

## ***Directional Antenna System for WVRI, Clifton Forge, Virginia***

October 4, 2010

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 WVRI.

The antenna is the ERI model LP-2E-DA configuration. The circular polarized system consists of 2 full-wavelength spaced bays using one driven circular polarized radiating element, two horizontal parasitic elements placed one quarter wave above and below each bay and three vertical parasitic elements per bay. The antenna was mounted on the North 325 degrees East tower leg with bracketry to provide an antenna orientation of North 300 degrees East. The antenna was tested on a Rohn 45G tower, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 90.9 megahertz, which is the center of the FM broadcast channel assigned to WVRI.

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 Proposed For WVRI, Clifton Forge, Virginia

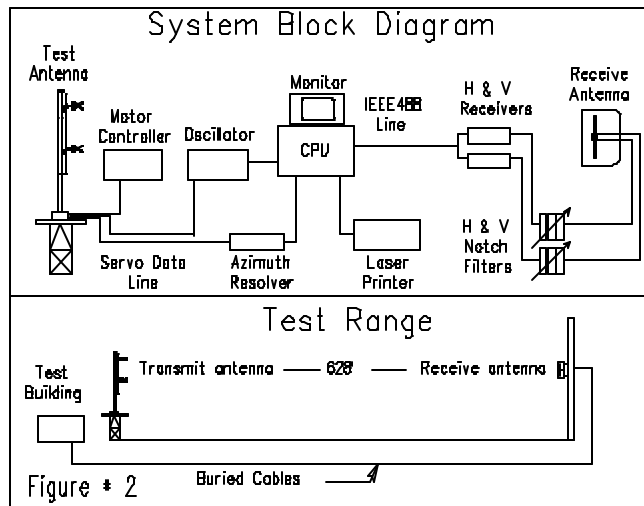
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## DESCRIPTION OF THE TEST PROCEDURE

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 Rohn 45G 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 90.9 MHz and was constantly monitored by a Rohde & Schwarz ESVD measuring receiver.

# Directional Antenna System Proposed For WVRI, Clifton Forge, Virginia

(Continued)

A broadband horizontal and vertical dipole system, located approximately 628 feet from the test antenna, was used to receive the emitted test signals. 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 2 full-wavelength spaced bays using one driven circular polarized radiating element, two horizontal parasitic elements placed one quarter wave above and below each bay and three vertical parasitic elements per bay. The power distribution and phase relationship will be fixed when antenna is manufactured. Proper maintenance of the elements should be all that is required to maintain the pattern in adjustment.

The LP-2E-DA array is to be mounted on the North 325 degrees East tower leg of the Rohn 45G tower at a bearing of North 300 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 maximum value of either the horizontal or vertical component at any azimuth. The measured horizontal plane relative field pattern, for both the horizontal and vertical polarization components, is shown on Figure #2 attached. 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 1.00 kilowatts (0.00 dBk).

The power at North 130 degrees East does not exceed 0.033 kilowatts (-14.815 dBk).

Directional Antenna System  
Proposed For  
WVRI, Clifton Forge, Virginia

(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 25 feet 9 inches.

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.



