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REMITTANCE ADVICE
FORM 159

2018 APR 17 PM 1:38

Approved by OMB
3060-0589
Page No 1 of 2

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SECTION A – PAYER INFORMATION

(2) PAYER NAME (if paying by credit card enter name exactly as it appears on the card) Global Radio, L.L.C. (Delaware)		(3) TOTAL AMOUNT PAID (U.S. Dollars and cents) $1,505.00
(4) STREET ADDRESS LINE NO. 1 Suite 201		
(5) STREET ADDRESS LINE NO. 2 2890 Emma Lee Street		
(6) CITY Falls Church	(7) STATE VA	(8) ZIP CODE 22042
(9) DAYTIME TELEPHONE NUMBER (include area code) 703-532-0400	(10) COUNTRY CODE (if not in U.S.A.)	

FCC REGISTRATION NUMBER (FRN) REQUIRED

(11) PAYER (FRN) 0013816491	(12) FCC USE ONLY

IF MORE THAN ONE APPLICANT, USE CONTINUATION SHEETS (FORM 159-C)
COMPLETE SECTION BELOW FOR EACH SERVICE, IF MORE BOXES ARE NEEDED, USE CONTINUATION SHEET

(13) APPLICANT NAME		
(14) STREET ADDRESS LINE NO. 1		
(15) STREET ADDRESS LINE NO. 2		
(16) CITY 0013816491	(17) STATE	(18) ZIP CODE
(19) DAYTIME TELEPHONE NUMBER (include area code)	(20) COUNTRY CODE (if not in U.S.A.)	

FCC REGISTRATION NUMBER (FRN) REQUIRED

(21) APPLICANT (FRN) 0013816491	(22) FCC USE ONLY

COMPLETE SECTION C FOR EACH SERVICE, IF MORE BOXES ARE NEEDED, USE CONTINUATION SHEET

(23A) CALL SIGN/OTHER ID WCRW	(24A) PAYMENT TYPE CODE MMR	(25A) QUANTITY 1
(26A) FEE DUE FOR (PTC) $700.00	(27A) TOTAL FEE $700.00	FCC USE ONLY
(28A) FCC CODE 1	(29A) FCC CODE 2	
(23B) CALL SIGN/OTHER ID WCRW	(24B) PAYMENT TYPE CODE MOR	(25B) QUANTITY 1
(26B) FEE DUE FOR (PTC) $805.00	(27B) TOTAL FEE $805.00	FCC USE ONLY
(28B) FCC CODE 1	(29B) FCC CODE 2	

SECTION D – CERTIFICATION

CERTIFICATION STATEMENT

I, ____________________, certify under penalty of perjury that the foregoing and supporting information is true and correct to the best of my knowledge, information and belief.

SIGNATURE ________________________________ DATE ____________________

SECTION E - CREDIT CARD PAYMENT INFORMATION

ACCOUNT NUMB

I hereby authorize tl

SIGNATURE____

PAID BY CREDIT CARD

JARY 2003

Alan Pendleton

Federal Communications Commission
Washington, D. C. 20554

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

FOR FCC USE ONLY

FCC 302-AM
APPLICATION FOR AM BROADCAST STATION LICENSE

(Please read instructions before filling out form.)

FOR COMMISSION USE ONLY
FILE NO. BMML-20180411AAY

SECTION I - APPLICANT FEE INFORMATION

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

Potomac Radio, LLC (Delaware)

MAILING ADDRESS (Line 1) (Maximum 35 characters)
Suite 201

MAILING ADDRESS (Line 2) (Maximum 35 characters)
2890 Emma Lee Street

CITY	STATE OR COUNTRY (if foreign address)	ZIP CODE
Falls Church	VA	22042

TELEPHONE NUMBER (include area code)	CALL LETTERS	OTHER FCC IDENTIFIER (If applicable)
703-532-0400	WCRW	FIN: 54876

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:

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
	0 0 0 1	$	

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
	0 0 0 1	$	

ADD ALL AMOUNTS SHOWN IN COLUMN C, AND ENTER THE TOTAL HERE. THIS AMOUNT SHOULD EQUAL YOUR ENCLOSED REMITTANCE.

TOTAL AMOUNT REMITTED WITH THIS APPLICATION	FOR FCC USE ONLY
$	

SECTION II - APPLICANT INFORMATION

1. NAME OF APPLICANT Potomac Radio, LLC (Delaware)		
MAILING ADDRESS Suite 201, 2890 Emma Lee Street		
CITY Falls Church	STATE VA	ZIP CODE 22042

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
WCRW	Leesburg, VA	BP-20161130AAH		5/3/2020

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

If No, explain in an Exhibit.

☐ Yes ☑ No

Exhibit No. A

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

If No, state exceptions in an Exhibit.

☑ Yes ☐ No

Exhibit No.

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?

If Yes, explain in an Exhibit.

☐ Yes ☑ No

Exhibit No.

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)?

If No, explain in an Exhibit.

☐ Yes ☐ No

☑ Does not apply

Exhibit No.

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.

8. Does the applicant, or any party to the application, have a petition on file to migrate to the expanded band (1605-1705 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.

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	
Alan Pendleton	Alan Pendleton	
Title	**Date**	**Telephone Number**
President	4-3-2018	703-532-0400

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

SECTION III - LICENSE APPLICATION ENGINEERING DATA

Name of Applicant
Potomac Radio, LLC (Delaware)

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
WCRW	BP-20161130AAH	1190	Unlimited	1.2	50

2. Station location	
State	City or Town
Virginia	Leesburg

3. Transmitter location			
State	County	City or Town	Street address (or other identification)
Virginia	Loudoun	Ashburn	21054 Loudoun County Parkway

4. Main studio location			
State	County	City or Town	Street address (or other identification)
Virginia		Falls Church	2890 Emma Lee Street, Suite 201

5. Remote control point location (specify only if authorized directional antenna)			
State	County	City or Town	Street address (or other identification)
Virginia		Falls Church	2890 Emma Lee Street, Suite 201

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.
Statement E

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
5.373	34.436

Measured antenna or common point resistance (in ohms) at operating frequency		Measured antenna or common point reactance (in ohms) at operating frequency	
Night	Day	Night	Day
44.9	44.4	-17.2	-0.3

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 (SE) ASRN 1255859	-157.8	-82.7	0.518	0.490	Not Required	Not Required
2 (C) ASRN 1255860	0.0	0.0	1.000	1.000	Not Required	Not Required
3 (NW) ASRN 1255861	140.0	154.1	0.893	0.322	Not Required	Not Required

Manufacturer and type of antenna monitor: Potomac Instruments AM-1901-3

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.
Self-supporting towers	57.87	59.4	59.4	Exhibit No. N/A

Excitation ☑ 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	39 °	02 '	28 "	West Longitude	77 °	26 '	42 "

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. Statement E

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

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

None

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

Addition of nighttime mode of operation; internal changes to RF systems.

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)
Garrison C. Cavell	[signature]
Address (include ZIP Code) Cavell, Mertz & Associates, Inc. 7724 Donegan Drive Manassas, VA 20109-2868	Date 04/02/2018 Telephone No. (Include Area Code) (703) 392-9090

☐ Technical Director
☐ Registered Professional Engineer
☐ Chief Operator
☑ Technical Consultant
☐ Other (specify)

THOMPSON HINE
ATLANTA CLEVELAND DAYTON WASHINGTON, D.C.
CINCINNATI COLUMBUS NEW YORK

April 9, 2018

BY EXPRESS MAIL TO POST OFFICE BOX

Federal Communications Commission
Media Bureau
P.O. Box 979089
St. Louis, Missouri 63197-9000

Re: Station WCRW(AM)
Leesburg, Virginia
Facility ID No. 54876
Application for License to Cover

Dear Sir:

Transmitted herewith, in triplicate, on behalf of Potomac Radio, LLC (Delaware), the licensee of Station WCRW(AM), Leesburg, Virginia, is an application on FCC Form 302-AM. The application requests authority for a license to cover, based on the completion of the construction of new facilities for the Station, as authorized in FCC File No. BP-20161130AAH.

Also enclosed is FCC Form 159, providing for a credit card payment in the amount of $1,505.00 for the required filing fee for a license to cover a construction permit and for the AM directional antenna system.

Finally, we are also providing a copy of this submission along with a stamped, self-addressed envelope. We request that a stamped copy of the submission be returned to us in that envelope.

THOMPSON HINE LLP
ATTORNEYS AT LAW
1919 M Street, N.W.
Suite 700
Washington, D.C. 20036-3537
www.ThompsonHine.com
Phone 202.331.8800
Fax 202.331.8330

Should there be any questions in regard hereto, please communicate with the undersigned.

Respectfully submitted,

Barry A. Friedman

Enclosures

cc: Mr. Alan Pendleton (For Public Inspection)
Ms. Kay Whitfield (FCC Audio Division)
Mr. Jerry Manarchuck (FCC Audio Division)

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EXHIBIT A

The instant application requests a license to cover for a directional AM station. Pursuant to Section 73.1620(a)(4), an application for a license to cover, on FCC Form 302-AM, must be filed at least 10 days "prior to the date on which [the permittee] desires to commence program test operations."

Statement E

Attachment to FCC Form 302-AM for WCRW
APPLICATION FOR STATION LICENSE
(Method of Moments Proof-of-Performance)

Supporting FCC Construction Permit BP-20161130AAH

WCRW Leesburg, Virginia - Facility ID 54876
Potomac Radio, LLC (Delaware)

Prepared by
Garrison C. Cavell
CAVELL, MERTZ & ASSOCIATES, INC.
APRIL 2, 2018

Statement E
APPLICATION FOR STATION LICENSE
Supporting FCC Construction Permit BP-20161130AAH
WCRW Leesburg, Virginia (Facility ID 54876)

Table of Contents

Introduction and Summary

This Statement has been prepared on behalf of ***Potomac Radio, LLC (Delaware)***, ("*Potomac Radio*"), licensee of Station WCRW, Leesburg, Virginia. WCRW is presently licensed to operate only during daytime-hours on the frequency of 1190 kHz at 50 kW, using a three-element directional antenna system (see FCC File Number BMML-20110208ADY.) *Potomac Radio* also holds a Construction Permit (FCC File Number BP-20161130AAH) authorizing the addition of nighttime operation for WCRW at 1.2 kW using the same physical antenna array as is employed for the licensed daytime facility. The construction authorized in the nighttime Construction Permit ("CP") has now been completed. Installation and adjustment of the additional RF phasing and coupling systems necessary to operate with the authorized new nighttime facilities has been accomplished; new nighttime operating parameters have been achieved using the results of Method-of-Moments ("MoM") analysis as permitted by Section 73.151(c) of the FCC Rules[1]. Inasmuch as changes were noted in the tower base impedances of the licensed daytime operation (discussed below), and certain sample system components were replaced, updated *daytime* parameters have also been developed using MoM techniques and are also discussed herein. Accordingly, this Statement and its attachments provide a new Proof-of-Performance ("Proof") for both the WCRW daytime and nighttime antenna systems[2]. As such, this facility is now able to operate in compliance with the terms and conditions of its Nighttime CP and all applicable FCC Rules and policies. *Program Test Authority* ("PTA") is herein respectfully requested on behalf of *Potomac Radio*.

MoM Analysis Basis - Daytime Proof-of-Performance

As part of the normal pre-construction site evaluation, open-circuit "self" impedance measurements were taken at the tower bases in December of 2017 and compared to those that were obtained as part of the site's original 2011 daytime MoM proof-of-performance. It should be noted that, prior to taking these new measurements, necessary minor RF feed changes were made between the tuning units and the towers, and additional RF system enclosures were incorporated at two of the existing tuning units (to accommodate the nighttime system components). Some small differences in results were also expected and observed due to the construction changes and because (at the time of the measurements) the site was somewhat wetter than when the original measurements were done in 2011.

[1] The WCRW antenna array is eligible for licensing under the Commission's MoM Rules in that the antenna system consists of series fed, base insulated towers, using a conventional buried-wire ground system. Further, a MoM Proof-of-Performance has been previously used for this Station as the basis for a 2011 grant of its present daytime license following completion of construction for the (then) new replacement daytime site.

[2] Both antenna systems have been adjusted to produce antenna monitor parameters that are within +/- 5 percent in ratio and +/- 3 degrees in phase of MoM modeled values as required by the FCC Rules. Further, the operating power of the adjusted antenna systems was determined in accordance with the requirements of FCC Rule Sections 73.51(b) and 73.54(b).

The final impedance measurements, shown below, demonstrate that the just-completed (December 2017) open-circuit-self measurements did very slightly differ at all towers, with a slight excursion just outside the FCC's "+/- 2 Ohms and +/- 4%" impedance tolerance window occurring for Tower 2.

Tower	Dec. 2017 Measured Open Circuit-Self	2011 Measured Open Circuit-Self	2011 Lower Limit Resistance	2011 Lower Limit Reactance	2011 Upper Limit Resistance	2011 Upper Limit Reactance
1 (SE)	30.63 +j 0.3 Ω	29.7 -j 1.0 Ω	26.51 Ω	-j 2.96 Ω	32.89 Ω	+j 0.96 Ω
2 (C)	28.96 +j 3.5 Ω	25.8 +j 2.8 Ω	22.77 Ω	-j 4.69 Ω	28.83 Ω	-j 0.91 Ω
3 (NW)	31.40 +j 2.4 Ω	30.2 +j 0.5 Ω	26.99 Ω	-j 1.52 Ω	33.41 Ω	+j 2.52 Ω

These observations were informally discussed with FCC staff. Because of the change for Tower 2, it was agreed that a new MoM analysis should be conducted for the daytime directional operation using the above more recent measurement data. Further, a new sampling system certification is necessary pursuant to Section 73.155 of the FCC's rules because the original toroidal current transformer ("TCT") sampling devices were replaced with new units. Accordingly, the analysis, documented herein, constitutes an updated proof-of-performance for the daytime array and an analysis and new proof-of performance for the completed nighttime array.

