Shively Labs
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S.O. 27795

Report of Test 6810-2R-SS-DA

for

UNIVERSITY OF MASSACHUSETTS

WBPR 91.9 MHz Worcester, MA

OBJECTIVE:

The objective of this test was to demonstrate the directional characteristics of a 6810-2R-SS-DA to meet the needs of WBPR and to comply with the requirements of the FCC construction permit, file number BMPED-20090817ABI.

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 BMPED-20090817ABI indicates that the Horizontal radiation component shall not exceed 0.37 kW at any azimuth and is restricted to the following values at the azimuths specified:

300 Degrees T through 350 Degrees T: 0.0180 kW

From Figure 1A, the maximum radiation of the Horizontal component occurs at 153 Degrees T to 206 Degrees T. At the restricted azimuth of 300 Degrees T through 350 Degrees T the Vertical component is 13.98 dB down from the maximum of 0.37 kW, or 0.0150 kW.

The R.M.S. of the Horizontal component is 0.631. The total Horizontal power gain is 1.758. The R.M.S. of the Vertical component is 0.631. The total Vertical power gain is 1.723. See Figure 4 for calculations. The R.M.S. of the FCC composite pattern is 0.661. The R.M.S. of the measured composite pattern is 0.638. Eighty-five percent (85%) of the original authorized FCC composite pattern is 0.561. Therefore this pattern complies with the FCC requirement of 73.316(c)(2)(ix)(A).

METHOD OF DIRECTIONALIZATION:

One bay of the 6810-2R-SS-DA was mounted on a pole of precise scale to the 3 ½" OD pole at the WBPR site. The spacing of the antenna to the pole 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 BMPED-20090817ABI, a single level of the 6810-2R-SS-DA was set up on the Howell Laboratories 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 an Associate Member of the AFCCE and a 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 8753 Network Analyzer
PC Based Controller
Hewlett Packard 7550A Graphics Plotter

The test equipment is calibrated to ANSI/NCSL Z540-1-1994.

TEST PROCEDURES:

The corner reflector is mounted so that the horizontal and vertical azimuth patterns are measured independently by rotating the corner reflector by 90 degrees. The network analyzer was set to 413.55 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 27795
September 17, 2009

