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S.O. 29037

Report of Test Scala CA-2 Slant (45º) Yagi Array

for

Highland Community Broadcasting

WCNU 91.5 MHz Bow, NH

OBJECTIVE:

The objective of this test was to demonstrate the directional characteristics of a Scala CA-2 Slant (45º) Yagi Array to meet the needs of WCNU and to comply with the requirements of the FCC construction permit, file number BMPED-20100916ABJ. 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-20100916ABJ indicates that the Horizontal radiation component shall not exceed 0.190 kW at any azimuth and is restricted to the following values at the azimuths specified:

087 - 227 Degrees T: 0.006kW

From Figure 1A, the maximum radiation of the Horizontal component occurs at 335 Degrees T. At the restricted azimuth of 210 Degrees T. the Vertical component is 20.92 dB down from the maximum of 0.190 kW, or 0.002 kW.

The R.M.S. of the Horizontal component is 0.402. The total Horizontal power gain is 3.047. The R.M.S. of the Vertical component is 0.400. The total Vertical power gain is 1.902. See Figure 4 for calculations. The R.M.S. of the FCC composite pattern is 0.493. The R.M.S. of the measured composite pattern is 0.445. Eighty-five percent (85%) of the original authorized FCC composite pattern is 0.419. Therefore this pattern complies with the FCC requirement of 73.316(c)(2)(ix)(A).

METHOD OF DIRECTIONALIZATION:
One bay of the Scala CA-2 Slant (45º) Yagi Array was mounted on a pole of precise scale to the pole at the WCNU site. The spacing of the antenna to the pole was varied to achieve the horizontal and vertical patterns shown in Figure 1A. See Figure 2 for mechanical details.

METHOD OF MEASUREMENT:
As allowed by the construction permit, file number BMPED-20100916ABJ, a single level of the Scala CA-2 Slant (45º) Yagi Array 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 411.75 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 29037
May 2, 2011

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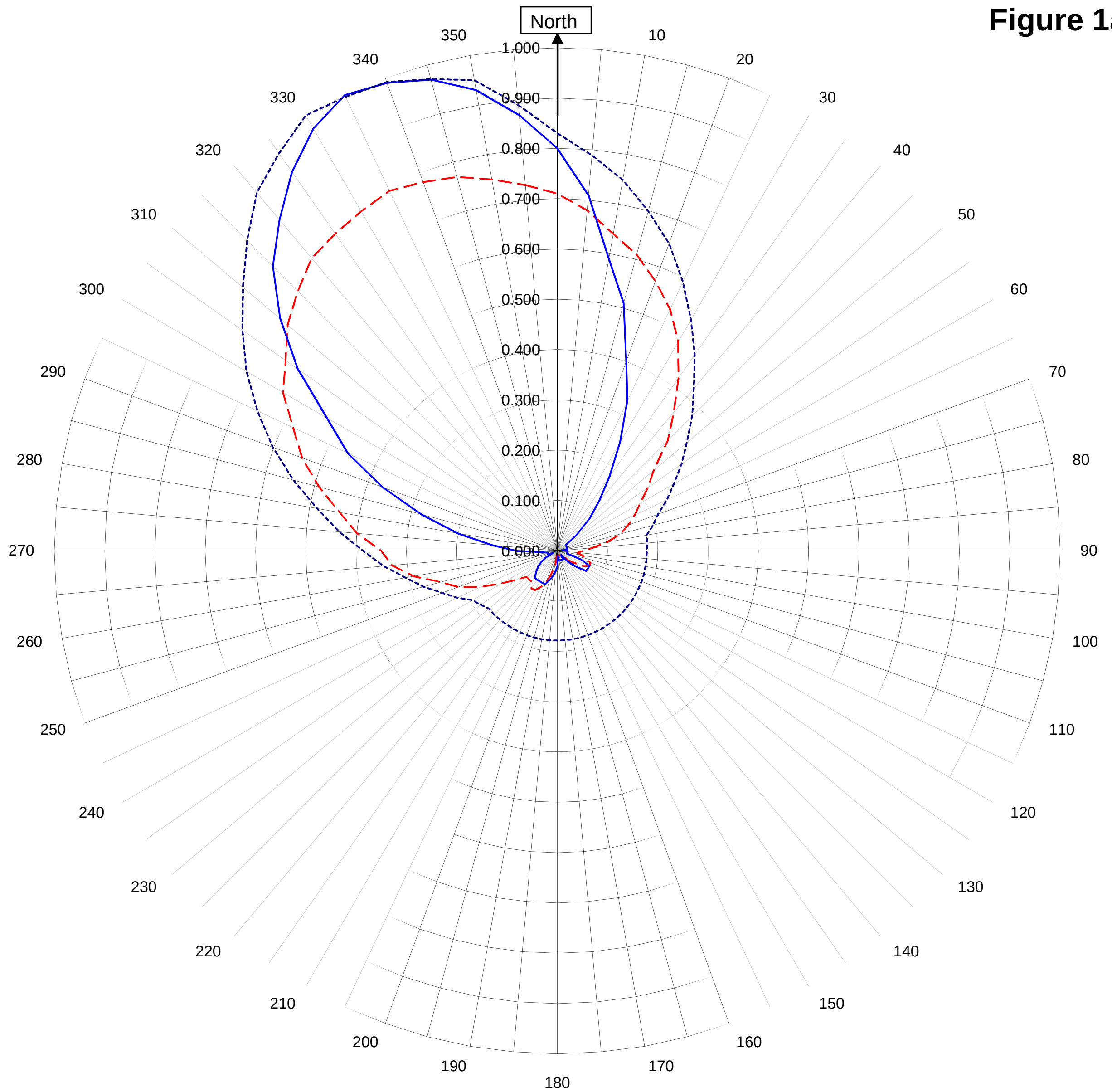
Figure 1a



