

## ***Modifications to an Existing Directional Antenna System for KRFC, Fort Collins, Colorado***

August 21, 2022

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

The antenna is the ERI model LP-8C-DA configuration. The circular polarized system consists of eight full wave spaced bays using one driven circular polarized radiating element and 2 horizontal parasitic elements per bay. The horizontal parasites are mounted with one  $\frac{1}{4}$  wave above and below each of the antenna bays. The antenna was tested on a full scale model of a Sabre triangular tower with a 39" face width, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 88.9 megahertz, which is the center of the FM broadcast channel assigned to KRFC.

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.



# ***Modifications to an Existing Directional Antenna System for KRFC, Fort Collins, Colorado***

(Continued)

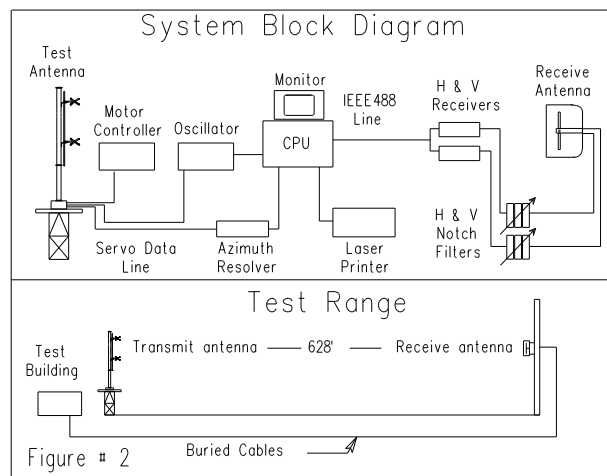
## **DESCRIPTION OF THE TEST PROCEDURE**

The test antenna consisted of two bay levels of the circular polarized system. The elements and brackets that were used in this test are electrically equivalent to those that will be supplied with the 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 full scale model of a Sabre triangular tower with a 39" face width 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 88.9 MHz and was constantly monitored by a Rohde & Schwarz ESVD measuring receiver.



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(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 eight full wave spaced bays using one driven circular polarized radiating element and 2 horizontal parasitic elements per bay. The horizontal parasites are mounted with one  $\frac{1}{4}$  wave above and below each of the antenna 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 LP-8C-DA array is to be mounted on the 39" Sabre triangular tower at a bearing of North 180 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 #23 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 #22A. The actual measured pattern does not exceed the authorized FCC composite pattern at any azimuth.

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(Continued)

A calculated vertical plane relative field pattern is shown on Figure #3 attached. The power in the maximum will reach 50 kilowatts (16.990 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 #23 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 92 feet 2 inches with the antenna mounted near the top of the tower.

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, reading "Dan Dowdle", is positioned above a horizontal line.

