2017 DEC 26 AM 5: 30

December 20, 2017

BY EXPRESS MAIL TO POST OFFICE BOX

RECEIVED - FCC

DEC 20 2017

Federal Communications Commission
Bureau / Office

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

Re: Station WNWR(AM)
Washington, D.C.
Facility ID No. ~~1072~~ 1027
Application for Direct Power Measurement and Revised Station License

Dear Sir:

Transmitted herewith, in triplicate, on behalf of Global Radio, L.L.C. (Delaware), the licensee of Station WNWR(AM), Washington, D.C., is an application on FCC Form 302-AM. The application requests authority for direct measurement of power and a revised license for the Station based on the completion of the construction of new facilities for the Station, as authorized in FCC File No. BP-20161215ABM.

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.

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)

4848-2526-8045

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. BZ-20171220ACU

SECTION I - APPLICANT FEE INFORMATION

1. PAYOR NAME (Last, First, Middle Initial)
Global Radio, L.L.C. (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	WNWR	FIN: 1027

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: 0003737616

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 Global Radio, L.L.C. (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
WNWR	Philadelphia, PA	BP-20161215ABM		May 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	12/18/2017	702-532-0400

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

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

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

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

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

SECTION III - LICENSE APPLICATION ENGINEERING DATA

Name of Applicant
Global Radio, L.L.C. (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	Power in kilowatts Day
WNWR	BP-20161215ABM	1540	Unlimited	0.25	50.0

2. Station location

State	City or Town
Pennsylvania	Philadelphia

3. Transmitter location

State	County	City or Town	Street address (or other identification)
PA	Montgomery	Philadelphia	7360 Ridge Avenue

4. Main studio location

State	County	City or Town	Street address (or other identification)
PA	Montgomery	Philadelphia	7360 Ridge Avenue

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

State	County	City or Town	Street address (or other identification)
PA	Montgomery	Philadelphia	7360 Ridge Avenue

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.
See 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
1.964	32.45

Measured antenna or common point resistance (in ohms) at operating frequency Night	Day	Measured antenna or common point reactance (in ohms) at operating frequency Night	Day
70	50	-30.8	-7.7

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
Tower 1 (Center)	99.4	0.0	1.340	1.000	Not Required	Not Required
Tower 2 (Southeast)	0.0	-119.3	1.000	0.441	Not Required	Not Required
Tower 3 (Northwest)	-106.1	141.7	0.440	0.735	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.
uniform cross section	44.2 (all)	T1=45.8, T2=45.3, T3=45.4	T1=45.8, T2=45.3, T3=45.4	Exhibit No. See Statement E

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 40 ° 02 ' 46 "	West Longitude 75 ° 14 ' 09 "

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. See 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. See 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?

Constructed facility does not differ from that described in the CP application

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

No change in authorized Daytime common point resistance.

New construction for Nighttime system - new common point resistance

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	
Address (include ZIP Code)	Date
Cavell, Mertz & Associates, Inc. 7724 Donegan Drive Manassas, VA 20109	December 15, 2017
	Telephone No. (Include Area Code)
	(703) 392-9090

☐ Technical Director

☐ Registered Professional Engineer

☐ Chief Operator

☑ Technical Consultant

☐ Other (specify)

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 WNWR

APPLICATION FOR DIRECT POWER MEASUREMENT AND REVISED STATION LICENSE

(Method of Moments Proof-of-Performance)

Supporting FCC Construction Permit BP-20161215ABM

WNWR Philadelphia, Pennsylvania - Facility ID 1027
Global Radio, L.L.C. (Delaware)

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

DECEMBER 15, 2017

Statement E
APPLICATION FOR DIRECT POWER MEASUREMENT AND REVISED STATION LICENSE
Supporting FCC Construction Permit BP-20161215ABM
WNWR Philadelphia, Pennsylvania (Facility ID 1027)

Introduction and Summary

This Statement has been prepared on behalf of ***Global Radio, L.L.C. (Delaware)***, ("*Global Radio*"), licensee of radio station WNWR, Philadelphia, Pennsylvania. WNWR is presently authorized to operate during daytime-hours on a frequency of 1540 kHz with a nominal operating power of 50,000 Watts using a directional antenna system (see FCC File Number BMML-20120724AFT.) *Global Radio* also holds a Construction Permit (FCC File Number BP-20161215ABM) authorizing the addition of nighttime operation for WNWR at 250 Watts using the same physical antenna tower array as is employed for the daytime operation.

The installation of the additional RF phasing and coupling systems necessary to operate with the authorized new nighttime facilities has now been completed and the nighttime system 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.

The WNWR 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 2012 grant of its present daytime license (following completion of certain antenna and ground system improvements),

As is demonstrated in the following, the new nighttime directional antenna system has been adjusted to produce antenna monitor parameters that are within +/- 5 percent in ratio and +/- 3 degrees in phase of the MoM modeled values. Additionally, the operating power of the nighttime antenna system was determined and adjusted per the requirements of FCC Rule Sections 73.51 and 73.54(b). Finally, the authorized daytime array remains in adjustment and in full compliance with the FCC's Rules. This Exhibit and the FCC Form 302-AM demonstrate that the WNWR antenna system is adjusted in accordance with pertinent FCC Rules and policies, as well as the terms and conditions of its Construction Permit ("CP").

Status of Licensed Daytime Operation

The daytime tuning units that were put in place during the 2012 system renovation were constructed using internal "partitions" in anticipation of adding another station or mode of operation. As such the process of adding and adjusting the RF component for the new WNWR nighttime system was not expected to have a material impact on the WNWR daytime mode of operation. Nevertheless, "before" and "after" daytime antenna monitor operating parameters and base current indications were observed, and checks of the daytime common point resistance, reactance, and common point current were accomplished. No material changes were noted.

Statement E
APPLICATION FOR DIRECT POWER MEASUREMENT AND REVISED STATION LICENSE
Supporting FCC Construction Permit BP-20161215ABM
WNWR Philadelphia, Pennsylvania (Facility ID 1027)

Basis for 2017 Nighttime Proof-of-Performance

As part of the antenna plant re-checking process, the open-circuit "self" impedance of each tower was also measured and compared against the "baseline" impedance measurement gathered in 2012 for the daytime MoM proof. The results are tabulated below.

Tower	*2017* Measured Open Circuit-Self	*2012* Measured Open Circuit-Self
1 (C)	60.22 +j 111.85 Ω	61.10 +j 107.10 Ω
2 (SE)	63.23 +j 105.91 Ω	65.10 +j 100.40 Ω
3 (NW)	65.92 +j 104.48 Ω	62.60 +j 101.50 Ω

As shown below, the measured day array open-circuit-self impedances (taken in the winter of 2012) are within the FCC Rule[1] tolerance of plus or minus two Ohms and four percent of the values observed in the summer 2017 re-measurement. Conversely, the 2017 readings are within the tolerance window of the 2012 readings. This shows excellent stability over the seasons and intervening years.

2017 Lower Limit		2017 Upper Limit	
Resistance	Reactance	Resistance	Reactance
55.81 Ω	105.38 Ω	64.63 Ω	118.32 Ω
58.70 Ω	99.67 Ω	67.76 Ω	112.15 Ω
61.28 Ω	98.30 Ω	70.56 Ω	110.66 Ω

2012 Lower Limit		2012 Upper Limit	
Resistance	Reactance	Resistance	Reactance
56.66 Ω	100.82 Ω	65.54 Ω	113.38 Ω
60.50 Ω	94.38 Ω	69.70 Ω	106.42 Ω
58.10 Ω	95.44 Ω	67.10 Ω	107.56 Ω

Given the above results, it was concluded (and informally confirmed with FCC staff) that a reanalysis (re-proofing) of the WNWR *daytime* array is *not* necessary since the daytime open-circuit impedances remain within their FCC's prescribed impedance tolerances.[2] Accordingly, the licensed daytime array is <u>not</u> being re-proofed at this time.

A question had arisen as to which set of Open-Circuit-Self measurements (2012 or 2017) would be preferred for use in the new nighttime MoM analysis. After some discussion, it was informally recommended by FCC staff that the 2017 WNWR nighttime Proof-of-Performance, employing the most recent (2017) open-circuit-self impedance measurements for the purposes of MiniNEC model convergence be submitted, rather than the 2012 data. Accordingly, the 2017 measurements are used herein.

[1] FCC Rule Section 73.151(c)(2)(ii)

[2] The WNWR sample system, which serves both operating modes, is being recertified as part of this Proof since the sampling devices are being replaced as part of the addition of the nighttime mode. Further, while not required, a fresh set of Daytime mode Reference Point field strength readings will be supplied in this Proof document (along with the required new nighttime mode Reference Point readings).

Statement E
APPLICATION FOR DIRECT POWER MEASUREMENT AND REVISED STATION LICENSE
Supporting FCC Construction Permit BP-20161215ABM
WNWR Philadelphia, Pennsylvania (Facility ID 1027)

Antenna and Ground System Description

The existing WNWR daytime antenna system consists of three, uniform cross-section, guyed, base insulated, series excited steel towers[3]. Each tower uses 21 foot (6.4 meter) lengths of guy wire to provide approximately 8.3 electrical degrees of top-loading. The nighttime CP specified the use of this existing antenna array; no tower or top-loading changes were required.

The WNWR ground system consists of 120 equally spaced #10 soft-drawn, copper radial wires buried into the ground and arrayed every 3° around each tower, to a length of 160 feet (48.8 meters), except where truncated at the nearest property boundary or where shortened and bonded to transverse copper straps located at points midway between towers. An additional 120 radials, each 50 feet (15.2 meters) in length, are interspersed between the primary radials around each tower.[4] No changes were required or made to this existing system as a result of the construction of the nighttime CP facility.

MoM Modeling Process

FCC Rule Section 73.151(c) permits the use of computer modeling techniques ("Method of Moments" or "MoM" modeling) as a means of verifying AM radio station directional antenna performance for certain "qualified" antenna systems. The WNWR directional antenna array is "qualified" for such an analysis since it consists of series fed, base insulated (top loaded) towers, using a conventional, buried-wire, ground system. (The WNWR 2012 Proof-of-Performance for the licensed WNWR daytime operation used a MoM based Proof.)

Accordingly, the WNWR nighttime antenna system under discussion herein was evaluated using a MoM analysis; the particular program employed for this purpose was *Expert MININEC Broadcast Professional*[5], which is a PC compatible version of the Numerical Electromagnetics Code (NEC) family of analytical tools. This program uses the electric field integral equation for thin wires and the magnetic field integral equation for closed, conducting surfaces. The antennas can be modeled as a series of wires in free space or above a ground plane environment, as is the case with broadcast antennas.

---

[3] The height above the base insulator of each tower is 145 feet (44.2 m) or 81.7 degrees at the WNWR frequency. No new or modified antenna structure registration is required due to the modest tower height. Information on overall structure height (inclusive of base pier and insulator) is included on the attached FCC Form 302-AM.

[4] Additionally, each tuning unit support pad is topped with extruded copper mesh which is tied into the base ground system via copper straps. Each tuning unit is also securely bonded to the ground system through copper straps.

[5] The version of software used was Version 14.5, 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 (the "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 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 for use in Converging the WNWR Method of Moments Model

Before the model was run for the nighttime analysis, impedance measurements were taken at each of the WNWR 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[6] ("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"

[6] 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 WNWR frequency[7], and hence 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 measured impedances at the 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[8] provided by *Westberg Consulting.* These calculations were used throughout the proof process to relate the MoM modeled impedances[9] to the ATU output measurement (reference) points. As shown on the following pages, the Open Circuit 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 in 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}).

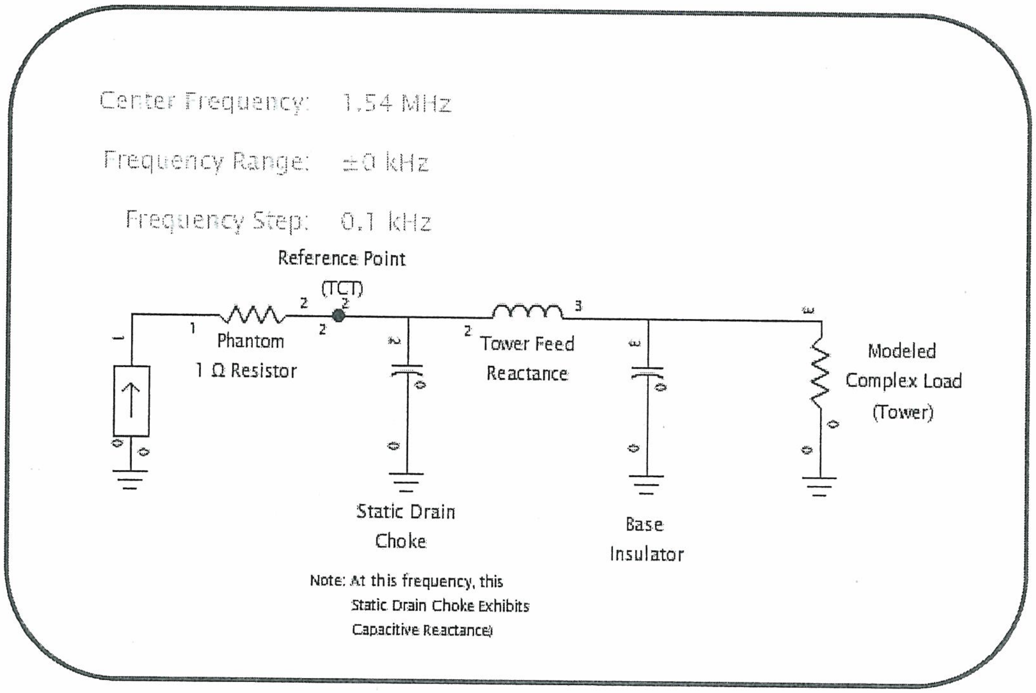
7 At the WNWR frequency, these chokes actually exhibit capacitive rather than inductive reactance.

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

9 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.

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.

