

S.O. 32827
Report of Test 6815-4R-DA
for
Washington State University
KWWS 89.7 MHz Walla Walla, WA.

OBJECTIVE:

The objective of this test was to demonstrate the directional characteristics of a 6815-4R-DA to meet the needs of KWWS and to comply with the requirements of the FCC construction permit, file number BMPED-20150619AAI. 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-20150619AAI indicates that the Horizontal radiation component shall not exceed 16 kW at any azimuth and is restricted to the following values at the azimuths specified:

100 Degrees True: 0.790 kilowatts

110 Degrees True: 0.770 kilowatts

From Figure 1A, the maximum radiation of the Horizontal component occurs at 285 Degrees True to 290 Degrees True. At the restricted azimuth of 100 Degrees True the vertical component is 14.33 down from the maximum of 16.0 kW, or 0.590 kW and at the restricted azimuth of 110 Degrees True the vertical component is 14.80 dB down from the maximum of 16.0 kW, or 0.530 kW.

The R.M.S. of the Horizontal component is 0.624. The total Horizontal power gain is 6.215. The R.M.S. of the Vertical component is 0.547. The total Vertical power gain is 3.534. See Figure 4 for calculations. The R.M.S. of the FCC composite pattern is 0.666. The R.M.S. of the measured composite pattern is 0.642. Eighty-five percent (85%) of the original authorized FCC composite pattern is 0.566. Therefore this pattern complies with the FCC requirement of 73.316(c)(2)(ix)(A).

METHOD OF DIRECTIONALIZATION:

One bay of the 6815-4R-DA was mounted on a tower of precise scale to the Utility-340 tower at the KWWS site. The spacing of the antenna to the tower was varied to achieve the vertical pattern shown in Figure 1A. Horizontal parasitic elements were placed above and below the bay. The position of these horizontal parasitic elements were 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-20150619AAI, a single level of the 6815-4R-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 403.65 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:

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

Martyn Gregory

Vice President, Shively Labs

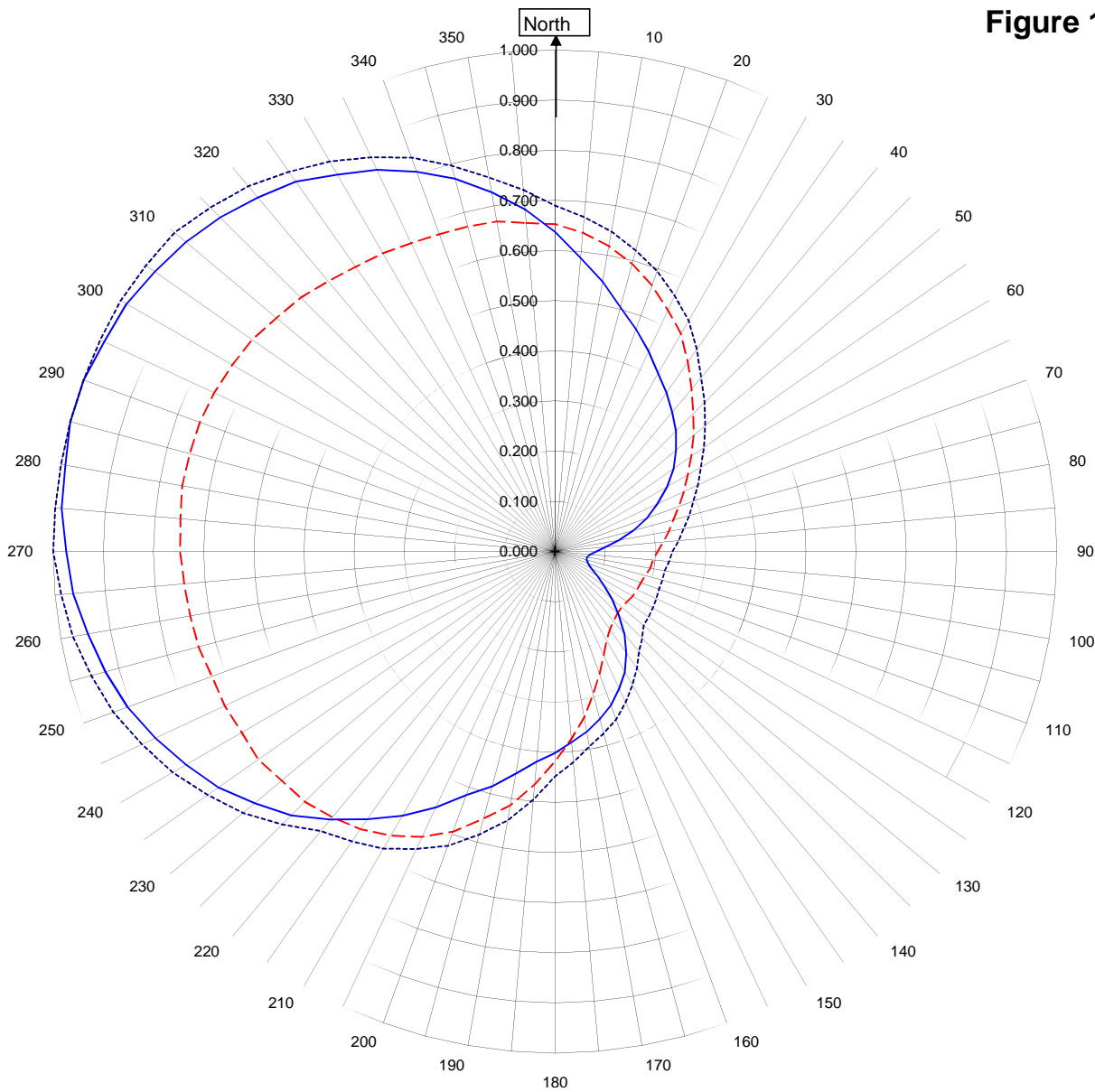
S/O 32827

October 7, 2015

Shively Labs

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

Figure 1A



