

**S.O. 22084**  
**Report of Test 6015-2/3R-SS-DA**  
**for**  
**BLACK HILLS BROADCASTING, L.P.**  
**KAYO-FM Elma, WA**

**OBJECTIVE:**

The objective of this test was to demonstrate the directional characteristics of a 6015-2/3R-SS-DA to meet the needs of KAYO-FM and to comply with the requirements of the FCC construction permit, file number BPH-20010530ABG.

**RESULTS:**

The measured azimuth pattern for the 6015-2/3R-SS-DA is shown in Figure 1. Figure 1A shows the Tabulation of the Horizontal Polarization. Figure 1B shows the Tabulation of the Vertical Polarization. The calculated elevation pattern of the antenna is shown in Figure 3. Construction permit file number BPH-20010530ABG indicates that the Horizontal radiation component shall not exceed 12.0 kW at any azimuth and is restricted to the following values at the azimuths specified:

0 Degrees T: 1.70 kW  
10 Degrees T: 1.70 kW  
160 Degrees T: 3.0 kW  
170 Degrees T: 3.0 kW

From Figure 1, the maximum radiation of the Horizontal component occurs at 217 Degrees T to 230 Degrees T and at 262 Degrees T to 275 Degrees T.

At the restricted azimuth of 0 Degrees T the Horizontal component is 9.63 dB down from the maximum of 12.0 kW, or 1.31 kW. At the restricted azimuth of 10 Degrees T the Vertical component is 9.37 dB down from the maximum of 12.0 kW, or 1.39 kW. At the restricted azimuth of 160 Degrees T, the Horizontal component is 6.56 dB down from the maximum of 12.0 kW, or 2.65 kW. At the restricted azimuth of 170 Degrees T, the Horizontal component is 6.75 dB down from the maximum of 12.0 kW, or 2.54 kW.

The R.M.S. of the Horizontal component is 0.755. The total Horizontal power gain is 1.324. The R.M.S. of the Vertical component is 0.700. The total Vertical power gain is 1.300. See Figure Four for calculations. The R.M.S. of the FCC composite pattern is 0.875. Therefore this Pattern complies with the FCC requirement of 73.316(c)(2)(ix)(A).

#### **METHOD OF DIRECTIONALIZATION:**

The 6015-2/3R-SS-DA was mounted on outriggered poles of exact scale to a 36" facewidth Sabre tower. The spacing of the antenna to the tower was varied to achieve both the horizontal and vertical patterns shown in Figure 1. See Figure 2 for mechanical details.

#### **METHOD OF MEASUREMENT:**

As allowed by the construction permit, file number BPH-20010530ABG, a single level of the 6015-2/3R-SS-DA was set up on the Howell Laboratories scale model antenna pattern measuring range. A scale of 4.5:1 was used.

**SUPERVISION:**

Mr. Surette was graduated from Lowell Technological Institute, Lowell, Massachusetts in 1973 with the degree of Bachelor of Science in Electrical Engineering. He has been directly involved with design and development of broadcast antennas, filter systems and RF transmission components since 1974, as an RF Engineer for six years with the original Shively Labs in Raymond, ME and for a short period of time with Dielectric Communications. He is currently an Associate Member of the AFCCE and a Senior Member of IEEE. He has authored a chapter on filters and combining systems for the latest edition of the CRC Electronics Handbook and for the 9<sup>th</sup> Edition of the NAB Handbook.

**EQUIPMENT:**

The scale model pattern range consists of a wooden rotating pedestal equipped with a position indicator. The scale model bay is placed on the top of this pedestal and is used in the transmission mode at approximately 20 feet above ground level. The receiving corner reflector is spaced 50 feet away from the rotating pedestal at the same level above ground as the transmitting model. The transmitting and receiving signals are carried to a control building by means of RG-9/U double shielded coax cable.

The control building is equipped with:

Hewlett Packard Model 8753 Network Analyzer  
PC Based Controller  
Hewlett Packard 7550A Graphics Plotter

The test equipment is calibrated to ANSI/NCSL Z540-1-1994.

