



ORIGINAL

**SYSTEMS WITH RELIABILITY, INC.**  
Broadcast Antennas and Transmission Systems

**619 Industrial Park Road • PO Box 856 • Ebensburg, PA 15931-0856**  
**Phone: (814) 472-5438**  
**FAX: (814) 472-5552**

## PATTERN CERTIFICATION

**DIRECTIONAL FM ANTENNA**  
**WDC-FM**  
**06 May 1998**

Station: WDC-FM  
Location: Chesapeake, Virginia  
Frequency: 88.5 MHz.  
Channel: 203  
Antenna Model: FMCE/6-DA  
Maximum Antenna Gain: Horizontal: 6.8 / (8.3 dB)  
Vertical: 6.8 / (8.3 dB)

## ANTENNA DESCRIPTION

A custom designed FM antenna was used in conjunction with a  $2\frac{3}{8}$  " inch diameter mast, to produce the required directional pattern. The antenna is comprised of a six bay radiating element mounted to the east side of the mast. All transmission lines and conduit relating to the antenna were in place during testing in a scale model manner. The antenna is a circularly polarized dipole radiating element with a horizontal and vertical parasitic director system.

### DESCRIPTION OF TEST PROCEDURE

The test antenna consisted of a 1/3 scale dipole antenna and parasitic system. The antenna under test was mounted directly to a 1/3 scale tower using brackets scaled to the equivalent that is supplied with the finalized antenna. All feed cables were properly grounded during pattern testing. Horizontal parasitic elements were used to obtain the directional pattern.

## Test Results

Enclosed calculations verify that the RMS value of this antenna is 95% of the RMS of the pattern authorized in the related construction permit (BLED-950512GP). The vertical component RMS value is 0.74, the horizontal component RMS value is 0.61.

Azimuth and elevation plots and associated tabulations of this antenna are included with this package.

Measured horizontal polarized directivity:	2.66 / 4.25 dB
Measured vertical polarized directivity:	1.83 / 2.63 dB
Measured composite azimuth pattern directivity:	1.62 / 2.09 dB

Gain in each polarization is calculate using the following relation:

Gain = Azimuth Directivity x Elevation Directivity x Power Ratio Between Polarizations

Using this relationship along with ratio measured at our testing facilities:

H-Pol. Gain:  $(2.66)(6.6)(0.40)(0.95) = 6.8$  (8.3 dB)

V-Pol. Gain:  $(1.83)(6.6)(0.50)(0.95) = 6.8$  (8.3 dB)

## INSTALLATION AND MOUNTING

The antenna is to be mounted in accordance with the supplied drawings. The antenna center of radiation is to be 110 feet above ground level. The antenna aperture is 55.5 feet. No other antennas are to be mounted within 10 feet of the antenna. No other obstructions other than those specified by the original drawings supplied are to be mounted at the same level as the antenna. The antenna is to be orientated 65 degrees true.

The parasitic system is custom designed to shape and direct the antenna pattern as required. The systems orientation is as shown on the attached drawing. The mounting details are described in the following drawings:

<i>DRAWING</i>	<i>DESCRIPTION</i>
0979-A04	Antenna Orientation
0980-C	Elevation View
0979-C	Typical Antenna Bay [Side View]

The scaled mast mounted vertically was elevated 20 feet on a platform. The source antenna, a vertical/horizontal dipole Cavity Back resonator antenna configuration was mounted approximately 100 feet from the test antenna. The sources height was adjusted to provide a uniform field at the test antenna location. The CBR antenna was operated in the transmit mode at a frequency of  $3 \times 88.5 = 265.5$  MHz. The antenna under test was rotated in a clockwise direction while the received signal was recorded on polar coordinate graph paper in a counterclockwise direction. A gain reference was taken using a dipole tuned to 265.5 MHz. No where does the received signal exceed a maximum to minimum of 15 dB.

## DOCUMENT EXHIBITS

The following exhibits are included as part of this Certificate of Compliance:

Exhibit 1	Measured Azimuth Pattern (Composite)
Exhibit 1-A	Measured Field Strength Tabulations (Composite)
Exhibit 2	Horizontally Measured Polarized Azimuth Pattern
Exhibit 2-A	Measured Field Strength Tabulations (Horizontal)
Exhibit 3	Vertically Measured Polarized Azimuth Pattern
Exhibit 3-A	Measured Field Strength Tabulations (Vertical)
Exhibit 4	Elevation Pattern
Exhibit 4-A	Elevation Pattern Tabulations