WCNU Bow, NH

29037

May 2, 2011

Horizontal RMS	0.402
Vertical RMS	0.400
H/V Composite RMS	0.445
……………FCC Composite RMS	0.493

Frequency	91.5 / 411.75 mHz
Plot	Relative Field
Scale	4.5 : 1
	See Figure 2 for Mechanical Details

Antenna Model	Scala CA-2 Slant (45°) Yagi Array
Pattern Type	Directional Azimuth

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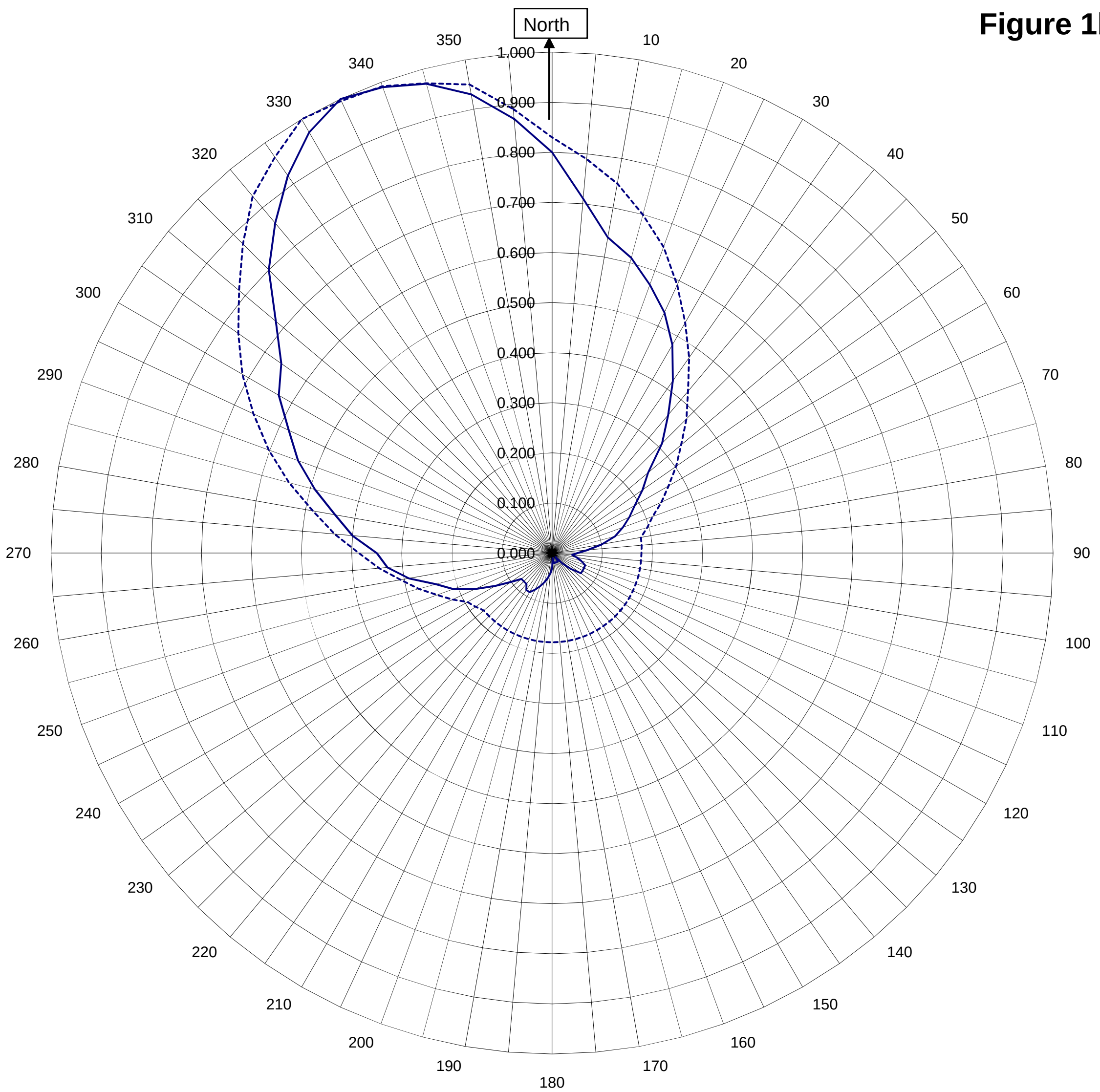
Figure 1b



