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S.O. 30151

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

for

State of Wisconsin – Educational Communications Board

WHSF 89.9 MHz Rhinelander, WI

OBJECTIVE:

The objective of this test was to demonstrate the directional characteristics of a 6810-3D-SS(0.5)-DA to meet the needs of WHSF and to comply with the requirements of the FCC construction permit, file number BMPED-20110407ABP. 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 BMPED-20110407ABP indicates that the Horizontal radiation component shall not exceed 16.5 kW at any azimuth and is restricted to the following values at the azimuths specified:

60 Degrees T: 0.770 kW

From Figure 1A, the maximum radiation of the Horizontal component occurs at 224 Degrees T to 285 Degrees T. At the restricted azimuth of 60 Degrees T the Horizontal component is 14.29 dB down from the maximum of 16.5 kW, or 0.615 kW.

The R.M.S. of the Horizontal component is 0.674. The total Horizontal power gain is 2.260. The R.M.S. of the Vertical component is 0.663. The total Vertical power gain is 2.215. See Figure 4 for calculations. The R.M.S. of the FCC composite pattern is 0.826. The R.M.S. of the measured composite pattern is 0.708. Eighty-five percent (85%) of the original authorized FCC composite pattern is 0.702. Therefore this pattern complies with the FCC requirement of 73.316(c)(2)(ix)(A).

METHOD OF DIRECTIONALIZATION:

One bay of the 6810-3D-SS(0.5)-DA was mounted on a tower of precise scale to the 7 ft. face tower at the WHSF 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 BMPED-20110407ABP, a single level of the 6810-3D-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 an Associate Member of the AFCCE and a Senior Member of IEEE.

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WHSF

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

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 404.55 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 30151
October 12, 2012

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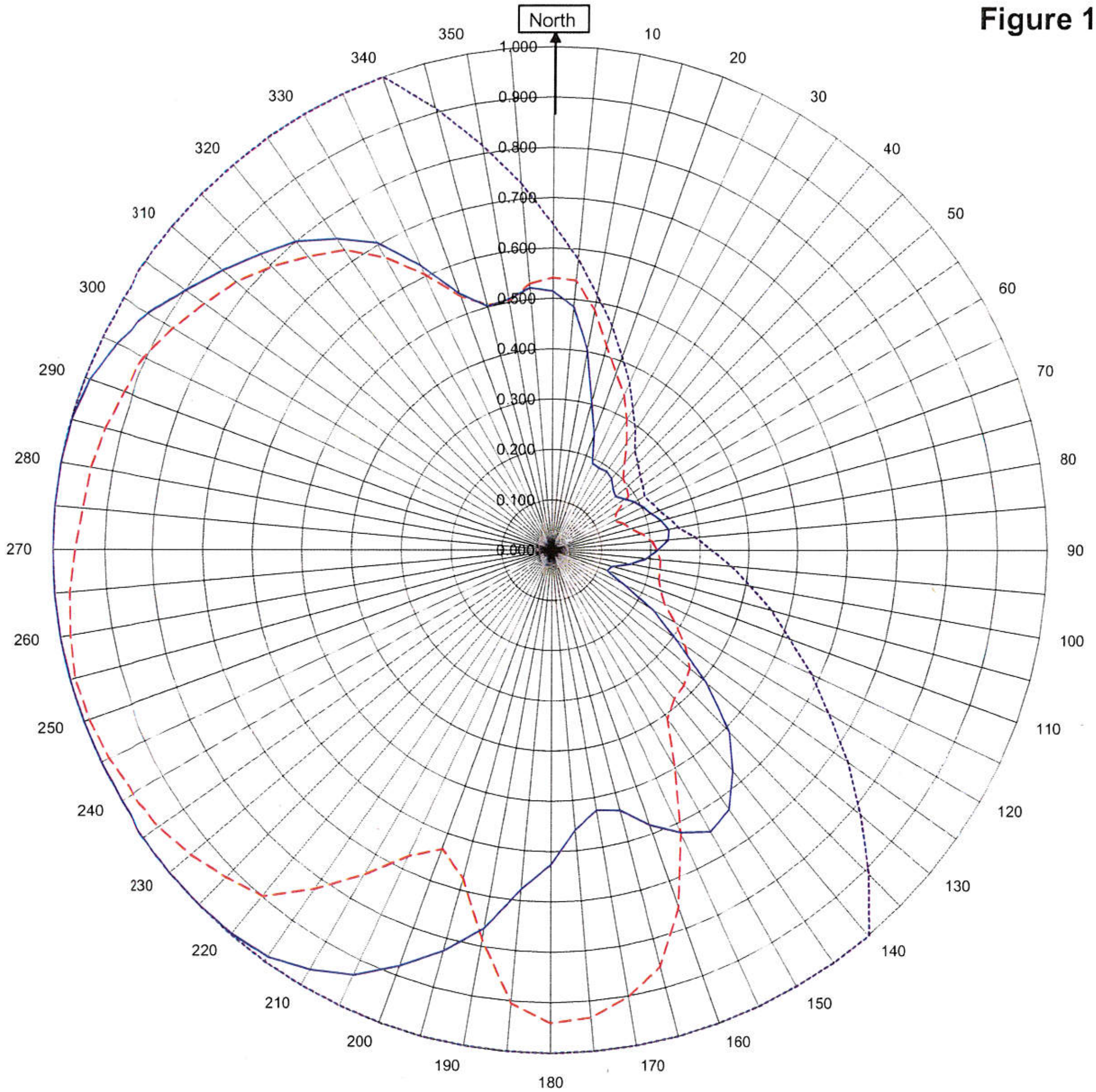
Figure 1A