Dan Dowdle  
Test Range Director ERI

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

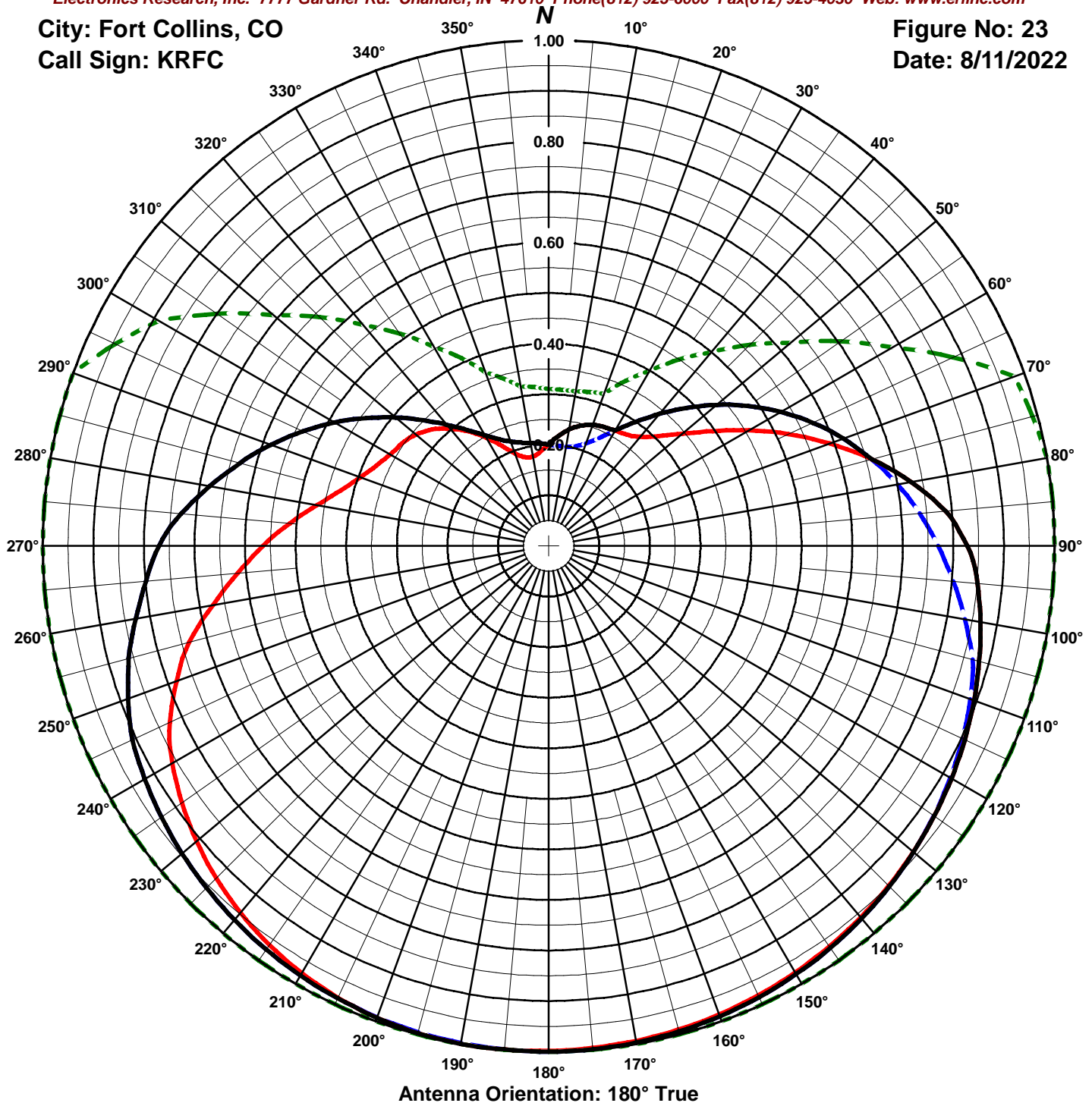
Electronics Research, Inc. 7777 Gardner Rd. Chandler, IN 47610 Phone(812) 925-6000 Fax(812) 925-4030 Web: [www.eriinc.com](http://www.eriinc.com)

City: Fort Collins, CO

Call Sign: KRFC

Figure No: 23

Date: 8/11/2022



Frequency: 88.9 MHz

Antenna Type: LP-8C-DA

Antenna Mounting: 26" Radome

Tower Type: 39" Sabre

## HORIZONTAL

RMS: .706

Maximum: 1 @ 188°

Minimum: .179 @ 348°

## VERTICAL

RMS: .735

Maximum: 1 @ 181°

Minimum: .199 @ 7°

## COMPOSITE

RMS: .74

Maximum: 1 @ 181°

Minimum: .201 @ 0°

## FCC ENVELOPE

RMS: .861

Maximum: 1 @ 80°

Minimum: .31 @ 0°

Two-bay test.