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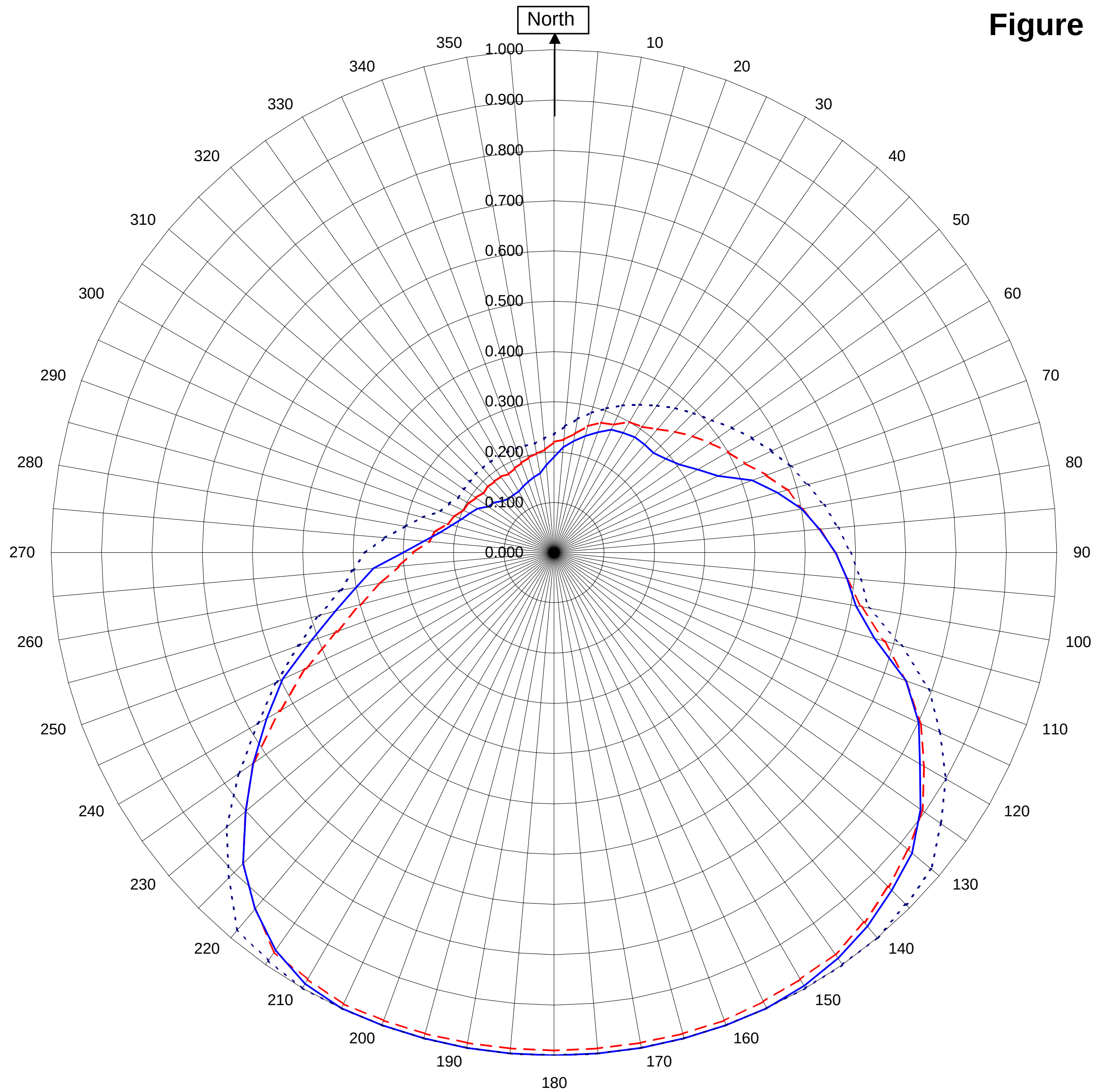
Figure 1a



WBPR Worcester, MA.

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____________Horizontal RMS	0.631
_ _ _ _ _ _ _ _ _ Vertical RMS	0.631
H/V Composite RMS	0.638
……………FCC Composite RMS	0.661

Frequency	91.9 / 413.55 mHz
Plot	Relative Field
Scale	4.5 : 1
	See Figure 2 for Mechanical Details