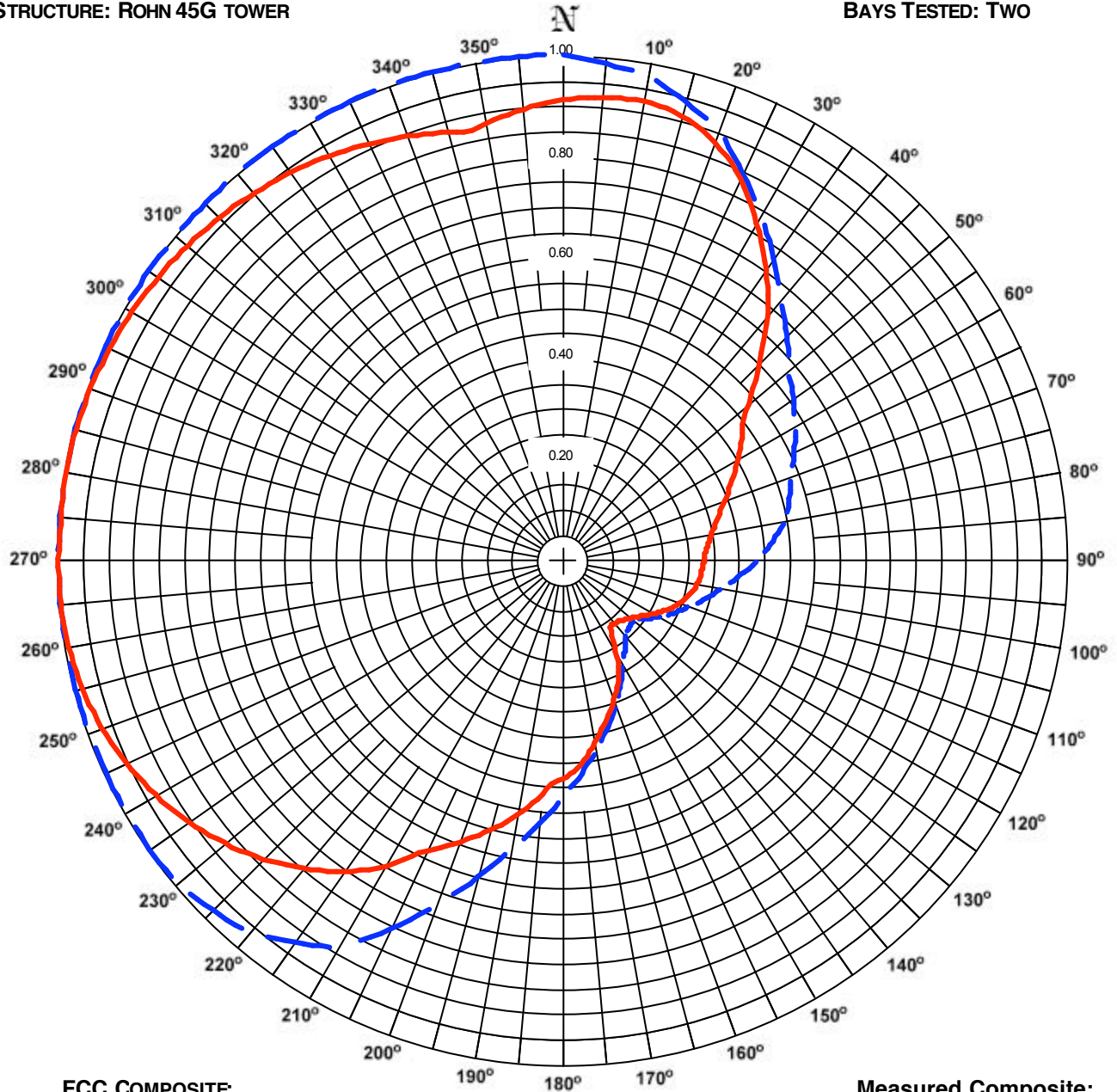
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# ERI<sup>®</sup> Horizontal Plane Relative Field Pattern

Electronics Research, Inc. 7777 Gardner Rd. Chandler, In 47610 Phone (812) 925-6000 Fax (812) 925-4030 <http://www.eriinc.com/>

FIGURE NO: 1  
STATION: WVRI  
LOCATION: CLIFTON FORGE, VA  
ANTENNA: LP-2E-DA  
STRUCTURE: ROHN 45G TOWER

DATE: 9/30/2010  
FREQUENCY: 90.9 MHz  
ORIENTATION: 300° TRUE  
MOUNTING: STANDARD  
BAYS TESTED: TWO



**FCC COMPOSITE:**  
RMS: 0.771  
MAXIMUM: 1.000 @ 0° TRUE  
MINIMUM: 0.183 @ 130° TRUE

**Measured Composite:**  
RMS: 0.714  
Maximum: 1.000 @ 267° True  
Minimum: 0.163 @ 143° True

COMMENTS: COMPOSITE PATTERN: THIS PATTERN SHOWS THE MAXIMUM OF EITHER THE H OR V AZIMUTH VALUES. THIS PATTERN IS GREATER THAN 85% OF THE FCC FILED COMPOSITE PATTERN BMPED-20100601AGR.

