

# ***ERI<sup>®</sup> Electronics Research, Inc.***

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

## Directional Antenna System For WRZK, Colonial Height, Tennessee

December 7, 2000

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 WRZK.

The antenna is the ERI model LP-2E-DA-HW configuration. The circular polarized system consists of two half-wavelength spaced bays using one driven circular polarized radiating element per bay, two horizontal parasitic elements per bay and four vertical parasitic elements interleaved between the bays. The antenna was mounted on the North 289.933 degrees East tower leg with bracketry to provide an antenna orientation of North 255 degrees East. The antenna was tested on a 18" face tower, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 95.9 megahertz which is the center of the FM broadcast channel assigned to WRZK.

Pattern measurements were made on a sixty-acre antenna pattern range which 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 WRZK, Colonial Height, Tennessee

(continued)

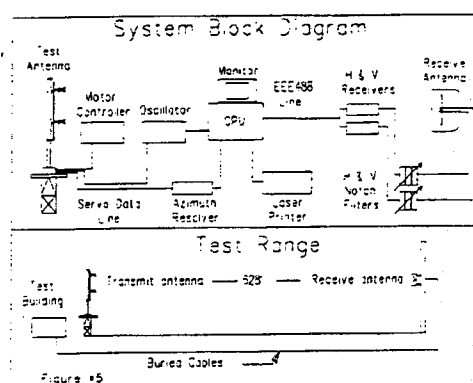
## DESCRIPTION OF THE TEST PROCEDURE

The test antenna consisted of a full scale model of the complete 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 18" 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 azimuth indicating mechanism, resolution of this azimuth measuring device is one-tenth of a degree.

The antenna under test was operated in the transmitting mode and fed from a Wavetek Model 3000 signal generator. The frequency of the signal source was set at 95.9 MHz and was constantly monitored by an Anritsu Model ML521B measuring receiver.



# Directional Antenna System For WRZK, Colonial Height, Tennessee

(continued)

A broad-band 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 an Anritsu Model ML521B measuring receiver. This data was interfaced to a Hewlett-Packard Laser Jet 4P printer by means of a pentium 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 two half-wavelength spaced bays using one driven circular polarized radiating element per bay, two horizontal parasitic elements per bay and four vertical parasitic elements interleaved between the bays. 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-HW array is to be mounted on the North 289.933 degrees East tower leg of the 18" face tower at a bearing of North 255 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 6.6 kilowatts (8.195 dBk).

Directional Antenna System  
For  
WRZK, Colonial Height, Tennessee

(continued)

The power at North 60 degrees East does not exceed 3.812 kilowatts (5.812 dBk).

The power at North 120-130 degrees East does not exceed 2.537 kilowatts (4.043 dBk).

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 21 feet if the antenna is to be top mounted. 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.