Representative Open Circuit Tower Base Environment Schematic for all WNWR Towers



Summary of Completed Open Circuit Analysis of WNWR 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 (C)	1.087 µH	10.52 Ω	57.604 +j 99.647 Ω	60.34 +j 111.823 Ω	60.22 +j 111.85 Ω
Tower 2 (SE)	1.291 µH	12.49 Ω	62.657 +j 92.070 Ω	63.34 +j 105.827 Ω	63.23 +j 105.91 Ω
Tower 3 (NW)	1.677 µH	16.23 Ω	63.143 +j 87.224 Ω	65.83 +j 104.503 Ω	65.92 +j 104.48 Ω

Notes:

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

Static Drain Choke Reactance at 1540 kHz: -11,600 Ω (8.909 pF)

Base Insulator Reactance at 1540 kHz: - 7381.95Ω (~ 14 pF)

Lumped Load Assumption at 1540 kHz: - 4511 Ω (Base Insulator and Static Drain Choke)

Statement E
APPLICATION FOR DIRECT POWER MEASUREMENT
AND REVISED STATION LICENSE
Supporting FCC Construction Permit BP-20161215ABM
WNWR Philadelphia, Pennsylvania (Facility ID 1027)

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

WCAP Tower Base Open Circuit "Self" Analysis – WNWR Tower 1 (C)

WCAP OUTPUT AT FREQUENCY: 1.540 MHz **WNWR Tower 1 (Center)**

NODE VOLTAGES

Node:	1	127.5400	∡	61.2549°	V
Node:	2	127.0621	∡	61.6503°	V
Node:	3	117.7964	∡	59.2203°	V

WCAP PART CURRENT IN CURRENT OUT

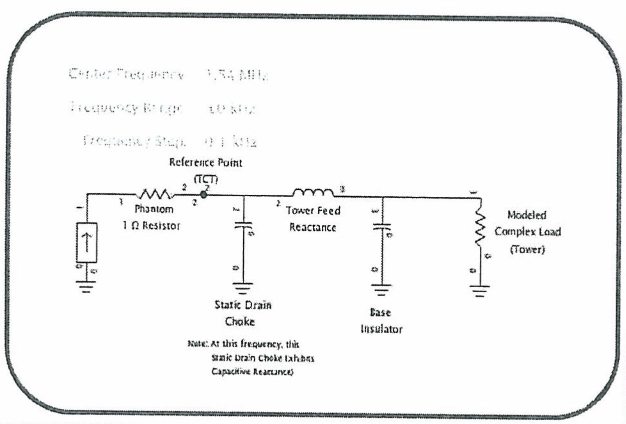
WCAP PART			BRANCH VOLTAGE				BRANCH CURRENT			
R	3→0	57.60400000	117.80	∡	59.220°	V	1.02	∡	-0.748°	A
C	3→0	0.00001400	117.80	∡	59.220°	V	0.02	∡	149.220°	A
L	2→3	1.08700000	10.62	∡	89.705°	V	1.01	∡	-0.295°	A
C	2→0	0.00000891	127.06	∡	61.650°	V	0.01	∡	151.650°	A
R	1→2	1.00000000	1.00	∡	0.000°	V	1.00	∡	0.000°	A

WCAP PART			FROM IMPEDANCE				TO IMPEDANCE			
R	3→0	57.60400000	57.60	+	j	99.647	0.00	+	j	0.000
C	3→0	0.00001400	0.00	-	j	7381.955	0.00	+	j	0.000
L	2→3	1.08700000	59.19	+	j	111.060	59.19	+	j	100.542
C	2→0	0.00000891	0.00	-	j	11600.333	0.00	+	j	0.000
R	**1→2**	1.00000000	61.34	+	j	111.823	**60.34**	**+**	**j**	**111.823**
						Measured:	**60.22**	**+j**		**111.85**
						Difference:	*0.12*			*0.027*

WCAP PART VSWR

WCAP INPUT DATA:
1.5400 0.00010000 1

R	57.60400000	3	0	99.64700000
C	0.00001400	3	0	
L	1.08700000	2	3	0.00000000
C	0.00000891	2	0	
R	1.00000000	1	2	0.00000000
I	1.00000000	0	1	0.00000000



Statement E
APPLICATION FOR DIRECT POWER MEASUREMENT AND REVISED STATION LICENSE
Supporting FCC Construction Permit BP-20161215ABM
WNWR Philadelphia, Pennsylvania (Facility ID 1027)

WCAP Tower Base Open Circuit "Self" Analysis – WNWR Tower 2 (SE)

WCAP OUTPUT AT FREQUENCY: 1.540 MHz — **WNWR Tower 2 (Southeast)**

NODE VOLTAGES

Node:	1	123.8491	∡	58.7030°	V
Node:	2	123.3326	∡	59.1000°	V
Node:	3	112.6637	∡	55.8358°	V

WCAP PART — CURRENT IN — CURRENT OUT

		WCAP PART	BRANCH VOLTAGE				BRANCH CURRENT			
R	3→0	60.65700000	112.66	∡	55.836°	V	1.02	∡	-0.787°	A
C	3→0	0.00001400	112.66	∡	55.836°	V	0.02	∡	145.836°	A
L	2→3	1.29100000	12.61	∡	89.690°	V	1.01	∡	-0.310°	A
C	2→0	0.00000891	123.33	∡	59.100°	V	0.01	∡	149.100°	A
R	1→2	1.00000000	1.00	∡	0.000°	V	1.00	∡	0.000°	A

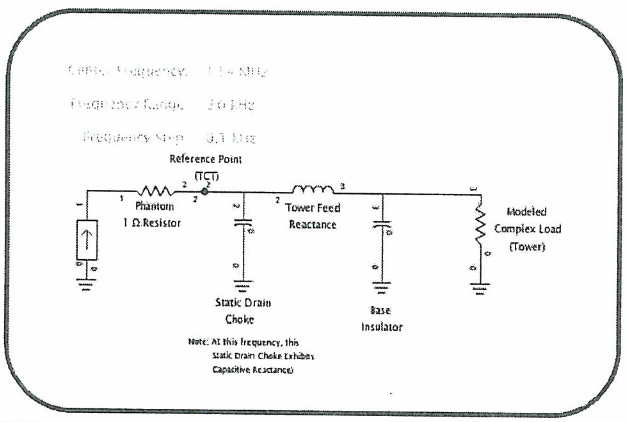
		WCAP PART	FROM IMPEDANCE				TO IMPEDANCE			
R	3→0	60.65700000	60.66	+	j	92.070	0.00	+	j	0.000
C	3→0	0.00001400	0.00	-	j	7381.955	0.00	+	j	0.000
L	2→3	1.29100000	62.19	+	j	105.207	62.19	+	j	92.715
C	2→0	0.00000891	0.00	-	j	11600.333	0.00	+	j	0.000
R	**1→2**	1.00000000	64.34	+	j	105.827	**63.34**	**+**	**j**	**105.827**
						Measured:	**63.23**	**+j**		**105.91**
						Difference:	*0.11*			*0.083*

WCAP PART — VSWR

WCAP INPUT DATA:

1.5400 0.00010000 1

R	60.65700000	3	0	92.0700000
C	0.00001400	3	0	
L	1.29100000	2	3	0.0000000
C	0.00000891	2	0	
R	1.00000000	1	2	0.0000000
I	1.00000000	0	1	0.0000000



Statement E
APPLICATION FOR DIRECT POWER MEASUREMENT
AND REVISED STATION LICENSE
Supporting FCC Construction Permit BP-20161215ABM
WNWR Philadelphia, Pennsylvania (Facility ID 1027)

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

WCAP OUTPUT AT FREQUENCY: 1.540 MHz **WNWR Tower 3 (Northwest)**

NODE VOLTAGES

Node:	1	124.0450	∡	57.4013°	V
Node:	2	123.5091	∡	57.7921°	V
Node:	3	109.9472	∡	53.2804°	V

WCAP PART CURRENT IN CURRENT OUT

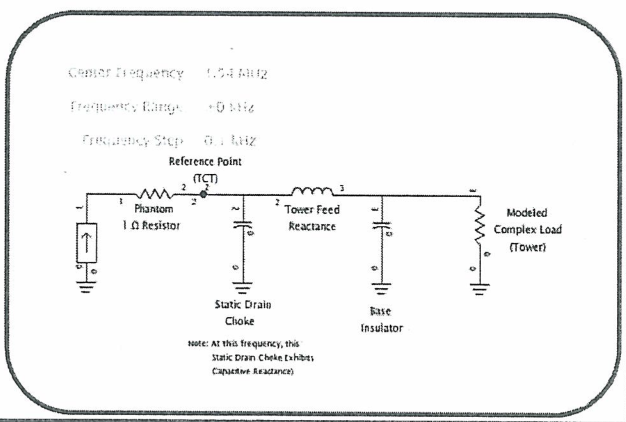
WCAP PART			BRANCH VOLTAGE				BRANCH CURRENT			
R	3→0	63.14300000	109.95	∡	53.280°	V	1.02	∡	-0.818°	A
C	3→0	0.00001400	109.95	∡	53.280°	V	0.01	∡	143.280°	A
L	2→3	1.67700000	16.37	∡	89.678°	V	1.01	∡	-0.322°	A
C	2→0	0.00000891	123.51	∡	57.792°	V	0.01	∡	147.792°	A
R	1→2	1.00000000	1.00	∡	0.000°	V	1.00	∡	0.000°	A

WCAP PART			FROM IMPEDANCE				TO IMPEDANCE			
R	3→0	63.14300000	63.14	+	j	87.224	0.00	+	j	0.000
C	3→0	0.00001400	0.00	-	j	7381.955	0.00	+	j	0.000
L	2→3	1.67700000	64.66	+	j	103.934	64.66	+	j	87.707
C	2→0	0.00000891	0.00	-	j	11600.333	0.00	+	j	0.000
R	**1→2**	1.00000000	66.83	+	j	104.503	**65.83**	**+**	**j**	**104.503**
						Measured:	**65.92**	**+j**		**104.48**
						Difference:	*0.09*			*0.002*

WCAP PART VSWR

WCAP INPUT DATA:

1.5400	0.00010000	1		
R	63.14300000	3	0	87.22400000
C	0.00001400	3	0	
L	1.67700000	2	3	0.00000000
C	0.00000891	2	0	
R	1.00000000	1	2	0.00000000
I	1.00000000	0	1	0.00000000

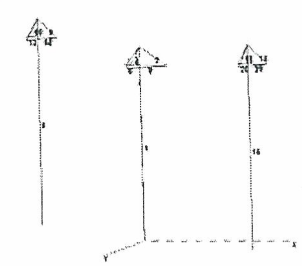


Details of MoM "Open Circuit" Modeling - for Towers Driven Individually

In the underlying MoM modeling used in the preceding (WCAP) circuit analysis, each tower is 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[10]. The results of this modeling work yields 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.

To construct the model in the MiniNEC program environment, all aspects of the radiating portions of the antenna system radiators are considered and entered into the program in mathematical terms the software can use. In this case, the WNWR towers are identical, eighteen inch face, uniform cross-section, guywire top-loaded, guyed towers, so given the relatively slender diameters of the involved towers, the accepted practice of using a single thick "wire" approach to represent each tower was selected, as opposed to developing a lattice or wire-frame model for each tower. The effective radius for the tower "wire" was calculated in the usual manner, and the top and bottom wire end points of each of the tower wires were specified in electrical degrees rather than meters for convenience. As the data were entered, no wire end caps were employed and a perfect ground environment was assumed.

The horizontal plane geometry data used in this analysis were taken from the licensed theoretical directional antenna specifications for WNWR, as discussed earlier in this report. Distances between elements were specified in electrical degrees, while azimuths - with respect to the center reference tower, Tower 1 (C) - are specified in degrees relative to True North. The guy wire top loading was laid out in the model in the same fashion, physical wire lengths, and relative orientations as is physically used at the site, including the "bridle" that connects the distal ends of the top load wires



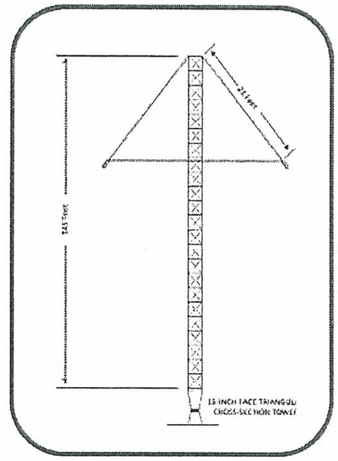
Relative Geometry

---

[10] For instance, the proximity of the tuning units to the towers, varying tuning unit size (especially the larger units for a higher power system at higher frequency arrays), their orientation with respect to the tower, differing lengths of feed line to the towers, and even differences in ground elevation at the tower base and the "lay of the land", all have an influence on the modeling outcome.

together.

With respect to model and FCC constraints, since the WNWR towers are "physically" 81.7 electrical degrees high at 1540 kHz, for the purposes of this analysis, the towers were modeled using 10 segments per tower. As such, the segment length is 8.2 degrees, which satisfies the Commission's §73.151(c)(1)(iii) requirement that no less than one segment be used for each 10 electrical degrees of the tower's physical height. The guy wire top loading was modeled as physically constructed. Given the short lengths of the wires (each 21 feet), 2 segments were used per wire, which also satisfies the Commission's segment number per 10 degree requirement.



After the initial setup of antenna array information in the model, the individual towers were studied iteratively with all other towers open circuited with appropriate lumped loads applied, while tower wire characteristics were adjusted (in height and radius) until the modeled resistance approximately matched the measured resistance. For simplicity, no changes were made in the relative top loading as the model was adjusted - the top loading "hat" system moved as an intact unit as the tower heights were adjusted. Final 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. The model assumption included loads at ground level having the reactances that were calculated for them using the base circuit models for the open circuited towers of the array. The same stray reactances as were used in the 2012 daytime proof were again used in this (2017) nighttime proof since nothing has changed in the base environment since the last analysis.

Each tower's adjusted modeled height relative to its physical height falls within the required range of 75 to 125 percent. Each modeled tower radius fell 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. A summary of this portion of the model input data is provided below:

Tower	Physical Height (at 1540 kHz)	Modeled Height	Modeled % of Height	Radiator Physical Equivalent Radius	Modeled Radius	Modeled % of Radius
1– Center	81.7° electrical	80.991°	99.13%	0.2180 m	0.2784 m	127.71%
2 – Southeast	81.7° electrical	84.793°	103.79%	0.2180 m	0.2210 m	101.38%
3 – Northwest	81.7° electrical	87.972°	107.68%	0.2180 m	0.2815 m	129.13%

Model Evaluation

The WNWR MiniNEC model was checked using the program's "problem definition evaluation" function in the course of undertaking the analysis. No segment warnings or errors were reported with respect to the towers and no model violations occurred. However, "junction radius ratio" warnings were given for the top loading wires, but this result was similarly observed in the previously granted WNWR 2012 MoM Proof. These warnings are due to the differences in radius between the "top-loading wires" and the equivalent radius "wires" representing the towers in the model. In this instance, the warnings are of no concern for the following reason.

