SYSTEMS WITH RELIABILITY, LP

BROADCAST ANTENNAS AND TRANSMISSION LINE

PATTERN CERTIFICATION

DIRECTIONAL FM ANTENNA
WHMA
April 1, 2019

Call Sign	:	WHMA
Location	:	Alexandria, AL
Frequency	:	95.3 MHz
Channel	:	237A
Antenna Model	:	FM3R/2-DA
Maximum Antenna Gain		
Horizontal	:	**2.531 / 4.032 dB**
Vertical	**:**	**2.531 / 4.032 dB**

ANTENNA DESCRIPTION

A custom designed FM3R/2-DA antenna was fabricated to conform to the prescribed directional azimuth pattern. The antenna consists of two (2) circularly polarized, radome enclosed cross-V dipole radiating elements full-wave spaced mounted to a 41" (INCH) face tower. The antenna points 305 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 pole 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 285.9 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 285.9 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 ***93.4%*** of the **RMS** value of the pattern authorized in the related FCC file **BPH-20071214AAR.** The vertical component **RMS** value is **0.694**. The horizontal component **RMS** value is **0.525**. The circular polarized component **RMS** value is **0.694.**

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

Measured vertical polarized directivity:	**2.0755 / 3.17 dB**
Measured horizontal polarized directivity:	**3.6214 / 5.25 dB**
Measured circular polarized pattern directivity:	**2.0748 / 3.17 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 = (2.07553)(.6357)(1.918) **= 2.531 / 4.032 dB**
H-Pol. Gain = (3.62137)(.3643)(1.918) **= 2.531 / 4.032 dB**

INSTALLATION AND MOUNTING

The antenna is to be mounted in accordance with the supplied drawings. The antenna center of radiation is to be **30** ***meters (98.43 ft.)*** above ground level. The antenna aperture is **10.32 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 ***305 degrees*** from true North.

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

DRAWING NO.	**TITLE**
0405D10	ELEVATION
0405D11	ANTENNA ORIENTATION
0405D12 – 0405D13	PARASITIC PLACEMENT
2105A10	TEST RANGE SCHEMATIC

The antenna elevation is shown on **DWG. 0405D10**.The antenna elements shall be aligned at the same heading as in **DWG. 0405D11**.This will ensure that the antenna is oriented properly at **305** degrees from true North**. DWG. 0405D12 – DWG. 0405D13** shows the parasitic placement. The test range schematic **DWG. 2105A10** shows the mounting configuration of the antenna setup on our range.

DOCUMENT EXHIBITS

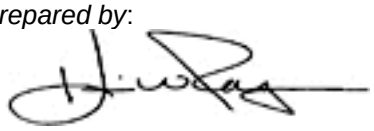
The following exhibits are included as part of this Certificate of Compliance:

Exhibit 1	Circular Polarized Azimuth Pattern Field Strength Tabulations (Composite)
Exhibit 2	Measured Horizontal Polarized Azimuth Pattern Measured Field Strength Tabulations (Horizontal)
Exhibit 3	Measured Vertical Polarized Azimuth Pattern Measured Field Strength Tabulations (Vertical)
Exhibit 4	Elevation Pattern Elevation Tabulations
Exhibit 5	Antenna Data Sheet
Exhibit 6	RMS Calculations
Exhibit 7	Drawings

TEST EQUIPMENT

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

Prepared by:



_____

Kevin W. Rager
Antenna Engineer
Systems With Reliability, LP

Surveyor's Declaration

I,_____, subject to the penalties of perjury, do declare the following:

1.) I am a licensed surveyor in the state(s) of _____, _____ and _____.

2.) I have provided professional services to _____ (permit tee name), permit tee of WHMA-FM, Alexandria (city of license), AL (state), during the installation of the WHMA-FM directional antenna.

3.) I certify that the WHMA-FM directional antenna has been oriented at the proper azimuth as authorized in the drawings section (Exhibit 7) of the Proof of Performance for WHMA-FM. Namely Drawing #0405D11 shows the proper heading to be 305 degrees from true North.

Sign_____ Dated: _____mm/dd/yy

Engineer's Declaration

I,_____, subject to the penalties of perjury, do declare the following:

1.) I am the holder of a valid General Radio Telephone Operators License, Number _____ (FCC License No.)

2.) I have been a member of the Society of Broadcast Engineer's since _____(year)

3.) That I have been employed as a technical consultant with the firm of:

_____ (firm name), of

_____(city state)

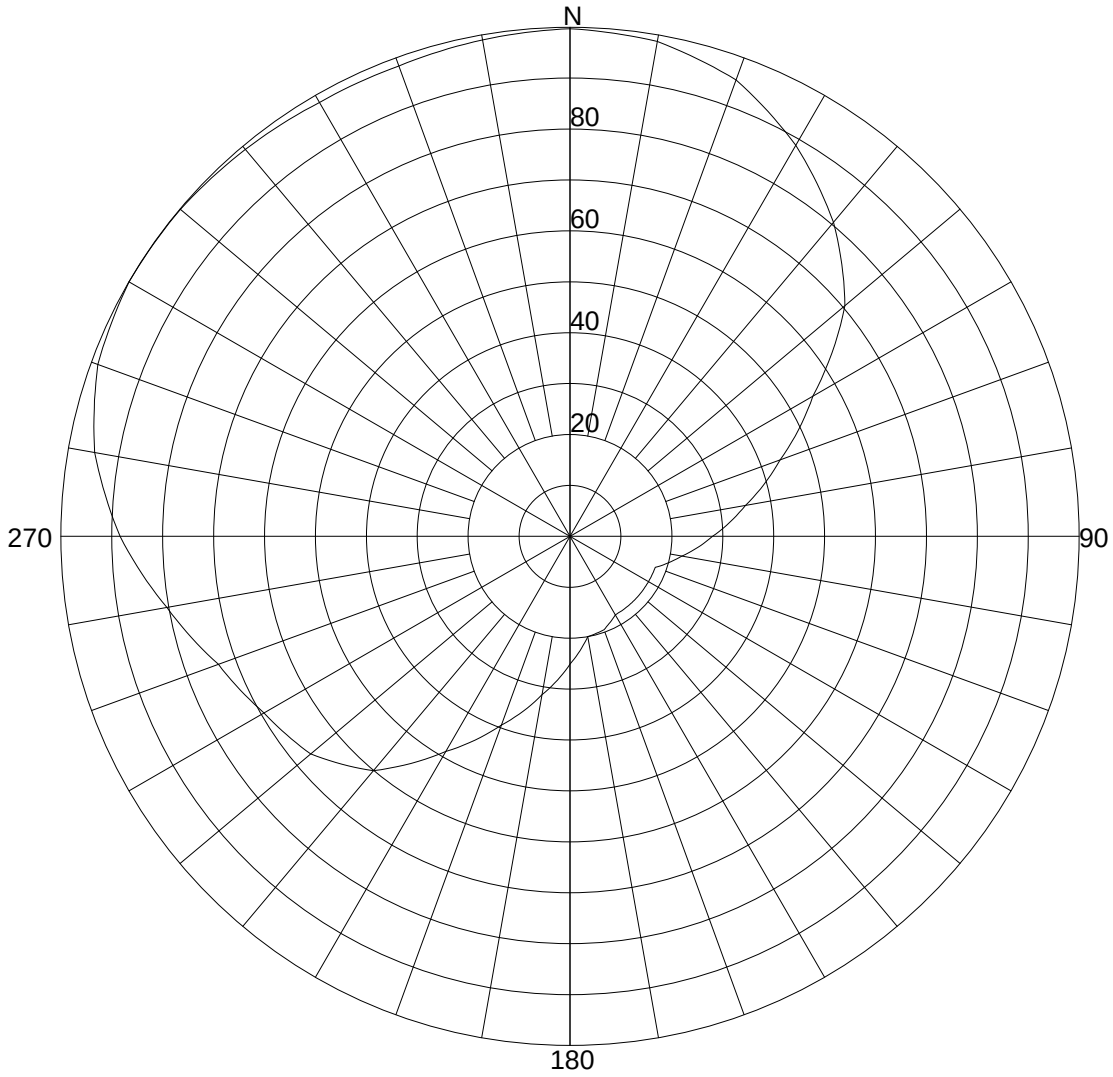
4.) That _____(Firm's Name) was retained by_____ (Permit tee's Name) for the purpose of preparing its application for the construction permit of WHMA-FM Alexandria (City), Alabama (State), from which the underlying Construction Permit (FCC File Number BPH-20071214AAR) was granted by the Commission.

1.) That I am familiar with the terms and conditions of the WHMA-FM Construction Permit.

2.) I hereby certify that I have overseen the installation of the WHMA-FM directional antenna and that the installation was complete to the manufacturer's instructions outlined in the Proof of Performance Drawings section (Exhibit 7) for WHMA-FM.

