Federal Communications Commission
Washington, D. C. 20554

Approved by OMB
3060-0627
Expires 01/31/98

FOR FCC USE ONLY

Accepted / Filed

OCT 20 2016

Federal Communications Commission
Office of the Secretary

FCC 302-AM
APPLICATION FOR AM BROADCAST STATION LICENSE

(Please read instructions before filling out form.

FOR COMMISSION USE ONLY
FILE NO. BL-20161020ACK

SECTION I - APPLICANT FEE INFORMATION

1. PAYOR NAME (Last, First, Middle Initial)

Saga Broadcasting, LLC

MAILING ADDRESS (Line 1) (Maximum 35 characters)
73 Kercheval Avenue, suite 201

MAILING ADDRESS (Line 2) (Maximum 35 characters)

CITY	STATE OR COUNTRY (if foreign address)	ZIP CODE
Grosse Pointe Farms	MI	48236

TELEPHONE NUMBER (include area code)	CALL LETTERS	OTHER FCC IDENTIFIER (If applicable)
313-886-7070	KPUG	58887

2. A. Is a fee submitted with this application? ☐ Yes ☑ No

B. If No, indicate reason for fee exemption (see 47 C.F.R. Section

☐ Governmental Entity ☐ Noncommercial educational licensee ☑ Other (Please explain):

C. If Yes, provide the following information: Direct Measurement of Power

Enter in Column (A) the correct Fee Type Code for the service you are applying for. Fee Type Codes may be found in the "Mass Media Services Fee Filing Guide." Column (B) lists the Fee Multiple applicable for this application. Enter fee amount due in Column (C).

(A) FEE TYPE CODE	(B) FEE MULTIPLE	(C) FEE DUE FOR FEE TYPE CODE IN COLUMN (A)	FOR FCC USE ONLY
	0001	$ 0.00	

To be used only when you are requesting concurrent actions which result in a requirement to list more than one Fee Type Code.

(A)	(B)	(C)	FOR FCC USE ONLY
	0001	$ 0.00	

	TOTAL AMOUNT REMITTED WITH THIS APPLICATION	FOR FCC USE ONLY
ADD ALL AMOUNTS SHOWN IN COLUMN C, AND ENTER THE TOTAL HERE. THIS AMOUNT SHOULD EQUAL YOUR ENCLOSED REMITTANCE.	$ 0.00	

SECTION II - APPLICANT INFORMATION		
1. NAME OF APPLICANT Saga Broadcasting, LLC		
MAILING ADDRESS 73 Kercheval Avenue, Suite 201		
CITY Grosse Pointe Farms	STATE Mi	ZIP CODE 48236

2. This application is for:

☑ Commercial ☐ Noncommercial

☑ AM Directional ☐ AM Non-Directional

Call letters	Community of License	Construction Permit File No.	Modification of Construction Permit File No(s).	Expiration Date of Last Construction Permit
KPUG	Bellingham, WA	N/A	N/A	N/A

3. Is the station now operating pursuant to automatic program test authority in accordance with 47 C.F.R. Section 73.1620?

☐ Yes ☐ No

If No, explain in an Exhibit.

Exhibit No. N/A

4. Have all the terms, conditions, and obligations set forth in the above described construction permit been fully met?

☐ Yes ☐ No

If No, state exceptions in an Exhibit.

Exhibit No. N/A

5. Apart from the changes already reported, has any cause or circumstance arisen since the grant of the underlying construction permit which would result in any statement or representation contained in the construction permit application to be now incorrect?

☐ Yes ☐ No

If Yes, explain in an Exhibit.

Exhibit No. N/A

6. Has the permittee filed its Ownership Report (FCC Form 323) or ownership certification in accordance with 47 C.F.R. Section 73.3615(b)?

☐ Yes ☐ No

☑ Does not apply

If No, explain in an Exhibit.

Exhibit No. N/A

7. Has an adverse finding been made or an adverse final action been taken by any court or administrative body with respect to the applicant or parties to the application in a civil or criminal proceeding, brought under the provisions of any law relating to the following: any felony; mass media related antitrust or unfair competition; fraudulent statements to another governmental unit; or discrimination?

☐ Yes ☑ No

If the answer is Yes, attach as an Exhibit a full disclosure of the persons and matters involved, including an identification of the court or administrative body and the proceeding (by dates and file numbers), and the disposition of the litigation. Where the requisite information has been earlier disclosed in connection with another application or as required by 47 U.S.C. Section 1.65(c), the applicant need only provide: (i) an identification of that previous submission by reference to the file number in the case of an application, the call letters of the station regarding which the application or Section 1.65 information was filed, and the date of filing; and (ii) the disposition of the previously reported matter.

Exhibit No. N/A

8. Does the applicant, or any party to the application, have a petition on file to migrate to the expanded band (1606-1705 kHz) or a permit or license either in the existing band or expanded band that is held in combination (pursuant to the 5 year holding period allowed) with the AM facility proposed to be modified herein?

☐ Yes ☑ No

If Yes, provide particulars as an Exhibit.

Exhibit No
N/A

The APPLICANT hereby waives any claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the United States because use of the same, whether by license or otherwise, and requests and authorization in accordance with this application. (See Section 304 of the Communications Act of 1934, as amended)

The APPLICANT acknowledges that all the statements made in this application and attached exhibits are considered material representations and that all the exhibits are a material part hereof and are incorporated herein as set out in full in

CERTIFICATION

1. By checking Yes, the applicant certifies, that, in the case of an individual applicant, he or she is not subject to a denial of federal benefits that includes FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. Section 862, or, in the case of a non-individual applicant (e.g., corporation, partnership or other unincorporated association), no party to the application is subject to a denial of federal benefits that includes FCC benefits pursuant to that section. For the definition of a "party" for these purposes, see 47 C.F.R. Section 1.2002(b).