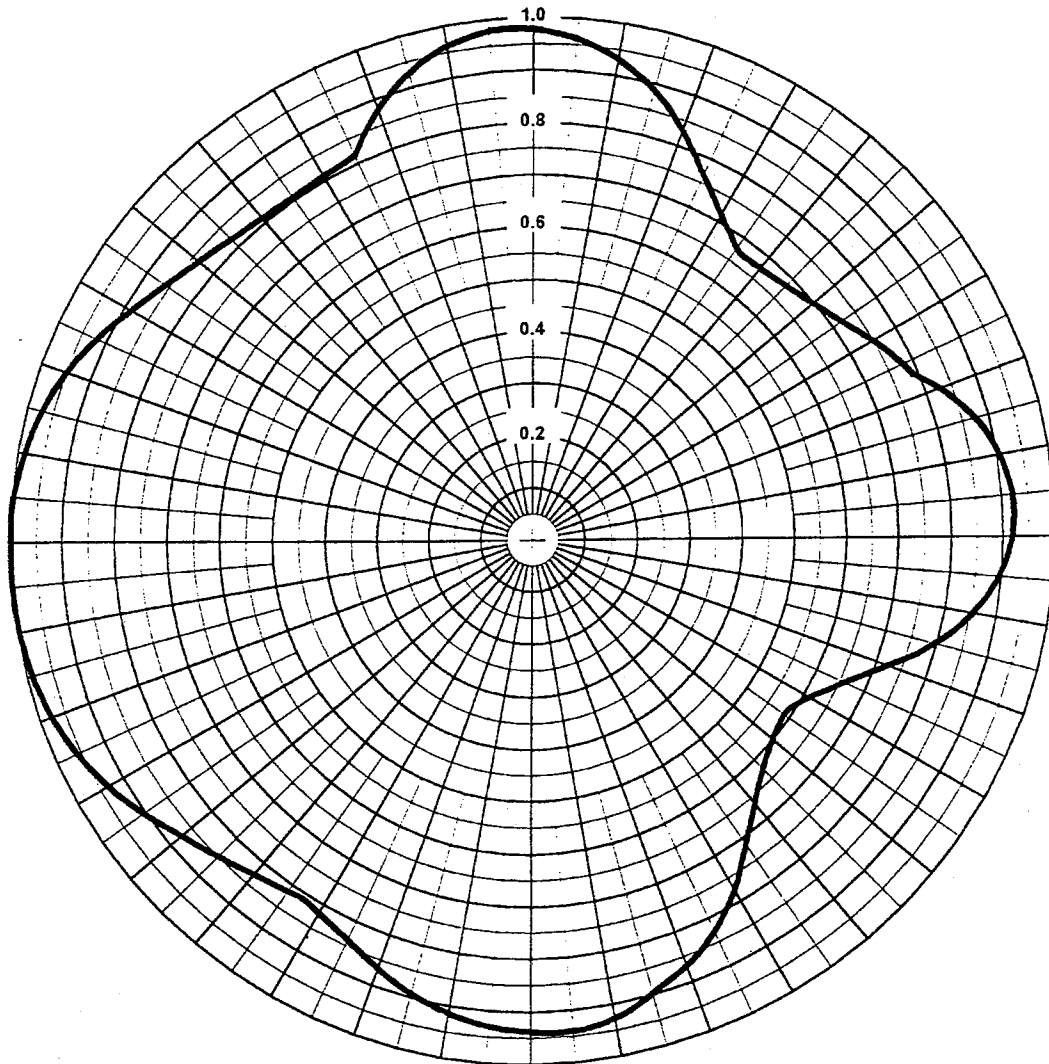
*Tom Schayl*

# **ERI**® *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: WRZK  
LOCATION: COLONIAL HEIGHTS, TN  
ANTENNA: LP-2E-DA-HW  
STRUCTURE: 18" FACE TOWER

DATE: 12/7/00  
FREQUENCY: 95.9 MHz  
ORIENTATION: 255° TRUE  
MOUNTING: STANDARD  
BAYS TESTED: TWO



## ENVELOPE

RMS: 0.854  
MAXIMUM: 1.000 @ 264° TRUE  
MINIMUM: 0.589 @ 125° TRUE

COMMENTS: COMPOSITE PATTERN: THIS PATTERN SHOWS THE MAXIMUM OF EITHER THE H OR V AZIMUTH VALUES. THIS PATTERN DOES NOT EXCEED THE FCC FILED COMPOSITE PATTERN AT ANY AZIMUTH. THE RMS OF THIS PATTERN IS GREATER THAN 85% OF THE FILED FCC COMPOSITE PATTERN BPH-20000414ACC.

