

## ***Directional Antenna System for WHHL, Hazelwood, Missouri***

November 14, 2023

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 WHHL

The antenna is the ERI model SHPX-6AE-HW-DA 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 four vertical parasitic elements centered between each of the 3 bay pairs. The antenna was pipe mounted off the North 6 degrees East tower face with bracketry to provide an antenna orientation of North 6 degrees East. The antenna was tested on a model of tapered triangular tower, which replicates the structure the station plans to use to support the array. All tests were performed on a frequency of 104.1 megahertz, which is the center of the FM broadcast channel assigned to WHHL.

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.



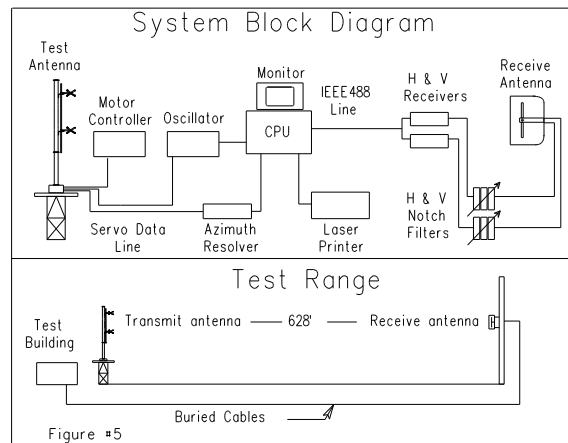
# Directional Antenna System for WHHL, Hazelwood , Missouri

## DESCRIPTION OF THE TEST PROCEDURE

The test antenna consisted of a model of two bay levels 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 3 1/8 inch o.d. rigid coaxial line was used to feed 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 tapered triangular 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.



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

## Directional Antenna System for WHHL, Hazelwood , Missouri

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 6 half-wavelength spaced bays using one driven circular polarized radiating element per bay, three horizontal parasitic elements per bay and four vertical parasitic elements centered between each of the bay pairs. 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 SHPX-6AE-HW-DA array is to be pipe mounted off the North 6 degrees East tower face of the tapered tower at a bearing of North 6 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 # 73A6 represents the measured individual horizontal and vertical components, the composite maximum of either the horizontal or

## Directional Antenna System for WHHL, Hazelwood , Missouri

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 #73A6. 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 50.000 kilowatts (16.99 dBk).

Neither the horizontal component or the vertical component at 190° True will exceed 16.5 kilowatts.

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 #73A6 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 70 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.

For further technical specifications, please consult the enclosed attachments. Should you desire any additional information, please contact us directly.

Electronics Research, Inc. values you as a customer. We are truly confident that we build the best antenna systems on the market. An ERI antenna and installation will fulfill your broadcasting needs.

Directional Antenna System  
for  
WHHL, Hazelwood , Missouri

ELECTRONICS RESEARCH, INC.

A handwritten signature in black ink, reading "Dan Dowdle". The signature is written in a cursive, flowing style with a large initial 'D'.