WCNU Bow, NH

29037

May 2, 2011

__________H/VComposite RMS	0.445
……………FCC Composite RMS	0.493

Frequency	91.5 / 411.75 mHz
Plot	Relative Field
Scale	4.5 : 1
	See Figure 2 for Mechanical Details

Antenna Model	Scala CA-2 Slant (45°) Yagi Array
Pattern Type	Directional H/V Composite

Figure 1c

Tabulation of Horizontal Azimuth Pattern
WCNU Bow, NH

Azimuth	Rel Field	Azimuth	Rel Field
0	0.800	180	0.030
10	0.590	190	0.050
20	0.400	200	0.070
30	0.250	210	0.070
40	0.130	220	0.070
45	0.090	225	0.060
50	0.050	230	0.050
60	0.020	240	0.030
70	0.020	250	0.020
80	0.020	260	0.020
90	0.020	270	0.080
100	0.020	280	0.200
110	0.050	290	0.370
120	0.070	300	0.530
130	0.050	310	0.720
135	0.030	315	0.800
140	0.010	320	0.860
150	0.020	330	0.970
160	0.020	335	1.000
170	0.020	340	0.990
		350	0.930

Figure 1d

Tabulation of Vertical Azimuth Pattern
WCNU Bow, NH

Azimuth	Rel Field	Azimuth	Rel Field
0	0.710	180	0.010
10	0.640	190	0.030
20	0.570	200	0.070
30	0.480	210	0.090
40	0.360	220	0.080
45	0.310	225	0.080
50	0.250	230	0.080
60	0.190	240	0.130
70	0.150	250	0.210
80	0.100	260	0.290
90	0.050	270	0.350
100	0.050	280	0.440
110	0.070	290	0.540
120	0.060	300	0.630
130	0.030	310	0.700
135	0.010	315	0.730
140	0.010	320	0.760
150	0.010	330	0.780
160	0.010	340	0.780
170	0.010	350	0.750

Figure 1e

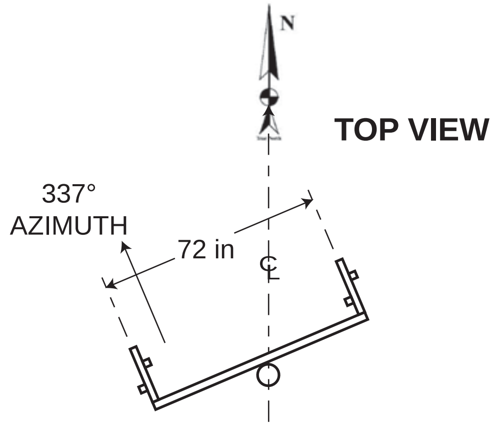
Tabulation of Composite Azimuth Pattern
WCNU Bow, NH

