



**SYSTEMS WITH RELIABILITY, LLP**  
**BROADCAST ANTENNAS AND TRANSMISSION LINE**

## **PATTERN CERTIFICATION**

### **DIRECTIONAL FM ANTENNA**

**WYBA**

**September 15, 2011**

<b>Call Sign</b>	:	WYBA
<b>Location</b>	:	Coldwater, MI
<b>Frequency</b>	:	90.1 MHz
<b>Channel</b>	:	211B
<b>Antenna Model</b>	:	FM10D/5-DA
<b>Maximum Antenna Gain</b>	:	
<b>Horizontal</b>	:	<b>4.598 / 6.626 dB</b>
<b>Vertical</b>	:	<b>4.598 / 6.626 dB</b>

### **ANTENNA DESCRIPTION**

A custom designed **FM10D/5-DA** antenna was used to produce the required directional azimuth pattern. Each antenna bay consists of a circularly polarized cross-V dipole-radiating element with horizontal parasitics. The array is comprised of five bays, that are spaced a wavelength apart, mounted to a support pipe and mounted to the tower pointing 110 degrees true north.

### **DESCRIPTION OF TEST PROCEDURE**

The test antenna consists of a single bay third-scale model antenna and parasitic system. This antenna was mounted to a pipe attached to an 8-inch third scale model tower (2400 Sabre) with the use of mounting brackets supplied with the finalized antenna. The tower was placed on a 20 ft. high platform. All feed cables are properly grounded during pattern testing. Horizontal and vertical parasitic elements were tried and horizontal parasitic were used to obtain the desired directional pattern.

The source antenna, a vertical/horizontal dipole Cavity Back Resonator 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 270.3 MHz. The antenna under test was rotated in a clockwise direction. A gain reference was taken using a dipole tuned to 270.3 MHz. Nowhere, does the received signal exceed a maximum to minimum ratio of 15 dB.

## TEST RESULTS

The attached calculations verify that the **RMS** value of this antenna is **97.4 %** of the **RMS** value of the pattern authorized in the related construction permit **BPED-20100716ACN**. The vertical component **RMS** value is **0.789**. The horizontal component **RMS** value is **0.713**. The circular polarized component **RMS** value is **0.802**.

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

Measured vertical polarized directivity:	1.606 / 2.060dB
Measured horizontal polarized directivity:	1.970 / 2.940 dB
Measured circular polarized pattern directivity:	1.554 / 1.920 dB

Gain in each polarization was calculated using the following relation:

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

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

V-Pol. Gain = (1.606)(.551)(5.197)	= 4.598 / 6.626 dB
H-Pol. Gain = (1.970)(.449)(5.197)	= 4.598 / 6.626 dB

## INSTALLATION AND MOUNTING

The antenna is to be mounted in accordance with the supplied drawings. The antenna center of radiation is to be **83 meters ( 272.32 ft.)** above ground level. The antenna aperture is **43.67 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 antenna is to be oriented **110 degrees** true North.

The parasitic system is custom designed to shape and direct the antenna pattern as required. The systems orientation and the mounting details are described in the following drawings:

DRAWING NO.	TITLE
1588D00	ELEVATION
1588D01	ANTENNA ORIENTATION WITH PARASITICS
1588D02	BAY 1-4 PARASITIC PLACEMENT AND ASSEMBLY
1588D03	BAY 5 PARASITIC PLACEMENT AND ASSEMBLY
2105A10	TEST RANGE SCHEMATIC

The array shall be mounted according to **DWG. 1588D00**. The antenna elements shall be aligned at the same heading as in **DWG. 1588D01**. This will ensure that the antenna is oriented properly at 110 degrees true north. Each bay's parasitic assembly is shown in **DWG. 1588D02 THRU 1588D03**.

## DOCUMENT EXHIBITS

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

<b>Exhibit 1</b>	Circular Polarized Azimuth Pattern Field Strength Tabulations (Composite)
<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 Tabulations
<b>Exhibit 5</b>	Antenna Data Sheet
<b>Exhibit 6</b>	RMS Calculations
<b>Exhibit 7</b>	Drawings

## TEST EQUIPMENT

**Network Analyzer** : Hewlett Packard Model # 8753C  
Serial Number: 08753 – 69138

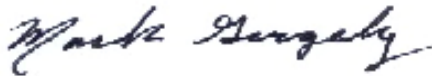
**Computer** : Pentium 3, 450 MHz, Range Program

**Printer** : Hewlett-Packard Laser Jet 6L

**Positioner** : Orbit Positioner

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

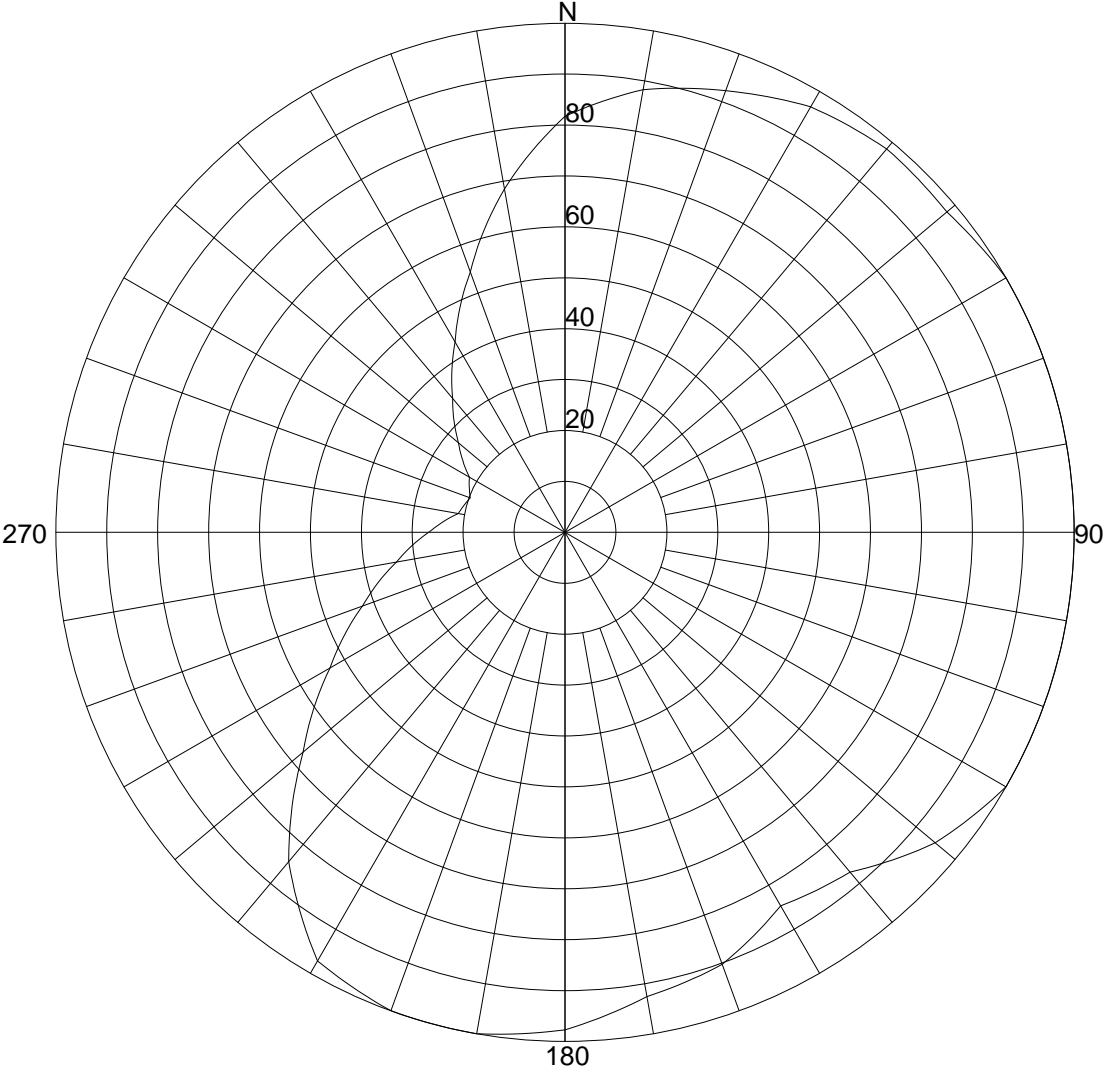
Prepared by:



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

Exhibit 1: Circular Polarized Azimuth Pattern



Azimuth Pattern

Systems With Reliability

Scale: Linear  
Unit: Relative Field

CLIENT: WYBA / BBN	Date: 9/7/2011
ANTENNA TYPE: FM10D/5-DA	
FREQUENCY: 90.1 MHz	
PATTERN POL.: Circular	CIRCULARITY(+/-dB):
AZ. DIRECTIVITY: 1.55441 / 1.92dB	PATTERN RMS: 0.802