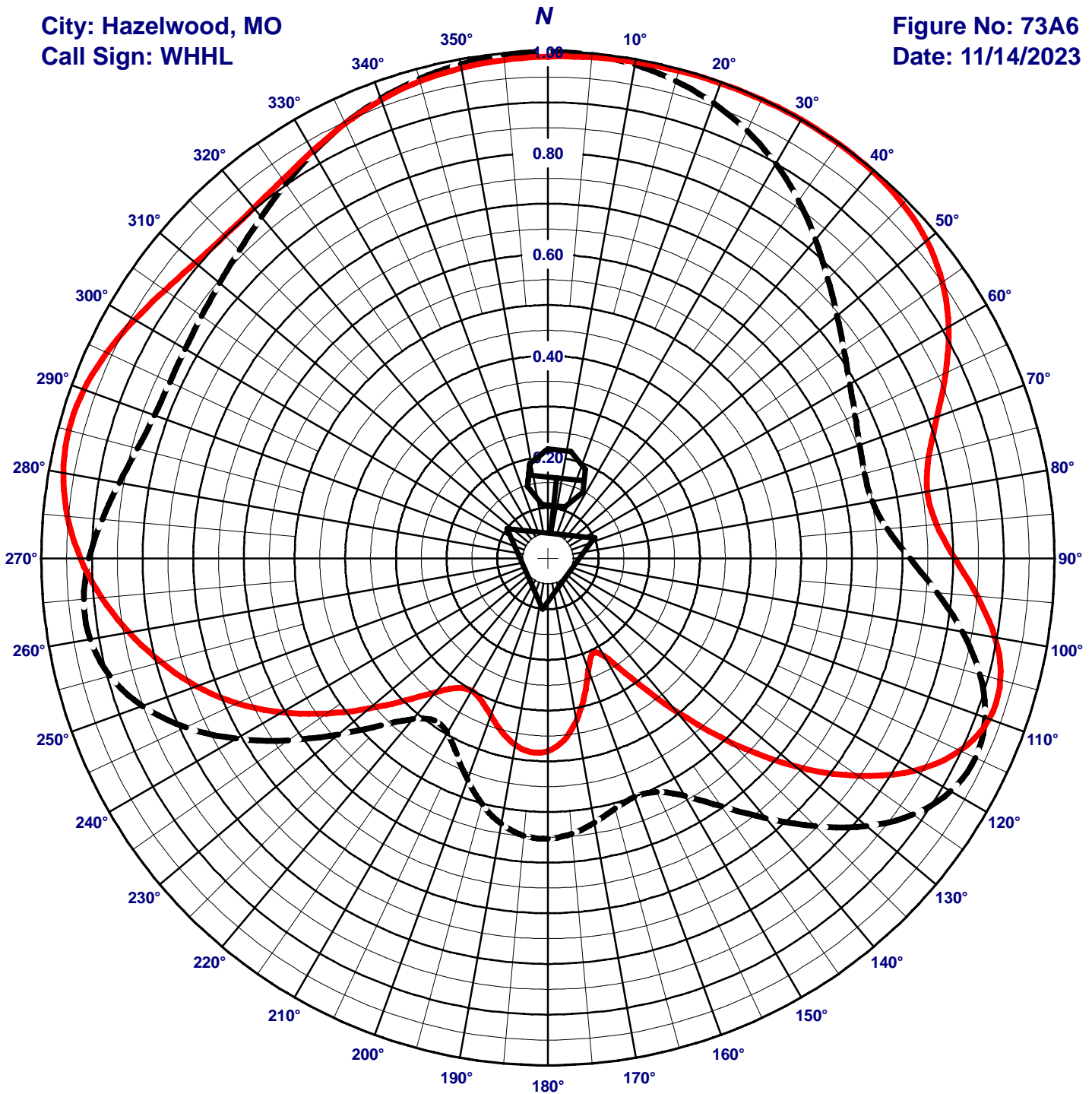
Dan Dowdle  
ERI Test Range Director

The Microsoft Word document on file electronically at Electronic Research, Inc. governs the specifications, scope, and configuration of the product described. All other representations whether verbal, printed, or electronic are subordinate to the master copy of this document on file at ERI.

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

City: Hazelwood, MO  
Call Sign: WHHL

Figure No: 73A6  
Date: 11/14/2023



Frequency: 104.1 MHz  
Antenna Type: SHPX-6AE-HW-DA  
Antenna Orientation: 6° True  
Antenna Mounting: 22" ELL  
Tower Type Self Support

**VERTICAL**  
RMS: .778  
Maximum: 1 @ 0°  
Minimum: .39 @ 214°

**HORIZONTAL**  
RMS: .786  
Maximum: 1 @ 32°  
Minimum: .207 @ 154°

Two-bay test. 1.5" stood off face mounted 4.5" pole. The antenna is mounted on the 6° tower face.