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Horizontal RMS	0.674
Vertical RMS	0.663
H/V Composite RMS	0.708
...............FCC Composite RMS	0.826

Frequency	89.9 / 404.55 mHz
Plot	Relative Field
Scale	4.5 : 1
	See Figure 2 for Mechanical Details

Antenna Model	6810-3D-SS(0.5)-DA
Pattern Type	Directional Azimuth

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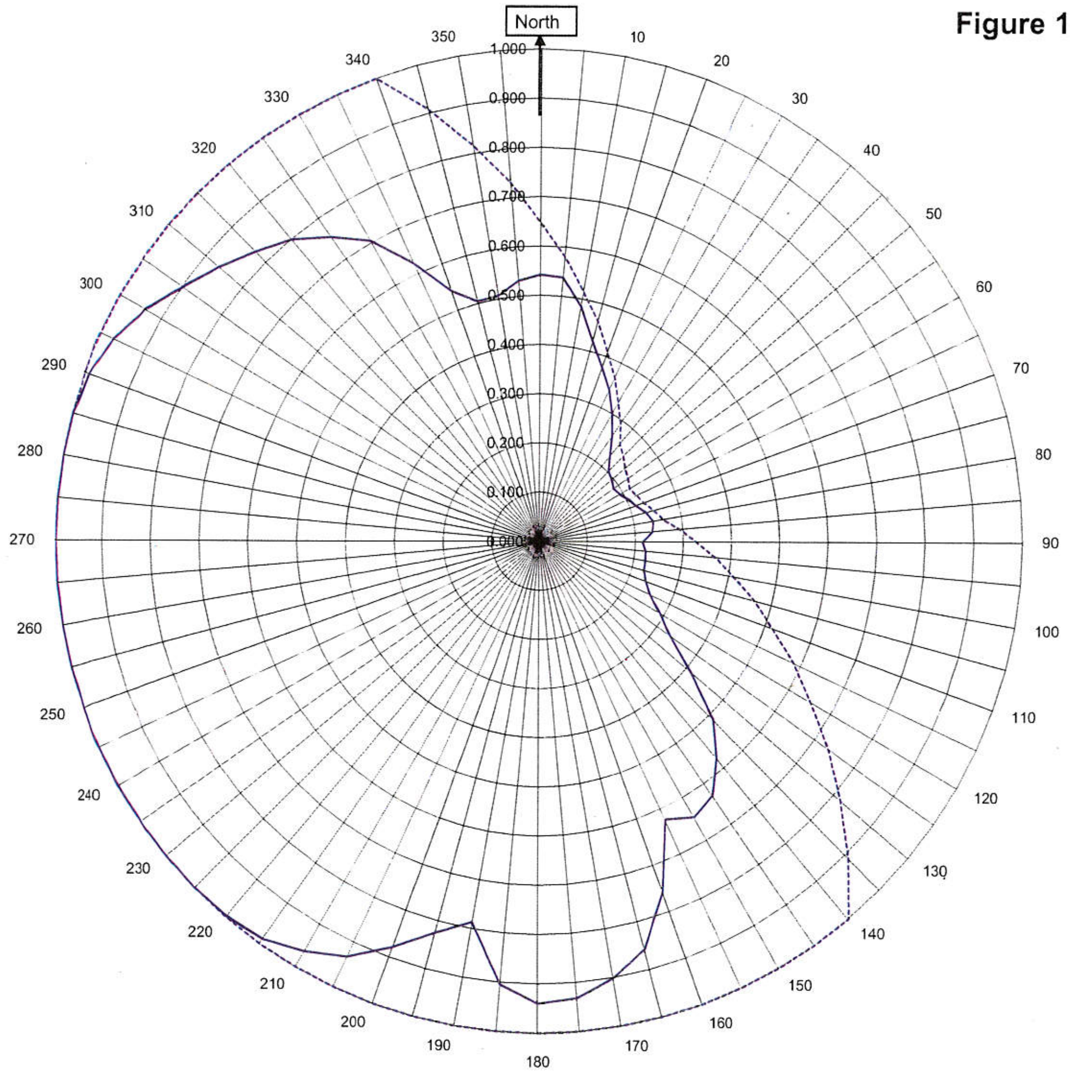
Figure 1B