This version of the MiniNec program has guidelines that consider a junction radius ratio of over 100 to constitute an error, while a warning is given for a ratio between 10 and 100 *as a cautionary measure*. The program instructions state that "*for best results the ratio of the radii of wires at a junction should be less than 10. However, Expert MININEC has shown reasonable results to ratios of 100.*" In this instance, the ratios in this model range from approximately 22 to 28. Inasmuch as the ratio is well below 100, this is comfortably within the confidence range of the software, and is verified by the fact that the impedance measurements easily match the model. It is therefore concluded that this model and the analysis is valid and satisfies the guidelines.

Other Model Considerations - Environmental Factors

The WNWR site is proximal to numerous other towers located in the Roxborough antenna farm, as has been noted in prior *Global Radio* submissions to the FCC. Accordingly, particular consideration had been given to these unrelated structures in the MoM Proof-of-Performance filed for WNWR in 2012[11]. After FCC staff review, a revised station license was subsequently granted based upon the techniques employed that Proof (see FCC File Number BMML-20120724AFT). The established 2012 "simplified approach" is again being used for this 2017 nighttime Proof and analysis because no material changes have occurred in the nearby environment, as demonstrated by a satisfactory comparison of the present (2017) "open-circuit self" base impedance measurements to the 2012 measurements (detailed in an earlier section of this report). Thus the use or this previously approved approach is justified.

[11] In 2012, an analysis was conducted to determine whether inclusion of the nearby towers in the WNWR model was necessary. After informal discussions with FCC staff, comparative MiniNEC models were run to determine the "with" and "without" adjoining tower impact on the WNWR individual open-circuit-self" base impedance values. It was found that the influence of these "other towers" did not disturb the open circuit-self base impedances of the WNWR towers to such an extent that the results fell out of the FCC's "impedance tolerance window" nor did the added impact of these other towers adversely affect the convergence. Hence, the neighboring structures were ignored for the purposes of converging the individual towers in the 2012 analysis. This conclusion and approach was accepted by FCC staff at the time and a license was subsequently granted on this basis.

MoM Model Details for Towers Driven Individually – WNWR Tower 1(C) OC Self - (Sheet 1 of 4)

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

wire	caps	Distance	Angle	Z	radius	segs
1	none	0	0	0	.2784	10
		0	0	80.991		
2	none	0	0	80.991	.01	2
		11.837	17.	72.691		
3	none	0	0	80.991	.01	2
		11.837	137.	72.691		
4	none	0	0	80.991	.01	2
		11.837	257.	72.691		
5	none	11.837	17.	72.691	.01	2
		11.837	137.	72.691		
6	none	11.837	137.	72.691	.01	2
		11.837	257.	72.691		
7	none	11.837	257.	72.691	.01	2
		11.837	17.	72.691		
8	none	107.	129.8	0	.221	10
		107.	129.8	84.793		
9	none	107.	129.8	84.793	.01	2
		104.21	125.511	76.493		
10	none	107.	129.8	84.793	.01	2
		115.377	130.325	76.493		
11	none	107.	129.8	84.793	.01	2
		102.119	134.427	76.493		
12	none	104.21	125.511	76.493	.01	2
		115.377	130.325	76.493		
13	none	115.377	130.325	76.493	.01	2
		102.119	134.427	76.493		
14	none	102.119	134.427	76.493	.01	2
		104.21	125.511	76.493		
15	none	74.5	324.9	0	.2815	10
		74.5	324.9	87.972		
16	none	74.5	324.9	87.972	.01	2
		79.962	329.677	79.672		
17	none	74.5	324.9	87.972	.01	2
		66.151	325.905	79.672		
18	none	74.5	324.9	87.972	.01	2
		78.068	319.152	79.672		
19	none	79.962	329.677	79.672	.01	2
		66.151	325.905	79.672		
20	none	66.151	325.905	79.672	.01	2
		78.068	319.152	79.672		
21	none	78.068	319.152	79.672	.01	2
		79.962	329.677	79.672		

Number of wires = 21 current nodes = 75

Individual wires	minimum wire	minimum value	maximum wire	maximum value
segment length	9	5.89762	5	10.2511
radius	2	.01	15	.2815

MoM Model Details for Towers Driven Individually – WNWR Tower 1(C) OC Self - (Sheet 2 of 4)

ELECTRICAL DESCRIPTION Frequencies (MHz)

no.	frequency lowest	step	no. of steps	segment length (wavelengths) minimum	maximum
1	1.54	0	1	.0163823	.0284754

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	26	0	-4,511.	0	0	0
3	51	0	-4,511.	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
1.54	57.604	99.647	115.1	60.	5.2782	-3.3315	-2.7112

CURRENT rms Frequency = 1.54 MHz Input power = .00217409 watts Efficiency = 100. %
coordinates in degrees

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	0	0	0	6.14E-03	300.	3.07E-03	-5.32E-03
2	0	0	8.0991	6.66E-03	297.3	3.05E-03	-5.92E-03
3	0	0	16.1982	6.88E-03	295.8	2.99E-03	-6.19E-03
4	0	0	24.2973	6.92E-03	294.7	2.89E-03	-6.29E-03
5	0	0	32.3964	6.82E-03	293.8	2.75E-03	-6.24E-03
6	0	0	40.4955	6.58E-03	293.1	2.58E-03	-6.05E-03
7	0	0	48.5946	6.21E-03	292.5	2.38E-03	-5.74E-03
8	0	0	56.6937	5.75E-03	292.1	2.16E-03	-5.33E-03
9	0	0	64.7928	5.23E-03	291.8	1.94E-03	-4.86E-03
10	0	0	72.8919	4.83E-03	291.6	1.78E-03	-4.49E-03
END	0	0	80.991	4.41E-03	291.7	1.63E-03	-4.09E-03
2J1	0	0	80.991	1.47E-03	291.7	5.42E-04	-1.36E-03
12	5.65989	-1.7304	76.841	1.21E-03	291.9	4.51E-04	-1.12E-03
END	11.3198	-3.4608	72.691	9.23E-04	292.	3.46E-04	-8.56E-04
2J1	0	0	80.991	1.47E-03	291.7	5.44E-04	-1.36E-03
14	-4.32852	-4.03641	76.841	1.21E-03	292.	4.54E-04	-1.12E-03
END	-8.65703	-8.07282	72.691	9.25E-04	292.2	3.5E-04	-8.56E-04
2J1	0	0	80.991	1.47E-03	291.7	5.42E-04	-1.36E-03
16	-1.33137	5.76681	76.841	1.21E-03	291.9	4.51E-04	-1.12E-03
END	-2.66274	11.5336	72.691	9.24E-04	292.	3.46E-04	-8.57E-04
2J2	11.3198	-3.4608	72.691	4.61E-04	291.9	1.72E-04	-4.28E-04
18	1.33137	-5.76681	72.691	2.11E-06	174.2	-2.09E-06	2.13E-07
END	-8.65704	-8.07282	72.691	4.63E-04	112.2	-1.75E-04	4.28E-04
2J3	-8.65703	-8.07282	72.691	4.62E-04	292.2	1.75E-04	-4.28E-04
21	-5.65989	1.7304	72.691	1.68E-06	8.3	1.66E-06	2.41E-07
END	-2.66275	11.5336	72.691	4.61E-04	111.9	-1.72E-04	4.28E-04
2J4	-2.66274	11.5336	72.691	4.63E-04	292.2	1.75E-04	-4.28E-04
24	4.32852	4.03641	72.691	5.58E-07	317.2	4.09E-07	-3.79E-07
END	11.3198	-3.4608	72.691	4.62E-04	112.1	-1.74E-04	4.28E-04

MoM Model Details for Towers Driven Individually – WNWR Tower 1(C) OC Self - (Sheet 3 of 4)

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	-68.4917	-82.2063	0	4.97E-05	149.1	-4.27E-05	2.56E-05
27	-68.4917	-82.2063	8.4793	2.4E-04	149.1	-2.06E-04	1.23E-04
28	-68.4917	-82.2063	16.9586	3.52E-04	149.1	-3.02E-04	1.81E-04
29	-68.4917	-82.2063	25.4379	4.31E-04	149.1	-3.7E-04	2.21E-04
30	-68.4917	-82.2063	33.9172	4.81E-04	149.2	-4.13E-04	2.46E-04
31	-68.4917	-82.2063	42.3965	5.04E-04	149.2	-4.33E-04	2.58E-04
32	-68.4917	-82.2063	50.8758	5.03E-04	149.2	-4.32E-04	2.57E-04
33	-68.4917	-82.2063	59.3551	4.78E-04	149.3	-4.11E-04	2.44E-04
34	-68.4917	-82.2063	67.8344	4.35E-04	149.3	-3.75E-04	2.22E-04
35	-68.4917	-82.2063	76.3137	3.91E-04	149.4	-3.37E-04	1.99E-04
END	-68.4917	-82.2063	84.793	3.41E-04	149.4	-2.93E-04	1.74E-04
2J8	-68.4917	-82.2063	84.793	1.17E-04	152.6	-1.04E-04	5.41E-05
37	-64.5116	-83.5169	80.643	9.36E-05	153.6	-8.38E-05	4.17E-05
END	-60.5314	-84.8274	76.493	6.86E-05	155.9	-6.26E-05	2.8E-05
2J8	-68.4917	-82.2063	84.793	1.1E-04	140.6	-8.48E-05	6.97E-05
39	-71.5774	-85.0841	80.643	8.74E-05	137.5	-6.44E-05	5.9E-05
END	-74.6631	-87.9618	76.493	6.55E-05	131.	-4.3E-05	4.94E-05
2J8	-68.4917	-82,2063	84.793	1.15E-04	154.5	-1.04E-04	4.97E-05
41	-69.9875	-77.567	80.643	8.81E-05	156.6	-8.08E-05	3.5E-05
END	-71.4833	-72.9276	76.493	6.01E-05	161.7	-5.71E-05	1.89E-05
2J9	-60.5314	-84.8274	76.493	3.2E-05	172.9	-3.18E-05	3.98E-06
43	-67.5972	-86.3946	76.493	1.25E-05	237.4	-6.73E-06	-1.05E-05
END	-74.6631	-87.9618	76.493	2.88E-05	310.4	1.87E-05	-2.19E-05
2J10	-74.6631	-87.9618	76.493	3.67E-05	131.5	-2.43E-05	2.75E-05
46	-73.0732	-80.4447	76.493	1.5E-05	76.9	3.39E-06	1.46E-05
END	-71.4833	-72.9276	76.493	3.13E-05	355.2	3.12E-05	-2.6E-06
2J11	-71.4833	-72.9276	76.493	3.06E-05	147.8	-2.59E-05	1.63E-05
49	-66.0073	-78.8775	76.493	5.33E-06	302.9	2.9E-06	-4.48E-06
END	-60.5314	-84.8274	76.493	3.91E-05	322.1	3.09E-05	-2.41E-05

MoM Model Details for Towers Driven Individually – WNWR Tower 1(C) OC Self - (Sheet 4 of 4)

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	60.9522	42.8379	0	6.42E-05	177.4	-6.41E-05	2.92E-06
52	60.9522	42.8379	8.7972	3.39E-04	177.5	-3.39E-04	1.5E-05
53	60.9522	42.8379	17.5944	4.96E-04	177.6	-4.96E-04	2.09E-05
54	60.9522	42.8379	26.3916	6.05E-04	177.7	-6.04E-04	2.38E-05
55	60.9522	42.8379	35.1888	6.71E-04	177.9	-6.71E-04	2.41E-05
56	60.9522	42.8379	43.986	6.99E-04	178.2	-6.99E-04	2.21E-05
57	60.9522	42.8379	52.7832	6.91E-04	178.5	-6.9E-04	1.84E-05
58	60.9522	42.8379	61.5804	6.49E-04	178.8	-6.49E-04	1.37E-05
59	60.9522	42.8379	70.3776	5.79E-04	179.1	-5.79E-04	9.02E-06
60	60.9522	42.8379	79.1748	5.07E-04	179.3	-5.07E-04	5.94E-06
END	60.9522	42.8379	87.972	4.29E-04	179.3	-4.29E-04	5.27E-06
2J15	60.9522	42.8379	87.972	1.39E-04	174.4	-1.38E-04	1.37E-05
62	64.9874	41.6043	83.822	1.08E-04	172.	-1.07E-04	1.5E-05
END	69.0226	40.3708	79.672	7.65E-05	166.5	-7.44E-05	1.78E-05
2J15	60.9522	42.8379	87.972	1.52E-04	186.7	-1.51E-04	-1.77E-05
64	57.8662	39.96	83.822	1.21E-04	189.3	-1.19E-04	-1.96E-05
END	54.7803	37.0821	79.672	8.83E-05	196.7	-8.45E-05	-2.54E-05
2J15	60.9522	42.8379	87.972	1.41E-04	176.2	-1.4E-04	9.32E-06
66	60.0033	46.9493	83.822	1.1E-04	174.7	-1.09E-04	1.02E-05
END	59.0544	51.0607	79.672	7.72E-05	171.1	-7.63E-05	1.19E-05
2J16	69.0226	40.3708	79.672	4.16E-05	151.9	-3.67E-05	1.96E-05
68	61.9015	38.7264	79.672	2.08E-05	84.2	2.09E-06	2.07E-05
END	54.7803	37.0821	79.672	4.48E-05	18.9	4.24E-05	1.45E-05
2J17	54.7803	37.0821	79.672	4.35E-05	194.5	-4.21E-05	-1.09E-05
71	56.9173	44.0714	79.672	1.79E-05	264.9	-1.6E-06	-1.78E-05
END	59.0544	51.0607	79.672	4.18E-05	333.8	3.75E-05	-1.84E-05
2J18	59.0544	51.0607	79.672	3.93E-05	189.6	-3.88E-05	-6.53E-06
74	64.0385	45.7157	79.672	2.88E-06	260.4	-4.81E-07	-2.84E-06
END	69.0226	40.3708	79.672	3.77E-05	2.6	3.77E-05	1.74E-06

MoM Model Details for Towers Driven Individually – WNWR Tower 2(SE) OC Self - (Sheet 1 of 4)

