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How to Use the New FCC AM Proximity Rules

A telecommunications antenna structure placed near an AM station antenna may produce re-radiation that triggers an FCC requirement to mitigate predicted distortion of the AM station signal pattern.

By Ben Dawson, P.E.

FCC policies on protection of AM antenna system operation have been confusing and not entirely consistent over the past several decades, but new rules adopted in August 2013 and now in effect provide comprehensive policies and procedures for evaluating the effect a new telecommunications facility antenna support structure may have on any nearby AM antenna system.

The history of the FCC's concern about the presence of nearby communications antenna towers on the operation of AM antenna systems dates back at least to the 1960s. More generally, it's based on the "last in" responsibility for the licensee of a new facility to protect pre-existing ones from interference, which itself dates back to the 1940s.

But the FCC's policies and rules about this have never been clear or even completely consistent — until now.

On Aug. 14, 2013, in the Third Report and Order and Second Order on Reconsideration in MM Docket 93-177, the FCC adopted new rules that apply to all services licensed by the agency. The new rules have two parts: first, a threshold test to determine if a study of the possible effect of a new or modified facility is necessary, and second, a method for making that study.

The litmus test is also twofold: how far the structure is located from the AM antenna, and how tall it is (or how tall the modification is if it's an existing structure).

If the new structure is within one wavelength of a nondirectional antenna, and if it's taller than 1/6 of a wavelength, then it requires study. A wavelength has an inverse relationship to frequency. Because electromagnetic waves travel at the speed of light, 300,000,000 meters per second, and because AM station frequencies can be defined in megahertz (1 MHz = 1,000 kHz), the wavelength can be calculated very simply:

wavelength in meters = 300/f in MHz (or 300,000/ f in kHz)

(It's really 299,792,456 but 300,000,000 is close enough for "government work," i.e., most engineering purposes.)

As an example, the wavelength of an AM station using 1430 kHz = 209.79 meters. And because 1 meter = 3.28 feet, the wavelength is 688.3 feet, and 1/6 wavelength or 60 degrees is 114.7 feet, and 1/10 wavelength or 36 degrees is 68.8 feet (see Figure 1).

For a directional AM antenna system, the litmus test is more complex. If the new structure is within the lesser of 10 wavelengths or 3 kilometers (9842.5 feet) of the reference coordinates of the AM antenna and is taller than 36 electrical degrees (1/10 wavelength), then it requires study (see Figure 2).

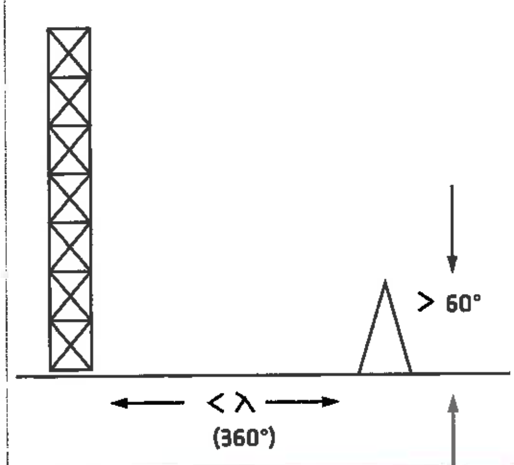

Figure 1. A threshold test for a nondirectional antenna

The FCC has a convenient website, which uses its accepted formulae for distance calculation: *www.fcc.gov/encyclopedia/distance-and-azimuths-between-two-sets-coordinates.*

But there are some things about use of this utility that need to be considered. First is the fact that broadcasting station geographic coordinates are referenced to the NAD-27 datum, while tower registrations and other FCC licenses use NAD-83 datum values. There's a convenient website for this conversion, too, from NOAA: *www.ngs.noaa.gov/cgi-bin/nadcon.prl.*

The FCC has also provided a utility to locate nearby AM antenna systems and to advise whether a proposed structure would fall within the restrictions of the new rule: *http://fcc.github.io/am-tower-locator.*

This utility is a bit difficult to use, however. It requires that you enter the coordinates of your proposed structure in decimal degrees. It does include a link to a conversion program from degrees/minutes/seconds for that purpose, but it uses the international standard, which calls for longitude as a negative number in the western hemisphere. That requirement isn't included in its instructions, so if you end up with a location somewhere in Asia, go back and make your longitude figure negative. It does the conversion of the AM antenna coordinates from NAD-27 to NAD-83 automatically, however.

