \frac{F_h \cdot \frac{H_{u\_min}}{2}}{L_{u\_min}} \quad P_{vWwind} = 309 \cdot lbf$$ <---vertical wind force on curb

$N_{clipsW} = 1$ <---number of clips on long side (Length) of unit

$$Uplift_W := \max\left(0lbf, \frac{P_{vWwind} - 0.6P_{dead}}{N_{clipsW}}\right)$$ <---uplift per clip

$Uplift_W = 190.49 \cdot lbf$

$$Uplift := \max\left[Uplift_L, Uplift_W, \frac{F_v - 0.6 \cdot P_{dead}}{2 \cdot (N_{clipsW} + N_{clipsL})}\right] \quad Uplift = 469.87 \cdot lbf$$

Check Clip

Shear

$v_{clip} := Uplift$ $v_{clip} = 469.87 \cdot lbf$ <---actual shear on clip

$V_{clip} = 2756.27 \cdot lbf$ $V_{clip} = 2756.27 \cdot lbf$ <---allowable shear on clip

Bending

$e_{force} = 4.63 \cdot in$ <---moment arm

$m_{clip} := e_{force} \cdot Uplift$ $m_{clip} = 2.17 \cdot kip \cdot in$ <---actual bending moment in clip

$M_a = 9.73 \cdot kip \cdot in$ <---allowable bending in clip

Interaction

$$Interaction := \left(\frac{v_{clip}}{V_{clip}}\right)^2 + \left(\frac{m_{clip}}{M_a}\right)^2 = 0.08$$ <---interaction for bendng and shear, Section C3.3 - Must be less than 1.0

Equipment: Lennox
Models: KCA-M, KGA-M, KHA-M 024-072 and LCH-M, LGH-M 036-072 (Worst Case) for use with Curbs Plus Curb #: LENNOX T/K-SERIES/LGH-LCH 024-072

$sub_{matrix1}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"KCA-024-M"	83.25	45	35.38	18	607	79.13	40.88
"KCA-030-M"	83.25	45	35.38	18	608	79.13	40.88
"KCA-036-M"	83.25	45	35.38	18	611	79.13	40.88
"KCA-048-M"	83.25	45	35.38	18	647	79.13	40.88
"KCA-060-M"	83.25	45	35.38	18	680	79.13	40.88
"KCA-072-M"	83.25	45	35.38	18	767	79.13	40.88

$sub_{matrix2}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"KGA-024-M"	83.25	45	35.38	18	631	79.13	40.88
"KGA-030-M"	83.25	45	35.38	18	633	79.13	40.88
"KGA-036-M"	83.25	45	35.38	18	635	79.13	40.88
"KGA-048-M"	83.25	45	35.38	18	682	79.13	40.88
"KGA-060-M"	83.25	45	35.38	18	712	79.13	40.88
"KGA-072-M"	83.25	45	35.38	18	797	79.13	40.88

$sub_{matrix3}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"KHA-024-M"	83.25	45	35.38	18	644	79.13	40.88
"KHA-030-M"	83.25	45	35.38	18	645	79.13	40.88
"KHA-036-M"	83.25	45	35.38	18	647	79.13	40.88
"KHA-048-M"	83.25	45	35.38	18	669	79.13	40.88
"KHA-060-M"	83.25	45	43.38	18	770	79.13	40.88
"KHA-072-M"	96.25	45	43.38	20.5	901	79.13	40.88

$sub_{matrix4}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"LCH-036-M"	83.25	45	35.38	18	714	79.13	40.88
"LCH-048-M"	83.25	45	35.38	18	748	79.13	40.88
"LCH-060-M"	83.25	45	43.38	18	856	79.13	40.88
"LCH-072-M"	83.25	45	43.38	18	904	79.13	40.88
"LGH-036-M"	83.25	45	35.38	18	735	79.13	40.88
"LGH-048-M"	83.25	45	35.38	18	778	79.13	40.88
"LGH-060-M"	83.25	45	43.38	18	883	79.13	40.88
"LGH-072-M"	83.25	45	43.38	18	930	79.13	40.88

Max Unit Data (see shop drawings in Appendix)

$L_{u\_max} = 83.25 \cdot in$ <---outside length of unit

$W_{u\_max} = 45 \cdot in$ <---outside width of unit

$H_{u\_max} = 43.38 \cdot in$ <---height of unit from top of curb

Cross_Section = "Square"

$Weight_{max} = 930\,lbf$ <---installation weight of mechanical unit.

Design Forces

Dead Forces

$$P_{dead} := \frac{Weight_{max} \cdot L_{cg\_max}}{W_{u\_max}} = 372\,lbf$$ <---minimum dead load per linear foot acting vertically on curb. Lcg (distance to center of gravity assumed at mid point)

Wind Forces

Wind blowing on Long side (Length) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_max} \cdot \max(L_{u\_max}, W_{u\_max})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 3302.15\,lbf$

Wind uplift on unit

$GC_r := 1.5$ <---factor for rooftop structures and equipment with Ar less than 0.1BL, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_r := W_{u\_max} \cdot L_{u\_max}$ <---horizontal projected area of the rooftop unit, ASCE 7-10

$F_v := q_h \cdot (GC_r) \cdot A_r$ <---vertical uplift force on rooftop unit, Eq. 29.5-3 ASCE 7-10

$F_v = 2704.63\,lbf$

$$P_{vLwind} := \frac{F_h \cdot \frac{H_{u\_max}}{2}}{W_{u\_max}} \quad P_{vLwind} = 1591 \cdot lbf$$ <---vertical wind force on curb

$N_{clipsL} = 2$ <---number of clips on long side (Length) of unit

$$Uplift_L := \max\left(0lbf, \frac{P_{vLwind} - 0.6P_{dead}}{N_{clipsL}}\right)$$ <---uplift per clip

$Uplift_L = 684.13 \cdot lbf$

Design Forces (continued_

Wind Forces (continued)

Wind blowing on short side (Width) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_max} \cdot \min(L_{u\_max}, W_{u\_max})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 1784.95\ lbf$

$$P_{vWwind} := \frac{F_h \cdot \frac{H_{u\_max}}{2}}{L_{u\_max}} = 465\ lbf$$ <---vertical wind force on curb

$N_{clipsW} = 1$ <---number of clips on long side (Length) of unit

$$Uplift_W := \max\left(0lbf, \frac{P_{vWwind} - 0.6P_{dead}}{N_{clipsW}}\right)$$ <---uplift per clip

$Uplift_W = 241.8 \cdot lbf$

$$Uplift := \max\left[Uplift_L, Uplift_W, \frac{F_v - 0.6 \cdot P_{dead}}{2 \cdot (N_{clipsW} + N_{clipsL})}\right]$$ $Uplift = 684.13 \cdot lbf$

Check Clip

Shear

$v_{clip} := Uplift$ $v_{clip} = 684 \cdot lbf$ <---actual shear on clip

$V_{clip} = 2756 \cdot lbf$ <---allowable shear on clip

Bending

$e_{force} = 4.63 \cdot in$ <---moment arm

$m_{clip} := e_{force} \cdot Uplift$ $m_{clip} = 3.16 \cdot kip \cdot in$ <---actual bending moment in clip

$M_a = 9.73 \cdot kip \cdot in$ <---allowable bending in clip

Interaction

$$Interaction := \left(\frac{v_{clip}}{V_{clip}}\right)^2 + \left(\frac{m_{clip}}{M_a}\right)^2 = 0.17$$ <---interaction for bendng and shear, Section C3.3 - Must be less than 1.0

Minimum Unit Data (see shop drawings in Appendix)

$L_{u\_min} = 83.25 \cdot in$ <---outside length of unit

$W_{u\_min} = 45 \cdot in$ <---outside width of unit

$H_{u\_min} = 35.38 \cdot in$ <---height of unit from top of curb

Cross Section = "Square"

$Weight_{min} = 607 \cdot lbf$ <---installation weight of mechanical unit.

Design Forces

Dead Forces

$$P_{dead} := \frac{Weight_{min} \cdot L_{cg\_min}}{W_{u\_min}}$$

<---minimum dead load per linear foot acting vertically on curb. Lcg (distance to center of gravity assumed at mid point)

Wind Forces

Wind blowing on Long side (Length) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_min} \cdot \max(L_{u\_min}, W_{u\_min})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 2693.11 \, lbf$

Wind uplift on unit

$GC_r := 1.5$ <---factor for rooftop structures and equipment with Ar less than 0.1BL, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_r := W_{u\_min} \cdot L_{u\_min}$ <---horizontal projected area of the rooftop unit, ASCE 7-10

$F_v := q_h \cdot (GC_r) \cdot A_r$ <---vertical uplift force on rooftop unit, Eq. 29.5-3 ASCE 7-10

$F_v = 2704.63 \, lbf$

$$P_{vLwind} := \frac{F_h \cdot \frac{H_{u\_min}}{2}}{W_{u\_min}} \quad P_{vLwind} = 1059 \cdot lbf$$

<---vertical wind force on curb

$N_{clipsL} = 2$ <---number of clips on long side (Length) of unit

$$Uplift_L := \max\left(0lbf, \frac{P_{vLwind} - 0.6P_{dead}}{N_{clipsL}}\right)$$

<---uplift per clip

$Uplift_L = 456.43 \cdot lbf$

Design Forces (continued_

Wind Forces (continued)

Wind blowing on short side (Width) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_min} \cdot \min(L_{u\_min}, W_{u\_min})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 1455.73\ lbf$

$P_{vWwind} := \frac{F_h \cdot \frac{H_{u\_min}}{2}}{L_{u\_min}}$ $P_{vWwind} = 309 \cdot lbf$ <---vertical wind force on curb

$N_{clipsW} = 1$ <---number of clips on long side (Length) of unit

$Uplift_W := \max\left(0lbf, \frac{P_{vWwind} - 0.6P_{dead}}{N_{clipsW}}\right)$ <---uplift per clip

$Uplift_W = 163.61 \cdot lbf$

$Uplift := \max\left[Uplift_L, Uplift_W, \frac{F_v - 0.6 \cdot P_{dead}}{2 \cdot (N_{clipsW} + N_{clipsL})}\right]$ $Uplift = 456.43 \cdot lbf$

Check Clip

Shear

$v_{clip} := Uplift$ $v_{clip} = 456.43 \cdot lbf$ <---actual shear on clip

$V_{clip} = 2756.27 \cdot lbf$ $V_{clip} = 2756.27 \cdot lbf$ <---allowable shear on clip

Bending

$e_{force} = 4.63 \cdot in$ <---moment arm

$m_{clip} := e_{force} \cdot Uplift$ $m_{clip} = 2.11 \cdot kip \cdot in$ <---actual bending moment in clip

$M_a = 9.73 \cdot kip \cdot in$ <---allowable bending in clip

Interaction

$Interaction := \left(\frac{v_{clip}}{V_{clip}}\right)^2 + \left(\frac{m_{clip}}{M_a}\right)^2 = 0.07$ <---interaction for bendng and shear, Section C3.3 - Must be less than 1.0

Equipment: Lennox
Model: K-Series 090 F.P. (Worst Case)
for use with Curbs Plus Curb
LENNOX K-SERIES 090 F.P.

$$Unit_{Data} = \begin{pmatrix} \text{"Unit"} & \text{"Lu (in)"} & \text{"Wu (in)"} & \text{"Hu (in)"} & \text{"Lcg(in)"} & \text{"Wm (lbf)"} & \text{"Lc(in)"} & \text{"Wc(in)"} \\ \text{"KCA-090"} & 96.25 & 45 & 43.38 & 21 & 767 & 92.13 & 40.88 \\ \text{"KGA-090"} & 96.25 & 45 & 43.38 & 21 & 781 & 92.13 & 40.88 \\ \text{"KCA-090-M"} & 96.25 & 45 & 43.38 & 21 & 873 & 92.13 & 40.88 \\ \text{"KGA-090-M"} & 96.25 & 45 & 43.38 & 21 & 911 & 92.13 & 40.88 \end{pmatrix}$$

Max Unit Data (see shop drawings in Appendix)

$L_{u\_max} = 96.25 \cdot in$ <---outside length of unit

$W_{u\_max} = 45 \cdot in$ <---outside width of unit

$H_{u\_max} = 43.38 \cdot in$ <---height of unit from top of curb

Cross_Section = "Square"

$Weight_{max} = 911\ lbf$ <---installation weight of mechanical unit.

