SYSTEMS WITH RELIABILITY, LP

BROADCAST ANTENNAS AND TRANSMISSION SYSTEMS

PATTERN CERTIFICATION

DIRECTIONAL FM ANTENNA
WITM
November 25, 2022

Call Sign	:	WITM
Location	:	West Frankfort, IL
Frequency	:	88.7 MHz
Channel	:	204
Antenna Model	:	FMECRA/3-PLUS-DA
Composite Gain	:	2.256 / 3.533 dB

ANTENNA DESCRIPTION

A custom designed **FMECRA/3-PLUS-DA** antenna was used to produce the required directional azimuth pattern. Each antenna bay consists of a circularly polarized dipole-radiating element and horizontal and vertical parasitic elements that are used for directing the signal. The array is comprised of **3** bays that are spaced a **full** wavelength apart. The array is mounted to the tower and orientated at **325** degrees from true north.

DESCRIPTION OF TEST PROCEDURE

The antenna under test consists of an exactly replicated third scale single bay model that is circular polarized. The antenna test model was mounted to an exact replicated third-scale model tower in accordance with tower drawings supplied by the customer. Mounting brackets that were used in the modeling were supplied with the finalized antenna. The tower was placed on 20 ft. high on a wooden platform. All feed cables are properly grounded during pattern testing. Horizontal and vertical readings were taken. The desired directional pattern was obtained by adjusting the distance between the tower and the antenna, modifying the direction of the azimuth heading. Parasitic elements were used for performance enhancement.

DESCRIPTION OF TEST EQUIPMENT AND PARAMETERS

The antenna under test was operated in the transmit mode at a frequency of 266.1 MHz (88.7 MHz x 3 = 266.1 MHz). Horizontal and vertical pattern readings were taken by mounting a source antenna – a vertical/horizontal dipole, Cavity Back Resonator (CBR) antenna bay - approximately 100’ (feet) from the third-scale antenna model. The source antenna’s height was adjusted to achieve a uniform field at the third-scale test antenna location. The CBR antenna was operated in receive mode at frequency 266.1 MHZ. The third-scale test antenna was then rotated

clockwise to achieve 360° (degree) pattern readings. A gain reference was taken using a dipole tuned to 266.1 MHz.

DOCUMENT EXHIBITS

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

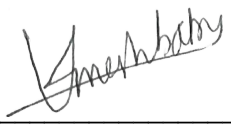
Exhibit 1	Circular Polarized Azimuth Pattern Field Strength Tabulations (Composite)
Exhibit 2	Measured Horizontal Polarized Azimuth Pattern Measured Field Strength Tabulations (Horizontal)
Exhibit 3	Measured Vertical Polarized Azimuth Pattern Measured Field Strength Tabulations (Vertical)
Exhibit 4	Elevation Pattern Elevation Tabulations
Exhibit 5	Antenna Data Sheet

TEST EQUIPMENT

Network Analyzer	:	Hewlett Packard Model # 8753C Serial Number: 08753 – 69138
Computer	:	450 MHz Intel PIII
Plotter	:	Hewlett-Packard Laser Jet 6L
Positioner	:	Antenna Positioner Orbit AL-860-1 Position Controller Orbit AL-4901-3A

The test equipment is calibrated in accordance with ANSI / NCSL Z540-1-1994

Prepared by:



Umesh Manedi
Electrical and Computer Engineer
SWR, LP.

TEST RESULTS

The attached calculations verify that the RMS value of this antenna is 93.1 % of the RMS value of the pattern authorized in the related FCC file 0000191069. The vertical component RMS value is 0.636. The horizontal component RMS value is 0.668. The circular polarized component RMS value is 0.814.

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

Measured horizontal polarized directivity	**:**	**2.24201 / 3.51 dB**
Measured vertical polarized directivity	**:**	**2.47594 / 3.94 dB**
Measured composite azimuth pattern directivity	**:**	**1.50825 / 1.78 dB**

Gain in each polarization was calculated 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:

Composite Gain = 1.50825*2.991*0.50 = 2.256 / 3.533 dB

INSTALLATION AND MOUNTING

The antenna is to be mounted in accordance with the supplied drawings. The antenna center of radiation is to be **197 feet (60 *meters)*** above ground level. The antenna aperture (Parasitic System included) is **22.19 *feet (6.76meters)***. No other antennas are to be mounted within ***10 feet*** of the antenna. No other obstructions other than those specified by original drawings supplied are to be mounted at the same level as the antenna. The antenna is to be oriented **325 *degrees*** true North.

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

DRAWING NO.	**TITLE**
2351D00	ANTENNA ASSEMBLY
2351D01	ANTENNA ORIENTATION
2351D02	PARASITIC PLACEMENT

The array shall be mounted according to **DWG. 2351D00.** The antenna elements shall be aligned at the same heading as in **DWG. 2351D01** to ensure that the antenna is oriented properly at **325** degrees true north.

Surveyor's Declaration

I,_____

_____, subject to the penalties of perjury, do declare the following:

1.) I am a licensed surveyor in the sate(s) of _____,
_____ and _____.
2.) I have provided professional services to _____(permit tee name), permit tee of _____-FM, _____(city of license), _____(state), during the installation of the _____-FM directional antenna.
3.) I certify that the _____-FM directional antenna has been oriented at the proper azimuth as authorized in the construction permit (FCC File Number_____).

Dated: _____mm/dd/yy

Engineer's Declaration

I,_____, subject to the penalties of perjury, do declare the following:

1.) I am the holder of a valid General Radio Telephone Operators License, Number _____(FCC License No.)

2.) I have been a member of the Society of Broadcast Engineer's since 19_____

3.) That I have been employed as a technical consultant with the firm of: _____(firm name), of _____(city state)

4.) That _____(Firm's Name) was retained by _____(Permittee's Name) for the purpose of preparing its application for the construction permit of _____-FM _____(City), _____(State), from which the underlying Construction Permit (FCC File Number_____) was granted by the Commission.

5.) That I am familiar with the terms and conditions of the _____-FM Construction Permit.

6.) I hereby certify that I have overseen the installation of the _____-FM directional antenna and that the installation was complete to the manufacturer's instructions.

Dated: _____mm/dd/yy

619 Industrial Park Road, Ebensburg, PA 15931 Tel. 800 762 7743 / 814 472 5436 ♦ Fax 814 472 5552

SYSTEMS WITH RELIABILITY, LP
Broadcast Antennas & Transmission Systems
619 Industrial Park Road, Ebensburg, PA 15931
Phone 814.472.5436 Fax 814.472.5552 www.swr-rf.com

Certified Proof of Performance

Customer:	Three Angels Broadcasting Network, Inc. WITM
Date:	09/28/2022
Antenna Model:	FMECRA/3 – PLUS – 88.7
Frequencies Tested:	88.7 MHz (+/- 200 KHz)
Return Loss @ Fc:	- 32.588 dB
Shop Order No.:	22210
Input:	7/8” EIA Flange

A reading of –17.7 dB is indicative of a 1.3:1 VSWR. The component specified has met or exceeds this 1.3:1 VSWR performance specification.

Computer / Vector Network Analyzer plots are enclosed to verify antenna performance.

Test Performed by:

Charles Edmiston Jr
Technician

SYSTEMS WITH RELIABILITY, LP
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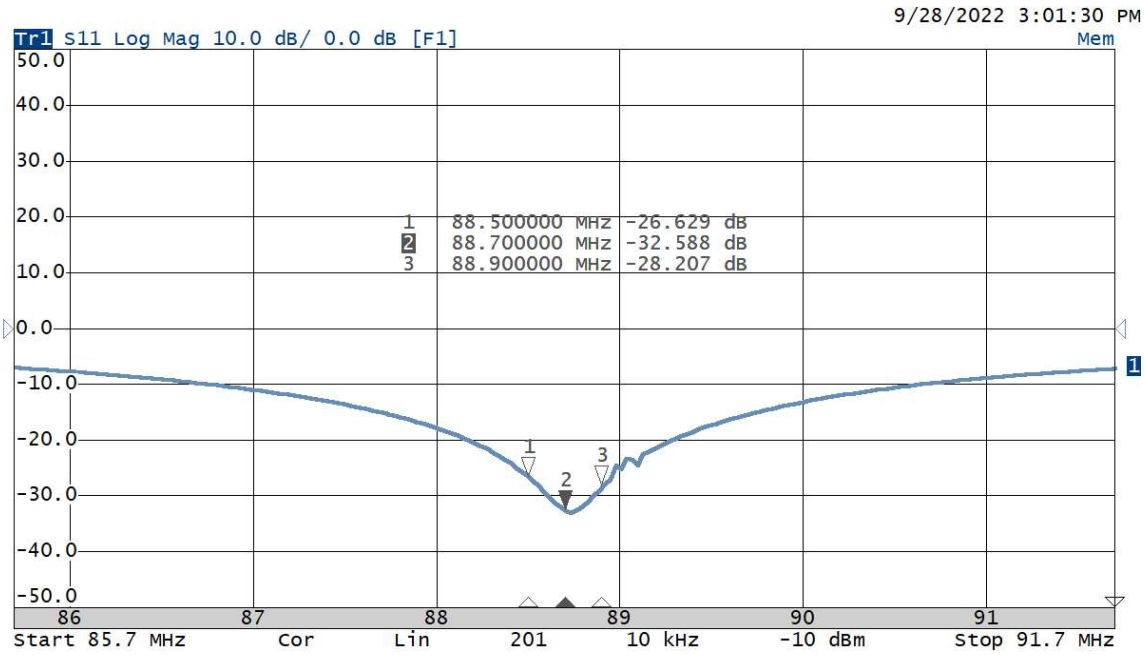
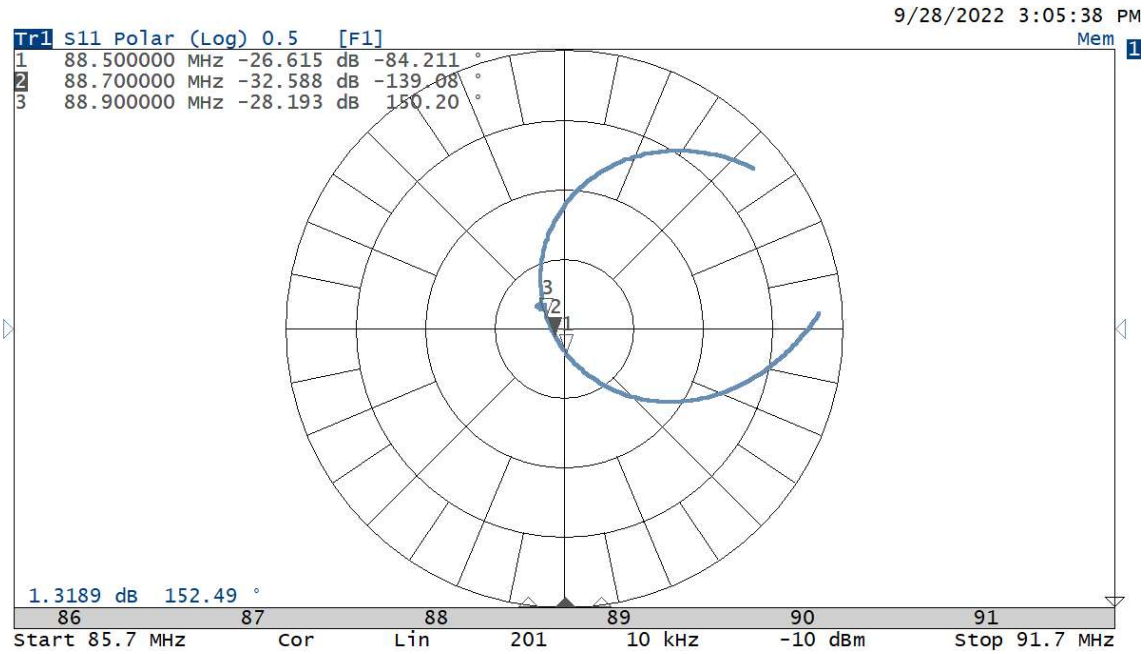