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

wire	caps	Distance	Angle	Z	radius	segs
1	none	0	0	0	.2784	10
		0	0	80.991		
2	none	0	0	80.991	.01	2
		11.837	17.	72.691		
3	none	0	0	80.991	.01	2
		11.837	137.	72.691		
4	none	0	0	80.991	.01	2
		11.837	257.	72.691		
5	none	11.837	17.	72.691	.01	2
		11.837	137.	72.691		
6	none	11.837	137.	72.691	.01	2
		11.837	257.	72.691		
7	none	11.837	257.	72.691	.01	2
		11.837	17.	72.691		
8	none	107.	129.8	0	.221	10
		107.	129.8	84.793		
9	none	107.	129.8	84.793	.01	2
		104.21	125.511	76.493		
10	none	107.	129.8	84.793	.01	2
		115.377	130.325	76.493		
11	none	107.	129.8	84.793	.01	2
		102.119	134.427	76.493		
12	none	104.21	125.511	76.493	.01	2
		115.377	130.325	76.493		
13	none	115.377	130.325	76.493	.01	2
		102.119	134.427	76.493		
14	none	102.119	134.427	76.493	.01	2
		104.21	125.511	76.493		
15	none	74.5	324.9	0	.2815	10
		74.5	324.9	87.972		
16	none	74.5	324.9	87.972	.01	2
		79.962	329.677	79.672		
17	none	74.5	324.9	87.972	.01	2
		66.151	325.905	79.672		
18	none	74.5	324.9	87.972	.01	2
		78.068	319.152	79.672		
19	none	79.962	329.677	79.672	.01	2
		66.151	325.905	79.672		
20	none	66.151	325.905	79.672	.01	2
		78.068	319.152	79.672		
21	none	78.068	319.152	79.672	.01	2
		79.962	329.677	79.672		

Number of wires = 21 current nodes = 75

Individual wires	minimum wire	minimum value	maximum wire	maximum value
segment length	9	5.89762	5	10.2511
radius	2	.01	15	.2815

MoM Model Details for Towers Driven Individually – WNWR Tower 2(SE) OC Self - (Sheet 2 of 4)

```
ELECTRICAL DESCRIPTION              Frequencies (MHz)
     frequency                    no. of  segment length (wavelengths)
 no. lowest        step           steps   minimum         maximum
 1    1.54         0              1       .0163823        .0284754

Sources            source node    sector  magnitude      phase          type
                     1     26       1      1.            0               voltage

Lumped loads          resistance    reactance     inductance  capacitance passive
       load   node    (ohms)        (ohms)        (mH)        (uF)        circuit
        1      1      0             -4,511.       0           0           0
        2      26     0             0             0           0           0
        3      51     0             -4,511.       0           0           0

IMPEDANCE    normalization = 50.

freq      resist    react     imped     phase     VSWR     S11      S12
(MHz)     (ohms)    (ohms)    (ohms)    (deg)              dB       dB
source =   1; node 26, sector 1
1.54      60.657    92.07     110.25    56.6      4.6158   -3.8241  -2.3252
```

```
CURRENT rms  Frequency = 1.54 MHz Input power = .00249493 watts Efficiency  = 100. %
coordinates in degrees
current                                         mag       phase   real       imaginary
no.    X           Y           Z                (amps)    (deg)   (amps)     (amps)
GND    0           0           0                5.2E-05   152.5   -4.61E-05  2.4E-05
 2     0           0           8.0991           2.64E-04  152.5   -2.34E-04  1.22E-04
 3     0           0           16.1982          3.86E-04  152.5   -3.43E-04  1.78E-04
 4     0           0           24.2973          4.74E-04  152.5   -4.2E-04   2.18E-04
 5     0           0           32.3964          5.32E-04  152.6   -4.72E-04  2.45E-04
 6     0           0           40.4955          5.64E-04  152.6   -5.01E-04  2.59E-04
 7     0           0           48.5946          5.71E-04  152.7   -5.07E-04  2.62E-04
 8     0           0           56.6937          5.56E-04  152.7   -4.94E-04  2.55E-04
 9     0           0           64.7928          5.24E-04  152.7   -4.66E-04  2.4E-04
 10    0           0           72.8919          4.91E-04  152.7   -4.36E-04  2.25E-04
END    0           0           80.991           4.44E-04  152.7   -3.95E-04  2.03E-04
2J1    0           0           80.991           1.45E-04  149.    -1.25E-04  7.49E-05
 12    5.65989     -1.7304     76.841           1.17E-04  147.7   -9.89E-05  6.25E-05
END    11.3198     -3.4608     72.691           8.91E-05  144.7   -7.27E-05  5.15E-05
2J1    0           0           80.991           1.57E-04  161.1   -1.49E-04  5.09E-05
 14    -4.32852    -4.03641    76.841           1.28E-04  163.9   -1.23E-04  3.54E-05
END    -8.65703    -8.07282    72.691           9.79E-05  170.6   -9.66E-05  1.6E-05
2J1    0           0           80.991           1.44E-04  147.4   -1.22E-04  7.76E-05
 16    -1.33137    5.76681     76.841           1.16E-04  145.6   -9.58E-05  6.56E-05
END    -2.66274    11.5336     72.691           8.9E-05   141.4   -6.96E-05  5.55E-05
2J2    11.3198     -3.4608     72.691           5.05E-05  128.7   -3.16E-05  3.94E-05
 18    1.33137     -5.76681    72.691           2.09E-05  67.2    8.08E-06   1.92E-05
END    -8.65704    -8.07282    72.691           4.87E-05  348.8   4.78E-05   -9.43E-06
2J3    -8.65703    -8.07282    72.691           4.92E-05  172.3   -4.88E-05  6.61E-06
 21    -5.65989    1.7304      72.691           2.31E-05  246.7   -9.13E-06  -2.12E-05
END    -2.66275    11.5336     72.691           5.01E-05  307.6   3.05E-05   -3.97E-05
2J4    -2.66274    11.5336     72.691           4.21E-05  158.    -3.9E-05   1.58E-05
 24    4.32852     4.03641     72.691           2.51E-06  64.8    1.07E-06   2.27E-06
END    11.3198     -3.4608     72.691           4.29E-05  343.6   4.11E-05   -1.21E-05
```

MoM Model Details for Towers Driven Individually – WNWR Tower 2(SE) OC Self - (Sheet 3 of 4)

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	-68.4917	-82.2063	0	6.41E-03	303.4	3.53E-03	-5.36E-03
27	-68.4917	-82.2063	8.4793	6.87E-03	300.6	3.5E-03	-5.91E-03
28	-68.4917	-82.2063	16.9586	7.04E-03	299.1	3.42E-03	-6.15E-03
29	-68.4917	-82.2063	25.4379	7.02E-03	297.9	3.28E-03	-6.2E-03
30	-68.4917	-82.2063	33.9172	6.83E-03	296.9	3.1E-03	-6.09E-03
31	-68.4917	-82.2063	42.3965	6.49E-03	296.2	2.86E-03	-5.83E-03
32	-68.4917	-82.2063	50.8758	6.01E-03	295.5	2.59E-03	-5.42E-03
33	-68.4917	-82.2063	59.3551	5.41E-03	295.	2.29E-03	-4.9E-03
34	-68.4917	-82.2063	67.8344	4.73E-03	294.6	1.97E-03	-4.3E-03
35	-68.4917	-82.2063	76.3137	4.17E-03	294.4	1.72E-03	-3.8E-03
END	-68.4917	-82.2063	84.793	3.66E-03	294.5	1.51E-03	-3.33E-03
2J8	-68.4917	-82.2063	84.793	1.24E-03	294.5	5.13E-04	-1.13E-03
37	-64.5116	-83.5169	80.643	1.E-03	294.7	4.2E-04	-9.12E-04
END	-60.5314	-84.8274	76.493	7.42E-04	294.9	3.12E-04	-6.73E-04
2J8	-68.4917	-82.2063	84.793	1.22E-03	294.4	5.06E-04	-1.11E-03
39	-71.5774	-85.0841	80.643	9.92E-04	294.6	4.14E-04	-9.02E-04
END	-74.6631	-87.9618	76.493	7.31E-04	294.8	3.06E-04	-6.63E-04
2J8	-68.4917	-82.2063	84.793	1.2E-03	294.5	4.97E-04	-1.09E-03
41	-69.9875	-77.567	80.643	9.3E-04	294.8	3.9E-04	-8.45E-04
END	-71.4833	-72.9276	76.493	6.36E-04	295.	2.69E-04	-5.77E-04
2J9	-60.5314	-84.8274	76.493	3.26E-04	295.	1.37E-04	-2.95E-04
43	-67.5972	-86.3946	76.493	1.13E-06	325.	9.26E-07	-6.47E-07
END	-74.6631	-87.9618	76.493	3.25E-04	114.8	-1.36E-04	2.95E-04
2J10	-74.6631	-87.9618	76.493	4.06E-04	294.7	1.7E-04	-3.69E-04
46	-73.0732	-80.4447	76.493	5.11E-05	293.8	2.06E-05	-4.68E-05
END	-71.4833	-72.9276	76.493	3.11E-04	115.	-1.32E-04	2.82E-04
2J11	-71.4833	-72.9276	76.493	3.25E-04	294.9	1.37E-04	-2.95E-04
49	-66.0073	-78.8775	76.493	5.13E-05	114.4	-2.12E-05	4.67E-05
END	-60.5314	-84.8274	76.493	4.16E-04	114.8	-1.74E-04	3.78E-04

MoM Model Details for Towers Driven Individually – WNWR Tower 2(SE) OC Self - (Sheet 4 of 4)

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	60.9522	42.8379	0	4.37E-05	81.5	6.45E-06	4.32E-05
52	60.9522	42.8379	8.7972	2.31E-04	81.5	3.43E-05	2.29E-04
53	60.9522	42.8379	17.5944	3.39E-04	81.4	5.1E-05	3.35E-04
54	60.9522	42.8379	26.3916	4.14E-04	81.2	6.32E-05	4.09E-04
55	60.9522	42.8379	35.1888	4.61E-04	81.1	7.14E-05	4.55E-04
56	60.9522	42.8379	43.986	4.82E-04	81.	7.57E-05	4.76E-04
57	60.9522	42.8379	52.7832	4.78E-04	80.8	7.62E-05	4.71E-04
58	60.9522	42.8379	61.5804	4.5E-04	80.7	7.29E-05	4.45E-04
59	60.9522	42.8379	70.3776	4.04E-04	80.6	6.61E-05	3.98E-04
60	60.9522	42.8379	79.1748	3.54E-04	80.5	5.84E-05	3.49E-04
END	60.9522	42.8379	87.972	2.99E-04	80.6	4.9E-05	2.95E-04
2J15	60.9522	42.8379	87.972	9.89E-05	75.8	2.42E-05	9.59E-05
62	64.9874	41.6043	83.822	7.72E-05	74.4	2.07E-05	7.44E-05
END	69.0226	40.3708	79.672	5.47E-05	71.2	1.76E-05	5.18E-05
2J15	60.9522	42.8379	87.972	1.03E-04	89.9	2.37E-07	1.03E-04
64	57.8662	39.96	83.822	8.11E-05	92.9	-4.06E-06	8.1E-05
END	54.7803	37.0821	79.672	5.8E-05	99.3	-9.35E-06	5.72E-05
2J15	60.9522	42.8379	87.972	9.92E-05	75.6	2.46E-05	9.61E-05
66	60.0033	46.9493	83.822	7.75E-05	74.2	2.11E-05	7.45E-05
END	59.0544	51.0607	79.672	5.51E-05	70.9	1.8E-05	5.21E-05
2J16	69.0226	40.3708	79.672	2.98E-05	60.3	1.48E-05	2.59E-05
68	61.9015	38.7264	79.672	1.07E-05	355.2	1.06E-05	-8.89E-07
END	54.7803	37.0821	79.672	2.9E-05	279.2	4.66E-06	-2.87E-05
2J17	54.7803	37.0821	79.672	2.89E-05	99.3	-4.69E-06	2.85E-05
71	56.9173	44.0714	79.672	1.07E-05	175.7	-1.07E-05	8.03E-07
END	59.0544	51.0607	79.672	2.98E-05	240.1	-1.48E-05	-2.58E-05
2J18	59.0544	51.0607	79.672	2.64E-05	83.2	3.15E-06	2.62E-05
74	64.0385	45.7157	79.672	2.2E-07	52.1	1.35E-07	1.74E-07
END	69.0226	40.3708	79.672	2.61E-05	263.7	-2.87E-06	-2.59E-05

MoM Model Details for Towers Driven Individually – WNWR Tower 3(NW) OC Self-(Sheet 1 of 4)

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

wire	caps	Distance	Angle	Z	radius	segs
1	none	0	0	0	.3255	10
		0	0	81.98		
2	none	0	0	81.98	.01	2
		11.837	17.	73.68		
3	none	0	0	81.98	.01	2
		11.837	137.	73.68		
4	none	0	0	81.98	.01	2
		11.837	257.	73.68		
5	none	11.837	17.	73.68	.01	2
		11.837	137.	73.68		
6	none	11.837	137.	73.68	.01	2
		11.837	257.	73.68		
7	none	11.837	257.	73.68	.01	2
		11.837	17.	73.68		
8	none	107.	129.8	0	.2961	10
		107.	129.8	86.75		
9	none	107.	129.8	86.75	.01	2
		104.21	125.511	78.45		
10	none	107.	129.8	86.75	.01	2
		115.377	130.325	78.45		
11	none	107.	129.8	86.75	.01	2
		102.119	134.427	78.45		
12	none	104.21	125.511	78.45	.01	2
		115.377	130.325	78.45		
13	none	115.377	130.325	78.45	.01	2
		102.119	134.427	78.45		
14	none	102.119	134.427	78.45	.01	2
		104.21	125.511	78.45		
15	none	74.5	324.9	0	.2517	10
		74.5	324.9	86.37		
16	none	74.5	324.9	86.37	.01	2
		79.962	329.677	78.09		
17	none	74.5	324.9	86.37	.01	2
		66.151	325.905	78.09		
18	none	74.5	324.9	86.37	.01	2
		78.068	319.152	78.09		
19	none	79.962	329.677	78.09	.01	2
		66.151	325.905	78.09		
20	none	66.151	325.905	78.09	.01	2
		78.068	319.152	78.09		
21	none	78.068	319.152	78.09	.01	2
		79.962	329.677	78.09		

Number of wires = 21 current nodes = 75

	minimum		maximum	
Individual wires	wire	value	wire	value
segment length	9	5.89762	5	10.2511
radius	2	.01	1	.3255

MoM Model Details for Towers Driven Individually – WNWR Tower 3(NW) OC Self-(Sheet 2 of 4)

