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Metal & Cable Corp., Inc.
Antenna Mount Calculations - R01

B & A Project 74035

Prepared for:
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July 24, 2010

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President
Beach & Associates, LLC

74035 Antenna Mount Calculations
74035R01
7/24/2010

Overview

The scope of Part 1 of the project required calculations based on AASHTO standards to determine loads at the base of a mounting system used to attach a dish/panel antenna array to the side of a water tower. The calculation set is shown on pages 0 thru 13 of the attached document and is loosely based on a proposed installation in Washington state. The general arrangement of that installation can be found in Appendix 1. Some of the geometric values used in the attached calculations such as the horizontal distances between components were scaled from this document.

Multiple exceptions and assumptions were employed in the execution of the calculation set. They are listed below in no specific order of priority.

1) The height above ground of the antenna array has been arbitrarily set to 200'.
2) The antenna array was assumed to have full exposure from a rear wind situation.
3) The exposure of the vertical pole was assumed to be negligible for front & rear wind situations.
4) The exposure of the various clamps, brackets, and hardware was assumed to inconsequential.
5) Loads per magnetic bracket in some cases were assumed to be evenly distributed even though the actual distribution is statically indeterminate.
6) Allowable loads per magnet and per magnetic bracket as well as the layout of the magnets on each bracket were supplied by the client.
7) The radius of curvature of the water tank was assumed to be negligible.
8) Ice loads, if applicable, are assumed to cover the entire component in question.

Constants used in the calculation set were taken from the AASHTO standard and are included in the appendix. All wind velocities were taken from the map on Appendix 2. It should be noted here that while the nominal wind velocities were used in generating the attached values, local building codes should be consulted in areas designated as special wind regions. The exposure factor, which is based on the height of the structure being analyzed relative to the local terrain, is taken from an AASHTO table and is shown in Appendix 3. A drawing of the magnet mounting plate is shown on Appendix 5. The magnets are attached to the 0.44 diameter thru holes. Other constants used in this report are the minimum gust factor of 1.14, a wind importance factor of 1.0, a drag co-efficient of 1.12, and an ice load of 3 lbs/ft^2.

The scope of Part 2 of this project involved the creation of an excel spreadsheet to be used in generating approximations of loadings where the installation is similar to the condition shown in Appendix 1. The results of this spreadsheet should be considered only as an approximation as each site should be carefully reviewed to apply the appropriate AASHTO values. A digital copy of this file has been supplied under separate cover under the file name of 74035genericR01.xls. A printed copy of a completed spreadsheet based on a specific example is shown on Appendix 4. A simplified general arrangement of the loading condition depicted by this spreadsheet is shown on page 15 of the calculation set. The tutorial on its use begins on page 14. The cells within the spreadsheet are NOT write protected. The overall accuracy can be verified using the example on pages 1 thru 13 and making allowances for round-off error.

Conclusion

Calculations for factors of safety for the conditions presented here-in are well within range of generally accepted safe working conditions.

ENGINEERING CALCULATIONS

Project# 74035 Client Metal-Cable Corp Date 07-08-10

Subject Antenna Mount Calculations - Abbreviations Page# 0 Next Page# 1

BB	Bottom bracket
FFBB	Front wind force @ bottom bracket
FFD	Wind load at front of dish antenna
FFP	Wind load at front of panel antenna
FFTB	Front wind force @ top bracket
FIB	Force @ magentic bracket from ice load
FID	Ice load on dish antenna
FIP	Ice load on panel antenna
FIT	Ice load on vertical tube
FMB	Force @ magentic bracket from component mass
FP	Force @ magentic pad
FRBB	Rear wind force @ bottom bracket
FRD	Wind load at rear of dish antenna
FRP	Wind load at rear of panel antenna
FRTB	Rear wind force @ top bracket
FSB	Shear load @ mounting bracket
FSD	Wind load at side of dish antenna
FSP	Wind load at side of panel antenna
FST	Wind load at side of vertical tube
FSV	Vertical shear force @ magnetic pad
MD	Mass of dish antenna
MP	Mass of panel antenna
MT	Mass of vertical tube
TB	Top bracket

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Subject Antenna Mount Calculations - Wind Loads Page# 1 Next Page# 2

Wind Load Equation (AASHTO LTS-4)

$P_z(\text{lbs/ft}^2) = .00256\, K_z G\, V^2 I_r C_d$

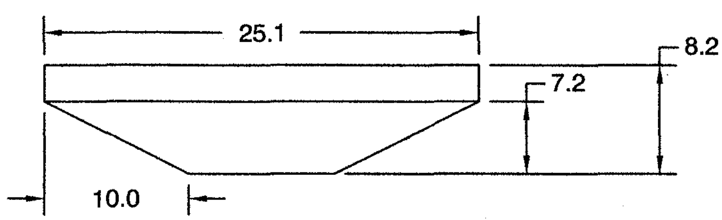
- K_z → Exposure Factor *
- G → Gust Factor
- V → Wind Velocity (mph)
- I_r → Wind Importance Factor
- C_d → Drag Coefficient

Calculate Dish Antenna Area & Wind Load (Front or Rear Exposure)

- 25.1" Dia (given)
- Area = $\pi r^2 = (\pi)(12.55^2) = 494.8 \text{ in}^2$
- $494.8 \text{ in}^2 / 144 = 3.44 \text{ ft}^2$
- $P_z(\text{lbs/ft}^2) = (.00256(1.46)(1.14)(85^2)(1.0)(1.12) = 34.47 \text{lbs/ft}^2$
- FFD = FRD = (34.47)(3.44) = 118.58 lbs.

Calculate Dish Antenna Area & Wind load (Top or Side Exposure)

- Simplified profile shown below



- Area = $(25.1)(8.2)-(10)(7.2) = 133.82 \text{ in}^2$
- $133.82 \text{ in}^2 / 144 = .93 \text{ ft}^2$
- $P_z(\text{lbs/ft}^2) = (.00256(1.46)(1.14)(85^2)(1.0)(1.12) = 34.47 \text{lbs/ft}^2$
- FSD = (34.47)(.93) = 32.06 lbs.

* Arbitrarily set at 200'

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Calculate Panel Antenna Area & Wind Load (Front or Rear Exposure)
- 12.7 " x 42" profile (given)
- Area = (12.7)(42) = 533.4 in ^{2}
- 533.4 in ^{2} / 144 = 3.70 ft ^{2}
- P_z (lbs/ft ^{2}) = (.00256(1.46)(1.14)(85 ^{2})(1.0)(1.12) = 34.47lbs/ft ^{2}
- FFP = FRP = (34.47)(3.7) = 127.54 lbs.

Calculate Panel Antenna Area & Wind Load (Side Exposure)
- 2.7 " x 42" profile (given)
- Area = (2.7)(42) = 113.4 in ^{2}
- 113.4 in ^{2} / 144 = .79 ft ^{2}
- P_z (lbs/ft ^{2}) = (.00256(1.46)(1.14)(85 ^{2})(1.0)(1.12) = 34.47lbs/ft ^{2}
- FSP = (34.47)(.79) = 27.23 lbs.

Calculate Panel Antenna Area (Top Exposure)
- 12.7 " x 2" profile (given)
- Area = (12.7)(2) = 34.29 in ^{2}
- 34.29 in ^{2} / 144 = .24 ft ^{2}

Calculate Tube Projected Area (Front or Rear or Side Exposure)
- 4.5 " OD (given) x 140" long
- Area = (4.5)(140) = 630in ^{2}
- 630 ^{2}/ 144 = 4.4 ft ^{2}
- P_z (lbs/ft ^{2}) = (.00256(1.46)(1.14)(85 ^{2})(1.0)(1.12) = 34.47lbs/ft ^{2}
- FST = (34.47)(4.4) = 151.66 lbs.

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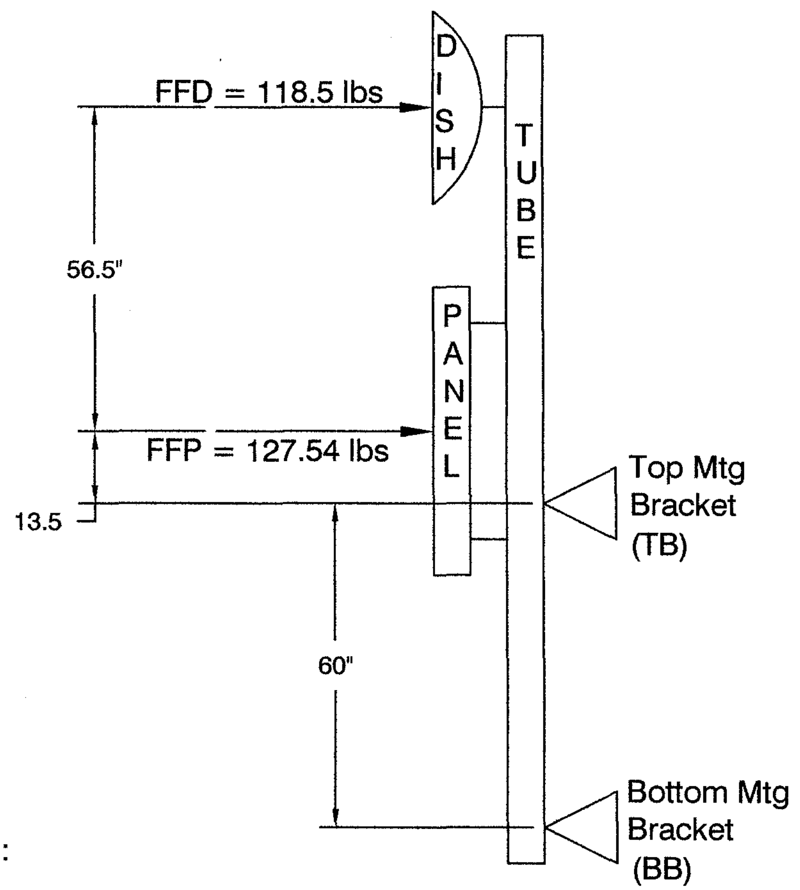
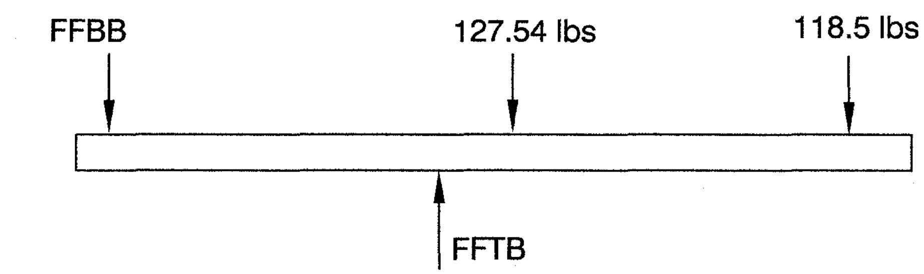
Subject Antenna Mount Calculations - Frontal Wind Loads Page# 3 Next Page# 4

Frontal Wind Loading

The top mounting bracket becomes the "pivot" for all horizontal forces in this configuration



Sum Moments about FFTB (cw= +):



ΣM @ TB = 0 = (13.5)(127.54)+(70)(118.5)-(60)(FFBB)
FFBB = ((13.5)(127.54)+(70)(118.5))/60 = 166.94 lbs

Solve for FFTB:

ΣF = 0 = 127.54+118.5 +166.94 - FFTB
FFTB = 412.98 lbs

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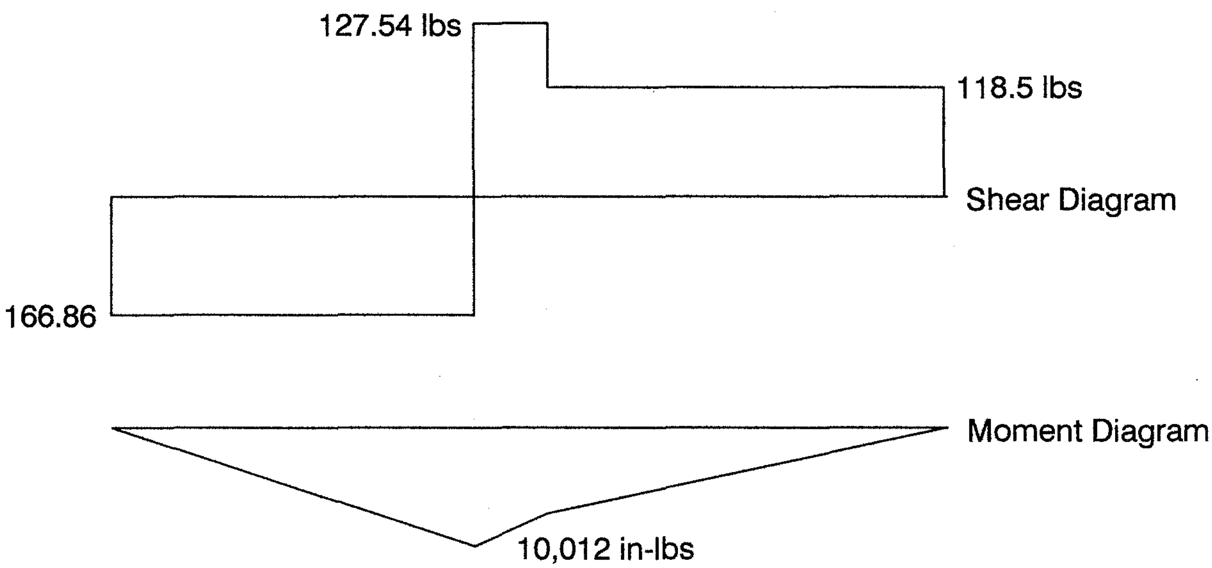
Subject Antenna Mount Calculations - Frontal Wind Loads Page# 4 Next Page# 5



The frontal wind condition puts the top magnetic mounting bracket into compression and applies a tensile load to the lower mounting bracket. Per the equations on the previous page, that total tensile load (FFBB) is 166.82 lbs. Assuming equal distribution on all magnets, each individual magnet is subject to 166.86/24 or 6.95 lbs.

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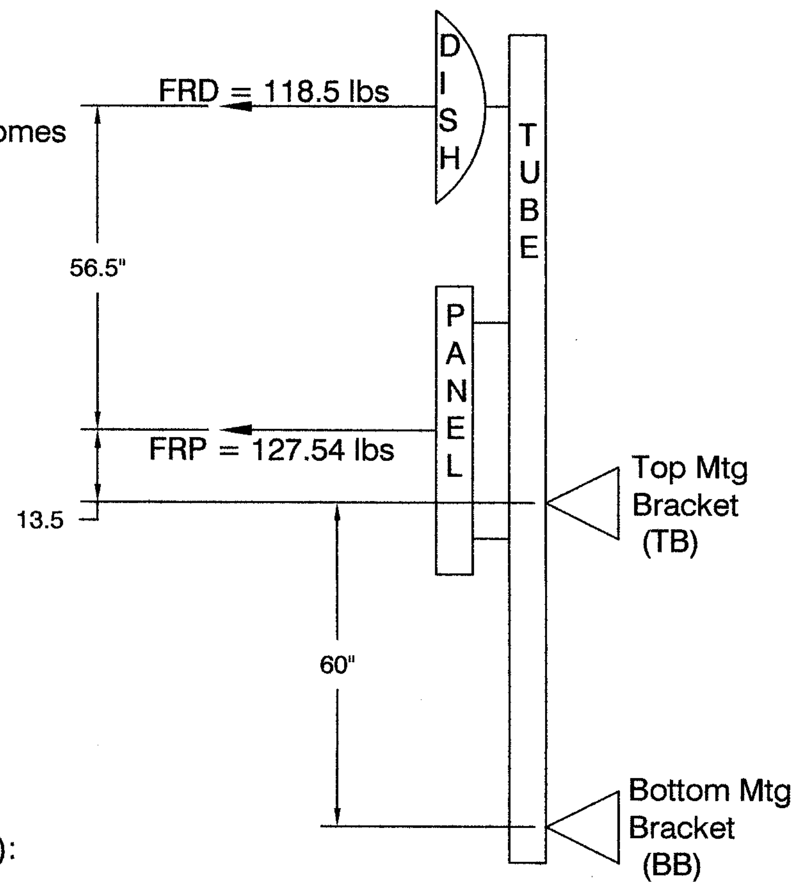
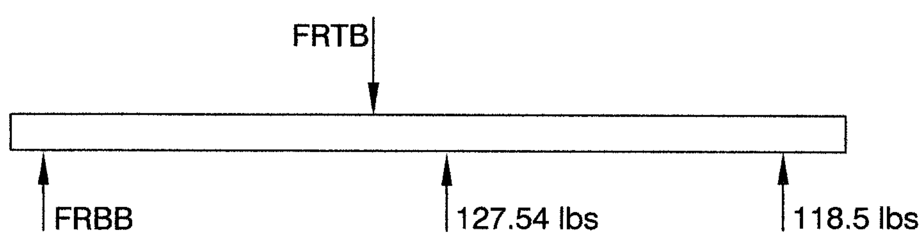
Subject Antenna Mount Calculations - Rear Wind Loads Page# 5 Next Page# 6

Rear Wind Loading

The "bottom" mounting bracket becomes the "pivot" for all horizontal forces in this configuration



Sum Moments about FRBB (cw= +):



ΣM @ BB = 0 = (60)(FRTB) - (73.5)(127.54) - (118.5)(130)
FRTB = ((73.5)(127.54)+(130)(118.5))/60 = 412.98 lbs

Solve for FRBB:

ΣF = 0 = 127.54+118.5 - 412.98 + FRBB
FRBB = 166.94 lbs

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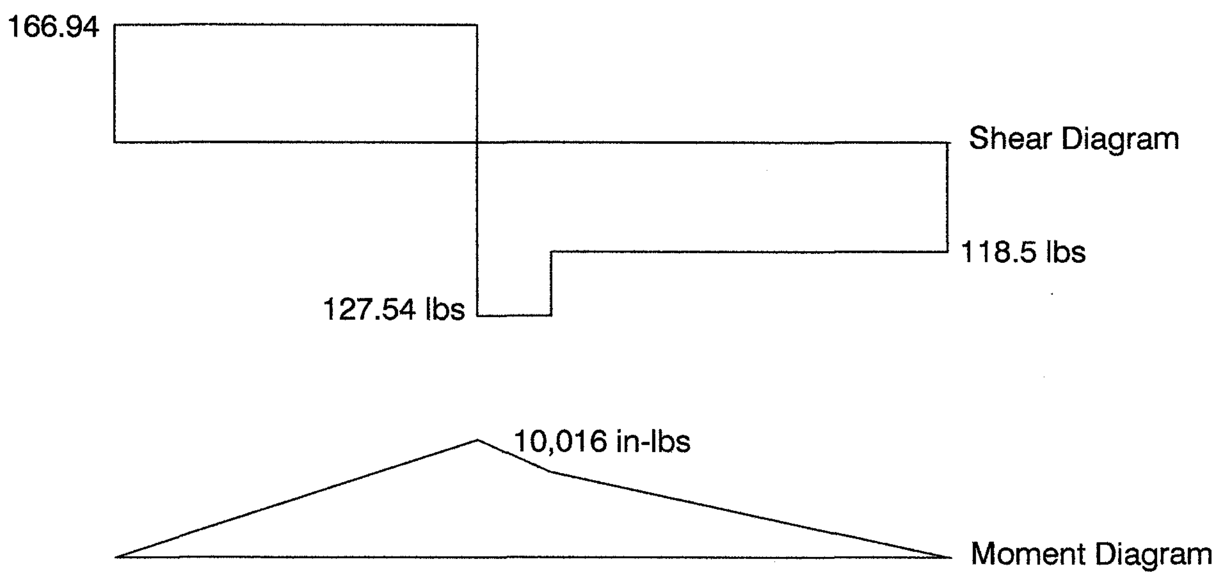
Subject Antenna Mount Calculations - Rear Wind Loads Page# 6 Next Page# 7



The rear wind condition puts the bottom magnetic mounting bracket into compression and applies a tensile load to the top mounting bracket. Per the equations on the previous page, that total tensile load (FRTB) is 412.98 lbs. Assuming equal distribution on all magnets, each individual magnet is subject to 412.98/24 or 17.20 lbs.

The analysis generated to this point indicates that the tensile loads created by the wind from the rear of the structure create higher "tensile" forces on the magnetic pads than do the winds from the front of the structure.

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Subject Antenna Mount Calculations - Side Wind Loads Page# 7 Next Page# 8

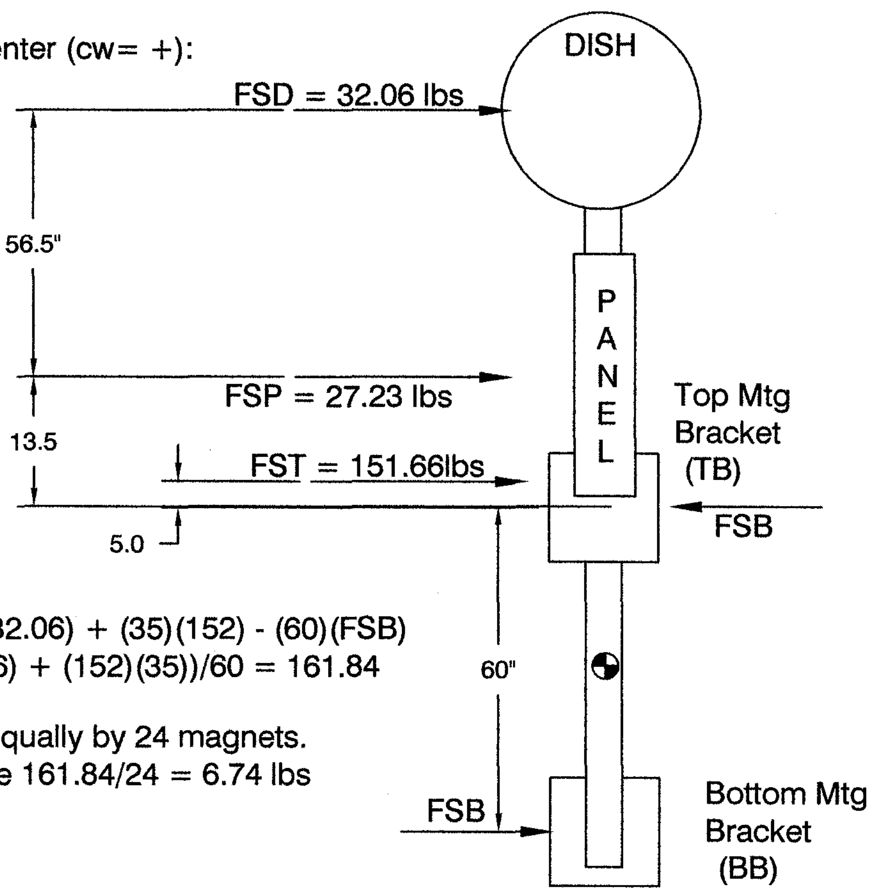
Side Wind Loading

Two types of loads are generated by winds blowing at the side profiles of the antennae. The first type of load is a shear loading which is discussed below. The second loading produces tensile and compressive loads on the magnets and is discussed on the following page.

Side Wind Loading - Shear

The shear loads generated by winds blowing at the side profiles of the antennae are resisted by a couple centered at the midpoint of the distance between the two magnetic mounting pads. By definition, both forces of a couple are equal to each other. Therefore, for subsequent shear calculations, FSBB and FSTB are renamed simply as FSB.

Sum Moments about couple center (cw= +):



$$\Sigma M = 0 = (43.5)(27.23) + (100)(32.06) + (35)(152) - (60)(FSB)$$
$$FSB = ((43.5)(27.23)+(100)(32.06) + (152)(35))/60 = 161.84$$

Each shear load will be resisted equally by 24 magnets.
the resulting individual load will be 161.84/24 = 6.74 lbs

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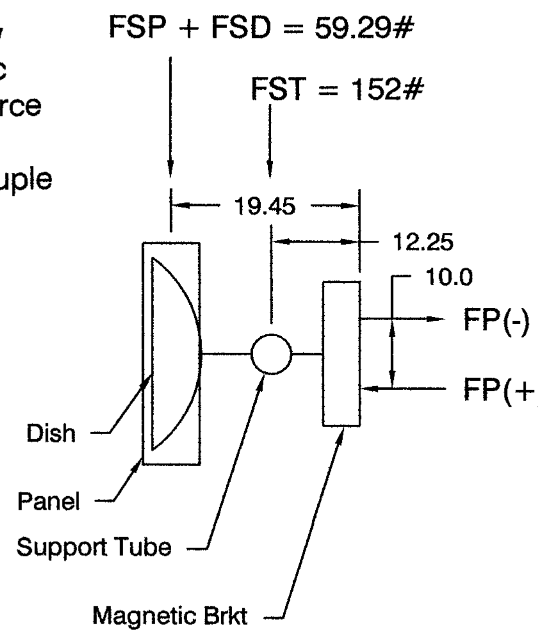
Subject Antenna Mount Calculations - Side Wind Loads Page# 8 Next Page# 9

Side Wind Loading - Tension & Compression

The relative orientation of the antennae to each other and to the magnetic brackets is shown in the plan view to the right. The antennae are offset from the magnetic brackets by the distance shown. The indicated side force creates a moment about the pad. This moment is resisted by a "couple" at the pad. Each force of the couple is located halfway from the center of the bracket to the center of its outer magnet.



Sum Moments about couple center (cw= +):

$$\Sigma M = 0 = (10)FP - (12.25)(152) - (19.45)(59.29)$$
$$FP = ((19.45)(59.29) + (12.25)(152))/10 = 302 \text{ lbs}$$

Each component of the couple will be shared equally by 12 magnets/bracket.
The resulting individual load will be 302/24 = 12.56 lbs

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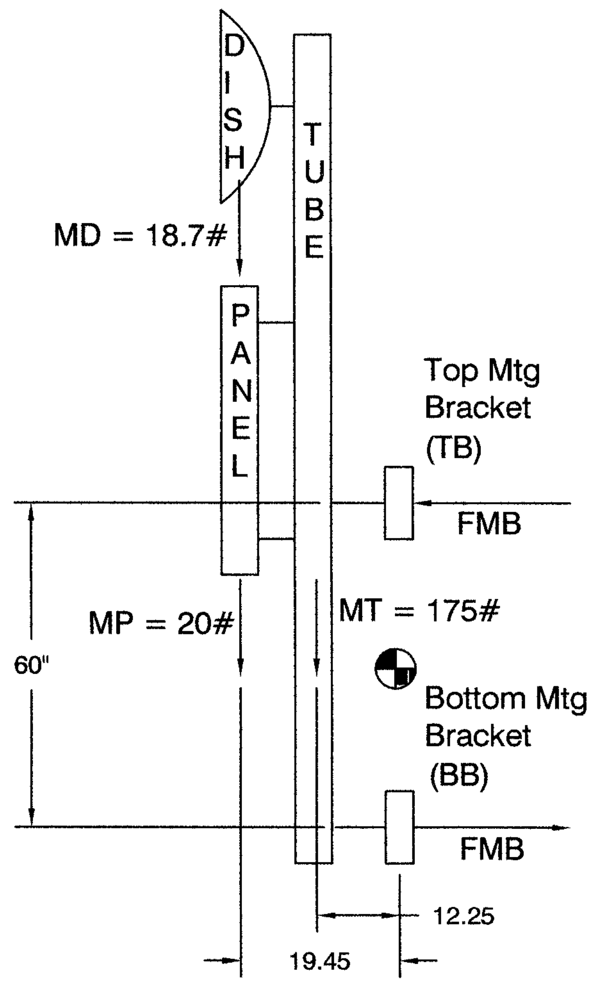
Mass Loads

Mass loads from the individual components are resisted by a force couple with its center halfway between the upper and lower mounting brackets. This couple is similar to that created by wind side loads. This force couple is solved on this page. The mass loads are also resisted by a vertical shear and are also discussed on this page.



Shear Forces from Mass Loads

The total shear force will be shared equally among 48 magnets. The load per individual magnet will be (20 + 18.7 + 175)/48 = FSV

4.45 lbs = FSV

Tensile and Compressive Forces from Mass Loads

Sum Moments about couple center (cw= +):

$$\Sigma M = 0 = (60)(FMB) - (175)(12.25) - (18.7)(19.45) - (20)(19.45)$$

$$FMB = ((12.25)(175)+(18.7)(19.45) + (20)(19.45))/60 = 48.27 \text{ lbs}$$

The tensile load on the top bracket will be shared equally by 24 magnets. The load per individual magnet will be 48.27/24 = 2 lbs.

