ELECTRONICS RESEARCH, INC. ERI®

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

Directional Antenna System for WCQS, Asheville, North Carolina

January 4, 2021

Electronics Research Inc. is providing modifications to an existing antenna system for an increase in ERP, that is specially designed to meet the FCC requirements and the general needs of radio station WCQS.

The antenna is the ERI model BEMP-2E-DA-HW configuration. The circular polarized system consists of two half-wavelength spaced bays using one driven circular polarized radiating element per bay, one horizontal parasitic element per bay and two vertical parasitic elements interleaved between the bays. The antenna was mounted on the North 35 degrees East tower face with bracketry to provide an antenna orientation of North 35 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 88.1 megahertz, which is the center of the FM broadcast channel assigned to WCQS.

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
WCQS, Asheville, North Carolina

(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 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.

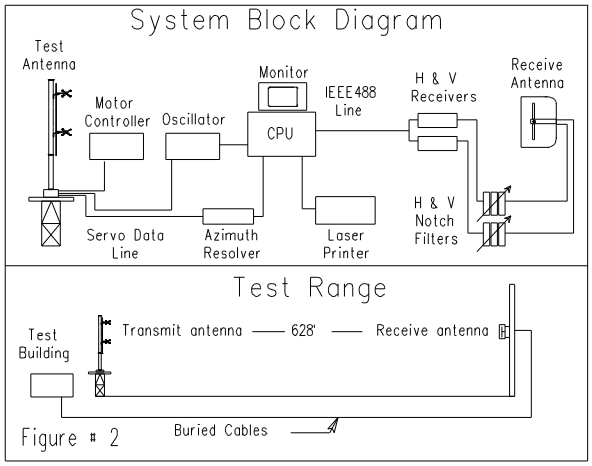

Figure # 2

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 88.1 MHz and was constantly monitored by a Rohde & Schwarz ESVD measuring receiver.

(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 Heliax 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 co-ordinated 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, one horizontal parasitic element per bay and two vertical parasitic elements interleaved between the bays. 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 BEMP-2E-DA-HW array is to be mounted on the North 35 degrees East tower face of the 24” face tower at a bearing of North 35 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.

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 patternThe 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 1.9 kilowatts (2.788 dBk).

(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 that 85% of the filed composite pattern.

The clear vertical length of the structure required to support the antenna is 20 7 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.

