



Propagation Systems, Inc.

Quality Broadcast Antenna Systems

Directional FM Antenna

WHBP

Interlochen Center for the Arts

Harbor Springs, MI

A custom designed PSIFMDP antenna with custom mounting brackets and feed network was used in conjunction with the customer's 36-inch face triangular tower to create the necessary directional radiation pattern. The final antenna consists of four panels secured with custom-mounting brackets and support masts. The antenna panels are fed from a power divider network that provides the necessary power and phase to each panel to produce the desired directional radiation pattern.

Pattern testing was performed using a 1/3 scale model antenna and tower. The azimuth plane measurements were taken on a ground reflection test range. This type of test range utilizes the reflected signal and direct signal from the source antenna to form an interference pattern on the antenna under test. The antenna and tower under test was mounted to a turntable that allowed the structure to be rotated 360° in the azimuth plane. The source antenna was located approximately 75 ft. from the antenna under test. The source height above ground was adjusted to peak the first lobe of the interference pattern at the antenna under test.

The test antenna was mounted in the center of rotation of the turntable. The antenna and mounting structure were rotated clockwise while data was recorded in a counter clockwise direction. All feed cables to the antenna were secured and grounded during pattern measurements. A Hewlett Packard 8753E-network analyzer operating at 270.3 MHz was used as both the source and receiver. The level of the received signal was compared with a standard dipole to establish the directivity of the final pattern. The final pattern measured does not exceed the envelope pattern and is 91.5% of the envelope RMS.

The antenna is to be mounted according to the enclosed drawings at the 131-meter (430 ft.) level above ground. At this elevation the antenna will be within the +2m/-4m deviation allowed from the 129-meter elevation specified in the construction permit. The antenna panels are to be mounted to the northeast tower face, positioned 80° True and the west tower leg and positioned 295° True. It is recommended that a broadcast engineer be present to supervise the installation of the antenna and that he or she certifies that the antenna has been installed according to the enclosed drawings.

An input power level of 2.97 kW will be necessary at the antenna input in order to reach the required 8.5 kW ERP. The measured principal minima at 0°-10° and 190°-200° are 1.23 kW and .41 kW respectively and do not exceed the approved levels of 1.25 kW and .41 kW. The transmitter output power requirements are dependent upon the transmission line size and length used to feed the antenna. The final length of transmission line must be determined after installation.

Antenna Specifications

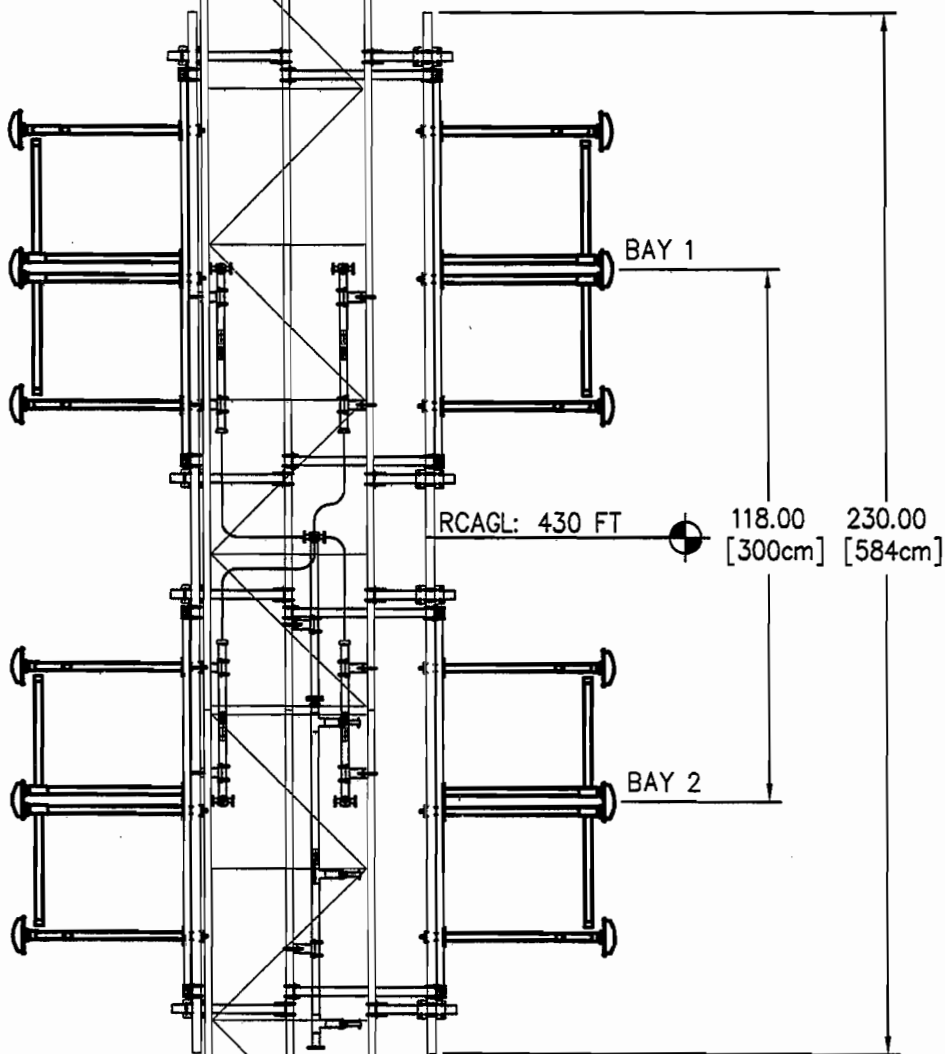
Antenna Model	PSIFMDP-2-DA
Type	2-bay directional FM panel antenna
Configuration	2-panels at 80° and 2-panels at 295°
Frequency	90.1 MHz
Polarization	Circular
Envelope RMS	.719
Composite RMS	.658
Gain (h-pol)	2.86 (4.57 dB)
Gain (v-pol)	2.86 (4.57 dB)
ERP	8.5 kW
Antenna input power	2.97 kW
Input	1-5/8" EIA center fed input
Power rating	9 kW
Length	19.17 ft.
Weight	783.2 lbs.
Wind Area	77.15 sq. ft.