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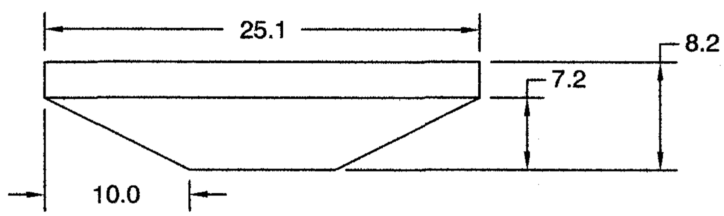
Ice Loads

Ice loads resulting from the coatings on individual components are calculated in exactly the same method as were the mass loads on the previous page. The mass of the ice is based on a constant of 3 lbs/ft of the surface being coated. Calculations of total areas and the corresponding ice masses are shown on this page.

Ice Surface Area - Dish Antenna

- Simplified profile shown below



- Area calculated via Solid Works = 8.18 ft^2
- FID = (8.18)(3.0) = 24.55 lbs.

Ice Surface Area - Panel Antenna

- 12.7 " x 42" x 2.7" profile (given)
- Area = ((12.7)(42)(2) + (12.7)(2.7)(2) + (2)(2.7)(42))/144 = 9.45 ft^2
- FIP = (9.45)(3.0) = 28.35 lbs.

Ice Surface Area - Support Tube

- 4.5 " OD (given) x 140" long
- Area = $((4.5)(140)(\pi) + (\pi)(2.25^2)(2))/144$ = 13.96 ft^2
- FIT = (13.96)(3.0) = 41.9 lbs.

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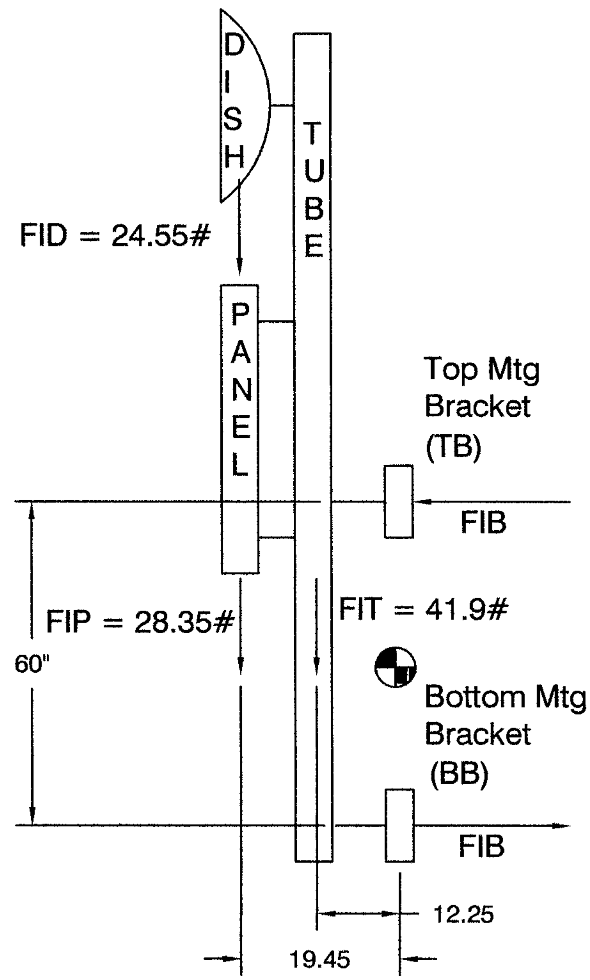
Subject Antenna Mount Calculations - Ice Loads Page# 11 Next Page# 12

Shear Forces from Ice Loads

The total shear force will be shared equally among 48 magnets. The load per individual magnet will be (24.55 + 28.35 + 41.9)/48 = 1.98 lbs.



Tensile and Compressive Forces from Ice Loads

Sum Moments about couple center (cw= +):

$$\Sigma M = 0 = (60)(FIB) - (41.9)(12.25) - (24.55)(19.45) - (28.35)(19.45)$$

$$FIB = ((12.25)(41.9)+(24.55)(19.45) + (28.35)(19.45))/60 = 25.70 \text{ lbs}$$

The tensile load on the top bracket will be shared equally by 24 magnets. The load per individual magnet will be 48.27/24 = 1.07 lbs.

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Subject Antenna Mount Calculations - Combined Loads Page# 12 Next Page# 13

Group I combined loads - Rear Wind Situation

This per magnet loading is a combination of the following components:
- Tensile from rear wind - 17.17 lbs
- Tensile from mass - 2.0 lbs
- Tensile from ice - 1.07 lbs
- Shear from mass - 4.45 lbs
- Shear from ice - 1.98 lbs

The shear forces resulting from ice and mass act in the same direction and can be added algebraically to form a single component.
That vector is 4.45(mass) + 1.98(ice) = 6.43 lbs
Factor of Safety = 35/6.43 = 5.44

Likewise, all tensile forces are acting in the same direction and can added algebraically to form a single component.
That vector is 17.17(wind) + 2.0(mass) + 1.07(ice) = 20.24 lbs
Factor of Safety = 100/20.24 = 4.94

Group II combined loads - Side Wind Situation

This per magnet loading is a combination of the following components:
- Tensile from side wind - 12.56 lbs
- Tensile from mass - 2.0 lbs
- Tensile from ice - 1.07 lbs
- Shear from side wind - 6.74 lbs
- Shear from mass - 4.45 lbs
- Shear from ice - 1.98 lbs

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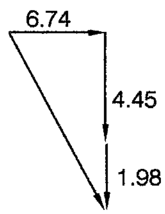
Subject Antenna Mount Calculations - Combined Loads Page# 13 Next Page# 14

The shear forces resulting from ice and mass act in the same direction and can be added algebraically to form a single component. The shear vector from the wind load acts in in the same plane but at right angles to the ice & mass vector all three can be combined per the diagram below.

Combined Shear



(4.45 + 1.98 = 6.43)

Combined Shear = $((6.74^2) + (6.43^2))^{1/2}$ = 9.31 lbs
Factor of Safety = 35/9.31 = 3.76

All tensile forces are acting in the same direction and can be added algebraically to form a single component.
That vector is 12.56(wind) + 2.0(mass) + 1.07(ice) = 15.63 lbs
Factor of Safety = 100/15.63 = 6.4

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Subject Tutorial - Generic Spreadsheet Page# 14 Next Page# 15

Note: The file 74035genericR01.xls is NOT write protected. Cells A7 thru A33 are user entered data and are relative to the geometry of specific components within the general arrangement being investigated. See page 0 of this calculation set to identify abbreviations for specific forces and reactions and see the next page to identify components and dimensions discussed below. Dimensions and mass values on the next page are marked with the appropriate cell where they should be entered (A19 thru A29). The user should not enter data into or alter any cells other than those discussed below. Note units where applicable.

Cell A7	Wind speed (mph) at location. See Appendix 02.
Cell A8	Exposure Factor based on elevation. See Appendix 03.
Cell A9	Ice Load Area? See Appendix 02. Enter 3 for yes and 0 for no.
Cell A11*	Antenna 1 exposure to rear winds (ft^2)
Cell A12*	Antenna 1 exposure to side winds (ft^2)
Cell A14*	Antenna 2 exposure to rear winds (ft^2)
Cell A15*	Antenna 2 exposure to side winds (ft^2)
Cell A17*	Vertical tube exposure area to side winds (ft^2)
Cell A19	Vertical distance between mounts. (in)
Cell A20	Vertical distance - Bottom mount to antenna #1 CG. (in)
Cell A21	Vertical distance - Bottom mount to antenna #2 CG. (in)
Cell A22	Vertical distance - Bottom mount to vertical tube CG. (in)
Cell A23	Horizontal distance - Magnet face to antenna #1 CG. (in)
Cell A24	Horizontal distance - Magnet face to antenna #2 CG. (in)
Cell A25	Horizontal distance - Magnet face to vertical tube CG. (in)
Cell A27	Mass (lbs) of antenna #1 (manufacturer supplied data)
Cell A28	Mass (lbs) of antenna #2 (manufacturer supplied data)
Cell A29*	Mass (lbs) of vertical tube.
Cell A31*	Ice surface area** (ft^2) of antenna #1
Cell A32*	Ice surface area** (ft^2) of antenna #2
Cell A33*	Ice surface area** (ft^2) of vertical tube

* Requires offline user calculation

** Ice surface area = Total outside surface

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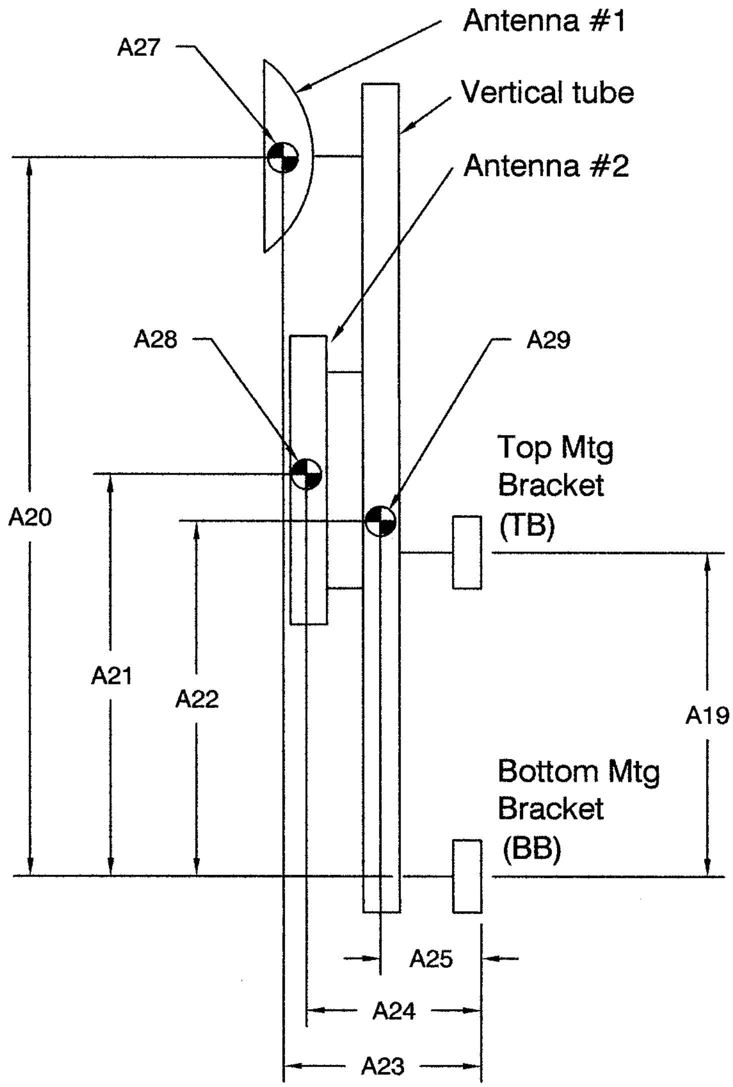
Project# 74035 Client Metal-Cable Corp Date 07-08-10

Subject Antenna Mount Calcs - Spreadsheet Example Page# 15 Next Page# -



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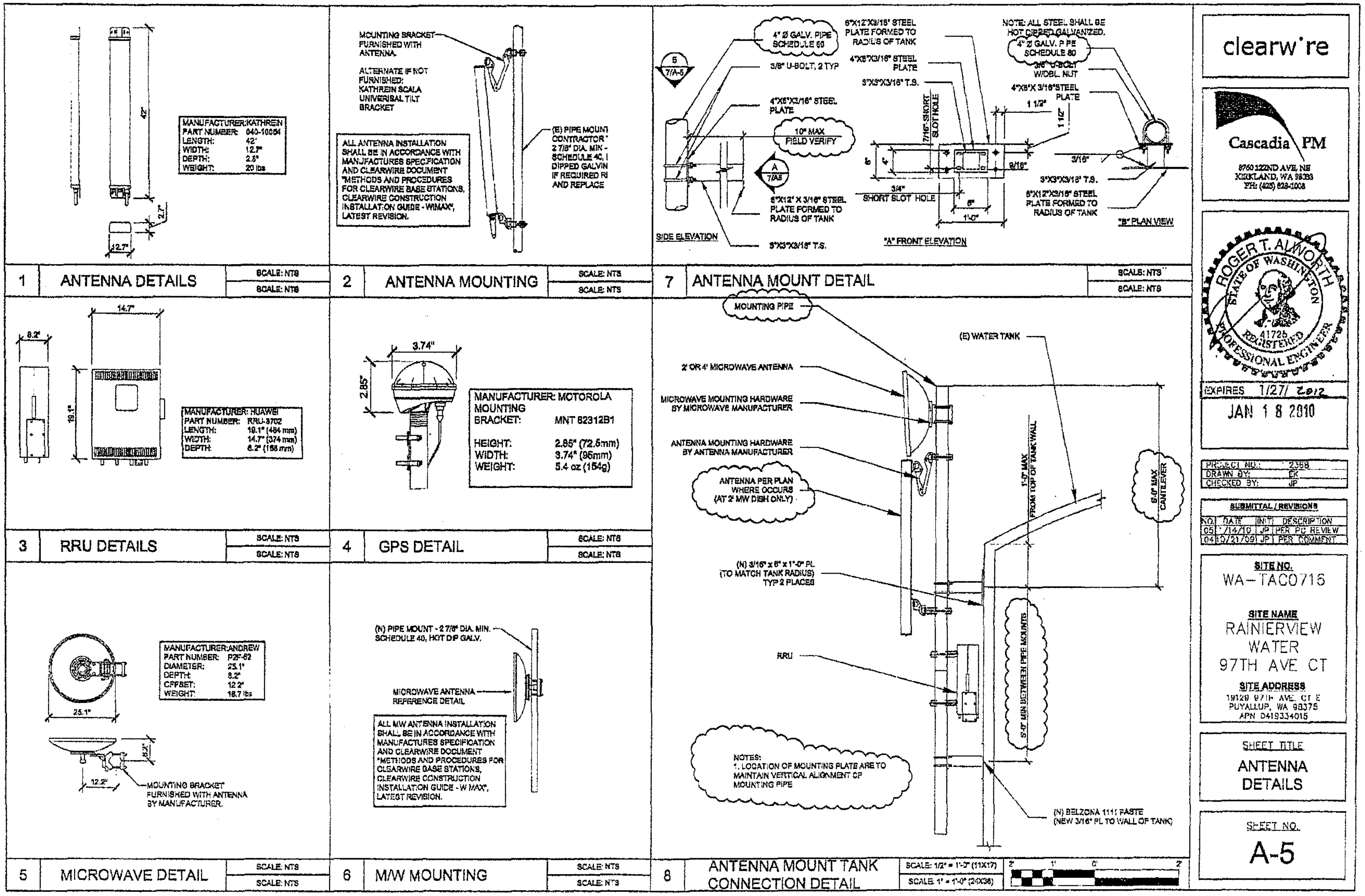
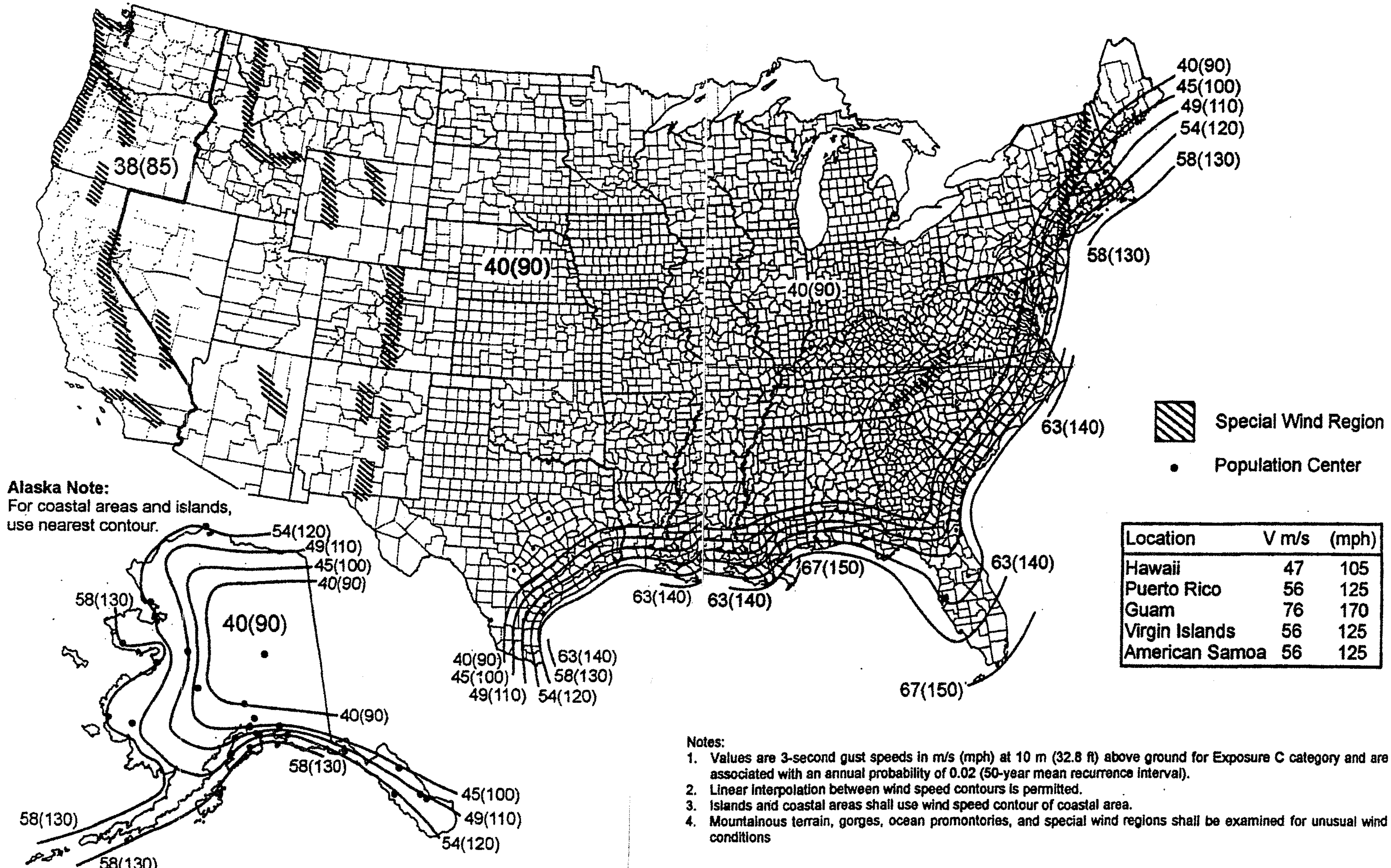


1 ANTENNA DETAILS SCALE: NTS
MANUFACTURER: KATHREIN
PART NUMBER: 840-10054
LENGTH: 42"
WIDTH: 12.7"
DEPTH: 2.8"
WEIGHT: 20 lbs
2 ANTENNA MOUNTING SCALE: NTS
MOUNTING BRACKET FURNISHED WITH ANTENNA.
ALTERNATE IF NOT FURNISHED: KATHREIN SCALA UNIVERSAL TILT BRACKET
ALL ANTENNA INSTALLATION SHALL BE IN ACCORDANCE WITH MANUFACTURES SPECIFICATION AND CLEARWIRE DOCUMENT "METHODS AND PROCEDURES FOR CLEARWIRE BASE STATIONS, CLEARWIRE CONSTRUCTION INSTALLATION GUIDE - WIMAX", LATEST REVISION.
7 ANTENNA MOUNT DETAIL SCALE: NTS
NOTE: ALL STEEL SHALL BE HOT DIPPED GALVANIZED.
SIDE ELEVATION
"A" FRONT ELEVATION
"B" PLAN VIEW
3 RRU DETAILS SCALE: NTS
MANUFACTURER: HUAWEI
PART NUMBER: RRU-3702
LENGTH: 19.1" (484 mm)
WIDTH: 14.7" (374 mm)
DEPTH: 6.2" (158 mm)
4 GPS DETAIL SCALE: NTS
MANUFACTURER: MOTOROLA
MOUNTING BRACKET: MNT 62312B1
HEIGHT: 2.85" (72.5mm)
WIDTH: 3.74" (95mm)
WEIGHT: 5.4 oz (154g)
5 MICROWAVE DETAIL SCALE: NTS
MANUFACTURER: ANDREW
PART NUMBER: P2F-52
DIAMETER: 25.1"
DEPTH: 8.2"
OFFSET: 12.2"
WEIGHT: 18.7 lbs
MOUNTING BRACKET FURNISHED WITH ANTENNA BY MANUFACTURER.
6 M/W MOUNTING SCALE: NTS
(N) PIPE MOUNT - 2 7/8" DIA. MIN. SCHEDULE 40, HOT DIP GALV.
MICROWAVE ANTENNA REFERENCE DETAIL
ALL MW ANTENNA INSTALLATION SHALL BE IN ACCORDANCE WITH MANUFACTURES SPECIFICATION AND CLEARWIRE DOCUMENT "METHODS AND PROCEDURES FOR CLEARWIRE BASE STATIONS, CLEARWIRE CONSTRUCTION INSTALLATION GUIDE - W MAX", LATEST REVISION.
8 ANTENNA MOUNT TANK CONNECTION DETAIL
SCALE: 1/2" = 1'-0" (11X17)
SCALE: 1" = 1'-0" (24X36)
MOUNTING PIPE
(E) WATER TANK
2' OR 4' MICROWAVE ANTENNA
MICROWAVE MOUNTING HARDWARE BY MICROWAVE MANUFACTURER
ANTENNA MOUNTING HARDWARE BY ANTENNA MANUFACTURER
ANTENNA PER PLAN WHERE OCCURS (AT 2' MW DISH ONLY)
(N) 3/16" x 6" x 1'-0" PL (TO MATCH TANK RADIUS) TYP 2 PLACES
RRU
NOTES:
1. LOCATION OF MOUNTING PLATE ARE TO MAINTAIN VERTICAL ALIGNMENT OF MOUNTING PIPE
clearwire
Cascadia PM
ROGER T. ALWORTH
STATE OF WASHINGTON
41725
REGISTERED PROFESSIONAL ENGINEER
EXPIRES 1/27/2012
JAN 18 2010
SITE NO.
WA-TAC0716
SITE NAME
RAINIERVIEW WATER 97TH AVE CT
SHEET TITLE
ANTENNA DETAILS
SHEET NO.
A-5

Appendix 01



Location	V m/s	(mph)
Hawaii	47	105
Puerto Rico	56	125
Guam	76	170
Virgin Islands	56	125
American Samoa	56	125

Notes:

1. Values are 3-second gust speeds in m/s (mph) at 10 m (32.8 ft) above ground for Exposure C category and are associated with an annual probability of 0.02 (50-year mean recurrence interval).
2. Linear interpolation between wind speed contours is permitted.
3. Islands and coastal areas shall use wind speed contour of coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions

Appendix 02

Height and Exposure Factors, K_z	
Height, m(ft)	K_z
5.0(16.4) or less	0.87
7.5 (24.6)	0.94
10.0 (32.8)	1.00
12.5 (41.0)	1.05
15.0 (49.2)	1.09
17.5 (57.4)	1.13
20.0 (65.6)	1.16
22.5 (73.8)	1.19
25.0 (82.0)	1.21
27.5 (90.2)	1.24
30.0 (98.4)	1.26
35.0 (114.8)	1.30
40.0 (131.2)	1.34
45.0 (147.6)	1.37
50.0 (164.0)	1.40
55.0 (180.5)	1.43
60.0 (196.9)	1.46
70.0 (229.7)	1.51
80.0 (262.5)	1.55
90.0 (295.3)	1.59
100.0 (328.1)	1.63

Generic Antenna Approximations
74035genericR01.xls
7/24/2010

User Entered Data

85.00 Wind Speed (mph)
1.46 Exposure Factor (per attached AASHTO table)
3.00 Ice (psf)

3.44 Antenna 1 Rear Exposure Area (square feet)
0.93 Antenna 1 Side Exposure Area (square feet)

3.70 Antenna 2 Rear Exposure Area (square feet)
0.79 Antenna 2 Side Exposure Area (square feet)

4.40 Vertical Tube Side Exposure Area (square feet)

60.00 Vertical Distance Between Mounts (in)
130.00 Vertical Distance - Bottom mount to antenna 1 CG (in)
73.50 Vertical Distance - Bottom mount to antenna 2 CG (in)
65.00 Vertical Distance - Bottom mount to vertical tube CG. (in)
19.45 Horizontal Distance - Magnet face to antenna 1 CG (in)
19.45 Horizontal Distance - Magnet face to antenna 2 CG (in)
12.25 Horizontal Distance - Magnet face to vertical tube CG (in)

18.70 Mass of Antenna #1 (lbs)
20.00 Mass of Antenna #2 (lbs)
175.00 Mass of Vertical Mount Tube (lbs)

8.18 Ice surface area antenna 1 (square feet)
9.45 Ice surface area antenna 2 (square feet)
13.96 Ice surface area vertical tube (square feet)

Calculated Constants

30.00 1/2 distance between magnetic mounts (in)

Calculated Component Wind Loads

118.61 FR1 (wind force (lbs) at rear of antenna 1)
32.07 FS1 (wind force (lbs) at side of antenna 1)

127.57 FR2 (wind force (lbs) at rear of antenna 2)
27.24 FS2 (wind force (lbs) at side of antenna 2)

151.71 FST (wind force (lbs) at side of mounting tube)

Calculated Component Ice Loads

24.54 Ice Load (lbs) Antenna 1
28.35 Ice Load (lbs) Antenna 2
41.88 Ice Load (lbs) Vertical Tube

Mounting Bracket Forces From Rear Winds

413.26 FRTB (top bracket force - rear wind)
167.08 FRBB (bottom bracket force - rear wind)
17.22 Top Mount Tension per magnet from rear wind

Mounting Bracket Forces from Side Winds

161.69 FSB horizontal "shear" load per bracket
6.74 Horizontal "shear" load per magnet from side wind

301.19 FP (mounting pad (lbs tension and compression) load from Side wind Loads
12.55 Tension load per magnet from side wind load

Mass Loads

106.85 FSVM Vertical "shear" load per bracket
4.45 Vertical "shear" load per magnet

48.27 FP (mounting pad (lbs tension and compression) load from Mass Loads
2.01 Tension load per magnet from Mass Load

Ice Loads

94.77 FSVI Vertical "shear" load per bracket
1.97 Vertical "shear" load per magnet

25.70 FP (mounting pad (lbs tension and compression) load from Mass Loads
1.07 Tension load per magnet from Mass Load

Combined Loads - Rear Wind Situation

6.43 Vertical "shear" (mass + ice)
5.45 Factor of Safety

20.30 Tensile Load (wind + mass + ice)
4.93 Factor of Safety

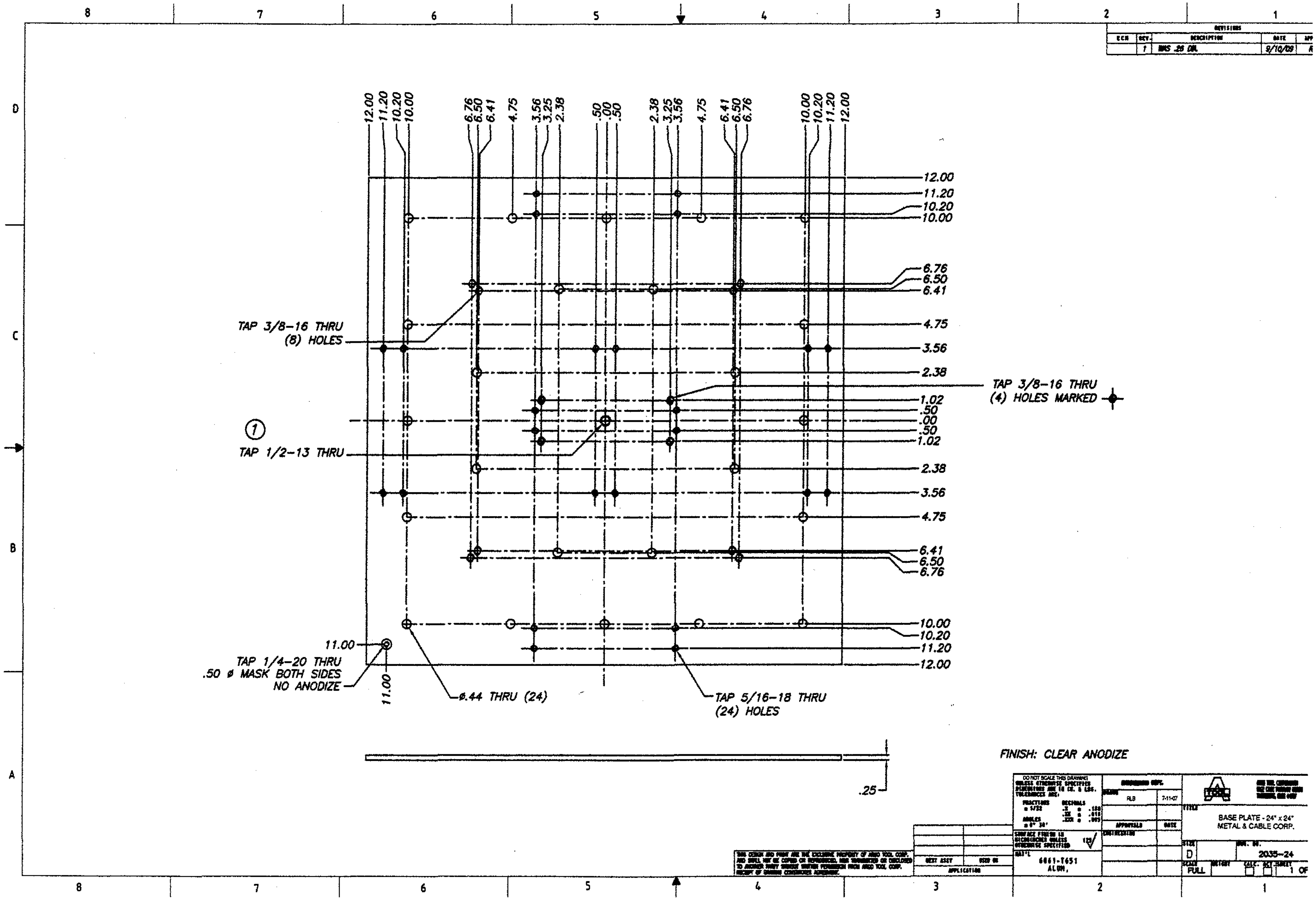
Combined Loads - Side Wind Situation

9.31 Combined "shear" (wind + mass + ice)
3.76 Factor of Safety

15.63 Tensile Load (wind + mass + ice)
6.40 Factor of Safety

Appendix 04

Appendix 05



TAP 3/8-16 THRU
(8) HOLES
TAP 3/8-16 THRU
(4) HOLES MARKED
TAP 1/2-13 THRU
TAP 1/4-20 THRU
.50 ø MASK BOTH SIDES
NO ANODIZE
ø.44 THRU (24)
TAP 5/16-18 THRU
(24) HOLES
FINISH: CLEAR ANODIZE
BASE PLATE - 24" x 24"
METAL & CABLE CORP.
6061-T651
ALUM.
2035-24
FULL

PREMIER ENGINEERING TECHNOLOGIES

14701 Detroit Rd. Suite 460, Lakewood Ohio 44107

March 5, 2005

Mr. David Klein
Metal & Cable Corp.
9337 Ravenna Rd. Unit C
Twinsburg, Ohio 44087

Reference: The Magnemount, Magnetic Mounting System

Dear Mr. Klein:

I am writing this to report my opinion on the above referenced mount. I have engineered and managed the rehabilitation of many tanks of various sizes with a total cost of over 18 million dollars. Exercising caution when a new product is introduced, a number of issues were studied as follows:

- Cost advantages of the mount's installation cost and the elimination of the need to repair the internal or external coatings due to welding of the mount are evident, especially if the tank already has the cable trays attached as part of its original construction or a previous antenna installation. Not having to repair internal coating eliminates interruption of the tank's operation, which is paramount.

