Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
An Inquiry Into the Commission's	)	MM Docket No. 93-177
Policies and Rules Regarding AM	)	
Radio Service Directional Antenna	)	
Performance Verification	)	

To: Secretary, FCC
For: Chief, Media Bureau

COMMENTS OF THE ASSOCIATION OF
FEDERAL COMMUNICATIONS CONSULTING ENGINEERS

The Association of Federal Communications Consulting Engineers (AFCCE), celebrating over 50 years, is an organization that includes approximately 90 full members who are Registered Professional Engineers engaged in the practice of consulting engineering before the Federal Communications Commission. In addition, AFCCE represents over 160 associate members in allied companies such as equipment manufacturers, service providers, government agencies and communications law professionals. AFCCE hereby submits comments in response to the Media Bureau's *Public Notice* in this proceeding,[1] .

INTRODUCTION

The Association of Federal Communications Consulting Engineers ("The AFCCE") represents more than 90 Registered Professional Engineers including group engineering directors and other interested professionals engaged in telecommunications engineering.

The AFCCE, through these comments, provides information

[1] *Comments Sought on Proposed Rules Permitting Antenna Modeling to Verify AM Directional Antenna Performance*, Public Notice, DA 07-2143 (rel. May 23, 2007) ("*Public Notice*").

based on the accumulated experience of its Professional membership, regarding the use of Method of Moments modeling for AM directional antenna ("AM DA") systems in lieu of field measurements of the magnetic field component of the transmitted wave for Proof of Performance of authorized directive arrays in the medium wave band from 540 to 1700 kilohertz.

The AFCCE submits these Comments in response to the Media Bureau’s May 23, 2004 Public Notice in the above-captioned proceeding. *See* Public Notice, “Comment Sought on Proposed Rules Permitting Antenna Modeling to Verify AM Directional Antenna Performance,” (DA 07-2143, released May 23, 2007).

In that Public Notice, the Media Bureau solicited comments on the AM Directional Antenna Performance Verification Coalition’s ("The Coalition") May 4, 2007 recommendations that the FCC authorize the use of moment method computer modeling to demonstrate that AM directional antennas perform as authorized and to assess the effects of nearby re-radiators on AM patterns. The Media Bureau also sought comments on the Coalition’s proposed new and modified rules to implement those recommendations.

It is the consensus of the engineers holding membership in AFCCE, many of whom were involved in the Coalition, that

computer modeling and internal array parameter monitoring will accurately and reliably verify the performance of most medium wave antenna systems.

It was widely acknowledged in the original proceeding in MM Docket 93-177 that the present process of using field strength measurements to verify the performance of an AM antenna system is fundamentally flawed. Because field strength measurements are subject to substantial variation caused by, among other things, proximity effects, diffraction effects, scattering, seasonal changes in ground conductivity, and land development along propagation paths, they often result in an oversimplified and therefore unreliable analysis. Computer modeling using method of moments analysis ("MOM"), such as Numerical Electromagnetic Code (“NEC”) or MININEC programs, are not subject to these same variations and limitations, and can predict accurately the far field pattern shape and size when the internal array parameters such as impedances, currents, and phases of each element are accurately modeled. These programs use the current flowing in each tower of an AM directional antenna to predict the electric and magnetic fields that will be produced by that element, which then can be used to accurately predict the current that will be induced by this field into the

other towers.

By performing this analysis for each tower in an AM directional array, and then combining the fields created by each tower, the programs can accurately predict how the overall AM antenna system will perform.

As the Media Bureau correctly observes in the Public Notice, method of moments analysis has become widely accepted by broadcast engineers and Commission staff, and the Coalition's recommendations reflect current broadcast industry practice. Moreover, as the Media Bureau acknowledged, the use of method of moments analysis will advance the public interest by substantially reducing the time required of both applicants and Commission staff to perform a directional antenna proof of performance. The AFCCE concurs.

The following comments pertain to the proposed Rule changes.

73.61 AM Directional Antenna Field Strength Measurements

The AFCCE supports the proposed changes to Section 73.61 of the Rules.

73.151, Directional Antenna Performance Verification

The AFCCE supports the proposed changes to Section 73.151 of the Rules. We suggest the following clarifications:

73.151(a)(2)(i):

. . . . . Samples may be obtained from current transformers at the output of the antenna coupling and matching equipment for base-fed towers whose actual electrical height is 120 degrees or less, or greater than 190 electrical degrees. Samples may be obtained from base voltage sampling devices at the output of the antenna coupling and matching equipment for base-fed towers whose actual electrical height is greater than 105 degrees.

In either of the above listed cases, towers with a base face width equal to or exceeding 3 electrical degrees shall employ a symmetrical ("Star or Spider") feed at the base of the tower.

Samples obtained from sample loops located as described above can be used for any height of tower. For towers using base current or base voltage sampling derived at the output of the antenna coupling and matching equipment, the sampling devices shall be disconnected and calibrated by measuring their outputs with a common reference signal (a current through them or a voltage across them, as appropriate) and the calibration must agree within the manufacturer’s specifications.

73.151(a)(3):

Reference field strength measurement locations shall be established in directions where the standard pattern unattenuated field strength is within 3 dB of the value for each pattern minimum
and the absolute pattern maximum.

