Shively Labs®
a division of Howell Laboratories,Inc.

P. O. Box 389, 188 Harrison Rd.
Bridgton, Maine 04009 USA
(207) 647-3327
888-SHIVELY
Fax: (207) 647-8273
E-mail: sales@shively.com
Web site: www.shively.com

S.O. 29102

Report of Test 6810-3R-DA

for

WINONA STATE UNIVERSITY

KQAL 89.5 MHz Winona, MN

OBJECTIVE:

The objective of this test was to demonstrate the directional characteristics of a 6810-3R-DA to meet the needs of KQAL and to comply with the requirements of the FCC construction permit, file number BPED-20100427ABH. 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-20100427ABH indicates that the Horizontal radiation component shall not exceed 2.50 kW at any azimuth and is restricted to the following values at the azimuths specified:

60 Degrees T: 0.38 kW
140 Degrees T: 1.45 kW
190 Degrees T: 1.15 kW

From Figure 1A, the maximum radiation of the Horizontal component occurs at 249 Degrees T to 290 Degrees T. At the restricted azimuth of 60 Degrees T the Horizontal component is 9.12 dB down from the maximum of 2.50 kW, or 0.31 kW. At the restricted azimuth of 140 Degrees T the Horizontal component is 3.10 dB down from the maximum of 2.50 kW, or 1.23 kW. At the restricted azimuth of 190 Degrees T the Horizontal component is 3.74 dB down from the maximum of 2.50 kW, or 1.06 kW.

The R.M.S. of the Horizontal component is 0.706. The total Horizontal power gain is 3.358. The R.M.S. of the Vertical component is 0.658. The total Vertical power gain is 3.031. 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 0.710. 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 6810-3R-DA was mounted on a tower of precise scale to the Central-42 tower at the KQAL 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 BPED-20100427ABH, a single level of the 6810-3R-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 402.75 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. All testing is carried out in strict accordance with procedures approved under ISO 9001:2008.

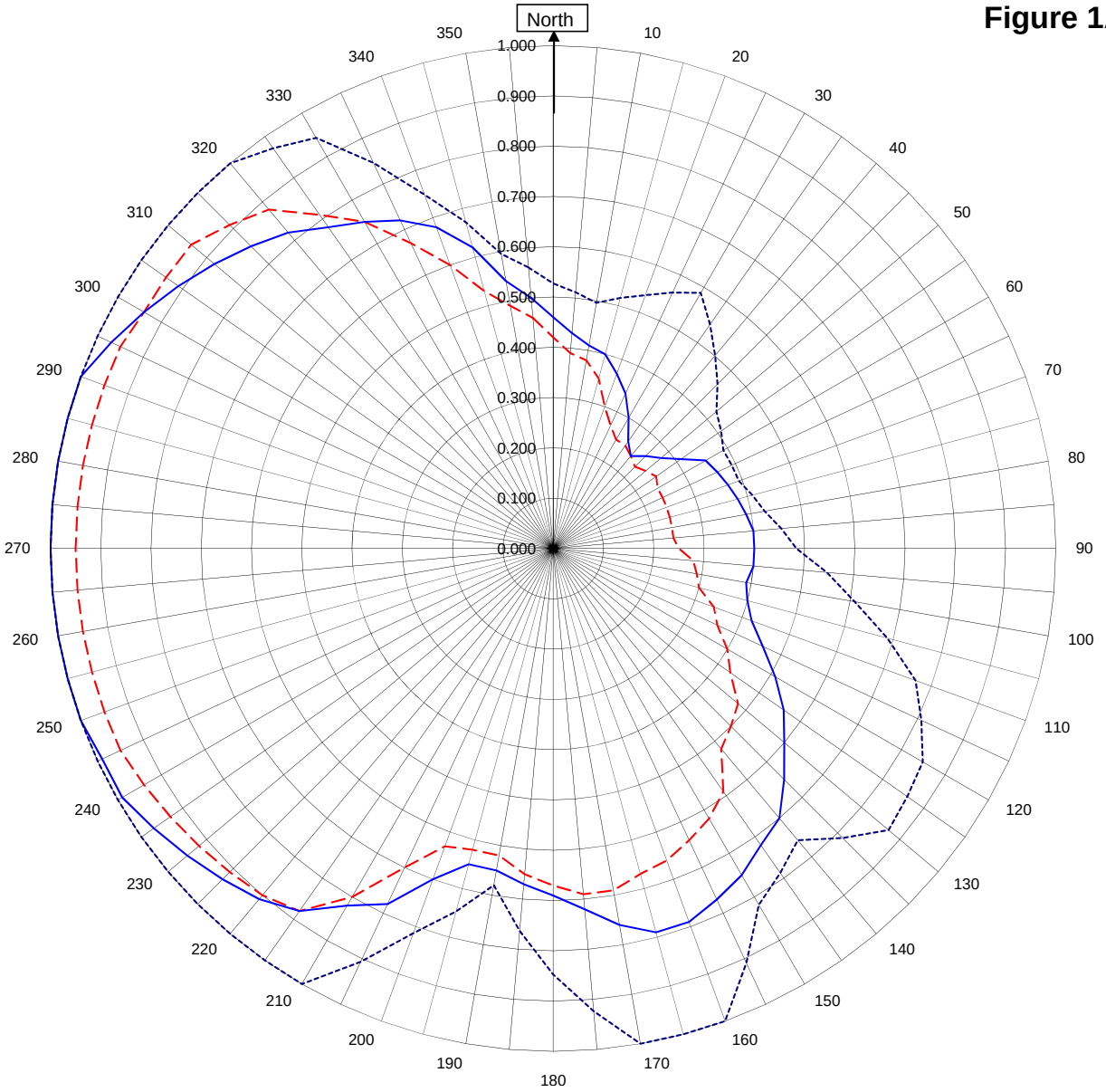
Respectfully submitted by:

Robert A. Surette
Director of Sales Engineering
S/O 29102
June 14, 2011

Shively Labs

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

Figure 1A



KQAL Winona, MN

29102

June 14, 2011

Horizontal RMS	0.706
Vertical RMS	0.658
H/V Composite RMS	0.710
FCC Composite RMS	0.810

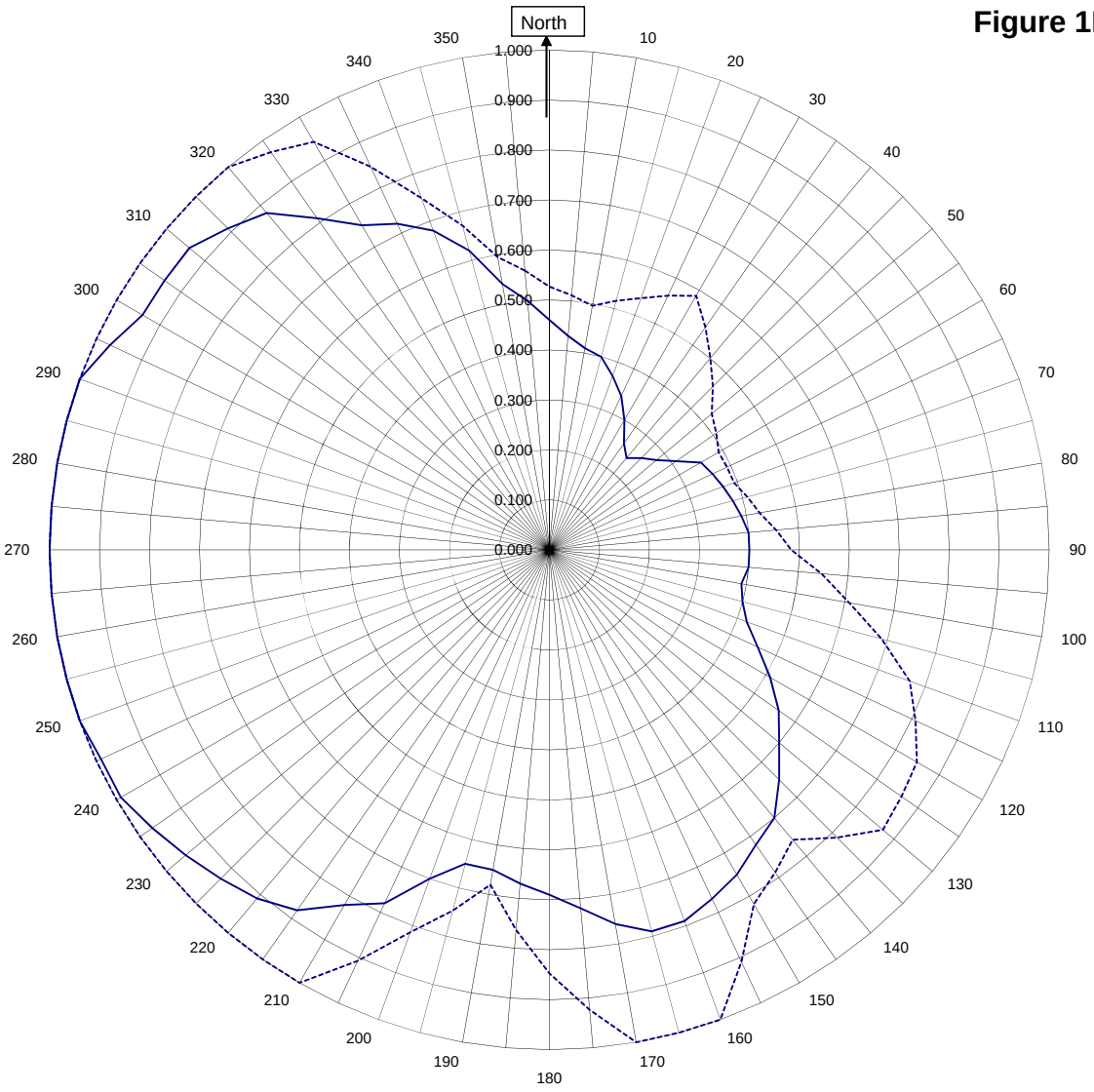
Frequency	89.5 / 402.75 mHz
Plot	Relative Field
Scale	4.5 : 1
	See Figure 2 for Mechanical Details

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

Shively Labs

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

Figure 1B



KQAL Winona, MN

29102

June 14, 2011

_____H/VComposite RMS	0.710
……..FCC Composite RMS	0.810

Frequency	89.5 / 402.75 mHz
Plot	Relative Field
Scale	4.5 : 1
	See Figure 2 for Mechanical Details

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

Figure 1C

Tabulation of Horizontal Azimuth Pattern
KQAL Winona, MN

Azimuth	Rel Field	Azimuth	Rel Field
0	0.460	180	0.690
