

***Directional Antenna System
for
WNCL, Milford, Delaware***

June 1, 2017

Electronics Research Inc. is providing a custom fabricated antenna system that is specially designed to meet the FCC requirements and the general needs of radio station WNCL.

The antenna is the ERI model LP-4E-DA configuration. The circular polarized system consists of 4 full-wavelength spaced bays using one driven circular polarized radiating element, one horizontal parasitic elements placed one quarter wave above and below each bay and four vertical parasitic elements per bay. The antenna was mounted on the North 171 degrees East tower face with bracketry to provide an antenna orientation of North 171 degrees East. The antenna was tested on a 24" face tower, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 101.3 megahertz, which is the center of the FM broadcast channel assigned to WNCL.

Pattern measurements were made on a sixty-acre antenna pattern range that is owned and operated by Electronics Research, Inc. The tests were performed under the direction of Thomas B. Silliman, president of Electronics Research, Inc. Mr. Silliman has the Bachelor of Electrical Engineering and the Master of Electrical Engineering degrees from Cornell University and is a registered professional engineer in the states of Indiana, Maryland and Minnesota.



Directional Antenna System For WNCL, Milford, Delaware

(Continued)

DESCRIPTION OF THE TEST PROCEDURE

The test antenna consisted of two bay levels of the circular polarized system with the associated horizontal and vertical parasitic elements. The elements and brackets that were used in this test are electrically equivalent to those that will be supplied with the antenna. A section of 1 5/8 inch o.d. rigid coaxial line was used to feed the test antenna, and a section of 1 5/8 inch o.d. rigid outer conductor only was attached above the test antenna. The lines were properly grounded during all tests.

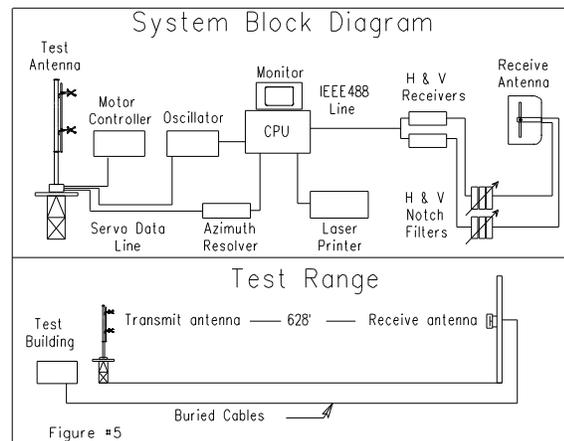
The power distribution and phase relationship to the antenna elements was adjusted in order to achieve the directional radiation patterns for both horizontal and vertical polarization components.

The proof-of-performance was accomplished using a 24" face tower with identical dimension and configuration including all braces, ladders, conduits, coaxial lines and other appurtenances that are included in the actual aperture at which the antenna will be installed. The structure was erected vertically on a turntable

mounted on a non-metallic building with the antenna centered vertically on the structure, making the center of radiation of the test approximately 30 feet above ground. The turntable is equipped with a motor drive and a US Digital angle position indicator. The resolution of this angle position indicator is one-hundredth of a degree.

The antenna under test was operated in the transmitting mode and fed from a HP8657D signal generator. The frequency of the signal source was set at 101.3 MHz and was constantly monitored by a Rohde & Schwarz ESVD measuring receiver.

A broadband horizontal and vertical dipole system, located approximately 628 feet from the test antenna, was used to receive the emitted test signals.



Directional Antenna System For WNCL, Milford, Delaware

(Continued)

The dipole system was mounted at the same height above terrain as the center of the antenna under test. The signals received by the dipole system were fed to the test building by way of two buried Heliac cables to a Rohde & Schwarz measuring receiver. This data was interfaced to a laser jet printer by means of a computer system. Relative field strength was plotted as a function of azimuth.

The measurements were performed by rotating the test antenna in a counter-clockwise direction and plotting the received signal on polar coordinated graph paper in a clockwise direction. Both horizontal and vertical components were recorded separately.

