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S.O. 29014

Report of Test 6014-2/3R-DA

for

Vermont Public Radio

WNCH 88.1 MHz Norwich, VT

OBJECTIVE:

The objective of this test was to demonstrate the directional characteristics of a 6014-2/3R-DA to meet the needs of WNCH and to comply with the requirements of the FCC construction permit, file number BPED-20110705AAY. 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-20110705AAY indicates that the Horizontal radiation component shall not exceed 1.55 kW at any azimuth and is restricted to the following values at the azimuths specified:

80-90 Degrees T (clockwise} : 0.178 kW

100 Degrees T: 0.181 kW

350 Degrees T: 1.297 kW

From Figure 1A, the maximum radiation of the Horizontal component occurs at 214 Degrees T to 216 Degrees T and 324 Degrees T to 326 Degrees T. At the restricted azimuth of 80-90 Degrees T (clockwise) the Vertical component is 10.145 dB down from the maximum of 1.55 kW, or 0.150 kW, at the restricted azimuth of 100 Degrees T the horizontal component is 0.271 dB down from the maximum of 1.55 kW, or 0.114 kW and at the restricted azimuth of 350 Degrees T the horizontal component is 1.250 dB down from the maximum of 1.55 kW, or 1.162 kW

The R.M.S. of the Horizontal component is 0.716. The total Horizontal power gain is 2.028. The R.M.S. of the Vertical component is 0.682. The total Vertical power gain is 1.792. See Figure 4 for calculations. The R.M.S. of the FCC composite pattern is 0.885. The R.M.S. of the measured composite pattern is 0.754. Eighty-five percent (85%) of the original authorized FCC composite pattern is 0.752. Therefore this pattern complies with the FCC requirement of 73.316(c)(2)(ix)(A).

METHOD OF DIRECTIONALIZATION:

One bay of the 6014-2/3R-DA was mounted on a tower of precise scale to the Stainless G-7 tower at the WNCH site. A power dividing coaxial feed system was designed to reduce the power to the East panel to produce the directional pattern shown in Figure 1A. See Figure 2 for mechanical details.

METHOD OF MEASUREMENT:

As allowed by the construction permit, file number BPED-20110705AAY, a single level of the 6014-2/3R-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.

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 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:

Robert A. Surette
Director of Sales Engineering
S/O 29014
August 1, 2012

Shively Labs

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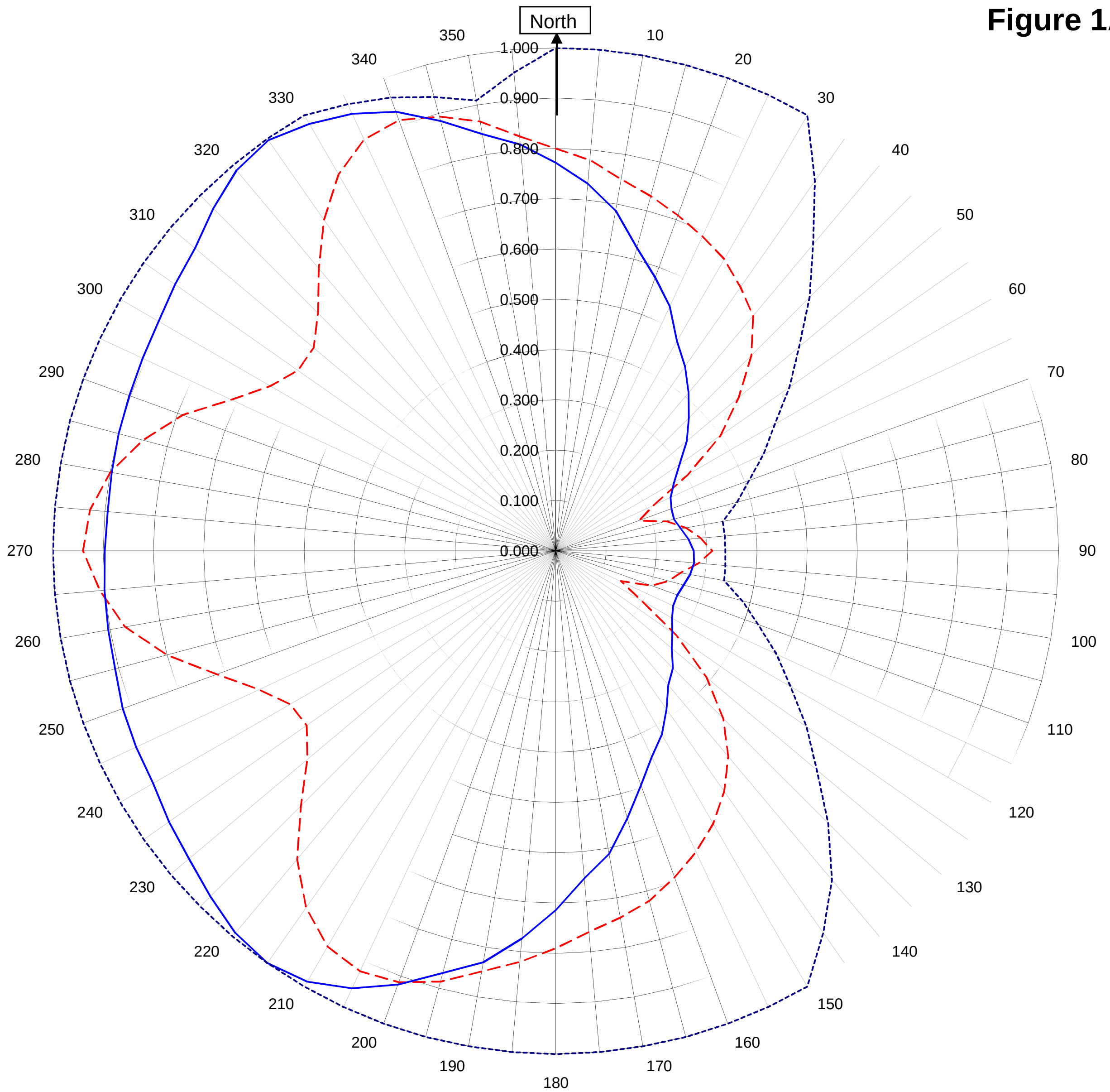
Figure 1A



WHCH NORWICH, VT.

29014

August 1, 2012

____________Horizontal RMS	0.716
_ _ _ _ _ _ _ _ _ Vertical RMS	0.682
H/V Composite RMS	0.754
……………FCC Composite RMS	0.885