## TEST EQUIPMENT

Network Analyzer: Hewlett Packard Model #8753C  
Serial Number: 08753-69138

Computer: White Mountain 366 Computer

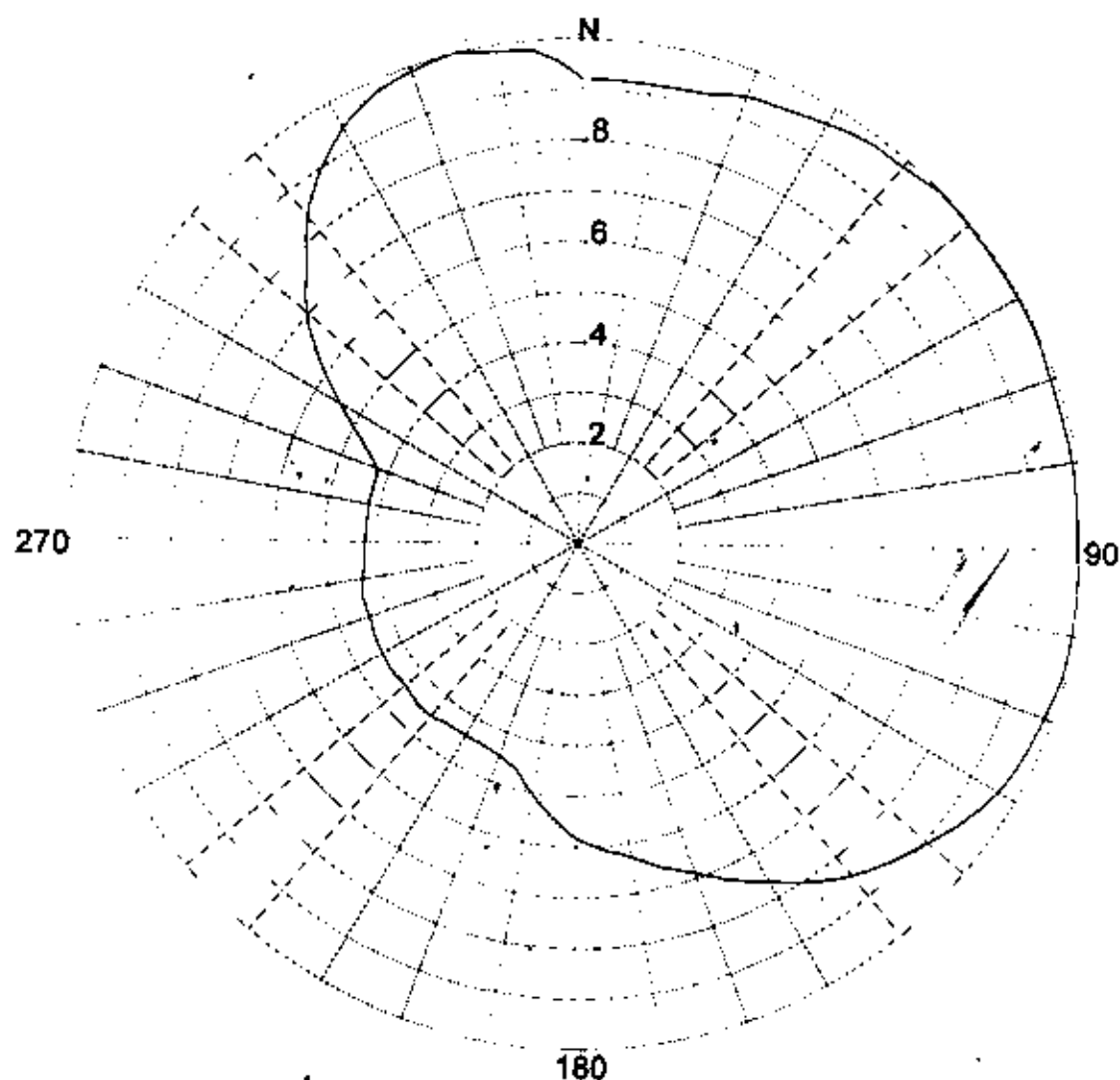
Plotter: Hewlett Packard HP 7550 A

Positioner: Orbit Positioner

Prepared by:



Robert W. Edmiston Jr.  
Vice President of Production



**Azimuth Pattern**

**Systems With Reliability Inc.**

Scale: Linear

Units: Absolute

CLIENT: WODC-FM

Date: 4/16/98

ANTENNA TYPE: FMEC/6-DA

FREQUENCY: 88.5 MHz.

