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 KBCS, Bellevue, Washington

December 11, 2012

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 KBCS.

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 two vertical parasitic elements interleaved between the bays. The antenna was tested on a 10 3/4" o.d. pole, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 91.3 megahertz, which is the center of the FM broadcast channel assigned to KBCS.

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
KBCS, Bellevue, Washington

(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 10 3/4" o.d. pole 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.

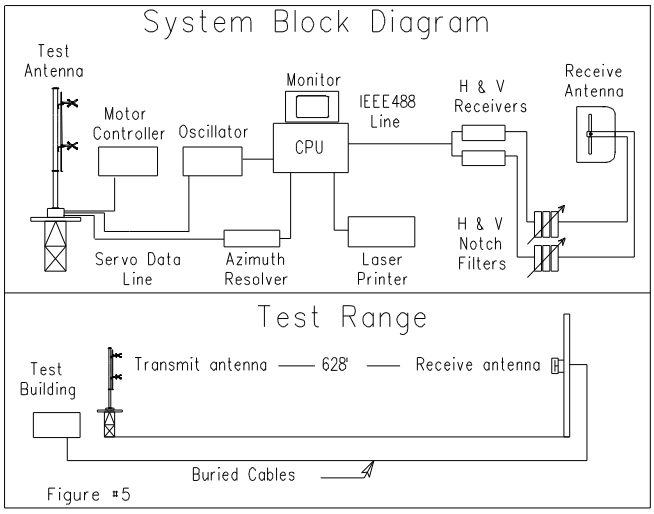

Figure #5

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

Directional Antenna System