WHSF Rhinelander, WI

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October 12, 2012

____________H/VComposite RMS	0.708
..............FCC Composite RMS	0.826

Frequency	89.9 / 404.55 mHz
Plot	Relative Field
Scale	4.5 : 1
	See Figure 2 for Mechanical Details

Antenna Model	6810-3D-SS(0.5)-DA
Pattern Type	Directional H/V Composite

Figure 1C

Tabulation of Horizontal Azimuth Pattern
WHSF Rhinelander, WI

Azimuth	Rel Field	Azimuth	Rel Field
0	0.515	180	0.626
10	0.404	190	0.764
20	0.246	200	0.879
30	0.189	210	0.964
40	0.186	220	0.998
45	0.173	225	1.000
50	0.167	230	1.000
60	0.193	240	1.000
70	0.214	250	1.000
80	0.240	260	1.000
90	0.213	270	1.000
100	0.159	280	1.000
110	0.118	290	0.990
120	0.236	300	0.940
130	0.409	310	0.865
135	0.510	315	0.832
140	0.573	320	0.800
150	0.646	330	0.705
160	0.582	340	0.542
170	0.525	350	0.507

Figure 1D

Tabulation of Vertical Azimuth Pattern
WHSF Rhinelander, WI

Azimuth	Rel Field	Azimuth	Rel Field
0	0.542	180	0.940
10	0.485	190	0.787
20	0.376	200	0.633
30	0.300	210	0.745
40	0.226	220	0.900
45	0.202	225	0.922
50	0.196	230	0.945
60	0.151	240	0.972
70	0.155	250	0.989
80	0.186	260	0.981
90	0.214	270	0.957
100	0.223	280	0.942
110	0.235	290	0.920
120	0.289	300	0.882
130	0.365	310	0.830
135	0.380	315	0.797
140	0.387	320	0.762
150	0.501	330	0.672
160	0.756	340	0.537
170	0.901	350	0.503