- Breakaway force of the magnets as shown in the tests conducted by Stork Materials Technology is more than sufficient for typical installations. Also the flexibility provided for magnet deflection and provision for normal magnet movement are adequate to provide the required magnet to steel contact for most if not all tanks. This was demonstrated in your facility on a curved plate.

- Magnemount's mode of failure is superior to a welded mount. The disengagement of the magnets, at extremely high and unforeseen loads, acts as a structural safety mechanism minimizing the amount of structural analysis and design needed. If a mount is subjected to extremely high loads it will topple over to the most aerodynamically neutral orientation and is held onto the tank by the securing cable. However, in the case of a welded non-magnetic mount, high loads may cause failure of the mount or cause local damage to the tank. Repair of the Magnemount is quicker and less expensive.

- A major issue is whether the magnets' metallic shell causes damage to a typical tank's coating. This was tested using five metal plates coated with five different epoxies typically used on tanks. We attached a magnet and slid it across the coated plates repeatedly. The magnet did not damage the coating when fitted with the adhesive protective film. The adhesive film is further held in place by the magnetic attraction between the magnet and the steel plate. The affect of the film thickness has been studied as shown by another experiment conducted Stork Materials Technology, and determined to produce a quantified minimal reduction in the magnetic force. We subjected the magnet with adhesive film to complete immersion in approximately 109 degrees Fahrenheit water for 30 minutes then cooled it off with a cold-water rinse. The magnet was then attached to a coated plate and slid it rapidly back and forth six inches for twenty cycles without any apparent damage to the film or coating. We then subjected the same magnet and film to running cold water of approximately 45 degrees Fahrenheit temperature at 75 gallons per minute for two hours. The film remained attached to the magnet. We followed that with another twenty cycles of rapid back and forth sliding of the magnet against a coated plate. Again there wasn't any apparent damage to the coating. It also appears that wetness causes a small film to form between the magnet and steel plate due to the shear forces created by the fast sliding surfaces. The aluminum frame of the mount will not cause any rust stains. Also the magnets' shells are plated and powder coated almost eliminating the possibility of any corrosion. In addition the magnets' powder coating is protected from direct ultraviolet rays by the mount's aluminum base. Hence if the mount is sized properly it should not move but even if it moved due to an unforeseen condition the adhesive film will protect the coating.

- If a tank's owner is more conservative, then I recommend they consider one of the many tank coatings that are highly resistant to scratching and can withstand the sliding action of the magnets even without the recommended adhesive protective film. Those coatings are desirable regardless of mount type, especially in the areas where foot traffic can occur to prevent damage to the coating by people's boots, equipment and tools. If proper color matching is done, the whole tank need not be coated with the mentioned coating. Making this a very economical option with a longer coating lifespan. I have used such coatings almost exclusively in the past with a lot of success. The extra cost of the coating materials is more than offset by the coating thickness needed and the longevity of the product. This is not to mention the considerable savings from mount installation.

- Magnemount will attach with a small gap between its plate and the tank's surface. This gap allows water to drain between the magnets and prevents it from accumulating under the mount. Hence there isn't a need to seal weld or caulk the perimeter. The seal weld requirement is intended for permanent plates that are attached to the tank which prevent access to the tank or plate surface for proper coating. The mount can be easily removed during scheduled tank rehabilitation projects then reinstalled with ease. This allows for coating repair and complete coating of the tank surface with the antennas out of the way. Reinstallation after rehabilitation introduces more savings.

In my opinion, as listed above, there are many benefits to this product. The failure mode by disengagement is especially attractive to me. I highly recommend the Magnemount for consideration as an alternative to welded in place mounts. If I can be of any help or if there are any questions please feel free to contact me.

Sincerely yours,

Sami Sarrouh

Sami F. Sarrouh, P.E.

Mr. Sarrouh has nineteen years of experience in applied research and design. Areas of expertise include mechanical and process systems, computational fluid dynamics, fluid structure interaction, machine design, turbo machinery, hydraulics, pneumatics, H.V.A.C., plumbing, plant layout, process piping and controls, water tank rehabilitation, tank mixing/baffling for water quality, tank and pump-station design and automation.

Having served fifteen of those years in the Cleveland Division of Water, Mr. Sarrouh completed work on more than seventy different projects. As a lead engineer in charge of a multi-discipline design and inspection team he was responsible for the design and construction management of all new or renovated pump stations and water storage facilities. As part of his responsibilities he researched, conceptualized, set design standards, worked on the design and managed construction, troubleshooting and startup of three new stations that were by scope trend setters in technology for all future designs. As a Project Manager he managed the design, construction and commissioning of a number of project in excess of $40 million about $18 million of which are on tank rehabilitation and coating.

Mr. Sarrouh has a track record of innovation including a number of patents and publications introducing new methodologies or mathematical algorithms. He is contributing member of the AWWA standard Committee on rate of flow meter.

Since Fall 2002 he teaches senior level courses at Cleveland State University. The evening courses include machine design, thermal systems, mechanical systems design and senior year design projects.

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P.O. 185, WATERFORD, WI 53185
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Metal & Cable Corp., Inc.
Antenna Mount Calculations - R01

B & A Project 74035

Prepared for:
David Klein
Metal & Cable Corp.
P.O. Box 117
Twinsburg, OH 44087
July 24, 2010

Michael E. Beach, P.E.
President
Beach & Associates, LLC

74035 Antenna Mount Calculations
74035R01
7/24/2010

Overview

The scope of Part 1 of the project required calculations based on AASHTO standards to determine loads at the base of a mounting system used to attach a dish/panel antenna array to the side of a water tower. The calculation set is shown on pages 0 thru 13 of the attached document and is loosely based on a proposed installation in Washington state. The general arrangement of that installation can be found in Appendix 1. Some of the geometric values used in the attached calculations such as the horizontal distances between components were scaled from this document.

Multiple exceptions and assumptions were employed in the execution of the calculation set. They are listed below in no specific order of priority.

1) The height above ground of the antenna array has been arbitrarily set to 200'.
2) The antenna array was assumed to have full exposure from a rear wind situation.
3) The exposure of the vertical pole was assumed to be negligible for front & rear wind situations.
4) The exposure of the various clamps, brackets, and hardware was assumed to inconsequential.
5) Loads per magnetic bracket in some cases were assumed to be evenly distributed even though the actual distribution is statically indeterminate.
6) Allowable loads per magnet and per magnetic bracket as well as the layout of the magnets on each bracket were supplied by the client.
7) The radius of curvature of the water tank was assumed to be negligible.
8) Ice loads, if applicable, are assumed to cover the entire component in question.

Constants used in the calculation set were taken from the AASHTO standard and are included in the appendix. All wind velocities were taken from the map on Appendix 2. It should be noted here that while the nominal wind velocities were used in generating the attached values, local building codes should be consulted in areas designated as special wind regions. The exposure factor, which is based on the height of the structure being analyzed relative to the local terrain, is taken from an AASHTO table and is shown in Appendix 3. A drawing of the magnet mounting plate is shown on Appendix 5. The magnets are attached to the 0.44 diameter thru holes. Other constants used in this report are the minimum gust factor of 1.14, a wind importance factor of 1.0, a drag co-efficient of 1.12, and an ice load of 3 lbs/ft^2.

The scope of Part 2 of this project involved the creation of an excel spreadsheet to be used in generating approximations of loadings where the installation is similar to the condition shown in Appendix 1. The results of this spreadsheet should be considered only as an approximation as each site should be carefully reviewed to apply the appropriate AASHTO values. A digital copy of this file has been supplied under separate cover under the file name of 74035genericR01.xls. A printed copy of a completed spreadsheet based on a specific example is shown on Appendix 4. A simplified general arrangement of

74035 Antenna Mount Calculations
74035R01
7/24/2010

the loading condition depicted by this spreadsheet is shown on page 15 of the calculation set. The tutorial on its use begins on page 14. The cells within the spreadsheet are NOT write protected. The overall accuracy can be verified using the example on pages 1 thru 13 and making allowances for round-off error.

Conclusion

Calculations for factors of safety for the conditions presented here-in are well within range of generally accepted safe working conditions.

ENGINEERING CALCULATIONS

Project# 74035 Client Metal-Cable Corp Date 07-08-10

Subject Antenna Mount Calculations - Abbreviations Page# 0 Next Page# 1

BB	Bottom bracket
FFBB	Front wind force @ bottom bracket
FFD	Wind load at front of dish antenna
FFP	Wind load at front of panel antenna
FFTB	Front wind force @ top bracket
FIB	Force @ magentic bracket from ice load
FID	Ice load on dish antenna
FIP	Ice load on panel antenna
FIT	Ice load on vertical tube
FMB	Force @ magentic bracket from component mass
FP	Force @ magentic pad
FRBB	Rear wind force @ bottom bracket
FRD	Wind load at rear of dish antenna
FRP	Wind load at rear of panel antenna
FRTB	Rear wind force @ top bracket
FSB	Shear load @ mounting bracket
FSD	Wind load at side of dish antenna
FSP	Wind load at side of panel antenna
FST	Wind load at side of vertical tube
FSV	Vertical shear force @ magnetic pad
MD	Mass of dish antenna
MP	Mass of panel antenna
MT	Mass of vertical tube
TB	Top bracket

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ENGINEERING CALCULATIONS

Project# 74035 Client Metal-Cable Corp Date 07-08-10

Subject Antenna Mount Calculations - Wind Loads Page# 1 Next Page# 2

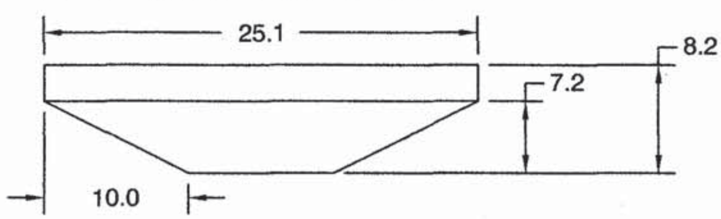
Wind Load Equation (AASHTO LTS-4)

$P_z(\text{lbs/ft}^2) = .00256\, K_z G\, V^2 I_r C_d$

- C_d → Drag Coefficient
- I_r → Wind Importance Factor
- V → Wind Velocity (mph)
- G → Gust Factor
- K_z → Exposure Factor *

Calculate Dish Antenna Area & Wind Load (Front or Rear Exposure)
- 25.1" Dia (given)
- Area = $\pi r^2 = (\pi)(12.55^2) = 494.8\ \text{in}^2$
- $494.8\ \text{in}^2 / 144 = 3.44\ \text{ft}^2$
- $P_z(\text{lbs/ft}^2) = (.00256(1.46)(1.14)(85^2)(1.0)(1.12) = 34.47\text{lbs/ft}^2$
- FFD = FRD = (34.47)(3.44) = 118.58 lbs.

Calculate Dish Antenna Area & Wind load (Top or Side Exposure)
- Simplified profile shown below



- Area = (25.1)(8.2)-(10)(7.2) = $133.82\ \text{in}^2$
- $133.82\ \text{in}^2 / 144 = .93\ \text{ft}^2$
- $P_z(\text{lbs/ft}^2) = (.00256(1.46)(1.14)(85^2)(1.0)(1.12) = 34.47\text{lbs/ft}^2$
- FSD = (34.47)(.93) = 32.06 lbs.

* Arbitrarily set at 200'

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ENGINEERING CALCULATIONS

Project# 74035 Client Metal-Cable Corp Date 07-08-10

Subject Antenna Mount Calculations - Wind Loads Page# 2 Next Page# 3

Calculate Panel Antenna Area & Wind Load (Front or Rear Exposure)
- 12.7 " x 42" profile (given)
- Area = $(12.7)(42) = 533.4\ in^2$
- $533.4\ in^2 / 144 = 3.70\ ft^2$
- $P_z\ (lbs/ft^2) = (.00256(1.46)(1.14)(85^2)(1.0)(1.12) = 34.47 lbs/ft^2$
- FFP = FRP = (34.47)(3.7) = 127.54 lbs.

Calculate Panel Antenna Area & Wind Load (Side Exposure)
- 2.7 " x 42" profile (given)
- Area = $(2.7)(42) = 113.4\ in^2$
- $113.4\ in^2 / 144 = .79\ ft^2$
- $P_z\ (lbs/ft^2) = (.00256(1.46)(1.14)(85^2)(1.0)(1.12) = 34.47 lbs/ft^2$
- FSP = (34.47)(.79) = 27.23 lbs.

Calculate Panel Antenna Area (Top Exposure)
- 12.7 " x 2" profile (given)
- Area = $(12.7)(2) = 34.29\ in^2$
- $34.29\ in^2 / 144 = .24\ ft^2$

Calculate Tube Projected Area (Front or Rear or Side Exposure)
- 4.5 " OD (given) x 140" long
- Area = $(4.5)(140) = 630 in^2$
- $630^2 / 144 = 4.4\ ft^2$
- $P_z\ (lbs/ft^2) = (.00256(1.46)(1.14)(85^2)(1.0)(1.12) = 34.47 lbs/ft^2$
- FST = (34.47)(4.4) = 151.66 lbs.

ff/calcgrid 990418

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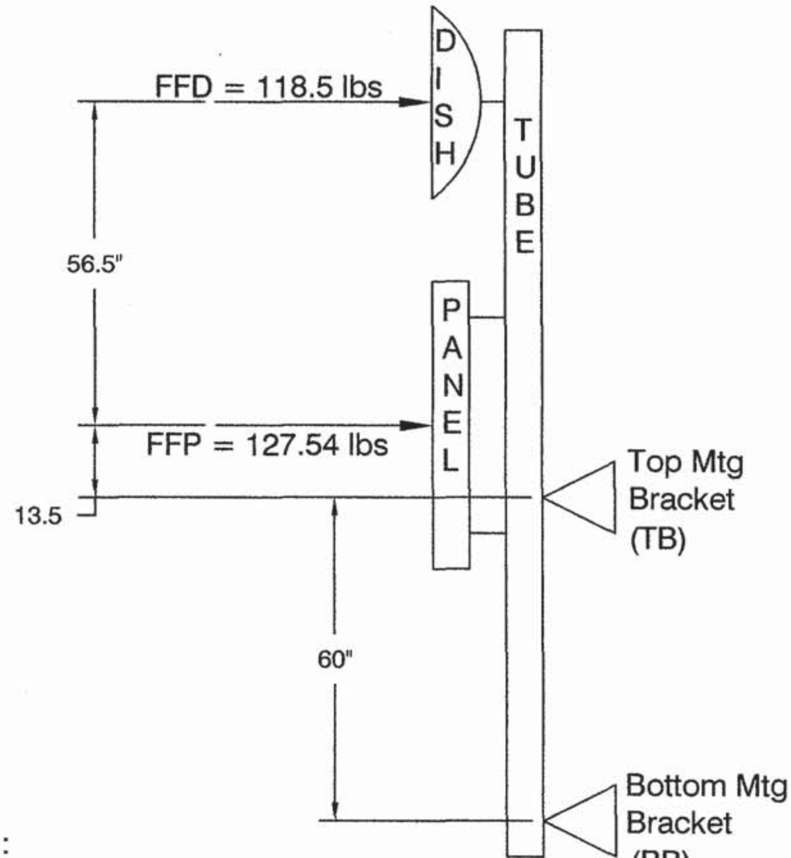
ENGINEERING CALCULATIONS

Project# 74035 Client Metal-Cable Corp Date 07-08-10

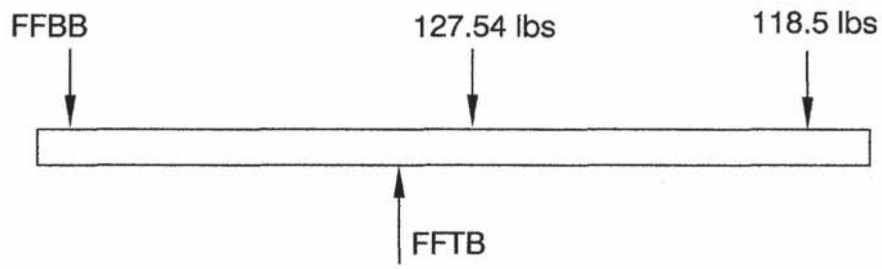
Subject Antenna Mount Calculations - Frontal Wind Loads Page# 3 Next Page# 4

Frontal Wind Loading

The top mounting bracket becomes the "pivot" for all horizontal forces in this configuration



Sum Moments about FFTB (cw= +):



ΣM @ TB = 0 = (13.5)(127.54)+(70)(118.5)-(60)(FFBB)

FFBB = ((13.5)(127.54)+(70)(118.5))/60 = 166.94 lbs

Solve for FFTB:

ΣF = 0 = 127.54+118.5 +166.94 - FFTB

FFTB = 412.98 lbs

ff/calcgrid 990418

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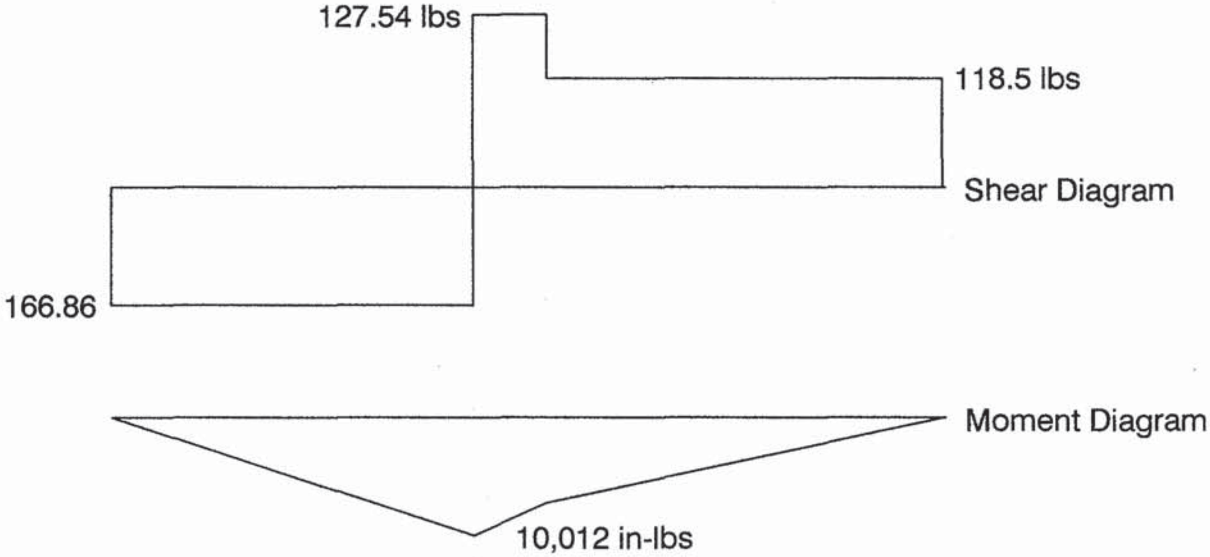
ENGINEERING CALCULATIONS

Project# 74035 Client Metal-Cable Corp Date 07-08-10

Subject Antenna Mount Calculations - Frontal Wind Loads Page# 4 Next Page# 5



The frontal wind condition puts the top magnetic mounting bracket into compression and applies a tensile load to the lower mounting bracket. Per the equations on the previous page, that total tensile load (FFBB) is 166.82 lbs. Assuming equal distribution on all magnets, each individual magnet is subject to 166.86/24 or 6.95 lbs.

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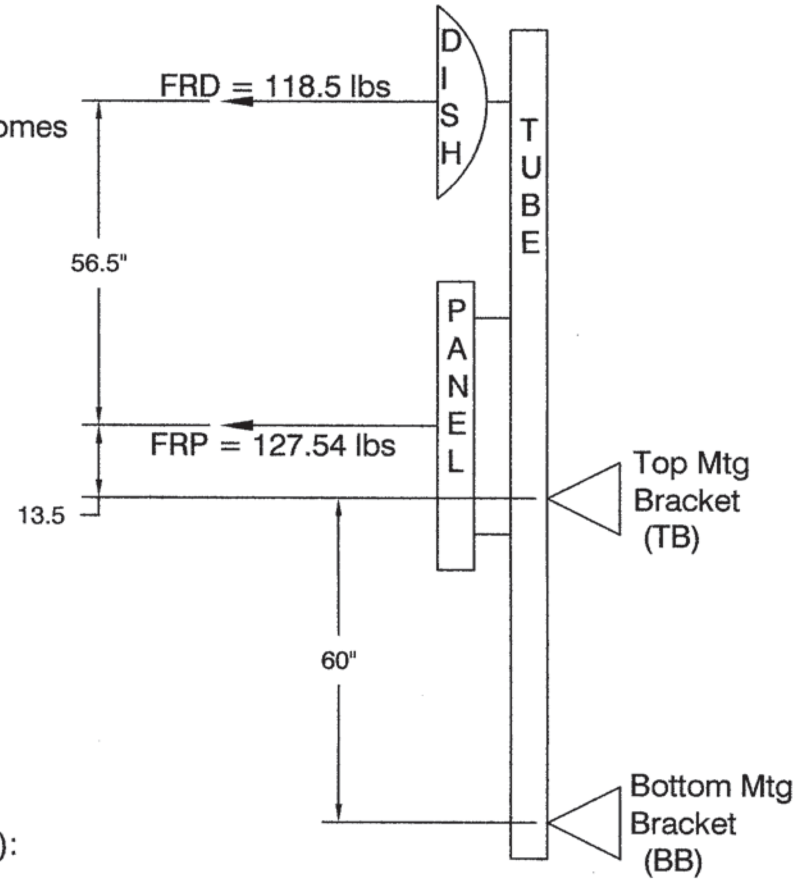
ENGINEERING CALCULATIONS

Project# 74035 Client Metal-Cable Corp Date 07-08-10

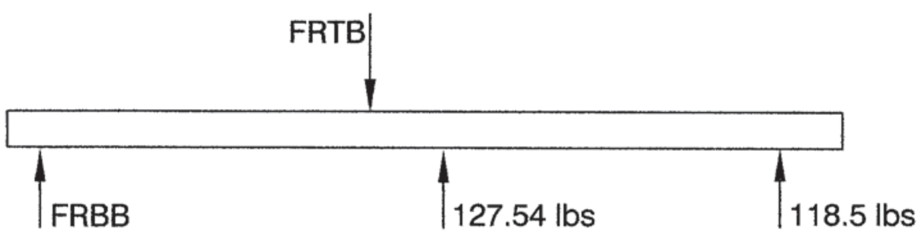
Subject Antenna Mount Calculations - Rear Wind Loads Page# 5 Next Page# 6

Rear Wind Loading

The "bottom" mounting bracket becomes the "pivot" for all horizontal forces in this configuration



Sum Moments about FRBB (cw= +):



ΣM @ BB = 0 = (60)(FRTB) - (73.5)(127.54) - (118.5)(130)

FRTB = ((73.5)(127.54)+(130)(118.5))/60 = 412.98 lbs

Solve for FRBB:

ΣF = 0 = 127.54+118.5 - 412.98 + FRBB

FRBB = 166.94 lbs

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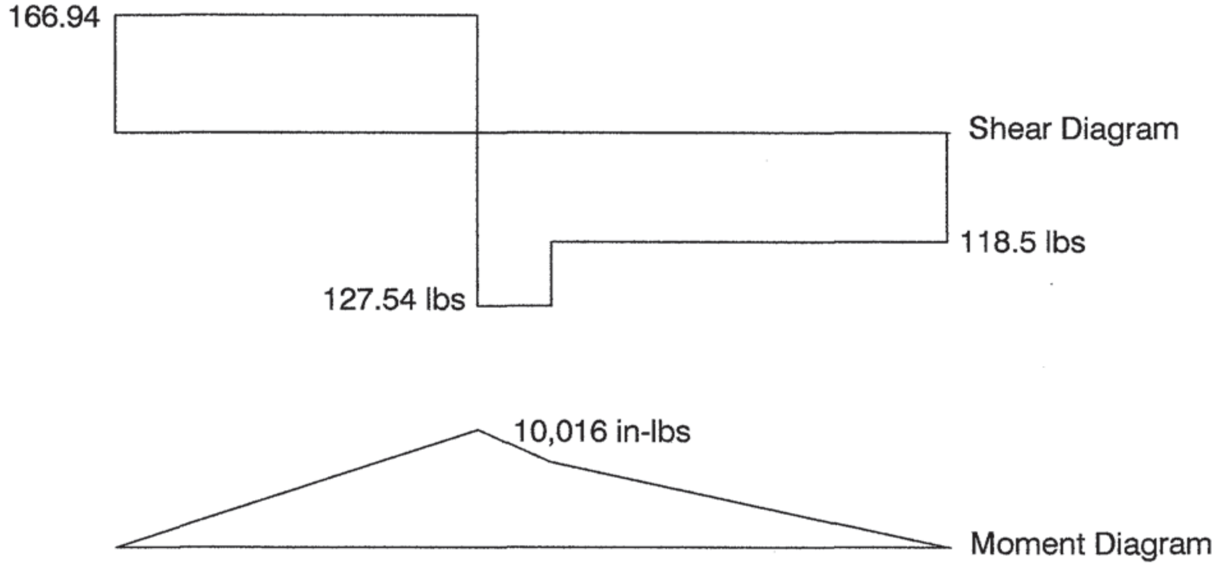
ENGINEERING CALCULATIONS

Project# 74035 Client Metal-Cable Corp Date 07-08-10

Subject Antenna Mount Calculations - Rear Wind Loads Page# 6 Next Page# 7



The rear wind condition puts the bottom magnetic mounting bracket into compression and applies a tensile load to the top mounting bracket. Per the equations on the previous page, that total tensile load (FRTB) is 412.98 lbs. Assuming equal distribution on all magnets, each individual magnet is subject to 412.98/24 or 17.20 lbs.

