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S.O. 31959

Report of Test 6810-3R-SS(0.5)-DA

for

Entercom License, LCC

WAAF 107.3 MHz Westborough, MA.

OBJECTIVE:

The objective of this test was to demonstrate the directional characteristics of a 6810-3R-SS(0.5)-DA to meet the needs of WAAF and to comply with the requirements of the FCC construction permit, file number BXPH-20140919ADC. 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 BXPH-20140919ADC indicates that the Horizontal radiation component shall not exceed 15.0 kW at any azimuth and is restricted to the following values at the azimuths specified:

210 degrees to 230 degrees True: 0.49 kilowatts

From Figure 1A, the maximum radiation of the Horizontal component occurs at 20 Degrees True to 30 Degrees True. At the restricted azimuth of 210 Degrees True to 230 Degrees True the Horizontal component is 17.016 dB down from the maximum of 15.0 kW, or 0.2982 kW.

The R.M.S. of the Horizontal component is 0.601. The total Horizontal power gain is 2.945. The R.M.S. of the Vertical component is 0.570. The total Vertical power gain is 2.199. See Figure 4 for calculations. The R.M.S. of the FCC composite pattern is 0.640. The R.M.S. of the measured composite pattern is 0.608. Eighty-five percent (85%) of the original authorized FCC composite pattern is 0.544. Therefore this pattern complies with the FCC requirement of 73.316(c)(2)(ix)(A).

METHOD OF DIRECTIONALIZATION:

One bay of the 6810-3R-SS(0.5)-DA was mounted on a pole of precise scale to the 21" reenforced pole at the WAAF site. The spacing of the antenna to the tower was varied to achieve the vertical pattern shown in Figure 1A. A horizontal parasitic element was placed directly under the bay. The position of this horizontal parasitic element was changed until the horizontal pattern shown in Figure 1A was achieved. See Figure 2 for mechanical details.

METHOD OF MEASUREMENT:

As allowed by the construction permit, file number BXPH-20140919ADC, a single level of the 6810-3R-SS(0.5)-DA was set up on the Shively Labs scale model antenna pattern measuring range. A scale of 4.5:1 was used.

SUPERVISION:

Mr. Surette was graduated from Lowell Technological Institute, Lowell, Massachusetts in 1973 with the degree of Bachelor of Science in Electrical Engineering. He has been directly involved with design and development of broadcast antennas, filter systems and RF transmission components since 1974. As an RF Engineer for six years with the original Shively Labs in Raymond, ME and for a short period of time with Dielectric Communications.
He is currently a Life Senior Member of IEEE.

He has authored a chapter on filters and combining systems for the latest edition of the CRC Electronics Handbook and for the 9th and 10th Editions of the NAB Handbook.

EQUIPMENT:

The 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 482.85 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:

Robert A. Surette
Director of Sales Engineering
S/O 31959
October 14, 2014

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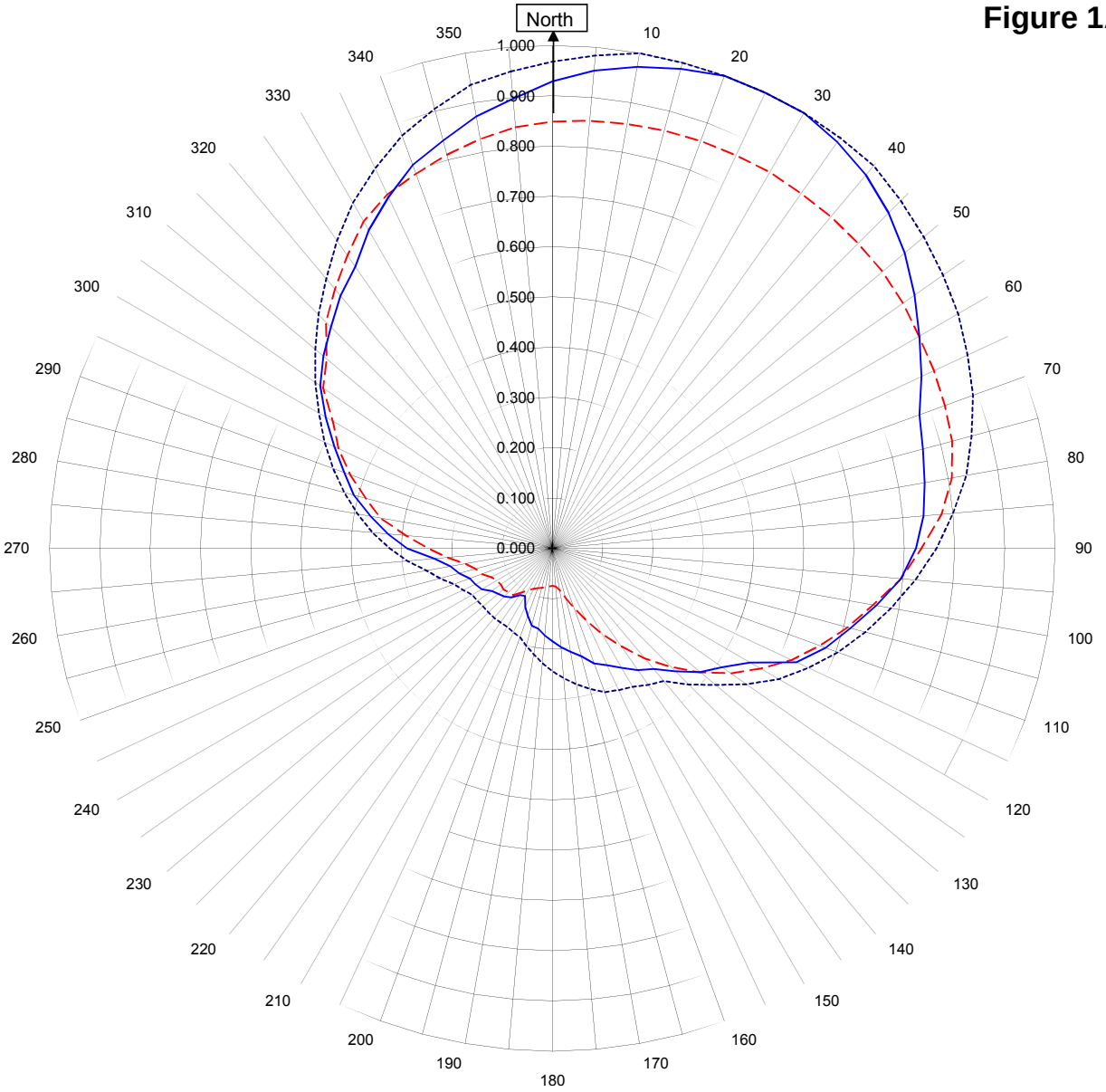
Figure 1A



WAAF WESTBOROUGH, MA.

31959

October 14, 2014

Horizontal RMS	0.601
Vertical RMS	0.570
H/V Composite RMS	0.608
FCC Composite RMS	0.640

Frequency	107.9 / 485.55 mHz
Plot	Relative Field
Scale	4.5 : 1
	See Figure 2 for Mechanical Details