Sign_____ Dated: _____mm/dd/yy

Exhibit 1: Circular Polarized Azimuth Pattern



Azimuth Pattern

Scale: Linear

Unit: Relative Field

Systems With Reliability

CLIENT: *WHMA*

Date: 6/20/2018

ANTENNA TYPE: FM3R/2-DA

FREQUENCY: 95.3 MHz

PATTERN POL.: Circular

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 2.07481 / 3.17dB

PATTERN RMS: *0.694*

Micro-Tek Eng. Ver. 2.6

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

Relative Field Tabulation(Azimuth)

Azimuth Heading	Normalized Field(dB)	Azimuth Heading	Normalized Field(dB)
0	.9970 (-0.03)	180	.2510 (-12.01)
5	.9920 (-0.07)	185	.2835 (-10.95)
10	.9870 (-0.11)	190	.3160 (-10.01)
15	.9705 (-0.26)	195	.3555 (-8.98)
20	.9540 (-0.41)	200	.3950 (-8.07)
25	.9205 (-0.72)	205	.4415 (-7.1)
30	.8870 (-1.04)	210	.4880 (-6.23)
35	.8460 (-1.45)	215	.5445 (-5.28)
40	.8050 (-1.88)	220	.6010 (-4.42)
45	.7550 (-2.44)	225	.6330 (-3.97)
50	.7050 (-3.04)	230	.6650 (-3.54)
55	.6280 (-4.04)	235	.6795 (-3.36)
60	.5510 (-5.18)	240	.6940 (-3.17)
65	.4950 (-6.11)	245	.7145 (-2.92)
70	.4390 (-7.15)	250	.7350 (-2.67)
75	.3945 (-8.08)	255	.7695 (-2.28)
80	.3500 (-9.12)	260	.8040 (-1.89)
85	.3150 (-10.03)	265	.8440 (-1.47)
90	.2800 (-11.06)	270	.8840 (-1.07)
95	.2515 (-11.99)	275	.9160 (-0.76)
100	.2230 (-13.03)	280	.9480 (-0.46)
105	.2005 (-13.96)	285	.9675 (-0.29)
110	.1780 (-14.99)	290	.9870 (-0.11)
115	.1780 (-14.99)	295	.9935 (-0.06)
120	.1780 (-14.99)	300	1.0000 (0)
125	.1780 (-14.99)	305	.9995 (0)
130	.1780 (-14.99)	310	.9990 (-0.01)
135	.1780 (-14.99)	315	.9955 (-0.04)
140	.1780 (-14.99)	320	.9920 (-0.07)
145	.1780 (-14.99)	325	.9880 (-0.1)
150	.1780 (-14.99)	330	.9840 (-0.14)
155	.1865 (-14.59)	335	.9835 (-0.14)
160	.1950 (-14.2)	340	.9830 (-0.15)
165	.1975 (-14.09)	345	.9865 (-0.12)
170	.2000 (-13.98)	350	.9900 (-0.09)
175	.2255 (-12.94)	355	.9935 (-0.06)

Systems With Reliability

CLIENT: *WHMA*

Date: 6/20/2018

ANTENNA TYPE: FM3R/2-DA

FREQUENCY: 95.3 MHz

PATTERN POL.: Circular

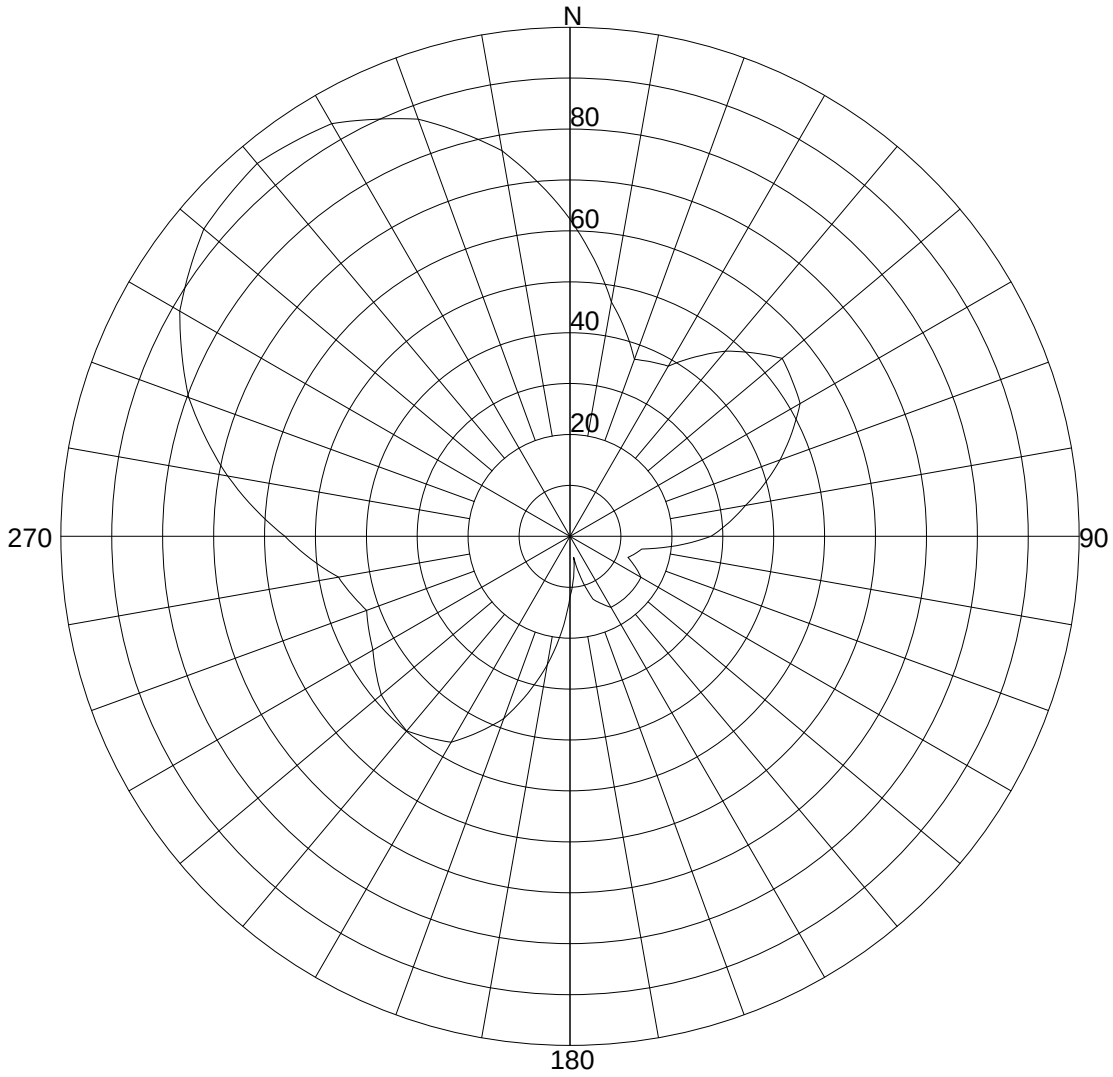
CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 2.07481 / 3.17dB

PATTERN RMS: *0.694*

Micro-Tek Eng. Ver. 2.6

Exhibit 2: Measured Horizontal Polarized Azimuth Pattern



Azimuth Pattern

Scale: Linear

Unit: Relative Field

Systems With Reliability

CLIENT: *WHMA-FM*

Date: 6/20/2018

ANTENNA TYPE: FM3R/2-DA

FREQUENCY: 95.3 MHz

PATTERN POL.: Horizontal

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 3.62137 / 5.59dB

PATTERN RMS: *0.525*

Micro-Tek Eng. Ver. 2.6

Exhibit 2 (cont'd): Measured Horizontal Polarized Azimuth Pattern Tabulations

Relative Field Tabulation(Azimuth)

Azimuth Heading	Normalized Field(dB)	Azimuth Heading	Normalized Field(dB)
0	.6230 (-4.11)	180	.1190 (-18.49)
5	.5455 (-5.26)	185	.1875 (-14.54)
10	.4680 (-6.6)	190	.2560 (-11.84)
15	.4190 (-7.56)	195	.3185 (-9.94)
20	.3700 (-8.64)	200	.3810 (-8.38)
25	.3780 (-8.45)	205	.4240 (-7.45)
30	.3860 (-8.27)	210	.4670 (-6.61)
35	.4305 (-7.32)	215	.4830 (-6.32)
40	.4750 (-6.47)	220	.4990 (-6.04)
45	.5095 (-5.86)	225	.4915 (-6.17)
50	.5440 (-5.29)	230	.4840 (-6.3)
55	.5330 (-5.47)	235	.4655 (-6.64)
60	.5220 (-5.65)	240	.4470 (-6.99)
65	.4805 (-6.37)	245	.4360 (-7.21)
70	.4390 (-7.15)	250	.4250 (-7.43)
75	.3945 (-8.08)	255	.4435 (-7.06)
80	.3500 (-9.12)	260	.4620 (-6.71)
85	.3135 (-10.08)	265	.5110 (-5.83)
90	.2770 (-11.15)	270	.5600 (-5.04)
95	.2100 (-13.56)	275	.6215 (-4.13)
100	.1430 (-16.89)	280	.6830 (-3.31)
105	.1320 (-17.59)	285	.7400 (-2.62)
110	.1210 (-18.34)	290	.7970 (-1.97)
115	.1410 (-17.02)	295	.8410 (-1.5)
120	.1610 (-15.86)	300	.8850 (-1.06)
125	.1615 (-15.84)	305	.9120 (-0.8)
130	.1620 (-15.81)	310	.9390 (-0.55)
135	.1620 (-15.81)	315	.9475 (-0.47)
140	.1620 (-15.81)	320	.9560 (-0.39)
145	.1615 (-15.84)	325	.9460 (-0.48)
150	.1610 (-15.86)	330	.9360 (-0.57)
155	.1460 (-16.71)	335	.9040 (-0.88)
160	.1310 (-17.65)	340	.8720 (-1.19)
165	.0865 (-21.26)	345	.8205 (-1.72)
170	.0420 (-27.54)	350	.7690 (-2.28)
175	.0805 (-21.88)	355	.6960 (-3.15)