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

Antenna Model	6014-2/3-DA
Pattern Type	Directional Azimuth

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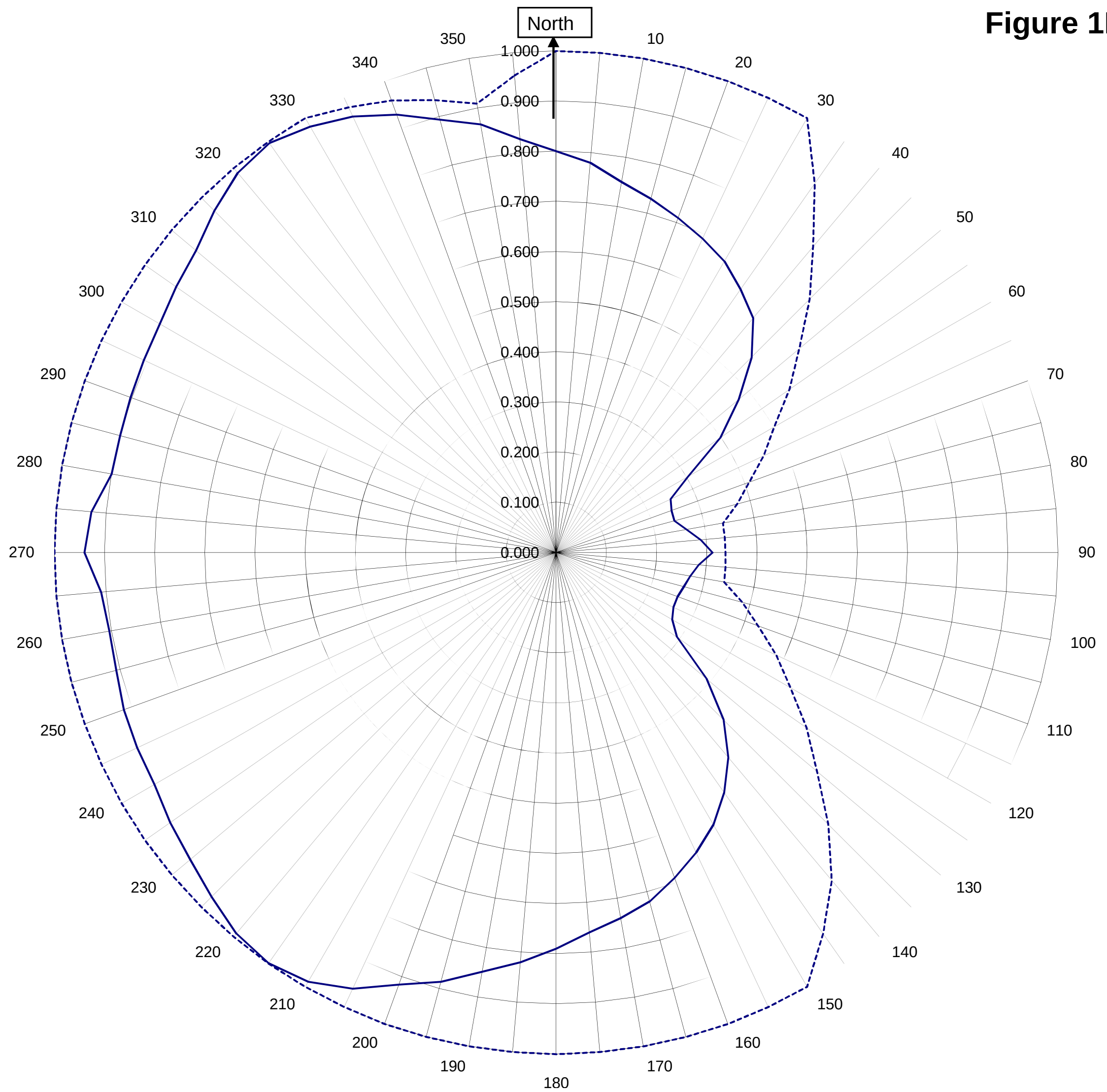
Figure 1B



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29014

August 1, 2012

__________H/VComposite RMS	0.754
……………FCC Composite RMS	0.885

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

Antenna Model	6014-2/3-DA
Pattern Type	Directional H/V Composite

Figure 1C

Tabulation of Horizontal Azimuth Pattern
WHCH NORWICH, VT.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.772	180	0.714
10	0.686	190	0.830
20	0.579	200	0.917
30	0.482	210	0.989
40	0.411	220	0.991
45	0.374	225	0.971
50	0.340	230	0.952
60	0.272	240	0.925
70	0.245	250	0.917
80	0.253	260	0.904
90	0.274	270	0.897
100	0.271	280	0.897
110	0.257	290	0.903
120	0.267	300	0.912
130	0.301	310	0.937
135	0.329	315	0.963
140	0.348	320	0.988
150	0.421	330	0.980
160	0.495	340	0.929
170	0.611	350	0.841

Figure 1D

Tabulation of Vertical Azimuth Pattern
WHCH NORWICH, VT.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.800	180	0.790
10	0.750	190	0.849
20	0.710	200	0.912
30	0.670	210	0.908
40	0.610	220	0.800
45	0.550	225	0.717
50	0.474	230	0.645
60	0.303	240	0.610
70	0.176	250	0.717
80	0.264	260	0.870
90	0.311	270	0.940
100	0.251	280	0.900
110	0.201	290	0.790
120	0.196	300	0.655
130	0.391	310	0.629
135	0.471	315	0.669
140	0.533	320	0.734
150	0.626	330	0.865
160	0.690	340	0.911
170	0.740	350	0.866

Figure 1E

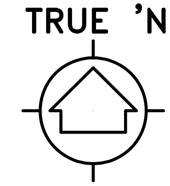
Tabulation of Composite Azimuth Pattern
WHCH NORWICH, VT.