☑ Yes ☐ No

2. I certify that the statements in this application are true, complete, and correct to the best of my knowledge and belief, and are made in good faith.

Name	Signature	
Don Kurtis		
Title	Date	Telephone Number
Vice President	10/20/16	360-734-4551

WILLFUL FALSE STATEMENTS ON THIS FORM ARE PUNISHABLE BY FINE AND/OR IMPRISONMENT (U.S. CODE, TITLE 18, SECTION 1001), AND/OR REVOCATION OF ANY STATION LICENSE OR CONSTRUCTION

FCC NOTICE TO INDIVIDUALS REQUIRED BY THE PRIVACY ACT AND THE PAPERWORK REDUCTION ACT

The solicitation of personal information requested in this application is authorized by the Communications Act of 1934, as amended. The Commission will use the information provided in this form to determine whether grant of the application is in the public interest. In reaching that determination, or for law enforcement purposes, it may become necessary to refer personal information contained in this form to another government agency. In addition, all information provided in this form will be available for public inspection. If information requested on the form is not provided, the application may be returned without action having been taken upon it or its processing may be delayed while a request is made to provide the missing information. Your response is required to obtain the requested authorization.

Public reporting burden for this collection of information is estimated to average 639 hours and 53 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, can be sent to the Federal Communications Commission, Records Management Branch, Paperwork Reduction Project (3060-0627), Washington, D.C. 20554. Do NOT send completed forms to this address.

THE FOREGOING NOTICE IS REQUIRED BY THE PRIVACY ACT OF 1974, P.L. 93-579, DECEMBER 31, 1974, 5 U.S.C. 552a(e)(3), AND THE PAPERWORK REDUCTION ACT OF 1980, P.L. 96-511, DECEMBER 11, 1980, 44 U.S.C. 3507.

SECTION III - LICENSE APPLICATION ENGINEERING DATA

Name of Applicant

Saga Broadcasting , LLC

PURPOSE OF AUTHORIZATION APPLIED FOR: (check one)

☐ Station License ☒ Direct Measurement of Power

1. Facilities authorized in construction permit

Call Sign	File No. of Construction Permit (if applicable)	Frequency (kHz)	Hours of Operation	Power in kilowatts	
				Night	Day
KPUG		1170	Unlimited	5.0	10.0

2. Station location

State	City or Town
WA	Bellingham

3. Transmitter location

State	County	City or Town	Street address (or other identification)
WA	Whatcom	Bellingham	2340 E. Sunset Drive

4. Main studio location

State	County	City or Town	Street address (or other identification)
WA	Whatcom	Bellingham	2219 Yew Street Road

5. Remote control point location (specify only if authorized directional antenna)

State	County	City or Town	Street address (or other identification)
WA	Whatcom	Bellingham	2219 Yew Street Road

6. Has type-approved stereo generating equipment been installed? ☐ Yes ☒ No

7. Does the sampling system meet the requirements of 47 C.F.R. Section 73.68? ☒ Yes ☐ No ☐ Not Applicable

Attach as an Exhibit a detailed description of the sampling system as installed. Exhibit No.

No change in data on file - BMML-20151005AFK

8. Operating constants:

RF common point or antenna current (in amperes) without modulation for night system	RF common point or antenna current (in amperes) without modulation for day system
10.4	14.14*
Measured antenna or common point resistance (in ohms) at operating frequency	**Measured antenna or common point reactance (in ohms) at operating frequency**
Night: 50 Day: 50	Night: 0 Day: 0

Antenna indications for directional operation

Towers	Antenna monitor Phase reading(s) in degrees		Antenna monitor sample current ratio(s)		Antenna base currents	
	Night	Day	Night	Day	Night	Day
1 (W) (1032002)	-97.1		0.374			
2 (C) (1032003)	0		1.000			
3 (E) (1032004)	+97.6		0.543			

Manufacturer and type of antenna monitor: Potomac Instruments AM-1901

*Daytime power measured at common point ammeter

SECTION III - Page 2

9. Description of antenna system ((f directional antenna is used, the information requested below should be given for each element of the array. Use separate sheets if necessary.)

Type Radiator	Overall height in meters of radiator above base insulator, or above base, if grounded.	Overall height in meters above ground (without obstruction lighting)	Overall height in meters above ground (include obstruction lighting)	If antenna is either top loaded or sectionalized, describe fully in an Exhibit.
(3) Uniform cross-section guyed steel tower	65.55	67.0	68.1	Exhibit No.

Excitation [X] Series [ ] Shunt

Geographic coordinates to nearest second. For directional antenna give coordinates of center of array. For single vertical radiator give tower location.

North Latitude	48 °	46 '	33 "	West Longitude	122 °	26 '	23 "

If not fully described above, attach as an Exhibit further details and dimensions including any other antenna mounted on tower and associated isolation circuits. Exhibit No. 1

Also, if necessary for a complete description, attach as an Exhibit a sketch of the details and dimensions of ground system. Exhibit No.

No change in data on file - BMML-20151005AFK

10. In what respect, if any, does the apparatus constructed differ from that described in the application for construction permit or in the permit?

DNA

11. Give reasons for the change in antenna or common point resistance.

No Change

I certify that I represent the applicant in the capacity indicated below and that I have examined the foregoing statement of technical information and that it is true to the best of my knowledge and belief.