Figure 1E

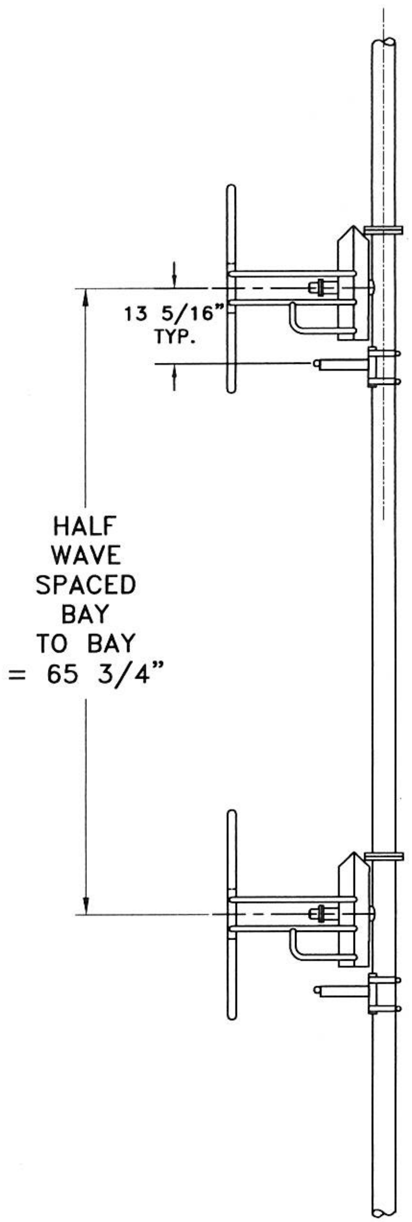
Tabulation of Composite Azimuth Pattern
WHSF Rhinelander, WI

Azimuth	Rel Field	Azimuth	Rel Field
0	0.542	180	0.940
10	0.485	190	0.787
20	0.376	200	0.879
30	0.300	210	0.964
40	0.226	220	0.998
45	0.202	225	1.000
50	0.196	230	1.000
60	0.193	240	1.000
70	0.214	250	1.000
80	0.240	260	1.000
90	0.214	270	1.000
100	0.223	280	1.000
110	0.235	290	0.990
120	0.289	300	0.940
130	0.409	310	0.865
135	0.510	315	0.832
140	0.573	320	0.800
150	0.646	330	0.705
160	0.756	340	0.542
170	0.901	350	0.507