KWWS WALLA WALLA, WA.
32827
October 7, 2015

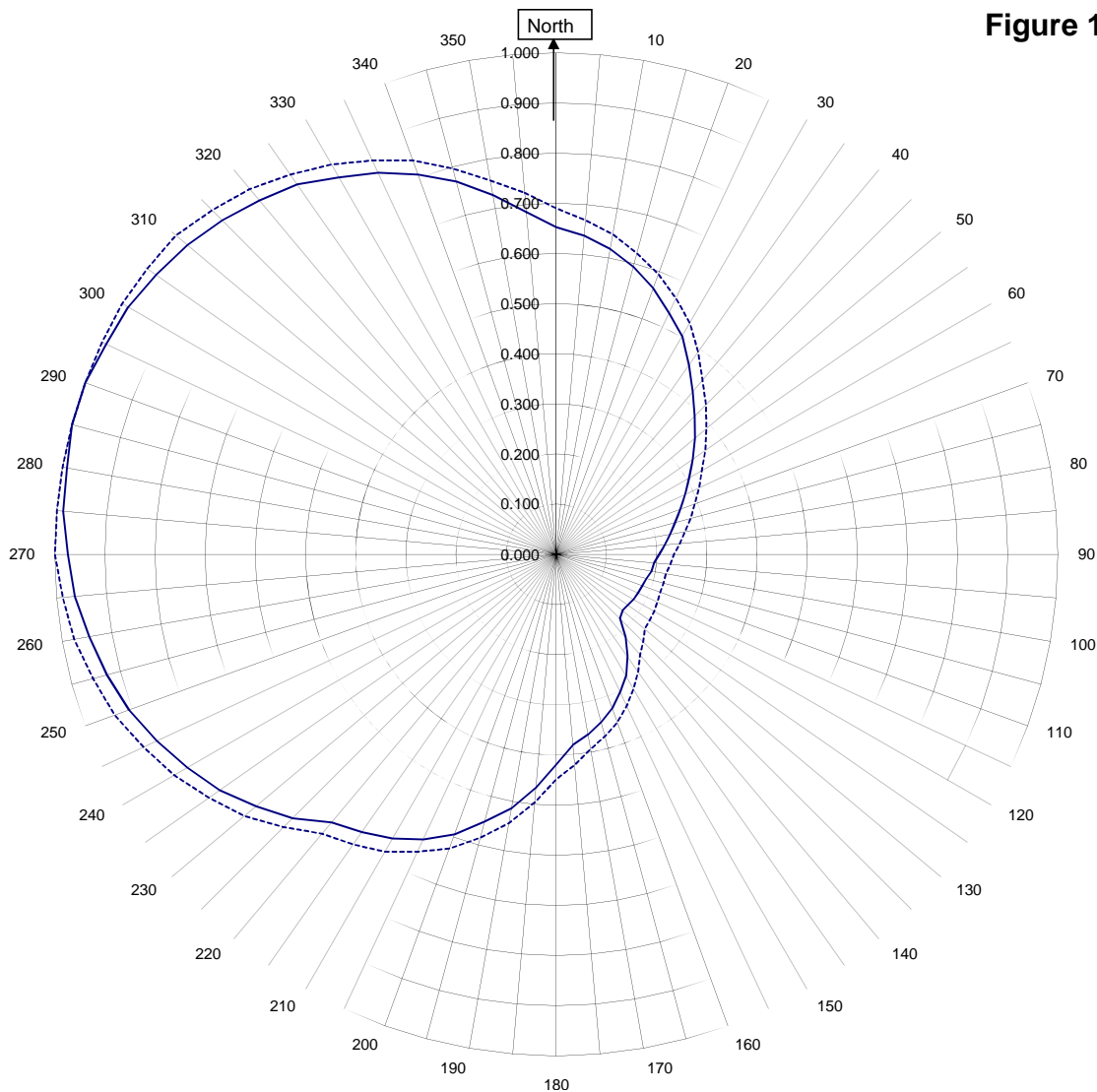
Horizontal RMS	0.624	Frequency	89.7 / 403.65 mHz
Vertical RMS	0.547	Plot	Relative Field
H/V Composite RMS	0.642	Scale	4.5 : 1
FCC Composite RMS	0.666	See Figure 2 for Mechanical Details	