ERI® Horizontal Plane Relative Field Pattern

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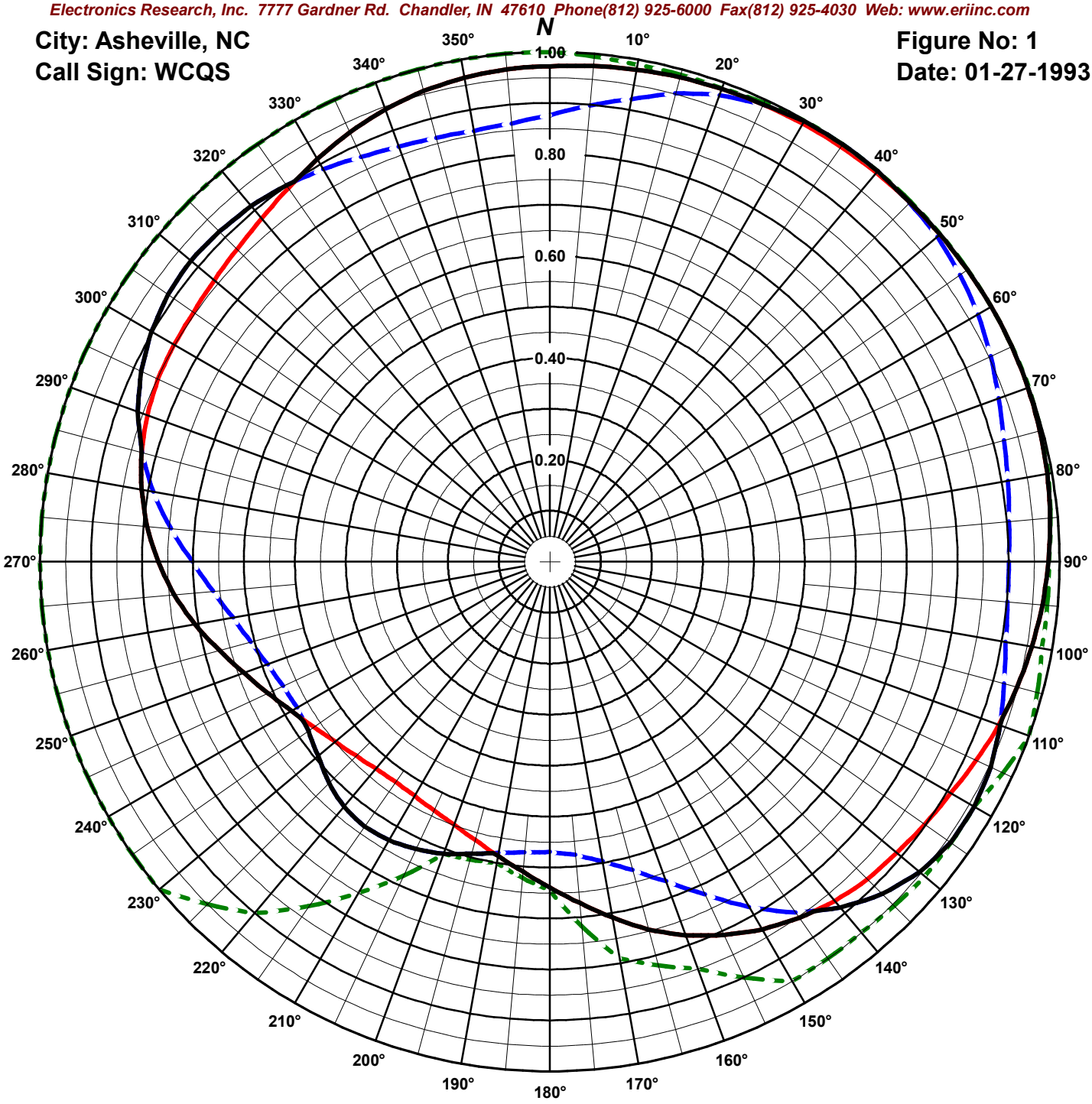
City: Asheville, NC
Call Sign: WCQS

Figure No: 1
Date: 01-27-1993



Antenna Orientation: 35° True

Frequency: 88.1 MHz
Antenna Type: BEMP-2E-DA-HW

Antenna Mounting: Standard
Tower Type: 24" central tower

HORIZONTAL	VERTICAL	COMPOSITE	FCC ENVELOPE
RMS: .846	RMS: .827	RMS: .86	RMS: .948
Maximum: 1 @ 60°	Maximum: 1 @ 35°	Maximum: 1 @ 35°	Maximum: 1 @ 0°
Minimum: .527 @ 215°	Minimum: .569 @ 180°	Minimum: .576 @ 237°	Minimum: .6 @ 190°

Measured patterns of the horizontal and vertical components.

ERI® Horizontal Plane Relative Field Pattern

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Figure# 1
Station: WCQS
Location: Asheville, NC
Frequency: 88.1 MHz

Date: 01-27-1993
Antenna: BEMP-2E-DA-HW
Antenna Orientation: 35° True
Number of Bays: 2

