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 KDDS, Elma, Washington*

October 10, 2008

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 KDDS.

The antenna is the ERI model SHP-6AC-DA-HW configuration. The circular polarized system consists of 6 half-wavelength spaced bays using one driven circular polarized radiating element per bay, three horizontal parasitic elements per bay and one vertical parasitic element per bay. The antenna was mounted on the North 193 degrees East tower leg with bracketry to provide an antenna orientation of North 183 degrees East. The antenna was tested on a 48" face tower, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 99.3 megahertz, which is the center of the FM broadcast channel assigned to KDDS.

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
KDDS, Elma, Washington

(Continued)

## 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 3 1/8 inch o.d. rigid coaxial line was used to feed the test antenna, and a section of 3 1/8 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 48" 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.

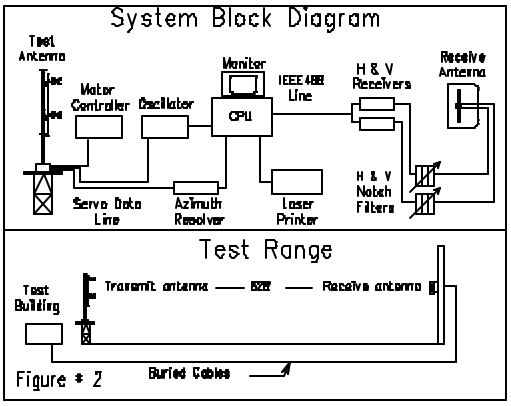

Figure # 2

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

A broadband horizontal and vertical dipole system, located approximately 628 feet from the test antenna, was used to receive the emitted test signals.

(Continued)

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 6 half-wavelength spaced bays using one driven circular polarized radiating element per bay, three horizontal parasitic elements per bay and one vertical parasitic element 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 SHP-6AC-DA-HW array is to be mounted on the North 193 degrees East tower leg of the 48" face tower 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 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 64 kilowatts (18.062 dBk).

The RMS of the vertically polarized horizontal plane component does not exceed the RMS of the horizontally polarized horizontal plane component.

(Continued)

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 40 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.