Statement of Certification

This is to certify the antenna has been designed, fabricated and tested under my supervision and it meets the required envelope pattern limitations set forth in the stations construction permit.

 8/24/2016

Douglas A. Ross
President
Propagation Systems Inc.



SPECIFICATIONS	
LENGTH:	19.17 FT [5.84m]
APERTURE:	9.83 FT [3.00m]
RATING:	9 kW
GAIN:	2.86 (4.57 dB)
WEIGHT:	783.2 LB [356 Kg]
WINDAREA:	77.15 FT ²
TIA-222-F	(NO ICE)

NOTE:
1. INDIVIDUAL PANEL CABLES NOT SHOWN FOR
DRAWING CLARITY

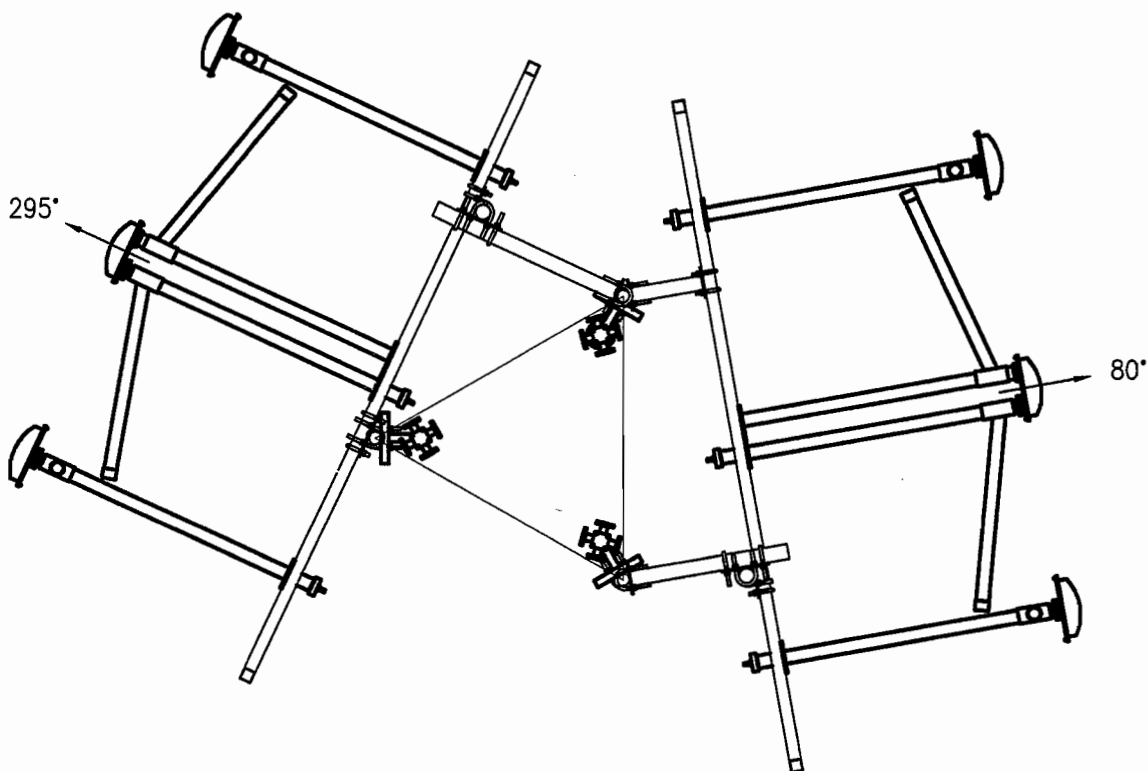
REV.	MADE BY	CHECKED BY	DATE	CHANGE
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				SIZE
				A

PROPAGATION SYSTEMS, INC.

