CARL T. JONES CORPORATION

ENGINEERING EXHIBIT
IN SUPPORT OF AN
APPLICATION FOR LICENSE
STATION WWTC - MINNEAPOLIS, MINNESOTA
1280 kHz - 5 kW, U, DA-N
Facility ID: 9676

Applicant: Salem Media Group, LLC

APRIL, 2010

Carl T. Jones Corporation
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SECTION III OF FCC FORM 302-AM

ENGINEERING STATEMENT OF JAMES D. SADLER

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I am a Technical Consultant, an employee in the firm of Carl T. Jones Corporation with offices located in Springfield, Virginia. My education and experience are a matter of record with the Federal Communications Commission.

1.0 GENERAL

Station WWTC is licensed for operation on 1280 kHz at a power of 5 kilowatts during daytime and nighttime hours employing a directional antenna pattern during nighttime hours (DA-N). This office has been authorized by Salem Media Group, LLC ("Salem"), licensee of Station WWTC, Minneapolis, Minnesota, to prepare this engineering statement and the associated figures and appendices in support of an Application for License. This application follows minor adjustments to the nighttime directional array to return the monitor points within licensed tolerances. During this process, it was determined that efforts to combat the seasonal field strength increases at the monitor points could be eliminated by performing a proof of performance in accordance with the computer modeling and sample system verification procedures contained in 47 CFR 73.151(c) of the

FCC Rules. Information is provided herein to support a complete directional antenna performance verification pursuant to the FCC Rules. The measurement and modeling techniques used to perform the proof of performance are described in this engineering statement. The measurement data and the pertinent computer generated input and output files are contained in the associated figures and Appendices A and B.

2.0 COMPUTER MODELING AND SAMPLE SYSTEM VERIFICATION

The proof of performance contained herein is based on the computer modeling and sample system verification procedures described in 47 CFR 73.151(c). The WWTC antenna array consists of four identical, triangular, uniform cross-section, steel, guyed, series-fed towers. Each tower is 90 electrical degrees (58.55 meters) in height. All towers have a 15-inch face width. The sampling system utilizes identical toroidal current transformers located at the output of the antenna matching network and prior to the diplexer network at the base of each tower.

2.1 INDIVIDUAL TOWER IMPEDANCE MEASUREMENTS

Impedance measurements were performed at the base of each tower by the undersigned at the output J-Plug of the antenna matching network. This measurement location corresponds to the input to the diplexer network and the location of the sampling system toroidal current transformer. The impedance measurements were performed using a Hewlett-Packard, Model 4396A, network analyzer; an Amplifier Research, Model

5W1000, power amplifier; and a Tunwall Radio directional coupler. The impedance was measured for each tower in the array with the other three towers open circuited at the same ATU output J-Plug location that was used to perform the impedance measurement.

2.2 INDIVIDUAL TOWER COMPUTER MODELS

A Method of Moments ("MoM") computer model was developed to model each element in the array using Expert MININEC Broadcast Professional (Version 12.5). The WWTC towers are all equal height, uniform cross-section, guyed structures with base insulators. A vertical wire model was developed for each tower. The radiator was defined by eighteen segments, and an equivalent radius was calculated based on the tower face width using the following formula:

$$R = \frac{1}{2} \times \frac{3F}{\pi}$$

where:

R *= Equivalent Radius*
F *= Tower face width*

The tower physical heights were adjusted and lumped series inductances and shunt capacitances were inserted at the base of each tower to replicate the individual measured tower base impedances within FCC Rule tolerances.

A tabulation of the details employed in the individual tower modeling is included herein as Figure 1. A comparison of the measured individual tower impedances versus the modeled individual tower impedances along with the shunt capacitances and the lumped

series inductances employed in the model is contained in Figure 2. The adjusted tower heights, radii, shunt capacitances, and lumped series inductances employed are all well within the corresponding tolerances set forth in the Rules. As demonstrated in Figure 2, the adjusted modeled individual tower resistances and reactances are within ± 2 ohms and ± 4 percent of the respective individual measured tower resistances and reactances. The text files containing all necessary input and output data associated with the individual tower modeling are contained in Appendix A.