## Exhibit 1 (cont'd): Circular Polarized Azimuth Pattern Tabulations

### Relative Field Tabulation(Azimuth)

Azimuth Heading	Relative Field(dB)	Azimuth Heading	Relative Field(dB)
0	.8170 (-1.74 )	180	.9770 (-0.19 )
5	.8500 (-1.4 )	185	.9885 (-0.09 )
10	.8830 (-1.07 )	190	1.0000 ( 0.01 )
15	.9030 (-0.88 )	195	1.0000 ( 0.01 )
20	.9230 (-0.69 )	200	1.0000 ( 0.01 )
25	.9440 (-0.49 )	205	.9860 (-0.11 )
30	.9650 (-0.3 )	210	.9720 (-0.24 )
35	.9740 (-0.22 )	215	.9080 (-0.83 )
40	.9830 (-0.14 )	220	.8440 (-1.46 )
45	.9810 (-0.16 )	225	.7577 (-2.4 )
50	.9790 (-0.18 )	230	.6713 (-3.45 )
55	.9895 (-0.08 )	235	.6022 (-4.39 )
60	1.0000 ( 0.01 )	240	.5331 (-5.45 )
65	1.0000 ( 0.01 )	245	.4782 (-6.39 )
70	1.0000 ( 0.01 )	250	.4234 (-7.45 )
75	1.0000 ( 0.01 )	255	.3798 (-8.39 )
80	1.0000 ( 0.01 )	260	.3361 (-9.44 )
85	1.0000 ( 0.01 )	265	.3018 (-10.38 )
90	1.0000 ( 0.01 )	270	.2675 (-11.42 )
95	1.0000 ( 0.01 )	275	.2401 (-12.36 )
100	1.0000 ( 0.01 )	280	.2127 (-13.41 )
105	1.0000 ( 0.01 )	285	.2053 (-13.71 )
110	1.0000 ( 0.01 )	290	.1980 (-14.02 )
115	1.0000 ( 0.01 )	295	.2075 (-13.62 )
120	1.0000 ( 0.01 )	300	.2170 (-13.23 )
125	.9745 (-0.22 )	305	.2450 (-12.18 )
130	.9490 (-0.45 )	310	.2730 (-11.25 )
135	.9100 (-0.81 )	315	.3080 (-10.2 )
140	.8710 (-1.19 )	320	.3430 (-9.27 )
145	.8590 (-1.31 )	325	.3875 (-8.21 )
150	.8470 (-1.43 )	330	.4320 (-7.27 )
155	.8750 (-1.15 )	335	.4880 (-6.21 )
160	.9030 (-0.88 )	340	.5440 (-5.27 )
165	.9145 (-0.77 )	345	.6145 (-4.22 )
170	.9260 (-0.66 )	350	.6850 (-3.27 )
175	.9515 (-0.42 )	355	.7510 (-2.48 )

### Systems With Reliability

CLIENT: WYBA / BBN

Date: 9/7/2011

ANTENNA TYPE: FM10D/5-DA

FREQUENCY: 90.1 MHz

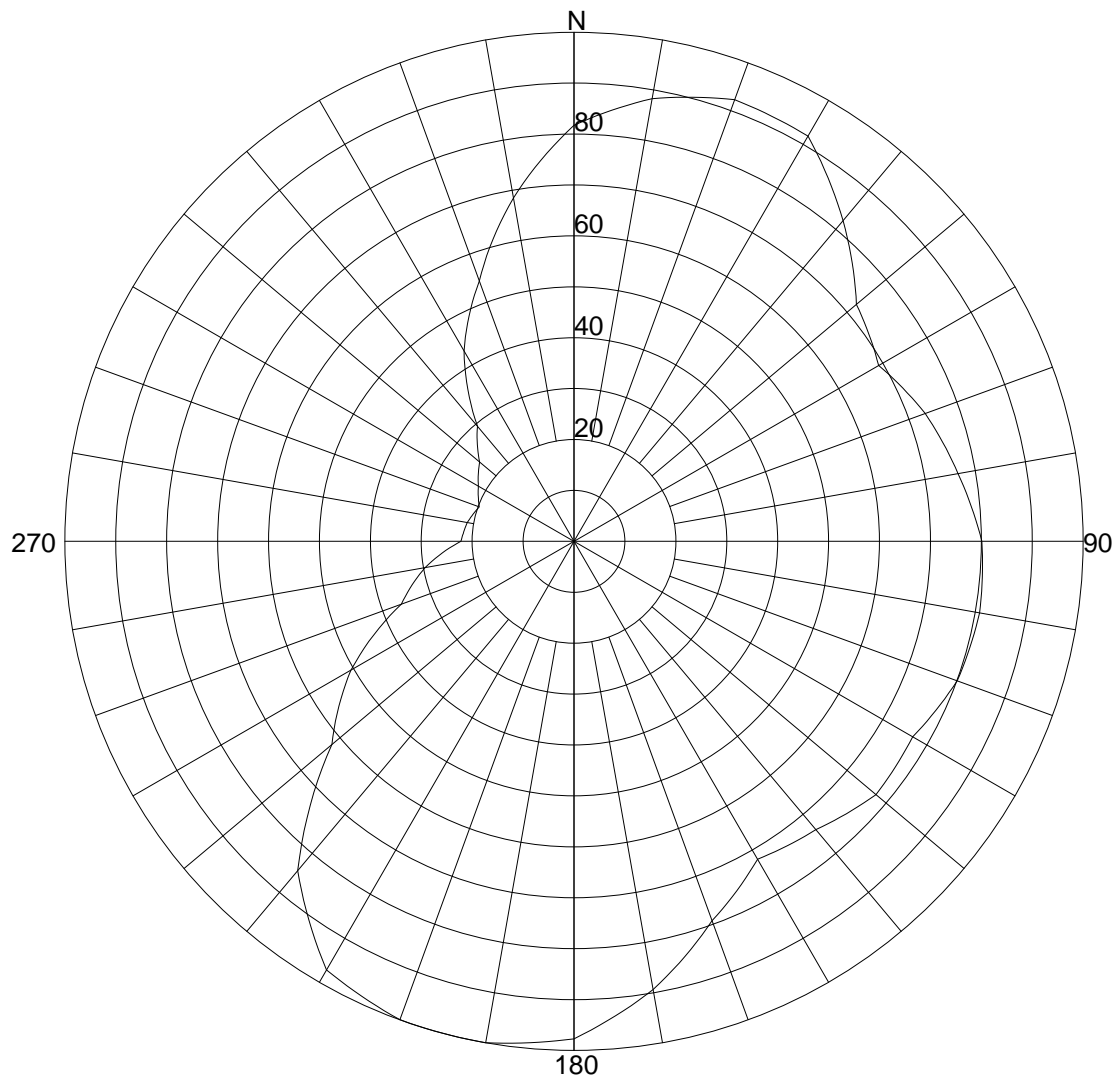
PATTERN POL.: Circular

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 1.55441 / 1.92dB

PATTERN RMS: 0.802

## Exhibit 2: Measured H-Pol Azimuth Pattern



### Azimuth Pattern

Scale: Linear

Unit: Relative Field

## Systems With Reliability

CLIENT: WYBA / BBN

Date: 9/7/2011

ANTENNA TYPE: FM10D/5-DA

FREQUENCY: 90.1 MHz

PATTERN POL.: Horizontal

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 1.96961 / 2.94dB

PATTERN RMS: 0.713

## Relative Field Tabulation(Azimuth)

Azimuth Heading	Relative Field(dB)	Azimuth Heading	Relative Field(dB)
0	.8170 (-1.74 )	180	.9770 (-0.19 )
5	.8500 (-1.4 )	185	.9885 (-0.09 )
10	.8830 (-1.07 )	190	1.0000 ( 0.01 )
15	.9030 (-0.88 )	195	1.0000 ( 0.01 )
20	.9230 (-0.69 )	200	1.0000 ( 0.01 )
25	.9210 (-0.71 )	205	.9860 (-0.11 )
30	.9190 (-0.72 )	210	.9720 (-0.24 )
35	.8705 (-1.19 )	215	.9080 (-0.83 )
40	.8220 (-1.69 )	220	.8440 (-1.46 )
45	.7730 (-2.23 )	225	.7325 (-2.69 )
50	.7240 (-2.79 )	230	.6210 (-4.12 )
55	.7075 (-2.99 )	235	.5635 (-4.97 )
60	.6910 (-3.2 )	240	.5060 (-5.9 )
65	.7125 (-2.93 )	245	.4335 (-7.24 )
70	.7340 (-2.67 )	250	.3610 (-8.83 )
75	.7500 (-2.49 )	255	.3290 (-9.63 )
80	.7660 (-2.3 )	260	.2970 (-10.52 )
85	.7835 (-2.11 )	265	.2595 (-11.68 )
90	.8010 (-1.92 )	270	.2220 (-13.03 )
95	.8050 (-1.87 )	275	.2173 (-13.22 )
100	.8090 (-1.83 )	280	.2127 (-13.41 )
105	.8050 (-1.87 )	285	.2053 (-13.71 )
110	.8010 (-1.92 )	290	.1980 (-14.02 )
115	.7845 (-2.1 )	295	.2075 (-13.62 )
120	.7680 (-2.28 )	300	.2170 (-13.23 )
125	.7710 (-2.25 )	305	.2295 (-12.75 )
130	.7740 (-2.21 )	310	.2420 (-12.29 )
135	.7565 (-2.41 )	315	.2685 (-11.39 )
140	.7390 (-2.62 )	320	.2950 (-10.57 )
145	.7300 (-2.72 )	325	.3635 (-8.77 )
150	.7210 (-2.83 )	330	.4320 (-7.27 )
155	.7570 (-2.41 )	335	.4880 (-6.21 )
160	.7930 (-2 )	340	.5440 (-5.27 )
165	.8435 (-1.47 )	345	.6145 (-4.22 )
170	.8940 (-0.96 )	350	.6850 (-3.27 )
175	.9355 (-0.57 )	355	.7510 (-2.48 )