10	0.410	190	0.650
20	0.370	200	0.700
30	0.300	210	0.820
40	0.240	220	0.910
45	0.260	225	0.930
50	0.280	230	0.950
60	0.350	240	0.990
70	0.370	250	1.000
80	0.390	260	1.000
90	0.400	270	1.000
100	0.390	280	1.000
110	0.420	290	1.000
120	0.510	300	0.940
130	0.600	310	0.880
135	0.650	315	0.850
140	0.700	320	0.820
150	0.750	330	0.750
160	0.790	340	0.680
170	0.760	350	0.540

Additional Azimuths:

156	0.775	327	0.770
173	0.750		

Figure 1D

Tabulation of Vertical Azimuth Pattern
KQAL Winona, MN

Azimuth	Rel Field	Azimuth	Rel Field
0	0.420	180	0.670
10	0.380	190	0.620
20	0.300	200	0.630
30	0.250	210	0.800
40	0.240	220	0.900
45	0.230	225	0.910
50	0.240	230	0.920
60	0.240	240	0.940
70	0.240	250	0.950
80	0.240	260	0.950
90	0.250	270	0.950
100	0.290	280	0.950
110	0.340	290	0.950
120	0.400	300	0.940
130	0.480	310	0.940
135	0.500	315	0.910
140	0.520	320	0.880
150	0.620	330	0.750
160	0.660	340	0.600
170	0.690	350	0.490

