W. Charles Perry & Associates

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November 20, 2006

Mr. David Rea
NPI Engineer
Tropos Networks, Inc.
555 Del Rey Avenue
Sunnyvale, CA 94085

Re: Analysis of Snow and Wind Loads for Tropos 5210 & 5320

Dear Mr. Rea:

Thank you for the opportunity to work for you on the referenced project. I analyzed the referenced network boxes to determine the most severe wind loads they would endure in the United States. I also analyzed them to determine the most severe snow and ice loads they would endure any metropolitan area in the United States exclusive of those cities or towns in special alpine regions with their own snow loading requirements. For the peak wind load I assumed a 3 second sustained gust of 170 mph in accordance with ASCI/SEI 7-05. In this analysis I assumed that the 5320 presented the maximum sail area with a pendant antennae configuration. For the peak snow load I assumed the equivalent of 6.2 feet of compacted snow or 9.4 feet of new snow pack in accordance with ASCE/SEI 7-05. This is also the equivalent of 3.3 feet of ice hanging from the referenced boxes.

The results of this analysis are presented in the following table:

	Snow		**Wind**			
Box	Downward Shear	Downward Moment	Front Wind Pull or Push	Side Wind Pull or Push	Side Wind Torque	45º Wind Pull or Push
5210	159 lbf	695 in-lbf	51 lbf	37 lbf	164 in-lbf	58 lbf
5320	157 lbf	688 in-lbf	73 lbf	55 lbf	293 in-lbf	84 lbf

The screws in the mounting bracket can support these loads. For your review and future reference, a copy of my calculations is attached.

If you have any further questions or concerns about this matter, please contact me via telephone or e-mail. I am …

Yours Sincerely,

W. Charles Perry, M.S., P.E.
Principal Engineer
License No. C38622 & M25554

Digitally signed by
W. Charles Perry
Date: 2006.11.20
15:09:51 -08'00'

Wind and Snow Load Analysis of 5210 & 5310

Tropos Wireless Network Box Analysis

W. Charles Perry & Associates / November 20, 2006 / Rev. 1.0

Snow Loads per ASCE/SEI 7-05

$p_g := 160 \frac{lbf}{ft^2}$ ... max. ground snow load value per Table 7.1 exclusive of Whittier, Alaska at 300 psf; 100 psf max per lower 48 states exclusive of site specific alpine locations.

$C_e := 1.2$ ... max value per Table 7.2 for sheltered location

$C_t := 1.2$ ... max value per table 7-3

$I := 1.2$ ... max value per table 7-4 for Category IV structures - high importance structure

$p_f := 0.7 \cdot C_e \cdot C_t \cdot I \cdot p_g$

$p_f = 193.536 \frac{lbf}{ft^2}$

Snow Loads on Network Boxes

$w_{5320} := 13.375 \cdot in$

$d_{5320} := 8.75 \cdot in$

$A_{plan.5320} := w_{5320} \cdot d_{5320}$ $A_{plan.5320} = 117.031\ in^2$

$F_{snow.5320} := A_{plan.5320} \cdot p_f$ $F_{snow.5320} = 157.29\ lbf$

$w_{5210} := 13.5 \cdot in$

$d_{5210} := 8.75 \cdot in$

$A_{plan.5210} := w_{5210} \cdot d_{5210}$ $A_{plan.5210} = 118.125\ in^2$

$F_{snow.5210} := A_{plan.5210} \cdot p_f$ $F_{snow.5210} = 158.76\ lbf$

Snow Loads on Mounting Brackets

$r_{5320} := \frac{d_{5320}}{2}$ ... distance from center of snow load to mounting bracket screws

$M_{5320} := r_{5320} \cdot F_{snow.5320}$ $M_{5320} = 688.144\ in \cdot lbf$

$r_{screws} := 4 \cdot in$

$T_{screw} := \frac{M_{5320}}{r_{screws}}$ $T_{screw} = 172.036\ lbf$ ... tensile load on screws

Stresses from Snow Loads on Mounting Bracket Screws

$D_{screw} := 0.125 \cdot in$

$A_{screw} := \frac{D_{screw}^{\ 2} \cdot \pi}{4}$ $A_{screw} = 0.012\ in^2$

$\sigma_{screw.snow} := \frac{T_{screw}}{A_{screw}}$ $\sigma_{screw.snow} = 1.402 \times 10^4\ \frac{lbf}{in^2}$

$\tau_{screw.snow} := \frac{F_{snow.5320}}{2 \cdot A_{screw}}$ $\tau_{screw.snow} = 6.409 \times 10^3\ \frac{lbf}{in^2}$ ... ignores middle screw used for pivot

$\sigma_{screw.p1.snow} := \left(\sigma_{screw.snow}^{\ 2} + \tau_{screw.snow}^{\ 2}\right)^{0.5}$ $\sigma_{screw.p1.snow} = 1.541 \times 10^4\ \frac{lbf}{in^2}$