## Systems With Reliability

CLIENT: WYBA / BBN

Date: 9/7/2011

ANTENNA TYPE: FM10D/5-DA

FREQUENCY: 90.1 MHz

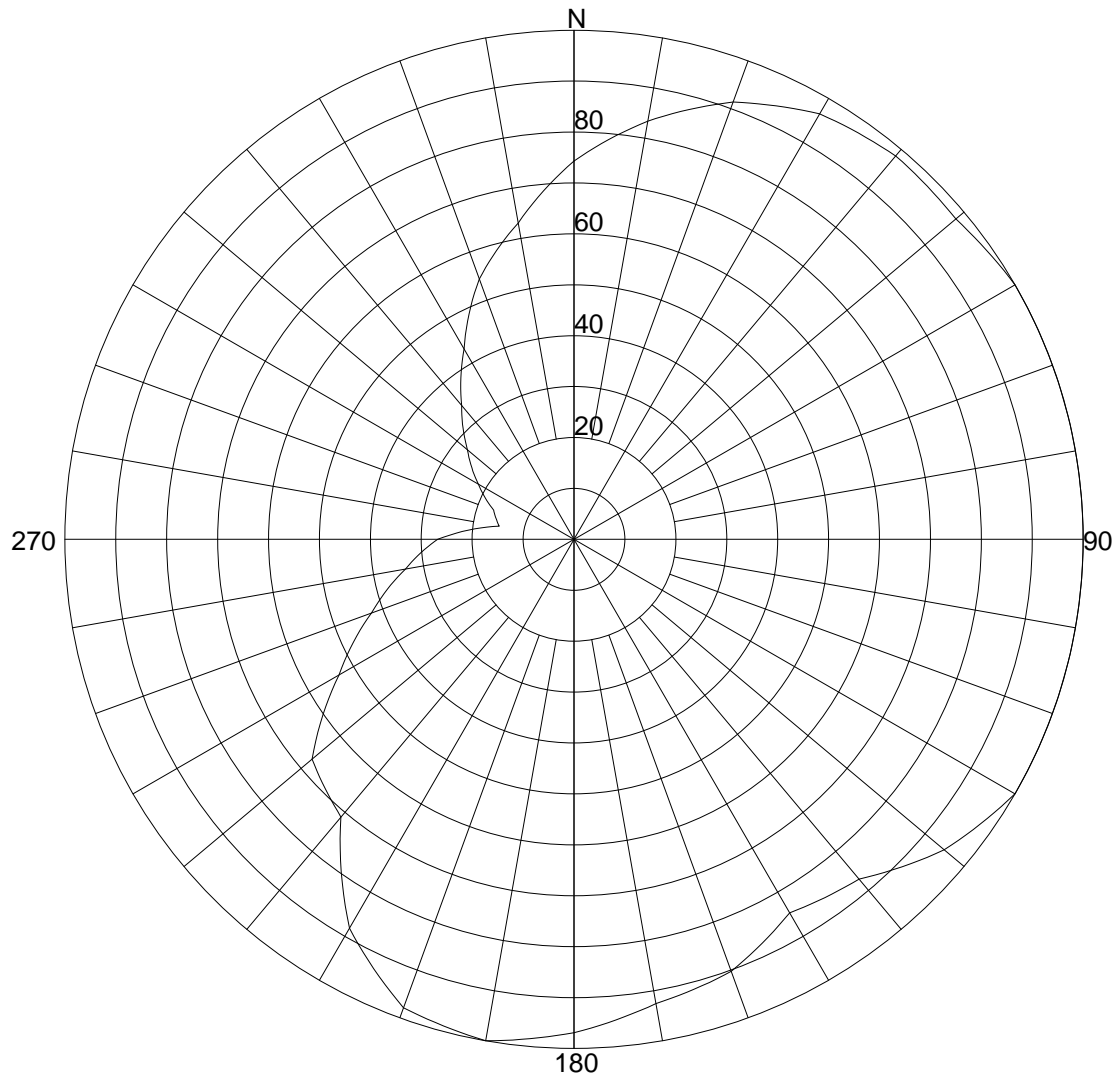
PATTERN POL.: Horizontal

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 1.96961 / 2.94dB

PATTERN RMS: 0.713

### Exhibit 3: Measured V-POL Azimuth Pattern



Azimuth Pattern

## Systems With Reliability

Scale: Linear

Unit: Relative Field

CLIENT: WYBA / BBN

Date: 9/7/2011

ANTENNA TYPE: FM10D/5-DA

FREQUENCY: 90.1 MHz

PATTERN POL.: Vertical

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 1.60645 / 2.06dB

PATTERN RMS: 0.789

## Relative Field Tabulation(Azimuth)

Azimuth Heading	Relative Field(dB)	Azimuth Heading	Relative Field(dB)
0	.7430 (-2.57 )	180	.9690 (-0.26 )
5	.7885 (-2.05 )	185	.9845 (-0.13 )
10	.8340 (-1.57 )	190	1.0000 ( 0.01 )
15	.8740 (-1.16 )	195	.9895 (-0.08 )
20	.9140 (-0.77 )	200	.9790 (-0.18 )
25	.9395 (-0.53 )	205	.9305 (-0.62 )
30	.9650 (-0.3 )	210	.8820 (-1.08 )
35	.9740 (-0.22 )	215	.7970 (-1.96 )
40	.9830 (-0.14 )	220	.7120 (-2.94 )
45	.9810 (-0.16 )	225	.6917 (-3.19 )
50	.9790 (-0.18 )	230	.6713 (-3.45 )
55	.9895 (-0.08 )	235	.6022 (-4.39 )
60	1.0000 ( 0.01 )	240	.5331 (-5.45 )
65	1.0000 ( 0.01 )	245	.4782 (-6.39 )
70	1.0000 ( 0.01 )	250	.4234 (-7.45 )
75	1.0000 ( 0.01 )	255	.3798 (-8.39 )
80	1.0000 ( 0.01 )	260	.3361 (-9.44 )
85	1.0000 ( 0.01 )	265	.3018 (-10.38 )
90	1.0000 ( 0.01 )	270	.2675 (-11.42 )
95	1.0000 ( 0.01 )	275	.2083 (-13.59 )
100	1.0000 ( 0.01 )	280	.1490 (-16.48 )
105	1.0000 ( 0.01 )	285	.1585 (-15.94 )
110	1.0000 ( 0.01 )	290	.1680 (-15.44 )
115	1.0000 ( 0.01 )	295	.1925 (-14.27 )
120	1.0000 ( 0.01 )	300	.2170 (-13.23 )
125	.9745 (-0.22 )	305	.2450 (-12.18 )
130	.9490 (-0.45 )	310	.2730 (-11.25 )
135	.9100 (-0.81 )	315	.3080 (-10.2 )
140	.8710 (-1.19 )	320	.3430 (-9.27 )
145	.8590 (-1.31 )	325	.3875 (-8.21 )
150	.8470 (-1.43 )	330	.4320 (-7.27 )
155	.8750 (-1.15 )	335	.4880 (-6.21 )
160	.9030 (-0.88 )	340	.5440 (-5.27 )
165	.9145 (-0.77 )	345	.5875 (-4.61 )
170	.9260 (-0.66 )	350	.6310 (-3.99 )
175	.9475 (-0.46 )	355	.6870 (-3.25 )