2.3 DIRECTIONAL ANTENNA COMPUTER MODEL

The theoretical directional antenna parameters were used in conjunction with the individual tower computer models to produce the nighttime directional antenna computer model. From the computer model, tower current distributions were derived that, when numerically integrated and normalized to the reference tower, are identical to the authorized field parameters of the theoretical directional antenna patterns. The modeled relative antenna monitor parameters, as calculated at the base of the tower and corresponding to the location of the individual tower impedance measurement locations used in the model, are provided in Figure 3. Shunt capacitances employed for each tower were used to derive the final antenna monitor parameters. The text files containing all necessary input and output data associated with the nighttime directional antenna computer model are contained in Appendix B.

2.4 COMMON POINT IMPEDANCE AND CURRENT

The networks associated with the nighttime directional antenna system were adjusted for proper impedance transformation and the common point impedance matching network was set for Z = 50 -j13 ohms. The type accepted transmitter output power level was adjusted such that the common point current was 10.39 amperes to achieve an input power of 5,400 Watts. The daytime base impedance remains as currently licensed, Z = 89 +j 140. The daytime base current remains 7.49 amperes for an antenna input power of 5,000 Watts.

2.5 SAMPLE SYSTEM DESCRIPTION AND VERIFICATION MEASUREMENTS

The WWTC antenna sampling system utilizes identical Delta Electronics, Model TCT-1, toroidal current transformers mounted at the output of each tower's impedance matching network. The transformers are connected to a Potomac Instruments, Model 1901-4, antenna monitor with equal lengths of Cablewave, Type FCC38-50J, phase stabilized, foam dielectric, ⅜ inch coaxial cable. The sample cables, including excess lengths of cable, are buried such that each cable is subjected to the same environmental conditions.

In accordance with the Rules, the sampling system toroidal current transformer performance was verified by driving a common reference current through all four transformers and comparing their outputs against one another as observed on the Potomac Instruments Model 1901-4 antenna monitor. The devices were found to perform well within

the manufacturer's stated accuracy. A tabulation of the measured values along with the serial number for each of the toroidal current transformers is included in Figure 4. The antenna monitor, Serial Number 473, was calibrated by the manufacturer April 13, 2010, as required by 47 CFR 73.69(e).

The sample lines were verified to be equal in length by measuring the open-circuit series resonate frequency closest to the carrier frequency. The characteristic impedance was verified by measuring the impedance at frequencies corresponding to odd multiples of 1/8 wavelength immediately above and below the open circuit series resonant frequency closest to the carrier frequency, while the line was open circuited. The characteristic impedance was calculated by the following formula:

$$Z = \sqrt{\sqrt{R_1^2 + X_1^2} \times \sqrt{R_2^2 + X_2^2}}$$

where:

$\boldsymbol{Z}$ = *Characteristic impedance and*

$\boldsymbol{R_1 + j\,X_1}$ *and* $\boldsymbol{R_2 + j\,X_2}$ *are the measured impedances at ± 45 degrees offset frequencies.*

A tabulation of the sample line verification measurements is included herein as Figure 5. All sample line verification measurements were performed by the undersigned using a Hewlett-Packard, Model4396A, network analyzer; an Amplifier Research, Model 5W1000, power amplifier; and a Tunwall Radio directional coupler. As demonstrated by the measured values in Figure 5, the measured sample line lengths are within 1 electrical

degree of each other and the measured characteristic impedances are well within 2 ohms of each other as required by 47 CFR 73.151(c)(2)(i) of the FCC Rules and Regulations.

An impedance measurement was performed at the input to each sample line, at the antenna monitor end of the line, with the sample toroid connected. The measurement was performed at the WWTC operating frequency of 1280 kilohertz. The measurements are contained in the table of Figure 5.

2.7 POST-CONSTRUCTION CERTIFICATION

In accordance with the Rules, this facility is exempt from the requirement of submitting a surveyor's certification as to the location of the towers as the application merely proposes a re-licensing of this existing facility under the new rules.

2.8 REFERENCE FIELD STRENGTH MEASUREMENTS

Reference field strength measurements were performed on a total of five radial bearings. The 26° radial corresponds to the major lobe while the 107°, 158°, 241°, and 307° radials correspond to the pattern minima. A total of three field strength measurements were performed on each of the five radials. The measurements were performed by Mr. Rob Goldberg, contract engineer for the station, using a Potomac Instruments, Model FIM-21, field intensity meter, Serial Number 926, calibrated May 5, 2006. The meter was checked against a meter calibrated in the last two years and was found to be in close agreement. The GPS coordinates (NAD83) and descriptions of the reference point

locations are provided in Figure 6 along with the corresponding measured field strength value for each established location.