Systems With Reliability

CLIENT: *WHMA-FM*

Date: 6/20/2018

ANTENNA TYPE: FM3R/2-DA

FREQUENCY: 95.3 MHz

PATTERN POL.: Horizontal

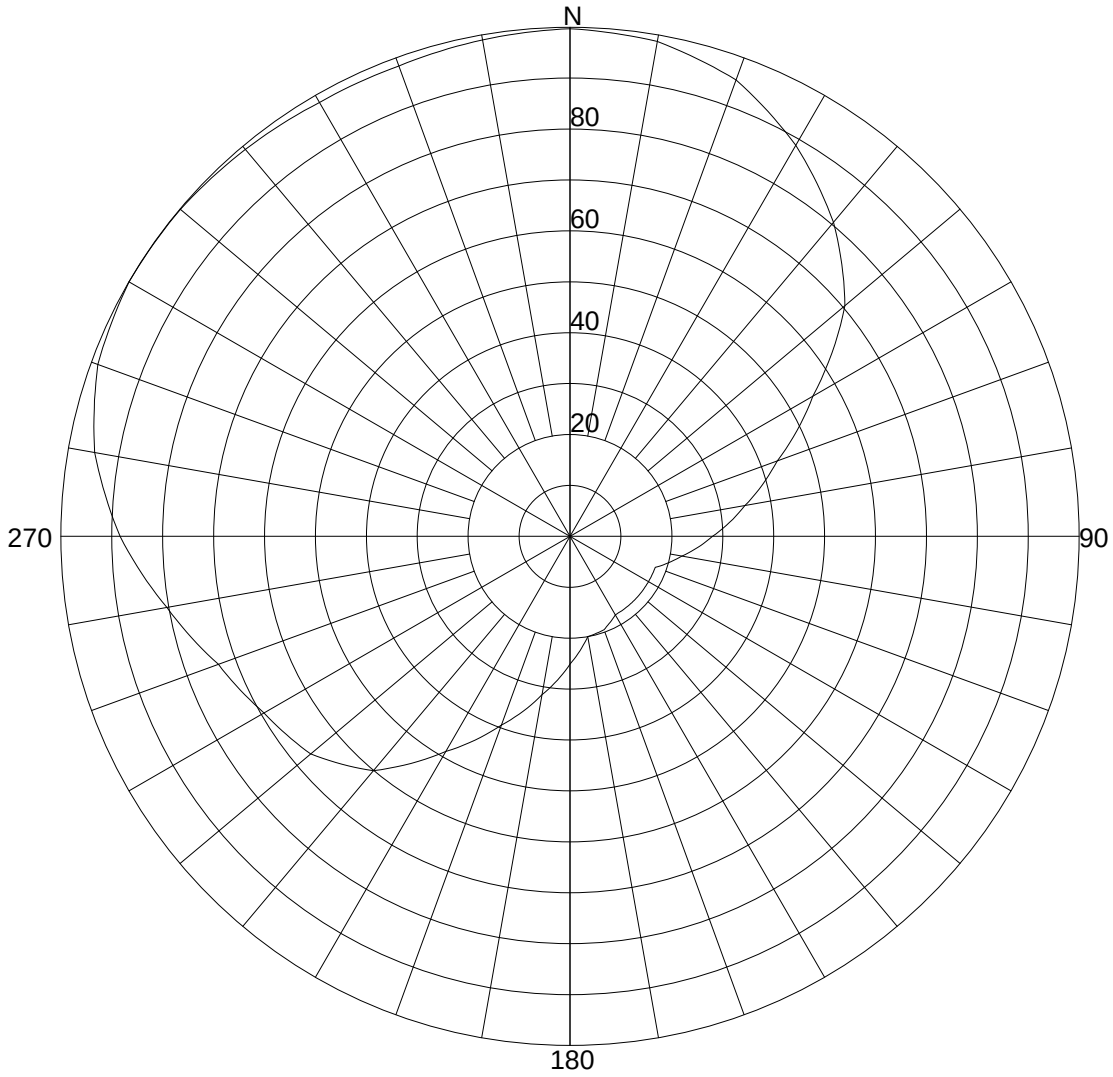
CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 3.62137 / 5.59dB

PATTERN RMS: *0.525*

Micro-Tek Eng. Ver. 2.6

Exhibit 3: Measured Vertical Polarized Azimuth Pattern



Azimuth Pattern

Scale: Linear

Unit: Relative Field

Systems With Reliability

CLIENT: *WHMA*

Date: 6/20/2018

ANTENNA TYPE: FM3R/2-DA

FREQUENCY: 95.3 MHz

PATTERN POL.: Vertical

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 2.07553 / 3.17dB

PATTERN RMS: *0.694*

Micro-Tek Eng. Ver. 2.6

Exhibit 3 (cont'd): Measured Vertical polarized Azimuth Pattern Tabulations

Relative Field Tabulation(Azimuth)

Azimuth Heading	Normalized Field(dB)	Azimuth Heading	Normalized Field(dB)
0	.9970 (-0.03)	180	.2510 (-12.01)
5	.9920 (-0.07)	185	.2835 (-10.95)
10	.9870 (-0.11)	190	.3160 (-10.01)
15	.9705 (-0.26)	195	.3555 (-8.98)
20	.9540 (-0.41)	200	.3950 (-8.07)
25	.9205 (-0.72)	205	.4415 (-7.1)
30	.8870 (-1.04)	210	.4880 (-6.23)
35	.8460 (-1.45)	215	.5445 (-5.28)
40	.8050 (-1.88)	220	.6010 (-4.42)
45	.7550 (-2.44)	225	.6330 (-3.97)
50	.7050 (-3.04)	230	.6650 (-3.54)
55	.6280 (-4.04)	235	.6795 (-3.36)
60	.5510 (-5.18)	240	.6940 (-3.17)
65	.4920 (-6.16)	245	.7145 (-2.92)
70	.4330 (-7.27)	250	.7350 (-2.67)
75	.3910 (-8.16)	255	.7695 (-2.28)
80	.3490 (-9.14)	260	.8040 (-1.89)
85	.3145 (-10.05)	265	.8440 (-1.47)
90	.2800 (-11.06)	270	.8840 (-1.07)
95	.2515 (-11.99)	275	.9160 (-0.76)
100	.2230 (-13.03)	280	.9480 (-0.46)
105	.2005 (-13.96)	285	.9675 (-0.29)
110	.1780 (-14.99)	290	.9870 (-0.11)
115	.1780 (-14.99)	295	.9935 (-0.06)
120	.1780 (-14.99)	300	1.0000 (0)
125	.1780 (-14.99)	305	.9995 (0)
130	.1780 (-14.99)	310	.9990 (-0.01)
135	.1780 (-14.99)	315	.9955 (-0.04)
140	.1780 (-14.99)	320	.9920 (-0.07)
145	.1780 (-14.99)	325	.9880 (-0.1)
150	.1780 (-14.99)	330	.9840 (-0.14)
155	.1865 (-14.59)	335	.9835 (-0.14)
160	.1950 (-14.2)	340	.9830 (-0.15)
165	.1975 (-14.09)	345	.9865 (-0.12)
170	.2000 (-13.98)	350	.9900 (-0.09)
175	.2255 (-12.94)	355	.9935 (-0.06)

