



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

**PATTERN CERTIFICATION**  
**DIRECTIONAL FM ANTENNA**  
**WYHW**  
**June 7, 2016**

<b>Call Sign</b>	:	WYHW
<b>Location</b>	:	Carolina Beach, NC
<b>Frequency</b>	:	104.5 MHz
<b>Channel</b>	:	283C3
<b>Antenna Model</b>	:	FM3/4-DA
<b>Maximum Antenna Gain</b>	:	
<b>Horizontal</b>	:	<b>3.964 / 5.98 dB</b>
<b>Vertical</b>	:	<b>3.964 / 5.98 dB</b>

**ANTENNA DESCRIPTION**

A custom designed FM3/4-DA antenna was fabricated to conform to the prescribed directional azimuth pattern. The antenna consists of four (4) circularly polarized, cross-V dipole radiating elements full wave spaced mounted to a Sabre 4400 SRWD forty-four (44)" (inch) face tower. The antenna array points 55 degrees true north.

**DESCRIPTION OF TEST PROCEDURE**

The test antenna consisted of a single third-scale bay. The antenna was mounted to a third-scale pipe, which was mounted to a third-scale tower by use of third-scale brackets identical to those shipped with the final, full-scale antenna. For testing, the entire third-scale model was then mounted atop a 20' (foot) high platform, and all feed cables were properly grounded. Horizontal and vertical readings were taken. The desired directional pattern was obtained by adjusting the distance between the tower and the antenna, and modifying the direction of the azimuth heading. Parasitic elements were used for performance enhancement.

**DESCRIPTION OF TEST PARAMETERS AND EQUIPMENT**

Horizontal and vertical pattern readings were taken by mounting a source antenna - a vertical/horizontal dipole, Cavity Back Resonator (CBR) antenna bay - approximately 100' (feet) from the third-scale antenna model. The source antenna's height was adjusted to achieve a uniform field at the third-scale test antenna location. The CBR antenna was operated in receive mode, at frequency 313.5 MHz. The third-scale test antenna was then rotated clockwise in order to achieve 360° (degree) pattern readings. A gain reference was taken using a dipole tuned to 313.5 MHz. Nowhere did the received signal, or resultant documentation, exceed a maximum to minimum ratio of 15dB (decibels).

## TEST RESULTS

The attached calculations verify that the **RMS** value of this antenna is **85.4%** of the **RMS** value of the pattern authorized in the related FCC file **BPH-20141119AAN**. The vertical component **RMS** value is **0.750**. The horizontal component **RMS** value is **0.684**. The circular polarized component **RMS** value is **0.829**.

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

<b>Measured vertical polarized directivity:</b>	<b>1.776 / 2.50 dB</b>
<b>Measured horizontal polarized directivity:</b>	<b>2.135 / 3.29 dB</b>
<b>Measured circular polarized pattern directivity:</b>	<b>1.456 / 1.63 dB</b>

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:

<b>V-Pol. Gain</b> = (1.77625)(.5458)(4.088)	<b>= 3.964 / 5.98 dB</b>
<b>H-Pol. Gain</b> = (2.13484)(.4542)(4.088)	<b>= 3.964 / 5.98 dB</b>

## INSTALLATION AND MOUNTING

The antenna is to be mounted in accordance with the supplied drawings. The antenna center of radiation is to be **120 meters (393.72 ft.)** above ground level. The antenna aperture is **28.24 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 **55 degrees** true North.

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

<b>DRAWING NO.</b>	<b>TITLE</b>
2022D00	ELEVATION
2022D01	ANTENNA ORIENTATION
2022D02/2022D03	PARASITIC PLACEMENT
2105A10	TEST RANGE SCHEMATIC

The array shall be mounted according to all details outlined in **DWG. 2022D00**. The antenna elements shall be aligned at the same heading as in **DWG. 2022D01**. This will ensure that the antenna is oriented properly at 55 degrees true north. The parasitic placement is shown on **DWG. 2022D02** and **2022D03**. The test range schematic **DWG. 2105A10** shows the mounting configuration of the antenna setup on our range.

## 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

<b>Network Analyzer</b>	:	Hewlett Packard Model # 8753C Serial Number: 08753 – 69138
<b>Computer</b>	:	Pentium 3, 450 MHz, SAMS Range Program
<b>Printer</b>	:	Hewlett-Packard Laser Jet 6L
<b>Positioner</b>	:	Orbit Positioner
All equipment is calibrated to ANSI/NCSS Z540-1-1994 specs		

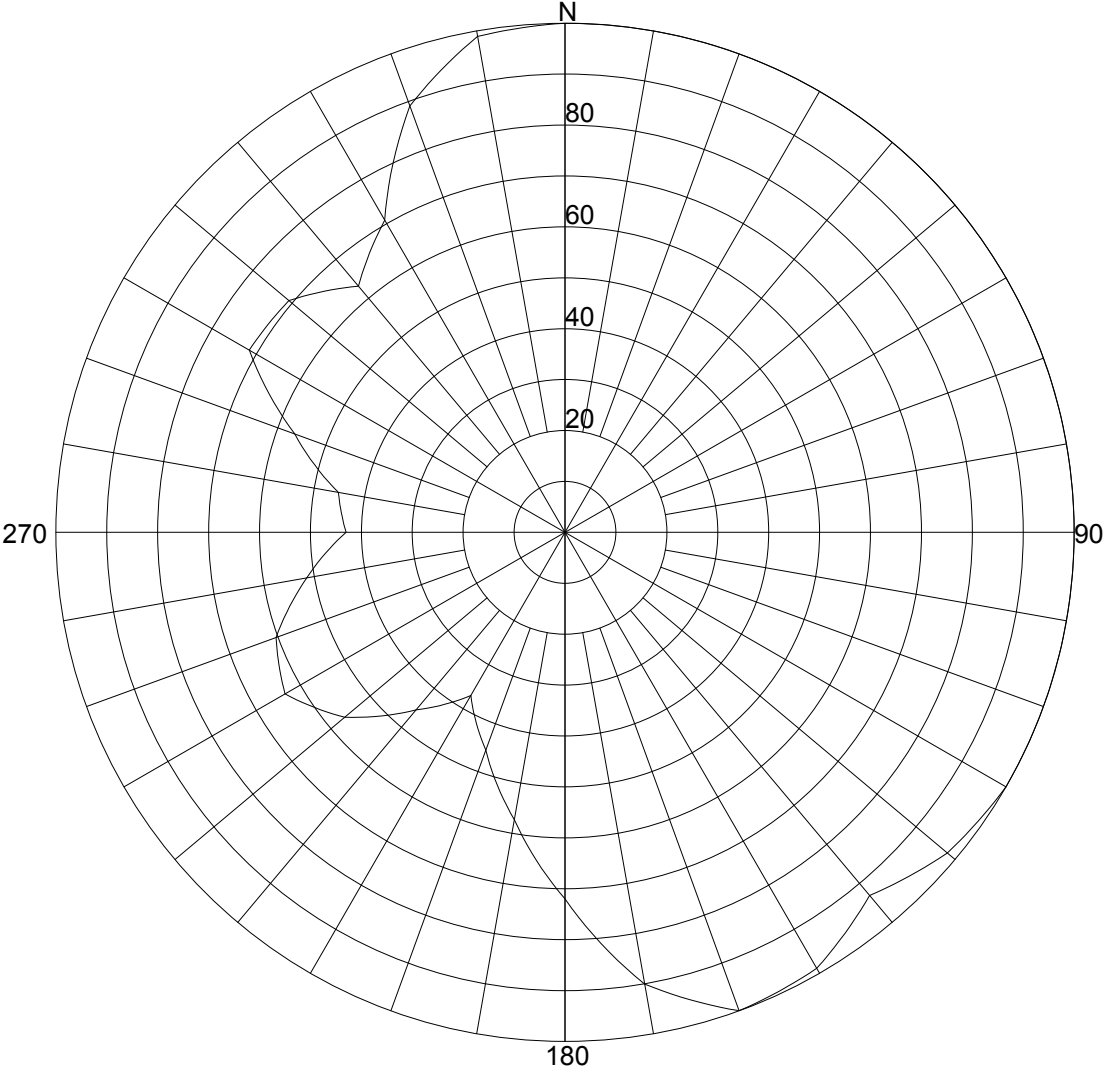
Prepared by:



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**Kevin W. Rager**  
Antenna Engineer  
Systems With Reliability, LP

Exhibit 1: Circular Polarized Azimuth Pattern



Azimuth Pattern

Systems With Reliability

Scale: Linear  
Unit: Relative Field

CLIENT: WYHW - Composite Range	Date: 5/18/2016
ANTENNA TYPE: FM3/4-DA	
FREQUENCY: 104.5 MHz	
PATTERN POL.: Circular	CIRCULARITY(+/-dB):
AZ. DIRECTIVITY: 1.45606 / 1.63dB	PATTERN RMS: 0.829