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

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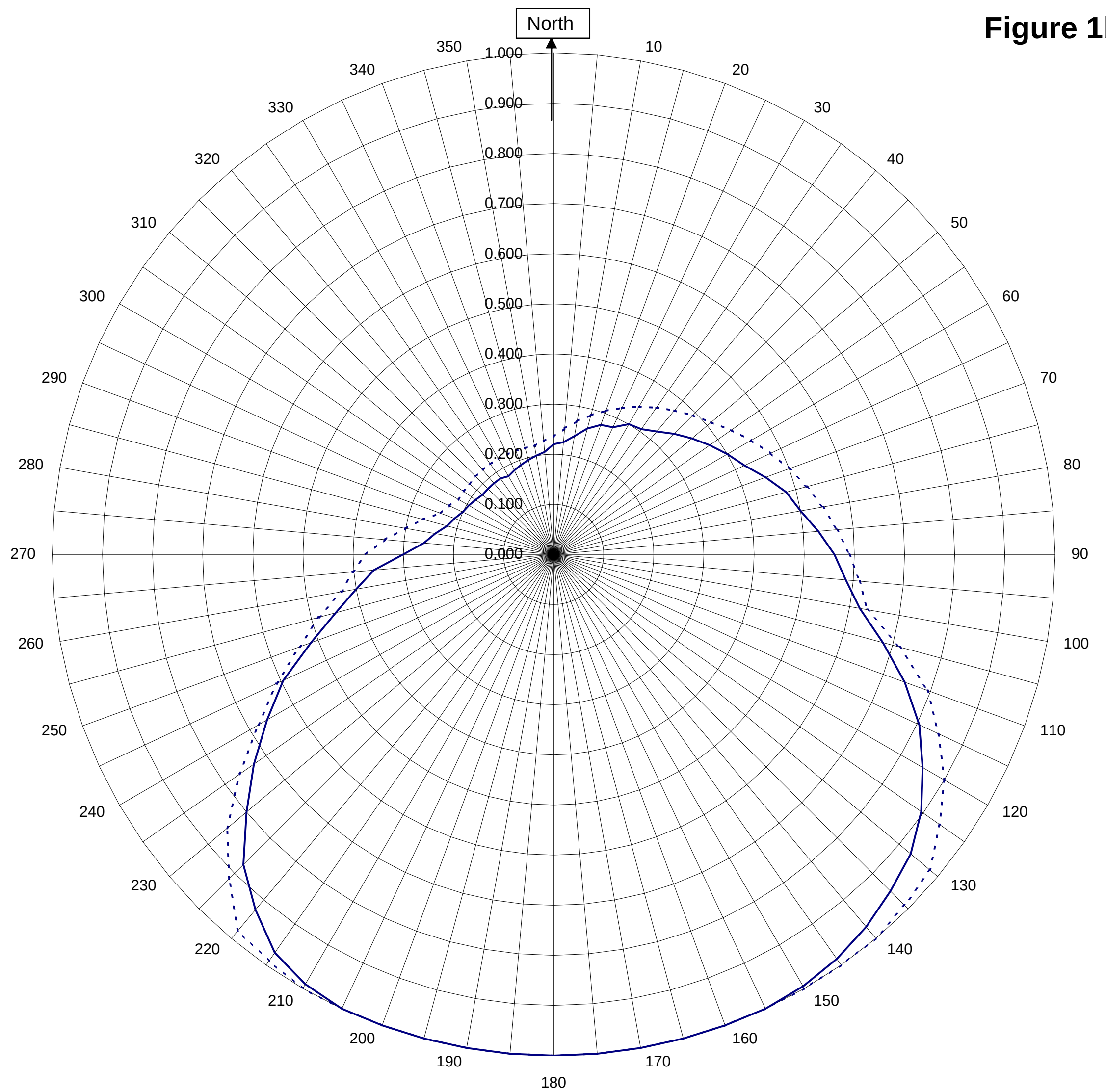
Figure 1b



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__________H/VComposite RMS	0.638
……………FCC Composite RMS	0.661

Frequency	91.9 / 413.55 mHz
Plot	Relative Field
Scale	4.5 : 1
	See Figure 2 for Mechanical Details

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

Figure 1c

Tabulation of Horizontal Azimuth Pattern
WBPR Worcester, MA

Azimuth	Rel Field	Azimuth	Rel Field
0	0.190	180	1.000
10	0.225	190	1.000
20	0.255	200	1.000
30	0.275	210	0.990
40	0.280	220	0.925
45	0.280	225	0.875
50	0.290	230	0.800
60	0.330	240	0.660
70	0.420	250	0.515
80	0.500	260	0.400
90	0.560	270	0.300
100	0.610	280	0.230
110	0.745	290	0.195
120	0.840	300	0.175
130	0.930	310	0.155
135	0.950	315	0.145
140	0.970	320	0.140
150	0.995	330	0.140
160	1.000	340	0.150
170	1.000	350	0.160

Figure 1d

Tabulation of Vertical Azimuth Pattern
WBPR Worcester, MA

Azimuth	Rel Field	Azimuth	Rel Field
0	0.220	180	0.990
10	0.240	190	0.990
20	0.275	200	0.990
30	0.300	210	0.980
40	0.320	220	0.925
45	0.340	225	0.875
50	0.360	230	0.800
60	0.400	240	0.630
70	0.450	250	0.460
80	0.500	260	0.350
90	0.560	270	0.280
100	0.620	280	0.240
110	0.745	290	0.210
120	0.850	300	0.195
130	0.920	310	0.185
135	0.940	315	0.185
140	0.960	320	0.185
150	0.980	330	0.180
160	0.990	340	0.190
170	0.990	350	0.200