**TEST PROCEDURES:**

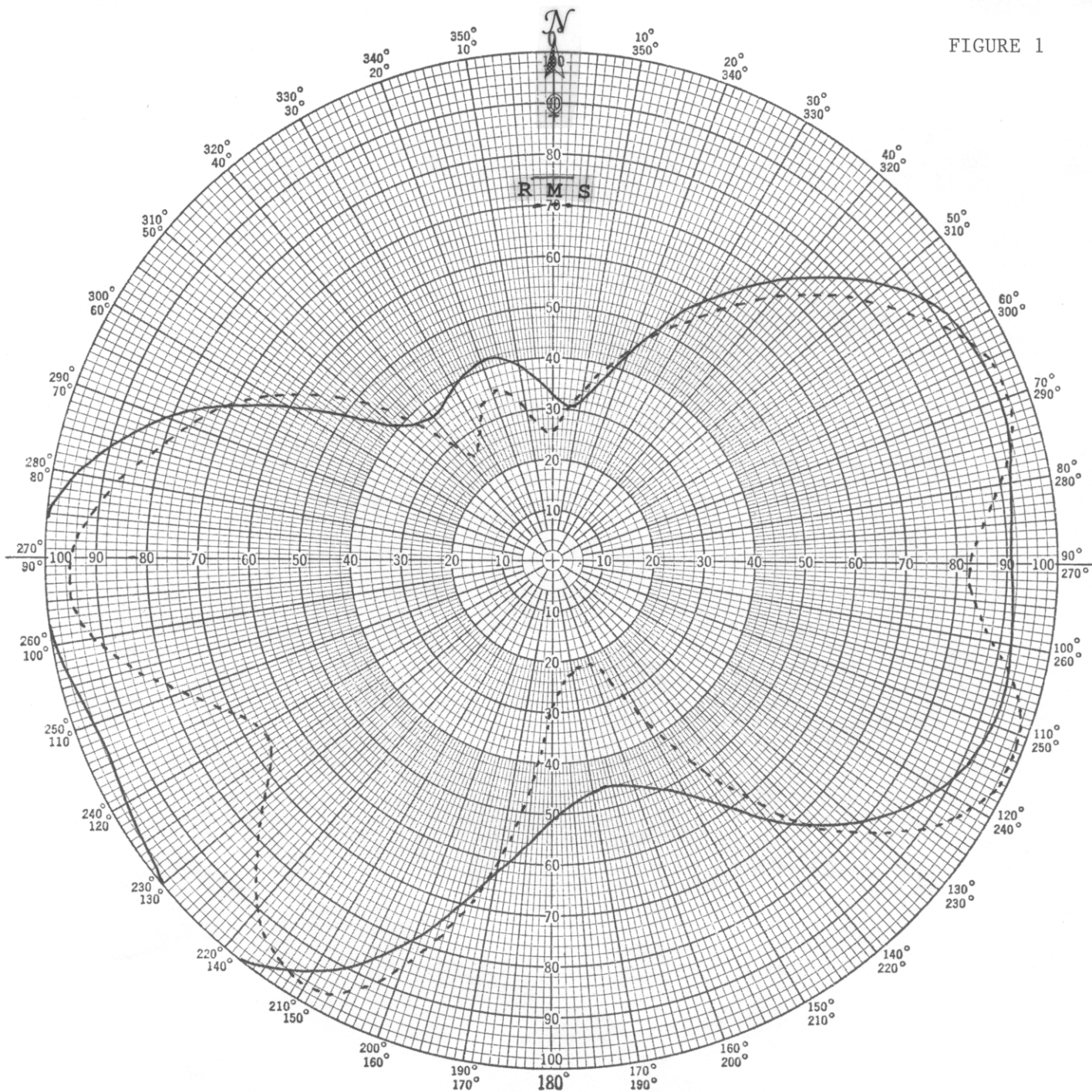
The corner reflector is mounted so that the horizontal and vertical azimuth patterns are measured independently by rotating the corner reflector by 90 degrees. The network analyzer was set to 446.85 MHz. Calibrated pads are used to check the linearity of the measuring system. For example, 6 dB padding yields a scale reading of 50 from an unpadded reading of 100 in voltage. From the recorded patterns, the R.M.S. values are calculated and recorded as shown in Figure 1.

Respectfully submitted by:

A handwritten signature in black ink, appearing to read "Robert A. Surette", with a long horizontal flourish extending to the right.