The field strength shall be measured at each reference location, at the time of the proof of performance and its value, along with a complete description of the location, shall be placed in the station's public inspection file ***and shall be filed as an exhibit with FCC Form 302-AM.***

73.151(b)(iii)(B):

(B) An accurate and detailed description of each monitoring point. The description shall include, but shall not be limited to, geographic coordinates determined with a Global Positioning System receiver ***with the reference datum used by the receiver reported***.

73.155: Periodic Directional Antenna Recertification

The AFCCE supports the proposed Section 73.155 of the Rules. We suggest the following clarifications:

(a) Measurements shall be made to verify the continuing integrity of the antenna monitor sampling system.

(1) For towers using base current or base voltage sampling derived at the output of the antenna coupling and matching equipment, the sampling devices shall be disconnected and calibrated by measuring their outputs with a common reference signal (a current through them or a voltage across them, as appropriate) and the calibration must agree with the manufacturer's specifications.

(c) The results of the periodic directional antenna performance recertification measurements shall be retained in the station's public inspection file ***and shall be filed as an exhibit with Form 302-AM reporting any changes to the system***.

SAMPLE SYSTEM DOCUMENTATION AND REPORTING

The following comments are offered to explain the detail required to allow restoration or reconstruction of a sample system used for directional antenna performance verification to prove proper adjustment of a directional antenna placed into service under the method of moments modeling method. It must be kept in mind that the sample system is the **only** method of verifying proper adjustment of an array since no field measurements are recorded to substantiate the performance. As such, details of the sample system construction must be readily available to the Commission Staff and engineers and technicians

responsible for maintenance of the directive array. For this reason, The AFCCE believes that the data relevant to construction of the system should be filed as part of FCC Form 302-AM.

It is well established by the number of fines related to items missing from "Public Files" that information frequently disappears from such files. Formal filing of a form which is part of Form 302-AM will assure future availability of information critical to verification of directional antenna performance in the manner of the present practice related to Directional Antenna Proof(s) of Performance. The addition to Form 302-AM merely formalizes reporting of measured data normally acquired during the adjustment process of a directive array and is much less burdensome to the licensee and the Commission Staff than the volume of data required to document a full proof of performance as presently required.

To that end, it is suggested that a section be added to FCC Form 302-AM which thoroughly and accurately documents the original sampling system in sufficient detail that any part of the system may be replaced as needed in the future and the original adjustment be restored by reference to the antenna monitor parameters. Sufficient measurements of the system

elements shall be made and properly documented at the time of the original adjustment. This will assure that the system as constructed can be restored to the original condition at any time in the future should a sampling element, an isolation coil, if one is used, or a section of transmission line is damaged or destroyed.

SAMPLE SYSTEM CONSTRUCTION DETAILS

It is well understood that the Commission Staff does not normally become involved in construction details of Broadcast facilities. The AFCCE does not advocate such involvement. It does suggest, however, that certain details of the sample system be reported on Form 302-AM for information purposes only to preserve the original construction details of the sample system to facilitate future repair and maintenance of the system. The supplied details should be in the form of an exhibit attached to the Form 302-AM filing and need not be appended to the resulting license if the Commission does not deem it necessary. It should be retained in the station files for future reference.

Such details as the connector type on a sample line, length and type of a tower mounted sample line or loop on a tower are critical to proper maintenance of the system. Having this information readily available on an FCC form, either on line or

retrievable from the Commission's files, is invaluable when the files maintained at the radio station get lost as they frequently do in this "modern age" of broadcasting. The effort to compile and file the data as part of Form 302-AM is much less burdensome than preparation of the full proof of performance currently required.

It is suggested that flexible jumpers be accommodated at the monitor and at the sampling transformers if they are used. The use of solid outer conductor cables, particularly one half inch cables, places unnecessary stress on the monitor connectors which can be exacerbated by a technician poking around in a rack. This cable should be flexible and of the double shielded variety such as RG-142/U, RG-223/U or similar cables. These cables will satisfy the original intent of solid outer conductor cable without the problems related to cable rigidity resulting from such cables. A reasonable limit should be placed on the length of the cables. A length of ten feet is suggested for monitor cables and three feet for sample transformer cables.

LOCATION OF SAMPLING ELEMENTS FOR MULTIPLEXED ARRAYS

When a directional array also supports operation of one or more additional stations through multiplexing, the sample system elements shall be located on the output side (tower side)

following all filters in the desired signal path, if current or voltage sampling is used.

The loop placement on the tower should be determined for each frequency using the computer modeling techniques described in Section 73.151(a)(2)(i). Where the difference in the determined loop placement heights is small, a single loop may be used, provided that at the selected loop location there is no material change in the model derived relative ratio and phase of the current from that determined at the ideal loop placement height. Otherwise multiple sample loops must be used.

In the case of multiplexed operation, the monitors shall be equipped with filters having sufficient rejection at the other frequencies, if necessary, to permit stable operation of the antenna monitor in the presence of normally modulated carriers at the other frequencies. The filters, if used, shall be designed so that they provide accurate ratio and phase indications at the operating frequencies.

MEASUREMENTS REQUIRED

It is recognized that certain electrical measurements of sample lines and devices will be required to establish cable electrical lengths and impedance. The open circuit and all measurements made with the system terminated in the sample

devices shall be made with all connectors in place with the distant end of the cable disconnected or terminated in the sample device as appropriate. This will assure consistent results which are easily repeatable at any time.