Ebensburg, Pennsylvania USA 814-472-5540

ANTENNA ELEVATION AND SPECIFICATIONS

MODEL:	PSIFMDP-2-DA	DRAWN BY:	B.K.SCHILLING	DATE:	8/16/16
CHANNEL/FREQUENCY:	90.1 MHz	APPROVED BY:		DATE:	
SCALE:		DRAWING NO.:	1599-001	REV.	



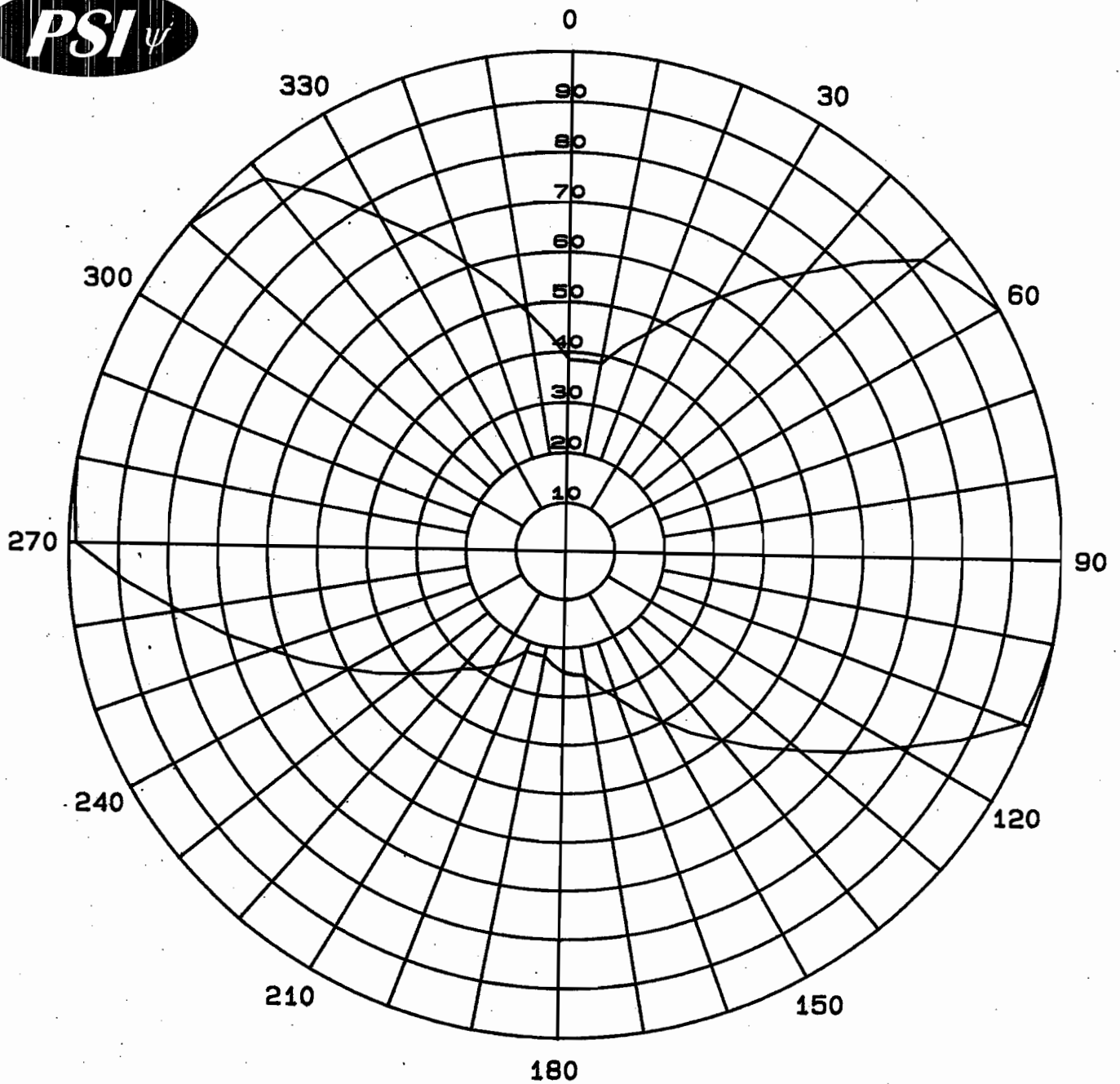
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ANTENNA ORIENTATION AND PLAN VIEW

MODEL:	PSIFMDP-2-DA	DRAWN BY:	B.K.SCHILLING	DATE:	8/16/16
CHANNEL/FREQUENCY:	90.1 MHz	APPROVED BY:		DATE:	
SCALE:		DRAWING NO.:	1599-002	REV.	