Additional Azimuths:

156	0.645	327	0.790
173	0.690		

Figure 1E

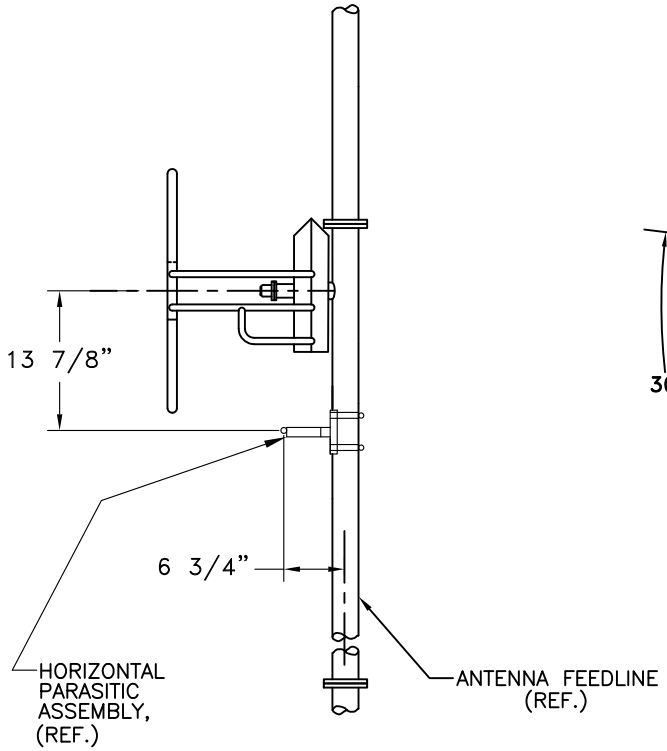
Tabulation of Composite Azimuth Pattern
KQAL Winona, MN

Azimuth	Rel Field	Azimuth	Rel Field
0	0.460	180	0.690
10	0.410	190	0.650
20	0.370	200	0.700
30	0.300	210	0.820
40	0.240	220	0.910
45	0.260	225	0.930
50	0.280	230	0.950
60	0.350	240	0.990
70	0.370	250	1.000
80	0.390	260	1.000
90	0.400	270	1.000
100	0.390	280	1.000
110	0.420	290	1.000
120	0.510	300	0.940
130	0.600	310	0.940
135	0.650	315	0.910
140	0.700	320	0.880
150	0.750	330	0.750
160	0.790	340	0.680
170	0.760	350	0.540