## Relative Field Tabulation(Azimuth)

Azimuth Heading	Normalized Field(dB)	Azimuth Heading	Normalized Field(dB)
0	1.0000 ( 0 )	180	.7200 (-2.85 )
5	1.0000 ( 0 )	185	.6465 (-3.79 )
10	1.0000 ( 0 )	190	.5730 (-4.84 )
15	1.0000 ( 0 )	195	.5140 (-5.78 )
20	1.0000 ( 0 )	200	.4550 (-6.84 )
25	1.0000 ( 0 )	205	.4125 (-7.69 )
30	1.0000 ( 0 )	210	.3700 (-8.64 )
35	1.0000 ( 0 )	215	.4125 (-7.69 )
40	1.0000 ( 0 )	220	.4550 (-6.84 )
45	1.0000 ( 0 )	225	.5100 (-5.85 )
50	1.0000 ( 0 )	230	.5650 (-4.96 )
55	1.0000 ( 0 )	235	.6000 (-4.44 )
60	1.0000 ( 0 )	240	.6350 (-3.94 )
65	1.0000 ( 0 )	245	.6195 (-4.16 )
70	1.0000 ( 0 )	250	.6040 (-4.38 )
75	1.0000 ( 0 )	255	.5595 (-5.04 )
80	1.0000 ( 0 )	260	.5150 (-5.76 )
85	1.0000 ( 0 )	265	.4725 (-6.51 )
90	1.0000 ( 0 )	270	.4300 (-7.33 )
95	1.0000 ( 0 )	275	.4410 (-7.11 )
100	1.0000 ( 0 )	280	.4520 (-6.9 )
105	1.0000 ( 0 )	285	.5085 (-5.87 )
110	1.0000 ( 0 )	290	.5650 (-4.96 )
115	1.0000 ( 0 )	295	.6405 (-3.87 )
120	1.0000 ( 0 )	300	.7160 (-2.9 )
125	.9900 (-0.09 )	305	.7120 (-2.95 )
130	.9800 (-0.18 )	310	.7080 (-3 )
135	.9555 (-0.4 )	315	.6695 (-3.48 )
140	.9310 (-0.62 )	320	.6310 (-4 )
145	.9600 (-0.35 )	325	.6695 (-3.48 )
150	.9890 (-0.1 )	330	.7080 (-3 )
155	.9945 (-0.05 )	335	.7995 (-1.94 )
160	1.0000 ( 0 )	340	.8910 (-1 )
165	.9505 (-0.44 )	345	.9400 (-0.54 )
170	.9010 (-0.91 )	350	.9890 (-0.1 )
175	.8105 (-1.82 )	355	.9945 (-0.05 )

## Systems With Reliability

CLIENT: WYHW - Composite Range

Date: 5/18/2016

ANTENNA TYPE: FM3/4-DA

FREQUENCY: 104.5 MHz

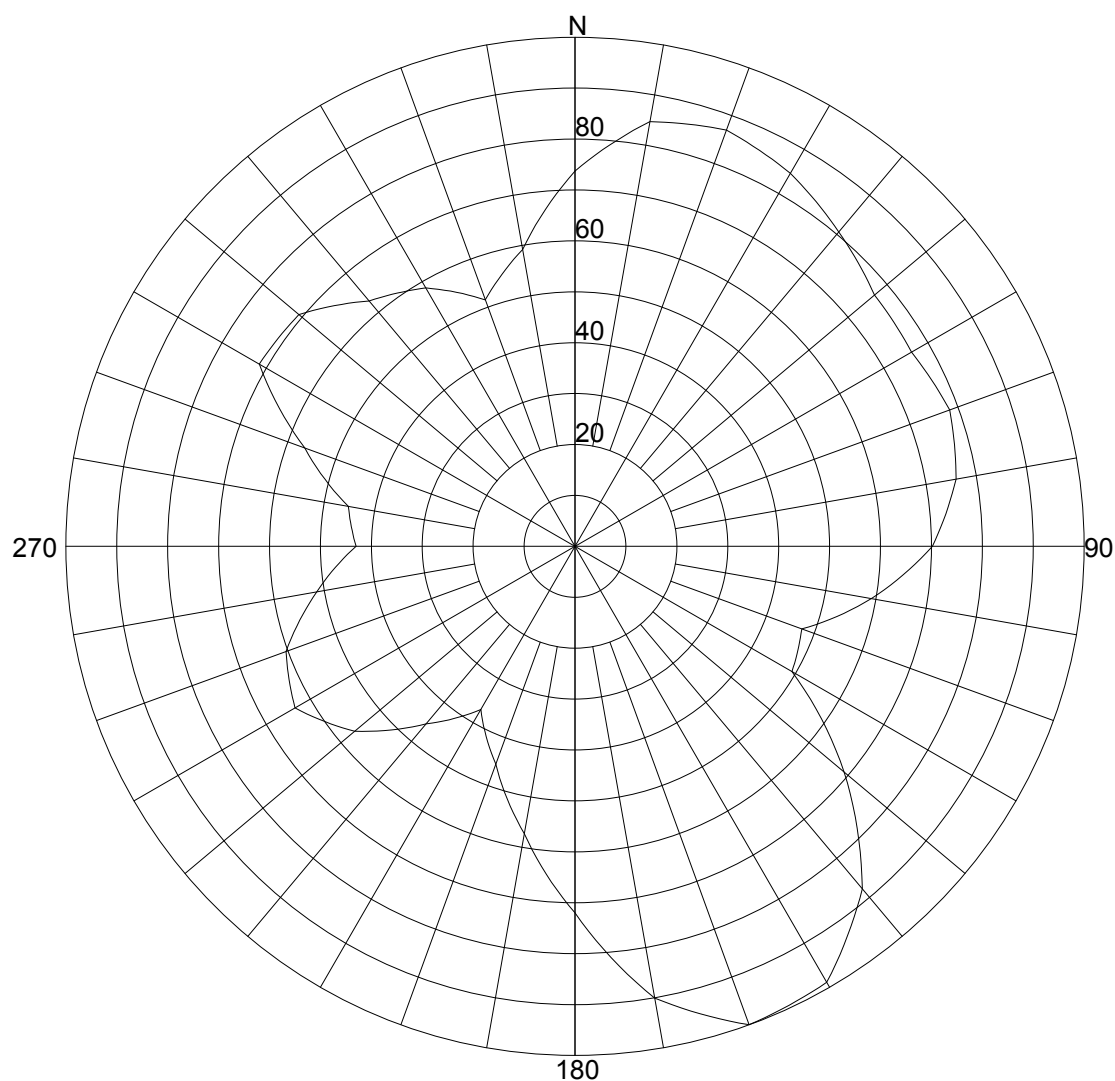
PATTERN POL.: Circular

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 1.45606 / 1.63dB

PATTERN RMS: 0.829

## Exhibit 2: Measured Horizontal Polarized Azimuth Pattern



### Azimuth Pattern

Scale: Linear

Unit: Relative Field

## Systems With Reliability

CLIENT: WYHW - H-POL Range

Date: 5/18/2016

ANTENNA TYPE: FM3/4-DA

FREQUENCY: 104.5 MHz

PATTERN POL.: Horizontal

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 2.13484 / 3.29dB

PATTERN RMS: 0.684

## Relative Field Tabulation(Azimuth)

Azimuth Heading	Normalized Field(dB)	Azimuth Heading	Normalized Field(dB)
0	.7370 (-2.65 )	180	.7200 (-2.85 )
5	.7920 (-2.03 )	185	.6465 (-3.79 )
10	.8470 (-1.44 )	190	.5730 (-4.84 )
15	.8585 (-1.33 )	195	.5140 (-5.78 )
20	.8700 (-1.21 )	200	.4550 (-6.84 )
25	.8580 (-1.33 )	205	.4125 (-7.69 )
30	.8460 (-1.45 )	210	.3700 (-8.64 )
35	.8260 (-1.66 )	215	.4125 (-7.69 )
40	.8060 (-1.87 )	220	.4550 (-6.84 )
45	.7870 (-2.08 )	225	.5100 (-5.85 )
50	.7680 (-2.29 )	230	.5650 (-4.96 )
55	.7655 (-2.32 )	235	.6000 (-4.44 )
60	.7630 (-2.35 )	240	.6350 (-3.94 )
65	.7730 (-2.24 )	245	.6195 (-4.16 )
70	.7830 (-2.12 )	250	.6040 (-4.38 )
75	.7715 (-2.25 )	255	.5595 (-5.04 )
80	.7600 (-2.38 )	260	.5150 (-5.76 )
85	.7310 (-2.72 )	265	.4725 (-6.51 )
90	.7020 (-3.07 )	270	.4300 (-7.33 )
95	.6465 (-3.79 )	275	.4410 (-7.11 )
100	.5910 (-4.57 )	280	.4520 (-6.9 )
105	.5325 (-5.47 )	285	.5085 (-5.87 )
110	.4740 (-6.48 )	290	.5650 (-4.96 )
115	.4830 (-6.32 )	295	.6405 (-3.87 )
120	.4920 (-6.16 )	300	.7160 (-2.9 )
125	.5910 (-4.57 )	305	.7120 (-2.95 )
130	.6900 (-3.22 )	310	.7080 (-3 )
135	.7840 (-2.11 )	315	.6685 (-3.5 )
140	.8780 (-1.13 )	320	.6290 (-4.03 )
145	.9335 (-0.6 )	325	.6075 (-4.33 )
150	.9890 (-0.1 )	330	.5860 (-4.64 )
155	.9945 (-0.05 )	335	.5505 (-5.18 )
160	1.0000 ( 0 )	340	.5150 (-5.76 )
165	.9505 (-0.44 )	345	.5535 (-5.14 )
170	.9010 (-0.91 )	350	.5920 (-4.55 )
175	.8105 (-1.82 )	355	.6645 (-3.55 )