Antenna Model	6810-3R-SS-DA
Pattern Type	Directional Azimuth

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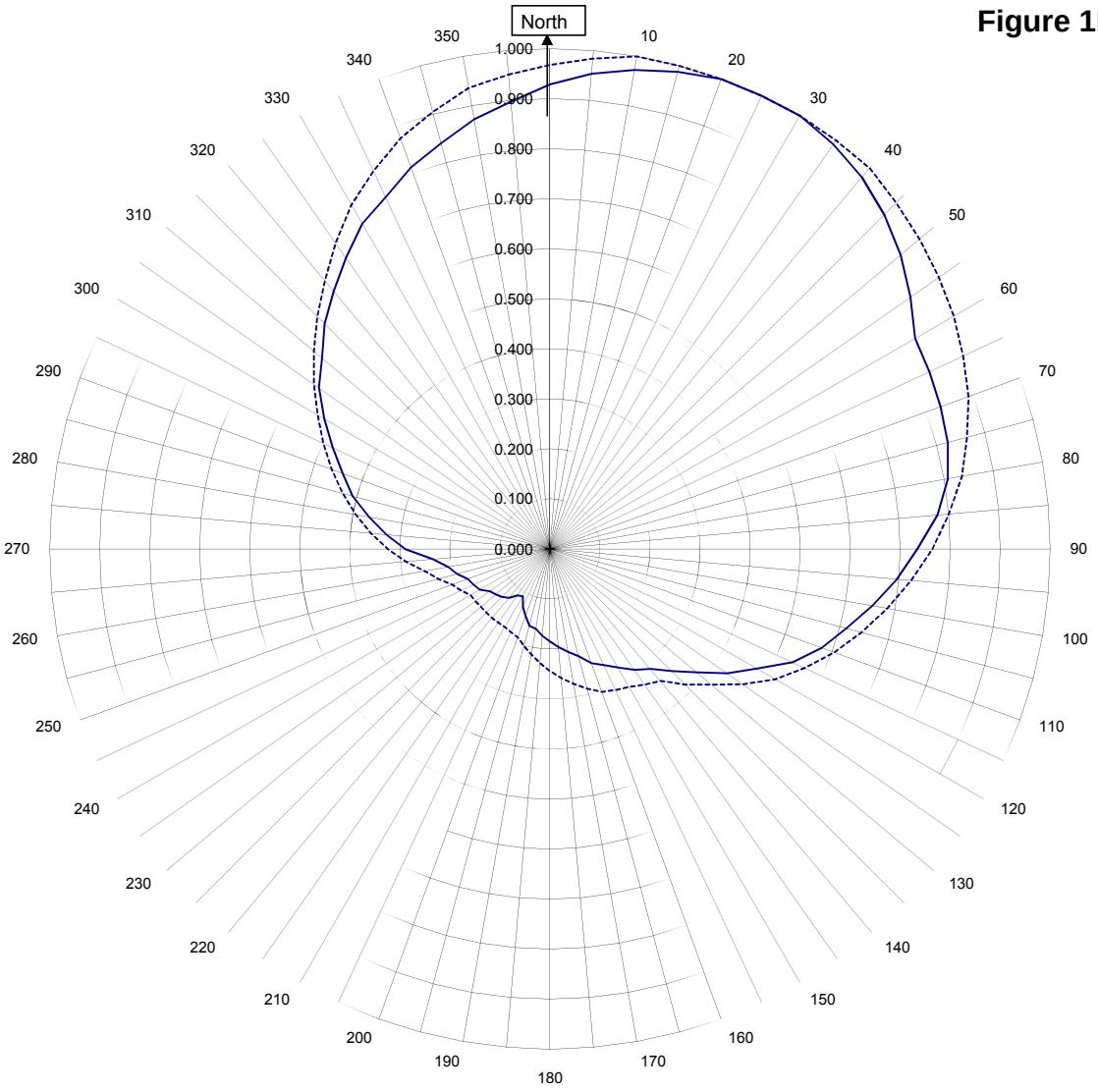
Figure 1B



WAAF WESTBOROUGH, MA

31959

October 14, 2014

_____H/VComposite RMS	0.608
……FCC Composite RMS	0.640

Frequency	107.9 / 485.55 mHz
Plot	Relative Field
Scale	4.5 : 1
	See Figure 2 for Mechanical Details