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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, two horizontal parasitic elements per bay and two 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 10 3/4" o.d. pole at a bearing of North 183 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.

A calculated vertical plane relative field pattern is shown on Figure #3 attached. The power in the maximum will reach 1.800 kilowatts (2.553 dBk).

The power at North 10 degrees East does not exceed 0.510 kilowatts (-2.924 dBk).

Directional Antenna System
For
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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 that 85% of the filed composite pattern.

The clear vertical length of the structure required to support the antenna is 25 feet 4 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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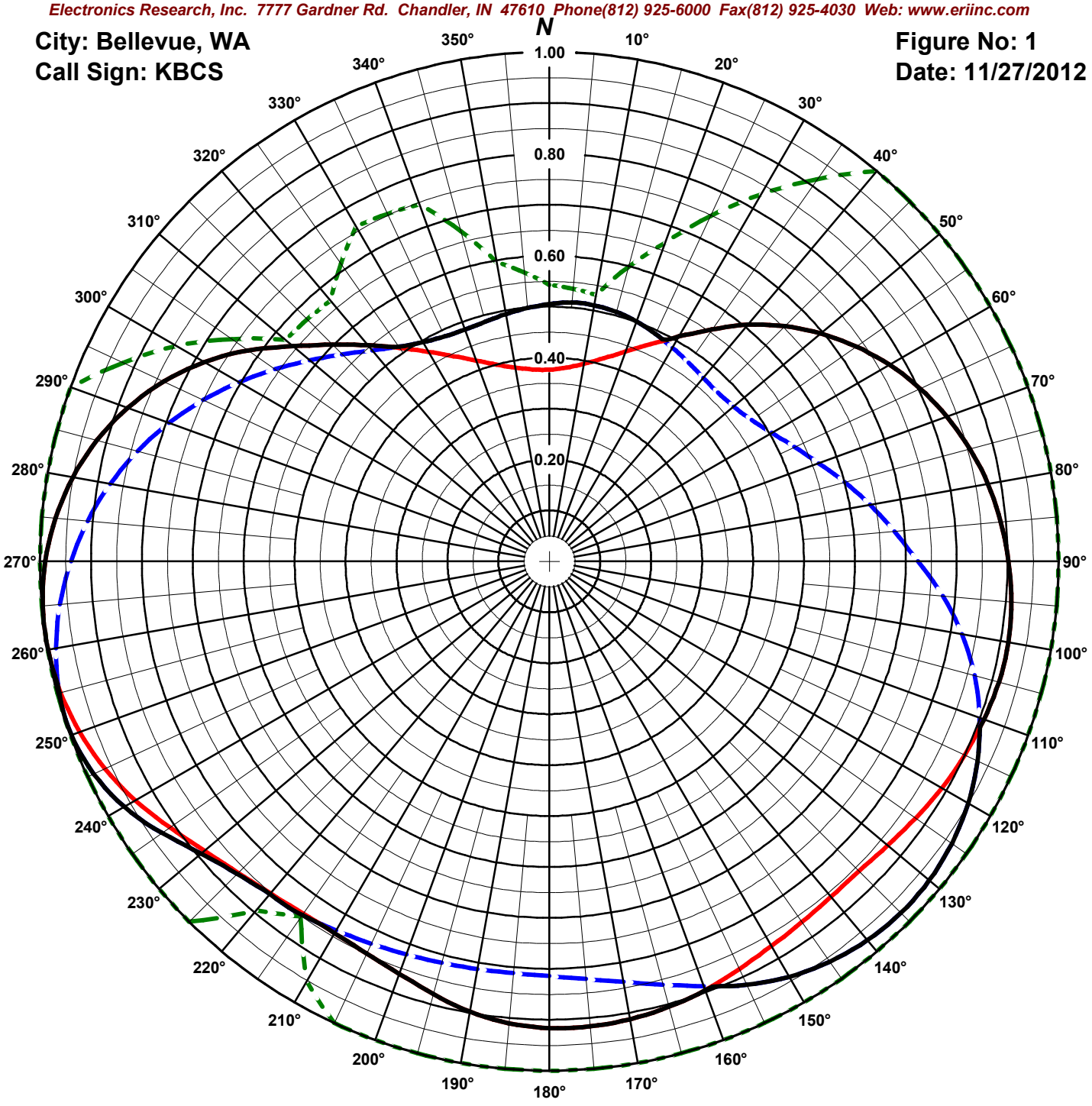
City: Bellevue, WA
Call Sign: KBCS