## Systems With Reliability

CLIENT: WYHW - H-POL Range

Date: 5/18/2016

ANTENNA TYPE: FM3/4-DA

FREQUENCY: 104.5 MHz

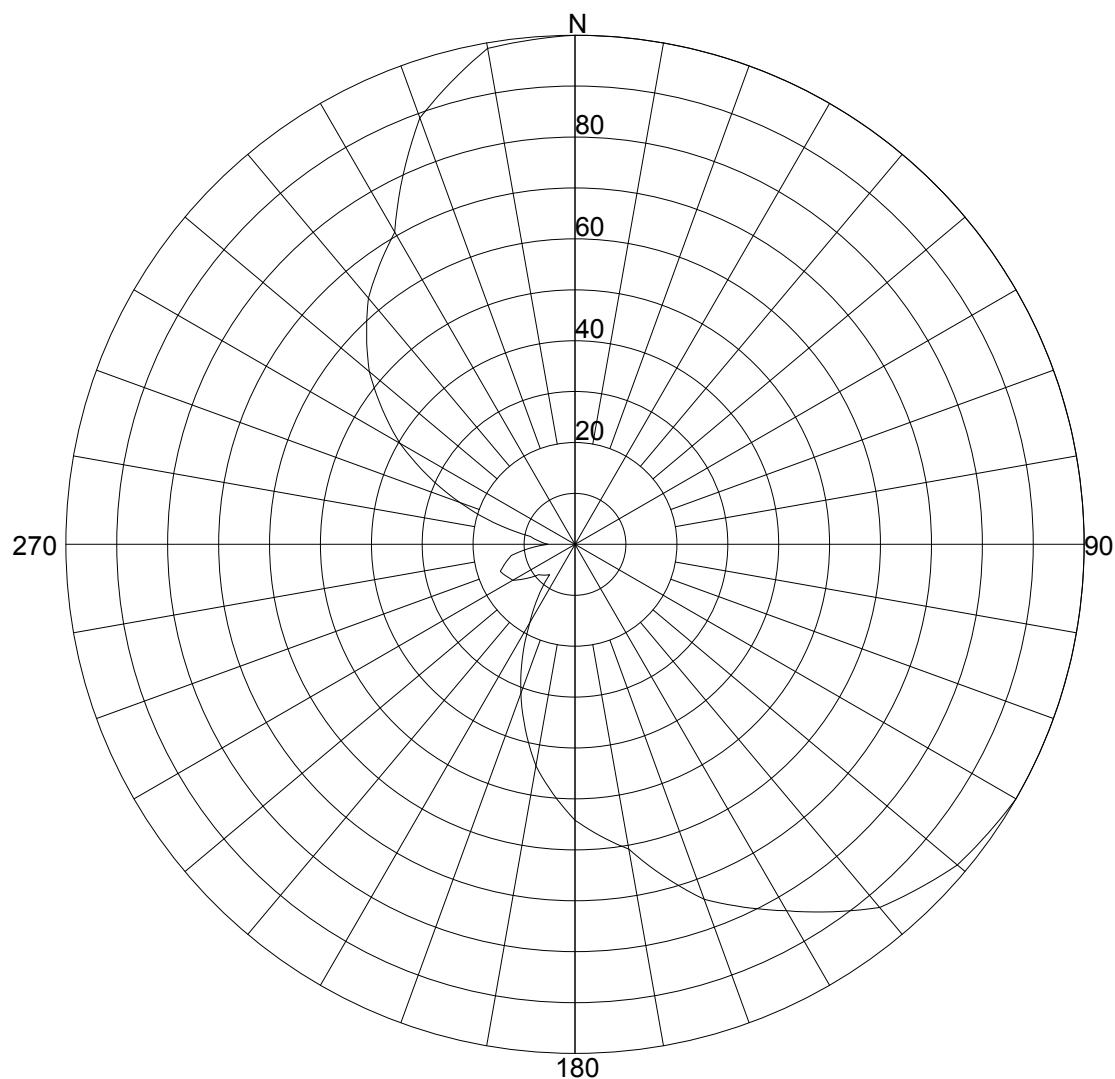
PATTERN POL.: Horizontal

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 2.13484 / 3.29dB

PATTERN RMS: 0.684

### Exhibit 3: Measured Vertical Polarized Azimuth Pattern



## Azimuth Pattern

Scale: Linear

Unit: Relative Field

## Systems With Reliability

CLIENT: WYHW - V-POL Range

Date: 5/18/2016

ANTENNA TYPE: FM3/4-DA

FREQUENCY: 104.5 MHz

PATTERN POL.: Vertical

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 1.77625 / 2.5dB

PATTERN RMS: 0.750



## Relative Field Tabulation(Azimuth)

Azimuth Heading	Normalized Field(dB)	Azimuth Heading	Normalized Field(dB)
0	1.0000 ( 0 )	180	.5420 (-5.32 )
5	1.0000 ( 0 )	185	.4920 (-6.16 )
10	1.0000 ( 0 )	190	.4420 (-7.09 )
15	1.0000 ( 0 )	195	.3765 (-8.48 )
20	1.0000 ( 0 )	200	.3110 (-10.14 )
25	1.0000 ( 0 )	205	.2440 (-12.25 )
30	1.0000 ( 0 )	210	.1770 (-15.04 )
35	1.0000 ( 0 )	215	.1275 (-17.89 )
40	1.0000 ( 0 )	220	.0780 (-22.16 )
45	1.0000 ( 0 )	225	.0855 (-21.36 )
50	1.0000 ( 0 )	230	.0930 (-20.63 )
55	1.0000 ( 0 )	235	.1170 (-18.64 )
60	1.0000 ( 0 )	240	.1410 (-17.02 )
65	1.0000 ( 0 )	245	.1485 (-16.57 )
70	1.0000 ( 0 )	250	.1560 (-16.14 )
75	1.0000 ( 0 )	255	.1415 (-16.98 )
80	1.0000 ( 0 )	260	.1270 (-17.92 )
85	1.0000 ( 0 )	265	.0900 (-20.92 )
90	1.0000 ( 0 )	270	.0530 (-25.51 )
95	1.0000 ( 0 )	275	.0710 (-22.97 )
100	1.0000 ( 0 )	280	.0890 (-21.01 )
105	1.0000 ( 0 )	285	.1650 (-15.65 )
110	1.0000 ( 0 )	290	.2410 (-12.36 )
115	1.0000 ( 0 )	295	.3190 (-9.92 )
120	1.0000 ( 0 )	300	.3970 (-8.02 )
125	.9900 (-0.09 )	305	.4620 (-6.71 )
130	.9800 (-0.18 )	310	.5270 (-5.56 )
135	.9555 (-0.4 )	315	.5790 (-4.75 )
140	.9310 (-0.62 )	320	.6310 (-4 )
145	.8810 (-1.1 )	325	.6695 (-3.48 )
150	.8310 (-1.61 )	330	.7080 (-3 )
155	.7865 (-2.09 )	335	.7995 (-1.94 )
160	.7420 (-2.59 )	340	.8910 (-1 )
165	.6750 (-3.41 )	345	.9400 (-0.54 )
170	.6080 (-4.32 )	350	.9890 (-0.1 )
175	.5750 (-4.81 )	355	.9945 (-0.05 )