# ERI® Horizontal Plane Relative Field Pattern

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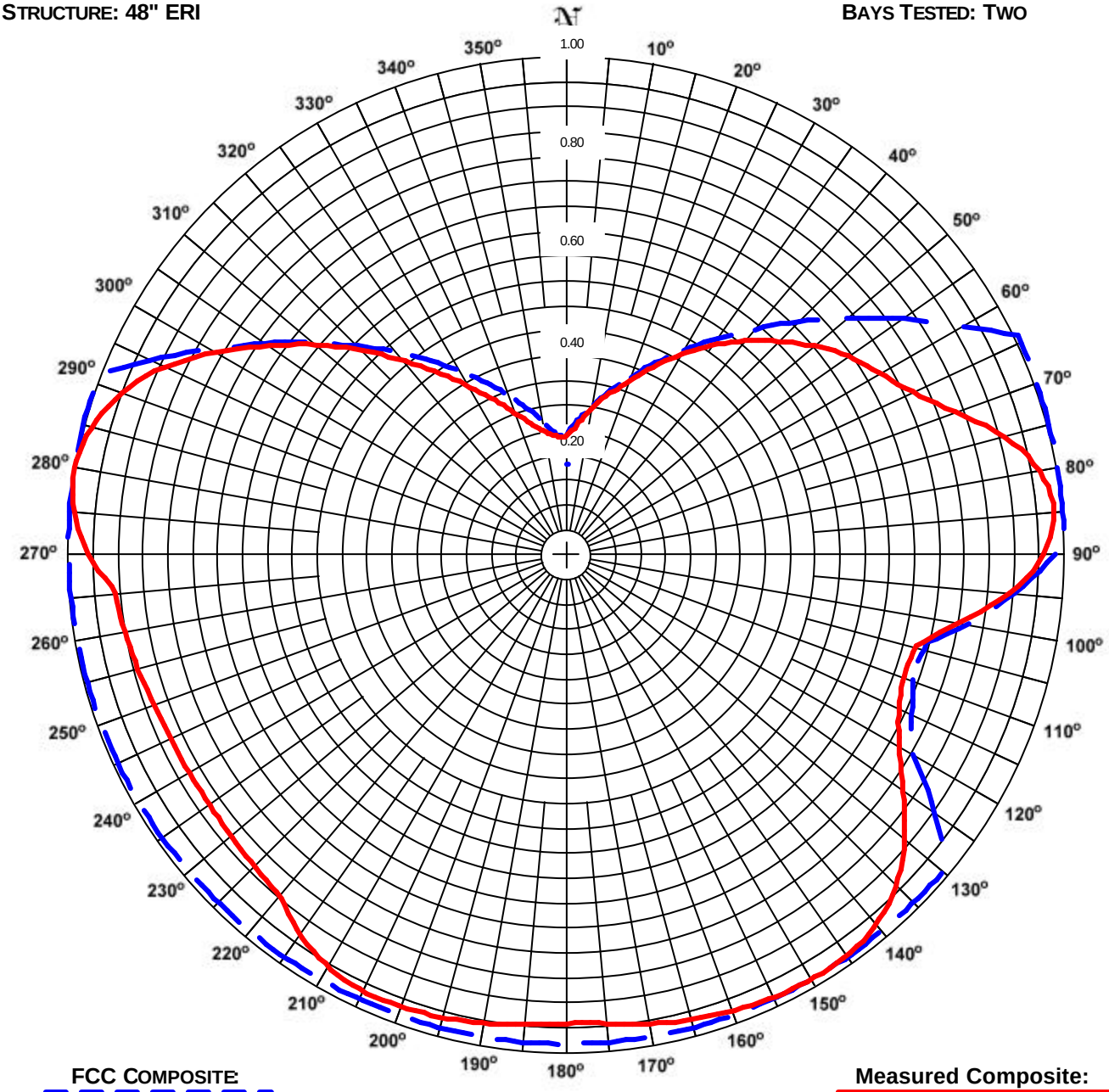
FIGURE NO: 1
STATION: KDDS
LOCATION: ELMA WA
ANTENNA: SHP-6AC-DA-HW
STRUCTURE: 48" ERI

DATE: 10/7/2008
FREQUENCY: 99.3 MHZ
ORIENTATION: 183° TRUE
MOUNTING: STANDARD
BAYS TESTED: TWO




**FCC COMPOSITE:**
RMS: 0.842
MAXIMUM: 1.000 @ 65° TRUE
MINIMUM: 0.224 @ 0° TRUE

**Measured Composite:**
RMS: 0.794
Maximum: 1.000 @ 150° True
Minimum: 0.220 @ 359° True

COMMENTS: COMPOSITE PATTERN: THIS PATTERN SHOWS THE MAXIMUM OF EITHER THE H OR V AZIMUTH VALUES. THIS PATTERN IS GREATER THAT 85% OF THE FCC FILED COMPOSITE PATTERN BLH-20070723ADO.

