

**S.O. 32839**  
**Report of Test 6810-2D-DA**  
**for**  
**Bloomfield Hills School District**  
**WBFH 88.1 MHz Bloomfield Hills, MI.**

**OBJECTIVE:**

The objective of this test was to demonstrate the directional characteristics of a 6810-2D-DA to meet the needs of WBFH and to comply with the requirements of the FCC construction permit, file number BPED-20150828ABJ. 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-20150828ABJ indicates that the Horizontal radiation component shall not exceed 0.36 kW at any azimuth and is restricted to the following values at the azimuths specified:

140 Degrees True: 0.0115 kilowatts

180 Degrees True: 0.0115 kilowatts

From Figure 1A, the maximum radiation of the Horizontal component occurs at 340 Degrees True to 0 Degrees True. At the restricted azimuth of 140 Degrees True the Horizontal component is 16.54 dB down from the maximum of 0.36 kW, or 0.008 kW and at the restricted azimuth of 180 Degrees True the horizontal component is 16.19 dB down from the maximum of 0.36 kW, or 0.009 kW.

The R.M.S. of the Horizontal component is 0.625. The total Horizontal power gain is 2.607. The R.M.S. of the Vertical component is 0.608. The total Vertical power gain is 2.372. See Figure 4 for calculations. The R.M.S. of the FCC composite pattern is 0.654. The R.M.S. of the measured composite pattern is 0.629. Eighty-five percent (85%) of the original authorized FCC composite pattern is 0.556. Therefore this pattern complies with the FCC requirement of 73.316(c)(2)(ix)(A).

#### **METHOD OF DIRECTIONALIZATION:**

One bay of the 6810-2D-DA was mounted on a tower of precise scale to the Rohn mono pole at the WBFH site. The spacing of the antenna to the tower was varied and the addition of vertical parasitics were used 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-20150828ABJ, a single level of the 6810-2D-DA was set up on the Shively Labs scale model antenna pattern measuring range. A scale of 4.5:1 was used.

#### **EQUIPMENT:**

The 4.5:1 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 396.45 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:

A handwritten signature in blue ink, appearing to read 'Martyn Gregory', with a stylized, flowing script.

