Kessler and Gehman Associates
Consultants • Broadcast • Wireless

APPLICATION FOR LICENSE TO COVER A CONSTRUCTION PERMITTED NON-COMMERCIAL FM BROADCAST STATION

CALL SIGN: KUHF(FM)
FACILITY ID: 69150
FCC FILE NO.: 0000138517
LOCATION: HOUSTON, TX

Prepared For:

University Of Houston System
311 E. Cullen Building
4800 Calhoun
Houston, TX 77204

Prepared By:

Ryan Wilhour
Consulting Engineer
Kessler and Gehman Associates
507 NW 60th Street, Suite D
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June 9, 2021

1.0 EXECUTIVE SUMMARY

University of Houston System has a construction permit for a non-commercial Class C FM broadcast station having FCC File No.: 0000138517. The construction permit specifies 5 special operating conditions or restrictions which require documentation to satisfy the requirements for a license to cover application. The following section addresses the special operating conditions with supporting material and appendices.

2.0 SPECIAL OPERATING CONDITIONS OR RESTRICTIONS

The following special operating conditions and restrictions are observed on the construction permit.

- **The permittee must submit the results of a complete proof-of-performance to establish the horizontal plane radiation patterns for both the horizontally and vertically polarized radiation components.**

  Appendix A is a proof of performance from the antenna manufacturer demonstrating compliance pursuant to the technical parameters of the underlying construction permit.

- **The permittee must submit a certification executed by a licensed surveyor showing that the FM directional antenna system has been oriented at the azimuth(s) specified in the directional antenna proof of performance.**

  Appendix B is a signed and sealed affidavit from a licensed surveyor certifying the antenna elements are oriented at 49.23, 138.49, 229.23, and 318.49 degrees from true north which corresponds to the antenna pattern horizontal polarization minima shown in Appendix A at 49, 139, 229, and 319 degrees from true north and are thus within a half degree tolerance.

- **The permittee must submit an affidavit that the installation of the directional antenna system was overseen by a qualified engineer.**

  Appendix C is a notarized affidavit from the qualifying engineer who supervised the installation of the KUHF(FM) antenna and certifies that it was installed according to the manufacturer's instructions.

- **The permittee must submit an exhibit demonstrating that the measured directional antenna pattern complies with the appropriate community coverage requirements.**

  Appendix D demonstrates that the measured directional antenna pattern provided in Appendix A has a §73.515 60-dbμV/m f(50,50) contour which completely subsumes the population and area of Houston, TX which is the KUHF-FM community of license. All contours were generated in accordance with 47 CFR § 73.333 engineering charts utilizing FCC 30 arc second terrain data.

- **The RMS of the composite measured relative field horizontal plane directional antenna pattern must encompass at least 85% of the RMS of the composite relative field horizontal plane directional antenna pattern authorized by this construction permit.**

  The enveloping pattern for the construction permit was based upon the real measured relative field pattern from the proof of performance; therefore, the measured pattern *is* the enveloping pattern and thus provides 100% RMS coverage. As such, the facility as built is compliant with Section 73.316(c)(2)(ix)(A).

- **The relative field strength of neither the measured horizontally nor vertically polarized radiation component shall exceed at any azimuth the value indicated on the composite radiation pattern authorized by this construction permit. A relative field strength of 1.0 on the composite radiation pattern herein authorized corresponds to the following effective radiated power: 100.0 kilowatts. Principal minima and their associated field strength limits: 140 degrees True: 56.100 kilowatts.**

  Appendix A demonstrates that a relative field strength of 1.0 represents a peak ERP of 100KW and at no azimuth does the horizontal or vertical measured radiation exceed the authorized composite radiation pattern. In this case the composite pattern is the measured horizontal radiation pattern where the vertical pattern does not encroach beyond the horizontal for any azimuth degree. At the restricted azimuth of 140 Degrees True, the Horizontal component is 2.52 dB down from the maximum of 100 kW, or 56.04 kW and is thus compliant.

3.0 CERTIFICATION

The foregoing statement and the report regarding the aforementioned engineering work are true and correct to the best of my knowledge. Executed on June 9, 2021

KESSLER AND GEHMAN ASSOCIATES, INC.

