

S.O. 33197
Report of Test 6810-2R-DA
for
AMERICAN FAMILY ASSOCIATION, INC.
WTRM 91.1 MHz WINCHESTER, VA.

OBJECTIVE:

The objective of this test was to demonstrate the directional characteristics of a 6810-2R-DA to meet the needs of WTRM and to comply with the requirements of the FCC construction permit, file number BPED-20130426AAR. This test characterizes only the radiation characteristics of the antenna when mounted on the tower as described. It does not represent or imply any guarantee of specific coverage which can be influenced by factors beyond the scope of this test.

RESULTS:

The following Figures are the results of the measurements from our pattern range:

- Figure 1A - Measured Azimuth Pattern with the FCC Composite
- Figure 1B - Measured Composite Azimuth Pattern with the FCC Composite
- Figure 1C - Tabulation of the Horizontal Polarization for the Measured Azimuth Pattern
- Figure 1D - Tabulation of the Vertical Polarization for the Measured Azimuth Pattern
- Figure 1E - Tabulation of the Measured Composite Azimuth Pattern
- Figure 1F - Tabulation of the FCC Composite

The calculated elevation pattern of the antenna is shown in Figure 3.

Construction permit file number BPED-20130426AAR indicates that the Horizontal radiation component shall not exceed 0.075 kW at any azimuth and is restricted to the following values at the azimuths specified:

170 – 180 Degrees True: 0.033 kilowatts

340 – 350 Degrees True: 0.033 kilowatts

From Figure 1A, the maximum radiation of the Horizontal component occurs at 278 Degrees True to 282 Degrees True. At the restricted azimuth of 170 - 180 Degrees True the Horizontal component is 3.68 dB down from the maximum of 0.075 kW, or 0.031 kW and at the restricted azimuth of 340 - 350 Degrees True the Vertical component is 3.70 dB down from the maximum of 0.075 kW, or 0.032 kW.

The R.M.S. of the Horizontal component is 0.795. The total Horizontal power gain is 1.729. The R.M.S. of the Vertical component is 0.721. The total Vertical power gain is 1.633. See Figure 4 for calculations. The R.M.S. of the FCC composite pattern is 0.910. The R.M.S. of the measured composite pattern is 0.802. Eighty-five percent (85%) of the original authorized FCC composite pattern is 0.7735. Therefore this pattern complies with the FCC requirement of 73.316(c)(2)(ix)(A).

METHOD OF DIRECTIONALIZATION:

One bay of the 6810-2R-DA was mounted on a tower of precise scale to the Pi-Rod 24-in tower at the WTRM site. The spacing of the antenna to the tower was varied and the addition of vertical parasitic elements were used to achieve the horizontal and vertical patterns shown in Figure 1A. See Figure 2 for mechanical details.

METHOD OF MEASUREMENT:

As allowed by the construction permit, file number BPED-20130426AAR, a single level of the 6810-2R-DA was set up on the Shively Labs scale model antenna pattern measuring range. A scale of 4.5:1 was used.

EQUIPMENT:

The 4.5:1 scale model pattern range consists of a wooden rotating pedestal equipped with a position indicator. The scale model bay is placed on the top of this pedestal and is used in the transmission mode at approximately 20 feet above ground level. The receiving corner reflector is spaced 50 feet away from the rotating pedestal at the same level above ground as the transmitting model. The transmitting and receiving signals are carried to a control building by means of RG-9/U double shielded coax cable.

The control building is equipped with:

Hewlett Packard Model 4395-A Network Analyzer

PC Based Controller

Output Standard Printer or 'pdf'

All testing is carried out in strict accordance with approved procedures under our ISO9001:2008.

TEST PROCEDURES:

The receiving antenna system is mounted so that the horizontal and vertical azimuth patterns are measured independently. The network analyzer was set to 409.95 MHz. Calibrated pads are used to check the linearity of the measuring system. For example, 6 dB padding yields a scale reading of 50 from an unpadded reading of 100 in voltage. From the recorded patterns, the R.M.S. values are calculated and recorded as shown in Figure 1A.

Respectfully submitted by:

A handwritten signature in blue ink, appearing to read 'Martyn Gregory', with a stylized, flowing script.