SUMMARY

It is submitted that the WWTC nighttime directional antenna system has been adjusted to conform with the technical specifications contained in the Station License. The WWTC nighttime pattern performance has been verified using computer modeling and sample system verification procedures in accordance with Section 47 CFR 73.151(c) and it is believed that the WWTC antenna system is operating within the terms of it's License Authorization and the FCC's Rules and Regulations. It is requested that a superceding license authorization be issued to reflect the new operating parameters and additional supporting data contained herein. The license should reflect the replacement of the existing monitoring points with the newly established reference points.

This engineering statement, FCC Form 302-AM, Section III, and the attached figures and appendices were prepared by the undersigned or under the direct supervision of the undersigned and are believed to be true and correct.

Dated: April 21, 2010

James D. Sadler

TOWER MODEL HEIGHT AND RADIUS

STATION WWTC - MINNEAPOLIS, MINNESOTA
1280 kHz - 5 kW, U, DA-N
APRIL, 2010

Tower	Physical Height (meters)	Modeled Height (meters)	Percent of Physical Height	Tower Face Width (meters)	Equivalent Radius (meters)	Modeled Radius (meters)	Percent of Equivalent Radius
1	58.55	64.40	110.0	0.3810	0.1819	0.1819	100.0
2	58.55	64.40	110.0	0.3810	0.1819	0.1819	100.0
3	58.55	64.40	110.0	0.3810	0.1819	0.1819	100.0
4	58.55	64.40	110.0	0.3810	0.1819	0.1819	100.0

MEASURED AND MODELED IMPEDANCES

STATION WWTC - MINNEAPOLIS, MINNESOTA
1280 kHz - 5 kW, U, DA-N
APRIL, 2010

Tower	Measured Tower Base Impedance[1]	Modeled Tower Base Impedance	Shunt Capacitance (pF)	Lumped Series Inductance (uH)	Adjusted Tower Base Impedance
1	69.4 +j 139.8	57.3 +j 74.7	155.0	7.8	69.2 +j 139.6
2	63.6 +j 127.5	55.3 +j 76.7	110.0	6.0	63.4 +j 127.3
3	55.8 +j 121.6	57.3 +j 74.7	0.0	5.8	57.3 +j 121.3
4	61.3 +j 121.9	55.3 +j 76.7	90.0	5.4	61.8 +j 122.1

[1] Measured at output J-Plug of matching network with other towers opened at J-Plug

ANTENNA MONITOR PARAMETERS AND COMMON POINT DATA

STATION WWTC - MINNEAPOLIS, MINNESOTA
1280 kHz - 5 kW, U, DA-N
APRIL, 2010

NIGHTTIME				
	Mininec Modeled Parameters		Final Circuit Modeled Parameters	
Tower	Ratio	Phase (degrees)	Ratio	Phase (degrees)
1	1.000	0.0	1.000	0.0
2	0.644	-143.7	0.654	-141.6
3	0.352	80.0	0.393	78.2
4	0.650	-129.7	0.675	-128.5

Common Point Impedance = 50 -j 13 ohms

Common Point Current = 10.39 amperes

Antenna Input Power = 5,400 Watts

SAMPLE DEVICE CALIBRATION

STATION WWTC - MINNEAPOLIS, MINNESOTA
1280 kHz - 5 kW, U, DA-N
APRIL, 2010

Reference Sample Toroid Number	Measured Sample Toroid Number	Measured	
		Field Ratio	Phase (degrees)
1	2	0.992	-36.9
1	3	0.995	-36.9
1	4	0.998	-36.8
3	4	0.998	-36.6

Sample Toroid Number	Type	Serial Number
1	Delta Electronics, TCT-1	1781
2	Delta Electronics, TCT-1	5399
3	Delta Electronics, TCT-1	15714
4	Delta Electronics, TCT-1	1042