Antenna and Ground System Description

The existing WCRW daytime antenna system consists of three, tapered, base insulated, series excited self-supporting steel towers. The nighttime CP specified the use of this existing antenna array; no tower modifications were specified or required.

The WCRW ground system remains as previously licensed. It is a conventional buried copper wire ground system, consisting of 120 equally spaced number 10 soft-drawn, copper radial wires buried into the ground and arrayed every 3° around each tower, to a length of 63 meters (206 feet), except where terminated in common, four inch transverse copper straps or shortened by setbacks from certain local boundary features. Additionally, each concrete tower base foundation is covered with extruded copper mesh, which is crossed by several (4-inch wide) copper straps. The periphery of the foundation-top mesh area is bonded to a 4-inch perimeter strap around the tower base foundation, to which the 120 copper ground radials are silver soldered. An additional set of 120 shorter copper radials are bonded to the tower base perimeter strap and interspersed (and buried) between the longer radials. These short supplemental radials are each 15.2 meters (50 feet) in length, and are also number 10 soft-drawn copper wire. Copper straps are also run to seven, 8-foot long buried copper ground rods evenly distributed around each tower base to aid in lightning protection. Copper straps are also buried between the towers and in the transmission line trench and are also tied to the tower base ground strap as well as to the transmitter building grounding system.

Statement E
APPLICATION FOR STATION LICENSE
Supporting FCC Construction Permit BP-20161130AAH
WCRW Leesburg, Virginia (Facility ID 54876)

Antenna Monitor and Sample System

As will be demonstrated in the following, the installed antenna monitor - sampling system complies with the requirements of the FCC Rule Section 73.151(c).

A *Potomac Instruments Inc.* Model AM-1901-3 Antenna Monitor, Serial Number 836, is in service for this station. The factory calibration date for this monitor is August 5, 2010. The calibration was verified using the manufacturer's instrument self-calibration procedures and by observing indications when channel were fed by voltages having equal magnitude and phase. *Phasetek Inc.* toroidal current transformers are employed to provide sample currents for the antenna sampling system. The operating characteristics of these TCTs were verified per the requirements of the FCC's Rules prior to antenna array adjustment. (See following separate section of this Statement regarding TCT calibration checks.)

These TCTs feed individual phase stabilized, factory connectorized, equal length, half-inch *Andrew Corporation* coaxial sample cables (Model 42394-14VA). They are installed at the site under equal environmental conditions, all being buried except where extending equally to terminating locations. The electrical lengths and characteristic impedance of these lines were verified prior to array adjustment per the Commission's MoM proof requirements, as discussed later in this Statement.

This sampling system, as constructed, conforms to the provisions of Section 73.68(a) of the Commission's Rules that were in effect prior to January 1, 1986. Approval of this sampling system is therefore being requested, if pertinent, pursuant to the FCC's Public Notice of December 9, 1985.

MoM Modeling Process

FCC Rule Section 73.151(c) permits the use of computer modeling techniques (i.e.: Method-of-Moments) as a means of verifying AM radio station directional antenna performance for "qualified" antenna systems. As was noted previously, the WCRW directional antenna array is qualified for such an analysis since it consists of series fed, base insulated towers, using a conventional, buried-wire, ground system. Additionally, the WCRW 2011 Proof for the licensed WCRW daytime operation also used a MoM-based Proof to establish its performance. Accordingly, the WCRW antenna system was once again evaluated using a MoM analysis for both the day and night patterns. The particular computer program employed for this purpose was *Expert MININEC Broadcast Professional*[3] Version 14.5, which is a PC compatible version of the Numerical Electromagnetics Code (NEC) family of analytical tools.

[3] *Expert MININEC Broadcast Professional* was published by *EM Scientific Inc.*

The procedure for conducting a broadcast MoM proof first involves making impedance measurements at each of the towers to serve as benchmarks for calibrating the findings of the MoM calculations. An initial model of the characteristics of each individual tower is developed (in this case, the "open-circuit" "self" condition), and then model tower characteristics (height and width) are then adjusted, while consideration is made of the stray reactances found in the antenna base environment using circuit analysis methods. In this manner, the modeled impedance is "converged" to the measured values, thus establishing a calibrated mathematical version of the antennas. Then, using the calibrated antenna model for all towers, the theoretical directional antenna field parameters are introduced into the software to synthesize the pattern for the Station in each directional mode of operation. Required base currents and driving point impedance conditions are then derived along with a set of antenna monitor parameters for the modeled array. These parameters are used as "targets" by the field engineer or technician to achieve the authorized pattern by adjusting the RF phasing and coupling system to the modeled values. The following text describes the specific approach taken in the modeling and adjustment of this particular directional antenna system.

Tower Impedance Measurements Used to Converge the WCRW Method of Moments Model

Before the model was run for the directional pattern analysis, new impedance measurements were taken at each of the WCRW tower bases using a precision, calibrated measurement system consisting of a *Hewlett-Packard* model 8753C network analyzer in conjunction with a *Tunwall Radio* directional coupler system and an *Electronic Navigation Industries* ("*ENI*") Model 310 L RF amplifier. Analyzer calibration was field verified prior to each measurement using the procedures specified in the manufacturer's instruction manual and using precision calibration standards. After calibration of the measurement system, impedance measurements were made at each tower at the location of the final output jacks[4] ("J-plugs") within the respective Antenna Tuning Units ("ATUs"). As each tower was being measured, all the other tower bases were "open circuited" at the same impedance measurement locations. This J-Plug reference point at each ATU is located immediately adjacent to the sampling transformer of the antenna monitor system at the output of the ATU system enclosure. At each ATU enclosure, it was confirmed that the tower RF current passes directly from that point, through heavy conductors, through the tuning unit enclosure bowl insulator, and on to the tower attachment point above the base insulators, without any intervening adjustable shunt components following the sampling transformers. A fixed value static drain choke is in place for each tower as is the base insulator, so an assumed value for these reactances, as well as other stray reactances encountered in the base region, was employed for the "base circuit"

[4] This point is referred to in this report as the tower "reference point", since it is the location where the sampling system toroidal current transformers ("TCTs") are also installed and from which antenna monitor (current) samples are taken.

calculations for each tower. The installed static-drain chokes exhibit very high reactances at the WCRW frequency of 1190 kHz, and do not require particular consideration in this analysis. Nevertheless, their effects were included in the "base circuit" strays analysis for completeness. As is shown in the following pages, the open-circuit "self" impedances measured at the respective tower TCT reference points materially agree with converged modeled expectations.

Tower Base Environment (Base Circuit Analysis) Calculations

After the base impedance measurements were harvested, tower base environment circuit calculations were performed both manually and by using the "WCAP" network analysis program software[5] provided by *Westberg Consulting.* These calculations were used throughout the proof process to relate the MoM modeled impedances[6] to the ATU output measurement (reference) points. As shown on the following pages, the Open Circuit stray reactance found at each tower was calculated for the assumed base conditions for all towers. This value was then used in the MoM model as a "lumped load" at ground level for the open circuited ("OC") MoM individual model "self" (individual tower) case. Using these assumed lumped loads, base environment, and MoM analysis, initial values were derived and the model converged for each tower. A schematic of the assumed circuit, along with a summary of results and a tabulation of WCAP calculated values, is provided on the following page. Values for the various shunt stray reactances for base insulators and static drain chokes, are based upon manufacturer supplied information, and are included below the representative schematic along with the realized "lumped load" value. In each of the WCAP tabulations, as illustrated by the representative schematic, "Node 2" represents the ATU output "reference point" (TCT location). "Node 3" represents the tower feed-point. "Node 0" represents ground potential. In the Open Circuit "Tower Self" analysis tabulations for each tower, the calculated ATU output impedances appear under the "TO IMPEDANCE" columns, following the "phantom" 1 ohm resistors (R_{1-2}). This phantom resistor is included in series with the drive current sources (I_{0-1}) to provide defined calculation points in the software. The tower feed-point impedances from the MoM model are represented by "complex loads" from "Node 3" to ground (R_{3-0}). An assumed aggregate base insulator stray capacitance of 55.5 pF (picoFarads) was used across all of the tower bases. As shown, the modeled and measured base impedances at the ATU output jacks (with the other towers open circuited at their ATU output jacks) agree with each other within +/- 2 ohms and +/- 4 percent for resistance and reactance, as required under the Commission's MoM Rules.

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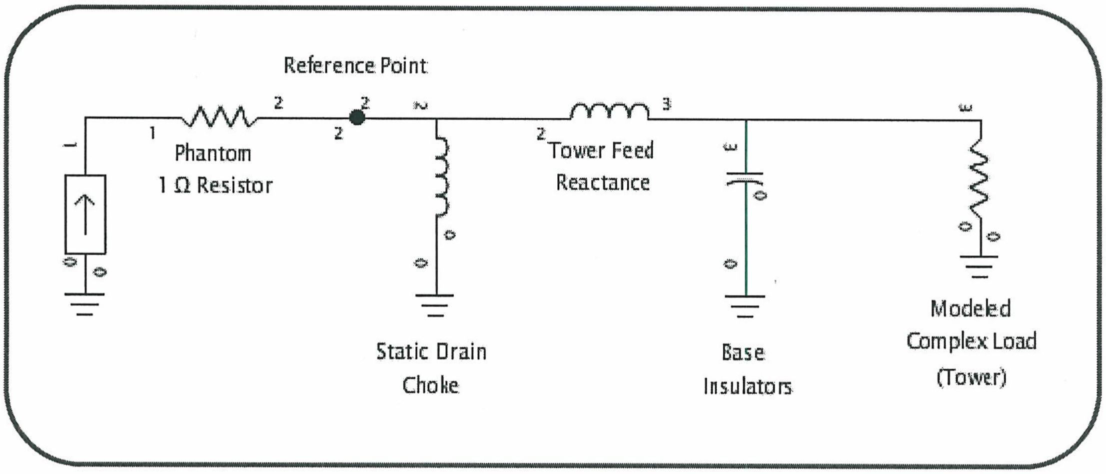
[5] The WCAP software performs nodal analysis calculations, similar to the well-known "SPICE" circuit analysis software.

[6] The MoM model was run for each tower starting with the physical array geometry, element heights, element radii and other as-built antenna information. This "starting point" model for each tower was then converged by adjusting element heights and radii as generally described in the above and in following sections to achieve the final model.

Representative Open Circuit Tower Base Environment Schematic for all WCRW Towers



Schematic Notes:

Node 2 represents the ATU output "reference point" (TCT location).

The reference point impedance is listed in the following tabulations in the "To Impedance" column of the table at row (R1→2).

Node 3 represents the tower feed-point.

Node 0 represents ground potential.

The tower feed-point impedances from the MoM model are represented by "complex loads" from *Node 3* to ground (R3→0)

Summary of Completed Open Circuit Analysis of WCRW Tower Base Environment

Tower Number and Relative Location	Tower Feed Inductance	Tower Feed Reactance	MiniNEC Modeled Complex Load Impedance	WCAP Reference Point* Z_{ATU} Modeled	2017 Reference Point* Z_{ATU} Measured
Tower 1 (SE)	2.881 μH	21.54 Ω	31.174 -j 21.036 Ω	30.63 +j 0.304 Ω	30.63 +j 0.30 Ω
Tower 2 (C)	3.287 μH	24.58 Ω	29.465 -j 20.912 Ω	28.95 +j 3.502 Ω	28.96 +j 3.50 Ω
Tower 3 (NW)	2.855 μH	21.35 Ω	31.893 -j 18.688 Ω	31.40 +j 2.400 Ω	31.40 +j 2.40 Ω

Table Notes:

* - At ATU Output Jack J-Plug (TCT Location);
Designated as ATU "Reference Point"

Static Drain Choke Reactance at 1190 kHz: 100,000 Ω (13,374.4 μH)

Base Insulator Reactance at 1190 kHz: - 2,409.793 Ω total (Capacitance: ~18.5 pF each, ~55.5 pF total)

Lumped Load Assumption at 1190 kHz: -2,469.3 Ω (Base Insulators and Static Drain Choke)

Circuit Analysis Used for Each Tower to Verify Method of Moments Model

WCAP Tower Base Open Circuit "Self" Analysis – WCRW Tower 1 (SE)

WCAP OUTPUT AT FREQUENCY: 1.190 MHz

NODE VOLTAGES

Node:	1	31.6330	∡	0.5503°	V
Node:	2	30.6331	∡	0.5682°	V
Node:	3	37.2790	∡	-34.7284°	V

WCAP PART CURRENT IN CURRENT OUT

WCAP PART			BRANCH VOLTAGE				BRANCH CURRENT			
R	3→0	31.17400000	37.28	∡	-34.728°	V	0.99	∡	-0.717°	A
C	3→0	0.00005550	37.28	∡	-34.728°	V	0.02	∡	55.272°	A
L	2→3	2.88100000	21.54	∡	90.018°	V	1.00	∡	0.018°	A
L	2→0	13374.40000000	30.63	∡	0.568°	V	0.00	∡	-89.432°	A
R	1→2	1.00000000	1.00	∡	0.000°	V	1.00	∡	0.000°	A

WCAP PART			FROM IMPEDANCE				TO IMPEDANCE			
R	3→0	31.17400000	31.17	-	j	21.036	0.00	+	j	0.000
C	3→0	0.00005550	0.00	-	j	2409.795	0.00	+	j	0.000
L	2→3	2.88100000	30.63	+	j	0.294	30.63	-	j	21.247
L	2→0	13374.40000000	0.00	+	j	100000.262	0.00	+	j	0.000
R	**1→2**	1.00000000	31.63	+	j	0.304	**30.63**	**+**	**j**	**0.304**
						Measured:	**30.63**	**+j**		**0.30**
						Difference:	*0.00*			*0.004*

WCAP PART VSWR

WCAP INPUT DATA:

1.1900 0.00010000 1

R	31.17400000	3	0	-21.03600000
C	0.00005550	3	0	
L	2.88100000	2	3	0.00000000
L	13374.40000000	2	0	0.00000000
R	1.00000000	1	2	0.00000000
I	1.00000000	0	1	0.00000000