Martyn Gregory

Vice President, Shively Labs

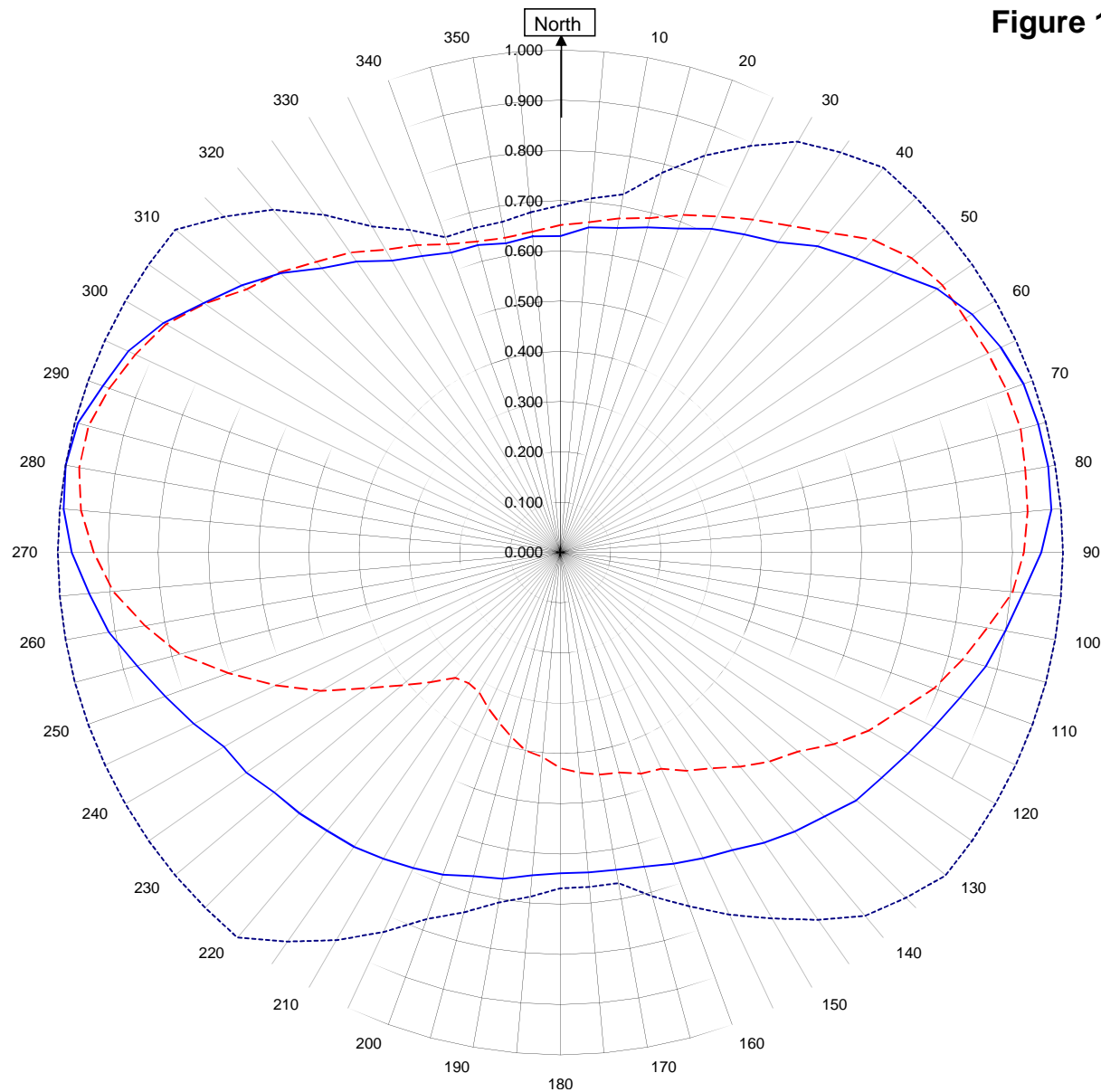
S/O 33197

January 5, 2016

Shively Labs

Shively Labs, a division of Howell Laboratories, Inc. Bridgton, ME (207)647-3327

Figure 1A



WTRM WINCHESTER, VA.
33197
January 5, 2016

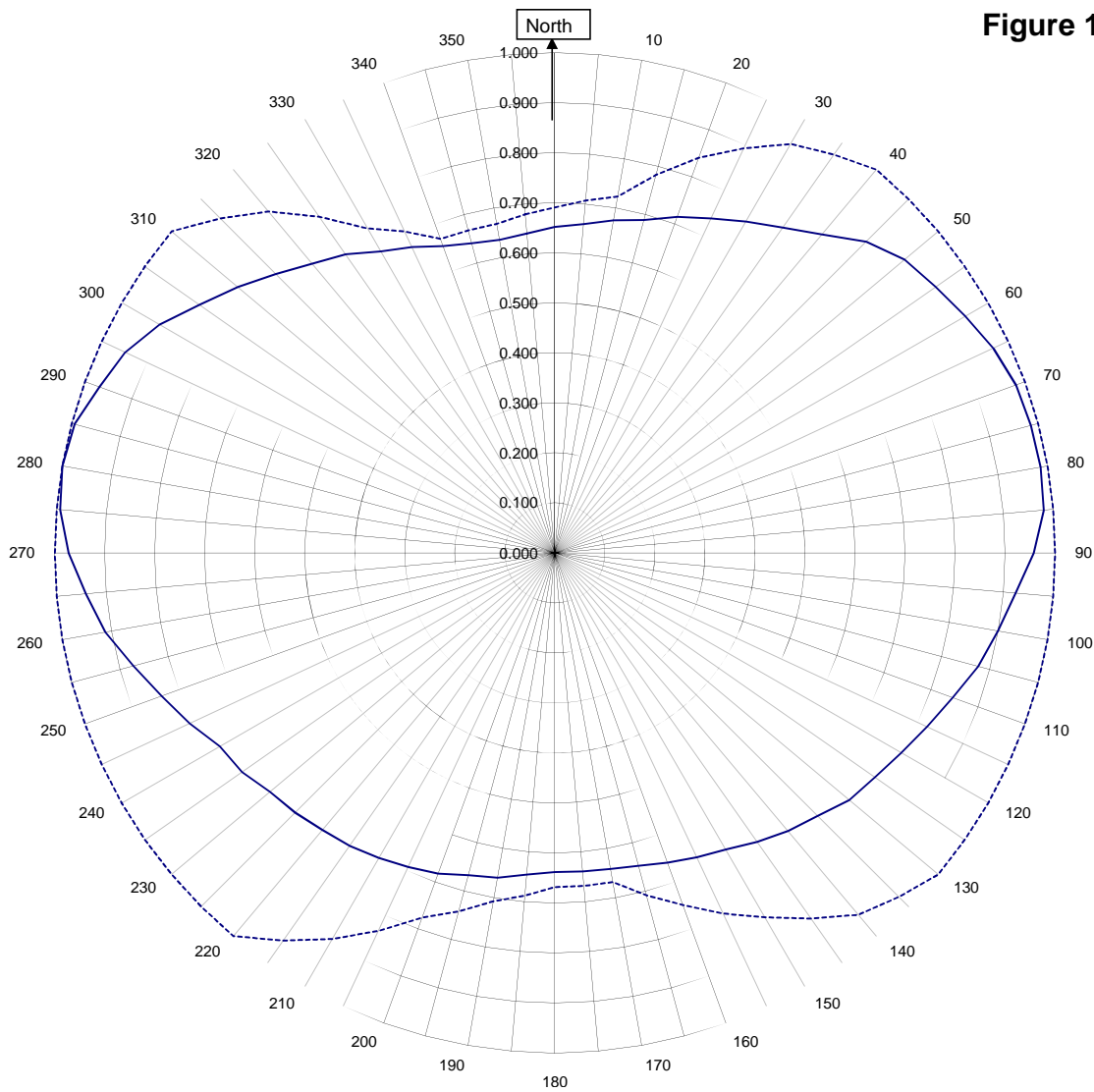
Horizontal RMS	0.795	Frequency	91.1 / 409.95 MHz
Vertical RMS	0.721	Plot	Relative Field
H/V Composite RMS	0.802	Scale	4.5 : 1
FCC Composite RMS	0.910	See Figure 2 for Mechanical Details	

Antenna Model	6810-2R-DA
Pattern Type	Directional Azimuth

Shively Labs

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Figure 1B



WTRM WINCHESTER, VA.