ELECTRICAL DESCRIPTION Frequencies (MHz)

no.	frequency lowest	step	no. of steps	segment length (wavelengths) minimum	maximum
1	1.54	0	1	.0163823	.0284754

Sources

source	node	sector	magnitude	phase	type
1	51	1	1.	0	voltage

Lumped loads

load	node	resistance (ohms)	reactance (ohms)	inductance (mH)	capacitance (uF)	passive circuit
1	1	0	-4,511.	0	0	0
2	26	0	-4,511.	0	0	0
3	51	0	0	0	0	0

IMPEDANCE normalization = 50.

source = 1; node 51, sector 1

freq (MHz)	resist (ohms)	react (ohms)	imped (ohms)	phase (deg)	VSWR	S11 dB	S12 dB
1.54	63.143	87.224	107.68	54.1	4.228	-4.188	-2.0848

CURRENT rms Frequency = 1.54 MHz Input power = .00272282 watts Efficiency = 100. %
coordinates in degrees

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	0	0	0	6.88E-05	183.3	-6.87E-05	-4.02E-06
2	0	0	8.0991	3.49E-04	183.4	-3.49E-04	-2.06E-05
3	0	0	16.1982	5.11E-04	183.4	-5.1E-04	-3.08E-05
4	0	0	24.2973	6.27E-04	183.5	-6.26E-04	-3.87E-05
5	0	0	32.3964	7.04E-04	183.6	-7.03E-04	-4.48E-05
6	0	0	40.4955	7.46E-04	183.8	-7.45E-04	-4.92E-05
7	0	0	48.5946	7.55E-04	183.9	-7.54E-04	-5.19E-05
8	0	0	56.6937	7.36E-04	184.1	-7.34E-04	-5.26E-05
9	0	0	64.7928	6.93E-04	184.3	-6.91E-04	-5.16E-05
10	0	0	72.8919	6.49E-04	184.4	-6.47E-04	-4.94E-05
END	0	0	80.991	5.88E-04	184.3	-5.86E-04	-4.45E-05
2J1	0	0	80.991	2.04E-04	188.3	-2.02E-04	-2.92E-05
12	5.65989	-1.7304	76.841	1.65E-04	189.7	-1.63E-04	-2.78E-05
END	11.3198	-3.4608	72.691	1.26E-04	193.8	-1.22E-04	-3.E-05
2J1	0	0	80.991	1.85E-04	177.5	-1.85E-04	7.93E-06
14	-4.32852	-4.03641	76.841	1.48E-04	174.3	-1.47E-04	1.46E-05
END	-8.65703	-8.07282	72.691	1.14E-04	166.9	-1.11E-04	2.57E-05
2J1	0	0	80.991	2.01E-04	186.6	-2.E-04	-2.32E-05
16	-1.33137	5.76681	76.841	1.63E-04	187.4	-1.61E-04	-2.1E-05
END	-2.66274	11.5336	72.691	1.24E-04	189.7	-1.22E-04	-2.09E-05
2J2	11.3198	-3.4608	72.691	6.86E-05	208.4	-6.04E-05	-3.26E-05
18	1.33137	-5.76681	72.691	3.07E-05	268.6	-7.31E-07	-3.07E-05
END	-8.65704	-8.07282	72.691	5.79E-05	344.1	5.57E-05	-1.59E-05
2J3	-8.65703	-8.07282	72.691	5.58E-05	169.9	-5.49E-05	9.81E-06
21	-5.65989	1.7304	72.691	2.58E-05	87.4	1.17E-06	2.57E-05
END	-2.66275	11.5336	72.691	6.73E-05	27.5	5.97E-05	3.1E-05
2J4	-2.66274	11.5336	72.691	6.29E-05	170.7	-6.21E-05	1.01E-05
24	4.32852	4.03641	72.691	5.03E-06	95.3	-4.68E-07	5.01E-06
END	11.3198	-3.4608	72.691	6.21E-05	357.6	6.21E-05	-2.59E-06

MoM Model Details for Towers Driven Individually – WNWR Tower 3(NW) OC Self-(Sheet 3 of 4)

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	-68.4917	-82.2063	0	4.48E-05	84.1	4.62E-06	4.46E-05
27	-68.4917	-82.2063	8.4793	2.16E-04	84.	2.25E-05	2.15E-04
28	-68.4917	-82.2063	16.9586	3.18E-04	83.9	3.36E-05	3.17E-04
29	-68.4917	-82.2063	25.4379	3.9E-04	83.9	4.18E-05	3.88E-04
30	-68.4917	-82.2063	33.9172	4.37E-04	83.7	4.76E-05	4.34E-04
31	-68.4917	-82.2063	42.3965	4.59E-04	83.6	5.1E-05	4.56E-04
32	-68.4917	-82.2063	50.8758	4.59E-04	83.5	5.2E-05	4.56E-04
33	-68.4917	-82.2063	59.3551	4.38E-04	83.4	5.06E-05	4.35E-04
34	-68.4917	-82.2063	67.8344	4.E-04	83.3	4.69E-05	3.97E-04
35	-68.4917	-82.2063	76.3137	3.6E-04	83.2	4.26E-05	3.58E-04
END	-68.4917	-82.2063	84.793	3.13E-04	83.3	3.67E-05	3.11E-04
2J8	-68.4917	-82.2063	84.793	1.07E-04	87.8	4.21E-06	1.07E-04
37	-64.5116	-83.5169	80.643	8.53E-05	89.2	1.24E-06	8.53E-05
END	-60.5314	-84.8274	76.493	6.23E-05	91.9	-2.05E-06	6.22E-05
2J8	-68.4917	-82.2063	84.793	1.03E-04	73.8	2.88E-05	9.9E-05
39	-71.5774	-85.0841	80.643	8.22E-05	71.1	2.66E-05	7.77E-05
END	-74.6631	-87.9618	76.493	6.16E-05	65.7	2.53E-05	5.62E-05
2J8	-68.4917	-82.2063	84.793	1.05E-04	88.	3.67E-06	1.05E-04
41	-69.9875	-77.567	80.643	7.94E-05	89.8	2.22E-07	7.94E-05
END	-71.4833	-72.9276	76.493	5.37E-05	93.8	-3.56E-06	5.36E-05
2J9	-60.5314	-84.8274	76.493	2.84E-05	106.	-7.8E-06	2.73E-05
43	-67.5972	-86.3946	76.493	1.09E-05	176.	-1.09E-05	7.66E-07
END	-74.6631	-87.9618	76.493	2.77E-05	243.4	-1.24E-05	-2.48E-05
2J10	-74.6631	-87.9618	76.493	3.39E-05	67.6	1.29E-05	3.14E-05
46	-73.0732	-80.4447	76.493	1.18E-05	17.4	1.12E-05	3.53E-06
END	-71.4833	-72.9276	76.493	2.71E-05	286.4	7.66E-06	-2.6E-05
2J11	-71.4833	-72.9276	76.493	2.79E-05	81.5	4.1E-06	2.76E-05
49	-66.0073	-78.8775	76.493	4.22E-06	257.4	-9.18E-07	-4.12E-06
END	-60.5314	-84.8274	76.493	3.54E-05	260.6	-5.76E-06	-3.5E-05

MoM Model Details for Towers Driven Individually – WNWR Tower 3(NW) OC Self-(Sheet 4 of 4)

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	60.9522	42.8379	0	6.57E-03	305.9	3.85E-03	-5.32E-03
52	60.9522	42.8379	8.7972	7.07E-03	302.7	3.82E-03	-5.95E-03
53	60.9522	42.8379	17.5944	7.24E-03	301.	3.72E-03	-6.2E-03
54	60.9522	42.8379	26.3916	7.2E-03	299.6	3.56E-03	-6.26E-03
55	60.9522	42.8379	35.1888	6.99E-03	298.6	3.34E-03	-6.14E-03
56	60.9522	42.8379	43.986	6.6E-03	297.7	3.07E-03	-5.85E-03
57	60.9522	42.8379	52.7832	6.06E-03	297.	2.75E-03	-5.4E-03
58	60.9522	42.8379	61.5804	5.39E-03	296.4	2.39E-03	-4.83E-03
59	60.9522	42.8379	70.3776	4.62E-03	295.9	2.02E-03	-4.15E-03
60	60.9522	42.8379	79.1748	3.96E-03	295.7	1.71E-03	-3.57E-03
END	60.9522	42.8379	87.972	3.37E-03	295.7	1.46E-03	-3.04E-03
2J15	60.9522	42.8379	87.972	1.13E-03	295.8	4.89E-04	-1.01E-03
62	64.9874	41.6043	83.822	8.98E-04	296.	3.94E-04	-8.07E-04
END	69.0226	40.3708	79.672	6.39E-04	296.2	2.82E-04	-5.73E-04
2J15	60.9522	42.8379	87.972	1.12E-03	295.7	4.87E-04	-1.01E-03
64	57.8662	39.96	83.822	8.94E-04	296.	3.91E-04	-8.04E-04
END	54.7803	37.0821	79.672	6.35E-04	296.1	2.79E-04	-5.7E-04
2J15	60.9522	42.8379	87.972	1.12E-03	295.7	4.88E-04	-1.01E-03
66	60.0033	46.9493	83.822	8.97E-04	296.	3.93E-04	-8.06E-04
END	59.0544	51.0607	79.672	6.38E-04	296.2	2.81E-04	-5.72E-04
2J16	69.0226	40.3708	79.672	3.2E-04	296.3	1.42E-04	-2.87E-04
68	61.9015	38.7264	79.672	1.97E-06	324.7	1.61E-06	-1.14E-06
END	54.7803	37.0821	79.672	3.17E-04	116.	-1.39E-04	2.85E-04
2J17	54.7803	37.0821	79.672	3.18E-04	296.1	1.4E-04	-2.85E-04
71	56.9173	44.0714	79.672	1.5E-06	147.9	-1.27E-06	7.97E-07
END	59.0544	51.0607	79.672	3.2E-04	116.3	-1.42E-04	2.87E-04
2J18	59.0544	51.0607	79.672	3.18E-04	296.1	1.4E-04	-2.86E-04
74	64.0385	45.7157	79.672	4.75E-07	136.5	-3.45E-07	3.27E-07
END	69.0226	40.3708	79.672	3.19E-04	116.1	-1.4E-04	2.86E-04

Derivation of Directional Antenna Operating Parameters

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

Specifically, "medium wave array synthesis" MoM calculations were made for the nighttime directional mode of operation using the WNWR Construction Permit 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 that 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 for the WNWR nighttime directional antenna 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:

Tower	Wire	Base Node
1 (C)	1	1
2 (SE)	8	26
3 (NW)	15	51

The resulting normalized antenna monitor parameters, derived from the WCAP analysis, are provided after the pattern synthesis model data shown in the following pages.

MoM Model Details –Directional Antenna Array Synthesis (Sheet 1 of 7)

MEDIUM WAVE ARRAY SYNTHESIS FROM FIELD RATIOS

Frequency = 1.54 MHz

Tower	Field Ratio Magnitude	Phase (deg)
1	1.000	0.0
2	0.801	-106.1
3	0.319	159.1

VOLTAGES AND CURRENTS - rms

Source Node	Voltage Magnitude	Current Phase (deg)	Current Magnitude	Phase (deg)
1	195.516	79.2	1.84066	2.5
26	222.851	318.2	1.38505	262.2
51	45.8714	259.2	0.599812	157.5

Sum of square of source currents = 11.3323
Total power = 250. watts

TOWER ADMITTANCE MATRIX

Admittance	Real (mhos)	Imaginary (mhos)
Y(1, 1)	0.003878850	-0.005310520
Y(1, 2)	0.003002640	0.000778430
Y(1, 3)	0.003007980	0.001963260
Y(2, 1)	0.003002770	0.000777867
Y(2, 2)	0.005449950	-0.006813920
Y(2, 3)	0.000937757	-0.000739506
Y(3, 1)	0.003008270	0.001962470
Y(3, 2)	0.000937753	-0.000739601
Y(3, 3)	0.004753310	-0.006492270

TOWER IMPEDANCE MATRIX

Impedance	Real (ohms)	Imaginary (ohms)
Z(1, 1)	58.2911	99.7025
Z(1, 2)	17.8819	-31.3371
Z(1, 3)	39.2357	-24.6114
Z(2, 1)	17.8873	-31.3336
Z(2, 2)	60.7048	91.8907
Z(2, 3)	-19.4274	-22.7725
Z(3, 1)	39.2438	-24.6042
Z(3, 2)	-19.4267	-22.7733
Z(3, 3)	63.3793	87.4053

MoM Model Details - Directional Antenna Array Synthesis (Sheet 2 of 7)

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

wire	caps	Distance	Angle	Z	radius	segs
1	none	0	0	0	.2784	10
		0	0	80.991		
2	none	0	0	80.991	.01	2
		11.837	17.	72.691		
3	none	0	0	80.991	.01	2
		11.837	137.	72.691		
4	none	0	0	80.991	.01	2
		11.837	257.	72.691		
5	none	11.837	17.	72.691	.01	2
		11.837	137.	72.691		
6	none	11.837	137.	72.691	.01	2
		11.837	257.	72.691		
7	none	11.837	257.	72.691	.01	2
		11.837	17.	72.691		
8	none	107.	129.8	0	.221	10
		107.	129.8	84.793		
9	none	107.	129.8	84.793	.01	2
		104.21	125.511	76.493		
10	none	107.	129.8	84.793	.01	2
		115.377	130.325	76.493		
11	none	107.	129.8	84.793	.01	2
		102.119	134.427	76.493		
12	none	104.21	125.511	76.493	.01	2
		115.377	130.325	76.493		
13	none	115.377	130.325	76.493	.01	2
		102.119	134.427	76.493		
14	none	102.119	134.427	76.493	.01	2
		104.21	125.511	76.493		
15	none	74.5	324.9	0	.2815	10
		74.5	324.9	87.972		
16	none	74.5	324.9	87.972	.01	2
		79.962	329.677	79.672		
17	none	74.5	324.9	87.972	.01	2
		66.151	325.905	79.672		
18	none	74.5	324.9	87.972	.01	2
		78.068	319.152	79.672		
19	none	79.962	329.677	79.672	.01	2
		66.151	325.905	79.672		
20	none	66.151	325.905	79.672	.01	2
		78.068	319.152	79.672		
21	none	78.068	319.152	79.672	.01	2
		79.962	329.677	79.672		

Number of wires = 21 current nodes = 75

Individual wires	minimum wire	minimum value	maximum wire	maximum value
segment length	9	5.89762	5	10.2511
radius	2	.01	15	.2815