Design Forces

Dead Forces

$$P_{dead} := \frac{Weight_{max} \cdot L_{cg\_max}}{W_{u\_max}} = 425.13\ lbf$$ <---minimum dead load per linear foot acting vertically on curb. Lcg (distance to center of gravity assumed at mid point)

Wind Forces

Wind blowing on Long side (Length) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_max} \cdot \max(L_{u\_max}, W_{u\_max})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 3817.8\ lbf$

Wind uplift on unit

$GC_r := 1.5$ <---factor for rooftop structures and equipment with Ar less than 0.1BL, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_r := W_{u\_max} \cdot L_{u\_max}$ <---horizontal projected area of the rooftop unit, ASCE 7-10

$F_v := q_h \cdot (GC_r) \cdot A_r$ <---vertical uplift force on rooftop unit, Eq. 29.5-3 ASCE 7-10

$F_v = 3126.97\ lbf$

$$P_{vLwind} := \frac{F_h \cdot \frac{H_{u\_max}}{2}}{W_{u\_max}} \quad P_{vLwind} = 1840 \cdot lbf$$ <---vertical wind force on curb

$N_{clipsL} = 2$ <---number of clips on long side (Length) of unit

$$Uplift_L := \max\left(0lbf, \frac{P_{vLwind} - 0.6P_{dead}}{N_{clipsL}}\right)$$ <---uplift per clip

$Uplift_L = 792.44 \cdot lbf$

Design Forces (continued_

Wind Forces (continued)

Wind blowing on short side (Width) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_max} \cdot \min(L_{u\_max}, W_{u\_max})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 1784.95\ lbf$

$$P_{vWwind} := \frac{F_h \cdot \frac{H_{u\_max}}{2}}{L_{u\_max}} = 402.19\ lbf$$ <---vertical wind force on curb

$N_{clipsW} = 1$ <---number of clips on long side (Length) of unit

$$Uplift_W := \max\left(0lbf, \frac{P_{vWwind} - 0.6P_{dead}}{N_{clipsW}}\right)$$ <---uplift per clip

$Uplift_W = 147.11 \cdot lbf$

$$Uplift := \max\left[Uplift_L, Uplift_W, \frac{F_v - 0.6 \cdot P_{dead}}{2 \cdot (N_{clipsW} + N_{clipsL})}\right]$$ $Uplift = 792.44 \cdot lbf$

Check Clip

Shear

$v_{clip} := Uplift$ $v_{clip} = 792 \cdot lbf$ <---actual shear on clip

$V_{clip} = 2756 \cdot lbf$ <---allowable shear on clip

Bending

$e_{force} = 4.63 \cdot in$ <---moment arm

$m_{clip} := e_{force} \cdot Uplift$ $m_{clip} = 3.67 \cdot kip \cdot in$ <---actual bending moment in clip

$M_a = 9.73 \cdot kip \cdot in$ <---allowable bending in clip

Interaction

$$Interaction := \left(\frac{v_{clip}}{V_{clip}}\right)^2 + \left(\frac{m_{clip}}{M_a}\right)^2 = 0.22$$ <---interaction for bendng and shear, Section C3.3 - Must be less than 1.0

Minimum Unit Data (see shop drawings in Appendix)

$L_{u\_min} = 96.25 \cdot in$ <---outside length of unit

$W_{u\_min} = 45 \cdot in$ <---outside width of unit

$H_{u\_min} = 43.38 \cdot in$ <---height of unit from top of curb

Cross Section = "Square"

$Weight_{min} = 767 \cdot lbf$ <---installation weight of mechanical unit.

Design Forces

Dead Forces

$$P_{dead} := \frac{Weight_{min} \cdot L_{cg\_min}}{W_{u\_min}}$$

<---minimum dead load per linear foot acting vertically on curb. Lcg (distance to center of gravity assumed at mid point)

Wind Forces

Wind blowing on Long side (Length) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_min} \cdot \max(L_{u\_min}, W_{u\_min})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 3817.8\,lbf$

Wind uplift on unit

$GC_r := 1.5$ <---factor for rooftop structures and equipment with Ar less than 0.1BL, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_r := W_{u\_min} \cdot L_{u\_min}$ <---horizontal projected area of the rooftop unit, ASCE 7-10

$F_v := q_h \cdot (GC_r) \cdot A_r$ <---vertical uplift force on rooftop unit, Eq. 29.5-3 ASCE 7-10

$F_v = 3126.97\,lbf$

$$P_{vLwind} := \frac{F_h \cdot \frac{H_{u\_min}}{2}}{W_{u\_min}} \quad P_{vLwind} = 1840 \cdot lbf$$ <---vertical wind force on curb

$N_{clipsL} = 2$ <---number of clips on long side (Length) of unit

$$Uplift_L := \max\left(0lbf, \frac{P_{vLwind} - 0.6P_{dead}}{N_{clipsL}}\right)$$ <---uplift per clip

$Uplift_L = 812.6 \cdot lbf$

Design Forces (continued_

Wind Forces (continued)

Wind blowing on short side (Width) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_min} \cdot \min(L_{u\_min}, W_{u\_min})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 1784.95\ lbf$

$$P_{vWwind} := \frac{F_h \cdot \frac{H_{u\_min}}{2}}{L_{u\_min}} \quad P_{vWwind} = 402 \cdot lbf$$ <---vertical wind force on curb

$N_{clipsW} = 1$ <---number of clips on long side (Length) of unit

$$Uplift_W := \max\left(0lbf, \frac{P_{vWwind} - 0.6P_{dead}}{N_{clipsW}}\right)$$ <---uplift per clip

$Uplift_W = 187.43 \cdot lbf$

$$Uplift := \max\left[Uplift_L, Uplift_W, \frac{F_v - 0.6 \cdot P_{dead}}{2 \cdot (N_{clipsW} + N_{clipsL})}\right] \quad Uplift = 812.6 \cdot lbf$$

Check Clip

Shear

$v_{clip} := Uplift$ $v_{clip} = 812.6 \cdot lbf$ <---actual shear on clip

$V_{clip} = 2756.27 \cdot lbf$ $V_{clip} = 2756.27 \cdot lbf$ <---allowable shear on clip

Bending

$e_{force} = 4.63 \cdot in$ <---moment arm

$m_{clip} := e_{force} \cdot Uplift$ $m_{clip} = 3.76 \cdot kip \cdot in$ <---actual bending moment in clip

$M_a = 9.73 \cdot kip \cdot in$ <---allowable bending in clip

Interaction

$$Interaction := \left(\frac{v_{clip}}{V_{clip}}\right)^2 + \left(\frac{m_{clip}}{M_a}\right)^2 = 0.24$$ <---interaction for bendng and shear, Section C3.3 - Must be less than 1.0

Equipment: Lennox
Models: KCA, KGA, KHA 092-150
and LCH, LGH 092-150 (Worst Case)
for use with Curbs Plus Curb
LENNOX K-SERIES/LGH-LCH 092-150

$sub_{matrix1} =$

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"KCA-092"	99.25	58.13	43.38	24.5	942	94.75	53.63
"KCA-102"	99.25	58.13	43.38	24.5	962	94.75	53.63
"KCA-120"	99.25	58.13	43.38	24.5	1002	94.75	53.63
"KCA-150"	99.25	58.13	43.38	24.5	1093	94.75	53.63
"KGA-092"	99.25	58.13	43.38	24.5	990	94.75	53.63
"KGA-102"	99.25	58.13	43.38	24.5	1011	94.75	53.63
"KGA-120"	99.25	58.13	43.38	24.5	1051	94.75	53.63
"KGA-150"	99.25	58.13	43.38	24.5	1141	94.75	53.63

$sub_{matrix2} =$

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"KHA-092"	99.25	58.13	43.38	24.5	1052	94.75	40.88
"KHA-102"	99.25	58.13	43.38	24.5	1084	94.75	53.63
"KHA-120"	99.25	58.13	43.38	24.5	1151	94.75	53.63

$sub_{matrix3} =$

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"LCH-092"	99.25	58.13	43.38	24.5	1120	94.75	53.63
"LCH-102"	99.25	58.13	43.38	24.5	1126	94.75	53.63
"LCH-120"	99.25	58.13	43.38	24.5	1162	94.75	53.63
"LCH-150"	99.25	58.13	43.38	24.5	1202	94.75	53.63
"LGH-092"	99.25	58.13	43.38	24.5	1168	94.75	53.63
"LGH-102"	99.25	58.13	43.38	24.5	1175	94.75	53.63
"LGH-120"	99.25	58.13	43.38	24.5	1210	94.75	53.63
"LGH-150"	99.25	58.13	43.38	24.5	1249	94.75	53.63

Max Unit Data (see shop drawings in Appendix)

$L_{u\_max} = 99.25 \cdot in$ <---outside length of unit

$W_{u\_max} = 58.13 \cdot in$ <---outside width of unit

$H_{u\_max} = 43.38 \cdot in$ <---height of unit from top of curb

Cross_Section = "Square"

$Weight_{max} = 1249\,lbf$ <---installation weight of mechanical unit.

