Shively Labs
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S.O. 27880

Report of Test 6810-3D-SS-DA

for

MAYNARD SCHOOL COMMITTEE

WAVM 91.7 MHz Maynard, MA

OBJECTIVE:

The objective of this test was to demonstrate the directional characteristics of a 6810-3D-SS-DA to meet the needs of WAVM and to comply with the requirements of the FCC construction permit, file number BPED-19990726MA.

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-19990726MA indicates that the Horizontal radiation component shall not exceed 0.5 kW at any azimuth and is restricted to the following values at the azimuths specified:

320 Degrees T: 0.036 kW

From Figure 1A, the maximum radiation of the Horizontal component occurs at 085 Degrees T to 146 Degrees T. At the restricted azimuth of 320 Degrees T the Vertical component is 12.04 dB down from the maximum of 0.5 kW, or 0.031 kW.

The R.M.S. of the Horizontal component is 0.767. The total Horizontal power gain is 1.843. The R.M.S. of the Vertical component is 0.723. The total Vertical power gain is 1.806. See Figure 4 for calculations. The R.M.S. of the FCC composite pattern is 0.810. The R.M.S. of the measured composite pattern is 0.768. Eighty-five percent (85%) of the original authorized FCC composite pattern is 0.689. 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-DA was mounted on a pole of precise scale to the 3" OD pole at the WAVM 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 BPED-19990726MA, a single level of the 6810-3D-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 412.65 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 27880
November 20, 2009

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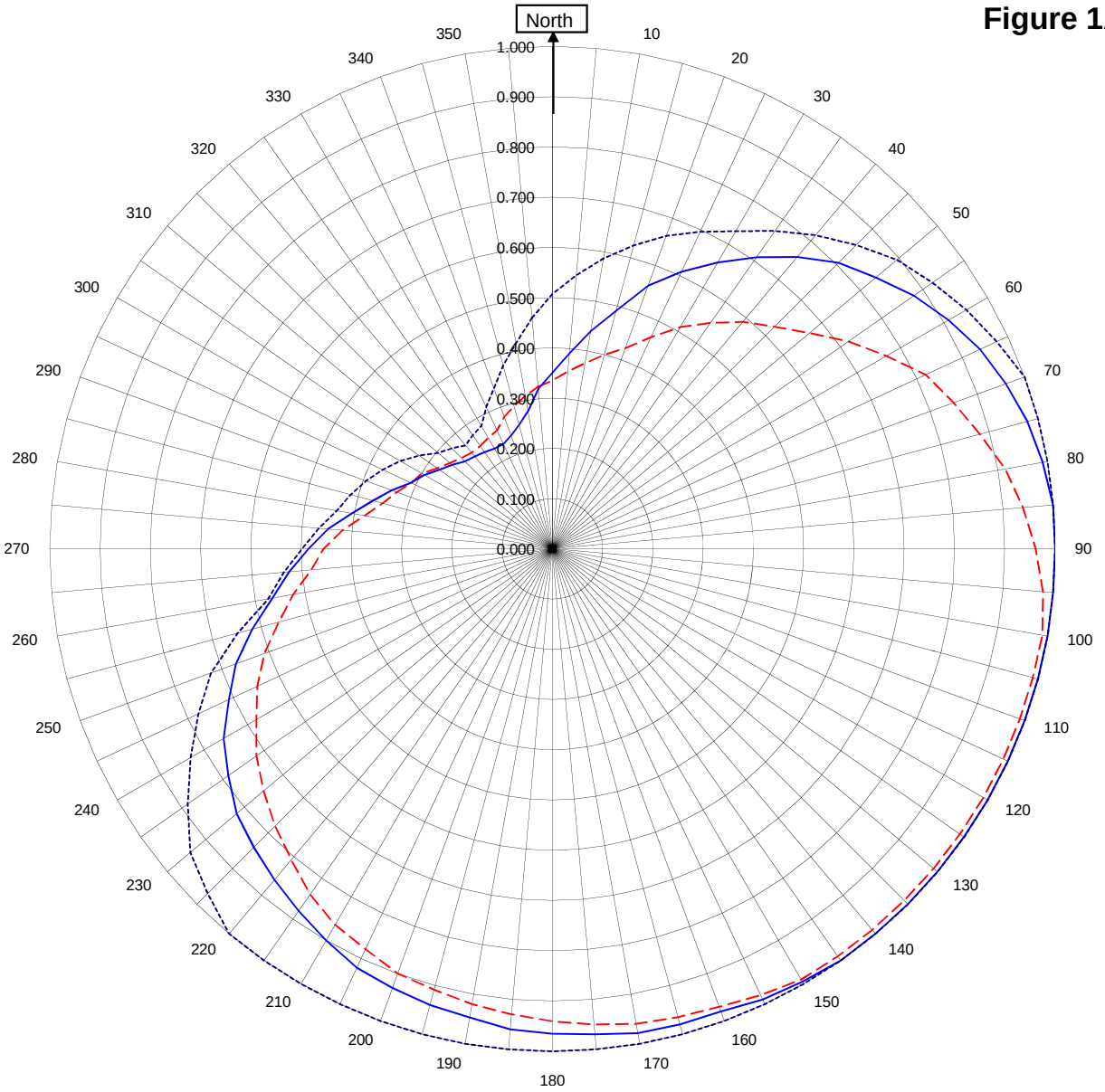
Figure 1A