WCAP Tower Base Open Circuit "Self" Analysis – WCRW Tower 2 (C)

WCAP OUTPUT AT FREQUENCY: 1.190 MHz

NODE VOLTAGES

Node:	1	30.1579	∡	6.6684°	V
Node:	2	29.1649	∡	6.8965°	V
Node:	3	35.8169	∡	-36.0421°	V

WCAP PART   CURRENT IN   CURRENT OUT

WCAP PART			BRANCH VOLTAGE				BRANCH CURRENT			
R	3→0	29.46500000	35.82	∡	-36.042°	V	0.99	∡	-0.678°	A
C	3→0	0.00005550	35.82	∡	-36.042°	V	0.01	∡	53.958°	A
L	2→3	3.28700000	24.58	∡	90.017°	V	1.00	∡	0.017°	A
L	2→0	13374.400000000	29.16	∡	6.897°	V	0.00	∡	-83.103°	A
R	1→2	1.00000000	1.00	∡	0.000°	V	1.00	∡	0.000°	A

WCAP PART			FROM IMPEDANCE				TO IMPEDANCE			
R	3→0	29.46500000	29.46	-	j	20.912	0.00	+	j	0.000
C	3→0	0.00005550	0.00	-	j	2409.795	0.00	+	j	0.000
L	2→3	3.28700000	28.96	+	j	3.494	28.96	-	j	21.083
L	2→0	13374.400000000	0.00	+	j	100000.262	0.00	+	j	0.000
R	**1→2**	1.00000000	29.95	+	j	3.502	**28.95**	**+**	**j**	**3.502**
						Measured:	**28.96**	**+j**		**3.50**
						Difference:	*0.01*			*0.002*

WCAP PART   VSWR

WCAP INPUT DATA:

1.1900   0.00010000   1

R	29.46500000	3	0	-20.91200000
C	0.00005550	3	0	
L	3.28700000	2	3	0.00000000
L	13374.400000000	2	0	0.00000000
R	1.00000000	1	2	0.00000000
I	1.00000000	0	1	0.00000000

WCAP Tower Base Open Circuit "Self" Analysis – WCRW Tower 3 (NW)

WCAP OUTPUT AT FREQUENCY: 1.190 MHz

NODE VOLTAGES

Node:	1	32.4859	∡	4.2369°	V
Node:	2	31.4887	∡	4.3713°	V
Node:	3	36.6764	∡	-31.1030°	V

WCAP PART CURRENT IN CURRENT OUT

WCAP PART			BRANCH VOLTAGE				BRANCH CURRENT			
R	3→0	31.89300000	36.68	∡	-31.103°	V	0.990	∡	-0.734°	A
C	3→0	0.00005550	36.68	∡	-31.103°	V	0.020	∡	58.897°	A
L	2→3	2.85500000	21.35	∡	90.018°	V	1.000	∡	0.018°	A
L	2→0	13374.400000000	31.49	∡	4.371°	V	0.000	∡	-85.629°	A
R	1→2	1.00000000	1.00	∡	0.000°	V	1.000	∡	0.000°	A

WCAP PART			FROM IMPEDANCE				TO IMPEDANCE			
R	3→0	31.89300000	31.89	-	j	18.688	0.00	+	j	0.000
C	3→0	0.00005550	0.00	-	j	2409.795	0.00	+	j	0.000
L	2→3	2.85500000	31.40	+	j	2.390	31.40	-	j	18.957
L	2→0	13374.400000000	0.00	+	j	100000.262	0.00	+	j	0.000
R	**1→2**	1.00000000	32.40	+	j	2.400	**31.40**	**+**	**j**	**2.400**
						Measured:	**31.40**	**+j**		**2.40**
						Difference:	*0.00*			*0.000*

WCAP PART VSWR

WCAP INPUT DATA:

1.1900 0.00010000 1

R	31.89300000	3	0	-18.68800000
C	0.00005550	3	0	
L	2.85500000	2	3	0.00000000
L	13374.400000000	2	0	0.00000000
R	1.00000000	1	2	0.00000000
I	1.00000000	0	1	0.00000000

As demonstrated in the preceding, successful convergence has been achieved; the measured impedances agree with the modeled impedances well within the FCC's +/- 2Ω and +/- 4% criteria. Thus a basis has been established for developing the directional antenna parameters.

Details of MoM "Open Circuit" Modeling - for Towers Driven Individually

In the underlying MoM modeling used in the preceding (WCAP) circuit analysis, each tower is first considered individually, with the companion towers present in the model with "loaded" bases. "Open Circuit Self" ("OC") analysis calculations are initially made based upon the actual physical characteristics of the array. Then modeled data is then "converged" with the "as-measured" data for each tower by applying corrections to the tower dimensions to compensate for velocity of propagation, assumed stray base reactances, and other less readily quantified "real world" effects. The results of this modeling work yield the "modeled complex load impedances" shown in preceding circuit analysis. Copies of the resulting model program outputs for each tower follow this section of this report.

Although all of the antenna system radiators are identical tapered self-supporting *Valmont* towers, the accepted practice of using a single "wire" "wedding cake" approach to represent each tower was employed[7], as opposed to a lattice or wire-frame model. The geometry data used in this analysis were taken from the theoretical directional antenna specifications. Each tower was modeled using 11 segments. The top and bottom wire end points of each of the tower wires were specified in electrical degrees in the Cartesian coordinate system. No end caps were employed. A perfect ground environment was also assumed. After the initial setup of antenna array information in the model, the individual towers were studied iteratively with all other towers open circuited[8], while characteristics were adjusted (in height and radius) until the modeled resistance approximately matched the measured resistance. In this instance, the top tier (or wire) of each tower was adjusted as necessary. Adjustments to converge the model reactances with the measured reactances were made through the introduction of the WCAP circuit model, shown in the preceding pages, which allowed an approximation of the series stray reactances found in the tower base environment. Specifics on the developed model follow.

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[7] This approach was also used and accepted in the prior WCRW (then WAGE) MoM Proof. (Please see FCC File No. BMML-20110208ADY.)

[8] The MoM model incorporated assumed loads at ground level for the "other" open circuited towers in the array using the stray shunt reactance data that were calculated using the base circuit models for the open circuited towers. The overall circuit model consists of series and parallel branches representing feedline inductances, shunt inductances (such as static drain chokes), and stray capacitances, such as aggregate base insulator capacitance to ground. For the initial lumped load assumptions, only shunt reactances were considered. Series stray reactances are added in the final convergence step.

Statement E
APPLICATION FOR STATION LICENSE
Supporting FCC Construction Permit BP-20161130AAH
WCRW Leesburg, Virginia (Facility ID 54876)

Model Evaluation

The final WCRW MiniNEC model was checked for program guideline issues as shown on the following table, which includes details of the model geometry.

Tower Number	Wire Number	End 1	End 2	Average Radius	Number of Segments	Wire Length	Segment Length	Segment Length/Radius
1	1	1	2	0.6549 m	2	17.422°	8.711° or 6.096 m	9.308
	2	2	3	0.4912 m	3	21.778°	7.259° or 5.080 m	10.342
	3	3	4	0.3093 m	3	21.778°	7.259° or 5.080 m	16.424
	4	4	5	0.2183 m	3	26.092°	8.697° or 6.086 m	27.881
2	5	6	7	0.6549 m	2	17.422°	8.711° or 6.096m	9.308
	6	7	8	0.4912 m	3	21.778°	7.259° or 5.080 m	10.342
	7	8	9	0.3093 m	3	21.778°	7.259° or 5.080 m	16.424
	8	9	10	0.2183 m	3	26.232°	8.744° or 6.119 m	28.030
3	9	11	12	0.6549 m	2	17.422°	8.711° or 6.096m	9.308
	10	12	13	0.4912 m	3	21.778°	7.259° or 5.080 m	10.342
	11	13	143	0.3093 m	3	21.778°	7.259° or 5.080 m	16.424
	12	14	15	0.2183 m	3	26.742°	8.914° or 6.238 m	28.575

Note: The height (length) of top wire (model tier) was adjusted for each tower to achieve convergence; see following text. As shown above, all segment lengths are < 10°. All "Segment to Length" Ratios are > 8.

The model was also checked by using the MiniNEC program's "problem definition evaluation" function. A copy of the program's diagnostic report is provided below.

PROBLEM DEFINITION EVALUATION

maximum frequency = 1.19 MHz
shortest wavelength = 251.933 meters
number of wires = 12

INDIVIDUAL WIRES

segment length to wavelength ratio:
No detected violations!

segment length to radius ratio:
No detected violations!

radius to wavelength ratio:
No detected violations!

checking for wires in ground plane:
No detected violations!

PROBLEM DEFINITION EVALUATION
(continued)

WIRE JUNCTIONS

junction segment length ratio:
No detected violations!

junction radius ratio:
No detected violations!

ELECTRICAL DESCRIPTION

No detected violations!

As shown from the program diagnostic tool report, copied above, no segment warnings or errors were reported and no model violations occurred.

With respect to the FCC guidelines provided in FCC Rule Section 73.151(c), each tower's adjusted modeled height relative to its physical height must fall within the required range of 75 to 125 percent. As shown in the following tabulation, that criteria is satisfied in this model.

The FCC also requires that each tower's modeled radius fall 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 sides. In this instance, no change was made in modeled tower radius.

Tower	Radiator Physical Height	Modeled Height (degrees)	Modeled % of Height	Modeled Radius	Equivalent Radius
1-Southeast	57.87 m / 82.7°	**87.07°**	105.3%	Unchanged	100%
2-Center	57.87 m / 82.7°	**87.21°**	105.5%	Unchanged	100%
3-Northwest	57.87 m / 82.7°	**87.72°**	106.1%	Unchanged	100%

It is our conclusion that this model and the analysis is valid and satisfies both the software model rules and FCC guidelines.

MoM Model Details - for Towers Driven Individually

The preceding three WCAP tabulations detailed the base circuit analysis; the following tabulations show the details of the MoM "Open Circuit – Self" models for the individually driven towers.

MoM Model Details for Towers Driven Individually

WCRW Tower 1(SE) OC Self
(Sheet 1 of 3)

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

wire	caps	Distance	Angle	Z	radius	segs
1	none	96.5	130.1	0	.6549	2
		96.5	130.1	17.422		
2	none	96.5	130.1	17.422	.4912	3
		96.5	130.1	39.2		
3	none	96.5	130.1	39.2	.3093	3
		96.5	130.1	60.978		
4	none	96.5	130.1	60.978	.2183	3
		96.5	130.1	87.07		
5	none	0	0	0	.6549	2
		0	0	17.422		
6	none	0	0	17.422	.4912	3
		0	0	39.2		
7	none	0	0	39.2	.3093	3
		0	0	60.978		
8	none	0	0	60.978	.2183	3
		0	0	87.21		
9	none	89.9	335.1	0	.6549	2
		89.9	335.1	17.422		
10	none	89.9	335.1	17.422	.4912	3
		89.9	335.1	39.2		
11	none	89.9	335.1	39.2	.3093	3
		89.9	335.1	60.978		
12	none	89.9	335.1	60.978	.2183	3
		89.9	335.1	87.72		

Number of wires = 12
current nodes = 33

	minimum		maximum	
Individual wires	**wire**	**value**	**wire**	**value**
segment length	2	7.25933	5	8.914
radius	4	.2183	15	.6549

MoM Model Details for Towers Driven Individually

WCRW Tower 1(SE) OC Self
(Sheet 2 of 3)

ELECTRICAL DESCRIPTION — Frequencies (MHz)

no.	frequency lowest	step	no. of steps	segment length (wavelengths) minimum	maximum
1	1.19	0	1	.0201648	.0247611

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	1	0	0	0	0	0
2	12	0	-2,469.3	0	0	0
3	23	0	-2,469.3	0	0	0

IMPEDANCE normalization = 50.

source = 1; node 1, sector 1

freq (MHz)	resist (ohms)	react (ohms)	imped (ohms)	phase (deg)	VSWR	S11 dB	S12 dB
1.19	31.174	-21.036	37.608	326.	2.015	-9.4564	-.5224

MoM Model Details for Towers Driven Individually – WCRW Tower 1(SE) OC Self - (Sheet 3 of 3)

CURRENT rms Frequency = 1.19 MHz Input power = .0110207 watts
Efficiency = 100. % coordinates in degrees