## Systems With Reliability

CLIENT: WYHW - V-POL Range

Date: 5/18/2016

ANTENNA TYPE: FM3/4-DA

FREQUENCY: 104.5 MHz

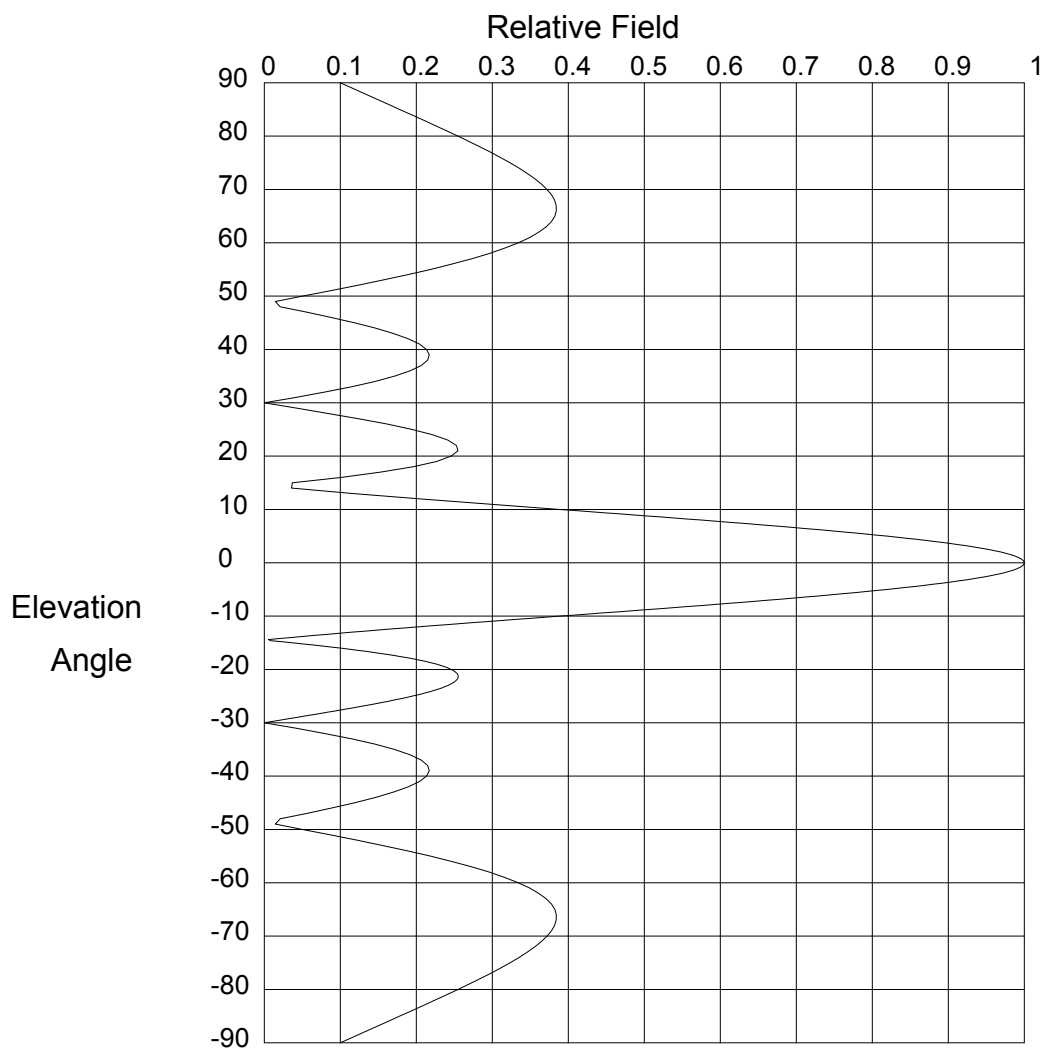
PATTERN POL.: Vertical

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 1.77625 / 2.5dB

PATTERN RMS: 0.750

#### Exhibit 4: Elevation Pattern



### Elevation Pattern

Scale: Linear

Units: Field, Relative

## Systems With Reliability

CLIENT: WYHW

Date: 6/1/2016

ANTENNA TYPE: FM3/4-DA

FREQUENCY: 104.5 MHz

PATTERN POL.: Circular

DIRECTIVITY(Peak): 4.088/6.115 dBd

Beam Tilt (Deg.) : 0

DIRECTIVITY(Horiz): 4.088/6.115 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	.122 (-18.296)	14.0	.036 (-28.925 )
89.0	.116 (-18.733)	51.0	.087 (-21.259)	13.0	.116 (-18.677 )
88.0	.131 (-17.628)	50.0	.051 (-25.907)	12.0	.203 (-13.829 )
87.0	.147 (-16.648)	49.0	.015 (-36.679)	11.0	.295 (-10.601 )
86.0	.163 (-15.769)	48.0	.021 (-33.591)	10.0	.389 (-8.198 )
85.0	.178 (-14.973)	47.0	.055 (-25.123)	9.8	.408 (-7.785 )
84.0	.194 (-14.247)	46.0	.088 (-21.083)	9.6	.427 (-7.391 )
83.0	.209 (-13.581)	45.0	.119 (-18.507)	9.4	.446 (-7.015 )
82.0	.225 (-12.967)	44.0	.146 (-16.7)	9.2	.465 (-6.656 )
81.0	.24 (-12.4)	43.0	.17 (-15.39)	9.0	.484 (-6.311 )
80.0	.255 (-11.875)	42.0	.19 (-14.446)	8.8	.502 (-5.981 )
79.0	.269 (-11.39)	41.0	.204 (-13.798)	8.6	.521 (-5.665 )
78.0	.284 (-10.941)	40.0	.214 (-13.409)	8.4	.539 (-5.362 )
77.0	.298 (-10.528)	39.0	.217 (-13.261)	8.2	.558 (-5.071 )
76.0	.311 (-10.149)	38.0	.215 (-13.353)	8.0	.576 (-4.792 )
75.0	.323 (-9.803)	37.0	.207 (-13.7)	7.8	.594 (-4.524 )
74.0	.335 (-9.491)	36.0	.192 (-14.331)	7.6	.612 (-4.266 )
73.0	.346 (-9.212)	35.0	.172 (-15.306)	7.4	.63 (-4.019 )
72.0	.356 (-8.968)	34.0	.146 (-16.728)	7.2	.647 (-3.782 )
71.0	.365 (-8.759)	33.0	.115 (-18.8)	7.0	.664 (-3.554 )
70.0	.372 (-8.587)	32.0	.08 (-21.983)	6.8	.681 (-3.335 )
69.0	.378 (-8.453)	31.0	.041 (-27.75)	6.6	.698 (-3.125 )
68.0	.382 (-8.359)	30.0	.00 (-50)	6.4	.714 (-2.924 )
67.0	.384 (-8.309)	29.0	.042 (-27.509)	6.2	.73 (-2.731 )
66.0	.384 (-8.305)	28.0	.084 (-21.504)	6.0	.746 (-2.546 )
65.0	.382 (-8.352)	27.0	.125 (-18.095)	5.8	.761 (-2.368 )
64.0	.378 (-8.452)	26.0	.162 (-15.813)	5.6	.776 (-2.199 )
63.0	.371 (-8.611)	25.0	.195 (-14.205)	5.4	.791 (-2.036 )
62.0	.362 (-8.836)	24.0	.222 (-13.076)	5.2	.805 (-1.881 )
61.0	.349 (-9.134)	23.0	.242 (-12.335)	5.0	.819 (-1.733 )
60.0	.334 (-9.515)	22.0	.253 (-11.938)	4.8	.833 (-1.591 )
59.0	.317 (-9.989)	21.0	.255 (-11.878)	4.6	.846 (-1.457 )
58.0	.296 (-10.571)	20.0	.246 (-12.177)	4.4	.858 (-1.329 )
57.0	.273 (-11.282)	19.0	.226 (-12.899)	4.2	.87 (-1.207 )
56.0	.247 (-12.148)	18.0	.196 (-14.173)	4.0	.882 (-1.092 )
55.0	.219 (-13.205)	17.0	.153 (-16.282)	3.8	.893 (-0.983 )
54.0	.188 (-14.511)	16.0	.10 (-19.974)	3.6	.904 (-0.88 )
53.0	.156 (-16.155)	15.0	.037 (-28.661)	3.4	.914 (-0.783 )