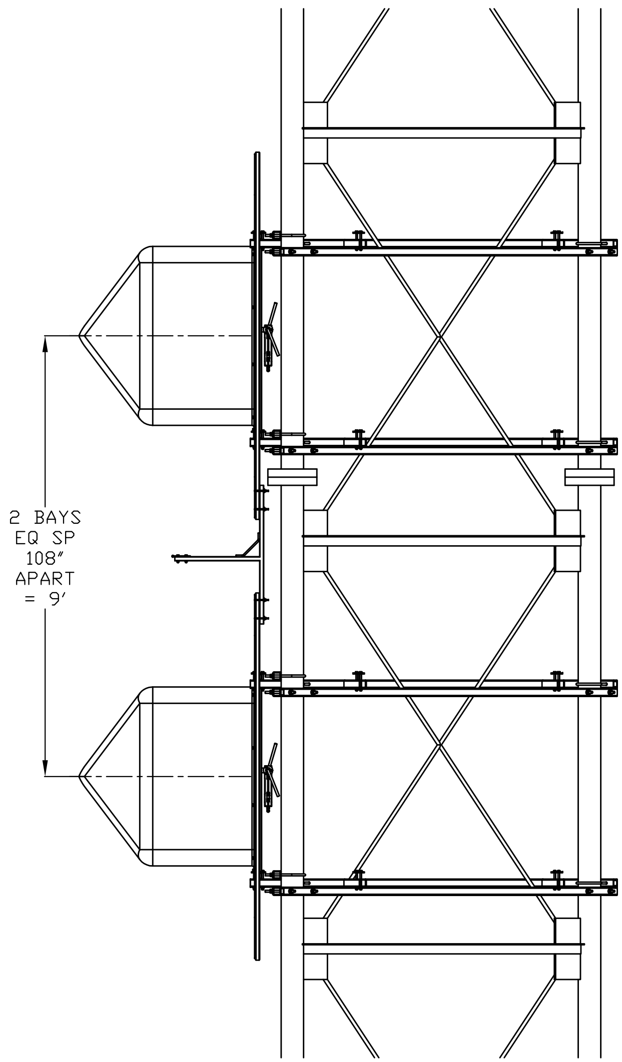
Azimuth	Rel Field	Azimuth	Rel Field
0	0.800	180	0.790
10	0.750	190	0.849
20	0.710	200	0.917
30	0.670	210	0.989
40	0.610	220	0.991
45	0.550	225	0.971
50	0.474	230	0.952
60	0.303	240	0.925
70	0.245	250	0.917
80	0.264	260	0.904
90	0.311	270	0.940
100	0.271	280	0.900
110	0.257	290	0.903
120	0.267	300	0.912
130	0.391	310	0.937
135	0.471	315	0.963
140	0.533	320	0.988
150	0.626	330	0.980
160	0.690	340	0.929
170	0.740	350	0.866

