



## SYSTEMS WITH RELIABILITY, LP

BROADCAST ANTENNAS AND TRANSMISSION SYSTEMS

### PATTERN CERTIFICATION

#### DIRECTIONAL FM ANTENNA

**WWCJ**

*June 1, 2012*

<b>Call Letters</b>	: WWCJ
<b>Location</b>	: CAPE MAY, NJ
<b>Frequency</b>	: 89.1 MHz
<b>Channel</b>	: 206B1
<b>Antenna Model</b>	: FMI3D/4-DA-EP
<b>Maximum Antenna Gain</b>	
<b>Vertical</b>	: 3.102 / 4.916 dB
<b>Horizontal</b>	: 1.706 / 2.320 dB

#### ANTENNA DESCRIPTION

A custom designed **FMI3D/4-DA-EP** antenna was used to produce the required directional azimuth pattern. Each antenna bay consists of a circularly polarized "cross-v" dipole-radiating element with a horizontal parasitic system. The array is comprised of four bays, that are spaced one half wavelength apart, mounted to a tower pointing **180 Degrees** true north.

#### DESCRIPTION OF TEST PROCEDURE

The test antenna consisted of two one third scale antenna bays and parasitic system spaced one half wavelength apart. This configuration was mounted to a pipe attached to a one third scale model tower section with the use of one third scale mounting brackets like those supplied with the final antenna. The tower was placed on a 20 ft. high platform. All feed cables were properly grounded during pattern testing. Horizontal parasitic elements were used to obtain the desired directional pattern. The vertical polarization was obtained by adjusting the mounting distance and orientation.

The source antenna, a vertical/horizontal Cavity Backed Radiator antenna configuration was mounted approximately 100 feet from the test antenna. The source's height was adjusted to provide a uniform field at the test antenna location. The CBR antenna was operated in the transmit mode at a frequency of 267.3 MHz. The antenna under test was rotated in a clockwise direction. A gain reference was taken using a dipole tuned to 267.3 MHz. The received signal does not exceed a maximum to minimum ratio of 15 dB.

## TEST RESULTS

The attached calculations verify that the **RMS** value of this antenna is **97.0 %** of the **RMS** value of the pattern authorized in the related construction permit **BMPED-20120502ABP**. The elliptical polarized component **RMS** value is **0.686**. The horizontal polarized component **RMS** value is **0.667**. The vertical polarized component **RMS** value is **0.653**.

Azimuth and elevation plots and associated tabulations of this antenna are included with this package.

**Calculated composite azimuth pattern directivity: 2.123 / 3.269 dB**

Gain in each polarization was calculated using the following relation:

**GAIN = Azimuth Directivity x Elevation Directivity x Power Ratio Between Polarizations**

Using this relationship along with ratio measured at our testing facilities:

**V-Pol. Gain = (2.344)(2.127)(0.622) = 3.102 / 4.916 dB**

**H-Pol. Gain = (2.249)(2.127)(0.378) = 1.706 / 2.320 dB**

## INSTALLATION AND MOUNTING

The antenna is to be mounted in accordance with the supplied drawings. The antenna center of radiation is to be **116.7 meters** (383.0 ft.) above ground level. The antenna total length is **22.56 feet**. No other antennas are to be mounted within **10 feet** of the antenna. No other obstructions other than those specified by original drawings supplied are to be mounted at the same level as the antenna.

The system's orientation and the mounting details are described in the following drawings:

<b>DRAWING NO.</b>	<b>TITLE</b>
1540D00	ANTENNA ELEVATION
1540D01	ANTENNA ORIENTATION
1540D02	PARASITIC PLACEMENT BAY1
1540D03	PARASITIC PLACEMENT BAY2
1540D04	PARASITIC PLACEMENT BAY3
1540D05	PARASITIC PLACEMENT BAY4
2105A10	TEST RANGE SCHEMATIC

The array shall be mounted according to **DWG. 1540D00**. The antenna elements shall be aligned at **180 Degrees** as in **DWG. 1540D01**. The parasitic are to be mounted according to **DRAWINGS 1540D02 through 1540D05**.

## DOCUMENT EXHIBITS

The following exhibits are included as part of this Certificate of Compliance:

<b>Exhibit 1</b>	Elliptical Polarized Azimuth Pattern (Composite) Field Strength Tabulations
<b>Exhibit 2</b>	Measured Horizontal Polarized Azimuth Pattern Measured Field Strength Tabulations (Horizontal)
<b>Exhibit 3</b>	Measured Vertical Polarized Azimuth Pattern Measured Field Strength Tabulations (Vertical)
<b>Exhibit 4</b>	Elevation Pattern Elevation Pattern Tabulations
<b>Exhibit 5</b>	System Data Sheet
<b>Exhibit 6</b>	RMS Calculations
<b>Exhibit 7</b>	Drawings

## TEST EQUIPMENT

<b>Network Analyzer</b>	:	Hewlett Packard Model # 8753C Serial Number: 08753 – 69138
<b>Computer</b>	:	Pentium 3, 450 MHz, Range Program
<b>Printer</b>	:	Hewlett-Packard Laser Jet 6L
<b>Positioner</b>	:	Orbit Controller and Positioner

All equipment was calibrated to ANSI/NCSL Z540-1-1994 specs

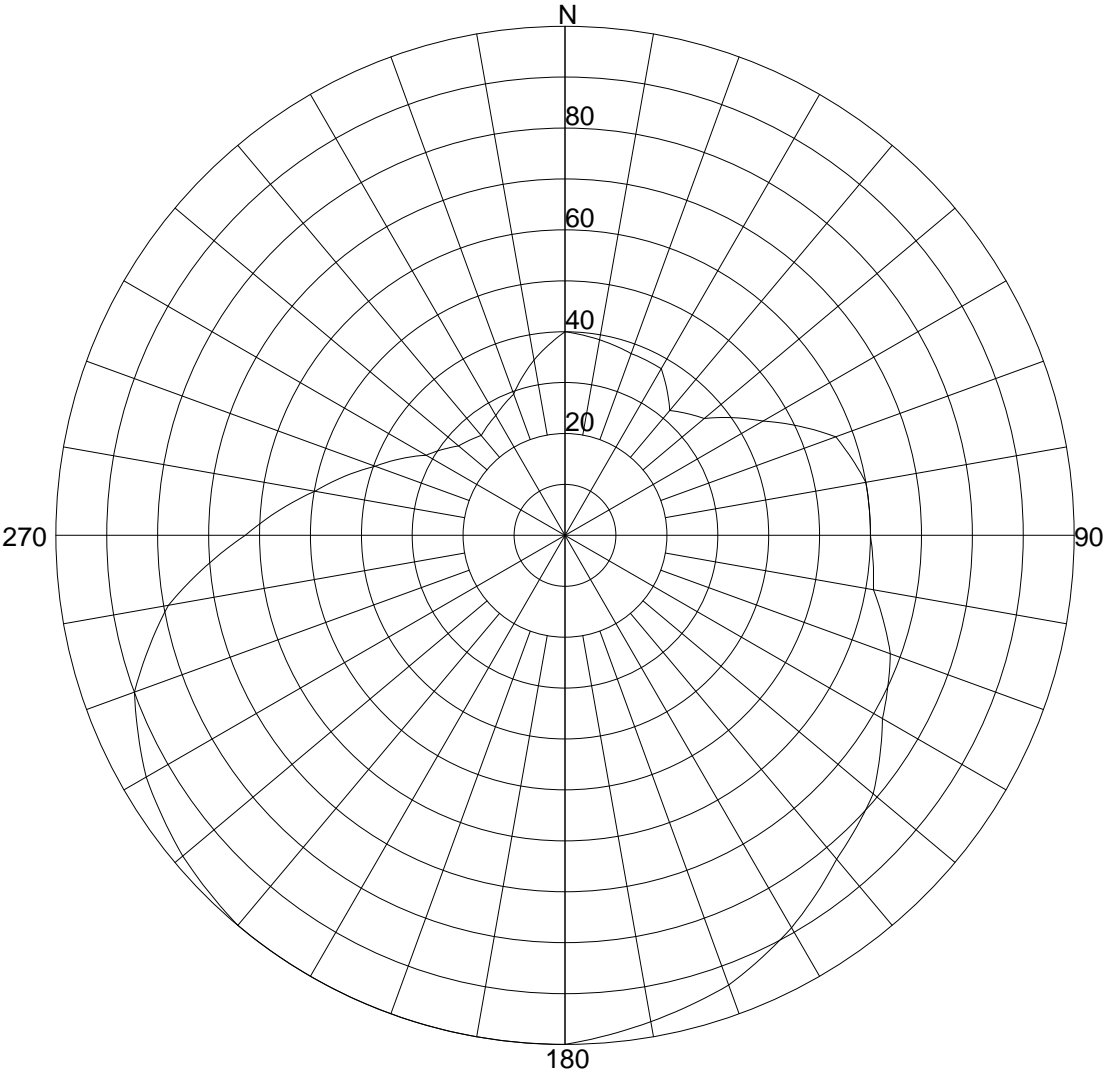
*Prepared by:*



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**Mark A. Gergely**  
Electrical Engineer  
Systems With Reliability LP

Exhibit 1: Elliptical Polarized Azimuth Pattern



Azimuth Pattern

Systems With Reliability

Scale: Linear  
Unit: Relative Field

CLIENT: WWCJ	Date: 6/1/2012
ANTENNA TYPE: FMI3D/4-DA-EP	
FREQUENCY: 89.1 MHz	
PATTERN POL.: Elliptical	CIRCULARITY(+/-dB):
AZ. DIRECTIVITY: 2.12261 / 3.269dB	PATTERN RMS: 0.686