## Systems With Reliability

CLIENT: WYBA / BBN

Date: 9/7/2011

ANTENNA TYPE: FM10D/5-DA

FREQUENCY: 90.1 MHz

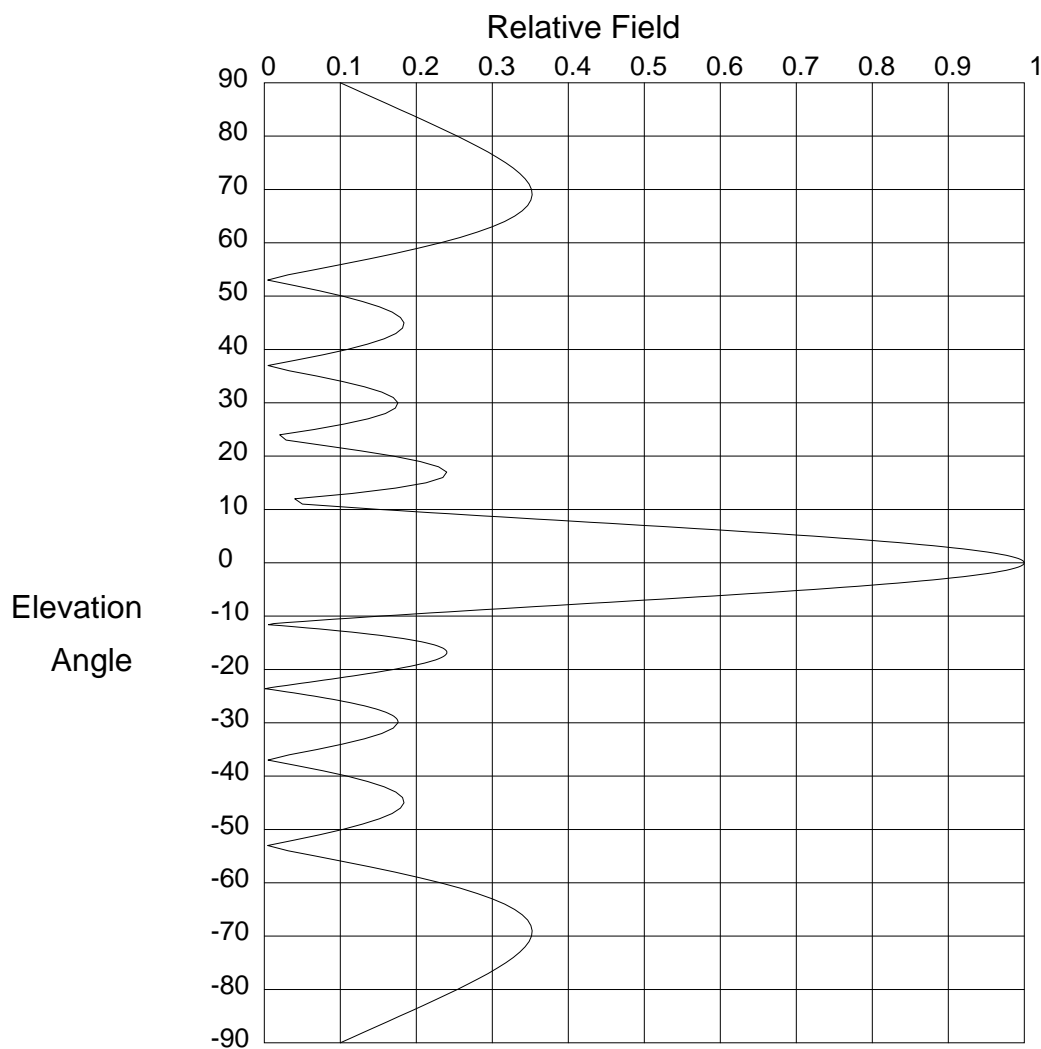
PATTERN POL.: Vertical

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 1.60645 / 2.06dB

PATTERN RMS: 0.789

## Exhibit 4: Elevation Pattern



### Elevation Pattern

Scale: Linear

Units: Field, Relative

### Systems With Reliability

CLIENT: WYBA

Date: 9/15/2011

ANTENNA TYPE: FM10D/5 DA

FREQUENCY: 90.1 MHz

PATTERN POL.: Circular

DIRECTIVITY(Peak): 5.19/7.152 dBd

Beam Tilt (Deg.) : 0

DIRECTIVITY(Horiz): 5.19/7.152 dBd

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

## Relative Field Tabulation

Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)
90.0	.10 (-20)	52.0	.04 (-28.037)	14.0	.173 (-15.244 )
89.0	.116 (-18.733)	51.0	.073 (-22.772)	13.0	.115 (-18.791 )
88.0	.131 (-17.628)	50.0	.103 (-19.753)	12.0	.04 (-27.96 )
87.0	.147 (-16.648)	49.0	.129 (-17.759)	11.0	.05 (-25.993 )
86.0	.163 (-15.77)	48.0	.151 (-16.392)	10.0	.153 (-16.311 )
85.0	.178 (-14.975)	47.0	.168 (-15.477)	9.8	.175 (-15.154 )
84.0	.194 (-14.251)	46.0	.179 (-14.928)	9.6	.197 (-14.119 )
83.0	.209 (-13.588)	45.0	.184 (-14.706)	9.4	.219 (-13.181 )
82.0	.224 (-12.979)	44.0	.182 (-14.802)	9.2	.242 (-12.325 )
81.0	.239 (-12.419)	43.0	.173 (-15.231)	9.0	.265 (-11.537 )
80.0	.254 (-11.905)	42.0	.158 (-16.038)	8.8	.288 (-10.808 )
79.0	.268 (-11.433)	41.0	.136 (-17.315)	8.6	.311 (-10.131 )
78.0	.282 (-11.003)	40.0	.109 (-19.243)	8.4	.335 (-9.499 )
77.0	.295 (-10.613)	39.0	.077 (-22.23)	8.2	.359 (-8.907 )
76.0	.307 (-10.264)	38.0	.042 (-27.5)	8.0	.382 (-8.351 )
75.0	.318 (-9.955)	37.0	.005 (-46.165)	7.8	.406 (-7.828 )
74.0	.328 (-9.688)	36.0	.033 (-29.676)	7.6	.43 (-7.335 )
73.0	.336 (-9.464)	35.0	.069 (-23.177)	7.4	.454 (-6.868 )
72.0	.343 (-9.286)	34.0	.103 (-19.746)	7.2	.477 (-6.427 )
71.0	.348 (-9.157)	33.0	.132 (-17.594)	7.0	.501 (-6.008 )
70.0	.352 (-9.079)	32.0	.155 (-16.215)	6.8	.524 (-5.612 )
69.0	.352 (-9.057)	31.0	.17 (-15.409)	6.6	.547 (-5.235 )
68.0	.351 (-9.096)	30.0	.176 (-15.095)	6.4	.57 (-4.878 )
67.0	.347 (-9.201)	29.0	.173 (-15.259)	6.2	.593 (-4.538 )
66.0	.34 (-9.38)	28.0	.159 (-15.946)	6.0	.616 (-4.215 )
65.0	.33 (-9.642)	27.0	.137 (-17.284)	5.8	.638 (-3.909 )
64.0	.316 (-9.997)	26.0	.105 (-19.575)	5.6	.659 (-3.617 )
63.0	.30 (-10.46)	25.0	.066 (-23.657)	5.4	.681 (-3.34 )
62.0	.28 (-11.047)	24.0	.02 (-33.83)	5.2	.702 (-3.077 )
61.0	.258 (-11.782)	23.0	.029 (-30.87)	5.0	.722 (-2.827 )
60.0	.232 (-12.698)	22.0	.079 (-22.091)	4.8	.742 (-2.59 )
59.0	.203 (-13.842)	21.0	.127 (-17.942)	4.6	.762 (-2.366 )
58.0	.172 (-15.287)	20.0	.17 (-15.395)	4.4	.78 (-2.154 )
57.0	.139 (-17.153)	19.0	.205 (-13.761)	4.2	.799 (-1.953 )
56.0	.104 (-19.67)	18.0	.229 (-12.791)	4.0	.816 (-1.763 )
55.0	.068 (-23.366)	17.0	.24 (-12.394)	3.8	.833 (-1.584 )
54.0	.031 (-30.047)	16.0	.235 (-12.576)	3.6	.85 (-1.416 )
53.0	.005 (-46.648)	15.0	.213 (-13.434)	3.4	.865 (-1.258 )