# 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: WRZK

Location: Colonial Heights, TN

Frequency: 95.9 MHz

Antenna: LP-2E-DA-HW

Orientation: 255° True

Tower: 18" face tower

Figure: 1

Date: 12/7/00

Reference: wrzk2m.fig

Angle	Envelope			Polarization	Angle	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0°	0.974	6.26	7.97	Horizontal	180°	0.942	5.85	7.67	Horizontal
5°	0.958	6.05	7.82	Horizontal	185°	0.933	5.74	7.59	Horizontal
10°	0.928	5.68	7.55	Horizontal	190°	0.918	5.56	7.45	Horizontal
15°	0.884	5.16	7.13	Horizontal	195°	0.897	5.31	7.25	Horizontal
20°	0.827	4.52	6.55	Horizontal	200°	0.869	4.99	6.98	Horizontal
25°	0.764	3.85	5.85	Horizontal	205°	0.842	4.68	6.70	Horizontal
30°	0.712	3.35	5.25	Horizontal	210°	0.821	4.44	6.48	Horizontal
35°	0.674	3.00	4.77	Horizontal	215°	0.817	4.41	6.44	Vertical
40°	0.670	2.96	4.72	Vertical	220°	0.832	4.57	6.60	Vertical
45°	0.679	3.04	4.83	Vertical	225°	0.852	4.79	6.81	Vertical
50°	0.694	3.18	5.02	Vertical	230°	0.878	5.08	7.06	Vertical
55°	0.717	3.39	5.30	Vertical	235°	0.908	5.44	7.36	Vertical
60°	0.746	3.68	5.65	Vertical	240°	0.937	5.79	7.63	Vertical
65°	0.777	3.99	6.01	Vertical	245°	0.960	6.08	7.84	Vertical
70°	0.824	4.48	6.51	Horizontal	250°	0.978	6.31	8.00	Vertical
75°	0.872	5.02	7.00	Horizontal	255°	0.990	6.48	8.11	Vertical
80°	0.904	5.39	7.32	Horizontal	260°	0.998	6.57	8.18	Vertical
85°	0.920	5.59	7.47	Horizontal	265°	1.000	6.60	8.20	Vertical
90°	0.918	5.56	7.45	Horizontal	270°	1.000	6.60	8.20	Horizontal
95°	0.896	5.30	7.24	Horizontal	275°	0.998	6.57	8.18	Horizontal
100°	0.857	4.85	6.85	Horizontal	280°	0.986	6.42	8.07	Vertical
105°	0.799	4.22	6.25	Horizontal	285°	0.970	6.21	7.93	Vertical
110°	0.726	3.48	5.41	Horizontal	290°	0.947	5.92	7.73	Vertical
115°	0.661	2.89	4.60	Horizontal	295°	0.919	5.57	7.46	Vertical
120°	0.615	2.49	3.97	Horizontal	300°	0.885	5.17	7.13	Vertical
125°	0.589	2.29	3.60	Vertical	305°	0.856	4.84	6.85	Vertical
130°	0.600	2.38	3.76	Vertical	310°	0.834	4.59	6.61	Vertical
135°	0.624	2.57	4.10	Vertical	315°	0.817	4.41	6.44	Vertical
140°	0.662	2.89	4.61	Vertical	320°	0.807	4.30	6.34	Vertical
145°	0.713	3.36	5.26	Vertical	325°	0.804	4.26	6.30	Vertical
150°	0.776	3.97	5.99	Vertical	330°	0.806	4.29	6.32	Vertical
155°	0.830	4.54	6.57	Vertical	335°	0.813	4.36	6.40	Horizontal
160°	0.870	5.00	6.99	Vertical	340°	0.877	5.08	7.06	Horizontal
165°	0.900	5.35	7.28	Horizontal	345°	0.926	5.66	7.53	Horizontal
170°	0.930	5.71	7.56	Horizontal	350°	0.959	6.07	7.83	Horizontal
175°	0.943	5.87	7.69	Horizontal	355°	0.975	6.28	7.98	Horizontal