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	-62.1579	-73.8149	0	.0188021	34.	.0155856	.0105171
2	-62.1579	-73.8149	8.711	.0180934	31.7	.0153869	9.52E-03
END	-62.1579	-73.8149	17.422	.01714	30.4	.0147769	8.68E-03
2J1	-62.1579	-73.8149	17.422	.01714	30.4	.0147769	8.68E-03
4	-62.1579	-73.8149	24.6813	.0161807	29.7	.0140616	8.01E-03
5	-62.1579	-73.8149	31.9407	.0149411	28.9	.0130762	7.23E-03
END	-62.1579	-73.8149	39.2	.0134019	28.3	.0118049	6.34E-03
2J2	-62.1579	-73.8149	39.2	.0134019	28.3	.0118049	6.34E-03
7	-62.1579	-73.8149	46.4593	.0119207	27.7	.0105505	5.55E-03
8	-62.1579	-73.8149	53.7187	.0101782	27.2	9.05E-03	4.66E-03
END	-62.1579	-73.8149	60.978	8.2E-03	26.8	7.32E-03	3.69E-03
2J3	-62.1579	-73.8149	60.978	8.2E-03	26.8	7.32E-03	3.69E-03
10	-62.1579	-73.8149	69.6753	5.86E-03	26.3	5.25E-03	2.59E-03
11	-62.1579	-73.8149	78.3727	3.21E-03	25.8	2.89E-03	1.4E-03
END	-62.1579	-73.8149	87.07	0	0	0	0
GND	0	0	0	1.53E-04	255.2	-3.89E-05	-1.48E-04
13	0	0	8.711	6.11E-04	255.3	-1.55E-04	-5.91E-04
END	0	0	17.422	8.27E-04	255.5	-2.08E-04	-8.01E-04
2J5	0	0	17.422	8.27E-04	255.5	-2.08E-04	-8.01E-04
15	0	0	24.6813	9.21E-04	255.6	-2.3E-04	-8.92E-04
16	0	0	31.9407	9.68E-04	255.7	-2.39E-04	-9.38E-04
END	0	0	39.2	9.65E-04	255.9	-2.35E-04	-9.36E-04
2J6	0	0	39.2	9.65E-04	255.9	-2.35E-04	-9.36E-04
18	0	0	46.4593	9.23E-04	256.	-2.23E-04	-8.96E-04
19	0	0	53.7187	8.4E-04	256.2	-2.01E-04	-8.16E-04
END	0	0	60.978	7.17E-04	256.4	-1.69E-04	-6.97E-04
2J7	0	0	60.978	7.17E-04	256.4	-1.69E-04	-6.97E-04
21	0	0	69.722	5.41E-04	256.6	-1.26E-04	-5.26E-04
22	0	0	78.466	3.12E-04	256.8	-7.14E-05	-3.03E-04
END	0	0	87.21	0	0	0	0
GND	81.5433	37.8511	0	1.13E-04	175.8	-1.13E-04	8.3E-06
24	81.5433	37.8511	8.711	4.53E-04	175.7	-4.52E-04	3.37E-05
END	81.5433	37.8511	17.422	6.16E-04	175.6	-6.14E-04	4.7E-05
2J9	81.5433	37.8511	17.422	6.16E-04	175.6	-6.14E-04	4.7E-05
26	81.5433	37.8511	24.6813	6.89E-04	175.5	-6.87E-04	5.37E-05
27	81.5433	37.8511	31.9407	7.27E-04	175.4	-7.25E-04	5.82E-05
END	81.5433	37.8511	39.2	7.29E-04	175.3	-7.26E-04	6.01E-05
2J10	81.5433	37.8511	39.2	7.29E-04	175.3	-7.26E-04	6.01E-05
29	81.5433	37.8511	46.4593	7.01E-04	175.1	-6.99E-04	5.94E-05
30	81.5433	37.8511	53.7187	6.43E-04	175.	-6.4E-04	5.61E-05
END	81.5433	37.8511	60.978	5.54E-04	174.8	-5.51E-04	4.99E-05
2J11	81.5433	37.8511	60.978	5.54E-04	174.8	-5.51E-04	4.99E-05
32	81.5433	37.8511	69.892	4.2E-04	174.6	-4.18E-04	3.94E-05
33	81.5433	37.8511	78.806	2.44E-04	174.4	-2.42E-04	2.38E-05
END	81.5433	37.8511	87.72	0	0	0	0

MoM Model Details for Towers Driven Individually

WCRW Tower 2(C) OC Self
(Sheet 1 of 3)

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

wire	caps	Distance	Angle	Z	radius	segs
1	none	96.5	130.1	0	.6549	2
		96.5	130.1	17.422		
2	none	96.5	130.1	17.422	.4912	3
		96.5	130.1	39.2		
3	none	96.5	130.1	39.2	.3093	3
		96.5	130.1	60.978		
4	none	96.5	130.1	60.978	.2183	3
		96.5	130.1	87.07		
5	none	0	0	0	.6549	2
		0	0	17.422		
6	none	0	0	17.422	.4912	3
		0	0	39.2		
7	none	0	0	39.2	.3093	3
		0	0	60.978		
8	none	0	0	60.978	.2183	3
		0	0	87.21		
9	none	89.9	335.1	0	.6549	2
		89.9	335.1	17.422		
10	none	89.9	335.1	17.422	.4912	3
		89.9	335.1	39.2		
11	none	89.9	335.1	39.2	.3093	3
		89.9	335.1	60.978		
12	none	89.9	335.1	60.978	.2183	3
		89.9	335.1	87.72		

Number of wires = 12
current nodes = 33

	minimum		maximum	
Individual wires	**wire**	**value**	**wire**	**value**
segment length	2	7.25933	5	8.914
radius	4	.2183	15	.6549

MoM Model Details for Towers Driven Individually

WCRW Tower 2(C) OC Self
(Sheet 2 of 3)

ELECTRICAL DESCRIPTION

Frequencies (MHz)

no.	frequency lowest	step	no. of steps	segment length (wavelengths) minimum	maximum
1	1.19	0	1	.0201648	.0247611

Sources

source	node	sector	magnitude	phase	type
1	12	1	1.	0	voltage

Lumped loads

load	node	resistance (ohms)	reactance (ohms)	inductance (mH)	capacitance (uF)	passive circuit
1	1	0	-2,469.3	0	0	0
2	12	0	0	0	0	0
3	23	0	-2,469.3	0	0	0

IMPEDANCE normalization = 50.

freq (MHz)	resist (ohms)	react (ohms)	imped (ohms)	phase (deg)	VSWR	S11 dB	S12 dB
source = 1; node 12 sector 1							
1.19	29.465	-20.912	36.132	324.6	2.1089	-8.9542	-.59099

MoM Model Details for Towers Driven Individually – WCRW Tower 2(C) OC Self - (Sheet 3 of 3)

CURRENT rms Frequency = 1.19 MHz Input power = .0112849 watts
Efficiency = 100. % coordinates in degrees

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	-62.1579	-73.8149	0	1.59E-04	256.6	-3.7E-05	-1.55E-04
2	-62.1579	-73.8149	8.711	6.35E-04	256.6	-1.47E-04	-6.18E-04
END	-62.1579	-73.8149	17.422	8.61E-04	256.8	-1.97E-04	-8.38E-04
2J1	-62.1579	-73.8149	17.422	8.61E-04	256.8	-1.97E-04	-8.38E-04
4	-62.1579	-73.8149	24.6813	9.59E-04	256.9	-2.17E-04	-9.34E-04
5	-62.1579	-73.8149	31.9407	1.01E-03	257.	-2.26E-04	-9.81E-04
END	-62.1579	-73.8149	39.2	1.E-03	257.2	-2.22E-04	-9.78E-04
2J2	-62.1579	-73.8149	39.2	1.E-03	257.2	-2.22E-04	-9.78E-04
7	-62.1579	-73.8149	46.4593	9.59E-04	257.4	-2.1E-04	-9.36E-04
8	-62.1579	-73.8149	53.7187	8.73E-04	257.5	-1.88E-04	-8.52E-04
END	-62.1579	-73.8149	60.978	7.44E-04	257.7	-1.58E-04	-7.27E-04
2J3	-62.1579	-73.8149	60.978	7.44E-04	257.7	-1.58E-04	-7.27E-04
10	-62.1579	-73.8149	69.6753	5.61E-04	257.9	-1.17E-04	-5.49E-04
11	-62.1579	-73.8149	78.3727	3.23E-04	258.2	-6.63E-05	-3.16E-04
END	-62.1579	-73.8149	87.07	0	0	0	0
GND	0	0	0	.0195704	35.4	.0159593	.011327
13	0	0	8.711	.0188348	33.2	.0157564	.0103192
END	0	0	17.422	.0178437	32.	.0151336	9.45E-03
2J5	0	0	17.422	.0178437	32.	.0151336	9.45E-03
15	0	0	24.6813	.0168467	31.2	.0144031	8.74E-03
16	0	0	31.9407	.0155586	30.6	.0133969	7.91E-03
END	0	0	39.2	.0139595	29.9	.0120986	6.96E-03
2J6	0	0	39.2	.0139595	29.9	.0120986	6.96E-03
18	0	0	46.4593	.012421	29.4	.0108176	6.1E-03
19	0	0	53.7187	.0106115	29.	9.28E-03	5.14E-03
END	0	0	60.978	8.55E-03	28.5	7.52E-03	4.08E-03
2J7	0	0	60.978	8.55E-03	28.5	7.52E-03	4.08E-03
21	0	0	69.722	6.11E-03	28.	5.39E-03	2.87E-03
22	0	0	78.466	3.35E-03	27.6	2.97E-03	1.55E-03
END	0	0	87.21	0	0	0	0
GND	81.5433	37.8511	0	1.68E-04	262.1	-2.32E-05	-1.67E-04
24	81.5433	37.8511	8.711	6.73E-04	262.2	-9.17E-05	-6.67E-04
END	81.5433	37.8511	17.422	9.12E-04	262.4	-1.21E-04	-9.04E-04
2J9	81.5433	37.8511	17.422	9.12E-04	262.4	-1.21E-04	-9.04E-04
26	81.5433	37.8511	24.6813	1.02E-03	262.5	-1.32E-04	-1.01E-03
27	81.5433	37.8511	31.9407	1.07E-03	262.7	-1.35E-04	-1.06E-03
END	81.5433	37.8511	39.2	1.07E-03	263.	-1.31E-04	-1.06E-03
2J10	81.5433	37.8511	39.2	1.07E-03	263.	-1.31E-04	-1.06E-03
29	81.5433	37.8511	46.4593	1.02E-03	263.2	-1.21E-04	-1.01E-03
30	81.5433	37.8511	53.7187	9.33E-04	263.4	-1.07E-04	-9.27E-04
END	81.5433	37.8511	60.978	7.99E-04	263.7	-8.79E-05	-7.95E-04
2J11	81.5433	37.8511	60.978	7.99E-04	263.7	-8.79E-05	-7.95E-04
32	81.5433	37.8511	69.892	6.04E-04	264.	-6.32E-05	-6.E-04
33	81.5433	37.8511	78.806	3.48E-04	264.3	-3.45E-05	-3.46E-04
END	81.5433	37.8511	87.72	0	0	0	0

MoM Model Details for Towers Driven Individually

WCRW Tower 3(NW) OC Self
(Sheet 1 of 3)

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

wire	caps	Distance	Angle	Z	radius	segs
1	none	96.5	130.1	0	.6549	2
		96.5	130.1	17.422		
2	none	96.5	130.1	17.422	.4912	3
		96.5	130.1	39.2		
3	none	96.5	130.1	39.2	.3093	3
		96.5	130.1	60.978		
4	none	96.5	130.1	60.978	.2183	3
		96.5	130.1	87.07		
5	none	0	0	0	.6549	2
		0	0	17.422		
6	none	0	0	17.422	.4912	3
		0	0	39.2		
7	none	0	0	39.2	.3093	3
		0	0	60.978		
8	none	0	0	60.978	.2183	3
		0	0	87.21		
9	none	89.9	335.1	0	.6549	2
		89.9	335.1	17.422		
10	none	89.9	335.1	17.422	.4912	3
		89.9	335.1	39.2		
11	none	89.9	335.1	39.2	.3093	3
		89.9	335.1	60.978		
12	none	89.9	335.1	60.978	.2183	3
		89.9	335.1	87.72		

Number of wires = 12
current nodes = 33

	minimum		maximum	
Individual wires	**wire**	**value**	**wire**	**value**
segment length	2	7.25933	5	8.914
radius	4	.2183	15	.6549

MoM Model Details for Towers Driven Individually

WCRW Tower 3(NW) OC Self
(Sheet 2 of 3)

ELECTRICAL DESCRIPTION — Frequencies (MHz)

no.	frequency lowest	step	no. of steps	segment length (wavelengths) minimum	segment length (wavelengths) maximum
1	1.19	0	1	.0201648	.0247611

Sources

source	node	sector	magnitude	phase	type
1	23	1	1.	0	voltage

Lumped loads

load	node	resistance (ohms)	reactance (ohms)	inductance (mH)	capacitance (uF)	passive circuit
1	1	0	-2,469.3	0	0	0
2	12	0	-2,469.3	0	0	0
3	23	0	0	0	0	0

IMPEDANCE normalization = 50.

source = 1; node 23, sector 1

freq (MHz)	resist (ohms)	react (ohms)	imped (ohms)	phase (deg)	VSWR	S11 dB	S12 dB
1.19	31.893	-18.688	36.965	329.6	1.8976	-10.179	-.43815

MoM Model Details for Towers Driven Individually – WCRW Tower 3(NW) OC Self - (Sheet 3 of 3)

```
CURRENT rms  Frequency = 1.19 MHz Input power = .0116705 watts
Efficiency  = 100. %   coordinates in degrees
```