$\sigma_{yield} := 24000 \cdot \frac{lbf}{in^2}$ ... minimum yield strength for low carbon steel

$FS_{snow} := \frac{\sigma_{yield}}{\sigma_{screw.p1.snow}}$ $FS_{snow} = 1.557$

Wind Loads per ASCE/SEI 7-05

$v_{wind} := 170 \cdot mph$ $v_{wind} = 249.333\ \frac{ft}{s}$ ... maximum 3 second gust from Figure 6.1

$\rho_{air} := 0.00228 \cdot \frac{lbf \cdot sec^2}{ft^4}$

$$p_{wind} := \frac{\rho_{air} \cdot v_{wind}^2}{2} \qquad p_{wind} = 0.492 \frac{lbf}{in^2} \qquad p_{wind} = 70.871 \frac{lbf}{ft^2}$$

Wind Loads on 5320 with Descending Antennae

$h_{antennae} := 17.25 \cdot in$

$d_{antennae} := 0.75 \cdot in$

$A_{antennae} := h_{antennae} \cdot d_{antennae} \qquad A_{antennae} = 12.937\ in^2$

$n_{antennae.5320} := 3$

$h_{5320} := 8.25 \cdot in$

$A_{5320.wind.0} := h_{5320} \cdot w_{5320} + n_{antennae.5320} \cdot A_{antennae} \qquad A_{5320.wind.0} = 149.156\ in^2$

$A_{5320.wind.90} := h_{5320} \cdot d_{5320} + n_{antennae.5320} \cdot A_{antennae} \qquad A_{5320.wind.90} = 111\ in^2$

$L_{diag.5320} := \left(w_{5320}^2 + d_{5320}^2\right)^{0.5} \qquad L_{diag.5320} = 15.983\ in$

$A_{5320.wind.45} := h_{5320} \cdot L_{diag.5320} + n_{antennae.5320} \cdot A_{antennae} \qquad A_{5320.wind.45} = 170.671\ in^2$

$F_{5320.wind.0} := A_{5320.wind.0} \cdot p_{wind} \qquad F_{5320.wind.0} = 73.408\ lbf$

$F_{5320.wind.90} := A_{5320.wind.90} \cdot p_{wind} \qquad F_{5320.wind.90} = 54.629\ lbf$

$F_{5320.wind.45} := A_{5320.wind.45} \cdot p_{wind} \qquad F_{5320.wind.45} = 83.997\ lbf$

$T_{5320.max} := F_{5320.wind.90} \cdot r_{5320} \qquad T_{5320.max} = 239.003\ in \cdot lbf$

Wind Loads on 5210

$n_{antennae.5210} := 2$

$h_{5210} := 5.75 \cdot in$

$A_{5210.wind.0} := h_{5210} \cdot w_{5210} + n_{antennae.5210} \cdot A_{antennae} \qquad A_{5210.wind.0} = 103.5\ in^2$

$A_{5210.wind.90} := h_{5210} \cdot d_{5210} + n_{antennae.5210} \cdot A_{antennae}$ $\quad A_{5210.wind.90} = 76.187\ in^2$

$L_{diag.5210} := \left(w_{5210}{}^2 + d_{5210}{}^2\right)^{0.5}$ $\quad L_{diag.5210} = 16.088\ in$

$A_{5210.wind.45} := h_{5210} \cdot L_{diag.5210} + n_{antennae.5210} \cdot A_{antennae}$ $\quad A_{5210.wind.45} = 118.379\ in^2$

$F_{5210.wind.0} := A_{5210.wind.0} \cdot p_{wind}$ $\quad F_{5210.wind.0} = 50.938\ lbf$

$F_{5210.wind.90} := A_{5210.wind.90} \cdot p_{wind}$ $\quad F_{5210.wind.90} = 37.496\ lbf$

$F_{5210.wind.45} := A_{5210.wind.45} \cdot p_{wind}$ $\quad F_{5210.wind.45} = 58.261\ lbf$

$T_{5210.max} := F_{5210.wind.90} \cdot \frac{d_{5210}}{2}$ $\quad T_{5210.max} = 164.046\ in \cdot lbf$

Stresses from Wind Loads on Mounting Bracket Screws

$r_{bracket.screw} := 2 \cdot in$

$F_{screw.T} := \frac{T_{5320.max}}{r_{bracket.screw}}$ $\quad F_{screw.T} = 119.502\ lbf$

$\sigma_{screw.wind} := \frac{F_{screw.T}}{2A_{screw}}$ $\quad \sigma_{screw.wind} = 4.869 \times 10^3 \frac{lbf}{in^2}$ ... ignores middle screw used for pivot

$FS_{wind} := \frac{\sigma_{yield}}{\sigma_{screw.wind}}$ $\quad FS_{wind} = 4.929$