Although most AM antenna towers are required to be registered, it's generally better to obtain the location of the AM antenna from the FCC's AM engineering database rather than the tower registration database, particularly because the AM database gives the array center coordinates that are called for in the new rules if the antenna is directional.

This URL will allow you to obtain those coordinates and other information necessary for the analysis: *www.fcc.gov/encyclopedia/am-query-broadcast-station-search.*

Entering the call letters of the AM station will extract its technical parameters from the FCC's Consolidated Database System database and will give the information you need for the next part of the process if your proposed new structure falls within the threshold tests for distance and height.

Performing an Analysis

The new rules call for an analysis of the re-radiation potential of the new or modified antenna structure using a technique called the method of moments. The method of moments is a mathematical technique that allows the computation of currents flowing in a wire conductor, such as an antenna tower. That in turn allows the calculation of the electromagnetic fields generated by an antenna or a re-radiating object because those fields are completely dependent upon the currents.

It's not necessary to be a math whiz to use this technique. There are a variety of computer programs that use the moment method technique, that have data entry that's straightforward and that produce equally straightforward results. The most commonly used program for AM antenna analysis — and the one that has been used by engineers analyzing possible re-radiation almost since its first publication — is MININEC. (See The Mininec System: Microcomputer Analysis of Wire Antennas by J.W. Rockway, J.C. Logan, D.W.S. Tam, and S.T. Li, published by Artech House in 1988.) There is a version of this program specifically configured for AM antenna problems, MININEC Broadcast Pro. (See Mininec Broadcast Professional for Windows by J.W. Rockway and J.C. Logan, published by EM Scientific in 1996.)

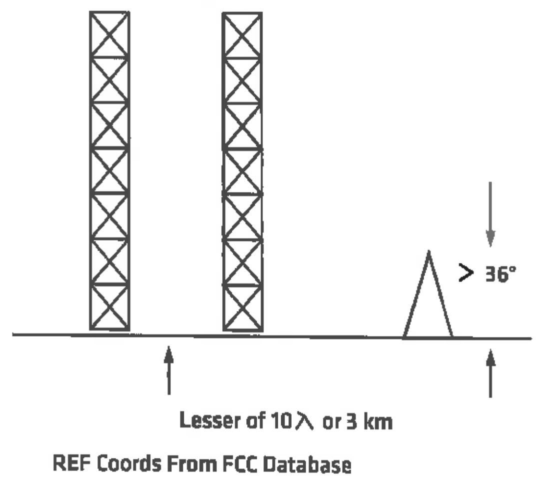

Figure 2. A threshold test for a directional antenna.

A variety of other programs can be used, such as versions of NEC, including some commercially available versions such as Ez-NEC and programs tailored for the antenna and EMC design market such as Wipl-D. Those choosing to use NEC (developed for the U.S. Navy and in the public domain) can benefit from a good textbook for its use for AM antenna problems, Basic NEC with Broadcast Applications by J. L. Smith, published by Elsevier/Focal Press in 2008.