Antenna Model	6810-3R-SS-DA
Pattern Type	Directional H/V Composite

Figure 1C

Tabulation of Horizontal Azimuth Pattern
WAAF WESTBOROUGH, MA.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.929	180	0.185
10	0.972	190	0.162
20	1.000	200	0.143
30	1.000	210	0.109
40	0.970	220	0.127
45	0.945	225	0.135
50	0.915	230	0.141
60	0.843	240	0.162
70	0.777	250	0.175
80	0.752	260	0.206
90	0.723	270	0.289
100	0.654	280	0.367
110	0.578	290	0.441
120	0.454	300	0.521
130	0.383	310	0.595
135	0.345	315	0.623
140	0.313	320	0.656
150	0.274	330	0.731
160	0.243	340	0.812
170	0.209	350	0.872

Figure 1D

Tabulation of Vertical Azimuth Pattern
WAAF WESTBOROUGH, MA.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.849	180	0.074
10	0.857	190	0.078
20	0.862	200	0.084
30	0.864	210	0.096
40	0.861	220	0.121
45	0.859	225	0.123
50	0.857	230	0.127
60	0.842	240	0.128
70	0.831	250	0.149
80	0.807	260	0.176
90	0.734	270	0.247
100	0.647	280	0.347
110	0.565	290	0.428
120	0.478	300	0.504
130	0.383	310	0.587
135	0.333	315	0.637
140	0.286	320	0.673
150	0.196	330	0.751
160	0.126	340	0.793
170	0.085	350	0.827

Figure 1E

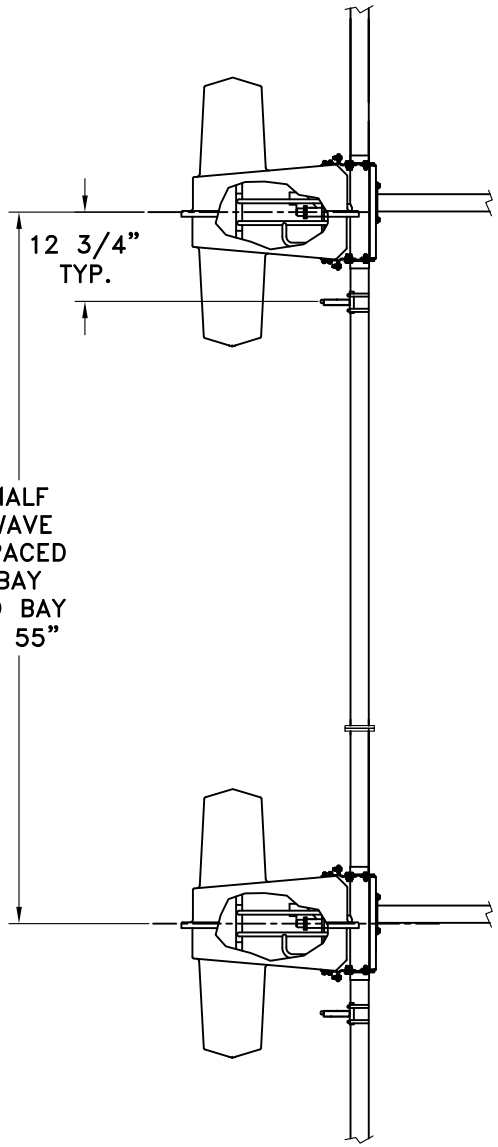
Tabulation of Composite Azimuth Pattern
WAAF WESTBOROUGH, MA.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.929	180	0.185
10	0.972	190	0.162
20	1.000	200	0.143
30	1.000	210	0.109
40	0.970	220	0.127
45	0.945	225	0.135
50	0.915	230	0.141
60	0.843	240	0.162
70	0.831	250	0.175
80	0.807	260	0.206
90	0.734	270	0.289
100	0.654	280	0.367
110	0.578	290	0.441
120	0.478	300	0.521
130	0.383	310	0.595
135	0.345	315	0.637
140	0.313	320	0.673
150	0.274	330	0.751
160	0.243	340	0.812
170	0.209	350	0.872