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	-62.1579	-73.8149	0	1.15E-04	172.2	-1.14E-04	1.57E-05
2	-62.1579	-73.8149	8.711	4.6E-04	172.1	-4.56E-04	6.31E-05
END	-62.1579	-73.8149	17.422	6.25E-04	172.	-6.19E-04	8.69E-05
2J1	-62.1579	-73.8149	17.422	6.25E-04	172.	-6.19E-04	8.69E-05
4	-62.1579	-73.8149	24.6813	6.99E-04	171.9	-6.92E-04	9.83E-05
5	-62.1579	-73.8149	31.9407	7.36E-04	171.8	-7.29E-04	1.05E-04
END	-62.1579	-73.8149	39.2	7.37E-04	171.7	-7.29E-04	1.07E-04
2J2	-62.1579	-73.8149	39.2	7.37E-04	171.7	-7.29E-04	1.07E-04
7	-62.1579	-73.8149	46.4593	7.07E-04	171.5	-6.99E-04	1.04E-04
8	-62.1579	-73.8149	53.7187	6.46E-04	171.4	-6.39E-04	9.7E-05
END	-62.1579	-73.8149	60.978	5.54E-04	171.2	-5.47E-04	8.47E-05
2J3	-62.1579	-73.8149	60.978	5.54E-04	171.2	-5.47E-04	8.47E-05
10	-62.1579	-73.8149	69.6753	4.2E-04	171.	-4.15E-04	6.56E-05
11	-62.1579	-73.8149	78.3727	2.43E-04	170.8	-2.4E-04	3.89E-05
END	-62.1579	-73.8149	87.07	0	0	0	0
GND	0	0	0	1.64E-04	257.1	-3.66E-05	-1.6E-04
13	0	0	8.711	6.57E-04	257.2	-1.45E-04	-6.41E-04
END	0	0	17.422	8.9E-04	257.4	-1.94E-04	-8.68E-04
2J5	0	0	17.422	8.9E-04	257.4	-1.94E-04	-8.68E-04
15	0	0	24.6813	9.91E-04	257.6	-2.13E-04	-9.68E-04
16	0	0	31.9407	1.04E-03	257.8	-2.21E-04	-1.02E-03
END	0	0	39.2	1.04E-03	258.	-2.16E-04	-1.01E-03
2J6	0	0	39.2	1.04E-03	258.	-2.16E-04	-1.01E-03
18	0	0	46.4593	9.92E-04	258.2	-2.03E-04	-9.71E-04
19	0	0	53.7187	9.04E-04	258.4	-1.81E-04	-8.85E-04
END	0	0	60.978	7.71E-04	258.7	-1.51E-04	-7.56E-04
2J7	0	0	60.978	7.71E-04	258.7	-1.51E-04	-7.56E-04
21	0	0	69.722	5.82E-04	259.	-1.11E-04	-5.71E-04
22	0	0	78.466	3.35E-04	259.2	-6.25E-05	-3.29E-04
END	0	0	87.21	0	0	0	0
GND	81.5433	37.8511	0	.0191293	30.4	.0165046	9.67E-03
24	81.5433	37.8511	8.711	.0184666	28.1	.0162968	8.69E-03
END	81.5433	37.8511	17.422	.0175329	26.7	.015659	7.89E-03
2J9	81.5433	37.8511	17.422	.0175329	26.7	.015659	7.89E-03
26	81.5433	37.8511	24.6813	.0165801	25.9	.014911	7.25E-03
27	81.5433	37.8511	31.9407	.0153404	25.2	.0138804	6.53E-03
END	81.5433	37.8511	39.2	.013794	24.5	.0125504	5.72E-03
2J10	81.5433	37.8511	39.2	.013794	24.5	.0125504	5.72E-03
29	81.5433	37.8511	46.4593	.0123013	24.	.0112383	5.E-03
30	81.5433	37.8511	53.7187	.0105411	23.5	9.67E-03	4.2E-03
END	81.5433	37.8511	60.978	8.54E-03	23.	7.86E-03	3.34E-03
2J11	81.5433	37.8511	60.978	8.54E-03	23.	7.86E-03	3.34E-03
32	81.5433	37.8511	69.892	6.1E-03	22.5	5.64E-03	2.33E-03
33	81.5433	37.8511	78.806	3.35E-03	22.	3.1E-03	1.25E-03
END	81.5433	37.8511	87.72	0	0	0	0

Derivation of Daytime and Nighttime Directional Antenna System Operating Parameters

The general array model, whose validity is now established with the convergence to the measured individual open circuited base impedances, was then utilized as the basis for the WCRW daytime and nighttime directional antenna calculations.

Specifically, "medium wave array synthesis" MoM calculations were made for the both directional modes of operation using the theoretical values of theoretical antenna field ratio magnitudes and phases, the array geometry, and the established converged tower heights and radii. This process yielded the complex voltage values for sources located at the base insulator for each tower, from which current moment sums are produced. These values, when normalized, equate to the theoretical field parameters for the authorized directional antenna pattern. Tower base currents and driving point impedances were then calculated for the directional pattern. (Note: within the program reports, voltages and currents not specified as "RMS" values are the corresponding "peak" values.)

This information was then used to calculate the currents at the ATU J-plug "reference points" (where the Toroidal Current Transformer derived antenna monitor samples are taken) by using the WCAP circuit modeling software, and the same base circuit environment assumptions that were derived from the single tower open-circuit measurements.

The following pages provide details of the MoM array synthesis modeling, as performed both directional antenna arrays, along with the resulting normalized antenna monitor parameters, derived from the WCAP analysis. The designations employed in the model output data for the antenna "wire" and corresponding base node information are as follows for both the day and night arrays:

Tower	Wire	Base Node
1 (SE)	1	1
2 (C)	5	12
3 (NW)	9	23

The resulting normalized antenna monitor parameters, derived from the WCAP analysis, are provided after the pattern synthesis model data for both operational modes as shown on the following pages.

MoM Model Details

Daytime Directional Antenna Array Synthesis
(Sheet 1 of 5)

MEDIUM WAVE ARRAY SYNTHESIS FROM FIELD RATIOS

Frequency = 1.19 MHz

Tower	Field Ratio Magnitude	Phase (deg)
1	0.544	-88.7
2	1.000	0.0
3	0.343	159.0

VOLTAGES AND CURRENTS - rms

Source Node	Voltage Magnitude	Current Phase (deg)	Current Magnitude	Phase (deg)
1	1,173.96	290.2	18.8800	279.4
12	1,140.12	316.0	38.0022	3.1
23	103.98	343.8	12.3584	157.9

Sum of square of source currents = 3,906.71
Total power = 50,000. watts

TOWER ADMITTANCE MATRIX

Admittance	Real (mhos)	Imaginary (mhos)
Y(1, 1)	0.03001760	0.0279817
Y(1, 2)	-0.02671170	-0.0246755
Y(1, 3)	0.00841610	0.0238726
Y(2, 1)	-0.02671130	-0.0246749
Y(2, 2)	0.05981510	0.0387482
Y(2, 3)	-0.03006440	-0.0262559
Y(3, 1)	0.00841635	0.0238712
Y(3, 2)	-0.03006430	-0.0262541
Y(3, 3)	0.03441230	0.0292023

TOWER IMPEDANCE MATRIX

Impedance	Real (ohms)	Imaginary (ohms)
Z(1, 1)	31.25220	-21.0793
Z(1, 2)	13.54010	-15.1839
Z(1, 3)	-8.93261	-11.8787
Z(2, 1)	13.54040	-15.1839
Z(2, 2)	29.81260	-20.9203
Z(2, 3)	15.77450	-14.5976
Z(3, 1)	-8.93258	-11.8793
Z(3, 2)	15.77540	-14.5973
Z(3, 3)	31.99620	-18.7678

MoM Model Details

Daytime Directional Antenna Array Synthesis
(Sheet 2 of 5)

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

wire	caps	Distance	Angle	Z	radius	segs
1	none	96.5	130.1	0	.6549	2
		96.5	130.1	17.422		
2	none	96.5	130.1	17.422	.4912	3
		96.5	130.1	39.2		
3	none	96.5	130.1	39.2	.3093	3
		96.5	130.1	60.978		
4	none	96.5	130.1	60.978	.2183	3
		96.5	130.1	87.07		
5	none	0	0	0	.6549	2
		0	0	17.422		
6	none	0	0	17.422	.4912	3
		0	0	39.2		
7	none	0	0	39.2	.3093	3
		0	0	60.978		
8	none	0	0	60.978	.2183	3
		0	0	87.21		
9	none	89.9	335.1	0	.6549	2
		89.9	335.1	17.422		
10	none	89.9	335.1	17.422	.4912	3
		89.9	335.1	39.2		
11	none	89.9	335.1	39.2	.3039	3
		89.9	335.1	60.978		
12	none	89.9	335.1	60.978	.2183	3
		89.9	335.1	87.72		

Number of wires = 12
current nodes = 33

	minimum		maximum	
Individual wires	wire	value	wire	value
segment length	2	7.25933	12	8.914
radius	4	.2183	1	.6549

MoM Model Details

Daytime Directional Antenna Array Synthesis
(Sheet 3 of 5)

ELECTRICAL DESCRIPTION - Frequencies (MHz)

no.	frequency lowest	step	no. of steps	segment length (wavelengths) minimum	maximum
1	1.19	0	1	.0201648	.0247611

Sources

source	node	sector	magnitude	phase	type
1	1	1	1,660.22	290.2	voltage
2	12	1	1,612.38	316.	voltage
3	23	1	147.05	343.8	voltage

IMPEDANCE - normalization = 50.

freq (MHz)	resist (ohms)	react (ohms)	imped (ohms)	phase (deg)	VSWR	S11 dB	S12 dB
source = 1; node 1, sector 1							
1.19	61.077	11.656	62.18	10.8	1.3364	-16.834	-9.1E-02
source = 2; node 12, sector 1							
1.19	20.432	-21.969	30.001	312.9	2.9943	-6.0331	-1.2452
source = 3; node 23, sector 1							
1.19	-8.3699	-.85807	8.4137	185.9	****	****	****

MoM Model Details – Daytime Directional Antenna Array Synthesis (Sheet 4 of 5)

```
CURRENT rms   Frequency    = 1.19 MHz  Input power = 50,000. watts
Efficiency   = 100. %    coordinates in degrees
```

current no.	X	Y	Z		mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	-62.1579	-73.8149	0	Twr 1	18.88	279.4	3.09407	-18.6248
2	-62.1579	-73.8149	8.711		18.9604	275.2	1.71176	-18.8829
END	-62.1579	-73.8149	17.422		18.4197	272.9	.938896	-18.3958
2J1	-62.1579	-73.8149	17.422		18.4197	272.9	.938896	-18.3958
4	-62.1579	-73.8149	24.6813		17.6595	271.6	.498598	-17.6525
5	-62.1579	-73.8149	31.9407		16.5385	270.5	.137288	-16.5379
END	-62.1579	-73.8149	39.2		15.0324	269.4	-.145632	-15.0317
2J2	-62.1579	-73.8149	39.2		15.0324	269.4	-.145632	-15.0317
7	-62.1579	-73.8149	46.4593		13.5062	268.7	-.309411	-13.5027
8	-62.1579	-73.8149	53.7187		11.6437	268.	-.410214	-11.6364
END	-62.1579	-73.8149	60.978		9.46355	267.3	-.443139	-9.45316
2J3	-62.1579	-73.8149	60.978		9.46355	267.3	-.443139	-9.45316
10	-62.1579	-73.8149	69.6753		6.8258	266.7	-.397336	-6.81423
11	-62.1579	-73.8149	78.3727		3.78005	266.1	-.260348	-3.77108
END	-62.1579	-73.8149	87.07		0	0	0	0
GND	0	0	0	Twr 2	38.0023	3.1	37.9484	2.02214
13	0	0	8.711		36.511	1.6	36.4974	.993987
END	0	0	17.422		34.5425	.7	34.54	.421062
2J5	0	0	17.422		34.5425	.7	34.54	.421062
15	0	0	24.6813		32.5809	.2	32.5808	.0972505
16	0	0	31.9407		30.0601	359.7	30.0597	-.164622
END	0	0	39.2		26.9431	359.2	26.9406	-.363532
2J6	0	0	39.2		26.9431	359.2	26.9406	-.363532
18	0	0	46.4593		23.9535	358.9	23.9489	-.470883
19	0	0	53.7187		20.4461	358.5	20.4393	-.524447
END	0	0	60.978		16.4658	358.2	16.4576	-.519083
2J7	0	0	60.978		16.4658	358.2	16.4576	-.519083
21	0	0	69.722		11.7525	357.8	11.7442	-.441915
22	0	0	78.466		6.44201	357.5	6.43591	-.280459
END	0	0	87.21		0	0	0	0
GND	81.5433	37.8511	0	Twr 3	12.3584	157.9	-11.4542	4.64006
24	81.5433	37.8511	8.711		12.1869	158.5	-11.3416	4.45986
END	81.5433	37.8511	17.422		11.6934	158.8	-10.9049	4.22126
2J9	81.5433	37.8511	17.422		11.6934	158.8	-10.9049	4.22126
26	81.5433	37.8511	24.6813		11.12	159.	-10.3819	3.98371
27	81.5433	37.8511	31.9407		10.3338	159.1	-9.65688	3.67857
END	81.5433	37.8511	39.2		9.32295	159.3	-8.71898	3.30103
2J10	81.5433	37.8511	39.2		9.32295	159.3	-8.71898	3.30103
29	81.5433	37.8511	46.4593		8.33642	159.3	-7.8003	2.94129
30	81.5433	37.8511	53.7187		7.15957	159.4	-6.70192	2.51866
END	81.5433	37.8511	60.978		5.81057	159.5	-5.44096	2.03928
2J11	81.5433	37.8511	60.978		5.81057	159.5	-5.44096	2.03928
32	81.5433	37.8511	69.892		4.15561	159.5	-3.89234	1.45562
33	81.5433	37.8511	78.806		2.28045	159.5	-2.13637	.797729
END	81.5433	37.8511	87.72		0	0	0	0

MoM Model Details – Daytime Directional Antenna Array Synthesis (Sheet 5 of 5)

CURRENT MOMENTS
(amp-degrees) rms

Frequency = 1.19 MHz
Input power = 50,000. watts

			vertical current moment	
wire	**magnitude**	**phase (deg)**	**magnitude**	**phase (deg)**
1	323.971	275.7	323.971	275.7
2	365.794	271.2	365.794	271.2
3	268.665	268.4	268.665	268.4
4	132.016	266.7	132.016	266.7
5	627.407	1.7	627.407	1.70
6	670.890	360.0	670.890	360.0
7	474.913	358.8	474.913	358.8
8	228.690	357.9	228.696	357.9
9	208.739	158.5	208.739	158.5
10	229.628	159.1	229.628	159.1
11	165.693	159.4	165.693	159.4
12	82.4098	159.5	82.4098	159.5

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	1,088.74	271.3
2	2,001.35	0.0
3	686.454	159.0

Above Data Normalized and Converted

Tower	Magnitude	Phase
1	0.544	-88.7°
2	1.000	0.0°
3	0.343	159.0°

Theoretical Field Data

Tower	Magnitude	Phase
1	0.544	-88.7°
2	1.000	0.0°
3	0.343	159.0°

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MoM Model Details

Nighttime Directional Antenna Array Synthesis
(Sheet 1 of 5)

MEDIUM WAVE ARRAY SYNTHESIS FROM FIELD RATIOS

Frequency = 1.19 MHz

Tower	Field Ratio Magnitude	Phase (deg)
1	0.543	-153.9
2	1.000	0.0
3	0.828	140.8

VOLTAGES AND CURRENTS - rms

Source Node	Voltage Magnitude	Current Phase (deg)	Current Magnitude	Phase (deg)
1	75.5097	312.5	3.61003	205.3
12	124.248	10.4	6.91516	2.5
23	170.244	77.0	6.11043	142.6