Name (Please Print or Type)	Signature (check appropriate box below)
Thomas S. Gorton P.E.	
Address (include ZIP Code) Hatfield & Dawson Consulting Engineers 9500 Greenwood Ave N Seattle, WA 98103	Date October 3, 2016
	Telephone No. (Include Area Code) 206-783-9151

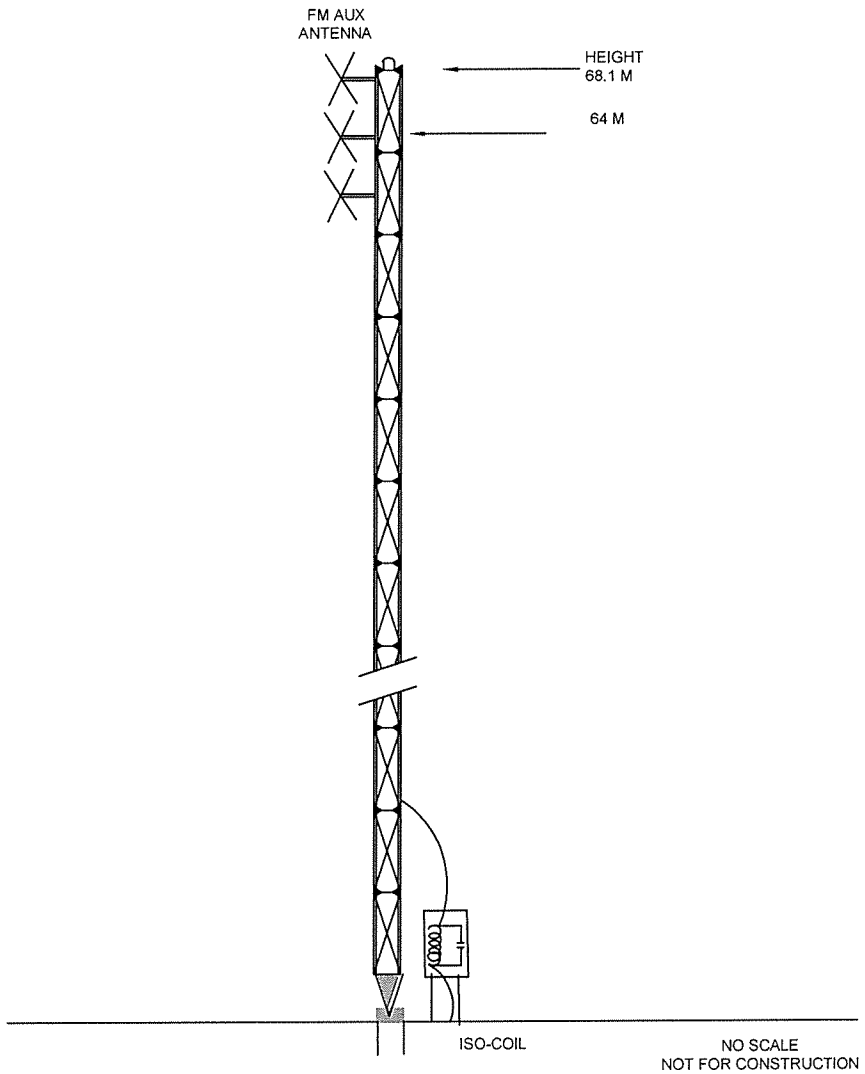
[ ] Technical Director

[X] Registered Professional Engineer

[ ] Chief Operator

[ ] Technical Consultant

[ ] Other (specify)



Dwayne Straume, H&D 9/30/2016 11:30 AM KPUG Antenna.dwg

HATFIELD & DAWSON
CONSULTING ENGINEERS

TOWER #1 EXHIBIT 1

KPUG-AM BELLINGHAM WASHINGTON 10/2016

HATFIELD & DAWSON
CONSULTING ELECTRICAL ENGINEERS
9500 GREENWOOD AVE. N.
SEATTLE, WASHINGTON 98103

BENJAMIN F. DAWSON III, PE
THOMAS M. ECKELS, PE
STEPHEN S. LOCKWOOD, PE
DAVID J. PINION, PE
ERIK C. SWANSON, PE

THOMAS S. GORTON, PE
MICHAEL H. MEHIGAN, PE

TELEPHONE (206) 783-9151
FACSIMILE (206) 789-9834
E-MAIL hatdaw@hatdaw.com

JAMES B. HATFIELD, PE
CONSULTANT

MAURY L. HATFIELD, PE
(1942-2009)
PAUL W. LEONARD, PE
(1925-2011)

Method of Moments Proof of Performance
and
Application for Direct Measurement of Power

KPUG (AM)

Bellingham, Washington

Facility ID 58887

1170 kHz

10 kW Day, 5 kW Night DA-N

Saga Broadcasting, LLC

October 2016

APPLICATION FOR LICENSE

RADIO STATION KPUG-AM Bellingham, Washington

1170 kHz 10 kW Day, 5 kW Night DA-N

Purpose of Application

Item 1	Analysis of Tower Impedance Measurements to Verify Method of Moments Model
Item 2	Method of Moments Model Details for Towers Driven Individually
Item 3	Method of Moments Model Details for Directional Antenna Pattern
Item 4	Derivation of Operating Parameters for Directional Antenna
Item 5	Direct Measurement of Power

Appendix A	FCC Form 302-AM

Purpose of Application

This engineering exhibit supports an application for return to Direct Measurement of Power for KPUG(AM), Bellingham, WA following the installation of an FM auxiliary antenna on the #1 (west) tower of the KPUG antenna array. The FM auxiliary facilities are authorized by construction permits BXP-20160329ABY (KISM-FM) and BXPH-20160329ACN (KAFE-FM). Per §1.30003 of the Commission's rules, base impedance measurements were taken on tower #1 of the KPUG antenna array. While not required by the rule, measurements were also taken on the other towers, due to recent repairs to the antenna ground system. The measurements taken on towers 2 and 3 differ only slightly from those taken for the previous method of moments proof of performance. This engineering exhibit contains an updated method of moment analysis of the KPUG array, based on the new impedance measurements.