PATTERN POL.: Circular

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 1.6185/ 2.0912dB

PATTERN RMS:

Software Design by: Micro-Tek Engineering

Exhibit 1

# Field Strength Tabulation

Azimuth Heading	Field strength(dB)	Azimuth Heading	Field Strength(dB)
0	.92 (-.71)	180	.58 (-4.67)
5	.92 (-.71)	185	.54 (-5.27)
10	.92 (-.71)	190	.50 (-5.93)
15	.93 (-.67)	195	.46 (-6.69)
20	.95 (-.48)	200	.45 (-6.99)
25	.95 (-.42)	205	.44 (-7.11)
30	.96 (-.30)	210	.44 (-7.11)
35	.98 (-.14)	215	.44 (-7.11)
40	.98 (-.15)	220	.45 (-6.92)
45	1.00 (-.01)	225	.45 (-6.92)
50	1.00 (-.03)	230	.44 (-7.09)
55	1.00 (-.03)	235	.45 (-6.96)
60	1.00 (-.03)	240	.44 (-7.03)
65	1.00 (-.03)	245	.44 (-7.07)
70	.99 (-.10)	250	.44 (-7.19)
75	.99 (-.10)	255	.44 (-7.13)
80	.99 (-.07)	260	.43 (-7.29)
85	.99 (-.10)	265	.42 (-7.43)
90	.99 (-.10)	270	.42 (-7.47)
95	.99 (-.07)	275	.42 (-7.54)
100	.99 (-.06)	280	.42 (-7.49)
105	.99 (-.06)	285	.42 (-7.51)
110	.98 (-.15)	290	.42 (-7.51)
115	.98 (-.20)	295	.47 (-6.48)
120	.96 (-.32)	300	.55 (-5.26)
125	.94 (-.54)	305	.63 (-4.03)
130	.91 (-.84)	310	.71 (-3.00)
135	.88 (-1.11)	315	.76 (-2.33)
140	.85 (-1.41)	320	.84 (-1.48)
145	.81 (-1.81)	325	.90 (-.92)
150	.77 (-2.30)	330	.94 (-.49)
155	.73 (-2.72)	335	.98 (-.19)
160	.69 (-3.24)	340	.99 (-.07)
165	.66 (-3.60)	345	1.00 (.01)
170	.63 (-4.07)	350	.98 (-.12)
175	.61 (-4.34)	355	.98 (-.17)

## Systems With Reliability Inc.

CLIENT: WODC-FM

Date: 4/16/98

ANTENNA TYPE: FMEC/6-DA

FREQUENCY: 88.5 MHz.

PATTERN POL.: Circular

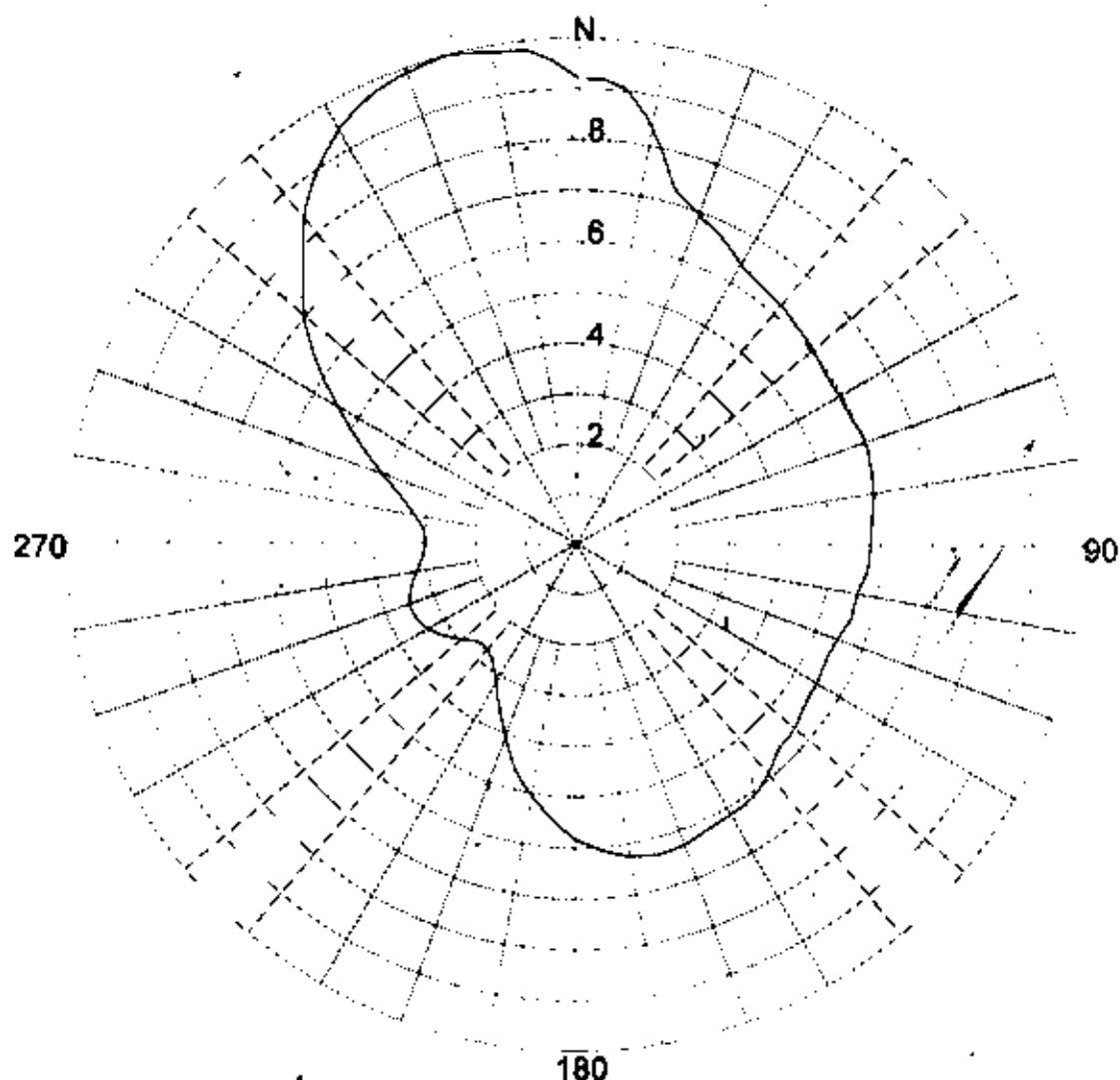
CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 1.6185/ 2.0912dB