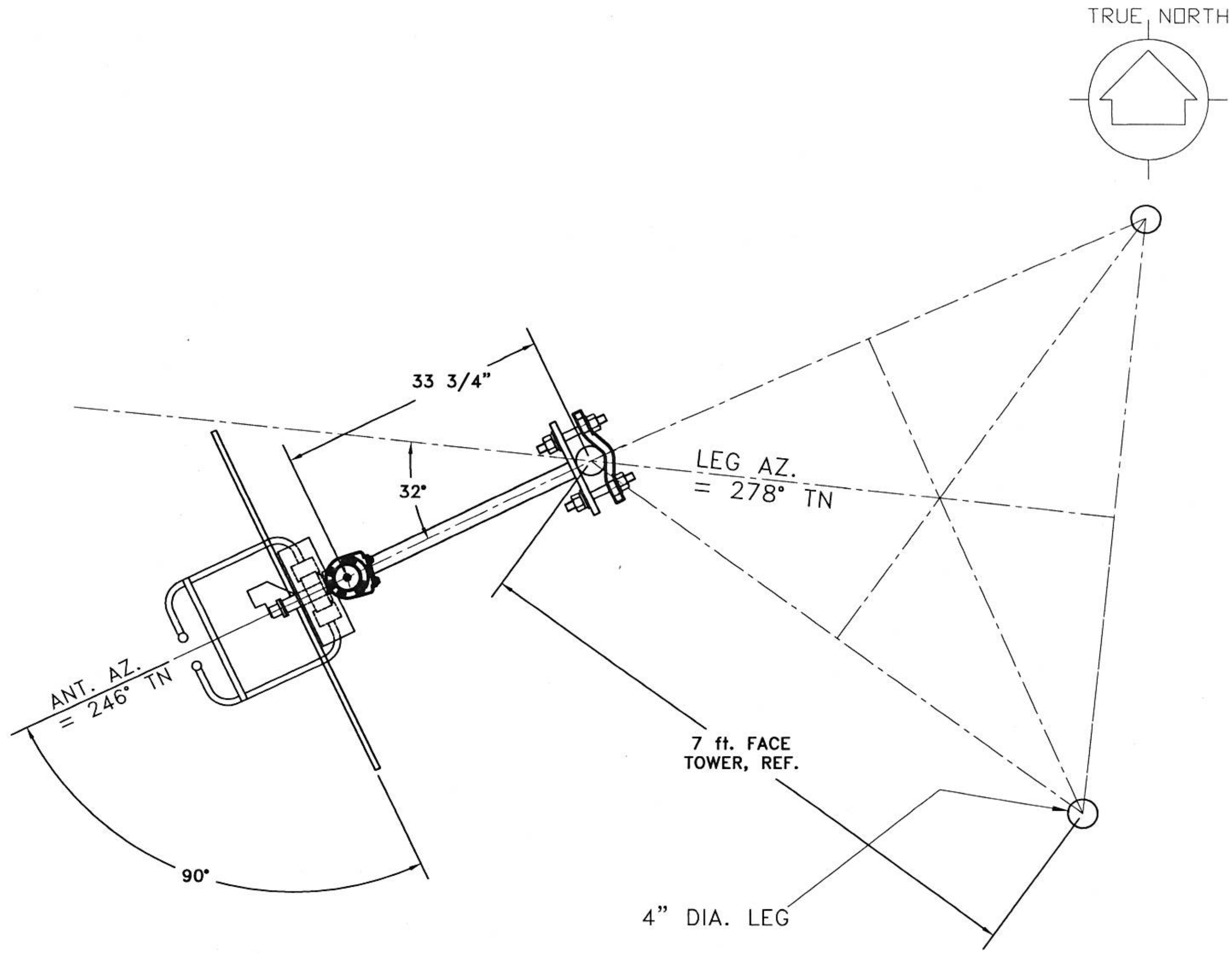
Figure 1F

Tabulation of FCC Directional Composite
WHSF Rhinelander, WI

Azimuth	Rel Field	Azimuth	Rel Field
0	0.648	180	1.000
10	0.515	190	1.000
20	0.409	200	1.000
30	0.325	210	1.000
40	0.259	220	1.000
50	0.232	230	1.000
60	0.215	240	1.000
70	0.231	250	1.000
80	0.261	260	1.000
90	0.325	270	1.000
100	0.409	280	1.000
110	0.514	290	1.000
120	0.648	300	1.000
130	0.815	310	1.000
140	1.000	320	1.000
150	1.000	330	1.000
160	1.000	340	1.000
170	1.000	350	0.816