## Relative Field Tabulation(Azimuth)

Azimuth Heading	Normalized Field(dB)	Azimuth Heading	Normalized Field(dB)
0	.4000 (-7.959 )	180	1.0000 ( 0 )
5	.3950 (-8.068 )	185	1.0000 ( 0 )
10	.3900 (-8.179 )	190	1.0000 ( 0 )
15	.3850 (-8.291 )	195	1.0000 ( 0 )
20	.3800 (-8.404 )	200	1.0000 ( 0 )
25	.3790 (-8.427 )	205	1.0000 ( 0 )
30	.3780 (-8.45 )	210	1.0000 ( 0 )
35	.3490 (-9.143 )	215	1.0000 ( 0 )
40	.3200 (-9.897 )	220	1.0000 ( 0 )
45	.3385 (-9.409 )	225	.9900 (-0.087 )
50	.3570 (-8.947 )	230	.9800 (-0.175 )
55	.4030 (-7.894 )	235	.9650 (-0.309 )
60	.4490 (-6.955 )	240	.9500 (-0.446 )
65	.5075 (-5.891 )	245	.9250 (-0.677 )
70	.5660 (-4.944 )	250	.9000 (-0.915 )
75	.5830 (-4.687 )	255	.8455 (-1.458 )
80	.6000 (-4.437 )	260	.7910 (-2.036 )
85	.6000 (-4.437 )	265	.7095 (-2.981 )
90	.6000 (-4.437 )	270	.6280 (-4.041 )
95	.6075 (-4.329 )	275	.5635 (-4.982 )
100	.6150 (-4.222 )	280	.4990 (-6.038 )
105	.6475 (-3.775 )	285	.4480 (-6.974 )
110	.6800 (-3.35 )	290	.3970 (-8.024 )
115	.7000 (-3.098 )	295	.3560 (-8.971 )
120	.7200 (-2.853 )	300	.3150 (-10.034 )
125	.7550 (-2.441 )	305	.2940 (-10.633 )
130	.7900 (-2.047 )	310	.2730 (-11.277 )
135	.8100 (-1.83 )	315	.2645 (-11.551 )
140	.8300 (-1.618 )	320	.2560 (-11.835 )
145	.8600 (-1.31 )	325	.2640 (-11.568 )
150	.8900 (-1.012 )	330	.2720 (-11.309 )
155	.9150 (-0.772 )	335	.2835 (-10.949 )
160	.9400 (-0.537 )	340	.2950 (-10.604 )
165	.9550 (-0.4 )	345	.3225 (-9.829 )
170	.9700 (-0.265 )	350	.3500 (-9.119 )
175	.9850 (-0.131 )	355	.3750 (-8.519 )

## Systems With Reliability

CLIENT: WW CJ

Date: 6/1/2012

ANTENNA TYPE: FMI3D/4-DA-EP

FREQUENCY: 89.1 MHz

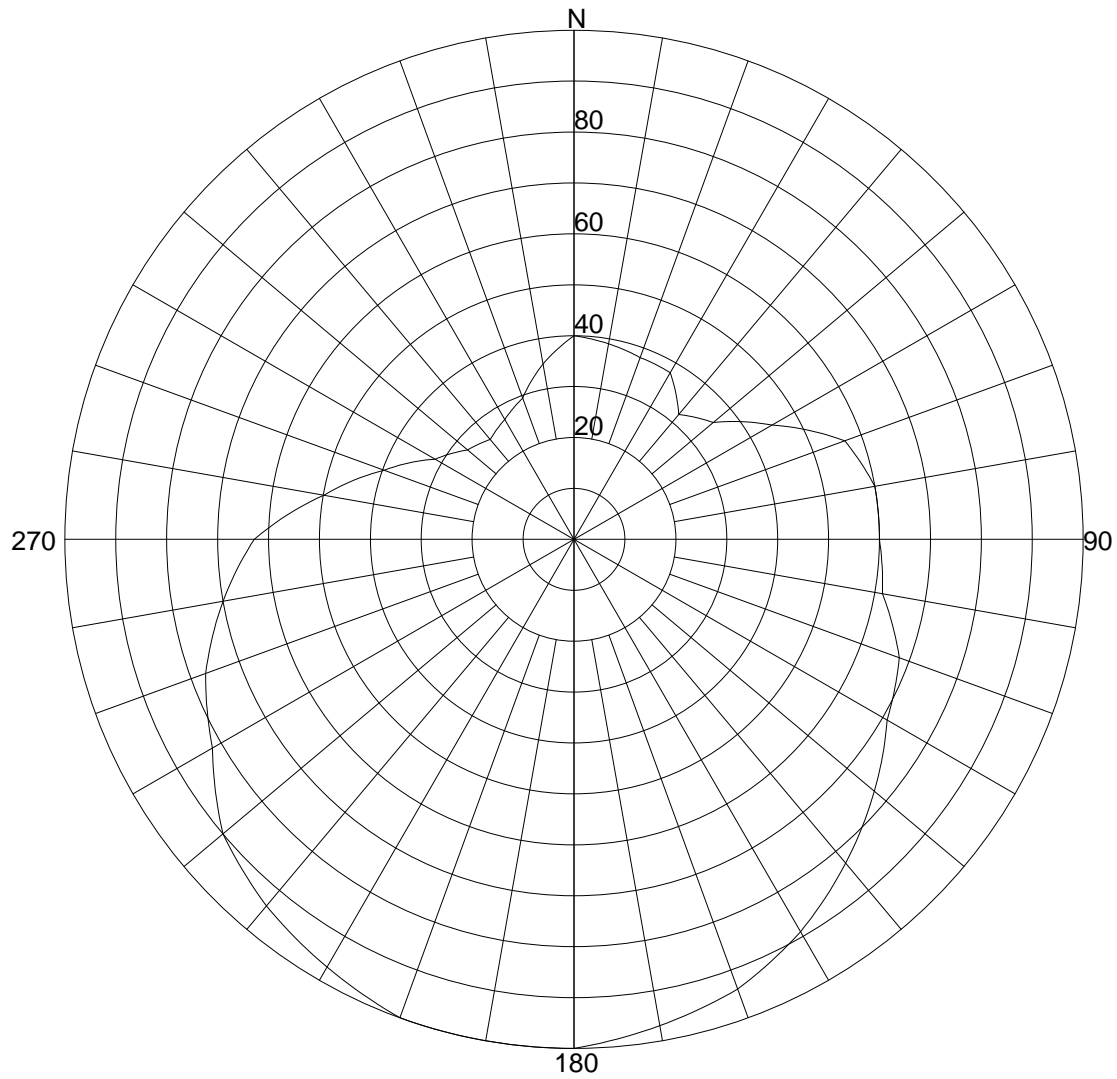
PATTERN POL.: Elliptical

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 2.12261 / 3.269dB

PATTERN RMS: 0.686

## Exhibit 2: Measured Horizontal Polarized Azimuth Pattern



### Azimuth Pattern

## Systems With Reliability

Scale: Linear

Unit: Relative Field

CLIENT: *WWCJ*

Date: 6/1/2012

ANTENNA TYPE: FMI3D/4-DA-EP

FREQUENCY: 89.1 MHz

PATTERN POL.: Horizontal

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 2.2487 / 3.519dB

PATTERN RMS: 0.667

## Relative Field Tabulation(Azimuth)

Azimuth Heading	Normalized Field(dB)	Azimuth Heading	Normalized Field(dB)
0	.4000 (-7.959 )	180	1.0000 ( 0 )
5	.3950 (-8.068 )	185	1.0000 ( 0 )
10	.3900 (-8.179 )	190	1.0000 ( 0 )
15	.3850 (-8.291 )	195	1.0000 ( 0 )
20	.3800 (-8.404 )	200	1.0000 ( 0 )
25	.3790 (-8.427 )	205	.9850 (-0.131 )
30	.3780 (-8.45 )	210	.9700 (-0.265 )
35	.3490 (-9.143 )	215	.9550 (-0.4 )
40	.3200 (-9.897 )	220	.9400 (-0.537 )
45	.3385 (-9.409 )	225	.9200 (-0.724 )
50	.3570 (-8.947 )	230	.9000 (-0.915 )
55	.4030 (-7.894 )	235	.8600 (-1.31 )
60	.4490 (-6.955 )	240	.8200 (-1.724 )
65	.5075 (-5.891 )	245	.7950 (-1.993 )
70	.5660 (-4.944 )	250	.7700 (-2.27 )
75	.5830 (-4.687 )	255	.7350 (-2.674 )
80	.6000 (-4.437 )	260	.7000 (-3.098 )
85	.6000 (-4.437 )	265	.6640 (-3.557 )
90	.6000 (-4.437 )	270	.6280 (-4.041 )
95	.6075 (-4.329 )	275	.5635 (-4.982 )
100	.6150 (-4.222 )	280	.4990 (-6.038 )
105	.6475 (-3.775 )	285	.4480 (-6.974 )
110	.6800 (-3.35 )	290	.3970 (-8.024 )
115	.6950 (-3.16 )	295	.3560 (-8.971 )
120	.7100 (-2.975 )	300	.3150 (-10.034 )
125	.7400 (-2.615 )	305	.2940 (-10.633 )
130	.7700 (-2.27 )	310	.2730 (-11.277 )
135	.8000 (-1.938 )	315	.2645 (-11.551 )
140	.8300 (-1.618 )	320	.2560 (-11.835 )
145	.8600 (-1.31 )	325	.2640 (-11.568 )
150	.8900 (-1.012 )	330	.2720 (-11.309 )
155	.9150 (-0.772 )	335	.2835 (-10.949 )
160	.9400 (-0.537 )	340	.2950 (-10.604 )
165	.9550 (-0.4 )	345	.3225 (-9.829 )
170	.9700 (-0.265 )	350	.3500 (-9.119 )
175	.9850 (-0.131 )	355	.3750 (-8.519 )