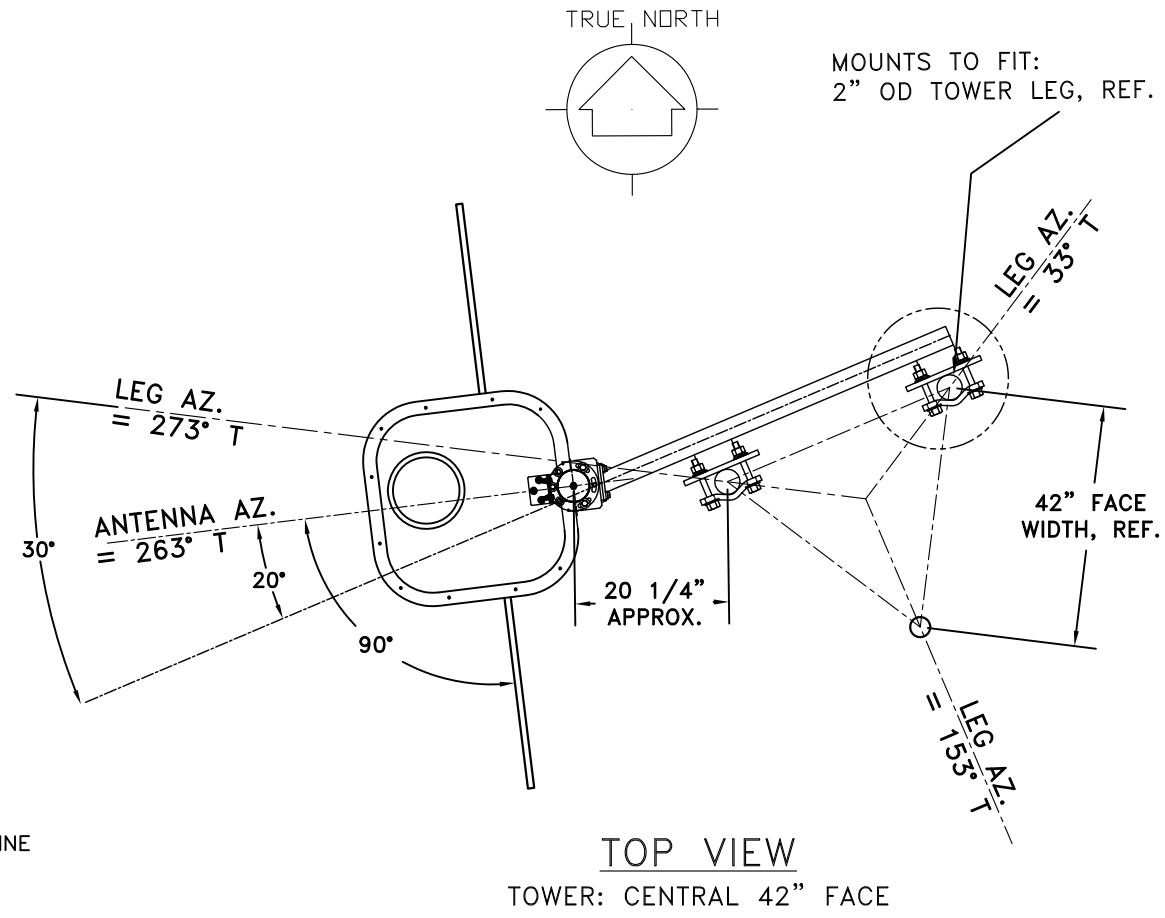
Figure 1F

Tabulation of FCC Directional Composite
KQAL Winona, MN

Azimuth	Rel Field	Azimuth	Rel Field
0	0.527	180	0.847
10	0.496	190	0.680
20	0.536	200	0.814
30	0.587	210	1.000
40	0.501	220	1.000
50	0.424	230	1.000
60	0.391	240	1.000
70	0.393	250	1.000
80	0.427	260	1.000
90	0.484	270	1.000
100	0.609	280	1.000
110	0.767	290	1.000
120	0.849	300	1.000
130	0.871	310	1.000
140	0.757	320	1.000
150	0.818	330	0.943
160	1.000	340	0.749
170	1.000	350	0.595
Additional Azimuths:			
156	1.000	327	1.000
173	1.000		



