

DIGIOIA GRAY

& ASSOCIATES

December 31, 2013

Project 2013-229

Mrs. Mary Jane McMillen
American Electric Power
PO Box 2021
Roanoke, VA 24022

***Structural Engineering Review for Support of PCS Equipment
Bethel – Summit View – Verizon Wireless
Structure 29
Bethel – Sawmill 138kV Line***

Dear Mary Jane:

The purpose of this letter is to summarize the results of the structural engineering review performed on AEP structure number 29 along the Bethel – Sawmill 138kV line with the change out of Verizon Wireless PCS equipment. The site is located off of Glen Cree Place northwest of the intersection of Summit View Road and Sawmill Road in Dublin, Ohio at GPS coordinates 40°8'12.51"N, 83°5'42.23"W. This review will determine the effects of installing new equipment and removing some existing equipment on an existing FWT Powermount system that is located at this site.

The existing structure and configuration at the Bethel – Summit View site is a 94'-0" type 60'- ST steel lattice tower with Verizon antennas supported on an FWT Powermount and 12' triangular platform. The tower has a non-typical configuration in that the legs do not extend all the way to the peak of the tower. Instead the traditional four legs start at the foundation, run through the tower body and end at the bottom cross arm. The cage consists of crossing diagonal members on each face of the tower. The FWT Powermount currently supports twelve (12) PCS antennas (4 per sector) and twelve (12) 2" coax cables running up the inside of the pipe. The tower also supports three (3) 636.0 kcmil ACSR conductors on single suspension insulator assemblies and two (2) 7/8" extra high strength (EHS) steel 7-strand shield wires supported via a suspension connections mounted to the shield wire peaks of the tower. Note that the right (east) circuit was previously relocated to a line of distribution poles located within the right-of-way. The current RAD center for the platform mounted antennas is 104'-0".

The Verizon application consists of removing six (6) antennas (2 per sector) and installing six (6) new antennas (2 per sector), three (3) RRHs (1 per sector), one (1) OVP distribution box (surge protector) and one (1) new 1-5/8" hybrid cable run up the inside of the FWT pipe if space is available. If there is not enough space available inside the FWT pipe, the new hybrid cable will have to be run up the outside of the FWT pipe. Verizon is also proposing to reinforce the antenna mounts. The proposed mounting reinforcements will be reviewed when carrier site plans are submitted. The total proposed configuration consists of twelve (12) antennas (4 per sector), three (3) RRHs (1 per sector), one (1) surge protector, twelve (12) 2" coax cables and one (1) 1-5/8" hybrid cable. The new configuration has a reduced wind area, reduced ice area and an increased total weight. See the attached "Antenna Change Out" calculation sheet for specific model numbers, dimensions and a comparison of the overall loads associated with the equipment.

This site does not require a full structural analysis at this time. The new PCS equipment configuration will not significantly impact the lattice tower and FWT Powermount system. The proposed wind area and

ice area are approximately 80% of the previous structural analysis. The total weight increased by 40% (approximately 186 pounds). It is important to note that the loads associated with the Verizon equipment are less than 10% of the total loads on the structure and the lattice tower had extra capacity at the time of its last structural analysis.

The previous structural analysis indicates that the critical load case for the tower is the AEP 1 1/4" Heavy Ice load case. Under this load case the increase in equipment weight is approximately 60% of the reduction in ice weight resulting in an overall reduction in load transferred to the structure. In addition note that the additional antenna weight is minimal compared to the overall loading on the structure and that the vertical load is predominately carried by the FWT pipe to the foundation and not transferred to the tower. Based on the previous analysis the FWT pipe is controlled by bending moment due to the AEP High Wind load case; therefore the reduction in wind area will easily mitigate the additional weight.

Respectfully submitted,
DiGioia, Gray & Associates, LLC



Christopher D. Fornataro, EIT
Project Manager

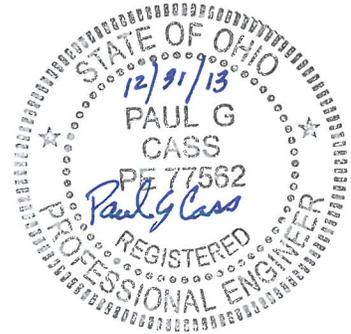


Paul G. Cass, PE
Sr. Consultant

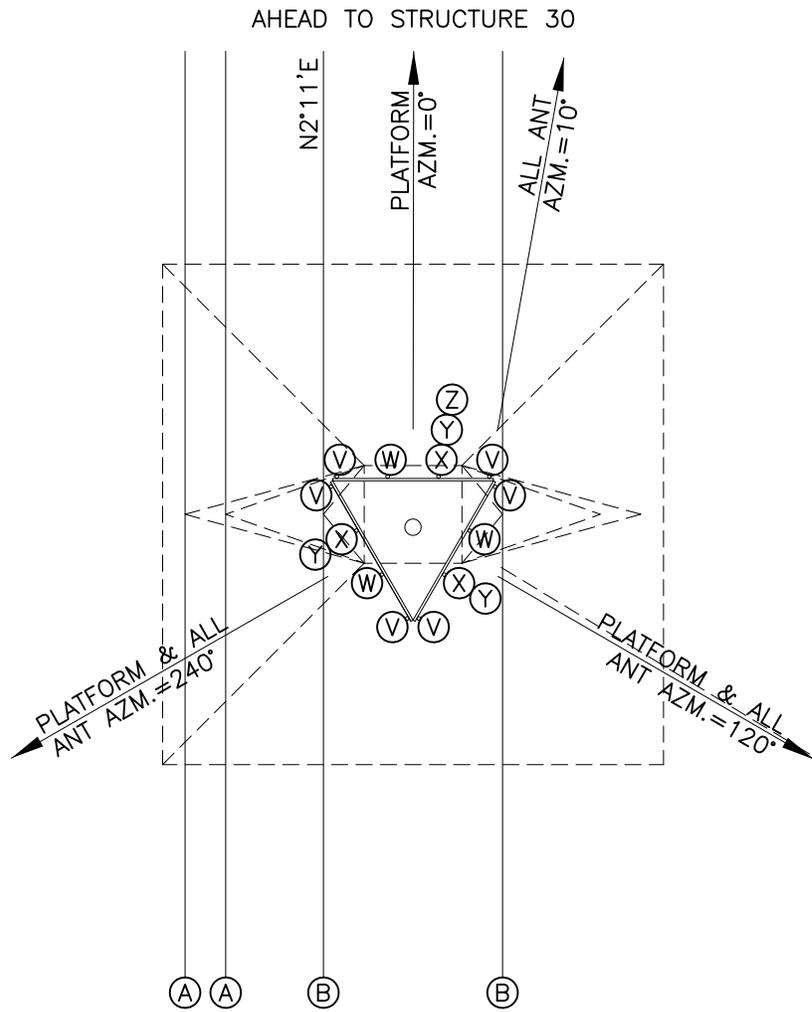


Greg R. Ullom, PE
Engineer

CDF:PGC:GRU



- Attachments:
- Drawing 660-173-D-1 Rev. 1 – PCS Equipment Layout
 - Drawing 660-173-D-2&3 Rev. 1 – PCS Co-Location Design Summary
 - Drawing 660-173-S-1 Rev. 1 – PCS Design Profile
 - Antenna Change Out – Load Comparison Calculation
 - Customer Entry Form for Antennas – Verizon Application
 - RFS APL866513-42T6 – Antenna Specification Sheet
 - CSS AXP19-60 – Antenna Specification Sheet
 - CSS X7CAP-665 – Antenna Specification Sheet
 - Alcatel-Lucent RRH2x40-AWS – RRH Specification Sheet
 - Raycap RxxDC-4750-PF-48 – OVP Dist. Box (Surge Protection) Specification Sheet
 - Top Mount OVP Mount Pipe to Platform Details from Verizon
 - Andrew RFA1206-24S26-300 Hybrid Cable Specification Sheet
 - Bethel – Sawmill Structure 29 Structural Analysis to Support Antenna Loads, AEP, February 17, 2004 (excerpt consisting of main body of report)
 - Previous Sawmill PCS Antenna Site Drawings (660-173-D-1 through D-3 and 660-173-S-1 through S-4)



SECTION A-A

- (A) CONDUCTOR (3) - 636.0 KCM ACSR 26/7 @ 10000 LBS. NESC HEAVY
- (B) STATIC WIRE (2) - 3/8" EHS STEEL 7-STRAND @ 5020 LBS. NESC HEAVY
- (V) ANTENNA APL866513-42T2 - EXISTING
- (W) ANTENNA X7CAP-665-62IP - NEW
- (X) ANTENNA AXP19-60-2IP - NEW
- (Y) RRH2X40AWS - NEW
- (Z) SURGE PROTECTOR RXXDC-331-PF-48 - NEW

DRAWN BY:	MPS
DESIGNED BY:	GRU
CHECKED BY:	CDF
APP BY:	PGC 10/31/2013
DGA PROJ. NO.:	2013-229

DIGIOIA GRAY & ASSOCIATES

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TRANSMISSION LINE ENGINEERING		BETHEL - SAWMILL 138kV	
APP'D BY :	DR. BY :	CH. BY :	DATE :
		1 RIVERSIDE PLAZA COLUMBUS, OH 43215	COMPUTER DRAWING MANUAL REVISIONS NOT PERMITTED
BETHEL-SUMMIT VIEW PCS ANTENNA VERIZON SITE TOWER #29 TYPE 60'-ST			
DWG. No. 660-173-D-1 REV. 1			

Line Information:

Line Name: Bethel – Sawmill 138kV Line

Structure No. 29

Tower Type: 60'-ST

Circuit Name		No.	Description	Design Condition
Brookside – Sawmill 138kV (West Circuit)	Ground Wire :	1	3/8" EHS Steel 7-Strand 636.0 kcm ACSR 26/7	5020 lb NESC Heavy 10000 lb NESC Heavy
	Conductor:	3		
Bethel – Sawmill 138kV (East Circuit)*	Ground Wire :	1	3/8" EHS Steel 7-Strand	5020 lb NESC Heavy

* The east circuit was previously relocated to an adjacent set of distribution poles within the R/W.

Antenna Information:

Azm	Ant Qty	Ant	Antenna Type	Elev (ft)*	Azm (deg)	Coax Qty	Coax Type	Dia. (In.)	Antenna Dimensions/ Weight (In./ Lbs.)
A	2	V	APL866513-42T2 – existing	104	10	4	Coax	2	48.0x9.2x8.0/15.7
	1	W	X7CAP-665-62ip – new			1	Hybrid	1-5/8	72.0x12.5x7.1/50.2
	1	X	AXP19-60-2ip – new						69.1x6.7x4.5/28.0
	1	Y	RRH2x40AWS – new						24.4x10.6x6.7/44.0
	1	Z	RxxDC-331-PF-48 – new						19.2x2.4x2.4/53.8
B	2	V	APL866513-42T2 – existing	104	120	4	Coax	2	48.0x9.2x8.0/15.7
	1	W	X7CAP-665-62ip – new						72.0x12.5x7.1/50.2
	1	X	AXP19-60-2ip – new						69.1x6.7x4.5/28.0
	1	Y	RRH2x40AWS – new						24.4x10.6x6.7/44.0
C	2	V	APL866513-42T2 – existing	104	240	4	Coax	2	48.0x9.2x8.0/15.7
	1	W	X7CAP-665-62ip – new						72.0x12.5x7.1/50.2
	1	X	AXP19-60-2ip – new						69.1x6.7x4.5/28.0
	1	Y	RRH2x40AWS – new						24.4x10.6x6.7/44.0

*Elevations are above grade and are approximate.



AEP: America's Energy Partner®

TRANSMISSION LINE ENGINEERING
BETHEL – SAWMILL 138 KV LINE

AEP Dwg No. **660-173-D2 Rev. 1**

Date: 12/27/2013

Loading Information:**Conductor Attachment Type: SUSPENSION**

Wind Span: 655 ft

Vertical Span: 755 ft

Line Angle: 0.0°

Load Case No.	Load Case Name	Wind Speed mph	Radial Ice in	Basic Wind Pressure lbs/sqft	Wind Pressure on Tower lbs/sqft	Wind Pressure on Tower Attach'ts Flat lbs/sqft	Wind Pressure on Tower Attach'ts Round lbs/sqft
<u>Intact Cases</u>							
1	NESC Heavy 250B	40	1/2	10.24	32.76	16.38	10.24
2	AEP High Wind	100	Bare	25.60	81.92	40.96	25.60
3	AEP Wind & Ice	50	1	6.40	20.48	10.24	6.40
4	AEP Heavy Ice	0	1 ¼	0	0	0	0
5	AEP Unbalanced Wind and Ice - Susp	50	1/2 / bare	6.40	20.48	10.24	6.40
6	AEP 70 mph Broken Wire	70	Bare	12.54	40.12	20.06	12.54
7	AEP Cold Uplift	0	Bare	0	0	0	0
8	Normal Everyday	0	Bare	0	0	0	0
9	AEP Construction	20	Bare	1.02	3.26	1.63	1.02

Loading Notes:

1. NESC Loading includes overload factors. A vertical overload factor of 1.5 should be included in the weight of the tower and attachments.
2. The wind pressure on tower shall be applied to the projected area of the tower. The wind pressure acts in the positive transverse direction. It includes adjustments for shape and gusts.
3. The basic wind pressure represents the wind load applied to the conductors. For conductor loads see attached loading sheets.
4. The reduction of 45% can be applied to the differential tension for the unbalanced ice condition due to insulator deflection and 20% reduction can be applied to the broken wire condition for suspension structures.