Martyn Gregory

Vice President, Shively Labs

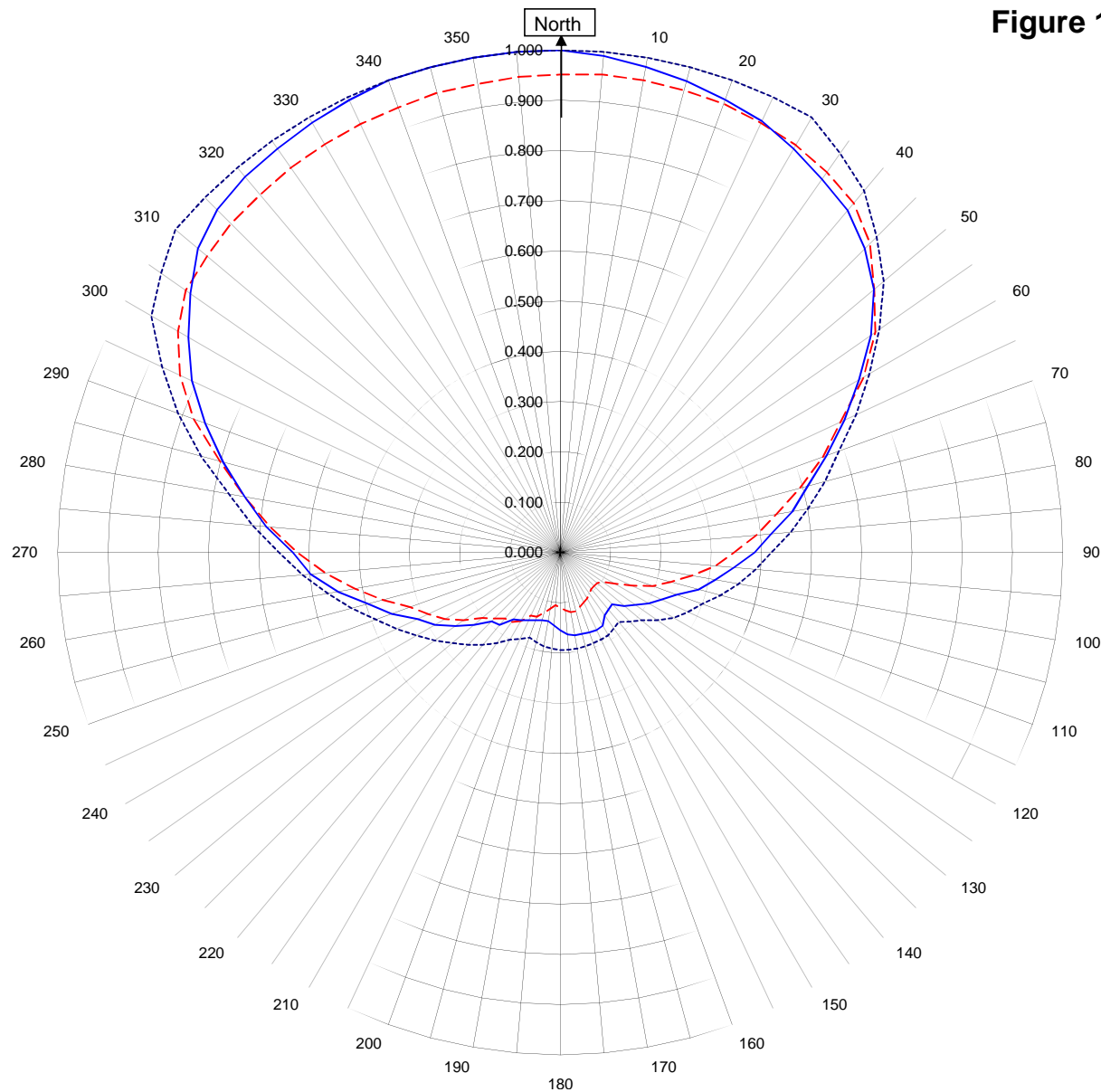
S/O 32839

Date September 22, 2015

# Shively Labs

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

Figure 1A



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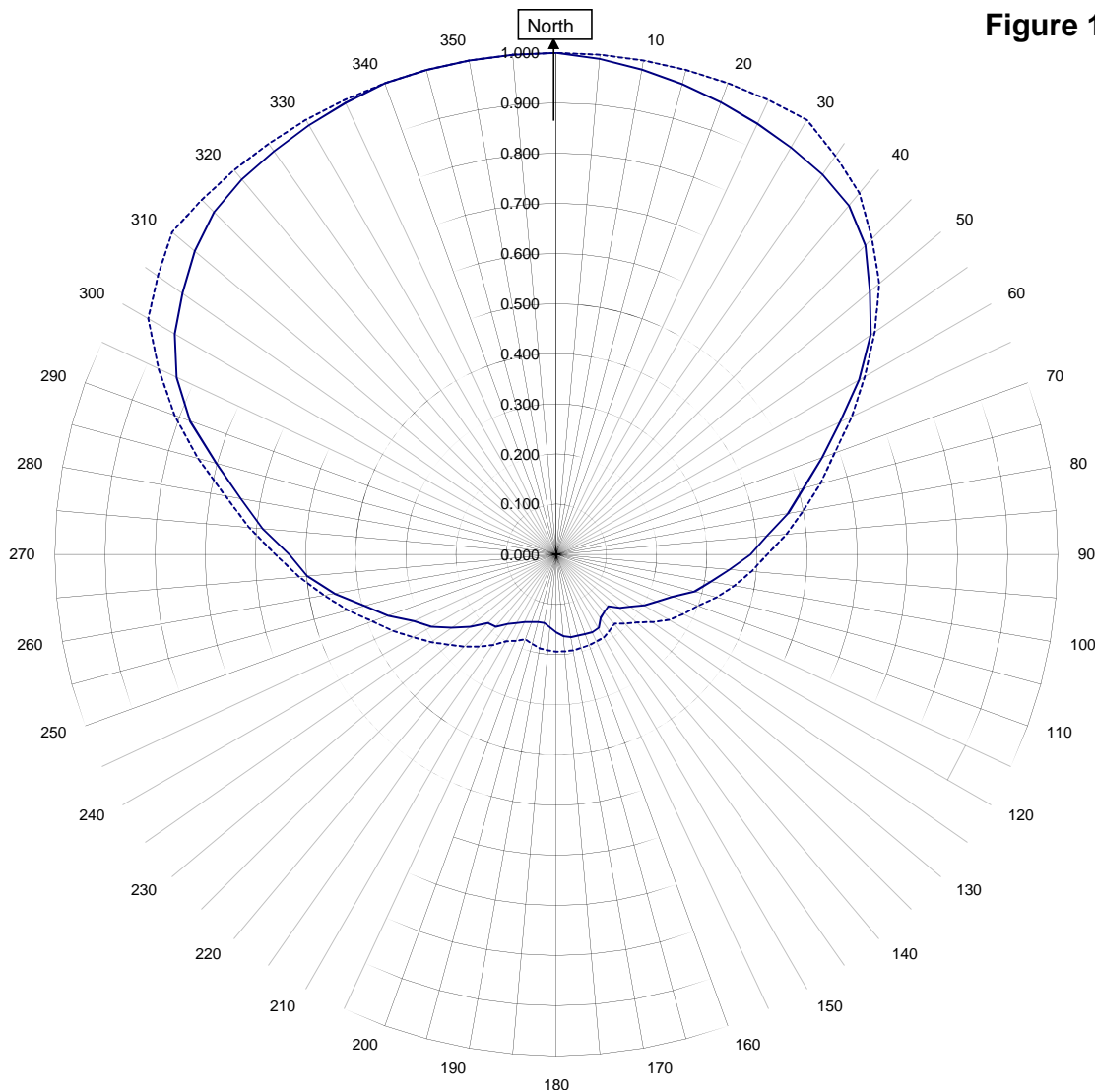
Horizontal RMS	0.625	Frequency	88.1 / 396.45 mHz
Vertical RMS	0.608	Plot	Relative Field
H/V Composite RMS	0.629	Scale	4.5 : 1
FCC Composite RMS	0.654	See Figure 2 for Mechanical Details	

Antenna Model	6810-2D-DA
Pattern Type	Directional Azimuth

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Figure 1B



**WBFH      Bloomfield Hills, MI.**

32839

September 22, 2015

—————H/VComposite RMS	0.629
.....FCC Composite RMS	0.654

Frequency	88.1 / 396.45    mHz
Plot	Relative Field
Scale	4.5 : 1
See Figure 2 for Mechanical Details	

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

Figure 1C

Tabulation of Horizontal Azimuth Pattern  
WBFH Bloomfield Hills, MI.

Azimuth	Rel Field	Azimuth	Rel Field
0	1.000	180	0.155
10	0.982	190	0.139
20	0.959	200	0.144
30	0.928	210	0.156
40	0.889	220	0.188
45	0.856	225	0.194
50	0.815	230	0.224
60	0.686	240	0.288
70	0.563	250	0.358
80	0.469	260	0.450
90	0.387	270	0.532
100	0.313	280	0.638
110	0.246	290	0.752
120	0.203	300	0.855
130	0.165	310	0.941
135	0.146	315	0.965
140	0.149	320	0.976
150	0.169	330	0.988
160	0.169	340	1.000
170	0.168	350	1.000