The analysis generated to this point indicates that the tensile loads created by the wind from the rear of the structure create higher "tensile" forces on the magnetic pads than do the winds from the front of the structure.

ff/calcgrid 990418

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Project# 74035 Client Metal-Cable Corp Date 07-08-10

Subject Antenna Mount Calculations - Side Wind Loads Page# 7 Next Page# 8

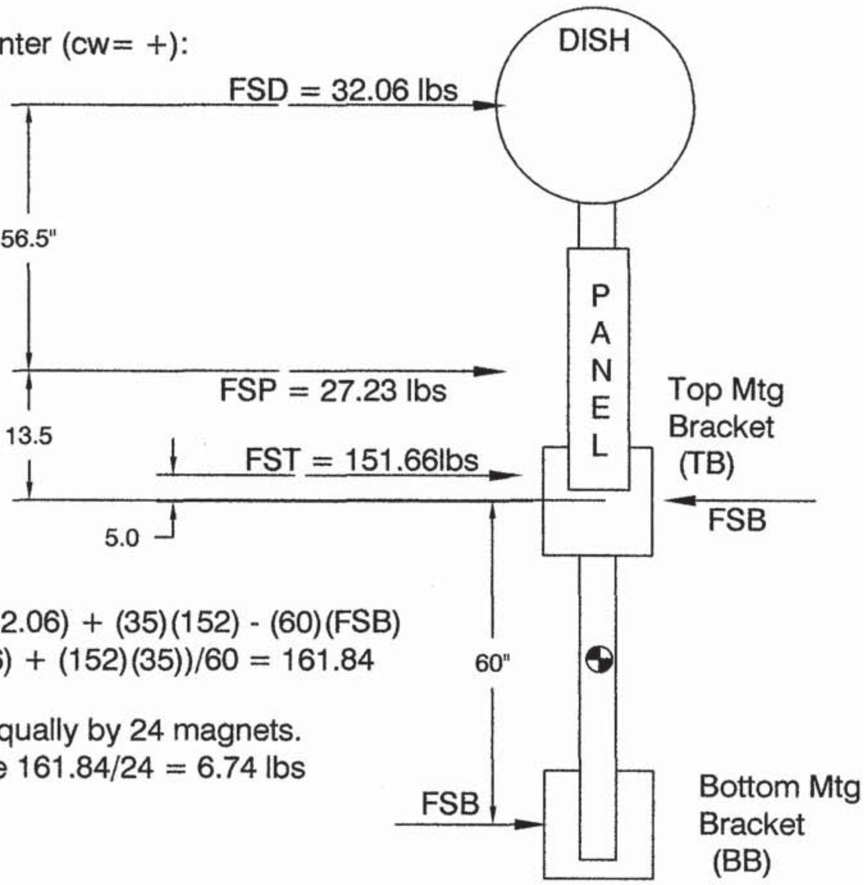
Side Wind Loading

Two types of loads are generated by winds blowing at the side profiles of the antennae. The first type of load is a shear loading which is discussed below. The second loading produces tensile and compressive loads on the magnets and is discussed on the following page.

Side Wind Loading - Shear

The shear loads generated by winds blowing at the side profiles of the antennae are resisted by a couple centered at the midpoint of the distance between the two magnetic mounting pads. By definition, both forces of a couple are equal to each other. Therefore, for subsequent shear calculations, FSBB and FSTB are renamed simply as FSB.

Sum Moments about couple center (cw= +):



$\Sigma M = 0 = (43.5)(27.23) + (100)(32.06) + (35)(152) - (60)(FSB)$
$FSB = ((43.5)(27.23)+(100)(32.06) + (152)(35))/60 = 161.84$

Each shear load will be resisted equally by 24 magnets.
the resulting individual load will be 161.84/24 = 6.74 lbs

ff/calcgrid 990418

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P.O. 185, WATEFORD, WI 53185
TELEPHONE 262-534-9001

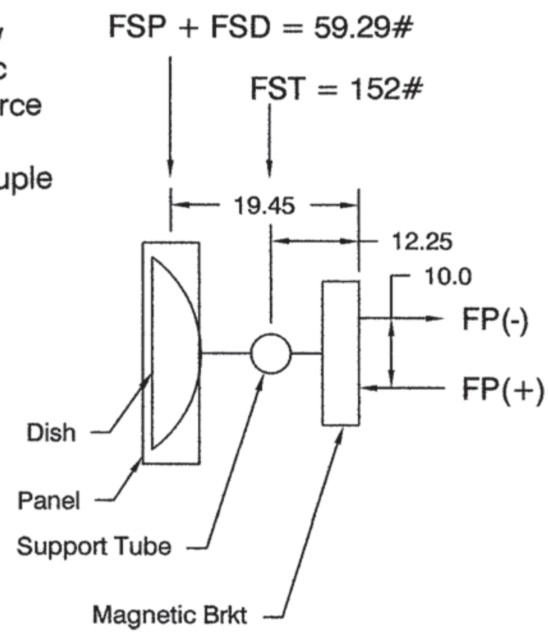
ENGINEERING CALCULATIONS

Project# 74035 Client Metal-Cable Corp Date 07-08-10

Subject Antenna Mount Calculations - Side Wind Loads Page# 8 Next Page# 9

Side Wind Loading - Tension & Compression

The relative orientation of the antennae to each other and to the magnetic brackets is shown in the plan view to the right. The antennae are offset from the magnetic brackets by the distance shown. The indicated side force creates a moment about the pad. This moment is resisted by a "couple" at the pad. Each force of the couple is located halfway from the center of the bracket to the center of its outer magnet.



Sum Moments about couple center (cw= +):

$$\Sigma M = 0 = (10)FP - (12.25)(152) - (19.45)(59.29)$$
$$FP = ((19.45)(59.29) + (12.25)(152))/10 = 302 \text{ lbs}$$

Each component of the couple will be shared equally by 12 magnets/bracket.
The resulting individual load will be 302/24 = 12.56 lbs

ff/calcgrid 990418

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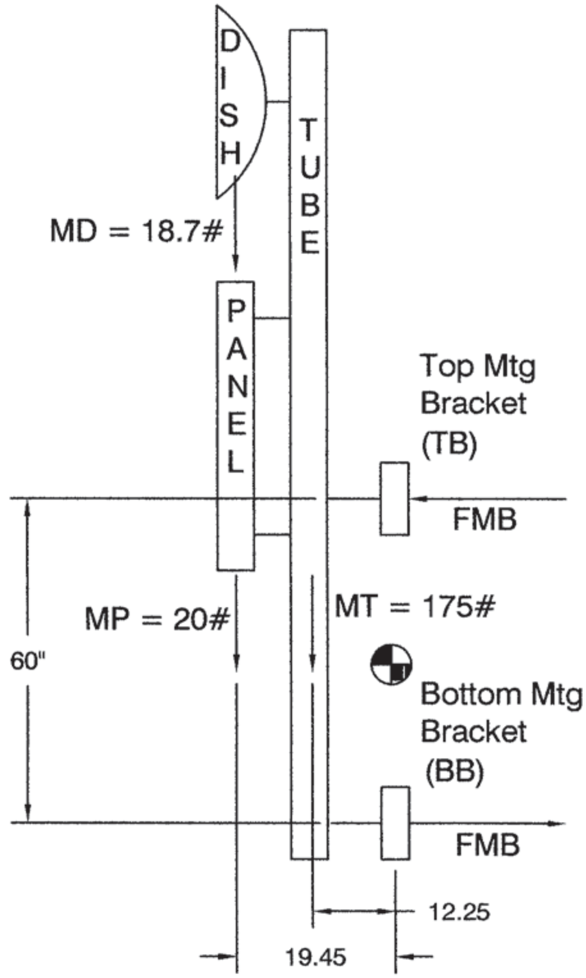

Mass Loads

Mass loads from the individual components are resisted by a force couple with its center halfway between the upper and lower mounting brackets. This couple is similar to that created by wind side loads. This force couple is solved on this page. The mass loads are also resisted by a vertical shear and are also discussed on this page.

Shear Forces from Mass Loads

The total shear force will be shared equally among 48 magnets. The load per individual magnet will be (20 + 18.7 + 175)/48 = FSV

4.45 lbs = FSV

Tensile and Compressive Forces from Mass Loads

Sum Moments about couple center (cw= +):

$$\Sigma M = 0 = (60)(FMB) - (175)(12.25) - (18.7)(19.45) - (20)(19.45)$$

$$FMB = ((12.25)(175)+(18.7)(19.45) + (20)(19.45))/60 = 48.27 \text{ lbs}$$

The tensile load on the top bracket will be shared equally by 24 magnets. The load per individual magnet will be 48.27/24 = 2 lbs.

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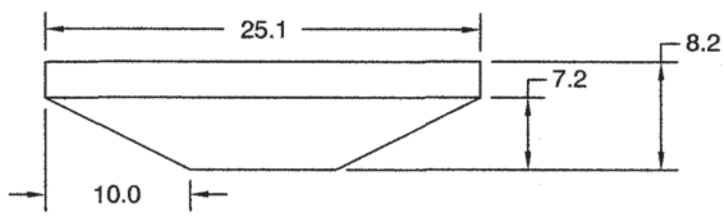
Ice Loads

Ice loads resulting from the coatings on individual components are calculated in exactly the same method as were the mass loads on the previous page. The mass of the ice is based on a constant of 3 lbs/ft of the surface being coated. Calculations of total areas and the corresponding ice masses are shown on this page.

Ice Surface Area - Dish Antenna
- Simplified profile shown below



- Area calculated via Solid Works = 8.18 ft^2
- FID = (8.18)(3.0) = 24.55 lbs.

Ice Surface Area - Panel Antenna
- 12.7 " x 42" x 2.7" profile (given)
- Area = ((12.7)(42)(2) + (12.7)(2.7)(2) + (2)(2.7)(42))/144 = 9.45 ft^2
- FIP = (9.45)(3.0) = 28.35 lbs.

Ice Surface Area - Support Tube
- 4.5 " OD (given) x 140" long
- Area = $((4.5)(140)(\pi) + (\pi)(2.25^2)(2))/144$ = 13.96 ft^2
- FIT = (13.96)(3.0) = 41.9 lbs.

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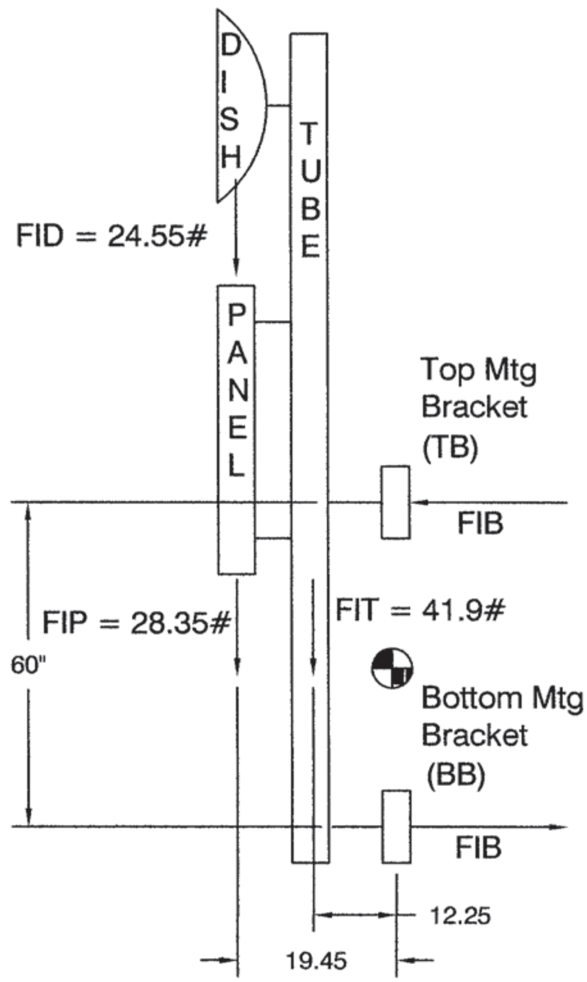
ENGINEERING CALCULATIONS

Project# 74035 Client Metal-Cable Corp Date 07-08-10

Subject Antenna Mount Calculations - Ice Loads Page# 11 Next Page# 12

Shear Forces from Ice Loads

The total shear force will be shared equally among 48 magnets. The load per individual magnet will be (24.55 + 28.35 + 41.9)/48 = 1.98 lbs.



Tensile and Compressive Forces from Ice Loads

Sum Moments about couple center (cw= +):

$$\Sigma M = 0 = (60)(FIB) - (41.9)(12.25) - (24.55)(19.45) - (28.35)(19.45)$$

$$FIB = ((12.25)(41.9)+(24.55)(19.45) + (28.35)(19.45))/60 = 25.70 \text{ lbs}$$

The tensile load on the top bracket will be shared equally by 24 magnets. The load per individual magnet will be 48.27/24 = 1.07 lbs.

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Group I combined loads - Rear Wind Situation

This per magnet loading is a combination of the following components:
- Tensile from rear wind - 17.17 lbs
- Tensile from mass - 2.0 lbs
- Tensile from ice - 1.07 lbs
- Shear from mass - 4.45 lbs
- Shear from ice - 1.98 lbs

The shear forces resulting from ice and mass act in the same direction and can be added algebraically to form a single component.
That vector is 4.45(mass) + 1.98(ice) = 6.43 lbs
Factor of Safety = 35/6.43 = 5.44

Likewise, all tensile forces are acting in the same direction and can added algebraically to form a single component.
That vector is 17.17(wind) + 2.0(mass) + 1.07(ice) = 20.24 lbs
Factor of Safety = 100/20.24 = 4.94

Group II combined loads - Side Wind Situation

This per magnet loading is a combination of the following components:
- Tensile from side wind - 12.56 lbs
- Tensile from mass - 2.0 lbs
- Tensile from ice - 1.07 lbs
- Shear from side wind - 6.74 lbs
- Shear from mass - 4.45 lbs
- Shear from ice - 1.98 lbs

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TELEPHONE 262-534-9001

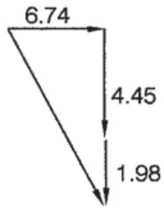
ENGINEERING CALCULATIONS

Project# 74035 Client Metal-Cable Corp Date 07-08-10

Subject Antenna Mount Calculations - Combined Loads Page# 13 Next Page# 14

The shear forces resulting from ice and mass act in the same direction and can be added algebraically to form a single component. The shear vector from the wind load acts in in the same plane but at right angles to the ice & mass vector all three can be combined per the diagram below.

Combined Shear



(4.45 + 1.98 = 6.43)

Combined Shear = $((6.74^2) + (6.43^2))^{1/2}$ = 9.31 lbs
Factor of Safety = 35/9.31 = 3.76

All tensile forces are acting in the same direction and can be added algebraically to form a single component.
That vector is 12.56(wind) + 2.0(mass) + 1.07(ice) = 15.63 lbs
Factor of Safety = 100/15.63 = 6.4

ff/calcgrid 990418

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Note: The file 74035genericR01.xls is NOT write protected. Cells A7 thru A33 are user entered data and are relative to the geometry of specific components within the general arrangement being investigated. See page 0 of this calculation set to identify abbreviations for specific forces and reactions and see the next page to identify components and dimensions discussed below. Dimensions and mass values on the next page are marked with the appropriate cell where they should be entered (A19 thru A29). The user should not enter data into or alter any cells other than those discussed below. Note units where applicable.

Cell A7	Wind speed (mph) at location. See Appendix 02.
Cell A8	Exposure Factor based on elevation. See Appendix 03.
Cell A9	Ice Load Area? See Appendix 02. Enter 3 for yes and 0 for no.
Cell A11*	Antenna 1 exposure to rear winds (ft^2)
Cell A12*	Antenna 1 exposure to side winds (ft^2)
Cell A14*	Antenna 2 exposure to rear winds (ft^2)
Cell A15*	Antenna 2 exposure to side winds (ft^2)
Cell A17*	Vertical tube exposure area to side winds (ft^2)
Cell A19	Vertical distance between mounts. (in)
Cell A20	Vertical distance - Bottom mount to antenna #1 CG. (in)
Cell A21	Vertical distance - Bottom mount to antenna #2 CG. (in)
Cell A22	Vertical distance - Bottom mount to vertical tube CG. (in)
Cell A23	Horizontal distance - Magnet face to antenna #1 CG. (in)
Cell A24	Horizontal distance - Magnet face to antenna #2 CG. (in)
Cell A25	Horizontal distance - Magnet face to vertical tube CG. (in)
Cell A27	Mass (lbs) of antenna #1 (manufacturer supplied data)
Cell A28	Mass (lbs) of antenna #2 (manufacturer supplied data)
Cell A29*	Mass (lbs) of vertical tube.
Cell A31*	Ice surface area** (ft^2) of antenna #1
Cell A32*	Ice surface area** (ft^2) of antenna #2
Cell A33*	Ice surface area** (ft^2) of vertical tube

* Requires offline user calculation
** Ice surface area = Total outside surface

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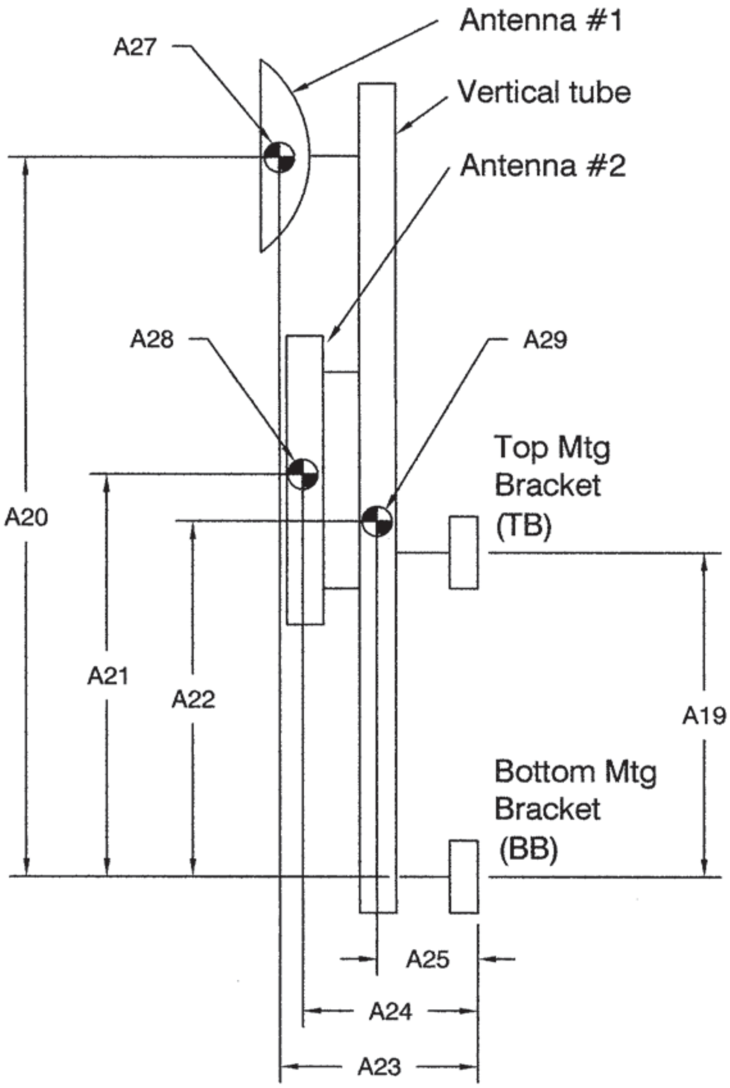
ENGINEERING CALCULATIONS

Project# 74035 Client Metal-Cable Corp Date 07-08-10

Subject Antenna Mount Calcs - Spreadsheet Example Page# 15 Next Page# -



ff/calcgrid 990418

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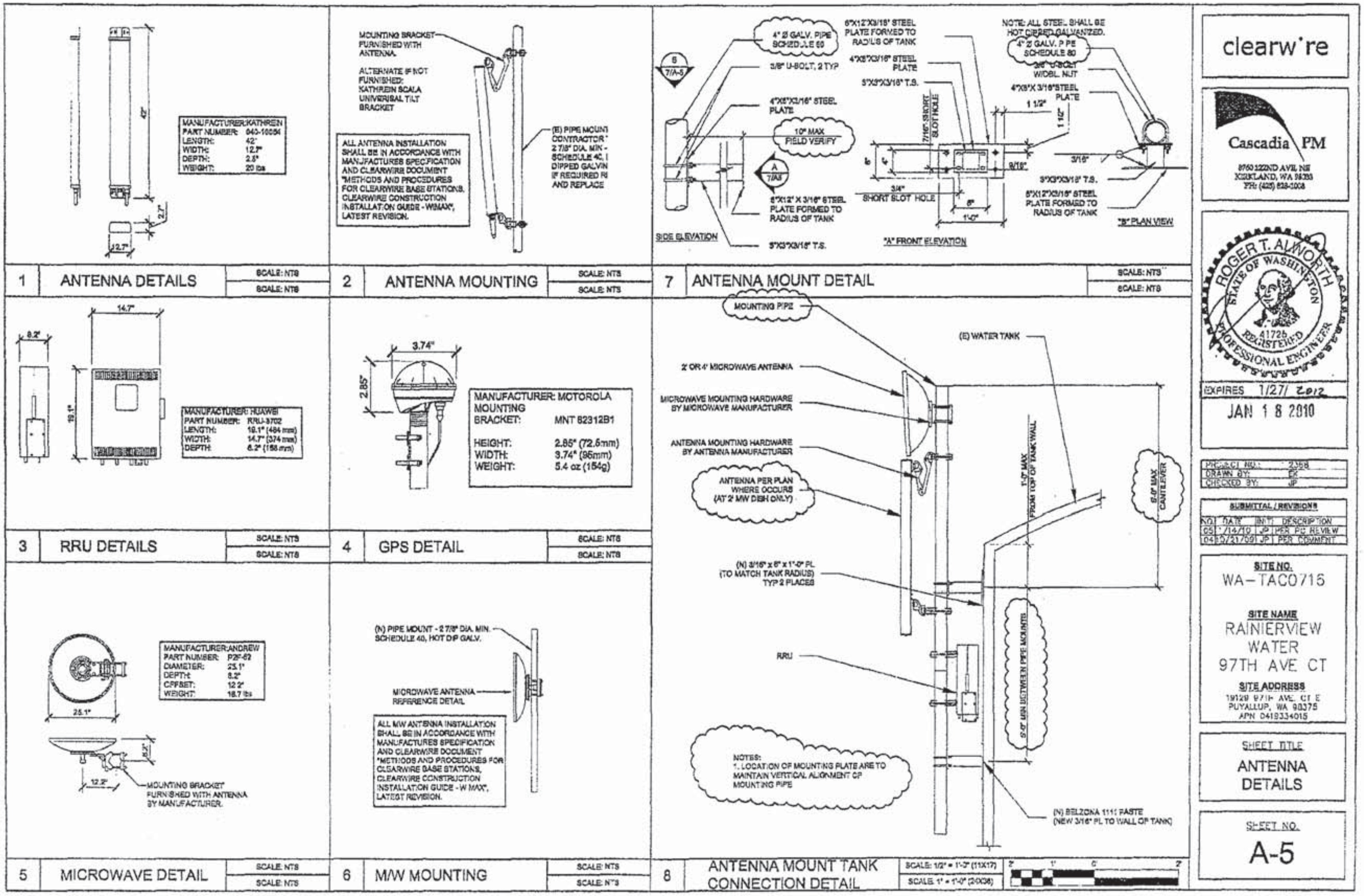
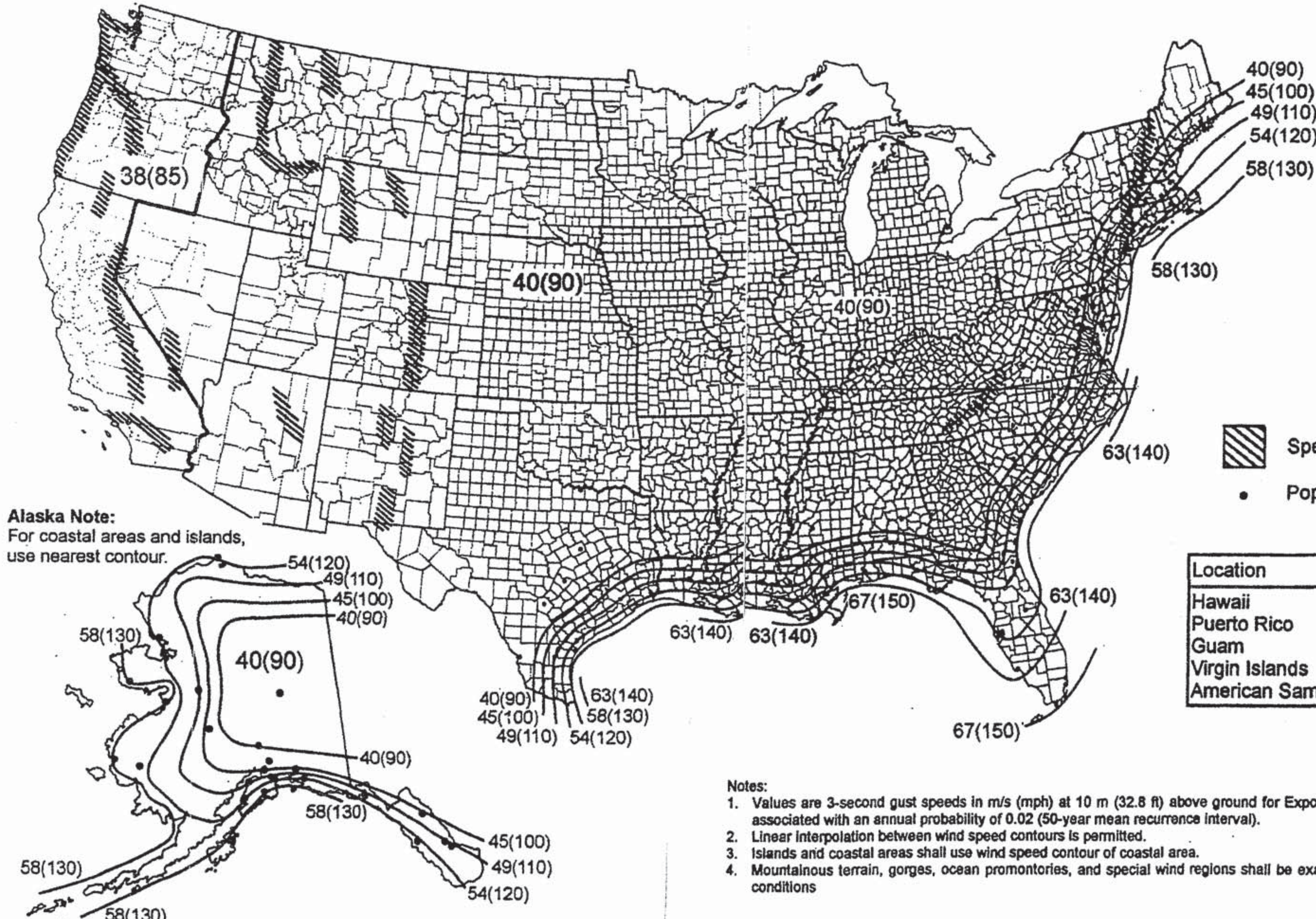