Plot 1: Return Loss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Tr1 S11 Polar (Log) 0.5 [F1]
Mem
1 88.500000 MHz -26.615 dB -84.211 °
2 88.700000 MHz -32.588 dB -139.08 °
3 88.900000 MHz -28.193 dB 150.20 °
1.3189 dB 152.49 °
86
87
88
89
90
91
Start 85.7 MHz
Cor
Lin
201
10 kHz
-10 dBm
Stop 91.7 MHz

Plot 2: Polar

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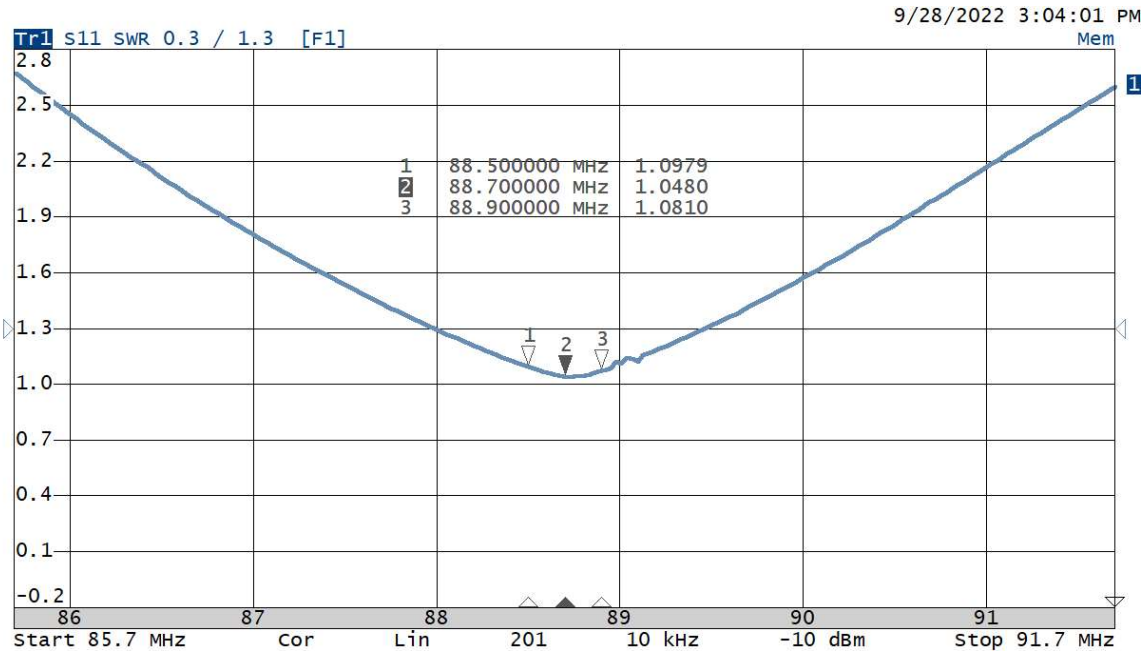


Plot 3: VSWR

(800) 762-7743 (814) 472-5436 Fax: (814) 472-5552

SYSTEMS WITH RELIABILITY, LP

Broadcast Antennas & Transmission Systems

Digital Transmission Systems ®

SYSTEM DATA SHEET

CALL SIGN / CUSTOMER	WITM(FM) (File # 0000191069)
LOCATION	West Frankfort, IL
CONTACT	Michael Babb
ANTENNA MODEL	FMECRA/3-PLUS-DA
FREQUENCY	88.7 MHz

ELECTRICAL SPECIFICATIONS

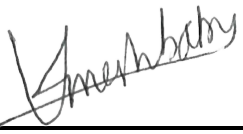
Polarization Type		Circular	
Polarization Ratio			
H-Pol. (PRH)		50.00	**%**
V-Pol. (PRV)		50.00	**%**
Elevation Directivity (ED)		2.991	
Azimuth Directivity (AD) H-Pol.		1.508	
Azimuth Directivity (AD) V-Pol.		1.508	
Antenna Efficiency		100.00	**%**
Antenna Gain (GH)			
H-Pol. (GH)		2.256	
V-Pol. (GV)		2.256	
dB Gain (AG)			
H-Pol (AGH)		3.533	**dB**
V-Pol (AGV)		3.533	**dB**
ERP			
H-Pol. (ERPH)		0.670	**kW**
V-Pol. (ERPV)		0.670	**kW**
Line Type		7/8" Foam	**LCF78-50JA**
Attenuation		0.320	**dB/100'**
Line length (LL) (Given)	**	235.00	**ft.**
Total line attenuation		0.752	**dB**
Line Efficiency (LE)		84.10	**%**
Line Loss (LPL)		0.056	**kW**
Antenna Input Power (AIP)		0.297	**kW**
Req'd. Transmitter Output Power		0.353	**kW**

MECHANICAL SPECIFICATIONS

No. Of Bays	3	**#**		
Center of Radiation AGL	197	**ft.**	60.04	**m**
Antenna Aperture	22.19	**ft.**	6.76	**m**
Antenna Total Length	26.69	**ft.**	8.14	**m**
Antenna Weight Excluding Brackets	195.00	**lbs.**	88.64	**kg**
Windload: 50/33 psf / CaAc	545.00	**lbs.**	14.99	**ft.^2**

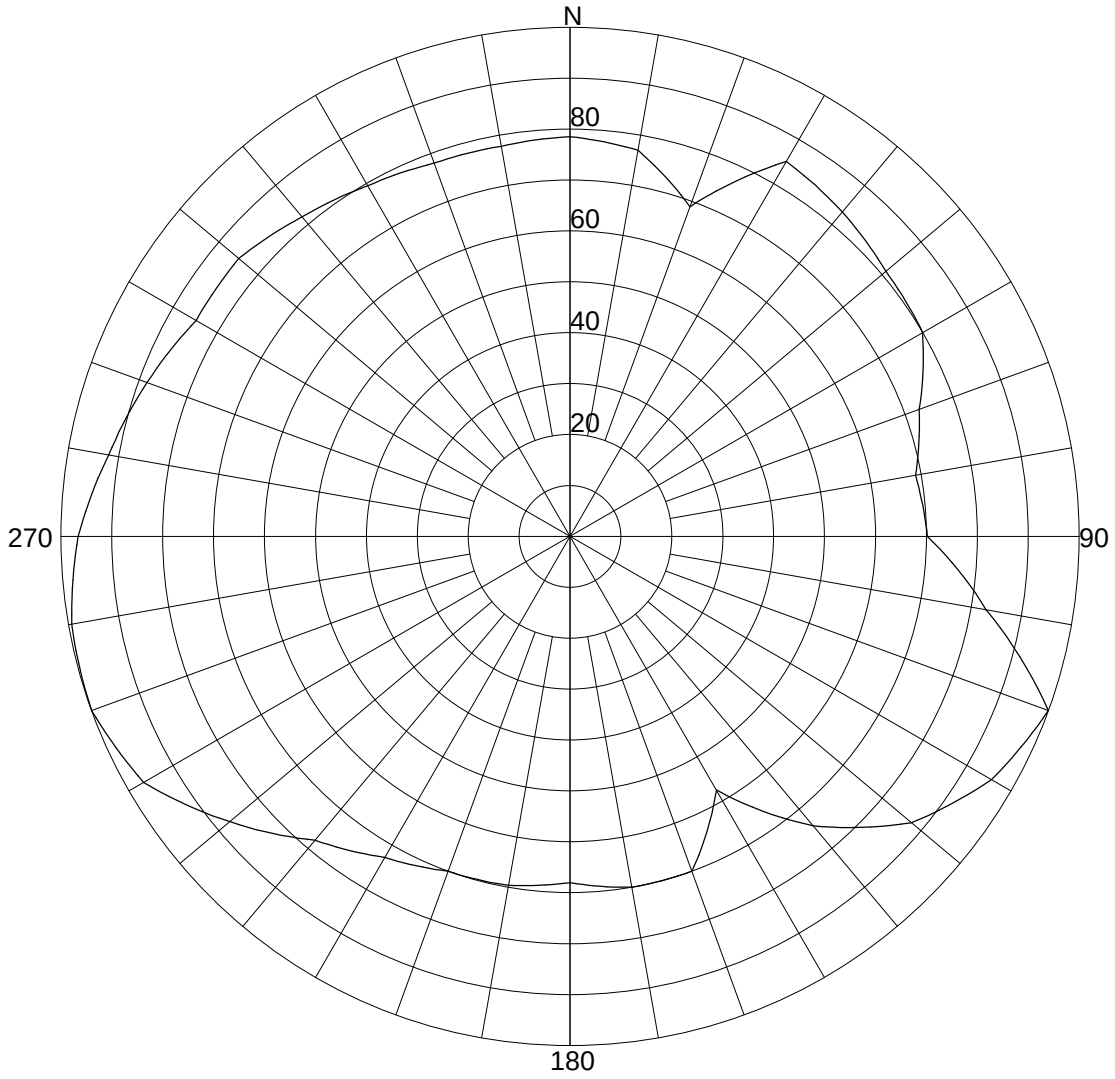
Specifications will be certified upon final construction and testing.
The given values can be used for system planning.