Antenna Model	6815-4R-DA
Pattern Type	Directional Azimuth

Shively Labs

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Figure 1B



KWWS WALLA WALLA, WA
32827
October 7, 2015

—————H/V Composite RMS	0.642
.....FCC Composite RMS	0.666

Frequency	89.7 / 403.65 mHz
Plot	Relative Field
Scale	4.5 : 1
See Figure 2 for Mechanical Details	

Antenna Model	6815-4R-DA
Pattern Type	Directional H/V Composite

Figure 1C

Tabulation of Horizontal Azimuth Pattern
KWWS WALLA WALLA, WA.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.637	180	0.402
10	0.546	190	0.449
20	0.471	200	0.516
30	0.411	210	0.608
40	0.363	220	0.697
45	0.340	225	0.743
50	0.314	230	0.781
60	0.257	240	0.850
70	0.194	250	0.907
80	0.130	260	0.946
90	0.082	270	0.974
100	0.064	280	0.991
110	0.070	290	1.000
120	0.098	300	0.986
130	0.148	310	0.960
135	0.179	315	0.942
140	0.215	320	0.921
150	0.278	330	0.868
160	0.326	340	0.806
170	0.364	350	0.727

Figure 1D

Tabulation of Vertical Azimuth Pattern
KWWS WALLA WALLA, WA.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.653	180	0.418
10	0.618	190	0.514
20	0.565	200	0.594
30	0.502	210	0.654
40	0.423	220	0.691
45	0.389	225	0.705
50	0.360	230	0.711
60	0.305	240	0.721
70	0.263	250	0.728
80	0.230	260	0.738
90	0.204	270	0.747
100	0.192	280	0.754
110	0.182	290	0.754
120	0.178	300	0.743
130	0.173	310	0.725
135	0.176	315	0.717
140	0.181	320	0.704
150	0.205	330	0.687
160	0.259	340	0.673
170	0.335	350	0.668