Information is provided herein demonstrating that the directional antenna parameters for the patterns authorized by the station license have been determined in accordance with the requirements of section §73.151(c) of the FCC Rules. The system has been adjusted to produce antenna monitor parameters within +/- 5 percent in ratio and +/- 3 degrees in phase of the modeled values, as required by the Rules.

All measurements used in this report were made by the undersigned engineer.

Item 1

Analysis of Tower Impedance Measurements to Verify Method of Moments Model - KPUG

Tower base impedance measurements were made at the locations of the sample system current transformers (the "measurement points") using a Hewlett Packard 8751A network analyzer in a calibrated measurement system. The other towers were open circuited at their respective measurement points.

KPUG measured "measurement point" impedances

Tower	Measured R	Measured X
1 (W)	62.9	+j108.1
2 (C)	55.0	+j86.4
3 (E)	53.4	+j90.2

Circuit calculations were performed to relate the method of moments modeled impedances at the tower base feed points to those at the measurement locations as shown in the diagram titled *Analysis of Tower Impedance Measurements to Verify Method of Moments Model*. The series/parallel equivalent impedance of X_C, X_s and X_{LC} was used in the moment method model as a load at ground level (lumped load) for the open circuited towers. In all cases, the modeled impedance at the reference point is within one ohm of the measured reference point impedance.

Item 2

Method of Moments Model Details for Towers Driven Individually - KPUG

The array of towers was modeled using Expert MININEC Broadcast Professional Ver 14.0. The top and bottom wire end points were specified in degrees in the geographic coordinate system, using the theoretical directional antenna specifications for tower spacing and orientation. All towers are 92.1 electrical degrees in height, and are modeled using 21 segments per tower. Therefore, all segments are less than 10° in length, as required by the Commission's rules. All towers are uniform cross-section three-sided guyed towers with 24 inch faces. Tower #1 is now equipped with an 3 bay FM auxiliary antenna and iso-coil. The impedance value for the iso-coil used in the model is a measured value obtained from the manufacturer.

Each tower's modeled height relative to its physical height falls within the required range of 75 to 125 percent and each modeled radius falls within the required range of 80 percent to 150 percent of the radius of a circle having a circumference equal to the sum of the widths of the tower faces.

KPUG Tower Dimensions - Physical and Modeled

Tower	Physical Height (degrees)	Modeled Height (degrees)	Modeled Percentage of Height	Modeled Radius (meters)	Percentage of Equivalent Radius
1	92.1	101.7	110.4	.29	100
2	92.1	99.5	108.0	.29	100
3	92.1	98	106.4	.29	100

KPUG MININEC Model Node and Wire Numbering

Tower	Wires	Base Node
1	1-21	1
2	22-42	22
3	43-63	43

KPUG Tower 1 Driven Towers 2 & 3 Open Circuit at Current Transformer Location

GEOMETRY
Wire coordinates in degrees; other dimensions in meters
Environment: perfect ground

wire	caps	Distance	Angle	Z	radius	segs
1	none	0	0	0	.29	21
		0	0	101.7		
2	none	67.7	110.	0	.29	21
		67.7	110.	99.5		
3	none	135.4	110.	0	.29	21
		135.4	110.	98.		

Number of wires = 3
current nodes = 63

	minimum		maximum	
Individual wires	wire	value	wire	value
segment length	3	4.66667	1	4.84286
radius	1	.29	1	.29

ELECTRICAL DESCRIPTION
Frequencies (KHz)

	frequency		no. of	segment length (wavelengths)	
no.	lowest	step	steps	minimum	maximum
1	1,170.	0	1	.012963	.0134524

Sources

source	node	sector	magnitude	phase	type
1	1	1	1.	0	voltage

Lumped loads

load	node	resistance (ohms)	reactance (ohms)	inductance (mH)	capacitance (uF)	passive circuit
1	43	0	4,412.	0	0	0
2	22	0	7,600.	0	0	0

IMPEDANCE
normalization = 50.

freq (KHz)	resist (ohms)	react (ohms)	imped (ohms)	phase (deg)	VSWR	S11 dB	S12 dB
source = 1; node 1, sector 1							
1,170.	**64.71**	**84.302**	106.27	52.5	4.0143	-4.4205	-1.9475

KPUG Tower 2 Driven Towers 1 & 3 Open Circuit at Current Transformer Location

GEOMETRY
Wire coordinates in degrees; other dimensions in meters
Environment: perfect ground

wire	caps	Distance	Angle	Z	radius	segs
1	none	0	0	0	.29	21
		0	0	101.7		
2	none	67.7	110.	0	.29	21
		67.7	110.	99.5		
3	none	135.4	110.	0	.29	21
		135.4	110.	98.		