Systems With Reliability

CLIENT: *WHMA*

Date: 6/20/2018

ANTENNA TYPE: FM3R/2-DA

FREQUENCY: 95.3 MHz

PATTERN POL.: Vertical

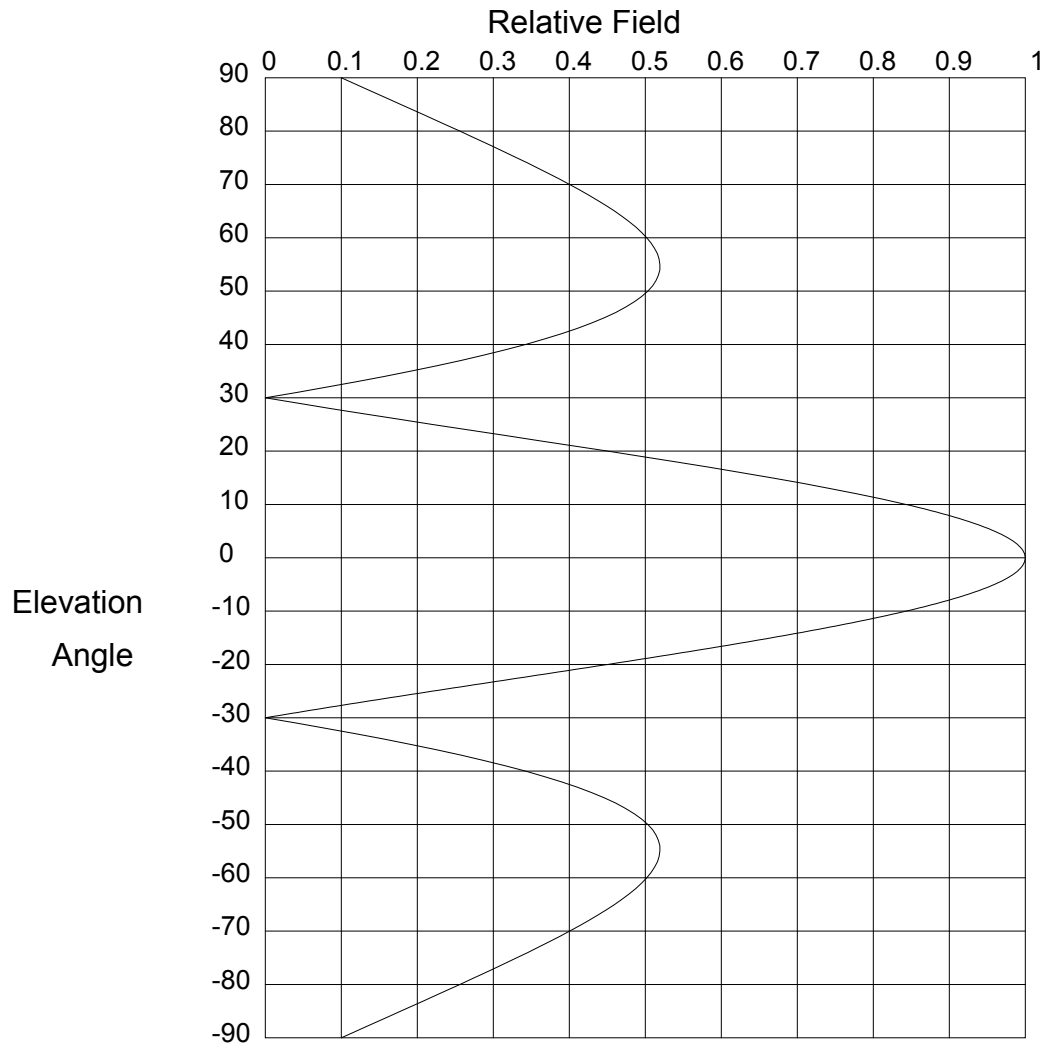
CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 2.07553 / 3.17dB

PATTERN RMS: *0.694*

Micro-Tek Eng. Ver. 2.6

Exhibit 4: Elevation Pattern



Elevation Pattern

Scale: Linear

Units: Field, Relative

Systems With Reliability

CLIENT: *WHMA-FM*

Date: 5/1/2018

ANTENNA TYPE: FM3R/2-DA

FREQUENCY: 95.3 MHz

PATTERN POL.: Circular

DIRECTIVITY(Peak): 1.918/2.828 dBd

Beam Tilt (Deg.) : *0*

DIRECTIVITY(Horiz): 1.918/2.828 dBd

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

Micro-Tek Eng. Ver. 2.6

Exhibit 4 (cont'd): Elevation Pattern Tabulations

Relative Field Tabulation

Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)
90.0	.10 (-20)	52.0	.514 (-5.775)	14.0	.705 (-3.031)
89.0	.116 (-18.733)	51.0	.51 (-5.855)	13.0	.743 (-2.581)
88.0	.131 (-17.627)	50.0	.503 (-5.963)	12.0	.779 (-2.174)
87.0	.147 (-16.648)	49.0	.495 (-6.101)	11.0	.812 (-1.809)
86.0	.163 (-15.768)	48.0	.486 (-6.272)	10.0	.843 (-1.482)
85.0	.178 (-14.971)	47.0	.474 (-6.479)	9.8	.849 (-1.421)
84.0	.194 (-14.242)	46.0	.461 (-6.724)	9.6	.855 (-1.361)
83.0	.21 (-13.571)	45.0	.446 (-7.013)	9.4	.861 (-1.303)
82.0	.225 (-12.951)	44.0	.429 (-7.349)	9.2	.866 (-1.246)
81.0	.241 (-12.374)	43.0	.41 (-7.738)	9.0	.872 (-1.191)
80.0	.256 (-11.835)	42.0	.39 (-8.189)	8.8	.877 (-1.137)
79.0	.271 (-11.332)	41.0	.367 (-8.709)	8.6	.883 (-1.084)
78.0	.286 (-10.859)	40.0	.342 (-9.31)	8.4	.888 (-1.033)
77.0	.301 (-10.415)	39.0	.316 (-10.008)	8.2	.893 (-0.983)
76.0	.316 (-9.997)	38.0	.288 (-10.824)	8.0	.898 (-0.935)
75.0	.331 (-9.603)	37.0	.257 (-11.786)	7.8	.903 (-0.887)
74.0	.345 (-9.231)	36.0	.225 (-12.937)	7.6	.908 (-0.841)
73.0	.36 (-8.881)	35.0	.192 (-14.343)	7.4	.912 (-0.797)
72.0	.374 (-8.551)	34.0	.156 (-16.113)	7.2	.917 (-0.753)
71.0	.387 (-8.24)	33.0	.119 (-18.454)	7.0	.921 (-0.711)
70.0	.401 (-7.948)	32.0	.081 (-21.828)	6.8	.926 (-0.67)
69.0	.413 (-7.673)	31.0	.041 (-27.712)	6.6	.93 (-0.631)
68.0	.426 (-7.417)	30.0	.00 (-50)	6.4	.934 (-0.593)
67.0	.438 (-7.178)	29.0	.042 (-27.469)	6.2	.938 (-0.556)
66.0	.449 (-6.956)	28.0	.086 (-21.343)	6.0	.942 (-0.52)
65.0	.46 (-6.751)	27.0	.13 (-17.727)	5.8	.946 (-0.485)
64.0	.47 (-6.563)	26.0	.175 (-15.145)	5.6	.949 (-0.452)
63.0	.479 (-6.392)	25.0	.22 (-13.135)	5.4	.953 (-0.42)
62.0	.488 (-6.239)	24.0	.266 (-11.491)	5.2	.956 (-0.389)
61.0	.495 (-6.103)	23.0	.312 (-10.103)	5.0	.959 (-0.36)
60.0	.502 (-5.986)	22.0	.359 (-8.906)	4.8	.963 (-0.331)
59.0	.508 (-5.887)	21.0	.405 (-7.858)	4.6	.966 (-0.304)
58.0	.512 (-5.807)	20.0	.45 (-6.929)	4.4	.969 (-0.278)
57.0	.516 (-5.747)	19.0	.495 (-6.1)	4.2	.971 (-0.253)
56.0	.518 (-5.708)	18.0	.54 (-5.356)	4.0	.974 (-0.229)
55.0	.519 (-5.69)	17.0	.583 (-4.685)	3.8	.976 (-0.207)
54.0	.519 (-5.694)	16.0	.625 (-4.078)	3.6	.979 (-0.186)
53.0	.517 (-5.722)	15.0	.666 (-3.528)	3.4	.981 (-0.165)

Systems With Reliability

CLIENT: *WHMA-FM*
Date: 5/1/2018
ANTENNA TYPE: FM3R/2-DA
FREQUENCY: 95.3 MHz
PATTERN POL.: Circular
DIRECTIVITY(Peak): 1.918/2.828 dBd
Beam Tilt (Deg.) : *0*
DIRECTIVITY(Horiz): 1.918/2.828 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	.983 (-0.146)	-4.4	.969 (-0.278)	-12.0	.779 (-2.174)
3.0	.985 (-0.129)	-4.6	.966 (-0.304)	-12.2	.772 (-2.252)
2.8	.987 (-0.112)	-4.8	.963 (-0.331)	-12.4	.765 (-2.332)
2.6	.989 (-0.097)	-5.0	.959 (-0.36)	-12.6	.757 (-2.413)
2.4	.991 (-0.082)	-5.2	.956 (-0.389)	-12.8	.75 (-2.496)
2.2	.992 (-0.069)	-5.4	.953 (-0.42)	-13.0	.743 (-2.581)
2.0	.993 (-0.057)	-5.6	.949 (-0.452)	-13.2	.736 (-2.667)
1.8	.995 (-0.046)	-5.8	.946 (-0.485)	-13.4	.728 (-2.755)
1.6	.996 (-0.037)	-6.0	.942 (-0.52)	-13.6	.721 (-2.845)
1.4	.997 (-0.028)	-6.2	.938 (-0.556)	-13.8	.713 (-2.937)
1.2	.998 (-0.021)	-6.4	.934 (-0.593)	-14.0	.705 (-3.031)
1.0	.998 (-0.014)	-6.6	.93 (-0.631)	-14.2	.698 (-3.126)
.8	.999 (-0.009)	-6.8	.926 (-0.67)	-14.4	.69 (-3.224)
.6	.999 (-0.005)	-7.0	.921 (-0.711)	-14.6	.682 (-3.323)
.4	1.00 (-0.002)	-7.2	.917 (-0.753)	-14.8	.674 (-3.425)
.2	1.00 (-0.001)	-7.4	.912 (-0.797)	-15.0	.666 (-3.528)
.0	1.00 (0)	-7.6	.908 (-0.841)	-15.2	.658 (-3.634)
-.2	1.00 (-0.001)	-7.8	.903 (-0.887)	-15.4	.65 (-3.742)
-.4	1.00 (-0.002)	-8.0	.898 (-0.935)	-15.6	.642 (-3.851)
-.6	.999 (-0.005)	-8.2	.893 (-0.983)	-15.8	.634 (-3.963)
-.8	.999 (-0.009)	-8.4	.888 (-1.033)	-16.0	.625 (-4.078)
-1.0	.998 (-0.014)	-8.6	.883 (-1.084)	-16.2	.617 (-4.194)
-1.2	.998 (-0.021)	-8.8	.877 (-1.137)	-16.4	.609 (-4.313)
-1.4	.997 (-0.028)	-9.0	.872 (-1.191)	-16.6	.60 (-4.435)
-1.6	.996 (-0.037)	-9.2	.866 (-1.246)	-16.8	.592 (-4.558)
-1.8	.995 (-0.046)	-9.4	.861 (-1.303)	-17.0	.583 (-4.685)
-2.0	.993 (-0.057)	-9.6	.855 (-1.361)	-17.2	.575 (-4.814)
-2.2	.992 (-0.069)	-9.8	.849 (-1.421)	-17.4	.566 (-4.945)
-2.4	.991 (-0.082)	-10.0	.843 (-1.482)	-17.6	.557 (-5.079)
-2.6	.989 (-0.097)	-10.2	.837 (-1.544)	-17.8	.549 (-5.216)
-2.8	.987 (-0.112)	-10.4	.831 (-1.608)	-18.0	.54 (-5.356)
-3.0	.985 (-0.129)	-10.6	.825 (-1.674)	-18.2	.531 (-5.499)
-3.2	.983 (-0.146)	-10.8	.818 (-1.74)	-18.4	.522 (-5.644)
-3.4	.981 (-0.165)	-11.0	.812 (-1.809)	-18.6	.513 (-5.793)
-3.6	.979 (-0.186)	-11.2	.805 (-1.879)	-18.8	.504 (-5.945)
-3.8	.976 (-0.207)	-11.4	.799 (-1.95)	-19.0	.495 (-6.1)
-4.0	.974 (-0.229)	-11.6	.792 (-2.023)	-19.2	.486 (-6.259)
-4.2	.971 (-0.253)	-11.8	.785 (-2.098)	-19.4	.477 (-6.421)