## Systems With Reliability

Page 1 of 3

CLIENT: WYBA

Date: 9/15/2011

ANTENNA TYPE: FM10D/5 DA

FREQUENCY: 90.1 MHz

PATTERN POL.: Circular

DIRECTIVITY(Peak): 5.19/7.152 dBd

Beam Tilt (Deg.) : 0

DIRECTIVITY(Horiz): 5.19/7.152 dBd

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

## Relative Field Tabulation

Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)
3.2	.88 (-1.111)	-4.4	.78 (-2.154)	-12.0	.04 (-27.96 )
3.0	.894 (-0.973)	-4.6	.762 (-2.366)	-12.2	.056 (-24.995 )
2.8	.907 (-0.845)	-4.8	.742 (-2.59)	-12.4	.072 (-22.864 )
2.6	.92 (-0.727)	-5.0	.722 (-2.827)	-12.6	.087 (-21.218 )
2.4	.931 (-0.617)	-5.2	.702 (-3.077)	-12.8	.101 (-19.891 )
2.2	.942 (-0.518)	-5.4	.681 (-3.34)	-13.0	.115 (-18.791 )
2.0	.952 (-0.427)	-5.6	.659 (-3.617)	-13.2	.128 (-17.861 )
1.8	.961 (-0.345)	-5.8	.638 (-3.909)	-13.4	.14 (-17.063 )
1.6	.969 (-0.272)	-6.0	.616 (-4.215)	-13.6	.152 (-16.373 )
1.4	.976 (-0.208)	-6.2	.593 (-4.538)	-13.8	.163 (-15.771 )
1.2	.983 (-0.153)	-6.4	.57 (-4.878)	-14.0	.173 (-15.244 )
1.0	.988 (-0.106)	-6.6	.547 (-5.235)	-14.2	.182 (-14.782 )
.8	.992 (-0.068)	-6.8	.524 (-5.612)	-14.4	.191 (-14.375 )
.6	.996 (-0.038)	-7.0	.501 (-6.008)	-14.6	.199 (-14.018 )
.4	.998 (-0.017)	-7.2	.477 (-6.427)	-14.8	.206 (-13.706 )
.2	1.00 (-0.004)	-7.4	.454 (-6.868)	-15.0	.213 (-13.434 )
.0	1.00 (0)	-7.6	.43 (-7.335)	-15.2	.219 (-13.199 )
-.2	1.00 (-0.004)	-7.8	.406 (-7.828)	-15.4	.224 (-12.997 )
-.4	.998 (-0.017)	-8.0	.382 (-8.351)	-15.6	.228 (-12.828 )
-.6	.996 (-0.038)	-8.2	.359 (-8.907)	-15.8	.232 (-12.688 )
-.8	.992 (-0.068)	-8.4	.335 (-9.499)	-16.0	.235 (-12.576 )
-1.0	.988 (-0.106)	-8.6	.311 (-10.131)	-16.2	.237 (-12.49 )
-1.2	.983 (-0.153)	-8.8	.288 (-10.808)	-16.4	.239 (-12.43 )
-1.4	.976 (-0.208)	-9.0	.265 (-11.537)	-16.6	.24 (-12.395 )
-1.6	.969 (-0.272)	-9.2	.242 (-12.325)	-16.8	.24 (-12.383 )
-1.8	.961 (-0.345)	-9.4	.219 (-13.181)	-17.0	.24 (-12.394 )
-2.0	.952 (-0.427)	-9.6	.197 (-14.119)	-17.2	.239 (-12.429 )
-2.2	.942 (-0.518)	-9.8	.175 (-15.154)	-17.4	.238 (-12.486 )
-2.4	.931 (-0.617)	-10.0	.153 (-16.311)	-17.6	.235 (-12.565 )
-2.6	.92 (-0.727)	-10.2	.132 (-17.621)	-17.8	.233 (-12.667 )
-2.8	.907 (-0.845)	-10.4	.11 (-19.133)	-18.0	.229 (-12.791 )
-3.0	.894 (-0.973)	-10.6	.09 (-20.923)	-18.2	.225 (-12.938 )
-3.2	.88 (-1.111)	-10.8	.07 (-23.123)	-18.4	.221 (-13.107 )
-3.4	.865 (-1.258)	-11.0	.05 (-25.993)	-18.6	.216 (-13.301 )
-3.6	.85 (-1.416)	-11.2	.031 (-30.166)	-18.8	.211 (-13.518 )
-3.8	.833 (-1.584)	-11.4	.012 (-38.116)	-19.0	.205 (-13.761 )
-4.0	.816 (-1.763)	-11.6	.006 (-44.992)	-19.2	.199 (-14.03 )
-4.2	.799 (-1.953)	-11.8	.023 (-32.725)	-19.4	.192 (-14.326 )

## Systems With Reliability

Page 2 of 3

CLIENT: WYBA

Date: 9/15/2011

ANTENNA TYPE: FM10D/5 DA

FREQUENCY: 90.1 MHz

PATTERN POL.: Circular

DIRECTIVITY(Peak): 5.19/7.152 dBd

Beam Tilt (Deg.) : 0

DIRECTIVITY(Horiz): 5.19/7.152 dBd

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

## Relative Field Tabulation

Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)
-19.6	.185 (-14.651)	-27.2	.142 (-16.953)	-54.0	.031 (-30.047 )
-19.8	.178 (-15.007)	-27.4	.147 (-16.657)	-55.0	.068 (-23.366 )
-20.0	.17 (-15.395)	-27.6	.152 (-16.392)	-56.0	.104 (-19.67 )
-20.2	.162 (-15.819)	-27.8	.156 (-16.155)	-57.0	.139 (-17.153 )
-20.4	.153 (-16.282)	-28.0	.159 (-15.946)	-58.0	.172 (-15.287 )
-20.6	.145 (-16.786)	-28.2	.163 (-15.762)	-59.0	.203 (-13.842 )
-20.8	.136 (-17.338)	-28.4	.166 (-15.603)	-60.0	.232 (-12.698 )
-21.0	.127 (-17.942)	-28.6	.169 (-15.466)	-61.0	.258 (-11.782 )
-21.2	.117 (-18.606)	-28.8	.171 (-15.352)	-62.0	.28 (-11.047 )
-21.4	.108 (-19.339)	-29.0	.173 (-15.259)	-63.0	.30 (-10.46 )
-21.6	.098 (-20.153)	-29.2	.174 (-15.187)	-64.0	.316 (-9.997 )
-21.8	.088 (-21.063)	-29.4	.175 (-15.135)	-65.0	.33 (-9.642 )
-22.0	.079 (-22.091)	-29.6	.176 (-15.102)	-66.0	.34 (-9.38 )
-22.2	.069 (-23.266)	-29.8	.176 (-15.089)	-67.0	.347 (-9.201 )
-22.4	.059 (-24.632)	-30.0	.176 (-15.095)	-68.0	.351 (-9.096 )
-22.6	.049 (-26.26)	-31.0	.17 (-15.409)	-69.0	.352 (-9.057 )
-22.8	.039 (-28.265)	-32.0	.155 (-16.215)	-70.0	.352 (-9.079 )
-23.0	.029 (-30.87)	-33.0	.132 (-17.594)	-71.0	.348 (-9.157 )
-23.2	.019 (-34.588)	-34.0	.103 (-19.746)	-72.0	.343 (-9.286 )
-23.4	.009 (-41.163)	-35.0	.069 (-23.177)	-73.0	.336 (-9.464 )
-23.6	.001 (-59.447)	-36.0	.033 (-29.676)	-74.0	.328 (-9.688 )
-23.8	.011 (-39.355)	-37.0	.005 (-46.165)	-75.0	.318 (-9.955 )
-24.0	.02 (-33.83)	-38.0	.042 (-27.5)	-76.0	.307 (-10.264 )
-24.2	.03 (-30.522)	-39.0	.077 (-22.23)	-77.0	.295 (-10.613 )
-24.4	.039 (-28.17)	-40.0	.109 (-19.243)	-78.0	.282 (-11.003 )
-24.6	.048 (-26.355)	-41.0	.136 (-17.315)	-79.0	.268 (-11.433 )
-24.8	.057 (-24.885)	-42.0	.158 (-16.038)	-80.0	.254 (-11.905 )
-25.0	.066 (-23.657)	-43.0	.173 (-15.231)	-81.0	.239 (-12.419 )
-25.2	.074 (-22.61)	-44.0	.182 (-14.802)	-82.0	.224 (-12.979 )
-25.4	.082 (-21.702)	-45.0	.184 (-14.706)	-83.0	.209 (-13.588 )
-25.6	.09 (-20.906)	-46.0	.179 (-14.928)	-84.0	.194 (-14.251 )
-25.8	.098 (-20.202)	-47.0	.168 (-15.477)	-85.0	.178 (-14.975 )
-26.0	.105 (-19.575)	-48.0	.151 (-16.392)	-86.0	.163 (-15.77 )
-26.2	.112 (-19.014)	-49.0	.129 (-17.759)	-87.0	.147 (-16.648 )
-26.4	.119 (-18.511)	-50.0	.103 (-19.753)	-88.0	.131 (-17.628 )
-26.6	.125 (-18.059)	-51.0	.073 (-22.772)	-89.0	.116 (-18.733 )
-26.8	.131 (-17.651)	-52.0	.04 (-28.037)	-90.0	.10 (-20 )
-27.0	.137 (-17.284)	-53.0	.005 (-46.648)	90.0	.00 (-50 )

## Systems With Reliability

Page 3 of 3

CLIENT: WYBA

Date: 9/15/2011

ANTENNA TYPE: FM10D/5 DA

FREQUENCY: 90.1 MHz

PATTERN POL.: Circular

DIRECTIVITY(Peak): 5.19/7.152 dBd

Beam Tilt (Deg.) : 0

DIRECTIVITY(Horiz): 5.19/7.152 dBd

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

## Exhibit 5: Antenna Data Sheet



**SYSTEMS WITH RELIABILITY, LLP**

**BROADCAST ANTENNAS AND TRANSMISSION LINE**

# SYSTEM DATA SHEET

<b>Customer</b>	WYBA
<b>Contact</b>	Mike Raley
<b>Location</b>	Coldwater, MI
<b>Antenna Model</b>	FM10D/5-DA
<b>Channel / Frequency</b>	211B / 90.1 MHz