Maximum Envelope
Azimuth Plane Pattern
Antenna: PSIFMDP-2-DA
Type: 2-Bay Directional FM Antenna
ERP: 8.5 kW (9.29 dBk)
RMS Envelope: .719
Frequency: 90.1 MHz
WHBP Harbor Springs, MI

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PO Box 113
Ebensburg, PA 15931

Maximum Envelope Tabulation

Antenna: PSIFMDP-2-DA

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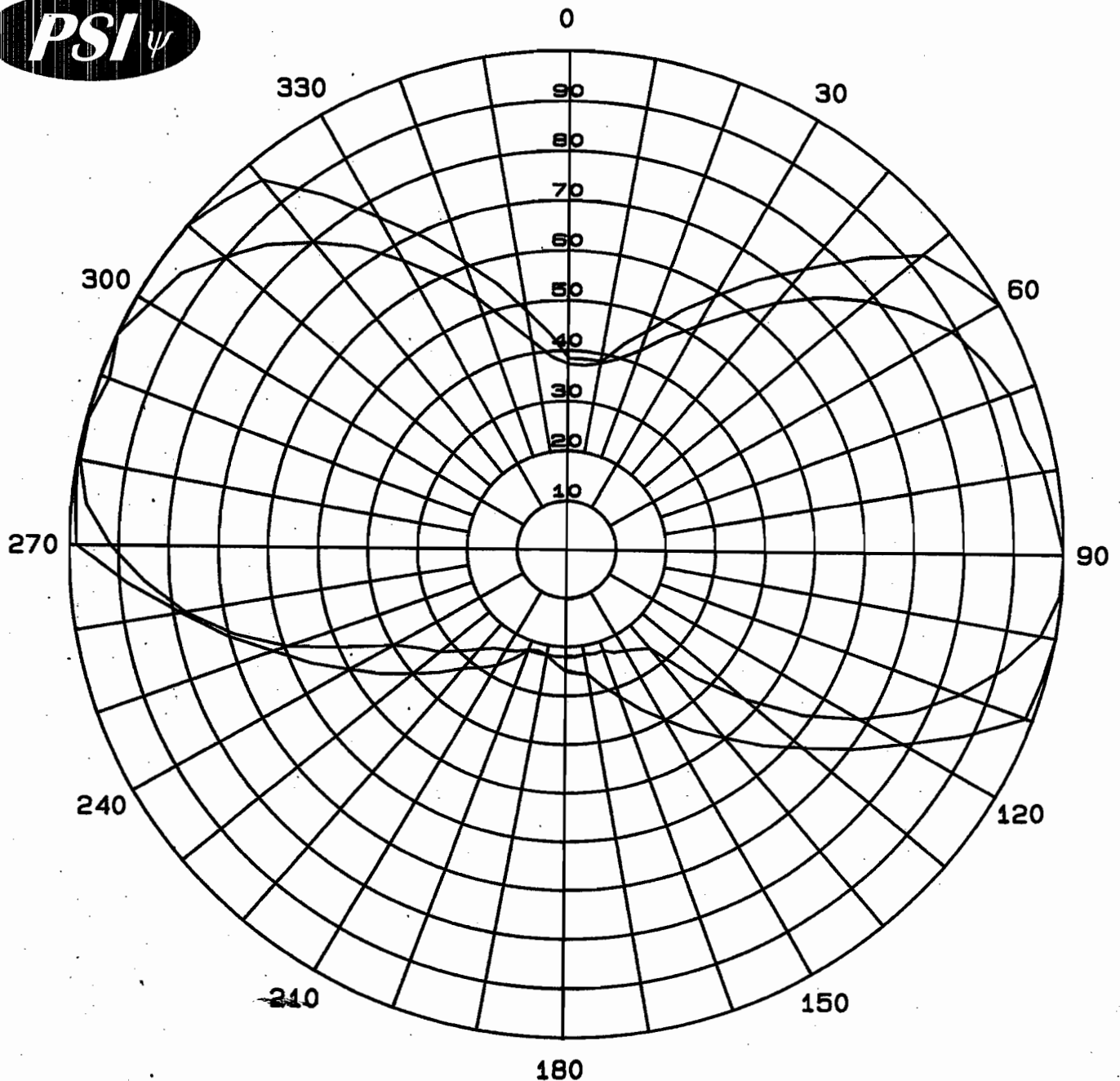
Station: WHBP