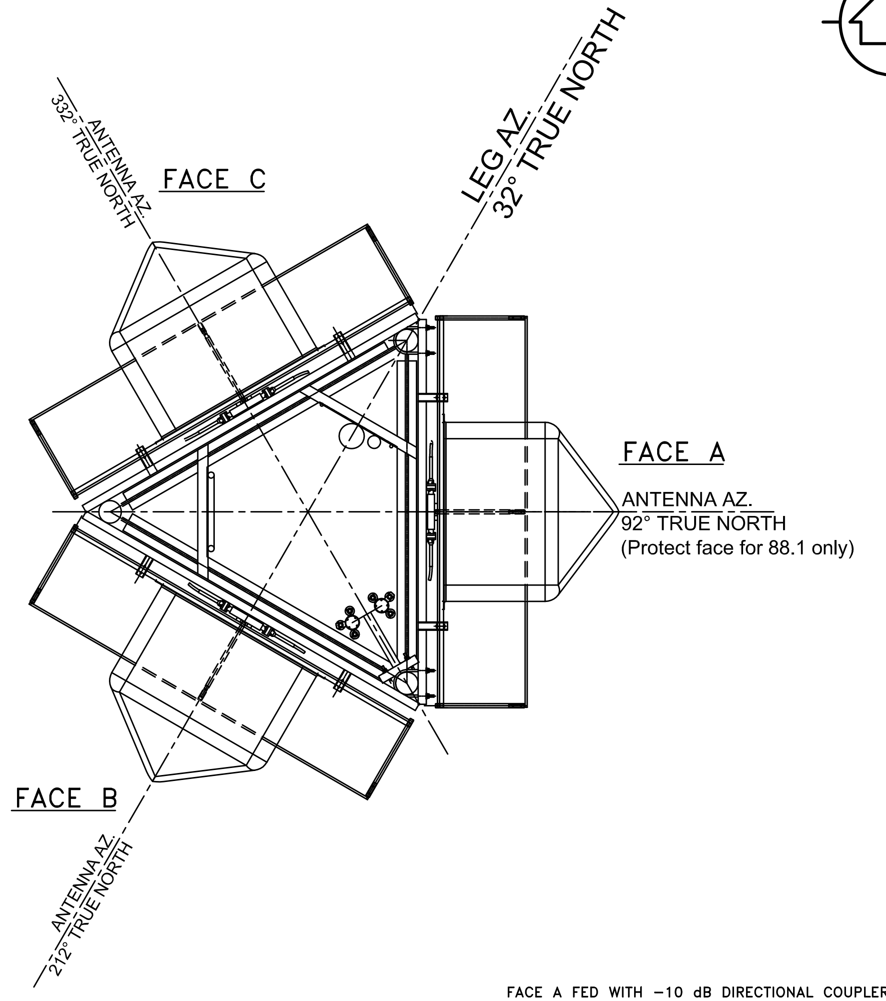
Figure 1F

Tabulation of FCC Directional Composite
WHCH NORWICH, VT.

Azimuth	Rel Field	Azimuth	Rel Field
0	1.000	180	1.000
10	1.000	190	1.000
20	1.000	200	1.000
30	1.000	210	1.000
40	0.796	220	1.000
50	0.632	230	1.000
60	0.502	240	1.000
70	0.409	250	1.000
80	0.337	260	1.000
90	0.337	270	1.000
100	0.340	280	1.000
110	0.428	290	1.000
120	0.539	300	1.000
130	0.678	310	1.000
140	0.854	320	1.000
150	1.000	330	1.000
160	1.000	340	0.959
170	1.000	350	0.909