# ERI® Horizontal Plane Relative Field Pattern

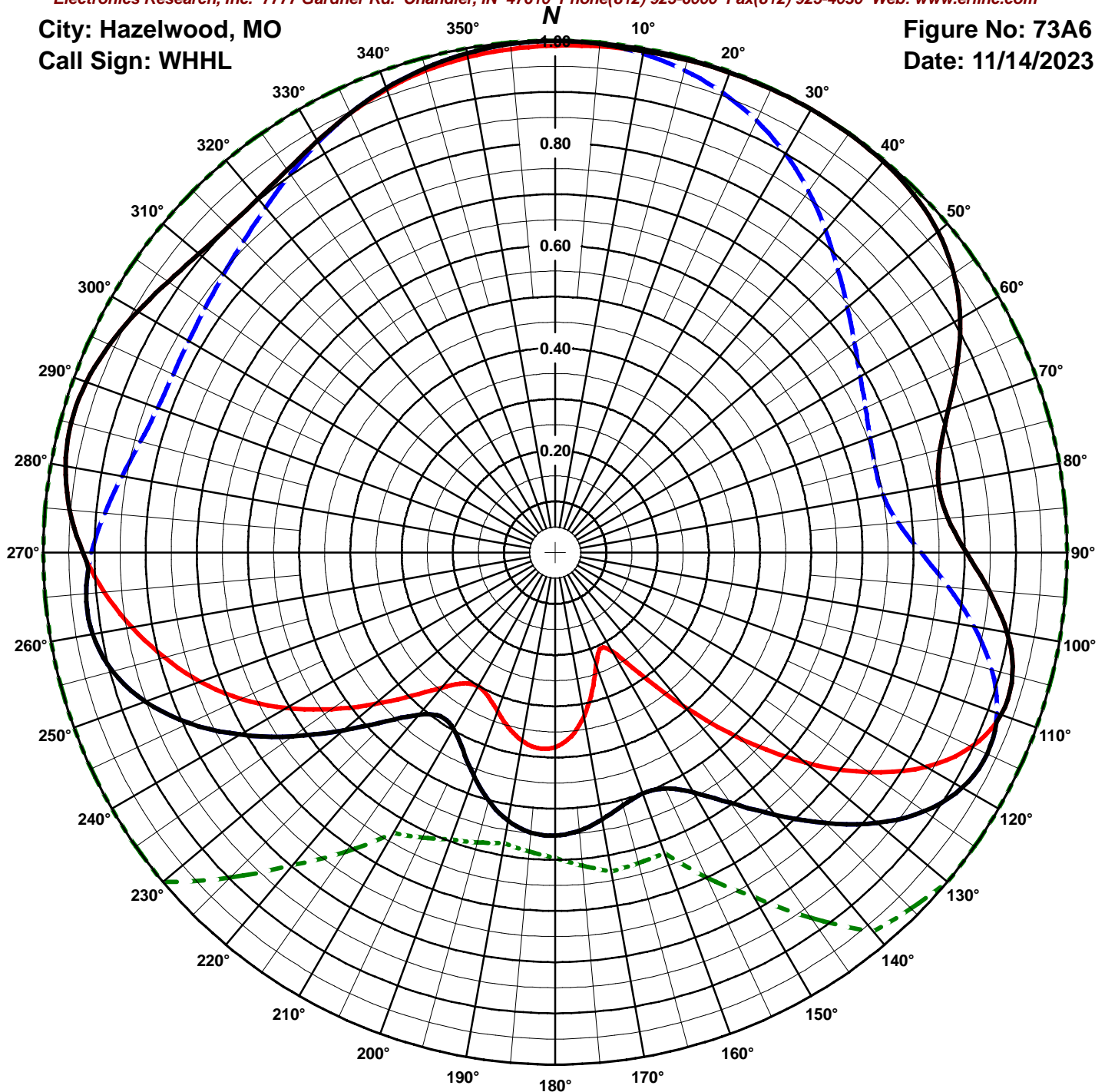
Electronics Research, Inc. 7777 Gardner Rd. Chandler, IN 47610 Phone(812) 925-6000 Fax(812) 925-4030 Web: www.eriinc.com

City: Hazelwood, MO

Call Sign: WHHL

Figure No: 73A6

Date: 11/14/2023



Frequency: 104.1 MHz

Antenna Type: SHPX-6AE-HW-DA

Antenna Mounting: 22" ELL

Tower Type: Self Support

## HORIZONTAL

RMS: .786

Maximum: 1 @ 32°

Minimum: .207 @ 154°

## VERTICAL

RMS: .778

Maximum: 1 @ 0°

Minimum: .39 @ 214°

## COMPOSITE

RMS: .828

Maximum: 1 @ 0°

Minimum: .39 @ 214°

## FCC ENVELOPE

RMS: .934

Maximum: 1 @ 0°

Minimum: .576 @ 190°

Two-bay test. 1.5" stood off face mounted 4.5" pole.

