
FM DIRECTIONAL BROADCAST ANTENNA
PROOF-OF-PERFORMANCE

MODEL JFCB-2-1-2-1(6) DA

SERIAL NUMBER 19123-A

WRFE

Chesterfield, S.C.



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DATE: February 05, 2018

| | | |
|---------------------|---------------|---------------|
| ANTENNA GAIN | <u>H-pol</u> | <u>V-pol</u> |
| relative | 5.55 | 5.10 |
| (dBd) | (7.45) | (7.08) |

RMS OF THE
AZIMUTH PATTERNS:

FM ANTENNA FOR:

STATION: **WRFE**

LOCATION: **Chesterfield, SC**

MODEL NUMBER: JFCB-2-1-2-1(6) DA

FREQUENCY & ERP: **89.3MHz, 50 kW**

ANTENNA INPUT POWER: **9.01 kW**

ANTENNA BOOM HEADING: **See Dwgs.**

| | | |
|-----------|-------|-------|
| Composite | H-pol | V-pol |
|-----------|-------|-------|

| | | |
|--------------|--------------|--------------|
| 0.554 | 0.549 | 0.529 |
|--------------|--------------|--------------|

CERTIFICATION

This certification, along with the accompanying antenna specification sheet, antenna mounting sketches, and azimuth and elevation patterns, certifies the construction and measurement of the *JAMPRO* FM CP antenna to the station's requirements, as measured at the *JAMPRO* antenna site in Sacramento, California. The following is an outline of construction methods, pattern measurements, installation requirements, recommended maintenance and equipment used.

CONSTRUCTION

A standard CP FM panel antenna model was used and parasitic reflectors were added to create the required directional patterns. In this model the parasitic reflectors are integral to the antenna panel. These panels were mounted in accordance with the geometry used by full wave analysis software (HFSS) to predict the final radiation pattern. The azimuth patterns of the assembly were electrically measured using the techniques described below. Adjustments in the panel positions were made to produce the required final results. Measurements of critical lengths to establish the exact location of the panels are shown on the antenna mounting sketches.



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MEASUREMENT

One bay (two levels) of the full scale antenna was mounted on an exact duplicate of its final support at the station. This constituted half of the final array. We were careful to duplicate conduits, cables and anything peculiar to this mounting. This was then placed on an outdoor turntable at the JAMPRO factory. This directional antenna was used for receiving the radiation from a transmitting antenna that was elevated 45 feet above ground and located at a distance of 100 feet. This transmitting antenna is capable of transmitting either horizontal or vertical polarization. A vector network analyzer (VNA) operating under the control of a proprietary application, "Antenna Array", was used to measure complex-valued data of the S21 behavior of the transmit-receive system. Data was taken at 1023 points through 0-360 degrees of azimuth and reported to a laptop computer. Time domain gating of a wide-band frequency sweep was implemented in real measurement time by the VNA to remove ground reflections and scattering from other nearby objects. The application performed a near field-to-far field transformation via cylindrical wave function representation in post-processing the raw data, although this adjustment was seen to be small due to the approximately 10 lambda measurement range length used.

INSTALLATION

The antenna must be installed in exactly the manner in which it was measured at the factory. This is shown in detail on the antenna mounting sketch, including the azimuth bearing of the elements. This boom must be verified by a surveyor at the site when installation is being completed. Good engineering practices should be followed in any details not covered by specific instructions.

MAINTENANCE

Annual or regular inspection should be made on the antenna system. At this time, tightness of U-bolts, or other fastenings, should be routinely checked. Any deterioration of the antenna due to lightning, or other causes should be promptly repaired.



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EQUIPMENT

- 8753ES Hewlett Packard Network Analyzer, Serial #US39171485,
Cal'd 3/2017
- Gaebridge Optical shaft encoder 10BITCW/45HD/5/10
- National Instruments PCMC1A-GPIB Interface
- BIODATA Microlink II Custom Interface Controller
- Gateway Laptop Computer, model MX 6930, Windows XP OS
- JAMPRO JADP TUNED CAVITY DIPOLE

CONCLUSION

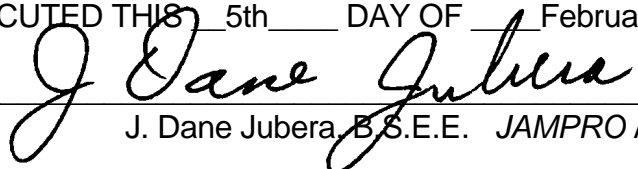
In the development of this pattern, *JAMPRO* antennas, Inc. observed known requirements of the FCC, as stated on the station construction permit.

Gain figures and required input power to achieve station ERP, as well as other details, are found on the first page.

This certification with its calculations were performed by J. Dane Jubera, B.S.E.E., Electrical Engineer, *JAMPRO* Antennas, Inc.