Ryan Wilhour
Consulting Engineer

APPENDIX A – Antenna Manufacturer Proof of Performance

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The Complete Broadcast Solution

KUHF, Houston, TX

FM DIRECTIONAL BROADCAST ANTENNA

MODEL LAMBDA-8

SERIAL NUMBER 19463-A

Proof of Performance

Created by	**Alan Dick Broadcast** **Chris Randall** Senior RF Engineer
Approved by	**Jon Watson** RF Engineer
Date of issue:	9th March 2021
Document number:	19463-A
Version:	4.0

Communication Infrastructure Solutions

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1.)Engineers Statement

FM ANTENNA FOR:	
STATION:	**KUHF**
LOCATION:	**HOUSTON, TX**
MODEL NUMBER:	**LAMBDA-8**
FREQUENCY & ERP:	**88.7MHz, 100Kw**
ANTENNA INPUT POWER:	**24.49kW**
ANTENNA BOOM ORIENTATION:	**SEE Dwg's**

ANTENNA GAIN	H-POL	V-POL
Relative	**4.08**	**2.43**
(dBd)	**(6.11)**	**(3.85)**

RMS GAIN OF THE AZIMUTH PATTERNS	H-POL	V-POL
Relative	**1.31**	**1.08**
(dBd)	**(1.18)**	**(0.34)**

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2.)Certification

This certification, along with the accompanying antenna specification sheet, antenna drawings, and azimuth and elevation patterns, certifies the construction and measurement of the AlanDick Lambda 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.

3.)Construction

An FM Lambda antenna model was used to create the required directional patterns. 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.

4.)Measurement

The full final build of 8 bays was erected and impedance measurements were carried out on the full array. Once completed, pattern measurements were carried out on 2 bays of the array only. Feeding of the 2 bays of the array was done form the bottom, below the pole, so no changes to the cable routing was required. The patterns measured fully represented the final build antenna configuration. The antenna was mounted on an outdoor turntable at the JAMPRO Sky Creek Drive factory. The antenna was used for receiving radiation from a transmitting antenna elevated 45 feet above ground and located at a distance of 100 feet away. The 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.

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5.)Installation

The antenna was assembled in is final form at the Jampro factory and is designed to be installed with minimal disruption to the cabling system. Extension cables run from the distribution power dividers located within the support structure to the antenna tails located below the pole. The tails must be installed in exactly in the way 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.

6.)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.

7.)Equipment

-8753ES Hewlett Packard Network Analyzer, Serial #US39171485,

Cal'd 4/30/2019, Due 4/30/2021.

-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

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8.)Conclusion

In the development of this pattern, AlanDick Broadcast, 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 Chris Randall, Antenna Engineer, AlanDick Broadcast Ltd.

EXECUTED THIS 9th MARCH 2021

BY: 