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

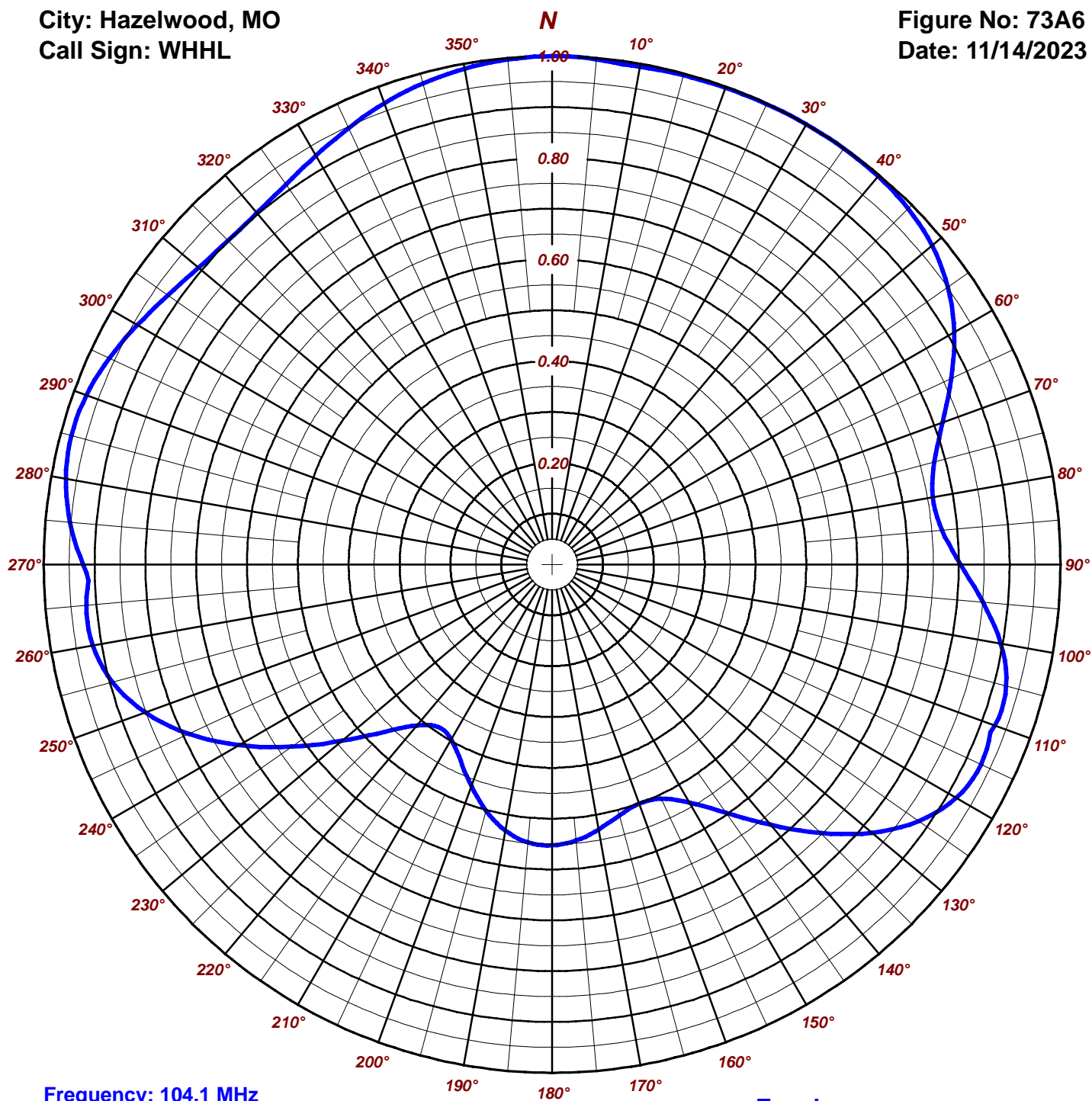
Electronics Research, Inc. 7777 Gardner Rd. Chandler, IN 47610 Phone(812) 925-6000 Fax(812) 925-4030 Web: [www.eriinc.com](http://www.eriinc.com)