Systems With Reliability

CLIENT: *WHMA-FM*
Date: 5/1/2018

ANTENNA TYPE: FM3R/2-DA
FREQUENCY: 95.3 MHz
PATTERN POL.: Circular
DIRECTIVITY(Peak): 1.918/2.828 dBd
Beam Tilt (Deg.) : *0*
DIRECTIVITY(Horiz): 1.918/2.828 dBd
Null Fill(s)(%) : *0, 0, 0*

Exhibit 4 (cont'd): Elevation Pattern Tabulations

Relative Field Tabulation

Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)
-19.6	.468 (-6.587)	-27.2	.121 (-18.344)	-54.0	.519 (-5.694)
-19.8	.459 (-6.756)	-27.4	.112 (-19.006)	-55.0	.519 (-5.69)
-20.0	.45 (-6.929)	-27.6	.103 (-19.721)	-56.0	.518 (-5.708)
-20.2	.441 (-7.106)	-27.8	.094 (-20.496)	-57.0	.516 (-5.747)
-20.4	.432 (-7.288)	-28.0	.086 (-21.343)	-58.0	.512 (-5.807)
-20.6	.423 (-7.473)	-28.2	.077 (-22.278)	-59.0	.508 (-5.887)
-20.8	.414 (-7.663)	-28.4	.068 (-23.322)	-60.0	.502 (-5.986)
-21.0	.405 (-7.858)	-28.6	.06 (-24.503)	-61.0	.495 (-6.103)
-21.2	.396 (-8.057)	-28.8	.051 (-25.863)	-62.0	.488 (-6.239)
-21.4	.386 (-8.261)	-29.0	.042 (-27.469)	-63.0	.479 (-6.392)
-21.6	.377 (-8.471)	-29.2	.034 (-29.429)	-64.0	.47 (-6.563)
-21.8	.368 (-8.686)	-29.4	.025 (-31.951)	-65.0	.46 (-6.751)
-22.0	.359 (-8.906)	-29.6	.017 (-35.496)	-66.0	.449 (-6.956)
-22.2	.349 (-9.132)	-29.8	.008 (-41.54)	-67.0	.438 (-7.178)
-22.4	.34 (-9.365)	-30.0	.00 (-50)	-68.0	.426 (-7.417)
-22.6	.331 (-9.604)	-31.0	.041 (-27.712)	-69.0	.413 (-7.673)
-22.8	.322 (-9.85)	-32.0	.081 (-21.828)	-70.0	.401 (-7.948)
-23.0	.312 (-10.103)	-33.0	.119 (-18.454)	-71.0	.387 (-8.24)
-23.2	.303 (-10.364)	-34.0	.156 (-16.113)	-72.0	.374 (-8.551)
-23.4	.294 (-10.632)	-35.0	.192 (-14.343)	-73.0	.36 (-8.881)
-23.6	.285 (-10.909)	-36.0	.225 (-12.937)	-74.0	.345 (-9.231)
-23.8	.276 (-11.195)	-37.0	.257 (-11.786)	-75.0	.331 (-9.603)
-24.0	.266 (-11.491)	-38.0	.288 (-10.824)	-76.0	.316 (-9.997)
-24.2	.257 (-11.797)	-39.0	.316 (-10.008)	-77.0	.301 (-10.415)
-24.4	.248 (-12.113)	-40.0	.342 (-9.31)	-78.0	.286 (-10.859)
-24.6	.239 (-12.441)	-41.0	.367 (-8.709)	-79.0	.271 (-11.332)
-24.8	.23 (-12.781)	-42.0	.39 (-8.189)	-80.0	.256 (-11.835)
-25.0	.22 (-13.135)	-43.0	.41 (-7.738)	-81.0	.241 (-12.374)
-25.2	.211 (-13.503)	-44.0	.429 (-7.349)	-82.0	.225 (-12.951)
-25.4	.202 (-13.887)	-45.0	.446 (-7.013)	-83.0	.21 (-13.571)
-25.6	.193 (-14.287)	-46.0	.461 (-6.724)	-84.0	.194 (-14.242)
-25.8	.184 (-14.706)	-47.0	.474 (-6.479)	-85.0	.178 (-14.971)
-26.0	.175 (-15.145)	-48.0	.486 (-6.272)	-86.0	.163 (-15.768)
-26.2	.166 (-15.606)	-49.0	.495 (-6.101)	-87.0	.147 (-16.648)
-26.4	.157 (-16.092)	-50.0	.503 (-5.963)	-88.0	.131 (-17.627)
-26.6	.148 (-16.605)	-51.0	.51 (-5.855)	-89.0	.116 (-18.733)
-26.8	.139 (-17.149)	-52.0	.514 (-5.775)	-90.0	.10 (-20)
-27.0	.13 (-17.727)	-53.0	.517 (-5.722)	90.0	.00 (-50)

Systems With Reliability

CLIENT: *WHMA-FM*
Date: 5/1/2018

ANTENNA TYPE: FM3R/2-DA

FREQUENCY: 95.3 MHz

PATTERN POL.: Circular

DIRECTIVITY(Peak): 1.918/2.828 dBd

Beam Tilt (Deg.) : *0*

DIRECTIVITY(Horiz): 1.918/2.828 dBd

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

Exhibit 5: Antenna Data Sheet

SYSTEMS WITH RELIABILITY, LP

BROADCAST ANTENNAS AND TRANSMISSION LINE

SYSTEM DATA SHEET

Customer	WHMA
Contact	John George
Location	Alexandria, AL
Antenna Model	FM3R/2-DA
Channel / Frequency	237A / 95.3 MHz

ELECTRICAL SPECIFICATIONS

Antenna Specifications:

	H-POL	dB	V. Pol.	dB
License ERP (KW)	0.400		0.400	
FCC Limit Pattern Directivity	1.812	2.581 **dB**	1.812	2.581 **dB**
Elevation Directivity	1.918	2.828 **dB**	1.918	2.828 **dB**
Azimuth Directivity	3.621	5.589 **dB**	2.076	3.171 **dB**
Composite Pattern	2.075	3.170 **dB**	2.075	3.170 **dB**
Polarization Ratio	0.364		0.636	
RMS Comp./RMS Limit	93.4 **%**			
Antenna Efficiency %	100		100	
Power Ratio (Pol. Ratio X Efficiency)	0.3643		0.6357	
Antenna Gain	2.531	4.032 **dB**	2.531	4.032 **dB**

Antenna Input Power (KW)	0.158 **kW**	-8.012 **(dBK)**

Feed Line Specifications:

Line Type: Comscope	7/8" Air **50 Ω HJ5-50**	
Attenuation Per 100 ft (dB)	0.36 **dB**	
Line Length (ft) AGL + Horizontal Run	115.00 **ft.**	
Total Line Attenuation (dB)	0.4140 **dB**	
Line Efficiency	90.91 **%**	
Power Input to the Line (KW)	0.174 **kW**	-7.598 **(dBK)**

MECHANICAL SPECIFICATIONS

No. Of Bays	2				
Antenna Aperture	10.32	**ft.**		3.15	**meter**
Center of Radiation AGL	98.43	**ft.**		30.00	**meter**
Antenna Weight (Everything)	275.00	**lbs.**		125.00	**kg**
Windload (50/33)	647.50	**lbs.**	**Windload CaAc**	18.50	**ft^2**

Prepared by:

Kevin W. Rager
SWR, LP ENGINEERING

Exhibit 6: RMS Calculations

SYSTEMS WITH RELIABILITY, LP
Broadcast Antennas and Transmission Systems

WHMA Antenna RMS Comparison

PROPOSED ANTENNA		DESIGNED ANTENNA	
Azimuth Heading	**Relative Field**	**Azimuth Heading**	**Relative Field**
0	1	0	0.997
10	1	10	0.987
20	1	20	0.954
30	1	30	0.887
40	0.891	40	0.805
50	0.708	50	0.705
60	0.562	60	0.551
70	0.447	70	0.437
80	0.355	80	0.35
90	0.282	90	0.28
100	0.224	100	0.22
110	0.178	110	0.178
120	0.178	120	0.178
130	0.178	130	0.178
140	0.178	140	0.178
150	0.178	150	0.178
160	0.2	160	0.195
170	0.2	170	0.194
180	0.251	180	0.201
190	0.316	190	0.256
200	0.398	200	0.395
210	0.501	210	0.488
220	0.631	220	0.601
230	0.794	230	0.665
240	1	240	0.694
250	1	250	0.735
260	1	260	0.804
270	1	270	0.884
280	1	280	0.948
290	1	290	0.987
300	1	300	1
310	1	310	0.999
320	1	320	0.992
330	1	330	0.984
340	1	340	0.983
350	1	350	0.99

Sum of Relative Field Squared :	**19.906**	**Sum of Relative Field Squared :**	**17.311**
Sum Divided by 36 (Readings) :	**0.553**	**Sum Divided by 36 (Readings) :**	**0.481**
Square Root :	**0.744**	**Square Root :**	**0.693**

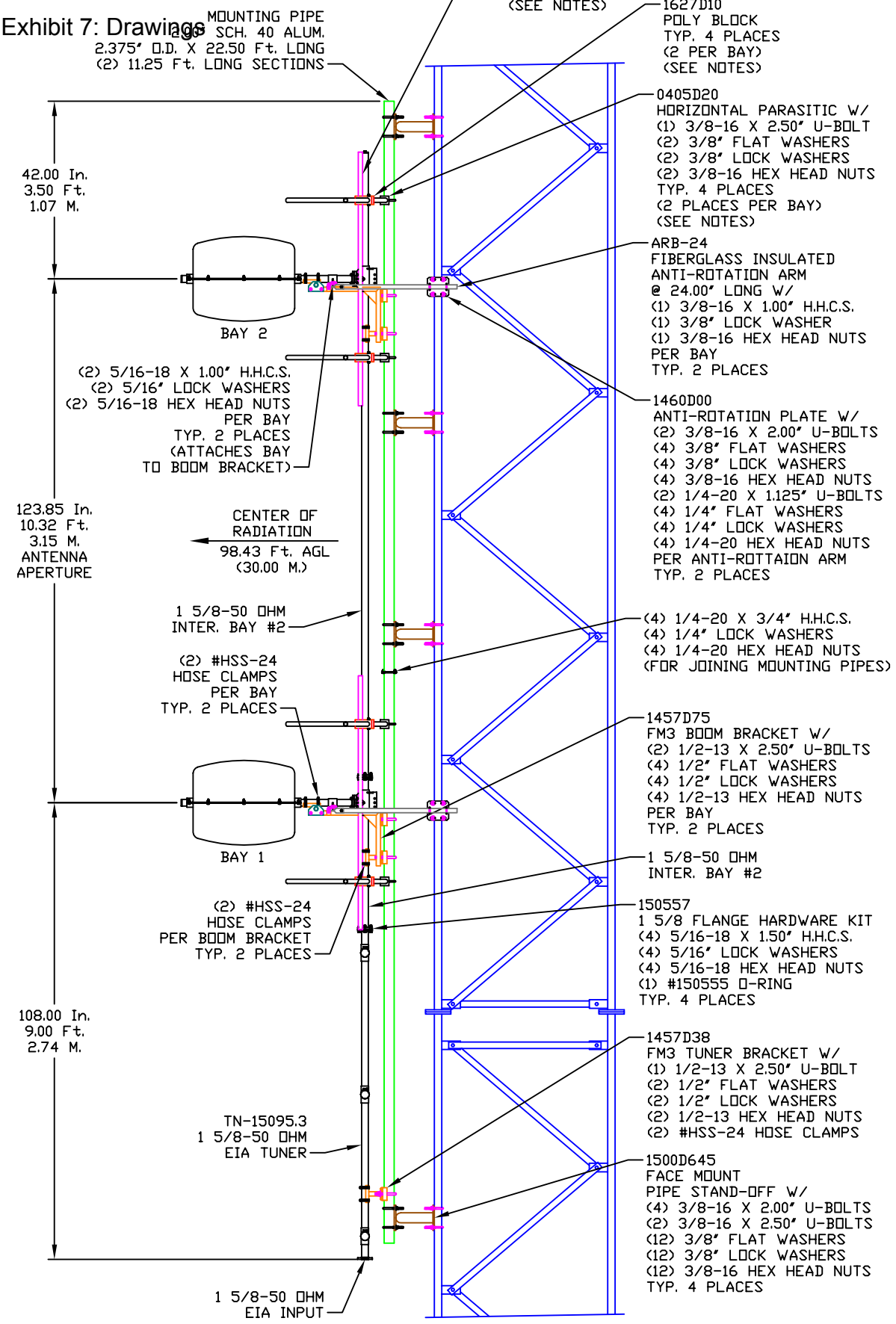
Percentage of Construction Permit Antenna Filled : **93.3%**

S.O. #18176

DRAWING NUMBER: 0405D10

NOTES:
1. REFERENCE DWG. 0405D11 FOR ANTENNA ORIENTATION.
2. REFERENCE DWG. 0405D12 FOR BAY 1 PARASITIC PLACEMENT.
3. REFERENCE DWG. 0405D13 FOR BAY 2 PARASITIC PLACEMENT.
4. ITEMS ROTATED IN THIS VIEW FOR CLARITY ONLY.

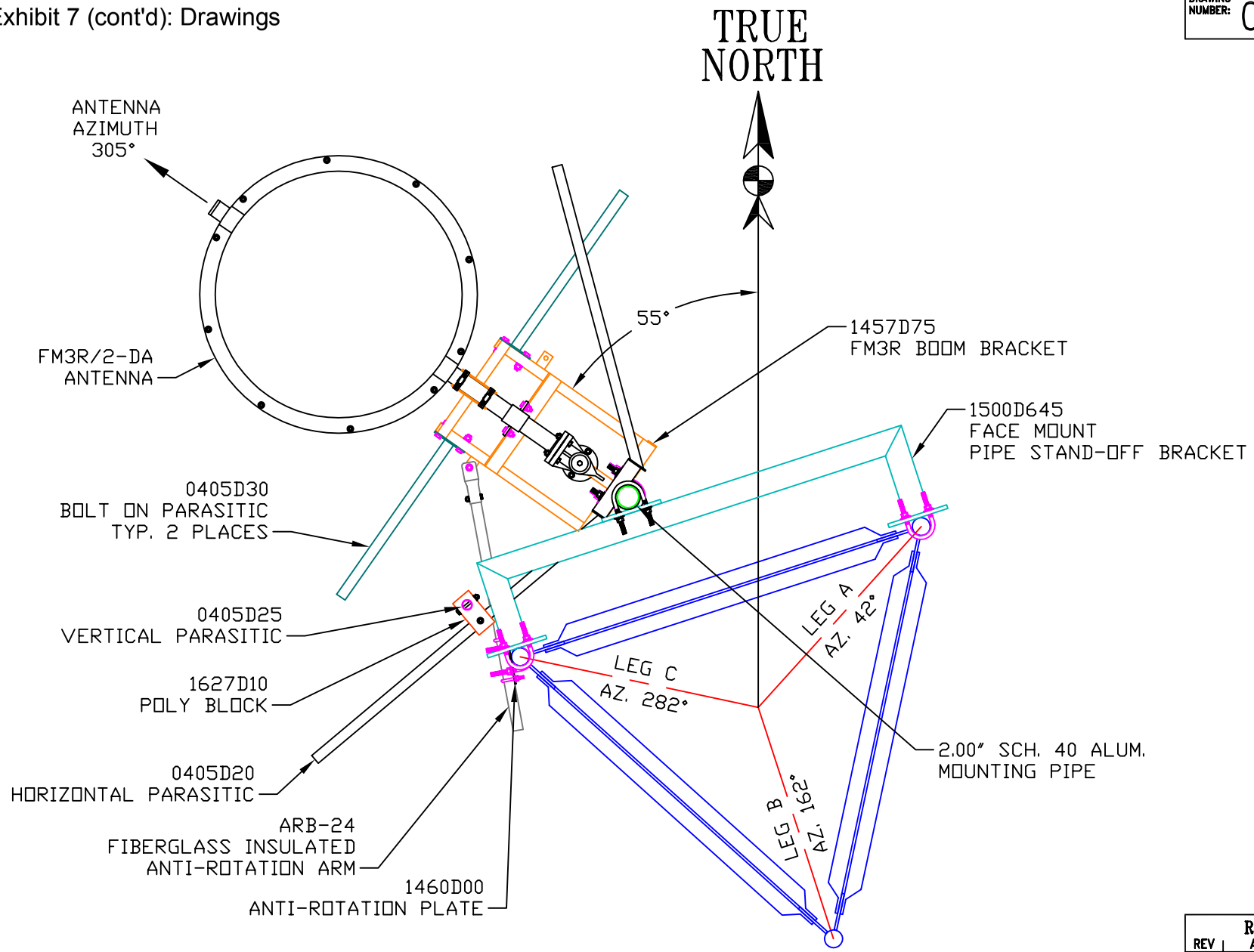
Exhibit 7: Drawings



SYSTEMS WITH RELIABILITY, LP 619 INDUSTRIAL PARK ROAD EBENSBURG, PENNSYLVANIA 15931	TITLE: FM3R/2-DA, FREQ. 95.3 WHMA, ALEXANDRIA, AL MATERIAL:	SIZE C	REV 1 2 3	APPR.	DATE	ENGINEER:	DRAWING NUMBER: 0405D10
						SCALE: NTS NAME: RAC DATE: 8/3/18	SHEET 1 OF 1