These measurements shall be reported on FCC Form 302-AM under the paragraph titled "SAMPLE SYSTEM DATA".

PLACEMENT OF SAMPLE LOOPS ON TOWERS

The sample loop shall be located at the location on the tower where the field in the tower would be at minimum when the tower is properly detuned. The height above ground level of the bottom of the loop and bearing of the plane of the loop, referenced to true north, along with the physical height and width of the loop and the distance of the grounded side of the loop from the tower shall be reported in the Sample System paragraph of FCC Form 302-AM. The bottom of the loop (connector end) shall be electrically bonded to the tower through a metal or plating compatible with a galvanized surface.

A suggested addition to Form 302-AM is attached for consideration.

RECERTIFICATION OF SAMPLE SYSTEMS

The AFCCE fully supports a requirement for recertification of sampling systems used in conjunction with arrays initially

certified by method of moments modeling at two year intervals. The recertification measurements should be performed by a competent engineer, using properly calibrated equipment in accordance with the proposed Rule 73.155

CONSTRUCTION NEAR AM DIRECTIONAL ARRAYS, PART 17

The Coalition also proposed a new rule under Part 17 that would harmonize the disparate treatment afforded under Section 22.371, Section 27.63, and Section 73.1692 with respect to disturbances caused to AM stations as a consequence of construction near or installation on an AM broadcast antenna system or tower.

The AFCCE offers the attached information showing the effects on a typical four element directive array caused by parasitic radiators located in the major lobe of the array. The relative effects of heights of 36°, 45°, 60° and 90° re-radiators are shown for spacings from 0.25 to 10 wavelengths. All information was developed from NEC-4 models. See Appendix "A", attached.

The AFCCE believes that this proposal will reduce confusion among affected FCC licensees with respect to the proper procedures for the protection of AM broadcast stations whose antenna patterns can be adversely affected by the proximity of

new towers or antenna. In addition, the proposed procedures will substantially reduce the time required to determine the impact on the affected AM station and the expense associated with that analysis.

CONCLUSIONS

For the reasons set forth herein, The AFCCE respectfully requests that the Commission authorize the use of moment method computer modeling to verify the performance of AM directional antennas and to evaluate the potential effects of nearby re-radiators on AM patterns. We support adoption of the proposed new and modified rules proposed by the Coalition.

Respectfully submitted,

Ross J. Heide

Ross J. Heide, P.E.
President

July 23, 2007

(-) SAMPLE SYSTEM DESCRIPTION

FACILITY ID: _____ CALL: _____ FREQ: _____ LOCATION: _____

(A) SAMPLE TYPE:

☐ CURRENT TRANSFORMER MFR: _____ TYPE: _____ SENSITIVITY: _____ V/A

☐ VOLTAGE SAMPLE MFR: _____ TYPE: _____ SENSITIVITY: _____ V/V

☐ SIDE MOUNTED LOOP MFR: _____ TYPE: _____ LENGTH: _____ INCHES WIDTH: _____ INCHES TWR OFFSET, INCHES: _____

ELEVATION, MTRS AGL: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

BEARING (DEG TRUE): TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

(B) TRANSMISSION LINES:

MONITOR JUMPER CABLE (IF USED):
MFR: _____ TYPE: _____ LENGTH: _____ INCHES MON CONN; MFR: _____ TYPE: _____ LINE CONN; MFR: _____ TYPE: _____

SAMPLE LINE, ACU TO MONITOR LOCATION:
MFR: _____ TYPE: _____ LENGTH: _____ METERS

MON CONN; MFR: _____ TYPE: _____ ACU CONN; MFR: _____ TYPE: _____

1/4 WAVE RES FREQ, kHz: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

ACU JUMPER CABLE (IF USED):
MFR: _____ TYPE: _____ LENGTH: _____ INCHES

MON CONN; MFR: _____ TYPE: _____ LINE CONN; MFR: _____ TYPE: _____

SAMPLE LINE, TOWER RUN:
MFR: _____ TYPE: _____ LENGTH: _____ METERS

ACU CONN; MFR: _____ TYPE: _____ LOOP CONN; MFR: _____ TYPE: _____

1/4 WAVE RES FREQ, kHz: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

(C) ISOLATION INDUCTOR (IF USED):

MFR: _____ TYPE: _____ INDUCTANCE: _____ uHy TURNS: TOTAL: _____ TAPPED AT: _____ ☐ OPEN ☐ SHORTED

DIA: _____ INCHES LENGTH: _____ INCHES RESONATING CAPACITOR, (IF USED): VALUE: _____ pFd TYPE: _____ VOLTAGE: _____ kV

LINE MFR: _____ TYPE: _____ LENGTH: _____ INCHES

LINE CONN-1; MFR: _____ TYPE: _____ LINE CONN-2; MFR: _____ TYPE: _____

1/4 WAVE RES FREQ, kHz: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

(D) SYSTEM MEASUREMENTS, MONITOR CONNECTOR TO SAMPLE DEVICE

1/4 WAVE RES FREQ, kHz: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

ELECT LENGTH, DEGREES: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

DIFFERENTIAL DEGREES: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

MEASURED SYSTEM O/C RESISTANCE
AT - 1/8 LAMDA, OHMS: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

MEASURED SYSTEM O/C REACTANCE
AT -1/8 LAMDA, OHMS: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

MEASURED SYSTEM O/C RESISTANCE
AT + 1/8 LAMDA, OHMS: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

MEASURED SYSTEM O/C REACTANCE
AT +1/8 LAMDA, OHMS: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

MEASURED SYSTEM
IMPEDANCE, OHMS: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