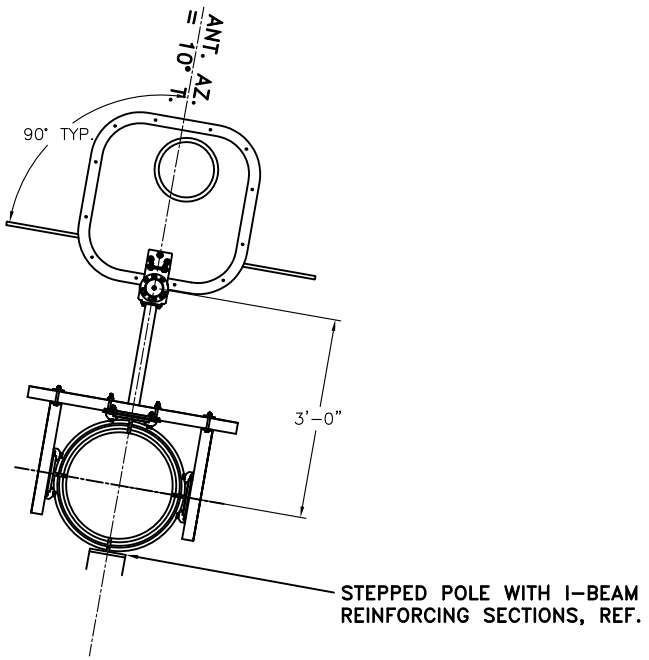
Figure 1F

Tabulation of FCC Directional Composite
WAAF WESTBOROUGH, MA.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.968	180	0.244
10	1.000	190	0.214
20	1.000	200	0.188
30	1.000	210	0.180
40	0.994	220	0.180
50	0.964	230	0.180
60	0.932	240	0.184
70	0.890	250	0.208
80	0.836	260	0.254
90	0.764	270	0.324
100	0.684	280	0.394
110	0.604	290	0.464
120	0.520	300	0.536
130	0.422	310	0.616
140	0.344	320	0.700
150	0.318	330	0.794
160	0.304	340	0.874
170	0.274	350	0.936