Robert A. Surette  
Manager of RF Engineering  
S/O 22084  
April 3, 2002

FIGURE 1



## Shively Labs

PROJECT NAME KAYO-FM ELMA, WAPROJECT NUMBER 22084 DATE 1/24/02MODEL (X) FULL SCALE ( ) FREQUENCY 446.85/99.3 MHzPOLARIZATION HORIZ (—); VERT (----)

CURVE PLOTTED IN: VOLTAGE (X) POWER ( ) DB ( )

OBSERVER RASANTENNA TYPE 6015-2/3R-SS-DAPATTERN TYPE DIRECTIONAL AZIMUTHREMARKS: SEE FIGURE 2 FOR MECHANICAL  
DETAILS

Figure 1A

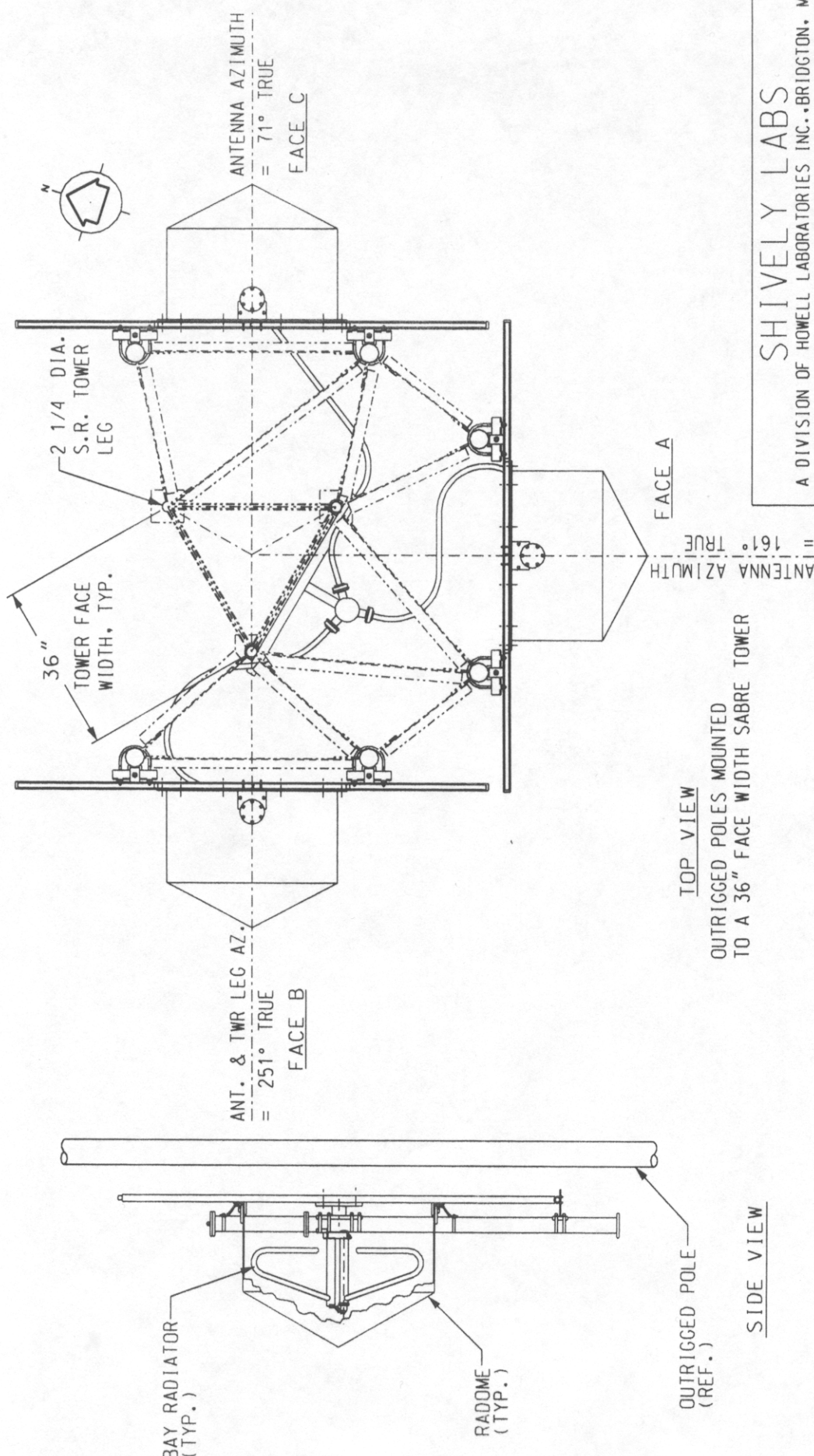
S/O 22084  
TABULATION OF HORIZONTAL POLARIZATION  
KAYO-FM ELMA, WA