Figure 1E

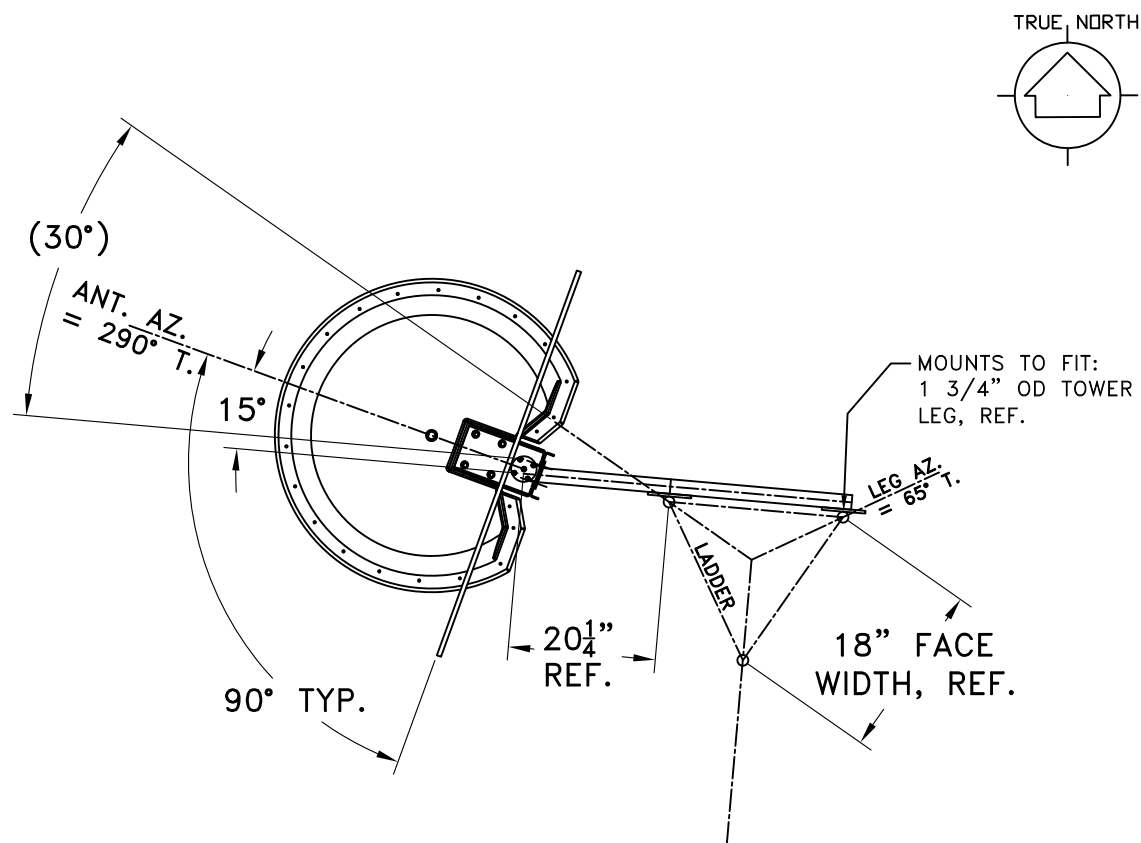
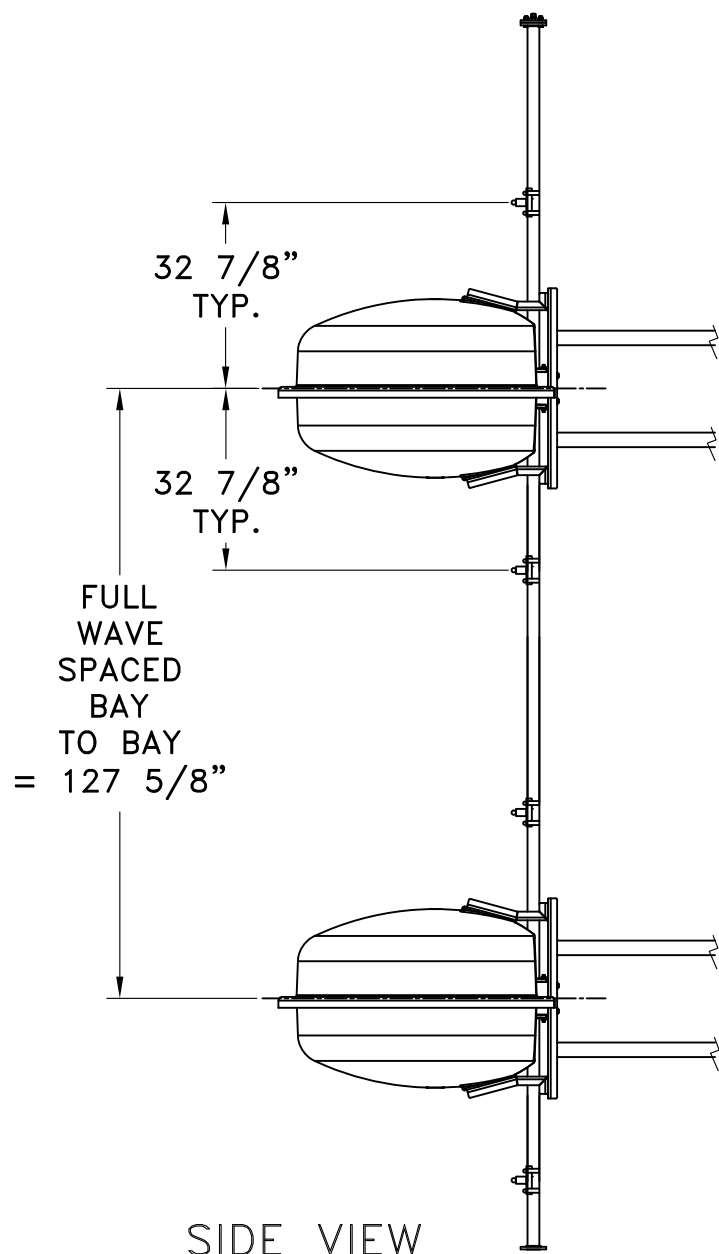
Tabulation of Composite Azimuth Pattern
KWWS WALLA WALLA, WA.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.653	180	0.418
10	0.618	190	0.514
20	0.565	200	0.594
30	0.502	210	0.654
40	0.423	220	0.697
45	0.389	225	0.743
50	0.360	230	0.781
60	0.305	240	0.850
70	0.263	250	0.907
80	0.230	260	0.946
90	0.204	270	0.974
100	0.192	280	0.991
110	0.182	290	1.000
120	0.178	300	0.986
130	0.173	310	0.960
135	0.179	315	0.942
140	0.215	320	0.921
150	0.278	330	0.868
160	0.326	340	0.806
170	0.364	350	0.727