# ERI® 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: KDDS**
**Location: Elma WA**
**Frequency: 99.3 MHz**

**Antenna: SHP-6AC-DA-HW**
**Orientation: 183° True**
**Tower: 48" ERI**

**Figure: 1**
**Date: 10/7/2008**
**Reference: KDDS1M.fig**

| Angle | Envelope | | | Polarization | Angle | Envelope | | | Polarization |
|---|---|---|---|---|---|---|---|---|---|
| | Field | kW | dBk | | | Field | kW | dBk | |
| 0º | 0.223 | 3.18 | 5.03 | Vertical | 180º | 0.959 | 58.82 | 17.69 | Horizontal |
| 5º | 0.243 | 3.79 | 5.79 | Horizontal | 185º | 0.965 | 59.61 | 17.75 | Horizontal |
| 10º | 0.278 | 4.96 | 6.96 | Horizontal | 190º | 0.973 | 60.57 | 17.82 | Horizontal |
| 15º | 0.312 | 6.24 | 7.95 | Horizontal | 195º | 0.979 | 61.31 | 17.88 | Horizontal |
| 20º | 0.347 | 7.71 | 8.87 | Horizontal | 200º | 0.982 | 61.75 | 17.91 | Horizontal |
| 25º | 0.391 | 9.79 | 9.91 | Horizontal | 205º | 0.982 | 61.69 | 17.90 | Horizontal |
| 30º | 0.440 | 12.40 | 10.93 | Horizontal | 210º | 0.969 | 60.09 | 17.79 | Horizontal |
| 35º | 0.488 | 15.22 | 11.83 | Horizontal | 215º | 0.941 | 56.62 | 17.53 | Horizontal |
| 40º | 0.537 | 18.47 | 12.66 | Horizontal | 220º | 0.907 | 52.62 | 17.21 | Vertical |
| 45º | 0.583 | 21.73 | 13.37 | Horizontal | 225º | 0.897 | 51.47 | 17.12 | Vertical |
| 50º | 0.630 | 25.42 | 14.05 | Horizontal | 230º | 0.889 | 50.58 | 17.04 | Vertical |
| 55º | 0.675 | 29.15 | 14.65 | Horizontal | 235º | 0.884 | 50.03 | 16.99 | Vertical |
| 60º | 0.712 | 32.40 | 15.11 | Horizontal | 240º | 0.882 | 49.84 | 16.98 | Vertical |
| 65º | 0.751 | 36.14 | 15.58 | Horizontal | 245º | 0.884 | 50.02 | 16.99 | Vertical |
| 70º | 0.812 | 42.15 | 16.25 | Horizontal | 250º | 0.889 | 50.55 | 17.04 | Vertical |
| 75º | 0.893 | 51.02 | 17.08 | Horizontal | 255º | 0.896 | 51.41 | 17.11 | Vertical |
| 80º | 0.954 | 58.30 | 17.66 | Horizontal | 260º | 0.905 | 52.40 | 17.19 | Vertical |
| 85º | 0.982 | 61.70 | 17.90 | Horizontal | 265º | 0.917 | 53.76 | 17.30 | Horizontal |
| 90º | 0.967 | 59.89 | 17.77 | Horizontal | 270º | 0.967 | 59.88 | 17.77 | Horizontal |
| 95º | 0.911 | 53.06 | 17.25 | Horizontal | 275º | 0.995 | 63.37 | 18.02 | Horizontal |
| 100º | 0.824 | 43.48 | 16.38 | Horizontal | 280º | 0.998 | 63.74 | 18.04 | Horizontal |
| 105º | 0.742 | 35.20 | 15.47 | Horizontal | 285º | 0.977 | 61.05 | 17.86 | Horizontal |
| 110º | 0.727 | 33.82 | 15.29 | Vertical | 290º | 0.934 | 55.79 | 17.47 | Horizontal |
| 115º | 0.739 | 34.97 | 15.44 | Vertical | 295º | 0.869 | 48.35 | 16.84 | Horizontal |
| 120º | 0.771 | 38.09 | 15.81 | Vertical | 300º | 0.786 | 39.52 | 15.97 | Horizontal |
| 125º | 0.824 | 43.44 | 16.38 | Vertical | 305º | 0.704 | 31.69 | 15.01 | Horizontal |
| 130º | 0.889 | 50.53 | 17.04 | Vertical | 310º | 0.628 | 25.24 | 14.02 | Horizontal |
| 135º | 0.944 | 56.98 | 17.56 | Vertical | 315º | 0.550 | 19.38 | 12.87 | Horizontal |
| 140º | 0.980 | 61.43 | 17.88 | Vertical | 320º | 0.479 | 14.70 | 11.67 | Horizontal |
| 145º | 0.996 | 63.55 | 18.03 | Vertical | 325º | 0.417 | 11.11 | 10.46 | Horizontal |
| 150º | 1.000 | 64.00 | 18.06 | Vertical | 330º | 0.363 | 8.43 | 9.26 | Horizontal |
| 155º | 0.998 | 63.69 | 18.04 | Vertical | 335º | 0.318 | 6.46 | 8.10 | Horizontal |
| 160º | 0.992 | 63.00 | 17.99 | Vertical | 340º | 0.281 | 5.06 | 7.04 | Horizontal |
| 165º | 0.984 | 62.00 | 17.92 | Vertical | 345º | 0.253 | 4.09 | 6.12 | Horizontal |
| 170º | 0.974 | 60.74 | 17.83 | Vertical | 350º | 0.233 | 3.48 | 5.41 | Horizontal |
| 175º | 0.963 | 59.35 | 17.73 | Vertical | 355º | 0.222 | 3.17 | 5.00 | Horizontal |