# ERI<sup>®</sup> *Horizontal Plane Relative Field List*

Electronics Research, Inc. 7777 Gardner Rd. Chandler, In 47610 Phone (812) 925-6000 Fax (812) 925-4030 <http://www.eriinc.com/>

**Station: WVRI**

**Location: Clifton Forge, VA**

**Frequency: 90.9 MHz**

**Antenna: LP-2E-DA**

**Orientation: 300° True**

**Tower: Rohn 45G tower**

**Figure: 1**

**Date: 9/30/2010**

**Reference: wvri1m.fig**

Angle	Envelope			Polarization	Angle	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0°	0.910	0.83	-0.82	Horizontal	180°	0.435	0.19	-7.24	Horizontal
5°	0.919	0.84	-0.73	Horizontal	185°	0.467	0.22	-6.62	Vertical
10°	0.921	0.85	-0.71	Horizontal	190°	0.515	0.27	-5.76	Vertical
15°	0.909	0.83	-0.82	Horizontal	195°	0.556	0.31	-5.10	Vertical
20°	0.880	0.77	-1.11	Horizontal	200°	0.596	0.35	-4.50	Vertical
25°	0.833	0.69	-1.59	Horizontal	205°	0.638	0.41	-3.90	Vertical
30°	0.769	0.59	-2.28	Horizontal	210°	0.702	0.49	-3.07	Horizontal
35°	0.701	0.49	-3.08	Horizontal	215°	0.756	0.57	-2.43	Horizontal
40°	0.632	0.40	-3.99	Horizontal	220°	0.801	0.64	-1.93	Horizontal
45°	0.552	0.30	-5.16	Horizontal	225°	0.840	0.71	-1.51	Horizontal
50°	0.480	0.23	-6.37	Horizontal	230°	0.876	0.77	-1.15	Horizontal
55°	0.433	0.19	-7.26	Vertical	235°	0.907	0.82	-0.85	Horizontal
60°	0.402	0.16	-7.92	Vertical	240°	0.933	0.87	-0.60	Horizontal
65°	0.370	0.14	-8.63	Vertical	245°	0.955	0.91	-0.40	Horizontal
70°	0.342	0.12	-9.33	Vertical	250°	0.973	0.95	-0.24	Horizontal
75°	0.318	0.10	-9.95	Vertical	255°	0.986	0.97	-0.12	Horizontal
80°	0.300	0.09	-10.46	Vertical	260°	0.995	0.99	-0.04	Horizontal
85°	0.287	0.08	-10.84	Vertical	265°	1.000	1.00	0.00	Horizontal
90°	0.280	0.08	-11.05	Vertical	270°	0.999	1.00	0.00	Horizontal
95°	0.277	0.08	-11.16	Vertical	275°	0.999	1.00	-0.01	Vertical
100°	0.271	0.07	-11.32	Vertical	280°	1.000	1.00	0.00	Vertical
105°	0.263	0.07	-11.61	Vertical	285°	0.998	1.00	-0.01	Vertical
110°	0.250	0.06	-12.05	Vertical	290°	0.995	0.99	-0.04	Vertical
115°	0.233	0.05	-12.67	Vertical	295°	0.991	0.98	-0.08	Vertical
120°	0.213	0.05	-13.43	Vertical	300°	0.985	0.97	-0.13	Vertical
125°	0.195	0.04	-14.21	Vertical	305°	0.978	0.96	-0.20	Vertical
130°	0.180	0.03	-14.89	Vertical	310°	0.969	0.94	-0.27	Vertical
135°	0.170	0.03	-15.40	Vertical	315°	0.960	0.92	-0.36	Vertical
140°	0.164	0.03	-15.71	Vertical	320°	0.949	0.90	-0.45	Vertical
145°	0.164	0.03	-15.72	Vertical	325°	0.937	0.88	-0.57	Vertical
150°	0.210	0.04	-13.55	Horizontal	330°	0.924	0.85	-0.69	Vertical
155°	0.260	0.07	-11.71	Horizontal	335°	0.909	0.83	-0.83	Vertical
160°	0.296	0.09	-10.58	Horizontal	340°	0.893	0.80	-0.98	Vertical
165°	0.330	0.11	-9.62	Horizontal	345°	0.875	0.77	-1.16	Vertical
170°	0.369	0.14	-8.65	Horizontal	350°	0.877	0.77	-1.14	Horizontal
175°	0.408	0.17	-7.78	Horizontal	355°	0.895	0.80	-0.96	Horizontal