# 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 Web: www.eriinc.com

Figure# 23

Station: KRFC

Location: Fort Collins, CO

Frequency: 88.9 MHz

Date: 8/11/2022

Antenna: LP-8C-DA

Antenna Orientation: 180° True

Number of Bays: 8

Azimuth	Horizontal			Vertical			Azimuth	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.201	2.024	3.062	0.201	2.014	3.040	180°	0.999	49.853	16.977	1.000	49.998	16.990
5°	0.218	2.376	3.759	0.199	1.979	2.964	185°	1.000	49.970	16.987	1.000	49.958	16.986
10°	0.234	2.736	4.371	0.199	1.983	2.973	190°	1.000	49.986	16.989	0.998	49.804	16.973
15°	0.246	3.031	4.816	0.204	2.080	3.180	195°	0.998	49.773	16.970	0.995	49.539	16.949
20°	0.255	3.245	5.113	0.216	2.323	3.661	200°	0.993	49.296	16.928	0.992	49.166	16.917
25°	0.259	3.365	5.270	0.235	2.771	4.426	205°	0.985	48.559	16.863	0.987	48.685	16.874
30°	0.263	3.466	5.399	0.264	3.478	5.413	210°	0.975	47.568	16.773	0.981	48.098	16.821
35°	0.269	3.610	5.575	0.300	4.487	6.520	215°	0.963	46.331	16.659	0.974	47.407	16.758
40°	0.282	3.965	5.983	0.341	5.804	7.637	220°	0.947	44.857	16.518	0.966	46.615	16.685
45°	0.307	4.716	6.735	0.386	7.443	8.718	225°	0.929	43.160	16.351	0.956	45.723	16.601
50°	0.345	5.965	7.756	0.434	9.414	9.738	230°	0.908	41.253	16.155	0.946	44.735	16.506
55°	0.396	7.848	8.947	0.482	11.631	10.656	235°	0.885	39.154	15.928	0.934	43.655	16.400
60°	0.457	10.452	10.192	0.530	14.038	11.473	240°	0.859	36.881	15.668	0.922	42.486	16.282
65°	0.523	13.679	11.360	0.576	16.590	12.199	245°	0.826	34.143	15.333	0.908	41.233	16.152
70°	0.592	17.500	12.430	0.620	19.202	12.833	250°	0.783	30.626	14.861	0.884	39.098	15.921
75°	0.662	21.900	13.404	0.661	21.857	13.396	255°	0.735	27.019	14.317	0.859	36.928	15.674
80°	0.728	26.493	14.231	0.700	24.524	13.896	260°	0.674	22.689	13.558	0.829	34.326	15.356
85°	0.788	31.051	14.921	0.736	27.111	14.332	265°	0.617	19.042	12.797	0.799	31.929	15.042
90°	0.827	34.235	15.345	0.770	29.644	14.719	270°	0.565	15.952	12.028	0.770	29.634	14.718
95°	0.851	36.211	15.588	0.803	32.241	15.084	275°	0.514	13.189	11.202	0.729	26.580	14.245
100°	0.867	37.547	15.746	0.836	34.924	15.431	280°	0.465	10.801	10.335	0.680	23.138	13.643
105°	0.881	38.814	15.890	0.868	37.656	15.758	285°	0.425	9.047	9.565	0.632	19.967	13.003
110°	0.895	40.028	16.024	0.887	39.341	15.948	290°	0.396	7.844	8.946	0.585	17.090	12.327
115°	0.908	41.184	16.147	0.902	40.712	16.097	295°	0.376	7.058	8.487	0.536	14.366	11.573
120°	0.920	42.280	16.261	0.916	41.998	16.232	300°	0.362	6.543	8.158	0.489	11.942	10.771
125°	0.931	43.312	16.366	0.930	43.201	16.355	305°	0.354	6.257	7.964	0.441	9.729	9.881
130°	0.941	44.279	16.462	0.941	44.316	16.466	310°	0.342	5.858	7.678	0.395	7.791	8.916
135°	0.951	45.177	16.549	0.952	45.341	16.565	315°	0.326	5.299	7.242	0.352	6.189	7.916
140°	0.959	46.005	16.628	0.962	46.271	16.653	320°	0.302	4.572	6.601	0.313	4.894	6.897
145°	0.967	46.759	16.699	0.971	47.104	16.731	325°	0.276	3.817	5.817	0.280	3.908	5.920
150°	0.974	47.438	16.761	0.978	47.835	16.797	330°	0.247	3.048	4.840	0.253	3.200	5.051
155°	0.980	48.040	16.816	0.985	48.464	16.854	335°	0.218	2.377	3.761	0.233	2.710	4.330
160°	0.986	48.564	16.863	0.990	48.987	16.901	340°	0.195	1.898	2.784	0.220	2.413	3.825
165°	0.990	49.009	16.903	0.994	49.403	16.938	345°	0.182	1.649	2.173	0.211	2.236	3.495
170°	0.994	49.372	16.935	0.997	49.711	16.965	350°	0.179	1.608	2.062	0.207	2.134	3.291
175°	0.997	49.654	16.960	0.999	49.909	16.982	355°	0.187	1.751	2.433	0.203	2.068	3.157

Horizontal Polarization:

Maximum: 8.209 (9.143 dB)

Horizontal Plane: 8.209 (9.143 dB)

Maximum ERP: 50.000 kW

Vertical Polarization:

Maximum: 8.209 (9.143 dB)

Horizontal Plane: 8.209 (9.143 dB)

Maximum ERP: 50.000 kW

Total Input Power: 6.091 kW

Reference: KRFC23.FIG

Two-bay test. 1 3/4" stood off face mount brackets.