MEASURED SYSTEM RESISTANCE
AT CXR FREQ, OHMS: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

MEASURED SYSTEM REACTANCE
AT CXR FREQ, OHMS: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

(E) OBSERVED ANTENNA MONITOR PARAMETERS

RATIO: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

PHASE: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

SAMPLE DEVICE SERIAL NO: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

F) MONITOR SYSTEM CALIBRATION, NON-DIRECTIONAL:

RATIO: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

PHASE: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

NON-DIRECTIONAL TWR: TWR-1: _____ TWR-2: _____ TWR-3: _____ TWR-4: _____ TWR-5: _____ TWR-6: _____

(G) ANTENNA MONITOR INFORMATION

MANUFACTURER: _____ TYPE: _____ SERIAL NO: _____ CAL DATE: _____

APPENDIX A

The Coalition proposes that new Rules be included under Part 17 with regard to disturbances caused to AM stations from construction of nearby towers and support structures by other Commission licensees. The proposed new Rules are intended to replace the current Rules contained in Sections 22.371, Section 27.63 and Section 73.1692.

The new rules proposed by the Coalition establish structure height thresholds under which a proponent of a new tower would have to take no action with respect to a nearby AM non-directional or directional antenna system. Further, the proposed new Rules modify the area of potential impact surrounding an AM station by defining the distance from the station in terms of wavelengths at the station’s carrier frequency. These proposed Rule changes are expected to materially reduce the burden on other Commission licensees and reduce the burden on Commission staff while continuing to provide adequate protection to existing AM directional and non-directional antenna licensees.

The AFCCE has examined the new proposed height threshold of 60 electrical degrees with respect to non-directional AM stations and 45 electrical degrees with respect to directional

AM stations and believes that these height thresholds are adequate to protect the vast majority of AM stations. In this Appendix, the AFCCE presents several examples of modeling results (NEC-4) that support the Coalition's proposed height threshold criteria.

The polar plots of Figures 1 through 3 are examples of the predicted impact on the far field pattern of a proposed monopole located in the main radiation lobe on a typical AM directional antenna pattern. In each case, a four-tower in-line pattern was chosen. The standard pattern minimum null depth radiation for the selected test pattern is approximately 26 dB below the main lobe radiation. Each of the polar plots represents an expanded view of the resulting perturbed far field patterns showing the null and minor lobe structure of the patterns.

The polar plots of Figure 1 show the predicted impact of a monopole tower added to the four-tower array model, having a height of 60 electrical degrees, the height threshold selected for the non-directional case. The predicted impact on the directional pattern is shown for monopole locations ranging from 0.25 wavelengths to 2 wavelengths from the end tower of the array. Based on this example, a 60 degree grounded monopole located in close proximity to a typical AM directional pattern

could result in substantial distortion of the directional pattern particularly in the null regions of the pattern.

The polar plots of Figure 2 were developed in a similar manner to those of Figure 1 with the exception that the monopole height in each case is reduced to 45 electrical degrees, the height threshold proposed by the Coalition with respect to directional antenna arrays. In this figure, the predicted pattern distortion can be seen to be significantly less than observed for the case of a 60 degree monopole height. Although pattern distortion is predicted to be present, it is believed that the magnitude of this distortion would result in no material adverse impact to the vast majority of directional stations.

The polar plots of Figure 3 were developed in the same manner as those of Figures 1 and 2 with the exception that the monopole height in each case has been reduced to 36 electrical degrees. For a 36 degree monopole height, the predicted pattern distortion at all distances studied is discernable but not considered to result in any material impact. Based on the test cases studied, it is concluded that the Coalition selected height threshold of 45 degrees would protect the vast majority of AM directional stations while accomplishing the goal of

reducing burden on Commission staff and other FCC licensees.

The Coalition proposes that should a proposed tower exceed the height threshold criteria discussed above, further study or potential mitigation would only be required by the proponent if the construction would be within 1 wavelength of an AM non-directional tower or no greater than the lesser of 10 wavelengths or 3.0 kilometers from the nearest element of a directional antenna array.

To evaluate the distance threshold proposed for the non-directional case, computer modeling was performed using the NEC-4 computer code. The model consisted of a 90 degree omni-directional antenna and a grounded 90 degree monopole separated by one wavelength. The 90 degree monopole is near the worst case scatterer for a grounded structure. The resulting pattern distortion for this case is approximately 2 dB which corresponds to the Coalition’s proposed level of distortion deemed to have no adverse impact on an omni-directional pattern. Therefore, it follows that if the proposed 2 dB criterion is adopted then the one wavelength distance criterion would be a consistent choice.