### ELECTRICAL SPECIFICATIONS

#### Antenna Specifications:

	H-POL			V. Pol.	
		dB			dB
License ERP ( KW)	32.000	15.051	<b>dB</b>	32.000	15.051 <b>dB</b>
FCC Limit Pattern Directivity	1.475	1.688	<b>dB</b>	1.475	1.688 <b>dB</b>
Elevation Directivity	5.197	7.158	<b>dB</b>	5.197	7.158 <b>dB</b>
Azimuth Directivity	1.970	2.944	<b>dB</b>	1.606	2.059 <b>dB</b>
Composite Pattern	1.554	1.916	<b>dB</b>	1.554	1.916 <b>dB</b>
Polarization Ratio	0.449	-3.475	<b>dB</b>	0.551	-2.590 <b>dB</b>
<b>RMS Comp./RMS Limit</b>	97.4 %				
Antenna Efficiency %	100	0		100	0
Power Ratio ( Pol. Ratio X Efficiency)	0.4492	0		0.5508	0
Antenna Gain	4.598	6.626	<b>dB</b>	4.598	6.626 <b>dB</b>

<b>Antenna Input Power (KW)</b>	6.959 kW	8.426 (dBK)
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#### Feed Line Specifications:

Line Type- ANDREW	1 5/8" Air	<b>50 Ω</b>	<b>HJ7-50A</b>
Attenuation Per 100 ft (dB)	0.196	<b>dB</b>	
Line Length (ft) AGL + Horizontal - ant/2	262.99	<b>ft.</b>	
Total Line Attenuation (dB)	0.5155	<b>dB</b>	
Line Efficiency	88.81	<b>%</b>	
<b>Power Input to the Line (KW)</b>	7.836 kW	8.941 (dBK)	

### MECHANICAL SPECIFICATIONS

<b>No. Of Bays</b>	5		
<b>Antenna Aperture</b>	43.67	<b>ft.</b>	13.31 <b>meter</b>
<b>Center of Radiation AGL</b>	272.32	<b>ft.</b>	83.00 <b>meter</b>
<b>Antenna Weight with Pole</b>	705.00	<b>lbs.</b>	320.45 <b>kg</b>
<b>Windload (50/33)</b>	1060.00	<b>lbs.</b>	<b>Windload CaAc</b> 30.70 <b>ft^2</b>

Prepared by:

*David K. Edmiston Jr.*

David K. Edmiston Jr.  
SWR, LLP

## Exhibit 6: RMS Calculations



*SYSTEMS WITH RELIABILITY, INC.*  
Broadcast Antennas and Transmission Systems

# WYBA Antenna RMS Comparison

### PROPOSED ANTENNA

**Azimuth  
Heading**      **Relative  
Field**

0	0.862
10	1.000
20	1.000
30	1.000
40	1.000
50	1.000
60	1.000
70	1.000
80	1.000
90	1.000
100	1.000
110	1.000
120	1.000
130	1.000
140	0.926
150	0.906
160	0.926
170	1.000
180	1.000
190	1.000
200	1.000
210	1.000
220	0.862
230	0.685
240	0.544
250	0.432
260	0.343
270	0.273
280	0.217
290	0.198
300	0.217
310	0.273
320	0.343
330	0.432
340	0.544
350	0.685

Sum of Relative Field Squared :      24.443  
Sum Divided by 36 (Readings) :      0.679  
Square Root :      0.824

### DESIGNED ANTENNA

**Azimuth  
Heading**      **Relative  
Field**

0	0.817
10	0.883
20	0.923
30	0.965
40	0.983
50	0.979
60	1.000
70	1.000
80	1.000
90	1.000
100	1.000
110	1.000
120	1.000
130	0.949
140	0.871
150	0.847
160	0.903
170	0.926
180	0.977
190	1.000
200	1.000
210	0.972
220	0.844
230	0.671
240	0.533
250	0.423
260	0.336
270	0.268
280	0.213
290	0.198
300	0.217
310	0.273
320	0.343
330	0.432
340	0.544
350	0.685

Sum of Relative Field Squared :      23.190  
Sum Divided by 36 (Readings) :      0.644  
Square Root :      0.803

Percentage of Construction Permit Antenna Filled :

**97.4%**

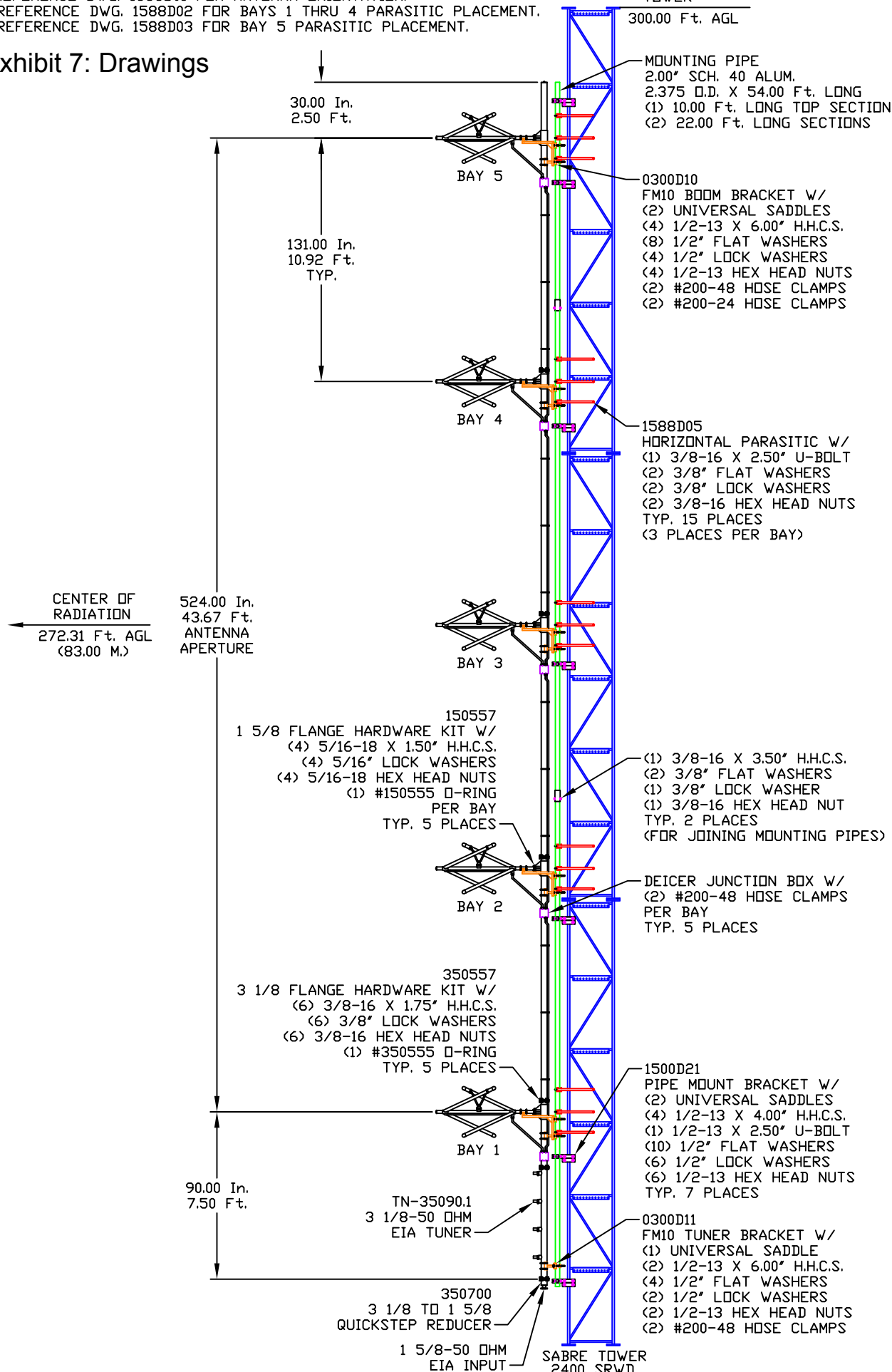
**NOTES:**

1. REFERENCE DWG. 1588D01 FOR ANTENNA ORIENTATION.
2. REFERENCE DWG. 1588D02 FOR BAYS 1 THRU 4 PARASITIC PLACEMENT.
3. REFERENCE DWG. 1588D03 FOR BAY 5 PARASITIC PLACEMENT.