Figure 1e

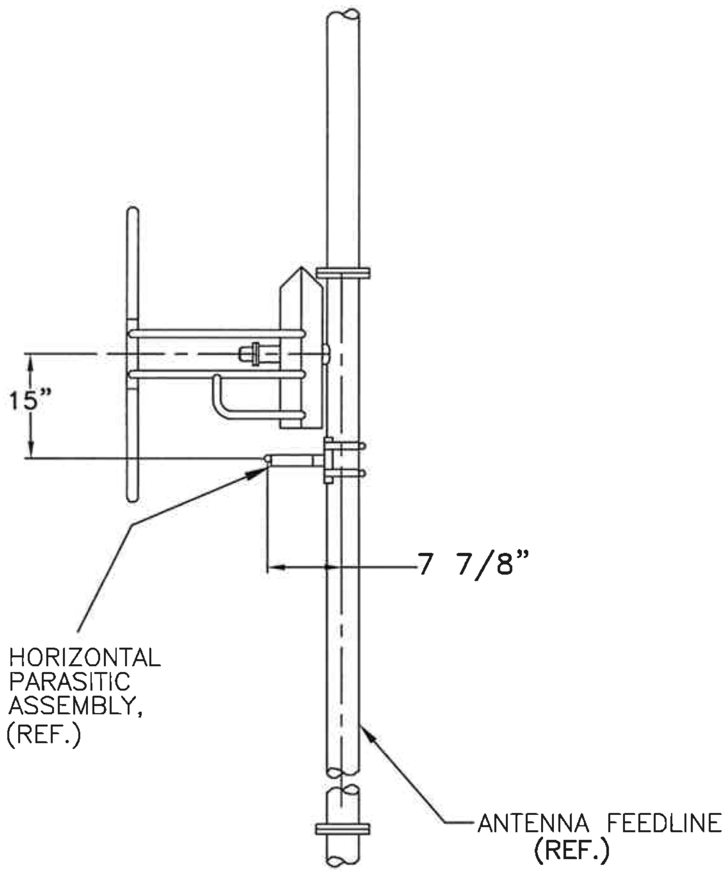
Tabulation of Composite Azimuth Pattern
WBPR Worcester, MA

Azimuth	Rel Field	Azimuth	Rel Field
0	0.220	180	1.000
10	0.240	190	1.000
20	0.275	200	1.000
30	0.300	210	0.990
40	0.320	220	0.925
45	0.340	225	0.875
50	0.360	230	0.800
60	0.400	240	0.660
70	0.450	250	0.515
80	0.500	260	0.400
90	0.560	270	0.300
100	0.620	280	0.240
110	0.745	290	0.210
120	0.850	300	0.195
130	0.930	310	0.185
135	0.950	315	0.185
140	0.970	320	0.185
150	0.995	330	0.180
160	1.000	340	0.190
170	1.000	350	0.200