Design Forces

Dead Forces

$P_{dead} := \frac{Weight_{max} \cdot L_{cg\_max}}{W_{u\_max}} = 526.46\,lbf$ <---minimum dead load per linear foot acting vertically on curb. Lcg (distance to center of gravity assumed at mid point)

Wind Forces

Wind blowing on Long side (Length) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_max} \cdot \max(L_{u\_max}, W_{u\_max})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 3936.8\,lbf$

Wind uplift on unit

$GC_r := 1.5$ <---factor for rooftop structures and equipment with Ar less than 0.1BL, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_r := W_{u\_max} \cdot L_{u\_max}$ <---horizontal projected area of the rooftop unit, ASCE 7-10

$F_v := q_h \cdot (GC_r) \cdot A_r$ <---vertical uplift force on rooftop unit, Eq. 29.5-3 ASCE 7-10

$F_v = 4164.89\,lbf$

$P_{vLwind} := \frac{F_h \cdot \frac{H_{u\_max}}{2}}{W_{u\_max}}$ $P_{vLwind} = 1469 \cdot lbf$ <---vertical wind force on curb

$N_{clipsL} = 2$ <---number of clips on long side (Length) of unit

$Uplift_L := \max\left(0lbf, \frac{P_{vLwind} - 0.6P_{dead}}{N_{clipsL}}\right)$ <---uplift per clip

$Uplift_L = 576.51 \cdot lbf$

Design Forces (continued_

Wind Forces (continued)

Wind blowing on short side (Width) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_max} \cdot \min(L_{u\_max}, W_{u\_max})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 2305.55\,lbf$

$$P_{vWwind} := \frac{F_h \cdot \frac{H_{u\_max}}{2}}{L_{u\_max}} = 503.8\,lbf$$ <---vertical wind force on curb

$N_{clipsW} = 1$ <---number of clips on long side (Length) of unit

$$Uplift_W := \max\left(0lbf, \frac{P_{vWwind} - 0.6P_{dead}}{N_{clipsW}}\right)$$ <---uplift per clip

$Uplift_W = 187.92 \cdot lbf$

$$Uplift := \max\left[Uplift_L, Uplift_W, \frac{F_v - 0.6 \cdot P_{dead}}{2 \cdot (N_{clipsW} + N_{clipsL})}\right]$$ $Uplift = 641.5 \cdot lbf$

Check Clip

Shear

$v_{clip} := Uplift$ $v_{clip} = 642 \cdot lbf$ <---actual shear on clip

$V_{clip} = 2756 \cdot lbf$ <---allowable shear on clip

Bending

$e_{force} = 4.63 \cdot in$ <---moment arm

$m_{clip} := e_{force} \cdot Uplift$ $m_{clip} = 2.97 \cdot kip \cdot in$ <---actual bending moment in clip

$M_a = 9.73 \cdot kip \cdot in$ <---allowable bending in clip

Interaction

$$Interaction := \left(\frac{v_{clip}}{V_{clip}}\right)^2 + \left(\frac{m_{clip}}{M_a}\right)^2 = 0.15$$ <---interaction for bendng and shear, Section C3.3 - Must be less than 1.0

Minimum Unit Data (see shop drawings in Appendix)

$L_{u\_min} = 99.25 \cdot in$ <---outside length of unit

$W_{u\_min} = 58.13 \cdot in$ <---outside width of unit

$H_{u\_min} = 43.38 \cdot in$ <---height of unit from top of curb

Cross Section = "Square"

$Weight_{min} = 942 \cdot lbf$ <---installation weight of mechanical unit.

Design Forces

Dead Forces

$$P_{dead} := \frac{Weight_{min} \cdot L_{cg\_min}}{W_{u\_min}}$$ <---minimum dead load per linear foot acting vertically on curb. Lcg (distance to center of gravity assumed at mid point)

Wind Forces

Wind blowing on Long side (Length) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_min} \cdot \max(L_{u\_min}, W_{u\_min})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 3936.8\,lbf$

Wind uplift on unit

$GC_r := 1.5$ <---factor for rooftop structures and equipment with Ar less than 0.1BL, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_r := W_{u\_min} \cdot L_{u\_min}$ <---horizontal projected area of the rooftop unit, ASCE 7-10

$F_v := q_h \cdot (GC_r) \cdot A_r$ <---vertical uplift force on rooftop unit, Eq. 29.5-3 ASCE 7-10

$F_v = 4164.89\,lbf$

$$P_{vLwind} := \frac{F_h \cdot \frac{H_{u\_min}}{2}}{W_{u\_min}}$$ $P_{vLwind} = 1469 \cdot lbf$ <---vertical wind force on curb

$N_{clipsL} = 2$ <---number of clips on long side (Length) of unit

$$Uplift_L := \max\left(0lbf, \frac{P_{vLwind} - 0.6P_{dead}}{N_{clipsL}}\right)$$ <---uplift per clip

$Uplift_L = 615.33 \cdot lbf$

Design Forces (continued_

Wind Forces (continued)

Wind blowing on short side (Width) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_min} \cdot \min(L_{u\_min}, W_{u\_min})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 2305.55\ lbf$

$$P_{vWwind} := \frac{F_h \cdot \frac{H_{u\_min}}{2}}{L_{u\_min}} \quad P_{vWwind} = 504 \cdot lbf$$ <---vertical wind force on curb

$N_{clipsW} = 1$ <---number of clips on long side (Length) of unit

$$Uplift_W := \max\left(0lbf, \frac{P_{vWwind} - 0.6P_{dead}}{N_{clipsW}}\right)$$ <---uplift per clip

$Uplift_W = 265.56 \cdot lbf$

$$Uplift := \max\left[Uplift_L, Uplift_W, \frac{F_v - 0.6 \cdot P_{dead}}{2 \cdot (N_{clipsW} + N_{clipsL})}\right] \quad Uplift = 654.44 \cdot lbf$$

Check Clip

Shear

$v_{clip} := Uplift$ $v_{clip} = 654.44 \cdot lbf$ <---actual shear on clip

$V_{clip} = 2756.27 \cdot lbf$ $V_{clip} = 2756.27 \cdot lbf$ <---allowable shear on clip

Bending

$e_{force} = 4.63 \cdot in$ <---moment arm

$m_{clip} := e_{force} \cdot Uplift$ $m_{clip} = 3.03 \cdot kip \cdot in$ <---actual bending moment in clip

$M_a = 9.73 \cdot kip \cdot in$ <---allowable bending in clip

Interaction

$$Interaction := \left(\frac{v_{clip}}{V_{clip}}\right)^2 + \left(\frac{m_{clip}}{M_a}\right)^2 = 0.15$$ <---interaction for bendng and shear, Section C3.3 - Must be less than 1.0

Equipment: Lennox
Models: KCA-M, KGA-M, KHA-M 092-150 and LCH-M, LGH-M 092-150 (Worst Case) for use with Curbs Plus Curb
LENNOX K-SERIES/LGH-LCH 092-150

$sub_{matrix1}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"KCA-092-M"	99.25	58.13	43.38	25.5	1099	94.75	53.63
"KCA-102-M"	99.25	58.13	43.38	25.5	1119	94.75	53.63
"KCA-120-M"	99.25	58.13	43.38	25.5	1166	94.75	53.63
"KCA-150-M"	99.25	58.13	43.38	25.5	1256	94.75	53.63
"KGA-092-M"	99.25	58.13	43.38	25.5	1140	94.75	53.63
"KGA-102-M"	99.25	58.13	43.38	25.5	1161	94.75	53.63
"KGA-120-M"	99.25	58.13	43.38	25.5	1202	94.75	53.63
"KGA-150-M"	99.25	58.13	43.38	25.5	1291	94.75	53.63

$sub_{matrix2}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"KHA-092-M"	99.25	58.13	43.38	25.5	1210	94.75	40.88
"KHA-102-M"	99.25	58.13	43.38	25.5	1241	94.75	53.63
"KHA-120-M"	99.25	58.13	43.38	25.5	1314	94.75	53.63

$sub_{matrix3}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"LCH-092-M"	99.25	58.13	43.38	25.5	1277	94.75	53.63
"LCH-102-M"	99.25	58.13	43.38	25.5	1284	94.75	53.63
"LCH-120-M"	99.25	58.13	43.38	25.5	1327	94.75	53.63
"LCH-150-M"	99.25	58.13	43.38	25.5	1366	94.75	53.63
"LGH-092-M"	99.25	58.13	43.38	25.5	1319	94.75	53.63
"LGH-102-M"	99.25	58.13	43.38	25.5	1327	94.75	53.63
"LGH-120-M"	99.25	58.13	43.38	25.5	1362	94.75	53.63
"LGH-150-M"	99.25	58.13	43.38	25.5	1400	94.75	53.63

Max Unit Data (see shop drawings in Appendix)

$L_{u\_max} = 99.25 \cdot in$ <---outside length of unit

$W_{u\_max} = 58.13 \cdot in$ <---outside width of unit

$H_{u\_max} = 43.38 \cdot in$ <---height of unit from top of curb

Cross_Section = "Square"

$Weight_{max} = 1400\,lbf$ <---installation weight of mechanical unit.

Design Forces

Dead Forces

$P_{dead} := \frac{Weight_{max} \cdot L_{cg\_max}}{W_{u\_max}} = 614.19\,lbf$ <---minimum dead load per linear foot acting vertically on curb. Lcg (distance to center of gravity assumed at mid point)

Wind Forces

Wind blowing on Long side (Length) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_max} \cdot \max(L_{u\_max}, W_{u\_max})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 3936.8\,lbf$

Wind uplift on unit

$GC_r := 1.5$ <---factor for rooftop structures and equipment with Ar less than 0.1BL, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_r := W_{u\_max} \cdot L_{u\_max}$ <---horizontal projected area of the rooftop unit, ASCE 7-10

$F_v := q_h \cdot (GC_r) \cdot A_r$ <---vertical uplift force on rooftop unit, Eq. 29.5-3 ASCE 7-10

$F_v = 4164.89\,lbf$

$P_{vLwind} := \frac{F_h \cdot \frac{H_{u\_max}}{2}}{W_{u\_max}}$ $P_{vLwind} = 1469 \cdot lbf$ <---vertical wind force on curb

$N_{clipsL} = 2$ <---number of clips on long side (Length) of unit

$Uplift_L := \max\left(0lbf, \frac{P_{vLwind} - 0.6P_{dead}}{N_{clipsL}}\right)$ <---uplift per clip

$Uplift_L = 550.19 \cdot lbf$

Design Forces (continued_

Wind Forces (continued)

Wind blowing on short side (Width) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_max} \cdot \min(L_{u\_max}, W_{u\_max})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 2305.55\,lbf$

$$P_{vWwind} := \frac{F_h \cdot \frac{H_{u\_max}}{2}}{L_{u\_max}} = 503.8\,lbf$$ <---vertical wind force on curb

$N_{clipsW} = 1$ <---number of clips on long side (Length) of unit

$$Uplift_W := \max\left(0lbf, \frac{P_{vWwind} - 0.6P_{dead}}{N_{clipsW}}\right)$$ <---uplift per clip

$Uplift_W = 135.28 \cdot lbf$

$$Uplift := \max\left[Uplift_L, Uplift_W, \frac{F_v - 0.6 \cdot P_{dead}}{2 \cdot (N_{clipsW} + N_{clipsL})}\right]$$ $Uplift = 632.73 \cdot lbf$

Check Clip

Shear

$v_{clip} := Uplift$ $v_{clip} = 633 \cdot lbf$ <---actual shear on clip

$V_{clip} = 2756 \cdot lbf$ <---allowable shear on clip

Bending

$e_{force} = 4.63 \cdot in$ <---moment arm

$m_{clip} := e_{force} \cdot Uplift$ $m_{clip} = 2.93 \cdot kip \cdot in$ <---actual bending moment in clip

$M_a = 9.73 \cdot kip \cdot in$ <---allowable bending in clip

Interaction

$$Interaction := \left(\frac{v_{clip}}{V_{clip}}\right)^2 + \left(\frac{m_{clip}}{M_a}\right)^2 = 0.14$$ <---interaction for bendng and shear, Section C3.3 - Must be less than 1.0

Minimum Unit Data (see shop drawings in Appendix)

$L_{u\_min} = 99.25 \cdot in$ <---outside length of unit

$W_{u\_min} = 58.13 \cdot in$ <---outside width of unit

$H_{u\_min} = 43.38 \cdot in$ <---height of unit from top of curb

Cross Section = "Square"

$Weight_{min} = 1099 \cdot lbf$ <---installation weight of mechanical unit.