The first step is to obtain the data on the horizontal plane radiation pattern

Tower Information:

Tower No.	Field Ratio	Phase (deg)	Spacing (deg)	Orientation (deg)	Electrical Height (deg)	Twr Ref.	-No (#0)	Top Loaded or Sectionalized Tower(s)-				Antenna Structure Registration Number
								A	B	C	D	
1	0.550	-118.00	120.00	270.00	196.00	0	0	0.00	0.00	0.00	0.00	1037777
2	1.000	0.00	35.00	285.00	196.00	0	0	0.00	0.00	0.00	0.00	1037776
3	0.610	60.00	120.00	90.00	196.00	0	0	0.00	0.00	0.00	0.00	1037778

Figure 3: FCC tower data for a directional antenna.

of the AM antenna. This can be done by copying the information from the FCC's website access to the CDBS database, as described previously.

The FCC's Radio Tools utility for AM data is available at *www.fcc.gov/encyclopedia/am-query-broadcast-station-search*. Simply enter the call letters in the call sign box and ask for detailed output, and it will return the data.

The data for a nondirectional antenna is simple. The database gives the tower height in degrees, the power and the inverse distance field at 1 kilometer, among other things.

The additional data for a directional station obtained from the FCC database shows the electrical and physical parameters of each of the towers in the antenna. An example is shown in Figure 3.

Figure 4 shows the field strength values computed from the antenna parameters. These field strength values represent the inverse distance field at each azimuth (in 5-degree intervals) for the basic theoretical pattern; the FCC's standard or "allocation rules" pattern, which is the theoretical pattern with some specific fudge factors, and, if applicable, the augmented pattern, which is a "tire-patch" for a case in which the measured pattern exceeded the standard pattern but no interference problems resulted. The data also shows the radiation values at pattern maxima and minima as well as at 5-degree intervals.

The theoretical pattern is calculated by a specific formula contained in the FCC rules. There are some simplifying assumptions in that formula, however, and as a result the pattern for an AM antenna calculated with the moment method will not be identical, and in some cases may be quite a bit different. However, our task is not to calculate an absolute value of signal strength, but instead to calculate the effect of the possible re-radiating antenna or tower.

What is needed, then, is a comparison. And this is made by making a moment method model of the AM antenna and the possible re-radiator and calculating the ratio between the results of the model with and without

Azimuth	E_{min}	Azimuth	E_{max}
74.2	183.6	126.2	409.6
147.1	228.1	222.0	4685.9
273.4	3968.9	317.3	4431.1

Azimuth	$E_{theoretical}$	$E_{standard}$	$E_{augmented}$
0.0	2364.54	2483.94	
5.0	2002.31	2103.80	2103.80
10.0	1665.67	1750.61	1750.61
15.0	1373.15	1443.82	1443.82
20.0	1138.19	1197.53	1197.53
25.0	964.68	1015.78	1015.78
30.0	843.69	889.15	889.15
35.0	756.10	797.56	797.56
40.0	681.13	719.23	965.61
45.0	604.01	638.78	831.72
50.0	518.36	549.59	750.45
55.0	424.77	452.48	632.37
60.0	328.90	353.66	553.01
65.0	240.89	264.17	470.37
70.0	177.48	201.35	504.74
75.0	159.62	184.13	1004.12

Azimuth	$E_{theoretical}$	$E_{standard}$	$E_{augmented}$
180.0	2335.75	2453.72	2453.72
185.0	2773.41	2913.08	2913.08
190.0	3185.26	3345.40	3345.40
195.0	3554.50	3733.00	3733.00
200.0	3867.78	4061.89	4061.89
205.0	4116.29	4322.78	4322.78
210.0	4296.11	4511.56	4511.56
215.0	4408.22	4629.26	4629.26
220.0	4457.90	4681.42	4681.42
225.0	4453.83	4677.15	4677.15
230.0	4406.97	4627.95	4627.95
235.0	4329.40	4546.51	4546.51
240.0	4233.25	4445.56	4445.56
245.0	4129.83	4336.99	4336.99
250.0	4029.03	4231.17	4231.17
255.0	3938.92	4136.57	4136.57

Figure 4. An example of field strength data from a directional antenna.

the re-radiator. Thus, the results of the moment method model calculation of field at each azimuth can be examined to determine the maximum and minimum values. For the non-directional case, when the ratio of the two values, with and without the re-radiator, is converted to dB and exceeds 2.0 dB, then the possible re-radiator should be arranged so that it can be detuned when constructed.