SAMPLE LINE VERIFICATION MEASUREMENTS

STATION WWTC - MINNEAPOLIS, MINNESOTA
1280 kHz - 5 kW, U, DA-N
APRIL, 2010

Tower	Open Circuit Series Resonant Frequency[1] (kHz)	Open Circuit Measured Line Length[2] (degrees)	Resonant Frequency -45 degree Offset Frequency (kHz)	Resonant Frequency -45 degree Offset Impedance (Ohms)	Resonant Frequency +45 degree Offset Frequency (kHz)	Resonant Frequency +45 degree Offset Impedance (Ohms)	Calculated Characteristic Impedance (Ohms)	Reference Impedance Sample Toroid Connected[2] (Ohms)
1	1154.0	499.1	1038.6	10.45 -j 45.35	1269.4	9.71 +j 52.10	49.66	49.14 -j0.60
2	1154.8	498.8	1039.3	10.53 -j 45.58	1270.3	9.48 +j 51.75	49.61	49.05 +j0.79
3	1154.4	499.0	1039.0	10.50 -j 45.55	1269.8	9.12 +j 50.85	49.14	48.79 +j0.28
4	1155.8	498.4	1040.2	10.42 -j 45.45	1271.4	9.78 +j 52.41	49.86	48.76 -j1.01

[1] At this frequency, the sample line electrical length is equal to 450°.

[2] At carrier frequency (1280 kHz)

Figure 5

REFERENCE FIELD STRENGTH MEASUREMENTS

STATION WWTC - MINNEAPOLIS, MINNESOTA
1280 kHz - 5 kW, U, DA-N
APRIL, 2010

Nighttime - 26 Degree Radial

Point Number	Distance (km)	Measured Field (mV/m)	Geographic Coordinates (NAD83)		Description
			Latitude	Longitude	
1	1.88	339	44° 58' 34"	93° 20' 48"	Point is located at the west side of Lawn Terrace, south corner of driveway entrance at 115 Lawn Terrace.
2	6.67	98	45° 00' 54"	93° 19' 11"	Point is located at the north peak of the corner of crosswalk of Lakeland Avenue N and York Avenue N.
3	8.92	71	45° 01' 59"	93° 18' 26"	Point is located at the corner of 43rd Avenue N and N Oliver Avenue on the south side of 43rd and the eastside of N Oliver.

Nighttime - 107 Degree Radial

Point Number	Distance (km)	Measured Field (mV/m)	Geographic Coordinates (NAD83)		Description
			Latitude	Longitude	
1	1.58	99	44° 57' 25"	93° 20' 16"	Point is located on the west side of Monterey Avenue S, at the curb in front of the front door to 2524 Monterey Avenue S.
2	4.28	66	44° 57' 00"	93° 18' 17"	Point is located on east bound W 29th Street (Mall Street - one way) at the corner of S Knox Avenue and Mall Street.
3	8.40	8.3	44° 56' 21"	93° 15' 18"	Point is located on the west side of 14th Avenue S directly in front of 3508 14th Avenue S.

REFERENCE FIELD STRENGTH MEASUREMENTS

STATION WWTC - MINNEAPOLIS, MINNESOTA
1280 kHz - 5 kW, U, DA-N
APRIL, 2010

Nighttime - 158 Degree Radial

Point Number	Distance (km)	Measured Field (mV/m)	Geographic Coordinates (NAD83)		Description
			Latitude	Longitude	
1	2.57	40	44° 56' 22"	93° 20' 40"	Point is located on the east side of Raleigh Avenue S, 25 feet south of the stop sign near the corner of W 35th Street and Raleigh Avenue S.
2	4.96	8.2	44° 55' 10"	93° 19' 59"	Point is located 10 feet north of the stop sign on the south east corner of Sunnyside Road and Townes Road.
3	9.59	6.1	44° 52' 44"	93° 18' 35"	Point is located on the east side of Queen Avenue S at curb directly in front of 6825 Queen Avenue S.

Nighttime - 241 Degree Radial

Point Number	Distance (km)	Measured Field (mV/m)	Geographic Coordinates (NAD83)		Description
			Latitude	Longitude	
1	1.42	34.5	44° 57' 17"	93° 22' 23"	Point is located on the south side of W 27th Street at the east tip of curb at the entrance to parking lot for building 7309 W 27th Street.
2	4.32	13.9	44° 56' 32"	93° 24' 19"	Point is located on the north side of Lahti Lane (Gaynor Street), 40 feet east of Oak Ridge Road and 30 feet east of the stop sign at Oak Ridge Road and Lahti Lane.
3	7.55	8.1	44° 55' 41"	93° 26' 27"	Point is located on the west side of Windridge Circle at north tip of curb for driveway at 4136 Windridge Circle.