PATTERN RMS:

Software Design by: Micro-Tek Engineering

Exhibit 1-A



**Azimuth Pattern**

**Systems With Reliability Inc.**

Scale: Linear  
Units: Absolute

CLIENT: *WODC-FM*

Date: 4/16/98

ANTENNA TYPE: *FMEC/6-DA*

FREQUENCY: *88.5 MHz.*

PATTERN POL.: *Horizontal*

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: *2.6633/ 4.2542dB*

PATTERN RMS:

Software Design by: *Micro-Tek Engineering*

**Exhibit 2**

# Field Strength Tabulation

Azimuth Heading	Field strength(dB)	Azimuth Heading	Field Strength(dB)
0	.92 (-.71)	180	.58 (-4.67)
5	.92 (-.71)	185	.54 (-5.27)
10	.84 (-1.50)	190	.50 (-5.93)
15	.73 (-2.72)	195	.46 (-6.69)
20	.69 (-3.17)	200	.40 (-7.85)
25	.67 (-3.44)	205	.36 (-8.90)
30	.64 (-3.85)	210	.31 (-10.03)
35	.63 (-4.03)	215	.28 (-10.87)
40	.62 (-4.11)	220	.27 (-11.28)
45	.61 (-4.26)	225	.27 (-11.21)
50	.61 (-4.34)	230	.29 (-10.60)
55	.59 (-4.51)	235	.32 (-9.92)
60	.59 (-4.50)	240	.34 (-9.37)
65	.59 (-4.50)	245	.35 (-9.12)
70	.61 (-4.34)	250	.35 (-9.04)
75	.60 (-4.45)	255	.34 (-9.40)
80	.59 (-4.50)	260	.32 (-9.67)
85	.58 (-4.67)	265	.30 (-10.29)
90	.58 (-4.73)	270	.30 (-10.52)
95	.58 (-4.76)	275	.30 (-10.43)
100	.56 (-5.02)	280	.32 (-9.79)
105	.56 (-5.01)	285	.36 (-8.92)
110	.55 (-5.24)	290	.41 (-7.79)
115	.54 (-5.30)	295	.47 (-6.48)
120	.55 (-5.22)	300	.55 (-5.26)
125	.55 (-5.18)	305	.63 (-4.03)
130	.56 (-4.94)	310	.71 (-3.00)
135	.57 (-4.90)	315	.76 (-2.33)
140	.59 (-4.55)	320	.84 (-1.48)
145	.61 (-4.25)	325	.90 (-.92)
150	.61 (-4.21)	330	.94 (-.49)
155	.62 (-4.15)	335	.98 (-.19)
160	.63 (-3.99)	340	.99 (-.07)
165	.63 (-3.96)	345	1.00 (.01)
170	.63 (-4.07)	350	.98 (-.12)
175	.61 (-4.34)	355	.98 (-.17)

## Systems With Reliability Inc.

CLIENT: WODC-FM

Date: 4/16/98

ANTENNA TYPE: FMEC/6-DA

FREQUENCY: 88.5 MHz.