Sum of square of source currents = 196.378
Total power = 1,200. watts

TOWER ADMITTANCE MATRIX

Admittance	Real (mhos)	Imaginary (mhos)
Y(1, 1)	0.03004520	0.0280148
Y(1, 2)	-0.02677550	-0.0247000
Y(1, 3)	0.00848884	0.0239016
Y(2, 1)	-0.02677510	-0.0246994
Y(2, 2)	0.05992260	0.0387327
Y(2, 3)	-0.03018780	-0.0262397
Y(3, 1)	0.00848908	0.0239003
Y(3, 2)	-0.03018770	-0.0262380
Y(3, 3)	0.03455400	0.0291846

TOWER IMPEDANCE MATRIX

Impedance	Real (ohms)	Imaginary (ohms)
Z(1, 1)	31.25190	-21.0793
Z(1, 2)	13.54010	-15.1841
Z(1, 3)	-8.93138	-11.8781
Z(2, 1)	13.54040	-15.1841
Z(2, 2)	29.81300	-20.9202
Z(2, 3)	15.77370	-14.5966
Z(3, 1)	-8.93127	-11.8786
Z(3, 2)	15.77460	-14.5964
Z(3, 3)	31.99090	-18.6976

MoM Model Details

Nighttime Directional Antenna Array Synthesis
(Sheet 2 of 5)

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

wire	caps	Distance	Angle	Z	radius	segs
1	none	96.5	130.1	0	.6549	2
		96.5	130.1	17.422		
2	none	96.5	130.1	17.422	.4912	3
		96.5	130.1	39.2		
3	none	96.5	130.1	39.2	.3093	3
		96.5	130.1	60.978		
4	none	96.5	130.1	60.978	.2183	3
		96.5	130.1	87.07		
5	none	0	0	0	.6549	2
		0	0	17.422		
6	none	0	0	17.422	.4912	3
		0	0	39.2		
7	none	0	0	39.2	.3093	3
		0	0	60.978		
8	none	0	0	60.978	.2183	3
		0	0	87.21		
9	none	89.9	335.1	0	.6549	2
		89.9	335.1	17.422		
10	none	89.9	335.1	17.422	.4912	3
		89.9	335.1	39.2		
11	none	89.9	335.1	39.2	.3039	3
		89.9	335.1	60.978		
12	none	89.9	335.1	60.978	.2183	3
		89.9	335.1	87.72		

Number of wires = 12
current nodes = 33

	minimum		maximum	
Individual wires	wire	value	wire	value
segment length	2	7.25933	12	8.914
radius	4	.2183	1	.6549

MoM Model Details

Nighttime Directional Antenna Array Synthesis
(Sheet 3 of 5)

ELECTRICAL DESCRIPTION - Frequencies (MHz)

no.	frequency lowest	step	no. of steps	segment length (wavelengths) minimum	segment length (wavelengths) maximum
1	1.19	0	1	.0201648	.0247611

Sources

source	node	sector	magnitude	phase	type
1	1	1	106.787	312.5	voltage
2	12	1	175.713	10.4	voltage
3	23	1	240.762	77.	voltage

IMPEDANCE - normalization = 50.

freq (MHz)	resist (ohms)	react (ohms)	imped (ohms)	phase (deg)	VSWR	S11 dB	S12 dB
source = 1; node 1, sector 1							
1.19	**-6.1955**	**19.978**	20.917	107.2	****	****	****
source = 2; node 12, sector 1							
1.19	**17.795**	**2.4837**	17.967	7.9	2.8177	-6.4455	-1.1165
source = 3; node 23, sector 1							
1.19	**11.511**	**-25.372**	27.861	294.4	5.5108	-3.1876	-2.84

MoM Model Details – Nighttime Directional Antenna Array Synthesis (Sheet 4 of 5)

CURRENT rms Frequency = 1.19 MHz Input power = 1,200. watts
Efficiency = 100. % coordinates in degrees

current no.	X	Y	Z		mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	-62.1579	-73.8149	0	Twr 1	3.61004	205.3	-3.26508	-1.54001
2	-62.1579	-73.8149	8.711		3.65185	205.7	-3.29111	-1.5826
END	-62.1579	-73.8149	17.422		3.5528	205.9	-3.19558	-1.55262
2J1	-62.1579	-73.8149	17.422		3.5528	205.9	-3.19558	-1.55262
4	-62.1579	-73.8149	24.6813		3.40616	206.1	-3.06011	-1.49588
5	-62.1579	-73.8149	31.9407		3.1882	206.2	-2.86126	-1.40635
END	-62.1579	-73.8149	39.2		2.89507	206.3	-2.5956	-1.28229
2J2	-62.1579	-73.8149	39.2		2.89507	206.3	-2.5956	-1.28229
7	-62.1579	-73.8149	46.4593		2.59851	206.4	-2.32795	-1.15452
8	-62.1579	-73.8149	53.7187		2.2375	206.5	-2.00306	-.99709
END	-62.1579	-73.8149	60.978		1.81615	206.5	-1.62469	-.811659
2J3	-62.1579	-73.8149	60.978		1.81615	206.5	-1.62469	-.811659
10	-62.1579	-73.8149	69.6753		1.3079	206.6	-1.16917	-.586229
11	-62.1579	-73.8149	78.3727		.723127	206.7	-.645965	-.325024
END	-62.1579	-73.8149	87.07		0	0	0	0
GND	0	0	0	Twr 2	6.91516	2.5	6.90879	.296734
13	0	0	8.711		6.8492	1.2	6.84769	.143816
END	0	0	17.422		6.58971	.5	6.58944	.0594492
2J5	0	0	17.422		6.58971	.5	6.58944	.0594492
15	0	0	24.6813		6.27738	.1	6.27737	.0122627
16	0	0	31.9407		5.84291	359.8	5.84285	-.0254509
END	0	0	39.2		5.27929	359.4	5.27901	-.0536573
2J6	0	0	39.2		5.27929	359.4	5.27901	-.0536573
18	0	0	46.4593		4.72155	359.2	4.72105	-.0685428
19	0	0	53.7187		4.05276	358.9	4.05206	-.0755967
END	0	0	60.978		3.28109	358.7	3.28025	-.0742377
2J7	0	0	60.978		3.28109	358.7	3.28025	-.0742377
21	0	0	69.722		2.35417	358.5	2.35333	-.0627051
22	0	0	78.466		1.29677	358.3	1.29617	-.0395279
END	0	0	87.21		0	0	0	0
GND	81.5433	37.8511	0	Twr 3	6.11043	142.6	-4.85363	3.7121
24	81.5433	37.8511	8.711		5.84421	141.7	-4.58921	3.61856
END	81.5433	37.8511	17.422		5.51448	141.2	-4.30027	3.45212
2J9	81.5433	37.8511	17.422		5.51448	141.2	-4.30027	3.45212
26	81.5433	37.8511	24.6813		5.19333	140.9	-4.032	3.27317
27	81.5433	37.8511	31.9407		4.78556	140.6	-3.69989	3.03519
END	81.5433	37.8511	39.2		4.28563	140.4	-3.29982	2.73456
2J10	81.5433	37.8511	39.2		4.28563	140.4	-3.29982	2.73456
29	81.5433	37.8511	46.4593		3.80923	140.1	-2.92348	2.44202
30	81.5433	37.8511	53.7187		3.25318	139.9	-2.48862	2.09522
END	81.5433	37.8511	60.978		2.62521	139.7	-2.00166	1.69855
2J11	81.5433	37.8511	60.978		2.62521	139.7	-2.00166	1.69855
32	81.5433	37.8511	69.892		1.86972	139.4	-1.42055	1.21569
33	81.5433	37.8511	78.806		1.02208	139.2	-.773772	.66778
END	81.5433	37.8511	87.72		0	0	0	0

MoM Model Details – Nighttime Directional Antenna Array Synthesis (Sheet 5 of 5)

CURRENT MOMENTS
(amp-degrees) rms

Frequency = 1.19 MHz
Input power = 1,200. watts

wire	magnitude	phase (deg)	vertical current moment magnitude	vertical current moment phase (deg)
1	62.3586	205.6	62.3586	205.6
2	70.5389	206.1	70.5389	206.1
3	51.6679	206.4	51.6679	206.4
4	25.2987	206.6	25.2987	206.6
5	117.253	1.4	117.253	1.4
6	129.711	360	129.711	360
7	93.7888	359.1	93.7888	359.1
8	45.7913	358.5	45.7913	358.5
9	100.49	141.8	100.49	141.8
10	106.896	140.8	106.896	140.8
11	75.5644	140	75.5644	140
12	37.0914	139.5	37.0914	139.5

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	209.860	206.1
2	386.484	0.0
3	320.008	140.8

Above Data Normalized and Converted

Tower	Magnitude	Phase
1	0.543	-153.9°
2	1.000	0.0°
3	0.828	140.8°

Theoretical Field Data

Tower	Magnitude	Phase
1	0.545	-153.9°
2	1.000	0.0°
3	0.828	140.8°

Directional Antenna System "Antenna Monitor" Parameters

With the modeled directional antenna ground level complex voltage and current values for sources located at ground level for each tower now being derived, WCAP circuit analysis calculations[9] were run to develop the current magnitude and phase information that will be present at the ATU reference point, where the TCT sampling devices are located. Since the current transformers and sampling lines are essentially identical, the antenna monitor ratios and phases corresponding to the theoretical parameters can be calculated and normalized directly from the modeled ATU currents, as shown below. Since the theoretical parameters are normalized with respect to Tower 2 for both patterns, antenna monitor parameters can be derived as follows:

Daytime Directional Antenna Monitor Operating Parameters – Normalized to Tower 2

Tower	Modeled Current Pulse	Modeled Current Magnitude at Toroid	Modeled Current Phase at Toroid	**Antenna Monitor Ratio**	**Antenna Monitor Phase**
1 (SE)	1	18.80 A	280.824°	**0.490**	**-82.7°**
2 (C)	12	38.3481 A	3.57°	**1.000**	**0.0°**
3 (NW)	23	12.3668 A	157.706°	**0.322**	**154.1°**

Nighttime Directional Antenna Monitor Operating Parameters – Normalized to Tower 2

Tower	Modeled Current Pulse	Modeled Current Magnitude at Toroid	Modeled Current Phase at Toroid	**Antenna Monitor Ratio**	**Antenna Monitor Phase**
1 (SE)	1	3.58008 A	205.155°	**0.518**	**-157.8°**
2 (C)	12	6.910323 A	2.913°	**1.000**	**0.0°**
3 (NW)	23	6.17086 A	142.864°	**0.893**	**140.0° [10]**

Accordingly, the phasing and coupling systems for the authorized patterns were adjusted such that the antenna monitor phase and ratio indications were within 5% of the ratio values, and 3° of the phase values shown above, per the requirements of §73.62(a) of the Commission's Rules.

The base circuit analysis (for each tower) used to develop the above tabulation is provided in the following three pages.

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[9] For the WCAP analysis, the same schematic diagrams and node nomenclature are employed as were described previously for the OC-self analysis. Specifically, node 2 represents the ATU TCT reference point and node 3 represents the tower feedpoint. Node 0 represents ground potential. The tower operating impedances were represented by complex loads from node 3 to ground (R_{3-0}). Please see the tabulations following this page.

[10] Rounded to 140.0° from actual value of 139.951°

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Circuit Analysis Used for Each Tower to Develop Antenna Monitor Parameters

Daytime Directional Antenna Base Circuit Analysis – WCRW Tower 1 (SE)

WCAP OUTPUT AT FREQUENCY: 1.190 MHz

NODE VOLTAGES

Node:	1	1319.1595	∡	-52.3075°	V
Node:	2	1302.4168	∡	-51.9337°	V
Node:	3	1173.8991	∡	-69.7951°	V

WCAP PART			BRANCH VOLTAGE				BRANCH CURRENT				
R	**3→0**	61.07700000	1173.90	∡	-69.795°	V	**18.88**	**∡**	**-80.600°**	**A**	**Current at Load**
C	3→0	0.00005550	1173.90	∡	-69.795°	V	0.49	∡	20.205°	A	
L	2→3	2.88100000	404.85	∡	10.859°	V	18.79	∡	-79.141°	A	
L	2→0	13374.400000	1302.42	∡	-51.934°	V	0.01	∡	-141.934°	A	
R	1→2	1.00000000	18.80	∡	-79.176°	V	18.80	∡	-79.176°	A	

WCAP PART			FROM IMPEDANCE				TO IMPEDANCE			
R	**3→0**	61.07700000	**61.08**	**+**	**j**	**11.656**	0.00	+	j	0.000
C	3→0	0.00005550	0.00	-	j	2409.795	0.00	+	j	0.000
L	2→3	2.88100000	61.63	+	j	31.684	61.63	+	j	10.143
L	2→0	13374.400000	0.01	+	j	100000.262	0.00	+	j	0.000
R	1→2	1.00000000	62.59	+	j	31.712	61.59	+	j	31.712

WCAP INPUT DATA:

1.1900 0.00010000 1

R	**61.07700000**	**3**	**0**	**11.65600000**	**Modeled Base Impedance**
C	0.00005550	3	0		
L	2.88100000	2	3	0.00000000	
L	13374.40000000	2	0	0.00000000	
R	1.00000000	1	2	0.00000000	
I	**18.80000000**	**0**	**1**	**280.82400000**	**Modeled Current Magnitude & Phase at Toroid**

Daytime Directional Antenna Base Circuit Analysis – WCRW Tower 2 (C)

WCAP OUTPUT AT FREQUENCY: 1.190 MHz

NODE VOLTAGES

Node:	1	814.0168	∡	10.7190°	V
Node:	2	775.9815	∡	11.0714°	V
Node:	3	1140.0450	∡	-43.9759°	V