**Polarization:**

**Maximum Field:**

**Minimum Field:**

**RMS:**

**Maximum ERP:**

**Maximum Power Gain:**

**Envelope**

**1.000 @ 267° True**

**0.163 @ 143° True**

**0.714**

**1.000 kW**

**2.010 (3.031 dB)**

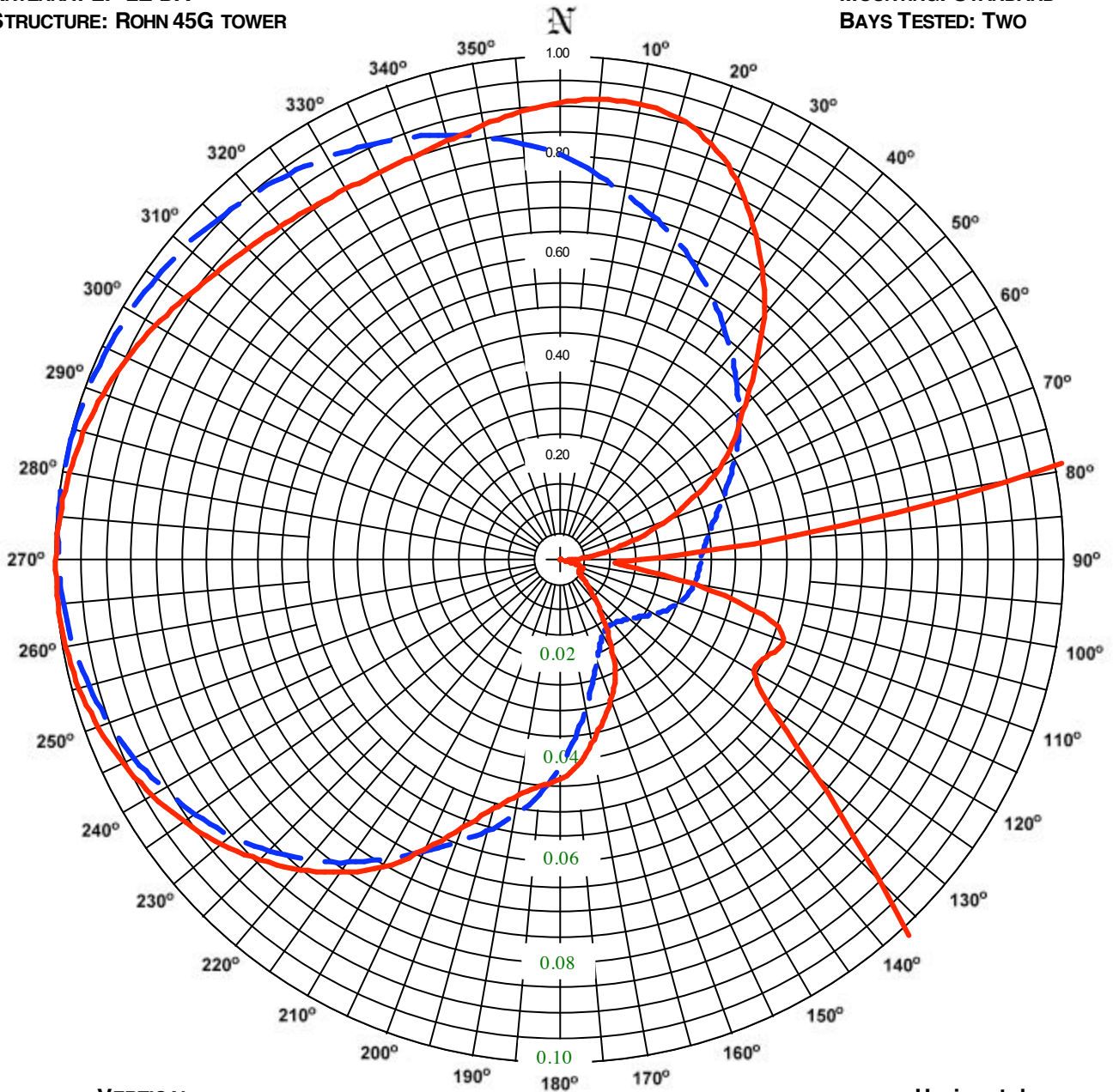
**Total Input Power: 0.498 kW**

# ERI<sup>®</sup> Horizontal Plane Relative Field Pattern

Electronics Research, Inc. 7777 Gardner Rd. Chandler, In 47610 Phone (812) 925-6000 Fax (812) 925-4030 <http://www.eriinc.com/>