Chris Randall. *AlanDick Broadcast Ltd.*

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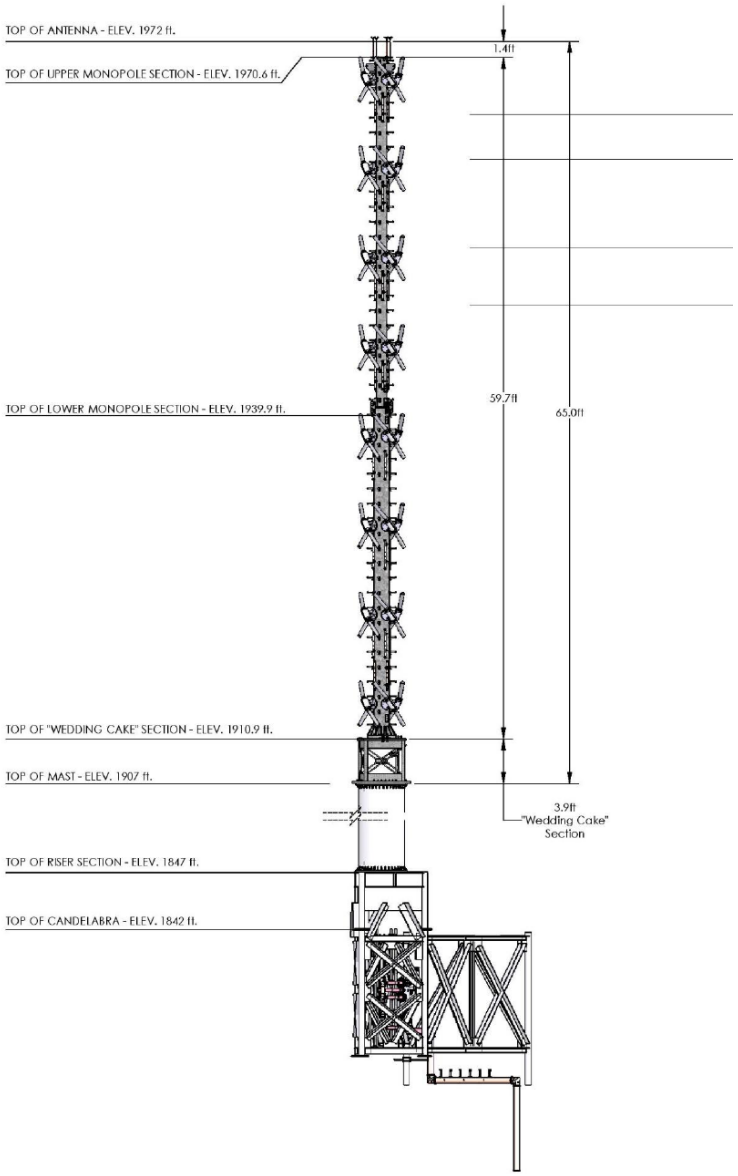
9.)Drawings

Side View of Array



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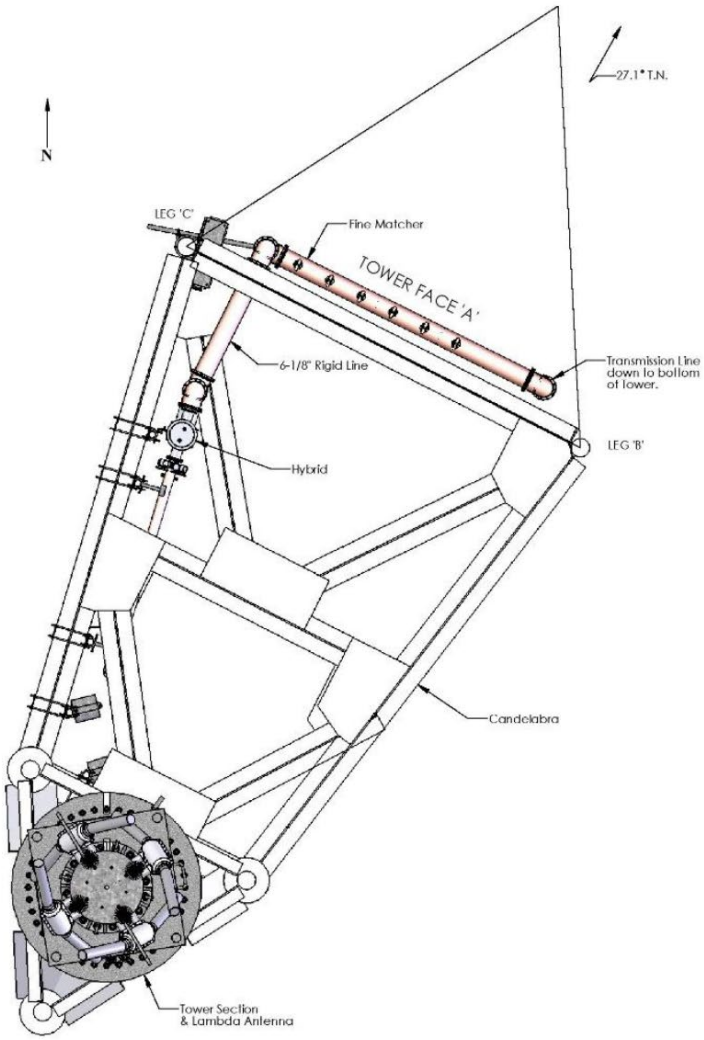
Top View of Array