WAVM Maynard, MA

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November 20, 2009

Horizontal RMS	0.767
Vertical RMS	0.723
H/V Composite RMS	0.768
FCC Composite RMS	0.810

Frequency	91.7 / 412.65 mHz
Plot	Relative Field
Scale	4.5 : 1
	See Figure 2 for Mechanical Details

Antenna Model	6810-3D-SS-DA Patt 03A
Pattern Type	Directional Azimuth

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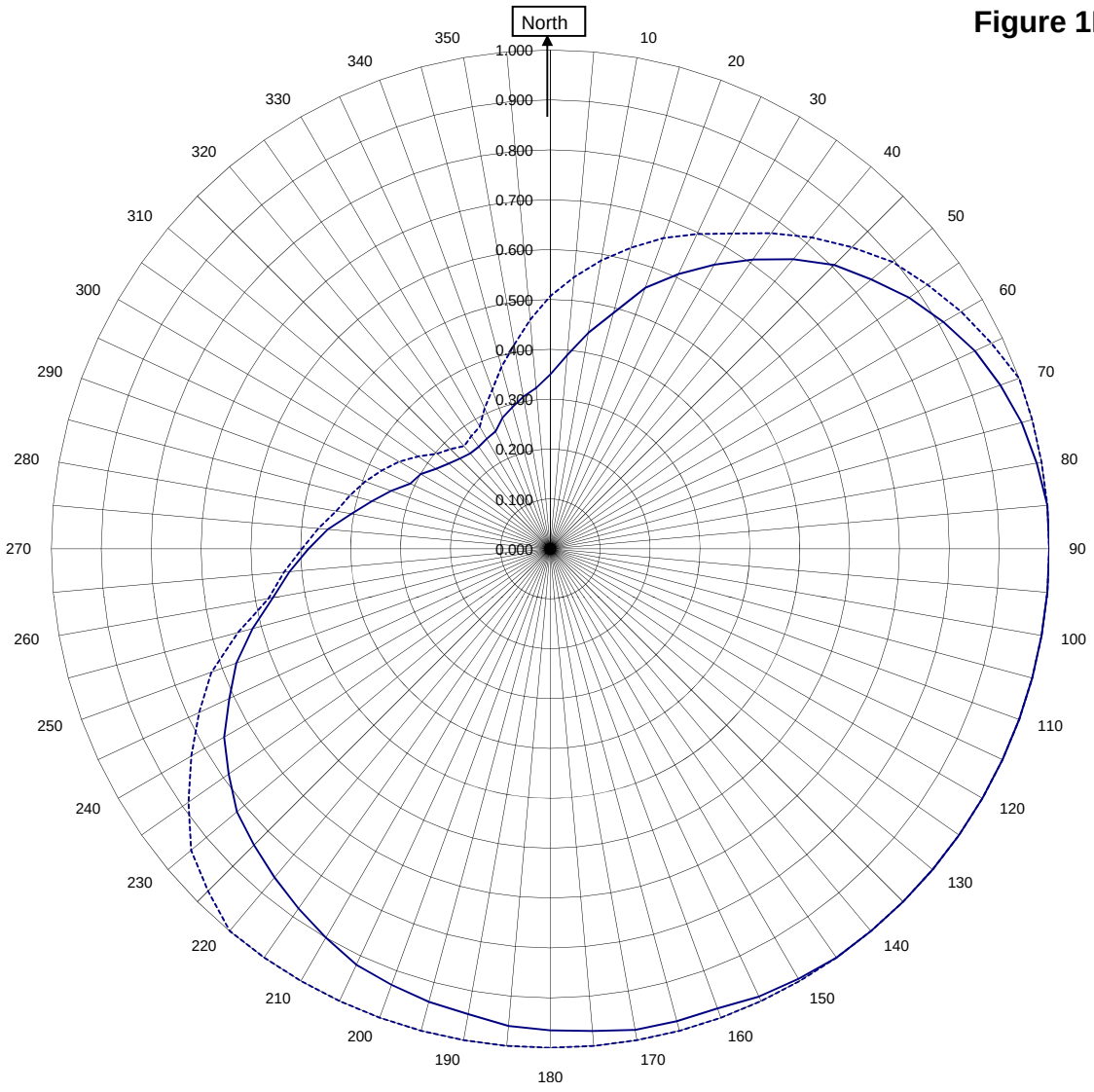
Figure 1B