	WCAP PART		**BRANCH VOLTAGE**				**BRANCH CURRENT**				
R	**3→0**	20.43200000	1140.04	∡	-43.976°	V	**38.00**	∡	**3.100°**	**A**	**Current at Load**
C	3→0	0.00005550	1140.04	∡	-43.976°	V	0.47	∡	46.024°	A	
L	2→3	3.28700000	942.45	∡	93.581°	V	38.35	∡	3.581°	A	
L	2→0	13374.40000000	775.98	∡	11.071°	V	0.01	∡	-78.929°	A	
R	1→2	1.00000000	38.35	∡	3.570°	V	38.35	∡	3.570°	A	

	WCAP PART		**FROM IMPEDANCE**				**TO IMPEDANCE**			
R	**3→0**	20.43200000	**20.43**	**-**	**j**	**21.969**	0.00	+	j	0.000
C	3→0	0.00005550	0.00	-	j	2409.795	0.00	+	j	0.000
L	2→3	3.28700000	20.06	+	j	2.638	20.06	-	j	21.939
L	2→0	13374.40000000	0.00	+	j	100000.2620	0.00	+	j	0.000
R	1→2	1.00000000	21.06	+	j	2.642	20.06	+	j	2.642

WCAP INPUT DATA:

1.1900 0.00010000 1

R	**20.43200000**	**3**	**0**	**-21.96900000**	**Modeled Base Impedance**
C	0.00005550	3	0		
L	3.28700000	2	3	0.00000000	
L	13374.40000000	2	0	0.00000000	
R	1.00000000	1	2	0.00000000	
I	**38.34810000**	**0**	**1**	**3.57000000**	**Modeled Current Magnitude & Phase at Toroid**

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Daytime Directional Antenna Base Circuit Analysis – WCRW Tower 3 (NW)

WCAP OUTPUT AT FREQUENCY: 1.190 MHz

NODE VOLTAGES

Node:	1	268.8592	∡	-92.5049°	V
Node:	2	273.2939	∡	-90.0645°	V
Node:	3	103.9925	∡	-16.2464°	V

	WCAP PART		BRANCH VOLTAGE				BRANCH CURRENT				
R	**3→0**	-8.36990000	103.99	∡	-16.246°	V	**12.36**	**∡**	**157.900°**	**A**	**Current at Load**
C	3→0	0.00005550	103.99	∡	-16.246°	V	0.04	∡	73.754°	A	
L	2→3	2.85500000	263.94	∡	-112.299°	V	12.36	∡	157.701°	A	
L	2→0	13374.40000000	273.29	∡	-90.065°	V	0.00	∡	179.935°	A	
R	1→2	1.00000000	12.37	∡	157.706°	V	12.37	∡	157.706°	A	

	WCAP PART		FROM IMPEDANCE				TO IMPEDANCE			
R	**3→0**	-8.36990000	**-8.37**	**-**	**j**	**0.858**	0.00	+	j	0.000
C	3→0	0.00005550	0.01	-	j	2409.795	0.00	+	j	0.000
L	2→3	2.85500000	-8.36	+	j	20.460	-8.36	-	j	0.887
L	2→0	13374.40000000	0.00	+	j	100000.262	0.00	+	j	0.000
R	1→2	1.00000000	-7.36	+	j	20.457	-8.36	+	j	20.457

WCAP INPUT DATA:
1.1900 0.00010000 1

R	**-8.36990000**	**3**	**0**	**-0.858070000**	**Modeled Base Impedance**
C	0.00005550	3	0		
L	2.85500000	2	3	0.000000000	
L	13374.40000000	2	0	0.000000000	
R	1.00000000	1	2	0.000000000	
I	**12.36680000**	**0**	**1**	**157.706000000**	**Modeled Current Magnitude & Phase at Toroid**

Nighttime Daytime Directional Antenna Base Circuit Analysis – WCRW Tower 1 (SE)

WCAP OUTPUT AT FREQUENCY: 1.190 MHz

NODE VOLTAGES

Node:	1	150.3205	∡	-57.6014°	V
Node:	2	150.8138	∡	-56.2520°	V
Node:	3	75.4774	∡	-47.4706°	V

WCAP PART			BRANCH VOLTAGE				BRANCH CURRENT				
R	**3→0**	-6.19550000	75.48	∡	-47.471°	V	**3.61**	∡	**-154.700°**	**A**	**Current at Load**
C	3→0	0.00005550	75.48	∡	-47.471°	V	0.03	∡	42.529°	A	
L	2→3	2.88100000	77.09	∡	-64.849°	V	3.58	∡	-154.849°	A	
L	2→0	13374.40000000	150.81	∡	-56.252°	V	0.00	∡	-146.252°	A	
R	1→2	1.00000000	3.58	∡	-154.845°	V	3.58	∡	-154.845°	A	

WCAP PART			FROM IMPEDANCE				TO IMPEDANCE			
R	**3→0**	-6.19550000	**-6.20**	+	**j**	**19.978**	0.00	+	j	0.000
C	3→0	0.00005550	0.00	-	j	2409.795	0.00	+	j	0.000
L	2→3	2.88100000	-6.30	+	j	41.670	-6.30	+	j	20.129
L	2→0	13374.40000000	0.00	+	j	100000.262	0.00	+	j	0.000
R	1→2	1.00000000	-5.29	+	j	41.653	-6.29	+	j	41.653

WCAP INPUT DATA:

1.1900 0.00010000 1

R	**-6.19550000**	**3**	**0**	**19.97800000**	**Modeled Base Impedance**
C	0.00005550	3	0		
L	2.88100000	2	3	0.00000000	
L	13374.40000000	2	0	0.00000000	
R	1.00000000	1	2	0.00000000	
I	**3.58008000**	**0**	**1**	**205.15500000**	**Modeled Current Magnitude & Phase at Toroid**

Nighttime Directional Antenna Base Circuit Analysis – WCRW Tower 2 (C)

WCAP OUTPUT AT FREQUENCY: 1.190 MHz

NODE VOLTAGES

Node:	1	227.0240	∡	57.9609°	V
Node:	2	223.1371	∡	59.4154°	V
Node:	3	124.2524	∡	10.4453°	V

	WCAP PART		BRANCH VOLTAGE				BRANCH CURRENT				
R	**3→0**	17.79500000	124.25	∡	10.445°	V	**6.92**	**∡**	**2.500°**	**A**	**Current at Load**
C	3→0	0.00005550	124.25	∡	10.445°	V	0.05	∡	100.445°	A	
L	2→3	3.28700000	169.79	∡	92.923°	V	6.91	∡	2.923°	A	
L	2→0	13374.40000000	223.14	∡	59.415°	V	0.00	∡	-30.585°	A	
R	1→2	1.00000000	6.91	∡	2.913°	V	6.91	∡	2.913°	A	

	WCAP PART		FROM IMPEDANCE				TO IMPEDANCE			
R	**3→0**	17.79500000	**17.80**	**+**	**j**	**2.484**	0.00	+	j	0.000
C	3→0	0.00005550	0.00	-	j	2409.795	0.00	+	j	0.000
L	2→3	3.28700000	17.83	+	j	26.931	17.83	+	j	2.354
L	2→0	13374.40000000	0.00	+	j	100000.262	0.00	+	j	0.000
R	1→2	1.00000000	18.82	+	j	26.927	17.82	+	j	26.927

WCAP INPUT DATA:
1.1900 0.00010000 1

R	**17.79500000**	**3**	**0**	**2.48370000**	**Modeled Base Impedance**
C	0.00005550	3	0		
L	3.28700000	2	3	0.00000000	
L	13374.40000000	2	0	0.00000000	
R	1.00000000	1	2	0.00000000	
I	**6.91032000**	**0**	**1**	**2.91300000**	**Modeled Current Magnitude & Phase at Toroid**

Nighttime Directional Antenna Base Circuit Analysis – WCRW Tower 3 (NW)

WCAP OUTPUT AT FREQUENCY: 1.190 MHz

NODE VOLTAGES

Node:	1	79.3058	∡	125.6049°	V
Node:	2	73.4356	∡	124.1763°	V
Node:	3	170.1403	∡	77.0029°	V

	WCAP PART		BRANCH VOLTAGE				BRANCH CURRENT				
R	**3→0**	11.51100000	170.14	∡	77.003°	V	**6.11**	**∡**	**142.600°**	**A**	**Current at Load**
C	3→0	0.00005550	170.14	∡	77.003°	V	0.07	∡	167.003°	A	
L	2→3	2.85500000	131.73	∡	-127.130°	V	6.17	∡	142.870°	A	
L	2→0	13374.40000000	73.44	∡	124.176°	V	0.01	∡	34.176°	A	
R	1→2	1.00000000	6.17	∡	142.864°	V	6.17	∡	142.864°	A	

	WCAP PART		FROM IMPEDANCE				TO IMPEDANCE			
R	**3→0**	11.51100000	**11.51**	**-**	**j**	**25.372**	0.00	+	j	0.000
C	3→0	0.00005550	-0.01	-	j	2409.795	0.00	+	j	0.000
L	2→3	2.85500000	11.27	-	j	3.814	11.27	-	j	25.161
L	2→0	13374.40000000	0.01	+	j	100000.262	0.00	+	j	0.000
R	1→2	1.00000000	12.27	-	j	3.813	11.27	-	j	3.813

WCAP INPUT DATA:

1.1900 0.00010000 1

R	**11.51100000**	**3**	**0**	**-25.37200000**	**Modeled Base Impedance**
C	0.00005550	3	0		
L	2.85500000	2	3	0.00000000	
L	13374.40000000	2	0	0.00000000	
R	1.00000000	1	2	0.00000000	
I	**6.17086000**	**0**	**1**	**142.86400000**	**Modeled Current Magnitude & Phase at Toroid**

Antenna Monitor and Sample System

As discussed in a previous section of this Statement, a *Potomac Instruments* Inc. Model AM-1901-3 Antenna Monitor, Serial Number 836, is in service for this Station. The factory calibration date for this monitor is August 5, 2010. The calibration was verified using the manufacturer's instrument self-calibration procedures and by observing indications when channels were fed by voltages having equal magnitude and phase.

Toroidal current transformers are employed to provide sample currents for the antenna sampling system and replace the TCTs that were originally installed at this site. These *Phasetek, Inc. m*odel "P600-205" TCTs have "dual" sensitivity capability, making them well-suited to the difference in power levels encountered between the day and night operational modes. The characteristics of these TCTs were verified per the requirements of the FCC's Rules prior to antenna array adjustment; see the following section of this Statement regarding sample system TCT calibration.

These TCTs feed individual phase stabilized, factory connectorized, equal length, half-inch Andrew Corporation coaxial sample cables (Model 42394-14VA), which have been installed at the site under equal environmental conditions, all being buried except where extending equally to terminating locations. The electrical lengths and characteristic impedance of these lines were verified prior to array adjustment per the Commission's MoM proof requirements, as discussed below. Each sample line's impedance was also measured in the terminated condition, with the companion toroidal current sampling transformer devices connected. The results are included in a tabulation which follows this section.

This sampling system conforms to the provisions of Section 73.68(a) of the Commission's Rules that were in effect prior to January 1, 1986, essentially qualifying the system as an "approved" sampling system. Accordingly, if pertinent, approval of this sampling system is being requested pursuant to the FCC's Public Notice of December 9, 1985. Further, as will be demonstrated herein, the installed antenna monitor - sampling system also complies with the requirements of the newly adopted MoM Proof Rules under Section 73.151(c).

Sampling System Measurements

Impedance and length measurements were made of the antenna monitor sampling system as required by FCC Rule Section 73.151(c)(2)(i). The equipment used for these measurements consisted of a precision calibrated *Hewlett-Packard* model 8753C vector network analyzer, a *Tunwall Radio* directional coupler system, and an *Electronic Navigation Industries* (ENI) Model 310 L RF amplifier. The calibration of this equipment (as configured for these tests), was field verified prior to each measurement using the procedures specified in the manufacturer's instruction manual and precision calibration standards. Sample system measurements were accomplished by attaching the test equipment at the "antenna monitor ends" of the sampling lines and making observations for two test conditions – an unterminated "open circuit" condition (without the sampling lines connected to any loads or sampling devices), and then with the (TCT) sampling devices connected to the lines at their distant ends (at the tower bases). The first test condition (with unterminated sample lines) is used to establish the electrical length of each sample line. Impedance measurements are made on each sample line to find the frequency closest to the carrier frequency where the line is series resonant (a frequency where the resistance is low and the reactance is zero). The line length will be an odd multiple of 90 degrees in length at that frequency, or in this instance, 450 degrees. The line length at carrier can therefore be calculated by dividing the carrier frequency by the measured frequency, then multiplying the result by the 450 degrees. As shown in the table below, using this method, the sampling line lengths meet the Commission's requirement that they be equal in length within +/-1 electrical degree. These measurements also compare favorably to the original installation data.

Sample Line for Tower	Open-Circuit Resonance Nearest to 1190 kHz	Calculated Electrical Length
1 – Southeast	1464.46 kHz	**365.66°**
2 – Center	1464.46 kHz	**365.66°**
3 – Northwest	1464.02 kHz	**365.77°**

For the second test condition, impedance measurements were then made at frequencies corresponding to 1⁄8 wavelength (45°) immediately above and below the open circuit resonant frequency closest to carrier frequency, to establish the sample line's characteristic impedance. The characteristic impedance of the sample lines can then be calculated using the following formula:

$$Zo = \sqrt{\sqrt{R_1^2 + X_1^2} \bullet \sqrt{R_2^2 + X_2^2}}$$

where $R_1 + jX_1$ and $R_2 + jX_2$ are the measured impedances at the +45 and –45 degree offset frequencies, respectively.

The data and calculation results are tabulated below. As shown, the sampling line measured characteristic impedances meet the Commission's requirement that they be equal within +/-2 ohms.

Sample Line for Tower	-45° Offset Frequency	-45° Measured Impedance	+45° Offset Frequency	+45° Measured Impedance	Characteristic Impedance
1 – Southeast	1318.01 kHz	5.79 –j50.19 Ω	1610.91 kHz	7.24 +j50.53 Ω	**50.78 Ω**
2 – Center	1318.01 kHz	5.87 –j50.16 Ω	1610.91 kHz	7.25 +j50.45 Ω	**50.73 Ω**
3 – Northwest	1317.62 kHz	5.80 –j50.03 Ω	1610.42 kHz	7.29 +j50.56 Ω	**50.72 Ω**

Impedance measurements were then taken at carrier frequency for each sample line with the new *Phasetek* TCTs connected to the lines. Since these TCTs are dual range devices, measurements were taken for each sensitivity range (day versus night mode) as shown below.