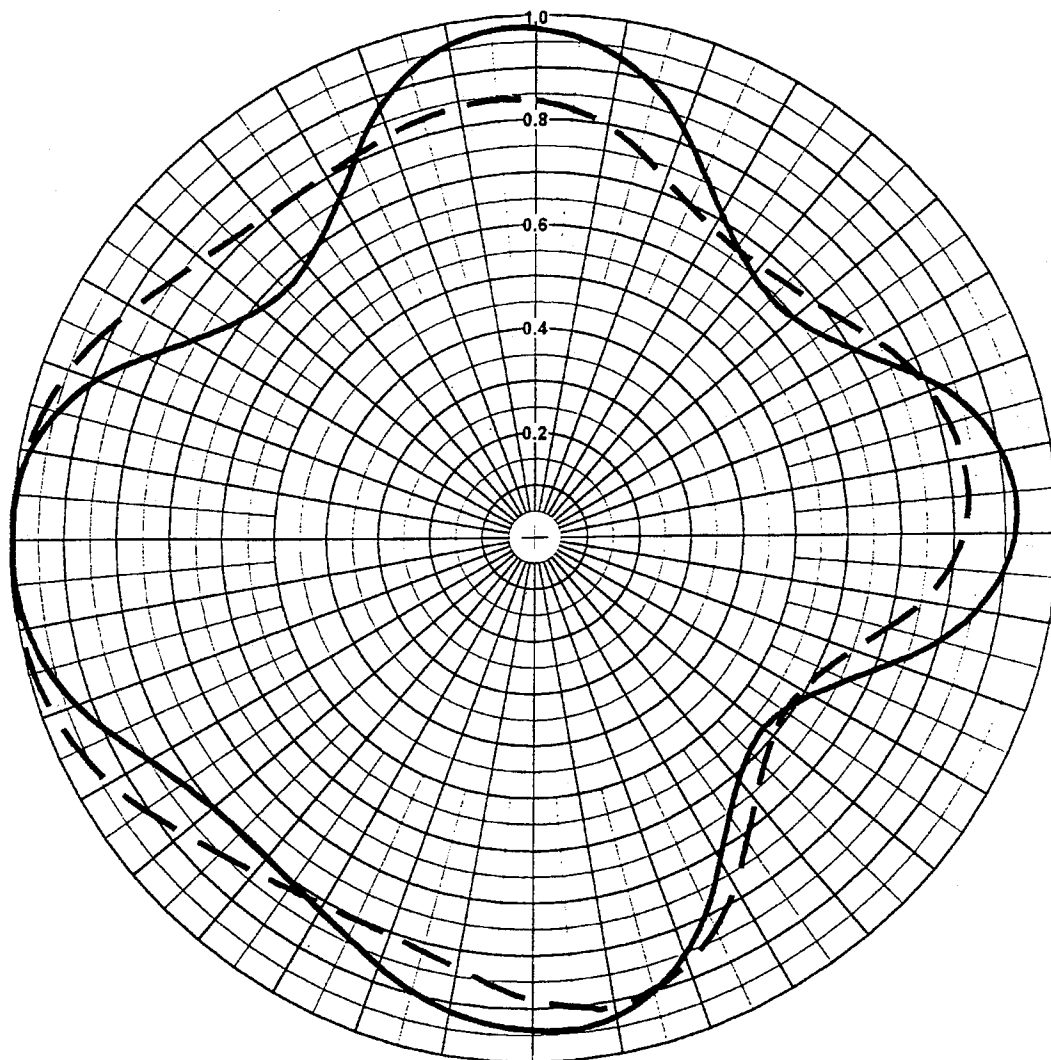
Polarization: Envelope  
 Maximum Field: 1.000 @ 264° True  
 Minimum Field: 0.589 @ 125° True  
 RMS: 0.854  
 Maximum ERP: 6.600 kW  
 Maximum Power Gain: 0.982 (-0.077 dB)  
 Horizontal Plane Gain: 0.982 (-0.077 dB)  
 Total Input Power: 6.718 kW