Number of wires = 3
current nodes = 63

	minimum		maximum	
Individual wires	wire	value	wire	value
segment length	3	4.66667	1	4.84286
radius	1	.29	1	.29

ELECTRICAL DESCRIPTION
Frequencies (KHz)

	frequency		no. of	segment length (wavelengths)	
no.	lowest	step	steps	minimum	maximum
1	1,170.	0	1	.012963	.0134524

Sources

source	node	sector	magnitude	phase	type
1	22	1	1.	0	voltage

Lumped loads

load	node	resistance (ohms)	reactance (ohms)	inductance (mH)	capacitance (uF)	passive circuit
1	43	0	4,412.	0	0	0
2	1	0	11,500.	0	0	0

IMPEDANCE
normalization = 50.

freq (KHz)	resist (ohms)	react (ohms)	imped (ohms)	phase (deg)	VSWR	S11 dB	S12 dB
source = 1; node 22, sector 1							
1,170.	**56.898**	**67.489**	88.274	49.9	3.3162	-5.4065	-1.475

KPUG Tower 3 Driven Towers 1 & 2 Open Circuit at Current Transformer Location

GEOMETRY
Wire coordinates in degrees; other dimensions in meters
Environment: perfect ground

wire	caps	Distance	Angle	Z	radius	segs
1	none	0	0	0	.29	21
		0	0	101.7		
2	none	67.7	110.	0	.29	21
		67.7	110.	99.5		
3	none	135.4	110.	0	.29	21
		135.4	110.	98.		

Number of wires = 3
current nodes = 63

	minimum		maximum	
Individual wires	wire	value	wire	value
segment length	3	4.66667	1	4.84286
radius	1	.29	1	.29

ELECTRICAL DESCRIPTION
Frequencies (KHz)

	frequency		no. of	segment length (wavelengths)	
no.	lowest	step	steps	minimum	maximum
1	1,170.	0	1	.012963	.0134524

Sources

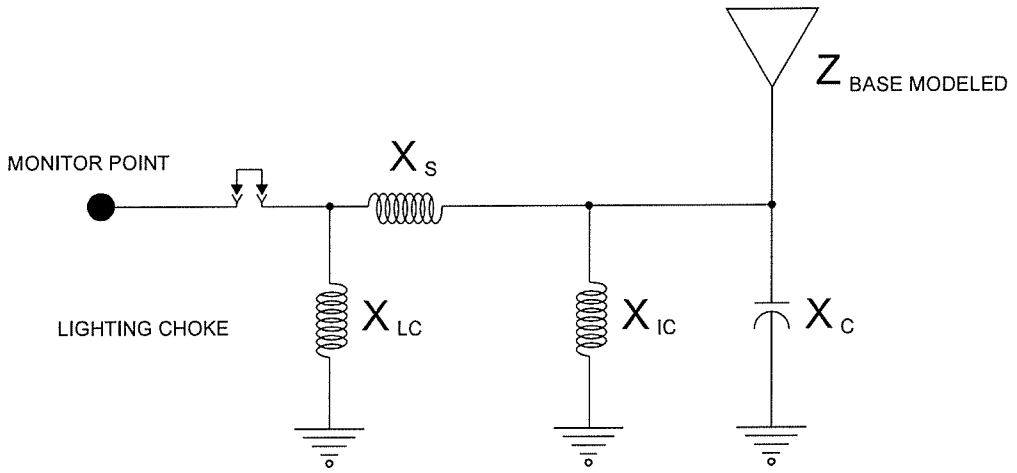
source	node	sector	magnitude	phase	type
1	43	1	1.	0	voltage

Lumped loads

load	node	resistance (ohms)	reactance (ohms)	inductance (mH)	capacitance (uF)	passive circuit
1	22	0	7,600.	0	0	0
2	1	0	11,500.	0	0	0

IMPEDANCE
normalization = 50.

freq (KHz)	resist (ohms)	react (ohms)	imped (ohms)	phase (deg)	VSWR	S11 dB	S12 dB
source = 1; node 43, sector 1							
1,170.	**55.758**	**63.805**	84.735	48.9	3.1552	-5.7021	-1.361



TOWER	X_{LC} (Ω)	X_S (Ω)	X_{IC} (Ω)	X_C (Ω)	Z_{BASE} MODELED (Ω)	Z_{MP} MODELED (Ω)	Z_{MP} MEASURED (Ω)
#1	+j2600	+j26	-j25325	-j3000	64.7 + j84.3	62.5 +j108.1	62.9 +j108.1
#2	+j2600	+j20	-------	-j4000	56.9 +j67.5	55.0 +j86.1	55.0 +j86.4
#3	+j2600	+j28	-------	-j6500	55.8 +j63.8	53.1 +j89.9	53.4 +j90.2

Dwayne Straume, H&D 10/3/2016 KPUG MOM TABLE.dwg

HATFIELD & DAWSON
CONSULTING ENGINEERS

ANALYSIS OF TOWER IMPEDANCE MEASUREMENTS TO VERIFY METHOD OF MOMENTS MODEL

RADIO STATION KPUG 1170 kHz BELLINGHAM, WA 10/2016

Item 3

Method of Moments Model Details for Directional Antenna- KPUG

The array of towers was modeled using MININEC with the individual tower characteristics that were verified by the individual tower impedance measurements. Calculations were made to determine the complex voltage values for sources located at ground level under each tower of the array to produce current moment sums for the towers that, when normalized, equated to the theoretical field parameters of the authorized directional antenna patterns. The following pages contain details of the method of moments models of the directional antenna patterns.