# 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 Web: www.eriinc.com

Figure# 1

Station: KRFC

Location: Fort Collins, CO

Frequency: 88.9 MHz

Date: 8/11/2022

Antenna: LP-8C-DA

Antenna Orientation: 180° True

Number of Bays: 8

Azimuth	Envelope			Polarization Maximum	Azimuth	Envelope			Polarization Maximum
	Field	kW	dBk			Field	kW	dBk	
0°	0.201	2.024	3.062	Horizontal	180°	1.000	49.998	16.990	Vertical
5°	0.218	2.376	3.759	Horizontal	185°	1.000	49.970	16.987	Horizontal
10°	0.234	2.736	4.371	Horizontal	190°	1.000	49.986	16.989	Horizontal
15°	0.246	3.031	4.816	Horizontal	195°	0.998	49.773	16.970	Horizontal
20°	0.255	3.245	5.113	Horizontal	200°	0.993	49.296	16.928	Horizontal
25°	0.259	3.365	5.270	Horizontal	205°	0.987	48.685	16.874	Vertical
30°	0.264	3.478	5.413	Vertical	210°	0.981	48.098	16.821	Vertical
35°	0.300	4.487	6.520	Vertical	215°	0.974	47.407	16.758	Vertical
40°	0.341	5.804	7.637	Vertical	220°	0.966	46.615	16.685	Vertical
45°	0.386	7.443	8.718	Vertical	225°	0.956	45.723	16.601	Vertical
50°	0.434	9.414	9.738	Vertical	230°	0.946	44.735	16.506	Vertical
55°	0.482	11.631	10.656	Vertical	235°	0.934	43.655	16.400	Vertical
60°	0.530	14.038	11.473	Vertical	240°	0.922	42.486	16.282	Vertical
65°	0.576	16.590	12.199	Vertical	245°	0.908	41.233	16.152	Vertical
70°	0.620	19.202	12.833	Vertical	250°	0.884	39.098	15.921	Vertical
75°	0.662	21.900	13.404	Horizontal	255°	0.859	36.928	15.674	Vertical
80°	0.728	26.493	14.231	Horizontal	260°	0.829	34.326	15.356	Vertical
85°	0.788	31.051	14.921	Horizontal	265°	0.799	31.929	15.042	Vertical
90°	0.827	34.235	15.345	Horizontal	270°	0.770	29.634	14.718	Vertical
95°	0.851	36.211	15.588	Horizontal	275°	0.729	26.580	14.245	Vertical
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145°	0.971	47.104	16.731	Vertical	325°	0.280	3.908	5.920	Vertical
150°	0.978	47.835	16.797	Vertical	330°	0.253	3.200	5.051	Vertical
155°	0.985	48.464	16.854	Vertical	335°	0.233	2.710	4.330	Vertical
160°	0.990	48.987	16.901	Vertical	340°	0.220	2.413	3.825	Vertical
165°	0.994	49.403	16.938	Vertical	345°	0.211	2.236	3.495	Vertical
170°	0.997	49.711	16.965	Vertical	350°	0.207	2.134	3.291	Vertical
175°	0.999	49.909	16.982	Vertical	355°	0.203	2.068	3.157	Vertical

Horizontal Polarization:

Maximum: 8.209 (9.143 dB)

Horizontal Plane: 8.209 (9.143 dB)

Maximum ERP: 50.000 kW

Vertical Polarization:

Maximum: 8.209 (9.143 dB)

Horizontal Plane: 8.209 (9.143 dB)