PATTERN POL.: Horizontal

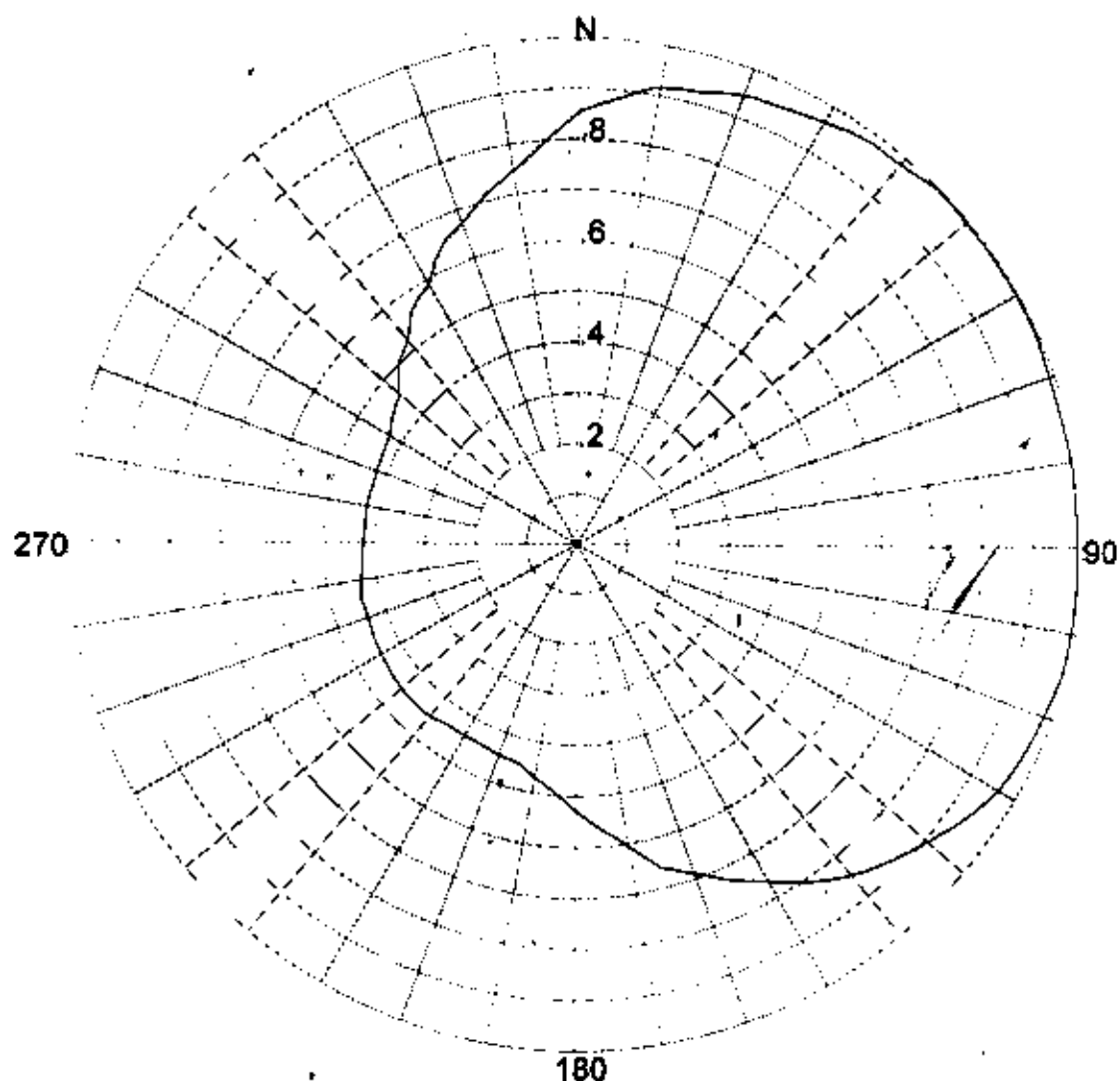
CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 2.6633/ 4.2542dB

PATTERN RMS:

Software Design by: Micro-Tek Engineering

Exhibit 2-A



**Azimuth Pattern**

**Systems With Reliability Inc.**

Scale: Linear  
Units: Absolute

CLIENT: WODC-FM

Date: 4/16/98

ANTENNA TYPE: FMEC/6-DA

FREQUENCY: 88.5 MHz.