Frequency: 90.1 MHz

Location: Harbor Springs, MI

Maximum ERP: 8.5 kW (9.29 dBk)

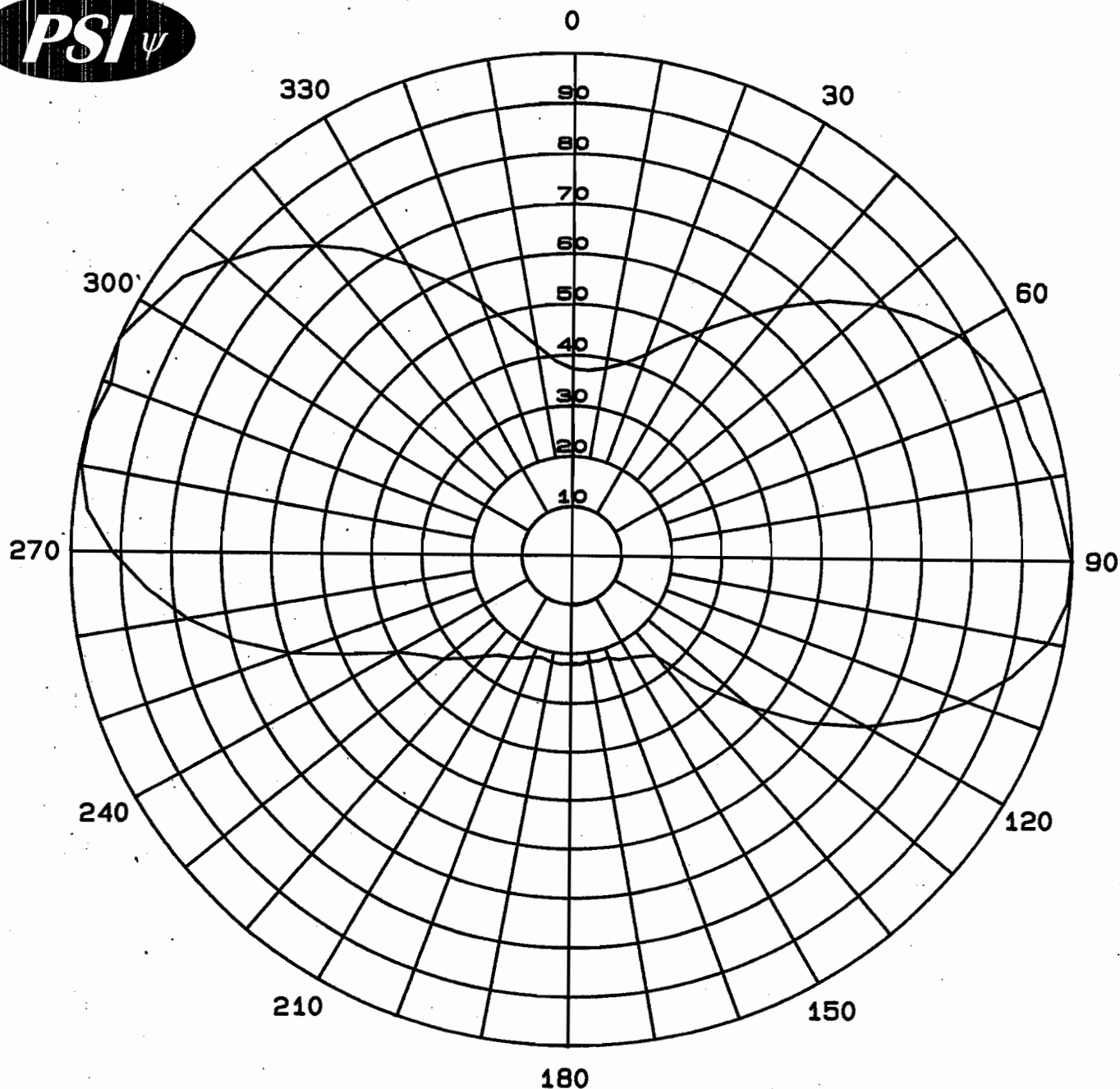
Angle	Relative Field	ERP (kW)	ERP (dBk)
0	0.384	1.25	0.97
10	0.384	1.25	0.97
20	0.470	1.88	2.74
30	0.590	2.96	4.71
40	0.740	4.65	6.68
50	0.930	7.35	8.66
60	1.000	8.50	9.29
70	1.000	8.50	9.29
80	1.000	8.50	9.29
90	1.000	8.50	9.29
100	1.000	8.50	9.29
110	0.985	8.25	9.16
120	0.785	5.24	7.19
130	0.625	3.32	5.21
140	0.500	2.13	3.27
150	0.400	1.36	1.34
160	0.320	0.87	-0.60
170	0.260	0.57	-2.41
180	0.250	0.53	-2.75
190	0.220	0.41	-3.86
200	0.220	0.41	-3.86
210	0.275	0.64	-1.92
220	0.320	0.87	-0.60
230	0.400	1.36	1.34
240	0.500	2.13	3.27
250	0.625	3.32	5.21
260	0.785	5.24	7.19
270	0.985	8.25	9.16
280	1.000	8.50	9.29
290	1.000	8.50	9.29
300	1.000	8.50	9.29
310	1.000	8.50	9.29
320	0.960	7.83	8.94
330	0.765	4.97	6.97
340	0.610	3.16	5.00
350	0.485	2.00	3.01