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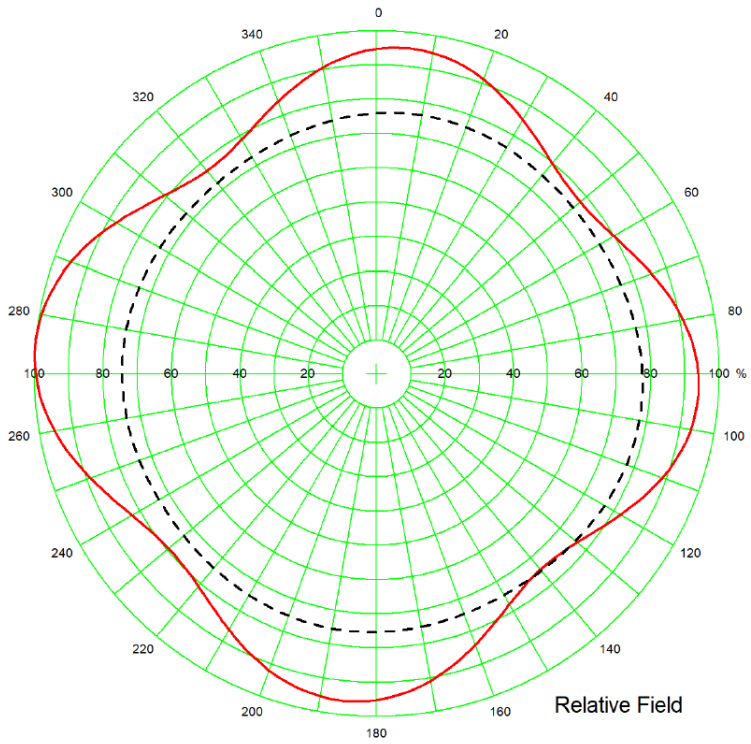
10.) Azimuth Patterns

HORIZONTAL RADIATION PATTERN

Station	***Houston KUHF***
Frequency	***88.7 MHz***
Type	***8 Bay FM Lambda***



Horizontal Field

Vertical Field

Date ***5 Mar 2021***

Pat. No. 420305031 Chris Randall v8.1.1

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Tabulation Horizontal Field

KUHF Lambda-8 ERP = 100kW March 9, 2021

TABULATION OF RELATIVE FIELD MEASURED PATTERN (Horizontal Field)

Bearing	Field	dB	ERP (kW)	dBk
0	94.99	-0.45	90.23	19.55
10	95.24	-0.42	90.71	19.58
20	91.66	-0.76	84.02	19.24
30	85.76	-1.33	73.55	18.67
40	80.24	-1.91	64.38	18.09
50	78.04	-2.15	60.90	17.85
60	80.39	-1.90	64.63	18.10
70	85.81	-1.33	73.63	18.67
80	91.33	-0.79	83.41	19.21
90	94.39	-0.50	89.09	19.50
100	93.65	-0.57	87.70	19.43
110	89.22	-0.99	79.60	19.01
120	82.67	-1.65	68.34	18.35
130	76.84	-2.29	59.04	17.71
140	74.86	-2.52	56.04	17.48
150	78.02	-2.16	60.87	17.84
160	84.61	-1.45	71.59	18.55
170	91.39	-0.78	83.52	19.22
180	95.65	-0.39	91.49	19.61
190	95.98	-0.36	92.12	19.64
200	92.46	-0.68	85.49	19.32
210	86.63	-1.25	75.05	18.75
220	81.32	-1.80	66.13	18.20
230	79.63	-1.98	63.41	18.02
240	82.86	-1.63	68.66	18.37
250	89.39	-0.97	79.91	19.03
260	96.03	-0.35	92.22	19.65
270	100	0.00	100.00	20.00
280	99.79	-0.02	99.58	19.98
290	95.36	-0.41	90.94	19.59
300	88.18	-1.09	77.76	18.91
310	81.05	-1.82	65.69	18.18
320	77.37	-2.23	59.86	17.77
330	78.99	-2.05	62.39	17.95
340	84.6	-1.45	71.57	18.55
350	90.92	-0.83	82.66	19.17
360	94.99	-0.45	90.23	19.55