TOP OF  
TOWER

DRAWING  
NUMBER: 1588D00

**Exhibit 7: Drawings**



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

TITLE: FM10D/5-DA, FREQ. 90.1  
WYBA, COLDWATER, MI

MATERIAL:

SIZE

REV APPR. DATE

ENGINEER:

SCALE: NTS

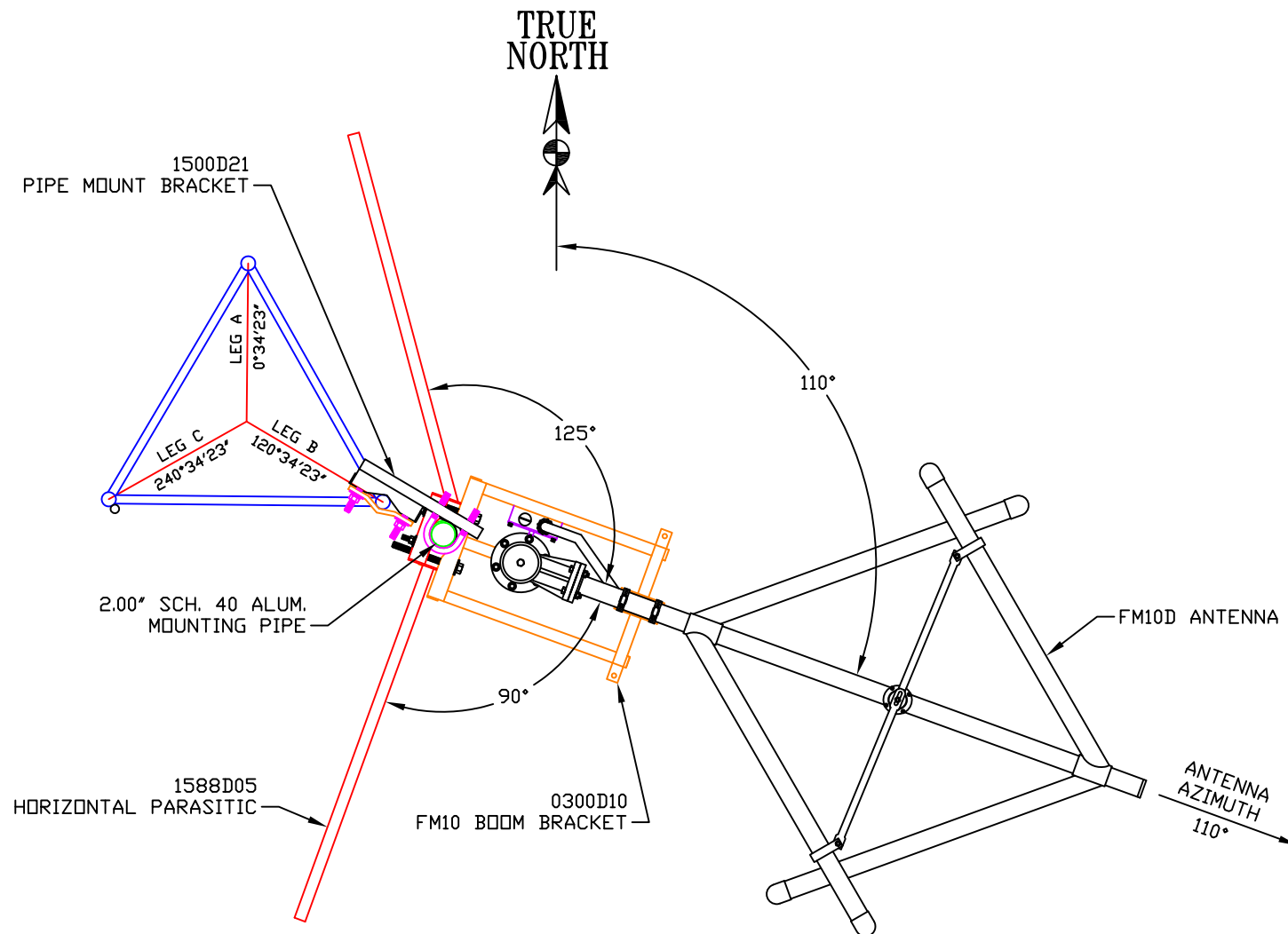
NAME: RAC

DATE: 9/14/11

SHEET

1 OF 1

DRAWING  
NUMBER: 1588D00



TOP VIEW

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: 1588D01	
NAME: RAC	DATE: 9/14/11	SHEET 1 OF 1	



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

TITLE:	FM10D/5-DA, FREQ. 90.1 WYBA, COLDWATER, MI
MATERIAL:	ANTENNA ORIENTATION FROM TRUE NORTH

**SIZE**

A

PARTS MADE BY THIS DRAWING

SCALE: NTS

NAME: RAC

DATE: 9/14/11

**SHEET 1 OF 1**

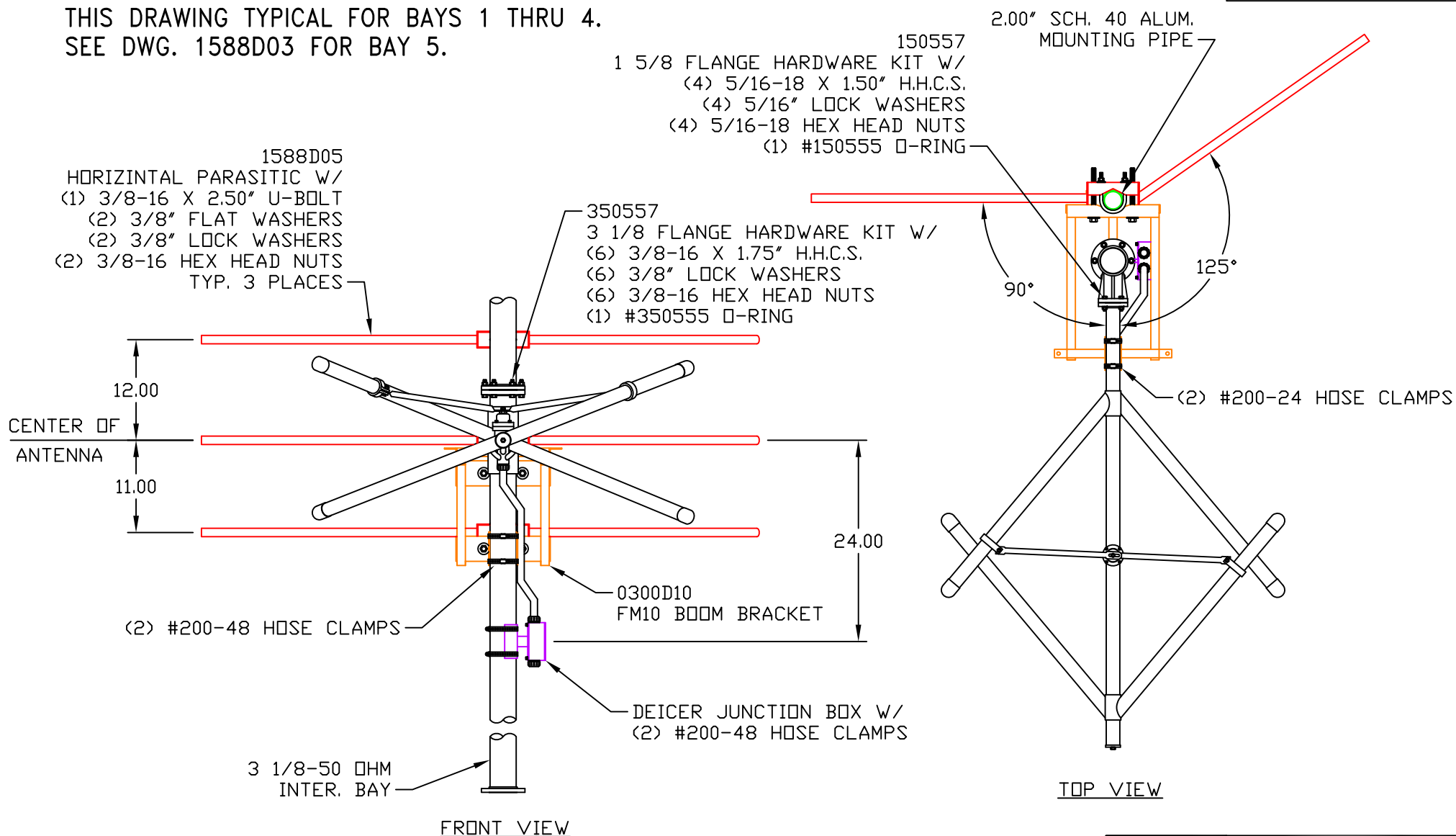
NOTE:

## Exhibit 7 (cont'd): Drawings

DRAWING  
NUMBER:

1588D02

THIS DRAWING TYPICAL FOR BAYS 1 THRU 4.  
SEE DWG. 1588D03 FOR BAY 5.