Prepared by:



Umesh Babu
Director of Engineering

WITM(COMPOSITE)



Azimuth Pattern

Scale: Linear

Unit: Relative Field

Systems With Reliability (SWR, L.P.)

CLIENT: *WITM(COMPOSITE)*

Date: 9/20/2022

ANTENNA TYPE: FMECRA/3-PLUS-DA

FREQUENCY: 88.7

PATTERN POL.: Circular

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 1.50825 / 1.78dB

PATTERN RMS: *0.814*

Relative Field Tabulation(Azimuth)

Azimuth Heading	Normalized Field(dB)	Azimuth Heading	Normalized Field(dB)
0	.7850 (-2.1)	180	.6800 (-3.35)
5	.7775 (-2.19)	185	.6880 (-3.25)
10	.7700 (-2.27)	190	.6960 (-3.15)
15	.7295 (-2.74)	195	.6980 (-3.12)
20	.6890 (-3.24)	200	.7000 (-3.1)
25	.7695 (-2.28)	205	.7140 (-2.93)
30	.8500 (-1.41)	210	.7280 (-2.76)
35	.8410 (-1.5)	215	.7535 (-2.46)
40	.8320 (-1.6)	220	.7790 (-2.17)
45	.8210 (-1.71)	225	.8255 (-1.67)
50	.8100 (-1.83)	230	.8720 (-1.19)
55	.8050 (-1.88)	235	.9195 (-0.73)
60	.8000 (-1.94)	240	.9670 (-0.29)
65	.7650 (-2.33)	245	.9835 (-0.14)
70	.7300 (-2.73)	250	1.0000 (0)
75	.7095 (-2.98)	255	.9970 (-0.03)
80	.6890 (-3.24)	260	.9940 (-0.05)
85	.6955 (-3.15)	265	.9800 (-0.18)
90	.7020 (-3.07)	270	.9660 (-0.3)
95	.7660 (-2.32)	275	.9430 (-0.51)
100	.8300 (-1.62)	280	.9200 (-0.72)
105	.9150 (-0.77)	285	.9020 (-0.9)
110	1.0000 (0)	290	.8840 (-1.07)
115	.9780 (-0.19)	295	.8660 (-1.25)
120	.9560 (-0.39)	300	.8480 (-1.43)
125	.9155 (-0.77)	305	.8485 (-1.43)
130	.8750 (-1.16)	310	.8490 (-1.42)
135	.8085 (-1.85)	315	.8340 (-1.58)
140	.7420 (-2.59)	320	.8190 (-1.73)
145	.6585 (-3.63)	325	.8070 (-1.86)
150	.5750 (-4.81)	330	.7950 (-1.99)
155	.6375 (-3.91)	335	.7875 (-2.07)
160	.7000 (-3.1)	340	.7800 (-2.16)
165	.7000 (-3.1)	345	.7790 (-2.17)
170	.7000 (-3.1)	350	.7780 (-2.18)
175	.6900 (-3.22)	355	.7815 (-2.14)

Systems With Reliability (SWR, L.P.)

CLIENT: *WITM(COMPOSITE)*

Date: 9/20/2022

ANTENNA TYPE: FMECRA/3-PLUS-DA

FREQUENCY: 88.7

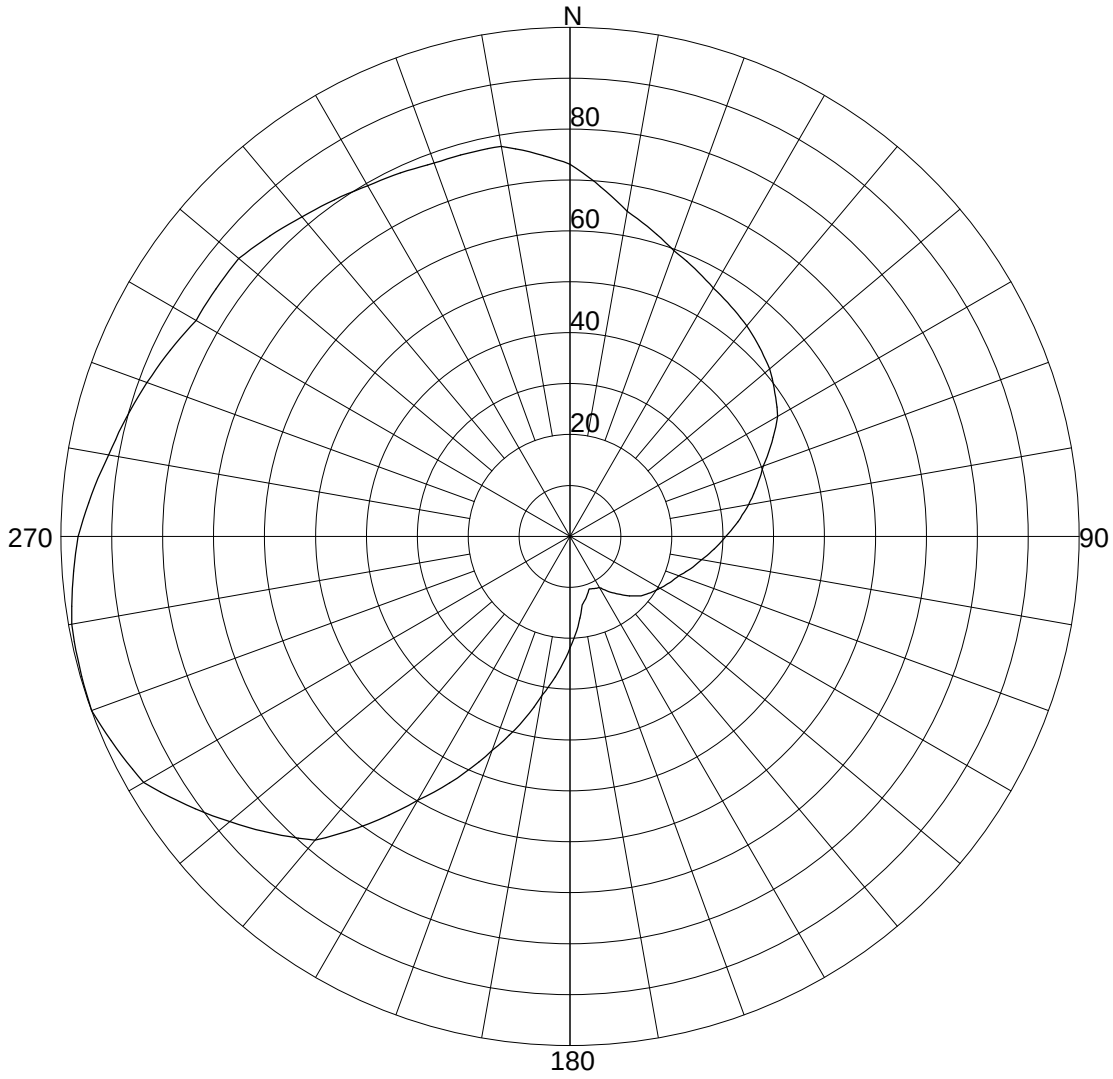
PATTERN POL.: Circular

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 1.50825 / 1.78dB

PATTERN RMS: *0.814*

WITM(VERTICAL)



Azimuth Pattern

Scale: Linear

Unit: Relative Field

Systems With Reliability (SWR, L.P.)

CLIENT: *WITM*

Date: 9/19/2022

ANTENNA TYPE: FMECRA/3-PLUS-DA

FREQUENCY: 88.7

PATTERN POL.: Vertical

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 2.47594 / 3.94dB

PATTERN RMS: *0.636*

Relative Field Tabulation(Azimuth)

Azimuth Heading	Normalized Field(dB)	Azimuth Heading	Normalized Field(dB)
0	.7310 (-2.72)	180	.2190 (-13.19)
5	.6895 (-3.23)	185	.2680 (-11.44)
10	.6480 (-3.77)	190	.3170 (-9.98)
15	.6225 (-4.12)	195	.3825 (-8.35)
20	.5970 (-4.48)	200	.4480 (-6.97)
25	.5800 (-4.73)	205	.5235 (-5.62)
30	.5630 (-4.99)	210	.5990 (-4.45)
35	.5515 (-5.17)	215	.6890 (-3.24)
40	.5400 (-5.35)	220	.7790 (-2.17)
45	.5260 (-5.58)	225	.8255 (-1.67)
50	.5120 (-5.81)	230	.8720 (-1.19)
55	.4915 (-6.17)	235	.9195 (-0.73)
60	.4710 (-6.54)	240	.9670 (-0.29)
65	.4375 (-7.18)	245	.9835 (-0.14)
70	.4040 (-7.87)	250	1.0000 (0)
75	.3800 (-8.4)	255	.9970 (-0.03)
80	.3560 (-8.97)	260	.9940 (-0.05)
85	.3310 (-9.6)	265	.9800 (-0.18)
90	.3060 (-10.29)	270	.9660 (-0.3)
95	.2845 (-10.92)	275	.9430 (-0.51)
100	.2630 (-11.6)	280	.9200 (-0.72)
105	.2450 (-12.22)	285	.9020 (-0.9)
110	.2270 (-12.88)	290	.8840 (-1.07)
115	.2155 (-13.33)	295	.8660 (-1.25)
120	.2040 (-13.81)	300	.8480 (-1.43)
125	.1930 (-14.29)	305	.8485 (-1.43)
130	.1820 (-14.8)	310	.8490 (-1.42)
135	.1650 (-15.65)	315	.8340 (-1.58)
140	.1480 (-16.59)	320	.8190 (-1.73)
145	.1320 (-17.59)	325	.8070 (-1.86)
150	.1160 (-18.71)	330	.7950 (-1.99)
155	.1130 (-18.94)	335	.7875 (-2.07)
160	.1100 (-19.17)	340	.7800 (-2.16)
165	.1235 (-18.17)	345	.7790 (-2.17)
170	.1370 (-17.27)	350	.7780 (-2.18)
175	.1780 (-14.99)	355	.7545 (-2.45)

Systems With Reliability (SWR, L.P.)