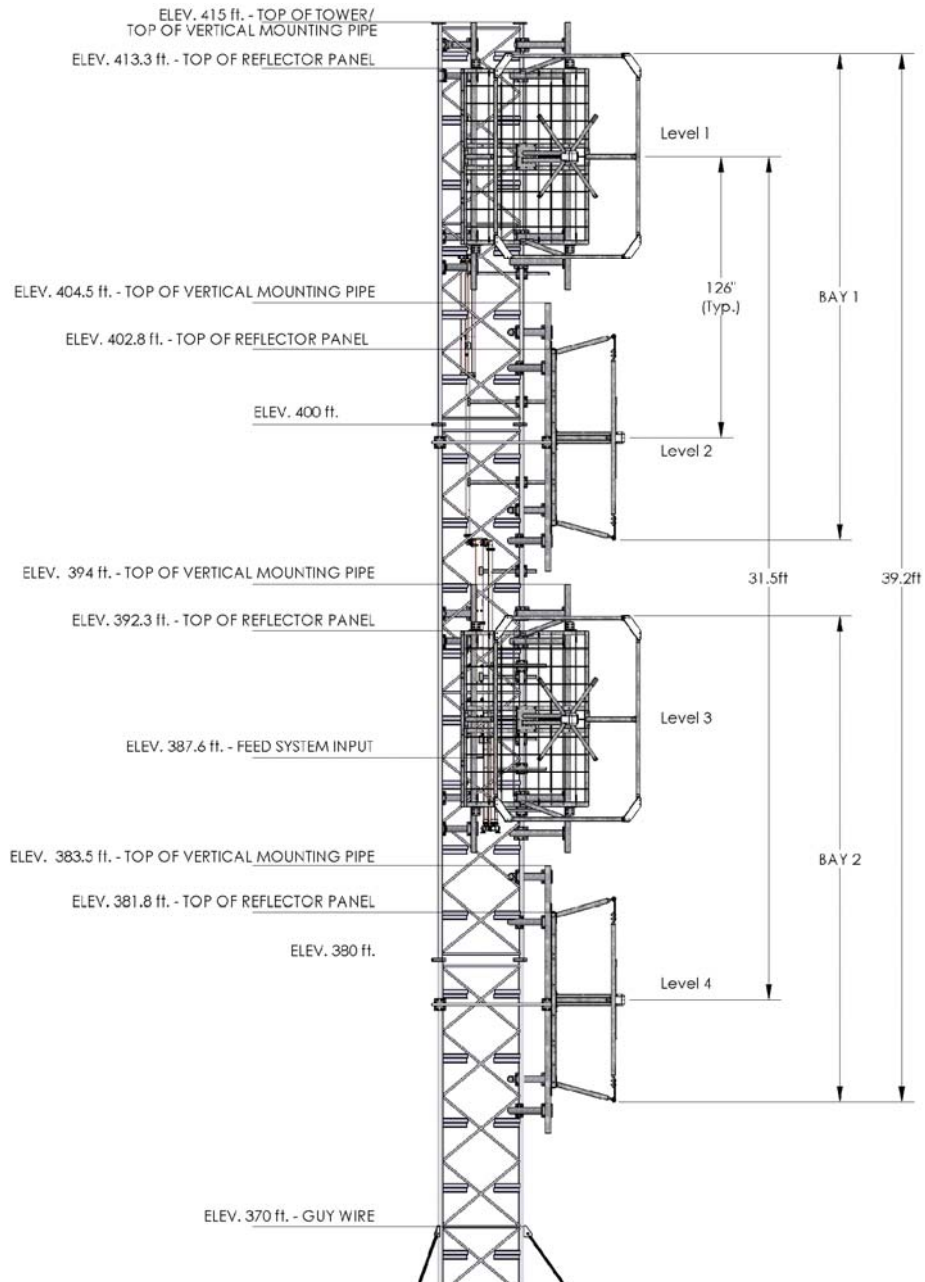
EXECUTED THIS 5th DAY OF February, 2018

BY:


J. Dane Jubera, B.S.E.E. *JAMPRO* Antennas, Inc.

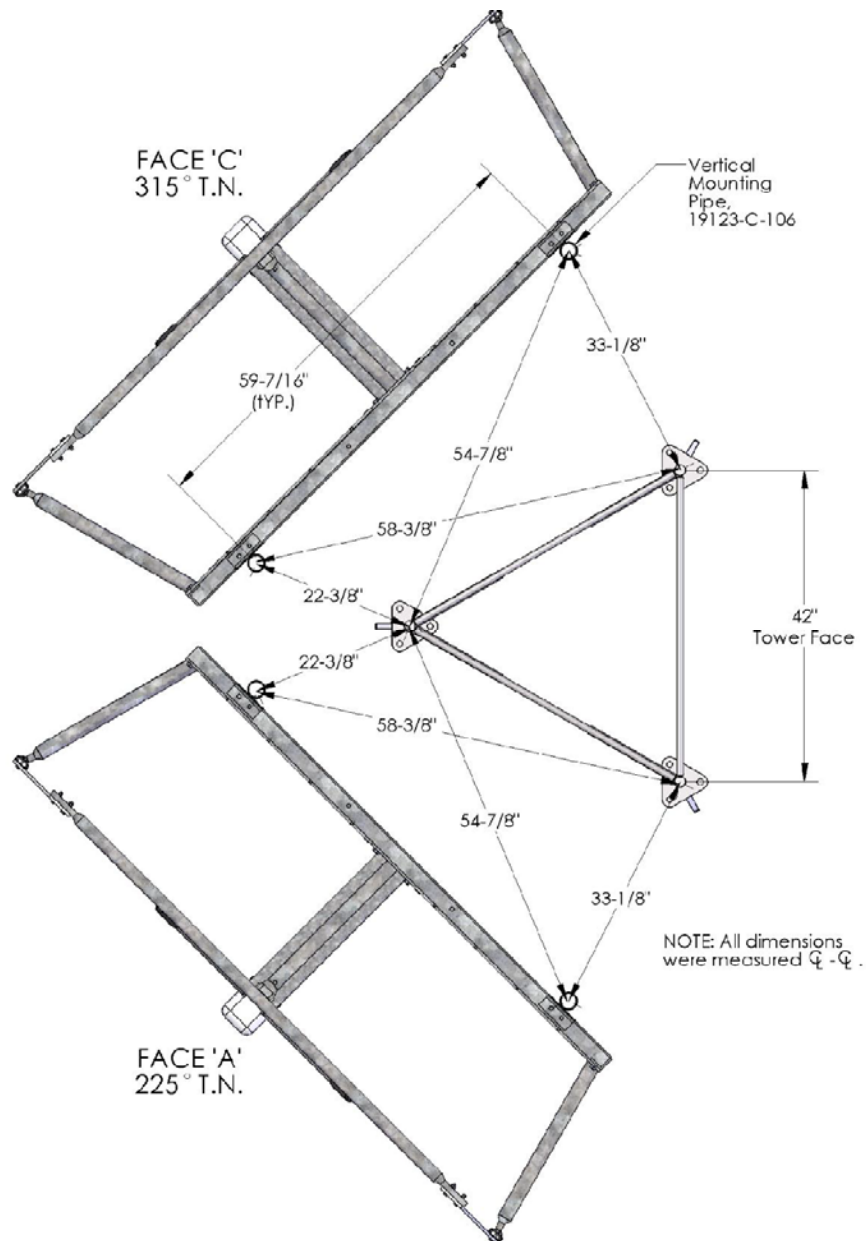


Side View of Array



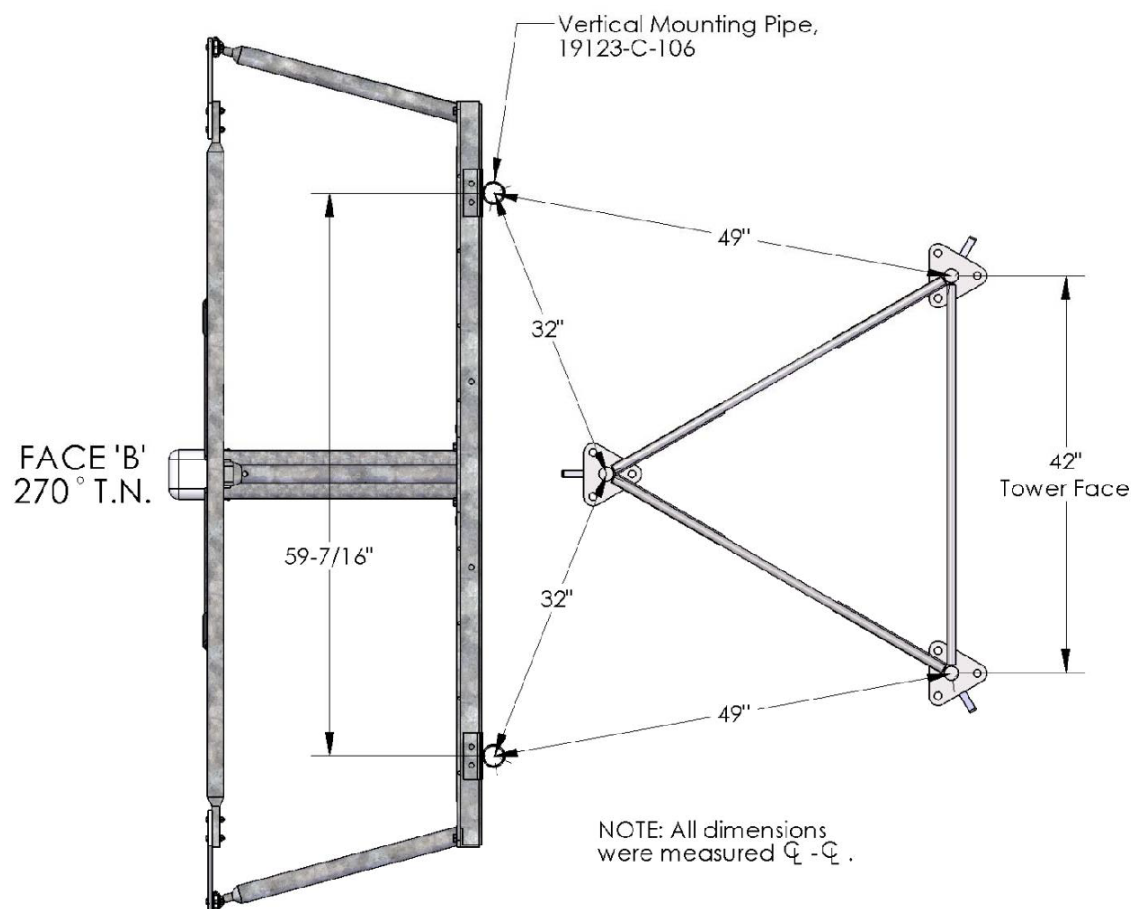


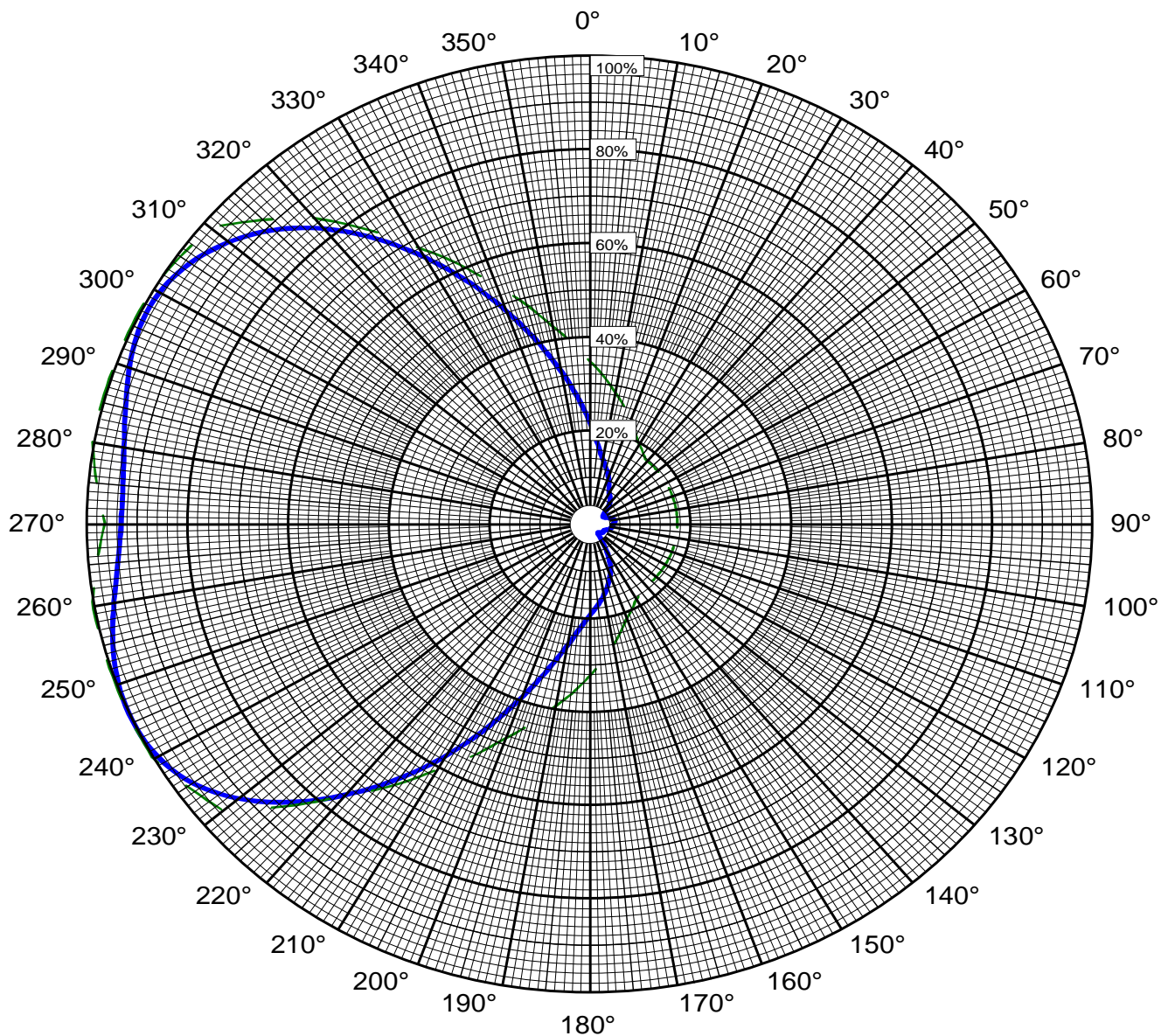