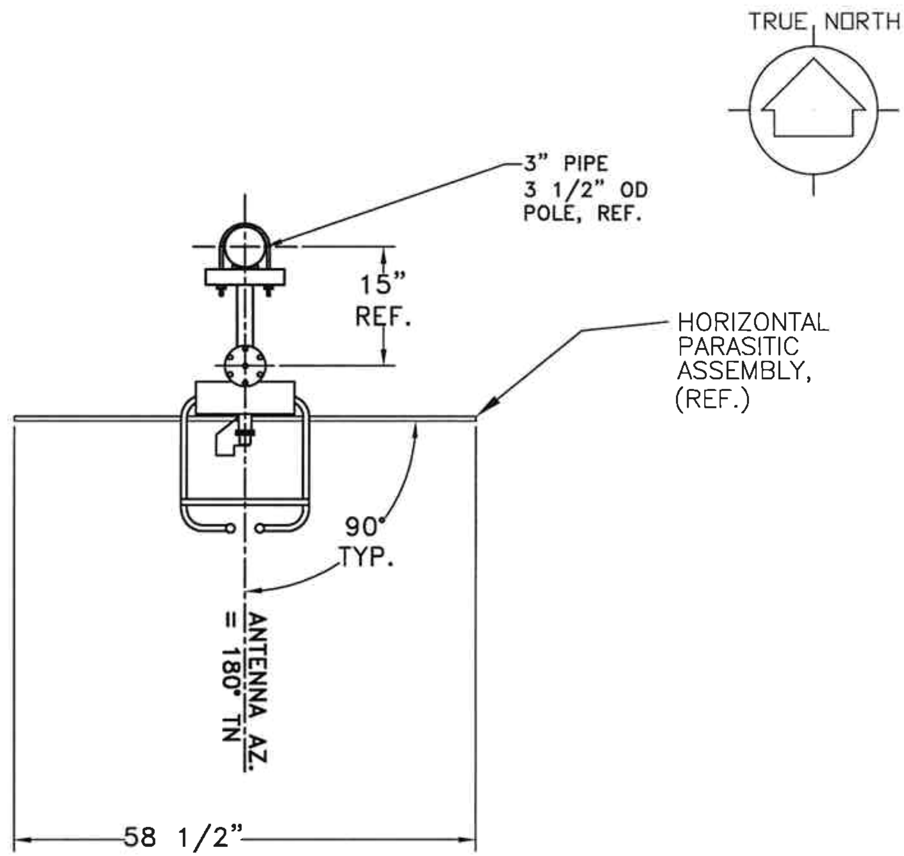
Figure 1f

Tabulation of FCC Directional Composite
WBPR Worcester, MA

Azimuth	Rel Field	Azimuth	Rel Field
0	0.235	180	1.000
10	0.270	190	1.000
20	0.305	200	1.000
30	0.340	210	1.000
40	0.375	220	0.980
50	0.410	230	0.850
60	0.455	240	0.680
70	0.500	250	0.540
80	0.545	260	0.430
90	0.590	270	0.375
100	0.635	280	0.300
110	0.794	290	0.240
120	0.900	300	0.220
130	0.980	310	0.220
140	1.000	320	0.220
150	1.000	330	0.220
160	1.000	340	0.220
170	1.000	350	0.220