## Systems With Reliability

CLIENT: WW CJ

Date: 6/1/2012

ANTENNA TYPE: FMI3D/4-DA-EP

FREQUENCY: 89.1 MHz

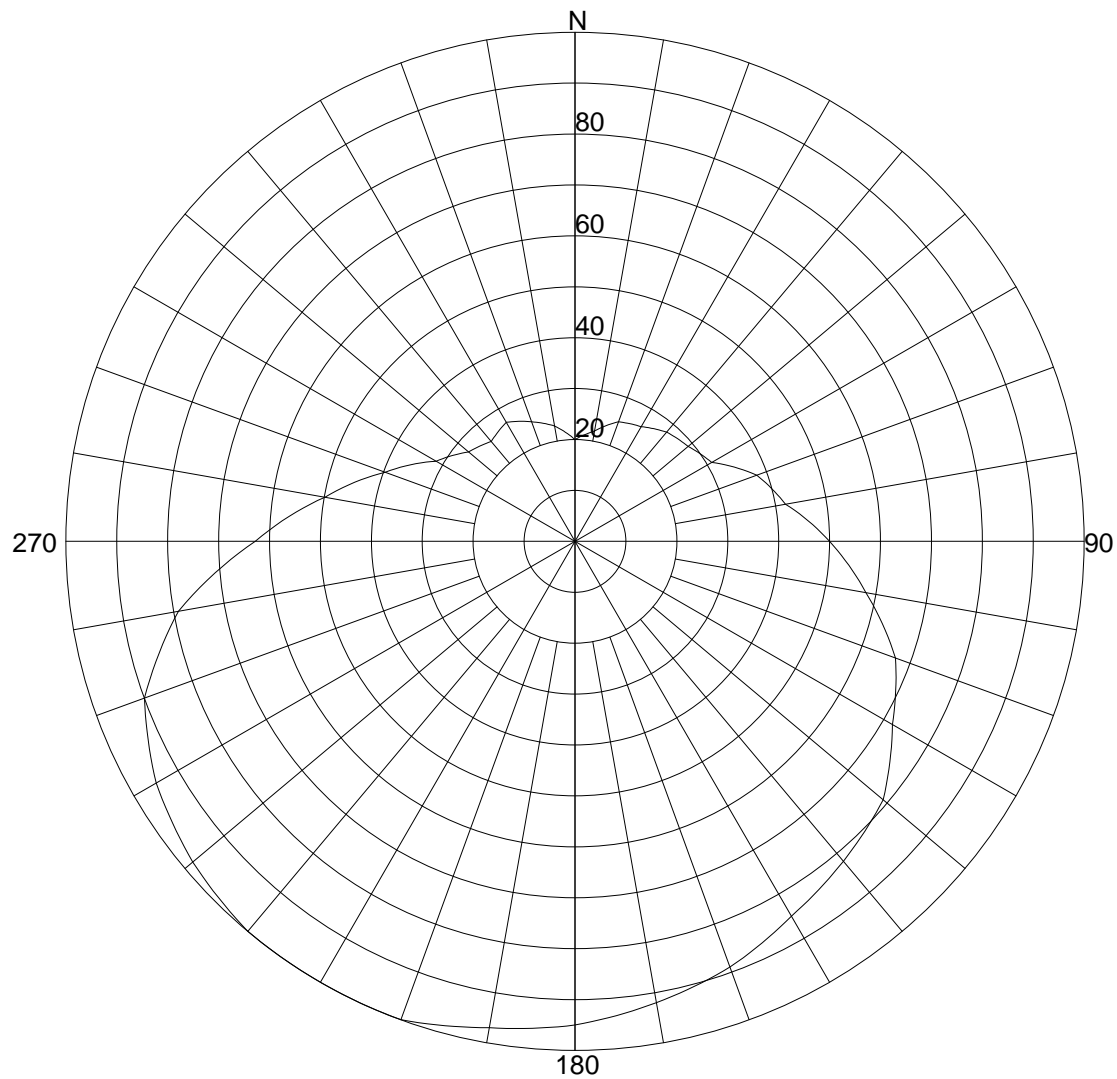
PATTERN POL.: Horizontal

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 2.2487 / 3.519dB

PATTERN RMS: 0.667

## Exhibit 3: Measured Vertical Polarized Azimuth Pattern



### Azimuth Pattern

## Systems With Reliability

Scale: Linear

Unit: Relative Field

CLIENT: *WWCJ*

Date: 6/1/2012

ANTENNA TYPE: FMI3D/4-DA-EP

FREQUENCY: 89.1 MHz

PATTERN POL.: Vertical

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 2.34386 / 3.699dB

PATTERN RMS: 0.653



## Relative Field Tabulation(Azimuth)

Azimuth Heading	Normalized Field(dB)	Azimuth Heading	Normalized Field(dB)
0	.2000 (-13.979 )	180	.9500 (-0.446 )
5	.2100 (-13.556 )	185	.9600 (-0.355 )
10	.2200 (-13.152 )	190	.9700 (-0.265 )
15	.2350 (-12.579 )	195	.9850 (-0.131 )
20	.2500 (-12.041 )	200	1.0000 ( 0 )
25	.2550 (-11.869 )	205	1.0000 ( 0 )
30	.2600 (-11.701 )	210	1.0000 ( 0 )
35	.2700 (-11.373 )	215	1.0000 ( 0 )
40	.2800 (-11.057 )	220	1.0000 ( 0 )
45	.2850 (-10.903 )	225	.9900 (-0.087 )
50	.2900 (-10.752 )	230	.9800 (-0.175 )
55	.3000 (-10.458 )	235	.9650 (-0.309 )
60	.3100 (-10.173 )	240	.9500 (-0.446 )
65	.3450 (-9.244 )	245	.9250 (-0.677 )
70	.3800 (-8.404 )	250	.9000 (-0.915 )
75	.4000 (-7.959 )	255	.8455 (-1.458 )
80	.4200 (-7.535 )	260	.7910 (-2.036 )
85	.4600 (-6.745 )	265	.7095 (-2.981 )
90	.5000 (-6.021 )	270	.6280 (-4.041 )
95	.5400 (-5.352 )	275	.5635 (-4.982 )
100	.5800 (-4.731 )	280	.4990 (-6.038 )
105	.6250 (-4.082 )	285	.4480 (-6.974 )
110	.6700 (-3.479 )	290	.3970 (-8.024 )
115	.6950 (-3.16 )	295	.3560 (-8.971 )
120	.7200 (-2.853 )	300	.3150 (-10.034 )
125	.7550 (-2.441 )	305	.2940 (-10.633 )
130	.7900 (-2.047 )	310	.2730 (-11.277 )
135	.8050 (-1.884 )	315	.2645 (-11.551 )
140	.8200 (-1.724 )	320	.2560 (-11.835 )
145	.8350 (-1.566 )	325	.2630 (-11.601 )
150	.8500 (-1.412 )	330	.2700 (-11.373 )
155	.8700 (-1.21 )	335	.2600 (-11.701 )
160	.8900 (-1.012 )	340	.2500 (-12.041 )
165	.9050 (-0.867 )	345	.2400 (-12.396 )
170	.9200 (-0.724 )	350	.2300 (-12.765 )
175	.9350 (-0.584 )	355	.2150 (-13.351 )

## Systems With Reliability

CLIENT: WW CJ

Date: 6/1/2012

ANTENNA TYPE: FMI3D/4-DA-EP

FREQUENCY: 89.1 MHz

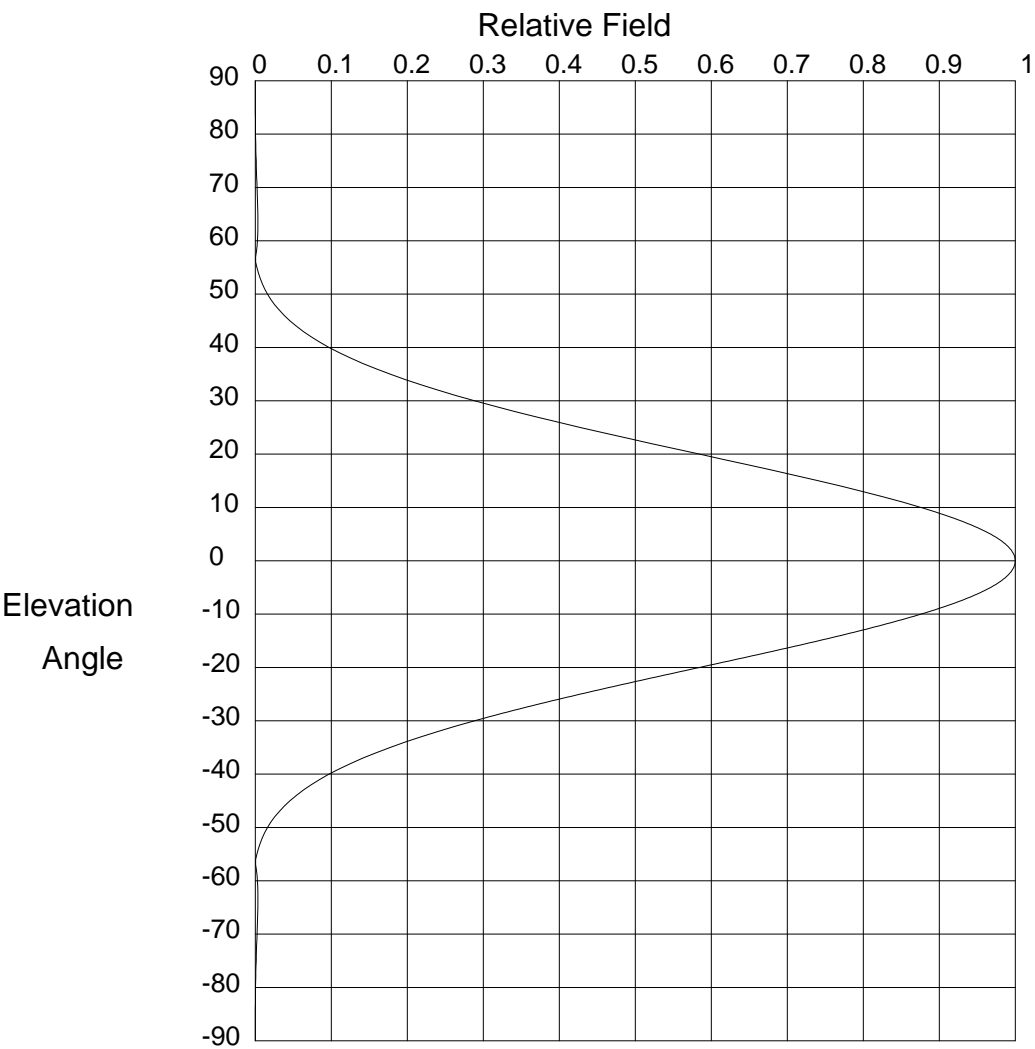
PATTERN POL.: Vertical

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 2.34386 / 3.699dB

PATTERN RMS: 0.653

Exhibit 4: Elevation Pattern



Elevation Pattern

Systems With Reliability

Scale: Linear  
Units: Field, Relative

CLIENT: <i>WWCJ</i>		Date: 6/1/2012
ANTENNA TYPE: <i>FMI3D/4-DA-EP</i>		
FREQUENCY: <i>89.1 MHz</i>		
PATTERN POL.: <i>Elliptical</i>		
DIRECTIVITY(Peak): <i>2.127/3.277 dBd</i>	Beam Tilt (Deg.) :	<i>0</i>
DIRECTIVITY(Horiz): <i>2.127/3.277 dBd</i>	Null Fill(s)(%) :	<i>-34, 0, 0</i>