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January 5, 2016

—————H/V Composite RMS	0.802
.....FCC Composite RMS	0.910

Frequency	91.1 / 409.95 mHz
Plot	Relative Field
Scale	4.5 : 1
See Figure 2 for Mechanical Details	

Antenna Model	6810-2R-DA
Pattern Type	Directional H/V Composite

Figure 1C

Tabulation of Horizontal Azimuth Pattern
WTRM WINCHESTER, VA.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.630	180	0.638
10	0.656	190	0.659
20	0.686	200	0.682
30	0.731	210	0.704
40	0.796	220	0.723
45	0.829	225	0.734
50	0.867	230	0.743
60	0.947	240	0.773
70	0.981	250	0.837
80	0.986	260	0.912
90	0.957	270	0.972
100	0.899	280	1.000
110	0.846	290	0.969
120	0.799	300	0.913
130	0.768	310	0.827
135	0.743	315	0.787
140	0.725	320	0.738
150	0.684	330	0.671
160	0.659	340	0.635
170	0.641	350	0.625

Figure 1D

Tabulation of Vertical Azimuth Pattern
WTRM WINCHESTER, VA.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.652	180	0.429
10	0.675	190	0.400
20	0.715	200	0.359
30	0.765	210	0.322
40	0.831	220	0.326
45	0.880	225	0.365
50	0.912	230	0.411
60	0.931	240	0.550
70	0.945	250	0.703
80	0.940	260	0.839
90	0.922	270	0.929
100	0.863	280	0.972
110	0.791	290	0.955
120	0.709	300	0.908
130	0.616	310	0.815
135	0.588	315	0.789
140	0.557	320	0.755
150	0.501	330	0.696
160	0.468	340	0.653
170	0.448	350	0.636

Figure 1E

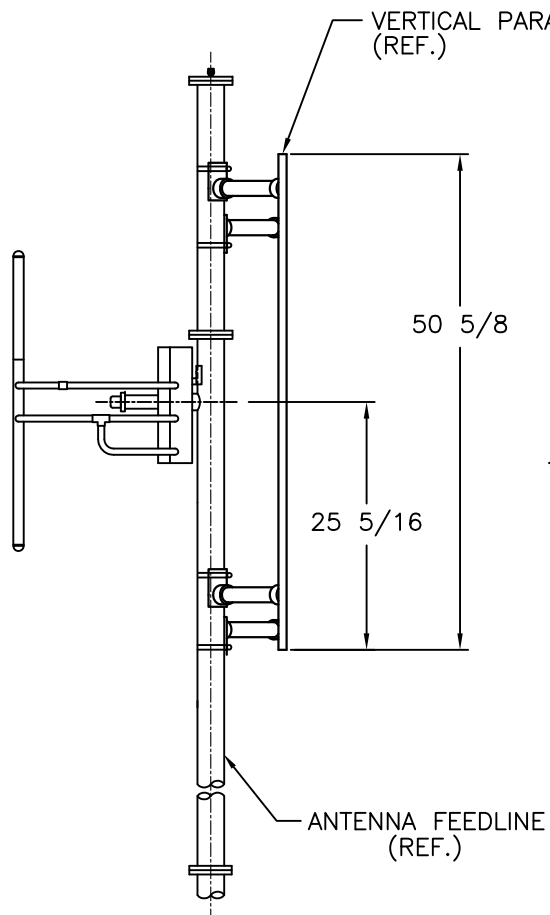
Tabulation of Composite Azimuth Pattern
WTRM WINCHESTER, VA.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.652	180	0.638
10	0.675	190	0.659
20	0.715	200	0.682
30	0.765	210	0.704
40	0.831	220	0.723
45	0.880	225	0.734
50	0.912	230	0.743
60	0.947	240	0.773
70	0.981	250	0.837
80	0.986	260	0.912
90	0.957	270	0.972
100	0.899	280	1.000
110	0.846	290	0.969
120	0.799	300	0.913
130	0.768	310	0.827
135	0.743	315	0.789
140	0.725	320	0.755
150	0.684	330	0.696
160	0.659	340	0.653
170	0.641	350	0.636