# **ERI**® *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: WRZK  
LOCATION: COLONIAL HEIGHTS, TN  
ANTENNA: LP-2E-DA-HW  
STRUCTURE: 18" FACE TOWER

DATE: 12/7/00  
FREQUENCY: 95.9 MHz  
ORIENTATION: 255° TRUE  
MOUNTING: STANDARD  
BAYS TESTED: TWO



VERTICAL

RMS: 0.821  
MAXIMUM: 1.000 @ 264° TRUE  
MINIMUM: 0.589 @ 124° TRUE

HORIZONTAL

RMS: 0.828  
MAXIMUM: 1.000 @ 268° TRUE  
MINIMUM: 0.575 @ 130° 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 47510 Phone (812) 925-6000 Fax (812) 925-4030 <http://www.eriinc.com/>

Station: WRZK

Location: Colonial Heights, TN

Frequency: 95.9 MHz

Antenna: LP-2E-DA-HW

Orientation: 255° True

Tower: 18" face tower

Figure: 2

Date: 12/7/00

Reference: wrzk2m.fig

Angle	Horizontal			Vertical			Angle	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.974	6.26	7.97	0.836	4.61	6.64	180°	0.942	5.85	7.67	0.885	5.17	7.13
5°	0.958	6.05	7.82	0.821	4.45	6.48	185°	0.933	5.74	7.59	0.861	4.89	6.89
10°	0.928	5.68	7.55	0.796	4.19	6.22	190°	0.918	5.56	7.45	0.835	4.60	6.63
15°	0.884	5.16	7.13	0.763	3.84	5.84	195°	0.897	5.31	7.25	0.817	4.41	6.44
20°	0.827	4.52	6.55	0.726	3.48	5.41	200°	0.869	4.99	6.98	0.807	4.29	6.33
25°	0.764	3.85	5.85	0.698	3.21	5.07	205°	0.842	4.68	6.70	0.804	4.26	6.30
30°	0.712	3.35	5.25	0.679	3.04	4.83	210°	0.821	4.44	6.48	0.808	4.31	6.34
35°	0.674	3.00	4.77	0.669	2.96	4.71	215°	0.806	4.28	6.32	0.817	4.41	6.44
40°	0.650	2.79	4.45	0.670	2.96	4.72	220°	0.797	4.19	6.22	0.832	4.57	6.60
45°	0.639	2.69	4.30	0.679	3.04	4.83	225°	0.795	4.17	6.20	0.852	4.79	6.81
50°	0.645	2.74	4.38	0.694	3.18	5.02	230°	0.803	4.25	6.29	0.878	5.08	7.06
55°	0.667	2.94	4.68	0.717	3.39	5.30	235°	0.821	4.45	6.48	0.908	5.44	7.36
60°	0.706	3.29	5.17	0.746	3.68	5.65	240°	0.850	4.76	6.78	0.937	5.79	7.63