## Relative Field Tabulation

Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)
90.0	.00 (-50)	52.0	.009 (-40.777)	14.0	.771 (-2.264 )
89.0	.00 (-50)	51.0	.012 (-38.123)	13.0	.799 (-1.95 )
88.0	.00 (-50)	50.0	.016 (-35.791)	12.0	.826 (-1.659 )
87.0	.00 (-92.873)	49.0	.021 (-33.694)	11.0	.852 (-1.393 )
86.0	.00 (-86.999)	48.0	.026 (-31.779)	10.0	.876 (-1.15 )
85.0	.00 (-82.329)	47.0	.032 (-30.01)	9.8	.881 (-1.104 )
84.0	.00 (-78.44)	46.0	.038 (-28.361)	9.6	.885 (-1.06 )
83.0	.00 (-75.101)	45.0	.046 (-26.815)	9.4	.89 (-1.016 )
82.0	.00 (-72.175)	44.0	.054 (-25.358)	9.2	.894 (-0.973 )
81.0	.00 (-69.572)	43.0	.063 (-23.978)	9.0	.898 (-0.931 )
80.0	.00 (-67.23)	42.0	.074 (-22.669)	8.8	.903 (-0.89 )
79.0	.001 (-65.106)	41.0	.085 (-21.423)	8.6	.907 (-0.85 )
78.0	.001 (-63.167)	40.0	.097 (-20.234)	8.4	.911 (-0.81 )
77.0	.001 (-61.389)	39.0	.111 (-19.098)	8.2	.915 (-0.772 )
76.0	.001 (-59.755)	38.0	.126 (-18.012)	8.0	.919 (-0.735 )
75.0	.001 (-58.25)	37.0	.142 (-16.972)	7.8	.923 (-0.699 )
74.0	.001 (-56.865)	36.0	.159 (-15.975)	7.6	.927 (-0.663 )
73.0	.002 (-55.592)	35.0	.177 (-15.019)	7.4	.93 (-0.629 )
72.0	.002 (-54.426)	34.0	.197 (-14.102)	7.2	.934 (-0.595 )
71.0	.002 (-53.363)	33.0	.218 (-13.223)	7.0	.937 (-0.562 )
70.0	.002 (-52.405)	32.0	.24 (-12.379)	6.8	.941 (-0.531 )
69.0	.003 (-51.55)	31.0	.264 (-11.57)	6.6	.944 (-0.5 )
68.0	.003 (-50.804)	30.0	.289 (-10.794)	6.4	.947 (-0.47 )
67.0	.003 (-50.171)	29.0	.314 (-10.049)	6.2	.951 (-0.441 )
66.0	.003 (-49.663)	28.0	.341 (-9.336)	6.0	.954 (-0.413 )
65.0	.003 (-49.294)	27.0	.369 (-8.654)	5.8	.957 (-0.386 )
64.0	.004 (-49.084)	26.0	.398 (-8)	5.6	.959 (-0.36 )
63.0	.004 (-49.067)	25.0	.428 (-7.376)	5.4	.962 (-0.334 )
62.0	.003 (-49.291)	24.0	.458 (-6.78)	5.2	.965 (-0.31 )
61.0	.003 (-49.836)	23.0	.489 (-6.211)	5.0	.968 (-0.287 )
60.0	.003 (-50.844)	22.0	.521 (-5.669)	4.8	.97 (-0.264 )
59.0	.002 (-52.602)	21.0	.552 (-5.154)	4.6	.972 (-0.243 )
58.0	.002 (-55.84)	20.0	.584 (-4.665)	4.4	.975 (-0.222 )
57.0	.001 (-63.775)	19.0	.616 (-4.202)	4.2	.977 (-0.202 )
56.0	.001 (-64.529)	18.0	.648 (-3.765)	4.0	.979 (-0.183 )
55.0	.002 (-53.354)	17.0	.68 (-3.353)	3.8	.981 (-0.165 )
54.0	.004 (-47.825)	16.0	.711 (-2.965)	3.6	.983 (-0.148 )
53.0	.006 (-43.907)	15.0	.741 (-2.602)	3.4	.985 (-0.132 )

## Systems With Reliability

Page 1 of 3

CLIENT: WW CJ

Date: 6/1/2012

ANTENNA TYPE: FMI3D/4-DA-EP

FREQUENCY: 89.1 MHz

PATTERN POL.: Elliptical

DIRECTIVITY(Peak): 2.127/3.277 dBd

Beam Tilt (Deg.) : 0

DIRECTIVITY(Horiz): 2.127/3.277 dBd

Null Fill(s)(%) : -34, 0, 0

## Relative Field Tabulation

Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)
3.2	.987 (-0.117)	-4.4	.975 (-0.222)	-12.0	.826 (-1.659 )
3.0	.988 (-0.103)	-4.6	.972 (-0.243)	-12.2	.821 (-1.716 )
2.8	.99 (-0.09)	-4.8	.97 (-0.264)	-12.4	.815 (-1.773 )
2.6	.991 (-0.077)	-5.0	.968 (-0.287)	-12.6	.81 (-1.831 )
2.4	.992 (-0.066)	-5.2	.965 (-0.31)	-12.8	.804 (-1.89 )
2.2	.994 (-0.055)	-5.4	.962 (-0.334)	-13.0	.799 (-1.95 )
2.0	.995 (-0.046)	-5.6	.959 (-0.36)	-13.2	.793 (-2.011 )
1.8	.996 (-0.037)	-5.8	.957 (-0.386)	-13.4	.788 (-2.072 )
1.6	.997 (-0.029)	-6.0	.954 (-0.413)	-13.6	.782 (-2.135 )
1.4	.997 (-0.022)	-6.2	.951 (-0.441)	-13.8	.776 (-2.199 )
1.2	.998 (-0.016)	-6.4	.947 (-0.47)	-14.0	.771 (-2.264 )
1.0	.999 (-0.011)	-6.6	.944 (-0.5)	-14.2	.765 (-2.33 )
.8	.999 (-0.007)	-6.8	.941 (-0.531)	-14.4	.759 (-2.396 )
.6	1.00 (-0.004)	-7.0	.937 (-0.562)	-14.6	.753 (-2.464 )
.4	1.00 (-0.002)	-7.2	.934 (-0.595)	-14.8	.747 (-2.533 )
.2	1.00 (0)	-7.4	.93 (-0.629)	-15.0	.741 (-2.602 )
.0	1.00 (0)	-7.6	.927 (-0.663)	-15.2	.735 (-2.673 )
-.2	1.00 (0)	-7.8	.923 (-0.699)	-15.4	.729 (-2.745 )
-.4	1.00 (-0.002)	-8.0	.919 (-0.735)	-15.6	.723 (-2.817 )
-.6	1.00 (-0.004)	-8.2	.915 (-0.772)	-15.8	.717 (-2.891 )
-.8	.999 (-0.007)	-8.4	.911 (-0.81)	-16.0	.711 (-2.965 )
-1.0	.999 (-0.011)	-8.6	.907 (-0.85)	-16.2	.705 (-3.041 )
-1.2	.998 (-0.016)	-8.8	.903 (-0.89)	-16.4	.698 (-3.117 )
-1.4	.997 (-0.022)	-9.0	.898 (-0.931)	-16.6	.692 (-3.195 )
-1.6	.997 (-0.029)	-9.2	.894 (-0.973)	-16.8	.686 (-3.273 )
-1.8	.996 (-0.037)	-9.4	.89 (-1.016)	-17.0	.68 (-3.353 )
-2.0	.995 (-0.046)	-9.6	.885 (-1.06)	-17.2	.674 (-3.433 )
-2.2	.994 (-0.055)	-9.8	.881 (-1.104)	-17.4	.667 (-3.515 )
-2.4	.992 (-0.066)	-10.0	.876 (-1.15)	-17.6	.661 (-3.597 )
-2.6	.991 (-0.077)	-10.2	.871 (-1.197)	-17.8	.655 (-3.68 )
-2.8	.99 (-0.09)	-10.4	.867 (-1.244)	-18.0	.648 (-3.765 )
-3.0	.988 (-0.103)	-10.6	.862 (-1.293)	-18.2	.642 (-3.85 )
-3.2	.987 (-0.117)	-10.8	.857 (-1.342)	-18.4	.636 (-3.937 )
-3.4	.985 (-0.132)	-11.0	.852 (-1.393)	-18.6	.629 (-4.024 )
-3.6	.983 (-0.148)	-11.2	.847 (-1.444)	-18.8	.623 (-4.113 )
-3.8	.981 (-0.165)	-11.4	.842 (-1.497)	-19.0	.616 (-4.202 )
-4.0	.979 (-0.183)	-11.6	.837 (-1.55)	-19.2	.61 (-4.293 )
-4.2	.977 (-0.202)	-11.8	.831 (-1.604)	-19.4	.604 (-4.385 )