Statement E
APPLICATION FOR DIRECT POWER MEASUREMENT
AND REVISED STATION LICENSE
Supporting FCC Construction Permit BP-20161215ABM
WNWR Philadelphia, Pennsylvania (Facility ID 1027)

MoM Model Details - Daytime Directional Antenna Array Synthesis (3 of 7)

ELECTRICAL DESCRIPTION - Frequencies (MHz)

no.	frequency lowest	step	no. of steps	segment length (wavelengths) minimum	maximum
1	1.54	0	1	.0163823	.0284754

Sources

source	node	sector	magnitude	phase	type
1	1	1	276.501	79.2	voltage
2	26	1	315.159	318.2	voltage
3	51	1	64.872	259.2	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							
1.54	24.489	103.35	106.21	76.7	11.165	-1.5602	-5.2029
source = 2; node 26, sector 1							
1.54	90.024	133.37	160.91	56.	6.1446	-2.8525	-3.174
source = 3; node 51, sector 1							
1.54	-15.463	74.919	76.498	101.7	****	****	****

MoM Model Details - Directional Antenna Array Synthesis (Sheet 4 of 7)

```
CURRENT rms
Frequency    = 1.54 MHz
Input power = 250. watts
Efficiency   = 100. %
coordinates in degrees
```

Tower 1

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	0	0	0	**1.84047**	**2.5**	1.83867	.0812741
2	0	0	8.0991	2.0008	1.4	2.00023	.0475114
3	0	0	16.1982	2.0653	.7	2.06513	.0263671
4	0	0	24.2973	2.07863	.3	2.0786	9.4E-03
5	0	0	32.3964	2.04663	359.9	2.04662	-4.18E-03
6	0	0	40.4955	1.97324	359.6	1.97318	-.0146336
7	0	0	48.5946	1.86283	359.3	1.8627	-.0220483
8	0	0	56.6937	1.72241	359.1	1.72221	-.0264859
9	0	0	64.7928	1.56781	359.	1.56756	-.0281314
10	0	0	72.8919	1.4461	358.9	1.44583	-.0276583
END	0	0	80.991	1.31946	358.9	1.31923	-.0244695
2J1	0	0	80.991	.441429	359.1	.441377	-6.76E-03
12	5.65989	-1.7304	76.841	.364238	359.3	.364211	-4.37E-03
END	11.3198	-3.4608	72.691	.278366	359.6	.278359	-2.E-03
2J1	0	0	80.991	.435305	358.6	.435181	-.0103944
14	-4.32852	-4.03641	76.841	.358099	358.6	.357992	-8.75E-03
END	-8.65703	-8.07282	72.691	.272098	358.2	.271968	-8.39E-03
2J1	0	0	80.991	.442736	359.1	.442675	-7.32E-03
16	-1.33137	5.76681	76.841	.365672	359.2	.365639	-4.9E-03
END	-2.66274	11.5336	72.691	.280155	359.5	.280143	-2.49E-03
2J2	11.3198	-3.4608	72.691	.140849	.6	.14084	1.57E-03
18	1.33137	-5.76681	72.691	4.53E-03	59.9	2.27E-03	3.92E-03
END	-8.65704	-8.07282	72.691	.136605	178.2	-.136539	4.22E-03
2J3	-8.65703	-8.07282	72.691	.135493	358.2	.135429	-4.17E-03
21	-5.65989	1.7304	72.691	4.92E-03	230.	-3.16E-03	-3.77E-03
END	-2.66275	11.5336	72.691	.141164	180.5	-.141158	-1.3E-03
2J4	-2.66274	11.5336	72.691	.139037	358.4	.138986	-3.79E-03
24	4.32852	4.03641	72.691	9.25E-04	353.8	9.19E-04	-9.91E-05
END	11.3198	-3.4608	72.691	.137566	178.5	-.137519	3.57E-03

MoM Model Details - Directional Antenna Array Synthesis (Sheet 5 of 7)

Tower 2

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	-68.4917	-82.2063	0	**1.38468**	**262.2**	-.187444	-1.37193
27	-68.4917	-82.2063	8.4793	1.53426	258.3	-.312043	-1.50219
28	-68.4917	-82.2063	16.9586	1.60126	256.2	-.383245	-1.55472
29	-68.4917	-82.2063	25.4379	1.62045	254.6	-.429928	-1.56238
30	-68.4917	-82.2063	33.9172	1.59628	253.4	-.45552	-1.52991
31	-68.4917	-82.2063	42.3965	1.53162	252.5	-.461582	-1.46041
32	-68.4917	-82.2063	50.8758	1.42958	251.7	-.449341	-1.35713
33	-68.4917	-82.2063	59.3551	1.29501	251.1	-.420445	-1.22486
34	-68.4917	-82.2063	67.8344	1.13845	250.6	-.378382	-1.07373
35	-68.4917	-82.2063	76.3137	1.00592	250.4	-.338254	-.947345
END	-68.4917	-82.2063	84.793	.881376	250.4	-.295072	-.830516
2J8	-68.4917	-82.2063	84.793	.299234	250.8	-.098417	-.282587
37	-64.5116	-83.5169	80.643	.242488	251.2	-.0782286	-.229523
END	-60.5314	-84.8274	76.493	.179185	251.6	-.0565954	-.170012
2J8	-68.4917	-82.2063	84.793	.291174	249.6	-.10163	-.272862
39	-71.5774	-85.0841	80.643	.234812	249.6	-.0820376	-.220014
END	-74.6631	-87.9618	76.493	.171679	249.	-.0615834	-.160254
2J8	-68.4917	-82.2063	84.793	.291019	250.9	-.0950251	-.275068
41	-69.9875	-77.567	80.643	.225703	251.5	-.0717112	-.214007
END	-71.4833	-72.9276	76.493	.154824	252.2	-.0472355	-.147442
2J9	-60.5314	-84.8274	76.493	.0799014	253.6	-.0225857	-.0766429
43	-67.5972	-86.3946	76.493	4.13E-03	312.5	2.79E-03	-3.04E-03
END	-74.6631	-87.9618	76.493	.0762064	69.	.0273667	.071123
2J10	-74.6631	-87.9618	76.493	.0954726	249.	-.0342167	-.0891305
46	-73.0732	-80.4447	76.493	.0110712	228.7	-7.3E-03	-8.32E-03
END	-71.4833	-72.9276	76.493	.07662	73.9	.0212695	.0736086
2J11	-71.4833	-72.9276	76.493	.0782663	250.6	-.025966	-.0738334
49	-66.0073	-78.8775	76.493	.0119308	67.5	4.56E-03	.0110264
END	-60.5314	-84.8274	76.493	.0993705	70.	.0340097	.0933694

MoM Model Details - Directional Antenna Array Synthesis (Sheet 6 of 7)

Tower 3

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	60.9522	42.8379	0	**.59951**	**157.5**	-.554027	.229056
52	60.9522	42.8379	8.7972	.637082	158.3	-.592035	.235302
53	60.9522	42.8379	17.5944	.646371	158.7	-.602416	.234287
54	60.9522	42.8379	26.3916	.638262	159.1	-.596092	.22815
55	60.9522	42.8379	35.1888	.614429	159.3	-.574721	.2173
56	60.9522	42.8379	43.986	.576185	159.5	-.539574	.202111
57	60.9522	42.8379	52.7832	.525031	159.6	-.492093	.183036
58	60.9522	42.8379	61.5804	.46309	159.7	-.434302	.160731
59	60.9522	42.8379	70.3776	.394345	159.8	-.369975	.136479
60	60.9522	42.8379	79.1748	.336432	159.8	-.315698	.116282
END	60.9522	42.8379	87.972	.286946	159.8	-.269253	.0992
2J15	60.9522	42.8379	87.972	.0977354	159.3	-.0914076	.0345957
62	64.9874	41.6043	83.822	.0790735	159.1	-.0738935	.028149
END	69.0226	40.3708	79.672	.0578619	159.	-.0540067	.020767
2J15	60.9522	42.8379	87.972	.0928749	160.3	-.0874564	.031259
64	57.8662	39.96	83.822	.0734175	160.4	-.0691823	.0245754
END	54.7803	37.0821	79.672	.0500395	160.7	-.0472136	.0165781
2J15	60.9522	42.8379	87.972	.0963434	159.8	-.0903889	.0333453
66	60.0033	46.9493	83.822	.0775332	159.7	-.0727306	.0268638
END	59.0544	51.0607	79.672	.0559721	159.7	-.0525055	.0193919
2J16	69.0226	40.3708	79.672	.03096	158.9	-.0288749	.0111699
68	61.9015	38.7264	79.672	4.18E-03	153.9	-3.75E-03	1.84E-03
END	54.7803	37.0821	79.672	.0244538	340.9	.0231082	-8.E-03
2J17	54.7803	37.0821	79.672	.0255862	160.4	-.0241054	8.58E-03
71	56.9173	44.0714	79.672	3.29E-03	336.5	3.02E-03	-1.31E-03
END	59.0544	51.0607	79.672	.030609	339.4	.0286511	-.0107715
2J18	59.0544	51.0607	79.672	.0253642	160.1	-.0238544	8.62E-03
74	64.0385	45.7157	79.672	9.34E-04	325.7	7.72E-04	-5.26E-04
END	69.0226	40.3708	79.672	.0269019	339.1	.0251319	-9.6E-03

MoM Model Details - Directional Antenna Array Synthesis (Sheet 7 of 7)

CURRENT MOMENTS (amp-degrees) rms

Frequency = 1.54 MHz

Input power = 250. watts

Wire	Magnitude	Phase (deg)	vertical current moment Magnitude	vertical current moment Phase (deg)
1	113.601	360	113.601	360
2	4.00303	359.3	2.29821	179.3
3	3.93485	358.5	2.25906	178.5
4	4.01952	359.2	2.30767	179.2
5	0.0636987	57.0	0	0
6	0.0695022	227.2	0	0
7	0.0130574	352.8	0	0
8	89.9087	253.8	89.9087	253.8
9	2.17255	251.1	1.52877	71.1
10	2.11017	249.5	1.47971	69.5
11	2.19634	251.4	1.42378	71.4
12	0.0430689	311.8	0	0
13	0.124429	229.4	0	0
14	0.139106	67.6	0	0
15	35.483	159.1	35.483	159.1
16	0.710023	159.2	0.497871	339.2
17	0.655727	160.4	0.459794	340.4
18	0.695618	159.7	0.487776	339.7
19	0.0417265	152.7	0	0
20	0.0324749	335.5	0	0
21	9.71E-03	324.3	0	0

Tower	Magnitude	Phase (deg)
1	106.738	0.0
2	85.4839	254.
3	34.0378	159.1

Above Data Normalized and Converted

Tower	Magnitude	Phase
1	1.000	0.0°
2	0.801	-106.0°
3	0.319	159.1°

CP Theoretical Field Data

Tower	Magnitude	Phase
1	1.000	0.0°
2	0.801	-106.1°
3	0.319	159.1°

Note: Minor differences are common between the normalized data and theoretical values due to internal program rounding.

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[12] 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 nighttime CP theoretical parameters are normalized with respect to Tower 1, antenna monitor parameters can rationally be developed as follows:

Prospective Directional Antenna Monitor Operating Parameters – Normalized to Tower 1

Tower	Modeled Current Pulse	Modeled Current Magnitude at Toroid	Modeled Current Phase at Toroid	Antenna Monitor Ratio	Antenna Monitor Phase
1 (C)	1	1.794523 A	2.818°	1.000	0.00°
2 (SE)	26	1.33936 A	263.379°	0.746	-99.44°
3 (NW)	51	0.58902 A	157.3°	0.328	154.48°

However, Tower 2 will be operating with the higher power level for the nighttime pattern, therefore it is more appropriate to use *Tower 2 as the Operating Parameter Reference Tower* than Tower 1. Accordingly, after normalizing to Tower 2, the Antenna Monitor (Operating Parameters) become:

Final 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**[13]
1 (C)	1	1.794523 A	2.818°	**1.340**	**99.4°**
2 (SE)	26	1.33936 A	263.379°	**1.000**	**0.00°**
3 (NW)	51	0.58902 A	157.3°	**0.440**	**-106.1°**

Accordingly, the phasing and coupling systems for the authorized nighttime pattern 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.

[12] 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.

[13] Rounded to the nearest tenth of a degree.