PATTERN POL.: Vertical

AZ. DIRECTIVITY: 1.8314/ 2.6279dB

CIRCULARITY(+/-dB):

PATTERN RMS:

Software Design by: Micro-Tek Engineering

Exhibit 3



# Field Strength Tabulation

Azimuth Heading	Field strength(dB)	Azimuth Heading	Field Strength(dB)
0	.85 (-1.36)	180	.53 (-5.53)
5	.88 (-1.07)	185	.49 (-6.16)
10	.92 (-.71)	190	.47 (-6.56)
15	.93 (-.67)	195	.45 (-6.96)
20	.95 (-.46)	200	.45 (-6.99)
25	.95 (-.42)	205	.44 (-7.11)
30	.96 (-.30)	210	.44 (-7.11)
35	.98 (-.14)	215	.44 (-7.11)
40	.98 (-.15)	220	.45 (-6.92)
45	1.00 (-.01)	225	.45 (-6.92)
50	1.00 (-.03)	230	.45 (-6.92)
55	1.00 (-.03)	235	.45 (-6.96)
60	1.00 (-.03)	240	.44 (-7.03)
65	1.00 (-.03)	245	.44 (-7.07)
70	.99 (-.10)	250	.44 (-7.19)
75	.99 (-.10)	255	.44 (-7.13)
80	.99 (-.07)	260	.43 (-7.29)
85	.99 (-.10)	265	.42 (-7.43)
90	.99 (-.10)	270	.42 (-7.47)
95	.99 (-.07)	275	.42 (-7.54)
100	.99 (-.06)	280	.42 (-7.49)
105	.99 (-.06)	285	.42 (-7.51)
110	.98 (-.15)	290	.42 (-7.51)
115	.98 (-.20)	295	.42 (-7.45)
120	.96 (-.32)	300	.43 (-7.35)
125	.94 (-.54)	305	.45 (-7.01)
130	.91 (-.84)	310	.46 (-6.74)
135	.88 (-1.11)	315	.50 (-5.97)
140	.85 (-1.41)	320	.52 (-5.66)
145	.81 (-1.81)	325	.57 (-4.82)
150	.77 (-2.30)	330	.59 (-4.58)
155	.73 (-2.72)	335	.65 (-3.76)
160	.69 (-3.24)	340	.67 (-3.44)
165	.66 (-3.60)	345	.71 (-2.93)
170	.60 (-4.39)	350	.75 (-2.53)
175	.56 (-4.96)	355	.80 (-1.98)

## Systems With Reliability Inc.

CLIENT: WODC-FM

Date: 4/16/98

ANTENNA TYPE: FMEC/6-DA

FREQUENCY: 88.5 MHz.

PATTERN POL.: Vertical

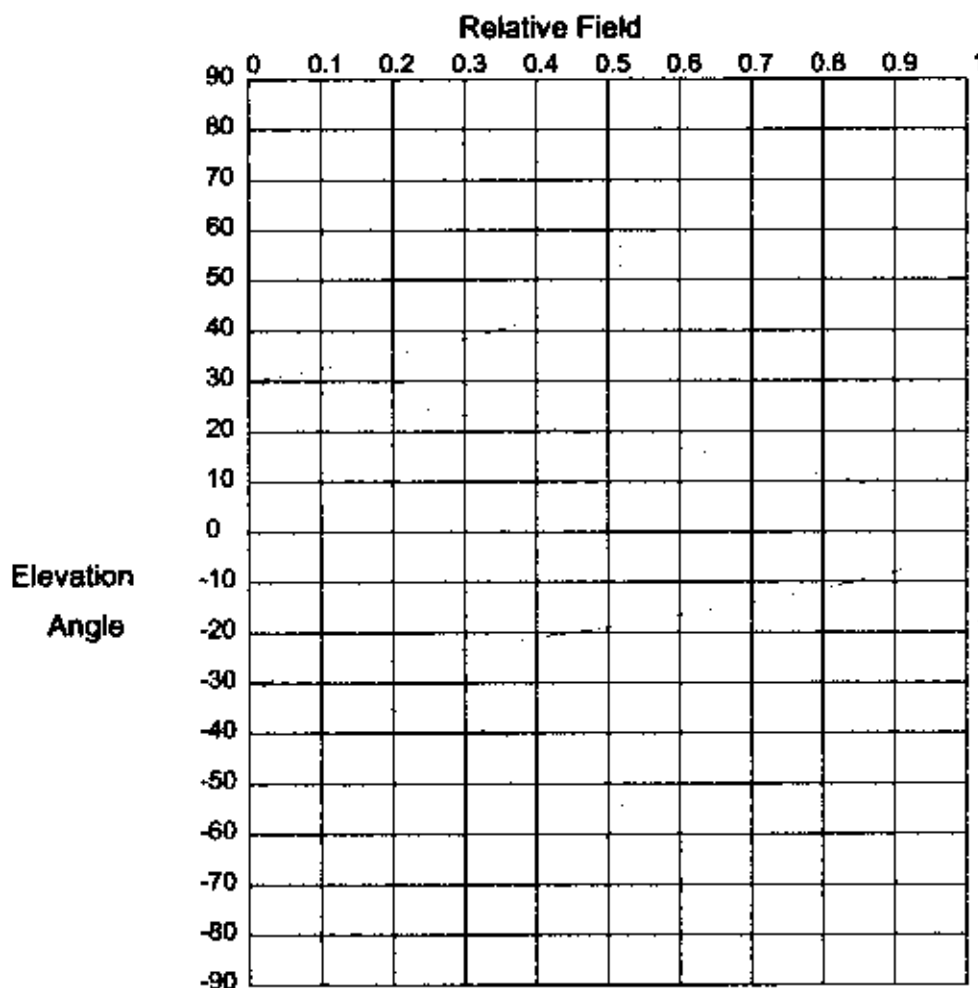
CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 1.8314/ 2.6279dB