Sample Line for Tower	Measured Impedance With TCT Connected Day Mode	Measured Impedance with TCT Connected Night Mode
1 – Southeast	50.62 +j0.88 Ω	50.45 +j2.69 Ω
2 – Center	50.63 +j0.83 Ω	50.39 +j2.75 Ω
3 – Northwest	50.60 +j0.78 Ω	50.40 +j2.89 Ω

The relative calibration of the toroidal transformers used for the station sampling system were calibrated by measuring their outputs with a common reference signal using a *Hewlett-Packard* 8753C network analyzer in a calibrated measurement system. They were placed side-by-side with a conductor passing the reference signal passing through them and their outputs were fed into the A and B receiver inputs of the analyzer which was configured to measure the relative ratios and phases of their output voltages. The following results were found for the carrier frequency, 1190 kilohertz:

TCT for Tower	Serial Number	Day Mode		Night Mode	
		Ratio	Phase	Ratio	Phase
1 – Southeast	11901	0.995	0.4°	1.000	0.1°
2 – Center (ref)	11902	1.000	0.0°	1.000	0.0°
3 – Northwest	11903	0.993	0.5°	1.008	0.4°

*Phasetek, Inc. m*odel "P600-205" toroidal transformers are rated for absolute magnitude accuracy of ±1.5% and absolute phase accuracy of ±2 degrees. As the maximum measured transformer-to-transformer variations between the three transformers were fractional amounts, they clearly provide far more accurate relative indications than could be the case assuming their rated accuracies.

Reference Field Strength Measurements

FCC Rule Section 73.151(c)(3) states that "Reference field strength measurement locations shall be established in directions of pattern minima and maxima" as companion information for a Method of Moments Proof-of-Performance. Accordingly, data were gathered as required by this Rule Section[11]. Operating mode, radial directions, measured field strength, measurement point distance, location description, and GPS coordinates (with datum reference) are shown in the following tables for both the daytime and nighttime patterns.

[11] Daytime reference point measurements are also being included with this Proof-of-Performance since both patterns are being "proofed". The requirements of FCC Rule Section 73.151(c)(3) are thus satisfied.

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The instrumentation used for these measurements was a *Potomac Instruments, Inc.* Model FIM-21 Field Strength Meter, Serial Number 117, which was last factory calibrated on February 21, 2018. The GPS unit employed for these measurements was a *Garmin* "GPSmap 60 csx", Serial Number 118744207. The measurements reported below were collected by Mr. Brian C. Edwards, Vice President and Group Chief Engineer for the Licensee.

Daytime Reference Point Data

Reference Field Strength Measurements – 149° (Main Lobe) Daytime

Point	Distance (km)	Field (mV/m)	Coordinates (NAD-83 Datum)		Measurement Location Description
1	0.88	3800	38° 52.342'	76° 55.351'	30 feet NE from the NE corner of the perimeter fence around the Water Treatment Facility.
2	1.73	1523	38° 52.400'	76° 55.146'	Median between East and West Bound lanes of Nokes Blvd, 100' West of the island of SB 28 on-ramp.
3	3.05	1007	38° 52.757'	76° 54.707'	South side of Atlantic Blvd. opposite Double Tree Hotel. Next to Dulles Sportsplex sign.

Reference Field Strength Measurements – 278° (Monitored Minima) Daytime

Point	Distance (km)	Field (mV/m)	Coordinates (NAD-83 Datum)		Measurement Location Description
1	0.38	730	39° 02.503'	77° 26.957'	100 yards north of first bridge on Loudoun County Parkway leaving site, 25 yards down in field off road
2	1.2	653	39° 02.550'	77° 27.523'	Marblehead Drive at Western Gailes Blvd.
3	2.36	225	39° 02.673'	77° 28.317'	Ashburn Village Shopping Center at corner of Christina Drive and Ashburn Village Drive

Nighttime Reference Point Data

Reference Field Strength Measurements – 30° (Minor Lobe) Nighttime

Point	Distance (km)	Field (mV/m)	Coordinates (NAD-83 Datum)		Measurement Location Description
1	0.13	500	39° 02.537'	077° 26.647'	Loudoun Water Site Access Road North Site
2	0.97	57.5	39° 02.917'	077° 26.336'	Russell Branch Parkway at Entrance to Ashburn North Park & Ride Lot
3	2.19	4.0	39° 03.529'	077° 25.978'	State Route 808 at Intersection with Dairy Ln

Nighttime Reference Point Data
(continued)

Reference Field Strength Measurements – 60° (Monitored Minima) Nighttime

Point	Distance (km)	Field (mV/m)	Coordinates (NAD-83 Datum)		Measurement Location Description
1	0.12	440	39° 02.743'	077° 26.494'	Loudoun Water Site Access Road North Site
2	1.46	15.0	39° 03.026'	077° 25.839'	State Route 808 900 feet from intersection of Route 7
3	3.13	2.20	39° 03.269'	077° 24.936'	Algonkian Parkway at intersection with Bentley Drive

Reference Field Strength Measurements – 143° (Major Lobe) Nighttime

Point	Distance (km)	Field (mV/m)	Coordinates (NAD-83 Datum)		Measurement Location Description
1	1.01	183	39° 02.019'	077° 26.298'	Loudoun Water Site Access Road East Site at Fork in Road
2	2.5	87	39° 01.466'	077° 25.581'	Parking lot at Sam's Club, Dulles Crossing Plaza
3	4.25	42	39° 00.656'	077° 24.929'	Cabin Branch Drive and Morning Way - End of Cul-de-sac

Reference Field Strength Measurements – 225.5° (Monitored Minima) Nighttime

Point	Distance (km)	Field (mV/m)	Coordinates (NAD-83 Datum)		Measurement Location Description
1	0.12	377	39° 02.347'	077° 26.832'	Loudoun Water Site Access Road West Site
2	1.69	64.0	39° 01.701'	077° 27.364'	Gloucester Parkway at Smith Switch Road
3	3.17	23.0	39° 01.224'	077° 28.239'	Cameron Chase Village Center at Fords Fish Shack

Reference Field Strength Measurements – 244° (Minor Lobe) Nighttime

Point	Distance (km)	Field (mV/m)	Coordinates (NAD-83 Datum)		Measurement Location Description
1	0.17	505	39° 02.433'	077° 26.812'	Loudoun Water Site Access Road West Site
2	2.30	34.0	39° 02.001'	077° 27.961'	Tillman Terrace at Lowery Park Terrace
3	3.81	24.6	39° 01.613'	077° 29.077'	Dodge Circle at Farmwell Road

Nighttime Reference Point Data
(continued)

Reference Field Strength Measurements – 296° (Monitored Minima) Nighttime

Point	Distance (km)	Field (mV/m)	Coordinates (NAD-83 Datum)		Measurement Location Description
1	0.27	450	39° 02.499'	077° 26.766'	Loudoun Water Site Access Road West Site
2	0.75	20.0	39° 02.664'	077° 27.216'	Exchange St at Collingdale Terrace
3	3.56	4.0	39° 03.341'	077° 28.938'	Boxwood Place at Camellia Street

Reference Field Strength Measurements – 352.5° (Monitored Minima) Nighttime

Point	Distance (km)	Field (mV/m)	Coordinates (NAD-83 Datum)		Measurement Location Description
1	1.52	0.60	39° 02.564'	077° 26.709'	Loudoun Water Site Access Road North Site
2	1.11	70.00	39° 03.024'	077° 26.639'	At 44901 Russel Branch Rd
3	3.04	8.5	39° 04.123'	077° 26.991'	Riverside Parkway intersection at Broad Vista Terrace

Direct Measurement of Power

Common point impedance measurements were made using the previously described network analyzer equipment for both the day and nighttime modes. The "as adjusted" common point impedance measurements were made at the respective phasor cabinet input jacks, adjacent to the common point current meter used to determine operating power. The results were confirmed by a *Delta Electronics* OIB-3 Operating Impedance Bridge. This data is shown below:

Operating Mode	Common Point Resistance	Common Point Reactance
Daytime	44.4 Ω	-0.3 Ω
Nighttime	44.9 Ω	-17.2 Ω

The authorized common point input power of the nominal 50 kW daytime directional antenna system for WCRW is 52,650 watts. This value is obtained by applying the provisions of Section 73.51(b)(2) of the FCC's Rules, whereby the authorized input power to directional antennas whose nominal powers are in excess of 5 kW are allowed to exceed the nominal power by 5.3 percent, (i.e. 50,000 Watts x 1.053 = 52,650 Watts). Accordingly, the appropriate **daytime common point current is 34.436 Amperes**, as found by the following calculation: (52,650 Watts/44.4 Ohms Daytime Common Point Resistance)$^{1/2}$ = **34.436 Amperes**. Given the resolution of the common point ammeter, this may be rounded to ***34.4 Amperes***.

The authorized common point input power of the nominal 0.12 kW (1200 Watt) nighttime directional antenna system is 1296 Watts. This value is obtained by applying the provisions of Section 73.51(b)(1) of the FCC's Rules, whereby the authorized input power to directional antennas whose nominal powers are 5 kW or less are allowed to exceed the nominal power by 8 percent, (i.e. 1200 Watts x 1.08 = 1296 Watts). The appropriate **nighttime common point current is 5.373 Amperes**, as found by the following calculation: (1296 Watts/44.9 Ohms Nighttime Common Point Resistance)$^{1/2}$ = **5.373 Amperes**. Given the resolution of the common point ammeter, this may be rounded to ***5.37 Amperes***.

These values are maintained by Station personnel using *Delta Electronics* Ammeters at each common point location.

Survey Certification

FCC Rule Section 73.151(c)(1)(ix) states: "Stations submitting a moment method proof for a pattern using towers that are part of an authorized AM array are exempt from the requirement to submit a surveyor's certification, provided that the tower geometry of the array is not being modified and that no new towers are being added to the array." Applying this recently amended rule, and because no new towers or changes to the existing tower locations have been made, a surveyor's certification is not required for this daytime and nighttime MoM Proof-of-Performance.

RF Exposure Evaluation

The operation of the facility described herein will not result in the exposure of workers or the general public to levels of radio frequency radiation in excess of the limits specified in FCC Rule Section 1.1310. *Potomac Radio* has installed locked fences around each of the tower bases to restrict public access (as described in the RF Exposure evaluations presented in prior WCRW applications for CP and License). The as-constructed fence distances are beyond those necessary to prevent electric and magnetic field exposure above the levels described in the Commission's Rules at the power levels specified for WCRW. Further, all fence enclosure areas are posted with RF exposure warning signs on all fence sides, RF burn warning signs are posted on the towers themselves, and the fence gates are securely chained and locked. Additionally, all metal fence metal materials are tied into the Station's RF ground system.

With respect to worker safety, no work will be permitted that will endanger employees or subcontractors. Access to high exposure or shock/burn areas will be controlled and supervised by knowledgeable, responsible, Station personnel. If it is necessary for workers to be inside the tower base fence enclosures for extended periods of time, the Station will switch to low power non-directional operation on Tower 2 (the Central tower), thus de-activating Towers 1, and 3, or it can temporarily terminate operation entirely while work is performed within the enclosures. No one will be permitted to climb an energized tower. It is therefore submitted that the constructed facility is in full compliance with the FCC's requirements with regard to radio frequency energy exposure.

Satisfaction of Nighttime CP Conditions

The WCRW Nighttime Construction Permit is subject to four Special Operating Conditions, which are discussed in the following paragraphs. All four Special Operating Conditions are complied with as of the filing of this Application. Specifically:

FCC Special Operating Condition 1 requires that the Permittee install a type-accepted transmitter. Type-accepted transmitters (Nautel) have been properly installed at the authorized transmitter site, satisfying this Special Operating Condition.

FCC Special Operating Condition 2 requires that a license application (FCC Form 302-AM) to cover this construction permit be filed with the Commission pursuant to Section 73.3536 of the Rules before the permit expires. FCC Form 302-AM, to which this exhibit is attached Statement E, is being filed prior to the CP expiration date of May 3, 2020, this satisfying this condition.

FCC Special Operating Condition 3 requires that a ground system be installed as follows: the ground system must consists of 120 equally spaced (every 3 degree) #10 AWG soft-drawn, buried, copper radials about the base of each tower, each being 90 degree (63 meters) in length except where terminated in common 4" transverse copper straps. An additional set of 120 copper radials, each 15.2 meters long are installed between the longer radials. A 4" wide copper strap is installed between each tower. Extruded copper mesh screens are placed atop each tower base foundation and each tuning unit support and are then tied into the ground system by a series of 4" wide copper straps. Additional copper straps connect the tower base ground point to 7 grounding rods. This system has been installed as required.

FCC Special Operating Condition 4 requires that the Permittee submit a proof of performance as set forth in either Sections 73.151(a) or 73.151(c) of the Rules before program tests can be authorized. This condition has been satisfied in that a Moment Method Proof-of-Performance, as set forth in Section 73.151(c) of the Commission's Rules has been completed. It is supplied with an FCC Form 302-AM in the form of this Statement. As is also required by **Special Operating Condition 4**, this antenna system uses series-fed radiators and the associated sampling system is constructed as described in Section 73.151(c)(2)(i) of the Commission's Rules. Therefore this Special Operating Condition is satisfied. Accordingly, prompt issuance of Program Test Authority for the newly constructed nighttime antenna mode is herein respectfully requested on behalf of *Potomac Radio*.

Certification

These application materials have been prepared on behalf of *Potomac Radio* by the undersigned or under his direction and are true and correct to the best of his information, knowledge and belief. Mr. Cavell's qualifications are a matter of record before the FCC.

Respectfully submitted,

Garrison C. Cavell April 2, 2018
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