FIGURE NO: 2  
STATION: WVRI  
LOCATION: CLIFTON FORGE, VA  
ANTENNA: LP-2E-DA  
STRUCTURE: ROHN 45G TOWER

DATE: 9/30/2010  
FREQUENCY: 90.9 MHz  
ORIENTATION: 300° TRUE  
MOUNTING: STANDARD  
BAYS TESTED: TWO



VERTICAL

RMS: 0.683  
MAXIMUM: 1.000 @ 279° TRUE  
MINIMUM: 0.163 @ 143° TRUE

10X Scale

Horizontal

RMS: 0.690  
Maximum: 1.000 @ 267° True  
Minimum: 0.011 @ 92° True

COMMENTS: MEASURED PATTERNS OF THE HORIZONTAL AND VERTICAL COMPONENTS.



# ERI<sup>®</sup> *Horizontal Plane Relative Field List*

Electronics Research, Inc. 7777 Gardner Rd. Chandler, In 47610 Phone (812) 925-6000 Fax (812) 925-4030 <http://www.eriinc.com/>

**Station: WVRI**

**Location: Clifton Forge, VA**

**Frequency: 90.9 MHz**

**Antenna: LP-2E-DA**

**Orientation: 300° True**

**Tower: Rohn 45G tower**

**Figure: 2**

**Date: 9/30/2010**

**Reference: wvri1m.fig**

Angle	Horizontal			Vertical			Angle	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.910	0.83	-0.82	0.806	0.65	-1.87	180°	0.435	0.19	-7.24	0.410	0.17	-7.74
5°	0.919	0.84	-0.73	0.774	0.60	-2.22	185°	0.450	0.20	-6.94	0.467	0.22	-6.62
10°	0.921	0.85	-0.71	0.741	0.55	-2.60	190°	0.473	0.22	-6.50	0.515	0.27	-5.76
15°	0.909	0.83	-0.82	0.710	0.50	-2.98	195°	0.511	0.26	-5.84	0.556	0.31	-5.10
20°	0.880	0.77	-1.11	0.678	0.46	-3.38	200°	0.564	0.32	-4.97	0.596	0.35	-4.50
25°	0.833	0.69	-1.59	0.641	0.41	-3.86	205°	0.632	0.40	-3.99	0.638	0.41	-3.90
30°	0.769	0.59	-2.28	0.604	0.36	-4.38	210°	0.702	0.49	-3.07	0.683	0.47	-3.31
35°	0.701	0.49	-3.08	0.568	0.32	-4.91	215°	0.756	0.57	-2.43	0.731	0.53	-2.72
40°	0.632	0.40	-3.99	0.532	0.28	-5.48	220°	0.801	0.64	-1.93	0.777	0.60	-2.20
45°	0.552	0.30	-5.16	0.497	0.25	-6.07	225°	0.840	0.71	-1.51	0.815	0.66	-1.78
50°	0.480	0.23	-6.37	0.464	0.22	-6.66	230°	0.876	0.77	-1.15	0.850	0.72	-1.41
55°	0.424	0.18	-7.46	0.433	0.19	-7.26	235°	0.907	0.82	-0.85	0.880	0.77	-1.11