WAVM Maynard, MA

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November 20, 2009

_____H/VComposite RMS	0.768
……..FCC Composite RMS	0.810

Frequency	91.7 / 412.65 mHz
Plot	Relative Field
Scale	4.5 : 1
	See Figure 2 for Mechanical Details

Antenna Model	6810-3D-SS-DA Patt 03A
Pattern Type	Directional H/V Composite

Figure 1C

Tabulation of Horizontal Azimuth Pattern
WAVM Maynard, MA

Azimuth	Rel Field	Azimuth	Rel Field
0	0.350	180	0.965
10	0.440	190	0.947
20	0.557	200	0.930
30	0.658	210	0.900
40	0.758	220	0.860
45	0.805	225	0.840
50	0.840	230	0.820
60	0.910	240	0.755
70	0.960	250	0.670
80	0.990	260	0.565
90	1.000	270	0.485
100	1.000	280	0.405
110	1.000	290	0.340
120	1.000	300	0.294
130	1.000	310	0.260
135	1.000	315	0.246
140	1.000	320	0.240
150	0.995	330	0.230
160	0.980	340	0.240
170	0.979	350	0.278

Figure 1D

Tabulation of Vertical Azimuth Pattern
WAVM Maynard, MA

Azimuth	Rel Field	Azimuth	Rel Field
0	0.335	180	0.940
10	0.375	190	0.920
20	0.425	200	0.899
30	0.510	210	0.864
40	0.590	220	0.808
45	0.625	225	0.780
50	0.668	230	0.750
60	0.768	240	0.680
70	0.850	250	0.610
80	0.915	260	0.524
90	0.962	270	0.455
100	0.990	280	0.380
110	0.990	290	0.330
120	0.990	300	0.300
130	0.990	310	0.266
135	0.990	315	0.256
140	0.990	320	0.250
150	0.990	330	0.255
160	0.970	340	0.280
170	0.960	350	0.310