Top View of Array Faces A & C





Top View of Array Face B





Azimuth Pattern

Customer: WRFE

Date: January 23, 2018

Frequency: 89.3 MHz

Type Number: JFCB-2-1-2-1(6)

Notes:

COMPOSITE PATTERN ENVELOPE (H & V)



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WRFE

ERP = 50.00 kW

January 23, 2018

JFCB-2-1-2-1(6)

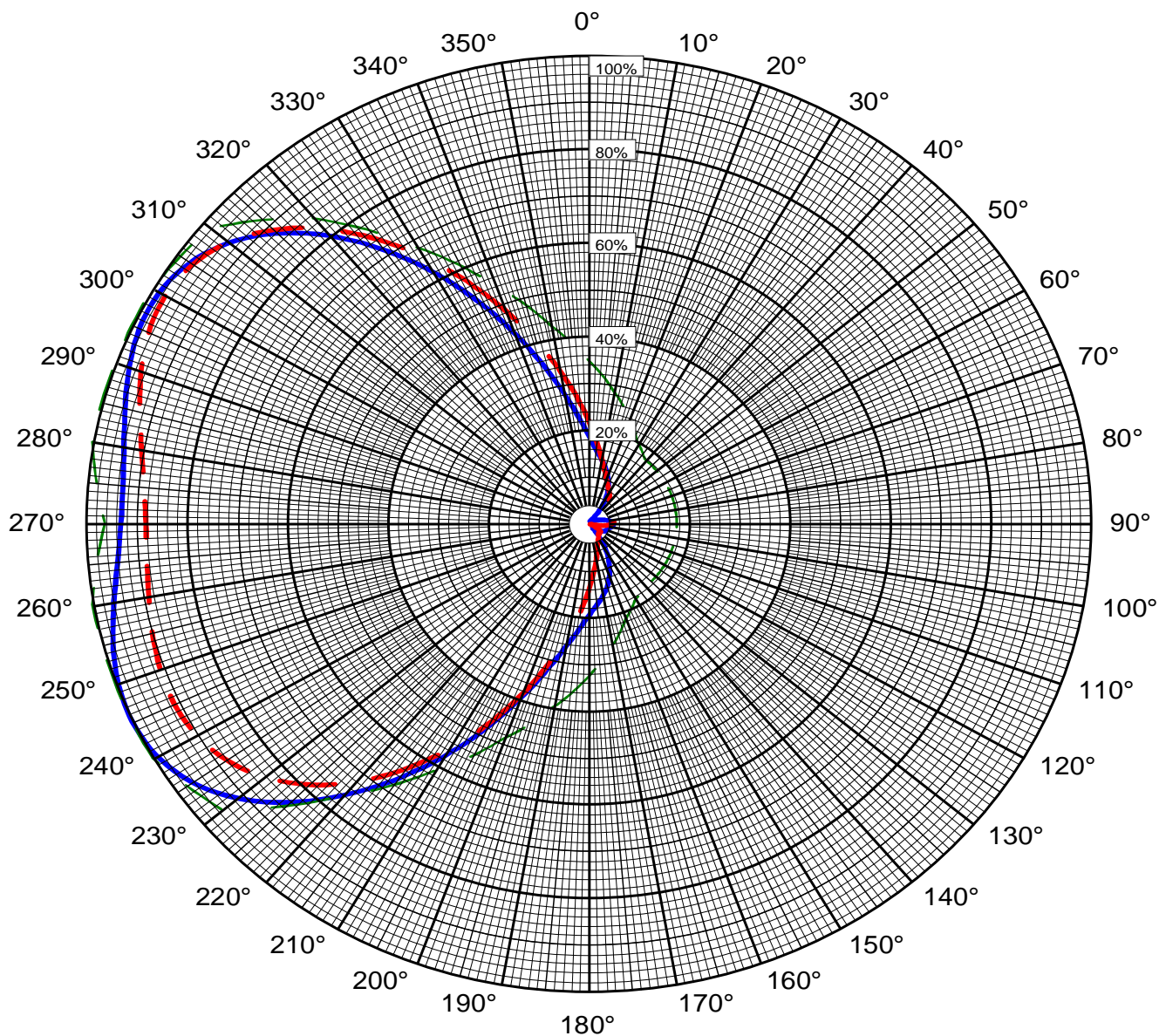
TABULATION OF RELATIVE FIELD

COMPOSITE MEASURED PATTERN (H & V)