Statement E
APPLICATION FOR DIRECT POWER MEASUREMENT AND REVISED STATION LICENSE
Supporting FCC Construction Permit BP-20161215ABM
WNWR Philadelphia, Pennsylvania (Facility ID 1027)

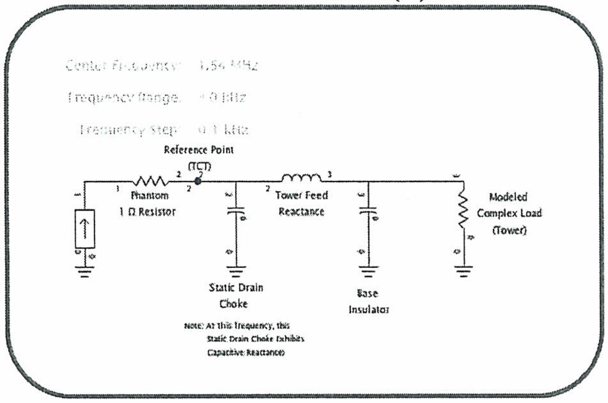
Circuit Analysis Used for Each Tower to Develop Antenna Monitor Parameters

WCAP Directional Antenna Base Circuit Analysis – WNWR Tower 1 (C)

WCAP OUTPUT AT FREQUENCY: 1.540 MHz **WNWR Tower 1 (C) – DA Mode**

NODE VOLTAGES

Node:	1	214.2201	∡ 79.8950°	V
Node:	2	213.8259	∡ 80.3637°	V
Node:	3	195.2440	∡ 79.1691°	V



WCAP PART			BRANCH VOLTAGE			BRANCH CURRENT			
R	**3→0**	24.48900000	195.24 ∡	79.169°	V	**1.84 ∡**	**2.500°**	**A**	**Current at Load**
C	3→0	0.00001400	195.24 ∡	79.169°	V	0.03 ∡	169.169°	A	
L	2→3	1.08700000	19.06 ∡	92.692°	V	1.81 ∡	2.692°	A	
C	2→0	0.00000891	213.83 ∡	80.364°	V	0.02 ∡	170.364°	A	
R	1→2	1.00000000	1.79 ∡	2.818°	V	1.79 ∡	2.818°	A	

WCAP PART			FROM IMPEDANCE				TO IMPEDANCE			
R	3→0	24.48900000	**24.49**	**+**	**j**	**103.350**	0.00	+	j	0.000
C	3→0	0.00001400	0.00	-	j	7381.955	0.00	+	j	0.000
L	2→3	1.08700000	25.19	+	j	115.251	25.19	+	j	104.733
C	2→0	0.00000891	0.00	-	j	11600.333	0.00	+	j	0.000
R	1→2	1.00000000	26.70	+	j	116.351	25.70	+	j	116.351

WCAP INPUT DATA:
1.5400 0.00010000 1

R	**24.48900000**	**3**	**0**	**103.35000000**	**Modeled Base Impedance**
C	0.00001400	3	0		
L	1.08700000	2	3	0.00000000	
C	0.00000891	2	0		
R	1.00000000	1	2	0.00000000	
I	**1.79452300**	**0**	**1**	**2.81800000**	**Modeled Current Magnitude and Phase at Toroid**

Statement E

APPLICATION FOR DIRECT POWER MEASUREMENT AND REVISED STATION LICENSE

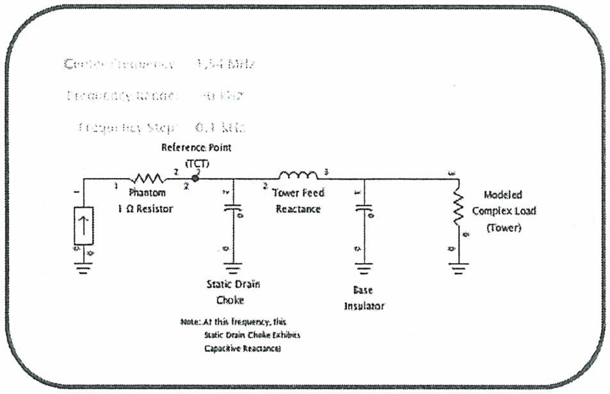
Supporting FCC Construction Permit BP-20161215ABM
WNWR Philadelphia, Pennsylvania (Facility ID 1027)

WCAP Directional Antenna Base Circuit Analysis – WNWR Tower 2 (SE)

WCAP OUTPUT AT FREQUENCY: 1.540 MHz — **WNWR Tower 2 (SE) – DA Mode**

NODE VOLTAGES

Node:	1	237.1297	∡	-39.7500°	V
Node:	2	236.4003	∡	-39.4782°	V
Node:	3	222.2766	∡	-41.8187°	V



WCAP PART			BRANCH VOLTAGE				BRANCH CURRENT				
R	**3→0**	90.02400000	222.28	∡	-41.819°	V	**1.38**	∡	**-97.800°**	**A**	**Current at Load**
C	3→0	0.00001400	222.28	∡	-41.819°	V	0.03	∡	48.181°	A	
L	2→3	1.29100000	16.95	∡	-7.088°	V	1.36	∡	-97.088°	A	
C	2→0	0.00000891	236.40	∡	-39.478°	V	0.02	∡	50.522°	A	
R	1→2	1.00000000	1.34	∡	-96.621°	V	1.34	∡	-96.621°	A	

WCAP PART			FROM IMPEDANCE				TO IMPEDANCE			
R	3→0	90.02400000	**90.02**	+	**j**	**133.370**	0.00	+	j	0.000
C	3→0	0.00001400	0.00	-	j	7381.955	0.00	+	j	0.000
L	2→3	1.29100000	93.35	+	j	147.156	93.35	+	j	134.665
C	2→0	0.00000891	0.00	-	j	11600.333	0.00	+	j	0.000
R	1→2	1.00000000	96.76	+	j	148.267	95.76	+	j	148.267

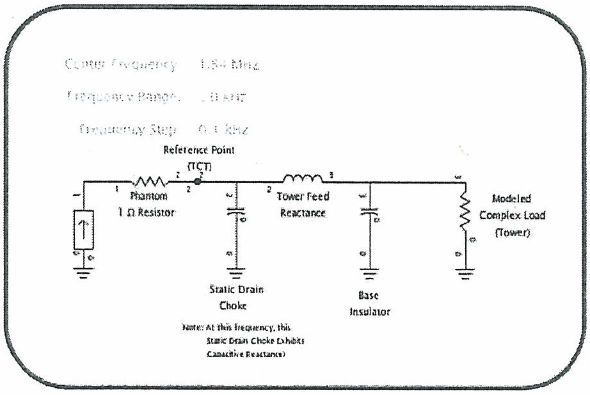
WCAP INPUT DATA:

1.5400 0.00010000 1

R	**90.02400000**	**3**	**0**	**133.37000000**	**Modeled Base Impedance**
C	**0.00001400**	**3**	**0**		
L	1.29100000	2	3	0.00000000	
C	0.00000891	2	0		
R	1.00000000	1	2	0.00000000	
I	**1.33936000**	**0**	**1**	**263.37900000**	**Modeled Current Magnitude and Phase at Toroid**

WCAP Directional Antenna Base Circuit Analysis – WNWR Tower 3 (NW)

WCAP OUTPUT AT FREQUENCY: 1.540 MHz **WNWR Tower 3 (NW) – DA Mode**



NODE VOLTAGES

Node:	1	55.2529	∡	-103.4771°	V
Node:	2	55.3504	∡	-102.8753°	V
Node:	3	45.8842	∡	-100.8383°	V

WCAP PART			BRANCH VOLTAGE				BRANCH CURRENT				
											Current at Load
R	**3→0**	-15.46300000	45.88	∡	-100.838°	V	**0.60**	∡	**157.500°**	A	
C	3→0	0.00001400	45.88	∡	-100.838°	V	0.01	∡	-10.838°	A	
L	2→3	1.67700000	9.63	∡	-112.621°	V	0.59	∡	157.379°	A	
C	2→0	0.00000891	55.35	∡	-102.875°	V	0.00	∡	-12.875°	A	
R	1→2	1.00000000	0.59	∡	157.300°	V	0.59	∡	157.300°	A	

WCAP PART			FROM IMPEDANCE				TO IMPEDANCE			
R	3→0	-15.46300000	**-15.46**	**+**	**j**	**74.919**	0.00	+	j	0.000
C	3→0	0.00001400	0.00	-	j	7381.955	0.00	+	j	0.000
L	2→3	1.67700000	-15.78	+	j	91.881	-15.78	+	j	75.654
C	2→0	0.00000891	0.00	-	j	11600.333	0.00	+	j	0.000
R	1→2	1.00000000	-15.03	+	j	92.592	-16.03	+	j	92.592

WCAP INPUT DATA:
1.5400 0.00010000 1

R	**-15.46300000**	**3**	**0**	**74.91900000**	**Modeled Base Impedance**
C	0.00001400	3	0		
L	1.67700000	2	3	0.00000000	
C	0.00000891	2	0		
R	1.00000000	1	2	0.00000000	
I	**0.58902000**	**0**	**1**	**157.30000000**	**Modeled Current Magnitude and Phase at Toroid**

Antenna Monitor and Sample System

The station's existing antenna monitor (a *Potomac Instruments Inc.* Model AM-1901-3, Serial Number 855), was returned to the manufacturer in order to have its calibration verified. A manufacturer's recalibration certificate (dated August 22, 2017) was issued – a copy of this certificate can be made available upon request. This monitor's calibration was also field-verified prior to initiating array tuning.

This antenna monitor is fed with the same coaxial sample lines that were installed as new equipment during the WNWR 2012 renovation project. These existing sample lines will now be used for both the day and night modes of operation.

All sampling lines are equal length, solid outer conductor, phase stabilized, "connectorized", half-inch, *Andrew Corporation* Model 42394-14VA coaxial cables. They are installed at the site under equal environmental conditions, all being buried except where they extend equally to terminating locations. The electrical length and characteristic impedance of these lines were again verified using the FCC's open-circuit methods prior to array adjustment per the Commission's MoM proof requirements. (A following section of this Statement documents the measured sample line lengths and their characteristic impedances.) 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.

Replacement toroidal current transformers ("TCTs") were purchased to accommodate the new nighttime operation. 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.

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).

Statement E
APPLICATION FOR DIRECT POWER MEASUREMENT AND REVISED STATION LICENSE
Supporting FCC Construction Permit BP-20161215ABM
WNWR Philadelphia, Pennsylvania (Facility ID 1027)

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, 270 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 270 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.

Sample Line for Tower	Open-Circuit Resonance Nearest to 1540 kHz	Calculated Electrical Length
1 – Center	1490.43 kHz	**278.98°**
2 – Southeast	1490.46 kHz	**278.97°**
3 – Northwest	1490.49 kHz	**278.97°**

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 – Center	1242.03 kHz	3.15 –j50.37 Ω	1738.84 kHz	4.63 +j49.97 Ω	**50.3 Ω**
2 – Southeast	1242.05 kHz	3.18 –j50.16 Ω	1738.87 kHz	4.63 +j50.14 Ω	**50.3 Ω**
3 – Northwest	1242.08 kHz	3.18 –j50.09 Ω	1738.91 kHz	4.62 +j50.08 Ω	**50.2 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 – Center	50.3 –j4.2 Ω	52.7 –j8.6 Ω
2 – Southeast	50.2 –j4.3 Ω	52.5 –j8.6 Ω
3 – Northwest	50.2 –j4.1 Ω	52.6 –j8.3 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, 1540 kilohertz:

TCT for Tower	Serial Number	Day Mode		Night Mode	
		Ratio	Phase	Ratio	Phase
1 – Center	15401	1.000 (ref)	0.0° (Ref)	1.003	+0.1°
2 – Southeast	15402	1.001	-0.2°	1.000 (Ref)	0.0° (Ref)
3 – Northwest	15403	1.000	-0.2°	0.999	0.0°

Phasetek, Inc. model "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.

Statement E
APPLICATION FOR DIRECT POWER MEASUREMENT AND REVISED STATION LICENSE
Supporting FCC Construction Permit BP-20161215ABM
WNWR Philadelphia, Pennsylvania (Facility ID 1027)

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[14]. 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.

The instrumentation used for these measurements was a *Potomac Instruments, Inc.* model FIM-41, Serial Number 2181, which was last factory calibrated on June 27, 2006. Prior to commencement of measurements, this meter's calibration was checked against a *Potomac Instruments* model PI-4100, Serial Number 248, which was last factory calibrated on January 21, 2016. Mr. William Smith, an engineer employed by *Phasetek, Inc.* (the provider of the WNWR RF phasing and coupling systems) collected the reference point field strength data for WNWR.

Reference Field Strength Measurements – 37° (Minima) Daytime

Point	Distance (km)	Field (mV/m)	Coordinates (WGS-84 Datum)		Measurement Location Description
1	1.41	281	40° 03.381'	75° 13.535'	Opposite driveway at 800 Wise's Mill Road
2	3.43	69	40° 04.244'	75° 12.660'	Seminole at Railroad Station, 40 feet Southeast of fire hydrant
3	4.54	48	40° 04.735'	75° 12.210'	End of East Highland Avenue at fire hydrant

Reference Field Strength Measurements – 138° (Maxima) Daytime

Point	Distance (km)	Field (mV/m)	Coordinates (WGS-84 Datum)		Measurement Location Description
1	1.50	950	40° 02.178'	75° 13.417'	Pechin and Gates streets. At the Southeast corner
2	3.04	328	40° 01.562'	75° 12.682'	454 Shurs Lane, on sidewalk
3	4.59	128	40° 00.942'	75° 11.954'	At driveway, 4000 Gypsy Lane

[14] Daytime reference point measurements are also being included with this nighttime Proof-of-Performance in order to establish a uniform benchmark for these measurements for both of the WNWR patterns. Also, as permitted under FCC Rule Section 73.155(b), the opportunity was taken to replace prior daytime reference points as necessary due to access/placement concerns or general environmental suitability issues. The requirements of FCC Rule Section 73.151(c)(3) are thus satisfied.

Statement E

APPLICATION FOR DIRECT POWER MEASUREMENT AND REVISED STATION LICENSE

Supporting FCC Construction Permit BP-20161215ABM

WNWR Philadelphia, Pennsylvania (Facility ID 1027)

Reference Field Strength Measurements – 235° (Minima) Daytime

Point	Distance (km)	Field (mV/m)	Coordinates (WGS-84 Datum)		Measurement Location Description
1	2.41	50.5	40° 02.032'	75° 15.516'	1462 Hagy's Ford Road (at Hollow Road)
2	3.13	27.2	40° 01.799'	75° 15.928'	Mailboxes 75/85/95 om Fairview Road
3	4.54	3.5	40° 01.388'	75° 16.761'	Mill Creek Road near Old Gulph Road at gravel Lot

Reference Field Strength Measurements – 290° (Minima) Daytime

Point	Distance (km)	Field (mV/m)	Coordinates (WGS-84 Datum)		Measurement Location Description
1	1.46	66	40° 03.027'	75° 15.094'	Opposite mailbox #230 on Port Royal Avenue
2	5.26	11.9	40° 03.737'	75° 17.612'	Philadelphia Country Club – by tree on island near lot exit
3	6.49	6.3	40° 03.946'	75° 18.432'	Merion Hill entrance off Route 23 at first drain

Reference Field Strength Measurements – 342° (Minima) Daytime

Point	Distance (km)	Field (mV/m)	Coordinates (WGS-84 Datum)		Measurement Location Description
1	1.01	352	40° 03.290'	75° 14.345'	Small sign at Summit Avenue and Granville Road
2	3.41	37	40° 04.527'	75° 14.853'	Eagle View Drive at mailboxes
3	4.37	26.7	40° 05.030'	75° 15.009'	Parking lot of General Lafayette Inn

Reference Field Strength Measurements – 139° (Maxima) Nighttime

Point	Distance (km)	Field (mV/m)	Coordinates (WGS-84 Datum)		Measurement Location Description
1	1.34	74	40° 02.227'	75° 13.516'	Pechin and Fountain Roads, at large evergreen
2	2.64	33.3	40° 01.696'	75° 12.921'	336-338 Roxborough Avenue on sidewalk
3	3.02	26.1	40° 01.554'	75° 12.721'	Freeland Avenue near Shurs Lane at lot entrance