NOTE: Exhibit 7 (cont'd): Drawings

DRAWING NUMBER: 0405D11



TOP VIEW

REVISION RECORD

REV	APPROVAL	DATE

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

TITLE: FM3R/2-DA, FREQ. 95.3 WHMA, ALEXANDRIA, AL

MATERIAL: ANTENNA ORIENTATION FROM TRUE NORTH

SIZE A

PARTS MADE BY THIS DRAWING

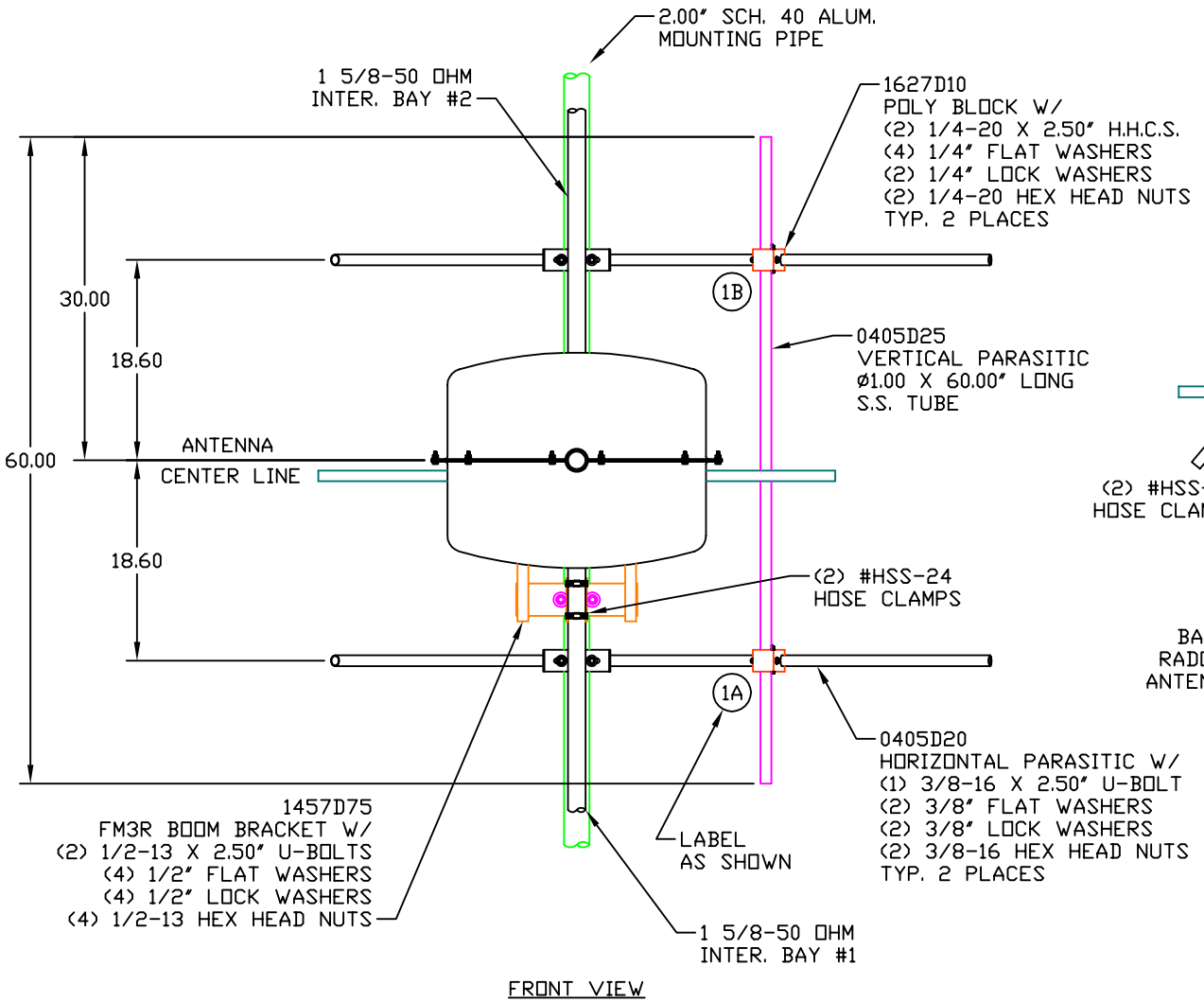
DRAWING NUMBER: 0405D11

SCALE: NTS | NAME: RAC | DATE: 8/3/18 | SHEET 1 OF 1

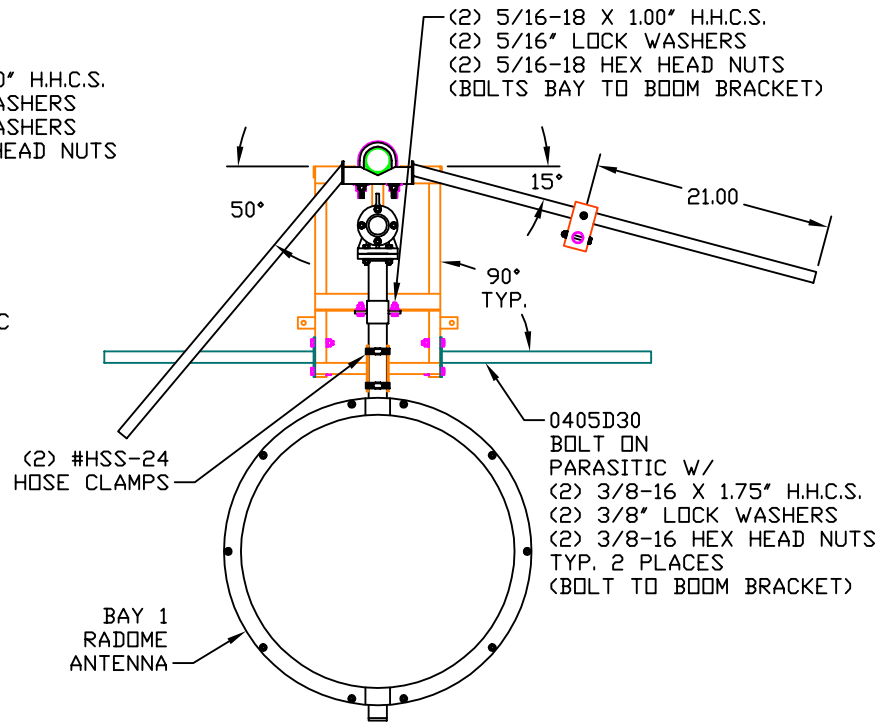
NOTE: Exhibit 7 (cont'd): Drawings

DRAWING NUMBER: 0405D12

THE POLY BLOCKS, HORIZONTAL & VERTICAL PARASITICS ARE FACTORY DRILLED AND LABELED. MATCH EACH CORRESPONDING LABEL DURING INSTALLATION.