CONCLUSIONS

The circular polarized system consists of 4 full-wavelength spaced bays using one driven circular polarized radiating element, one horizontal parasitic elements placed one quarter wave above and below each bay and four vertical parasitic elements per bay. The power distribution and phase relationship will be fixed when the antenna is manufactured. Proper maintenance of the elements should be all that is required to maintain the pattern in adjustment.

The LP-4E-DA array is to be mounted on the North 171 degrees East tower face of the 24" face tower at a bearing of North 171 degrees East. Blue prints provided with the antenna will show the proper antenna orientation alignment. The antenna alignment procedure should be directed by a licensed surveyor as prescribed by the FCC.

Figure #1 represents the measured individual horizontal and vertical components, the composite maximum of either the horizontal or vertical component at any azimuth and the FCC filed envelope pattern. The horizontal plane relative field list for the composite pattern and the individual H & V components are shown as Figure #1 & 1A respectively. The actual measured pattern does not exceed the authorized FCC composite pattern at any azimuth. A calculated vertical plane relative field pattern is shown on Figure #3 attached. The power in the maximum will reach 6 kilowatts (7.782 dBk).

The power at North 325 degrees East does not exceed 3.400 kilowatts (5.315 dBk).

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(Continued)

The RMS of the vertically polarized horizontal plane component does not exceed the RMS of the horizontally polarized horizontal plane component.

The composite horizontal and vertical maximum relative field pattern obtained from the measured data as shown on Figure #1 has an RMS that is greater than 85% of the filed composite pattern.

The clear vertical length of the structure required to support the antenna is 44 feet.

The directional antenna should not be mounted on the top of an antenna tower that includes a top-mounted platform larger than the cross-sectional area of the tower in the horizontal plane. No obstructions other than those that are specified by the blue prints supplied with the antenna are to be mounted within 75 ft. horizontally of the system. The vertical distance to the nearest obstruction should be a minimum of 10 ft. from the directional antenna. Metallic guy wires should be a minimum distance of forty feet horizontally from the antenna.

ELECTRONICS RESEARCH, INC.

A handwritten signature in black ink, appearing to read "Tom Scharf". The signature is written in a cursive style with a large initial "T" and a long, sweeping underline.