SIDE VIEW



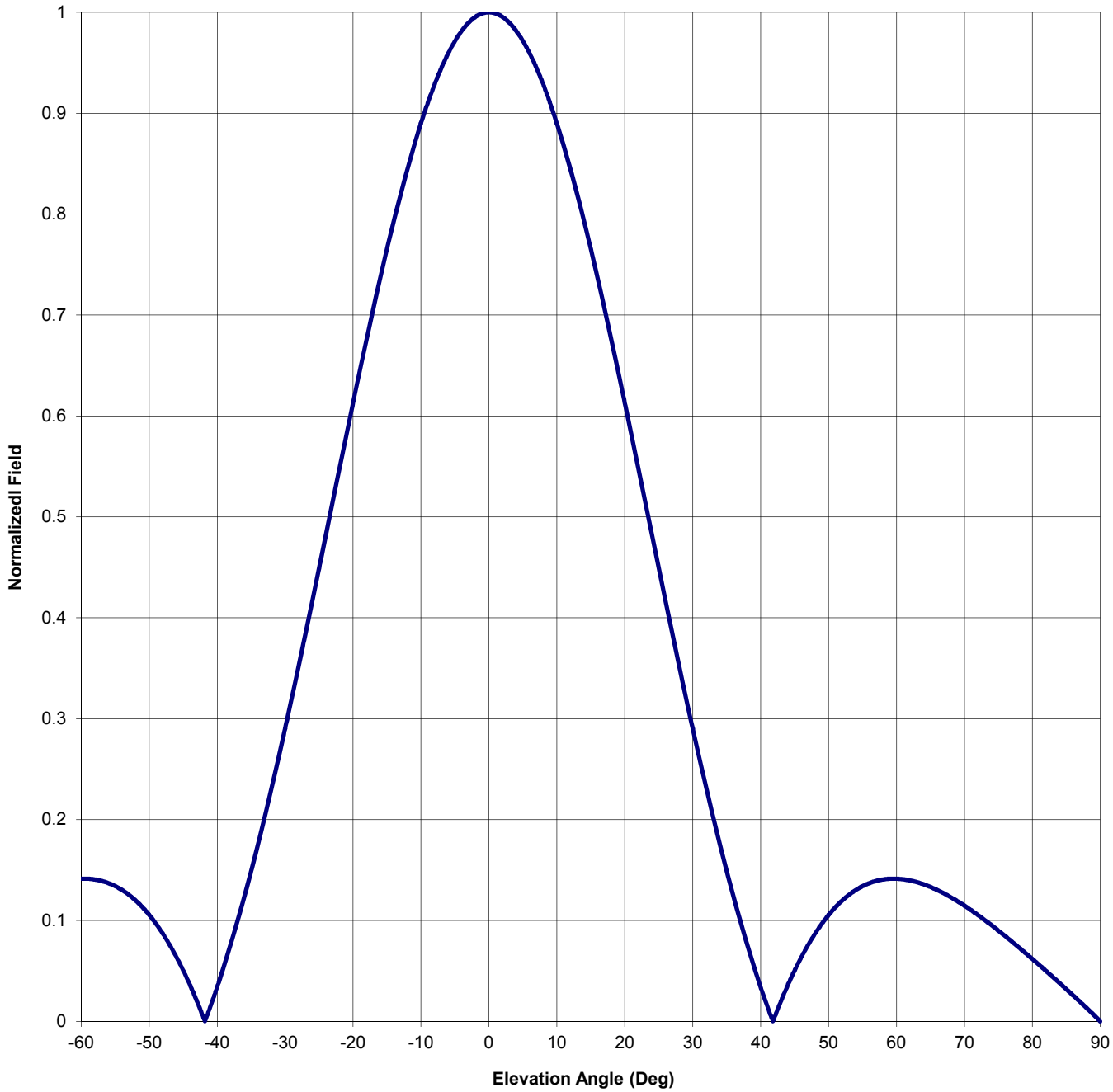
TOP VIEW

TOWER: STEPPED POLE WITH I-BEAM
REINFORCING SECTIONS

ANTENNA HEADING 10° TRUE NORTH

SHIVELY LABS A DIVISION OF HOWELL LABORATORIES INC.,BRIDGTON, MAINE			
SHOP ORDER: 31959	FREQUENCY: 107.3	SCALE: N.T.S.	DRAWN BY: ASP APPROVED BY: DAB
TITLE: MODEL-6810-3R-SS-DIRECTIONAL ANTENNA			
DATE: 10-14-14	FIGURE 2		

Antenna Mfg.:	**Shively Labs**			**Date: 10/14/2014**
Antenna Type:	**6810-3R-SS-DA**			
Station:	**WAAF**	**Beam Tilt**	**0**	
Frequency:	**107.3**	**Gain (Max)**	**2.945**	**4.691 dB**
Channel #:	**297**	**Gain (Horizon)**	**2.945**	**4.691 dB**
Figure:	**Figure 3**			