DEGREE	RELATIVE FIELD	DEGREE	RELATIVE FIELD
0	0.330	180	0.510
10	0.320	190	0.625
20	0.440	200	0.800
30	0.590	210	0.935
40	0.730	220	1.000
45	0.790	225	1.000
50	0.850	230	1.000
60	0.930	240	0.970
70	0.940	250	0.960
80	0.920	260	0.990
90	0.910	270	1.000
100	0.920	280	0.955
110	0.930	290	0.810
120	0.890	300	0.600
130	0.795	310	0.410
135	0.730	315	0.380
140	0.660	320	0.370
150	0.530	330	0.390
160	0.470	340	0.420
170	0.460	350	0.390

Figure 1B

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TABULATION OF VERTICAL POLARIZATION  
KAYO-FM ELMA, WA

DEGREE	RELATIVE FIELD	DEGREE	RELATIVE FIELD
0	0.260	180	0.300
10	0.340	190	0.600
20	0.440	200	0.850
30	0.550	210	0.970
40	0.680	220	0.900
45	0.740	225	0.820
50	0.800	230	0.740
60	0.910	240	0.670
70	0.960	250	0.770
80	0.900	260	0.920
90	0.830	270	0.950
100	0.880	280	0.870
110	0.980	290	0.770
120	0.960	300	0.650
130	0.830	310	0.480
135	0.750	315	0.360
140	0.610	320	0.280
150	0.360	330	0.290
160	0.220	340	0.350
170	0.225	350	0.300