SIDE VIEW



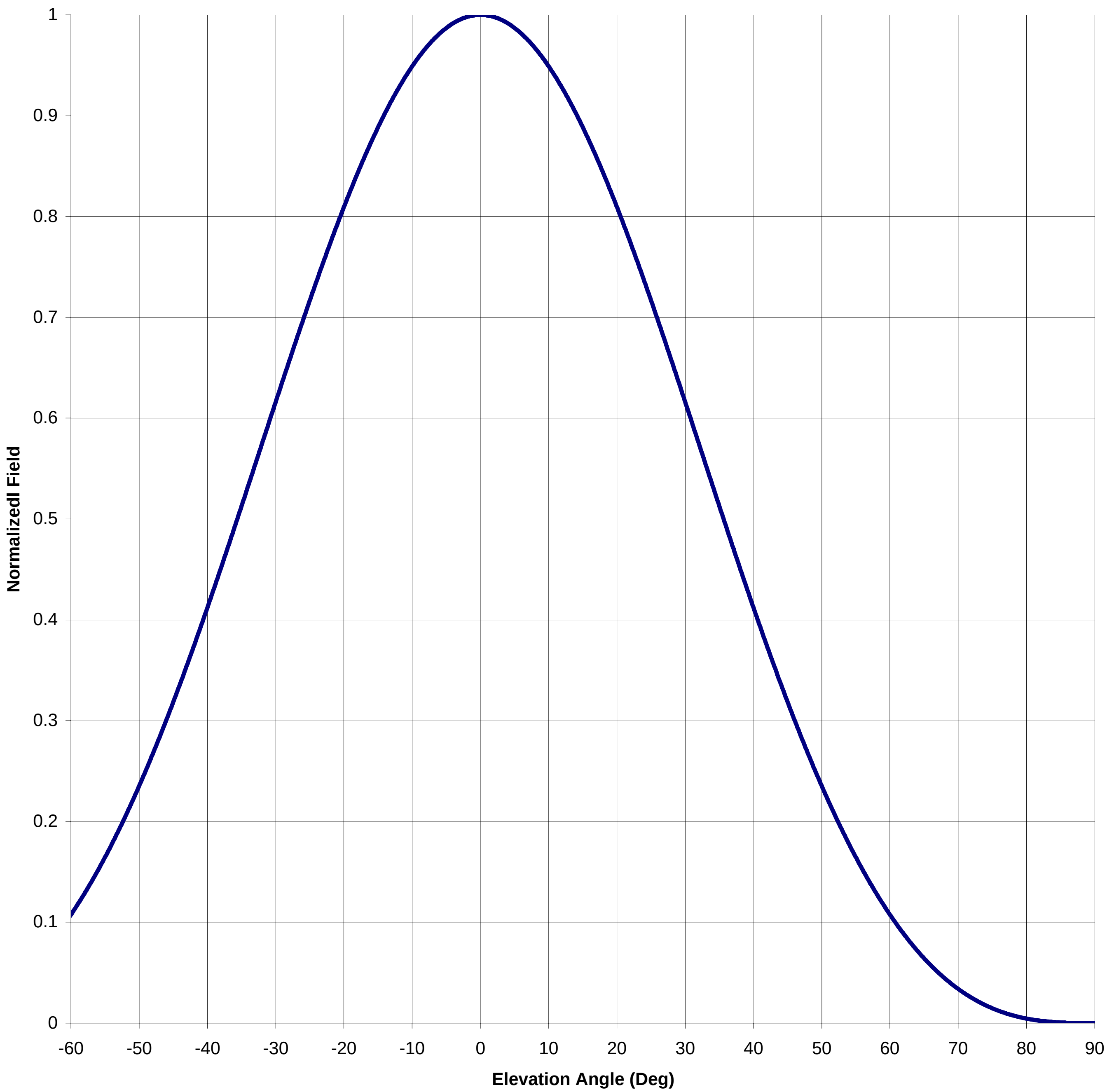
TOP VIEW

TOWER: POLE

ANTENNA HEADING 180° TRUE NORTH

SHIVELY LABS A DIVISION OF HOWELL LABORATORIES INC., BRIDGTON, MAINE			
SHOP ORDER: 27795	FREQUENCY: 91.9 MHz.	SCALE: N.T.S.	DRAWN BY: ASP APPROVED BY: DAB
TITLE: MODEL-6810-2R-SS-DIRECTIONAL ANTENNA			
DATE: 9/17/09	FIGURE 2		

Antenna Mfg.:	**Shively Labs**			**Date:**	**9/17/2009**
Antenna Type:	**6810-2R-SS-DA**				
Station:	**WBPR**	**Beam Tilt**	**0**		
Frequency:	**91.9**	**Gain (Max)**	**1.758**	**2.450**	**dB**
Channel #:	**220**	**Gain (Horizon)**	**1.758**	**2.450**	**dB**
Figure:	**Figure 3**				