65°	0.761	3.82	5.82	0.777	3.99	6.01	245°	0.888	5.21	7.17	0.960	6.08	7.84
70°	0.824	4.48	6.51	0.801	4.24	6.27	250°	0.930	5.71	7.57	0.978	6.31	8.00
75°	0.872	5.02	7.00	0.818	4.42	6.45	255°	0.963	6.12	7.87	0.990	6.48	8.11
80°	0.904	5.39	7.32	0.828	4.53	6.56	260°	0.985	6.41	8.07	0.998	6.57	8.18
85°	0.920	5.59	7.47	0.830	4.55	6.58	265°	0.998	6.57	8.17	1.000	6.60	8.20
90°	0.918	5.56	7.45	0.819	4.43	6.46	270°	1.000	6.60	8.20	1.000	6.60	8.20
95°	0.896	5.30	7.24	0.793	4.15	6.18	275°	0.998	6.57	8.18	0.996	6.55	8.16
100°	0.857	4.85	6.85	0.753	3.74	5.73	280°	0.980	6.34	8.02	0.986	6.42	8.07
105°	0.799	4.22	6.25	0.698	3.22	5.08	285°	0.945	5.90	7.71	0.970	6.21	7.93
110°	0.726	3.48	5.41	0.649	2.78	4.45	290°	0.893	5.26	7.21	0.947	5.92	7.73
115°	0.661	2.89	4.60	0.615	2.49	3.97	295°	0.823	4.47	6.51	0.919	5.57	7.46
120°	0.615	2.49	3.97	0.595	2.33	3.68	300°	0.760	3.81	5.81	0.885	5.17	7.13
125°	0.586	2.27	3.56	0.589	2.29	3.60	305°	0.715	3.37	5.28	0.856	4.84	6.85
130°	0.575	2.19	3.40	0.600	2.38	3.76	310°	0.687	3.11	4.93	0.834	4.59	6.61
135°	0.585	2.26	3.55	0.624	2.57	4.10	315°	0.676	3.02	4.79	0.817	4.41	6.44
140°	0.612	2.47	3.93	0.662	2.89	4.61	320°	0.686	3.10	4.92	0.807	4.30	6.34
145°	0.656	2.84	4.53	0.713	3.36	5.26	325°	0.712	3.34	5.24	0.804	4.26	6.30
150°	0.716	3.38	5.29	0.776	3.97	5.99	330°	0.754	3.75	5.75	0.806	4.29	6.32
155°	0.790	4.12	6.15	0.830	4.54	6.57	335°	0.813	4.36	6.40	0.812	4.35	6.39
160°	0.853	4.80	6.82	0.870	5.00	6.99	340°	0.877	5.08	7.06	0.822	4.46	6.50
165°	0.900	5.35	7.28	0.897	5.31	7.25	345°	0.926	5.66	7.53	0.833	4.58	6.61
170°	0.930	5.71	7.56	0.910	5.47	7.38	350°	0.959	6.07	7.83	0.839	4.65	6.67
175°	0.943	5.87	7.69	0.901	5.36	7.29	355°	0.975	6.28	7.98	0.841	4.67	6.70

