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S.O. 23086
Report of Test 6810-3R-SS-DA
for
THE COLLEGE OF WILLIAM & MARY IN VA
WCWM 90.9 MHZ WILLIAMSBURG, VA

OBJECTIVE:

The objective of this test was to demonstrate the directional characteristics of a 6810-3R-SS-DA to meet the needs of WCWM and to comply with the requirements of the FCC construction permit, file number BMPED-20030423AAR.

RESULTS:

The measured azimuth pattern for the 6810-3R-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 BMPED-20030423AAR indicates that the Horizontal radiation component shall not exceed 13.5 kW at any azimuth and is restricted to the following values at the azimuths specified:

140 Degrees T: 9.985 kW
300 Degrees T: 0.428 kW
310 Degrees T: 0.437 kW

From Figure 1, the maximum radiation of the Horizontal component occurs at 096 Degrees T to 106 Degrees T and at 173 Degrees T to 184 Degrees T. At the restricted azimuth of 140 Degrees T the Horizontal component is 1.671 dB down from the maximum of 13.5 kW, or 9.188 kW. At the restricted azimuth of 300 Degrees T the Horizontal component is 15.918 dB down from the maximum of 13.5 kW, or 0.346 kW. At the restricted azimuth of 310 Degrees T the Horizontal component is 17.721 dB down from the maximum of 13.5 kW, or 0.228 kW.

The R.M.S. of the Horizontal component is 0.646. The total Horizontal power gain is 2.432. The R.M.S. of the Vertical component is 0.643. The total Vertical power gain is 2.383. See Figure 4 for calculations. The R.M.S. of the FCC composite pattern is 0.700. Therefore this Pattern complies with the FCC requirement of 73.316(c)(2)(ix)(A).

METHOD OF DIRECTIONALIZATION:

One bay of the 6810-3R-SS-DA was mounted on a tower of exact scale to a Sabre Tower Model 06. The spacing of the antenna to the tower was varied to achieve the vertical pattern shown in Figure 1. A horizontal parasitic element was placed directly under the bay. The position of this horizontal parasitic element was changed until the horizontal pattern shown in Figure 1 was achieved. See Figure 2 for mechanical details.

METHOD OF MEASUREMENT:

As allowed by the construction permit, file number BMPED-20030423AAR, a single level of the 6810-3R-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 9th 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.

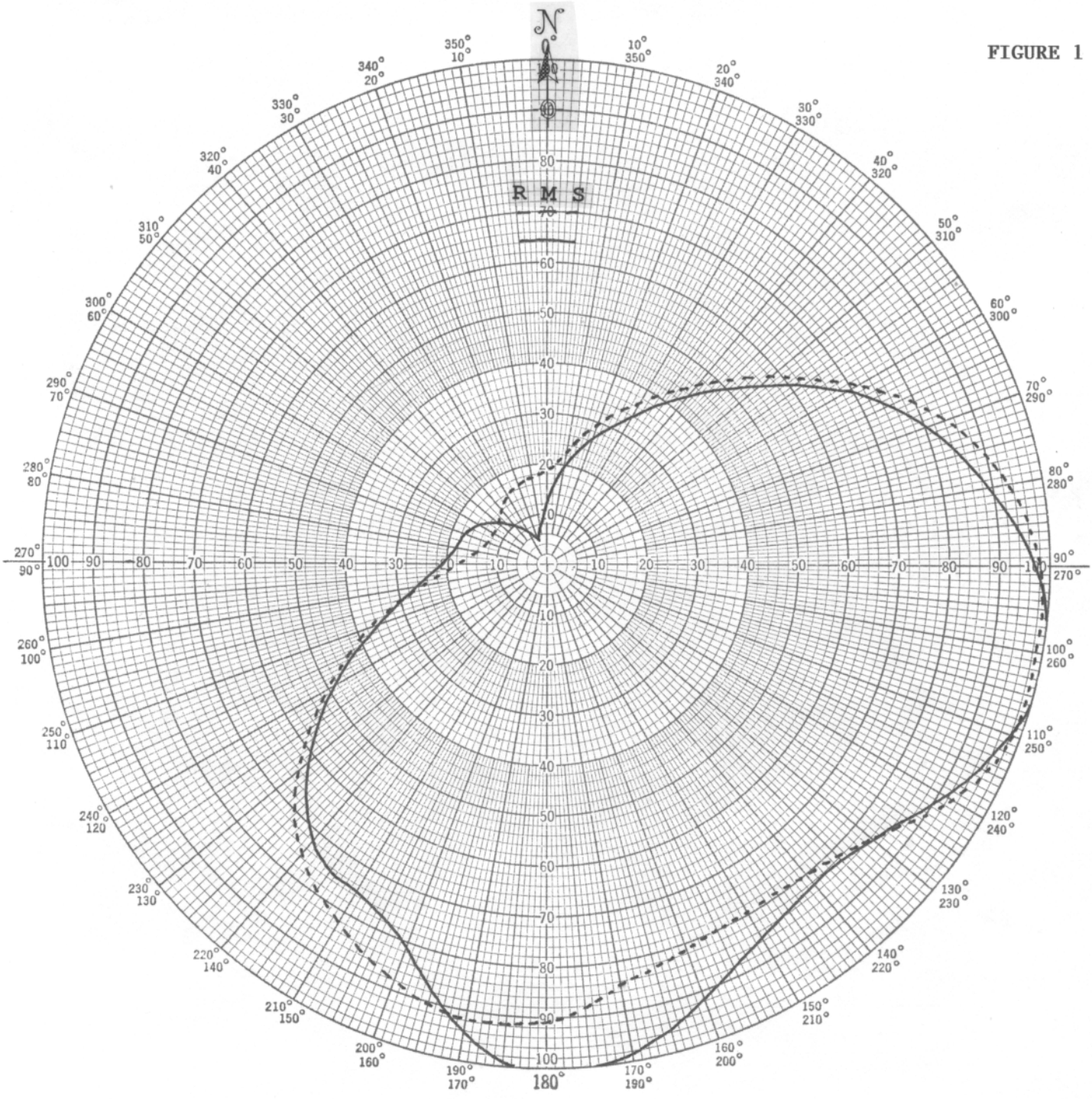
TEST PROCEDURES:

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 409.05 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:

Robert A. Surette
Manager of RF Engineering
S/O 23086
September 24, 2003

FIGURE 1



Shively Labs

PROJECT NAME WCWM WILLIAMSBURG, VA

PROJECT NUMBER 23086 DATE 8/11/03

MODEL (X) FULL SCALE ( ) FREQUENCY 409.05/90.9 MHZ

POLARIZATION HORIZ (——); VERT (----)

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

OBSERVER RAS

ANTENNA TYPE 6810-3R-SS-DA

PATTERN TYPE DIRECTIONAL AZIMUTH

REMARKS: SEE FIGURE 2 FOR MECHANICAL DETAILS

Figure 1A

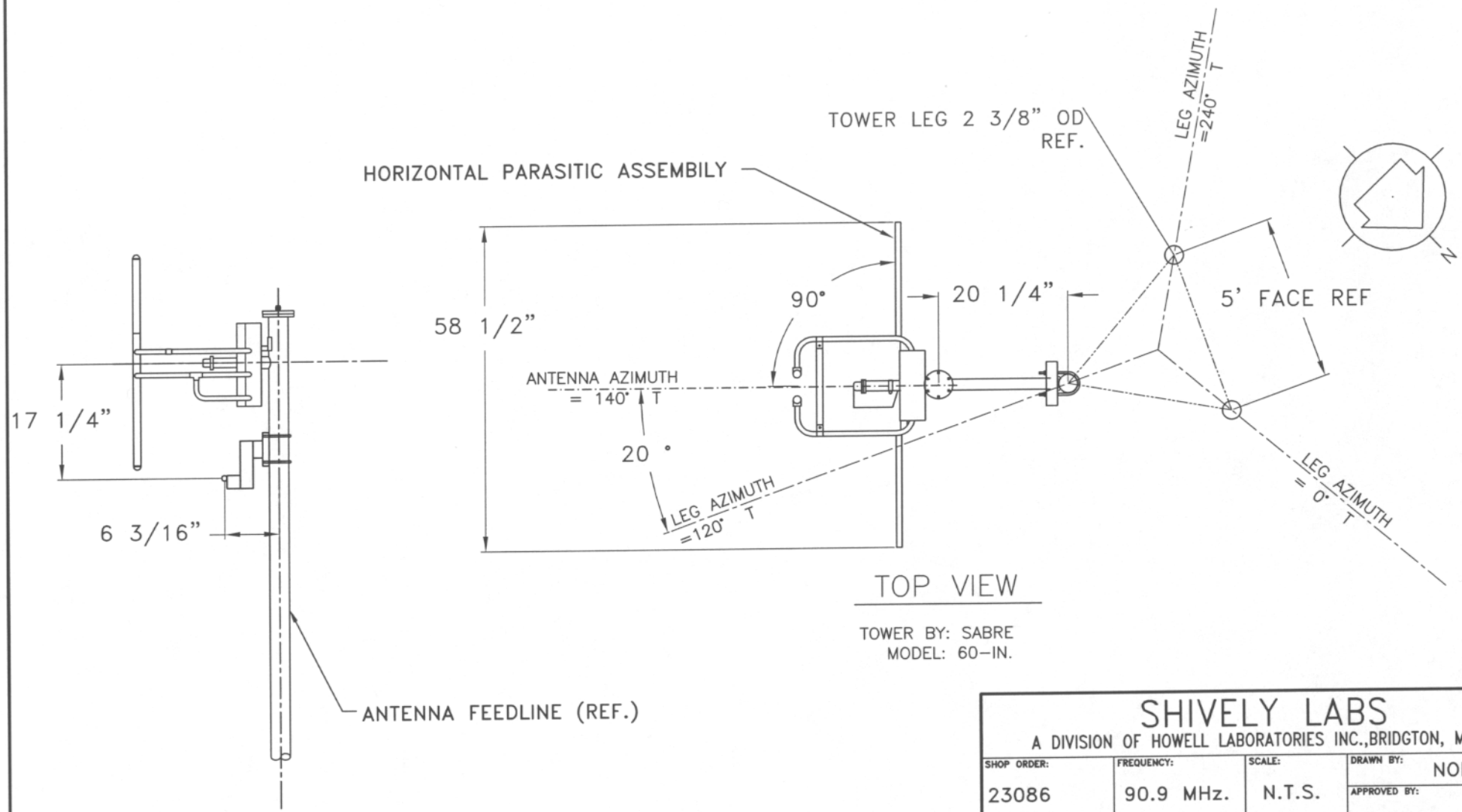
S/O 23086
TABULATION OF HORIZONTAL POLARIZATION
WCWM WILLIAMSBURG, VA

DEGREE	RELATIVE FIELD	DEGREE	RELATIVE FIELD
0	0.130	180	1.000
10	0.200	190	0.940
20	0.265	200	0.810
30	0.335	210	0.755
40	0.430	220	0.720
45	0.485	225	0.670
50	0.550	230	0.615
60	0.690	240	0.490
70	0.805	250	0.355
80	0.890	260	0.265
90	0.970	270	0.210
100	1.000	280	0.185
110	0.990	290	0.175
120	0.915	300	0.160
130	0.845	310	0.130
135	0.830	315	0.115
140	0.825	320	0.100
150	0.855	330	0.075
160	0.915	340	0.050
170	0.985	350	0.075