FACE A FED WITH −10 dB DIRECTIONAL COUPLER
TO DIGITAL 'D' PORT OF HYBRID AT
INPUT OF RADIATOR FOR 88.1 MHz STATION ONLY

ANTENNA HEADINGS 92°, 212° & 332° T

SHIVELY LABS
A DIVISION OF HOWELL LABORATORIES INC.,BRIDGTON, MAINE

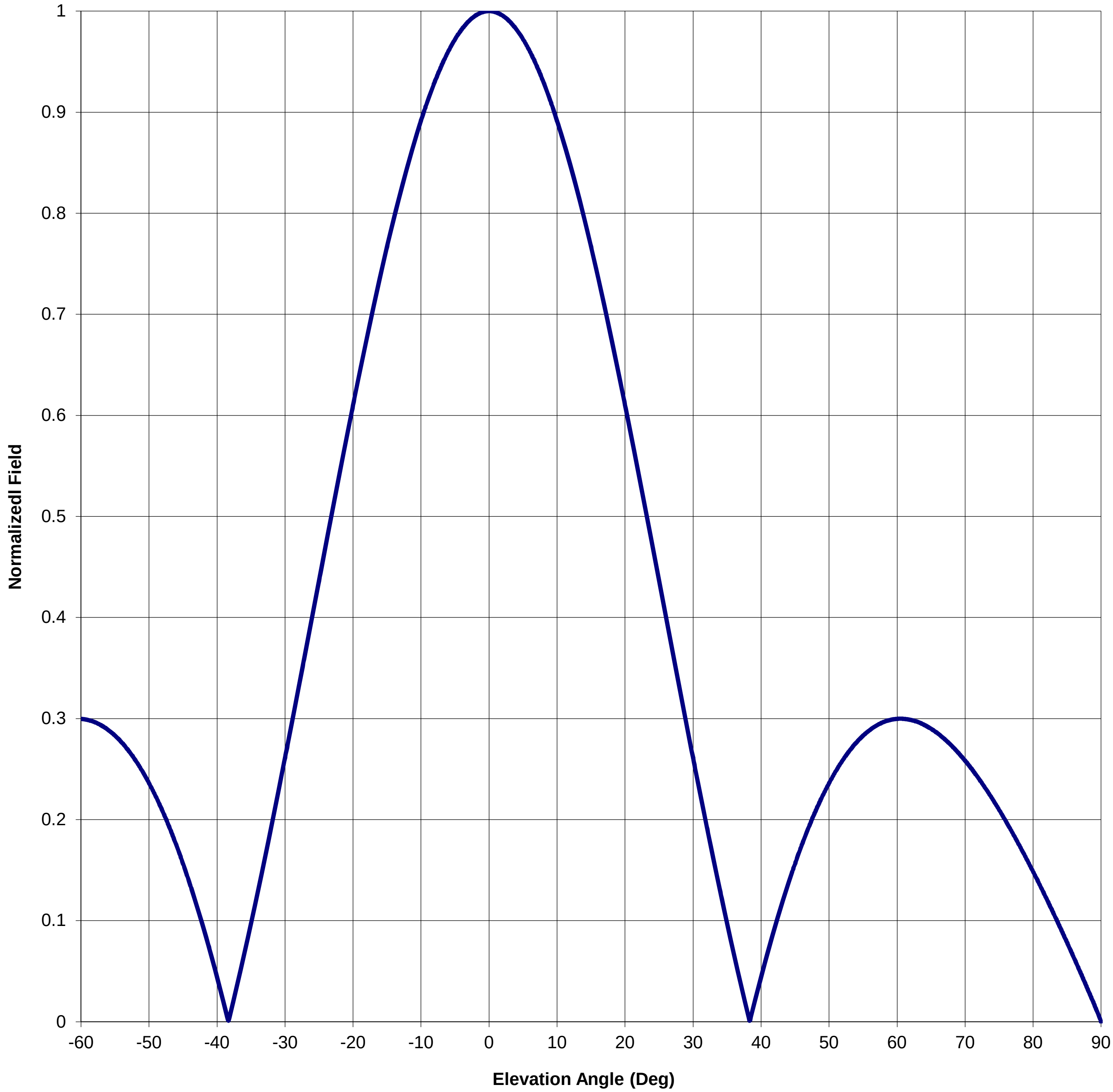
SHOP ORDER:	FREQUENCY:	SCALE:	DRAWN BY: / APPROVED BY:
29014	89.5 106.1 88.1	N.T.S.	DAB ASP

TITLE: MODEL-6014-2/3R-DIRECTIONAL ANTENNA

DATE: 8/2/12

FIGURE 2

Antenna Mfg.:	**Shively Labs**			**Date:**	**8/1/2012**
Antenna Type:	**6014-2/3R-DA**				
Station:	**WNCH**	**Beam Tilt**	**0**		
Frequency:	**88.1**	**Gain (Max)**	**2.028**	**3.071**	**dB**
Channel #:	**201**	**Gain (Horizon)**	**2.028**	**3.071**	**dB**
Figure:	**Figure 3**				