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Tabulation Vertical Field

KUHF Lambda-8 ERP = 59.5kW March 9, 2021

TABULATION OF RELATIVE FIELD MEASURED PATTERN (Vertical Field)

Bearing	Field	dB	ERP	dBk
0	97.2	-0.25	56.21	17.50
10	97.9	-0.18	57.03	17.56
20	97.89	-0.19	57.02	17.56
30	97.31	-0.24	56.34	17.51
40	96.58	-0.30	55.50	17.44
50	96.18	-0.34	55.04	17.41
60	96.44	-0.31	55.34	17.43
70	97.35	-0.23	56.39	17.51
80	98.57	-0.13	57.81	17.62
90	99.59	-0.04	59.01	17.71
100	100	0.00	59.50	17.75
110	99.6	-0.03	59.02	17.71
120	98.54	-0.13	57.78	17.62
130	97.21	-0.25	56.23	17.50
140	96.09	-0.35	54.94	17.40
150	95.54	-0.40	54.31	17.35
160	95.62	-0.39	54.40	17.36
170	96.09	-0.35	54.94	17.40
180	96.56	-0.30	55.48	17.44
190	96.69	-0.29	55.63	17.45
200	96.34	-0.32	55.22	17.42
210	95.61	-0.39	54.39	17.36
220	94.81	-0.46	53.48	17.28
230	94.27	-0.51	52.88	17.23
240	94.18	-0.52	52.78	17.22
250	94.5	-0.49	53.13	17.25
260	94.98	-0.45	53.68	17.30
270	95.28	-0.42	54.02	17.33
280	95.16	-0.43	53.88	17.31
290	94.56	-0.49	53.20	17.26
300	93.71	-0.56	52.25	17.18
310	92.97	-0.63	51.43	17.11
320	92.74	-0.65	51.17	17.09
330	93.26	-0.61	51.75	17.14
340	94.44	-0.50	53.07	17.25
350	95.91	-0.36	54.73	17.38
360	97.2	-0.25	56.21	17.50

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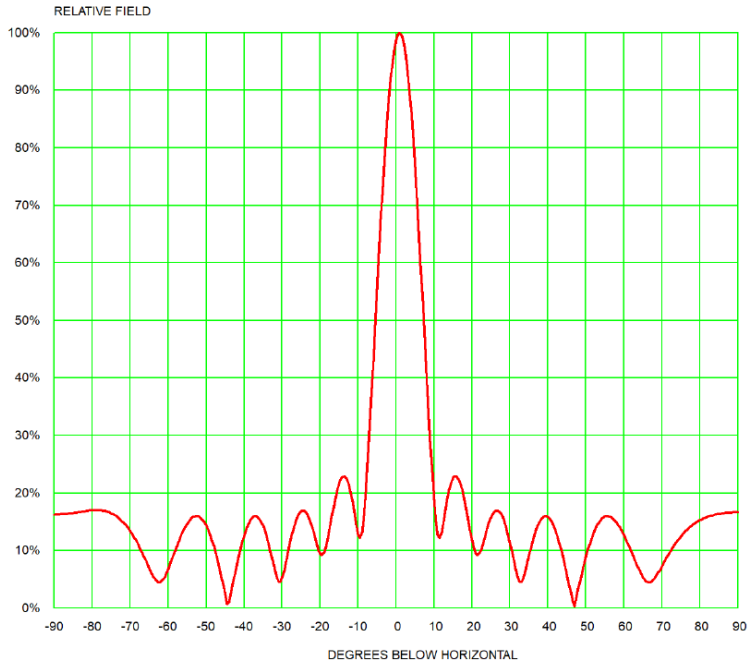
11.) Elevation Pattern

VERTICAL RADIATION PATTERN

Station ***Houston KUHF***

Frequency ***88.7 MHz***

Type ***8 Bay FM Lambda***



Beam Tilt ***1 deg***

Engineer ***Chris R*** Date ***15 Jun 2020***

Pat. No. 505115060 Chris Randall v8.1.1

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Tabulation Elevation Pattern