SIDE VIEW



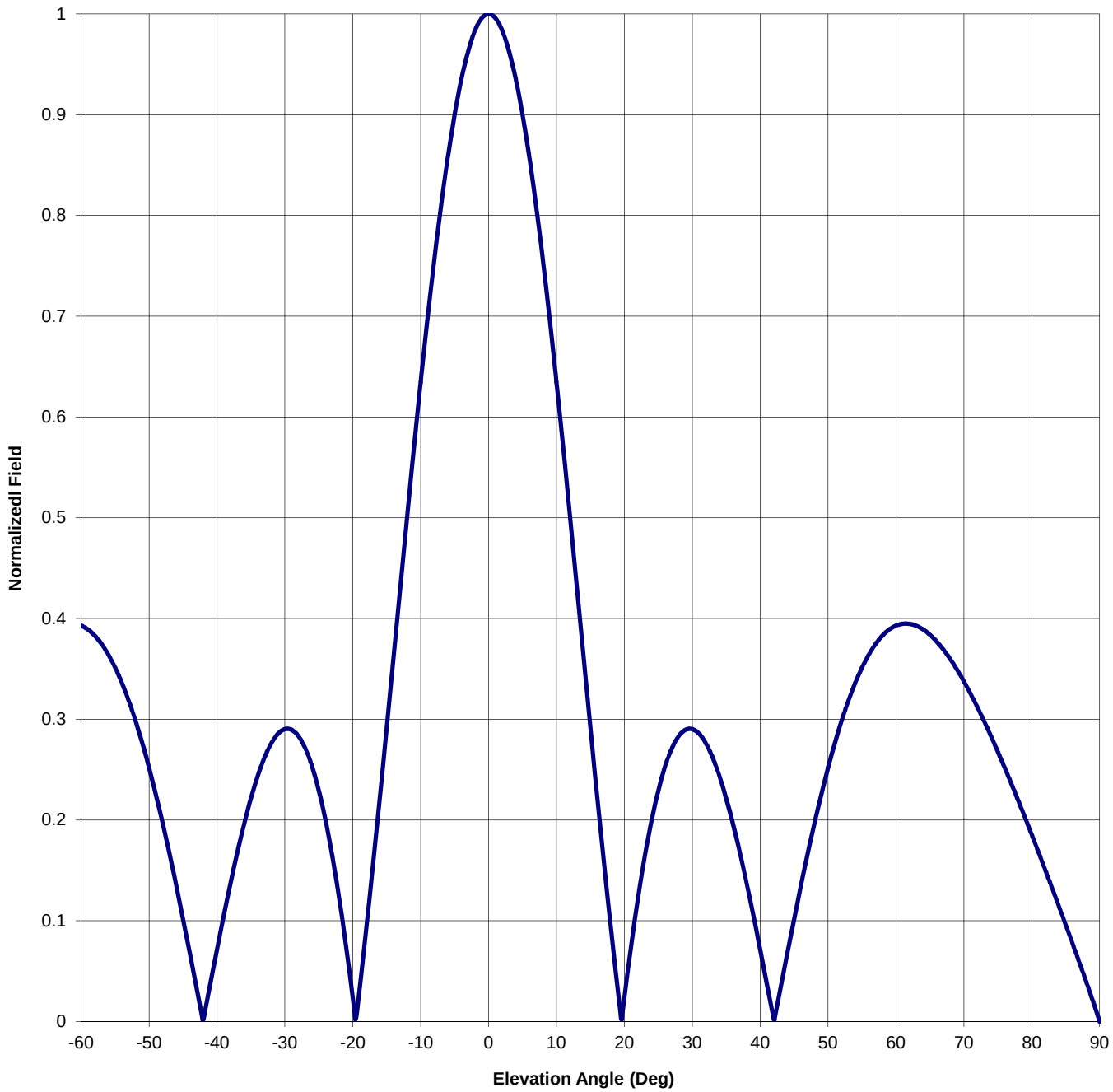
TOP VIEW

TOWER: CENTRAL 42" FACE

ANTENNA HEADING 263° TRUE NORTH

SHIVELY LABS A DIVISION OF HOWELL LABORATORIES INC.,BRIDGTON, MAINE			
SHOP ORDER: 29102	FREQUENCY: 89.5	SCALE: N.T.S.	DRAWN BY: ASP APPROVED BY: DAB
TITLE: MODEL–6810–3R–DIRECTIONAL ANTENNA			
DATE: 6/7/11	FIGURE 2		

Antenna Mfg.:	**Shively Labs**			**Date: 6/14/2011**
Antenna Type:	**6810-3R-DA**			
Station:	**KQAL**	**Beam Tilt**	**0**	
Frequency:	**89.5**	**Gain (Max)**	**3.358**	**5.261 dB**
Channel #:	**208**	**Gain (Horizon)**	**3.358**	**5.261 dB**
Figure:	**3**			



Antenna Mfg.: Shively Labs
Antenna Type: 6810-3R-DA
Station: KQAL
Frequency: 89.5
Channel #: 208
Figure: 3