60°	0.366	0.13	-8.74	0.402	0.16	-7.92	240°	0.933	0.87	-0.60	0.907	0.82	-0.84
65°	0.292	0.09	-10.68	0.370	0.14	-8.63	245°	0.955	0.91	-0.40	0.931	0.87	-0.62
70°	0.220	0.05	-13.16	0.342	0.12	-9.33	250°	0.973	0.95	-0.24	0.950	0.90	-0.44
75°	0.148	0.02	-16.57	0.318	0.10	-9.95	255°	0.986	0.97	-0.12	0.967	0.93	-0.29
80°	0.090	0.01	-20.94	0.300	0.09	-10.46	260°	0.995	0.99	-0.04	0.980	0.96	-0.17
85°	0.039	0.00	-28.26	0.287	0.08	-10.84	265°	1.000	1.00	0.00	0.989	0.98	-0.09
90°	0.013	0.00	-37.49	0.280	0.08	-11.05	270°	0.999	1.00	0.00	0.995	0.99	-0.05
95°	0.013	0.00	-37.46	0.277	0.08	-11.16	275°	0.996	0.99	-0.04	0.999	1.00	-0.01
100°	0.027	0.00	-31.36	0.271	0.07	-11.32	280°	0.989	0.98	-0.10	1.000	1.00	0.00
105°	0.042	0.00	-27.60	0.263	0.07	-11.61	285°	0.978	0.96	-0.19	0.998	1.00	-0.01
110°	0.047	0.00	-26.51	0.250	0.06	-12.05	290°	0.965	0.93	-0.31	0.995	0.99	-0.04
115°	0.045	0.00	-26.89	0.233	0.05	-12.67	295°	0.948	0.90	-0.46	0.991	0.98	-0.08
120°	0.045	0.00	-26.99	0.213	0.05	-13.43	300°	0.929	0.86	-0.64	0.985	0.97	-0.13
125°	0.051	0.00	-25.77	0.195	0.04	-14.21	305°	0.909	0.83	-0.83	0.978	0.96	-0.20
130°	0.066	0.00	-23.55	0.180	0.03	-14.89	310°	0.891	0.79	-1.01	0.969	0.94	-0.27
135°	0.090	0.01	-20.93	0.170	0.03	-15.40	315°	0.876	0.77	-1.15	0.960	0.92	-0.36
140°	0.122	0.01	-18.30	0.164	0.03	-15.71	320°	0.865	0.75	-1.26	0.949	0.90	-0.45
145°	0.162	0.03	-15.83	0.164	0.03	-15.72	325°	0.856	0.73	-1.35	0.937	0.88	-0.57
150°	0.210	0.04	-13.55	0.172	0.03	-15.31	330°	0.851	0.72	-1.40	0.924	0.85	-0.69
155°	0.260	0.07	-11.71	0.189	0.04	-14.48	335°	0.850	0.72	-1.42	0.909	0.83	-0.83
160°	0.296	0.09	-10.58	0.216	0.05	-13.32	340°	0.853	0.73	-1.38	0.893	0.80	-0.98
165°	0.330	0.11	-9.62	0.252	0.06	-11.96	345°	0.862	0.74	-1.29	0.875	0.77	-1.16
170°	0.369	0.14	-8.65	0.298	0.09	-10.50	350°	0.877	0.77	-1.14	0.854	0.73	-1.37
175°	0.408	0.17	-7.78	0.353	0.12	-9.04	355°	0.895	0.80	-0.96	0.831	0.69	-1.61