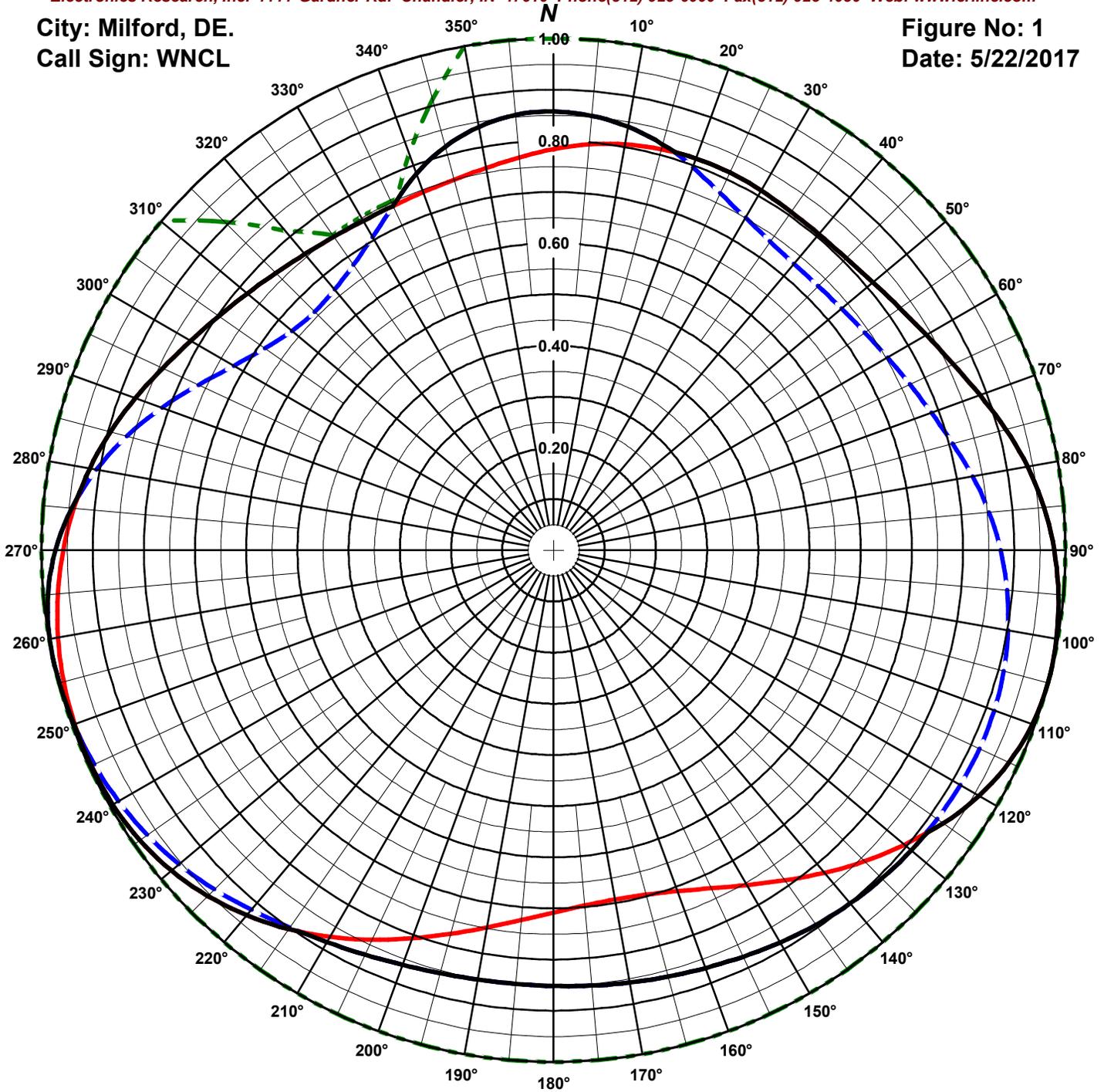
The Microsoft Word document on file electronically at Electronic Research, Inc. governs the specifications, scope, and configuration of the product described. All other representations whether verbal, printed, or electronic are subordinate to the master copy of this document on file at ERI.

ERI[®] Horizontal Plane Relative Field Pattern

Electronics Research, Inc. 7777 Gardner Rd. Chandler, IN 47610 Phone(812) 925-6000 Fax(812) 925-4030 Web: www.eriinc.com

City: Milford, DE.
Call Sign: WNCL

Figure No: 1
Date: 5/22/2017



Antenna Orientation: 171° True

Frequency: 101.3 MHz
Antenna Type: LP-4E-DA

Antenna Mounting: Standard
Tower Type: 24" face tower

HORIZONTAL

RMS: .857
Maximum: 1 @ 105°
Minimum: .693 @ 170°

VERTICAL

RMS: .851
Maximum: 1 @ 258°
Minimum: .659 @ 315°

COMPOSITE

RMS: .886
Maximum: 1 @ 105°
Minimum: .742 @ 334°

FCC ENVELOPE

RMS: .984
Maximum: 1 @ 0°
Minimum: .752 @ 325°

Measured patterns of the horizontal and vertical components. The composite pattern shows the maximum of either the H or V azimuth values. This patterns is greater than 85% of the FCC filed composite pattern BPH-20160426AAF.

ERI[®] Horizontal Plane Relative Field Pattern

Electronics Research, Inc. 7777 Gardner Rd. Chandler, IN 47610 Phone(812) 925-6000 Fax(812) 925-4030 Web: www.eriinc.com

Figure# 1

Station: WNCL

Location: Milford, DE.