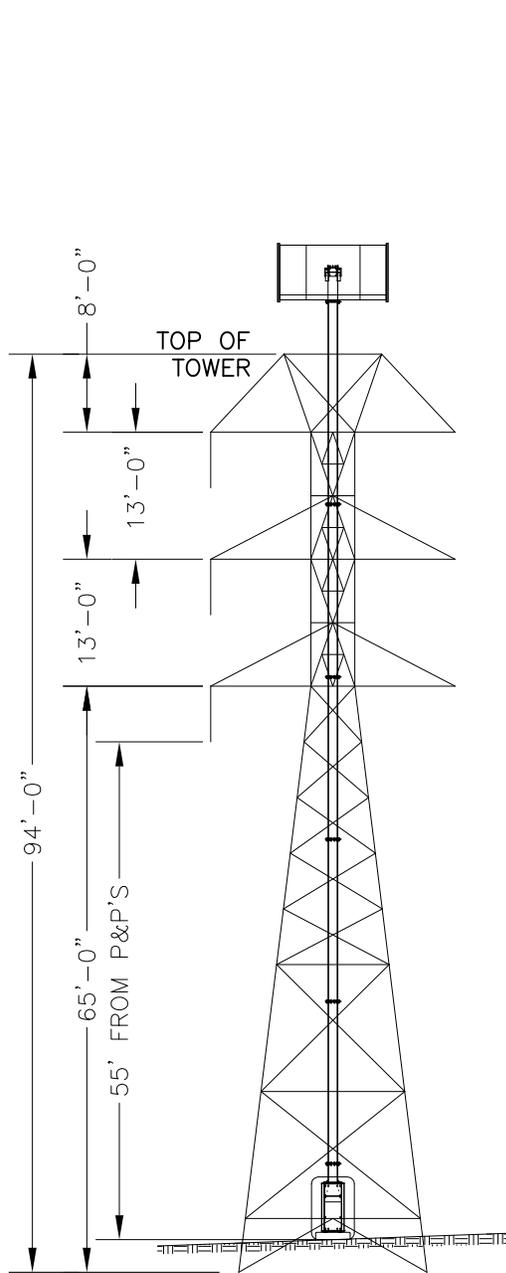


AEP: America's Energy Partner®

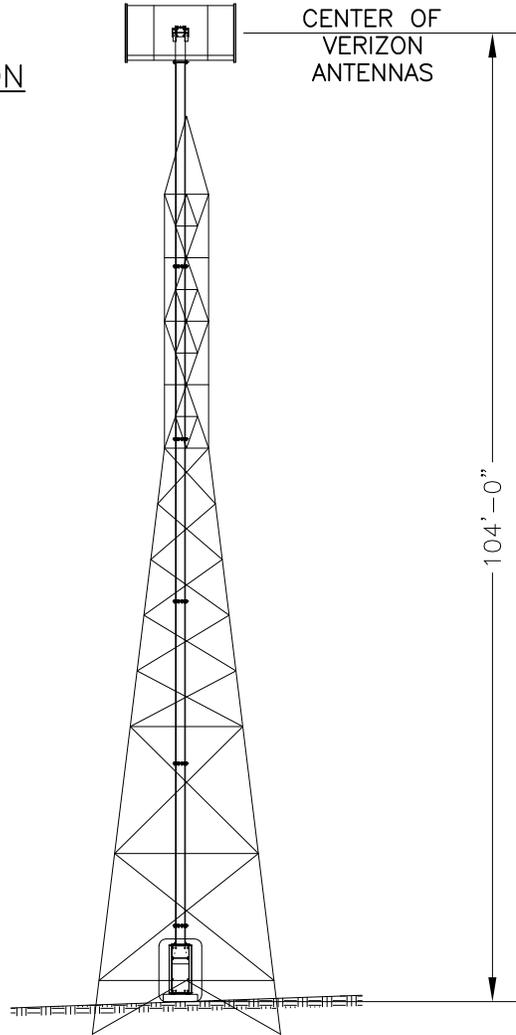
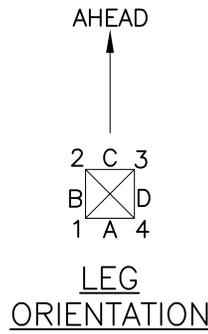
TRANSMISSION LINE ENGINEERING
BETHEL – SAWMILL 138 KV LINE

AEP Dwg No. **660-173-D3 Rev. 1**

Date: 12/27/2013



TRANSVERSE
FACE A
LOOKING AHEAD
TO STR. 30



LONGITUDINAL
FACE D

DRAWN BY:	MPS
DESIGNED BY:	GRU
CHECKED BY:	CDF
APP BY:	PGC 10/31/2013
DGA PROJ. NO.:	2013-229

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TRANSMISSION LINE ENGINEERING		BETHEL - SAWMILL 138kV	
APP'D BY :	DR. BY :	CH. BY :	DATE :

BETHEL-SUMMIT VIEW
PCS ANTENNA VERIZON SITE
TOWER #29 TYPE 60'-ST



1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

COMPUTER DRAWING
MANUAL REVISIONS
NOT PERMITTED

DWG. No. 660-173-S-1 REV. 1

AEP Customer Entry Form for Antennas

PCS Application Form*			
*If this is an equipment changeout request, please also fill out the top portion of this sheet and the additional PCS Equipment Changeout Form on the following spreadsheet tab.			
Licensee: New Par, d/b/a Verizon Wireless		N	
Requested by/Phone number: Randy Hartmeyer / SBA network Services / 740-624-2470 (M) 740-454-7177			Direct questions to: Drew Glover, AEP Eng P: (614) 552-1810 E: dcglover@aep.com
Date: 8/1/2013			
Search ring name & number: CLMB095 Summit View			
Billing Information			
Address: 180 Washington Valley Road 07921			
City/State/Zip Code: Bedminster, NJ			
Phone Number: 866-862-4404		Ext:	
Technical Contact: Maurice Vitali		Email: Maurice.Vitali@VerizonWireless.com	
Projected Construction/Rent Commencement Date: 11/1/2013			
Site Name: Summit View		Site Number: CLMB095	
Site Latitude & Longitude:		40.137019 / -83.095064	
Antenna Information	Sector 1	Sector 2	Sector 3
*Antenna Type & Quantity: (AEP requires all tower mounted equipment cut sheets be submitted along with this application form).			
*TMA Type & Quantity:			
*Coax Type & Quantity:			
Do you request the analysis to include consideration for additional antenna's installed at an undetermined future date? If so, list quantity and size.			
Antenna Azimuth:			
Antenna Spacing (Separation):			
Mounting Frame Desired (sector frame or platform):			
Mounting Equipment Desired (submit cut sheet):			
Microwave Dish Type:			
Other Equipment:			
Notes: REMOVE (6) ANTENNAS AND INSTALL (6) NEW ANTENNAS. INSTALL (3) RRH ON SECTOR MOUNTS. MOUNT (1) OVP DISTRIBUTION BOX ON BRACKET w/PIPE MOUNT TO PLATFORM (ABOVE VZW PLATFORM). INSTALL (1) HYBRID CABLE (1-5/8").			

PCS Equipment Changeout Form

PROPOSED NEW EQUIPMENT

	Sector 1	Sector 2	Sector 3
Azimuth	10 (mount 000)	120	240
Antenna (type/quantity)	CSS panel / X7CAP-665-62ip (1)	CSS panel / X7CAP-665-62ip (1)	CSS panel / X7CAP-665-62ip (1)
L"xW"xD" (each)	72"x12.5"x7.1"	72"x12.5"x7.1"	72"x12.5"x7.1"
Weight (lbs/antenna)	37 lbs	37 lbs	37 lbs
Azimuth	10 (mount 000)	120	240
Antenna (type/quantity)	CSS panel / AXP19-60-2ip (1)	CSS panel / AXP19-60-2ip (1)	CSS panel / AXP19-60-2ip (1)
L"xW"xD" (each)	69.1"x6.7"x4.5"	69.1"x6.7"x4.5"	69.1"x6.7"x4.5"
Weight (lbs/antenna)	15 lbs.	15 lbs.	15 lbs.
RRH (type/quantity)	ALU / RRH2x40-AWS (1)	ALU / RRH2x40-AWS (1)	ALU / RRH2x40-AWS (1)
L"xW"xD" (each)	24.4"x10.63"x6.7"	24.4"x10.63"x6.7"	24.4"x10.63"x6.7"
Weight (lbs/TMA)	44 lbs.	44 lbs.	44 lbs.
OVP Distribution Box		Raycap / RxxDC-3315-PF-48	
L"xW"xD" (each)		19.18"x10.25"x15.73"	
Weight (lbs.)		32 lbs.	
Coax (quantity/size)	(1) / Commscope RFA1608-16S26 hybrid cable / (1-5/8")		

EXISTING EQUIPMENT TO REMAIN OR BE REMOVED

	Sector 1	Sector 2	Sector 3
Azimuth	10 rad (mount 000)	120	240
Antenna (type/quantity)	RFS panel / APL866513-42T6 (2)	RFS panel / APL866513-42T6 (2)	RFS panel / APL866513-42T6 (2)
L"xW"xD" (each)	48"x9.2"x8"	48"x9.2"x8"	48"x9.2"x8"
Weight (lbs/antenna)	15.7 lbs	15.7 lbs	15.7 lbs
Remain or Removed	Remain	Remain	Remain
Azimuth	10 rad (mount 000)	120	240
Antenna (type/quantity)	CSS panel / X7-465-6 (1)	CSS panel / X7-465-6 (1)	CSS panel / X7-465-6 (1)
L"xW"xD" (each)	50.5"x12.5"x7.1"	50.5"x12.5"x7.1"	50.5"x12.5"x7.1"
Weight (lbs/antenna)	20 lbs.	20 lbs.	20 lbs.
Remain or Removed	Remove	Remove	Remove
Azimuth	10 rad (mount 000)	120	240
Antenna (type/quantity)	CSS panel / XP18-60-2i (1)	CSS panel / XP18-60-2i (1)	CSS panel / XP18-60-2i (1)
L"xW"xD" (each)	48"x6.7"x4.1"	48"x6.7"x4.1"	48"x6.7"x4.1"
Weight (lbs/antenna)	14 lbs.	14 lbs.	14 lbs.
Remain or Removed	Remove	Remove	Remove
Coax (quantity/size)	(12) / LDF7 (1-5/8")		
Remain or Removed	Remain		

Is this a change in azimuths? Yes No

Notes: Verizon to remove three X7-456-6 panel antennas (1 from each sector) and three XP18-60-2i antennas (1 from each sector). Install three new AXP19-60-2ip panel antennas (1 per sector) and three new X7CAP665-62ip (1 per sector) panels. Verizon to also install three remote radio heads (RRH) (1 per sector), one OVP Distribution Box (on pipe attached to platform) and one 1-5/8" hybrid cable. The platform antenna mounts will be reinforced (drawings attached). Final tower configuration will be 12 panel antennas, 3 RRH's, 1 OVP distribution box, 12 (1-5/8") coax lines and 1 (1-5/8") hybrid cable. Antenna platform mounted at 104' and antenna Rad Center at 107'. OVP box mounted to pipe at 106'.

Maximizer® Directional Panel Antenna

Product Description

The Celwave® Maximizer series is a log periodic dipole array which uses a patented design to achieve a front-to-back ratio of 45 dB, the highest front-to-back ratio in the industry. Maximizers are available to cover ESMR, AMPS, PCS and DCS frequency ranges. They use RFS's patented monolithic CELLite® technology, which eliminates cable and soldered joints to reduce the possibility of inter-modulation products. The CELLite technology assures high reliability and excellent repeatability of electrical characteristics. The cellular Maximizers are available in 65°, 80° and 90° horizontal beamwidths and the PCS/DCS Maximizers are available in 65° and 90° horizontal beamwidths. Patent number 6,133,889.

Features/Benefits

- 45 dB front-to-back ratio reduces co-channel interference.
- Monolithic construction reduces IM.
- No solder joints, high reliability.
- Surface treated components prevent galvanic corrosion.
- UV stabilized radome assures long life without radome deterioration due to UV exposure.



Technical Specifications

Electrical Specifications

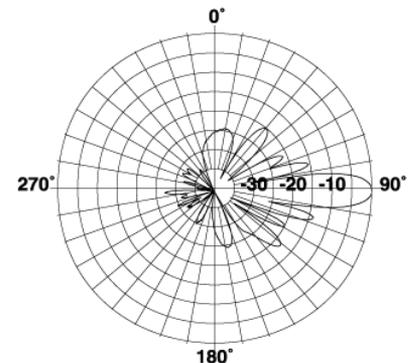
Frequency Range, MHz	806-894
Horizontal Beamwidth, deg	65
Vertical Beamwidth, deg	15
Electrical Downtilt, deg	6
Gain, dBi (dBd)	15.1 (13)
1st Upper Sidelobe Suppression, dB	>20
Upper Sidelobe Suppression, dB	>20
Front-To-Back Ratio, dB	45
Polarization	Vertical
VSWR	< 1.5:1
Impedance, Ohms	50
Maximum Power Input, W	500
Lightning Protection	Direct Ground
Connector Type	7-16 DIN Female

Mechanical Specifications

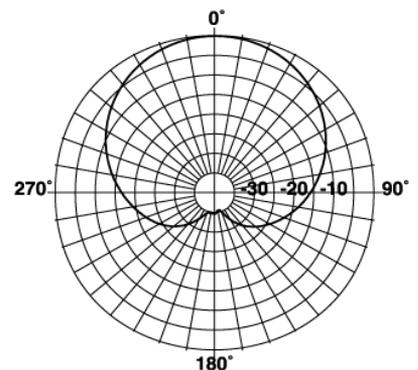
Dimensions - HxWxD, mm (in)	1219 x 234 x 203 (48 x 9.2 x 8)
Weight w/o Mtg Hardware, kg (lb)	7 (15.7)
Survival Wind Speed, km/h (mph)	200 (125)
Rated Wind Speed, km/h (mph)	180 (112)
Max Wind Loading Area, m² (ft²)	0.376 (4.05)
Maximum Thrust @ Rated Wind, N (lbf)	903 (203)
Wind Load - Side @ Rated Wind, N (lbf)	594 (133.5)
Radome Material	UV Stabilized High Impact ABS
Shipping Weight, kg (lb)	9.1 (20)
Packing Dimensions, HxWxD, mm (in)	1594 x 343 x 349 (62.75 x 13.5 x 13.75)

Ordering Information

Mounting Hardware	APM21-3
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Vertical Pattern



Horizontal Pattern

All information contained in the present datasheet is subject to confirmation at time of ordering



AXP19-60

Xpol, 60° H-Beams

1710-2170 MHz

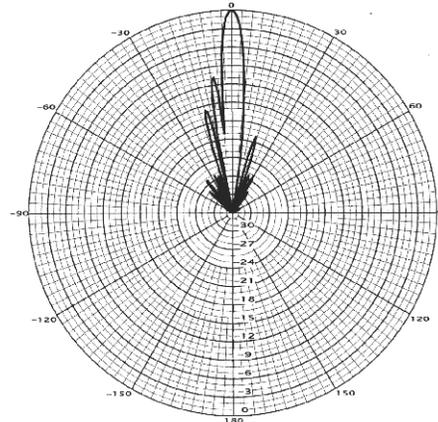
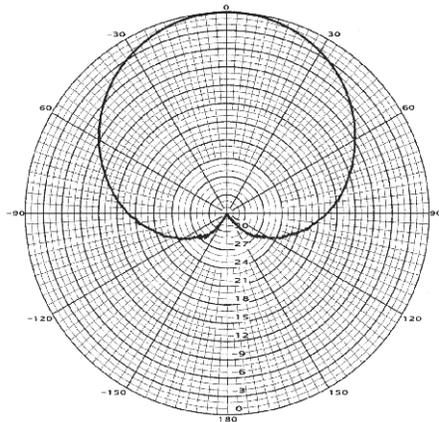
Electrical Specifications