CLIENT: *WITM*

Date: 9/19/2022

ANTENNA TYPE: FMECRA/3-PLUS-DA

FREQUENCY: 88.7

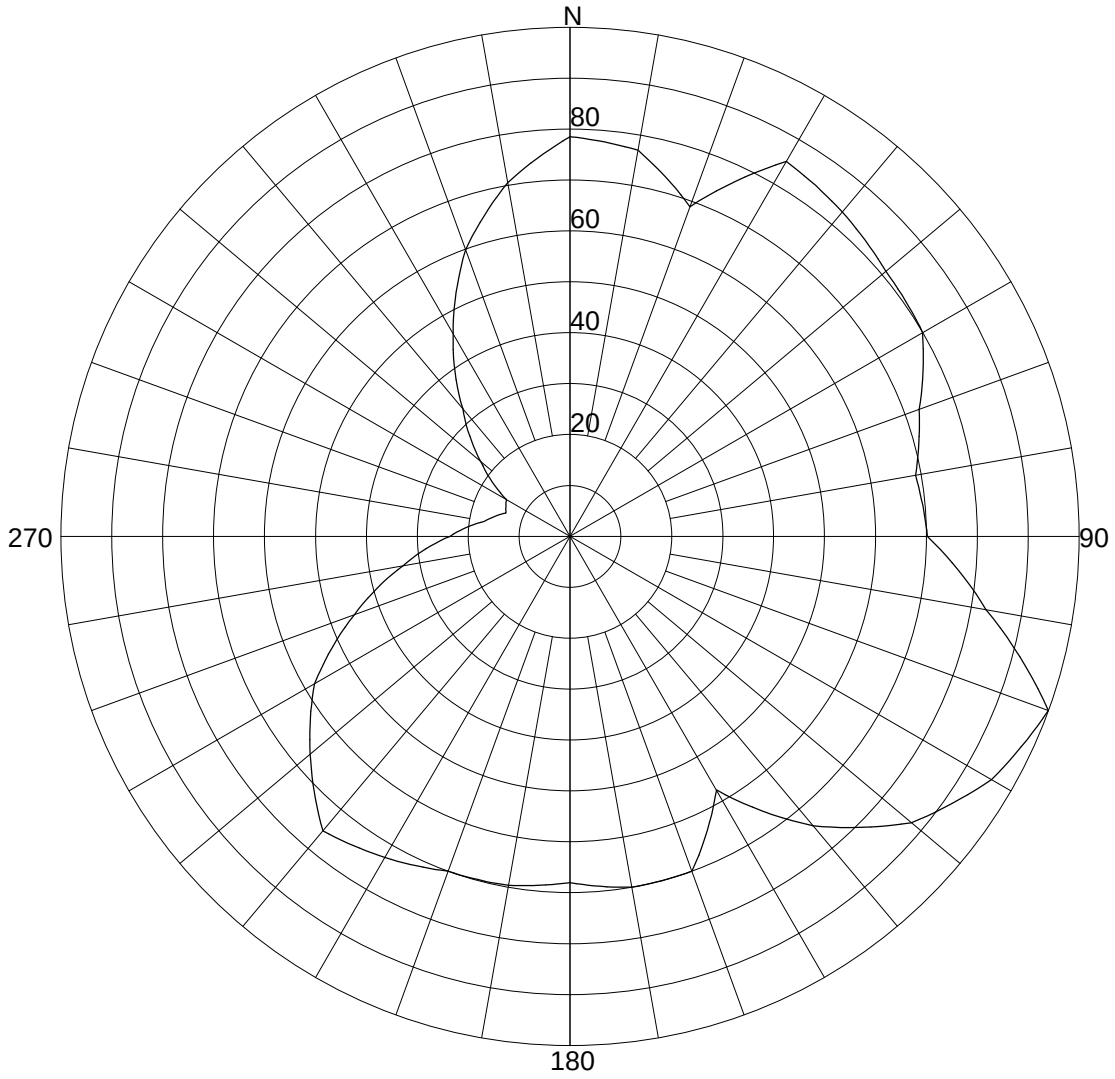
PATTERN POL.: Vertical

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 2.47594 / 3.94dB

PATTERN RMS: *0.636*

WITM(HORIZONTAL)



Azimuth Pattern

Scale: Linear

Unit: Relative Field

Systems With Reliability (SWR, L.P.)

Date: 9/19/2022

CLIENT: *WITM*

ANTENNA TYPE: FMECRA/3-PLUS-DA

FREQUENCY: 88.7

PATTERN POL.: Horizontal

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 2.24201 / 3.51dB

PATTERN RMS: *0.668*

Relative Field Tabulation(Azimuth)

Azimuth Heading	Normalized Field(dB)	Azimuth Heading	Normalized Field(dB)
0	.7850 (-2.1)	180	.6800 (-3.35)
5	.7775 (-2.19)	185	.6880 (-3.25)
10	.7700 (-2.27)	190	.6960 (-3.15)
15	.7295 (-2.74)	195	.6980 (-3.12)
20	.6890 (-3.24)	200	.7000 (-3.1)
25	.7695 (-2.28)	205	.7140 (-2.93)
30	.8500 (-1.41)	210	.7280 (-2.76)
35	.8410 (-1.5)	215	.7415 (-2.6)
40	.8320 (-1.6)	220	.7550 (-2.44)
45	.8210 (-1.71)	225	.7105 (-2.97)
50	.8100 (-1.83)	230	.6660 (-3.53)
55	.8050 (-1.88)	235	.6225 (-4.12)
60	.8000 (-1.94)	240	.5790 (-4.75)
65	.7650 (-2.33)	245	.5150 (-5.76)
70	.7300 (-2.73)	250	.4510 (-6.92)
75	.7095 (-2.98)	255	.3920 (-8.13)
80	.6890 (-3.24)	260	.3330 (-9.55)
85	.6955 (-3.15)	265	.2845 (-10.92)
90	.7020 (-3.07)	270	.2360 (-12.54)
95	.7660 (-2.32)	275	.2035 (-13.83)
100	.8300 (-1.62)	280	.1710 (-15.34)
105	.9150 (-0.77)	285	.1525 (-16.33)
110	1.0000 (0)	290	.1340 (-17.46)
115	.9780 (-0.19)	295	.1390 (-17.14)
120	.9560 (-0.39)	300	.1440 (-16.83)
125	.9155 (-0.77)	305	.1865 (-14.59)
130	.8750 (-1.16)	310	.2290 (-12.8)
135	.8085 (-1.85)	315	.2785 (-11.1)
140	.7420 (-2.59)	320	.3280 (-9.68)
145	.6585 (-3.63)	325	.3935 (-8.1)
150	.5750 (-4.81)	330	.4590 (-6.76)
155	.6375 (-3.91)	335	.5290 (-5.53)
160	.7000 (-3.1)	340	.5990 (-4.45)
165	.7000 (-3.1)	345	.6520 (-3.72)
170	.7000 (-3.1)	350	.7050 (-3.04)
175	.6900 (-3.22)	355	.7450 (-2.56)

Systems With Reliability (SWR, L.P.)

CLIENT: *WITM*

Date: 9/19/2022

ANTENNA TYPE: FMECRA/3-PLUS-DA

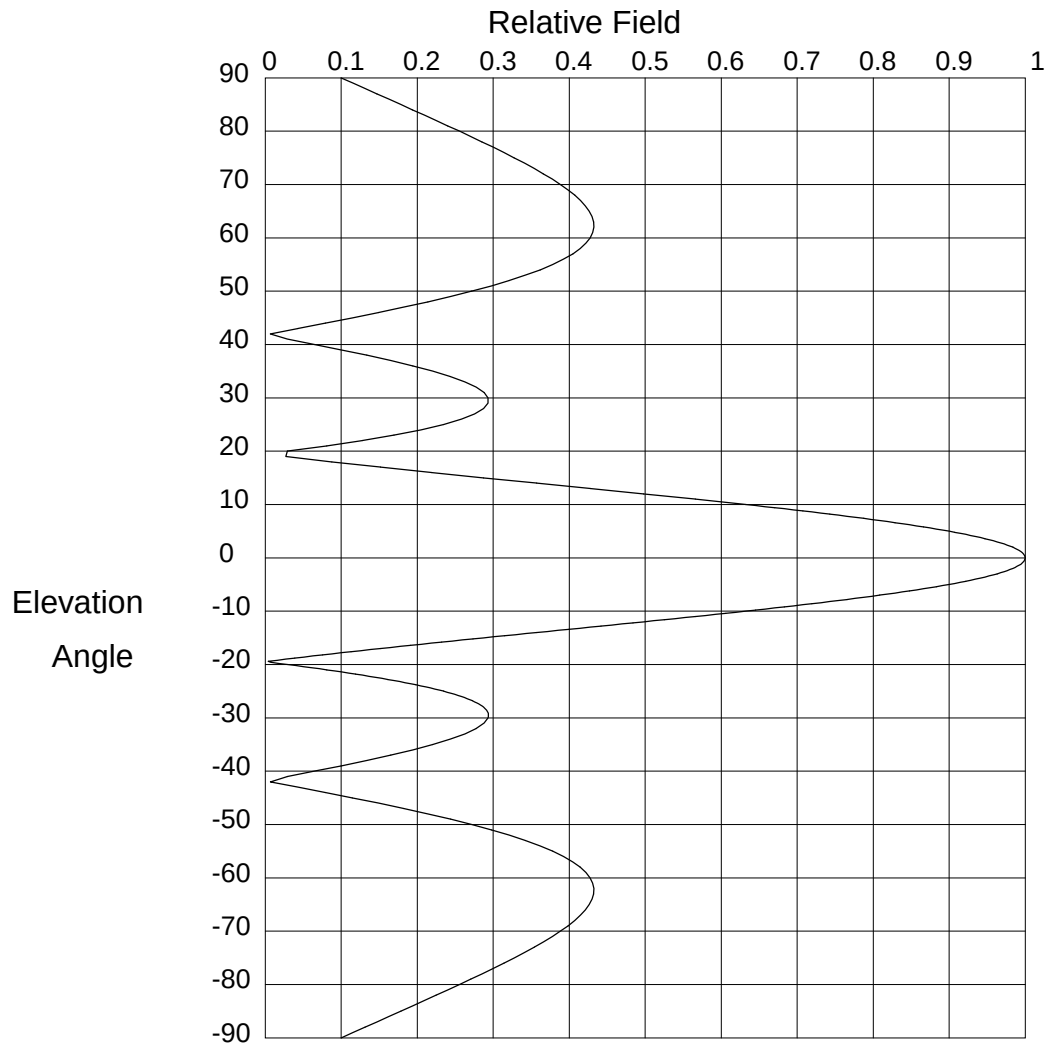
FREQUENCY: 88.7

PATTERN POL.: Horizontal

CIRCULARITY(+/-dB):