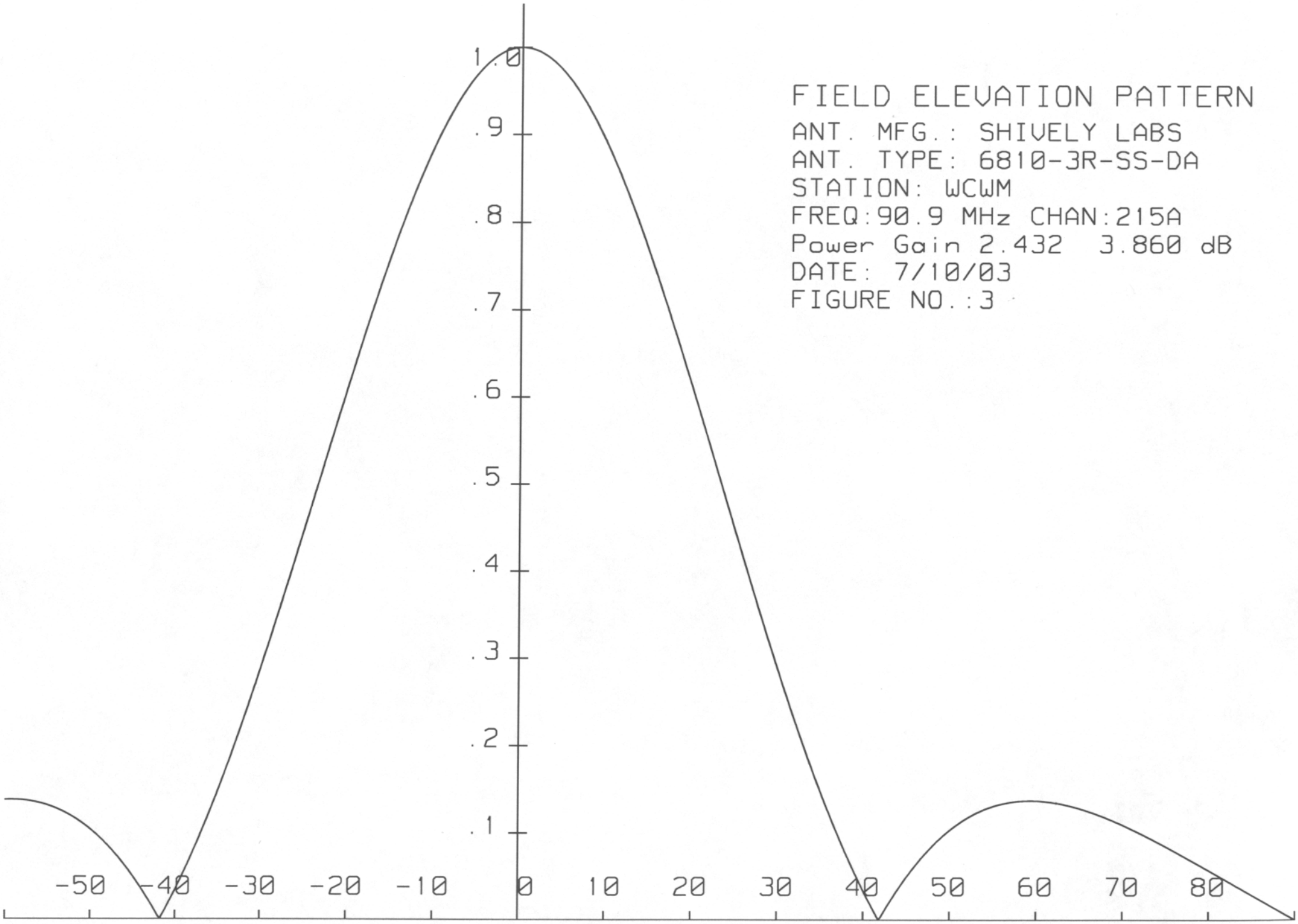
Figure 1B

S/O 23086
TABULATION OF VERTICAL POLARIZATION
WCWM WILLIAMSBURG, VA

DEGREE	RELATIVE FIELD	DEGREE	RELATIVE FIELD
0	0.185	180	0.910
10	0.225	190	0.920
20	0.295	200	0.880
30	0.370	210	0.825
40	0.470	220	0.750
45	0.520	225	0.705
50	0.580	230	0.645
60	0.715	240	0.500
70	0.840	250	0.380
80	0.930	260	0.265
90	0.990	270	0.190
100	0.985	280	0.145
110	0.985	290	0.125
120	0.930	300	0.120
130	0.845	310	0.130
135	0.820	315	0.135
140	0.800	320	0.140
150	0.795	330	0.160
160	0.815	340	0.170
170	0.845	350	0.180



SHIVELY LABS A DIVISION OF HOWELL LABORATORIES INC.,BRIDGTON, MAINE			
SHOP ORDER: 23086	FREQUENCY: 90.9 MHz.	SCALE: N.T.S.	DRAWN BY: NOH APPROVED BY:
TITLE: MODEL-6810-3R-SS-DIRECTIONAL ANTENNA			
DATE: 9/9/03	FIGURE 2		



FIELD ELEVATION PATTERN
ANT. MFG.: SHIVELY LABS
ANT. TYPE: 6810-3R-SS-DA
STATION: WCWM
FREQ:90.9 MHz CHAN:215A
Power Gain 2.432 3.860 dB
DATE: 7/10/03
FIGURE NO.:3

FIGURE 4

S.O. 23086

VALIDATION OF GAIN CALCULATION

WCWM WILLIAMSBURG, VA

MODEL 6810-3R-SS-DA

Elevation Gain of 6810-3R-SS-DA equals 1.01