| <u>BEARING</u> | <u>FIELD</u> | <u>ERP</u> <u>(kW)</u> | <u>dBk</u> |
|----------------|--------------|---------------------------|------------|
| 0 | 0.225 | 2.54 | 4.05 |
| 10 | 0.151 | 1.13 | 0.54 |
| 20 | 0.115 | 0.66 | -1.78 |
| 30 | 0.085 | 0.36 | -4.41 |
| 40 | 0.069 | 0.24 | -6.24 |
| 50 | 0.053 | 0.14 | -8.61 |
| 60 | 0.036 | 0.07 | -11.85 |
| 70 | 0.036 | 0.06 | -11.98 |
| 80 | 0.051 | 0.13 | -8.81 |
| 90 | 0.052 | 0.14 | -8.70 |
| 100 | 0.048 | 0.12 | -9.35 |
| 110 | 0.041 | 0.08 | -10.71 |
| 120 | 0.035 | 0.06 | -12.04 |
| 130 | 0.032 | 0.05 | -12.91 |
| 140 | 0.035 | 0.06 | -12.16 |
| 150 | 0.083 | 0.34 | -4.67 |
| 160 | 0.127 | 0.81 | -0.93 |
| 170 | 0.163 | 1.33 | 1.24 |
| 180 | 0.203 | 2.06 | 3.13 |
| 190 | 0.275 | 3.79 | 5.79 |
| 200 | 0.403 | 8.12 | 9.10 |
| 210 | 0.578 | 16.69 | 12.23 |
| 220 | 0.759 | 28.80 | 14.59 |
| 230 | 0.913 | 41.64 | 16.20 |
| 240 | 0.990 | 49.04 | 16.91 |
| 250 | 0.994 | 49.37 | 16.93 |
| 260 | 0.956 | 45.74 | 16.60 |
| 270 | 0.928 | 43.05 | 16.34 |
| 280 | 0.936 | 43.84 | 16.42 |
| 290 | 0.970 | 47.06 | 16.73 |
| 300 | 0.984 | 48.37 | 16.85 |
| 310 | 0.933 | 43.48 | 16.38 |
| 320 | 0.820 | 33.64 | 15.27 |
| 330 | 0.658 | 21.64 | 13.35 |
| 340 | 0.486 | 11.81 | 10.72 |
| 350 | 0.337 | 5.69 | 7.55 |

Relative fields at other azimuths:

| | | | |
|-----|-------|-----|-------|
| 45 | 0.062 | 225 | 0.842 |
| 135 | 0.028 | 315 | 0.884 |



Azimuth Pattern

| | |
|---|------------------------------|
| Customer: WRFE | Date: January 23, 2018 |
| Frequency: 89.3 MHz | Type Number: JFCB-2-1-2-1(6) |
| Notes: MEASURED PATTERN IN FULL SCALE | |
| <div style="display: flex; justify-content: space-between; align-items: center;"> ———— HPOL VPOL --- LIMITS </div> | |



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WRFE

ERP = 50.00 kW

January 23, 2018

JFCB-2-1-2-1(6)