Frequency: 101.3 MHz

Date: 5/22/2017

Antenna: LP-4E-DA

Antenna Orientation: 171° True

Number of Bays: 4

Azimuth	Envelope			Polarization	Azimuth	Envelope			Polarization
	Field	kW	dBk	Maximum		Field	kW	dBk	Maximum
0°	0.857	4.410	6.444	Vertical	180°	0.852	4.352	6.387	Vertical
5°	0.852	4.356	6.391	Vertical	185°	0.851	4.341	6.376	Vertical
10°	0.840	4.235	6.268	Vertical	190°	0.852	4.352	6.387	Vertical
15°	0.822	4.051	6.075	Vertical	195°	0.856	4.392	6.427	Vertical
20°	0.815	3.981	6.000	Horizontal	200°	0.862	4.462	6.495	Vertical
25°	0.814	3.979	5.998	Horizontal	205°	0.872	4.561	6.591	Vertical
30°	0.812	3.953	5.969	Horizontal	210°	0.884	4.691	6.713	Vertical
35°	0.808	3.917	5.929	Horizontal	215°	0.904	4.899	6.901	Horizontal
40°	0.806	3.899	5.910	Horizontal	220°	0.931	5.204	7.163	Horizontal
45°	0.808	3.917	5.930	Horizontal	225°	0.955	5.473	7.383	Horizontal
50°	0.814	3.980	5.999	Horizontal	230°	0.974	5.693	7.553	Horizontal
55°	0.825	4.088	6.116	Horizontal	235°	0.987	5.847	7.669	Horizontal
60°	0.841	4.245	6.279	Horizontal	240°	0.994	5.927	7.728	Horizontal
65°	0.861	4.452	6.485	Horizontal	245°	0.996	5.951	7.746	Horizontal
70°	0.886	4.712	6.732	Horizontal	250°	0.996	5.952	7.746	Vertical
75°	0.915	5.019	7.006	Horizontal	255°	0.999	5.992	7.776	Vertical
80°	0.940	5.305	7.247	Horizontal	260°	0.999	5.993	7.777	Vertical
85°	0.961	5.547	7.440	Horizontal	265°	0.991	5.892	7.702	Vertical
90°	0.978	5.739	7.589	Horizontal	270°	0.973	5.677	7.541	Vertical
95°	0.990	5.881	7.694	Horizontal	275°	0.944	5.348	7.282	Vertical
100°	0.997	5.968	7.759	Horizontal	280°	0.920	5.074	7.053	Horizontal
105°	1.000	6.000	7.782	Horizontal	285°	0.896	4.815	6.826	Horizontal
110°	0.995	5.942	7.739	Horizontal	290°	0.869	4.530	6.561	Horizontal
115°	0.982	5.782	7.621	Horizontal	295°	0.842	4.255	6.289	Horizontal
120°	0.960	5.529	7.426	Horizontal	300°	0.818	4.018	6.041	Horizontal
125°	0.930	5.185	7.148	Horizontal	305°	0.798	3.819	5.820	Horizontal
130°	0.912	4.989	6.980	Vertical	310°	0.780	3.655	5.629	Horizontal
135°	0.907	4.938	6.935	Vertical	315°	0.766	3.524	5.470	Horizontal
140°	0.901	4.873	6.878	Vertical	320°	0.755	3.424	5.346	Horizontal
145°	0.894	4.794	6.807	Vertical	325°	0.748	3.355	5.257	Horizontal
150°	0.885	4.702	6.723	Vertical	330°	0.743	3.314	5.204	Horizontal
155°	0.876	4.609	6.636	Vertical	335°	0.742	3.304	5.191	Horizontal
160°	0.869	4.530	6.561	Vertical	340°	0.783	3.680	5.658	Vertical
165°	0.863	4.465	6.498	Vertical	345°	0.816	3.999	6.020	Vertical
170°	0.858	4.413	6.448	Vertical	350°	0.840	4.233	6.266	Vertical
175°	0.854	4.376	6.411	Vertical	355°	0.854	4.372	6.407	Vertical

Horizontal Polarization:

Maximum: 2.776 (4.435 dB)

Horizontal Plane: 2.776 (4.435 dB)

Maximum ERP: 6.000 kW

Vertical Polarization:

Maximum: 2.776 (4.435 dB)

Horizontal Plane: 2.776 (4.435 dB)

Maximum ERP: 6.000 kW

Total Input Power: 2.161 kW

Reference: WNCL1M.FIG

This list shows the the maximum azimuth values of either the horizontal or vertical components.