Antenna Mfg.:	**Shively Labs**			**Date:**	**8/1/2012**
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Channel #:	**201**	**Gain (Horizon)**	**2.028**	**3.071**	**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	0.137	0	1.000	46	0.175
-89	0.017	-43	0.115	1	0.999	47	0.192
-88	0.033	-42	0.093	2	0.996	48	0.208
-87	0.048	-41	0.069	3	0.990	49	0.223
-86	0.063	-40	0.044	4	0.982	50	0.236
-85	0.078	-39	0.018	5	0.972	51	0.248
-84	0.093	-38	0.009	6	0.960	52	0.259
-83	0.107	-37	0.038	7	0.946	53	0.268
-82	0.121	-36	0.067	8	0.930	54	0.276
-81	0.135	-35	0.097	9	0.912	55	0.283
-80	0.149	-34	0.129	10	0.892	56	0.289
-79	0.162	-33	0.161	11	0.870	57	0.293
-78	0.174	-32	0.194	12	0.846	58	0.296
-77	0.187	-31	0.227	13	0.821	59	0.299
-76	0.198	-30	0.261	14	0.795	60	0.300
-75	0.210	-29	0.296	15	0.767	61	0.300
-74	0.221	-28	0.331	16	0.738	62	0.299
-73	0.231	-27	0.366	17	0.707	63	0.297
-72	0.241	-26	0.401	18	0.676	64	0.294
-71	0.250	-25	0.437	19	0.643	65	0.290
-70	0.258	-24	0.472	20	0.610	66	0.285
-69	0.266	-23	0.507	21	0.576	67	0.280
-68	0.273	-22	0.542	22	0.542	68	0.273
-67	0.280	-21	0.576	23	0.507	69	0.266
-66	0.285	-20	0.610	24	0.472	70	0.258
-65	0.290	-19	0.643	25	0.437	71	0.250
-64	0.294	-18	0.676	26	0.401	72	0.241
-63	0.297	-17	0.707	27	0.366	73	0.231
-62	0.299	-16	0.738	28	0.331	74	0.221
-61	0.300	-15	0.767	29	0.296	75	0.210
-60	0.300	-14	0.795	30	0.261	76	0.198
-59	0.299	-13	0.821	31	0.227	77	0.187
-58	0.296	-12	0.846	32	0.194	78	0.174
-57	0.293	-11	0.870	33	0.161	79	0.162
-56	0.289	-10	0.892	34	0.129	80	0.149
-55	0.283	-9	0.912	35	0.097	81	0.135
-54	0.276	-8	0.930	36	0.067	82	0.121
-53	0.268	-7	0.946	37	0.038	83	0.107
-52	0.259	-6	0.960	38	0.009	84	0.093
-51	0.248	-5	0.972	39	0.018	85	0.078
-50	0.236	-4	0.982	40	0.044	86	0.063
-49	0.223	-3	0.990	41	0.069	87	0.048
-48	0.208	-2	0.996	42	0.093	88	0.033
-47	0.192	-1	0.999	43	0.115	89	0.017
-46	0.175	0	1.000	44	0.137	90	0.000
-45	0.156			45	0.156		

S.O. 29014 Figure 4

VALIDATION OF TOTAL POWER GAIN CALCULATION

WHCH NORWICH, VT.

MODEL 6014-2/3-DA

Elevation Gain of Antenna 0.99

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

H RMS	0.716204	V RMS	0.681674	H/V Ratio	1.051

Elevation Gain of Horizontal Component	1.040
Elevation Gain of Vertical Component	0.942
Horizontal Azimuth Gain equals $1/(RMS)^2$.	1.950
Vertical Azimuth Gain equals $1/(RMS/Max Vert)^2$.	1.902

Max. Vertical 0.94

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

Total Horizontal Power Gain = **2.028**

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

Total Vertical Power Gain = **1.792**

===

ERP divided by Horizontal Power Gain equals Antenna Input Power

1.55 kW ERP Divided by H Gain 2.028 equals 0.764 kW H Antenna Input Power

Antenna Input Power times Vertical Power Gain equals Vertical ERP

0.764 kW Times V Gain 1.792 equals 1.370 kW V ERP

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

(0.94)^2 Times 1.55 Equals 1.370 kW Vertical ERP

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