SIDE VIEW



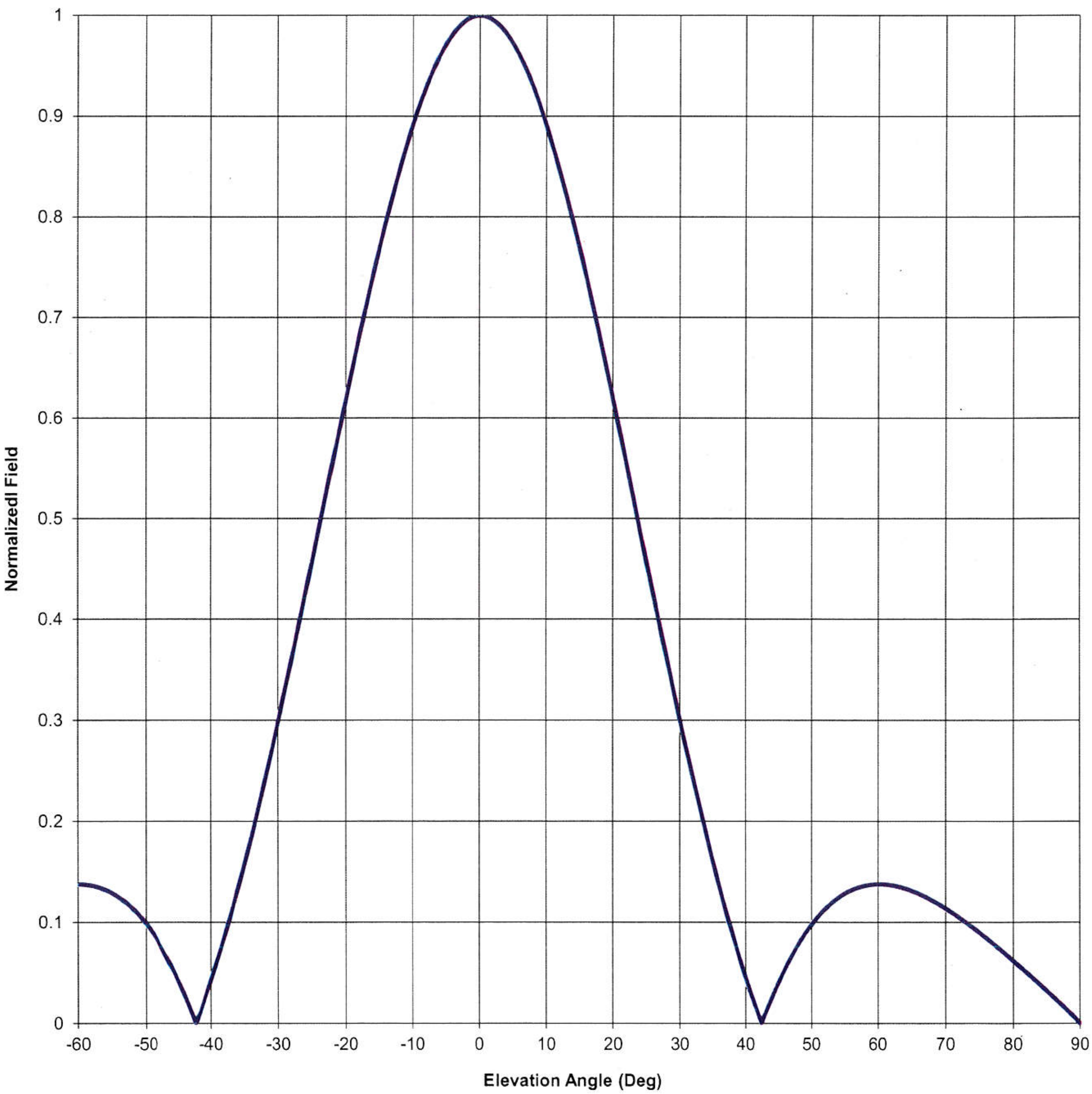
ANTENNA HEADING 246° TRUE NORTH

SHIVELY LABS A DIVISION OF HOWELL LABORATORIES INC., BRIDGTON, MAINE			
SHOP ORDER: 30151	FREQUENCY: 89.9	SCALE: N.T.S.	DRAWN BY: ASP APPROVED BY: DAB
TITLE: MODEL-6810-3D-SS-DIRECTIONAL ANTENNA			
DATE: 10-4-12	FIGURE 2		

Antenna Mfg.: Shively Labs
Antenna Type: 6810-3D-SS(0.5)-DA
Station: WHSF
Frequency: 89.9
Channel #: 210
Figure: Figure 3