Figure 1E

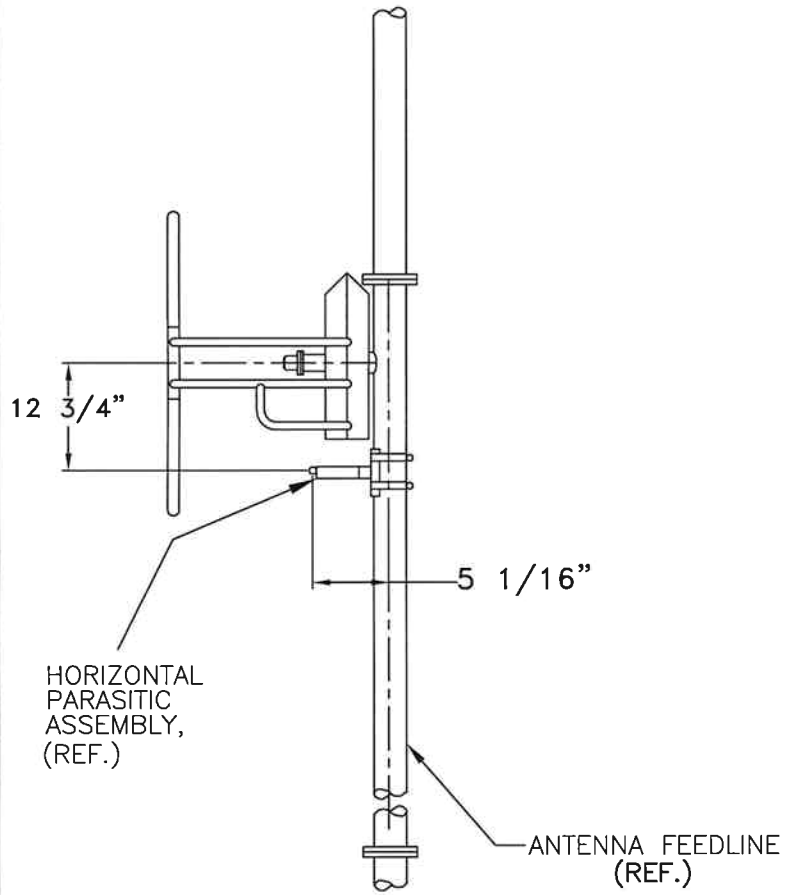
Tabulation of Composite Azimuth Pattern
WAVM Maynard, MA

Azimuth	Rel Field	Azimuth	Rel Field
0	0.350	180	0.965
10	0.440	190	0.947
20	0.557	200	0.930
30	0.658	210	0.900
40	0.758	220	0.860
45	0.805	225	0.840
50	0.840	230	0.820
60	0.910	240	0.755
70	0.960	250	0.670
80	0.990	260	0.565
90	1.000	270	0.485
100	1.000	280	0.405
110	1.000	290	0.340
120	1.000	300	0.300
130	1.000	310	0.266
135	1.000	315	0.256
140	1.000	320	0.250
150	0.995	330	0.255
160	0.980	340	0.280
170	0.979	350	0.310