## Systems With Reliability

Page 1 of 3

CLIENT: WYHW

Date: 6/1/2016

ANTENNA TYPE: FM3/4-DA

FREQUENCY: 104.5 MHz

PATTERN POL.: Circular

DIRECTIVITY(Peak): 4.088/6.115 dBd

Beam Tilt (Deg.) : 0

DIRECTIVITY(Horiz): 4.088/6.115 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	.923 (-0.692)	-4.4	.858 (-1.329)	-12.0	.203 (-13.829 )
3.0	.933 (-0.607)	-4.6	.846 (-1.457)	-12.2	.186 (-14.626 )
2.8	.941 (-0.528)	-4.8	.833 (-1.591)	-12.4	.168 (-15.493 )
2.6	.949 (-0.454)	-5.0	.819 (-1.733)	-12.6	.151 (-16.444 )
2.4	.956 (-0.386)	-5.2	.805 (-1.881)	-12.8	.133 (-17.497 )
2.2	.963 (-0.324)	-5.4	.791 (-2.036)	-13.0	.116 (-18.677 )
2.0	.97 (-0.268)	-5.6	.776 (-2.199)	-13.2	.10 (-20.021 )
1.8	.975 (-0.216)	-5.8	.761 (-2.368)	-13.4	.083 (-21.584 )
1.6	.981 (-0.171)	-6.0	.746 (-2.546)	-13.6	.067 (-23.455 )
1.4	.985 (-0.131)	-6.2	.73 (-2.731)	-13.8	.051 (-25.792 )
1.2	.989 (-0.096)	-6.4	.714 (-2.924)	-14.0	.036 (-28.925 )
1.0	.992 (-0.067)	-6.6	.698 (-3.125)	-14.2	.021 (-33.736 )
.8	.995 (-0.043)	-6.8	.681 (-3.335)	-14.4	.006 (-44.914 )
.6	.997 (-0.024)	-7.0	.664 (-3.554)	-14.6	.009 (-41.043 )
.4	.999 (-0.011)	-7.2	.647 (-3.782)	-14.8	.023 (-32.742 )
.2	1.00 (-0.003)	-7.4	.63 (-4.019)	-15.0	.037 (-28.661 )
.0	1.00 (0)	-7.6	.612 (-4.266)	-15.2	.05 (-25.959 )
-.2	1.00 (-0.003)	-7.8	.594 (-4.524)	-15.4	.063 (-23.954 )
-.4	.999 (-0.011)	-8.0	.576 (-4.792)	-15.6	.076 (-22.37 )
-.6	.997 (-0.024)	-8.2	.558 (-5.071)	-15.8	.088 (-21.07 )
-.8	.995 (-0.043)	-8.4	.539 (-5.362)	-16.0	.10 (-19.974 )
-1.0	.992 (-0.067)	-8.6	.521 (-5.665)	-16.2	.112 (-19.034 )
-1.2	.989 (-0.096)	-8.8	.502 (-5.981)	-16.4	.123 (-18.214 )
-1.4	.985 (-0.131)	-9.0	.484 (-6.311)	-16.6	.133 (-17.493 )
-1.6	.981 (-0.171)	-9.2	.465 (-6.656)	-16.8	.144 (-16.854 )
-1.8	.975 (-0.216)	-9.4	.446 (-7.015)	-17.0	.153 (-16.282 )
-2.0	.97 (-0.268)	-9.6	.427 (-7.391)	-17.2	.163 (-15.77 )
-2.2	.963 (-0.324)	-9.8	.408 (-7.785)	-17.4	.172 (-15.308 )
-2.4	.956 (-0.386)	-10.0	.389 (-8.198)	-17.6	.18 (-14.891 )
-2.6	.949 (-0.454)	-10.2	.37 (-8.63)	-17.8	.188 (-14.514 )
-2.8	.941 (-0.528)	-10.4	.351 (-9.085)	-18.0	.196 (-14.173 )
-3.0	.933 (-0.607)	-10.6	.333 (-9.563)	-18.2	.203 (-13.864 )
-3.2	.923 (-0.692)	-10.8	.314 (-10.068)	-18.4	.209 (-13.584 )
-3.4	.914 (-0.783)	-11.0	.295 (-10.601)	-18.6	.215 (-13.331 )
-3.6	.904 (-0.88)	-11.2	.276 (-11.166)	-18.8	.221 (-13.103 )
-3.8	.893 (-0.983)	-11.4	.258 (-11.767)	-19.0	.226 (-12.899 )
-4.0	.882 (-1.092)	-11.6	.24 (-12.407)	-19.2	.231 (-12.716 )
-4.2	.87 (-1.207)	-11.8	.222 (-13.092)	-19.4	.236 (-12.553 )

## Systems With Reliability

Page 2 of 3

CLIENT: WYHW

Date: 6/1/2016

ANTENNA TYPE: FM3/4-DA

FREQUENCY: 104.5 MHz

PATTERN POL.: Circular

DIRECTIVITY(Peak): 4.088/6.115 dBd

Beam Tilt (Deg.) : 0

DIRECTIVITY(Horiz): 4.088/6.115 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	.24 (-12.41)	-27.2	.117 (-18.664)	-54.0	.188 (-14.511 )
-19.8	.243 (-12.285)	-27.4	.109 (-19.281)	-55.0	.219 (-13.205 )
-20.0	.246 (-12.177)	-27.6	.101 (-19.954)	-56.0	.247 (-12.148 )
-20.2	.249 (-12.086)	-27.8	.092 (-20.691)	-57.0	.273 (-11.282 )
-20.4	.251 (-12.012)	-28.0	.084 (-21.504)	-58.0	.296 (-10.571 )
-20.6	.253 (-11.952)	-28.2	.076 (-22.408)	-59.0	.317 (-9.989 )
-20.8	.254 (-11.908)	-28.4	.067 (-23.424)	-60.0	.334 (-9.515 )
-21.0	.255 (-11.878)	-28.6	.059 (-24.581)	-61.0	.349 (-9.134 )
-21.2	.255 (-11.862)	-28.8	.051 (-25.921)	-62.0	.362 (-8.836 )
-21.4	.255 (-11.861)	-29.0	.042 (-27.509)	-63.0	.371 (-8.611 )
-21.6	.255 (-11.873)	-29.2	.034 (-29.455)	-64.0	.378 (-8.452 )
-21.8	.254 (-11.899)	-29.4	.025 (-31.965)	-65.0	.382 (-8.352 )
-22.0	.253 (-11.938)	-29.6	.017 (-35.502)	-66.0	.384 (-8.305 )
-22.2	.251 (-11.99)	-29.8	.008 (-41.542)	-67.0	.384 (-8.309 )
-22.4	.25 (-12.056)	-30.0	.00 (-50)	-68.0	.382 (-8.359 )
-22.6	.247 (-12.136)	-31.0	.041 (-27.75)	-69.0	.378 (-8.453 )
-22.8	.245 (-12.228)	-32.0	.08 (-21.983)	-70.0	.372 (-8.587 )
-23.0	.242 (-12.335)	-33.0	.115 (-18.8)	-71.0	.365 (-8.759 )
-23.2	.238 (-12.455)	-34.0	.146 (-16.728)	-72.0	.356 (-8.968 )
-23.4	.235 (-12.588)	-35.0	.172 (-15.306)	-73.0	.346 (-9.212 )
-23.6	.231 (-12.736)	-36.0	.192 (-14.331)	-74.0	.335 (-9.491 )
-23.8	.226 (-12.899)	-37.0	.207 (-13.7)	-75.0	.323 (-9.803 )
-24.0	.222 (-13.076)	-38.0	.215 (-13.353)	-76.0	.311 (-10.149 )
-24.2	.217 (-13.269)	-39.0	.217 (-13.261)	-77.0	.298 (-10.528 )
-24.4	.212 (-13.478)	-40.0	.214 (-13.409)	-78.0	.284 (-10.941 )
-24.6	.206 (-13.703)	-41.0	.204 (-13.798)	-79.0	.269 (-11.39 )
-24.8	.201 (-13.945)	-42.0	.19 (-14.446)	-80.0	.255 (-11.875 )
-25.0	.195 (-14.205)	-43.0	.17 (-15.39)	-81.0	.24 (-12.4 )
-25.2	.189 (-14.484)	-44.0	.146 (-16.7)	-82.0	.225 (-12.967 )
-25.4	.182 (-14.783)	-45.0	.119 (-18.507)	-83.0	.209 (-13.581 )
-25.6	.176 (-15.103)	-46.0	.088 (-21.083)	-84.0	.194 (-14.247 )
-25.8	.169 (-15.446)	-47.0	.055 (-25.123)	-85.0	.178 (-14.973 )
-26.0	.162 (-15.813)	-48.0	.021 (-33.591)	-86.0	.163 (-15.769 )
-26.2	.155 (-16.207)	-49.0	.015 (-36.679)	-87.0	.147 (-16.648 )
-26.4	.147 (-16.629)	-50.0	.051 (-25.907)	-88.0	.131 (-17.628 )
-26.6	.14 (-17.082)	-51.0	.087 (-21.259)	-89.0	.116 (-18.733 )
-26.8	.132 (-17.569)	-52.0	.122 (-18.296)	-90.0	.10 (-20 )
-27.0	.125 (-18.095)	-53.0	.156 (-16.155)	90.0	.00 (-50 )

## Systems With Reliability

Page 3 of 3

CLIENT: WYHW

Date: 6/1/2016

ANTENNA TYPE: FM3/4-DA

FREQUENCY: 104.5 MHz

PATTERN POL.: Circular

DIRECTIVITY(Peak): 4.088/6.115 dBd

Beam Tilt (Deg.) : 0

DIRECTIVITY(Horiz): 4.088/6.115 dBd

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

# Exhibit 5: Antenna Data Sheet



**SYSTEMS WITH RELIABILITY, LP**

*BROADCAST ANTENNAS AND TRANSMISSION LINE*

## SYSTEM DATA SHEET

<b>Customer</b>	WYHW
<b>Contact</b>	Ron Muffley
<b>Location</b>	Carolina Beach, NC
<b>Antenna Model</b>	FM3/4-DA
<b>Channel / Frequency</b>	104.5 MHz

### ELECTRICAL SPECIFICATIONS

#### Antenna Specifications:

	H-POL	dB	V. Pol.	dB
License ERP ( KW)	17.000		17.000	
FCC Limit Pattern Directivity	1.060	0.252 dB	1.060	0.252 dB
Elevation Directivity	4.088	6.115 dB	4.088	6.115 dB
Azimuth Directivity	2.135	3.294 dB	1.776	2.495 dB
Composite Pattern	1.456	1.632 dB	1.456	1.632 dB
Polarization Ratio	0.454		0.546	
<b>RMS Comp./RMS Limit</b>	85.3 %			
Antenna Efficiency %	100		100	
Power Ratio ( Pol. Ratio X Efficiency)	0.4542		0.5458	
Antenna Gain	3.964	5.981 dB	3.964	5.981 dB