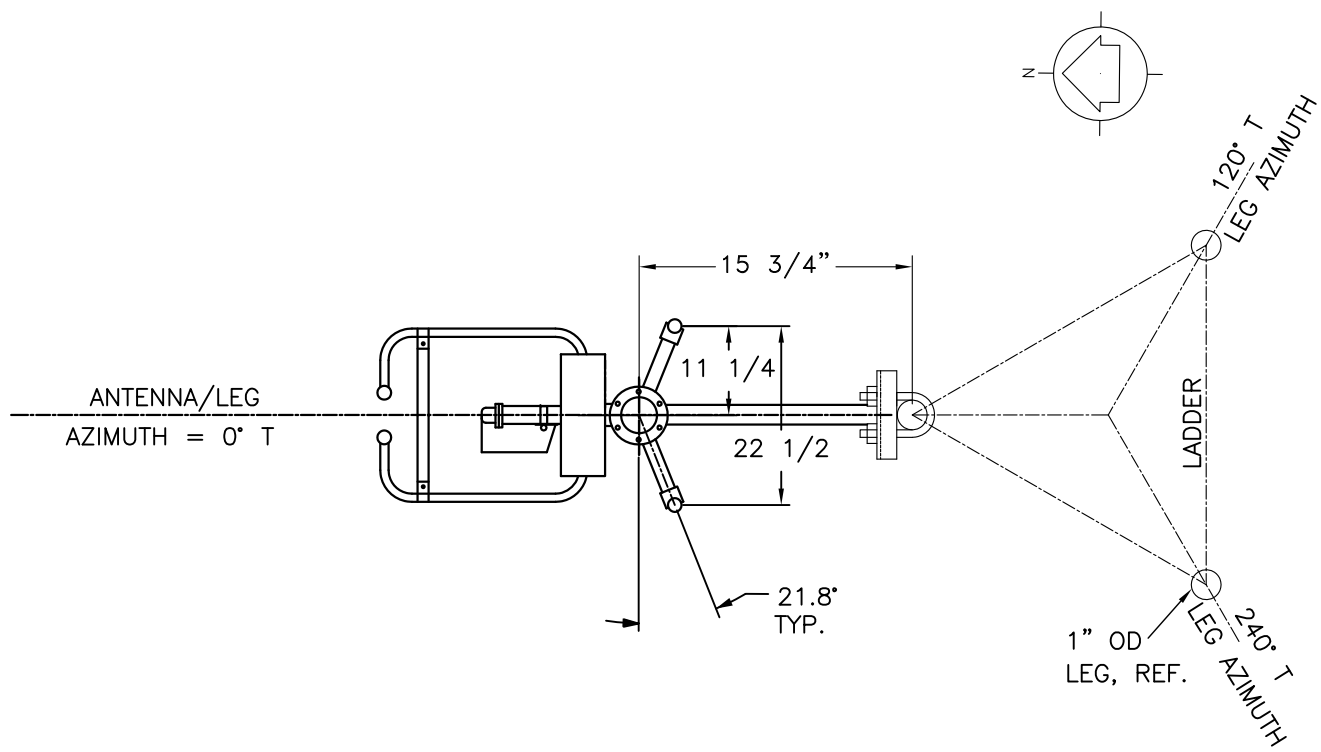
Figure 1F

Tabulation of FCC Directional Composite
WTRM WINCHESTER, VA.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.691	180	0.668
10	0.724	190	0.707
20	0.841	200	0.776
30	0.944	210	0.891
40	1.000	220	1.000
50	1.000	230	1.000
60	1.000	240	1.000
70	1.000	250	1.000
80	1.000	260	1.000
90	1.000	270	1.000
100	1.000	280	1.000
110	1.000	290	1.000
120	1.000	300	1.000
130	1.000	310	1.000
140	0.944	320	0.891
150	0.841	330	0.749
160	0.749	340	0.668
170	0.668	350	0.668



SIDE VIEW



TOP VIEW
TOWER: PIROD 24X

ANTENNA HEADING: 0° TRUE NORTH

SHIVELY LABS			
A DIVISION OF HOWELL LABORATORIES INC., BRIDGTON, MAINE			
SHOP ORDER:	FREQUENCY:	SCALE:	DRAWN BY:
33197	91.1 MHz	N.T.S.	ASP
APPROVED BY:			
TITLE:			
MODEL-6810-2R-DIRECTIONAL ANTENNA			
DATE:			
1-6-16	FIGURE 2		