1 ANTENNA DETAILS
SCALE: NTS
MANUFACTURER: KATHREIN
PART NUMBER: 840-10054
LENGTH: 42"
WIDTH: 12.7"
DEPTH: 2.8"
WEIGHT: 20 lbs
2 ANTENNA MOUNTING
SCALE: NTS
MOUNTING BRACKET FURNISHED WITH ANTENNA.
ALTERNATE IF NOT FURNISHED: KATHREIN SCALA UNIVERSAL TILT BRACKET
ALL ANTENNA INSTALLATION SHALL BE IN ACCORDANCE WITH MANUFACTURES SPECIFICATION AND CLEARWIRE DOCUMENT "METHODS AND PROCEDURES FOR CLEARWIRE BASE STATIONS, CLEARWIRE CONSTRUCTION INSTALLATION GUIDE - WIMAX", LATEST REVISION.
(E) PIPE MOUNT CONTRACTOR 2 7/8" DIA. MIN - SCHEDULE 40, DIPPED GALVIN IF REQUIRED RI AND REPLACE
7 ANTENNA MOUNT DETAIL
SCALE: NTS
4" Ø GALV. PIPE SCHEDULE 80
3/8" U-BOLT, 2 TYP
4"X8"X3/16" STEEL PLATE
10" MAX FIELD VERIFY
6"X12" X 3/16" STEEL PLATE FORMED TO RADIUS OF TANK
5"X3"X3/16" T.S.
SIDE ELEVATION
6"X12"X3/16" STEEL PLATE FORMED TO RADIUS OF TANK
4"X8"X3/16" STEEL PLATE
5"X3"X3/16" T.S.
7/16" SHORT SLOT HOLE
3/4" SHORT SLOT HOLE
"A" FRONT ELEVATION
NOTE: ALL STEEL SHALL BE HOT DIPPED GALVANIZED.
4" Ø GALV. PIPE SCHEDULE 80
3/8" U-BOLT W/DBL NUT
4"X8"X 3/16" STEEL PLATE
5"X3"X3/16" T.S.
6"X12"X3/16" STEEL PLATE FORMED TO RADIUS OF TANK
"B" PLAN VIEW
3 RRU DETAILS
SCALE: NTS
MANUFACTURER: HUAWEI
PART NUMBER: RRU-3702
LENGTH: 19.1" (484 mm)
WIDTH: 14.7" (374 mm)
DEPTH: 6.2" (158 mm)
4 GPS DETAIL
SCALE: NTS
MANUFACTURER: MOTOROLA
MOUNTING BRACKET: MNT 82312B1
HEIGHT: 2.85" (72.5mm)
WIDTH: 3.74" (95mm)
WEIGHT: 5.4 oz (154g)
5 MICROWAVE DETAIL
SCALE: NTS
MANUFACTURER: ANDREW
PART NUMBER: P2F-52
DIAMETER: 25.1"
DEPTH: 8.2"
OFFSET: 12.2"
WEIGHT: 18.7 lbs
MOUNTING BRACKET FURNISHED WITH ANTENNA BY MANUFACTURER.
6 M/W MOUNTING
SCALE: NTS
(N) PIPE MOUNT - 2 7/8" DIA. MIN. SCHEDULE 40, HOT DIP GALV.
MICROWAVE ANTENNA REFERENCE DETAIL
ALL MW ANTENNA INSTALLATION SHALL BE IN ACCORDANCE WITH MANUFACTURES SPECIFICATION AND CLEARWIRE DOCUMENT "METHODS AND PROCEDURES FOR CLEARWIRE BASE STATIONS, CLEARWIRE CONSTRUCTION INSTALLATION GUIDE - W MAX", LATEST REVISION.
8 ANTENNA MOUNT TANK CONNECTION DETAIL
SCALE: 1/2" = 1'-0" (11X17)
SCALE: 1" = 1'-0" (24X36)
MOUNTING PIPE
2' OR 4' MICROWAVE ANTENNA
MICROWAVE MOUNTING HARDWARE BY MICROWAVE MANUFACTURER
ANTENNA MOUNTING HARDWARE BY ANTENNA MANUFACTURER
ANTENNA PER PLAN WHERE OCCURS (AT 2' MW DISH ONLY)
(N) 3/16" x 6" x 1'-0" PL (TO MATCH TANK RADIUS) TYP 2 PLACES
RRU
NOTES: 1. LOCATION OF MOUNTING PLATE ARE TO MAINTAIN VERTICAL ALIGNMENT OF MOUNTING PIPE
(E) WATER TANK
1'-0" MAX FROM TOP OF TANK WALL
6'-0" MAX CANTILEVER
5'-0" MIN BETWEEN PIPE MOUNTS
(N) BELZONA 1111 PASTE (NEW 3/16" PL TO WALL OF TANK)
clearw're
Cascadia PM
8760 122ND AVE NE KIRKLAND, WA 98033
ROGER T. ALWORTH
STATE OF WASHINGTON
41726 REGISTERED PROFESSIONAL ENGINEER
EXPIRES 1/27/ 2012
JAN 1 8 2010
PROJECT NO: 2358
DRAWN BY: EK
CHECKED BY: JP
SUBMITTAL / REVISIONS
NO. DATE INIT. DESCRIPTION
05 7/14/10 JP PER PC REVIEW
04 5/21/09 JP PER COMMENT
SITE NO. WA-TAC0715
SITE NAME RAINIERVIEW WATER 97TH AVE CT
SITE ADDRESS 19129 97TH AVE CT E PUYALLUP, WA 98375 APN 0419334015
SHEET TITLE ANTENNA DETAILS
SHEET NO. A-5

Appendix 01



Location	V m/s	(mph)
Hawaii	47	105
Puerto Rico	56	125
Guam	76	170
Virgin Islands	56	125
American Samoa	56	125

Notes:
1. Values are 3-second gust speeds in m/s (mph) at 10 m (32.8 ft) above ground for Exposure C category and are associated with an annual probability of 0.02 (50-year mean recurrence interval).
2. Linear interpolation between wind speed contours is permitted.
3. Islands and coastal areas shall use wind speed contour of coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions

Appendix 02

Height and Exposure Factors, K_z	
Height, m(ft)	K_z
5.0(16.4) or less	0.87
7.5 (24.6)	0.94
10.0 (32.8)	1.00
12.5 (41.0)	1.05
15.0 (49.2)	1.09
17.5 (57.4)	1.13
20.0 (65.6)	1.16
22.5 (73.8)	1.19
25.0 (82.0)	1.21
27.5 (90.2)	1.24
30.0 (98.4)	1.26
35.0 (114.8)	1.30
40.0 (131.2)	1.34
45.0 (147.6)	1.37
50.0 (164.0)	1.40
55.0 (180.5)	1.43
60.0 (196.9)	1.46
70.0 (229.7)	1.51
80.0 (262.5)	1.55
90.0 (295.3)	1.59
100.0 (328.1)	1.63

Generic Antenna Approximations
74035genericR01.xls
7/24/2010

User Entered Data

85.00	Wind Speed (mph)
1.46	Exposure Factor (per attached AASHTO table)
3.00	Ice (psf)
3.44	Antenna 1 Rear Exposure Area (square feet)
0.93	Antenna 1 Side Exposure Area (square feet)
3.70	Antenna 2 Rear Exposure Area (square feet)
0.79	Antenna 2 Side Exposure Area (square feet)
4.40	Vertical Tube Side Exposure Area (square feet)
60.00	Vertical Distance Between Mounts (in)
130.00	Vertical Distance - Bottom mount to antenna 1 CG (in)
73.50	Vertical Distance - Bottom mount to antenna 2 CG (in)
65.00	Vertical Distance - Bottom mount to vertical tube CG. (in)
19.45	Horizontal Distance - Magnet face to antenna 1 CG (in)
19.45	Horizontal Distance - Magnet face to antenna 2 CG (in)
12.25	Horizontal Distance - Magnet face to vertical tube CG (in)
18.70	Mass of Antenna #1 (lbs)
20.00	Mass of Antenna #2 (lbs)
175.00	Mass of Vertical Mount Tube (lbs)
8.18	Ice surface area antenna 1 (square feet)
9.45	Ice surface area antenna 2 (square feet)
13.96	Ice surface area vertical tube (square feet)

Calculated Constants

30.00	1/2 distance between magnetic mounts (in)

Calculated Component Wind Loads

118.61	FR1 (wind force (lbs) at rear of antenna 1)
32.07	FS1 (wind force (lbs) at side of antenna 1)
127.57	FR2 (wind force (lbs) at rear of antenna 2)
27.24	FS2 (wind force (lbs) at side of antenna 2)
151.71	FST (wind force (lbs) at side of mounting tube)

Calculated Component Ice Loads

24.54	Ice Load (lbs) Antenna 1
28.35	Ice Load (lbs) Antenna 2
41.88	Ice Load (lbs) Vertical Tube

Mounting Bracket Forces From Rear Winds

413.26	FRTB (top bracket force - rear wind)
167.08	FRBB (bottom bracket force - rear wind)
17.22	Top Mount Tension per magnet from rear wind

Mounting Bracket Forces from Side Winds

161.69	FSB horizontal "shear" load per bracket
6.74	Horizontal "shear" load per magnet from side wind
301.19	FP (mounting pad (lbs tension and compression) load from Side wind Loads
12.55	Tension load per magnet from side wind load

Mass Loads

106.85	FSVM Vertical "shear" load per bracket
4.45	Vertical "shear" load per magnet
48.27	FP (mounting pad (lbs tension and compression) load from Mass Loads
2.01	Tension load per magnet from Mass Load

Ice Loads

94.77	FSVI Vertical "shear" load per bracket
1.97	Vertical "shear" load per magnet
25.70	FP (mounting pad (lbs tension and compression) load from Mass Loads
1.07	Tension load per magnet from Mass Load

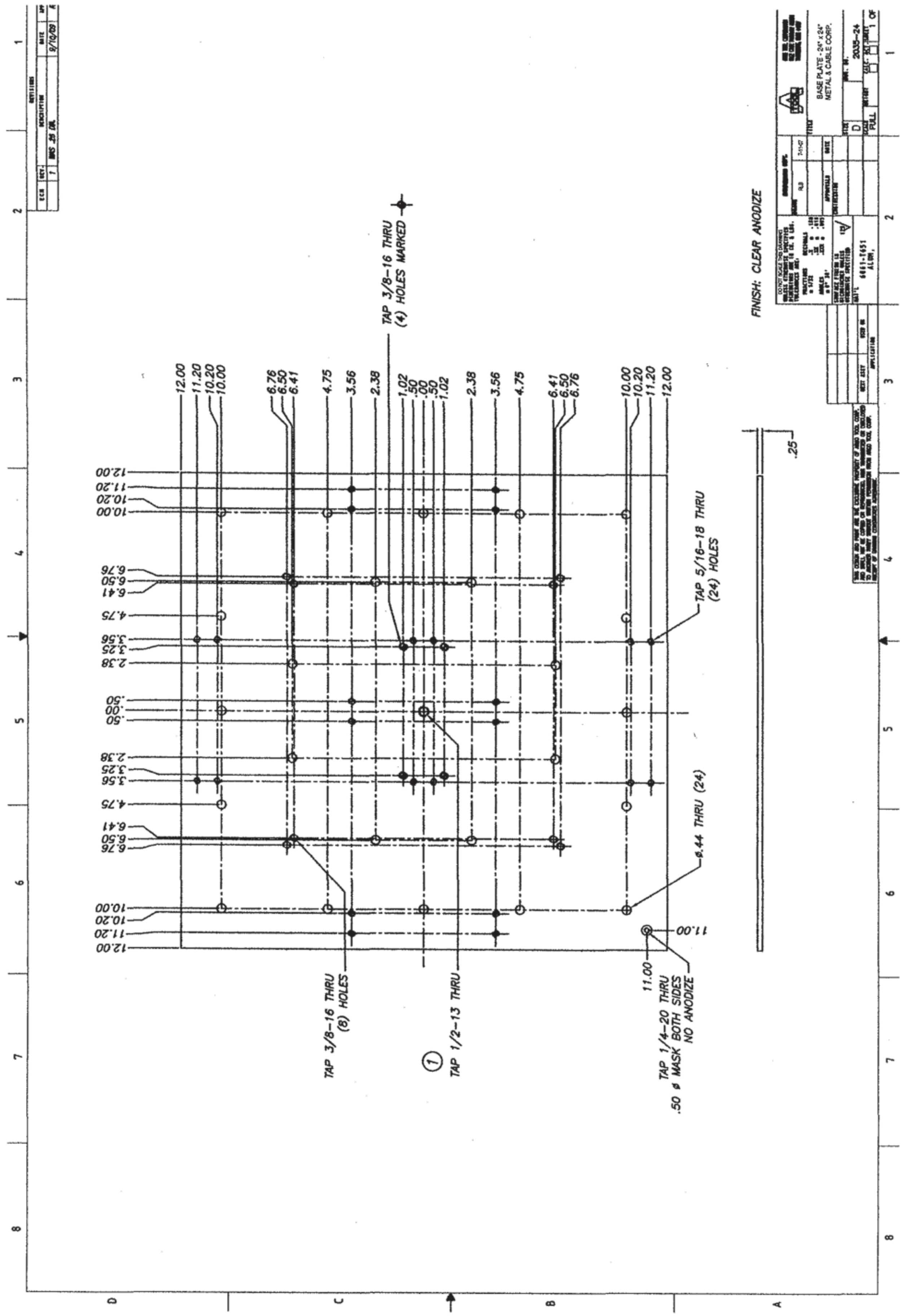
Combined Loads - Rear Wind Situation

6.43	Vertical "shear" (mass + ice)
5.45	Factor of Safety
20.30	Tensile Load (wind + mass + ice)
4.93	Factor of Safety

Combined Loads - Side Wind Situation

9.31	Combined "shear" (wind + mass + ice)
3.76	Factor of Safety
15.63	Tensile Load (wind + mass + ice)
6.40	Factor of Safety

Appendix 04


FINISH: CLEAR ANODIZE
TAP 3/8-16 THRU
(4) HOLES MARKED
TAP 5/16-18 THRU
(24) HOLES
ø.44 THRU (24)
TAP 3/8-16 THRU
(8) HOLES
TAP 1/2-13 THRU
TAP 1/4-20 THRU
.50 ø MASK BOTH SIDES
NO ANODIZE
11.00
.25
BASE PLATE - 24" x 24"
METAL & CABLE CORP.
2035-24
6061-T651
ALUM.

Appendix 05

BROOKS STEVENS

August 28, 2010

Mr. David Klein
Metal & Cable Corp., Inc.
9337 Ravenna Road, Unit C
P.O. Box 117
Twinsburg, OH 44087

Brooks Stevens, Inc. (BSI) certifies that the "SEISMIC QUALIFICATION TESTING OF A MAGNETOMOUNT MB, MAGNETIC MOUNTING SYSTEM FOR METAL & CABLE CORP., INC." identified by report number M109-14187 was performed at DATASYST's facilities on June 15-16, 2010 in compliance with ICC-ES AC156.

BSI has verified that the calculations performed by DATASYST are in accordance with ICC-ES AC156. This certification is based on design information, test procedures and miscellaneous information supplied to BSI by DATASYST. BSI claims no responsibility for errors resulting from misinformation or lack of information by DATASYST or METAL & CABLE CORP, INC.

This certification does not replace the full test report that includes boundary conditions, considerations and method of testing of the components verified by DATASYST.

Brooks Stevens, Inc.

George Konstantakis, P.E.
WI License 33350-006

WISCONSIN
GEORGE C.
KONSTANTAKIS
E-33350
FRANKLIN
WIS.
PROFESSIONAL ENGINEER

DATASYST
Engineering & Testing Services, Inc.
S14 W33511 Highway 18 • Delafield, WI 53018 • 262 968-4003 • Fax: 262 968-3050 • 800 969-4050

SEISMIC QUALIFICATION TESTING

OF A

MAGNEMOUNT MB, MAGNETIC MOUNTING SYSTEM

FOR

METAL & CABLE CORP., INC.

TEST DATES:
JUNE 15 - 16, 2010

DATASYST PROJECT NUMBER:
M109-14187

PREPARED FOR: DAVID KLEIN
METAL & CABLE CORP., INC.
9337 RAVENNA ROAD, UNIT C
P.O. BOX 117
TWINSBURG, OH 44087

PREPARED BY: EDWARD HANUS
DATASYST ENGINEERING & TESTING SERVICES, INC.
33511 HIGHWAY 18
DELAFIELD, WI 53018

WISCONSIN
GEORGE C. KONSTANTAKIS
E-33350
FRANKLIN
WIS.
PROFESSIONAL ENGINEER

TABLE OF CONTENTS

WISCONSIN
GEORGE C. KONSTANTAKIS
E-33350
FRANKLIN
WIS.
PROFESSIONAL ENGINEER

1.0 INTRODUCTION

Metal & Cable Corp., Inc., of Twinsburg, Ohio contracted DATASYST Engineering & Testing Services, Inc. of Delafield, Wisconsin to perform ICC-ES AC156 seismic qualification testing on a Magnemount MB (Magnemount) magnetic mounting system. Testing was performed at DATASYST's facilities on June 15-16, 2010.

2.0 CONCLUSIONS

The Magnemount magnetic mounting system was subjected to a resonant frequency search from 1.3 to 33.3 Hz followed by a thirty second seismic motion test in each of the three mutually perpendicular axes. Testing was performed with the Magnemount mounted to both vertical and horizontal surfaces. All testing was performed with a 54 pound dead weight fastened to the mast which simulated an antenna or other component.

The sine surveys showed that the structure has a resonant natural frequency of 11 Hz in both of the lateral axes (X and Y) which classifies the Magnemount as a flexible structure. In the Z axis, which is parallel to the centerline of the mast, there were no resonant natural frequencies below 33.3 Hz.

Throughout the course of seismic waveform testing there were no anomalies or visual structural failures within the Magnemount. The Magnemount remained magnetically coupled to the steel fixture plate for all tests.

The Magnemount is compliant to the AC156 specification.

WISCONSIN GEORGE C. KONSTANTAKIS E-33350 FRANKLIN WIS. PROFESSIONAL ENGINEER

3.0 TEST PROCEDURES

One sample of a Magnemount magnetic mounting system was tested. The Magnemount was 24" x 24" x 37.5" high, weighed 54 pounds, and contained (24)

3-3/4" diameter permanent magnet mounts. For all testing, a 54 pound dead weight was fastened to the top of the mast which simulated the weight of an antenna or other component. The center of the dead weight was located 3-3/4" from the top of the mast.

An arbitrary axis system was defined for the Magnemount and is used as a reference throughout this report. In this system the X and Y axes are in the plane of the 24" x 24" aluminum base plate and the Z axis is parallel to the main axis of the mast. A photograph of the defined axis system on the Magnemount is shown in the photographs section of this report.

The Magnemount was tested in all three mutually perpendicular axes when the mount was positioned in two distinct orientations, for a total of six seismic waveform tests. The first orientation is the "vertical face mount" where the surface that test article mounts to is in a vertical plane and the mast is parallel to the ground. The second orientation is the "horizontal face mount" where the mounting face is in a horizontal plane and the mast is positioned perpendicular to the ground. The Magnemount was held to a ¼" thick steel fixture plate using only the magnet mounting provisions of the test article. No other means were used to restrain the test article.

In each of the six test axes a 0.1g, 1.3 – 33.3 Hz, sine survey was performed to determine resonant natural frequencies of the system, followed by a 30 second seismic input. Two response accelerometers were mounted at the top of the mast to determine the resonant frequencies.

Prior to initiating the seismic waveform testing the Required Response Spectrum (RRS) was determined from the AC156 specification. Since it is unknown where the test article will be located in service the maximum RRS values defined by the specification are used. This RRS is defined by the acceleration values A_{FLX} and A_{RIG} and the defined frequency range from 1.3 to 33 Hz.

Determination of the maximum A_{FLX} and A_{RIG} values for, both the Uniform Building Code and International Building Code, are as follows:

UBC Horizontal Axes

$A_{FLX} = 2.5\ C_a\ (1+3(H_x/H_r)$, limited to $4C_a$

$A_{RIG} = C_a\ (1+3(H_x/H_r)$, limited to $3C_a$

UBC Vertical Axes

Vertical values are defined as 2/3 of the lateral axes and H_x is defined as zero.

$A_{FLX} = 2/3\ (2.5C_a)$

$A_{RIG} = 2/3\ C_a$

The largest value of C_a is defined as 0.66. Therefore, the maximum spectral response acceleration values, according to the UBC code, are:

Horizontal Axis $A_{FLX} = 2.64$ g

Horizontal $A_{RIG} = 1.98$ g

Vertical Axis $A_{FLX} = 1.10$ g

Vertical Axis $A_{RIG} = 0.44$ g

IBC Horizontal Axes

$A_{FLX} = S_{DS}(1+2(z/h))$, limited to $1.6S_{DS}$

$A_{RIG} = 0.4S_{DS}(1+2(z/h))$

IBC Vertical Axis

Vertical values are defined as 2/3 of the lateral axes and z is defined as zero.

$AFLX = 2/3S_{DS}$

$ARIG = 4/15S_{DS}$

Given that $S_{DS} = 2/3\ S_{MS}$, that $S_{MS} = F_aS_s$ and that the maximum site value coefficient is 1; $S_{DS} = 2/3\ S_s$. The maximum value for S_s defined in the IBC is 3g, therefore $S_{DS} = 2g$. Therefore, the maximum spectral response acceleration values, according to the IBC code, are:

Horizontal Axis $A_{FLX} = 3.20$ g

Horizontal $A_{RIG} = 2.40$ g

Vertical Axis $A_{FLX} = 1.34$ g

Vertical Axis $A_{RIG} = 0.54$ g

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Since the RRS amplitudes defined by the IBC are greater than the RRS amplitudes defined by the UBC, the IBC amplitudes are used throughout the course of testing.

Nomenclature

A_{FLX} – Horizontal spectral acceleration calculated for flexible equipment
A_{RIG} – Horizontal spectral acceleration calculated for rigid equipment
C_a – UBC seismic coefficient
F_a – IBC site coefficient
h – Average building/structure height relative to the base
H_x – Equipment attachment elevation with respect to grade (but not less than zero)
H_r – Building/structure roof elevation with respective to grade
IBC – International Building Code
S_S – Mapped spectral accelerations for short periods
S_{DS} – Spectral response acceleration at short period
S_{MS} – maximum considered earthquake spectral response accelerations for short period
UBC – Uniform Building Code
z – Height of structure with respect to grade, at point of equipment attachment (but not less than zero)

Photographs of the test setups are shown in Section 6.0 Photographs of this report.

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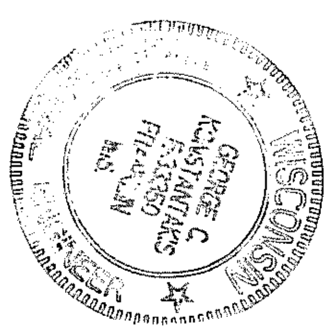
4.0 PLOTS AND DATA SUMMARY

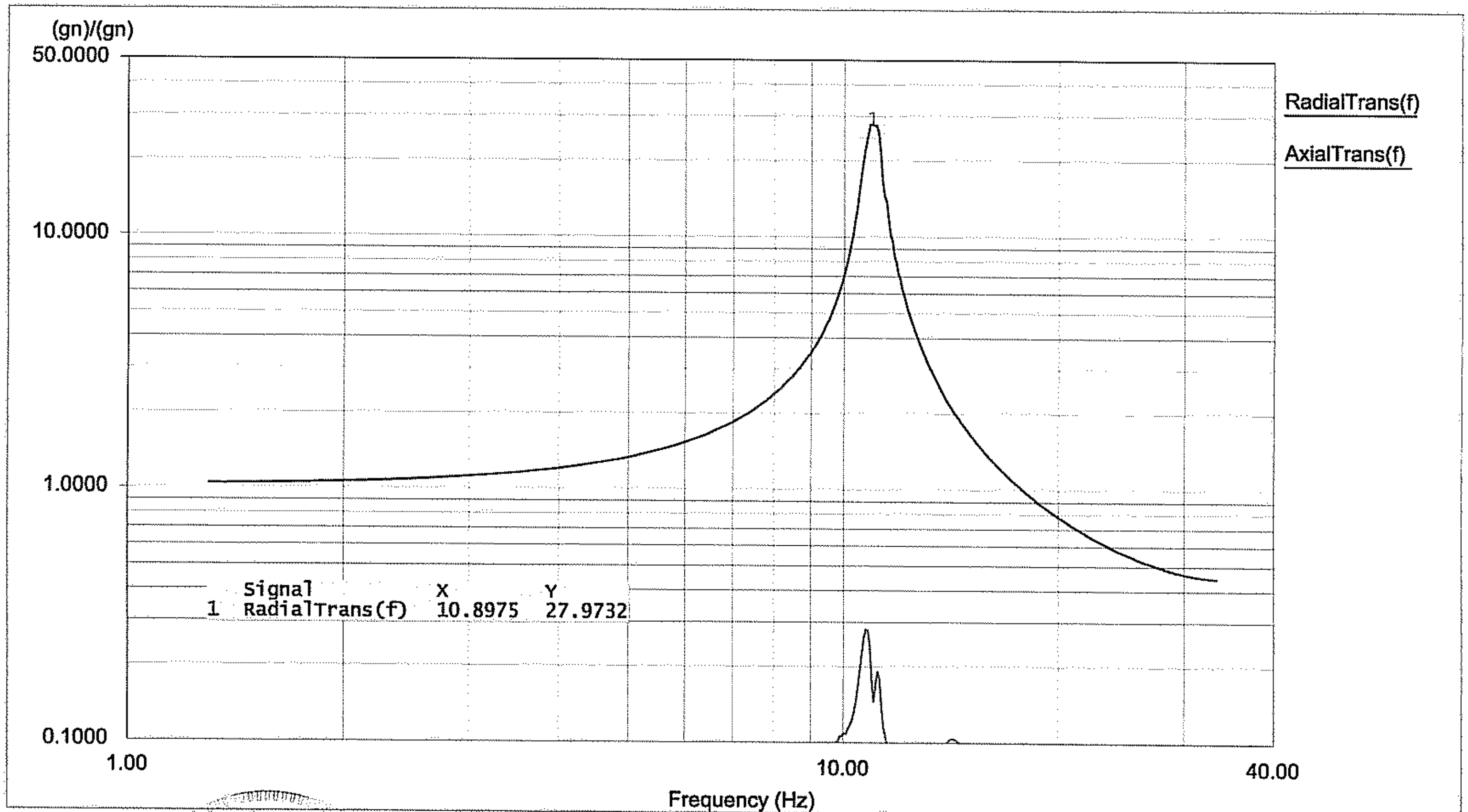
Table of Magnemount Natural Frequencies with 54 Pound Weight at Top of Mast

Orientation	Test Axis	Natural Frequency (Hz)
Vertical Mounting Face (Horizontal Mast)	X	10.9
Vertical Mounting Face (Horizontal Mast)	Y	11.6
Vertical Mounting Face (Horizontal Mast)	Z	None below 33.3 Hz
Horizontal Mounting Face (Vertical Mast)	X	11.0
Horizontal Mounting Face (Vertical Mast)	Y	11.0
Horizontal Mounting Face (Vertical Mast)	Z	None below 33.3 Hz



Vertical Face Mounting, X axis Sine Sweep, Transmissibility Plot

Project File Name: Sweep.prj
Profile Name: Low Level   Test Type: Swept Sine   Run Folder: .\RunDefault Jun 15, 2010 16-30-05



Level: 100 %   Full Level Time: 00:04:41   Sweep Type: Logarithmic
Frequency: 33.285889 Hz   Time Remaining: 00:00:00   Sweep Rate: 1 Oct/Min
Data saved at 04:36:54 PM, Tuesday, June 15, 2010   Report created at 04:36:56 PM, Tuesday, June 15, 2010