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

Horizontal RMS divided by Vertical RMS equals
$0.646 \div 0.643 = 1.005$

Elevation Gain of Horizontal Component equals
$1.01 \times 1.005 = 1.015$

Elevation Gain of Vertical Component equals
$1.01 \times 0.995 = 1.005$

Horizontal Azimuth Gain equals $1/(\text{RMS})^2$
$1/(0.646)^2 = 2.396$

Vertical Azimuth Gain equals $1/(\text{RMS} \div \text{Max Vert})^2$
$1/(0.643 \div 0.99)^2 = 2.371$

* **Total Horizontal Gain is Elevation Gain times Azimuth Gain**
  $1.015 \times 2.396 = 2.432$

* **Total Vertical Gain is Elevation Gain times Azimuth Gain**
  $1.005 \times 2.371 = 2.383$

ERP divided by Horizontal Gain equals Antenna Input Power
$13.5 \text{ kW} \div 2.432 = 5.551 \text{ kW}$

Antenna Input Power times Vertical Gain equals Vertical ERP
$5.551 \times 2.383 = 13.228 \text{ kW}$

Maximum Value of the Vertical Component squared times the Maximum ERP equals the Vertical ERP
$(0.99)^2 \times 13.5 \text{ kW} = 13.23 \text{ kW}$

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