Maximum Envelope and
Composite Pattern
Antenna: PSIFMDP-2-DA
Type: 2-Bay Directional FM Antenna
ERP: 8.5 kW (9.29 dBk)
RMS Envelope: .719
RMS Composite: .658
Frequency: 90.1 MHz

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WHBP Harbor Springs, MI



Measured Composite
Azimuth Plane Pattern
Antenna: PSIFMDP-2-DA
Type: 2-Bay Directional FM Antenna
ERP: 8.5 kW (9.29 dBk)
RMS Composite: .658
Frequency: 90.1 MHz
WHBP Harbor Springs, MI

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Composite Pattern Tabulation

Antenna: PSIFMDP-2-DA

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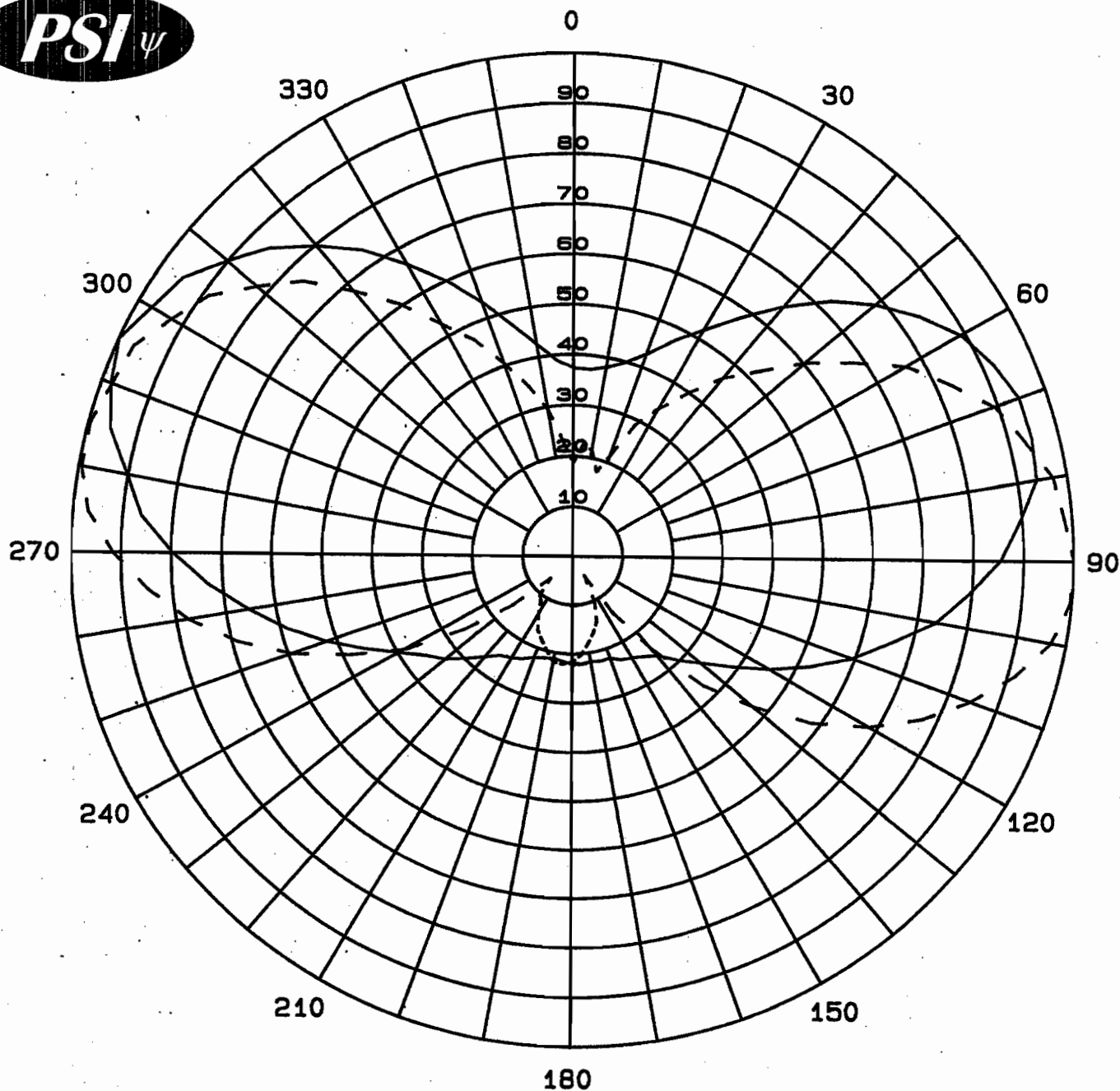
Station: WHBP