AZ. DIRECTIVITY: 2.24201 / 3.51dB

PATTERN RMS: *0.668*



Elevation Pattern

Scale: Linear

Units: Field, Relative

Systems With Reliability (SWR, L.P.)

CLIENT: *WITM*

Date: 2/2/2022

ANTENNA TYPE: FMECRA/3-PLUS-DA

FREQUENCY: 88.7

PATTERN POL.: Circular

DIRECTIVITY(Peak): 2.991/4.758 dBd

Beam Tilt (Deg.) : *0*

DIRECTIVITY(Horiz): 2.991/4.758 dBd

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

Relative Field Tabulation

Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)
90.0	.10 (-20)	52.0	.321 (-9.865)	14.0	.357 (-8.938)
89.0	.116 (-18.733)	51.0	.298 (-10.529)	13.0	.428 (-7.377)
88.0	.131 (-17.628)	50.0	.272 (-11.318)	12.0	.498 (-6.062)
87.0	.147 (-16.648)	49.0	.244 (-12.26)	11.0	.566 (-4.942)
86.0	.163 (-15.769)	48.0	.214 (-13.395)	10.0	.632 (-3.982)
85.0	.178 (-14.972)	47.0	.182 (-14.784)	9.8	.645 (-3.807)
84.0	.194 (-14.244)	46.0	.149 (-16.526)	9.6	.658 (-3.637)
83.0	.21 (-13.575)	45.0	.115 (-18.805)	9.4	.671 (-3.472)
82.0	.225 (-12.957)	44.0	.079 (-22.009)	9.2	.683 (-3.312)
81.0	.24 (-12.385)	43.0	.043 (-27.275)	9.0	.695 (-3.157)
80.0	.256 (-11.852)	42.0	.007 (-43.22)	8.8	.707 (-3.006)
79.0	.271 (-11.356)	41.0	.029 (-30.637)	8.6	.719 (-2.86)
78.0	.285 (-10.893)	40.0	.065 (-23.719)	8.4	.731 (-2.719)
77.0	.30 (-10.462)	39.0	.10 (-19.999)	8.2	.743 (-2.582)
76.0	.314 (-10.06)	38.0	.133 (-17.494)	8.0	.754 (-2.449)
75.0	.328 (-9.686)	37.0	.165 (-15.651)	7.8	.766 (-2.321)
74.0	.341 (-9.339)	36.0	.194 (-14.237)	7.6	.777 (-2.196)
73.0	.354 (-9.018)	35.0	.22 (-13.132)	7.4	.787 (-2.076)
72.0	.366 (-8.724)	34.0	.243 (-12.271)	7.2	.798 (-1.959)
71.0	.378 (-8.455)	33.0	.263 (-11.612)	7.0	.808 (-1.847)
70.0	.389 (-8.211)	32.0	.278 (-11.131)	6.8	.819 (-1.738)
69.0	.398 (-7.995)	31.0	.288 (-10.815)	6.6	.829 (-1.633)
68.0	.407 (-7.804)	30.0	.293 (-10.658)	6.4	.838 (-1.532)
67.0	.415 (-7.642)	29.0	.293 (-10.662)	6.2	.848 (-1.434)
66.0	.421 (-7.507)	28.0	.287 (-10.834)	6.0	.857 (-1.34)
65.0	.426 (-7.403)	27.0	.276 (-11.192)	5.8	.866 (-1.249)
64.0	.43 (-7.329)	26.0	.258 (-11.764)	5.6	.875 (-1.162)
63.0	.432 (-7.287)	25.0	.234 (-12.598)	5.4	.883 (-1.078)
62.0	.432 (-7.281)	24.0	.205 (-13.772)	5.2	.891 (-0.998)
61.0	.431 (-7.31)	23.0	.169 (-15.43)	5.0	.899 (-0.921)
60.0	.428 (-7.38)	22.0	.128 (-17.86)	4.8	.907 (-0.847)
59.0	.422 (-7.491)	21.0	.081 (-21.813)	4.6	.914 (-0.777)
58.0	.415 (-7.648)	20.0	.029 (-30.657)	4.4	.922 (-0.709)
57.0	.405 (-7.856)	19.0	.027 (-31.323)	4.2	.928 (-0.645)
56.0	.393 (-8.119)	18.0	.088 (-21.139)	4.0	.935 (-0.584)
55.0	.378 (-8.442)	17.0	.152 (-16.379)	3.8	.941 (-0.527)
54.0	.362 (-8.835)	16.0	.219 (-13.21)	3.6	.947 (-0.472)
53.0	.343 (-9.305)	15.0	.287 (-10.833)	3.4	.953 (-0.421)

Systems With Reliability (SWR, L.P.)

CLIENT: *WITM*

Date: 2/2/2022

ANTENNA TYPE: FMECRA/3-PLUS-DA

FREQUENCY: 88.7

PATTERN POL.: Circular

DIRECTIVITY(Peak): 2.991/4.758 dBd

Beam Tilt (Deg.) : *0*

DIRECTIVITY(Horiz): 2.991/4.758 dBd

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

Relative Field Tabulation

Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)
3.2	.958 (-0.372)	-4.4	.922 (-0.709)	-12.0	.498 (-6.062)
3.0	.963 (-0.327)	-4.6	.914 (-0.777)	-12.2	.484 (-6.308)
2.8	.968 (-0.284)	-4.8	.907 (-0.847)	-12.4	.47 (-6.562)
2.6	.972 (-0.245)	-5.0	.899 (-0.921)	-12.6	.456 (-6.825)
2.4	.976 (-0.208)	-5.2	.891 (-0.998)	-12.8	.442 (-7.096)
2.2	.98 (-0.175)	-5.4	.883 (-1.078)	-13.0	.428 (-7.377)
2.0	.983 (-0.145)	-5.6	.875 (-1.162)	-13.2	.414 (-7.667)
1.8	.987 (-0.117)	-5.8	.866 (-1.249)	-13.4	.40 (-7.968)
1.6	.989 (-0.092)	-6.0	.857 (-1.34)	-13.6	.385 (-8.28)
1.4	.992 (-0.071)	-6.2	.848 (-1.434)	-13.8	.371 (-8.603)
1.2	.994 (-0.052)	-6.4	.838 (-1.532)	-14.0	.357 (-8.938)
1.0	.996 (-0.036)	-6.6	.829 (-1.633)	-14.2	.343 (-9.287)
.8	.997 (-0.023)	-6.8	.819 (-1.738)	-14.4	.329 (-9.65)
.6	.999 (-0.013)	-7.0	.808 (-1.847)	-14.6	.315 (-10.027)
.4	.999 (-0.006)	-7.2	.798 (-1.959)	-14.8	.301 (-10.421)
.2	1.00 (-0.001)	-7.4	.787 (-2.076)	-15.0	.287 (-10.833)
.0	1.00 (0)	-7.6	.777 (-2.196)	-15.2	.273 (-11.263)
-.2	1.00 (-0.001)	-7.8	.766 (-2.321)	-15.4	.26 (-11.714)
-.4	.999 (-0.006)	-8.0	.754 (-2.449)	-15.6	.246 (-12.187)
-.6	.999 (-0.013)	-8.2	.743 (-2.582)	-15.8	.232 (-12.685)
-.8	.997 (-0.023)	-8.4	.731 (-2.719)	-16.0	.219 (-13.21)
-1.0	.996 (-0.036)	-8.6	.719 (-2.86)	-16.2	.205 (-13.766)
-1.2	.994 (-0.052)	-8.8	.707 (-3.006)	-16.4	.192 (-14.356)
-1.4	.992 (-0.071)	-9.0	.695 (-3.157)	-16.6	.178 (-14.984)
-1.6	.989 (-0.092)	-9.2	.683 (-3.312)	-16.8	.165 (-15.656)
-1.8	.987 (-0.117)	-9.4	.671 (-3.472)	-17.0	.152 (-16.379)
-2.0	.983 (-0.145)	-9.6	.658 (-3.637)	-17.2	.139 (-17.16)
-2.2	.98 (-0.175)	-9.8	.645 (-3.807)	-17.4	.126 (-18.01)
-2.4	.976 (-0.208)	-10.0	.632 (-3.982)	-17.6	.113 (-18.943)
-2.6	.972 (-0.245)	-10.2	.619 (-4.163)	-17.8	.10 (-19.978)
-2.8	.968 (-0.284)	-10.4	.606 (-4.349)	-18.0	.088 (-21.139)
-3.0	.963 (-0.327)	-10.6	.593 (-4.541)	-18.2	.075 (-22.464)
-3.2	.958 (-0.372)	-10.8	.58 (-4.739)	-18.4	.063 (-24.008)
-3.4	.953 (-0.421)	-11.0	.566 (-4.942)	-18.6	.051 (-25.862)
-3.6	.947 (-0.472)	-11.2	.553 (-5.153)	-18.8	.039 (-28.188)
-3.8	.941 (-0.527)	-11.4	.539 (-5.37)	-19.0	.027 (-31.323)
-4.0	.935 (-0.584)	-11.6	.525 (-5.593)	-19.2	.016 (-36.185)
-4.2	.928 (-0.645)	-11.8	.511 (-5.824)	-19.4	.004 (-47.865)

Systems With Reliability (SWR, L.P.)