KPUG Driven Array

GEOMETRY
Wire coordinates in degrees; other dimensions in meters
Environment: perfect ground

wire	caps	Distance	Angle	Z	radius	segs
1	none	0	0	0	.29	21
		0	0	101.7		
2	none	67.7	110.	0	.29	21
		67.7	110.	99.5		
3	none	135.4	110.	0	.29	21
		135.4	110.	98.		

Number of wires = 3
current nodes = 63

	minimum		maximum	
Individual wires	wire	value	wire	value
segment length	3	4.66667	1	4.84286
radius	1	.29	1	.29

ELECTRICAL DESCRIPTION
Frequencies (KHz)

	frequency		no. of	segment length (wavelengths)	
no.	lowest	step	steps	minimum	maximum
1	1,170.	0	1	.012963	.0134524

Sources

source	node	sector	magnitude	phase	type
1	1	1	1,170.05	337.7	voltage
2	22	1	1,085.68	59.9	voltage
3	43	1	183.815	157.2	voltage

IMPEDANCE
normalization = 50.

freq (KHz)	resist (ohms)	react (ohms)	imped (ohms)	phase (deg)	VSWR	S11 dB	S12 dB
source = 1; node 1, sector 1							
1,170.	**98.309**	**253.02**	271.45	68.8	15.434	-1.1271	-6.4096
source = 2; node 22, sector 1							
1,170.	**54.651**	**74.981**	92.784	53.9	3.8024	-4.6786	-1.808
source = 3; node 43, sector 1							
1,170.	**17.075**	**23.315**	28.898	53.8	3.6311	-4.911	-1.6927

CURRENT rms
Frequency = 1170 KHz
Input power = 5,000. watts
Efficiency = 100. %
coordinates in degrees

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	0	0	0	**3.04788**	**269.**	-.0556347	-3.04737
2	0	0	4.84286	3.52349	265.9	-.250144	-3.5146
3	0	0	9.68571	3.79033	264.5	-.365128	-3.77271
4	0	0	14.5286	3.98705	263.4	-.457482	-3.96072
5	0	0	19.3714	4.12707	262.6	-.532801	-4.09253
6	0	0	24.2143	4.21649	261.9	-.593561	-4.1745
7	0	0	29.0571	4.25838	261.3	-.640932	-4.20987
8	0	0	33.9	4.25468	260.9	-.675576	-4.2007
9	0	0	38.7429	4.20686	260.5	-.697935	-4.14856
10	0	0	43.5857	4.11622	260.1	-.708366	-4.05481
11	0	0	48.4286	3.98402	259.8	-.707192	-3.92075
12	0	0	53.2714	3.8116	259.5	-.694754	-3.74775
13	0	0	58.1143	3.60034	259.3	-.671422	-3.53718
14	0	0	62.9571	3.35168	259.	-.637588	-3.29048
15	0	0	67.8	3.06709	258.8	-.593668	-3.00909
16	0	0	72.6429	2.74797	258.7	-.540083	-2.69437
17	0	0	77.4857	2.39555	258.5	-.477224	-2.34754
18	0	0	82.3286	2.01058	258.4	-.405388	-1.96929
19	0	0	87.1714	1.59276	258.2	-.324649	-1.55932
20	0	0	92.0143	1.13927	258.1	-.234527	-1.11487
21	0	0	96.8571	.64121	258.	-.133233	-.627215
END	0	0	101.7	0	0	0	0
GND	-23.1548	-63.6172	0	**8.274**	**6.**	8.2286	.865591
23	-23.1548	-63.6172	4.7381	8.63721	4.2	8.6144	.627241
24	-23.1548	-63.6172	9.47619	8.80319	3.1	8.79005	.480885
25	-23.1548	-63.6172	14.2143	8.88355	2.3	8.87638	.356822
26	-23.1548	-63.6172	18.9524	8.88911	1.6	8.88565	.24831
27	-23.1548	-63.6172	23.6905	8.82516	1.	8.82385	.152382
28	-23.1548	-63.6172	28.4286	8.69485	.4	8.69459	.0676891
29	-23.1548	-63.6172	33.1667	8.50042	360.	8.50041	-6.45E-03
30	-23.1548	-63.6172	37.9048	8.24389	359.5	8.24359	-.070418
31	-23.1548	-63.6172	42.6429	7.9275	359.1	7.92653	-.124419
32	-23.1548	-63.6172	47.381	7.55336	358.7	7.55148	-.168588
33	-23.1548	-63.6172	52.1191	7.12381	358.4	7.12092	-.203018
34	-23.1548	-63.6172	56.8572	6.64127	358.	6.63736	-.227782
35	-23.1548	-63.6172	61.5952	6.10831	357.7	6.10348	-.242946
36	-23.1548	-63.6172	66.3333	5.52746	357.4	5.52187	-.248576
37	-23.1548	-63.6172	71.0714	4.90112	357.1	4.89501	-.244726
38	-23.1548	-63.6172	75.8095	4.23133	356.9	4.225	-.231425
39	-23.1548	-63.6172	80.5476	3.51928	356.6	3.51309	-.208643
40	-23.1548	-63.6172	85.2857	2.76438	356.3	2.75876	-.176208
41	-23.1548	-63.6172	90.0238	1.96171	356.1	1.95716	-.133594
42	-23.1548	-63.6172	94.7619	1.09626	355.8	1.09338	-.0794321
END	-23.1548	-63.6172	99.5	0	0	0	0
GND	-46.3095	-127.234	0	**4.49771**	**103.4**	-1.03999	4.37582
44	-46.3095	-127.234	4.66667	4.5499	102.8	-1.00629	4.43722
45	-46.3095	-127.234	9.33333	4.55233	102.4	-.979251	4.44576
46	-46.3095	-127.234	14.	4.52412	102.1	-.949779	4.4233
47	-46.3095	-127.234	18.6667	4.46737	101.8	-.917096	4.37223
48	-46.3095	-127.234	23.3333	4.38333	101.6	-.880942	4.29389
49	-46.3095	-127.234	28.	4.2729	101.4	-.841302	4.18925