Reference Field Strength Measurements – 274° (Minima) Nighttime

Point	Distance (km)	Field (mV/m)	Coordinates (WGS-84 Datum)		Measurement Location Description
1	1.07	4.6	40° 02.800'	75° 14.878'	Shawmont Avenue and Minerva at stop sign
2	1.55	2.89	40° 02.832'	75° 15.213'	Nixon Street at diamond sign "Share the Road"
3	4.90	0.229	40° 02.947'	75° 17.567'	Country Club Road off Route 23 at diamond sign

Reference Field Strength Measurements – 309.25° (Minima) Nighttime

Point	Distance (km)	Field (mV/m)	Coordinates (WGS-84 Datum)		Measurement Location Description
1	1.29	4.8	40° 03.222'	75° 14.819'	Mailbox 399 – Port Royal Avenue
2	4.91	1.23	40° 04.439'	75° 16.813'	River Road at curve, by black fence with #15
3	6.64	0.178	40° 05.028'	75° 17.754'	13th Avenue, East of Fayette at gravel driveway

Reference Field Strength Measurements – 342° (Minima) Nighttime

Point	Distance (km)	Field (mV/m)	Coordinates (WGS-84 Datum)		Measurement Location Description
1	1.01	20.9	40° 03.290'	75° 14.345'	Small sign at Summit Avenue and Granville Road
2	3.41	1.31	40° 04.527'	75° 14.853'	Eagle View Drive at mailboxes
3	4.37	1.27	40° 05.030'	75° 15.009'	Parking lot of General Lafayette Inn

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 Operating Impedance Bridge. This data is shown below:

Operating Mode	Common Point Resistance	Common Point Reactance
Daytime	50 Ω	-7.7 Ω
Nighttime	70 Ω	-30.8 Ω

Statement E
APPLICATION FOR DIRECT POWER MEASUREMENT
AND REVISED STATION LICENSE
Supporting FCC Construction Permit BP-20161215ABM
WNWR Philadelphia, Pennsylvania (Facility ID 1027)

The authorized common point input power of the nominal 50 kW daytime directional antenna system for WNWR is 52,650 watts. This value is obtained by applying the provisions of Section 73.51(b)(2) of the Commission'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 32.45 Amperes**, as found by the following calculation: (52,650 Watts/50 Ohms Daytime Common Point Resistance)$^{1/2}$ = **32.45 Amperes.**

The authorized common point input power of the nominal 0.25 kW (250 Watt) nighttime directional antenna system is 270 Watts. This value is obtained by applying the provisions of §73.51(b)(1) of the Commission'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. 250 Watts x 1.08 = 270 Watts). The appropriate **nighttime common point current is 1.964 Amperes**, as found by the following calculation: (270 Watts/70 Ohms Nighttime Common Point Resistance)$^{1/2}$ = **1.964 Amperes.**

These values are maintained by the station using Delta Ammeters at each common point location.

Survey Certification

The FCC's Public Notice ("PN") of October 29, 2009 (DA 09-2340) stated that licensed stations which are not proposing a change in the authorized theoretical patterns (or new patterns), are exempt from the array survey requirements of FCC Rule Section 73.151(c)(1)(ix). Based upon this PN, a surveyor's certification was not required or furnished for the prior (2012 daytime) WNWR MoM Proof-of-Performance.

However, Section 73.151(c)(1)(ix) of the rules requires that a station using MoM modeling to confirm an antenna pattern that is applying to license a (new) directional antenna array, must obtain a post-construction certificate from a licensed surveyor, verifying that the towers in the array have the proper spacing and orientation.

Inasmuch as the nighttime antenna system authorized in the WNWR CP (FCC File Number BP-20161215ABM) is a "new" directional antenna pattern, a surveyor's certification is technically required under the Section 73.151(c)(1)(ix). However, it is noted that in the FCC's proceeding, *In the Matter of Revitalization of the AM Radio Service,* THIRD REPORT AND ORDER ("*3rd R&O*") of MB Docket No. 13-249[15] this requirement was negated in those instances where a new pattern is being used with an existing antenna array. Unfortunately, Office of Management and Budget ("OMB") approval of this *3rd R&O* has not yet been received nor has the 3rd

[15] Adopted: September 22, 2017 Released: September 25, 2017, FCC 17-119.

R&O been published in the *Federal Register* advising the public of an effective date for this Rule change. Therefore, we have concluded that a surveyor's certification is still required.

Accordingly, a copy of the original "as-built" survey has been located in the Station's archives. A reduced copy, along with an enlarged portion of the pertinent part of the survey, is included the on following page. Using the information provided in the survey, the relative distances in feet and azimuths (referenced to true north) were compared to the relative distances and azimuths relative to true north of the array elements using the Construction Permit array geometry as baseline and the "Law of Cosines" analysis method. The following tabulation shows those distances and other information along with error determination.

"As-Built" Array Geometry Summary

Callsign:	WNWR	*Reference Tower:*	1
Freq. (kHz):	1540 kHz	*Feet per wavelength:*	638.6825042

Tower Pair Studied	*Licensed Spacing (Electrical degrees)*	*Licensed Azimuth (Degrees True)*	*Measured Distance (feet)*	*Measured Azimuth (Degrees True)*	*Tower Location Error from Licensed (Result in Feet)*	*Tower Location Error from Licensed (Electrical Degrees)*
1 (ref)	0.0	0.0	0.0	0.0	0.00	0.00 °
1 to 2	107.0	129.8	188.4	129.5	1.74	0.98 °
1 to 3	74.5	324.9	132.6	325.0	0.49	0.27 °

Law of Cosines Analysis

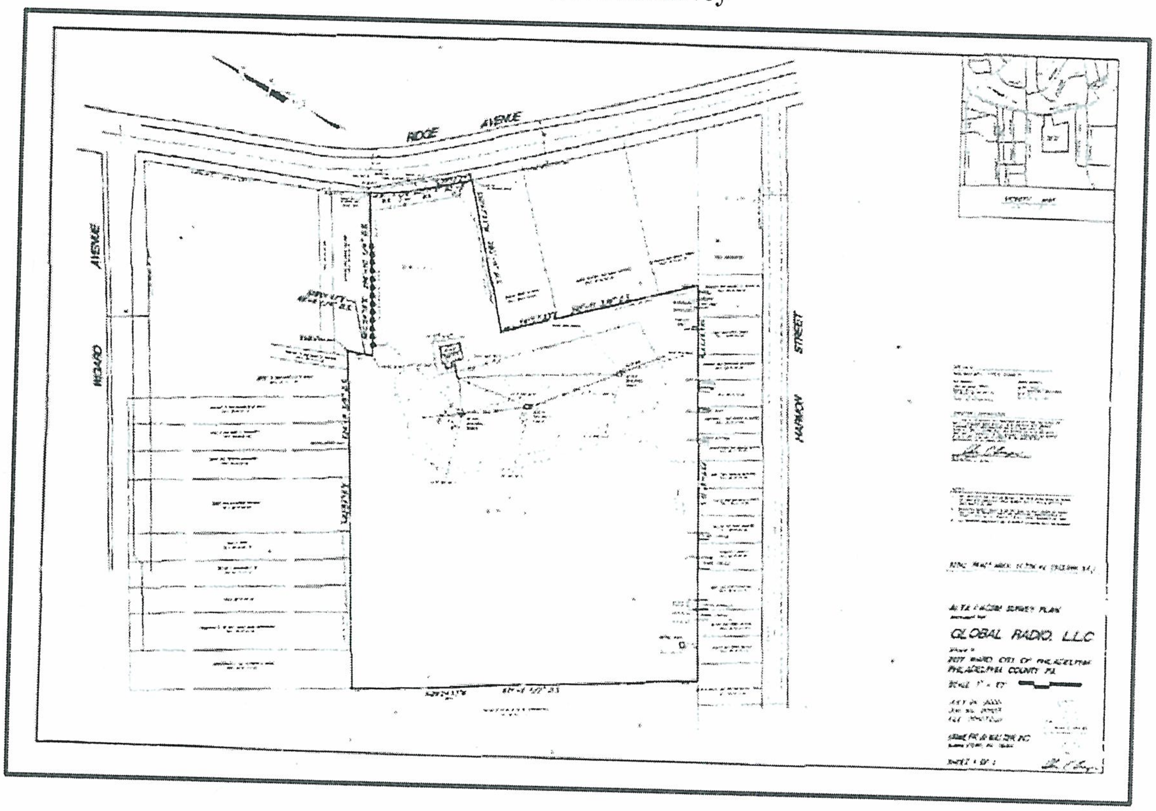
Tower Pair Studied	Licensed Specification (Side "a") of Triangle (Feet)	Licensed Azimuth Versus Measured Azimuth Difference	Included Angle A Converted to Radians	Tower Location Error from licensed position (Result in Feet)	Error in Feet Converted to Electrical Degrees	*Error Greater Greater Than 1.5° ? (2.66 ft)*
1 (ref)	--	--	--	0.0	0.0	N/A
1 to 2	189.83	0.3000 °	0.005235988	1.7	1.0	No - Therefore Okay
1 to 3	132.17	0.1000 °	0.001745329	0.5	0.3	No - Therefore Okay

The "as built" tower displacements from their specified locations, as documented in the survey of the following page, are expressed in the above table in terms of feet, as well as in electrical degrees at carrier frequency. (This corresponds to space phasing differences in the far-field radiation pattern of the array.)

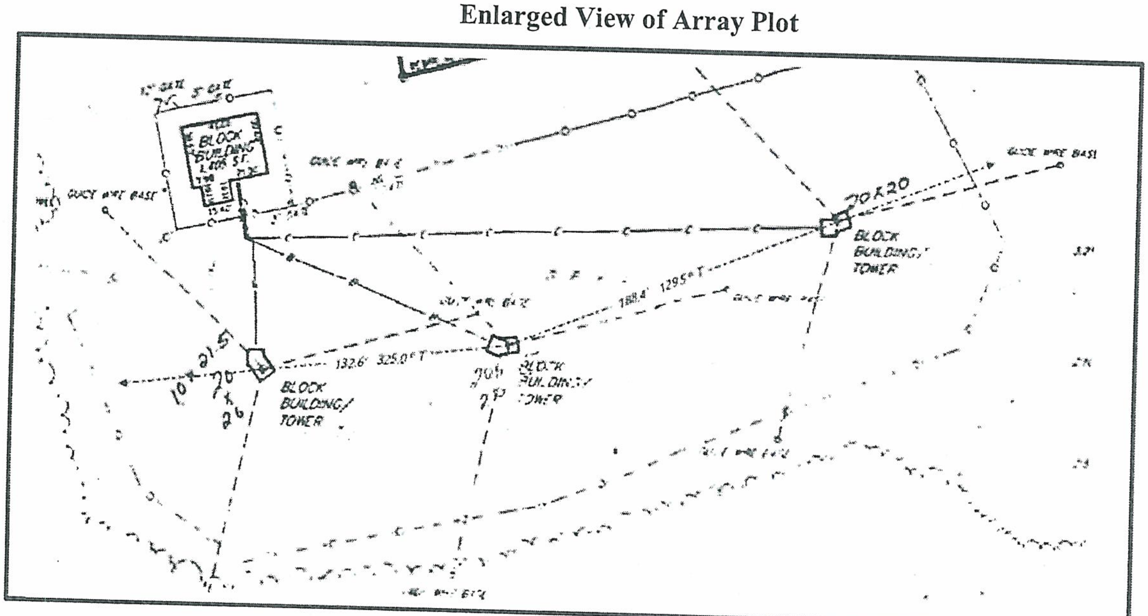
The results shown above are well below the +/- 3 degree operating phase range specified for antenna monitor parameters by the FCC Rules and well within the 1.5° tolerance specified in the Commission's DA 09-2340 Public Notice. As such, it has been proven that this existing antenna tower array has been constructed in accordance with the terms of its Construction Permit and the pertinent Rules and Regulations of the FCC.

Statement E
APPLICATION FOR DIRECT POWER MEASUREMENT AND REVISED STATION LICENSE
Supporting FCC Construction Permit BP-20161215ABM
WNWR Philadelphia, Pennsylvania (Facility ID 1027)

WNWR Survey



Enlarged View of Array Plot



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. *Global Radio* has installed locked fences around each of the tower bases to restrict public access. 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 WNWR.

The minimum fence sizes were determined with reference to FCC OET Bulletin 65 (Edition 97-01). Interpolated values from the Supplement A tables were employed to estimate the necessary "Distance for Compliance with FCC limits" at 1540 kilohertz using a "worst case" improbable assumption of 50 kW at each tower and no top loading. This distance is 4.92 meters, (16.2 feet). Accordingly, 40 by 40 foot fences were installed around each tower, ensuring that the closest point of approach to an energized element would be approximately 5.8 meters (19 feet). Based upon the above, it is believed that the Commission's RF exposure prevention requirements are met in that the fences limit public access to areas with fields that exceed the requirements of the Rules for this directional antenna operation. 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 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 may switch to low power nondirectional operation on Tower 1 (the Central tower), thus de-activating Towers 2, 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 CP Conditions

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

FCC Special Operating Condition 1 requires that a ground system be installed consisting of "120 equally spaced buried copper radials, 48.8 meters in length except where truncated at property boundary or where shortened and bonded to transverse straps between adjacent towers, plus 120 interspersed radials 15.2 meters in length, about the base of each tower." This condition has been satisfied. A ground system meeting the above requirement has been installed at this site, as was discussed in an earlier portion of this Statement.

FCC Special Operating Condition 2 requires that the Permittee submit a proof of performance as set forth in either Section 73.151(a) or 73.151(c) of the Rules before program tests are 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 FCC Form 302-AM in the form of this Statement. As is also required by **Condition 2**, 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, Program Test Authority for the newly constructed nighttime antenna mode are herein respectfully requested on behalf of *Global Radio*.

FCC Special Operating Condition 3 requires that the Permittee install a type-accepted transmitter. Type-accepted transmitters (Harris and Broadcast Electronics) have been acquired and are properly installed at the authorized transmitter site, satisfying this Special Operating Condition.

FCC Special Operating Condition 4 requires that the Permittee be responsible for satisfying all reasonable complaints of blanketing interference within the 1 V/m contour as required by Section 73.88 of the Commission's Rules. While instances of such interference is not expected given the low power level authorized under the nighttime CP, *Global Radio* acknowledges its responsibility under this Rule and has Station personnel prepared and available to respond appropriately.

Certification

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

Respectfully submitted,

Garrison C. Cavell December 15, 2017
Cavell, Mertz & Associates, Inc.
7724 Donegan Drive, Manassas, Virginia 20109
703.392.9090; Facsimile 703.392.9559
E-Mail: gcavell@cavellmertz.com