ERI[®] Horizontal Plane Relative Field Pattern

Electronics Research, Inc. 7777 Gardner Rd. Chandler, IN 47610 Phone(812) 925-6000 Fax(812) 925-4030 Web: www.eriinc.com

Figure# 1A

Date: 5/22/2017

Station: WNCL

Antenna: LP-4E-DA

Location: Milford, DE.

Antenna Orientation: 171° True

Frequency: 101.3 MHz

Number of Bays: 4

Azimuth	Horizontal			Vertical			Azimuth	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.784	3.689	5.669	0.857	4.410	6.444	180°	0.708	3.009	4.785	0.852	4.352	6.387
5°	0.796	3.804	5.802	0.852	4.356	6.391	185°	0.726	3.160	4.997	0.851	4.341	6.376
10°	0.805	3.892	5.902	0.840	4.235	6.268	190°	0.749	3.362	5.266	0.852	4.352	6.387
15°	0.811	3.951	5.967	0.822	4.051	6.075	195°	0.776	3.615	5.581	0.856	4.392	6.427
20°	0.815	3.981	6.000	0.797	3.807	5.806	200°	0.807	3.910	5.921	0.862	4.462	6.495
25°	0.814	3.979	5.998	0.770	3.559	5.513	205°	0.840	4.232	6.265	0.872	4.561	6.591
30°	0.812	3.953	5.969	0.750	3.378	5.287	210°	0.872	4.568	6.597	0.884	4.691	6.713
35°	0.808	3.917	5.929	0.737	3.260	5.133	215°	0.904	4.899	6.901	0.899	4.853	6.860
40°	0.806	3.899	5.910	0.731	3.202	5.054	220°	0.931	5.204	7.163	0.917	5.049	7.032
45°	0.808	3.917	5.930	0.731	3.202	5.055	225°	0.955	5.473	7.383	0.937	5.269	7.217
50°	0.814	3.980	5.999	0.735	3.239	5.104	230°	0.974	5.693	7.553	0.954	5.466	7.377
55°	0.825	4.088	6.116	0.742	3.306	5.193	235°	0.987	5.847	7.669	0.969	5.634	7.508
60°	0.841	4.245	6.279	0.753	3.405	5.321	240°	0.994	5.927	7.728	0.981	5.772	7.613
65°	0.861	4.452	6.485	0.768	3.537	5.486	245°	0.996	5.951	7.746	0.990	5.878	7.692
70°	0.886	4.712	6.732	0.786	3.703	5.686	250°	0.995	5.937	7.736	0.996	5.952	7.746
75°	0.915	5.019	7.006	0.807	3.907	5.919	255°	0.990	5.883	7.696	0.999	5.992	7.776
80°	0.940	5.305	7.247	0.831	4.148	6.178	260°	0.983	5.792	7.628	0.999	5.993	7.777
85°	0.961	5.547	7.440	0.854	4.377	6.412	265°	0.972	5.664	7.531	0.991	5.892	7.702
90°	0.978	5.739	7.589	0.873	4.577	6.606	270°	0.957	5.501	7.404	0.973	5.677	7.541
95°	0.990	5.881	7.694	0.889	4.744	6.762	275°	0.940	5.303	7.245	0.944	5.348	7.282
100°	0.997	5.968	7.759	0.902	4.878	6.882	280°	0.920	5.074	7.053	0.906	4.930	6.928
105°	1.000	6.000	7.782	0.911	4.975	6.968	285°	0.896	4.815	6.826	0.862	4.461	6.495
110°	0.995	5.942	7.739	0.916	5.035	7.020	290°	0.869	4.530	6.561	0.814	3.972	5.991
115°	0.982	5.782	7.621	0.918	5.058	7.040	295°	0.842	4.255	6.289	0.765	3.508	5.450
120°	0.960	5.529	7.426	0.917	5.049	7.032	300°	0.818	4.018	6.041	0.721	3.119	4.940
125°	0.930	5.185	7.148	0.915	5.026	7.013	305°	0.798	3.819	5.820	0.688	2.840	4.534
130°	0.895	4.807	6.818	0.912	4.989	6.980	310°	0.780	3.655	5.629	0.667	2.669	4.263
135°	0.860	4.434	6.468	0.907	4.938	6.935	315°	0.766	3.524	5.470	0.659	2.608	4.163
140°	0.823	4.063	6.088	0.901	4.873	6.878	320°	0.755	3.424	5.346	0.665	2.655	4.240
145°	0.787	3.720	5.705	0.894	4.794	6.807	325°	0.748	3.355	5.257	0.681	2.781	4.443
150°	0.756	3.425	5.346	0.885	4.702	6.723	330°	0.743	3.314	5.204	0.706	2.993	4.762
155°	0.729	3.187	5.034	0.876	4.609	6.636	335°	0.742	3.304	5.191	0.742	3.300	5.185
160°	0.709	3.015	4.793	0.869	4.530	6.561	340°	0.745	3.326	5.219	0.783	3.680	5.658
165°	0.697	2.915	4.647	0.863	4.465	6.498	345°	0.750	3.375	5.283	0.816	3.999	6.020
170°	0.693	2.882	4.597	0.858	4.413	6.448	350°	0.759	3.452	5.381	0.840	4.233	6.266
175°	0.697	2.913	4.644	0.854	4.376	6.411	355°	0.770	3.559	5.513	0.854	4.372	6.407