Polarization:

Maximum Field:

Minimum Field:

RMS:

Maximum ERP:

Maximum Power Gain:

Horizontal Plane Gain:

Total Input Power: 6.718 kW

Horizontal

1.000 @ 268° True

0.575 @ 130° True

0.828

6.600 kW

0.982 (-0.077 dB)

0.982 (-0.077 dB)

Vertical

1.000 @ 264° True

0.589 @ 124° True

0.821

6.600 kW

0.982 (-0.077 dB)

0.982 (-0.077 dB)





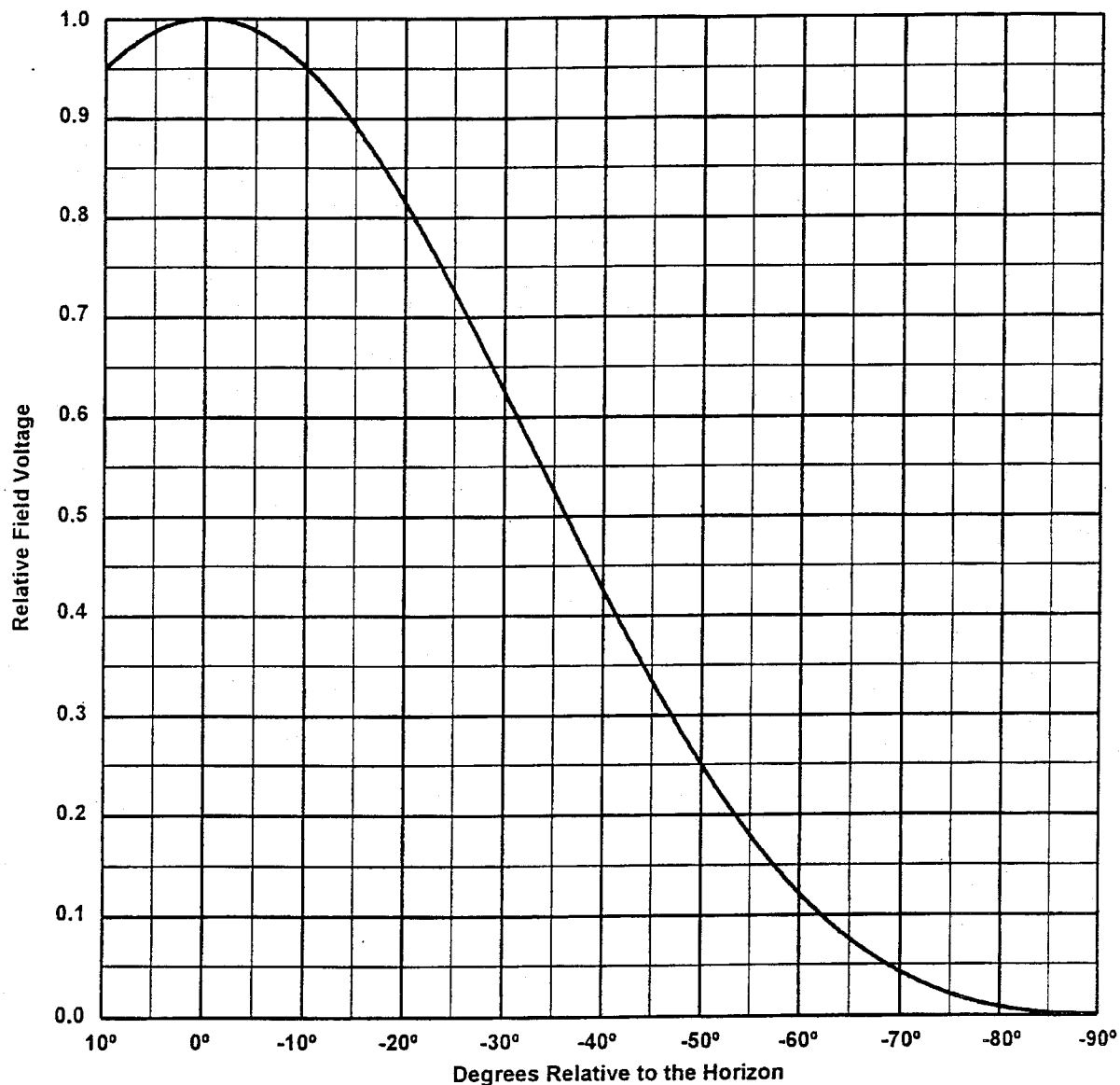
## **Vertical Plane Relative Field Pattern**

**WRZK, Colonial Heights, TN, 95.9 MHz**

Figure#: 1

Date: 12/7/00

*A 2 level, .5 wave-length spaced LP-2E-DA-HW directional antenna  
with 0° beam tilt, 0% null fill and a H/V maximum power ratio of 1.000*



Vertical Polarization Gain:
Maximum: 0.982 (-0.077 dB)
Horizontal Plane: 0.982 (-0.077 dB)

Horizontal Polarization Gain:
Maximum: 0.982 (-0.077 dB)
Horizontal Plane: 0.982 (-0.077 dB)

# Directional Antenna System For WRZK, Colonial Height, Tennessee

(continued)