FRONT VIEW



TOP VIEW

REVISION RECORD

REV	APPROVAL	DATE

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

TITLE: FM3R/2-DA, FREQ. 95.3
WHMA, ALEXANDRIA, AL

MATERIAL: BAY 1
PARASITIC PLACEMENT

SIZE A

PARTS MADE BY THIS DRAWING

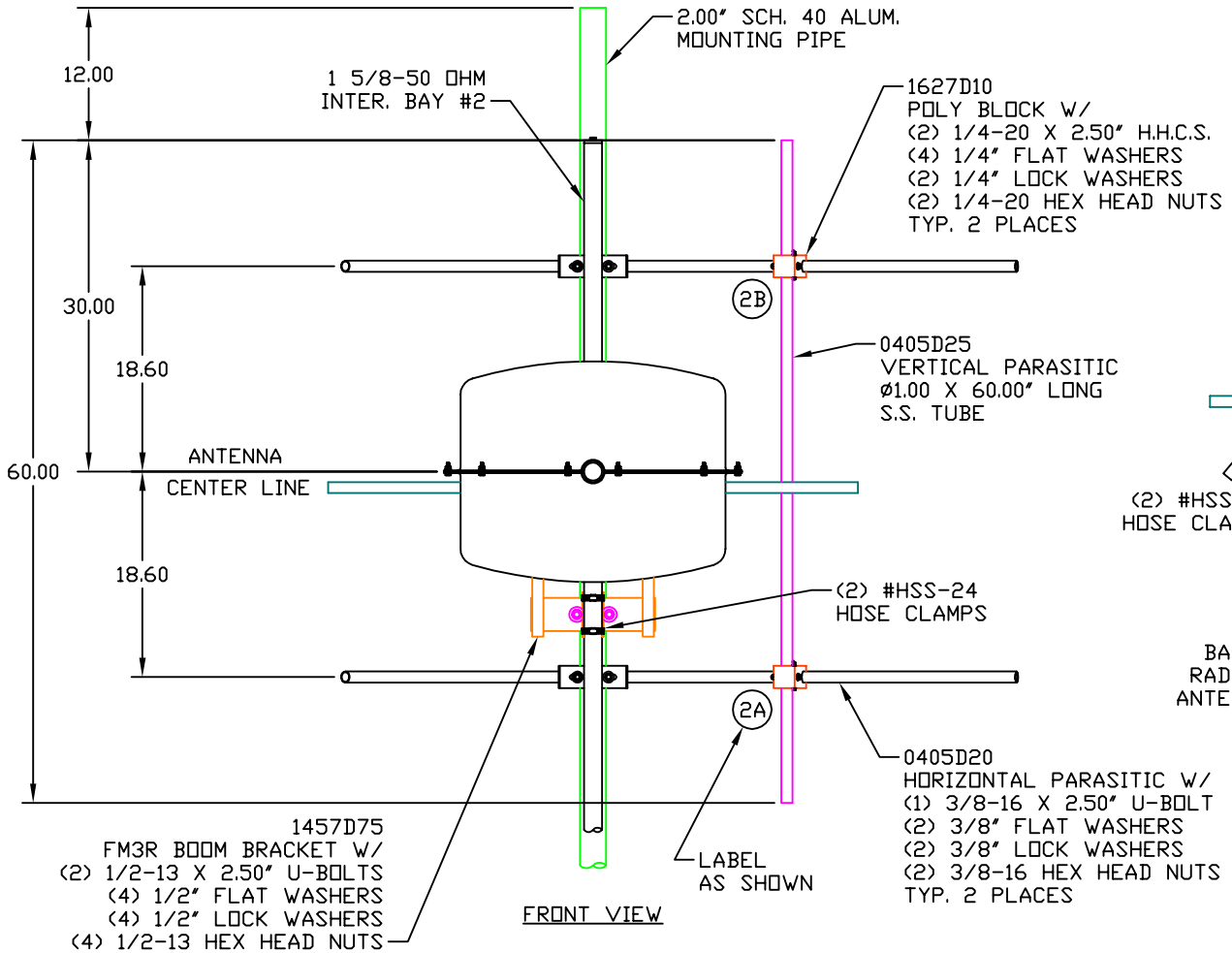
DRAWING NUMBER: 0405D12

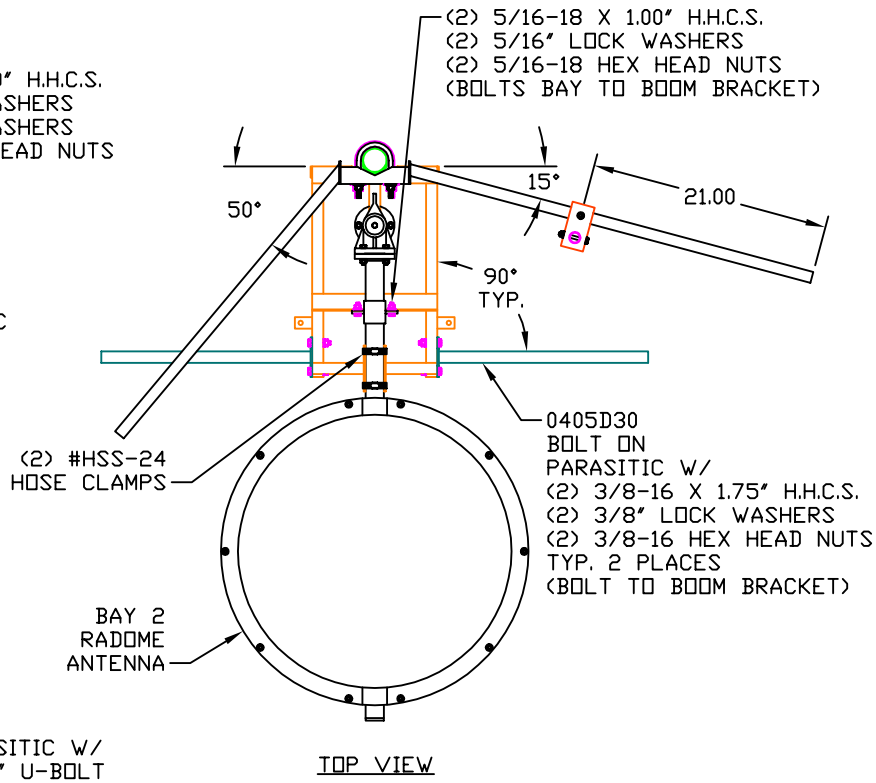
SCALE: NTS | NAME: RAC | DATE: 8/3/18 | SHEET 1 OF 1

NOTE: Exhibit 7 (cont'd): Drawings

DRAWING NUMBER: 0405D13

THE POLY BLOCKS, HORIZONTAL & VERTICAL PARASITICS ARE FACTORY DRILLED AND LABELED. MATCH EACH CORRESPONDING LABEL DURING INSTALLATION.





REVISION RECORD

REV	APPROVAL	DATE

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

TITLE: FM3R/2-DA, FREQ. 95.3
WHMA, ALEXANDRIA, AL

MATERIAL: BAY 2
PARASITIC PLACEMENT

SIZE A

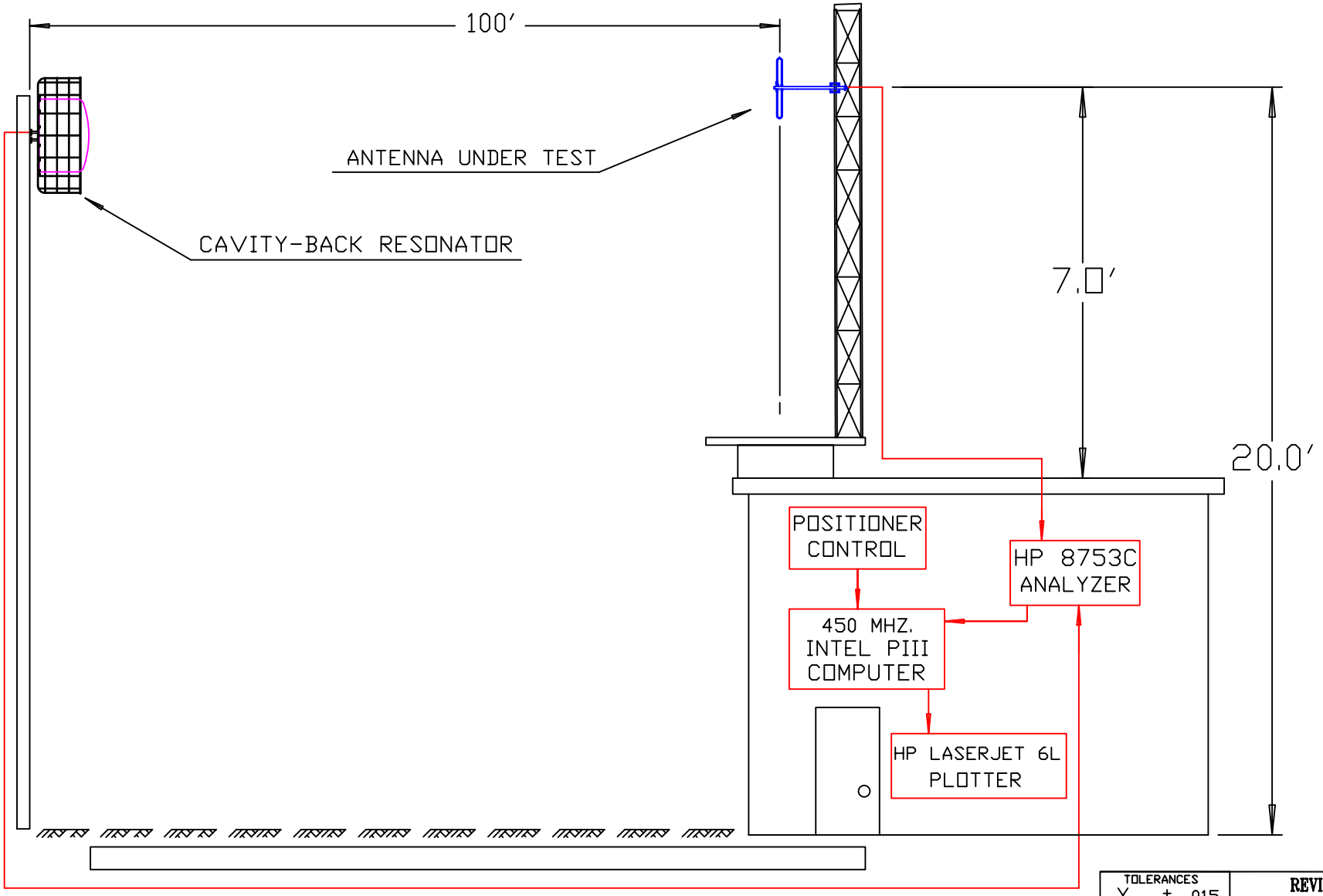
PARTS MADE BY THIS DRAWING

DRAWING NUMBER: 0405D13

SCALE: NTS | NAME: RAC | DATE: 8/3/18 | SHEET 1 OF 1

NOTE: Exhibit 7 (cont'd): Drawings

DRAWING NUMBER: 2105A10



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

REVISION RECORD

REV	APPROVAL	DATE
2		10/7/05
1		4/30/02

DRAWING NUMBER: 2105A10

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