In the directional antenna situation, it's somewhat more complicated. The moment method model for the case without the re-radiator needs to be compared with that for the case with the re-radiator. Then, at each azimuth, the ratio of those two values with and without the re-radiator should be multiplied against the theoretical pattern data from the FCC database.

If at every azimuth (those at 5-degree intervals from zero to 355 degrees azimuth and at the azimuths of the pattern maxima and minima shown in the FCC database information) the result does not exceed the standard pattern or (if applicable) the augmented pattern values, the possible re-radiator need not be detuned. If at any azimuth it does exceed, then the possible re-radiator should be detuned when constructed.

All of the values for radiation from AM antennas in the FCC database are for the assumption of perfect conductivity and at a distance of 1 kilometer from the antenna, and the FCC calculation formula assumes that at that distance, the electric and magnetic fields are in their far-field relationship of 120π. In reality, that's fairly often not the case, and the moment method calculation, based as it is on assumptions much closer to the real physics of the situation, will show that. The moment method calculation, however, as with the FCC inverse distance field values, does assume perfect conductivity so that field strength values diminish as 1/R. As a consequence, the comparison calculation using the moment method can be done at a greater distance, say, 10 kilometers, where the E/H ratio will be related by 120π because the ratio of the pattern with and without the re-radiator, not absolute value, is the determining factor in the analysis. This is particularly helpful when the potential re-radiator — your new tower project — is located close to a 1-kilometer radius from the AM antenna, which is often the case.

Figure 5 is a spreadsheet showing the results of an analysis where a substantial re-radiating communications tower is located less than 1,000 feet from a three-element directional antenna. The results show that the re-radiation is significant enough to result in pattern distortion values that exceed the standard or augmented values in most directions. This communications tower clearly needs to be detuned.

Some additional parts of the new rule are helpful in some cases. If a new antenna is to be mounted on an AM tower, there are specific rules for the new measurements that are required on the AM antenna, and these are all consistent with the basic AM antenna technical rules and now are clearly codified. The new rules also establish thresholds for the study of nearby AM antenna patterns when new construction or significant modification is to take place on an existing structure, and for structures