Figure No: 1
Date: 11/27/2012



Antenna Orientation: 183° True

Frequency: 91.3 MHz
Antenna Type: LP-2E-DA-HW

Antenna Mounting: Standard
Tower Type: 10 3\4" o.d. pole

HORIZONTAL	VERTICAL	COMPOSITE	FCC ENVELOPE
RMS: .796	RMS: .762	RMS: .817	RMS: .921
Maximum: 1 @ 262°	Maximum: 1 @ 252°	Maximum: 1 @ 262°	Maximum: 1 @ 40°
Minimum: .376 @ 0°	Minimum: .468 @ 44°	Minimum: .484 @ 340°	Minimum: .531 @ 10°

Measured patterns of the horizontal and vertical components, with the composite maximum of either the the H or V components and the filed FCC envelope pattern BPED-20100618AGR.

ERI® Horizontal Plane Relative Field Pattern

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Figure# 1 **Date: 11/27/2012**
Station: KBCS **Antenna: LP-2E-DA-HW**
Location: Bellevue, WA **Antenna Orientation: 183° True**
Frequency: 91.3 MHz **Number of Bays: 2**

Azimuth	Envelope			Polarization	Azimuth	Envelope			Polarization
	Field	kW	dBk	Maximum		Field	kW	dBk	Maximum
0°	0.505	0.460	-3.375	Vertical	180°	0.916	1.512	1.795	Horizontal
5°	0.510	0.469	-3.289	Vertical	185°	0.910	1.491	1.736	Horizontal
10°	0.511	0.469	-3.286	Vertical	190°	0.898	1.451	1.617	Horizontal
15°	0.507	0.463	-3.342	Vertical	195°	0.880	1.392	1.438	Horizontal
20°	0.501	0.452	-3.448	Vertical	200°	0.862	1.336	1.259	Horizontal
25°	0.493	0.437	-3.591	Vertical	205°	0.849	1.298	1.133	Horizontal
30°	0.510	0.467	-3.303	Horizontal	210°	0.843	1.279	1.070	Horizontal
35°	0.555	0.555	-2.556	Horizontal	215°	0.847	1.293	1.115	Vertical
40°	0.606	0.662	-1.793	Horizontal	220°	0.854	1.311	1.177	Vertical
45°	0.653	0.767	-1.153	Horizontal	225°	0.867	1.354	1.317	Vertical
50°	0.696	0.871	-0.599	Horizontal	230°	0.893	1.435	1.567	Vertical
55°	0.735	0.974	-0.116	Horizontal	235°	0.929	1.555	1.918	Vertical
60°	0.772	1.072	0.300	Horizontal	240°	0.964	1.673	2.235	Vertical
65°	0.803	1.162	0.650	Horizontal	245°	0.987	1.754	2.440	Vertical
70°	0.831	1.243	0.943	Horizontal	250°	0.999	1.795	2.541	Vertical
75°	0.855	1.314	1.187	Horizontal	255°	0.996	1.787	2.520	Vertical
80°	0.875	1.377	1.389	Horizontal	260°	0.999	1.798	2.548	Horizontal
85°	0.890	1.425	1.538	Horizontal	265°	0.998	1.794	2.538	Horizontal
90°	0.902	1.464	1.654	Horizontal	270°	0.990	1.763	2.461	Horizontal
95°	0.910	1.492	1.738	Horizontal	275°	0.973	1.705	2.318	Horizontal
100°	0.915	1.508	1.784	Horizontal	280°	0.950	1.624	2.106	Horizontal
105°	0.914	1.505	1.774	Horizontal	285°	0.919	1.520	1.819	Horizontal
110°	0.908	1.484	1.713	Horizontal	290°	0.881	1.396	1.449	Horizontal
115°	0.928	1.550	1.903	Vertical	295°	0.835	1.255	0.988	Horizontal
120°	0.950	1.624	2.106	Vertical	300°	0.782	1.101	0.419	Horizontal
125°	0.965	1.678	2.247	Vertical	305°	0.722	0.938	-0.278	Horizontal
130°	0.974	1.709	2.328	Vertical	310°	0.657	0.777	-1.098	Horizontal
135°	0.977	1.717	2.347	Vertical	315°	0.602	0.652	-1.858	Horizontal
140°	0.972	1.699	2.303	Vertical	320°	0.554	0.552	-2.580	Horizontal
145°	0.960	1.659	2.199	Vertical	325°	0.514	0.476	-3.220	Vertical
150°	0.942	1.598	2.035	Vertical	330°	0.497	0.444	-3.523	Vertical
155°	0.918	1.516	1.808	Vertical	335°	0.487	0.427	-3.694	Vertical
160°	0.896	1.444	1.595	Horizontal	340°	0.484	0.422	-3.746	Vertical
165°	0.906	1.477	1.693	Horizontal	345°	0.487	0.427	-3.696	Vertical
170°	0.913	1.500	1.760	Horizontal	350°	0.493	0.437	-3.591	Vertical
175°	0.917	1.512	1.797	Horizontal	355°	0.499	0.449	-3.479	Vertical

Horizontal Polarization:
Maximum: 1.099 (0.408 dB)
Horizontal Plane: 1.099 (0.408 dB)
Maximum ERP: 1.800 kW

Vertical Polarization:
Maximum: 1.099 (0.408 dB)
Horizontal Plane: 1.099 (0.408 dB)
Maximum ERP: 1.800 kW

Total Input Power: 1.639 kW
Reference: KBCS1.FIG

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

ERI® Horizontal Plane Relative Field Pattern

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Figure# 1A **Date: 11/27/2012**
Station: KBCS **Antenna: LP-2E-DA-HW**
Location: Bellevue, WA **Antenna Orientation: 183° True**
Frequency: 91.3 MHz **Number of Bays: 2**