50	-46.3095	-127.234	32.6667	4.13695	101.1	-.798281	4.0592
51	-46.3095	-127.234	37.3333	3.97637	100.9	-.752086	3.9046
52	-46.3095	-127.234	42.	3.79214	100.7	-.702971	3.72641
53	-46.3095	-127.234	46.6667	3.58528	100.5	-.651232	3.52564
54	-46.3095	-127.234	51.3333	3.3569	100.2	-.597215	3.30335
55	-46.3095	-127.234	56.	3.10818	100.	-.541294	3.06068
56	-46.3095	-127.234	60.6667	2.84031	99.8	-.483867	2.79879
57	-46.3095	-127.234	65.3333	2.55449	99.6	-.425345	2.51883
58	-46.3095	-127.234	70.	2.25184	99.4	-.366136	2.22187
59	-46.3095	-127.234	74.6667	1.9333	99.1	-.306632	1.90883
60	-46.3095	-127.234	79.3333	1.59943	98.9	-.247168	1.58021
61	-46.3095	-127.234	84.	1.24998	98.6	-.187966	1.23577
62	-46.3095	-127.234	88.6667	.882765	98.4	-.128983	.873291
63	-46.3095	-127.234	93.3333	.491155	98.1	-.06958	.486201
END	-46.3095	-127.234	98.	0	0	0	0

CURRENT MOMENTS(amp-degrees) rms

Frequency = 1170 KHz
Input power = 5,000. watts

			vertical current moment	
wire	magnitude	phase (deg)	magnitude	phase (deg)
1	323.136	261.	323.136	261.
2	633.599	360.	633.599	360.
3	304.127	101.	304.127	101.

Medium wave array vertical current moment (amps-degrees) rms
(Calculation assumes tower wires are grouped together.
The first wire of each group must contain the source.)

tower	magnitude	phase (deg)
1	323.136	261.
2	633.599	360.
3	304.127	101.

Comparison of Current Moments with Theoretical Antenna Field Parameters

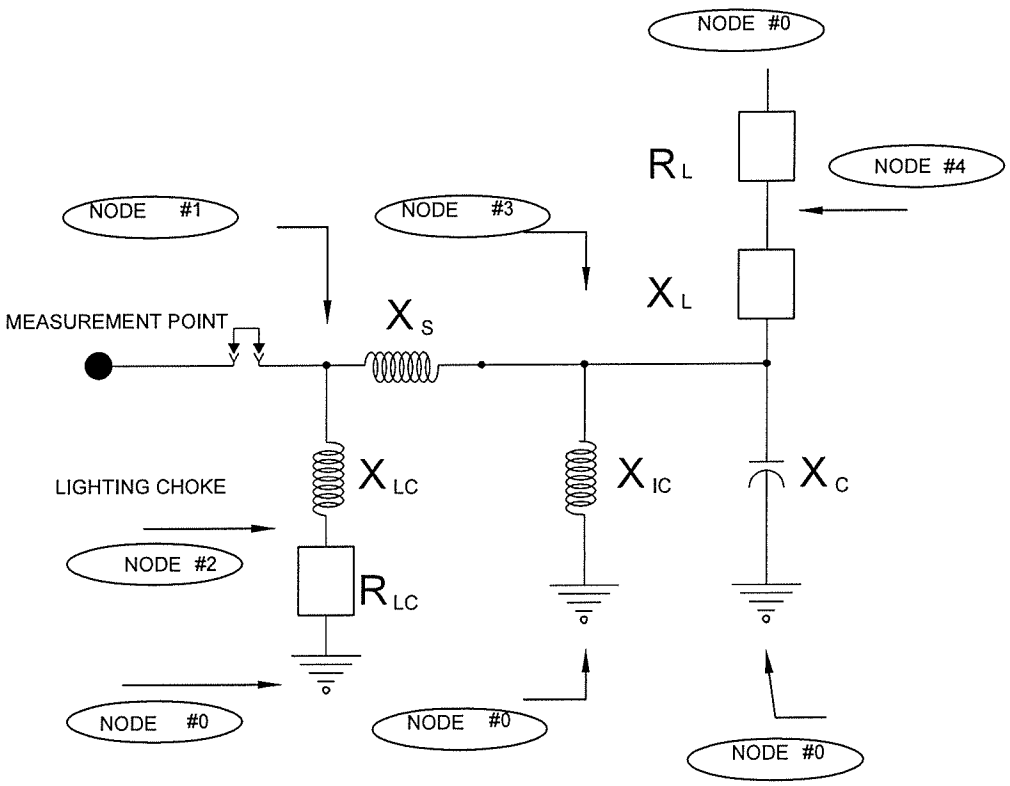
Tower	Current Moment Magnitude	Current Moment Phase	Normalized Magnitude	Normalized Phase	Standard Pattern Ratio	Standard Pattern Phase
1 (W)	323.136	261.0	0.510	-99.0	0.510	-99.0
2 (C)	633.599	360.0	1.0	0	1.0	0
3 (E)	304.127	101.0	0.480	+101.0	0.480	+101.0

As shown in the tables above, the base currents used in the Method of Moments computer model produce current moments in each of the towers that are identical to the field ratios and phases of the theoretical antenna parameters specified in the KPUG station license.