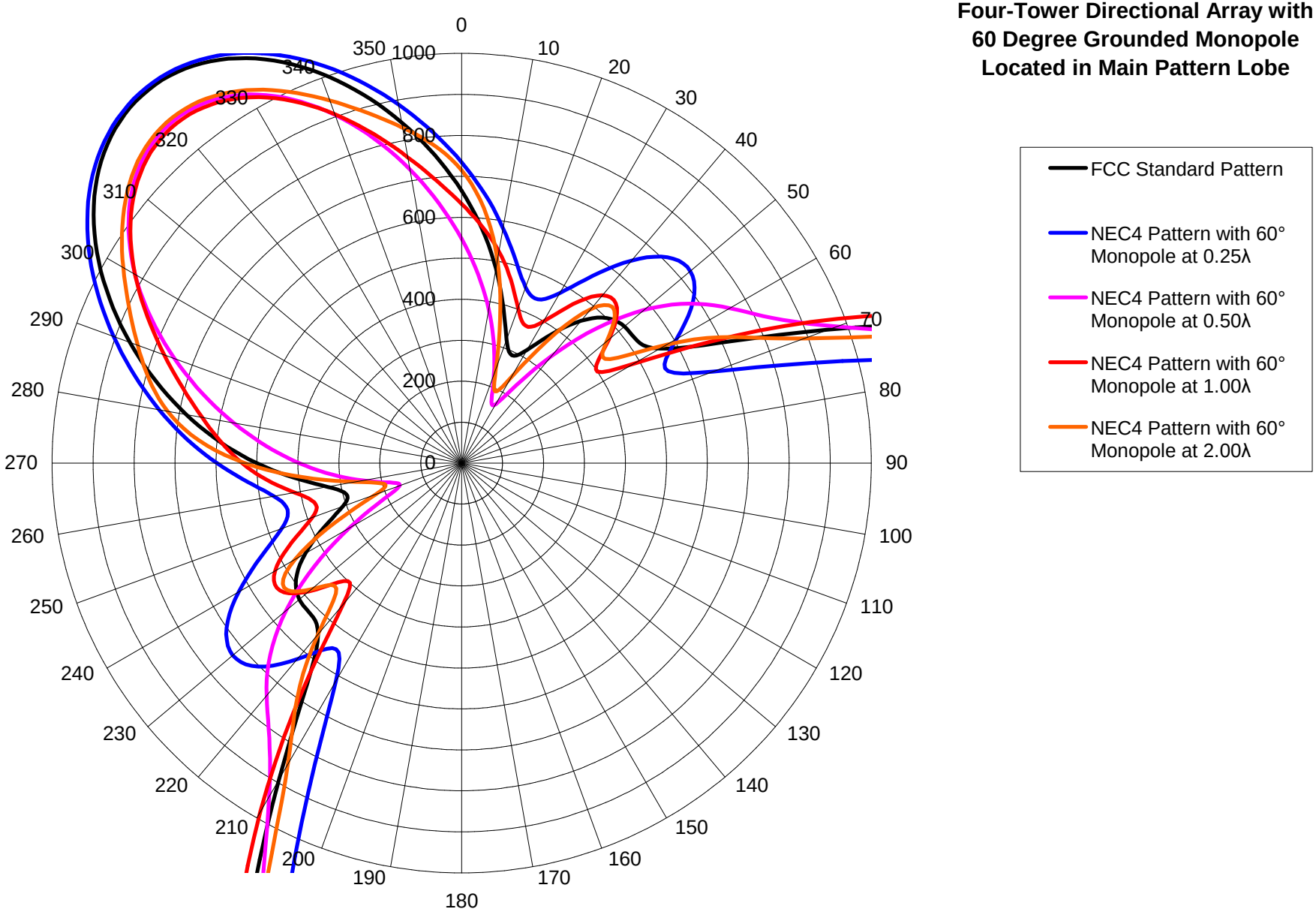
The polar plots of Figures 4 and 5 demonstrate the predicted impact of a 90 degree grounded monopole on a typical directional pattern for separation distances between the

monopole and the closest element of the array of 5 wavelengths and 10 wavelengths, respectively. In each case the monopole is placed in the main lobe of the directional pattern to simulate a worst case scenario.