Figure 1D

Tabulation of Vertical Azimuth Pattern  
 WBFH Bloomfield Hills, MI.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.951	180	0.110
10	0.954	190	0.113
20	0.950	200	0.136
30	0.936	210	0.158
40	0.908	220	0.171
45	0.871	225	0.185
50	0.815	230	0.203
60	0.697	240	0.265
70	0.556	250	0.318
80	0.436	260	0.415
90	0.346	270	0.524
100	0.266	280	0.639
110	0.195	290	0.777
120	0.123	300	0.879
130	0.095	310	0.918
135	0.094	315	0.927
140	0.095	320	0.930
150	0.106	330	0.938
160	0.115	340	0.943
170	0.120	350	0.947

Figure 1E

Tabulation of Composite Azimuth Pattern  
WBFH Bloomfield Hills, MI.

Azimuth	Rel Field	Azimuth	Rel Field
0	1.000	180	0.155
10	0.982	190	0.139
20	0.959	200	0.144
30	0.936	210	0.158
40	0.908	220	0.188
45	0.871	225	0.194
50	0.815	230	0.224
60	0.697	240	0.288
70	0.563	250	0.358
80	0.469	260	0.450
90	0.387	270	0.532
100	0.313	280	0.639
110	0.246	290	0.777
120	0.203	300	0.879
130	0.165	310	0.941
135	0.146	315	0.965
140	0.149	320	0.976
150	0.169	330	0.988
160	0.169	340	1.000
170	0.168	350	1.000



Figure 1F

Tabulation of FCC Directional Composite  
WBFH Bloomfield Hills, MI.

Azimuth	Rel Field	Azimuth	Rel Field
0	1.000	180	0.194
10	1.000	190	0.190
20	1.000	200	0.180
30	1.000	210	0.200
40	0.940	220	0.240
50	0.840	230	0.280
60	0.710	240	0.330
70	0.590	250	0.390
80	0.500	260	0.470
90	0.420	270	0.560
100	0.360	280	0.670
110	0.300	290	0.810
120	0.260	300	0.940
130	0.210	310	1.000
140	0.180	320	1.000
150	0.190	330	1.000
160	0.192	340	1.000
170	0.194	350	1.000