Frequency: 90.1 MHz

Location: Harbor Springs, MI

Maximum ERP: 8.5 kW (9.29 dBk)

Angle	Relative Field	ERP (kW)	ERP (dBk)
0	0.373	1.18	0.73
10	0.381	1.23	0.91
20	0.428	1.56	1.92
30	0.521	2.31	3.63
40	0.653	3.62	5.59
50	0.786	5.25	7.20
60	0.891	6.75	8.29
70	0.944	7.57	8.79
80	0.971	8.01	9.04
90	1.000	8.50	9.29
100	0.969	7.98	9.02
110	0.844	6.05	7.82
120	0.683	3.97	5.98
130	0.472	1.89	2.77
140	0.262	0.58	-2.34
150	0.238	0.48	-3.17
160	0.220	0.41	-3.86
170	0.218	0.40	-3.94
180	0.220	0.41	-3.86
190	0.220	0.41	-3.86
200	0.220	0.41	-3.86
210	0.240	0.49	-3.10
220	0.269	0.62	-2.11
230	0.330	0.93	-0.34
240	0.398	1.35	1.29
250	0.594	3.00	4.77
260	0.776	5.12	7.09
270	0.916	7.13	8.53
280	0.995	8.42	9.25
290	0.982	8.20	9.14
300	0.971	8.01	9.04
310	0.901	6.90	8.39
320	0.798	5.41	7.33
330	0.665	3.76	5.75
340	0.534	2.42	3.85
350	0.425	1.54	1.86



Measured Relative Field
Azimuth Plane Pattern
Antenna: PSIFMDP-2-DA
Type: 2-Bay Directional FM Antenna
Gain H-pol (solid): 2.86 (4.57 dB)
Gain V-pol (dash): 2.86 (4.57 dB)
Frequency: 90.1 MHz
WHBP Harbor Springs, MI

Propagation Systems Inc.
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Ebensburg, PA 15931

Measured Relative Field Tabulation

Antenna: PSIFMDP-2-DA

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Station: WHBP

Frequency: 90.1 MHz

Location: Harbor Springs, MI

Horizontal Polarization

Angle	Relative Field	Power Gain	Gain (dB)
0	0.373	0.398	-4.00
10	0.381	0.416	-3.81
20	0.428	0.525	-2.80
30	0.521	0.777	-1.09
40	0.653	1.221	0.87
50	0.786	1.769	2.48
60	0.891	2.274	3.57
70	0.944	2.552	4.07
80	0.939	2.525	4.02
90	0.853	2.084	3.19
100	0.736	1.551	1.91
110	0.593	1.007	0.03
120	0.454	0.590	-2.29
130	0.335	0.321	-4.93
140	0.262	0.197	-7.06
150	0.238	0.162	-7.90
160	0.220	0.139	-8.58
170	0.218	0.136	-8.66
180	0.220	0.139	-8.58
190	0.211	0.128	-8.94
200	0.220	0.139	-8.58
210	0.240	0.165	-7.83
220	0.269	0.207	-6.84
230	0.330	0.312	-5.06
240	0.398	0.454	-3.43
250	0.520	0.774	-1.11
260	0.654	1.225	0.88
270	0.796	1.815	2.59
280	0.901	2.325	3.66
290	0.982	2.762	4.41
300	0.971	2.700	4.31
310	0.901	2.325	3.66
320	0.798	1.824	2.61
330	0.665	1.267	1.03
340	0.534	0.817	-0.88
350	0.425	0.517	-2.86