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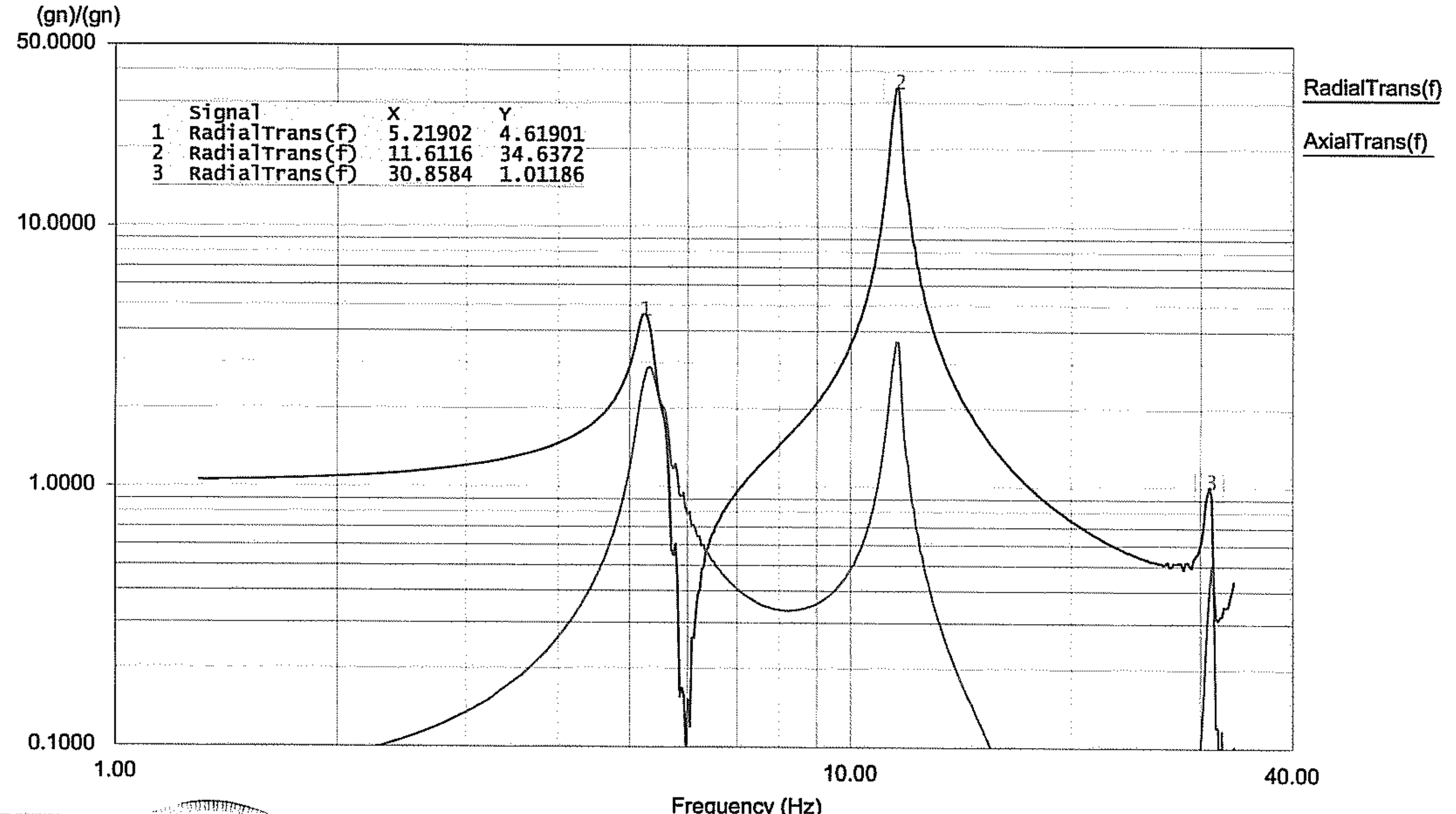
Vertical Face Mounting, Y axis Sine Sweep, Transmissibility Plot

Project File Name: Sweep.prj
Profile Name: Low Level   Test Type: Swept Sine   Run Folder: .\RunDefault Jun 16, 2010 13-49-49



Level: 100 %   Full Level Time: 00:04:41   Sweep Type: Logarithmic
Frequency: 33.294083 Hz   Time Remaining: 00:00:00   Sweep Rate: 1 Oct/Min

Data saved at 01:58:13 PM, Wednesday, June 16, 2010   Report created at 01:58:14 PM, Wednesday, June 16, 2010

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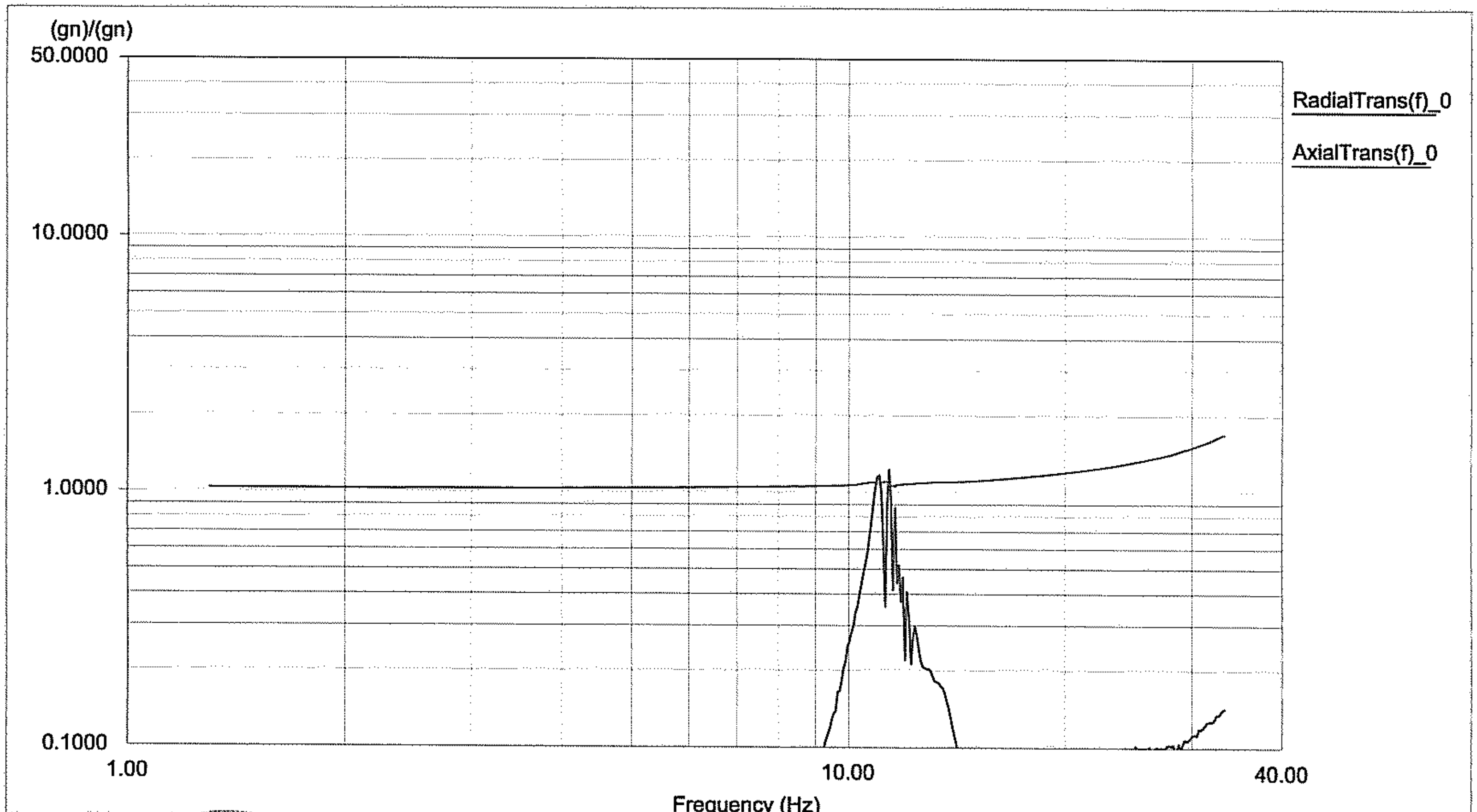
Vertical Face Mounting, Z axis Sine Sweep, Transmissibility Plot

Project File Name: Sweep.prj
Profile Name: Low Level   Test Type: Swept Sine   Run Folder: .\Sweep(SINE)



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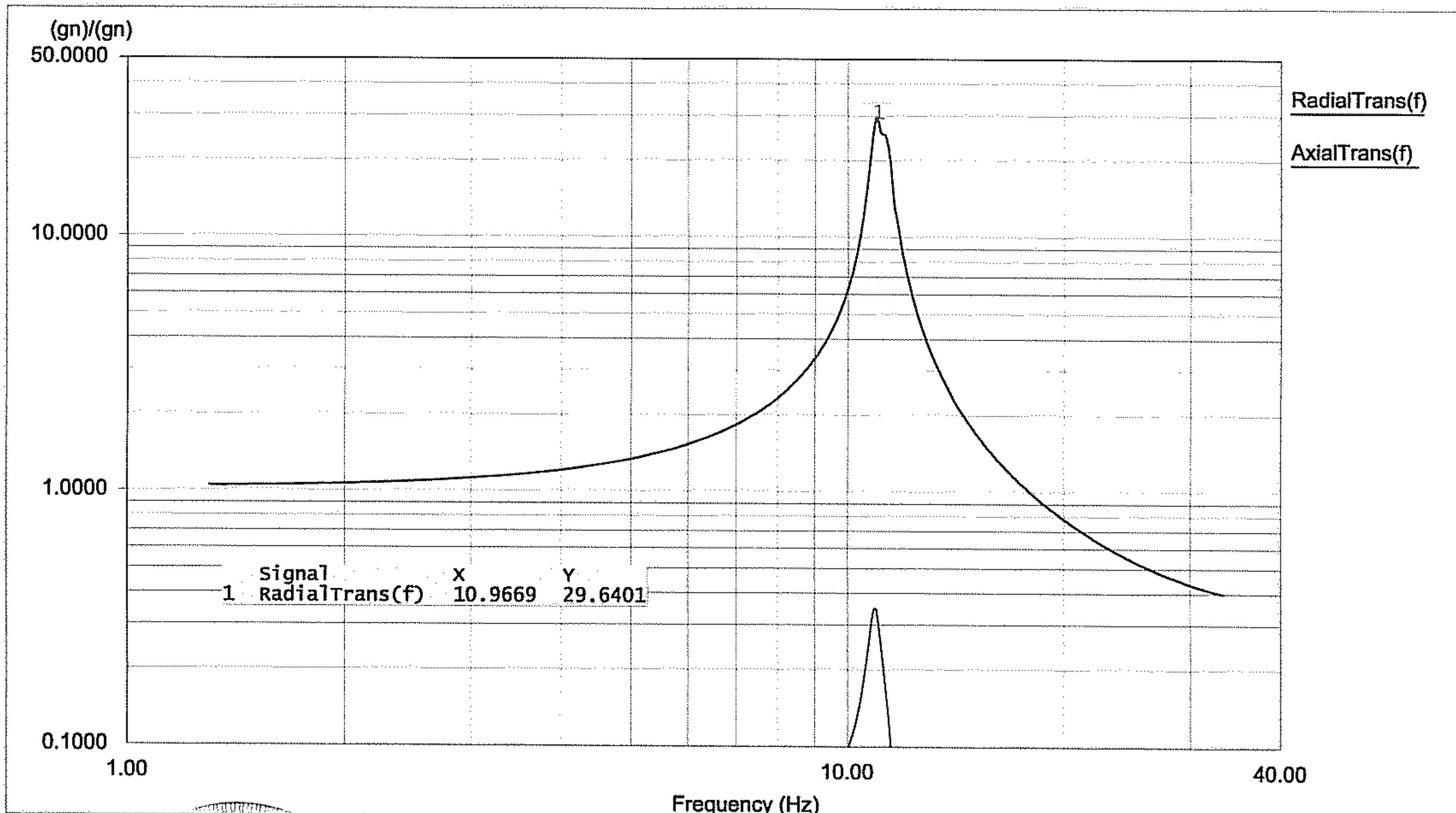
Horizontal Face Mounting, X axis Sine Sweep, Transmissibility Plot

Project File Name: Sweep.prj
Profile Name: Low Level   Test Type: Swept Sine   Run Folder: .\RunDefault Jun 15, 2010 18-33-05



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Frequency: 33.285889 Hz   Time Remaining: 00:00:00   Sweep Rate: 1 Oct/Min

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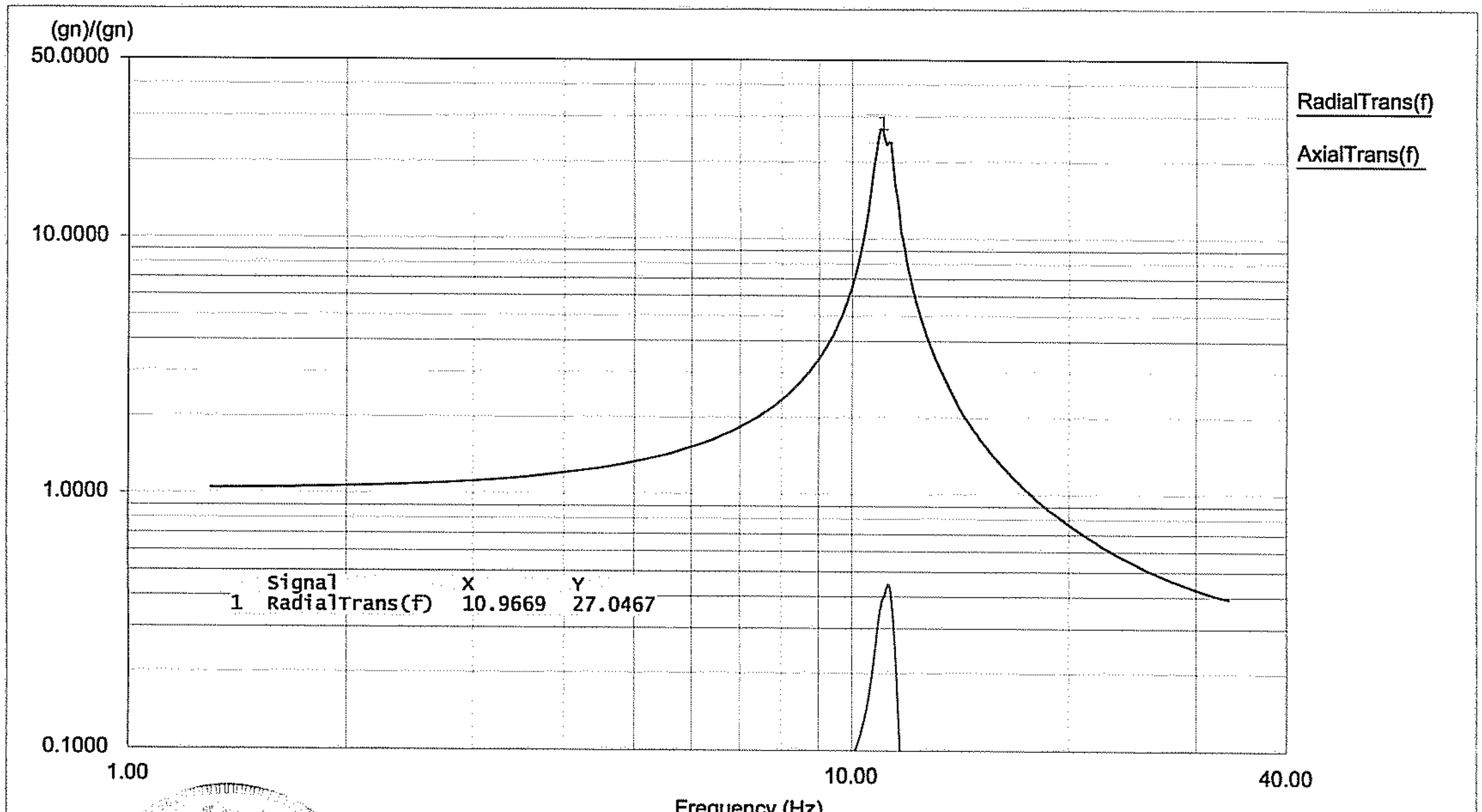
Horizontal Face Mounting, Y axis Sine Sweep, Transmissibility Plot

Project File Name: Sweep.prj
Profile Name: Low Level   Test Type: Swept Sine   Run Folder: .\RunDefault Jun 15, 2010 19-10-13



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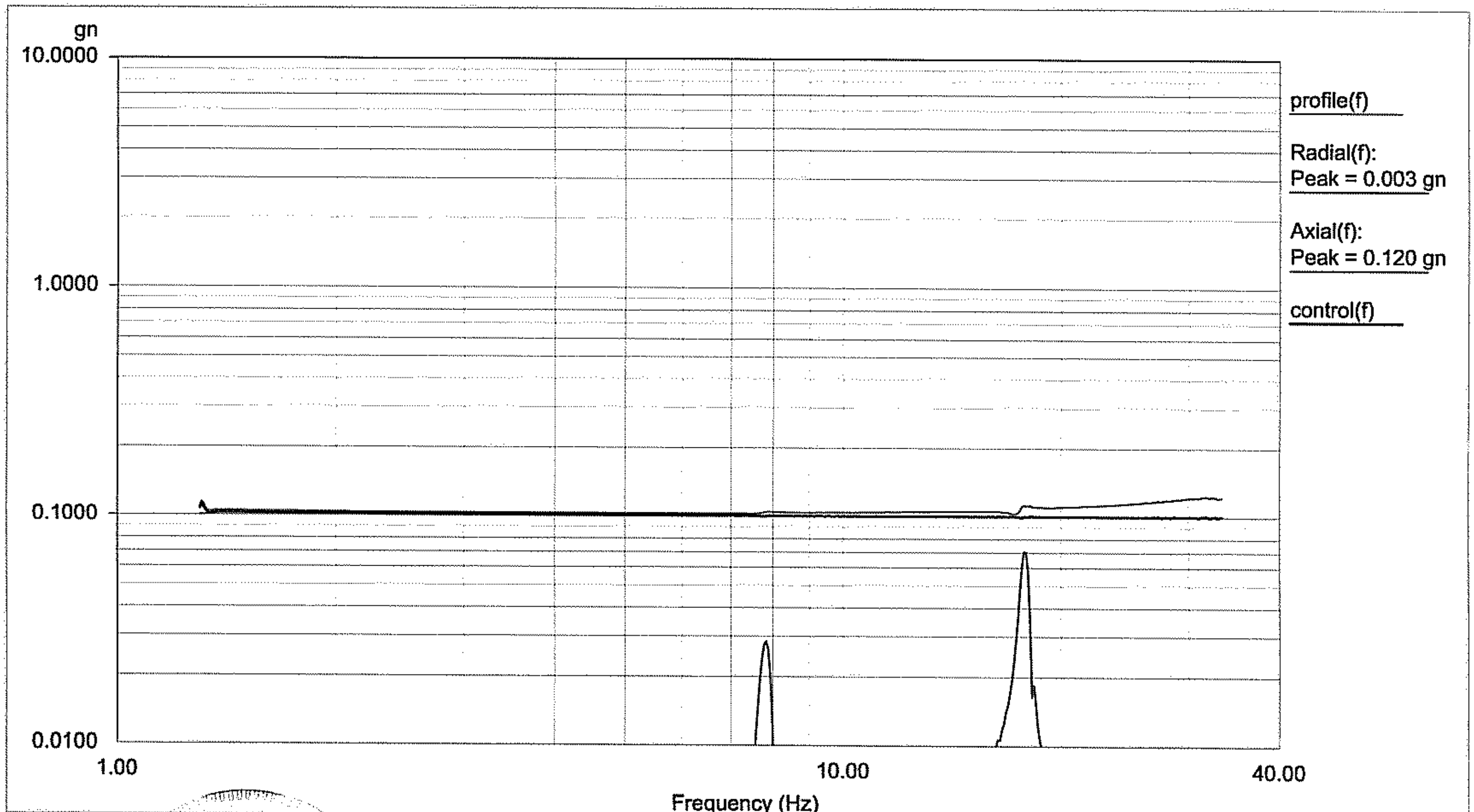
Frequency: 33.289986 Hz   Time Remaining: 00:00:00   Sweep Rate: 1 Oct/Min

Data saved at 07:16:25 PM, Tuesday, June 15, 2010   Report created at 07:16:26 PM, Tuesday, June 15, 2010

Horizontal Face Mounting, Z axis Sine Sweep, Transmissibility Plot

Project File Name: Sweep.prj
Profile Name: Low Level   Test Type: Swept Sine   Run Folder: .\RunDefault Jun 16, 2010 15-07-36



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Frequency: 33.289986 Hz   Time Remaining: 00:00:00   Sweep Rate: 1 Oct/Min

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Vertical Face Mounting, X axis Seismic Test, Response Spectrums Plot

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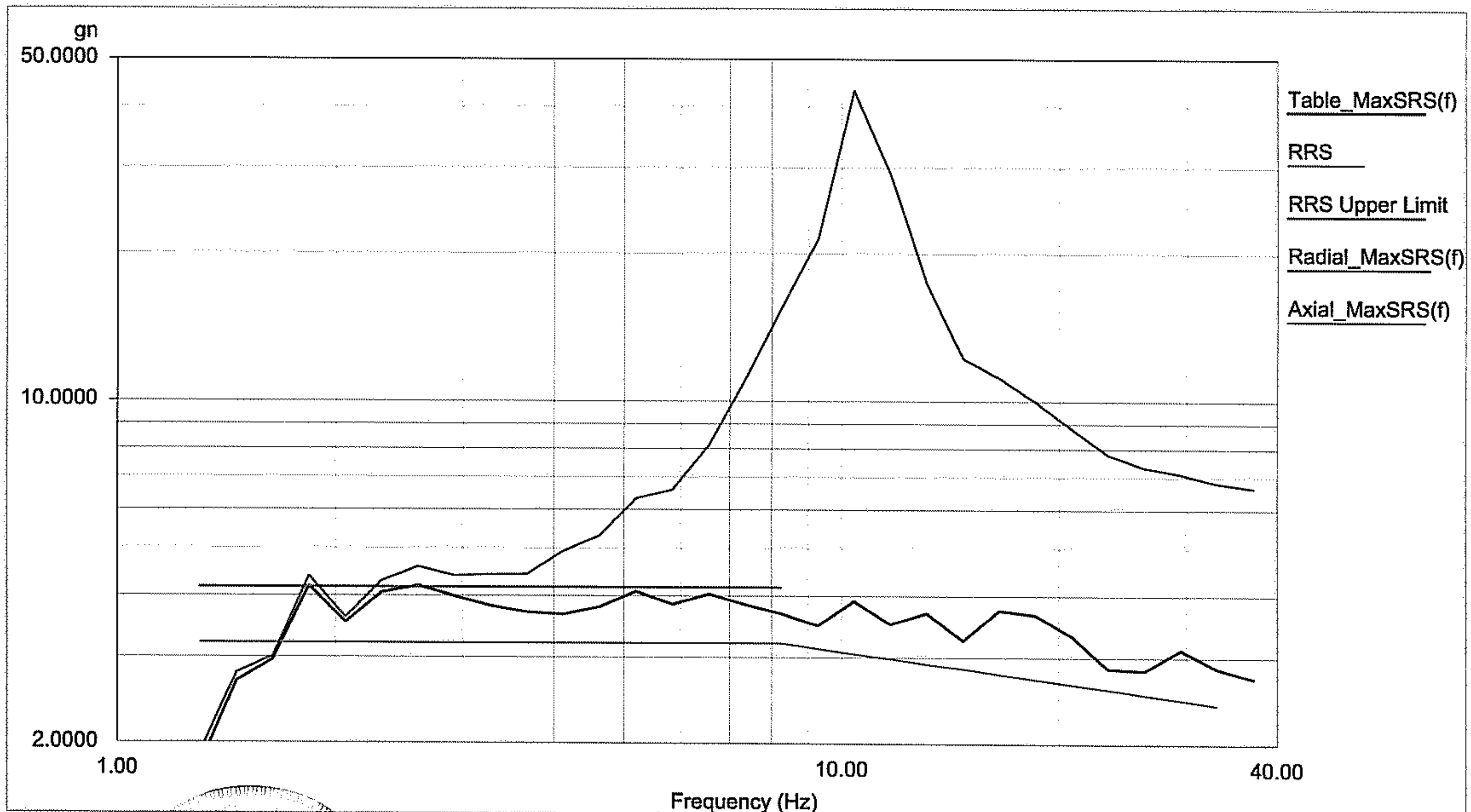

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Vertical Face Mounting, X axis Seismic Test, Time Histories Plot

Project File Name: Horizontal1.prj
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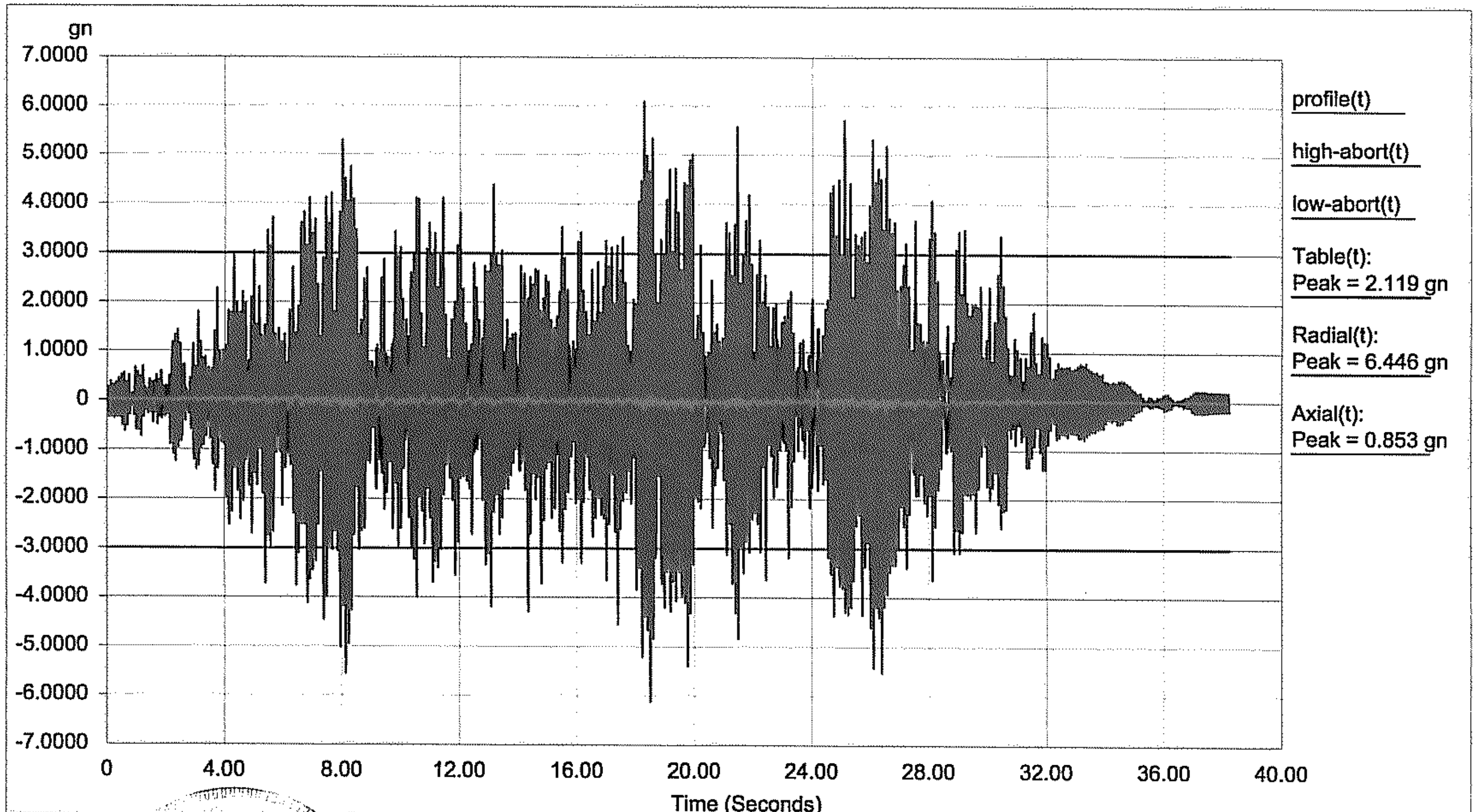

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dT:	0.002667 Seconds	Demand Peak:	1.975763	Demand RMS:	0.378507	Remaining Pulses:	0

Data saved at 04:47:58 PM, Tuesday, June 15, 2010 Report created at 04:48:00 PM, Tuesday, June 15, 2010