Frequency	1710-2170 MHz
Polarization	Slant +/- 45
Gain @ 1710 MHz	19.0 dBi
Gain @ 1920 MHz	19.3 dBi
Gain @ 2170 MHz	19.6 dBi
Horizontal Beam (3dB Points)	60°
Vertical Beam (3dB Points)	5°
Elect. Downtilt Range, 2° Increments	0-6°
VSWR / Return Loss	<1.40:1 / 15.6 dB
VSWR / Return Loss w/ip	<1.50:1 / 14.0 dB
Front-to-Back at Horizon	>30 dB
Upper Side Lobe Suppression	<-18 dB
Impedance	50 Ohms
Power Input Per Connector	250 CW at 1900 MHz
Isolation	< -28 dB
Intermodulation (2x20W)	typ -150 dBc

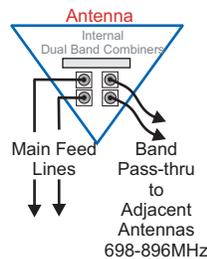
Mechanical Specifications

Input Connector (female)	Back 7/16 DIN or w/bot. opt.
Antenna Dimensions (LxWxD)	69.1 x 6.7 x 4.1 in. (1755 x 170 x 104mm)
Antenna Dimensions with Opt-"ip"	69.1 x 6.7 x 4.5 in. (1755 x 170 x 114mm)
*Antenna Weight	15.0 lbs
Bracket Weight	13.2 lbs
RF Distribution	Printed Microstrip Substrate
Radome	Ultra High-Strength Luran
Weatherability	UV Stabilized, ASTM D1925
Radome Water Absorption	ASTM D570, 0.45%
Environmental	MIL-STD-810E
Wind Survival	150 mph
Front Wind Load @100mph	105 lbf
Equivalent Flat Plate @100mph	2.13 sq-ft. (c=2)
Mounting Brackets	Fits 3.5 Inch Max. O.D. Pipe
Mechanical Downtilt Range	0-12°
Clamps/Bolts	Galvanized Steel/Stainless Steel

[Link to Mechanical Drawing](#) →



Available with Integrated Diplexers and back mounted connectors, bottom mounted connectors are not available with Integrated Diplexers



Integrated Pass-Thru Diplexers will work with TMA's

Recommended Connector Coupling Torque
7/16 DIN: 220-265 lbf-in (25-30 N-m)

Ordering Information & Options

- AXP19-60-x: "-x" is a placeholder for the built-in fixed electrical downtilt in degrees, set to 0, 2, 4 or 6
- AXP19-60-xip: "ip" option includes pass-thru integrated diplexer(s) which pass DC to the diplexer port(s)
- AXP19-60-x-bot: for bottom mounted connectors, add "-bot" (otherwise antenna comes standard with back mounted connectors)

*Antenna Weight may vary slightly with options.



X7CAP-665

Dual Band Xpol, 65° H-Beams

698-896 MHz
1710-2170 MHz

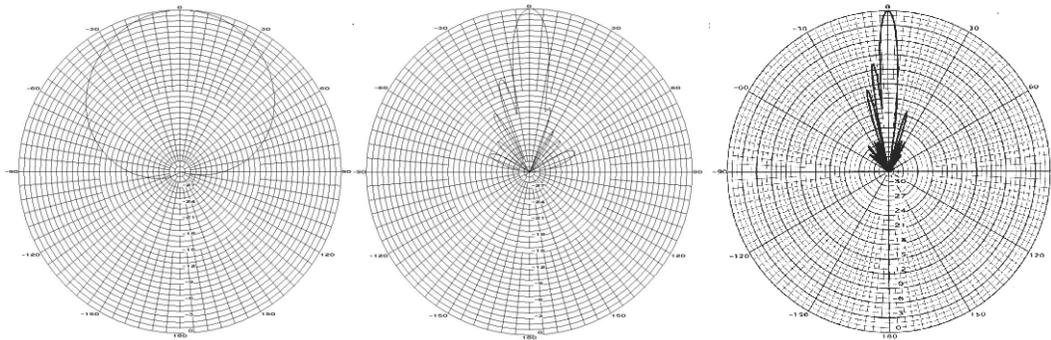
[Link to Mechanical Drawing](#) →

Electrical Specifications

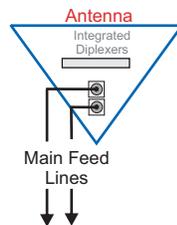
Frequency	698-896 & 1710-2170 MHz
Polarization	Slant +/- 45
Gain @ 698 MHz	15.3 dBi
Gain @ 896 MHz	15.9 dBi
Gain @ 1710 MHz	18.1 dBi
Gain @ 2155 MHz	18.7 dBi
Horizontal Beam (3dB Points)	65° & 65°
Vertical Beam (3dB Points)	11° & 5°
Elect. Downtilt Range, 2° Increments	0-10° low, 0-6° high band
VSWR / Return Loss	<1.40:1 / 15.6 dB
VSWR / Return Loss w/ip	<1.50:1 / 14.0 dB
Front-to-Back at Horizon	>27 dB & >27 dB
Upper Side Lobe Suppression	<-18 dB & <-18 dB
Impedance	50 Ohms
Power Input Per Connector ("ip")	500 CW at 800 MHz
Power Input Per Connector (no "ip")	500 CW at 800 MHz and 250 CW at 1900 MHz
Isolation	< -28 dB
Intermodulation (2x20W)	<-150 dBc

Mechanical Specifications

Input Connector (female)	Back 7/16 DIN or w/bot. opt.
Antenna Dimensions (LxWxD)	72.0 x 12.5 x 7.1 in (1829x318x180mm)
*Antenna Weight	37 lbs
Bracket Weight	13.2 lbs
RF Distribution	Printed Microstrip Substrate
Radome	Ultra High-Strength Luran
Weatherability	UV Stabilized, ASTM D1925
Radome Water Absorption	ASTM D570, 0.45%
Environmental	MIL-STD-810E
Wind Survival	150 mph
Front Wind Load @100mph	177.4 lbf
Equivalent Flat Plate @100mph	3.6 sq-ft. (c=2)
Mounting Brackets	Fits 3.5 Inch Max. O.D. Pipe
Mechanical Downtilt Range	0-12°
Clamps/Bolts	Galvanized Steel/Stainless Steel



Available with
Integrated Diplexers to
reduce mainline cables
and eliminate separate
external devices



Recommended Connector Coupling Torque
7/16 DIN: 220-265 lbf-in (25-30 N-m)

Ordering Information & Options

X7CAP-665-xy

"xy" is a placeholder for the built-in fixed electrical downtilt in degrees, "x" for low band, y for high band.

X7CAP-665-xyip

to add the option for integrated diplexers, add "ip" to model number

X7CAP-665-xyip-bot

for bottom mounted connectors, add "-bot" (otherwise antenna comes standard with back mounted connectors)

*Antenna Weight may vary slightly with options.

Alcatel-Lucent RRH2x40-AWS REMOTE RADIO HEAD

The Alcatel-Lucent RRH2x40-AWS is a high-power, small form-factor Remote Radio Head (RRH) operating in the AWS frequency band (1700/2100MHz - 3GPP Band 4). The Alcatel-Lucent RRH2x40-AWS is designed with an eco-efficient approach, providing operators with the means to achieve high quality and capacity coverage with minimum site requirements.



A distributed eNodeB expands deployment options by using two components, a Base Band Unit (BBU) containing the digital assets and a separate RRH containing the radio-frequency (RF) elements. This modular design optimizes available space and allows the main components of an eNodeB to be installed separately, within the same site or several kilometres apart.

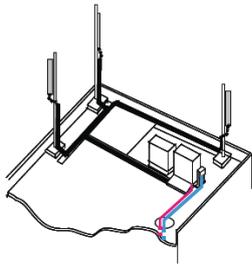
The Alcatel-Lucent RRH2x40-AWS is linked to the BBU by an optical-fiber connection carrying downlink and uplink digital radio signals along with operations, administration and maintenance (OA&M) information. The Alcatel-Lucent RRH2x40-AWS has two transmit RF paths, 40 W RF output power per transmit path, and is designed to manage up to four-way receive diversity. The device is ideally suited to support macro coverage, with multiple-input multiple-output (MIMO) 2x2 operation in up to 20 MHz of bandwidth.

The Alcatel-Lucent RRH2x40-AWS is designed to make available all the benefits of a distributed eNodeB, with excellent RF characteristics, with low capital expenditures (CAPEX) and low operating expenditures (OPEX). The limited space available in some

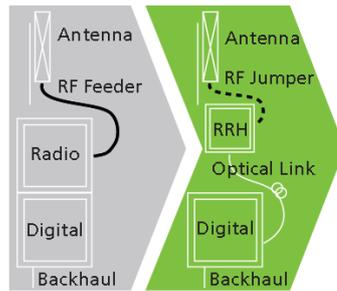
sites may prevent the installation of traditional single-cabinet BTS equipment or require costly cranes to be employed, leaving coverage holes. However, many of these sites can host an Alcatel-Lucent RRH2x40-AWS installation, providing more flexible site selection and improved network quality along with greatly reduced installation time and costs.

Fast, low-cost installation and deployment

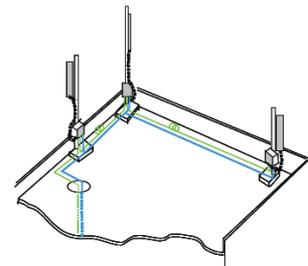
The Alcatel-Lucent RRH2x40-AWS is a zero-footprint solution and operates noise-free, simplifying negotiations with site property owners and minimizing environmental impacts. Installation can easily be done by a single person because the Alcatel-Lucent RRH2x40-AWS is compact and weighs less than 20 kg (44 lb), eliminating the need for a crane to hoist the BTS cabinet to the rooftop. A site can be in operation in less than one day — a fraction of the time required for a traditional BTS.



Macro



RRH for space-constrained cell sites



Distributed

Excellent RF performance

Because of its small size and weight, the Alcatel-Lucent RRH2x40-AWS can be installed close to the antenna. Operators can therefore locate the Alcatel-Lucent RRH2x40-AWS where RF engineering is deemed ideal, minimizing trade-offs between available sites and RF optimum sites. The RF feeder cost and installation costs are reduced or eliminated, and there is no need for a Tower Mounted Amplifier (TMA) because losses introduced by the RF feeder are greatly reduced. The Alcatel-Lucent RRH2x40-AWS provides more RF power while at the same time consuming less electricity.

Features

- Zero-footprint deployment
- Easy installation, with a lightweight unit can be carried and set up by one person
- Optimized RF power, with flexible site selection and elimination of a TMA
- Convection-cooled (fanless)
- Noise-free
- Best-in-class power efficiency, with significantly reduced energy consumption

Benefits

- Leverages existing real estate with lower site costs
- Reduces installation costs, with fewer installation materials and simplified logistics
- Decreases power costs and minimizes environmental impacts, with the potential for eco-sustainable power options
- Improves RF performance and adds flexibility to network planning

Technical specifications

Physical dimensions

- Height: 620 mm (24.4 in.)
- Width: 270 mm (10.63 in.)
- Depth: 170mm (6.7 in.)
- Weight (without mounting kit): less than 20 kg (44 lb)

Power

- Power supply: -48VDC

Operating environment

- Outdoor temperature range:
 - With solar load: -40°C to +50°C (-40°F to +122°F)
 - Without solar load: -40°C to +55°C (-40°F to +131°F)

- Passive convection cooling (no fans)
- Enclosure protection
 - IP65 (International Protection rating)

RF characteristics

- Frequency band: 1700/2100 MHz (AWS); 3GPP Band 4
- Bandwidth: up to 20 MHz
- RF output power at antenna port: 40 W nominal RF power for each Tx port
- Rx diversity: 2-way or 4-way with optional Rx Diversity module
- Noise figure: below 2.0 dB typical
- Antenna Line Device features
 - TMA and Remote electrical tilt (RET) support via AISG v2.0

Optical characteristics

Type/number of fibers

- Single-mode variant
 - One Single Mode Single Fiber per RRH2x, carrying UL and DL using CWDM
 - Single mode dual fiber (SM/DF)
- Multi-mode variant
 - Two Multi-mode fibers per RRH2x: one carrying UL, the other carrying DL

Optical fiber length

- Up to 500 m (0.31 mi), using MM fiber
- Up to 20 km (12.43 mi), using SM fiber

Digital Ports and Alarms

- Two optical ports to support daisy-chaining
- Six external alarms

**DC Surge Protection for RRH/Integrated Antenna Radio Head
RxxDC-4750-PF-48 • RxxDC-3315-PF-48**

Tower / Base / Rooftop / Rooftop Distribution Models

Raycap's flexible Tower, Base Stations and Rooftop protection and Distribution products provide protection for up to 6 Remote Radio Heads/Integrated Antennas. The solutions mitigate the risk of damage due to lightning and provide high levels of availability and reliability to radio equipment.



Shown with optional 90° elbow for side entry. Can be installed on left or right side of unit.

Mounting Bracket Included

Features

- Employs the Strikesorb® 30-V1-HV Surge Protective Device (SPD) specifically designed for the Remote Radio Head (RRH) installation environment and certified for use in DC applications and at low DC operating voltages (48V).
- The Strikesorb 30-V1-HV is a Class I SPD, certified by VDE per the IEC 61643-1 standard as suitable for installation in areas where direct lightning exposure is expected. Strikesorb 30-V1-HV is able to withstand direct lightning currents of up to 5kA (10/350) and induced surge currents of up to 60kA (8/20).
- Provides very low let through / clamping voltage - unique for a Class I product - as it does not employ spark gaps or other switching elements. Strikesorb offers unique protection levels to the RRH equipment as well as the Base Band Units.
- Alarms for SPD sacrifice, Moisture detection and Intrusion.
- Fully recognized to the UL 1449 3rd Edition Safety Standard.
- Patent pending design

Benefits

- Offers unique maintenance-free protection against direct lightning currents.
- Protects up to 6 Remote Radio Heads and connects up to 12 fiber pairs.
- Utilizes an IP 67 rated enclosure, allowing for indoor or outdoor installation on a roof or tower top.
- Configurable cable ports are designed to accommodate varying diameters of hybrid (combined power and fiber optic) or standard cables with diameters up to 2" (will fit most standard 1 5/8" coax class cables) depending upon port configuration.
- Lightweight aerodynamic design provides maximum flexibility for tower top installation.
- Companion to the RxxDC-1064-PF-48 (Sector) model.