TABULATION OF MEASURED FIELDS

| <u>BEARING</u> | <u>HORIZONTAL POLARIZATION</u> | | <u>VERTICAL POLARIZATION</u> | |
|------------------------|------------------------------------|----------------|----------------------------------|----------------|
| | <u>FIELD</u> | <u>ERP(kW)</u> | <u>FIELD</u> | <u>ERP(kW)</u> |
| 0 | 0.193 | 1.85 | 0.225 | 2.54 |
| 10 | 0.145 | 1.05 | 0.151 | 1.13 |
| 20 | 0.115 | 0.66 | 0.108 | 0.58 |
| 30 | 0.083 | 0.34 | 0.085 | 0.36 |
| 40 | 0.044 | 0.10 | 0.069 | 0.24 |
| 50 | 0.011 | 0.01 | 0.053 | 0.14 |
| 60 | 0.008 | 0.00 | 0.036 | 0.07 |
| 70 | 0.017 | 0.02 | 0.036 | 0.06 |
| 80 | 0.037 | 0.07 | 0.051 | 0.13 |
| 90 | 0.051 | 0.13 | 0.052 | 0.14 |
| 100 | 0.048 | 0.12 | 0.029 | 0.04 |
| 110 | 0.041 | 0.08 | 0.006 | 0.00 |
| 120 | 0.035 | 0.06 | 0.026 | 0.03 |
| 130 | 0.015 | 0.01 | 0.032 | 0.05 |
| 140 | 0.035 | 0.06 | 0.035 | 0.06 |
| 150 | 0.083 | 0.34 | 0.043 | 0.09 |
| 160 | 0.127 | 0.81 | 0.060 | 0.18 |
| 170 | 0.163 | 1.33 | 0.092 | 0.42 |
| 180 | 0.203 | 2.06 | 0.153 | 1.16 |
| 190 | 0.275 | 3.79 | 0.253 | 3.21 |
| 200 | 0.403 | 8.12 | 0.394 | 7.78 |
| 210 | 0.578 | 16.69 | 0.561 | 15.72 |
| 220 | 0.759 | 28.80 | 0.722 | 26.05 |
| 230 | 0.913 | 41.64 | 0.842 | 35.44 |
| 240 | 0.990 | 49.04 | 0.900 | 40.52 |
| 250 | 0.994 | 49.37 | 0.905 | 40.95 |
| 260 | 0.956 | 45.74 | 0.887 | 39.30 |
| 270 | 0.928 | 43.05 | 0.878 | 38.58 |
| 280 | 0.936 | 43.84 | 0.901 | 40.55 |
| 290 | 0.970 | 47.06 | 0.945 | 44.63 |
| 300 | 0.984 | 48.37 | 0.970 | 47.05 |
| 310 | 0.931 | 43.32 | 0.933 | 43.48 |
| 320 | 0.801 | 32.09 | 0.820 | 33.64 |
| 330 | 0.622 | 19.32 | 0.658 | 21.64 |
| 340 | 0.437 | 9.55 | 0.486 | 11.81 |
| 350 | 0.287 | 4.13 | 0.337 | 5.69 |
| MAXIMUM FIELDS: | | | | |
| 245 | 1.000 | 50.00 | | |
| 300 | | | 0.970 | 47.04 |
| MINIMUM FIELDS: | | | | |
| 55 | 0.006 | 0.00 | | |
| 110 | | | 0.006 | 0.00 |