## ANTENNA SPECIFICATIONS

Antenna Type:	LP-2E-DA-HW
Frequency:	95.9 MHz
Number of Bays:	2

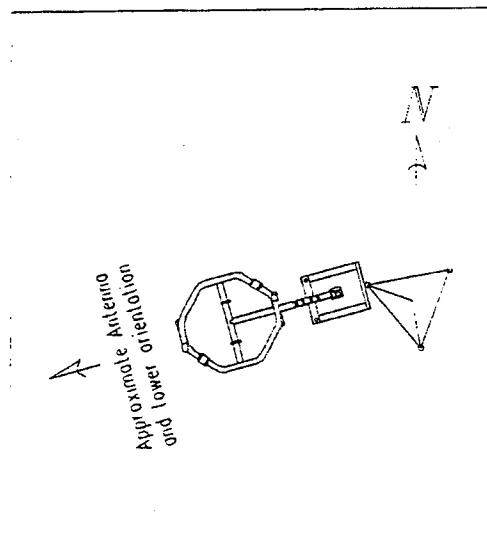
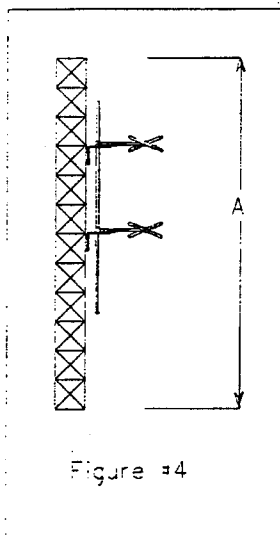
## MECHANICAL SPECIFICATIONS

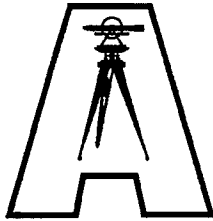
Mounting:	Standard
System length:	13 ft 9 in
Aperture length required:	21 ft.
Orientation:	255 true
Input flange to the antenna 1 5/8 inch female	

## ELECTRICAL SPECIFICATIONS

(For directional use)

Maximum horizontal ERP:	6.6 kW (8.195 dBk)
Horizontal maximum power gain:	0.982 (-0.077 dB)
Maximum vertical ERP:	6.6 kW (8.195 dBk)
Vertical maximum power gain:	0.982 (-0.077 dB)
Total input power:	6.718 kW (8.272 dBk)





## **Alley & Associates, Inc.**

**Surveyors • Planners • Managers**

243 East Market Street  
Kingsport, Tennessee 37660  
Telephone: (423) 392-8896  
FAX: (423) 392-8898

**March 1, 2001**

**Dave Murray  
Murray Communications  
1028 Woodstone Drive  
Kingsport, TN 37663**

**REF: Directional Antenna for WRZK**

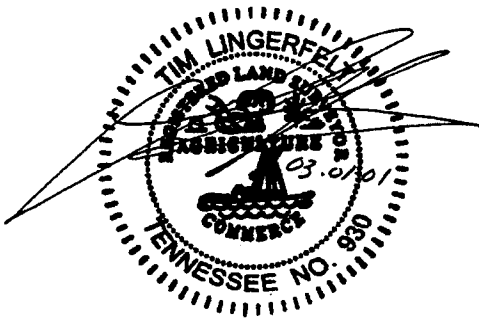
**Dave:**

**Please accept this letter as my affidavit that on February 26, 2001 I visited the Murray Communications tower site on Bays Mountain in Kingsport, Tennessee. At that time I established a reference line from the tower having a true azimuth of 255.00 degrees.**

**The antenna, which was installed on the tower, is oriented in accordance with the manufacturer's installation instructions.**

**Thank you,**

  
**Tim Lingerfelt  
P.L.S. TN License No. 930**



March 8, 2001

Reference Special Conditions #4-WRZK FM CP (BPH-20000414ACC)

This is to certify that I, John O. Davis, did oversee and supervise the installation of the ERI model LP-2E-DA-HW antenna on the Holston Valley Broadcasting tower as specified in the WRZK construction permit. The antenna was installed in accordance with the manufacturer's detailed instructions.

John O. Davis has been employed by Holston Valley Broadcasting since 1969, and have held a General Radiotelephone Operator License since 1970.

Prior to 1969 I was in the U.S. Army Signal Corps., and was in Television Equipment Repair from from 1966 to 1969.

In 1977 I was named Chief Engineer for WKPT-TV.

In 1993 I was named Chief Engineer for Holston Valley Broadcasting.

  
John O. Davis