**Polarization:** **Envelope**
**Maximum Field:** **1.000 @ 150° True**
**Minimum Field:** **0.220 @ 359° True**
**RMS:** **0.794**
**Maximum ERP:** **64.000 kW**
**Maximum Power Gain:** **3.112 (4.930 dB)**

**Total Input Power: 20.566 kW**

# ERI® Horizontal Plane Relative Field Pattern

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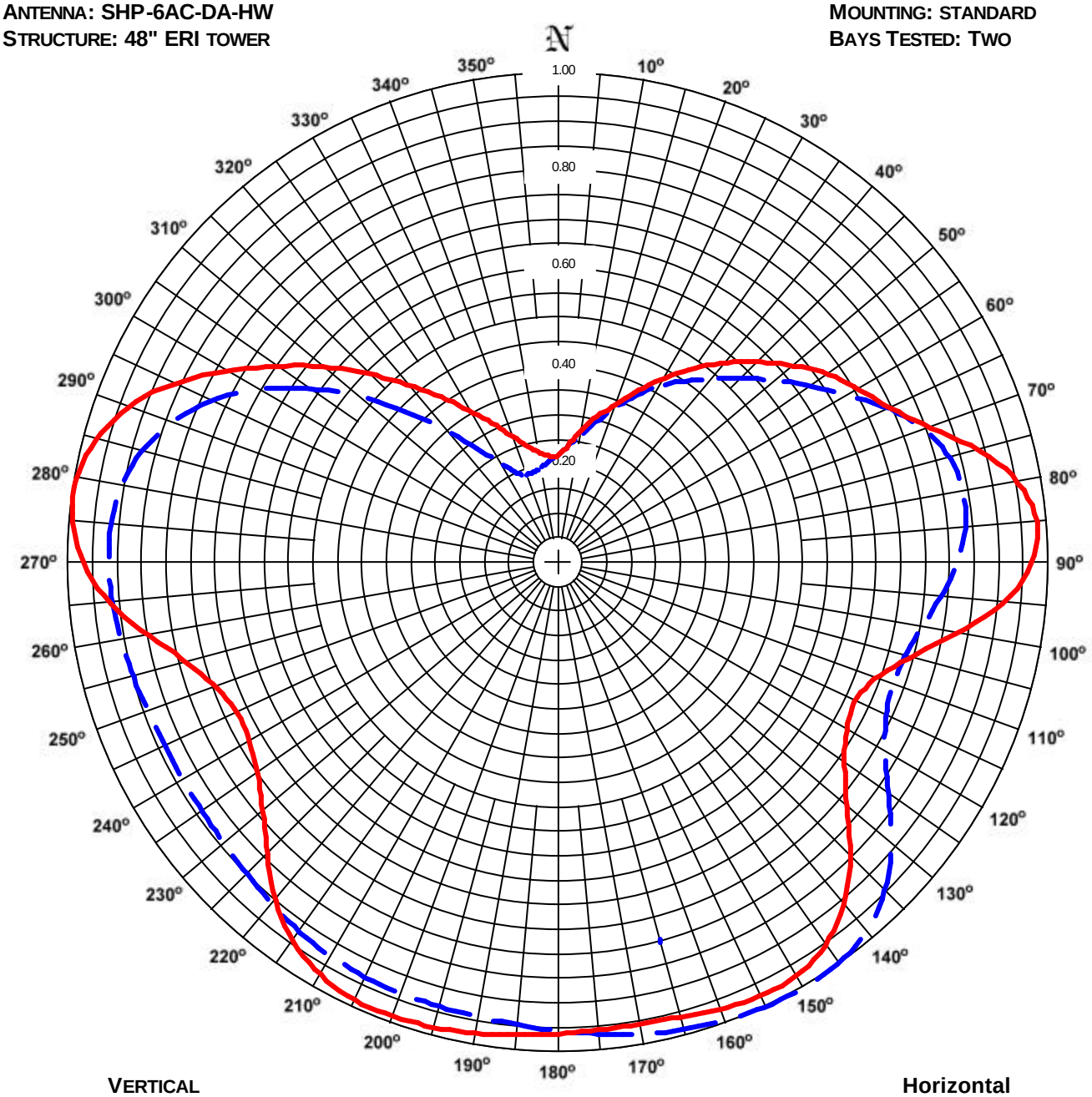
**FIGURE NO: 2**
**STATION: KDDS**
**LOCATION: ELMA WA**
**ANTENNA: SHP-6AC-DA-HW**
**STRUCTURE: 48" ERI TOWER**