## Systems With Reliability

Page 2 of 3

CLIENT: WW CJ

Date: 6/1/2012

ANTENNA TYPE: FMI3D/4-DA-EP

FREQUENCY: 89.1 MHz

PATTERN POL.: Elliptical

DIRECTIVITY(Peak): 2.127/3.277 dBd

Beam Tilt (Deg.) : 0

DIRECTIVITY(Horiz): 2.127/3.277 dBd

Null Fill(s)(%) : -34, 0, 0

## Relative Field Tabulation

Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)
-19.6	.597 (-4.477)	-27.2	.364 (-8.788)	-54.0	.004 (-47.825 )
-19.8	.591 (-4.571)	-27.4	.358 (-8.923)	-55.0	.002 (-53.354 )
-20.0	.584 (-4.665)	-27.6	.352 (-9.06)	-56.0	.001 (-64.529 )
-20.2	.578 (-4.761)	-27.8	.347 (-9.197)	-57.0	.001 (-63.775 )
-20.4	.572 (-4.858)	-28.0	.341 (-9.336)	-58.0	.002 (-55.84 )
-20.6	.565 (-4.956)	-28.2	.336 (-9.477)	-59.0	.002 (-52.602 )
-20.8	.559 (-5.054)	-28.4	.33 (-9.618)	-60.0	.003 (-50.844 )
-21.0	.552 (-5.154)	-28.6	.325 (-9.761)	-61.0	.003 (-49.836 )
-21.2	.546 (-5.255)	-28.8	.32 (-9.904)	-62.0	.003 (-49.291 )
-21.4	.54 (-5.357)	-29.0	.314 (-10.049)	-63.0	.004 (-49.067 )
-21.6	.533 (-5.46)	-29.2	.309 (-10.196)	-64.0	.004 (-49.084 )
-21.8	.527 (-5.564)	-29.4	.304 (-10.343)	-65.0	.003 (-49.294 )
-22.0	.521 (-5.669)	-29.6	.299 (-10.492)	-66.0	.003 (-49.663 )
-22.2	.514 (-5.775)	-29.8	.294 (-10.642)	-67.0	.003 (-50.171 )
-22.4	.508 (-5.883)	-30.0	.289 (-10.794)	-68.0	.003 (-50.804 )
-22.6	.502 (-5.991)	-31.0	.264 (-11.57)	-69.0	.003 (-51.55 )
-22.8	.495 (-6.1)	-32.0	.24 (-12.379)	-70.0	.002 (-52.405 )
-23.0	.489 (-6.211)	-33.0	.218 (-13.223)	-71.0	.002 (-53.363 )
-23.2	.483 (-6.322)	-34.0	.197 (-14.102)	-72.0	.002 (-54.426 )
-23.4	.477 (-6.435)	-35.0	.177 (-15.019)	-73.0	.002 (-55.592 )
-23.6	.471 (-6.549)	-36.0	.159 (-15.975)	-74.0	.001 (-56.865 )
-23.8	.464 (-6.664)	-37.0	.142 (-16.972)	-75.0	.001 (-58.25 )
-24.0	.458 (-6.78)	-38.0	.126 (-18.012)	-76.0	.001 (-59.755 )
-24.2	.452 (-6.897)	-39.0	.111 (-19.098)	-77.0	.001 (-61.389 )
-24.4	.446 (-7.015)	-40.0	.097 (-20.234)	-78.0	.001 (-63.167 )
-24.6	.44 (-7.134)	-41.0	.085 (-21.423)	-79.0	.001 (-65.106 )
-24.8	.434 (-7.254)	-42.0	.074 (-22.669)	-80.0	.00 (-67.23 )
-25.0	.428 (-7.376)	-43.0	.063 (-23.978)	-81.0	.00 (-69.572 )
-25.2	.422 (-7.498)	-44.0	.054 (-25.358)	-82.0	.00 (-72.175 )
-25.4	.416 (-7.622)	-45.0	.046 (-26.815)	-83.0	.00 (-75.101 )
-25.6	.41 (-7.747)	-46.0	.038 (-28.361)	-84.0	.00 (-78.44 )
-25.8	.404 (-7.873)	-47.0	.032 (-30.01)	-85.0	.00 (-82.329 )
-26.0	.398 (-8)	-48.0	.026 (-31.779)	-86.0	.00 (-86.999 )
-26.2	.392 (-8.129)	-49.0	.021 (-33.694)	-87.0	.00 (-92.873 )
-26.4	.386 (-8.258)	-50.0	.016 (-35.791)	-88.0	.00 (-50 )
-26.6	.381 (-8.389)	-51.0	.012 (-38.123)	-89.0	.00 (-50 )
-26.8	.375 (-8.521)	-52.0	.009 (-40.777)	-90.0	.00 (-50 )
-27.0	.369 (-8.654)	-53.0	.006 (-43.907)	90.0	.00 (-50 )

## Systems With Reliability

Page 3 of 3

CLIENT: WWCI

Date: 6/1/2012

ANTENNA TYPE: FMI3D/4-DA-EP

FREQUENCY: 89.1 MHz

PATTERN POL.: Elliptical

DIRECTIVITY(Peak): 2.127/3.277 dBd

Beam Tilt (Deg.) : 0

DIRECTIVITY(Horiz): 2.127/3.277 dBd

Null Fill(s)(%) : -34, 0, 0



# SYSTEMS WITH RELIABILITY, LP

BROADCAST ANTENNAS AND TRANSMISSION SYSTEMS

## SYSTEM DATA SHEET

<b>Call Sign</b>	WWCJ
<b>Customer</b>	Mercer County Community College
<b>Contact</b>	Peter Fretwell
<b>Location</b>	Cape May, NJ
<b>Antenna Model</b>	FMI3D/4-DA-EP
<b>Channel / Frequency</b>	206B1 / 89.1 MHz

### ELECTRICAL SPECIFICATIONS

#### Antenna Specifications:

	H-POL			V. Pol.		
License ERP ( KW)	8.200	9.138	dBk	13.500	11.303	dBk
FCC Limit Pattern Directivity	1.998	3.006	dB	1.998	3.006	dB
Elevation Directivity	2.127	3.278	dB	2.127	3.278	dB
Azimuth Directivity	2.249	3.519	dB	2.344	3.699	dB
Composite Pattern	2.123	3.269	dB	2.123	3.269	dB
Polarization Ratio	0.378	-4.226	dB	0.622	-2.061	dB
<b>RMS Comp./RMS Limit</b>	97.0	%		97.0	%	
Antenna Efficiency	100	%		100	%	
Power Ratio ( Pol. Ratio X Efficiency)	0.378	-4.226	dB	0.622	-2.061	dB
Antenna Gain	1.706	2.320	dB	3.102	4.916	dB
<b>Antenna Input Power (KW)</b>	4.806	kW	6.818	dBk		

#### Feed Line Specifications:

Line Type	HJ7-50A	1 5/8" Air	50 $\Omega$
Attenuation Per 100 ft (dB)		0.191	dB
Line Length (ft) Given		510.00	ft.
Total Line Attenuation (dB)		0.974	dB
Line Efficiency		79.91	%
<b>Power Input to the Line (kW)</b>		6.015	kW
			7.792 dBk

### MECHANICAL SPECIFICATIONS

<b>No. Of Bays</b>	4		
<b>Antenna Aperture</b>	16.56	ft.	
<b>Antenna Total Length</b>	22.56	ft.	6.88 m
<b>Center of Radiation AGL</b>	383.00	ft.	116.73 m
<b>Antenna Weight with Brackets</b>	350.00	lbs.	159.09 kg
<b>Windload (50/33 psf) / CaAc</b>	595.00	lbs.	17.00 ft^2

Prepared by:

Mark A. Gergely  
SWR, LP, Engineering



## SYSTEMS WITH RELIABILITY, LP

### Broadcast Antennas & Transmission Systems

#### WWCJ Composite E-POL RMS Comparison

PROPOSED ANTENNA		DESIGNED ANTENNA	
Azimuth Heading	Relative Field	Azimuth Heading	Relative Field
0	0.401	0	0.400
10	0.405	10	0.390
20	0.403	20	0.380
30	0.378	30	0.378
40	0.332	40	0.320
50	0.357	50	0.357
60	0.449	60	0.449
70	0.566	70	0.566
80	0.600	80	0.600
90	0.600	90	0.600
100	0.615	100	0.615
110	0.720	110	0.680
120	0.763	120	0.720
130	0.825	130	0.790
140	0.900	140	0.830
150	1.000	150	0.890
160	1.000	160	0.940
170	1.000	170	0.970
180	1.000	180	1.000
190	1.000	190	1.000
200	1.000	200	1.000
210	1.000	210	1.000
220	1.000	220	1.000
230	1.000	230	0.980
240	1.000	240	0.950
250	1.000	250	0.900
260	0.791	260	0.791
270	0.628	270	0.628
280	0.499	280	0.499
290	0.397	290	0.397
300	0.315	300	0.315
310	0.273	310	0.273
320	0.256	320	0.256
330	0.280	330	0.272
340	0.295	340	0.295
350	0.368	350	0.350
Sum of Relative Field Squared :	18.046	Sum of Relative Field Squared :	16.982
Sum Divided by 36 (Readings) :	0.501	Sum Divided by 36 (Readings) :	0.472
Square Root :	0.708	Square Root :	0.687
Percentage of Construction Permit Antenna Filled :		97.0%	

**NOTES:**

1. REFERENCE DWG. 1540D01 FOR ANTENNA ORIENTATION.
2. REFERENCE DWG. 1540D02 FOR BAY 1 PARASITIC PLACEMENT.
3. REFERENCE DWG. 1540D03 FOR BAY 2 PARASITIC PLACEMENT.
4. REFERENCE DWG. 1540D04 FOR BAY 3 PARASITIC PLACEMENT.
5. REFERENCE DWG. 1540D05 FOR BAY 4 PARASITIC PLACEMENT.
6. INSTALL THE FACE MOUNT PIPE SUPPORT BRACKETS AS CLOSE AS POSSIBLE TO EACH INTER. BAY GROUNDING BRACKET & THE INPUT OF THE CENTER TEE.
7. USE THE (2) HOSE CLAMPS TO ATTACH THE BRAIDED COPPER GROUND STRAP TO THE 30.00 In. LONG HORIZONTAL CUT SECTION & ATTACH THE ANGLE MEMBER ADAPTER TO THE CENTER FACE MOUNT PIPE SUPPORT BRACKET.