REFERENCE FIELD STRENGTH MEASUREMENTS

STATION WWTC - MINNEAPOLIS, MINNESOTA
1280 kHz - 5 kW, U, DA-N
APRIL, 2010

Nighttime - 307 Degree Radial

Point Number	Distance (km)	Measured Field (mV/m)	Geographic Coordinates (NAD83)		Description
			Latitude	Longitude	
1	2.49	66	44° 58' 29"	93° 22' 56"	Point is located on the west side of Utah Avenue S at the curb in front of 516 Utah Avenue S.
2	5.19	45	44° 59' 21"	93° 24' 35"	Point is located at the west corner of parking lot entrance for 10250 10th Avenue N.
3	8.42	23.2	45° 00' 24"	93° 26' 31"	Point is located 15 feet east of the north east corner of 25th Avenue N and Quinwood Lane N.

APPENDIX A

INDIVIDUAL TOWER MODELING

IMPEDANCE – TOWER 1
normalization = 50.

freq (MHz)	resist (ohms)	react (ohms)	imped (ohms)	phase (deg)	VSWR	S11 dB	S12 dB
source = 1; node 1, sector 1							
1.28	57.288	74.694	94.133	52.5	3.6957	-4.8206	-1.7364

GEOMETRY – TOWER 1
Wire coordinates in degrees; other dimensions in meters
Environment: perfect ground

wire	caps	Distance	Angle	Z	radius	segs
1	none	0	0	0	.1819	18
		0	0	99.		
2	none	120.	53.	0	.1819	18
		120.	53.	99.		
3	none	207.85	23.	0	.1819	18
		207.85	23.	99.		
4	none	120.	353.	0	.1819	18
		120.	353.	99.		

Number of wires = 4
current nodes = 72

	minimum		maximum	
Individual wires	wire	value	wire	value
segment length	1	5.5	1	5.5
radius	1	.1819	1	.1819

ELECTRICAL DESCRIPTION
Frequencies (MHz)

	frequency		no. of	segment length (wavelengths)	
no.	lowest	step	steps	minimum	maximum
1	1.28	0	1	.0152778	.0152778

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	19	0	-10,000.	0	0	0
3	37	0	-10,000.	0	0	0
4	55	0	-10,000.	0	0	0

IMPEDANCE – TOWER 2
normalization = 50.

freq (MHz)	resist (ohms)	react (ohms)	imped (ohms)	phase (deg)	VSWR	S11 dB	S12 dB
source = 1; node 19, sector 1							
1.28	55.252	76.733	94.555	54.2	3.8838	-4.5758	-1.862

GEOMETRY – TOWER 2
Wire coordinates in degrees; other dimensions in meters
Environment: perfect ground

wire	caps	Distance	Angle	Z	radius	segs
1	none	0	0	0	.1819	18
		0	0	99.		
2	none	120.	53.	0	.1819	18
		120.	53.	99.		
3	none	207.85	23.	0	.1819	18
		207.85	23.	99.		
4	none	120.	353.	0	.1819	18
		120.	353.	99.		

Number of wires = 4
current nodes = 72

	minimum		maximum	
Individual wires	wire	value	wire	value
segment length	1	5.5	1	5.5
radius	1	.1819	1	.1819

ELECTRICAL DESCRIPTION
Frequencies (MHz)

no.	frequency lowest	step	no. of steps	segment length (wavelengths) minimum	maximum
1	1.28	0	1	.0152778	.0152778

Sources

source	node	sector	magnitude	phase	type
1	19	1	1.	0	voltage

Lumped loads

load	node	resistance (ohms)	reactance (ohms)	inductance (mH)	capacitance (uF)	passive circuit
1	1	0	-10,000.	0	0	0
2	19	0	0	0	0	0
3	37	0	-10,000.	0	0	0
4	55	0	-10,000.	0	0	0

IMPEDANCE – TOWER 3
normalization = 50.

freq (MHz)	resist (ohms)	react (ohms)	imped (ohms)	phase (deg)	VSWR	S11 dB	S12 dB
source = 1; node 37, sector 1							
1.28	57.289	74.696	94.136	52.5	3.6958	-4.8204	-1.7365

GEOMETRY – TOWER 3
Wire coordinates in degrees; other dimensions in meters
Environment: perfect ground

wire	caps	Distance	Angle	Z	radius	segs
1	none	0	0	0	.1819	18
		0	0	99.		
2	none	120.	53.	0	.1819	18
		120.	53.	99.		
3	none	207.85	23.	0	.1819	18
		207.85	23.	99.		
4	none	120.	353.	0	.1819	18
		120.	353.	99.		