**DATE: 10/7/2008**
**FREQUENCY: 99.3 MHZ**
**ORIENTATION: 183° TRUE**
**MOUNTING: STANDARD**
**BAYS TESTED: TWO**




**VERTICAL**

**RMS: 0.760**
**MAXIMUM: 1.000 @ 150° TRUE**
**MINIMUM: 0.193 @ 343° TRUE**

**Horizontal**

**RMS: 0.768**
**Maximum: 1.000 @ 278° True**
**Minimum: 0.220 @ 359° True**

**COMMENTS: MEASURED PATTERNS OF THE HORIZONTAL AND VERTICAL COMPONENTS.**

# ERI® Horizontal Plane Relative Field List

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**Station: KDDS**
**Location: Elma WA**
**Frequency: 99.3 MHz**

**Antenna: SHP-6AC-DA-HW**
**Orientation: 183° True**
**Tower: 48" ERI tower**

**Figure: 2**
**Date: 10/7/2008**
**Reference: kdds1m.fig**

| Angle | Horizontal | | | Vertical | | | Angle | Horizontal | | | Vertical | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Field | kW | dBk | Field | kW | dBk | | Field | kW | dBk | Field | kW | dBk |
| 0° | 0.222 | 3.15 | 4.99 | 0.223 | 3.18 | 5.03 | 180° | 0.959 | 58.82 | 17.69 | 0.953 | 58.08 | 17.64 |
| 5° | 0.243 | 3.79 | 5.79 | 0.243 | 3.77 | 5.76 | 185° | 0.965 | 59.61 | 17.75 | 0.944 | 57.08 | 17.56 |
| 10° | 0.278 | 4.96 | 6.96 | 0.268 | 4.58 | 6.61 | 190° | 0.973 | 60.57 | 17.82 | 0.938 | 56.35 | 17.51 |
| 15° | 0.312 | 6.24 | 7.95 | 0.300 | 5.78 | 7.62 | 195° | 0.979 | 61.31 | 17.88 | 0.935 | 55.90 | 17.47 |
| 20° | 0.347 | 7.71 | 8.87 | 0.339 | 7.34 | 8.66 | 200° | 0.982 | 61.75 | 17.91 | 0.933 | 55.65 | 17.45 |
| 25° | 0.391 | 9.79 | 9.91 | 0.381 | 9.27 | 9.67 | 205° | 0.982 | 61.69 | 17.90 | 0.930 | 55.33 | 17.43 |
| 30° | 0.440 | 12.40 | 10.93 | 0.421 | 11.35 | 10.55 | 210° | 0.969 | 60.09 | 17.79 | 0.925 | 54.74 | 17.38 |
| 35° | 0.488 | 15.22 | 11.83 | 0.456 | 13.33 | 11.25 | 215° | 0.941 | 56.62 | 17.53 | 0.917 | 53.81 | 17.31 |
| 40° | 0.537 | 18.47 | 12.66 | 0.493 | 15.55 | 11.92 | 220° | 0.896 | 51.43 | 17.11 | 0.907 | 52.62 | 17.21 |
| 45° | 0.583 | 21.73 | 13.37 | 0.536 | 18.36 | 12.64 | 225° | 0.839 | 45.03 | 16.53 | 0.897 | 51.47 | 17.12 |
| 50° | 0.630 | 25.42 | 14.05 | 0.583 | 21.76 | 13.38 | 230° | 0.786 | 39.55 | 15.97 | 0.889 | 50.58 | 17.04 |
| 55° | 0.675 | 29.15 | 14.65 | 0.633 | 25.67 | 14.09 | 235° | 0.748 | 35.85 | 15.54 | 0.884 | 50.03 | 16.99 |
| 60° | 0.712 | 32.40 | 15.11 | 0.688 | 30.32 | 14.82 | 240° | 0.726 | 33.76 | 15.28 | 0.882 | 49.84 | 16.98 |
| 65° | 0.751 | 36.14 | 15.58 | 0.749 | 35.91 | 15.55 | 245° | 0.722 | 33.33 | 15.23 | 0.884 | 50.02 | 16.99 |