<b>Antenna Input Power (KW)</b>	4.289 kW	6.324 (dBK)
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### MECHANICAL SPECIFICATIONS

<b>No. Of Bays</b>	4		
<b>Antenna Aperture</b>	28.24 ft.	8.61 meter	
<b>Center of Radiation AGL</b>	393.72 ft.	120.00 meter	
<b>Antenna Weight (Everything)</b>	325.00 lbs.	147.73 kg	
<b>Windload (50/33) w/ Mount. Pipe</b>	700.00 lbs.	20.00 ft^2	<b>Windload CaAc</b>

Kevin W. Rager  
SWR, LP Engineering

## Exhibit 6: RMS Calculations



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

# WYHW Antenna RMS Comparison

### PROPOSED ANTENNA

Azimuth Heading	Relative Field
0	1
10	1
20	1
30	1
40	1
50	1
60	1
70	1
80	1
90	1
100	1
110	1
120	1
130	1
140	1
150	1
160	1
170	1
180	1
190	1
200	1
210	1
220	1
230	1
240	1
250	1
260	1
270	1
280	1
290	1
300	0.891
310	0.708
320	0.631
330	0.708
340	0.891
350	1

### DESIGNED ANTENNA

Azimuth Heading	Relative Field
0	1.000
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	0.980
140	0.931
150	0.989
160	1.000
170	0.901
180	0.720
190	0.573
200	0.455
210	0.370
220	0.455
230	0.565
240	0.635
250	0.604
260	0.515
270	0.430
280	0.452
290	0.565
300	0.716
310	0.708
320	0.631
330	0.708
340	0.891
350	0.989

Sum of Relative Field Squared : 33.988  
Sum Divided by 36 (Readings) : 0.944  
Square Root : 0.972

Sum of Relative Field Squared : 24.761  
Sum Divided by 36 (Readings) : 0.688  
Square Root : 0.829

Percentage of Construction Permit Antenna Filled :

**85.4%**

REFERENCE DRAWINGS	
DWG. #	DESCRIPTION
2022D01	ANTENNA ORIENTATION
2022D02	BAYS 1 THRU 3 PARASITIC PLACEMENT
2022D03	BAY 4 PARASITIC PLACEMENT

DRAWING NUMBER: 2022D00

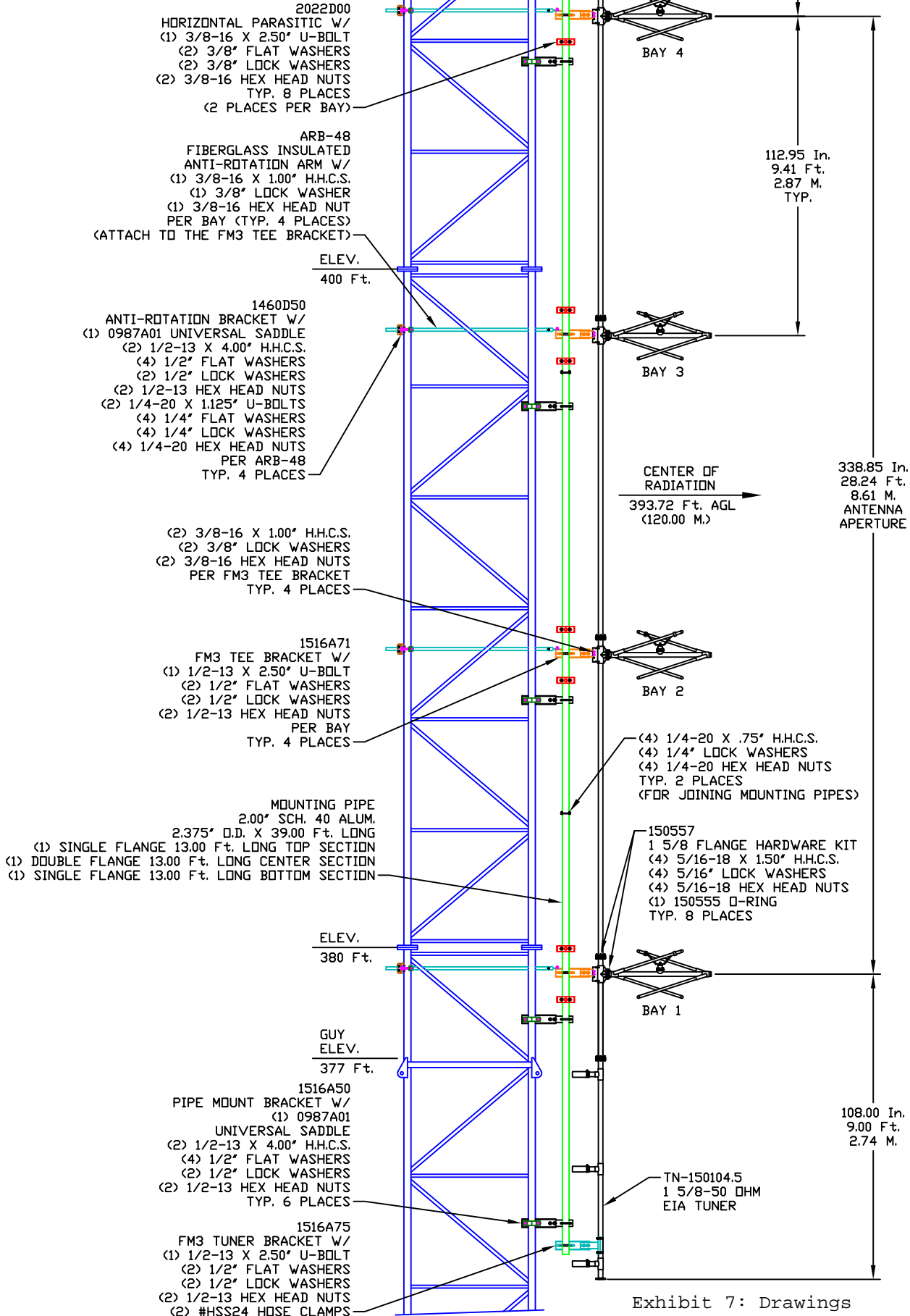
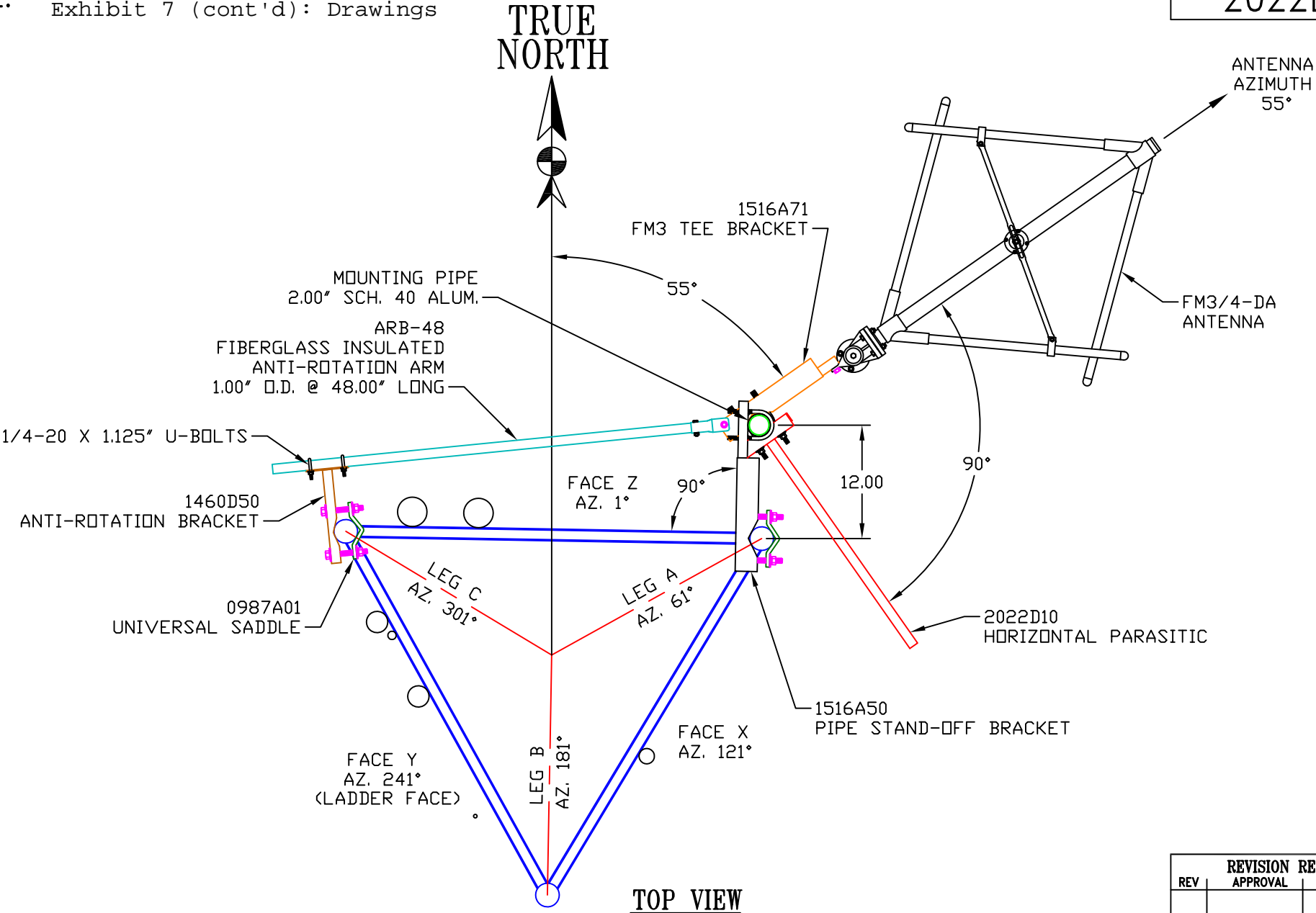