Antenna Mfg.: Shively Labs  
Antenna Type: 6810-2D-DA

Date: 9/24/2015

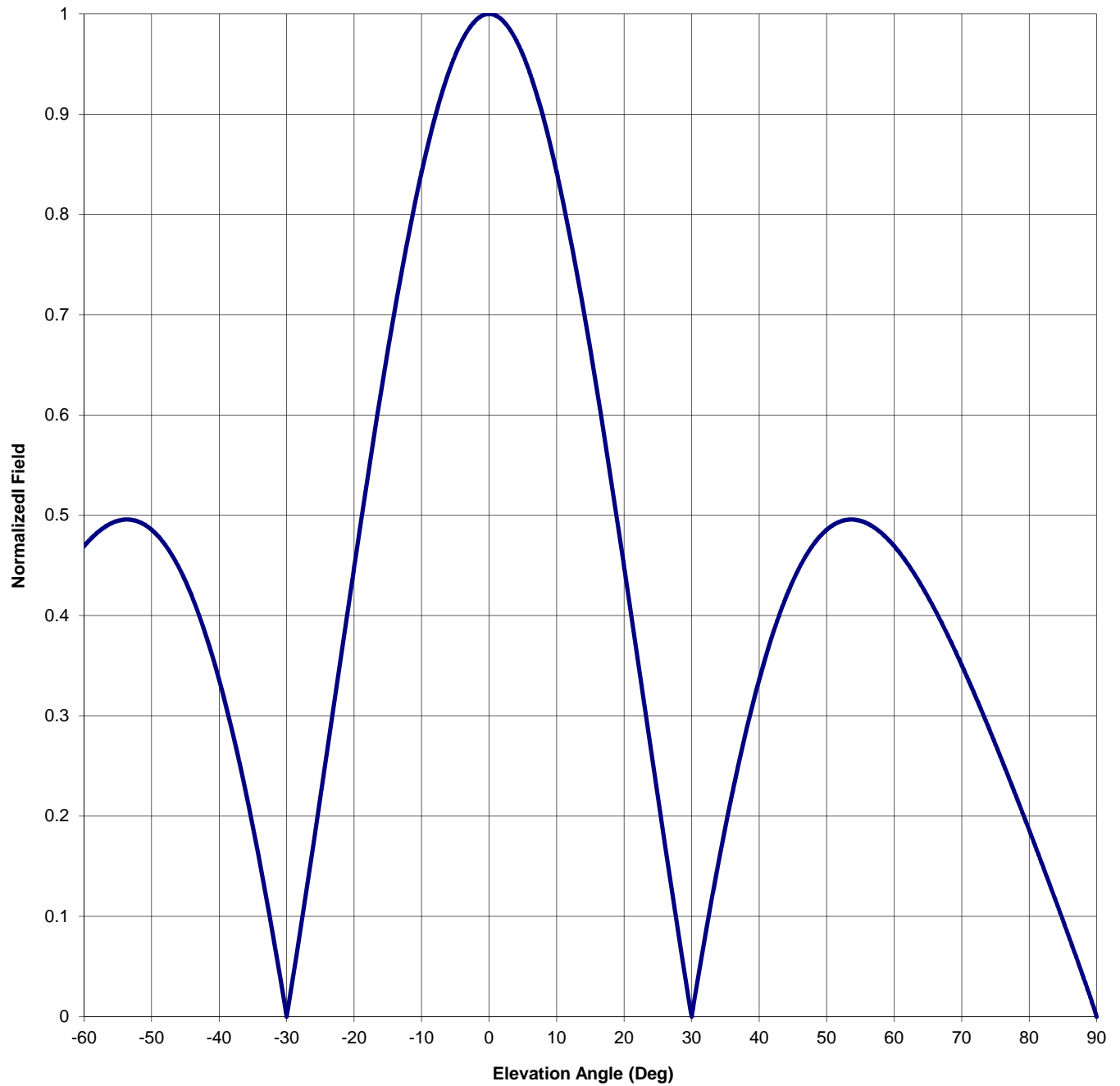
Station: WBFH

Frequency: 88.1

Channel #: 201

Figure: Figure 3

Beam Tilt	0	
Gain (Max)	2.607	4.161 dB
Gain (Horizon)	2.607	4.161 dB



Antenna Mfg.: Shively Labs

Date: 9/24/2015

Antenna Type: 6810-2D-DA

Station: WBFH

Beam Tilt 0

Frequency: 88.1

Gain (Max) 2.607 4.161 dB

Channel #: 201

Gain (Horizon) 2.607 4.161 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	0.419	0	1.000	46	0.448
-89	0.021	-43	0.401	1	0.998	47	0.460
-88	0.040	-42	0.381	2	0.993	48	0.471
-87	0.059	-41	0.360	3	0.985	49	0.479
-86	0.078	-40	0.336	4	0.974	50	0.486
-85	0.096	-39	0.311	5	0.959	51	0.490
-84	0.114	-38	0.283	6	0.942	52	0.494
-83	0.133	-37	0.254	7	0.921	53	0.496
-82	0.151	-36	0.222	8	0.897	54	0.496
-81	0.168	-35	0.189	9	0.871	55	0.495
-80	0.186	-34	0.155	10	0.842	56	0.492
-79	0.204	-33	0.118	11	0.811	57	0.488
-78	0.221	-32	0.080	12	0.777	58	0.483
-77	0.238	-31	0.041	13	0.742	59	0.477
-76	0.255	-30	0.000	14	0.704	60	0.469
-75	0.272	-29	0.042	15	0.665	61	0.461
-74	0.288	-28	0.085	16	0.624	62	0.452
-73	0.304	-27	0.129	17	0.581	63	0.441
-72	0.320	-26	0.173	18	0.538	64	0.430
-71	0.336	-25	0.219	19	0.494	65	0.419
-70	0.351	-24	0.265	20	0.448	66	0.406
-69	0.365	-23	0.311	21	0.403	67	0.393
-68	0.380	-22	0.357	22	0.357	68	0.380