Azimuth	Horizontal			Vertical			Azimuth	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.376	0.255	-5.939	0.505	0.460	-3.375	180°	0.916	1.512	1.795	0.814	1.194	0.769
5°	0.382	0.262	-5.813	0.510	0.469	-3.289	185°	0.910	1.491	1.736	0.812	1.186	0.740
10°	0.394	0.279	-5.542	0.511	0.469	-3.286	190°	0.898	1.451	1.617	0.813	1.189	0.753
15°	0.413	0.307	-5.136	0.507	0.463	-3.342	195°	0.880	1.392	1.438	0.816	1.199	0.788
20°	0.438	0.346	-4.613	0.501	0.452	-3.448	200°	0.862	1.336	1.259	0.821	1.214	0.842
25°	0.471	0.399	-3.995	0.493	0.437	-3.591	205°	0.849	1.298	1.133	0.828	1.235	0.916
30°	0.510	0.467	-3.303	0.484	0.422	-3.746	210°	0.843	1.279	1.070	0.837	1.261	1.008
35°	0.555	0.555	-2.556	0.476	0.409	-3.888	215°	0.844	1.282	1.077	0.847	1.293	1.115
40°	0.606	0.662	-1.793	0.470	0.398	-3.998	220°	0.851	1.304	1.152	0.854	1.311	1.177
45°	0.653	0.767	-1.153	0.468	0.395	-4.036	225°	0.865	1.345	1.288	0.867	1.354	1.317
50°	0.696	0.871	-0.599	0.473	0.403	-3.950	230°	0.884	1.407	1.483	0.893	1.435	1.567
55°	0.735	0.974	-0.116	0.485	0.423	-3.738	235°	0.910	1.490	1.731	0.929	1.555	1.918
60°	0.772	1.072	0.300	0.505	0.458	-3.388	240°	0.938	1.585	2.001	0.964	1.673	2.235
65°	0.803	1.162	0.650	0.531	0.508	-2.939	245°	0.963	1.669	2.224	0.987	1.754	2.440
70°	0.831	1.243	0.943	0.563	0.571	-2.432	250°	0.981	1.733	2.388	0.999	1.795	2.541
75°	0.855	1.314	1.187	0.601	0.649	-1.875	255°	0.993	1.776	2.495	0.996	1.787	2.520
80°	0.875	1.377	1.389	0.640	0.737	-1.323	260°	0.999	1.798	2.548	0.984	1.742	2.410
85°	0.890	1.425	1.538	0.680	0.833	-0.794	265°	0.998	1.794	2.538	0.965	1.675	2.240
90°	0.902	1.464	1.654	0.724	0.945	-0.248	270°	0.990	1.763	2.461	0.939	1.588	2.010
95°	0.910	1.492	1.738	0.775	1.083	0.344	275°	0.973	1.705	2.318	0.910	1.490	1.733
100°	0.915	1.508	1.784	0.823	1.219	0.862	280°	0.950	1.624	2.106	0.876	1.380	1.400
105°	0.914	1.505	1.774	0.864	1.345	1.288	285°	0.919	1.520	1.819	0.837	1.260	1.005
110°	0.908	1.484	1.713	0.899	1.456	1.632	290°	0.881	1.396	1.449	0.795	1.137	0.557
115°	0.900	1.458	1.636	0.928	1.550	1.903	295°	0.835	1.255	0.988	0.750	1.012	0.053
120°	0.890	1.426	1.542	0.950	1.624	2.106	300°	0.782	1.101	0.419	0.703	0.891	-0.503
125°	0.878	1.389	1.426	0.965	1.678	2.247	305°	0.722	0.938	-0.278	0.658	0.778	-1.089
130°	0.868	1.355	1.319	0.974	1.709	2.328	310°	0.657	0.777	-1.098	0.614	0.679	-1.681
135°	0.860	1.331	1.242	0.977	1.717	2.347	315°	0.602	0.652	-1.858	0.575	0.595	-2.253
140°	0.860	1.331	1.243	0.972	1.699	2.303	320°	0.554	0.552	-2.580	0.541	0.527	-2.782
145°	0.864	1.345	1.288	0.960	1.659	2.199	325°	0.512	0.471	-3.268	0.514	0.476	-3.220
150°	0.872	1.369	1.365	0.942	1.598	2.035	330°	0.475	0.406	-3.911	0.497	0.444	-3.523
155°	0.883	1.404	1.473	0.918	1.516	1.808	335°	0.444	0.355	-4.493	0.487	0.427	-3.694
160°	0.896	1.444	1.595	0.888	1.420	1.523	340°	0.419	0.316	-4.997	0.484	0.422	-3.746
165°	0.906	1.477	1.693	0.861	1.333	1.248	345°	0.400	0.288	-5.408	0.487	0.427	-3.696
170°	0.913	1.500	1.760	0.839	1.266	1.026	350°	0.386	0.268	-5.711	0.493	0.437	-3.591
175°	0.917	1.512	1.797	0.823	1.220	0.865	355°	0.378	0.258	-5.892	0.499	0.449	-3.479