Azimuth	Envelope			Polarization	Azimuth	Envelope			Polarization
	Field	kW	dBk	Maximum		Field	kW	dBk	Maximum
0°	0.972	1.795	2.541	Horizontal	180°	0.639	0.776	-1.102	Horizontal
5°	0.976	1.810	2.577	Horizontal	185°	0.610	0.707	-1.506	Horizontal
10°	0.980	1.825	2.612	Horizontal	190°	0.586	0.652	-1.855	Horizontal
15°	0.984	1.840	2.647	Horizontal	195°	0.593	0.668	-1.751	Vertical
20°	0.987	1.851	2.674	Horizontal	200°	0.610	0.707	-1.506	Vertical
25°	0.990	1.862	2.700	Horizontal	205°	0.622	0.735	-1.337	Vertical
30°	0.998	1.892	2.770	Vertical	210°	0.631	0.757	-1.212	Vertical
35°	1.000	1.900	2.788	Vertical	215°	0.634	0.764	-1.171	Vertical
40°	1.000	1.900	2.788	Vertical	220°	0.628	0.749	-1.253	Vertical
45°	0.998	1.892	2.770	Horizontal	225°	0.613	0.714	-1.463	Vertical
50°	0.999	1.896	2.779	Horizontal	230°	0.593	0.668	-1.751	Vertical
55°	0.999	1.896	2.779	Horizontal	235°	0.578	0.635	-1.974	Vertical
60°	1.000	1.900	2.788	Horizontal	240°	0.585	0.650	-1.869	Horizontal
65°	1.000	1.900	2.788	Horizontal	245°	0.610	0.707	-1.506	Horizontal
70°	0.998	1.892	2.770	Horizontal	250°	0.638	0.773	-1.116	Horizontal
75°	0.995	1.881	2.744	Horizontal	255°	0.671	0.855	-0.678	Horizontal
80°	0.991	1.866	2.709	Horizontal	260°	0.707	0.950	-0.224	Horizontal
85°	0.985	1.843	2.656	Horizontal	265°	0.740	1.040	0.172	Horizontal
90°	0.978	1.817	2.594	Horizontal	270°	0.768	1.121	0.495	Horizontal
95°	0.970	1.788	2.523	Horizontal	275°	0.793	1.195	0.773	Horizontal
100°	0.960	1.751	2.433	Horizontal	280°	0.813	1.256	0.989	Horizontal
105°	0.949	1.711	2.333	Horizontal	285°	0.829	1.306	1.159	Horizontal
110°	0.940	1.679	2.250	Vertical	290°	0.860	1.405	1.478	Vertical
115°	0.954	1.729	2.379	Vertical	295°	0.884	1.485	1.717	Vertical
120°	0.961	1.755	2.442	Vertical	300°	0.902	1.546	1.892	Vertical
125°	0.960	1.751	2.433	Vertical	305°	0.914	1.587	2.006	Vertical
130°	0.947	1.704	2.315	Vertical	310°	0.919	1.605	2.054	Vertical
135°	0.922	1.615	2.082	Vertical	315°	0.916	1.594	2.025	Vertical
140°	0.886	1.491	1.736	Vertical	320°	0.911	1.577	1.978	Vertical
145°	0.853	1.382	1.407	Horizontal	325°	0.901	1.542	1.882	Vertical
150°	0.833	1.318	1.200	Horizontal	330°	0.912	1.580	1.987	Horizontal
155°	0.808	1.240	0.936	Horizontal	335°	0.929	1.640	2.148	Horizontal
160°	0.780	1.156	0.629	Horizontal	340°	0.944	1.693	2.287	Horizontal
165°	0.747	1.060	0.254	Horizontal	345°	0.956	1.736	2.397	Horizontal
170°	0.709	0.955	-0.200	Horizontal	350°	0.964	1.766	2.469	Horizontal
175°	0.672	0.858	-0.665	Horizontal	355°	0.970	1.788	2.523	Horizontal

Horizontal Polarization:
Maximum: 0.954 (-0.206 dB)
Horizontal Plane: 0.954 (-0.206 dB)
Maximum ERP: 1.900 kW

Vertical Polarization:
Maximum: 0.954 (-0.206 dB)
Horizontal Plane: 0.954 (-0.206 dB)
Maximum ERP: 1.900 kW

Total Input Power: 1.992 kW
Reference: WCQS1M.FIG

ERI® Horizontal Plane Relative Field Pattern

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Figure# 1A
Station: WCQS
Location: Asheville, NC
Frequency: 88.1 MHz