Exhibit 7: Drawings




NOTE: Exhibit 7 (cont'd): Drawings

DRAWING NUMBER: 2022D01



TOP VIEW

REVISION RECORD		
REV	APPROVAL	DATE



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

TITLE: FM3/4-DA, FREQ. 104.5  
WYHW, CAROLINA BEACH, NC

MATERIAL: ANTENNA ORIENTATION  
FROM TRUE NORTH

SIZE  
A

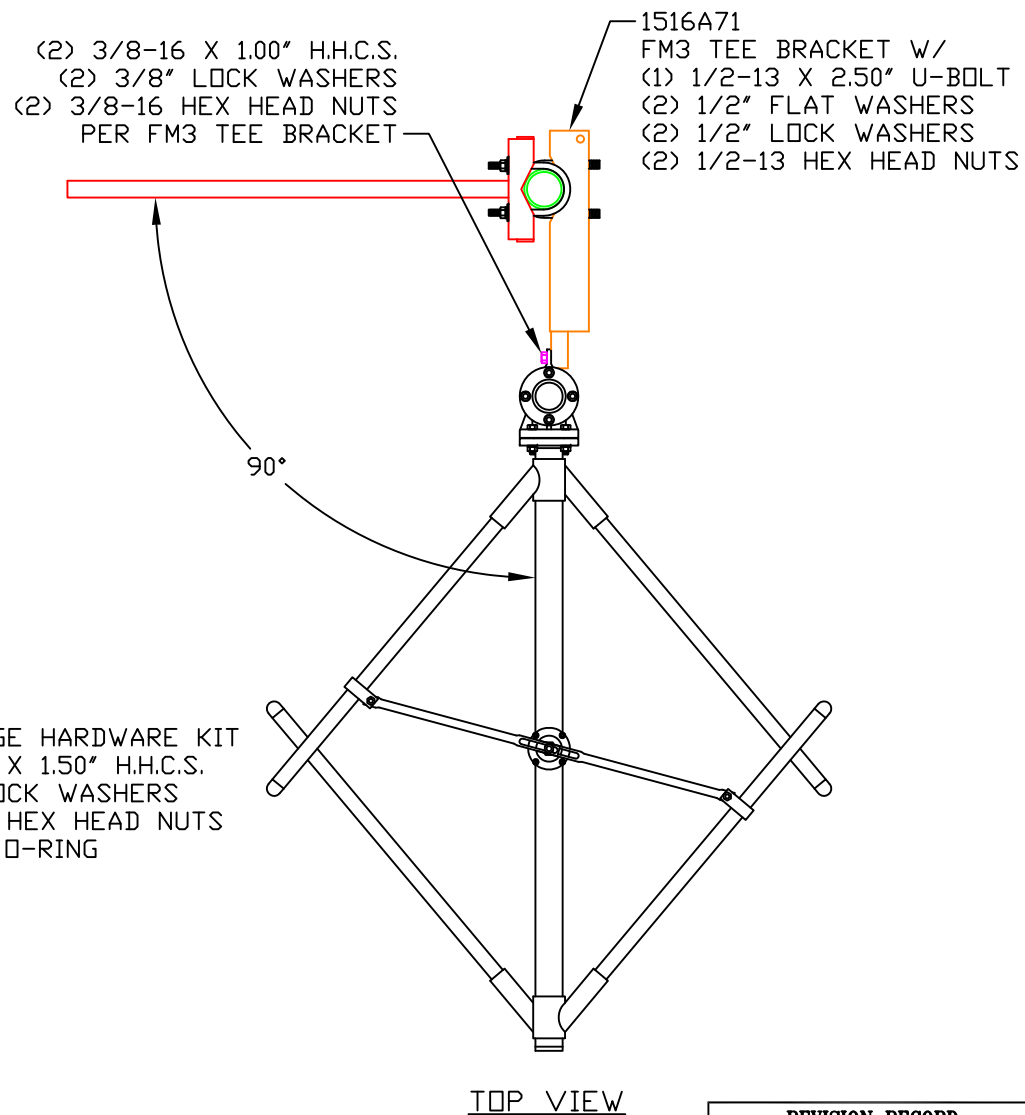
PARTS MADE BY THIS DRAWING

DRAWING NUMBER: 2022D01

SCALE: NTS NAME: RAC DATE: 5/26/16 SHEET 1 OF 1

DRAWING  
NUMBER: 2022D02

Exhibit 7 (cont'd): Drawings



REVISION RECORD		
REV	APPROVAL	DATE
DRAWING NUMBER: 2022D02		
5/26/16	SHEET 1	OF 1



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

TITLE:	FM3/4-DA, FREQ. 104.5 WYHW, CAROLINA BEACH, NC
MATERIAL:	BAYS 1 THRU 3 PARASITIC PLACEMENT

SIZE  
A