DC1-48-60-18U

Tower / Base / Rooftop / Rooftop Distribution Models:
RxxDC-4750-PF-48
RxxDC-3315-PF-48

Companion Sector Model:
RxxDC-1064-PF-48

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G02-00-236 130129

SPECIFICATIONS

DC Surge Protection for RRH/Integrated Antenna Radio Head RxxDC-4750-PF-48 • RxxDC-3315-PF-48

Tower / Base / Rooftop / Rooftop Distribution Models

Electrical

Model Numbers	RxxDC-4750-PF-48	RxxDC-3315-PF-48
Nominal Operating Voltage	48 VDC	48 VDC
Nominal Discharge Current [I_n]	n/a	20 kA 8/20 μ s
Maximum Surge Current [I_{max}]	n/a	60 kA 8/20 μ s
Maximum Impulse (Lightning) Current per IEC 61643-1	n/a	5 kA 10/350 μ s
Maximum Continuous Operating Voltage [U_c]	n/a	75 VDC
Voltage Protection Rating (VPR) per UL 1449 3rd Edition	n/a	400V
Protection Class as per IEC 61643-1	n/a	Class I
SPD Alarm	n/a	upon sacrifice
Intrusion Sensor	microswitch	microswitch
Moisture Sensor	infrared moisture detector	infrared moisture detector
Strikesorb Module Type		30-V1-HV
	No Strikesorb modules installed <i>(used as Distribution Unit only)</i>	Strikesorb modules installed to protect 6 Remote Radio Heads

Mechanical

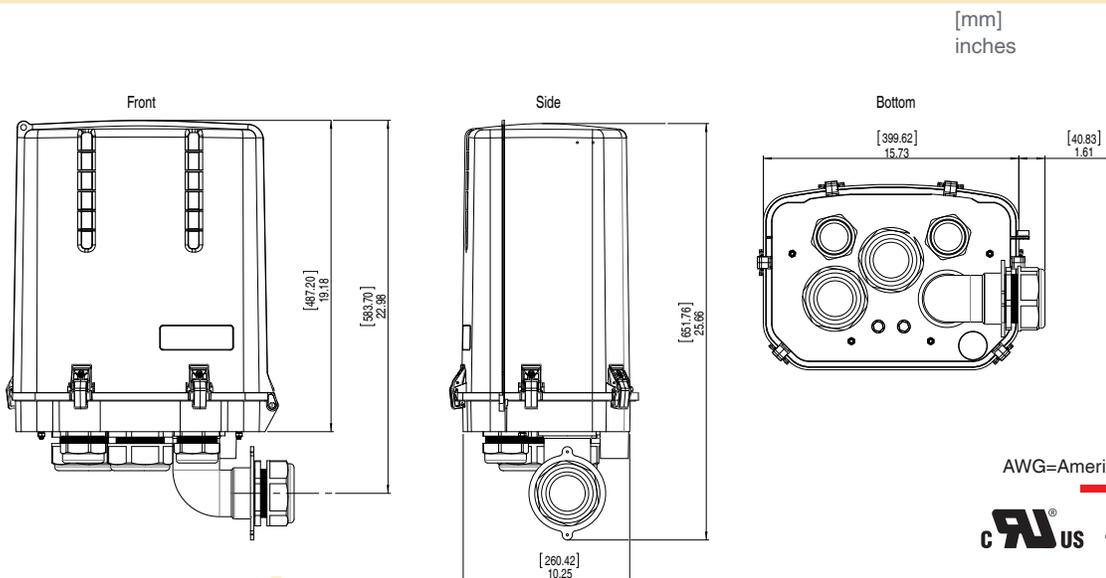
Suppression Connection Method	Compression lug, #20 - #6 AWG (0.5 mm ² - 16 mm ²)	
Fiber Connection Method	LC-LC Single mode	
Pressure Equalizing Vent	Gore™ Vent	
Environmental Rating	IP 67	
Operating Temperature	-40° C to +80° C	
UV Resistant	Yes	
Weight	System: 26 lbs (11.80 kg)	System: 32 lbs (14.51 kg)
Combined Wind Loading	150mph (sustained): 185 lbs (823 N)	

Standards Compliance

Strikesorb modules are compliant to the following Surge Protective Device (SPD) Standards

Standards	ANSI/UL 1449 3rd Edition
	IEEE C62.41
	NEMA LS-1, IEC 61643-1:2005 2nd Edition (Class I Protection)
	IEC 61643-12
	EN 61643-11:2002 (including A11:2007)

Product Diagram



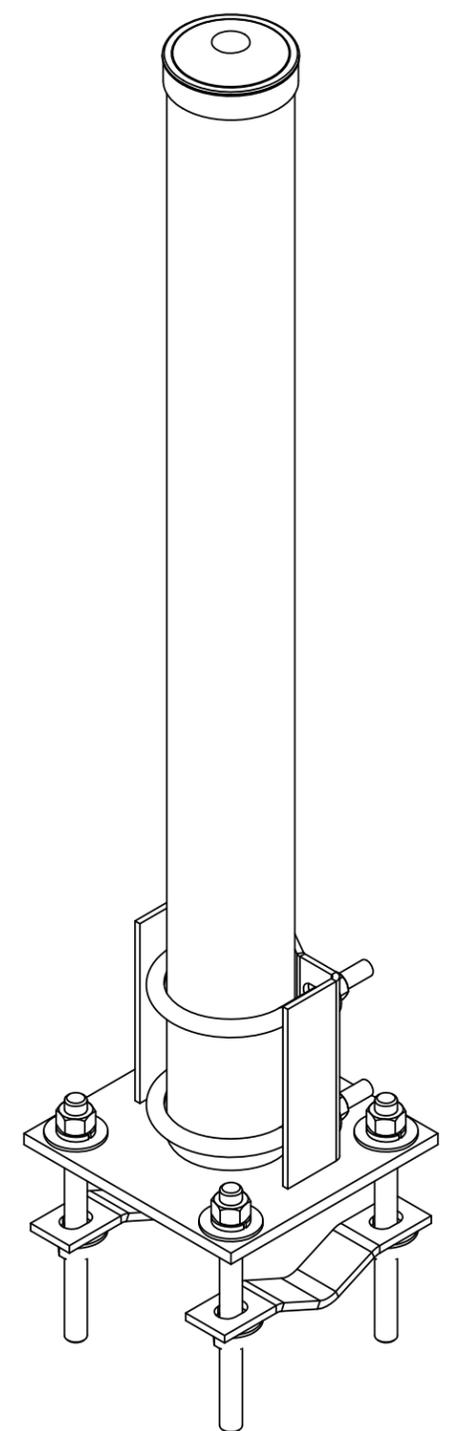
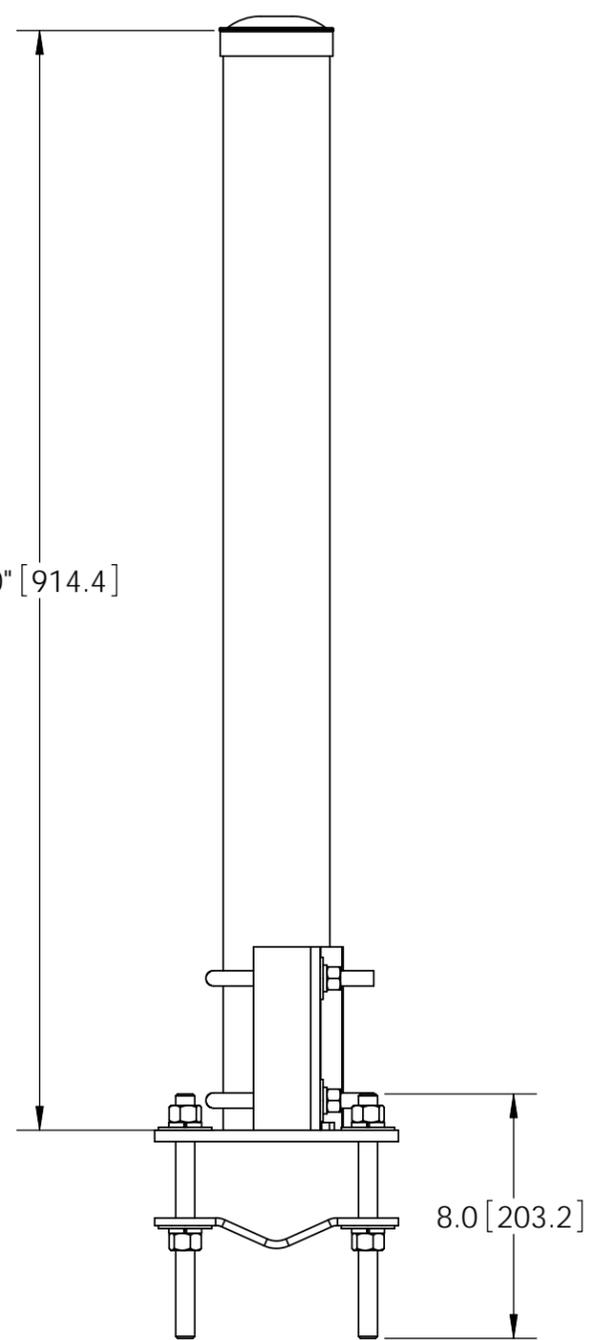
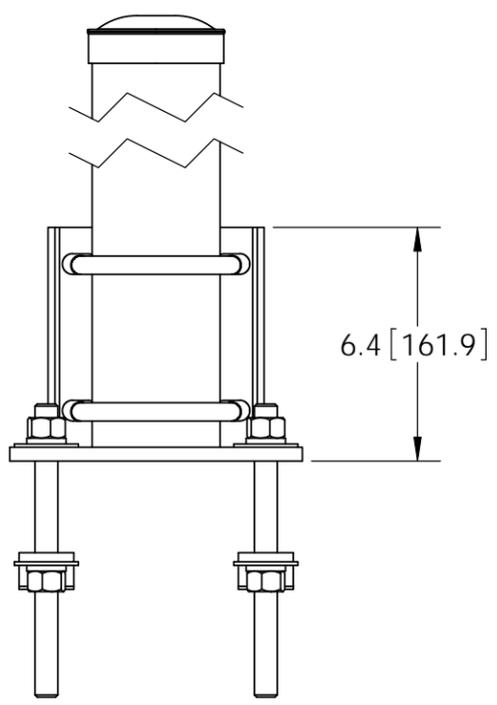
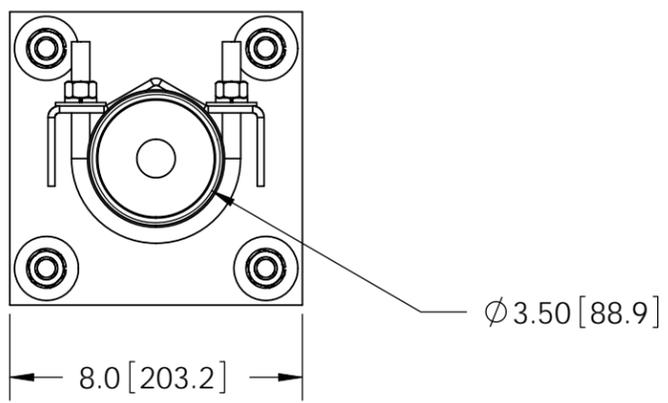
AWG=American Wire Gauge



Raycap

www.raycapsurgeprotection.com

REVISIONS				
REV.	ZONE	DESCRIPTION	BY	DATE
A		INITIAL RELEASE	MSM	05/07/13



NOTES:
 1. ALL METRIC DIMENSIONS ARE IN BRACKETS.

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 .XXX = ± .03

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DRAWN BY: MSM	SHEET: 1 of 1
CHECKED BY: TP	SCALE: NTS
DATE: 05/07/13	MATERIAL: A36
REVISION: A	FINISH: GALV A123
	WEIGHT: 38.98 LBS