Date: 01-27-1993
Antenna: BEMP-2E-DA-HW
Antenna Orientation: 35° True
Number of Bays: 2

Azimuth	Horizontal			Vertical			Azimuth	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.972	1.795	2.541	0.876	1.458	1.638	180°	0.639	0.776	-1.102	0.569	0.615	-2.110
5°	0.976	1.810	2.577	0.899	1.534	1.858	185°	0.610	0.707	-1.506	0.572	0.622	-2.065
10°	0.980	1.825	2.612	0.921	1.612	2.073	190°	0.586	0.652	-1.855	0.580	0.639	-1.944
15°	0.984	1.840	2.647	0.951	1.718	2.351	195°	0.565	0.607	-2.171	0.593	0.668	-1.751
20°	0.987	1.851	2.674	0.974	1.802	2.559	200°	0.549	0.573	-2.421	0.610	0.707	-1.506
25°	0.990	1.862	2.700	0.989	1.858	2.691	205°	0.538	0.550	-2.597	0.622	0.735	-1.337
30°	0.992	1.870	2.718	0.998	1.892	2.770	210°	0.530	0.534	-2.727	0.631	0.757	-1.212
35°	0.994	1.877	2.735	1.000	1.900	2.788	215°	0.527	0.528	-2.776	0.634	0.764	-1.171
40°	0.996	1.885	2.753	1.000	1.900	2.788	220°	0.530	0.534	-2.727	0.628	0.749	-1.253
45°	0.998	1.892	2.770	0.997	1.889	2.761	225°	0.538	0.550	-2.597	0.613	0.714	-1.463
50°	0.999	1.896	2.779	0.992	1.870	2.718	230°	0.549	0.573	-2.421	0.593	0.668	-1.751
55°	0.999	1.896	2.779	0.982	1.832	2.630	235°	0.565	0.607	-2.171	0.578	0.635	-1.974
60°	1.000	1.900	2.788	0.970	1.788	2.523	240°	0.585	0.650	-1.869	0.572	0.622	-2.065
65°	1.000	1.900	2.788	0.954	1.729	2.379	245°	0.610	0.707	-1.506	0.577	0.633	-1.989
70°	0.998	1.892	2.770	0.937	1.668	2.222	250°	0.638	0.773	-1.116	0.589	0.659	-1.810
75°	0.995	1.881	2.744	0.922	1.615	2.082	255°	0.671	0.855	-0.678	0.607	0.700	-1.549
80°	0.991	1.866	2.709	0.912	1.580	1.987	260°	0.707	0.950	-0.224	0.631	0.757	-1.212
85°	0.985	1.843	2.656	0.904	1.553	1.911	265°	0.740	1.040	0.172	0.663	0.835	-0.782
90°	0.978	1.817	2.594	0.900	1.539	1.872	270°	0.768	1.121	0.495	0.701	0.934	-0.298
95°	0.970	1.788	2.523	0.901	1.542	1.882	275°	0.793	1.195	0.773	0.746	1.057	0.242
100°	0.960	1.751	2.433	0.908	1.566	1.949	280°	0.813	1.256	0.989	0.790	1.186	0.740
105°	0.949	1.711	2.333	0.922	1.615	2.082	285°	0.829	1.306	1.159	0.828	1.303	1.148
110°	0.937	1.668	2.222	0.940	1.679	2.250	290°	0.840	1.341	1.273	0.860	1.405	1.478
115°	0.923	1.619	2.092	0.954	1.729	2.379	295°	0.848	1.366	1.355	0.884	1.485	1.717
120°	0.908	1.566	1.949	0.961	1.755	2.442	300°	0.851	1.376	1.386	0.902	1.546	1.892
125°	0.898	1.532	1.853	0.960	1.751	2.433	305°	0.853	1.382	1.407	0.914	1.587	2.006
130°	0.888	1.498	1.756	0.947	1.704	2.315	310°	0.859	1.402	1.467	0.919	1.605	2.054
135°	0.881	1.475	1.687	0.922	1.615	2.082	315°	0.867	1.428	1.548	0.916	1.594	2.025
140°	0.869	1.435	1.568	0.886	1.491	1.736	320°	0.879	1.468	1.667	0.911	1.577	1.978
145°	0.853	1.382	1.407	0.840	1.341	1.273	325°	0.894	1.519	1.814	0.901	1.542	1.882
150°	0.833	1.318	1.200	0.782	1.162	0.652	330°	0.912	1.580	1.987	0.889	1.502	1.766
155°	0.808	1.240	0.936	0.720	0.985	-0.066	335°	0.929	1.640	2.148	0.876	1.458	1.638
160°	0.780	1.156	0.629	0.667	0.845	-0.730	340°	0.944	1.693	2.287	0.866	1.425	1.538
165°	0.747	1.060	0.254	0.626	0.745	-1.281	345°	0.956	1.736	2.397	0.861	1.409	1.488
170°	0.709	0.955	-0.200	0.596	0.675	-1.708	350°	0.964	1.766	2.469	0.858	1.399	1.457
175°	0.672	0.858	-0.665	0.577	0.633	-1.989	355°	0.970	1.788	2.523	0.863	1.415	1.508