Maximum ERP: 50.000 kW

Total Input Power: 6.091 kW

Reference: KRFC23.FIG

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

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Figure No: 3

Call Sign: KRFC

Location: Fort Collins, CO

Frequency: 88.9 MHz

Antenna: 8 bay LP-8C-DA

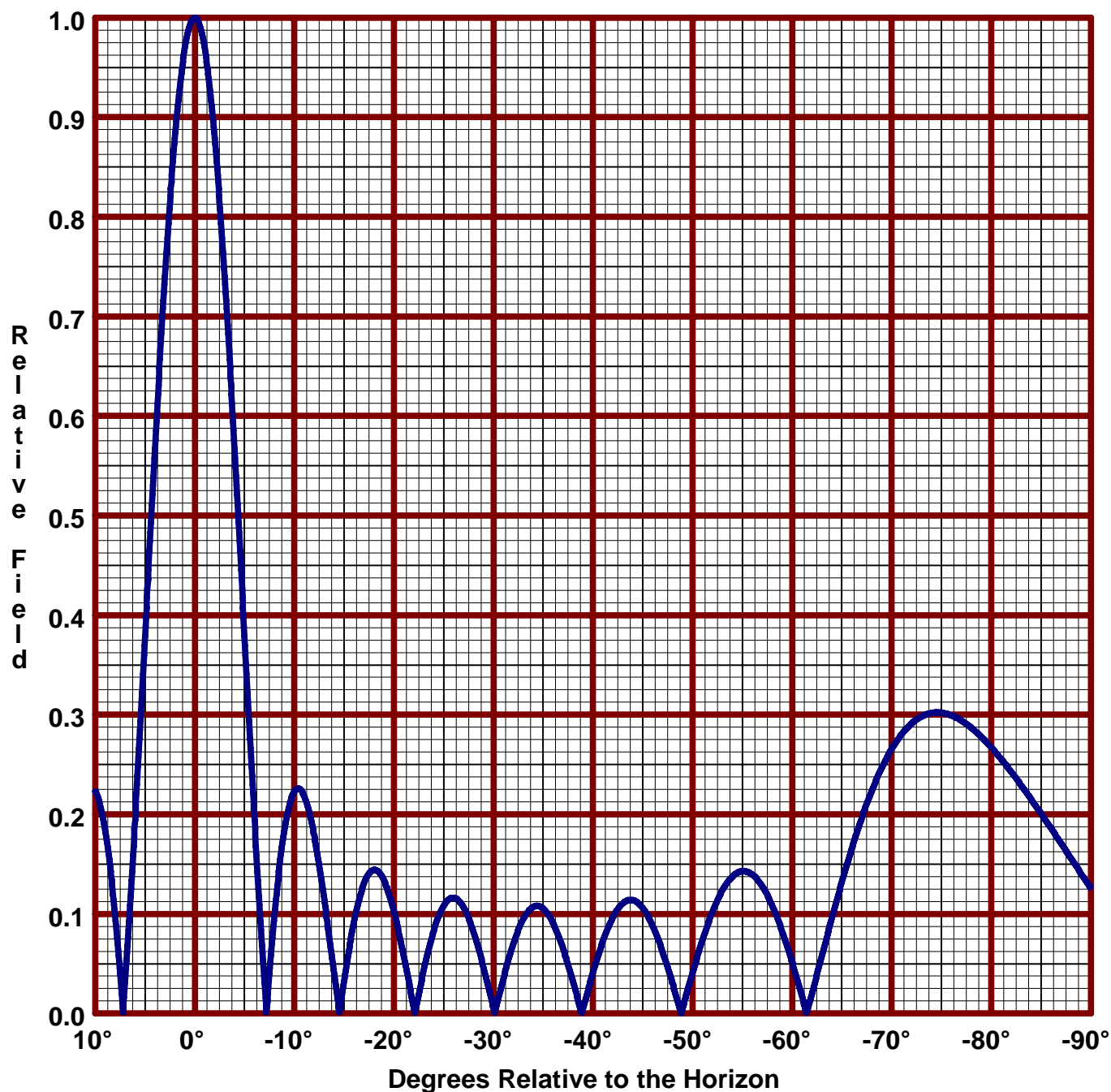
Date: 8/11/2022

H/V Power Ratio: 1

1 Wave-length Spacing

0° Beam Tilt

0% First Null Fill



Horizontal Polarization:

Maximum: 8.209 (9.143 dB)

Horizontal Plane: 8.209 (9.143 dB)

Maximum ERP: 50.000 kW

Vertical Polarization:

Maximum: 8.209 (9.143 dB)

Horizontal Plane: 8.209 (9.143 dB)

Maximum ERP: 50.000 kW



***Modifications to an Existing  
Directional Antenna System  
for  
KRFC, Fort Collins, Colorado***

(Continued)

ANTENNA SPECIFICATIONS

Antenna Type: LP-8C-DA  
Frequency: 88.9 MHz  
Number of Bays: Eight

MECHANICAL SPECIFICATIONS

(With Radomes)

Mounting: Custom  
System length: 81 ft 2 in  
Aperture length required: 92 ft 2 in  
Orientation: 180° true  
Input flange to the antenna 3-1/8-inch EIA, 50-ohm.

ELECTRICAL SPECIFICATIONS

(For directional use)

Maximum Horizontal ERP: 50.000 kW (16.990 dBk)  
Horizontal Maximum Power Gain: 8.209 (9.143 dB)  
Horizontal H Plane Power Gain: 8.209 (9.143 dB)  
Maximum Vertical ERP: 50.000 kW (16.990 dBk)  
Vertical Maximum Power Gain: 8.209 (9.143 dB)  
Vertical H Plane Power Gain: 8.209 (9.143 dB)  
Total input power: 6.091 kW (7.847 dBk)