City: Hazelwood, MO

Call Sign: WHHL

Figure No: 73A6

Date: 11/14/2023



Frequency: 104.1 MHz

Antenna Type: SHPX-6AE-HW-DA

Antenna Orientation: 6° True

Antenna Mounting: 22" ELL

Tower Type: Self Support

## Envelope

RMS: .828

Maximum: 1 @ 0°

Minimum: .39 @ 214°



# 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# 73A6

Date: 11/14/2023

Station: WHHL

Antenna: SHPX-6AE-HW-DA

Location: Hazelwood, MO

Antenna Orientation: 6° True

Frequency: 104.1 MHz

Number of Bays: 6

Azimuth	Horizontal			Vertical			Azimuth	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.990	49.050	16.906	1.000	50.000	16.990	180°	0.380	7.208	8.578	0.553	15.273	11.839
5°	0.993	49.261	16.925	0.998	49.751	16.968	185°	0.383	7.349	8.662	0.549	15.069	11.781
10°	0.995	49.453	16.942	0.989	48.947	16.897	190°	0.373	6.960	8.426	0.531	14.121	11.499
15°	0.996	49.629	16.957	0.976	47.589	16.775	195°	0.353	6.239	7.951	0.502	12.584	10.998
20°	0.998	49.775	16.970	0.956	45.699	16.599	200°	0.330	5.436	7.353	0.464	10.786	10.328
25°	0.999	49.903	16.981	0.931	43.310	16.366	205°	0.310	4.800	6.813	0.426	9.079	9.580
30°	1.000	49.992	16.989	0.900	40.466	16.071	210°	0.302	4.549	6.579	0.397	7.893	8.972
35°	1.000	49.964	16.987	0.863	37.224	15.708	215°	0.312	4.863	6.869	0.390	7.624	8.822
40°	0.997	49.714	16.965	0.822	33.774	15.286	220°	0.344	5.915	7.720	0.413	8.541	9.315
45°	0.990	49.040	16.905	0.781	30.522	14.846	225°	0.395	7.815	8.929	0.466	10.837	10.349
50°	0.976	47.619	16.778	0.745	27.739	14.431	230°	0.460	10.590	10.249	0.540	14.567	11.634
55°	0.951	45.185	16.550	0.714	25.476	14.061	235°	0.533	14.197	11.522	0.625	19.544	12.910
60°	0.913	41.701	16.201	0.688	23.701	13.748	240°	0.607	18.430	12.655	0.711	25.272	14.026
65°	0.866	37.535	15.744	0.669	22.373	13.497	245°	0.677	22.896	13.598	0.788	31.075	14.924
70°	0.818	33.433	15.242	0.655	21.458	13.316	250°	0.737	27.170	14.341	0.851	36.245	15.593
75°	0.779	30.307	14.815	0.647	20.955	13.213	255°	0.790	31.230	14.946	0.895	40.056	16.027
80°	0.761	28.934	14.614	0.650	21.136	13.250	260°	0.840	35.243	15.471	0.917	42.075	16.240
85°	0.770	29.649	14.720	0.672	22.594	13.540	265°	0.884	39.107	15.923	0.920	42.278	16.261
90°	0.804	32.284	15.090	0.715	25.553	14.074	270°	0.922	42.544	16.288	0.906	41.043	16.132
95°	0.851	36.182	15.585	0.771	29.720	14.731	275°	0.952	45.289	16.560	0.883	39.006	15.911
100°	0.896	40.145	16.036	0.831	34.495	15.378	280°	0.971	47.147	16.735	0.859	36.901	15.670
105°	0.925	42.749	16.309	0.883	38.963	15.907	285°	0.979	47.909	16.804	0.839	35.159	15.460
110°	0.927	42.924	16.327	0.918	42.157	16.249	290°	0.975	47.485	16.766	0.826	34.148	15.334
115°	0.897	40.251	16.048	0.931	43.340	16.369	295°	0.961	46.153	16.642	0.823	33.906	15.303
120°	0.836	34.985	15.439	0.918	42.130	16.246	300°	0.942	44.369	16.471	0.827	34.168	15.336
125°	0.748	27.961	14.466	0.880	38.752	15.883	305°	0.923	42.597	16.294	0.834	34.792	15.415
130°	0.638	20.332	13.082	0.821	33.710	15.278	310°	0.908	41.240	16.153	0.846	35.749	15.533
135°	0.515	13.268	11.228	0.747	27.894	14.455	315°	0.901	40.592	16.084	0.861	37.046	15.687
140°	0.393	7.712	8.872	0.669	22.361	13.495	320°	0.903	40.760	16.102	0.880	38.699	15.877
145°	0.288	4.155	6.185	0.597	17.809	12.506	325°	0.913	41.665	16.198	0.902	40.697	16.096
150°	0.223	2.485	3.953	0.541	14.628	11.652	330°	0.929	43.120	16.347	0.926	42.843	16.319
155°	0.208	2.163	3.350	0.509	12.931	11.116	335°	0.947	44.809	16.514	0.947	44.860	16.519
160°	0.234	2.738	4.374	0.501	12.532	10.980	340°	0.963	46.360	16.661	0.965	46.597	16.684
165°	0.279	3.896	5.906	0.511	13.059	11.159	345°	0.975	47.531	16.770	0.980	48.000	16.812
170°	0.325	5.267	7.216	0.529	13.999	11.461	350°	0.983	48.285	16.838	0.990	49.049	16.906
175°	0.360	6.473	8.111	0.545	14.849	11.717	355°	0.987	48.751	16.880	0.997	49.725	16.966