Horizontal Polarization:
Maximum: 0.954 (-0.206 dB)
Horizontal Plane: 0.954 (-0.206 dB)
Maximum ERP: 1.900 kW

Vertical Polarization:
Maximum: 0.954 (-0.206 dB)
Horizontal Plane: 0.954 (-0.206 dB)
Maximum ERP: 1.900 kW

Total Input Power: 1.992 kW
Reference: WCQS1M.FIG

Vertical Plane Relative Field Pattern

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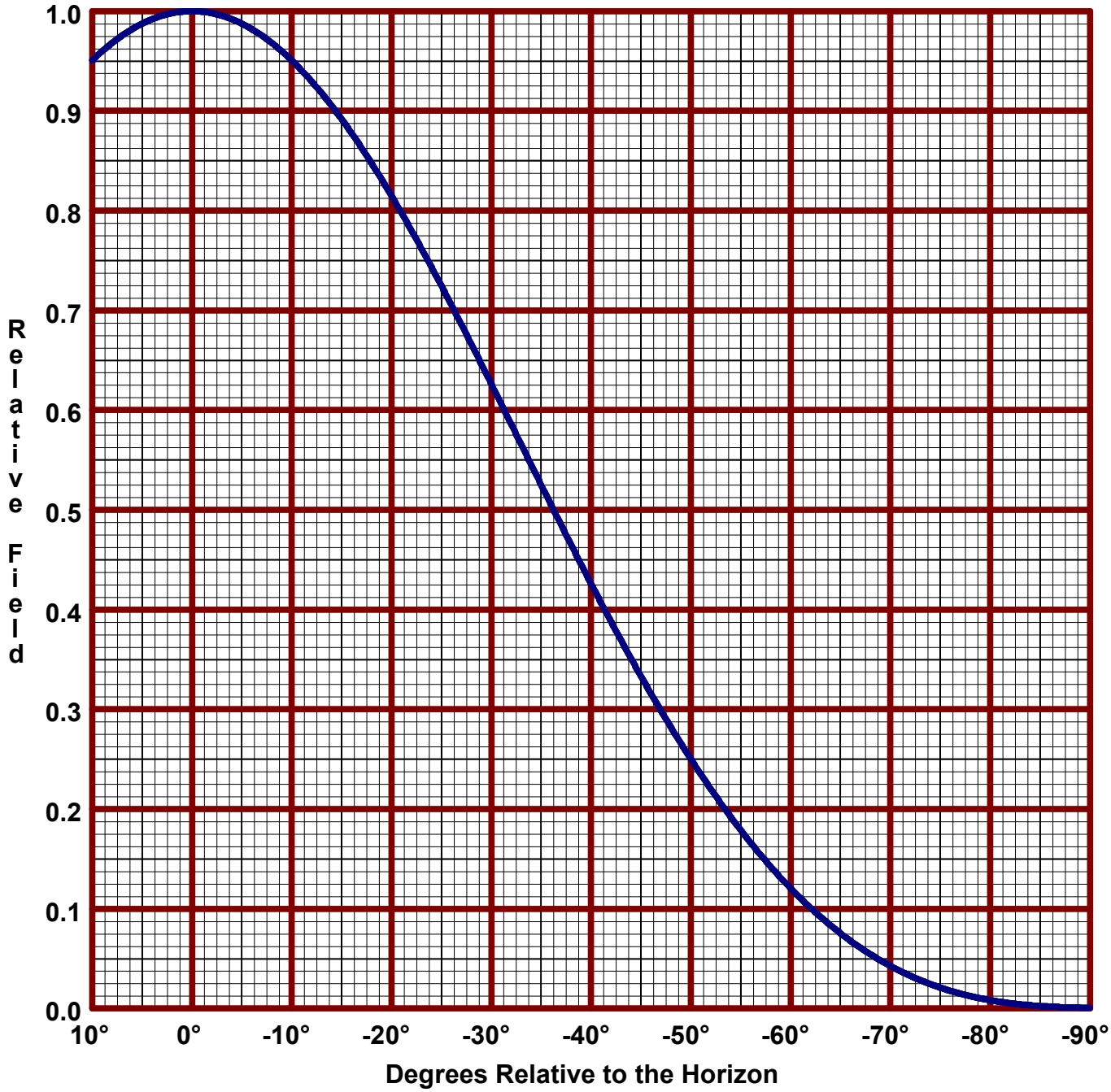
Figure No: 3
Call Sign: WCQS
Location: Asheville, NC
Frequency: 88.1 MHz
Antenna: 2 bay BEMP-2E-DA-HW