PART NUMBER: **MTC3556weightstudy**

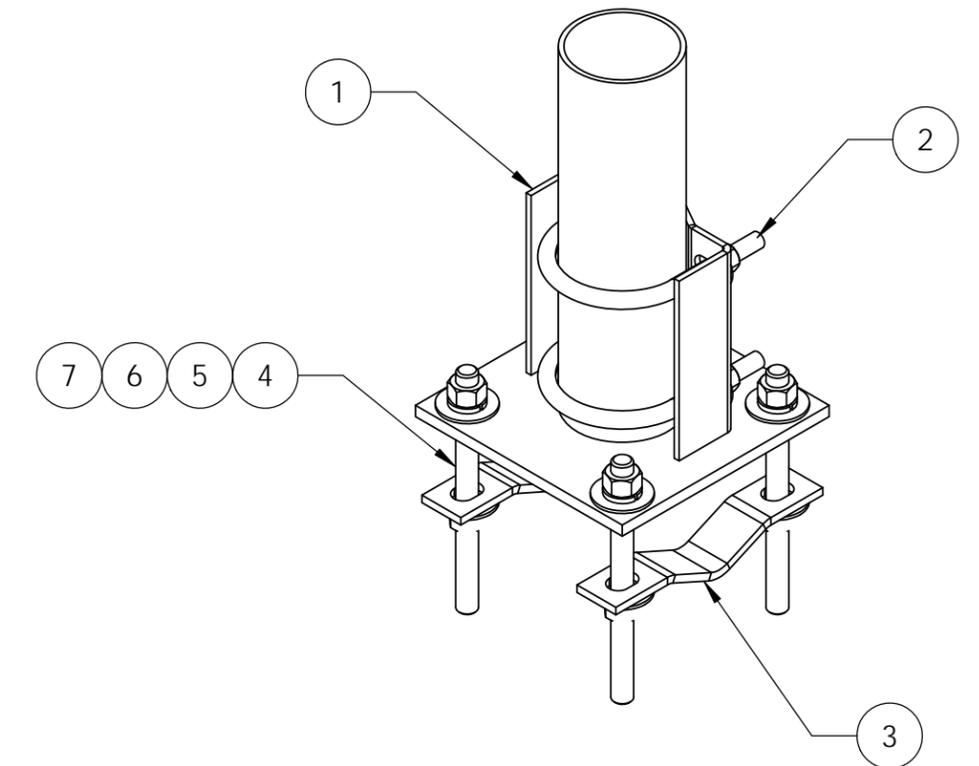
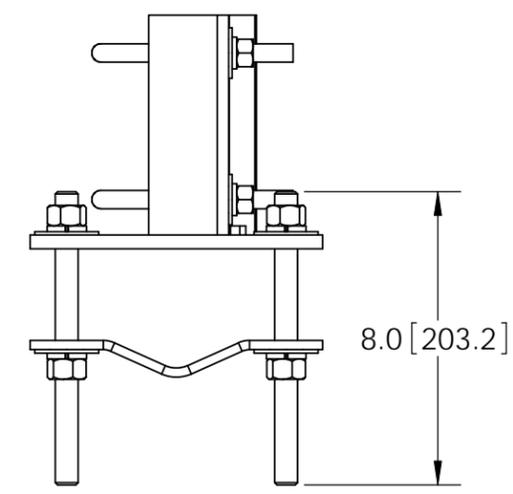
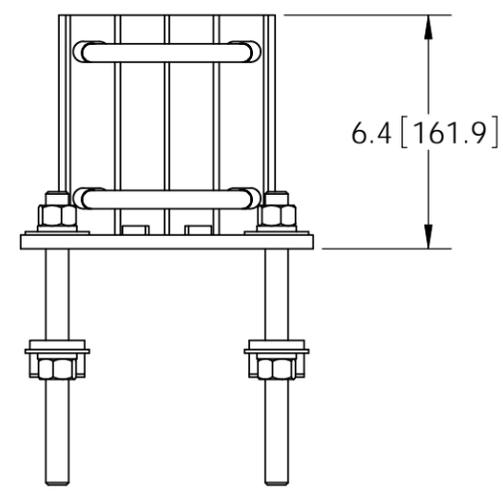
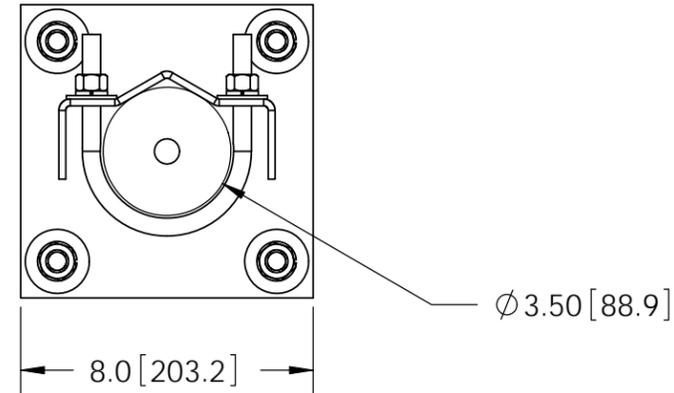
DESCRIPTION: **BASE U-FOOT FOR GRATING**

DRAWING TYPE: **ASSEMBLY DRAWING**

COMMSCOPE®
 Hickory, NC 28602 U.S.A.

ITEM	PART NO.	DESCRIPTION	QTY.	WEIGHT
1	WBBS.01	FOOT WELDMENT	1	9.73 LBS
2	GUB-4355	1/2" X 3-5/8" X 5" GALV U-BOLT KIT	2	0.71 LBS
3	MTC355601	1.5" - 4.5" O.D. CLAMP HALF	2	0.79 LBS
4	MT-381-8	5/8" X 8" GALV THREADED ROD	4	0.69 LBS
5	GWF-05	5/8" GALV FLAT WASHER	8	0.03 LBS
6	GWL-05	5/8" GALV LOCK WASHER	8	0.00 LBS
7	GN-05	5/8" GALV HEX NUT	8	0.04 LBS

REVISIONS				
REV.	ZONE	DESCRIPTION	BY	DATE
PRE1		INITIAL RELEASE	MSM	05/07/13

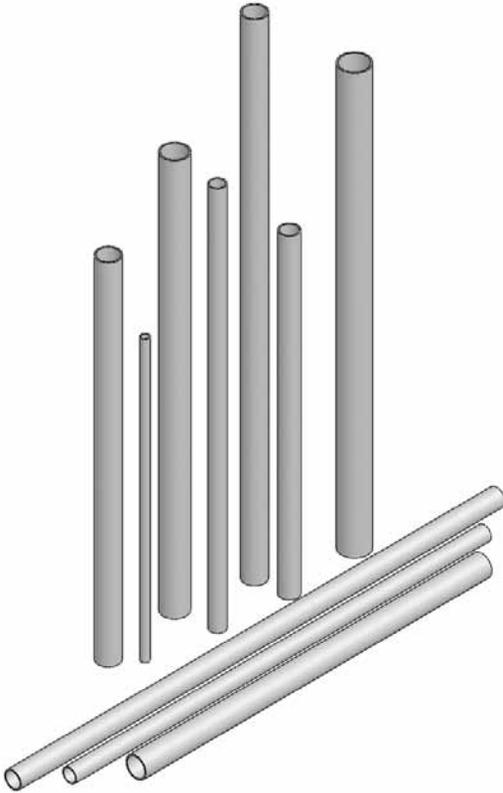


NOTES:
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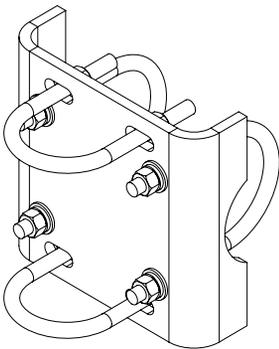
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	CHECKED BY: TP	SCALE: NTS	DESCRIPTION: BASE U-FOOT FOR GRATING
	DATE: 05/07/13	MATERIAL: A36	DRAWING TYPE: ASSEMBLY DRAWING
	REVISION: PRE1	FINISH: GALV A123	WEIGHT: 17.11 LBS



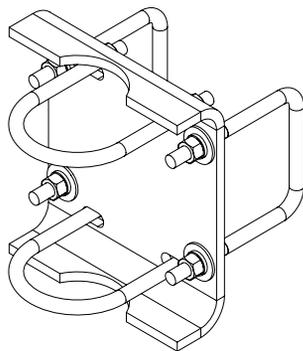
Pipes U-bolts and Pipe Mounts



Part Number	Description	Weight, lb (kg)
Pipe and U-bolts		
GUB-4240	1/2" x 2-1/2" x 4" (12.7 mm x 64 mm x 102 mm) Galvanized U-bolt Assembly	0.9 (0.4)
GUB-4352	1/2" x 3" x 5-1/4" (12.7 mm x 76 mm x 133 mm) Galvanized U-bolt Assembly	0.9 (0.4)
GUB-4356	1/2" x 3-5/8" x 6" (12.7 mm x 92.1 mm x 152.4 mm) Galvanized U-bolt Assembly	0.9 (0.4)
MT-651	2-3/8" OD x 72" (60.3 mm OD x 1.8 m) Galvanized Pipe	21 (9.5)
MT-651-84	2-3/8" OD x 84" (60.3 mm OD x 2.1 m) Galvanized Pipe	26 (11.8)
MT-651-96	2-3/8" OD x 96" (60.3 mm OD x 2.4 m) Galvanized Pipe	33 (15.2)
MT-537	2-3/8" OD x 126" (60.3 mm OD x 3.2 m) Galvanized Pipe	39 (18)
MT54672	2-7/8" OD x 72" (73 mm OD x 1.8 m) Galvanized Pipe	34 (15.4)
MT54684	2-7/8" OD x 84" (73 mm OD x 2.1 m) Galvanized Pipe	41 (18.6)
MT54696	2-7/8" OD x 96" (73 mm OD x 2.4 m) Galvanized Pipe	46 (20.8)
MT-546-126	2-7/8" OD x 126" (73 mm OD x 3.2 m) Galvanized Pipe	61 (27.6)
MT54772	3-1/2" OD x 72" (88.9 mm OD x 1.8 m) Galvanized Pipe	71 (32.2)
MT54784	3-1/2" OD x 84" (88.9 mm OD x 2.1 m) Galvanized Pipe	82 (37.2)
MT54796	3-1/2" OD x 96" (88.9 mm OD x 2.4 m) Galvanized Pipe	94 (42.6)
MT-547-126	3-1/2" OD x 126" (88.9 mm OD x 3.2 m) Galvanized Pipe	125 (56.7)



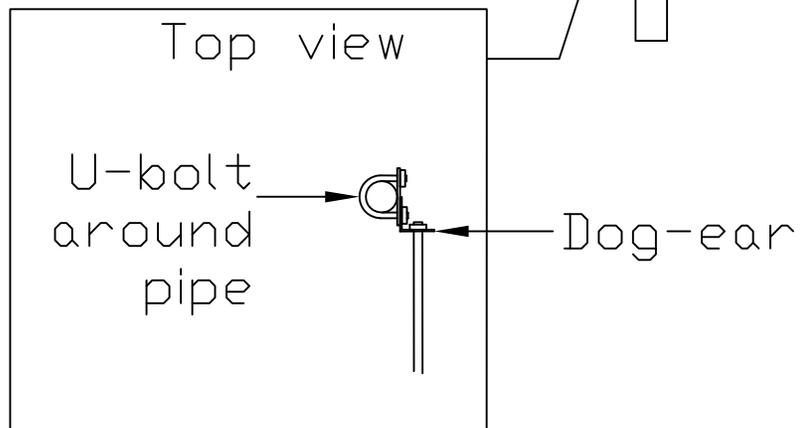
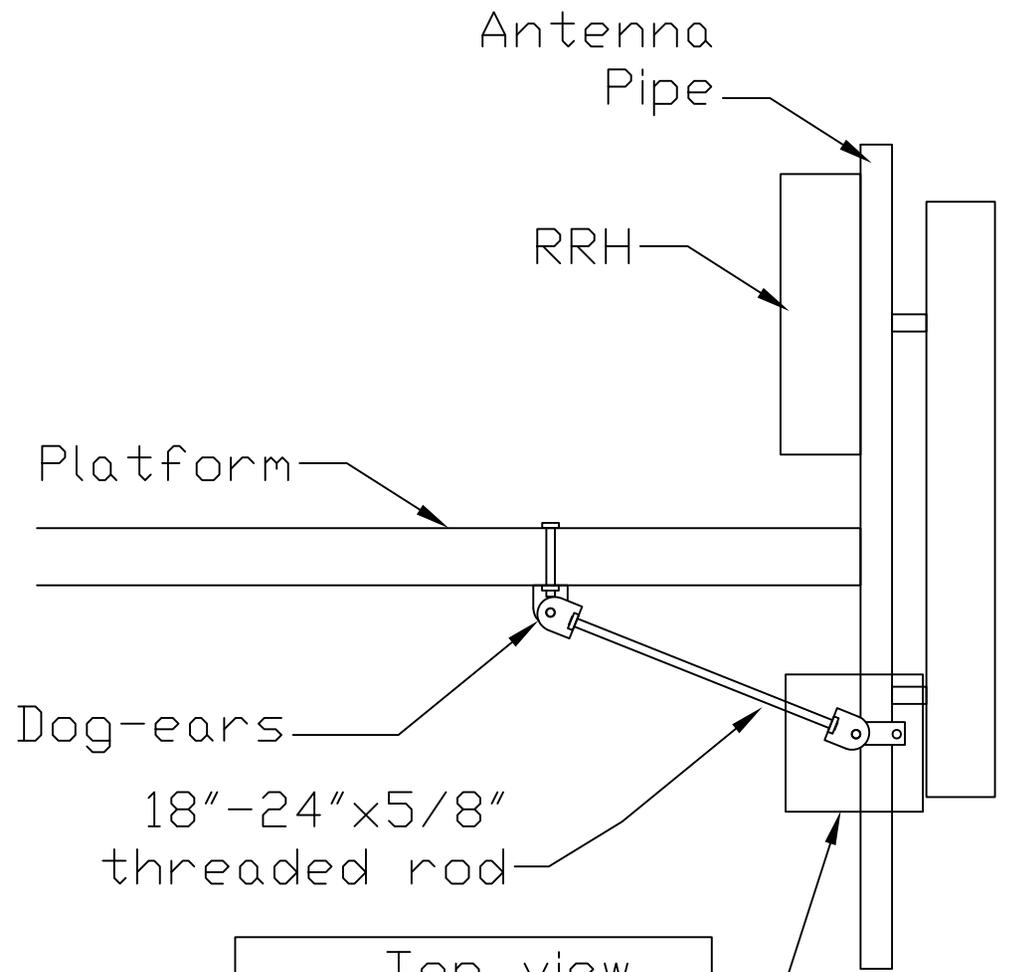
• MT-219



• MTC3055PM35

Part Number	Description	Weight, lb (kg)
Pipe Mount Kits for 3-1/2" (88.9 mm) Round Tube Faces		
MT-219-H	Pipe Mount for 2-3/8" OD (60.3 mm OD) Antenna Mount Pipe	11 (5.0)
MT-219M-H	Pipe Mount for 2-7/8" OD (73 mm OD) Antenna Mount Pipe	11 (5.0)
MT-219L-H	Pipe Mount for 3-1/2" OD (88.9mm OD) Antenna Mount Pipe	12 (5.4)
Pipe Mount Kits for 4" (102 mm) Square Tube Faces		
MTC3055PM3	Pipe Mount for 2-7/8" OD (73 mm OD) Antenna Mount Pipe	13 (5.9)
MTC3055PM35	Pipe Mount for 3-1/2" OD (88.9 mm OD) Antenna Mount Pipe	13 (5.9)

NOTE: Use square tube pipe mounts for SF-HPM series and MC-HPM1250-B mounts





Andrew Solutions
RFA1206-24S26-300

HELIAX® FiberFeed Hybrid Cable Assembly, 12 power conductors 6 AWG, 24-fiber, black jacket, aluminum armor, 300 ft

Construction Materials

Fiber Type	TeraSPEED®, zero water peak singlemode fiber (G.652.D or G.652.D OS2)
Total Fibers, quantity	24
Jacket Color	Black

Dimensions

Cord Length	91.4 m 300.0 ft
Breakout Length, Fiber, end 1	813 mm 32 in
Breakout Length, Power, end 1	737 mm 29 in
Breakout Length, Fiber, end 2	813 mm 32 in
Breakout Length, Power, end 2	737 mm 29 in