DRAWING NUMBER: 1540D00

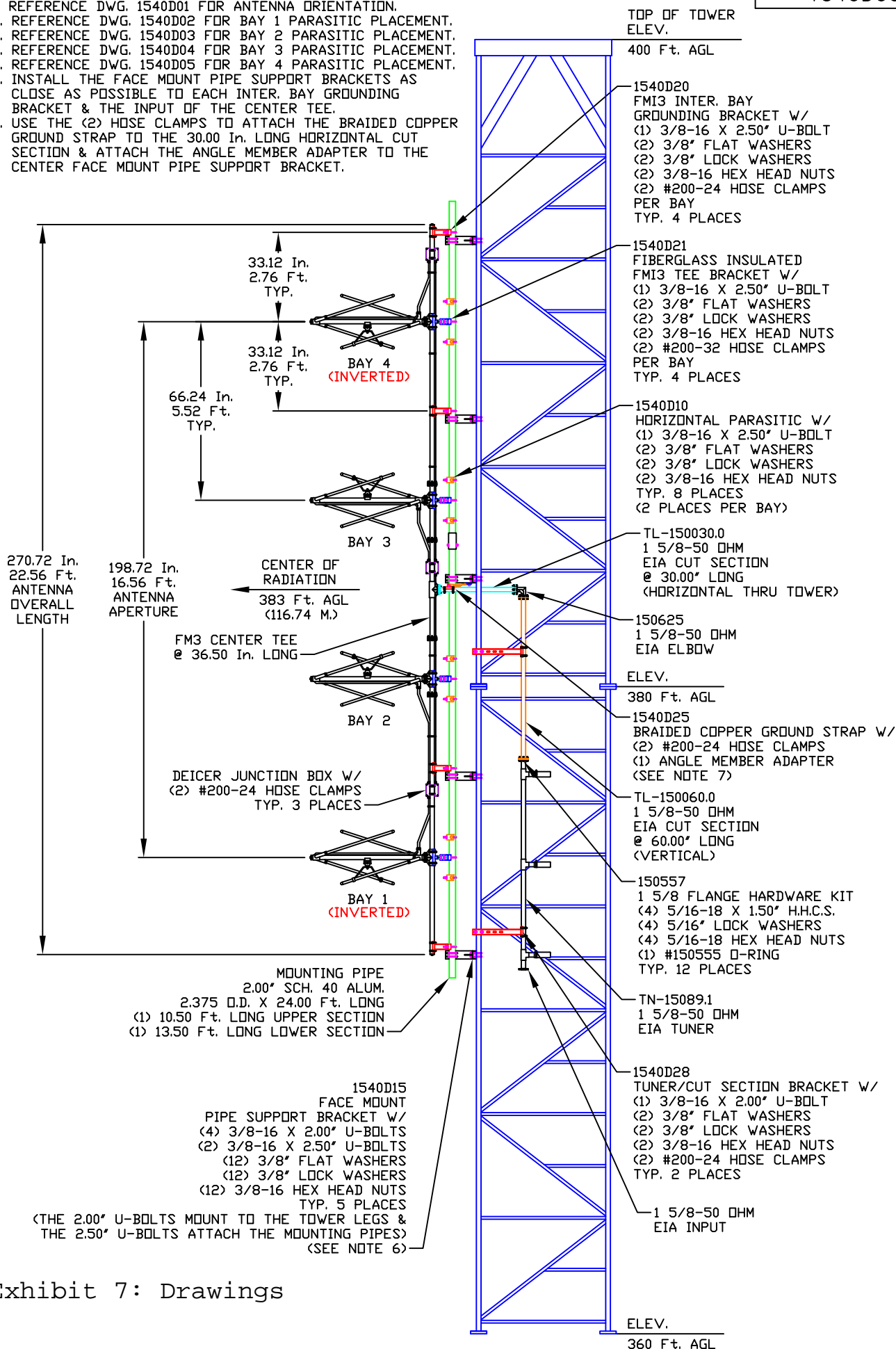


Exhibit 7: Drawings



SYSTEMS WITH RELIABILITY, INC.  
619 INDUSTRIAL PARK ROAD  
EBENSBURG, PENNSYLVANIA 15931

TITLE: FM13D/4-DA-EP, FREQ. 89.1  
WWCJ, CAPE MAY, NJ

MATERIAL:

SIZE REV APPR. DATE  
C 1  
2  
3

ENGINEER:

SCALE: NTS

NAME: RAC

DATE: 12/6/11

DRAWING NUMBER: 1540D00

SHEET 1 OF 1



**DRAWING  
NUMBER:** 1540D01

TOLERANCES		REVISION RECORD	
.X	± .015	REV	APPROVAL DATE
.XX	± .005		
.XXX	± .002		
X/X	± 1/32		
DEG.	± 1/2		
UNLESS OTHERWISE SPECIFIED			
BY THIS DRAWING		DRAWING NUMBER: 1540D01	
NAME: RAC	DATE: 12/6/11	SHEET 1 OF 1	



**SYSTEMS WITH RELIABILITY, INC**  
**619 INDUSTRIAL PARK ROAD**  
**EBensburg, PENNSYLVANIA 15931**

TITLE:	FMI3D/4-DA-EP, FREQ. 89.1 WWCJ, CAPE MAY, NJ
MATERIAL:	ANTENNA ORIENTATION FROM TRUE NORTH

SIZE  
A

PARTS MADE BY THIS DRAWING

SCALE: NTS

NAME: RAC

DATE: 12/6/11

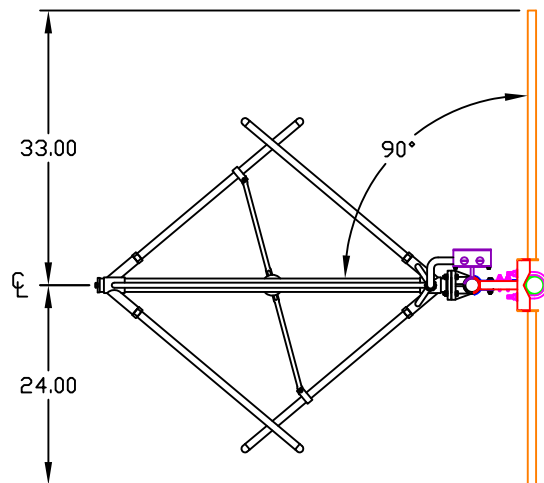
SHEET	1	OF	1
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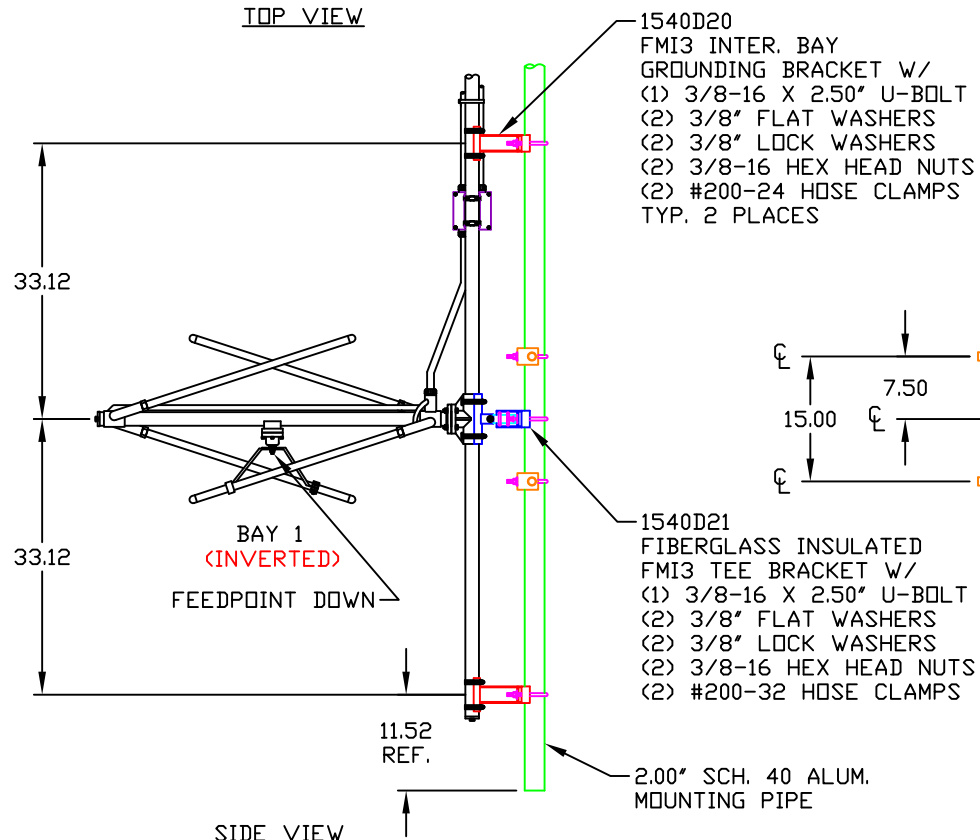
# Exhibit 7: Drawings

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NUMBER:

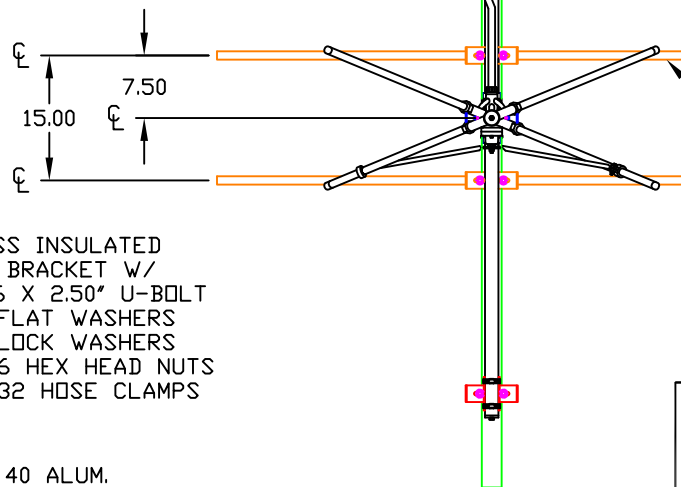
1540D02



TOP VIEW



SIDE VIEW



FRONT VIEW

TOLERANCES	
.X	± .015
.XX	± .005
.XXX	± .002
X/X	± 1/32
DEG.	± 1/2
UNLESS OTHERWISE SPECIFIED	

REVISION RECORD		
REV	APPROVAL	DATE



SYSTEMS WITH RELIABILITY, INC  
619 INDUSTRIAL PARK ROAD  
EBensburg, PENNSYLVANIA 15931

TITLE:

FMI3D/4-DA-EP, FREQ. 89.1  
WWCJ, CAPE MAY, NJ  
PARASITIC PLACEMENT  
BAY 1

MATERIAL:

SIZE

A

PARTS MADE BY THIS DRAWING

SCALE: NTS

NAME: RAC

DATE: 12/6/11

SHEET 1 OF 1

DRAWING  
NUMBER:

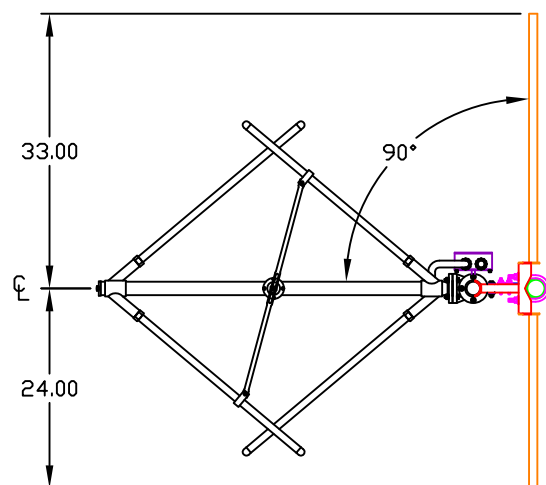
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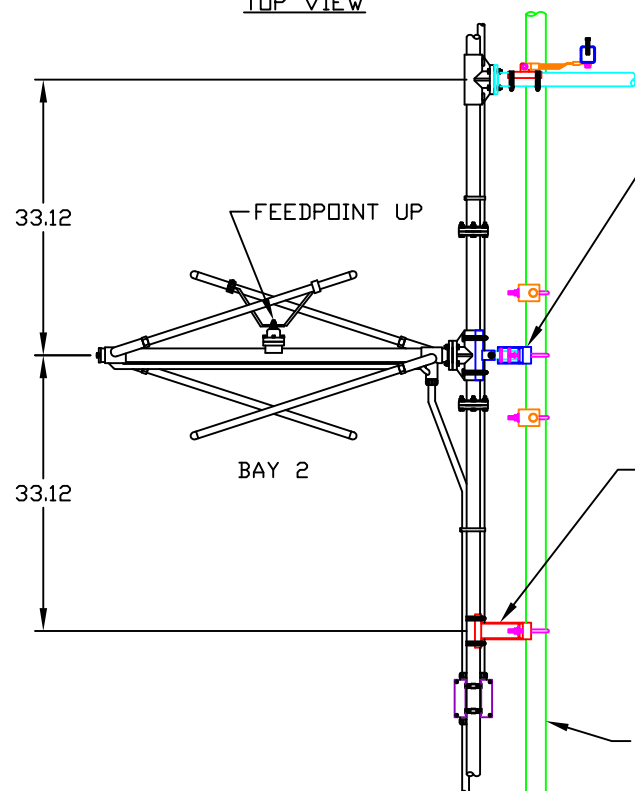
DRAWING  
NUMBER:

1540D03

## Exhibit 7: Drawings

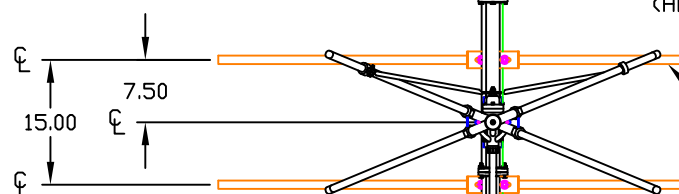


TOP VIEW



SIDE VIEW

1540D21  
FIBERGLASS INSULATED  
FMI3 TEE BRACKET W/  
(1) 3/8-16 X 2.50" U-BOLT  
(2) 3/8" FLAT WASHERS  
(2) 3/8" LOCK WASHERS  
(2) 3/8-16 HEX HEAD NUTS  
(2) #200-32 HOSE CLAMPS



FRONT VIEW

1 5/8-50 OHM  
CENTER TEE  
@ 36.50 In. LONG

1540D25  
BRAIDED COPPER GROUND STRAP W/  
(2) #200-24 HOSE CLAMPS  
(1) ANGLE MEMBER ADAPTER  
(ATTACH THE ANGLE MEMBER ADAPTER  
TO THE CENTER FACE MOUNT PIPE  
SUPPORT BRACKET)

TL-150030.0  
1 5/8-50 OHM  
EIA CUT SECTION  
@ 30.00 In. LONG  
(HORIZONTAL THRU TOWER)

1540D10  
HORIZONTAL PARASITIC W/  
(1) 3/8-16 X 2.50" U-BOLT  
(2) 3/8" FLAT WASHERS  
(2) 3/8" LOCK WASHERS  
(2) 3/8-16 HEX HEAD NUTS  
TYP. 2 PLACES

DEICER JUNCTION BOX W/  
(2) #200-24 HOSE CLAMPS  
(POWER TO BAY 1 & 2)

1540D20  
FMI3 INTER. BAY  
GROUNDING BRACKET W/  
(1) 3/8-16 X 2.50" U-BOLT  
(2) 3/8" FLAT WASHERS  
(2) 3/8" LOCK WASHERS  
(2) 3/8-16 HEX HEAD NUTS  
(2) #200-24 HOSE CLAMPS

2.00" SCH. 40 ALUM.  
MOUNTING PIPE

TOLERANCES	
.X	± .015
.XX	± .005
.XXX	± .002
X/X	± 1/32
DEG.	± 1/2
UNLESS OTHERWISE SPECIFIED	

## REVISION RECORD

REV	APPROVAL	DATE



SYSTEMS WITH RELIABILITY, INC  
619 INDUSTRIAL PARK ROAD  
EBensburg, PENNSYLVANIA 15931

TITLE:

FMI3D/4-DA-EP, FREQ. 89.1  
WWCJ, CAPE MAY, NJ  
PARASITIC PLACEMENT  
BAY 2

MATERIAL:

SIZE

A

PARTS MADE BY THIS DRAWING

SCALE: NTS

NAME: RAC

DATE: 12/6/11

SHEET 1 OF 1

DRAWING  
NUMBER:

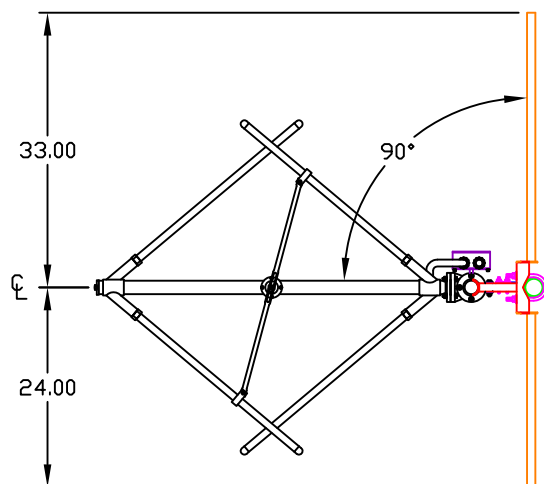
1540D03

NOTE:

DRAWING  
NUMBER:

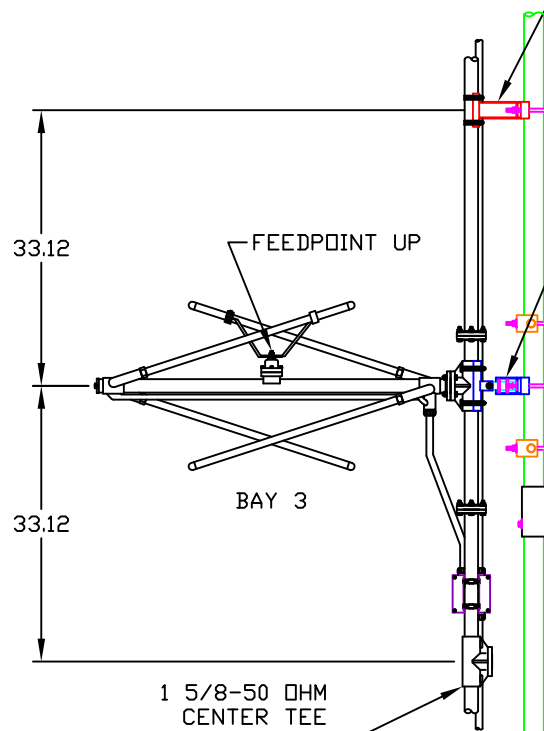
1540D04

# Exhibit 7: Drawings



TOP VIEW

1540D20  
FMI3 INTER. BAY  
GROUNDING BRACKET W/  
(1) 3/8-16 X 2.50" U-BOLT  
(2) 3/8" FLAT WASHERS  
(2) 3/8" LOCK WASHERS  
(2) 3/8-16 HEX HEAD NUTS  
(2) #200-24 HOSE CLAMPS



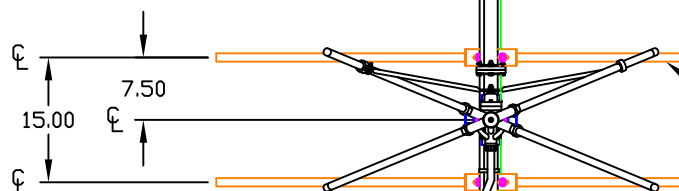
SIDE VIEW

1 5/8-50 OHM  
CENTER TEE  
@ 36.50 In. LONG

1540D21  
FIBERGLASS INSULATED  
FMI3 TEE BRACKET W/  
(1) 3/8-16 X 2.50" U-BOLT  
(2) 3/8" FLAT WASHERS  
(2) 3/8" LOCK WASHERS  
(2) 3/8-16 HEX HEAD NUTS  
(2) #200-32 HOSE CLAMPS

(1) 3/8-16 X 3.50" H.H.C.S.  
(2) 3/8" FLAT WASHERS  
(1) 3/8" LOCK WASHERS  
(1) 3/8-16 HEX HEAD NUT  
(FOR JOINING MOUNTING PIPES)

2.00" SCH. 40 ALUM.  
MOUNTING PIPE



FRONT VIEW

1540D10  
HORIZONTAL PARASITIC W/  
(1) 3/8-16 X 2.50" U-BOLT  
(2) 3/8" FLAT WASHERS  
(2) 3/8" LOCK WASHERS  
(2) 3/8-16 HEX HEAD NUTS  
TYP. 2 PLACES

DEICER JUNCTION BOX W/  
(2) #200-24 HOSE CLAMPS  
(POWER TO BAY 3)

TOLERANCES	
.X	± .015
.XX	± .005
.XXX	± .002
X/X	± 1/32
DEG.	± 1/2
UNLESS OTHERWISE SPECIFIED	

## REVISION RECORD

REV	APPROVAL	DATE

DRAWING  
NUMBER: 1540D04



SYSTEMS WITH RELIABILITY, INC  
619 INDUSTRIAL PARK ROAD  
EBENSBURG, PENNSYLVANIA 15931

TITLE:

FMI3D/4-DA-EP, FREQ. 89.1  
WWCJ, CAPE MAY, NJ  
PARASITIC PLACEMENT  
BAY 3

MATERIAL:

SIZE

A

PARTS MADE BY THIS DRAWING

SCALE: NTS

NAME: RAC

DATE: 12/6/11

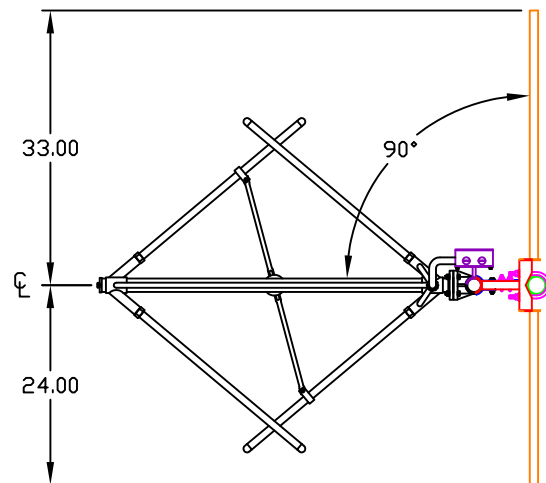
SHEET 1 OF 1

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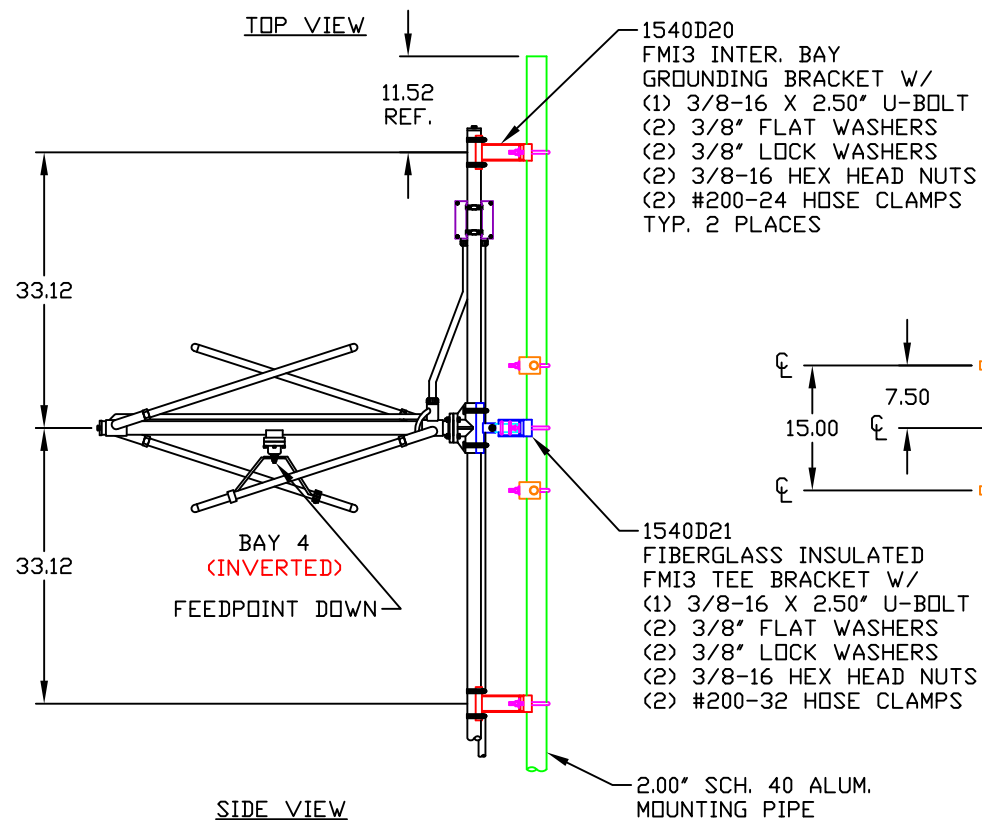
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NUMBER:

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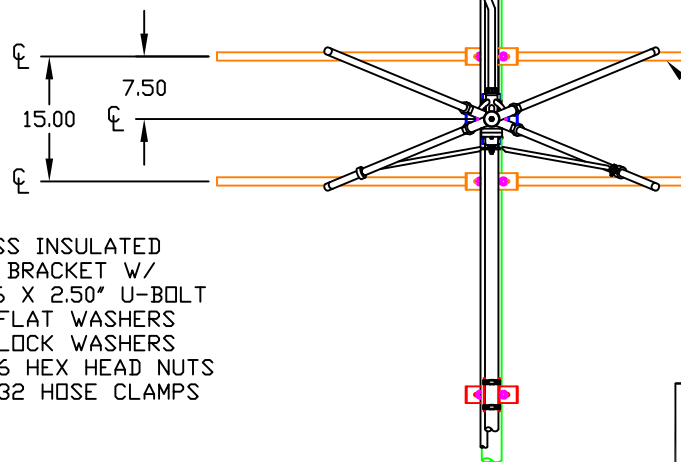
## Exhibit 7: Drawings



TOP VIEW



SIDE VIEW



FRONT VIEW

TOLERANCES	
.X	± .015
.XX	± .005
.XXX	± .002
X/X	± 1/32
DEG.	± 1/2
UNLESS OTHERWISE SPECIFIED	

## REVISION RECORD

REV APPROVAL DATE



SYSTEMS WITH RELIABILITY, INC  
619 INDUSTRIAL PARK ROAD  
EBensburg, PENNSYLVANIA 15931

TITLE:

FMI3D/4-DA-EP, FREQ. 89.1  
WWCJ, CAPE MAY, NJ  
PARASITIC PLACEMENT  
BAY 4

MATERIAL:

SIZE

A

PARTS MADE BY THIS DRAWING

SCALE: NTS

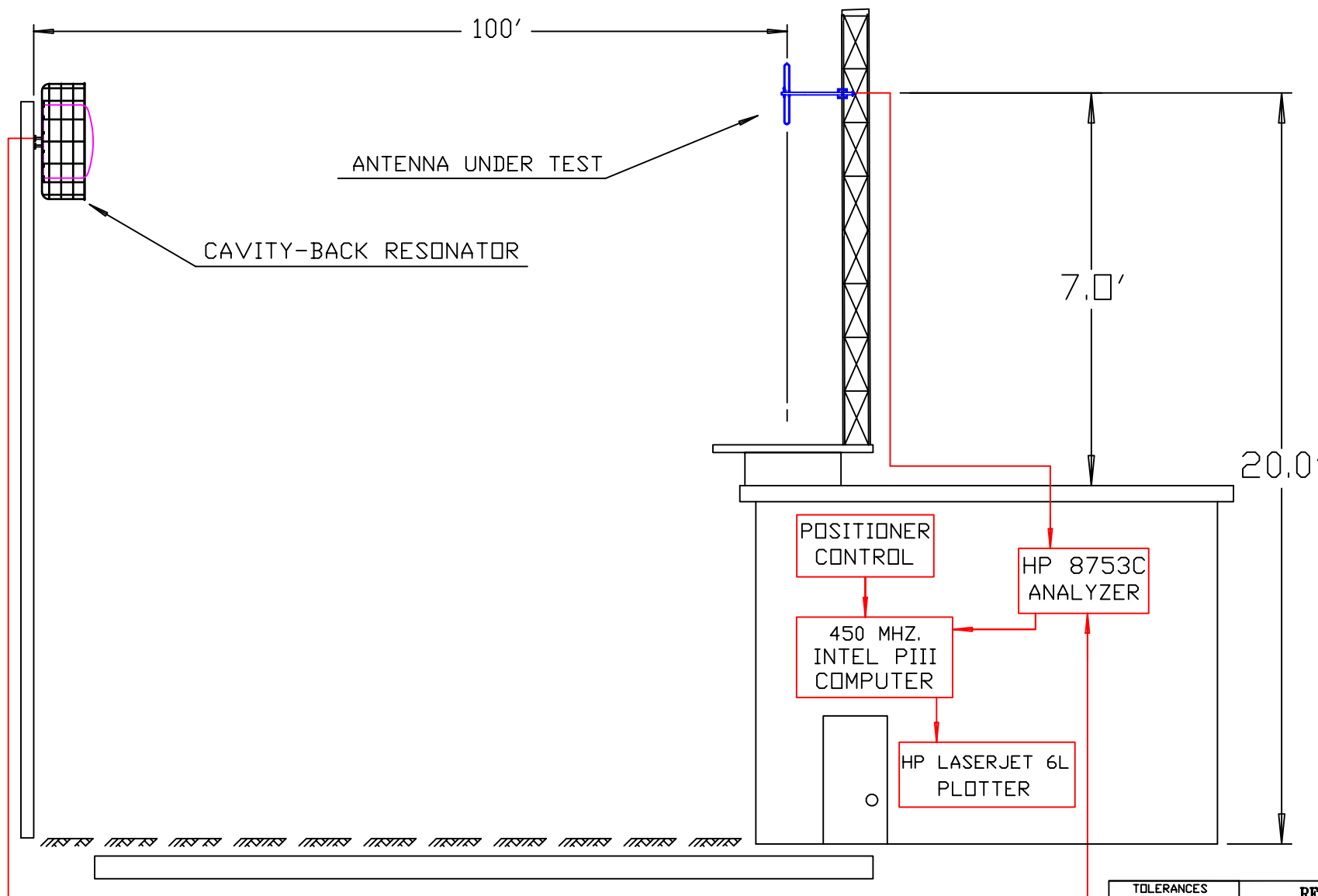
NAME: RAC

DATE: 12/6/11

SHEET 1 OF 1

DRAWING  
NUMBER:

1540D05



TOLERANCES		REVISION RECORD		
		REV	APPROVAL	DATE
.X	± .015			
.XX	± .005			
.XXX	± .002			
X/X	± 1/32			
DEG.	± 1/2			
UNLESS OTHERWISE SPECIFIED				
		2		10/7/05
		1		4/30/02
PARTS MADE BY THIS DRAWING		DRAWING NUMBER: 2105A10		
SCALE: NTS	NAME: JRM	DATE: 11/1/98	SHEET 1 OF 1	



SYSTEMS WITH RELIABILITY, INC  
619 INDUSTRIAL PARK ROAD  
EBENSBURG, PENNSYLVANIA 15931

TITLE: TEST RANGE SCHEMATIC

MATERIAL:

SIZE

A

PARTS MADE BY THIS DRAWING

SCALE: NTS

NAME: JRM

DATE: 11/1/98

SHEET 1 OF 1