Design Forces

Dead Forces

$$P_{dead} := \frac{Weight_{min} \cdot L_{cg\_min}}{W_{u\_min}}$$

<---minimum dead load per linear foot acting vertically on curb. Lcg (distance to center of gravity assumed at mid point)

Wind Forces

Wind blowing on Long side (Length) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_min} \cdot \max(L_{u\_min}, W_{u\_min})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 3936.8\,lbf$

Wind uplift on unit

$GC_r := 1.5$ <---factor for rooftop structures and equipment with Ar less than 0.1BL, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_r := W_{u\_min} \cdot L_{u\_min}$ <---horizontal projected area of the rooftop unit, ASCE 7-10

$F_v := q_h \cdot (GC_r) \cdot A_r$ <---vertical uplift force on rooftop unit, Eq. 29.5-3 ASCE 7-10

$F_v = 4164.89\,lbf$

$$P_{vLwind} := \frac{F_h \cdot \frac{H_{u\_min}}{2}}{W_{u\_min}} \quad P_{vLwind} = 1469 \cdot lbf$$

<---vertical wind force on curb

$N_{clipsL} = 2$ <---number of clips on long side (Length) of unit

$$Uplift_L := \max\left(0lbf, \frac{P_{vLwind} - 0.6P_{dead}}{N_{clipsL}}\right)$$

<---uplift per clip

$Uplift_L = 589.8 \cdot lbf$

Design Forces (continued_

Wind Forces (continued)

Wind blowing on short side (Width) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_min} \cdot \min(l_{u\_min}, W_{u\_min})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 2305.55\ lbf$

$$P_{vWwind} := \frac{F_h \cdot \frac{H_{u\_min}}{2}}{l_{u\_min}} \quad P_{vWwind} = 504 \cdot lbf$$ <---vertical wind force on curb

$N_{clipsW} = 1$ <---number of clips on long side (Length) of unit

$$Uplift_W := \max\left(0lbf, \frac{P_{vWwind} - 0.6P_{dead}}{N_{clipsW}}\right)$$ <---uplift per clip

$Uplift_W = 214.51 \cdot lbf$

$$Uplift := \max\left[Uplift_L, Uplift_W, \frac{F_v - 0.6 \cdot P_{dead}}{2 \cdot (N_{clipsW} + N_{clipsL})}\right] \quad Uplift = 645.93 \cdot lbf$$

Check Clip

Shear

$v_{clip} := Uplift$ $v_{clip} = 645.93 \cdot lbf$ <---actual shear on clip

$V_{clip} = 2756.27 \cdot lbf$ $V_{clip} = 2756.27 \cdot lbf$ <---allowable shear on clip

Bending

$e_{force} = 4.63 \cdot in$ <---moment arm

$m_{clip} := e_{force} \cdot Uplift$ $m_{clip} = 2.99 \cdot kip \cdot in$ <---actual bending moment in clip

$M_a = 9.73 \cdot kip \cdot in$ <---allowable bending in clip

Interaction

$$Interaction := \left(\frac{v_{clip}}{V_{clip}}\right)^2 + \left(\frac{m_{clip}}{M_a}\right)^2 = 0.15$$ <---interaction for bendng and shear, Section C3.3 - Must be less than 1.0

Equipment: Lennox
Models: KCA, KGA, KHA 180-300
and LCA, LCH, LGC, LGH 248-300 (Worst Case)
for use with Curbs Plus Curb
LENNOX L/T/K-SERIES/LGH-LCH 156-300S

$sub_{matrix1}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"KCA-180"	106.5	90.13	51	40	1855	101.5	85.63
"KCA-210"	106.5	90.13	51	39.25	2001	101.5	85.63
"KCA-240"	120.19	90.13	51	37.5	2270	101.5	85.63
"KCA-300"	120.19	90.13	51	37.5	2270	101.5	85.63
"KGA-180"	106.5	90.13	51	40	1855	101.5	85.63
"KGA-210"	106.5	90.13	51	39.25	2001	101.5	85.63
"KGA-240"	120.19	90.13	51	37.5	2270	101.5	85.63
"KGA-300"	120.19	90.13	51	37.5	2270	101.5	85.63

$sub_{matrix2}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"KHA-180"	128.5	90.13	51	39.75	1950	101.5	85.63
"KHA-240"	128.5	90.13	51	39	2150	101.5	85.63
"LCA-248"	132.38	90.13	61.75	37.25	2910	101.5	85.63
"LCA-300"	132.38	90.13	61.75	37.25	2910	101.5	85.63
"LCH-156"	106.5	90.13	51	39.75	1850	101.5	85.63
"LCH-180"	120.19	90.13	51	39.5	2070	101.5	85.63
"LCH-210"	120.19	90.13	51	39.5	2180	101.5	85.63
"LCH-240"	120.19	90.13	51	39	2280	101.5	85.63

$sub_{matrix3}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"LCH-300"	120.19	90.13	51	38.25	2344	101.5	85.63
"LGC-248"	132.38	90.13	61.75	36.75	3020	101.5	85.63
"LGC-300"	132.38	90.13	61.75	36.75	3020	101.5	85.63
"LGH-180"	120.19	90.13	51	39.5	2221	101.5	85.63
"LGH-210"	120.19	90.13	51	39.5	2330	101.5	85.63
"LGH-240"	120.19	90.13	51	39	2430	101.5	85.63
"LGH-300"	120.19	90.13	51	38.25	2496	101.5	85.63

Max Unit Data (see shop drawings in Appendix)

$L_{u\_max} = 132.38 \cdot in$ <---outside length of unit

$W_{u\_max} = 90.13 \cdot in$ <---outside width of unit

$H_{u\_max} = 61.75 \cdot in$ <---height of unit from top of curb

Cross_Section = "Square"

$Weight_{max} = 3020\,lbf$ <---installation weight of mechanical unit.

Design Forces

Dead Forces

$P_{dead} := \frac{Weight_{max} \cdot L_{cg\_max}}{W_{u\_max}} = 1231.46\,lbf$ <---minimum dead load per linear foot acting vertically on curb. Lcg (distance to center of gravity assumed at mid point)

Wind Forces

Wind blowing on Long side (Length) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_max} \cdot \max(L_{u\_max}, W_{u\_max})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 7475.08\,lbf$

Wind uplift on unit

$GC_r := 1.5$ <---factor for rooftop structures and equipment with Ar less than 0.1BL, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_r := W_{u\_max} \cdot L_{u\_max}$ <---horizontal projected area of the rooftop unit, ASCE 7-10

$F_v := q_h \cdot (GC_r) \cdot A_r$ <---vertical uplift force on rooftop unit, Eq. 29.5-3 ASCE 7-10

$F_v = 8613.14\,lbf$

$P_{vLwind} := \frac{F_h \cdot \frac{H_{u\_max}}{2}}{W_{u\_max}}$ $P_{vLwind} = 2561 \cdot lbf$ <---vertical wind force on curb

$N_{clipsL} = 2$ <---number of clips on long side (Length) of unit

$Uplift_L := \max\left(0lbf, \frac{P_{vLwind} - 0.6P_{dead}}{N_{clipsL}}\right)$ <---uplift per clip

$Uplift_L = 910.97 \cdot lbf$

Design Forces (continued_

Wind Forces (continued)

Wind blowing on short side (Width) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_max} \cdot \min(L_{u\_max}, W_{u\_max})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 5089.27\,lbf$

$$P_{vWwind} := \frac{F_h \cdot \frac{H_{u\_max}}{2}}{L_{u\_max}} = 1187.01\,lbf$$ <---vertical wind force on curb

$N_{clipsW} = 2$ <---number of clips on short side (Width) of unit

$$Uplift_W := \max\left(0lbf, \frac{P_{vWwind} - 0.6P_{dead}}{N_{clipsW}}\right)$$ <---uplift per clip

$Uplift_W = 224.07 \cdot lbf$

$$Uplift := \max\left[Uplift_L, Uplift_W, \frac{F_v - 0.6 \cdot P_{dead}}{2 \cdot (N_{clipsW} + N_{clipsL})}\right]$$ $Uplift = 984.28 \cdot lbf$

Check Clip

Shear

$v_{clip} := Uplift$ $v_{clip} = 984 \cdot lbf$ <---actual shear on clip

$V_{clip} = 2756 \cdot lbf$ <---allowable shear on clip

Bending

$e_{force} = 4.63 \cdot in$ <---moment arm

$m_{clip} := e_{force} \cdot Uplift$ $m_{clip} = 4.55 \cdot kip \cdot in$ <---actual bending moment in clip

$M_a = 9.73 \cdot kip \cdot in$ <---allowable bending in clip

Interaction

$$Interaction := \left(\frac{v_{clip}}{V_{clip}}\right)^2 + \left(\frac{m_{clip}}{M_a}\right)^2 = 0.35$$ <---interaction for bendng and shear, Section C3.3 - Must be less than 1.0

Minimum Unit Data (see shop drawings in Appendix)

$L_{u\_min} = 106.5 \cdot in$ <---outside length of unit

$W_{u\_min} = 90.13 \cdot in$ <---outside width of unit

$H_{u\_min} = 51 \cdot in$ <---height of unit from top of curb

Cross Section = "Square"

$Weight_{min} = 1850 \cdot lbf$ <---installation weight of mechanical unit.