Figure 1F

Tabulation of FCC Directional Composite
KWWWS WALLA WALLA, WA.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.690	180	0.448
10	0.648	190	0.544
20	0.595	200	0.624
30	0.532	210	0.684
40	0.453	220	0.727
50	0.390	230	0.811
60	0.335	240	0.880
70	0.293	250	0.937
80	0.260	260	0.976
90	0.234	270	1.000
100	0.222	280	1.000
110	0.220	290	1.000
120	0.225	300	1.000
130	0.230	310	0.990
140	0.260	320	0.951
150	0.308	330	0.898
160	0.356	340	0.836
170	0.394	350	0.757



TOP VIEW
TOWER MAKE: UTILITY 340

ANTENNA HEADING 290° TRUE NORTH

SHIVELY LABS			
A DIVISION OF HOWELL LABORATORIES INC., BRIDGTON, MAINE			
SHOP ORDER:	FREQUENCY:	SCALE:	DRAWN BY:
32827	89.7	N.T.S.	ASP
TITLE:		APPROVED BY:	
MODEL-6815-4R-DIRECTIONAL ANTENNA		DAB	
DATE:	FIGURE 2		
8-21-15			

Antenna Mfg.: Shively Labs
Antenna Type: 6815-4R-DA

Date: 10/7/2015

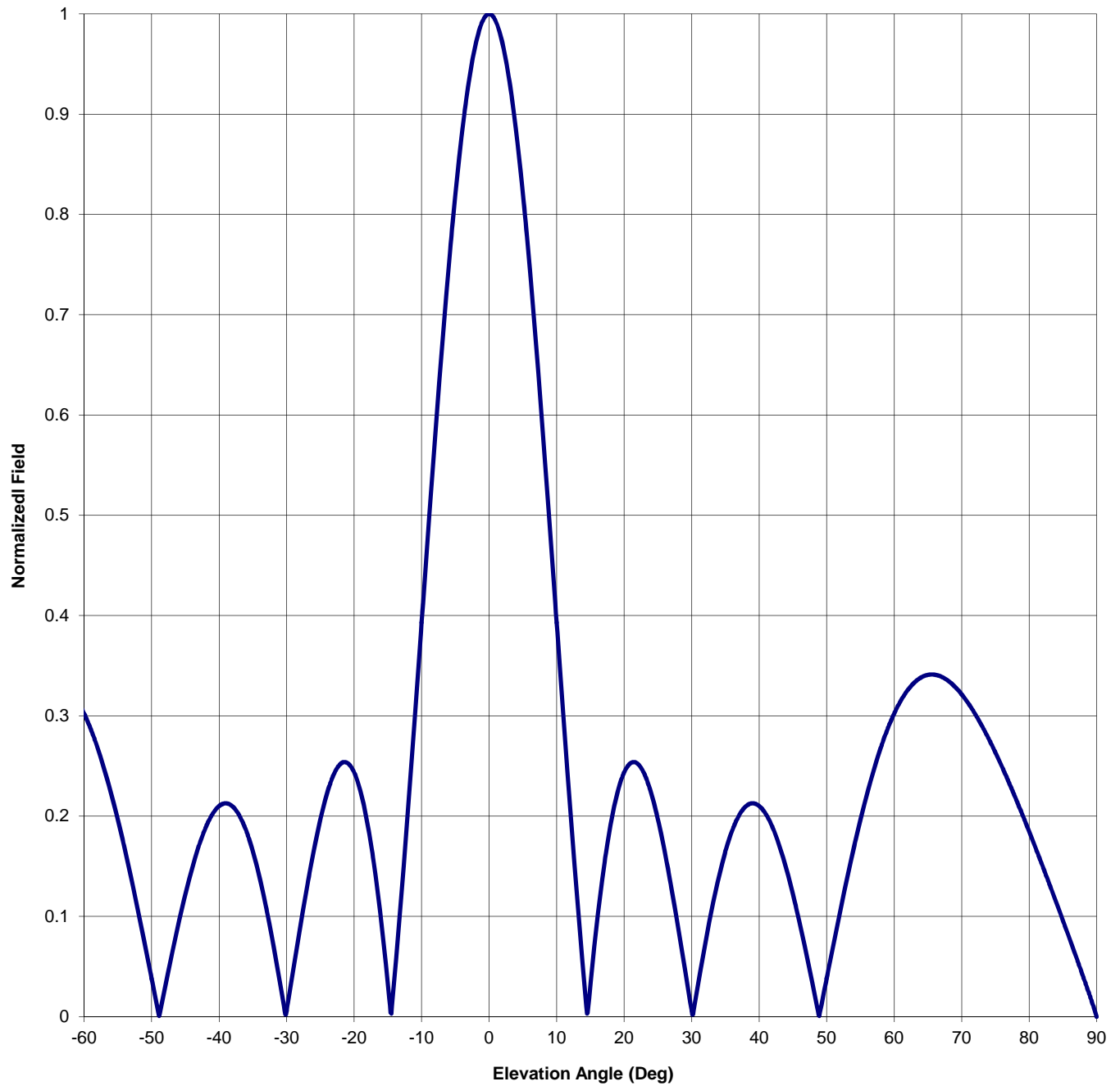
Station: KWWS

Frequency: 89.7

Channel #: 209

Figure: Figure 3

Beam Tilt	0	
Gain (Max)	6.216	7.935 dB
Gain (Horizon)	6.216	7.935 dB



Antenna Mfg.: Shively Labs
 Antenna Type: 6815-4R-DA
 Station: KWWS
 Frequency: 89.7
 Channel #: 209