Item 4

Derivation of Operating Parameters for Directional Antenna - KPUG

The currents at the tower reference points have been calculated by using the computer circuit simulation program pspice. A pspice model has been made for each tower using the antenna base currents and base impedances calculated by MININEC and shown above, and the reactances listed previously in the table *Analysis of Tower Impedance Measurements to Verify Method of Moments Model*. The magnitude and phase of the current source in the pspice model (IIN) was adjusted such that the current calculated in the output branch of the pspice model (the current through resistor R_L) was the same as the base current for the tower calculated by MININEC. The current at the reference point is the current source in the pspice model. These calculated currents are then normalized to the reference tower to obtain the antenna monitor phase and ratio readings, as shown in the tables labeled Antenna Monitor Parameters, which follow the pspice data below.



Dwayne Straume, H&D 9/30/2016 11:00 AM KPUG MOM TABLE.dwg

HATFIELD & DAWSON
CONSULTING ENGINEERS

PSPICE MODEL NODE MAP

RADIO STATION KPUG 1170 kHz BELLINGHAM WASHINGTON 10/16

```
## KPUG TOWER 1 NIGHT BASE MODEL

****     CIRCUIT DESCRIPTION

******************************************************************************


.OPT LIST NOPAGE NODE NOMOD
.AC LIN 1 1170kHz 1170kHz

IIN             0                       1       AC 3.146 -91.5
LXlc            1                       2               353.7uH
Rlc             2                       0               .001ohms
LXs             1                       3               3.537uH
CXc             3                       0               45.34pF
LXic            3                       0               3445uH
LL              3                       4               34.416uH
RL              4                       0               98.3ohms


.PRINT AC IM(RL) IP(RL)

##.PROBE
.END




****     AC ANALYSIS                    TEMPERATURE =   27.000 DEG C


 FREQ         IM(RL)       IP(RL)

  1.170E+06   3.048E+00   -9.102E+01
```

```
## KPUG TOWER 2 NIGHT BASE MODEL

 ****     CIRCUIT DESCRIPTION

******************************************************************************


.OPT LIST NOPAGE NODE NOMOD
.AC LIN 1 1170kHz 1170kHz

IIN             0                       1       AC 8.42 5.591
LX1c            1                       2               353.7uH
R1c             2                       0               .001ohms
LXs             1                       3               2.721uH
CXc             3                       0               34pF
LL              3                       4               10.202uH
RL              4                       0               54.7ohms


.PRINT AC IM(RL) IP(RL)

##.PROBE
.END



 ****     AC ANALYSIS                        TEMPERATURE =   27.000 DEG C


  FREQ         IM(RL)       IP(RL)

   1.170E+06   8.274E+00    6.000E+00
```

KPUG TOWER 3 NIGHT BASE MODEL

**** CIRCUIT DESCRIPTION

****

.OPT LIST NOPAGE NODE NOMOD
.AC LIN 1 1170kHz 1170kHz

IIN	0	1	**AC 4.57 103.2**
LX1c	1	2	353.7uH
R1c	2	0	.001ohms
LXs	1	3	3.81uH
CXc	3	0	20.93pF
LL	3	4	3.17uH
RL	4	0	17.1ohms

.PRINT AC IM(RL) IP(RL)

##.PROBE
.END

**** AC ANALYSIS TEMPERATURE = 27.000 DEG C

FREQ	IM(RL)	IP(RL)
1.170E+06	**4.498E+00**	**1.034E+02**

Antenna Monitor Parameters - KPUG

Tower	Ref Point Current Magnitude	Ref Point Current Phase	Normalized Magnitude	Normalized Phase
1 (W)	3.146	-91.5°	0.374	-97.1°
2 (C)	8.42	5.591°	1.0	0°
3 (E)	4.57	103.2°	0.543	+97.6°

Post Construction Array Geometry Statement & Survey - KPUG

Because the KPUG antenna system has been previously licensed (BZ-20071121ADE) via a traditional measurement based proof of performance and there have been no changes made to the theoretical antenna parameters, a post-construction survey is not required per FCC Public Notice DA 09-2340. (October 29, 2009)

Item 5

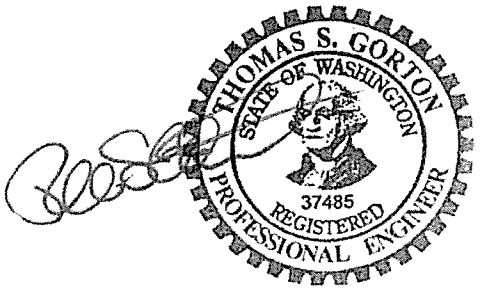
Direct Measurement of Power - KPUG

Common point impedance measurements were made using a Hewlett Packard 8751A network analyzer in a calibrated measurement system. The measurements were made at the phasor cabinet input jack adjacent to the common point current meter that is used to determine operating power. The impedance measured at this point was adjusted to a value of 50 +/- j0 Ohms. Daytime operating power is also measured at the common point meter.

Certification

This engineering exhibit has been prepared personally by the undersigned or under my immediate supervision, and all representations are true and correct to the best of my knowledge. I am an experienced radio engineer whose qualifications are a matter of record with the Federal Communications Commission, I am an engineer in the firm of Hatfield & Dawson Consulting Engineers, LLC, and I am Registered as a Professional Engineer in the States of Washington and Oregon.

October 3, 2016



Thomas S. Gorton P.E.