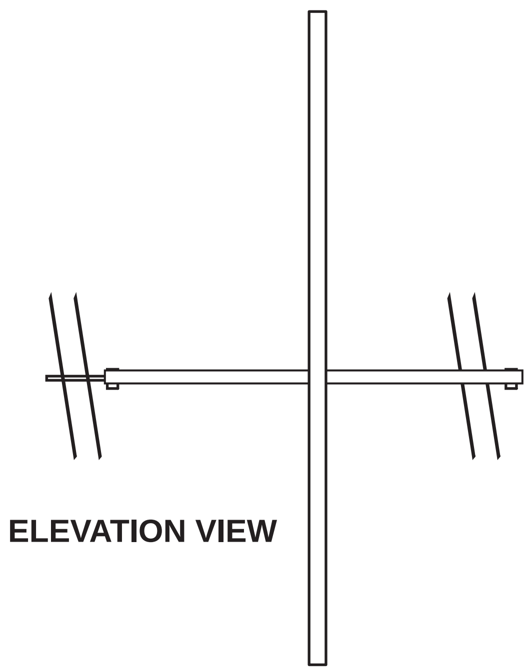
Azimuth	Rel Field	Azimuth	Rel Field
0	0.800	180	0.030
10	0.640	190	0.050
20	0.570	200	0.070
30	0.480	210	0.090
40	0.360	220	0.080
45	0.310	225	0.080
50	0.250	230	0.080
60	0.190	240	0.130
70	0.150	250	0.210
80	0.100	260	0.290
90	0.050	270	0.350
100	0.050	280	0.440
110	0.070	290	0.540
120	0.070	300	0.630
130	0.050	310	0.720
135	0.030	315	0.800
140	0.010	320	0.860
150	0.020	330	0.970
160	0.020	335	1.000
170	0.020	340	0.990
		350	0.930

Figure 1f

Tabulation of FCC Directional Composite
WCNU Bow, NH

Azimuth	Rel Field	Azimuth	Rel Field
0	0.830	180	0.178
10	0.749	190	0.178
20	0.650	200	0.178
30	0.531	210	0.178
40	0.422	220	0.178
50	0.336	230	0.178
60	0.268	240	0.195
70	0.213	250	0.244
80	0.180	260	0.307
90	0.178	270	0.386
100	0.178	280	0.485
110	0.178	290	0.602
120	0.178	300	0.714
130	0.178	310	0.816
140	0.178	320	0.930
150	0.178	330	1.000
160	0.178	340	0.992
170	0.178	350	0.950