Horizontal Polarization:

Maximum: 2.974 (4.733 dB)

Horizontal Plane: 2.974 (4.733 dB)

Maximum ERP: 50.000 kW

Vertical Polarization:

Maximum: 2.974 (4.733 dB)

Horizontal Plane: 2.974 (4.733 dB)

Maximum ERP: 50.000 kW

Total Input Power: 16.814 kW

Reference: WHHL73A6.FIG

# 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

Date: 11/14/2023

Station: WHHL

Antenna: SHPX-6AE-HW-DA

Location: Hazelwood, MO

Antenna Orientation: 6° True

Frequency: 104.1 MHz

Number of Bays: 6

Azimuth	Envelope			Polarization	Azimuth	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0°	1.000	50.000	16.990	Vertical	180°	0.553	15.273	11.839	Vertical
5°	0.998	49.751	16.968	Vertical	185°	0.549	15.069	11.781	Vertical
10°	0.995	49.453	16.942	Horizontal	190°	0.531	14.121	11.499	Vertical
15°	0.996	49.629	16.957	Horizontal	195°	0.502	12.584	10.998	Vertical
20°	0.998	49.775	16.970	Horizontal	200°	0.464	10.786	10.328	Vertical
25°	0.999	49.903	16.981	Horizontal	205°	0.426	9.079	9.580	Vertical
30°	1.000	49.992	16.989	Horizontal	210°	0.397	7.893	8.972	Vertical
35°	1.000	49.964	16.987	Horizontal	215°	0.390	7.624	8.822	Vertical
40°	0.997	49.714	16.965	Horizontal	220°	0.413	8.541	9.315	Vertical
45°	0.990	49.040	16.905	Horizontal	225°	0.466	10.837	10.349	Vertical
50°	0.976	47.619	16.778	Horizontal	230°	0.540	14.567	11.634	Vertical
55°	0.951	45.185	16.550	Horizontal	235°	0.625	19.544	12.910	Vertical
60°	0.913	41.701	16.201	Horizontal	240°	0.711	25.272	14.026	Vertical
65°	0.866	37.535	15.744	Horizontal	245°	0.788	31.075	14.924	Vertical
70°	0.818	33.433	15.242	Horizontal	250°	0.851	36.245	15.593	Vertical
75°	0.779	30.307	14.815	Horizontal	255°	0.895	40.056	16.027	Vertical
80°	0.761	28.934	14.614	Horizontal	260°	0.917	42.075	16.240	Vertical
85°	0.770	29.649	14.720	Horizontal	265°	0.920	42.278	16.261	Vertical
90°	0.804	32.284	15.090	Horizontal	270°	0.922	42.544	16.288	Horizontal
95°	0.851	36.182	15.585	Horizontal	275°	0.952	45.289	16.560	Horizontal
100°	0.896	40.145	16.036	Horizontal	280°	0.971	47.147	16.735	Horizontal
105°	0.925	42.749	16.309	Horizontal	285°	0.979	47.909	16.804	Horizontal
110°	0.927	42.924	16.327	Horizontal	290°	0.975	47.485	16.766	Horizontal
115°	0.931	43.340	16.369	Vertical	295°	0.961	46.153	16.642	Horizontal
120°	0.918	42.130	16.246	Vertical	300°	0.942	44.369	16.471	Horizontal
125°	0.880	38.752	15.883	Vertical	305°	0.923	42.597	16.294	Horizontal
130°	0.821	33.710	15.278	Vertical	310°	0.908	41.240	16.153	Horizontal
135°	0.747	27.894	14.455	Vertical	315°	0.901	40.592	16.084	Horizontal
140°	0.669	22.361	13.495	Vertical	320°	0.903	40.760	16.102	Horizontal
145°	0.597	17.809	12.506	Vertical	325°	0.913	41.665	16.198	Horizontal
150°	0.541	14.628	11.652	Vertical	330°	0.929	43.120	16.347	Horizontal
155°	0.509	12.931	11.116	Vertical	335°	0.947	44.860	16.519	Vertical
160°	0.501	12.532	10.980	Vertical	340°	0.965	46.597	16.684	Vertical
165°	0.511	13.059	11.159	Vertical	345°	0.980	48.000	16.812	Vertical
170°	0.529	13.999	11.461	Vertical	350°	0.990	49.049	16.906	Vertical
175°	0.545	14.849	11.717	Vertical	355°	0.997	49.725	16.966	Vertical

Horizontal Polarization:

Maximum: 2.974 (4.733 dB)

Horizontal Plane: 2.974 (4.733 dB)

Maximum ERP: 50.000 kW

Vertical Polarization:

Maximum: 2.974 (4.733 dB)

Horizontal Plane: 2.974 (4.733 dB)