Design Forces

Dead Forces

$$P_{dead} := \frac{Weight_{min} \cdot L_{cg\_min}}{W_{u\_min}}$$

<---minimum dead load per linear foot acting vertically on curb. Lcg (distance to center of gravity assumed at mid point)

Wind Forces

Wind blowing on Long side (Length) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_min} \cdot \max(L_{u\_min}, W_{u\_min})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 4966.98\ lbf$

Wind uplift on unit

$GC_r := 1.5$ <---factor for rooftop structures and equipment with Ar less than 0.1BL, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_r := W_{u\_min} \cdot L_{u\_min}$ <---horizontal projected area of the rooftop unit, ASCE 7-10

$F_v := q_h \cdot (GC_r) \cdot A_r$ <---vertical uplift force on rooftop unit, Eq. 29.5-3 ASCE 7-10

$F_v = 6929.56\ lbf$

$$P_{vLwind} := \frac{F_h \cdot \frac{H_{u\_min}}{2}}{W_{u\_min}} \quad P_{vLwind} = 1405 \cdot lbf$$

<---vertical wind force on curb

$N_{clipsL} = 2$ <---number of clips on long side (Length) of unit

$$Uplift_L := \max\left(0lbf, \frac{P_{vLwind} - 0.6P_{dead}}{N_{clipsL}}\right)$$

<---uplift per clip

$Uplift_L = 457.89 \cdot lbf$

Design Forces (continued_

Wind Forces (continued)

Wind blowing on short side (Width) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_min} \cdot \min(L_{u\_min}, W_{u\_min})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 4203.28\,lbf$

$$P_{vWwind} := \frac{F_h \cdot \frac{H_{u\_min}}{2}}{L_{u\_min}} \quad P_{vWwind} = 1006 \cdot lbf$$ <---vertical wind force on curb

$N_{clipsW} = 2$ <---number of clips on long side (Length) of unit

$$Uplift_W := \max\left(0lbf, \frac{P_{vWwind} - 0.6P_{dead}}{N_{clipsW}}\right)$$ <---uplift per clip

$Uplift_W = 258.42 \cdot lbf$

$$Uplift := \max\left[Uplift_L, Uplift_W, \frac{F_v - 0.6 \cdot P_{dead}}{2 \cdot (N_{clipsW} + N_{clipsL})}\right] \quad Uplift = 805 \cdot lbf$$

Check Clip

Shear

$v_{clip} := Uplift$ $v_{clip} = 805 \cdot lbf$ <---actual shear on clip

$V_{clip} = 2756.27 \cdot lbf$ $V_{clip} = 2756.27 \cdot lbf$ <---allowable shear on clip

Bending

$e_{force} = 4.63 \cdot in$ <---moment arm

$m_{clip} := e_{force} \cdot Uplift$ $m_{clip} = 3.72 \cdot kip \cdot in$ <---actual bending moment in clip

$M_a = 9.73 \cdot kip \cdot in$ <---allowable bending in clip

Interaction

$$Interaction := \left(\frac{v_{clip}}{V_{clip}}\right)^2 + \left(\frac{m_{clip}}{M_a}\right)^2 = 0.23$$ <---interaction for bendng and shear, Section C3.3 - Must be less than 1.0

Equipment: Lennox
Models: KCA-M, KGA-M, KHA-M 180-300 and LCA-M, LCH-M, LGC-M, LGH-M 248-300 (Worst Case) for use with Curbs Plus Curb LENNOX L/T/K-SERIES/LGH-LCH 156-300S

$sub_{matrix1}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"KCA-180-M"	106.5	90.13	51	42.5	2180	101.5	85.63
"KCA-210-M"	106.5	90.13	51	41.75	2325	101.5	85.63
"KCA-240-M"	120.19	90.13	51	39.5	2595	101.5	85.63
"KGA-180-M"	106.5	90.13	51	42.5	2180	101.5	85.63
"KGA-210-M"	106.5	90.13	51	41.75	2325	101.5	85.63
"KGA-240-M"	120.19	90.13	51	39.5	2595	101.5	85.63
"KHA-180-M"	128.5	90.13	51	41.75	2270	101.5	85.63
"KHA-240-M"	128.5	90.13	51	41	2480	101.5	85.63

$sub_{matrix2}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"LCH-156-M"	106.5	90.13	51	42.75	2159	101.5	85.63
"LCH-180-M"	120.19	90.13	51	42	2350	101.5	85.63
"LCH-210-M"	120.19	90.13	51	42	2470	101.5	85.63
"LCH-240-M"	120.19	90.13	51	41.5	2571	101.5	85.63
"LGH-180-M"	120.19	90.13	51	42	2505	101.5	85.63
"LGH-210-M"	120.19	90.13	51	42	2615	101.5	85.63
"LGH-240-M"	120.19	90.13	51	41.5	2716	101.5	85.63

$sub_{matrix3}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"KCA-300-M"	120.19	90.13	51	39.5	2595	101.5	85.63
"KGA-300-M"	120.19	90.13	51	39.5	2595	101.5	85.63

Max Unit Data (see shop drawings in Appendix)

$L_{u\_max} = 120.19 \cdot in$ <---outside length of unit

$W_{u\_max} = 90.13 \cdot in$ <---outside width of unit

$H_{u\_max} = 51 \cdot in$ <---height of unit from top of curb

Cross_Section = "Square"

$Weight_{max} = 2716\,lbf$ <---installation weight of mechanical unit.

Design Forces

Dead Forces

$P_{dead} := \frac{Weight_{max} \cdot L_{cg\_max}}{W_{u\_max}} = 1250.64\,lbf$ <---minimum dead load per linear foot acting vertically on curb. Lcg (distance to center of gravity assumed at mid point)

Wind Forces

Wind blowing on Long side (Length) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_max} \cdot \max(L_{u\_max}, W_{u\_max})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 5605.34\,lbf$

Wind uplift on unit

$GC_r := 1.5$ <---factor for rooftop structures and equipment with Ar less than 0.1BL, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_r := W_{u\_max} \cdot L_{u\_max}$ <---horizontal projected area of the rooftop unit, ASCE 7-10

$F_v := q_h \cdot (GC_r) \cdot A_r$ <---vertical uplift force on rooftop unit, Eq. 29.5-3 ASCE 7-10

$F_v = 7820.15\,lbf$

$P_{vLwind} := \frac{F_h \cdot \frac{H_{u\_max}}{2}}{W_{u\_max}}$ $P_{vLwind} = 1586 \cdot lbf$ <---vertical wind force on curb

$N_{clipsL} = 2$ <---number of clips on long side (Length) of unit

$Uplift_L := \max\left(0lbf, \frac{P_{vLwind} - 0.6P_{dead}}{N_{clipsL}}\right)$ <---uplift per clip

$Uplift_L = 417.8 \cdot lbf$

Design Forces (continued_

Wind Forces (continued)

Wind blowing on short side (Width) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_max} \cdot \min(L_{u\_max}, W_{u\_max})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 4203.28\,lbf$

$$P_{vWwind} := \frac{F_h \cdot \frac{H_{u\_max}}{2}}{L_{u\_max}} = 891.8\,lbf$$ <---vertical wind force on curb

$N_{clipsW} = 2$ <---number of clips on long side (Length) of unit

$$Uplift_W := \max\left(0lbf, \frac{P_{vWwind} - 0.6P_{dead}}{N_{clipsW}}\right)$$ <---uplift per clip

$Uplift_W = 70.71 \cdot lbf$

$$Uplift := \max\left[Uplift_L, Uplift_W, \frac{F_v - 0.6 \cdot P_{dead}}{2 \cdot (N_{clipsW} + N_{clipsL})}\right]$$ $Uplift = 883.72 \cdot lbf$

Check Clip

Shear

$v_{clip} := Uplift$ $v_{clip} = 884 \cdot lbf$ <---actual shear on clip

$V_{clip} = 2756 \cdot lbf$ <---allowable shear on clip

Bending

$e_{force} = 4.63 \cdot in$ <---moment arm

$m_{clip} := e_{force} \cdot Uplift$ $m_{clip} = 4.09 \cdot kip \cdot in$ <---actual bending moment in clip

$M_a = 9.73 \cdot kip \cdot in$ <---allowable bending in clip

Interaction

$$Interaction := \left(\frac{v_{clip}}{V_{clip}}\right)^2 + \left(\frac{m_{clip}}{M_a}\right)^2 = 0.28$$ <---interaction for bendng and shear, Section C3.3 - Must be less than 1.0

Minimum Unit Data (see shop drawings in Appendix)

$L_{u\_min} = 106.5 \cdot in$ <---outside length of unit

$W_{u\_min} = 90.13 \cdot in$ <---outside width of unit

$H_{u\_min} = 51 \cdot in$ <---height of unit from top of curb

Cross Section = "Square"

$Weight_{min} = 2159 \cdot lbf$ <---installation weight of mechanical unit.

Design Forces

Dead Forces

$$P_{dead} := \frac{Weight_{min} \cdot L_{cg\_min}}{W_{u\_min}}$$

<---minimum dead load per linear foot acting vertically on curb. Lcg (distance to center of gravity assumed at mid point)

Wind Forces

Wind blowing on Long side (Length) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_min} \cdot \max(L_{u\_min}, W_{u\_min})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 4966.98\,lbf$

Wind uplift on unit

$GC_r := 1.5$ <---factor for rooftop structures and equipment with Ar less than 0.1BL, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_r := W_{u\_min} \cdot L_{u\_min}$ <---horizontal projected area of the rooftop unit, ASCE 7-10

$F_v := q_h \cdot (GC_r) \cdot A_r$ <---vertical uplift force on rooftop unit, Eq. 29.5-3 ASCE 7-10

$F_v = 6929.56\,lbf$

$$P_{vLwind} := \frac{F_h \cdot \frac{H_{u\_min}}{2}}{W_{u\_min}} \quad P_{vLwind} = 1405 \cdot lbf$$

<---vertical wind force on curb

$N_{clipsL} = 2$ <---number of clips on long side (Length) of unit

$$Uplift_L := \max\left(0lbf, \frac{P_{vLwind} - 0.6P_{dead}}{N_{clipsL}}\right)$$

<---uplift per clip

$Uplift_L = 395.45 \cdot lbf$

Design Forces (continued_

Wind Forces (continued)

Wind blowing on short side (Width) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_min} \cdot \min(L_{u\_min}, W_{u\_min})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 4203.28\,lbf$

$$P_{vWwind} := \frac{F_h \cdot \frac{H_{u\_min}}{2}}{L_{u\_min}} \quad P_{vWwind} = 1006 \cdot lbf$$ <---vertical wind force on curb

$N_{clipsW} = 2$ <---number of clips on long side (Length) of unit

$$Uplift_W := \max\left(0lbf, \frac{P_{vWwind} - 0.6P_{dead}}{N_{clipsW}}\right)$$ <---uplift per clip