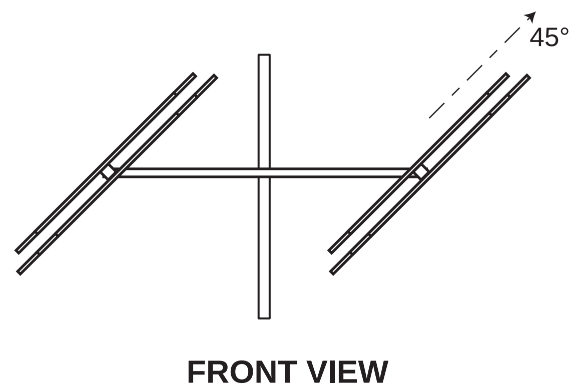


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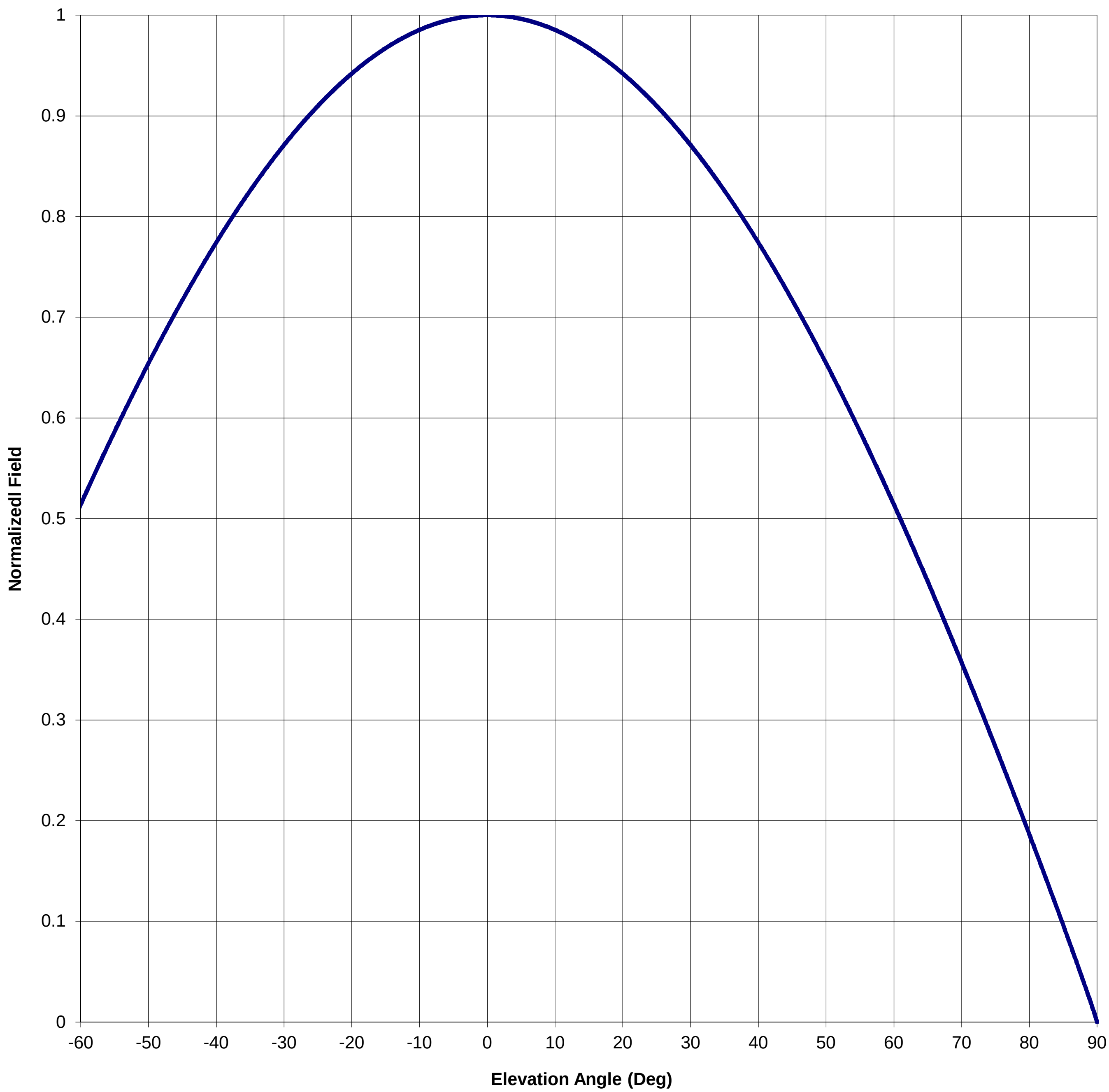
FIGURE 2, WCNU, 91.5 MHz
SCALA CA-2 SLANT (45°) YAGI ARRAY

SIZE	CODE IDENT. NO.	DRAWING NO.	REV
A	26750	AGF110427-001	—
SCALE NONE		S/O 29037	SHEET 1 OF 1

Antenna Mfg.:	**Shively Labs**			**Date:**	**4/28/2011**
Antenna Type:	**Scala CA-2 Slant (45º) Yagi Array**				
Station:	**WCNU**	**Beam Tilt**	**0**		
Frequency:	**91.5**	**Gain (Max)**	**3.047**	**4.838**	**dB**
Channel #:	**218**	**Gain (Horizon)**	**3.047**	**4.838**	**dB**
Figure:	**Figure 3**				