PARTS MADE BY THIS DRAWING

SCALE: NTS

NAME: RAC

DATE: 5/26/16

SHEET	1	OF	1
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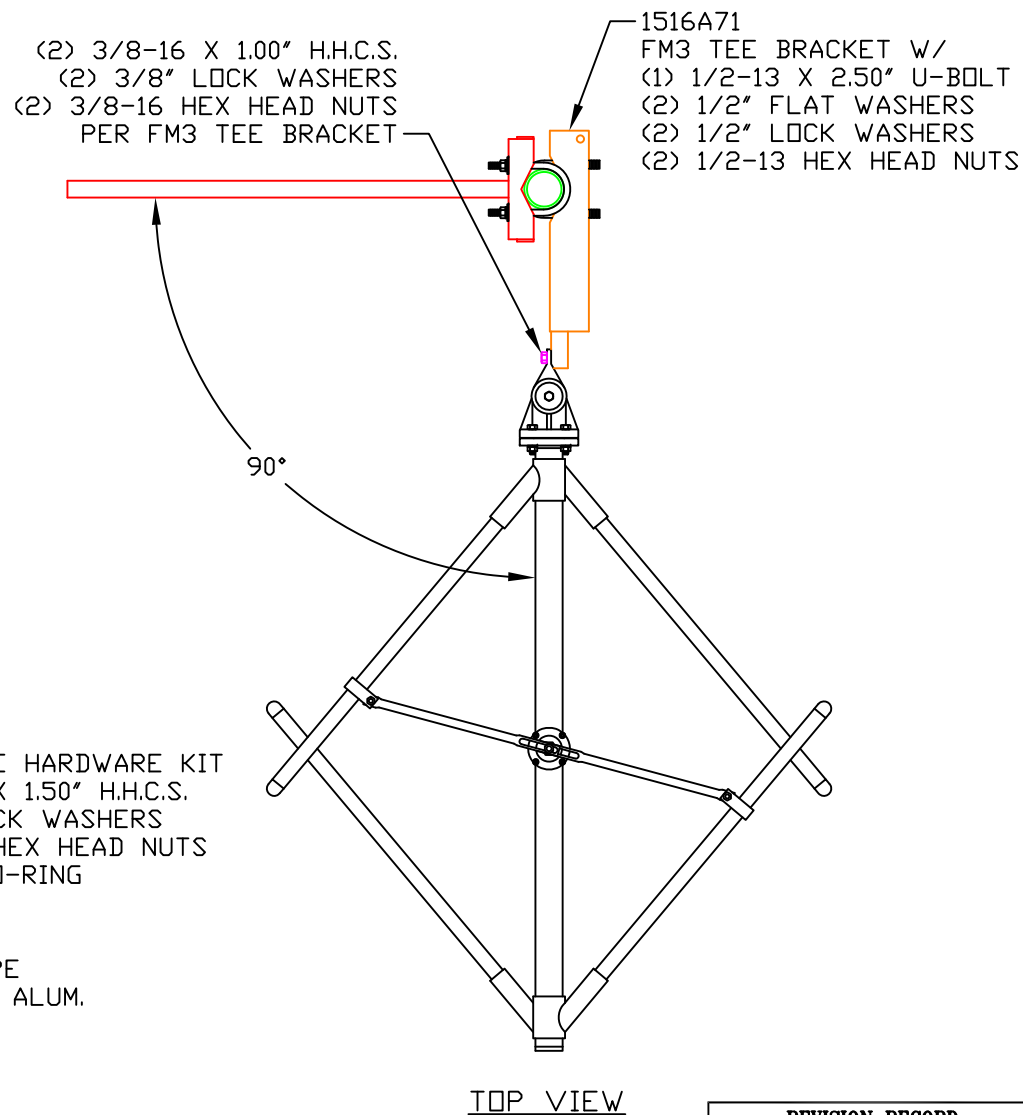
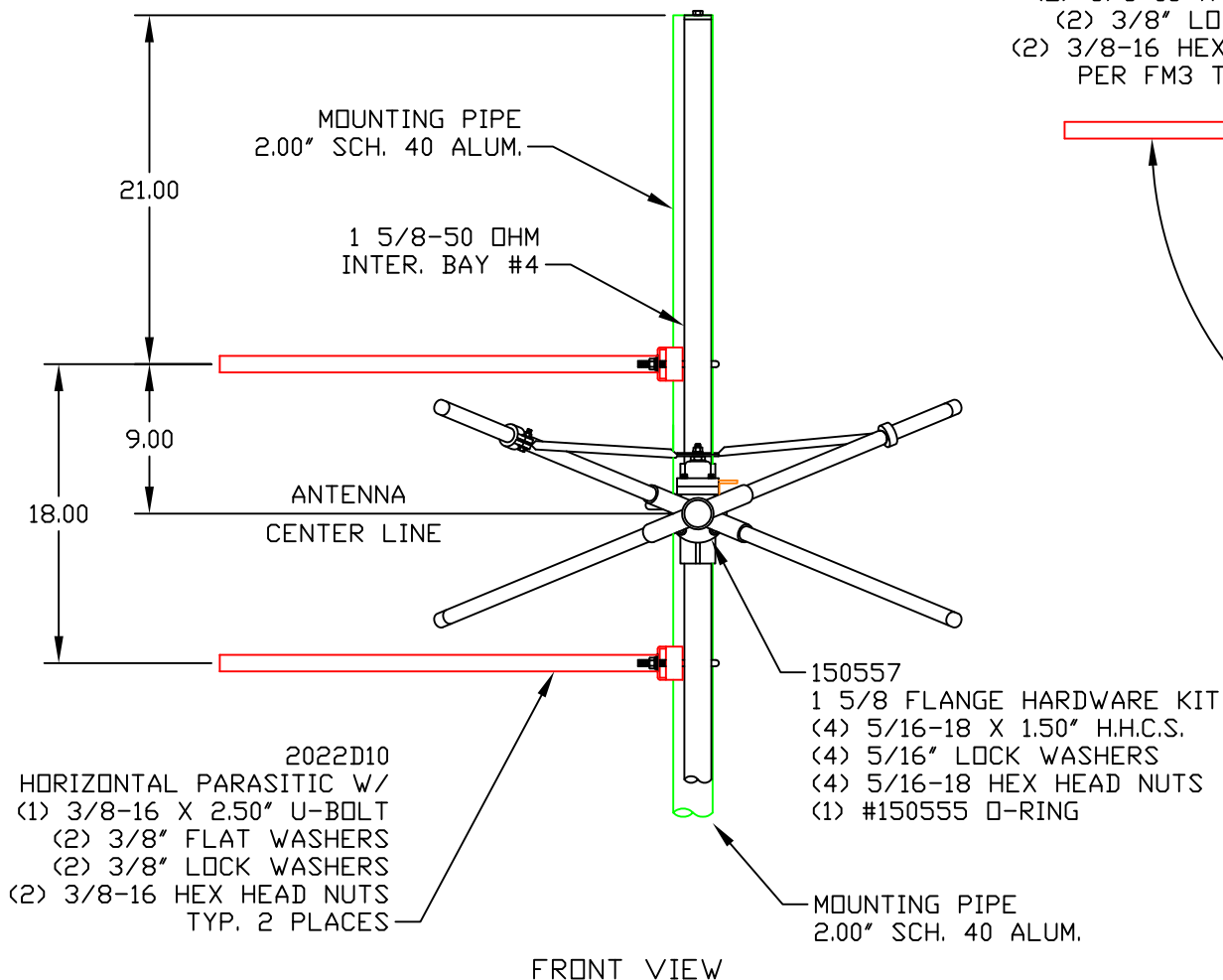
NOTE:

DRAWING  
NUMBER:

2022D03

THIS ASSEMBLY IS FOR BAY 4.

Exhibit 7 (cont'd): Drawings



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

TITLE:

FM3/4-DA, FREQ. 104.5  
WYHW, CAROLINA BEACH, NC

MATERIAL:

BAY 4  
PARASITIC PLACEMENT

SIZE

A

PARTS MADE BY THIS DRAWING

SCALE: NTS

NAME: RAC

DATE: 5/26/16

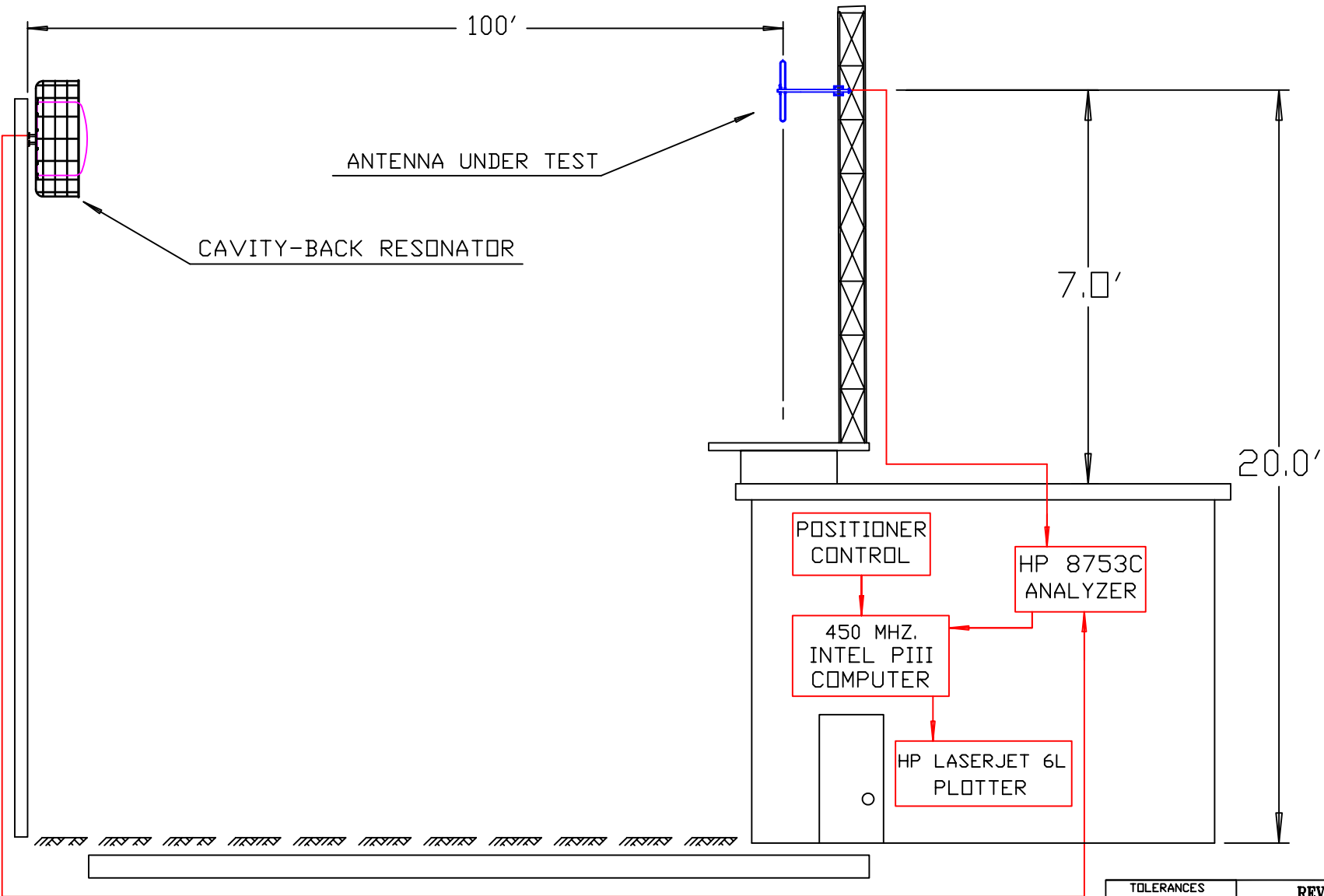
SHEET 1 OF 1

REVISION RECORD

REV APPROVAL DATE


DRAWING  
NUMBER:

2022D03



TOLERANCES			REVISION RECORD		
.X	±	.015	REV	APPROVAL	DATE
.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		