Date: 01-27-1993
H/V Power Ratio: 1
.5 Wave-length Spacing
0° Beam Tilt
0% First Null Fill



Horizontal Polarization:
Maximum: 0.954 (-0.206 dB)
Horizontal Plane: 0.954 (-0.206 dB)
Maximum ERP: 1.900 kW

Vertical Polarization:
Maximum: 0.954 (-0.206 dB)
Horizontal Plane: 0.954 (-0.206 dB)
Maximum ERP: 1.900 kW

Directional Antenna System
for
WCQS, Asheville, North Carolina

(Continued)

ANTENNA SPECIFICATIONS

Antenna Type:	BEMP-2E-DA-HW
Frequency:	88.1 MHz
Number of Bays:	Two

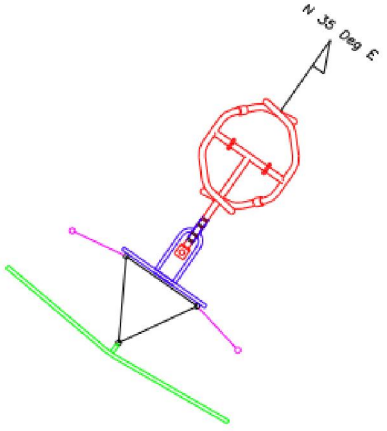
MECHANICAL SPECIFICATIONS

Mounting:	Standard
System length:	14 ft 5 in
Aperture length required:	20 ft 7 in
Orientation:	35° true

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

ELECTRICAL SPECIFICATIONS
(For directional use)

Maximum horizontal ERP:	1.900 kW (2.788 dBk)
Horizontal maximum power gain:	0.954 (-0.206 dB)
Maximum vertical ERP:	1.900 kW (2.788 dBk)
Vertical maximum power gain:	0.954 (-0.206 dB)
Total input power:	1.992 kW (2.993 dBk)



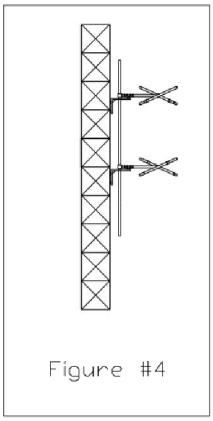


Figure #4