CLIENT: *WITM*

Date: 2/2/2022

ANTENNA TYPE: FMECRA/3-PLUS-DA

FREQUENCY: 88.7

PATTERN POL.: Circular

DIRECTIVITY(Peak): 2.991/4.758 dBd

Beam Tilt (Deg.) : *0*

DIRECTIVITY(Horiz): 2.991/4.758 dBd

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

Relative Field Tabulation

Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)	Elev. Angle	Rel. Fld(dB)
-19.6	.007 (-42.787)	-27.2	.278 (-11.104)	-54.0	.362 (-8.835)
-19.8	.018 (-34.715)	-27.4	.281 (-11.025)	-55.0	.378 (-8.442)
-20.0	.029 (-30.657)	-27.6	.283 (-10.953)	-56.0	.393 (-8.119)
-20.2	.04 (-27.943)	-27.8	.285 (-10.89)	-57.0	.405 (-7.856)
-20.4	.051 (-25.91)	-28.0	.287 (-10.834)	-58.0	.415 (-7.648)
-20.6	.061 (-24.292)	-28.2	.289 (-10.785)	-59.0	.422 (-7.491)
-20.8	.071 (-22.952)	-28.4	.29 (-10.744)	-60.0	.428 (-7.38)
-21.0	.081 (-21.813)	-28.6	.291 (-10.71)	-61.0	.431 (-7.31)
-21.2	.091 (-20.825)	-28.8	.292 (-10.682)	-62.0	.432 (-7.281)
-21.4	.101 (-19.956)	-29.0	.293 (-10.662)	-63.0	.432 (-7.287)
-21.6	.11 (-19.183)	-29.2	.293 (-10.648)	-64.0	.43 (-7.329)
-21.8	.119 (-18.489)	-29.4	.294 (-10.641)	-65.0	.426 (-7.403)
-22.0	.128 (-17.86)	-29.6	.294 (-10.64)	-66.0	.421 (-7.507)
-22.2	.137 (-17.288)	-29.8	.294 (-10.646)	-67.0	.415 (-7.642)
-22.4	.145 (-16.765)	-30.0	.293 (-10.658)	-68.0	.407 (-7.804)
-22.6	.153 (-16.284)	-31.0	.288 (-10.815)	-69.0	.398 (-7.995)
-22.8	.161 (-15.84)	-32.0	.278 (-11.131)	-70.0	.389 (-8.211)
-23.0	.169 (-15.43)	-33.0	.263 (-11.612)	-71.0	.378 (-8.455)
-23.2	.177 (-15.049)	-34.0	.243 (-12.271)	-72.0	.366 (-8.724)
-23.4	.184 (-14.695)	-35.0	.22 (-13.132)	-73.0	.354 (-9.018)
-23.6	.191 (-14.366)	-36.0	.194 (-14.237)	-74.0	.341 (-9.339)
-23.8	.198 (-14.059)	-37.0	.165 (-15.651)	-75.0	.328 (-9.686)
-24.0	.205 (-13.772)	-38.0	.133 (-17.494)	-76.0	.314 (-10.06)
-24.2	.211 (-13.505)	-39.0	.10 (-19.999)	-77.0	.30 (-10.462)
-24.4	.217 (-13.254)	-40.0	.065 (-23.719)	-78.0	.285 (-10.893)
-24.6	.223 (-13.021)	-41.0	.029 (-30.637)	-79.0	.271 (-11.356)
-24.8	.229 (-12.802)	-42.0	.007 (-43.22)	-80.0	.256 (-11.852)
-25.0	.234 (-12.598)	-43.0	.043 (-27.275)	-81.0	.24 (-12.385)
-25.2	.24 (-12.407)	-44.0	.079 (-22.009)	-82.0	.225 (-12.957)
-25.4	.245 (-12.229)	-45.0	.115 (-18.805)	-83.0	.21 (-13.575)
-25.6	.249 (-12.063)	-46.0	.149 (-16.526)	-84.0	.194 (-14.244)
-25.8	.254 (-11.908)	-47.0	.182 (-14.784)	-85.0	.178 (-14.972)
-26.0	.258 (-11.764)	-48.0	.214 (-13.395)	-86.0	.163 (-15.769)
-26.2	.262 (-11.63)	-49.0	.244 (-12.26)	-87.0	.147 (-16.648)
-26.4	.266 (-11.507)	-50.0	.272 (-11.318)	-88.0	.131 (-17.628)
-26.6	.269 (-11.393)	-51.0	.298 (-10.529)	-89.0	.116 (-18.733)
-26.8	.273 (-11.288)	-52.0	.321 (-9.865)	-90.0	.10 (-20)
-27.0	.276 (-11.192)	-53.0	.343 (-9.305)	90.0	.00 (-50)

Systems With Reliability (SWR, L.P.)