**Polarization:**

**Maximum Field:**

**Minimum Field:**

**RMS:**

**Maximum ERP:**

**Maximum Power Gain:**

**Horizontal**

**1.000 @ 267° True**

**0.011 @ 92° True**

**0.690**

**1.000 kW**

**2.010 (3.031 dB)**

**Vertical**

**1.000 @ 279° True**

**0.163 @ 143° True**

**0.683**

**1.000 kW**

**2.010 (3.031 dB)**

**Total Input Power: 0.498 kW**





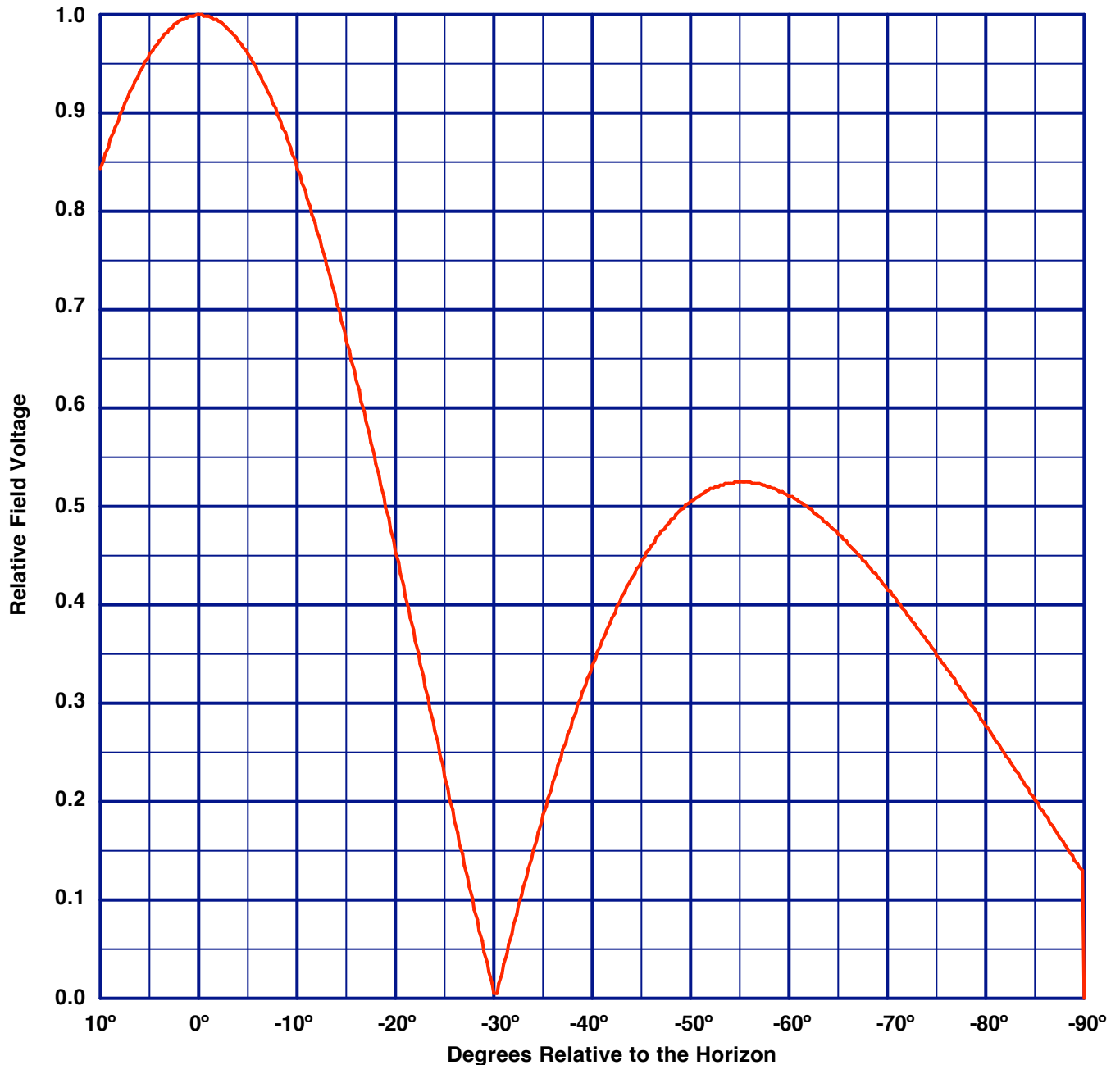
## ***Vertical Plane Relative Field Pattern***

***WVRI, Clifton Forge, VA, 90.9 MHz***

**Figure#: 3**

**Date: 9/30/2010**

***A 2 level, 1 wave-length spaced LP-2E-DA directional antenna  
with 0° beam tilt, 0% null fill and a H/V maximum power ratio of 1.000***



**Vertical Polarization Gain:**

**Maximum: 2.010 (3.031 dB)**

**Horizontal Plane: 2.010 (3.031 dB)**

**Horizontal Polarization Gain:**

**Maximum: 2.010 (3.031 dB)**

**Horizontal Plane: 2.010 (3.031 dB)**

# Directional Antenna System for WVRI, Clifton Forge, Virginia

(Continued)

## ANTENNA SPECIFICATIONS

Antenna Type:	LP-2E-DA
Frequency:	90.9 MHz
Number of Bays:	Two

## MECHANICAL SPECIFICATIONS

Mounting:	Standard
System length:	19 ft 7 in
Aperture length required:	25 ft 9 in
Orientation:	300° true

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

## ELECTRICAL SPECIFICATIONS (For directional use)

Maximum horizontal ERP:	1.000 kW (0.000 dBk)
Horizontal maximum power gain:	2.010 (3.031 dB)
Maximum vertical ERP:	1.000 kW (0.000 dBk)
Vertical maximum power gain:	2.010 (3.031 dB)
Total input power:	0.498 kW (-3.031 dBk)