$Uplift_W = 195.98 \cdot lbf$

$$Uplift := \max\left[Uplift_L, Uplift_W, \frac{F_v - 0.6 \cdot P_{dead}}{2 \cdot (N_{clipsW} + N_{clipsL})}\right] \quad Uplift = 789.39 \cdot lbf$$

Check Clip

Shear

$v_{clip} := Uplift$ $v_{clip} = 789.39 \cdot lbf$ <---actual shear on clip

$V_{clip} = 2756.27 \cdot lbf$ $V_{clip} = 2756.27 \cdot lbf$ <---allowable shear on clip

Bending

$e_{force} = 4.63 \cdot in$ <---moment arm

$m_{clip} := e_{force} \cdot Uplift$ $m_{clip} = 3.65 \cdot kip \cdot in$ <---actual bending moment in clip

$M_a = 9.73 \cdot kip \cdot in$ <---allowable bending in clip

Interaction

$$Interaction := \left(\frac{v_{clip}}{V_{clip}}\right)^2 + \left(\frac{m_{clip}}{M_a}\right)^2 = 0.22$$ <---interaction for bendng and shear, Section C3.3 - Must be less than 1.0

Equipment: Lennox
Model: LCA, LCH, LGC, LGH (Worst Case)
for use with Curbs Plus Curb
LENNOX L-SERIES 248,300H,360H

$sub_{matrix1}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"LCA-360"	132.38	90.13	61.75	37.25	2910	101.5	85.63
"LGC-360"	132.38	90.13	61.75	36.75	3020	101.5	85.63
"LCA-248-M"	132.38	90.13	61.75	40.13	3280	101.5	85.63
"LCA-300-M"	132.38	90.13	61.75	40.13	3280	101.5	85.63
"LCA-360-M"	132.38	90.13	61.75	40.13	3480	101.5	85.63
"LCH-300-M"	120.19	90.13	51	40.75	2635	101.5	85.63

$sub_{matrix2}$ =

"Unit"	"Lu (in)"	"Wu (in)"	"Hu (in)"	"Lcg(in)"	"Wm (lbf)"	"Lc(in)"	"Wc(in)"
"LGC-248-M"	132.38	90.13	61.75	39.75	3340	101.5	85.63
"LGC-300-M"	132.38	90.13	61.75	39.75	3340	101.5	85.63
"LGC-360-M"	132.38	90.13	61.75	39.75	3340	101.5	85.63
"LGH-300-M"	120.19	90.13	51	40.75	2780	101.5	85.63

Max Unit Data (see shop drawings in Appendix)

$L_{u\_max} = 132.38 \cdot in$ <---outside length of unit

$W_{u\_max} = 90.13 \cdot in$ <---outside width of unit

$H_{u\_max} = 61.75 \cdot in$ <---height of unit from top of curb

Cross_Section = "Square"

$Weight_{max} = 3480\,lbf$ <---installation weight of mechanical unit.

Design Forces

Dead Forces

$P_{dead} := \frac{Weight_{max} \cdot L_{cg\_max}}{W_{u\_max}} = 1549.35\,lbf$ <---minimum dead load per linear foot acting vertically on curb. Lcg (distance to center of gravity assumed at mid point)

Wind Forces

Wind blowing on Long side (Length) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_max} \cdot \max(L_{u\_max}, W_{u\_max})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 7475.08\,lbf$

Wind uplift on unit

$GC_r := 1.5$ <---factor for rooftop structures and equipment with Ar less than 0.1BL, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_r := W_{u\_max} \cdot L_{u\_max}$ <---horizontal projected area of the rooftop unit, ASCE 7-10

$F_v := q_h \cdot (GC_r) \cdot A_r$ <---vertical uplift force on rooftop unit, Eq. 29.5-3 ASCE 7-10

$F_v = 8613.14\,lbf$

$P_{vLwind} := \frac{F_h \cdot \frac{H_{u\_max}}{2}}{W_{u\_max}}$ $P_{vLwind} = 2561 \cdot lbf$ <---vertical wind force on curb

$N_{clipsL} = 2$ <---number of clips on long side (Length) of unit

$Uplift_L := \max\left(0lbf, \frac{P_{vLwind} - 0.6P_{dead}}{N_{clipsL}}\right)$ <---uplift per clip

$Uplift_L = 815.6 \cdot lbf$

Design Forces (continued_

Wind Forces (continued)

Wind blowing on short side (Width) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_max} \cdot \min(L_{u\_max}, W_{u\_max})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 5089.27\,lbf$

$$P_{vWwind} := \frac{F_h \cdot \frac{H_{u\_max}}{2}}{L_{u\_max}} = 1187.01\,lbf$$ <---vertical wind force on curb

$N_{clipsW} = 2$ <---number of clips on long side (Length) of unit

$$Uplift_W := \max\left(0lbf, \frac{P_{vWwind} - 0.6P_{dead}}{N_{clipsW}}\right)$$ <---uplift per clip

$Uplift_W = 128.7 \cdot lbf$

$$Uplift := \max\left[Uplift_L, Uplift_W, \frac{F_v - 0.6 \cdot P_{dead}}{2 \cdot (N_{clipsW} + N_{clipsL})}\right]$$ $Uplift = 960.44 \cdot lbf$

Check Clip

Shear

$v_{clip} := Uplift$ $v_{clip} = 960 \cdot lbf$ <---actual shear on clip

$V_{clip} = 2756 \cdot lbf$ <---allowable shear on clip

Bending

$e_{force} = 4.63 \cdot in$ <---moment arm

$m_{clip} := e_{force} \cdot Uplift$ $m_{clip} = 4.44 \cdot kip \cdot in$ <---actual bending moment in clip

$M_a = 9.73 \cdot kip \cdot in$ <---allowable bending in clip

Interaction

$$Interaction := \left(\frac{v_{clip}}{V_{clip}}\right)^2 + \left(\frac{m_{clip}}{M_a}\right)^2 = 0.33$$ <---interaction for bendng and shear, Section C3.3 - Must be less than 1.0

Minimum Unit Data (see shop drawings in Appendix)

$L_{u\_min} = 120.19 \cdot in$ <---outside length of unit

$W_{u\_min} = 90.13 \cdot in$ <---outside width of unit

$H_{u\_min} = 51 \cdot in$ <---height of unit from top of curb

Cross Section = "Square"

$Weight_{min} = 2635 \cdot lbf$ <---installation weight of mechanical unit.

Design Forces

Dead Forces

$$P_{dead} := \frac{Weight_{min} \cdot L_{cg\_min}}{W_{u\_min}}$$

<---minimum dead load per linear foot acting vertically on curb. Lcg (distance to center of gravity assumed at mid point)

Wind Forces

Wind blowing on Long side (Length) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_min} \cdot \max(L_{u\_min}, W_{u\_min})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 5605.34\ lbf$

Wind uplift on unit

$GC_r := 1.5$ <---factor for rooftop structures and equipment with Ar less than 0.1BL, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_r := W_{u\_min} \cdot L_{u\_min}$ <---horizontal projected area of the rooftop unit, ASCE 7-10

$F_v := q_h \cdot (GC_r) \cdot A_r$ <---vertical uplift force on rooftop unit, Eq. 29.5-3 ASCE 7-10

$F_v = 7820.15\ lbf$

$$P_{vLwind} := \frac{F_h \cdot \frac{H_{u\_min}}{2}}{W_{u\_min}} \quad P_{vLwind} = 1586 \cdot lbf$$

<---vertical wind force on curb

$N_{clipsL} = 2$ <---number of clips on long side (Length) of unit

$$Uplift_L := \max\left(0lbf, \frac{P_{vLwind} - 0.6P_{dead}}{N_{clipsL}}\right)$$

<---uplift per clip

$Uplift_L = 435.56 \cdot lbf$

Design Forces (continued_

Wind Forces (continued)

Wind blowing on short side (Width) of unit

$GC_r := 1.9$ <---factor for rooftop structures and equipment with Af less than 0.1Bh, Assumed Worst Case Condition, Section 29.5.1 ASCE 7-10

$A_f := H_{u\_min} \cdot \min(L_{u\_min}, W_{u\_min})$ <---vertical projected area of the rooftop unit, ASCE 7-10

$F_h := q_h \cdot (GC_r) \cdot A_f$ <---lateral force on rooftop structures, Eq. 29.5-2 ASCE 7-10

$F_h = 4203.28\,lbf$

$P_{vWwind} := \frac{F_h \cdot \frac{H_{u\_min}}{2}}{L_{u\_min}}$ $P_{vWwind} = 892 \cdot lbf$ <---vertical wind force on curb

$N_{clipsW} = 2$ <---number of clips on long side (Length) of unit

$Uplift_W := \max\left(0lbf, \frac{P_{vWwind} - 0.6P_{dead}}{N_{clipsW}}\right)$ <---uplift per clip

$Uplift_W = 88.48 \cdot lbf$

$Uplift := \max\left[Uplift_L, Uplift_W, \frac{F_v - 0.6 \cdot P_{dead}}{2 \cdot (N_{clipsW} + N_{clipsL})}\right]$ $Uplift = 888.16 \cdot lbf$

Check Clip

Shear

$v_{clip} := Uplift$ $v_{clip} = 888.16 \cdot lbf$ <---actual shear on clip

$V_{clip} = 2756.27 \cdot lbf$ $V_{clip} = 2756.27 \cdot lbf$ <---allowable shear on clip

Bending

$e_{force} = 4.63 \cdot in$ <---moment arm

$m_{clip} := e_{force} \cdot Uplift$ $m_{clip} = 4.11 \cdot kip \cdot in$ <---actual bending moment in clip