Horizontal Polarization:
Maximum: 1.099 (0.408 dB)
Horizontal Plane: 1.099 (0.408 dB)
Maximum ERP: 1.800 kW

Vertical Polarization:
Maximum: 1.099 (0.408 dB)
Horizontal Plane: 1.099 (0.408 dB)
Maximum ERP: 1.800 kW

Total Input Power: 1.639 kW
Reference: KBCS1.FIG

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

ERI® Vertical Plane Relative Field Pattern

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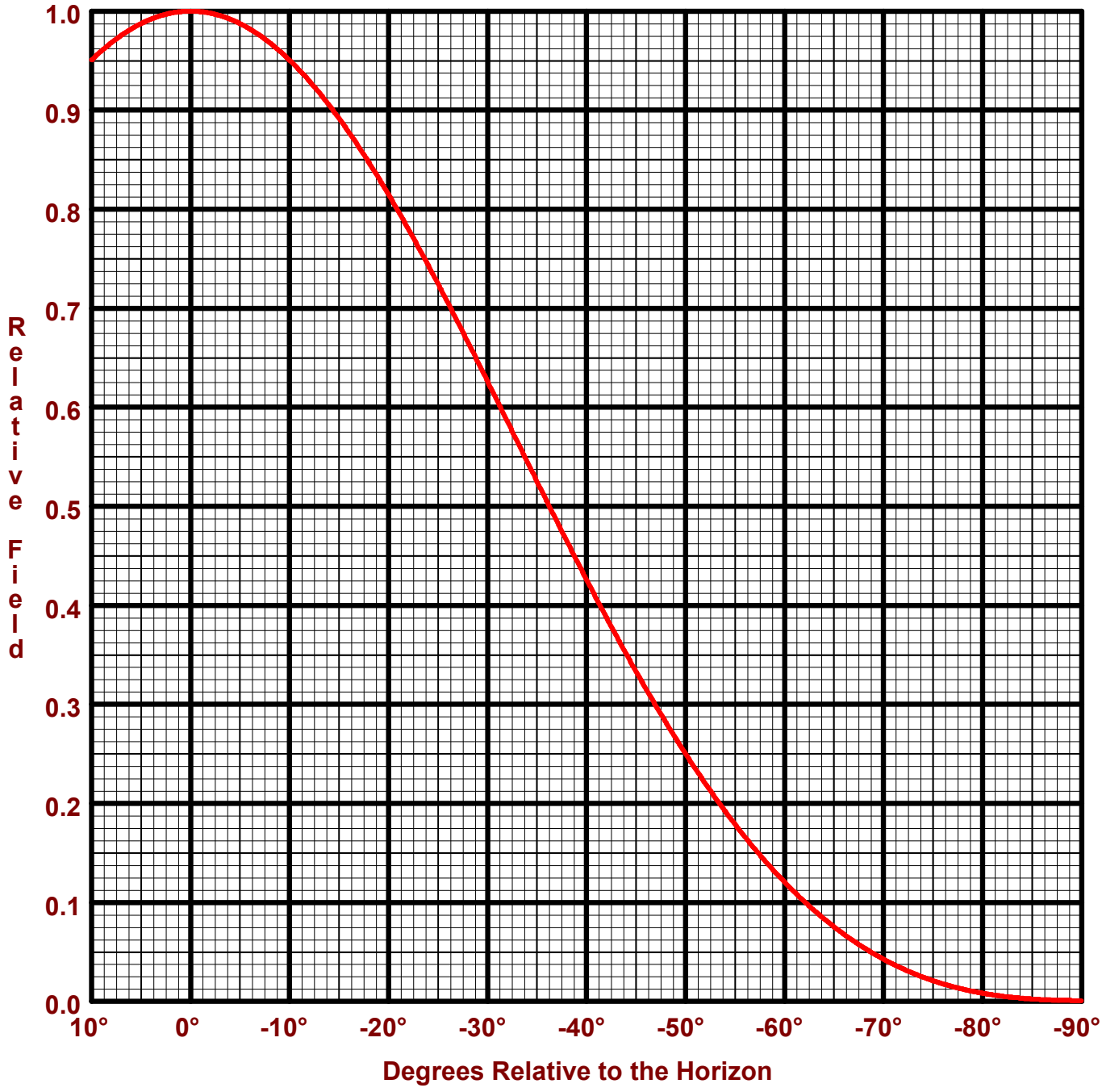
Figure No: 3
Call Sign: KBCS
Location: Bellevue, WA
Frequency: 91.3 MHz
2 bay LP-2E-DA-HW antenna