Number of wires = 4
current nodes = 72

	minimum		maximum	
Individual wires	wire	value	wire	value
segment length	1	5.5	1	5.5
radius	1	.1819	1	.1819

ELECTRICAL DESCRIPTION
Frequencies (MHz)

	frequency		no. of	segment length (wavelengths)	
no.	lowest	step	steps	minimum	maximum
1	1.28	0	1	.0152778	.0152778

Sources

source	node	sector	magnitude	phase	type
1	37	1	1.	0	voltage

Lumped loads

load	node	resistance (ohms)	reactance (ohms)	inductance (mH)	capacitance (uF)	passive circuit
1	1	0	-10,000.	0	0	0
2	19	0	-10,000.	0	0	0
3	37	0	0	0	0	0
4	55	0	-10,000.	0	0	0

IMPEDANCE – TOWER 4
normalization = 50.

freq (MHz)	resist (ohms)	react (ohms)	imped (ohms)	phase (deg)	VSWR	S11 dB	S12 dB
source = 1; node 55, sector 1							
1.28	55.251	76.733	94.555	54.2	3.8838	-4.5758	-1.862

GEOMETRY – TOWER 4
Wire coordinates in degrees; other dimensions in meters
Environment: perfect ground

wire	caps	Distance	Angle	Z	radius	segs
1	none	0	0	0	.1819	18
		0	0	99.		
2	none	120.	53.	0	.1819	18
		120.	53.	99.		
3	none	207.85	23.	0	.1819	18
		207.85	23.	99.		
4	none	120.	353.	0	.1819	18
		120.	353.	99.		

Number of wires = 4
current nodes = 72

	minimum		maximum	
Individual wires	wire	value	wire	value
segment length	1	5.5	1	5.5
radius	1	.1819	1	.1819

ELECTRICAL DESCRIPTION
Frequencies (MHz)

	frequency		no. of	segment length (wavelengths)	
no.	lowest	step	steps	minimum	maximum
1	1.28	0	1	.0152778	.0152778

Sources

source	node	sector	magnitude	phase	type
1	55	1	1.	0	voltage

Lumped loads

load	node	resistance (ohms)	reactance (ohms)	inductance (mH)	capacitance (uF)	passive circuit
1	1	0	-10,000.	0	0	0
2	19	0	-10,000.	0	0	0
3	37	0	-10,000.	0	0	0
4	**55**	**0**	**0**	**0**	**0**	**0**

APPENDIX B

NIGHTTIME DIRECTIONAL ARRAY MODEL

IMPEDANCE
normalization = 50.

freq (MHz)	resist (ohms)	react (ohms)	imped (ohms)	phase (deg)	VSWR	S11 dB	S12 dB
source = 1; node 1, sector 1							
1.28	22.731	84.47	87.475	74.9	8.8189	-1.9783	-4.3665
source = 2; node 19, sector 1							
1.28	69.591	104.55	125.6	56.4	5.0541	-3.4831	-2.584
source = 3; node 37, sector 1							
1.28	54.594	245.16	251.16	77.4	23.984	-.72472	-8.1334
source = 4; node 55, sector 1							
1.28	68.358	99.167	120.44	55.4	4.766	-3.6998	-2.4154

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

wire	caps	Distance	Angle	Z	radius	segs
1	none	0	0	0	.1819	18
		0	0	99.		
2	none	120.	53.	0	.1819	18
		120.	53.	99.		
3	none	207.85	23.	0	.1819	18
		207.85	23.	99.		
4	none	120.	353.	0	.1819	18
		120.	353.	99.		

Number of wires = 4
current nodes = 72

	minimum		maximum	
Individual wires	wire	value	wire	value
segment length	1	5.5	1	5.5
radius	1	.1819	1	.1819

ELECTRICAL DESCRIPTION
Frequencies (MHz)

no.	frequency lowest	step	no. of steps	segment length (wavelengths) minimum	maximum
1	1.28	0	1	.0152778	.0152778

Sources

source	node	sector	magnitude	phase	type
1	1	1	936.479	77.2	voltage
2	19	1	866.041	274.9	voltage
3	37	1	946.918	159.7	voltage
4	55	1	837.996	288.	voltage

MEDIUM WAVE ARRAY SYNTHESIS FROM FIELD RATIOS

Frequency = 1.28 MHz

tower	field ratio magnitude	phase (deg)
1	1.	0
2	.67	-148.
3	.45	78.
4	.67	-134.