Antenna Mfg.: Shively Labs **Date:** 10/14/2014

Antenna Type: 6810-3R-SS-DA

Station: WAAF **Beam Tilt** 0

Frequency: 107.3 **Gain (Max)** 2.945 4.691 dB

Channel #: 297 **Gain (Horizon)** 2.945 4.691 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	0.036	0	1.000	46	0.064
-89	0.007	-43	0.020	1	0.999	47	0.076
-88	0.013	-42	0.003	2	0.995	48	0.087
-87	0.020	-41	0.015	3	0.990	49	0.097
-86	0.026	-40	0.034	4	0.982	50	0.105
-85	0.032	-39	0.055	5	0.972	51	0.113
-84	0.038	-38	0.077	6	0.959	52	0.120
-83	0.044	-37	0.100	7	0.945	53	0.125
-82	0.050	-36	0.124	8	0.929	54	0.130
-81	0.056	-35	0.149	9	0.910	55	0.134
-80	0.062	-34	0.175	10	0.890	56	0.137
-79	0.068	-33	0.203	11	0.868	57	0.139
-78	0.073	-32	0.231	12	0.845	58	0.141
-77	0.079	-31	0.260	13	0.820	59	0.141
-76	0.085	-30	0.290	14	0.793	60	0.141
-75	0.090	-29	0.321	15	0.766	61	0.141
-74	0.095	-28	0.352	16	0.737	62	0.140
-73	0.100	-27	0.384	17	0.707	63	0.138
-72	0.105	-26	0.417	18	0.676	64	0.136
-71	0.110	-25	0.449	19	0.645	65	0.133
-70	0.115	-24	0.482	20	0.613	66	0.130
-69	0.119	-23	0.515	21	0.581	67	0.127
-68	0.123	-22	0.548	22	0.548	68	0.123
-67	0.127	-21	0.581	23	0.515	69	0.119
-66	0.130	-20	0.613	24	0.482	70	0.115
-65	0.133	-19	0.645	25	0.449	71	0.110
-64	0.136	-18	0.676	26	0.417	72	0.105
-63	0.138	-17	0.707	27	0.384	73	0.100
-62	0.140	-16	0.737	28	0.352	74	0.095
-61	0.141	-15	0.766	29	0.321	75	0.090
-60	0.141	-14	0.793	30	0.290	76	0.085
-59	0.141	-13	0.820	31	0.260	77	0.079
-58	0.141	-12	0.845	32	0.231	78	0.073
-57	0.139	-11	0.868	33	0.203	79	0.068
-56	0.137	-10	0.890	34	0.175	80	0.062
-55	0.134	-9	0.910	35	0.149	81	0.056
-54	0.130	-8	0.929	36	0.124	82	0.050
-53	0.125	-7	0.945	37	0.100	83	0.044
-52	0.120	-6	0.959	38	0.077	84	0.038
-51	0.113	-5	0.972	39	0.055	85	0.032
-50	0.105	-4	0.982	40	0.034	86	0.026
-49	0.097	-3	0.990	41	0.015	87	0.020
-48	0.087	-2	0.995	42	0.003	88	0.013
-47	0.076	-1	0.999	43	0.020	89	0.007
-46	0.064	0	1.000	44	0.036	90	0.000
-45	0.051			45	0.051		

S.O. 31959 Figure 4

VALIDATION OF TOTAL POWER GAIN CALCULATION

WAAF WESTBOROUGH, MA.

MODEL 6810-3R-SS-DA

Elevation Gain of Antenna 1.01

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

H RMS 0.601466 V RMS 0.570162 H/V Ratio 1.055

Elevation Gain of Horizontal Component 1.065

Elevation Gain of Vertical Component 0.957

Horizontal Azimuth Gain equals $1/(RMS)^2$. 2.764

Vertical Azimuth Gain equals $1/(RMS/Max\ Vert)^2$. 2.296

Max. Vertical 0.864

***Total Horizontal Power Gain is the Elevation Gain Times the Azimuth Gain**

Total Horizontal Power Gain = **2.945**

***Total Vertical Power Gain is the Elevation Gain Times the Azimuth Gain**

Total Vertical Power Gain = **2.199**

==========

ERP divided by Horizontal Power Gain equals Antenna Input Power

15 kW ERP Divided by H Gain 2.945 equals 5.093 kW H Antenna Input Power

Antenna Input Power times Vertical Power Gain equals Vertical ERP

5.093 kW Times V Gain 2.199 equals 11.197 kW V ERP

Maximum Value of the Vertical Component squared times the Maximum ERP equals the Vertical ERP

(0.864)^2 Times 15.00 Equals 11.197 kW Vertical ERP

NOTE: Calculating the ERP of the Vertical Component by two methods validates the total power gain calculations