Elevation Angle	Relative Field	Elevation Angle	Relative Field	Elevation Angle	Relative Field
-10	12.8	26	16.84	62	9.74
-9	13.23	27	16.88	63	8.17
-8	20.21	28	15.9	64	6.66
-7	30.82	29	13.99	65	5.4
-6	42.95	30	11.37	66	4.6
-5	55.48	31	8.33	67	4.51
-4	67.59	32	5.52	68	5.09
-3	78.54	33	4.5	69	6.08
-2	87.72	34	6.27	70	7.24
-1	94.59	35	9.04	71	8.42
0	98.76	36	11.68	72	9.56
1	99.99	37	13.81	73	10.62
2	98.21	38	15.25	74	11.58
3	93.54	39	15.93	75	12.44
4	86.24	40	15.83	76	13.19
5	76.72	41	14.98	77	13.85
6	65.54	42	13.45	78	14.41
7	53.35	43	11.34	79	14.88
8	40.87	44	8.78	80	15.27
9	28.95	45	5.88	81	15.6
10	18.78	46	2.8	82	15.86
11	12.7	47	0.34	83	16.07
12	13.22	48	3.4	84	16.24
13	17.11	49	6.29	85	16.37
14	20.63	50	8.9	86	16.46
15	22.61	51	11.16	87	16.53
16	22.83	52	13.01	88	16.58
17	21.43	53	14.42	89	16.6
18	18.75	54	15.38	90	16.61
19	15.29	55	15.88		
20	11.81	56	15.96		
21	9.48	57	15.63		
22	9.5	58	14.95		
23	11.43	59	13.95		
24	13.83	60	12.71		
25	15.77	61	11.28		

APPENDIX B – Antenna Azimuth Survey Certification

SURVTECH
SURVEYORS
PLANNERS

"A LAND SURVEYING COMPANY"

Jed Wilkinson

Feb 23 2021

Re: Antenna Installation Certification

Dear Jed:

On Feb 23 2021 we visited the KUHF-FM, Houston Texas antenna site, to verify the orientation of the installation of the new FM antenna, Model No. LAMBDA-8 Serial No 19463 The antenna's were attached on 8 per side, 4 sides, 90 degrees from each other, with an approximate height of 1990'MSL to 2045'MSL +/- .

The antenna's orientation was measured as follows
Azimuth: 49deg 13' 58" , (to NORTH, Texas South Central Zone, NAD 83)
Azimuth: 138deg 29' 41" , (to NORTH, Texas South Central Zone, NAD 83)
Azimuth: 229deg 13' 58" , (to NORTH Texas South Central Zone, NAD 83)
Azimuth: 318deg 29' 41" , (to NORTH Texas South Central Zone, NAD 83)

Grid Convergence: N 01° 42'34."W
(within 1.5 deg)

Sincerely,

Steve E Laughlin, RPLS #5178

STATE OF TEXAS
REGISTERED
STEVEN E LAUGHLIN
5178
PROFESSIONAL
LAND SURVEYOR

APPENDIX C – Notarized Affidavit from Qualifying Engineer

ROYCE TOWER SERVICE, LLC.
P.O. BOX 883
PORT BOLIVAR, TEXAS 77650
409-684-1913(office)
409-684-0409(fax)

TO: Ryan C. Wilhour – Consulting Engineer
Kessler and Gehman Associates, Inc.
Consultants – Broadcast - Wireless
507 NW 60th St. Suite D
Gainesville, FL 32607

June 4, 2021

ATTN: Mr. Ryan C. Wilhour

RE: KUHF FM antenna tower top orientation

Mr. Wilhour,

Royce Tower Service, LLC. certifies that the KUHF Jampro Lambda-8 FM antenna serial #19463-A is installed on the tower top according to the Jampro manual dated June 23, 2020, page 24.

Ray E. Royce

President, RTS, LLC.
since 1987

STATE OF TEXAS
COUNTY OF Galveston
SUBSCRIBED AND SWORN TO BEFORE ME
THIS 7th DAY OF June 2021
BY Ray E. Royce

NOTARY PUBLIC

SHERYL L CALDWELL
Notary ID #6139715
My Commission Expires
July 9, 2021

APPENDIX D – 47 CFR § 73.313 - Prediction of coverage