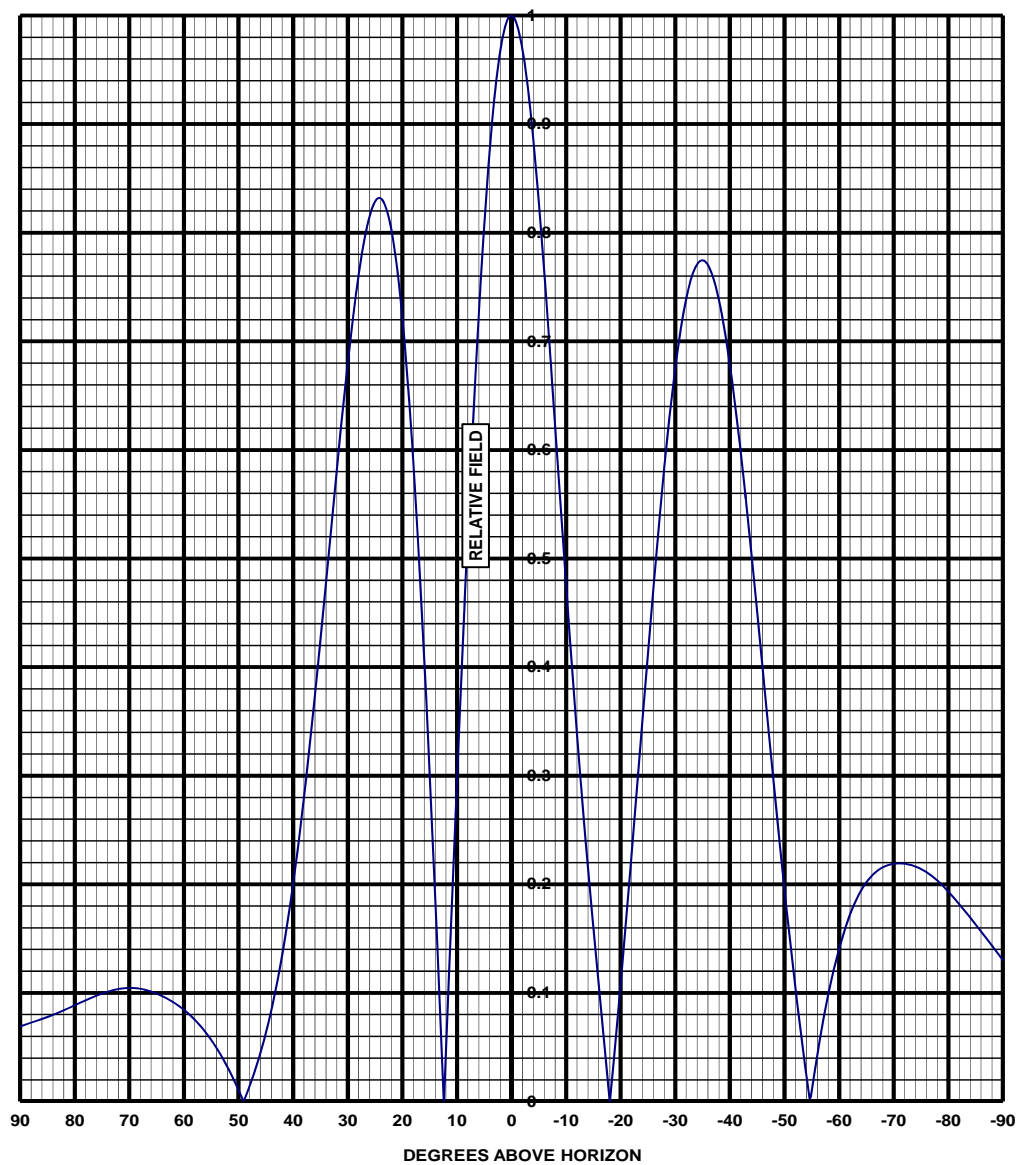


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PLOT OF ELEVATION PLANE PATTERN

STATION: WRFE-FM 89.3 MHz JFCB-2-1-2-1(6) 2.00 lambda spacing





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TABULATION OF ELEVATION PLANE PATTERN

WRFE-FM

89.3 MHz JFCB-2-1-2-1(6) 2.00 lambda spacing

| <u>ELEVATION</u> | <u>RELATIVE</u> | <u>ELEVATION</u> | <u>RELATIVE</u> | <u>ELEVATION</u> | <u>RELATIVE</u> |
|------------------|-----------------|------------------|-----------------|------------------|-----------------|
| <u>ANGLE</u> | <u>FIELD</u> | <u>ANGLE</u> | <u>FIELD</u> | <u>ANGLE</u> | <u>FIELD</u> |
| 10 | 0.295 | -25 | 0.414 | -60 | 0.141 |
| 9 | 0.413 | -26 | 0.474 | -61 | 0.158 |
| 8 | 0.526 | -27 | 0.532 | -62 | 0.172 |
| 7 | 0.630 | -28 | 0.585 | -63 | 0.184 |
| 6 | 0.725 | -29 | 0.634 | -64 | 0.194 |
| 5 | 0.807 | -30 | 0.676 | -65 | 0.202 |
| 4 | 0.876 | -31 | 0.711 | -66 | 0.208 |
| 3 | 0.931 | -32 | 0.739 | -67 | 0.212 |
| 2 | 0.969 | -33 | 0.760 | -68 | 0.216 |
| 1 | 0.993 | -34 | 0.771 | -69 | 0.218 |
| 0 | 1.000 | -35 | 0.775 | -70 | 0.219 |
| -1 | 0.991 | -36 | 0.770 | -71 | 0.219 |
| -2 | 0.969 | -37 | 0.758 | -72 | 0.219 |
| -3 | 0.933 | -38 | 0.738 | -73 | 0.218 |
| -4 | 0.885 | -39 | 0.711 | -74 | 0.216 |
| -5 | 0.828 | -40 | 0.678 | -75 | 0.214 |
| -6 | 0.764 | -41 | 0.640 | -76 | 0.211 |
| -7 | 0.694 | -42 | 0.597 | -77 | 0.208 |
| -8 | 0.621 | -43 | 0.551 | -78 | 0.203 |
| -9 | 0.548 | -44 | 0.501 | -79 | 0.199 |
| -10 | 0.475 | -45 | 0.450 | -80 | 0.193 |
| -11 | 0.405 | -46 | 0.398 | -81 | 0.188 |
| -12 | 0.338 | -47 | 0.346 | -82 | 0.182 |
| -13 | 0.275 | -48 | 0.294 | -83 | 0.176 |
| -14 | 0.215 | -49 | 0.244 | -84 | 0.170 |
| -15 | 0.159 | -50 | 0.195 | -85 | 0.163 |
| -16 | 0.106 | -51 | 0.148 | -86 | 0.157 |
| -17 | 0.053 | -52 | 0.104 | -87 | 0.150 |
| -18 | 0.000 | -53 | 0.063 | -88 | 0.144 |
| -19 | 0.054 | -54 | 0.024 | -89 | 0.137 |
| -20 | 0.110 | -55 | 0.011 | -90 | 0.130 |
| -21 | 0.168 | -56 | 0.043 | | |
| -22 | 0.228 | -57 | 0.072 | | |
| -23 | 0.290 | -58 | 0.098 | | |
| -24 | 0.352 | -59 | 0.121 | | |