<b>TOLERANCES</b> .X ± .015 .XX ± .005 .XXX ± .002 X/X ± 1/32 DEG. ± 1/2 UNLESS OTHERWISE SPECIFIED		<b>REVISION RECORD</b>		
		<b>REV</b>	<b>APPROVAL</b>	<b>DATE</b>
<b>BY THIS DRAWING</b>		<b>DRAWING</b> <b>NUMBER:</b> 1588D02		
<b>NAME:</b> RAC		<b>DATE:</b> 9/14/11 <b>SHEET</b> 1 <b>OF</b> 1		



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

TITLE:	FM10D/5-DA, FREQ. 90.1 WYBA, COLDWATER, MI
MATERIAL:	PARASITIC PLACEMENT BAYS 1 THRU 4

SIZE  
A

PARTS MADE BY THIS DRAWING

SCALE: NTS

NAME: RAC

DATE: 9/14/11

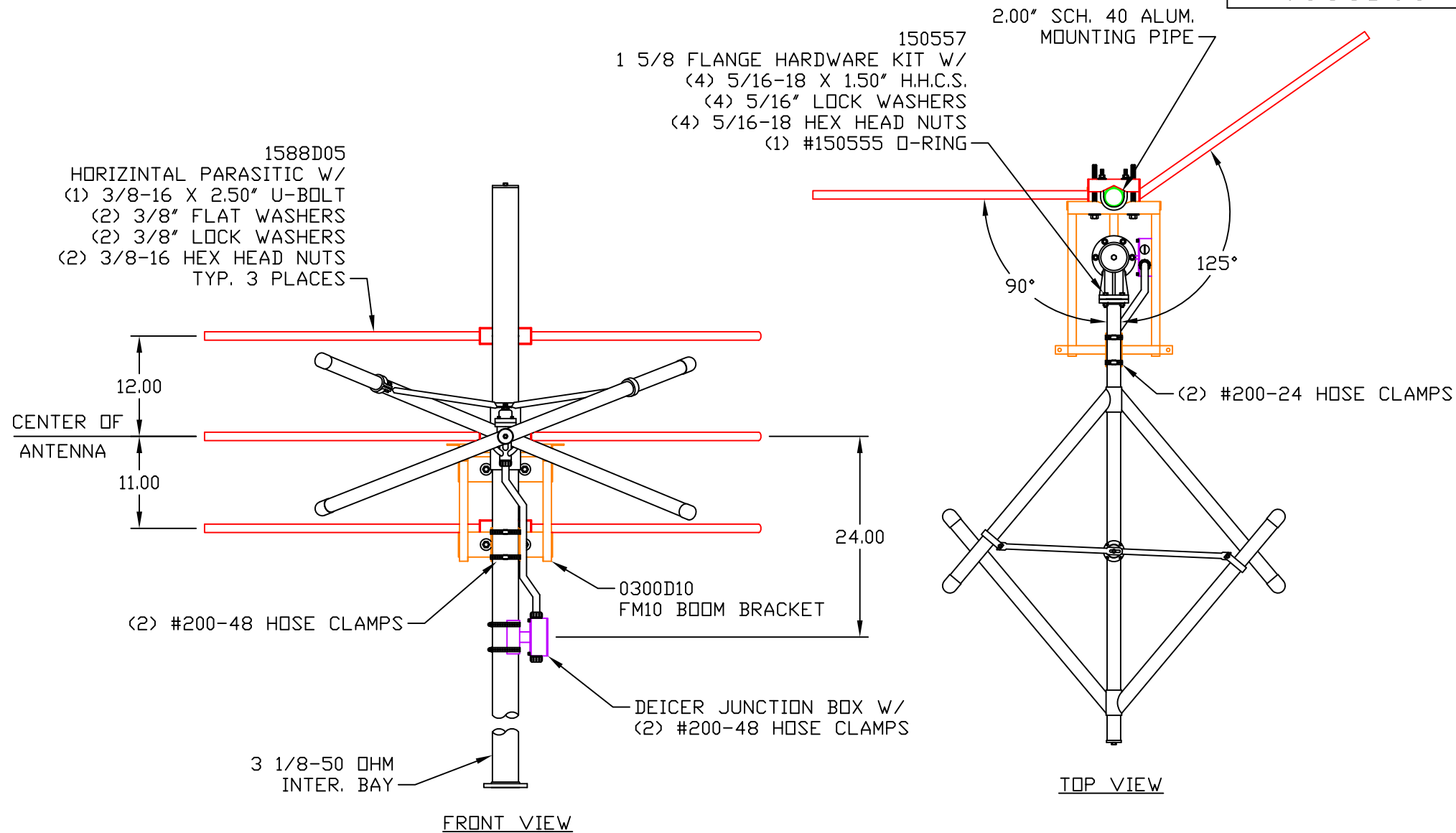
SHEET 1 OF 1
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NOTE:

# Exhibit 7 (cont'd): Drawings

DRAWING  
NUMBER:

1588D03



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

REVISION RECORD		
REV	APPROVAL	DATE
DRAWING NUMBER: 1588D03		
SCALE: NTS	NAME: RAC	DATE: 9/14/11
SHEET 1 OF 1		



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

TITLE:

FM10D/5-DA, FREQ. 90.1  
WYBA, COLDWATER, MI  
PARASITIC PLACEMENT  
BAY 5

MATERIAL:

SIZE

A

PARTS MADE BY THIS DRAWING

SCALE: NTS

NAME: RAC

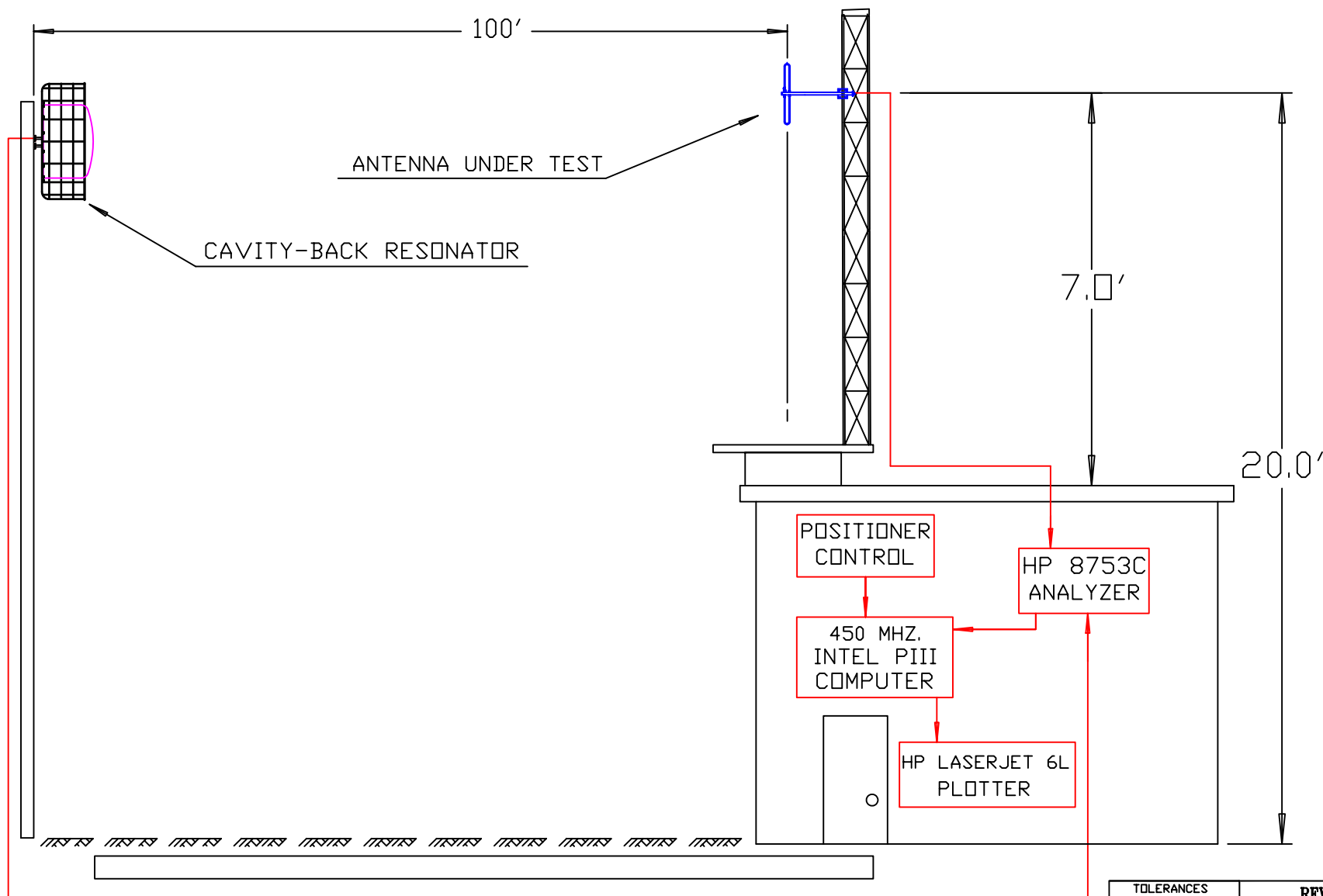
DATE: 9/14/11

SHEET 1 OF 1

NOTE:

# Exhibit 7 (cont'd): Drawings

DRAWING  
NUMBER: 2105A10



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			
			DRAWING NUMBER: 2105A10		
			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