-67	0.393	-21	0.403	23	0.311	69	0.365
-66	0.406	-20	0.448	24	0.265	70	0.351
-65	0.419	-19	0.494	25	0.219	71	0.336
-64	0.430	-18	0.538	26	0.173	72	0.320
-63	0.441	-17	0.581	27	0.129	73	0.304
-62	0.452	-16	0.624	28	0.085	74	0.288
-61	0.461	-15	0.665	29	0.042	75	0.272
-60	0.469	-14	0.704	30	0.000	76	0.255
-59	0.477	-13	0.742	31	0.041	77	0.238
-58	0.483	-12	0.777	32	0.080	78	0.221
-57	0.488	-11	0.811	33	0.118	79	0.204
-56	0.492	-10	0.842	34	0.155	80	0.186
-55	0.495	-9	0.871	35	0.189	81	0.168
-54	0.496	-8	0.897	36	0.222	82	0.151
-53	0.496	-7	0.921	37	0.254	83	0.133
-52	0.494	-6	0.942	38	0.283	84	0.114
-51	0.490	-5	0.959	39	0.311	85	0.096
-50	0.486	-4	0.974	40	0.336	86	0.078
-49	0.479	-3	0.985	41	0.360	87	0.059
-48	0.471	-2	0.993	42	0.381	88	0.040
-47	0.460	-1	0.998	43	0.401	89	0.021
-46	0.448	0	1.000	44	0.419	90	0.000
-45	0.435			45	0.435		

## VALIDATION OF TOTAL POWER GAIN CALCULATION

WBFH	Bloomfield Hills, MI.
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MODEL	6810-2D-DA
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Elevation Gain of Antenna

0.99

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

H RMS

0.625095

V RMS

0.607582

H/V Ratio

1.029

Elevation Gain of Horizontal Component

1.019

Elevation Gain of Vertical Component

0.962

Horizontal Azimuth Gain equals  $1/(\text{RMS})^2$ .