Environmental Specifications

Environmental Space	Wireless installation
Operating Temperature	-40 °C to +80 °C (-40 °F to +176 °F)

General Specifications

Conductors, quantity	12
Construction Type	Breakout, armored
Alarm Wire Gauge	18 AWG
Alarm Wire, quantity	6
Cable Glands	No glands
Color, connector A	Blue
Color, connector B	Blue
Interface Feature, connector A	Standard
Interface Feature, connector B	Standard
Interface, connector A	LC
Interface, connector B	LC
Minimum Bend Radius, furcation	30.0 mm 1.2 in
Pulling Grips, quantity	0

Regulatory Compliance/Certifications

Agency	Classification
RoHS 2011/65/EU	Compliant
ISO 9001:2008	Designed, manufactured and/or distributed under this quality management system

RFA1206-24S26-300



Included Products

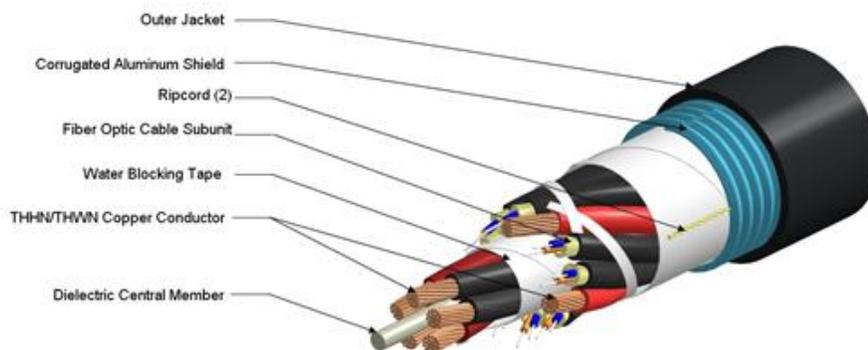
760177543 | RFF-24SM-1206-618-APE (Product Component—not orderable) — HELIAX® FiberFeed Hybrid Cable with aluminum armor

- CS-8F-MP (Product Component—not orderable) — Low Macrobending, Zero Water Peak, Dispersion-Unshifted Singlemode Fiber

Andrew Solutions
 760177543 | RFF-24SM-1206-618-APE
HELIAX® FiberFeed Hybrid Cable with aluminum armor



Representative Image



General Specifications

Cable Type	Wireless feeder
Center Conductor Gauge	6 AWG
Conductors, quantity	12
Construction Type	Armored
Alarm Wire Gauge	18 AWG
Alarm Wire, quantity	6
Application	Remote radio head
Brand	HELIAX® FiberFeed
Corrosion Protection	Water blocking tape
Inner Shield (Tape) Material	Corrugated aluminum
Outer Shield (Tape) Material	PE
Ripcord Material	Para-aramid synthetic fiber
Strength Member	Glass reinforced plastic rod

Construction Materials

Fiber Type Solution	Bend insensitive singlemode fiber (G.657.A1)
Total Fiber Count	24
Armor Type	Corrugated aluminum
Fiber Type	Bend insensitive singlemode fiber (G.657.A1)
Fiber Type, quantity	24
Fibers per Subunit, quantity	12

760177543 | RFF-24SM-1206-618-APE



Jacket Color Black

Electrical Specifications

dc Resistance, maximum	0.412 ohms/kft 1.348 ohms/km
dc Resistance Note	Maximum value based on a standard condition of 20 °C (68 °F)

Dimensions

Buffer Tube/Subunit Diameter	6.00 mm 0.24 in
Cable Weight	2198.0 kg/km 1477.0 lb/kft
Diameter Over Jacket	33.27 mm 1.31 in
Subunit, quantity	2

Physical Specifications

Minimum Bend Radius, multiple bends, loaded	662.9 mm 26.1 in
Minimum Bend Radius, multiple bends, unloaded	332.7 mm 13.1 in
Minimum Bend Radius, single bend, unloaded	231.1 mm 9.1 in
Tensile Load, long term, maximum	1068 N 240 lbf
Tensile Load, short term, maximum	3559 N 800 lbf

Environmental Specifications

Environmental Space	Wireless installation
Installation Temperature	-30 °C to +70 °C (-22 °F to +158 °F)
Operating Temperature	-40 °C to +80 °C (-40 °F to +176 °F)
Storage Temperature	-40 °C to +80 °C (-40 °F to +176 °F)

Mechanical Test Specifications

Compression	22 N/mm 126 lb/in
Compression Test Method	FOTP-41
Flex Test Method	FOTP-104
Impact	2.94 N-m 2.17 ft lb
Impact Test Method	FOTP-25
Twist	10 cycles
Twist Test Method	FOTP-85

Qualification Specifications

Cable Qualification Standards	Telcordia GR-20-CORE Issue 3 Telcordia GR-409-CORE Issue 2
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Regulatory Compliance/Certifications

Agency	Classification
RoHS 2011/65/EU	Compliant
ISO 9001:2008	Designed, manufactured and/or distributed under this quality management system



Included Products

CS-8F-MP (Product Component—not orderable) — Low Macrobending, Zero Water Peak, Dispersion-Unshifted Singlemode Fiber



Andrew Solutions

CS-8F-MP

Low Macrobending, Zero Water Peak, Dispersion-Unshifted Singlemode Fiber

Optical Specifications, Wavelength Specific

Standards Compliance	ITU-T G.657.A1 TIA-492CAAB (OS2)
Attenuation, maximum	0.50 db/m @ 1310 nm 0.50 db/km @ 1385 nm 0.50 db/km @ 1490 nm 0.50 db/km @ 1550 nm
Dispersion, maximum	18 ps(nm-km) at 1550 nm 3.5 ps(nm-km) from 1285 nm to 1330 nm at 1310 nm
Mode Field Diameter	8.9 μm @ 1310 nm 10.4 μm @ 1550 nm
Mode Field Diameter Tolerance	$\pm 0.4 \mu\text{m}$ @ 1310 nm $\pm 0.5 \mu\text{m}$ @ 1550 nm
Index of Refraction	1.467 @ 1310 nm 1.467 @ 1385 nm 1.468 @ 1550 nm
Polarization Mode Dispersion Link Design Value, maximum	0.06 ps/sqrt(km)

Physical Specifications

Cladding Diameter	125.0 μm
Cladding Diameter Tolerance	$\pm 0.7 \mu\text{m}$
Cladding Non-Circularity, maximum	1 %
Coating Diameter (Colored)	254 μm
Coating Diameter (Uncolored)	245 μm
Coating Diameter Tolerance (Colored)	$\pm 7 \mu\text{m}$
Coating Diameter Tolerance (Uncolored)	$\pm 10 \mu\text{m}$
Coating/Cladding Concentricity Error, maximum	12 μm
Core/Clad Offset, maximum	0.5 μm

Optical Specifications, General

Cabled Cutoff Wavelength, maximum	1260 nm
Point Defects, maximum	0.10 dB
Zero Dispersion Slope, maximum	0.092 ps/[km-nm-nm]
Zero Dispersion Wavelength, maximum	1322 nm
Zero Dispersion Wavelength, minimum	1302 nm

Mechanical Specifications

Coating Strip Force, maximum	8.9 N 2.0 lbf
Coating Strip Force, minimum	1.3 N 0.3 lbf
Dynamic Fatigue Parameter, minimum	18 nd
Fiber Curl, minimum	4.0 m 13.1 ft
Macrobending, 20 mm mandrel, 1 turn	0.20 dB @ 1550 nm
Macrobending, 30 mm mandrel, 1 turn	0.02 dB @ 1550 nm
Macrobending, 30 mm mandrel, 10 turns	0.20 dB @ 1550 nm 0.50 dB @ 1625 nm

CS-8F-MP



Macrobending, 50 mm mandrel, 100 turns	0.01 dB @ 1550 nm 0.05 dB @ 1625 nm
Proof Test	0.69 N/mm ² 100.00 psi

Environmental Specifications

Heat Aging, maximum	0.05 dB @ 85 °C
Temperature Dependence, maximum	0.05 dB
Temperature Humidity Cycling, maximum	0.05 dB
Water Immersion, maximum	0.05 dB @ 23 °C

Regulatory Compliance/Certifications

Agency	Classification
ISO 9001:2008	Designed, manufactured and/or distributed under this quality management system

* Footnotes

Temperature Dependence, maximum	Temperature dependence is conducted at -60 °C to +85 °C (-76 °F to +185 °F)
Temperature Humidity Cycling, maximum	Temperature humidity cycling is conducted at -10 °C to +85 °C (+14 °F to +185 °F) up to 95% relative humidity

AMERICAN ELECTRIC POWER
TRANSMISSION LINE PROJECTS
ENGINEERING

STRUCTURAL
ENGINEERING

BETHEL - SAWMILL
STRUCTURE 29

Structural Analysis
To Support Antenna Loads

Blaw-Knox
138 kV Single Circuit Suspension
Tower Height : 94'-0"

February 17, 2004

AEP
P.O. BOX 2021
ROANOKE, VA 24022-2121



SAWMILL
STRUCTURE 29
BETHEL-SAWMILL 138kV LINE

STRUCTURAL ANALYSIS
TO SUPPORT ANTENNA LOADS

BLAX-KNOX
138 kV SINGLE CIRCUIT SUSPENSION
HEIGHT: 94'-0"

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INTRODUCTION

The purpose of this report is to summarize the results of the structural analysis performed on structure number 29 along the Bethel - Sawmill 138kV line for Verizon. This analysis will determine the effects of adding a triangular platform, with twelve-foot long sides, mounted on a 12-inch diameter monopole that extends from a foundation at ground level to a point approximately ten feet above the structure. Twelve antennas will be mounted to the three-sector platform (providing four antennas per sector), as shown on drawing S-1. The platform will be designed and manufactured by Fort Worth Tower Inc. New antennas and mount will add approximately 19 square feet of wind area, 3300 pounds of weight, and 125 square feet of surface ice area.

The wind shear and the moments are transmitted to the tower through bracing members attached to the top and at four locations on the legs of the tower. These mounts will be designed to resist the above-mentioned loads.

ANALYSIS

The existing tower was analyzed using Power Line System's "PLS TOWER" structural analysis software. The software analyzes the tower in bending and shear while determining the reactions at the base connections supports. The program considers the tower as a cantilevered vertical truss structure utilizing steel angles for the members as required to resist the stresses. A general description of the program is enclosed in Section 1 of this report.

The loads for the analysis were based on the actual sag and tension characteristics of the wire on the Bethel - Sawmill 138kV Line as depicted on the plan and profile Drawing TL-C-746-404.09 Sheet 5 of 5. The Tower was modeled based on the Blaw - Knox Co. Design and Erection Drawings No. P84651

RESULTS

Suspension Structure No. 29 does not have the capacity to safely support the new antennas and mounting hardware for all load cases considered without additional modifications. Bolt bearing failure of 122% in the diagonal cage bracing and 110% failure in the upper diagonal body bracing was detected. In addition the cross members in the upper cage failed in compression, up to 177%. These members will be braced at third points and the bolts will have to be replaced to insure tower stability. Refer to drawing S-2 in Section 2 of this report.

After replacing the failing bolts with A394 Type 1 and bracing the failing members the maximum tensile load in the tower members is 81% (base leg) and the maximum compressive load is 97% (lower leg).

RECOMMENDATIONS

The tower model simulates the transfer of the riser pipe loads to the tower legs by dummy members and are not intended to be an indication of the size required. Special connections will be required to transfer the actual wind loads to the tower diaphragm due to the antennas, the mount, and the pipe support. These connections will be designed by Fort Worth Tower, Inc. The location of these attachments shall be as indicated by drawing S-1.

CONCLUSIONS

The tower will safely support all of the loads and conditions addressed in this analysis after the alterations are made. The additional loads, induced by mounting the antennas to this tower are substantial but they do not compromise the structural integrity of this tower.

Submitted by:


Keith W. Hemme, PE

Approved by:

Jeff Momme, PE

LOAD CASES

Load Case 1	NESC 40 mph wind ½ in. Ice Angle = 0 deg Wind Span = 690 ft. Temperature = 0°F	Overload Capacity Factors Vertical = 1.5 Wind = 2.5 Wire Tension at angles = 1.65 Vertical Span = 548 ft.
Load Case 2	High Wind 100 mph wind 0 in. Ice Angle = 0 deg Wind Span = 690 ft. Temperature = 60°F	Overload Capacity Factors Vertical = 1.0 Wind = 1.0 Wire Tension at angles = 1.65 Vertical Span = 548 ft.
Load Case 3	Ice & Wind 50 mph wind 1 in. Ice Angle = 0 deg Wind Span = 690 ft. Temperature = 0°F	Overload Capacity Factors Vertical = 1.0 Wind = 1.0 Wire Tension at angles = 1.65 Vertical Span = 548 ft.
Load Case 4	Heavy Ice 0 mph wind 1 ¼ in. Ice Angle = 0 deg Wind Span = 690 ft. Temperature = 0°F	Overload Capacity Factors Vertical = 1.0 Wind = 1.0 Wire Tension at angles = 1.65 Vertical Span = 548 ft.
Load Case 5	Unbalanced Ice 50 mph wind ½ in. Ice Angle = 0 deg Wind Span = 690 ft. Temperature = 0°F	Overload Capacity Factors Vertical = 1.0 Wind = 1.0 Wire Tension at angles = 1.65 Vertical Span = 548 ft.
Load Case 6	Broken Conductor 70 mph wind 0 in. Ice Angle = 0 deg Wind Span = 690 ft. Temperature = 0°F	Overload Capacity Factors Vertical = 1.0 Wind = 1.0 Wire Tension at angles = 1.65 Vertical Span = 548 ft.
Load Case 7	Broken Ground 70 mph wind 0 in. Ice Angle = 0 deg Wind Span = 690 ft. Temperature = 0°F	Overload Capacity Factors Vertical = 1.0 Wind = 1.0 Wire Tension at angles = 1.65 Vertical Span = 548 ft.

CODES AND STANDARDS

In tower evaluation, industry standards dictate that the following codes be utilized. The design criteria for the line and structures are governed by an AEP internal standard TLES-10.