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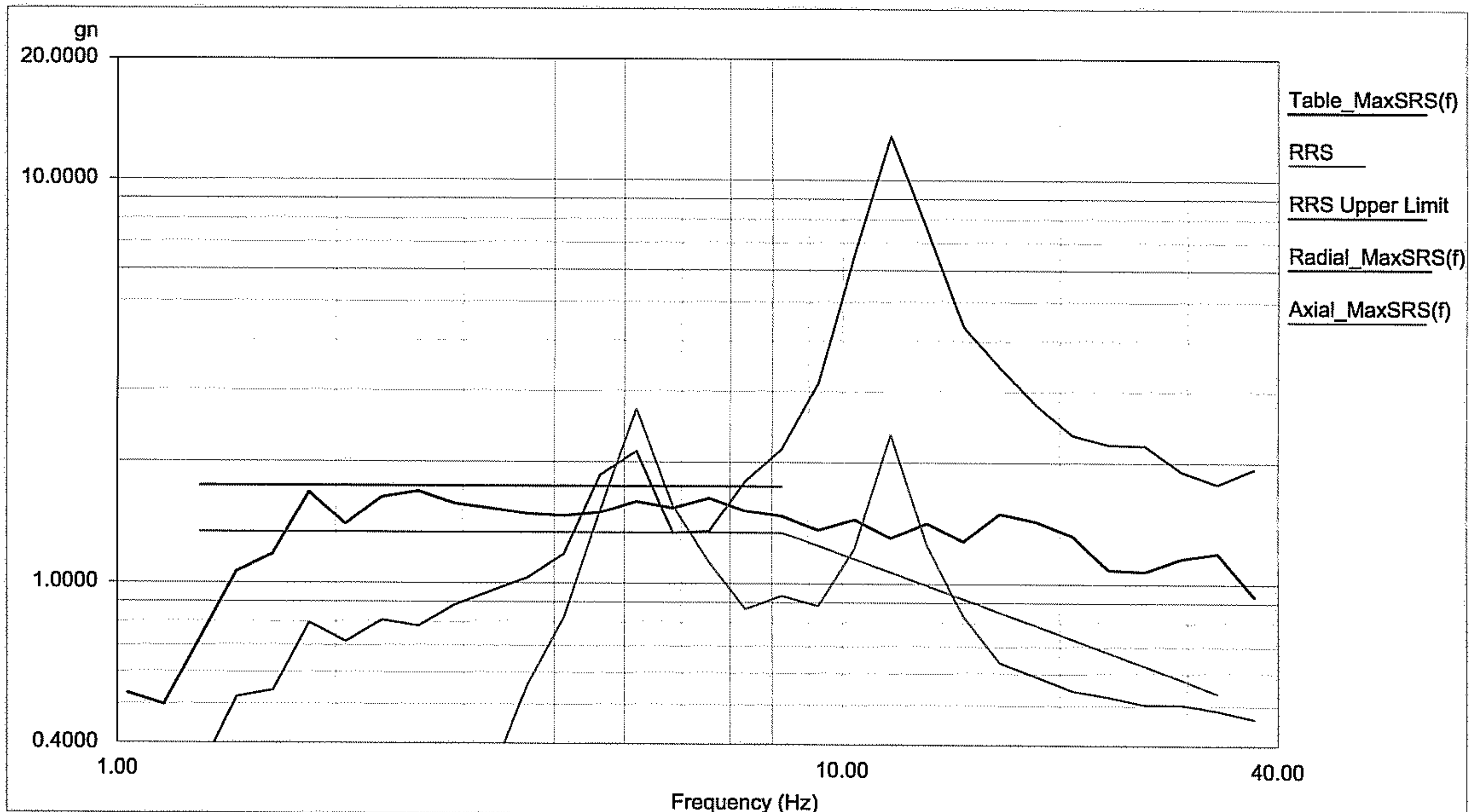
Vertical Face Mounting, Y axis Seismic Test, Response Spectrums Plot

Project File Name: Vertical.prj
Profile Name: Test Type: Transient Time History Run Folder: .\RunDefault Jun 16, 2010 14-09-13



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GEORGE C. KONSTANTAKIS E-33350 FRANKLIN WIS. PROFESSIONAL ENGINEER

Vertical Face Mounting, Y axis Seismic Test, Time Histories Plot

Project File Name: Vertical.prj
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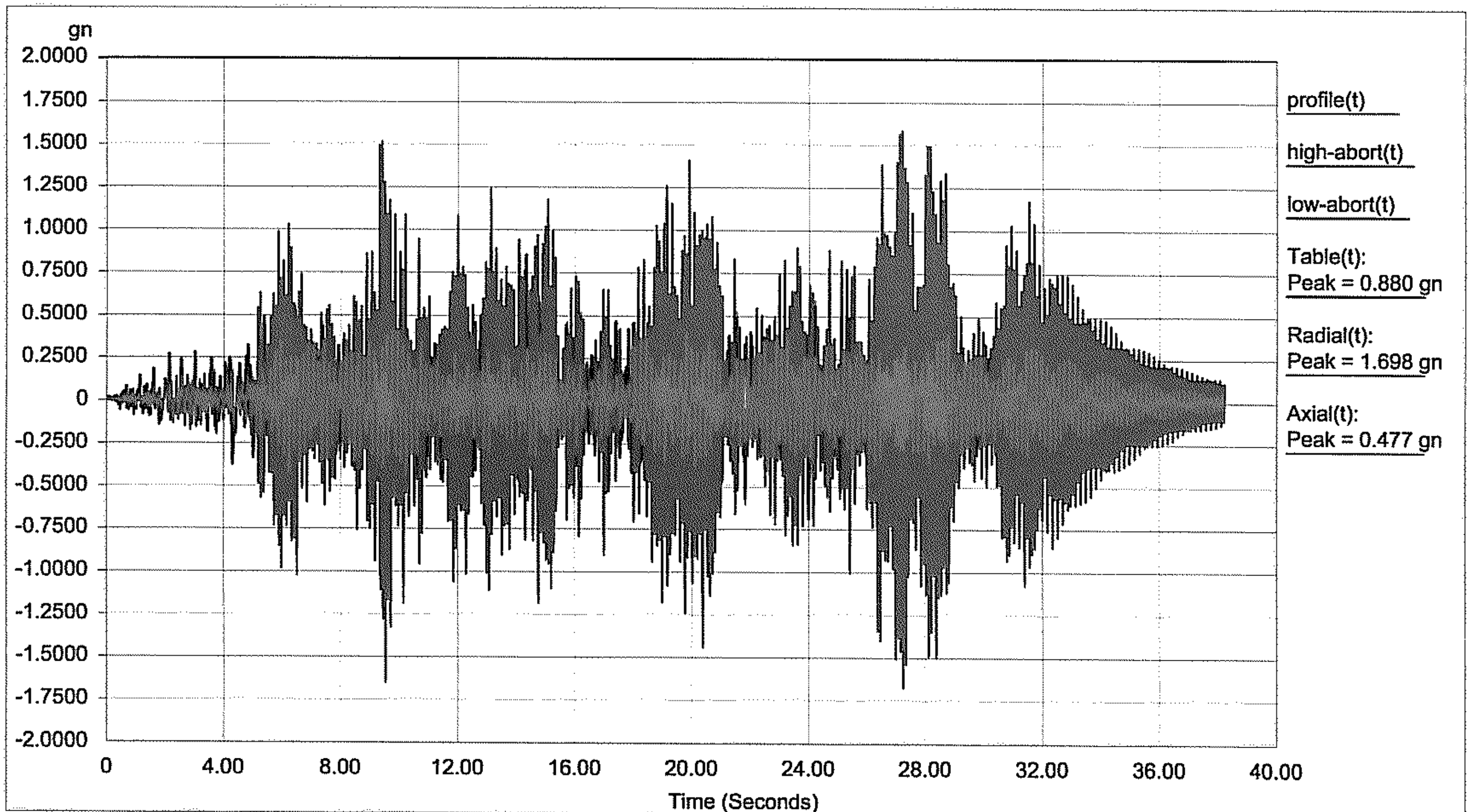

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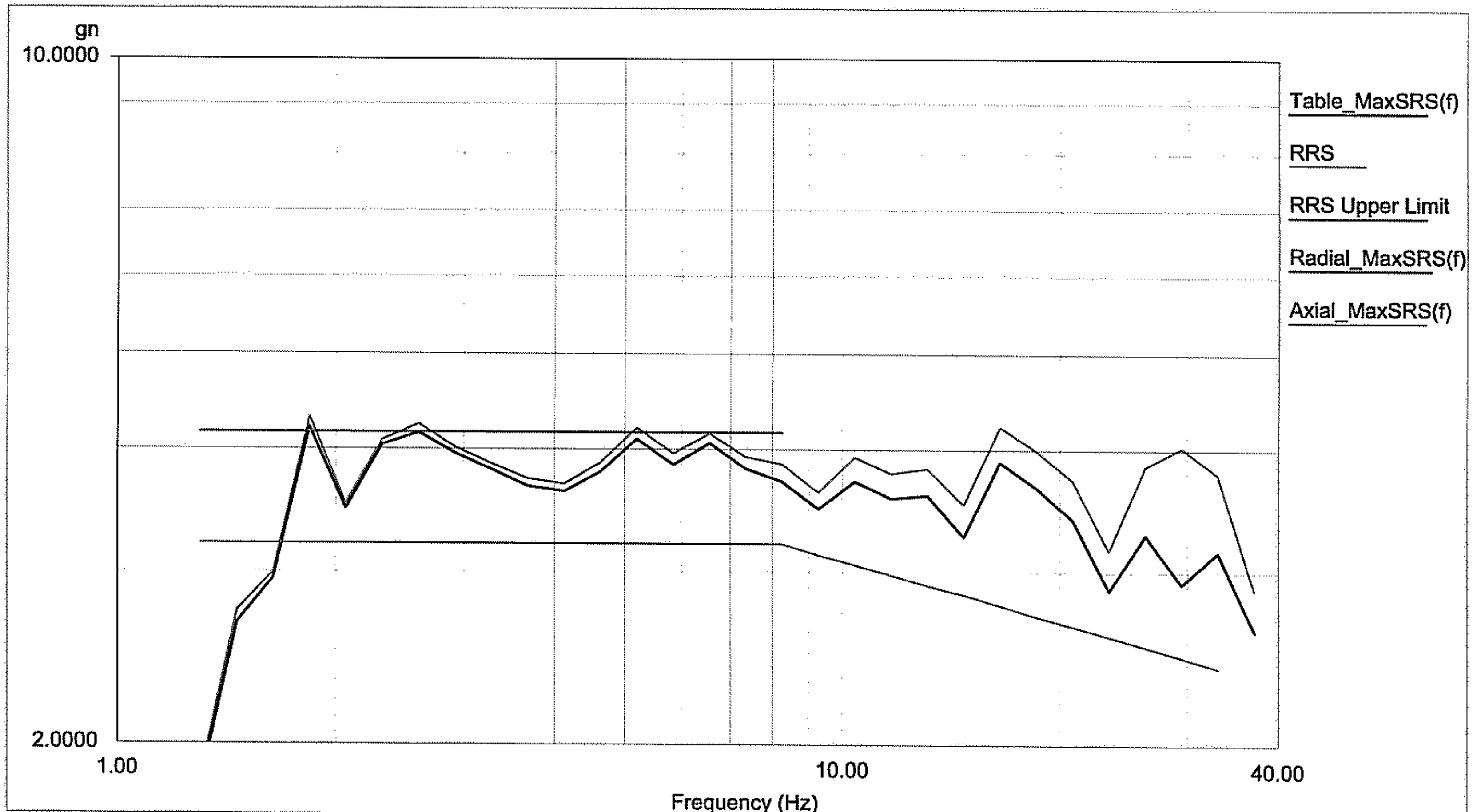
GEORGE C. KONSTANTAKIS E-33350 FRANKLIN WIS. WISCONSIN PROFESSIONAL ENGINEER

Vertical Face Mounting, Z axis Seismic Test, Response Spectrums Plot

Project File Name: Horizontal1.prj
Profile Name: Test Type: Transient Time History Run Folder: .\RunDefault Jun 15, 2010 14-50-51



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Report created at 02:54:14 PM, Tuesday, June 15, 2010

GEORGE C. KONSTANTAKIS E-33350 FRANKLIN WIS. WISCONSIN PROFESSIONAL ENGINEER

Vertical Face Mounting, Z axis Seismic Test, Time Histories Plot

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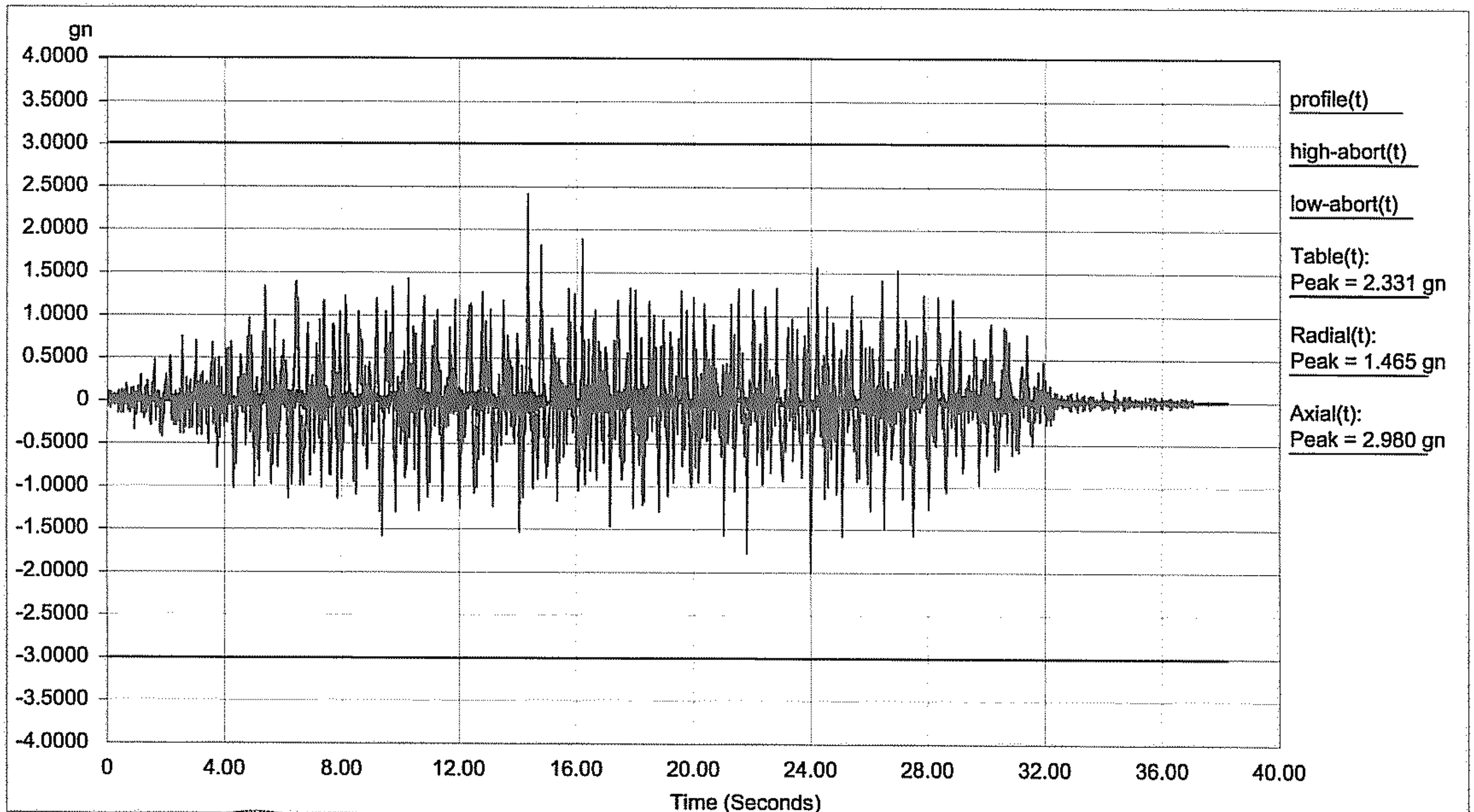

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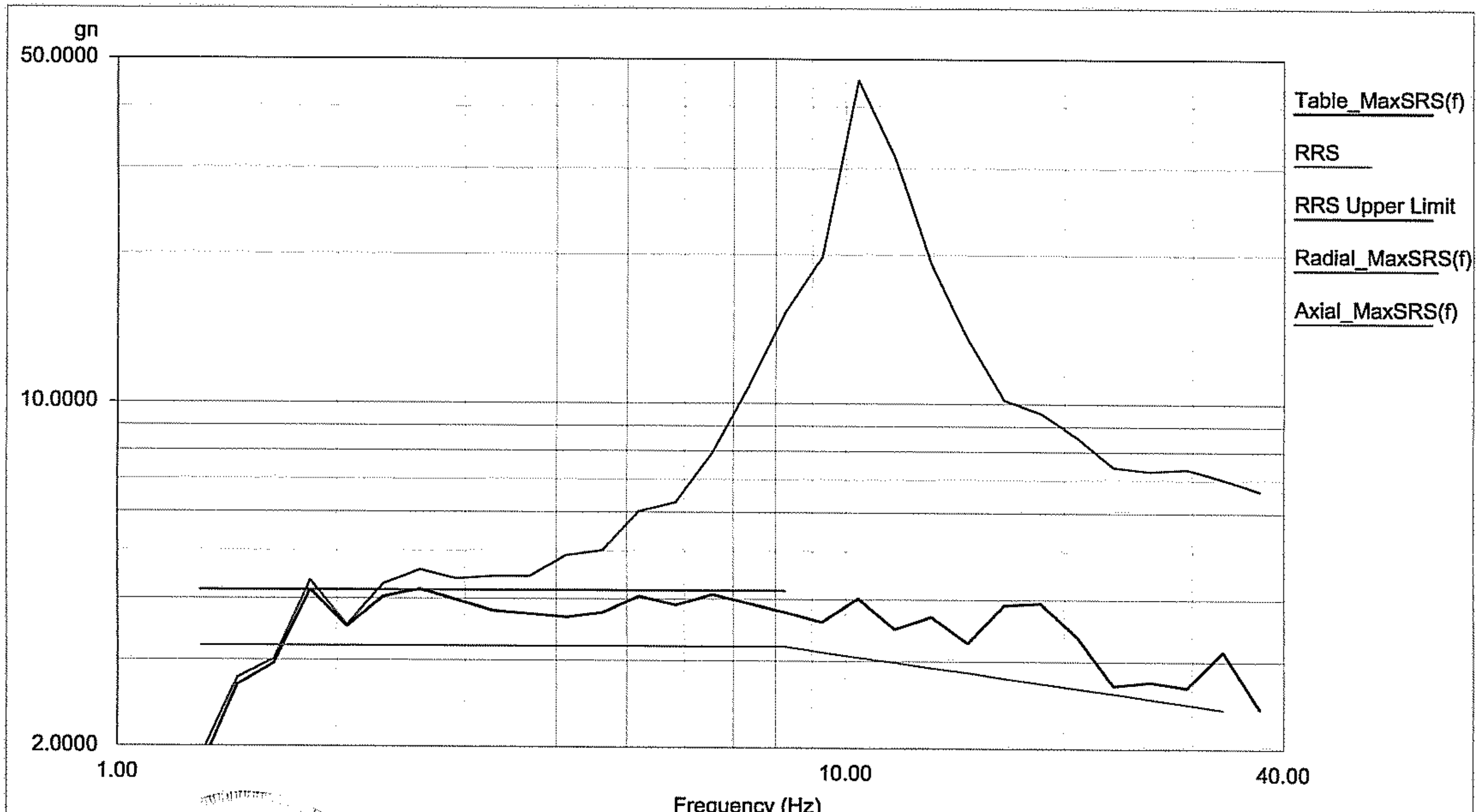
GEORGE C. KONSTANTAKIS E-33850 FRANKLIN WISCONSIN PROFESSIONAL ENGINEER

Horizontal Face Mounting, X axis Seismic Test, Response Spectrums Plot

Project File Name: Horizontal1.prj
Profile Name: Test Type: Transient Time History Run Folder: .\RunDefault Jun 15, 2010 18-41-42



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Horizontal Face Mounting, X axis Seismic Test, Time Histories Plot

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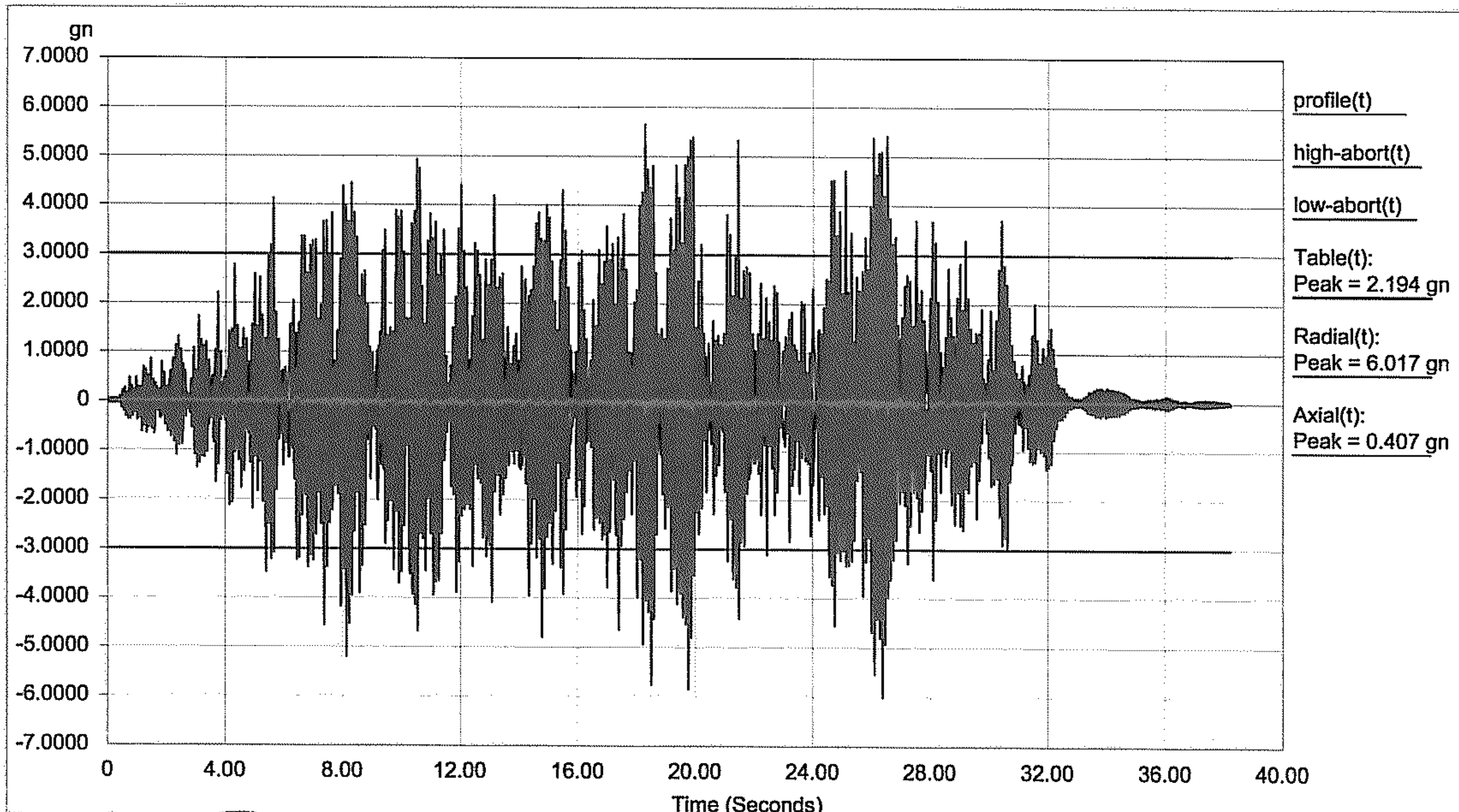

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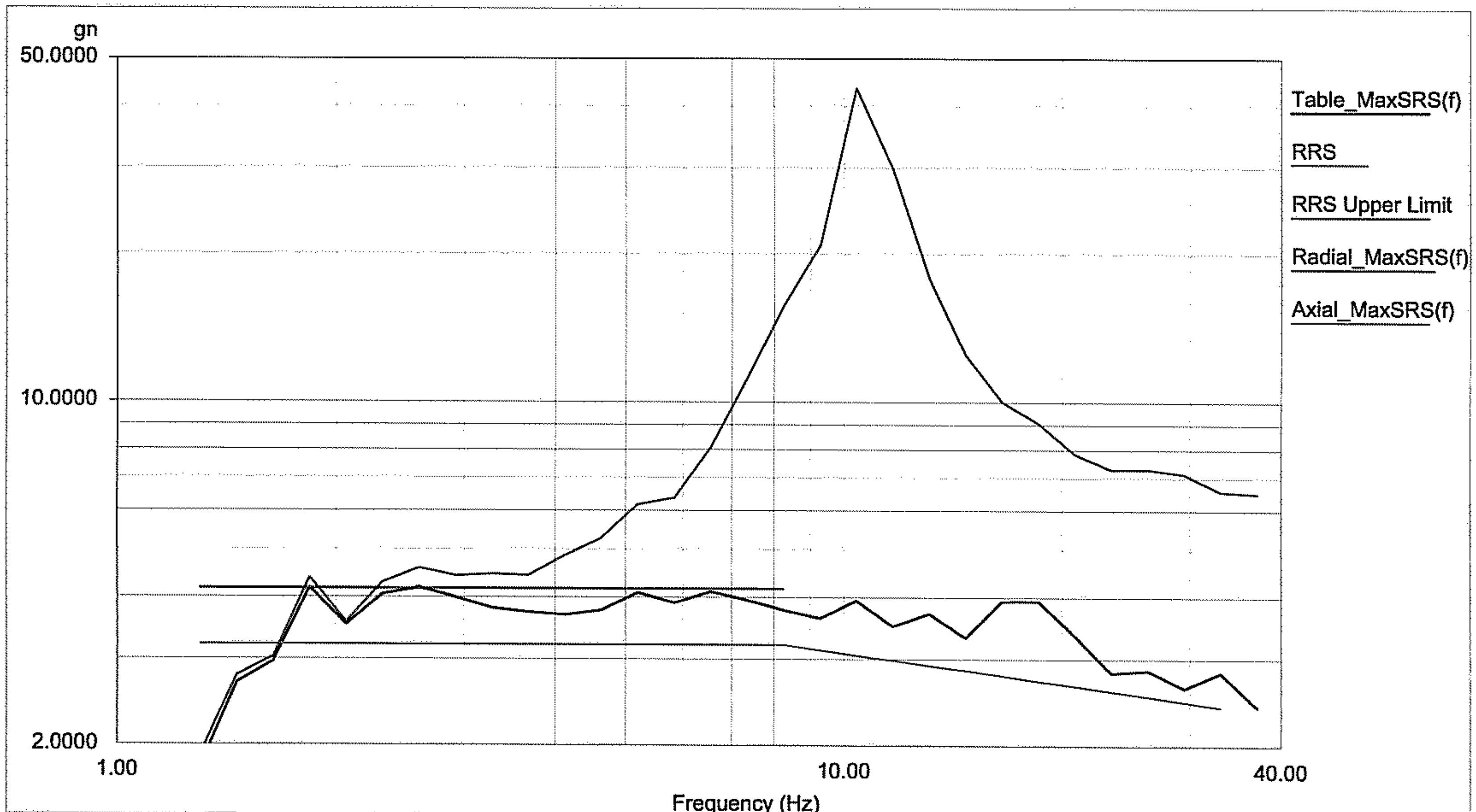
GEORGE C. KONSTANTAKIS E-33350 FRANKLIN WIS.

Horizontal Face Mounting, Y axis Seismic Test, Response Spectrums Plot

Project File Name: Horizontal1.prj
Profile Name: Test Type: Transient Time History Run Folder: .\RunDefault Jun 15, 2010 19-18-13



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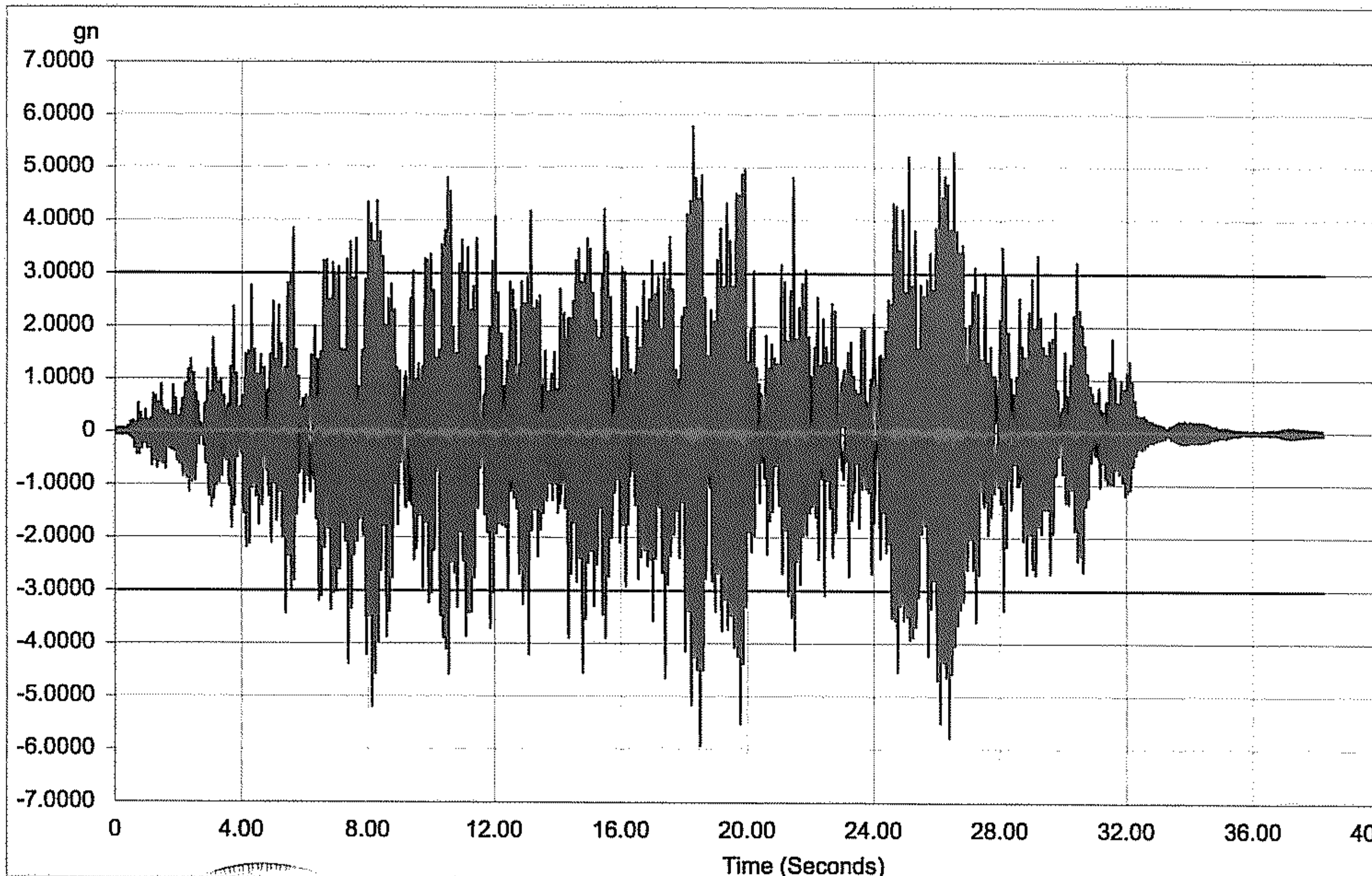
Report created at 07:20:46 PM, Tuesday, June 15, 2010

GEORGE C. KONSTANTAKIS E-23350 FRANKLIN WIS.