Maximum ERP: 50.000 kW

Total Input Power: 16.814 kW

Reference: WHHL73A6.FIG

# ERI<sup>®</sup> Vertical 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)

Figure No: 3

Call Sign: WHHL

Location: Hazelwood, MO

Frequency: 104.1 MHz

Antenna: 6 bay SHPX-6AE-HW-DA

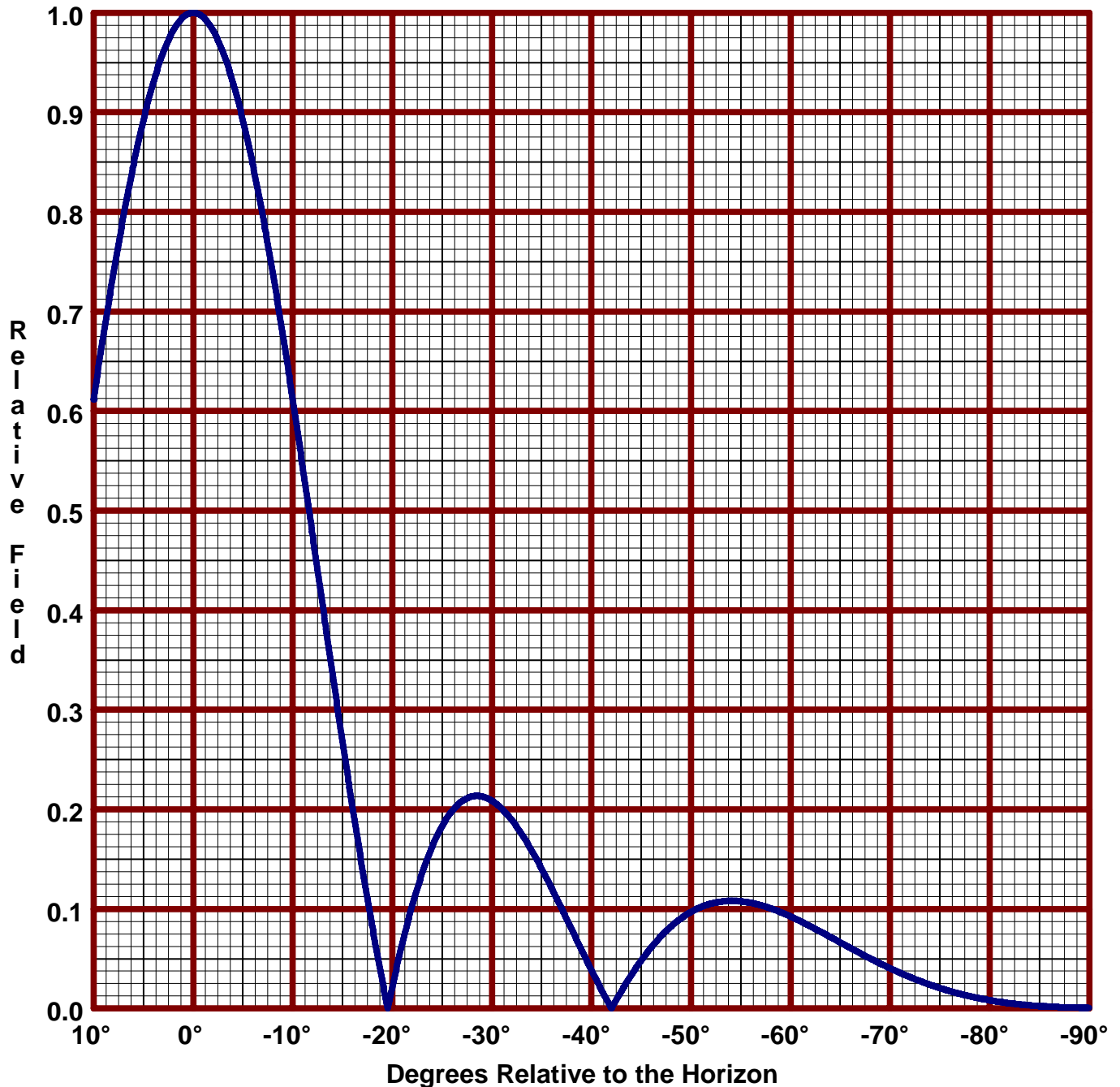
Date: 11/14/2023

H/V Power Ratio: 1

.5 Wave-length Spacing

0° Beam Tilt

0% First Null Fill



Horizontal Polarization:

Maximum: 2.974 (4.733 dB)

Horizontal Plane: 2.974 (4.733 dB)

Maximum ERP: 50.000 kW

Vertical Polarization:

Maximum: 2.974 (4.733 dB)

Horizontal Plane: 2.974 (4.733 dB)

Maximum ERP: 50.000 kW

# Directional Antenna System for WHHL, Hazelwood , Missouri

(Continued)

## ANTENNA SPECIFICATIONS

Antenna Type:	SHPX-6AE-HW-DA
Frequency:	104.1 MHz
Number of Bays:	Six

## MECHANICAL SPECIFICATIONS

Mounting:	Custom
System length:	32 ft 1 in
Aperture length required:	38 ft 7 in <sup>1</sup>
Orientation:	6° true
Input flange to the antenna 3 1/8" female.	

## ELECTRICAL SPECIFICATIONS

(For directional use)

Maximum horizontal ERP:	50.000 kW (16.990 dBk)
Horizontal maximum power gain:	2.974 (4.733 dB)
Maximum vertical ERP:	50.000 kW (16.990 dBk)
Vertical maximum power gain:	2.974 (4.733 dB)
Total input power:	16.814 kW (12.257 dBk)

<sup>1</sup> If the antenna is to be mounted at the top of the tower.