	Mininec	Mininec with Reradiator	Ratio	FCC	FCC	FCC Theo	If Theo *Ratio > Std/Aug
AZ	mV/m km	mV/m km	C/B	Theo	Augmented	x ratio	Over
0	778.9125	944.1892	1.212189046	805.62	846.50	976.56	OVER
5	667.2182	829.1488	1.242695118	690.10	725.30	857.58	OVER
10	560.8904	663.9324	1.18371147	580.12	610.00	686.69	OVER
15	466.9833	470.3284	1.007163211	483.00	508.10	486.46	OK
20	394.0137	317.8866	0.806790728	407.52	429.10	328.78	OK
25	349.8442	314.7455	0.89967334	361.84	381.30	325.54	OK
30	336.3035	406.6837	1.209275848	347.84	384.60	420.63	OVER
35	345.5956	471.6280	1.364681726	357.45	376.70	487.81	OVER
40	365.0928	472.9260	1.295358331	377.61	397.80	489.14	OVER
45	384.2873	422.5852	1.099659552	397.46	418.60	437.07	OVER
50	397.0504	359.6979	0.905925041	410.67	432.40	372.04	OK
55	400.9386	331.2987	0.826307819	414.69	436.60	342.66	OK
60	396.1025	351.4679	0.887315531	409.68	431.40	363.52	OK
65	384.4722	390.8243	1.016521611	397.66	418.80	404.23	OK
70	369.1517	421.8231	1.142682263	381.81	402.20	436.29	OVER
75	353.8397	436.8627	1.234634497	365.97	385.60	451.84	OVER
80	342.1169	440.6614	1.288043356	353.85	372.90	455.77	OVER
85	336.5789	441.2723	1.311051584	348.12	366.90	456.40	OVER
90	338.0922	444.4691	1.314638729	349.69	368.60	459.72	OVER
95	345.6397	451.9190	1.307485801	357.49	376.70	467.41	OVER
100	356.8876	462.2916	1.295342287	369.13	388.90	478.15	OVER
105	369.0634	473.2478	1.282294045	381.72	402.10	489.48	OVER
110	379.6551	482.7287	1.271492731	392.67	413.50	499.28	OVER
115	386.7728	489.3340	1.265171698	400.04	421.20	506.12	OVER
120	389.2722	492.2458	1.264528523	402.62	424.00	509.12	OVER
125	386.7728	491.0790	1.26968339	400.04	421.20	507.92	OVER
130	379.6551	485.8266	1.279652506	392.67	413.50	502.48	OVER
135	369.0635	476.9380	1.292292519	381.72	402.10	493.29	OVER
140	356.8876	465.4976	1.304325508	369.13	388.90	481.47	OVER
145	345.6397	453.3166	1.311529318	357.49	376.70	468.86	OVER
150	338.0922	442.5101	1.308844451	349.69	368.60	457.69	OVER
155	336.5789	434.1294	1.289829517	348.12	366.90	449.02	OVER
160	342.1169	426.2519	1.245924712	353.85	372.90	440.87	OVER
165	353.8397	413.4215	1.168386419	365.97	385.60	427.59	OVER
170	369.1517	389.6660	1.055571463	381.81	402.20	403.03	OVER
175	384.4722	355.8283	0.925498124	397.66	418.80	368.03	OK

Figure 5. An evaluation of data.

located on existing buildings. These are shown in Figures 6 and 7.

The new rules set forth the timetables for notification to the AM station of the proposed construction. If a structure that passed the threshold tests is perceived to actually cause a re-radiation problem by an AM station, there is a procedure for the station to make an analysis showing the problem and to provide that showing to the tower proponent or owner and to the FCC for the latter's determination of appropriate action. There is also a provision for an AM station to provide a showing to the FCC that a tower constructed prior to the adoption of these new rules is adversely affecting its radiation pattern, for possible FCC action. The new rules also allow a traditional field measurement or partial proof of performance before and after construction of a new tower if the AM antenna in question was licensed with a traditional fieldstrength measurement proof of performance.

Conclusion

In addition to the adoption of analysis methods that are much more scientifically defensible than the field measurement requirements of the previous rules and case law-based policies, the new rules provide a far more straightforward and clear-cut set of requirements for antenna structure proponents to follow.

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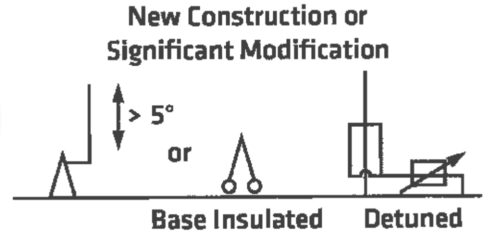

Figure 6. Existing structure changes requiring study

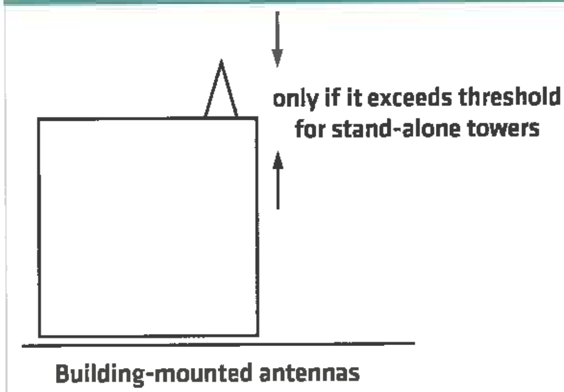

Figure 7. Construction on buildings requiring study