VOLTAGES AND CURRENTS - rms

source node	voltage magnitude	phase (deg)	current magnitude	phase (deg)
1	662.19	77.2	7.56328	2.3
19	612.384	274.9	4.87029	218.6
37	669.572	159.7	2.65858	82.3
55	592.553	288.	4.91447	232.6

Sum of square of source currents = 224.286
Total power = 5,000. watts

TOWER ADMITTANCE MATRIX

admittance	real (mhos)	imaginary (mhos)
Y(1, 1)	.00655061	-.00597279
Y(1, 2)	.00300558	.00208126
Y(1, 3)	.000567322	.000232731
Y(1, 4)	.00300563	.00208135
Y(2, 1)	.00300558	.00208126
Y(2, 2)	.0059049	-.00487818
Y(2, 3)	.00300564	.00208118
Y(2, 4)	.00242337	.00300198
Y(3, 1)	.000567322	.000232731
Y(3, 2)	.00300564	.00208118
Y(3, 3)	.00655092	-.00597282
Y(3, 4)	.00300569	.00208127
Y(4, 1)	.00300563	.00208135
Y(4, 2)	.00242337	.00300198
Y(4, 3)	.00300569	.00208127
Y(4, 4)	.00590513	-.00487814

TOWER IMPEDANCE MATRIX

impedance	real (ohms)	imaginary (ohms)
Z(1, 1)	57.4699	74.604
Z(1, 2)	10.7314	-29.8943
Z(1, 3)	-23.0497	-8.90501
Z(1, 4)	10.7315	-29.8943
Z(2, 1)	10.7314	-29.8943
Z(2, 2)	55.5247	76.5275
Z(2, 3)	10.7296	-29.8942
Z(2, 4)	8.61392	-29.6491
Z(3, 1)	-23.0497	-8.90501
Z(3, 2)	10.7296	-29.8942
Z(3, 3)	57.4701	74.6029
Z(3, 4)	10.7296	-29.8941
Z(4, 1)	10.7315	-29.8943
Z(4, 2)	8.61392	-29.6491
Z(4, 3)	10.7296	-29.8941
Z(4, 4)	55.5247	76.5242

CURRENT rms
Frequency = 1.28 MHz
Input power = 5,000. watts
Efficiency = 100. %
coordinates in degrees

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	0	0	0	7.57037	2.3	7.5644	.300629
2	0	0	5.5	7.89926	1.6	7.89626	.21784
3	0	0	11.	8.05011	1.1	8.0485	.160916
4	0	0	16.5	8.09907	.8	8.09829	.112542
5	0	0	22.	8.05829	.5	8.05798	.0702046
6	0	0	27.5	7.93331	.2	7.93324	.0330376
7	0	0	33.	7.72796	0.0	7.72796	7.16E-04
8	0	0	38.5	7.44544	359.8	7.44539	-.0268657
9	0	0	44.	7.08888	359.6	7.08871	-.0497132
10	0	0	49.5	6.66167	359.4	6.66133	-.0677898
11	0	0	55.	6.16745	359.2	6.16692	-.0810437
12	0	0	60.5	5.60995	359.1	5.60923	-.0894212
13	0	0	66.	4.993	358.9	4.99214	-.0928748
14	0	0	71.5	4.32028	358.8	4.31931	-.0913615
15	0	0	77.	3.59485	358.6	3.59385	-.0848304
16	0	0	82.5	2.81827	358.5	2.81732	-.073193
17	0	0	88.	1.98832	358.4	1.98752	-.0562422
18	0	0	93.5	1.09212	358.2	1.09161	-.0333994
END	0	0	99.	0	0	0	0
GND	72.2178	-95.8363	0	4.876	218.6	-3.81125	-3.04134
20	72.2178	-95.8363	5.5	5.14541	216.5	-4.13694	-3.05957
21	72.2178	-95.8363	11.	5.28328	215.2	-4.3172	-3.04546
22	72.2178	-95.8363	16.5	5.34883	214.2	-4.42458	-3.0055
23	72.2178	-95.8363	22.	5.35108	213.3	-4.47038	-2.94104
24	72.2178	-95.8363	27.5	5.2939	212.6	-4.45931	-2.85305
25	72.2178	-95.8363	33.	5.17971	212.	-4.39416	-2.74241
26	72.2178	-95.8363	38.5	5.01055	211.4	-4.27703	-2.61011
27	72.2178	-95.8363	44.	4.78844	210.9	-4.10988	-2.45724
28	72.2178	-95.8363	49.5	4.51552	210.4	-3.89471	-2.28499
29	72.2178	-95.8363	55.	4.19412	210.	-3.63361	-2.09464
30	72.2178	-95.8363	60.5	3.82666	209.6	-3.32875	-1.88752
31	72.2178	-95.8363	66.	3.41567	209.2	-2.98238	-1.665
32	72.2178	-95.8363	71.5	2.96359	208.8	-2.59665	-1.42838
33	72.2178	-95.8363	77.	2.47242	208.5	-2.17335	-1.17874
34	72.2178	-95.8363	82.5	1.9432	208.1	-1.71338	-.916699
35	72.2178	-95.8363	88.	1.37428	207.8	-1.21528	-.64166
36	72.2178	-95.8363	93.5	.756643	207.5	-.670992	-.349683
END	72.2178	-95.8363	99.	0	0	0	0