CLIENT: *WITM*

Date: 2/2/2022

ANTENNA TYPE: FMECRA/3-PLUS-DA

FREQUENCY: 88.7

PATTERN POL.: Circular

DIRECTIVITY(Peak): 2.991/4.758 dBd

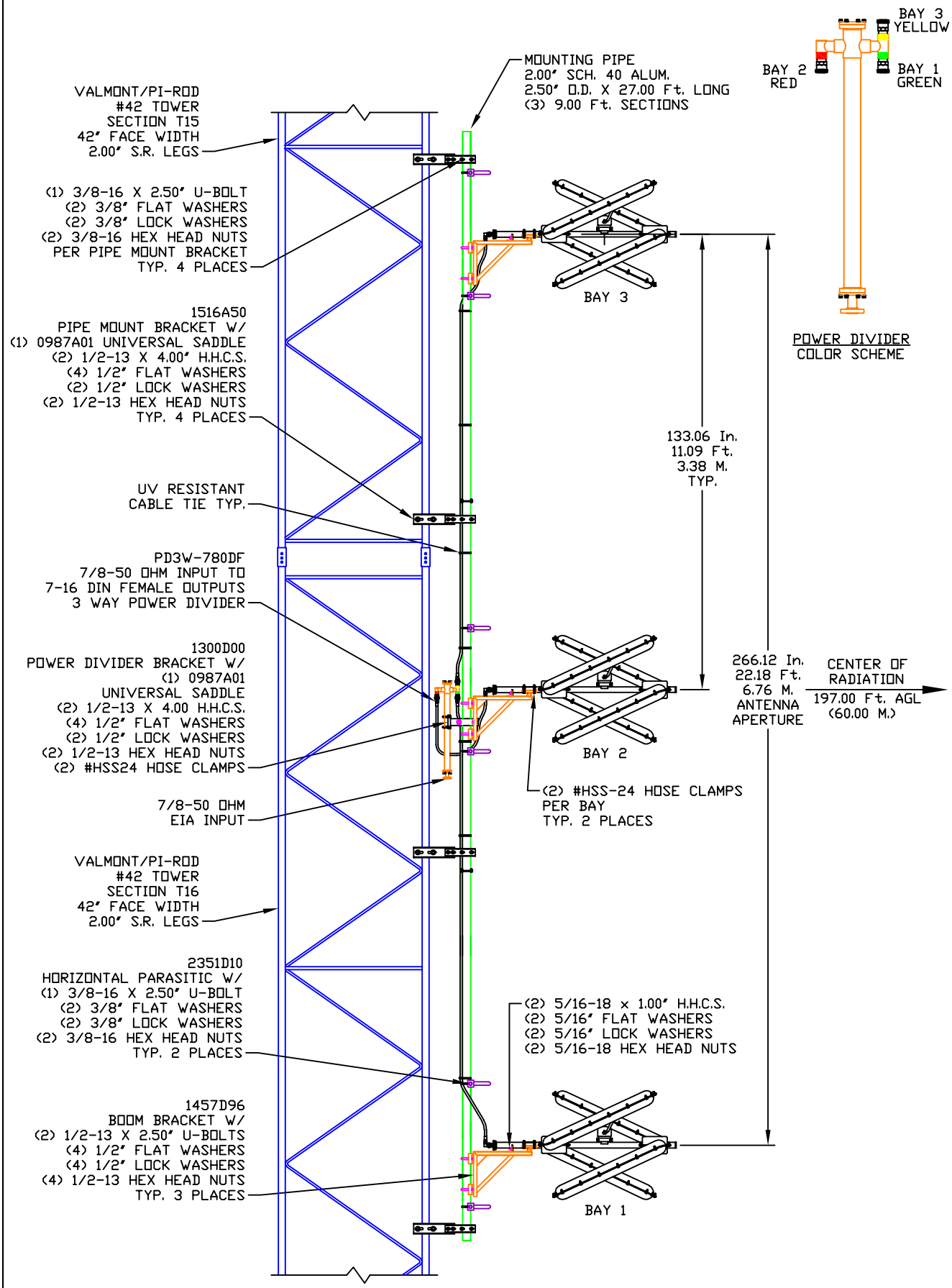
Beam Tilt (Deg.) : *0*

DIRECTIVITY(Horiz): 2.991/4.758 dBd

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

S.O. #22210

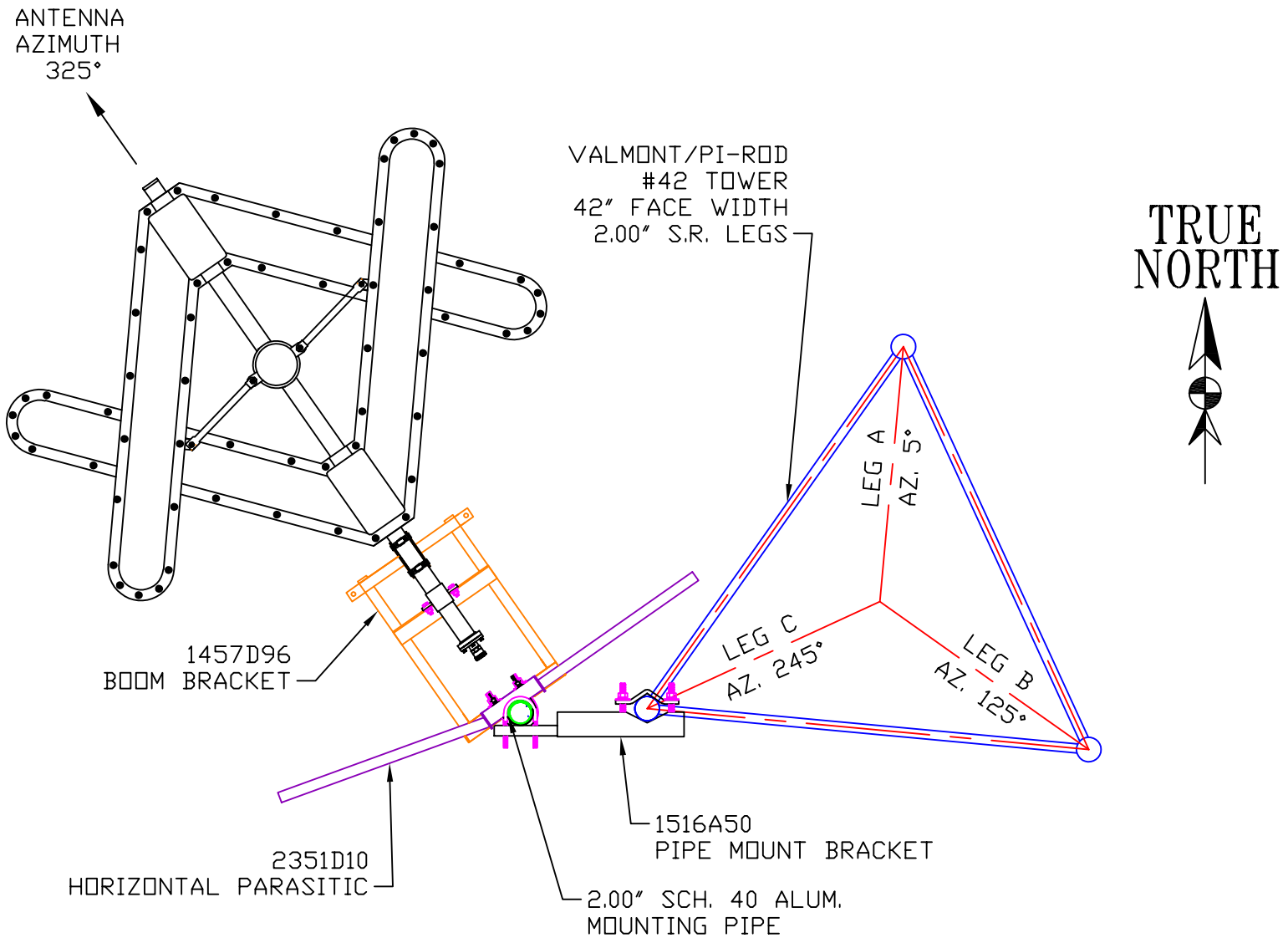
DRAWING NUMBER: 2351D00



SYSTEMS WITH RELIABILITY, LP 619 INDUSTRIAL PARK ROAD EBENSBURG, PENNSYLVANIA 15931	TITLE: FMECRA/3-PLUS-DA, FREQ. 88.7 WITM, WEST FRANKFORT, IL MATERIAL:	SIZE C	REV 1 2 3	APPR.	DATE	ENGINEER:	DRAWING NUMBER: 2351D00
						SCALE: NTS NAME: BJH DATE: 9/30/22	SHEET 1 OF 1

NOTE:

DRAWING NUMBER: 2351D01



REVISION RECORD		
REV	APPROVAL	DATE

SYSTEMS WITH RELIABILITY, LP
619 INDUSTRIAL PARK ROAD
EBENSBURG, PENNSYLVANIA 15931

TITLE: FMECRA/3-PLUS-DA, FREQ. 88.7
WITM, WEST FRANKFORT, IL

MATERIAL: ANTENNA ORIENTATION
FROM TRUE NORTH

SIZE: A

PARTS MADE BY THIS DRAWING

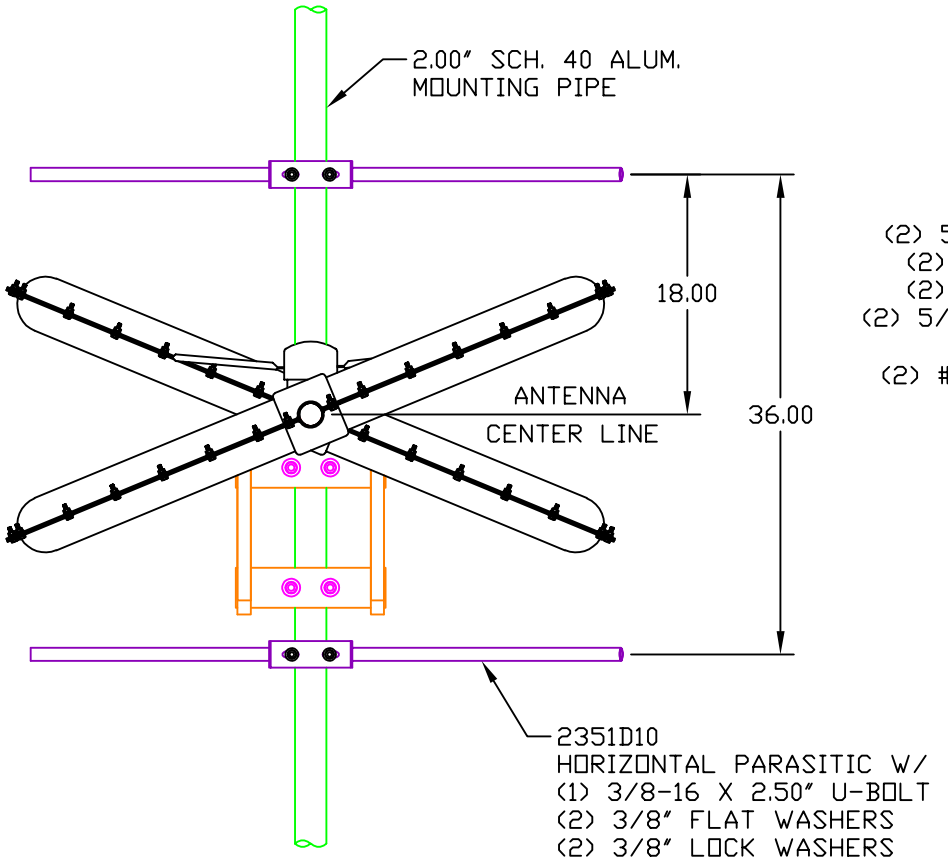
DRAWING NUMBER: 2351D01

SCALE: NTS | NAME: BJH | DATE: 9/30/22 | SHEET 1 OF 1

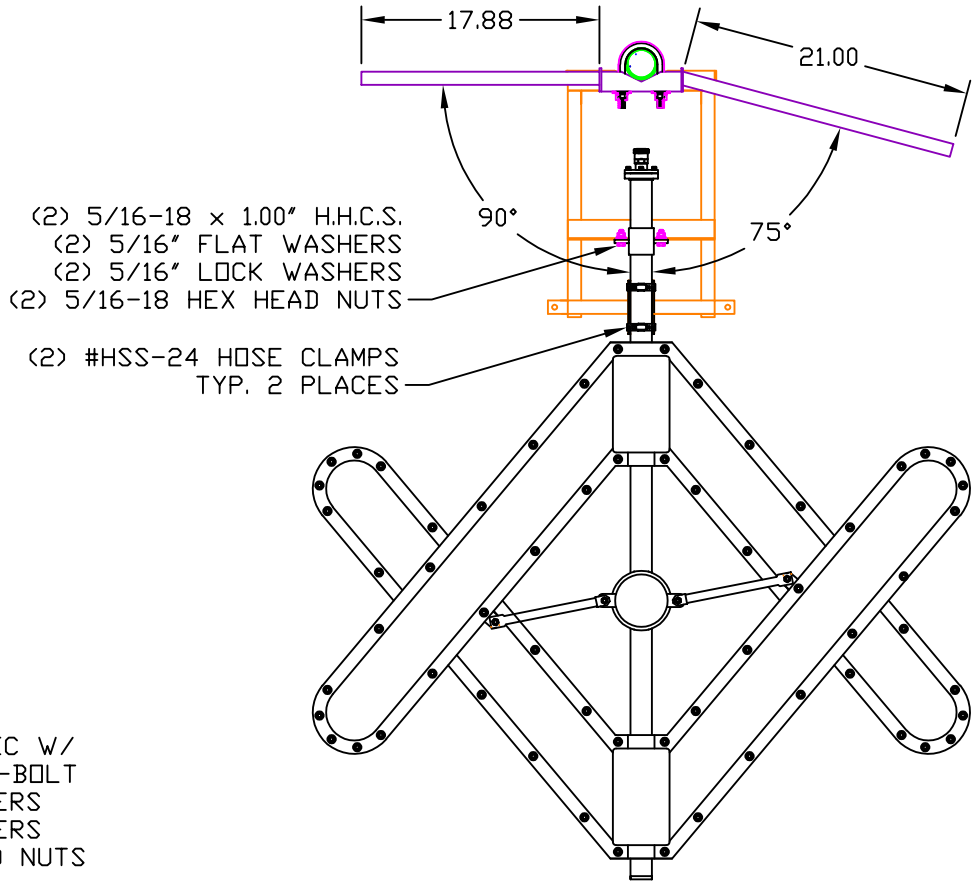
NOTE:

THIS ASSEMBLY IS TYPICAL FOR ALL BAYS.