Horizontal Face Mounting, Y axis Seismic Test, Time Histories Plot

Project File Name: Horizontal1.prj
Profile Name: Test Type: Transient Time History Run Folder: .\RunDefault Jun 15, 2010 19-18-13



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Report created at 07:20:45 PM, Tuesday, June 15, 2010

Horizontal Face Mounting, Z axis Seismic Test, Response Spectrums Plot

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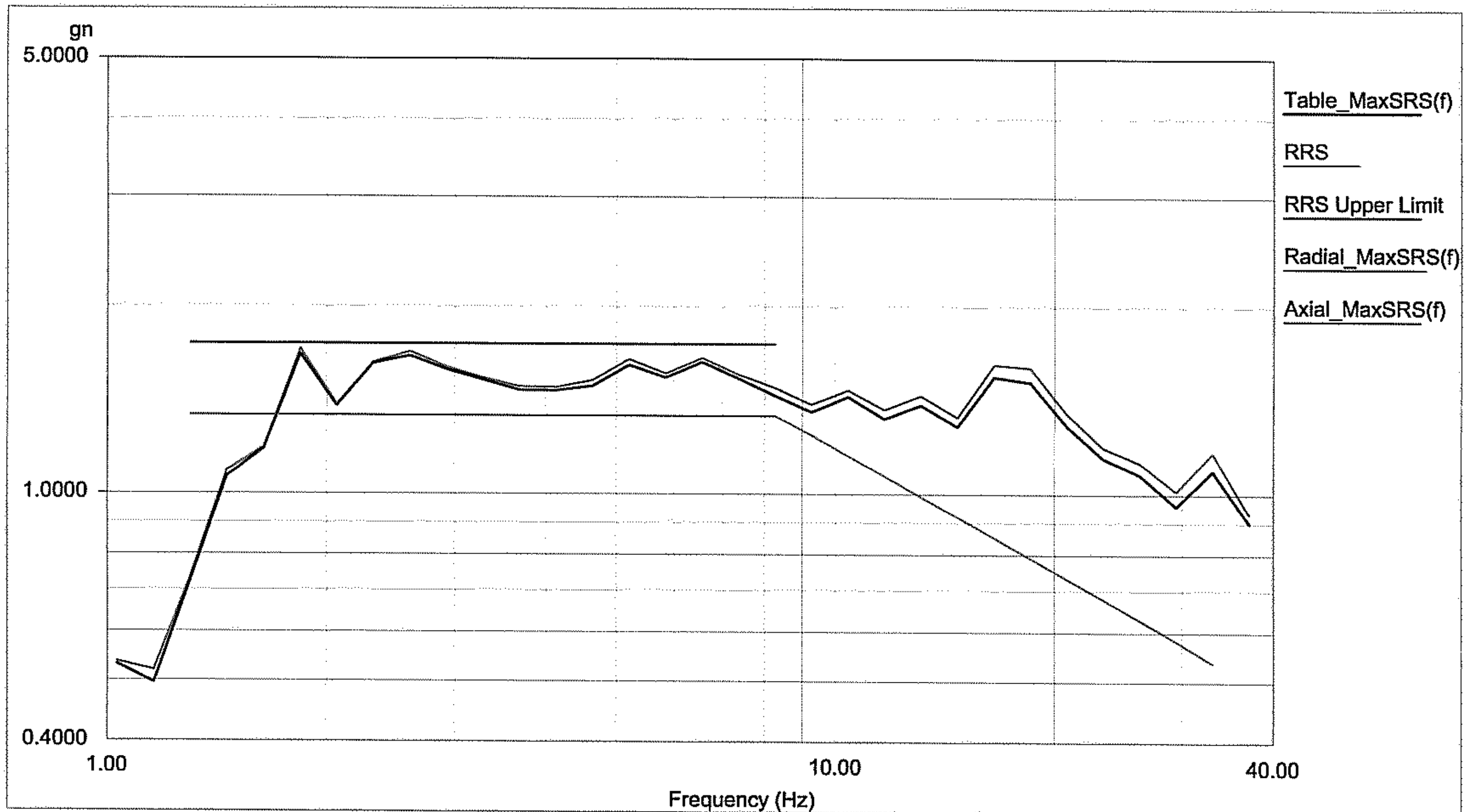

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Horizontal Face Mounting, Z axis Seismic Test, Time Histories Plot

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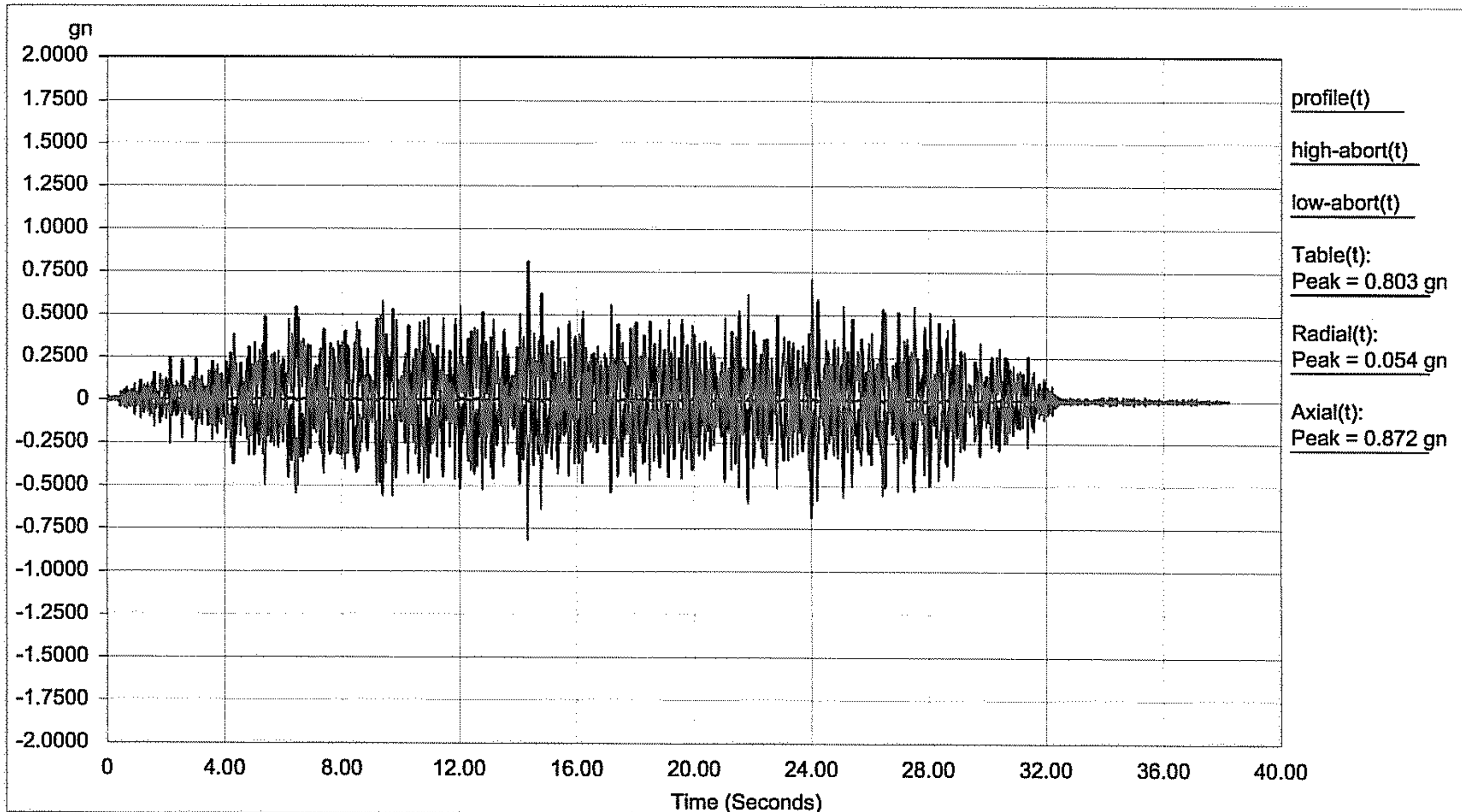

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5.0 EQUIPMENT LIST

DATASYST
Engineering & Testing Services, Inc.
514 W33511 Highway 18 · Delafield, WI 53018 · 262 968-4003 · Fax: 262 968-3050 · 800 969-405C

Test Equipment List

Test Description: AC156 Testing
Sample Description: Magnemount MB
Sample Number / Serial Number: -

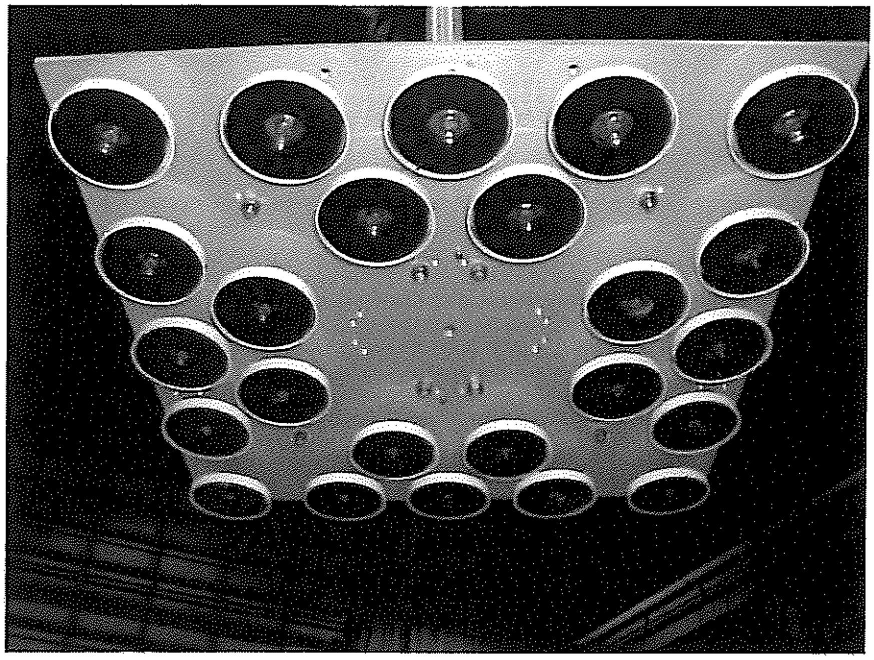
Project Number: M109-14187
Customer: Metal & Cable Corp., Inc.
Test Dates: 6/15/2010 - 6/16/2010

Equipment	Manufacturer	Model Number	Serial Number	Calibration	
				Last	Due
Actuator	MTS	204.61	155	-	-
Hydraulic controller	MTS	407	3	-	-
Servo valve	Moog	G761-3264	9222	-	-
Servo valve	Moog	G761-3264	9227	-	-
Vibration Controller 9	Dactron	Laser	5083465	10/1/2009	10/1/2010
Signal Conditioner	PCB	482A22	1565	1/23/2009	1/23/2011
Control Accelerometer	PCB	393A03	23408	1/8/2010	2/5/2011
Response Accelerometer	PCB	393A03	9652	6/24/2009	8/26/2010
Response Accelerometer	PCB	393A03	9653	7/21/2009	8/26/2010
Scale	Triner	5401SB3	13189	-	-

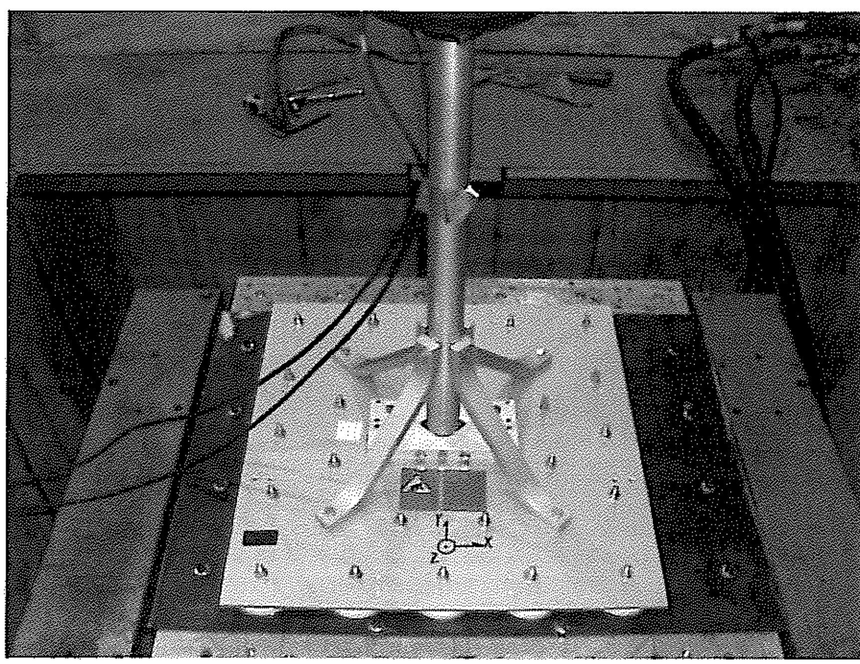
Certificates and reports of all calibrations are retained in the DATASYST Engineering & Testing Services, Inc. files and are available for inspection upon request.

GEORGE C. KONSTANTAKIS E-33250 FRANKLIN WIS.

6.0 PHOTOGRAPHS

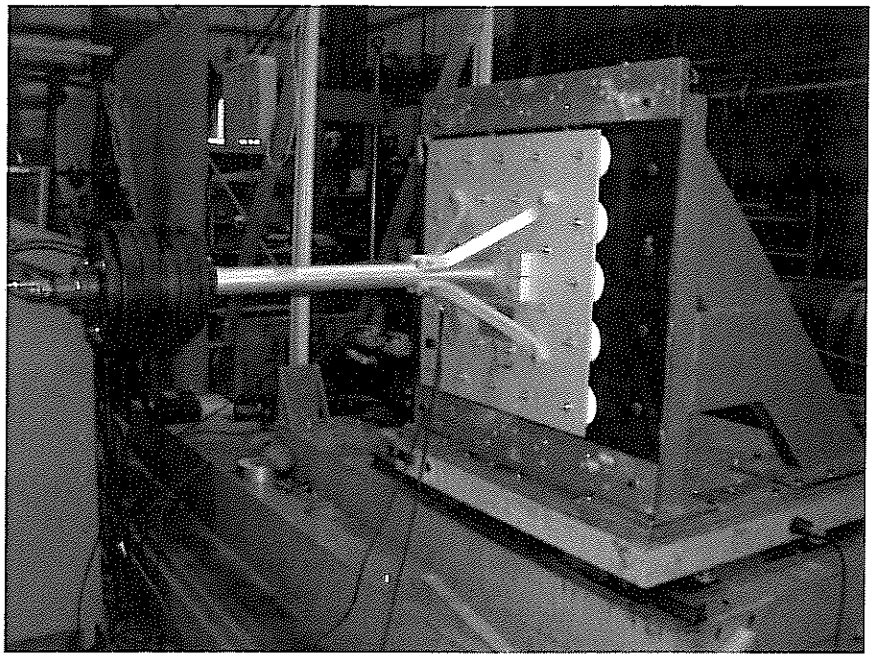


Twenty-Four Magnets on Magnemount Mounting Surface

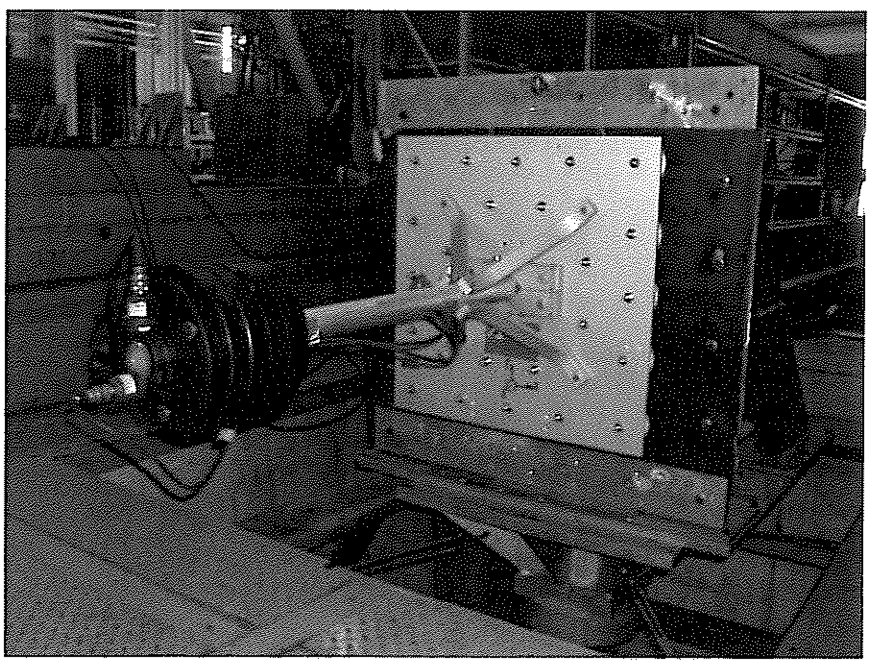


Axis Definition

WISCONSIN
GEORGE C.
KONSTANTAKIS
E-33350
FRANKLIN
WIS.

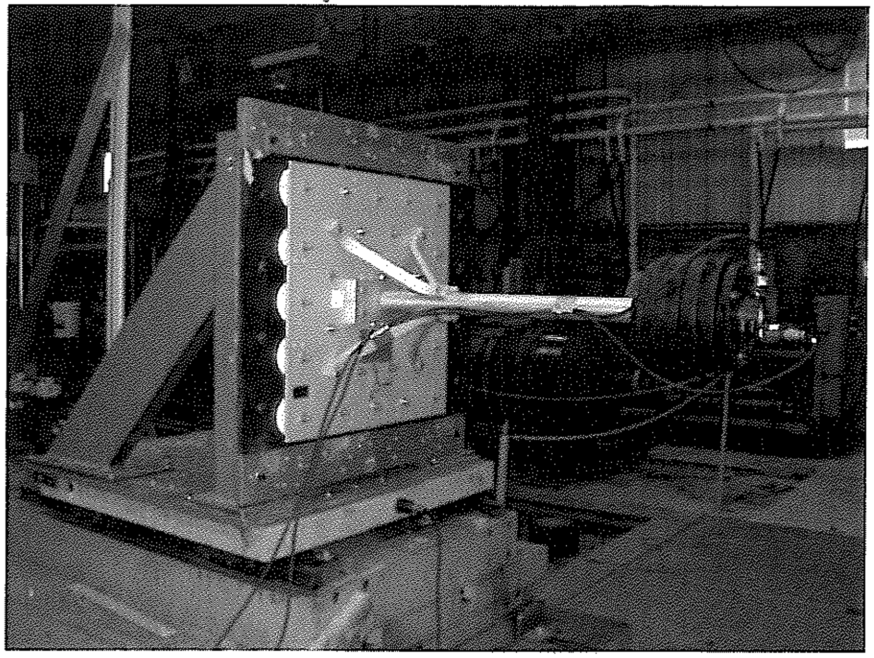


Vertical Mounting Face – X Axis Test

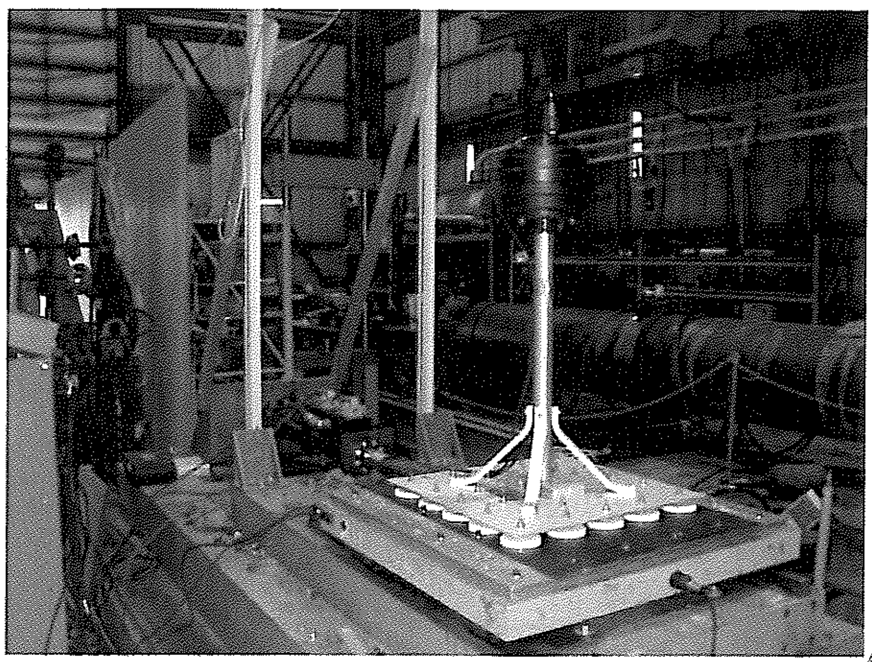


Vertical Mounting Face – Y Axis Test

GEORGE C.
KONSTANTAKIS
E-33350
FRANKLIN
WIS.



Vertical Mounting Face – Z Axis Test



Horizontal Mounting Face – X Axis Test

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E-33350
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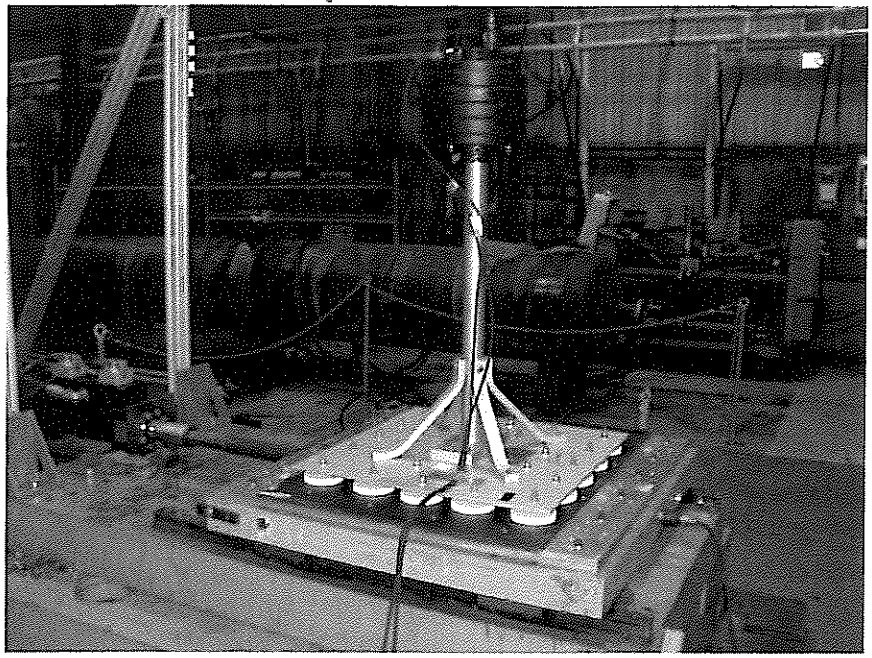
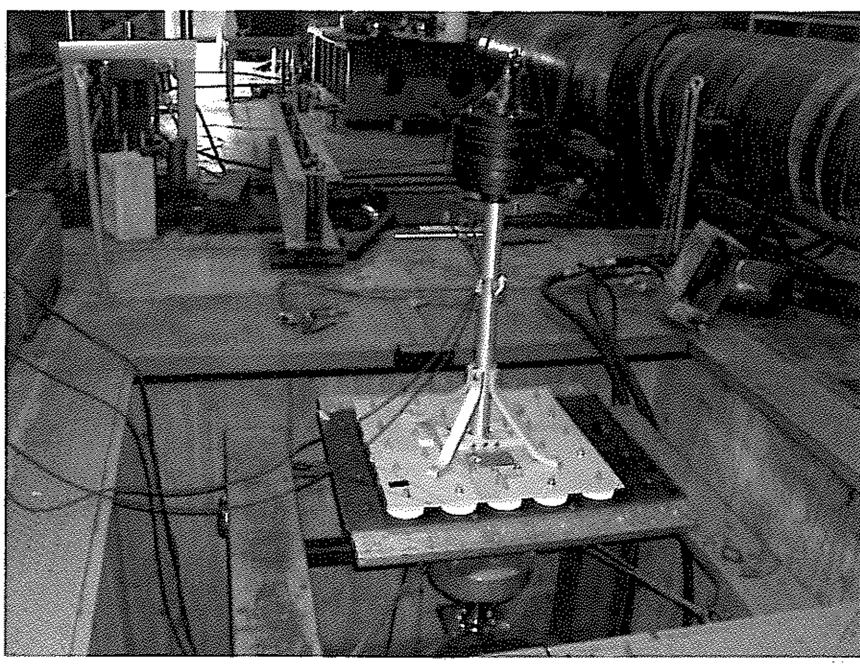
WIS.

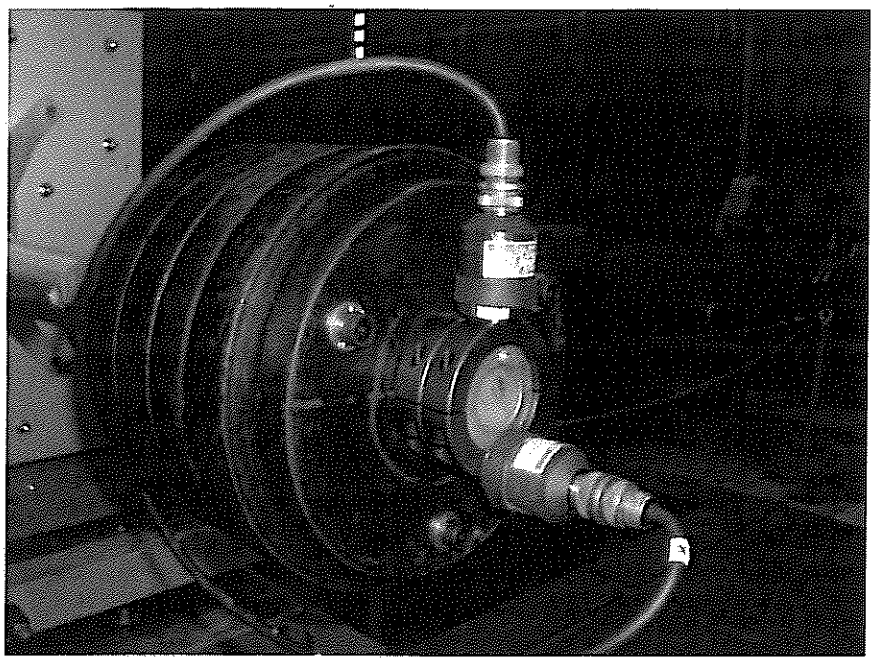


Horizontal Mounting Face – Y Axis Test



Horizontal Mounting Face – Z Axis Test

WISCONSIN
GEORGE C. KONSTANTAKIS E-33350 FRANKLIN WIS.
PROFESSIONAL ENGINEER



Response Accelerometers

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