| 70° | 0.812 | 42.15 | 16.25 | 0.799 | 40.84 | 16.11 | 250° | 0.740 | 35.06 | 15.45 | 0.889 | 50.55 | 17.04 |
| 75° | 0.893 | 51.02 | 17.08 | 0.830 | 44.10 | 16.44 | 255° | 0.782 | 39.12 | 15.92 | 0.896 | 51.41 | 17.11 |
| 80° | 0.954 | 58.30 | 17.66 | 0.842 | 45.32 | 16.56 | 260° | 0.846 | 45.86 | 16.61 | 0.905 | 52.40 | 17.19 |
| 85° | 0.982 | 61.70 | 17.90 | 0.835 | 44.65 | 16.50 | 265° | 0.917 | 53.76 | 17.30 | 0.912 | 53.24 | 17.26 |
| 90° | 0.967 | 59.89 | 17.77 | 0.815 | 42.53 | 16.29 | 270° | 0.967 | 59.88 | 17.77 | 0.917 | 53.78 | 17.31 |
| 95° | 0.911 | 53.06 | 17.25 | 0.784 | 39.32 | 15.95 | 275° | 0.995 | 63.37 | 18.02 | 0.916 | 53.74 | 17.30 |
| 100° | 0.824 | 43.48 | 16.38 | 0.753 | 36.32 | 15.60 | 280° | 0.998 | 63.74 | 18.04 | 0.905 | 52.47 | 17.20 |
| 105° | 0.742 | 35.20 | 15.47 | 0.733 | 34.42 | 15.37 | 285° | 0.977 | 61.05 | 17.86 | 0.880 | 49.60 | 16.95 |
| 110° | 0.688 | 30.33 | 14.82 | 0.727 | 33.82 | 15.29 | 290° | 0.934 | 55.79 | 17.47 | 0.840 | 45.15 | 16.55 |
| 115° | 0.669 | 28.63 | 14.57 | 0.739 | 34.97 | 15.44 | 295° | 0.869 | 48.35 | 16.84 | 0.784 | 39.34 | 15.95 |
| 120° | 0.680 | 29.63 | 14.72 | 0.771 | 38.09 | 15.81 | 300° | 0.786 | 39.52 | 15.97 | 0.713 | 32.49 | 15.12 |
| 125° | 0.715 | 32.70 | 15.14 | 0.824 | 43.44 | 16.38 | 305° | 0.704 | 31.69 | 15.01 | 0.626 | 25.08 | 13.99 |
| 130° | 0.771 | 38.02 | 15.80 | 0.889 | 50.53 | 17.04 | 310° | 0.628 | 25.24 | 14.02 | 0.533 | 18.18 | 12.60 |
| 135° | 0.844 | 45.58 | 16.59 | 0.944 | 56.98 | 17.56 | 315° | 0.550 | 19.38 | 12.87 | 0.442 | 12.50 | 10.97 |
| 140° | 0.908 | 52.71 | 17.22 | 0.980 | 61.43 | 17.88 | 320° | 0.479 | 14.70 | 11.67 | 0.358 | 8.22 | 9.15 |
| 145° | 0.951 | 57.83 | 17.62 | 0.996 | 63.55 | 18.03 | 325° | 0.417 | 11.11 | 10.46 | 0.290 | 5.36 | 7.30 |
| 150° | 0.972 | 60.48 | 17.82 | 1.000 | 64.00 | 18.06 | 330° | 0.363 | 8.43 | 9.26 | 0.239 | 3.65 | 5.62 |
| 155° | 0.974 | 60.73 | 17.83 | 0.998 | 63.69 | 18.04 | 335° | 0.318 | 6.46 | 8.10 | 0.208 | 2.76 | 4.40 |
| 160° | 0.967 | 59.79 | 17.77 | 0.992 | 63.00 | 17.99 | 340° | 0.281 | 5.06 | 7.04 | 0.195 | 2.42 | 3.84 |
| 165° | 0.957 | 58.65 | 17.68 | 0.984 | 62.00 | 17.92 | 345° | 0.253 | 4.09 | 6.12 | 0.194 | 2.40 | 3.81 |
| 170° | 0.954 | 58.19 | 17.65 | 0.974 | 60.74 | 17.83 | 350° | 0.233 | 3.48 | 5.41 | 0.200 | 2.55 | 4.07 |
| 175° | 0.955 | 58.33 | 17.66 | 0.963 | 59.35 | 17.73 | 355° | 0.222 | 3.17 | 5.00 | 0.210 | 2.82 | 4.50 |