Maximum Value

Field 1.00
Gain 2.86 (4.57 dB)
Azimuth Bearing 295 degrees

Minimum Field

Field 0.211
Gain -1.27 (-8.95 dB)
Azimuth Bearing 190 degrees

Vertical Polarization

Angle	Relative Field	Power Gain	Gain (dB)
0	0.187	0.100	-9.99
10	0.214	0.131	-8.82
20	0.217	0.135	-8.70
30	0.341	0.333	-4.78
40	0.466	0.622	-2.06
50	0.605	1.048	0.20
60	0.766	1.680	2.25
70	0.893	2.284	3.59
80	0.971	2.700	4.31
90	1.000	2.864	4.57
100	0.969	2.689	4.30
110	0.844	2.040	3.10
120	0.683	1.336	1.26
130	0.472	0.638	-1.95
140	0.245	0.172	-7.65
150	0.046	0.006	-22.18
160	0.141	0.057	-12.45
170	0.181	0.094	-10.28
180	0.217	0.135	-8.70
190	0.220	0.139	-8.58
200	0.182	0.095	-10.23
210	0.138	0.055	-12.63
220	0.103	0.030	-15.17
230	0.154	0.068	-11.68
240	0.384	0.422	-3.74
250	0.594	1.011	0.05
260	0.776	1.725	2.37
270	0.916	2.403	3.81
280	0.995	2.835	4.53
290	0.979	2.745	4.39
300	0.925	2.451	3.89
310	0.823	1.940	2.88
320	0.681	1.328	1.23
330	0.528	0.798	-0.98
340	0.405	0.470	-3.28
350	0.294	0.248	-6.06

Maximum Value

Field 1.00
Gain 2.86 (4.57 dB)
Azimuth Bearing 90 degrees

Minimum Field

Field 0.046
Gain -22.06 (-22.18 dB)
Azimuth Bearing 150 degrees

ERP Tabulation

Antenna: PSIFMDP-2-DA

Interlochen Center for the Arts

Station: WHBP

Frequency: 90.1 MHz

Location: Harbor Springs, MI

Maximum ERP: 8.5 kW (9.29 dBk)

Horizontal Polarization

Angle	Relative Field	ERP (kW)	ERP (dBk)
0	0.373	1.18	0.73
10	0.381	1.23	0.91
20	0.428	1.56	1.92
30	0.521	2.31	3.63
40	0.653	3.62	5.59
50	0.786	5.25	7.20
60	0.891	6.75	8.29
70	0.944	7.57	8.79
80	0.939	7.49	8.75
90	0.853	6.18	7.91
100	0.736	4.60	6.63
110	0.593	2.99	4.76
120	0.454	1.75	2.44
130	0.335	0.95	-0.20
140	0.262	0.58	-2.34
150	0.238	0.48	-3.17
160	0.220	0.41	-3.86
170	0.218	0.40	-3.94
180	0.220	0.41	-3.86
190	0.211	0.38	-4.22
200	0.220	0.41	-3.86
210	0.240	0.49	-3.10
220	0.269	0.62	-2.11
230	0.330	0.93	-0.34
240	0.398	1.35	1.29
250	0.520	2.30	3.61
260	0.654	3.64	5.61
270	0.796	5.39	7.31
280	0.901	6.90	8.39
290	0.982	8.20	9.14
300	0.971	8.01	9.04
310	0.901	6.90	8.39
320	0.798	5.41	7.33
330	0.665	3.76	5.75
340	0.534	2.42	3.85
350	0.425	1.54	1.86

Maximum Value (H-pol)

Field 1.00
ERP 8.5 kW (9.29 dBk)
Azimuth Bearing 295 degrees

Minimum Field (H-pol)

Field 0.211
ERP .38 kW (-4.22 dBk)
Azimuth Bearing 190 degrees

Vertical Polarization

Angle	Relative Field	ERP (kW)	ERP (dBk)
0	0.187	0.30	-5.27
10	0.214	0.39	-4.10
20	0.217	0.40	-3.98
30	0.341	0.99	-0.05
40	0.466	1.85	2.66
50	0.605	3.11	4.93
60	0.766	4.99	6.98
70	0.893	6.78	8.31
80	0.971	8.01	9.04
90	1.000	8.50	9.29
100	0.969	7.98	9.02
110	0.844	6.05	7.82
120	0.683	3.97	5.98
130	0.472	1.89	2.77
140	0.245	0.51	-2.92
150	0.046	0.02	-17.45
160	0.141	0.17	-7.72
170	0.181	0.28	-5.55
180	0.217	0.40	-3.98
190	0.220	0.41	-3.86
200	0.182	0.28	-5.50
210	0.138	0.16	-7.91
220	0.103	0.09	-10.45
230	0.154	0.20	-6.96
240	0.384	1.25	0.98
250	0.594	3.00	4.77
260	0.776	5.12	7.09
270	0.916	7.13	8.53
280	0.995	8.42	9.25
290	0.979	8.15	9.11
300	0.925	7.27	8.62
310	0.823	5.76	7.60
320	0.681	3.94	5.96
330	0.528	2.37	3.75
340	0.405	1.39	1.44
350	0.294	0.73	-1.34

Maximum Value (V-pol)

Field 1.00
ERP 8.5 kW (9.29 dBk)
Azimuth Bearing 90 degrees

Minimum Field (V-pol)

Field 0.046
ERP .02 kW (-17.45 dBk)
Azimuth Bearing 150 degrees



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Relative Field Elevation Pattern