Antenna Mfg.: Shively Labs
Antenna Type: 6810-2R-DA

Date: 1/5/2016

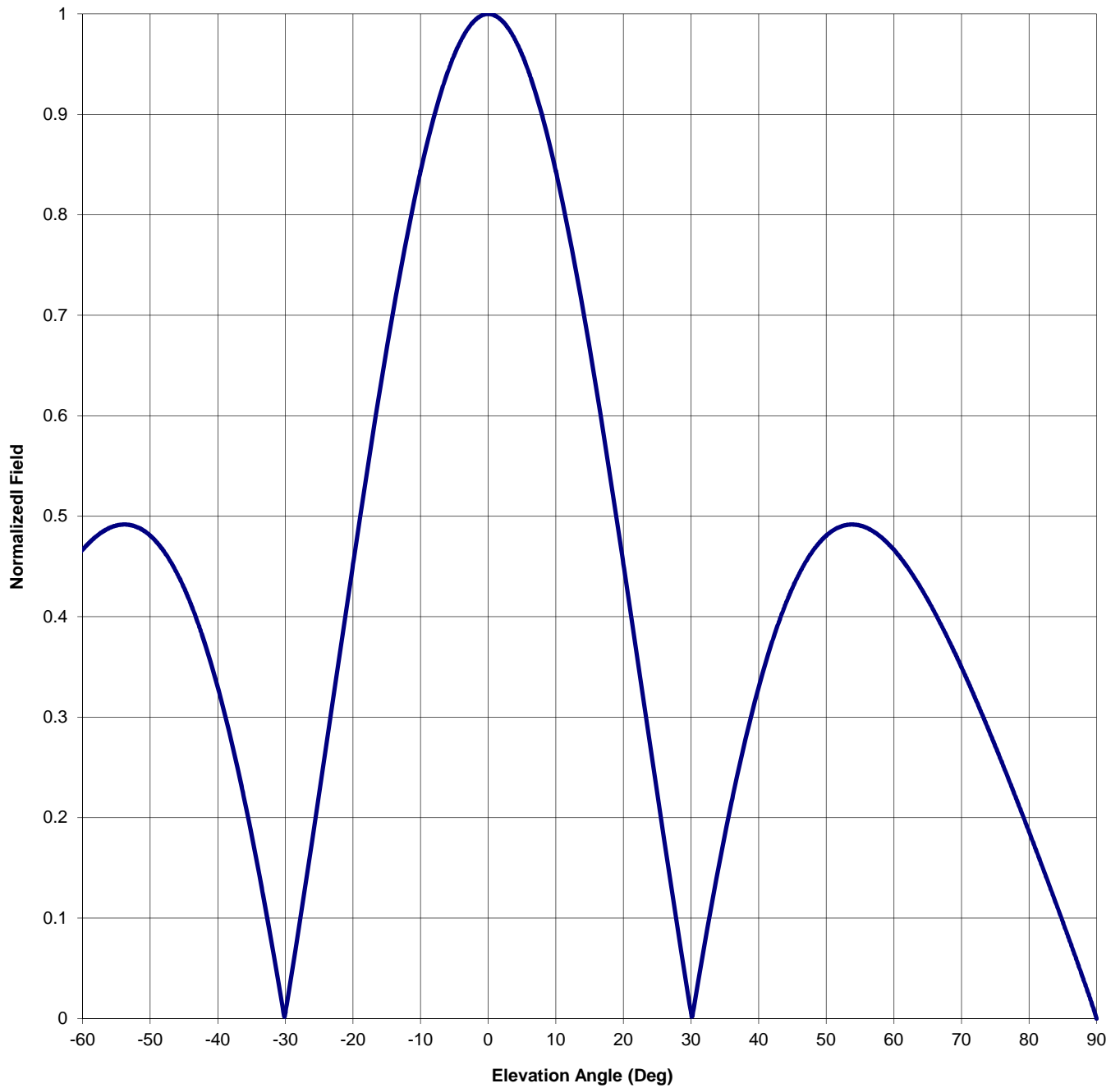
Station: WTRM

Frequency: 91.1

Channel #: 216

Figure: Figure 3

Beam Tilt	0	
Gain (Max)	1.729	2.378 dB
Gain (Horizon)	1.729	2.378 dB



Antenna Mfg.: Shively Labs

Date: 1/5/2016

Antenna Type: 6810-2R-DA

Station: WTRM

Beam Tilt 0

Frequency: 91.1

Gain (Max) 1.729 2.378 dB

Channel #: 216

Gain (Horizon) 1.729 2.378 dB

Figure: Figure 3

Angle of Depression (Deg)	Relative Field	Angle of Depression (Deg)	Relative Field	Angle of Depression (Deg)	Relative Field	Angle of Depression (Deg)	Relative Field
-90	0.000	-44	0.413	0	1.000	46	0.443
-89	0.021	-43	0.395	1	0.998	47	0.455
-88	0.040	-42	0.375	2	0.993	48	0.465
-87	0.059	-41	0.353	3	0.985	49	0.474
-86	0.078	-40	0.330	4	0.974	50	0.481
-85	0.096	-39	0.304	5	0.960	51	0.486
-84	0.114	-38	0.277	6	0.942	52	0.489
-83	0.132	-37	0.247	7	0.922	53	0.491
-82	0.150	-36	0.216	8	0.898	54	0.492
-81	0.168	-35	0.183	9	0.872	55	0.491
-80	0.186	-34	0.148	10	0.844	56	0.488
-79	0.203	-33	0.112	11	0.813	57	0.485
-78	0.221	-32	0.074	12	0.779	58	0.480
-77	0.238	-31	0.035	13	0.744	59	0.474
-76	0.255	-30	0.006	14	0.706	60	0.467
-75	0.271	-29	0.048	15	0.667	61	0.459
-74	0.288	-28	0.091	16	0.627	62	0.449
-73	0.304	-27	0.134	17	0.585	63	0.439
-72	0.319	-26	0.179	18	0.541	64	0.429
-71	0.335	-25	0.224	19	0.497	65	0.417
-70	0.350	-24	0.270	20	0.452	66	0.405
-69	0.364	-23	0.315	21	0.407	67	0.392
-68	0.378	-22	0.361	22	0.361	68	0.378
-67	0.392	-21	0.407	23	0.315	69	0.364
-66	0.405	-20	0.452	24	0.270	70	0.350
-65	0.417	-19	0.497	25	0.224	71	0.335
-64	0.429	-18	0.541	26	0.179	72	0.319
-63	0.439	-17	0.585	27	0.134	73	0.304
-62	0.449	-16	0.627	28	0.091	74	0.288
-61	0.459	-15	0.667	29	0.048	75	0.271
-60	0.467	-14	0.706	30	0.006	76	0.255
-59	0.474	-13	0.744	31	0.035	77	0.238
-58	0.480	-12	0.779	32	0.074	78	0.221
-57	0.485	-11	0.813	33	0.112	79	0.203
-56	0.488	-10	0.844	34	0.148	80	0.186
-55	0.491	-9	0.872	35	0.183	81	0.168
-54	0.492	-8	0.898	36	0.216	82	0.150
-53	0.491	-7	0.922	37	0.247	83	0.132
-52	0.489	-6	0.942	38	0.277	84	0.114