| **Polarization:** | **Horizontal** | **Vertical** |
|---|---|---|
| **Maximum Field:** | **1.000 @ 278° True** | **1.000 @ 150° True** |
| **Minimum Field:** | **0.220 @ 359° True** | **0.193 @ 343° True** |
| **RMS:** | **0.768** | **0.760** |
| **Maximum ERP:** | **64.000 kW** | **64.000 kW** |
| **Maximum Power Gain:** | **3.112 (4.930 dB)** | **3.112 (4.930 dB)** |

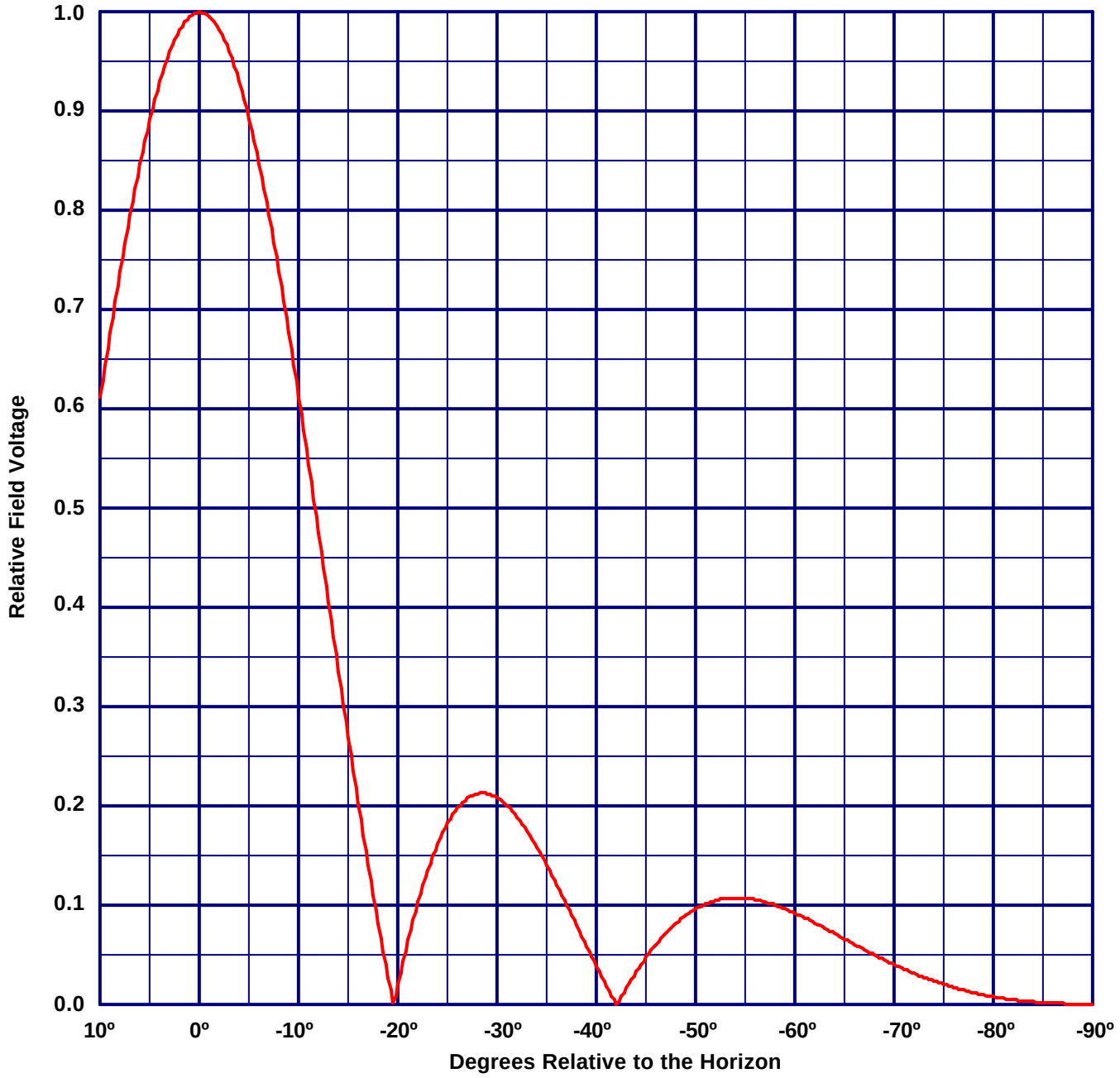
**Total Input Power: 20.566 kW**

# Vertical Plane Relative Field Pattern

## KDDS, Elma WA, 99.3 MHz

**Figure#: 3 Date: 10/7/2008**

***A 6 level, .5 wave-length spaced SHP-6AC-DA-HW directional antenna with 0° beam tilt, 0% null fill and a H/V maximum power ratio of 1.000***




| Vertical Polarization Gain: | Horizontal Polarization Gain: |
|---|---|
| Maximum: 3.112 (4.930 dB) | Maximum: 3.112 (4.930 dB) |
| Horizontal Plane: 3.112 (4.930 dB) | Horizontal Plane: 3.112 (4.930 dB) |

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# Directional Antenna System
# for
# KDDS, Elma, Washington

(Continued)

## ANTENNA SPECIFICATIONS

| | |
|---|---|
| Antenna Type: | SHP-6AC-DA-HW |
| Frequency: | 99.3 MHz |
| Number of Bays: | Six |

## MECHANICAL SPECIFICATIONS

| | |
|---|---|
| Mounting: | Standard |
| System length: | 28 ft 5 in |
| Aperture length required: | 39 ft 8 in |
| Orientation: | 183° true |

Input flange to the antenna 3 1/8“ female.

## ELECTRICAL SPECIFICATIONS
(For directional use)

| | |
|---|---|
| Maximum horizontal ERP: | 64 kW (18.062 dBk) |
| Horizontal maximum power gain: | 3.112 (4.930 dB) |
| Maximum vertical ERP: | 64 kW (18.062 dBk) |
| Vertical maximum power gain: | 3.112 (4.930 dB) |
| Total input power: | 20.566 kW (13.131 dBk) |