Date: 10/12/2012

Beam Tilt	0	
Gain (Max)	2.260	3.541 dB
Gain (Horizon)	2.260	3.541 dB



Antenna Mfg.: Shively Labs **Date:** 10/12/2012
Antenna Type: 6810-3D-SS(0.5)-DA
Station: WHSF **Beam Tilt** 0
Frequency: 89.9 **Gain (Max)** 2.260 3.541 dB
Channel #: 210 **Gain (Horizon)** 2.260 3.541 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	0.027	0	1.000	46	0.056
-89	0.007	-43	0.012	1	0.999	47	0.068
-88	0.013	-42	0.006	2	0.995	48	0.079
-87	0.020	-41	0.024	3	0.990	49	0.089
-86	0.026	-40	0.043	4	0.982	50	0.098
-85	0.032	-39	0.064	5	0.972	51	0.106
-84	0.038	-38	0.086	6	0.960	52	0.113
-83	0.044	-37	0.109	7	0.946	53	0.119
-82	0.050	-36	0.133	8	0.930	54	0.124
-81	0.056	-35	0.159	9	0.912	55	0.129
-80	0.062	-34	0.185	10	0.892	56	0.132
-79	0.067	-33	0.212	11	0.870	57	0.134
-78	0.073	-32	0.240	12	0.847	58	0.136
-77	0.079	-31	0.269	13	0.823	59	0.137
-76	0.084	-30	0.299	14	0.797	60	0.138
-75	0.089	-29	0.330	15	0.769	61	0.137
-74	0.095	-28	0.361	16	0.741	62	0.136
-73	0.100	-27	0.393	17	0.712	63	0.135
-72	0.104	-26	0.425	18	0.681	64	0.133
-71	0.109	-25	0.457	19	0.650	65	0.131
-70	0.113	-24	0.489	20	0.619	66	0.128
-69	0.117	-23	0.522	21	0.587	67	0.125
-68	0.121	-22	0.555	22	0.555	68	0.121
-67	0.125	-21	0.587	23	0.522	69	0.117
-66	0.128	-20	0.619	24	0.489	70	0.113
-65	0.131	-19	0.650	25	0.457	71	0.109
-64	0.133	-18	0.681	26	0.425	72	0.104
-63	0.135	-17	0.712	27	0.393	73	0.100
-62	0.136	-16	0.741	28	0.361	74	0.095
-61	0.137	-15	0.769	29	0.330	75	0.089
-60	0.138	-14	0.797	30	0.299	76	0.084
-59	0.137	-13	0.823	31	0.269	77	0.079
-58	0.136	-12	0.847	32	0.240	78	0.073
-57	0.134	-11	0.870	33	0.212	79	0.067
-56	0.132	-10	0.892	34	0.185	80	0.062
-55	0.129	-9	0.912	35	0.159	81	0.056
-54	0.124	-8	0.930	36	0.133	82	0.050
-53	0.119	-7	0.946	37	0.109	83	0.044
-52	0.113	-6	0.960	38	0.086	84	0.038
-51	0.106	-5	0.972	39	0.064	85	0.032
-50	0.098	-4	0.982	40	0.043	86	0.026
-49	0.089	-3	0.990	41	0.024	87	0.020
-48	0.079	-2	0.995	42	0.006	88	0.013
-47	0.068	-1	0.999	43	0.012	89	0.007
-46	0.056	0	1.000	44	0.027	90	0.000
-45	0.042			45	0.042		

S.O. 30151 Figure 4

VALIDATION OF TOTAL POWER GAIN CALCULATION

WHSF RHINEELANDER, WI.

MODEL 6810-3D-SS(0.5)-DA

Elevation Gain of Antenna 1.01

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

H RMS 0.673942 V RMS 0.663259 H/V Ratio 1.016

Elevation Gain of Horizontal Component 1.026

Elevation Gain of Vertical Component 0.994

Horizontal Azimuth Gain equals $1/(RMS)^2$. 2.202

Vertical Azimuth Gain equals $1/(RMS/Max Vert)^2$. 2.228
Max. Vertical 0.99

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

Total Horizontal Power Gain = **2.260**

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

Total Vertical Power Gain = **2.215**

===

ERP divided by Horizontal Power Gain equals Antenna Input Power

16.5 kW ERP Divided by H Gain 2.260 equals 7.302 kW H Antenna Input Power

Antenna Input Power times Vertical Power Gain equals Vertical ERP

7.302 kW Times V Gain 2.215 equals 16.172 kW V ERP

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

(0.99)^2 Times 16.50 Equals 16.172 kW Vertical ERP

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