2.559

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

2.465

Max. Vertical

0.954

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

Total Horizontal Power Gain =

2.607

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

Total Vertical Power Gain =

2.372

ERP divided by Horizontal Power Gain equals Antenna Input Power

0.36

kW ERP

Divided by H Gain

2.607

equals

0.138

kW H Antenna Input Power

Antenna Input Power times Vertical Power Gain equals Vertical ERP

0.138 kW

Times V Gain

2.372

equals

0.328

kW V ERP

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

 $(0.954)^2$ 

Times

0.36

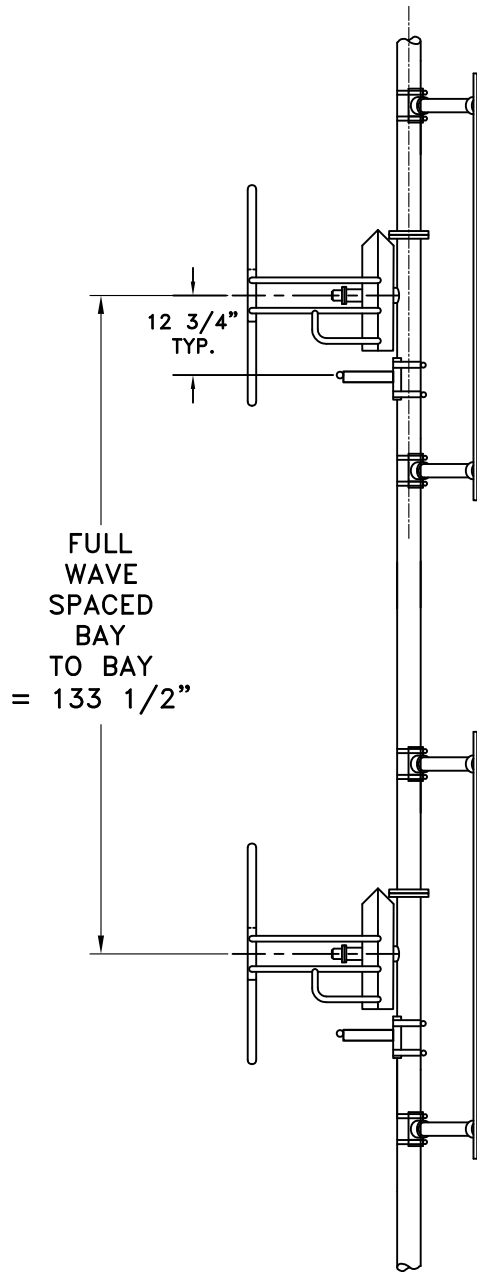
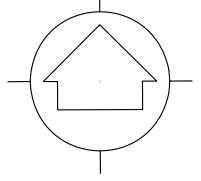
Equals

0.328

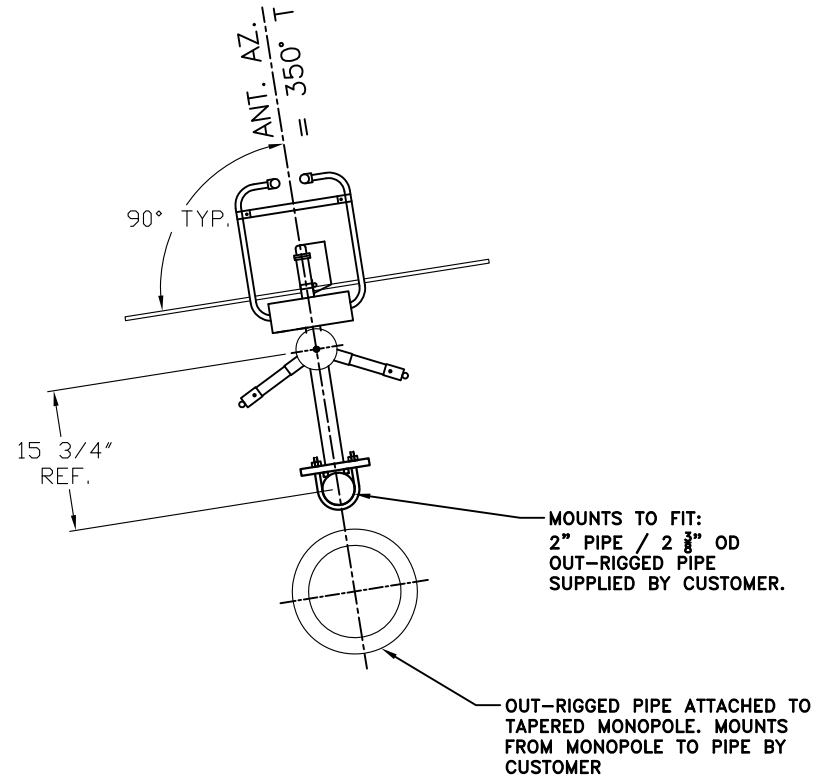
kW Vertical ERP

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

TRUE NORTH



SIDE VIEW



TOP VIEW

TOWER: 2" PIPE  
OUT-RIGGED  
FROM MONOPOLE

ANTENNA HEADING 350° TRUE NORTH

SHIVELY LABS			
A DIVISION OF HOWELL LABORATORIES INC., BRIDGTON, MAINE			
SHOP ORDER:	FREQUENCY:	SCALE:	DRAWN BY:
32839	88.1	N.T.S.	ASP
TITLE:			APPROVED BY:
MODEL-6810-2D-DIRECTIONAL ANTENNA			DAB
DATE:			
9-24-15	FIGURE 2		