-51	0.486	-5	0.960	39	0.304	85	0.096
-50	0.481	-4	0.974	40	0.330	86	0.078
-49	0.474	-3	0.985	41	0.353	87	0.059
-48	0.465	-2	0.993	42	0.375	88	0.040
-47	0.455	-1	0.998	43	0.395	89	0.021
-46	0.443	0	1.000	44	0.413	90	0.000
-45	0.429			45	0.429		

VALIDATION OF TOTAL POWER GAIN CALCULATION

WTRM WINCHESTER, VA.

MODEL 6810-2R-DA

Elevation Gain of Antenna

0.991

Horizontal RMS value divided by the Vertical RMS value equals the Horiz. - Vert. Ratio

H RMS	0.795468	V RMS	0.720606	H/V Ratio	1.104
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Elevation Gain of Horizontal Component	1.094
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Elevation Gain of Vertical Component	0.898
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Horizontal Azimuth Gain equals $1/(\text{RMS})^2$.	1.580
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Vertical Azimuth Gain equals $1/(\text{RMS}/\text{Max Vert})^2$.	1.819
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Max. Vertical	0.972
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***Total Horizontal Power Gain is the Elevation Gain Times the Azimuth Gain**

Total Horizontal Power Gain =	1.729
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***Total Vertical Power Gain is the Elevation Gain Times the Azimuth Gain**

Total Vertical Power Gain =	1.633
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ERP divided by Horizontal Power Gain equals Antenna Input Power

0.075	kW ERP	Divided by H Gain	1.729	equals	0.043	kW H Antenna Input Power
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Antenna Input Power times Vertical Power Gain equals Vertical ERP

0.043	kW	Times V Gain	1.633	equals	0.071	kW V ERP
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Maximum Value of the Vertical Component squared times the Maximum ERP equals the Vertical ERP

$(0.972)^2$	Times	0.08	Equals	0.071	kW Vertical ERP
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NOTE: Calculating the ERP of the Vertical Component by two methods validates the total power gain calculations