$M_a = 9.73 \cdot kip \cdot in$ <---allowable bending in clip

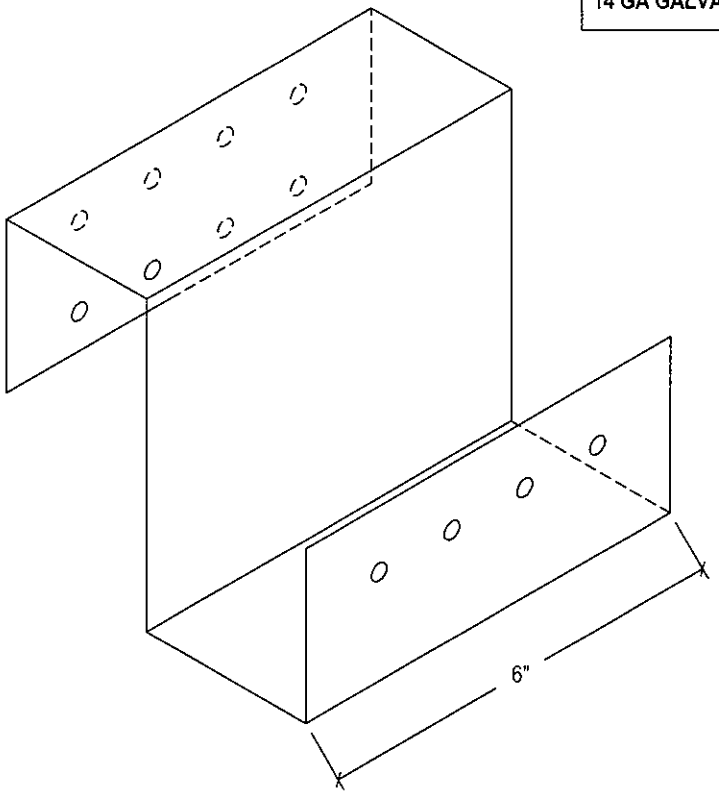
Interaction

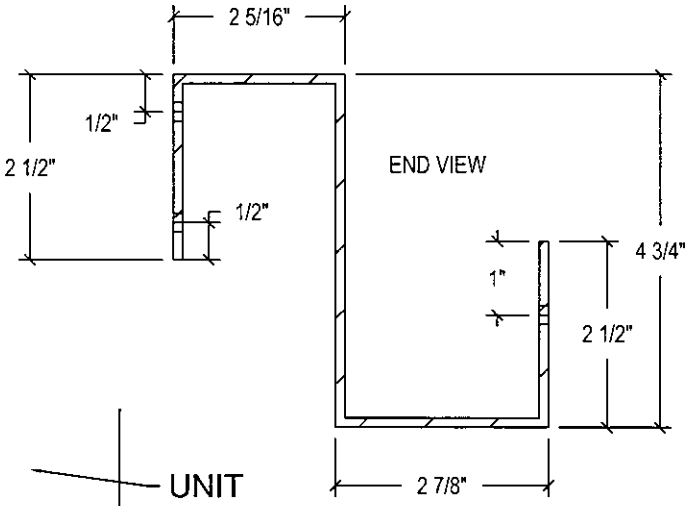
$Interaction := \left(\frac{v_{clip}}{V_{clip}}\right)^2 + \left(\frac{m_{clip}}{M_a}\right)^2 = 0.28$ <---interaction for bendng and shear, Section C3.3 - Must be less than 1.0

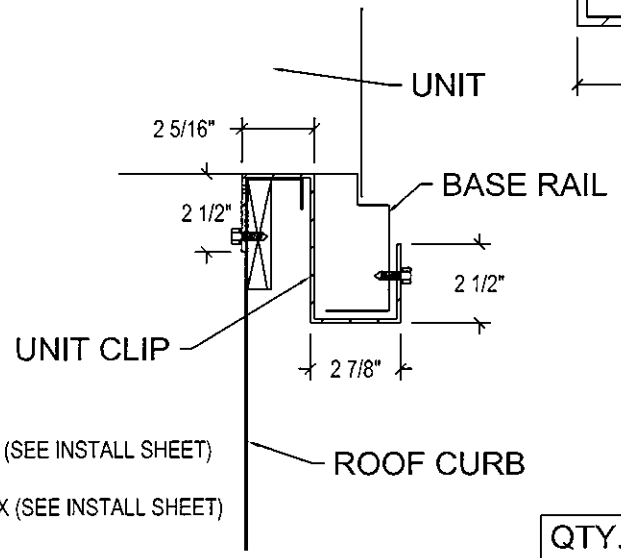
Appendix

Drawing Date:	REV: 10-10-14	Approved By:

14 GA GALVANIZED CONSTRUCTION







LENNOX: L/T/K-SERIES/LGH-LCH 024-150 UNITS USE (8) CLIPS PER CURB MAX (SEE INSTALL SHEET)

LENNOX: L/T/K-SERIES/LGH-LCH 156-360 UNITS USE (10) CLIPS PER CURB MAX (SEE INSTALL SHEET)

ATTACH VIA (8) $\frac{1}{4}$"X14X1 $\frac{1}{4}$" TEK SCREWS

QTY.: SET(S) (10 CLIPS PER SET)
PROJECT NAME:
CITY, STATE:
CUSTOMER:
JOB NUMBER:
TAG:

CURBS PLUS, INC.

8767 Alabama Hwy
Ringgold, GA 30736

205 Metcalf Rd.
El Dorado,KS 67042

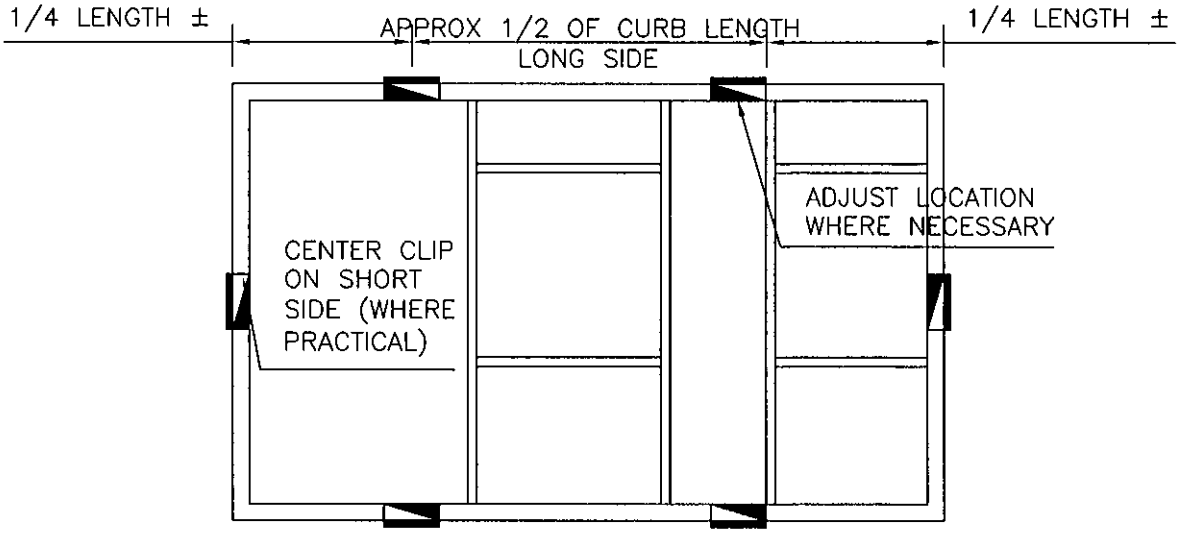
Phone: (706) 858-1188 / FAX (706) 866-2339
website: www.curbs-plus.com

LENNOX UNIT CLIPS
MODEL# L/T/K/S-SERIES/LGH-LCH 024-360

LENNOX PART# X6523

March Adams & Associates
Consulting Engineers
P.O. Box 3689
310 Dodds Avenue
Chattanooga, TN 37404
(423) 698-6675

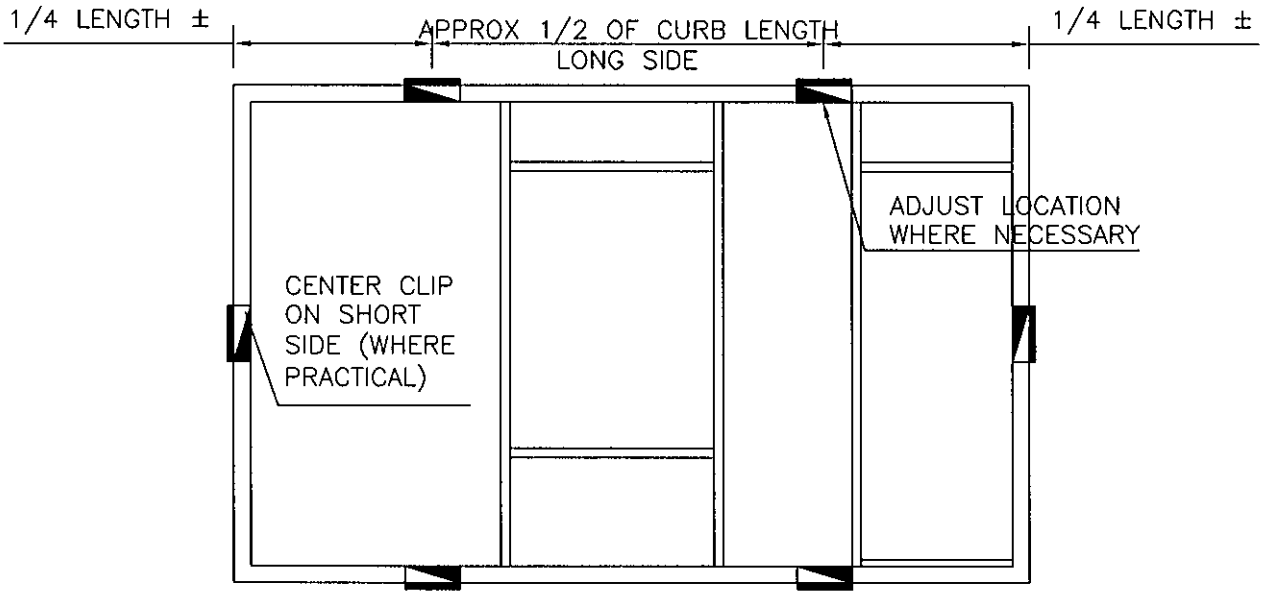
Job Name: Curbs Plus No. 18-098
Prepared By: THOMAS A. RETSECK Date: March 2018
Sheet No: of Scale: N.T.S.
Topic: Clip Locations for Curbs Plus Curb#:
Other: LENNOX T/K-SERIES/LGH-LCH 024-072
Other:



LENNOX T/K-SERIES/LGH-LCH 024-072
2 TO 6 TON UNITS - STANDARD AND MAX

March Adams & Associates
Consulting Engineers
P.O. Box 3689
310 Dodds Avenue
Chattanooga, TN 37404
(423) 698-6675