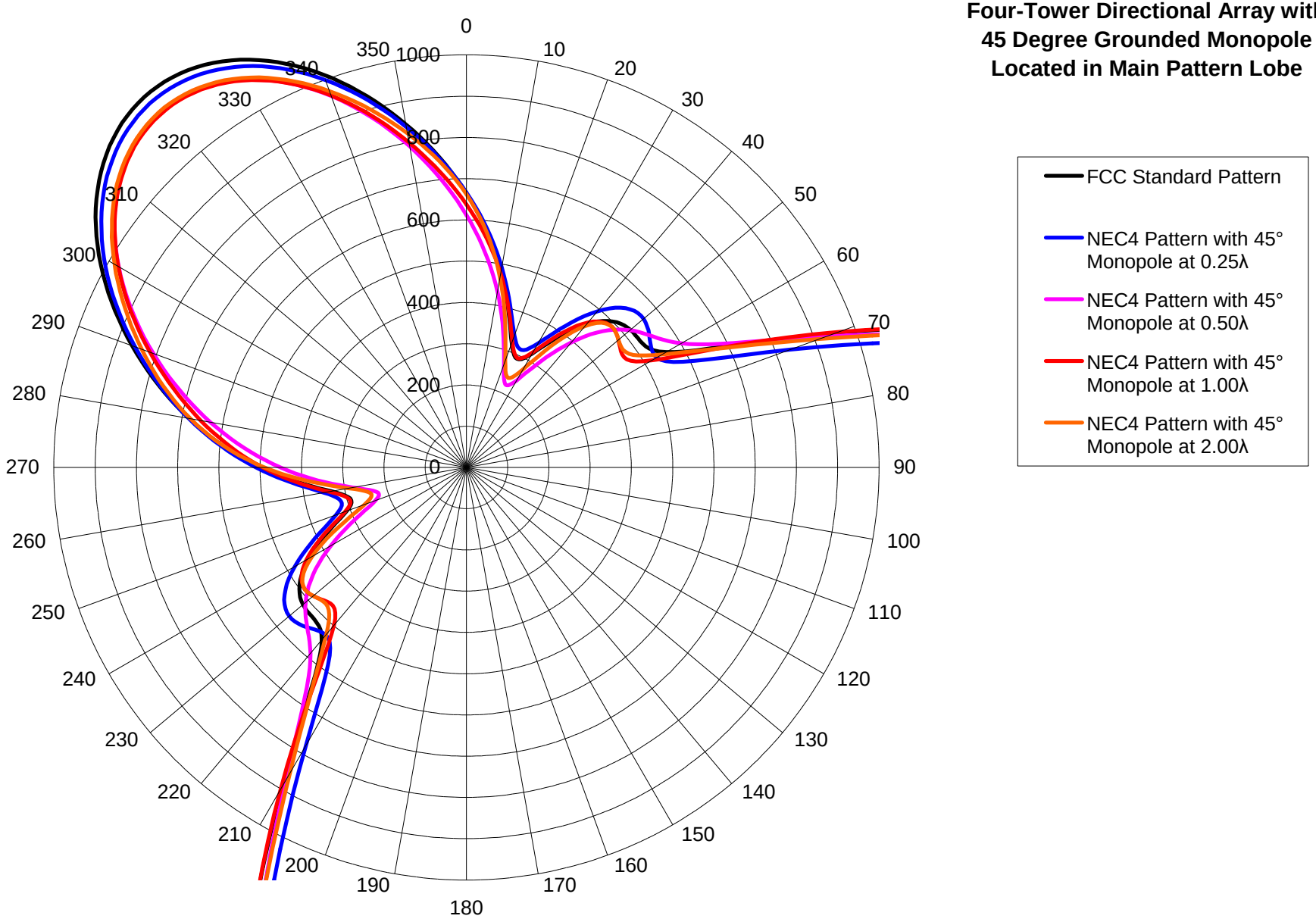
The polar plots of Figure 4 indicate that material adverse impact may result from construction of a 90 degree monopole at a separation distance of 5 wavelengths from the closest element of an AM directional array.

The predicted pattern distortion for a 10 wavelength separation distance is shown in Figure 5. In this case, there is a significant reduction in the resulting predicted pattern distortion when compared to the polar plot of Figure 4. However, even in the case of a 10 wavelength separation distance, radiation levels are predicted to exceed the standard pattern. It is believed that at this separation distance, path attenuation (not considered in the model) will play a role in mitigating, to a large degree, the adverse impact so that the vast majority of AM directional stations would not be adversely impacted by construction of monopole antennas at distances greater than 10 wavelengths from the nearest element of a directional antenna array.