ASCE 10-97-----Design of Steel Transmission Tower Structures

ASTM-A394----- Standard Specification for Zinc Coated Bolts

National Electrical Safety Code -----C2-2002

In the chart below, AEP has compared the loadings required by the EIA/TIA 222-F and the OBC 2002 to the NESC and AEP TLES-10 loading requirements. Results indicate that NESC and AEP loadings meet or exceed the loads on the tower required by these other codes.

The comparison below confirms the findings of the ASCE and SEI conference held in Omaha, NE on September 9-12, 2002. In the proceedings, of *Electrical Transmission in a New Age conference*, a report entitled "Overview of the Applicable Codes and Loads for Co-location of Telecommunication Equipment on Utility Structures" compared the results of EIA/TIA and ASCE 10-97 and concluded that the ASCE steel transmission tower code produces a more stringent result.

COMPARISON OF DESIGN LOADS VARIOUS CODES

CODE	Design Wind Speed (mph)	Wind Pressure One Tower Face (psf)	Radial Ice (inch)
AEP TLES-10 Intact Conditions			
NESC Intact	40	16	0.5
High Wind	100	50	none
Wind and Ice	50	16	1
Heavy Ice	none	0	1.25
2002 Ed. NESC Extreme Wind	90	22.1	none
ASCE Manual 74	90	29.4	none
TIA/EIA 222-F	70	26	none
ASCE 7-98 and OBC-2002	90	28.2	none

References:

- ASCE 7-98 Minimum Design Loads for Buildings and Other Structures
- 2002 Ohio Building Code (Based on ICC International Building Code /2000)
- IEE NESC C2-2002 National Electric Safety Code
- ASCE Manual No. 74 Guidelines for Electrical Transmission Line Structural Loading

TOWER LOAD PARAMETERS

Antenna:

12 – ALLGON 7125.16

Height= 52 in. Width= 17 in. Thickness= 11 in. Weight= 19 lbs

Mount:

12-FOOT FWT MOUNT

Weight= 3062 lbs

Height= 94.5 in. Width= 14.8 in. Thickness= 5.1 in.

Shield Wire:

1-3/8" EHS GW

Diameter= 0.36 in. Weight= 0.273lbs/ft Tension= See section 4

138 kV Conductors:

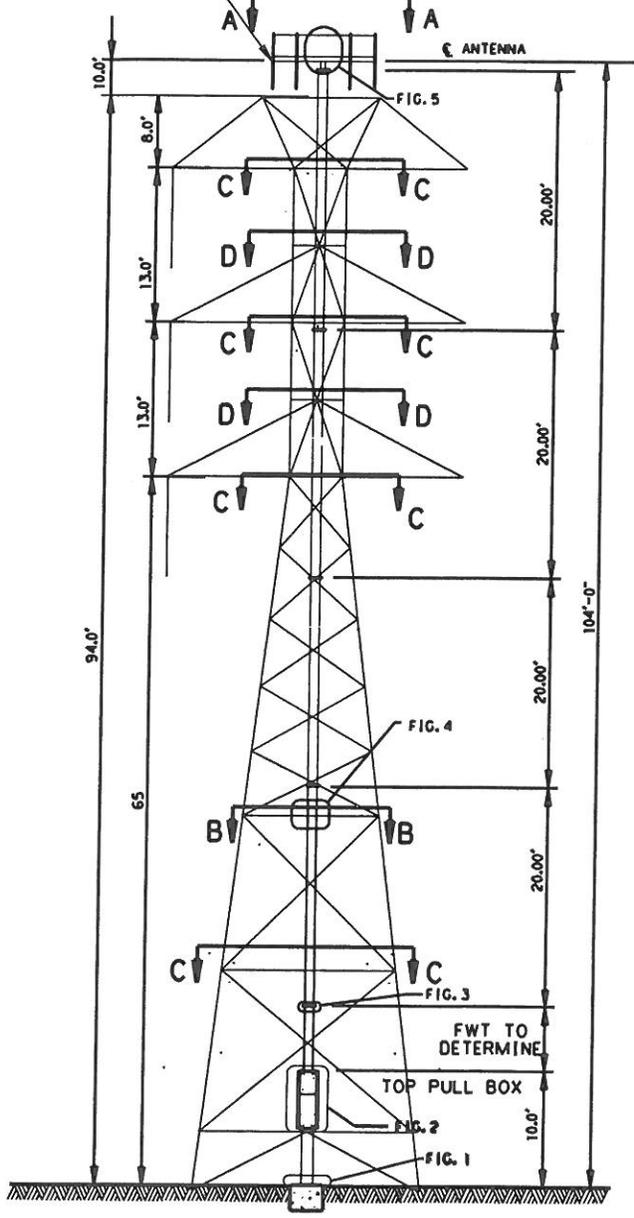
3-636 kcm ASCR 26/7

Diameter = .990 in. Weight = .875lbs/ft Tension = See section 4

REFERENCE DRAWINGS

Drawing # S-1 (TOWER PROFILE VIEWS)	JOB# 660-173 (SECTION 2)
Drawing # S-2 (ALTERATIONS)	JOB# 660-173 (SECTION 2)
Drawing # S-3 (FWT SUPPORT POINTS)	JOB# 660-173 (SECTION 2)
Drawing # S-4 (DETAILS)	JOB# 660-173 (SECTION 2)
Drawing # D-1 (PLAN VIEW ANTENNA AZIMUTH)	JOB# 660-173 (SECTION 3)

(9) RFS AP859012-4270



ELEVATION
Transverse Face

NOTE:

1. ALL NEW MEMBERS OR REPLACEMENTS SHALL HAVE THE MINIMUM CAPACITIES PER THE LOAD SUMMARY TABLE IN SECTION 5 OF LATEST EDITION OF AISC, WHICHEVER IS GREATER.
2. LOCATION OF POWER MOUNT IN FIELD ON SLOPE WILL DETERMINE THE ACTUAL OVERALL LENGTH OF PIPE.
3. SMALL CHANGES IN THE POWERMOUNT LOCATION CAN AFFECT CLEARANCE AND CREATE INTERFERENCE WITH EXISTING TOWER MEMBERS.
4. THIS IS NOT AN ERECTION OR A DETAIL DRAWING. MEMBER SIZES AND LENGTHS WITH CONNECTIONS WILL BE PROVIDED BY FWT UNLESS STATED OTHERWISE.
5. TOWER ANALYSIS BASED ON 12" Ø PIPE FOR THE POWERMOUNT PIPE RISER.
6. PROVIDE ONE (1) SET OF CLIMBING STEPBOLTS FOR THE FIRST TEN FOOT AND TWO (2) SETS OF WORKING STEPBOLTS FOR LAST TEN FOOT SECTION OF THE UPPER 20 FOOT SECTION OF THE POWERMOUNT PIPE RISER.

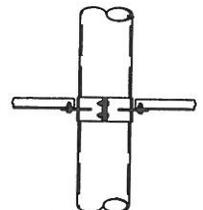
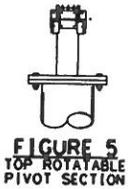


FIGURE 4
TYPICAL ELEVATION OF POWER MOUNT SUPPORT ELEVATION OF 4 PLACES

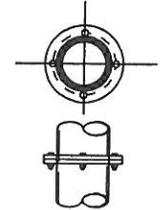
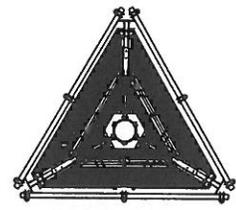
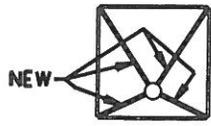


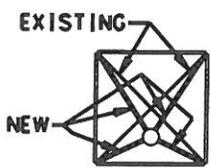
FIGURE 3
SECTION SPLICE



SECTION A-A
HIGH PROFILE 12' PLATFORM TOP VIEW



SECTION B-B
INTERNAL BRACING DETAIL



SECTION C-C
INTERNAL BRACING DETAIL

REQUIREMENTS FOR PULL BOX SHALL BE SUPPLIED TO FWT DIRECTLY.

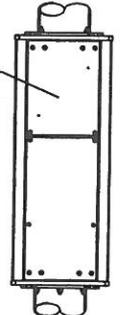


FIGURE 2
WAVE GUIDE PORTS

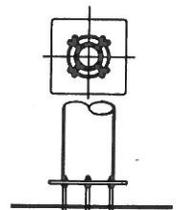


FIGURE 1
ANCHORING DETAIL



SECTION D-D
INTERNAL BRACING DETAIL

TRANS. LINE PROJECTS ENGINEERING		BETHEL-SAWMILL 138 kV LINE		SAWMILL P.C.S. ANTENNA SITE TOWER 29 GENERAL LAYOUT
CH. BY : KWH	DR. BY : KWH	SCALE: NTS	DATE : 02-16-04	
AEP AMERICAN ELECTRIC POWER	P.O. BOX 2021 ROANOKE VA. 24022 Phone 540-562-7055	COMPUTER DRAWING MANUAL REVISIONS NOT PERMITTED		DWG. NO. S-1
				JOB NO: 660-173

DETAIL 1
S-4

4 PLACES 4 SIDES

DETAIL 2
S-4

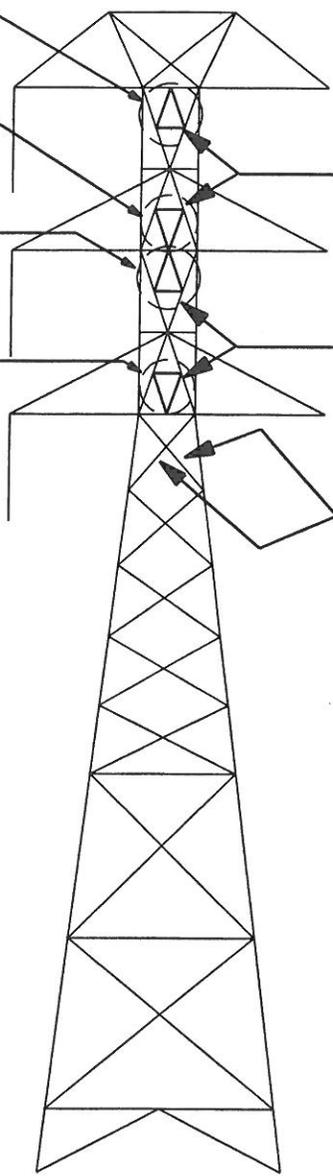
4 PLACES 4 SIDES

DETAIL 1
S-4

2 PLACES NS & FS

DETAIL 2
S-4

2 PLACES NS & FS



REPLACE EXISTING BOLTS (6) $\frac{5}{8}$ " X $1\frac{3}{4}$ " A394 TYPE 1 BOLT WITH NUT AND LOCK WASHER EACH END OF (8) MEMBERS FOR A TOTAL OF (48) BOLTS

REPLACE EXISTING BOLTS (6) $\frac{5}{8}$ " X $1\frac{3}{4}$ " A394 TYPE 1 BOLT WITH NUT AND LOCK WASHER EACH END OF (8) MEMBERS FOR A TOTAL OF (48) BOLTS

REPLACE EXISTING BOLTS (2) $\frac{5}{8}$ " X $1\frac{3}{4}$ " A394 TYPE 1 BOLT WITH NUT AND LOCK WASHER EACH END OF (8) MEMBERS FOR A TOTAL OF (16) BOLTS

TRANS. LINE PROJECTS ENGINEERING

BETHEL-SAWMILL 138 kV LINE

CH. BY : KWH

DR. BY :

SCALE: NTS

DATE : 07-16-04



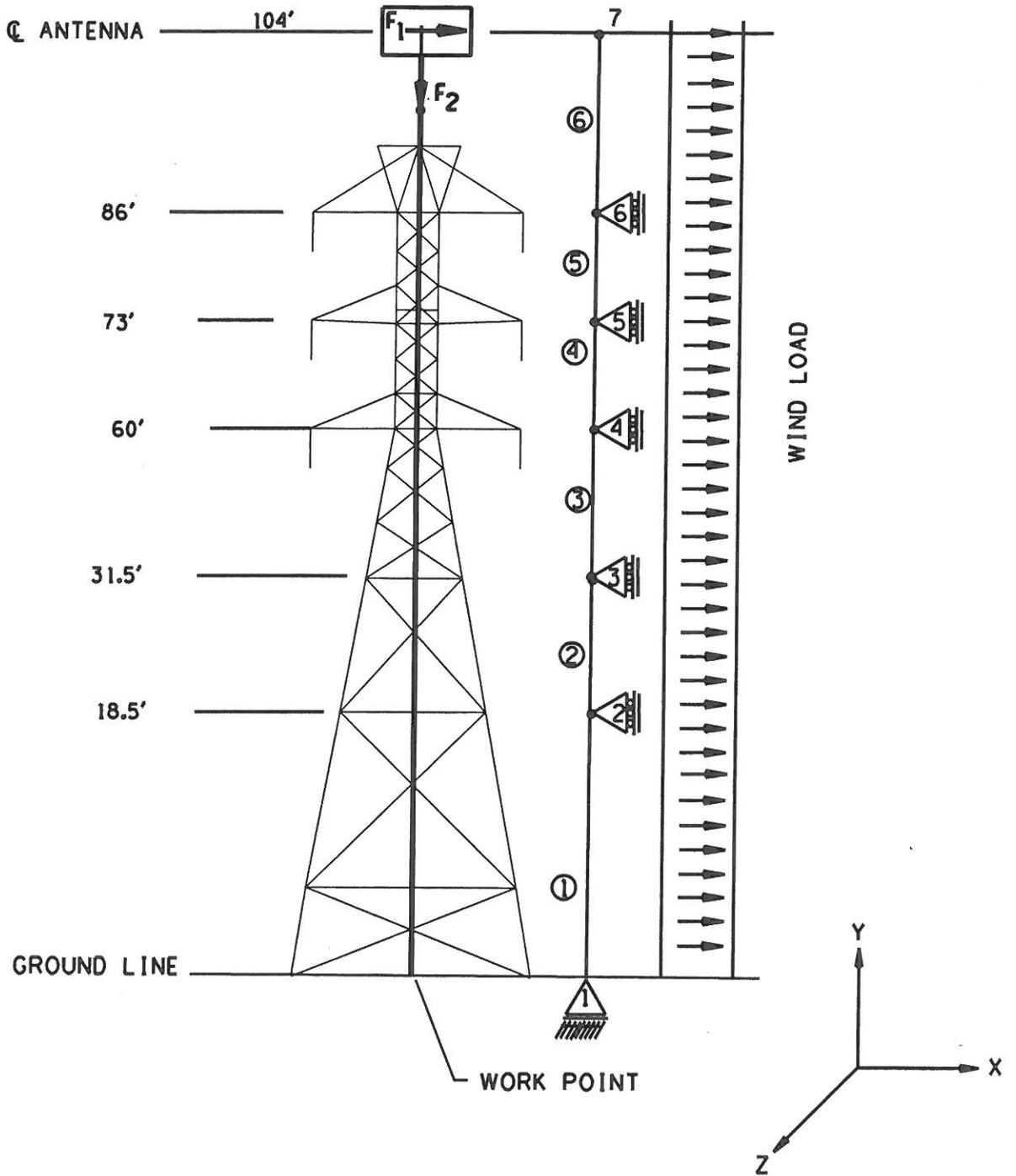
P.O. BOX 2021
ROANOKE VA. 24022
Phone 540-562-7055