Date: 11/27/2012
H/V Power Ratio: 1
.5 Wave-length Spacing
0° Beam Tilt
0% First Null Fill



Horizontal Polarization:
Maximum: 1.099 (0.408 dB)
Horizontal Plane: 1.099 (0.408 dB)
Maximum ERP: 1.800 kW

Vertical Polarization:
Maximum: 1.099 (0.408 dB)
Horizontal Plane: 1.099 (0.408 dB)
Maximum ERP: 1.800 kW

Directional Antenna System
for
KBCS, Bellevue, Washington

(Continued)

ANTENNA SPECIFICATIONS

Antenna Type:	LP-2E-DA-HW
Frequency:	91.3 MHz
Number of Bays:	Two

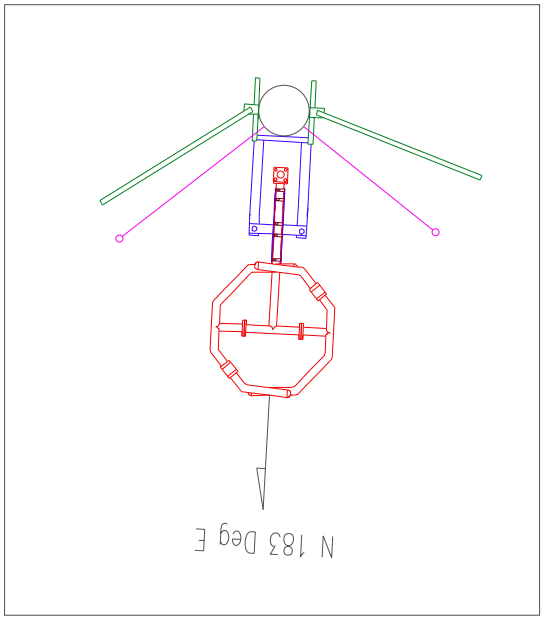
MECHANICAL SPECIFICATIONS

Mounting:	Standard
System length:	14 ft 2 in
Aperture length required:	25 ft 4 in
Orientation:	183° true

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

ELECTRICAL SPECIFICATIONS
(For directional use)

Maximum horizontal ERP:	1.800 kW (2.553 dBk)
Horizontal maximum power gain:	1.099 (0.408 dB)
Maximum vertical ERP:	1.800 kW (2.553 dBk)
Vertical maximum power gain:	1.099 (0.408 dB)
Total input power:	1.639 kW (2.145 dBk)



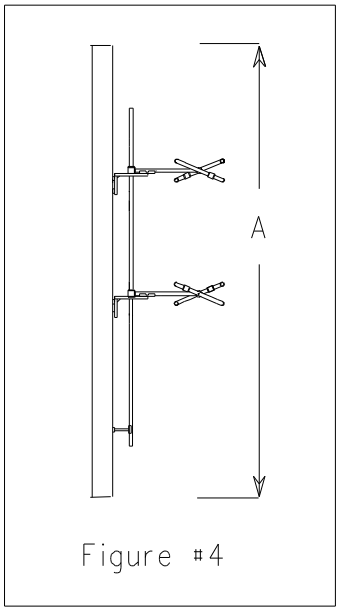


Figure #4