Beam Tilt 0
Gain (Max) 3.358 **5.261 dB**
Gain (Horizon) 3.358 **5.261 dB**

Date: 6/14/2011

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	0.068	0	1.000	46	0.135
-89	0.021	-43	0.033	1	0.996	47	0.167
-88	0.040	-42	0.002	2	0.984	48	0.197
-87	0.059	-41	0.037	3	0.963	49	0.226
-86	0.078	-40	0.072	4	0.935	50	0.252
-85	0.096	-39	0.105	5	0.900	51	0.276
-84	0.114	-38	0.138	6	0.858	52	0.299
-83	0.132	-37	0.168	7	0.810	53	0.319
-82	0.150	-36	0.196	8	0.756	54	0.336
-81	0.168	-35	0.222	9	0.697	55	0.351
-80	0.185	-34	0.244	10	0.635	56	0.364
-79	0.202	-33	0.262	11	0.569	57	0.375
-78	0.219	-32	0.276	12	0.501	58	0.383
-77	0.236	-31	0.286	13	0.431	59	0.389
-76	0.252	-30	0.290	14	0.361	60	0.393
-75	0.268	-29	0.290	15	0.292	61	0.395
-74	0.283	-28	0.283	16	0.223	62	0.395
-73	0.298	-27	0.271	17	0.157	63	0.393
-72	0.312	-26	0.253	18	0.093	64	0.389
-71	0.325	-25	0.229	19	0.033	65	0.384
-70	0.338	-24	0.200	20	0.024	66	0.377
-69	0.349	-23	0.164	21	0.076	67	0.369
-68	0.360	-22	0.122	22	0.122	68	0.360
-67	0.369	-21	0.076	23	0.164	69	0.349
-66	0.377	-20	0.024	24	0.200	70	0.338
-65	0.384	-19	0.033	25	0.229	71	0.325
-64	0.389	-18	0.093	26	0.253	72	0.312
-63	0.393	-17	0.157	27	0.271	73	0.298
-62	0.395	-16	0.223	28	0.283	74	0.283
-61	0.395	-15	0.292	29	0.290	75	0.268
-60	0.393	-14	0.361	30	0.290	76	0.252
-59	0.389	-13	0.431	31	0.286	77	0.236
-58	0.383	-12	0.501	32	0.276	78	0.219
-57	0.375	-11	0.569	33	0.262	79	0.202
-56	0.364	-10	0.635	34	0.244	80	0.185
-55	0.351	-9	0.697	35	0.222	81	0.168
-54	0.336	-8	0.756	36	0.196	82	0.150
-53	0.319	-7	0.810	37	0.168	83	0.132
-52	0.299	-6	0.858	38	0.138	84	0.114
-51	0.276	-5	0.900	39	0.105	85	0.096
-50	0.252	-4	0.935	40	0.072	86	0.078
-49	0.226	-3	0.963	41	0.037	87	0.059
-48	0.197	-2	0.984	42	0.002	88	0.040
-47	0.167	-1	0.996	43	0.033	89	0.021
-46	0.135	0	1.000	44	0.068	90	0.000
-45	0.102			45	0.102		

S.O. 29102 Figure 4

VALIDATION OF TOTAL POWER GAIN CALCULATION

KQAL 89.5 MHz Winona, MN

Model 6810-3R-DA

Elevation Gain of Antenna 1.56

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

H RMS	0.706	V RMS	0.658	H/V Ratio	1.073

Elevation Gain of Horizontal Component 1.674

Elevation Gain of Vertical Component 1.454

Horizontal Azimuth Gain equals $1/(RMS)^2$. 2.006

Vertical Azimuth Gain equals $1/(RMS/Max\ Vert)^2$. 2.084

Max. Vertical 0.95

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

Total Horizontal Power Gain = **3.358**

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

Total Vertical Power Gain = **3.031**

==========

ERP divided by Horizontal Power Gain equals Antenna Input Power

2.5	kW ERP	Divided by H Gain	3.358	equals	0.744	kW H Antenna Input Power

Antenna Input Power times Vertical Power Gain equals Vertical ERP

0.744	kW	Times V Gain	3.031	equals	2.256	kW V ERP

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

(0.95)^2	Times	2.50	Equals	2.256	kW Vertical ERP

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