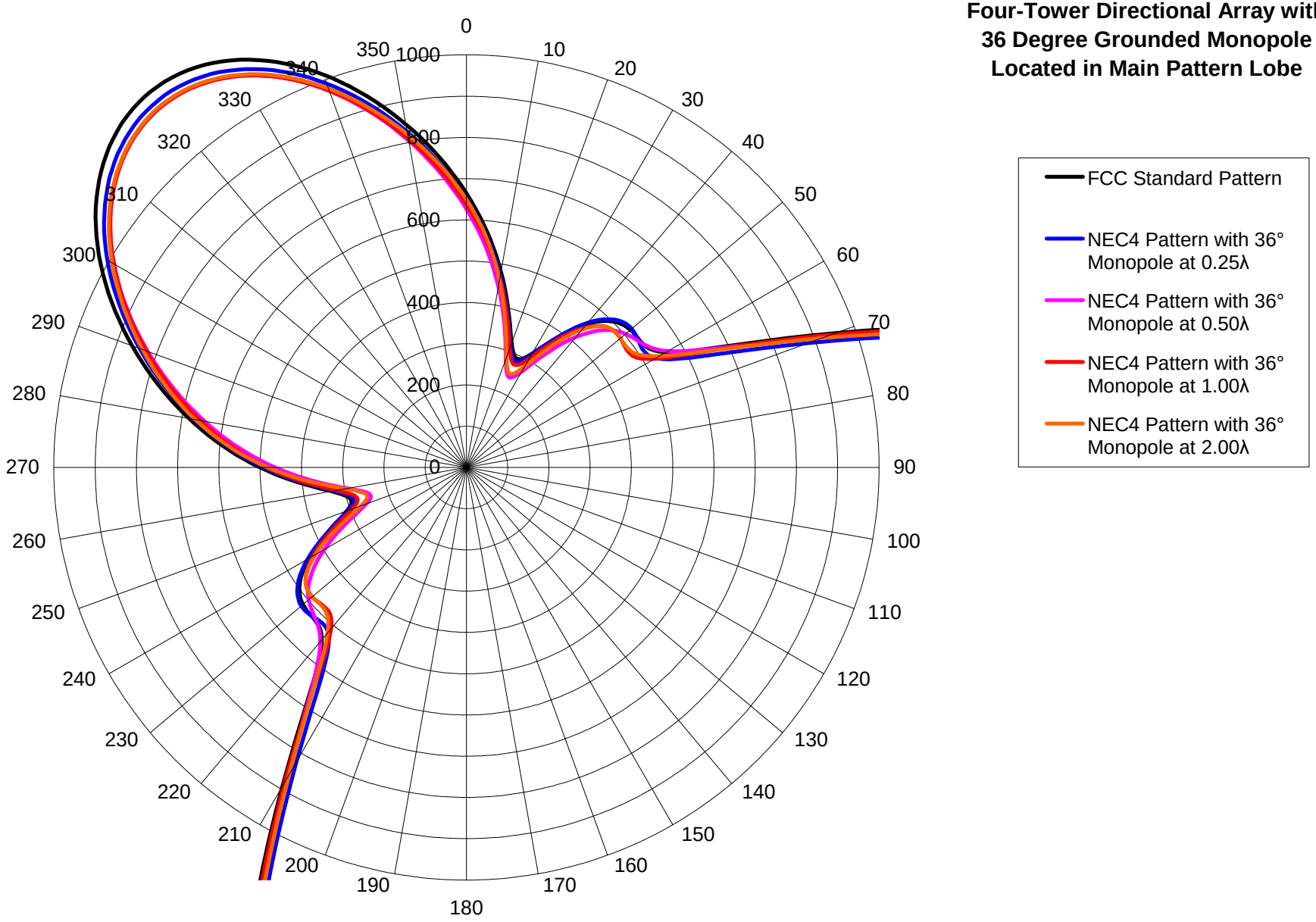
Four-Tower Directional Array with 60 Degree Grounded Monopole Located in Main Pattern Lobe



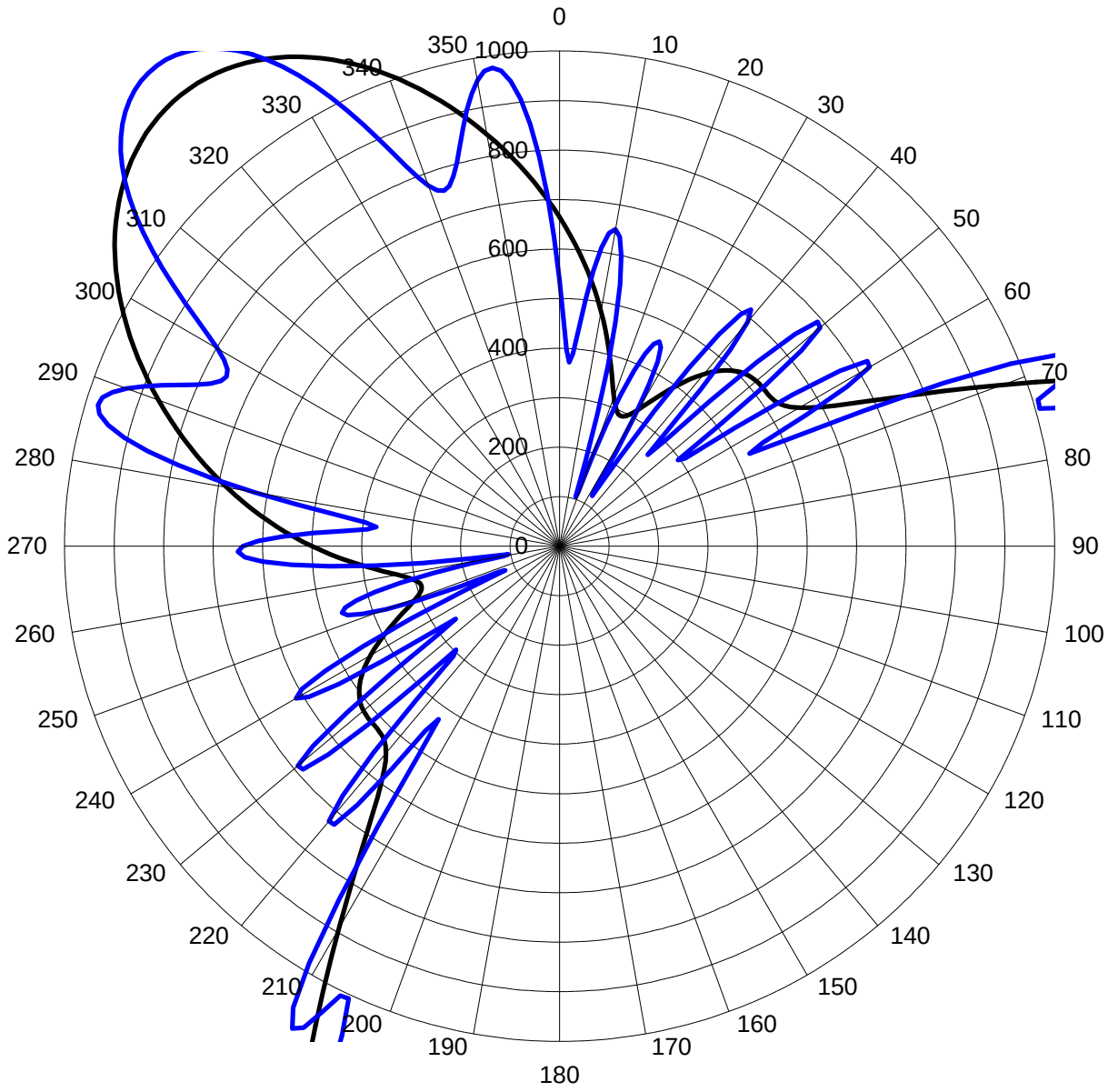
Four-Tower Directional Array with 45 Degree Grounded Monopole Located in Main Pattern Lobe