PATTERN RMS:

Software Design by: Micro-Tek Engineering

Exhibit 3-A



## Elevation Pattern

Scale: Linear

**Systems With Reliability Inc.**

Units: Field, Relative

CLIENT: LARRY WILL

Date: 2/22/2005

ANTENNA TYPE: FMEC2/88.5

FREQUENCY: 88.5

PATTERN POL.: Circular

DIRECTIVITY(Peak): 1.918/2.828 dBd

Beam Tilt (Deg.): 0

DIRECTIVITY(Horiz): 1.918/2.828 dBd

Null Fill(s)(%): 0, 0, 0

Micro-Tek Eng. ver. 2000

Figure 4

# Relative Field Tabulation

Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)
90.0	.10 (-20)	52.0	.514 (-5.775)	14.0	.705 (-3.031)
89.0	.116 (-18.733)	51.0	.51 (-5.855)	13.0	.743 (-2.581)
88.0	.131 (-17.627)	50.0	.503 (-5.963)	12.0	.779 (-2.174)
87.0	.147 (-16.648)	49.0	.495 (-6.101)	11.0	.812 (-1.809)
86.0	.163 (-15.768)	48.0	.486 (-6.272)	10.0	.843 (-1.482)
85.0	.178 (-14.971)	47.0	.474 (-6.479)	9.8	.849 (-1.421)
84.0	.194 (-14.242)	46.0	.461 (-6.724)	9.6	.855 (-1.361)
83.0	.21 (-13.571)	45.0	.446 (-7.013)	9.4	.861 (-1.303)
82.0	.225 (-12.951)	44.0	.429 (-7.349)	9.2	.866 (-1.246)
81.0	.241 (-12.374)	43.0	.41 (-7.738)	9.0	.872 (-1.191)
80.0	.256 (-11.836)	42.0	.39 (-8.189)	8.8	.877 (-1.137)
79.0	.271 (-11.332)	41.0	.367 (-8.709)	8.6	.883 (-1.084)
78.0	.286 (-10.859)	40.0	.342 (-9.31)	8.4	.888 (-1.033)
77.0	.301 (-10.415)	39.0	.316 (-10.008)	8.2	.893 (-0.983)
76.0	.316 (-9.997)	38.0	.288 (-10.824)	8.0	.898 (-0.935)
75.0	.331 (-9.603)	37.0	.257 (-11.786)	7.8	.903 (-0.887)
74.0	.345 (-9.231)	36.0	.225 (-12.937)	7.6	.908 (-0.841)
73.0	.36 (-8.881)	35.0	.192 (-14.343)	7.4	.912 (-0.797)
72.0	.374 (-8.551)	34.0	.156 (-16.113)	7.2	.917 (-0.753)
71.0	.387 (-8.24)	33.0	.119 (-18.454)	7.0	.921 (-0.711)
70.0	.401 (-7.948)	32.0	.081 (-21.628)	6.8	.926 (-0.67)
69.0	.413 (-7.673)	31.0	.041 (-27.712)	6.6	.93 (-0.631)
68.0	.426 (-7.417)	30.0	.00 (-50)	6.4	.934 (-0.593)
67.0	.436 (-7.178)	29.0	.042 (-27.469)	6.2	.938 (-0.556)
66.0	.449 (-6.956)	28.0	.086 (-21.343)	6.0	.942 (-0.52)
65.0	.46 (-6.751)	27.0	.13 (-17.727)	5.8	.946 (-0.486)
64.0	.47 (-6.563)	26.0	.175 (-15.145)	5.6	.949 (-0.452)
63.0	.479 (-6.392)	25.0	.22 (-13.135)	5.4	.953 (-0.42)
62.0	.488 (-6.239)	24.0	.266 (-11.491)	5.2	.956 (-0.389)
61.0	.495 (-6.103)	23.0	.312 (-10.103)	5.0	.959 (-0.36)
60.0	.502 (-5.986)	22.0	.359 (-8.906)	4.8	.963 (-0.331)
59.0	.508 (-5.887)	21.0	.405 (-7.858)	4.6	.966 (-0.304)
58.0	.512 (-5.807)	20.0	.45 (-6.929)	4.4	.969 (-0.278)
57.0	.516 (-5.747)	19.0	.495 (-6.1)	4.2	.971 (-0.253)
56.0	.518 (-5.708)	18.0	.54 (-5.356)	4.0	.974 (-0.229)
55.0	.519 (-5.69)	17.0	.583 (-4.685)	3.8	.976 (-0.207)
54.0	.519 (-5.694)	16.0	.625 (-4.078)	3.6	.979 (-0.186)
53.0	.517 (-5.722)	15.0	.666 (-3.528)	3.4	.981 (-0.165)