DRAWING NUMBER: 2351D02



FRONT VIEW



TOP VIEW

REVISION RECORD		
REV	APPROVAL	DATE

SYSTEMS WITH RELIABILITY, LP
619 INDUSTRIAL PARK ROAD
EBENSBURG, PENNSYLVANIA 15931

TITLE: FMECRA/3-PLUS-DA, FREQ. 88.7
WITM, WEST FRANKFORT, IL

MATERIAL: PARASITIC
PLACEMENT

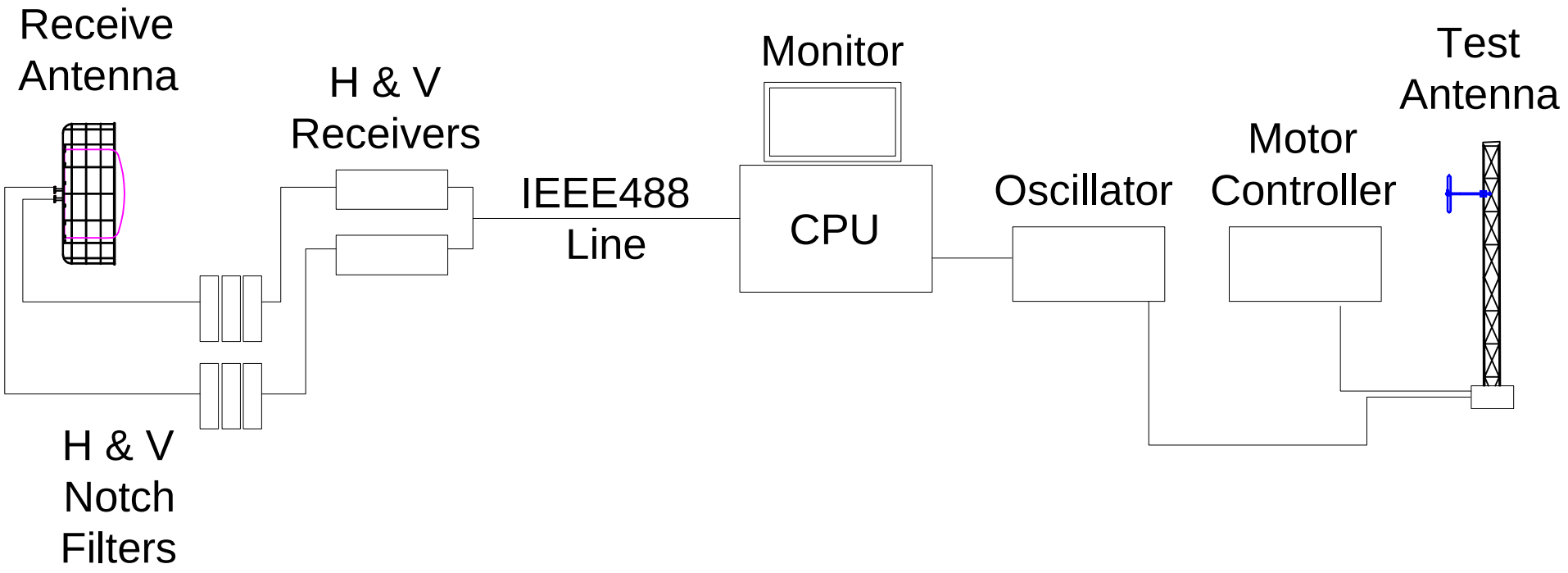
SIZE: A

PARTS MADE BY THIS DRAWING

DRAWING NUMBER: 2351D02

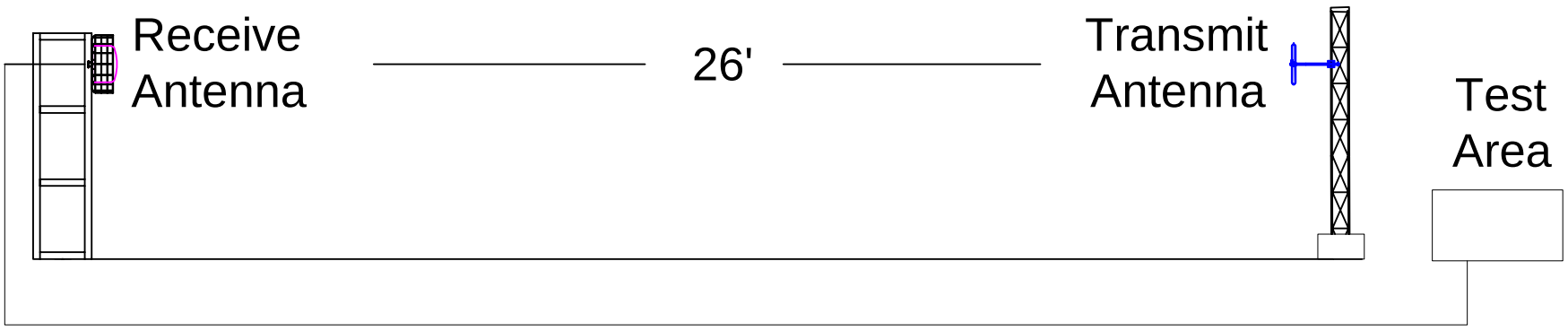
SCALE: NTS | NAME: BJH | DATE: 9/30/22 | SHEET 1 OF 1

SYSTEM BLOCK DIAGRAM



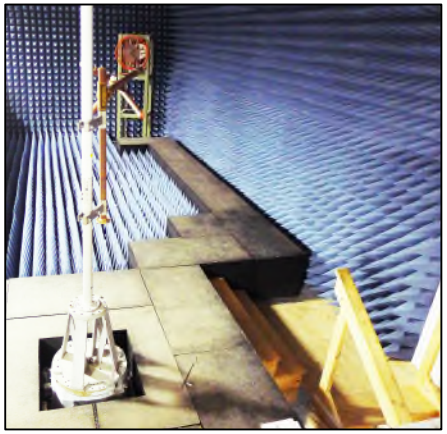
1/3 SCALE TEST RANGE

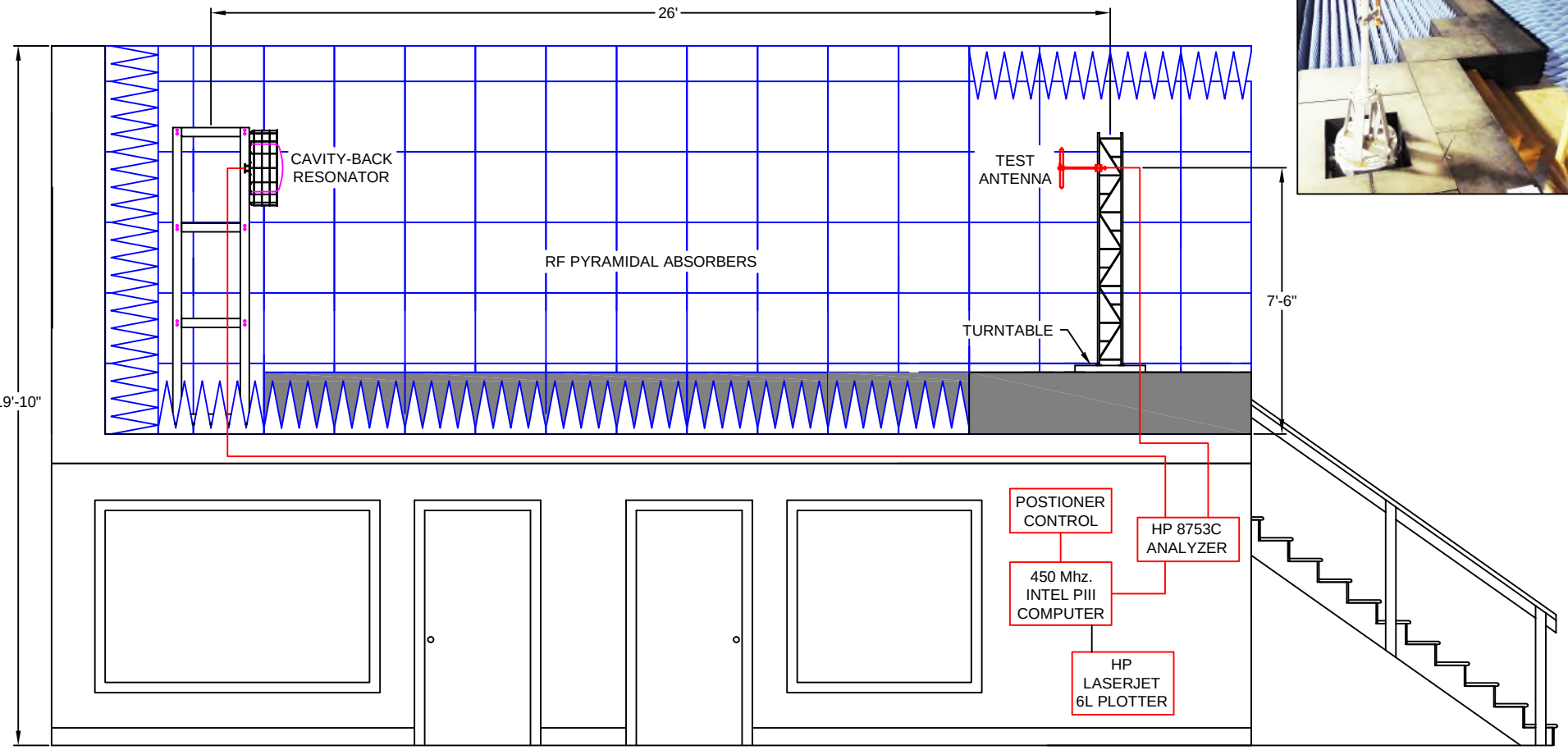
Anechoic Chamber



NOTE:

DRAWING NUMBER: 2105A15





TOLERANCES	
.X	± .015
.XX	± .005
.XXX	± .002
X/X	± 1/32
DEG.	± 1/2

UNLESS OTHERWISE SPECIFIED

REVISION RECORD

REV	APPROVAL	DATE

SYSTEMS WITH RELIABILITY, LP
619 INDUSTRIAL PARK ROAD
EBENSBURG, PENNSYLVANIA 15931

TITLE: TEST RANGE SCHEMATIC

MATERIAL:

SIZE A

PARTS MADE BY THIS DRAWING

DRAWING NUMBER: 2105A15

SCALE: NTS | NAME: BJH | DATE: 10/21/20 | SHEET 1 OF 1