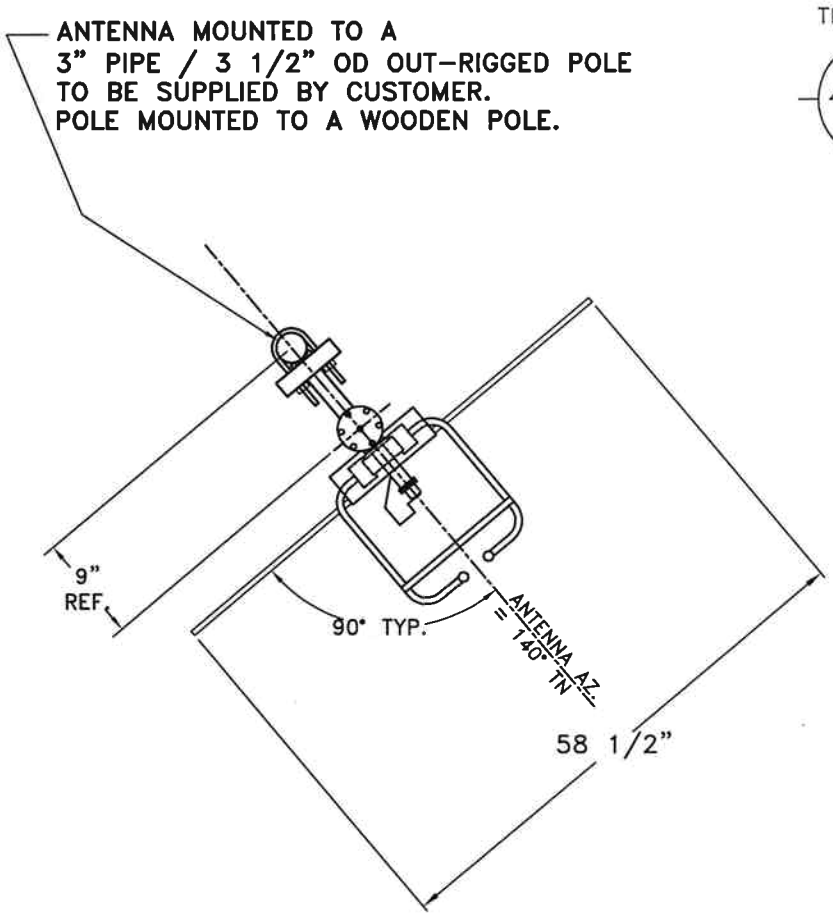
Figure 1F

Tabulation of FCC Directional Composite
WAVM Maynard, MA

Azimuth	Rel Field	Azimuth	Rel Field
0	0.507	180	1.000
10	0.587	190	1.000
20	0.663	200	1.000
30	0.730	210	1.000
40	0.815	220	1.000
50	0.895	230	0.940
60	0.951	240	0.831
70	1.000	250	0.723
80	1.000	260	0.574
90	1.000	270	0.498
100	1.000	280	0.436
110	1.000	290	0.395
120	1.000	300	0.350
130	1.000	310	0.297
140	1.000	320	0.269
150	1.000	330	0.283
160	1.000	340	0.340
170	1.000	350	0.416



SIDE VIEW



TOP VIEW

TOWER: 3" PIPE ATTACHED TO WOODEN POLE

ANTENNA HEADING 140° TRUE NORTH

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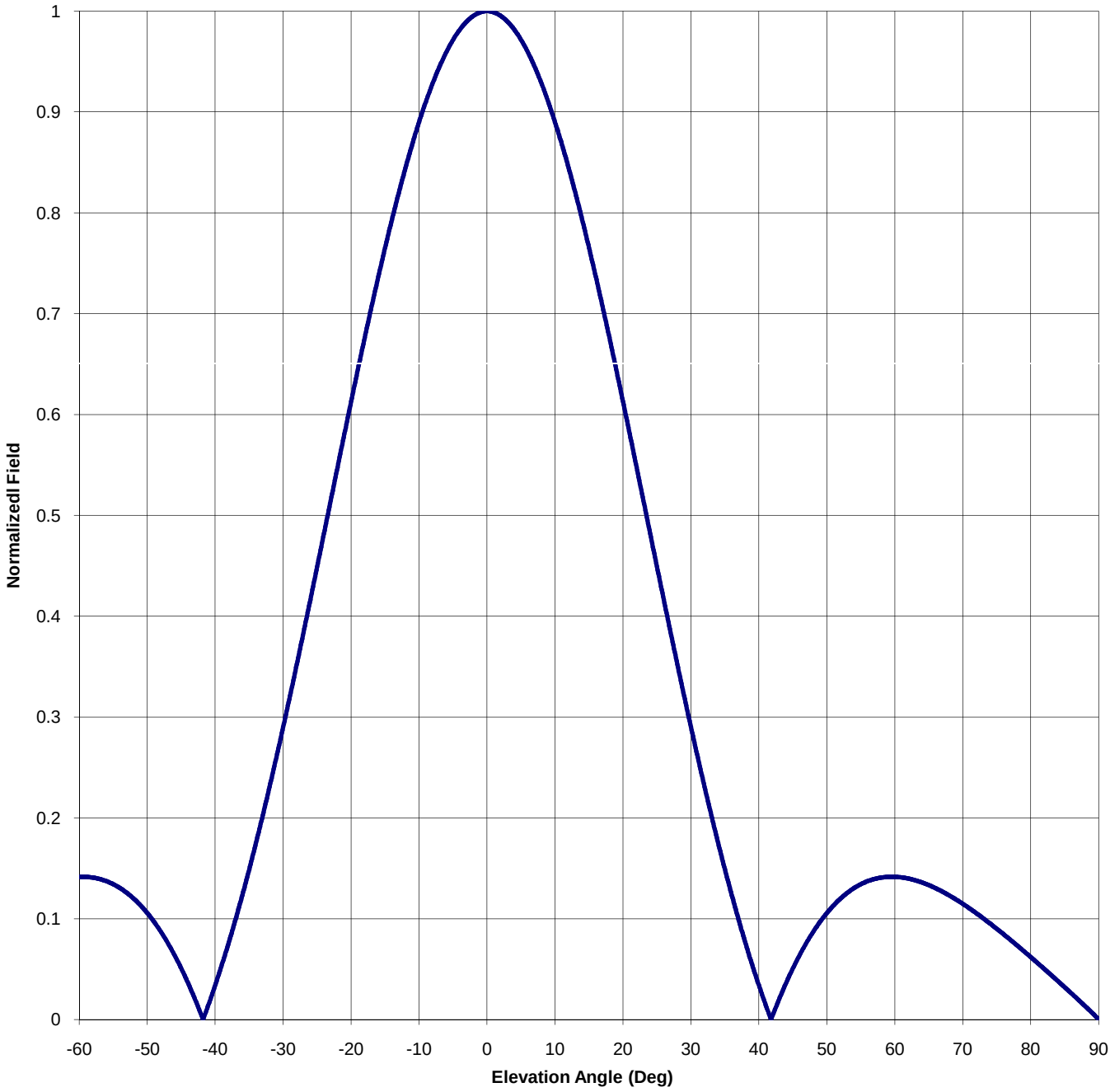
SHOP ORDER: 27880	FREQUENCY: 91.7 MHz.	SCALE: N.T.S.	DRAWN BY: ASP APPROVED BY: DAB
TITLE: MODEL-6810-3D-SS-DIRECTIONAL ANTENNA			
DATE: 11/20/09	FIGURE 2		