Horizontal Polarization:

Maximum: 2.776 (4.435 dB)

Horizontal Plane: 2.776 (4.435 dB)

Maximum ERP: 6.000 kW

Vertical Polarization:

Maximum: 2.776 (4.435 dB)

Horizontal Plane: 2.776 (4.435 dB)

Maximum ERP: 6.000 kW

Total Input Power: 2.161 kW

Reference: WNCL1M.FIG

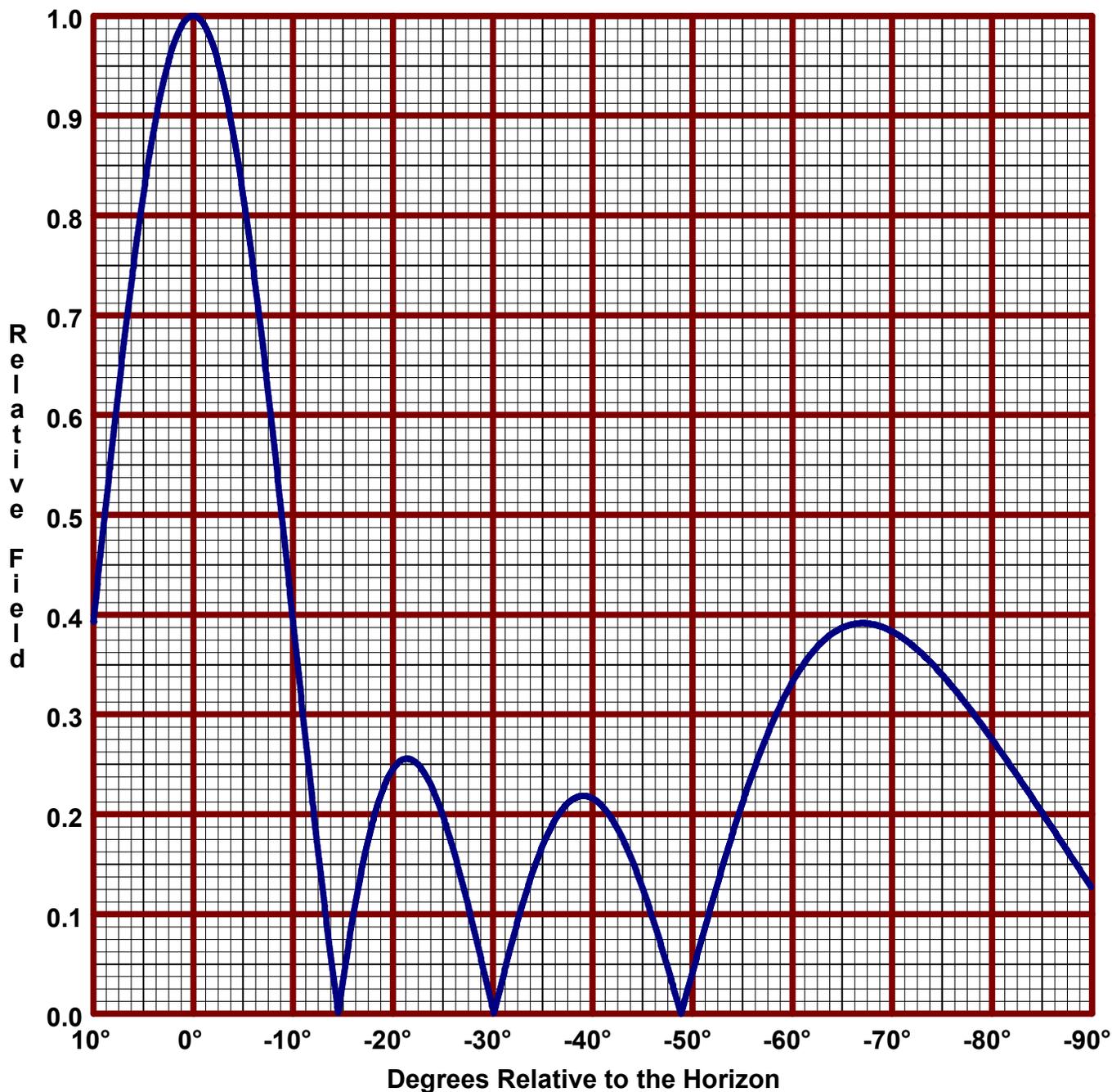
This list shows the azimuth values for the horizontal and vertical components.

ERI[®] Vertical Plane Relative Field Pattern

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Figure No: 3
Call Sign: WNCL
Location: Milford, DE.
Frequency: 101.3 MHz
Antenna: 4 bay LP-4E-DA

Date: 5/22/2017
H/V Power Ratio: 1
1 Wave-length Spacing
0° Beam Tilt
0% First Null Fill



Horizontal Polarization:
Maximum: 2.776 (4.435 dB)
Horizontal Plane: 2.776 (4.435 dB)
Maximum ERP: 6.000 kW

Vertical Polarization:
Maximum: 2.776 (4.435 dB)
Horizontal Plane: 2.776 (4.435 dB)
Maximum ERP: 6.000 kW

Directional Antenna System for WNCL, Milford, Delaware

(Continued)

ANTENNA SPECIFICATIONS

Antenna Type:	LP-4E-DA
Frequency:	101.3 MHz
Number of Bays:	Four

MECHANICAL SPECIFICATIONS

Mounting:	Standard
System length:	37 ft 7 in
Aperture length required:	44 ft
Orientation:	171° true

Input flange to the antenna 1 5/8" female.

ELECTRICAL SPECIFICATIONS

(For directional use)

Maximum horizontal ERP:	6.00 kW (7.782 dBk)
Horizontal maximum power gain:	2.776 (4.435 dB)
Maximum vertical ERP:	6.00 kW (7.782 dBk)
Vertical maximum power gain:	2.776 (4.435 dB)
Total input power:	2.161 kW (3.347 dBk)