Antenna Mfg.: Shively Labs | Date: 9/17/2009
Antenna Type: 6810-2R-SS-DA
Station: WBPR | Beam Tilt 0
Frequency: 91.9 | Gain (Max) 1.758 | 2.450 dB
Channel #: 220 | Gain (Horizon) 1.758 | 2.450 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	0.337	0	1.000	46	0.301
-89	0.000	-43	0.355	1	0.999	47	0.284
-88	0.000	-42	0.374	2	0.998	48	0.267
-87	0.000	-41	0.393	3	0.995	49	0.251
-86	0.000	-40	0.412	4	0.992	50	0.235
-85	0.001	-39	0.432	5	0.987	51	0.220
-84	0.001	-38	0.452	6	0.981	52	0.205
-83	0.002	-37	0.472	7	0.975	53	0.191
-82	0.002	-36	0.492	8	0.967	54	0.178
-81	0.003	-35	0.513	9	0.959	55	0.165
-80	0.005	-34	0.533	10	0.949	56	0.152
-79	0.006	-33	0.554	11	0.939	57	0.140
-78	0.008	-32	0.575	12	0.927	58	0.129
-77	0.010	-31	0.595	13	0.915	59	0.118
-76	0.012	-30	0.616	14	0.902	60	0.108
-75	0.015	-29	0.637	15	0.888	61	0.098
-74	0.018	-28	0.657	16	0.874	62	0.089
-73	0.021	-27	0.677	17	0.859	63	0.080
-72	0.025	-26	0.697	18	0.843	64	0.072
-71	0.029	-25	0.717	19	0.826	65	0.064
-70	0.034	-24	0.736	20	0.809	66	0.057
-69	0.039	-23	0.755	21	0.792	67	0.051
-68	0.045	-22	0.774	22	0.774	68	0.045
-67	0.051	-21	0.792	23	0.755	69	0.039
-66	0.057	-20	0.809	24	0.736	70	0.034
-65	0.064	-19	0.826	25	0.717	71	0.029
-64	0.072	-18	0.843	26	0.697	72	0.025
-63	0.080	-17	0.859	27	0.677	73	0.021
-62	0.089	-16	0.874	28	0.657	74	0.018
-61	0.098	-15	0.888	29	0.637	75	0.015
-60	0.108	-14	0.902	30	0.616	76	0.012
-59	0.118	-13	0.915	31	0.595	77	0.010
-58	0.129	-12	0.927	32	0.575	78	0.008
-57	0.140	-11	0.939	33	0.554	79	0.006
-56	0.152	-10	0.949	34	0.533	80	0.005
-55	0.165	-9	0.959	35	0.513	81	0.003
-54	0.178	-8	0.967	36	0.492	82	0.002
-53	0.191	-7	0.975	37	0.472	83	0.002
-52	0.205	-6	0.981	38	0.452	84	0.001
-51	0.220	-5	0.987	39	0.432	85	0.001
-50	0.235	-4	0.992	40	0.412	86	0.000
-49	0.251	-3	0.995	41	0.393	87	0.000
-48	0.267	-2	0.998	42	0.374	88	0.000
-47	0.284	-1	0.999	43	0.355	89	0.000
-46	0.301	0	1.000	44	0.337	90	0.000
-45	0.319			45	0.319		

S.O. 27795 Figure 4

VALIDATION OF TOTAL POWER GAIN CALCULATION

WBPR Worcester, MA

MODEL 6810-2R-SS-DA

Elevation Gain of Antenna 0.7

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

H RMS 0.631 V RMS 0.631 H/V Ratio 1.000

Elevation Gain of Horizontal Component 0.700

Elevation Gain of Vertical Component 0.700

Horizontal Azimuth Gain equals $1/(RMS)^2$. 2.512

Vertical Azimuth Gain equals $1/(RMS/Max\ Vert)^2$. 2.462

Max. Vertical 0.99

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

Total Horizontal Power Gain = **1.758**

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

Total Vertical Power Gain = **1.723**

==

ERP divided by Horizontal Power Gain equals Antenna Input Power

0.37 kW ERP Times H Gain 1.758 equals 0.21 kW H Antenna Input Power

Antenna Input Power times Vertical Power Gain equals Vertical ERP

0.21 kW Times V Gain 1.723 equals 0.36 kW V ERP

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

(0.99)^2 Times 0.37 Equals 0.36 kW Vertical ERP

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