Antenna Mfg.:	**Shively Labs**			**Date: 11/20/2009**
Antenna Type:	**6810-3D-SS-DA**			
Station:	**WAVM**	**Beam Tilt**	**0**	
Frequency:	**91.7**	**Gain (Max)**	**1.843**	**2.654 dB**
Channel #:	**219**	**Gain (Horizon)**	**1.843**	**2.654 dB**
Figure:	**3**			



Antenna Mfg.: Shively Labs
Antenna Type: 6810-3D-SS-DA
Station: WAVM
Frequency: 91.7
Channel #: 219
Figure: 3

Beam Tilt 0
Gain (Max) 1.843 **2.654 dB**
Gain (Horizon) 1.843 **2.654 dB**

Date: 11/20/2009

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	0.021	1	0.999	47	0.076
-88	0.013	-42	0.004	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	0.106
-85	0.032	-39	0.055	5	0.972	51	0.113
-84	0.038	-38	0.076	6	0.959	52	0.120
-83	0.044	-37	0.099	7	0.945	53	0.126
-82	0.050	-36	0.124	8	0.928	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	0.142
-76	0.085	-30	0.290	14	0.793	60	0.142
-75	0.090	-29	0.321	15	0.765	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	0.416	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	0.580	67	0.127
-68	0.123	-22	0.548	22	0.548	68	0.123
-67	0.127	-21	0.580	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	0.416	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	0.765	29	0.321	75	0.090
-60	0.142	-14	0.793	30	0.290	76	0.085
-59	0.142	-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	0.928	36	0.124	82	0.050
-53	0.126	-7	0.945	37	0.099	83	0.044
-52	0.120	-6	0.959	38	0.076	84	0.038
-51	0.113	-5	0.972	39	0.055	85	0.032
-50	0.106	-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	0.004	88	0.013
-47	0.076	-1	0.999	43	0.021	89	0.007
-46	0.064	0	1.000	44	0.036	90	0.000
-45	0.051			45	0.051		

S.O. 27880 Figure 4

VALIDATION OF TOTAL POWER GAIN CALCULATION

WAVM 91.7 MHz Maynard, MA

Model 6810-3D-SS-DA

Elevation Gain of Antenna 1.022

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

H RMS 0.767 V RMS 0.723 H/V Ratio 1.061

Elevation Gain of Horizontal Component 1.084

Elevation Gain of Vertical Component 0.963

Horizontal Azimuth Gain equals $1/(RMS)^2$. 1.700

Vertical Azimuth Gain equals $1/(RMS/Max\ Vert)^2$. 1.875

Max. Vertical 0.99

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

Total Horizontal Power Gain = **1.843**

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

Total Vertical Power Gain = **1.806**

==========

ERP divided by Horizontal Power Gain equals Antenna Input Power

0.5 kW ERP Divided by H Gain 1.843 equals 0.27 kW H Antenna Input Power

Antenna Input Power times Vertical Power Gain equals Vertical ERP

0.27 kW Times V Gain 1.806 equals 0.49 kW V ERP

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

(0.99)^2 Times 0.50 Equals 0.49 kW Vertical ERP

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