COMPUTER DRAWING
MANUAL REVISIONS
NOT PERMITTED

SAWMILL
P.C.S. ANTENNA SITE
TOWER 29

DWG. NO. S-2

JOB NO: 660-173



F_1 = WIND ON ANTENNA & MOUNT
 F_2 = WEIGHT ANTENNA MOUNT & ICE



ENG. BY: KWH TRANS. LINE PROJECTS ENGINEERING

CH. BY: KWH BETHEL - SAWMILL 138 kV

DR. BY: SCALE: NTS DATE: 02-17-04

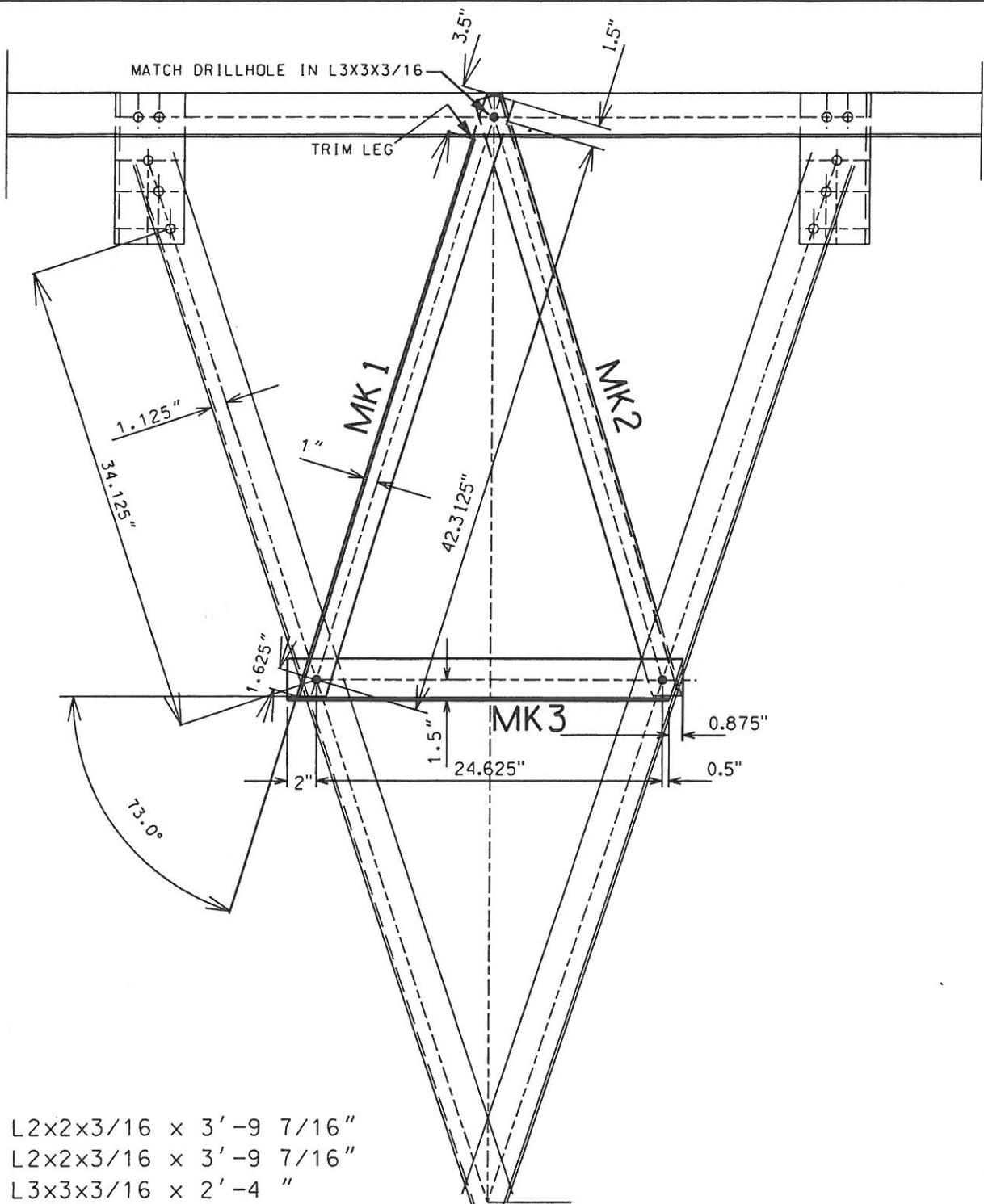
P.O. BOX 2021
 ROANOKE VA. 24022
 Phone 540-562-7055

COMPUTER DRAWING
 MANUAL REVISIONS
 NOT PERMITTED

BETHEL-SAWMILL
 P.C.S. ANTENNA SITE
 TOWER # 29

DWG. NO. S-3

JOB NO: 660-173

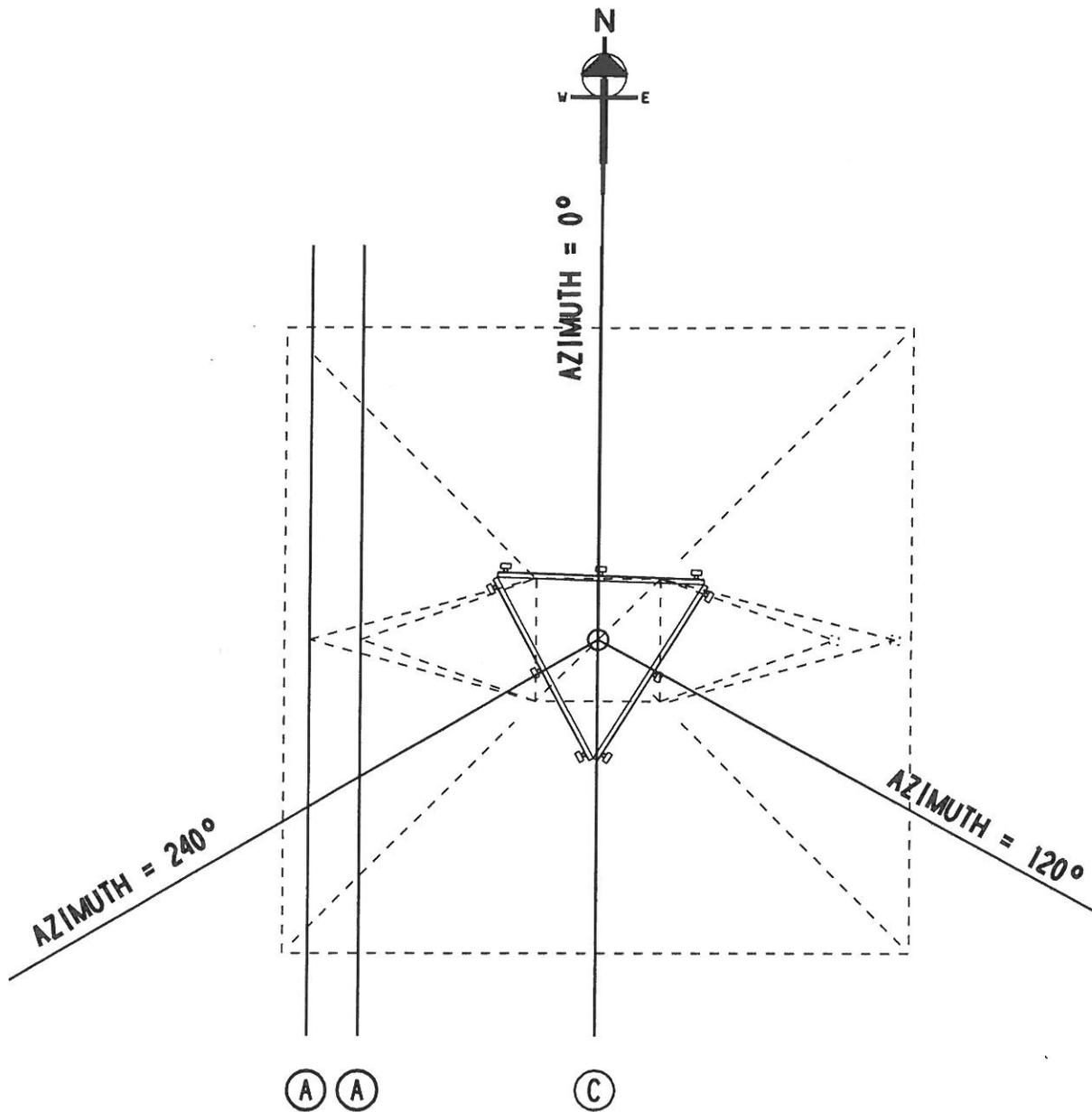


- MK1 L2x2x3/16 x 3'-9 7/16"
- MK2 L2x2x3/16 x 3'-9 7/16"
- MK3 L3x3x3/16 x 2'-4 "

11/16" HOLES FOR 5/8"X1 3/4" A394
 TYPE 1 BOLTS W/ NUT & LW

DETAIL 1
 DETAIL 2 (OPPOSITE)
 NTS

TRANS. LINE PROJECTS ENGINEERING		BETHEL-SAWMILL 138 kV LINE		SAWMILL P.C.S. ANTENNA SITE TOWER 29
CH. BY : KWH	DR. BY :	SCALE: NTS	DATE : 02-16-04	
AEP AMERICAN ELECTRIC POWER	P.O. BOX 2021 ROANOKE VA. 24022 Phone 540-562-7055		COMPUTER DRAWING MANUAL REVISIONS NOT PERMITTED	DWG. NO. S-4
				JOB NO: 660-173



- (A) CONDUCTOR (3) - 636,500 CM ACSR 26/7 @ 10000 LBS. NESC HL
- (C) STATIC WIRE (1): 1 WIRE - 3/8 EHS 7 STRAND-GW @ 5020 LBS. NESC HL

TRANS. LINE PROJECTS ENGINEERING		BETHEL-SAWMILL 138 kV LINE		SAWMILL P.C.S. ANTENNA SITE VERIZON TOWER 29	
CH. BY : KWH	DR. BY : KWH	SCALE: NTS	DATE : 02-16-04		
 AMERICAN ELECTRIC POWER	P.O. BOX 2021 ROANOKE VA. 24022 Phone 540-562-7055		COMPUTER DRAWING MANUAL REVISIONS NOT PERMITTED		DWG. NO. D-1 JOB NO: 660-173

AEP Transmission Line Engineering
 Structure Engineer Keith Hemme
 Drawing Number: **660 - 173**

PCS Co-Location Design Summary

Carrier: VERIZON

Site Name: SAWMILL

Line Information:

Line Name: BETHEL-SAWMILL 138 kV line

Structure No.: 29

Tower Type: N/A

Circuit Name	No.	Description	Design Condition
BETHEL-SAWMILL 138 kV	1	3/8 EHS 7 STRAND	5020 lb.
	3	636kcm ASCR 26/7	10000 lb.

Antenna Information:

	Qty	Antenna Type	*Elev ft	Az deg	Q ty	Coax Type	Dia. In.	Remarks (antenna dimensions) In.
A	4	ALLGON 7125.16	96	0	4	LDF7-50A	1 5/8	52 X 17.3 X11.4 4
B	4	ALLGON 7125.16	96	120	4	LDF7-50A	1 5/8	52 X 17.3 X11.4 4
C	4	ALLGON 7125.16	96	240	4	LDF7-50A	1 5/8	52 X 17.3 X11.4 4

- * Elevations approximate.



AEP: America's Energy Partner®

TRANSMISSION LINE ENGINEERING

BETHEL - SAWMILL 138 kV line

AEP Dwg No. 660-173-D2

date: 2/16/04

AEP Transmission Line Engineering
 Structure Engineer Keith Hemme

Drawing Number: **660 - 173**

PCS Co-Location Design Summary

Carrier: VERIZON

Site Name: SAWMILL

Loading Information: _____ Conductor Attachment Type: **SUSPENSION**

Wind Span: 655 ft Vertical Span: 755 ft Line Angle: 0°

Load Case No.	Load Case Name	Wind Speed mph	Radial Ice in	Basic Wind Pressure lbs/sqft	Wind Pressure on Twr lbs/sqft	Wind Pressure on Twr Attach'ts Flat lbs/sqft	Wind Pressure on Twr Attach'ts Round lbs/sqft
<u>Intact Cases</u>							
1	NESC gr B hvy	40	1/2	10	32	16	10
2	High Wind	100	bare	25	100	50	31.25
3	Wind & Ice	50	1	6.25	32	16	10
4	Heavy Ice	0	1 1/4	0	0	0	0
<u>Unbalanced Longitudinal</u>							
5	Unbalanced Ice	50	½ /bare	6.25	32	16	10
6&7	Broken Wire	70	0	12.25	56	28	18
<u>Strain Cases</u>							
N/A	UNBALANCED 1 ICE	50	1 / bare	6.25	32	16	10
N/A	UNBALANCED 1 ¼ ICE	0	1¼ /bare	0	0	0	0

Loading Notes

1. NESC Loading includes overload factors. A vertical overload factor of 1.5 should be included in the weight of the tower and attachments. If this factor decreases the design force of member, an overload factor of 1.0 should be used.
2. The wind pressure on tower shall be applied to the projected area of all members in on one face of the tower. The wind pressure acts in the positive transverse direction. It represents the total pressure on both faces of a square lattice tower. It includes adjustments for shape and gusts.
3. The basic wind pressure represents the wind load applied to the conductors. For conductor loads see attached loading sheets.
4. The reduction of 50% can be applied to the differential tension for the unbalanced ice condition due to insulator deflection and 25% reduction can be applied to the broken wire condition for suspension structures



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TRANSMISSION LINE ENGINEERING

BETHEL - SAWMILL 138 kV line

AEP Dwg No. 660-173-D3

date: 2/16/04