Antenna Mfg.:	**Shively Labs**			**Date: 4/28/2011**
Antenna Type:	**Scala CA-2 Slant (45º) Yagi Array**			
Station:	**WCNU**	**Beam Tilt**	**0**	
Frequency:	**91.5**	**Gain (Max)**	**3.047**	**4.838 dB**
Channel #:	**218**	**Gain (Horizon)**	**3.047**	**4.838 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	0.729	0	1.000	46	0.705
-89	0.021	-43	0.741	1	1.000	47	0.693
-88	0.040	-42	0.752	2	0.999	48	0.680
-87	0.059	-41	0.763	3	0.999	49	0.667
-86	0.078	-40	0.774	4	0.998	50	0.654
-85	0.096	-39	0.785	5	0.996	51	0.641
-84	0.114	-38	0.796	6	0.995	52	0.628
-83	0.133	-37	0.806	7	0.993	53	0.614
-82	0.151	-36	0.816	8	0.991	54	0.600
-81	0.168	-35	0.826	9	0.988	55	0.586
-80	0.186	-34	0.835	10	0.985	56	0.572
-79	0.204	-33	0.845	11	0.982	57	0.558
-78	0.221	-32	0.854	12	0.979	58	0.544
-77	0.239	-31	0.862	13	0.975	59	0.529
-76	0.256	-30	0.871	14	0.971	60	0.514
-75	0.273	-29	0.879	15	0.967	61	0.499
-74	0.290	-28	0.887	16	0.963	62	0.484
-73	0.307	-27	0.895	17	0.958	63	0.469
-72	0.324	-26	0.903	18	0.953	64	0.453
-71	0.341	-25	0.910	19	0.948	65	0.437
-70	0.357	-24	0.917	20	0.942	66	0.422
-69	0.373	-23	0.924	21	0.936	67	0.406
-68	0.390	-22	0.930	22	0.930	68	0.390
-67	0.406	-21	0.936	23	0.924	69	0.373
-66	0.422	-20	0.942	24	0.917	70	0.357
-65	0.437	-19	0.948	25	0.910	71	0.341
-64	0.453	-18	0.953	26	0.903	72	0.324
-63	0.469	-17	0.958	27	0.895	73	0.307
-62	0.484	-16	0.963	28	0.887	74	0.290
-61	0.499	-15	0.967	29	0.879	75	0.273
-60	0.514	-14	0.971	30	0.871	76	0.256
-59	0.529	-13	0.975	31	0.862	77	0.239
-58	0.544	-12	0.979	32	0.854	78	0.221
-57	0.558	-11	0.982	33	0.845	79	0.204
-56	0.572	-10	0.985	34	0.835	80	0.186
-55	0.586	-9	0.988	35	0.826	81	0.168
-54	0.600	-8	0.991	36	0.816	82	0.151
-53	0.614	-7	0.993	37	0.806	83	0.133
-52	0.628	-6	0.995	38	0.796	84	0.114
-51	0.641	-5	0.996	39	0.785	85	0.096
-50	0.654	-4	0.998	40	0.774	86	0.078
-49	0.667	-3	0.999	41	0.763	87	0.059
-48	0.680	-2	0.999	42	0.752	88	0.040
-47	0.693	-1	1.000	43	0.741	89	0.021
-46	0.705	0	1.000	44	0.729	90	0.000
-45	0.717			45	0.717		

S.O. 29037 Figure 4

VALIDATION OF TOTAL POWER GAIN CALCULATION

WCNU 91.5 Mhz Bow, NH

Scala CA-2 Slant (45°) Yagi Array

Elevation Gain of Antenna 0.49

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

H RMS 0.402 V RMS 0.4 H/V Ratio 1.005

Elevation Gain of Horizontal Component 0.492

Elevation Gain of Vertical Component 0.488

Horizontal Azimuth Gain equals $1/(RMS)^2$. 6.188

Vertical Azimuth Gain equals $1/(RMS/Max\ Vert)^2$. 3.901
Max. Vertical 0.79

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

Total Horizontal Power Gain = **3.047**

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

Total Vertical Power Gain = **1.902**

==

ERP divided by Horizontal Power Gain equals Antenna Input Power

0.19 kW ERP Divided by H Gain 3.047 equals 0.06 kW H Antenna Input Power

Antenna Input Power times Vertical Power Gain equals Vertical ERP

0.06 kW Times V Gain 1.902 equals 0.12 kW V ERP

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

(0.79)^2 Times 0.19 Equals 0.12 kW Vertical ERP

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