CURRENT rms - Continued
Frequency = 1.28 MHz
Input power = 5,000. watts
Efficiency = 100. %
coordinates in degrees

current no.	X	Y	Z	mag (amps)	phase (deg)	real (amps)	imaginary (amps)
GND	191.327	-81.2134	0	2.666	82.3	.359029	2.64171
38	191.327	-81.2134	5.5	3.02115	80.7	.487055	2.98163
39	191.327	-81.2134	11.	3.23143	79.9	.567794	3.18115
40	191.327	-81.2134	16.5	3.37397	79.3	.628772	3.31486
41	191.327	-81.2134	22.	3.46048	78.8	.674112	3.39419
42	191.327	-81.2134	27.5	3.49567	78.4	.705387	3.42376
43	191.327	-81.2134	33.	3.48209	78.	.723367	3.40612
44	191.327	-81.2134	38.5	3.42154	77.7	.728508	3.34309
45	191.327	-81.2134	44.	3.31563	77.4	.721161	3.23625
46	191.327	-81.2134	49.5	3.16592	77.2	.701642	3.08719
47	191.327	-81.2134	55.	2.97406	77.	.670274	2.89754
48	191.327	-81.2134	60.5	2.74177	76.8	.627391	2.66902
49	191.327	-81.2134	66.	2.47085	76.6	.573333	2.40341
50	191.327	-81.2134	71.5	2.163	76.4	.508428	2.1024
51	191.327	-81.2134	77.	1.81967	76.2	.432934	1.76741
52	191.327	-81.2134	82.5	1.4415	76.1	.346915	1.39914
53	191.327	-81.2134	88.	1.02717	75.9	.24993	.996301
54	191.327	-81.2134	93.5	.569687	75.8	.140112	.552189
END	191.327	-81.2134	99.	0	0	0	0
GND	119.106	14.6243	0	4.91992	232.5	-2.99296	-3.90485
56	119.106	14.6243	5.5	5.17691	230.5	-3.29582	-3.99224
57	119.106	14.6243	11.	5.30624	229.2	-3.46818	-4.01595
58	119.106	14.6243	16.5	5.36459	228.2	-3.57704	-3.99795
59	119.106	14.6243	22.	5.36061	227.3	-3.63273	-3.942
60	119.106	14.6243	27.5	5.29802	226.6	-3.63953	-3.85004
61	119.106	14.6243	33.	5.17921	226.	-3.59986	-3.7236
62	119.106	14.6243	38.5	5.00617	225.4	-3.51552	-3.5641
63	119.106	14.6243	44.	4.78091	224.9	-3.38813	-3.37308
64	119.106	14.6243	49.5	4.50557	224.4	-3.21933	-3.15215
65	119.106	14.6243	55.	4.18245	224.	-3.01083	-2.90306
66	119.106	14.6243	60.5	3.81398	223.5	-2.76442	-2.62762
67	119.106	14.6243	66.	3.40267	223.2	-2.48194	-2.32769
68	119.106	14.6243	71.5	2.95094	222.8	-2.16514	-2.00505
69	119.106	14.6243	77.	2.46081	222.5	-1.81552	-1.66117
70	119.106	14.6243	82.5	1.93328	222.1	-1.43378	-1.29686
71	119.106	14.6243	88.	1.36672	221.8	-1.01865	-.911197
72	119.106	14.6243	93.5	.752202	221.5	-.563346	-.498447
END	119.106	14.6243	99.	0	0	0	0