## Systems With Reliability Inc.

Page 1 of 3

CLIENT: LARRY WILL

Date: 2/22/2005

ANTENNA TYPE: FMEC2/88.5

FREQUENCY: 88.5

PATTERN POL.: Circular

DIRECTIVITY(Peak): 1.918/2.828 dBd

Beam Tilt (Deg.): 0

DIRECTIVITY(Horiz): 1.918/2.828 dBd

Null Fill(s)(%): 0, 0, 0

Micro-Tek Eng. ver. 2000

Table 4

# WODC-FM Antenna RMS Comparison

## Proposed Antenna

Azimuth  
Heading      Relative  
Field

0	1.00
5	1.00
10	1.00
15	1.00
20	1.00
25	1.00
30	1.00
35	1.00
40	1.00
45	1.00
50	1.00
55	1.00
60	1.00
65	1.00
70	1.00
75	1.00
80	1.00
85	1.00
90	1.00
95	1.00
100	1.00
105	1.00
110	1.00
115	1.00
120	1.00
125	1.00
130	1.00
135	0.98
140	0.95
145	0.91
150	0.89
155	0.85
160	0.82
165	0.78
170	0.73
175	0.68

## Designed Antenna

Azimuth  
Heading      Relative  
Field

0	0.92
5	0.92
10	0.92
15	0.93
20	0.95
25	0.95
30	0.96
35	0.98
40	0.98
45	1.00
50	1.00
55	1.00
60	1.00
65	1.00
70	0.99
75	0.99
80	0.99
85	0.99
90	0.99
95	0.99
100	0.99
105	0.99
110	0.98
115	0.98
120	0.96
125	0.94
130	0.91
135	0.88
140	0.85
145	0.81
150	0.77
155	0.73
160	0.69
165	0.66
170	0.63
175	0.61

180	0.64
185	0.59
190	0.56
195	0.54
200	0.51
205	0.48
210	0.45
215	0.45
220	0.45
225	0.45
230	0.45
235	0.45
240	0.45
245	0.45
250	0.45
255	0.45
260	0.45
265	0.45
270	0.45
275	0.48
280	0.51
285	0.54
290	0.56
295	0.59
300	0.64
305	0.68
310	0.73
315	0.81
320	0.89
325	0.93
330	0.95
335	0.98
340	1.00
345	1.00
350	1.00
355	1.00

180	0.58
185	0.54
190	0.50
195	0.46
200	0.45
205	0.44
210	0.44
215	0.44
220	0.45
225	0.45
230	0.44
235	0.45
240	0.44
245	0.44
250	0.44
255	0.44
260	0.43
265	0.42
270	0.42
275	0.42
280	0.42
285	0.42
290	0.42
295	0.47
300	0.55
305	0.63
310	0.71
315	0.76
320	0.84
325	0.90
330	0.94
335	0.98
340	0.99
345	1.00
350	0.98
355	0.98

Sum of Relative Fields Squared:	48.99
Sum Divided by 72 (Readings):	0.68
Square Root:	0.82

Sum of Relative Fields Squared:	44.36
Sum Divided by 72 (Readings):	0.62
Square Root:	0.78

Percentage of Construction Permit Antenna Filled:

95.16%