Date: 10/7/2015

Beam Tilt 0
 Gain (Max) 6.216 7.935 dB
 Gain (Horizon) 6.216 7.935 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	0.148	0	1.000	46	0.093
-89	0.021	-43	0.170	1	0.992	47	0.062
-88	0.040	-42	0.189	2	0.970	48	0.030
-87	0.059	-41	0.202	3	0.933	49	0.004
-86	0.078	-40	0.210	4	0.883	50	0.038
-85	0.096	-39	0.213	5	0.820	51	0.072
-84	0.114	-38	0.210	6	0.748	52	0.105
-83	0.132	-37	0.201	7	0.667	53	0.137
-82	0.150	-36	0.186	8	0.579	54	0.168
-81	0.167	-35	0.165	9	0.487	55	0.196
-80	0.184	-34	0.139	10	0.393	56	0.223
-79	0.201	-33	0.108	11	0.299	57	0.247
-78	0.218	-32	0.073	12	0.208	58	0.268
-77	0.234	-31	0.034	13	0.121	59	0.287
-76	0.249	-30	0.006	14	0.041	60	0.302
-75	0.263	-29	0.048	15	0.032	61	0.315
-74	0.277	-28	0.089	16	0.096	62	0.326
-73	0.290	-27	0.128	17	0.149	63	0.333
-72	0.302	-26	0.165	18	0.192	64	0.338
-71	0.312	-25	0.197	19	0.223	65	0.341
-70	0.321	-24	0.223	20	0.244	66	0.341
-69	0.329	-23	0.242	21	0.253	67	0.339
-68	0.335	-22	0.252	22	0.252	68	0.335
-67	0.339	-21	0.253	23	0.242	69	0.329
-66	0.341	-20	0.244	24	0.223	70	0.321
-65	0.341	-19	0.223	25	0.197	71	0.312
-64	0.338	-18	0.192	26	0.165	72	0.302
-63	0.333	-17	0.149	27	0.128	73	0.290
-62	0.326	-16	0.096	28	0.089	74	0.277
-61	0.315	-15	0.032	29	0.048	75	0.263
-60	0.302	-14	0.041	30	0.006	76	0.249
-59	0.287	-13	0.121	31	0.034	77	0.234
-58	0.268	-12	0.208	32	0.073	78	0.218
-57	0.247	-11	0.299	33	0.108	79	0.201
-56	0.223	-10	0.393	34	0.139	80	0.184
-55	0.196	-9	0.487	35	0.165	81	0.167
-54	0.168	-8	0.579	36	0.186	82	0.150
-53	0.137	-7	0.667	37	0.201	83	0.132
-52	0.105	-6	0.748	38	0.210	84	0.114
-51	0.072	-5	0.820	39	0.213	85	0.096
-50	0.038	-4	0.883	40	0.210	86	0.078
-49	0.004	-3	0.933	41	0.202	87	0.059
-48	0.030	-2	0.970	42	0.189	88	0.040
-47	0.062	-1	0.992	43	0.170	89	0.021
-46	0.093	0	1.000	44	0.148	90	0.000
-45	0.122			45	0.122		

VALIDATION OF TOTAL POWER GAIN CALCULATION

KWWWS WALLA WALLA, WA.

MODEL 6815-4R-DA

Elevation Gain of Antenna

2.12

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

H RMS

0.623715

V RMS

0.546859

H/V Ratio

1.141

Elevation Gain of Horizontal Component

2.418

Elevation Gain of Vertical Component

1.859

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

2.571

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

1.901

Max. Vertical

0.754

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

Total Horizontal Power Gain =

6.215

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

Total Vertical Power Gain =

3.534

ERP divided by Horizontal Power Gain equals Antenna Input Power

16

kW ERP

Divided by H Gain

6.215

equals

2.574

kW H Antenna Input Power

Antenna Input Power times Vertical Power Gain equals Vertical ERP

2.574 kW

Times V Gain

3.534

equals

9.096

kW V ERP

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

 $(0.754)^2$ Times 16.00 Equals 9.096 kW Vertical ERP

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