TOP VIEW  
OUTRIGGER POLES MOUNTED  
TO A 36" FACE WIDTH SABRE TOWER

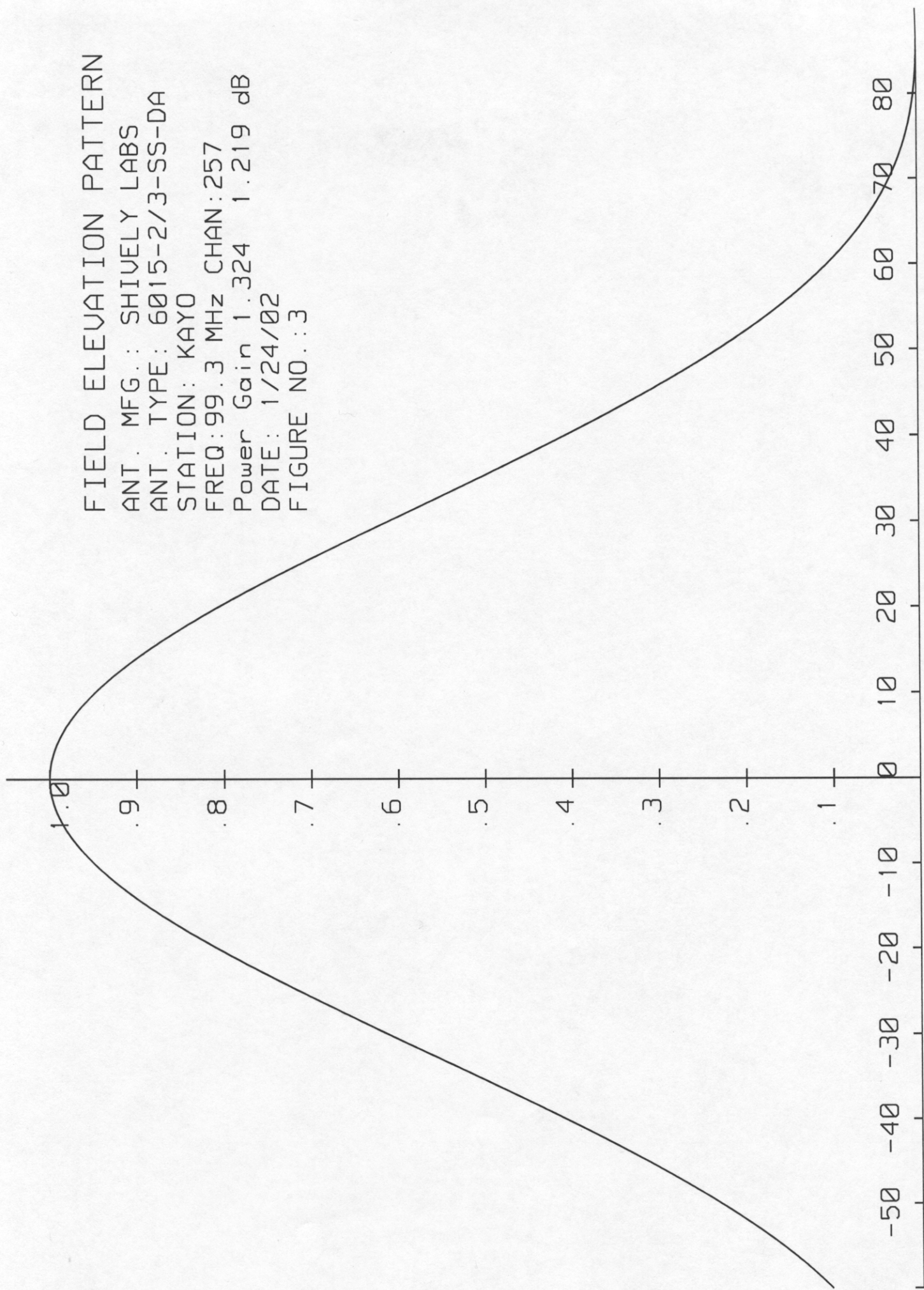
SIDE VIEW

SHIVELY LABS			
A DIVISION OF HOWELL LABORATORIES INC., BRIDGTON, MAINE			
SHOP ORDER:	22084	SCALE:	N.T.S.
FREQUENCY:	99.3 MHz.	DRAWN BY:	APL
WA		APPROVED BY:	
TITLE:			
MODEL -6015-2/3R-1/2SS-DIRECTIONAL ANTENNA			
STATION: KAYO-FM			
DATE:	10/25/01	FIGURE 2	
		REV. A 1/7/02	



FIELD ELEVATION PATTERN

ANT. MFG.: SHIVELY LABS  
ANT. TYPE: 6015-2/3-SS-DA  
STATION: KAYO  
FREQ: 99.3 MHz CHAN: 257  
Power Gain 1.324 1.219 dB  
DATE: 1/24/02  
FIGURE NO.: 3



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## VALIDATION OF GAIN CALCULATION

KAYO-FM ELMA, WA

MODEL 6015-2/3R-SS-DA

Elevation Gain of 6015-2/3R-SS-DA equals 0.701

**The RMS values are calculated utilizing the data of a planimeter.**

Horizontal RMS divided by Vertical RMS equals  
 $0.755 \div 0.700 = 1.0786$

Elevation Gain of Horizontal Component equals  
 $0.701 \times 1.0786 = 0.755$

Elevation Gain of Vertical Component equals  
 $0.701 \times 0.927 = 0.650$

Horizontal Azimuth Gain equals  $1/(\text{RMS})^2$   
 $1/(0.755)^2 = 1.754$

Vertical Azimuth Gain equals  $1/(\text{RMS} \div \text{Max Vert})^2$   
 $1/(0.700 \div 0.990)^2 = 2.0$

**\* Total Horizontal Gain is Elevation Gain times Azimuth Gain**  
 $0.755 \times 1.754 = 1.324$

**\* Total Vertical Gain is Elevation Gain times Azimuth Gain**  
 $0.650 \times 2.0 = 1.300$

ERP divided by Horizontal Gain equals Antenna Input Power  
 $12.0 \text{ kW} \div 1.324 = 9.063 \text{ kW}$

Antenna Input Power times Vertical Gain equals Vertical ERP  
 $9.063 \text{ kW} \times 1.300 = 11.78$

Maximum Value of the Vertical Component squared times the  
 Maximum ERP equals the Vertical ERP  
 $(0.99)^2 \times 12.0 \text{ kW} = 11.76$

NOTE: Calculating the ERP of the Vertical Component by two  
 methods validates the total antenna gain calculations