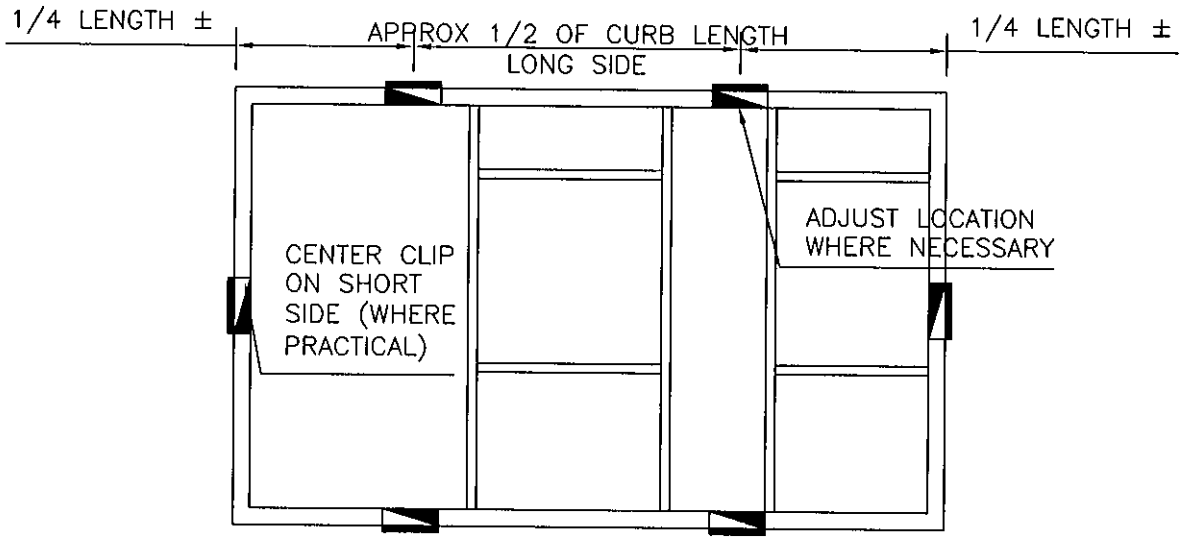
Job Name: Curbs Plus No. 18-098
Prepared By: THOMAS A. RETSECK Date: March 2018
Sheet No: ____ of ____ Scale: N.T.S.
Topic: Clip Locations for Curbs Plus Curb#:
Other: LENNOX K-SERIES 090 F.P.
Other:



LENNOX K-SERIES 090 F.P.
15 TON UNITS - STANDARD AND MAX

March Adams & Associates
Consulting Engineers
P.O. Box 3689
310 Dodds Avenue
Chattanooga, TN 37404
(423) 698-6675

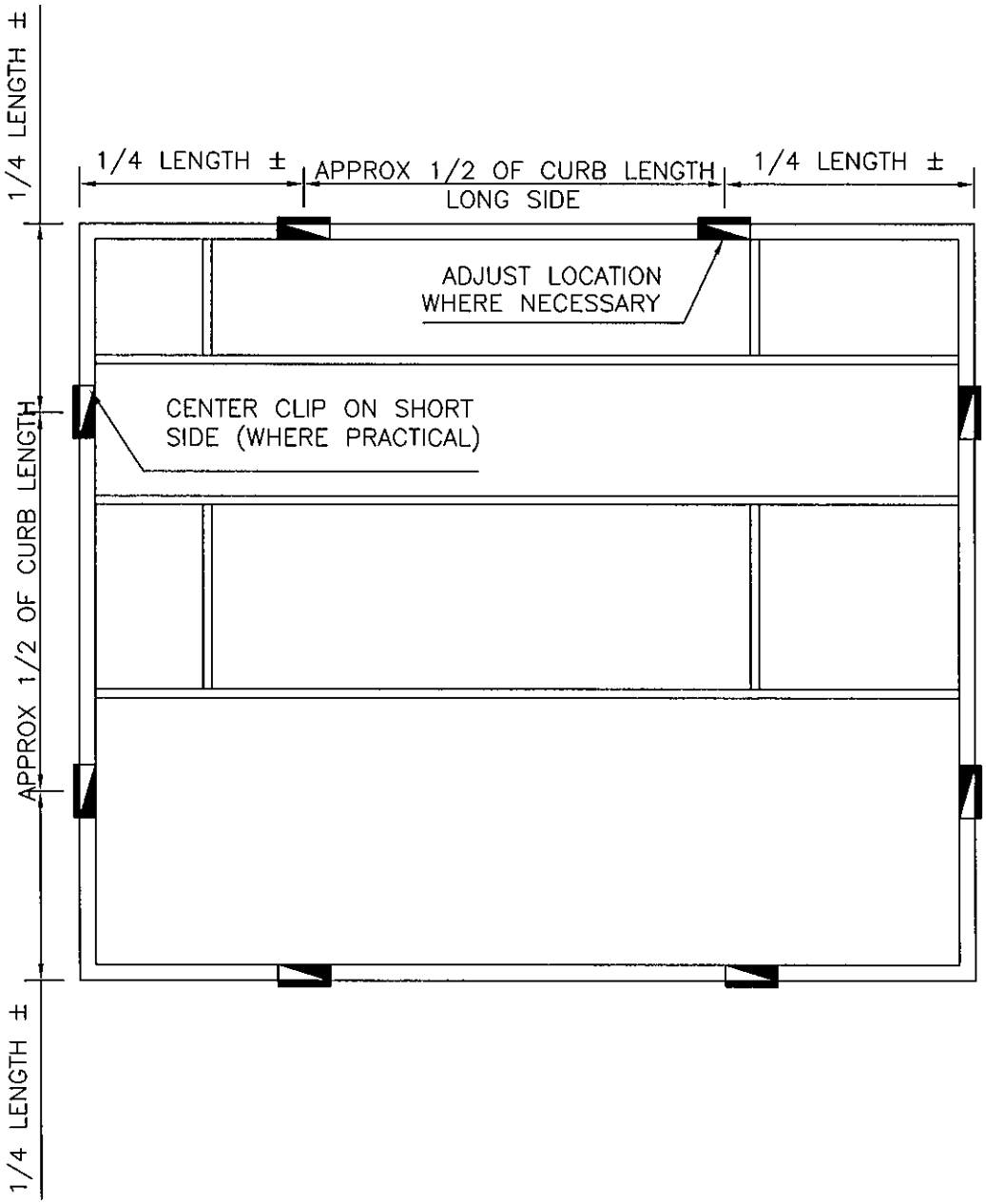
Job Name: Curbs Plus No. 18-098
Prepared By: THOMAS A. RETSECK Date: March 2018
Sheet No: ____ of ____ Scale: N.T.S.
Topic: Clip Locations for Curbs Plus Curb#:
Other: LENNOX K-SERIES/LGH-LCH 092-150
Other:



LENNOX K-SERIES/LGH-LCH 092-150
7.5 TO 12.5 TON UNITS - STANDARD AND MAX

March Adams & Associates
Consulting Engineers
P.O. Box 3689
310 Dodds Avenue
Chattanooga, TN 37404
(423) 698-6675

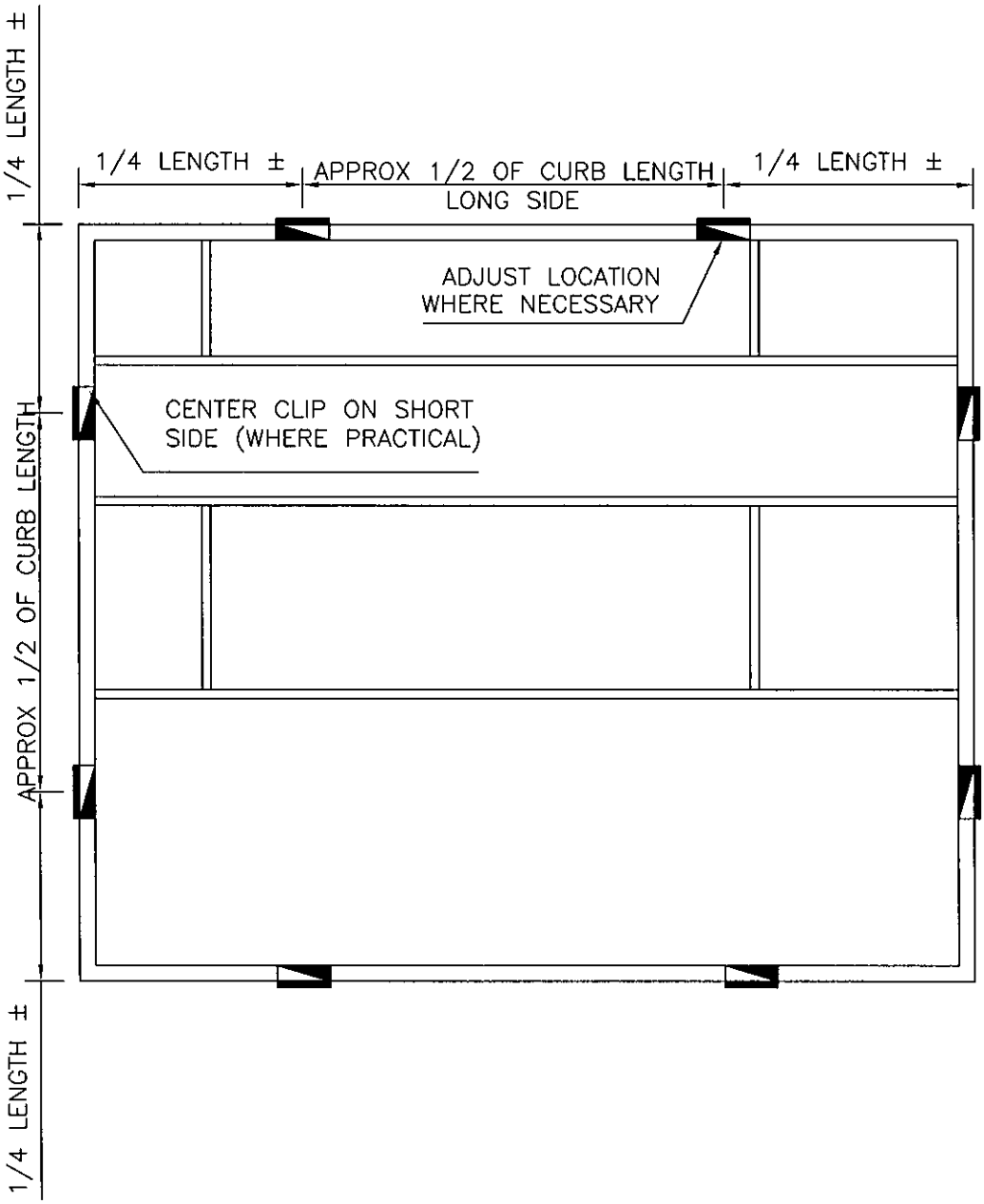
Job Name: Curbs Plus No. 18-098
Prepared By: THOMAS A. RETSECK Date: March 2018
Sheet No: of Scale: N.T.S.
Topic: Clip Locations for Curbs Plus Curb#:
Other: LENNOX L/T/K-SERIES/LGH-LCH 156-300S
Other:



LENNOX K-SERIES/LGH-LCH 092-150
13 - 25 TON UNITS - STANDARD (LIMITED MAX)

March Adams & Associates
Consulting Engineers
P.O. Box 3689
310 Dodds Avenue
Chattanooga, TN 37404
(423) 698-6675

Job Name: Curbs Plus No. 18-098
Prepared By: THOMAS A. RETSECK Date: March 2018
Sheet No: ____ of ____ Scale: N.T.S.
Topic: Clip Locations for Curbs Plus Curb#:
Other: LENNOX L-SERIES 248, 300H, 360H
Other:



LENNOX L-SERIES 248, 300H, 360H
21, 25 AND 30 TON UNITS - STANDARD AND MAX