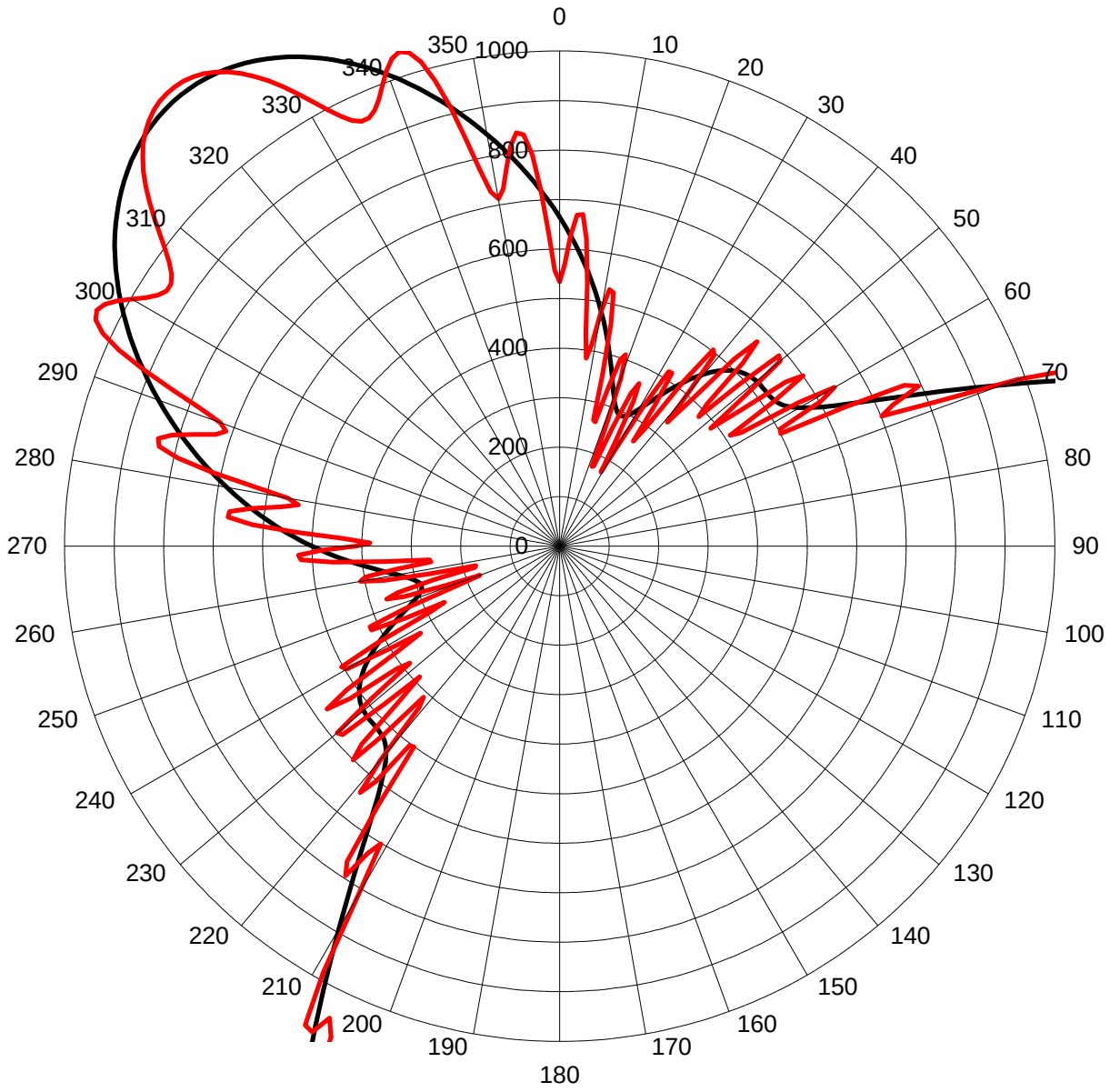
Four-Tower Directional Array with 36 Degree Grounded Monopole Located in Main Pattern Lobe



Four-Tower Directional Array with 90 Degree Grounded Monopole Located in Main Pattern Lobe at a Distance of Five Wavelengths



Four-Tower Directional Array with 90 Degree Grounded Monopole Located in Main Pattern Lobe at a Distance of Ten Wavelengths



FCC Standard Pattern

NEC4 Pattern with 90° Monopole at 10.00λ