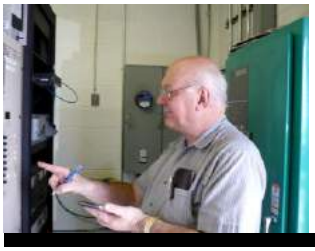

The
Broadcasters' Desktop Resource
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From the Transmitter Site

Understanding AM NRSC Measurements

By James Boyd

[January 2013] The FCC requires that AM stations perform their NRSC measurements each year. What do they mean? And how can this measurement be used to improve your station? James Boyd runs it down.

There are still some of us who remember those all-nighters at our AM stations doing the annual Equipment Performance Measurement (EPM), or what we lovingly called the "audio proof."

The EPM usually involved putting in a new set of modulator tubes – sometimes new finals too – and then turning knobs on the HP distortion analyzer to get the distortion null. At 50 Hertz, near 100% modulation the rig would occasional overload and drop off.

I think most of us rejoiced when the FCC did away with the EPM Rules. Unfortunately, the respite from the annual "proof" did not last very long. New Rules came along which made making the annual measurements more difficult for many station chief engineers.

THE ROAD FROM EPM TO NRSC

The increasingly poor audio response of AM receivers being manufactured triggered some of the change, and the rest was the result of a proliferation of AM stations and the need to minimize first adjacent channel interference at night.

In 1986 the National Radio Systems Committee (NRSC), a joint committee composed of representatives of AM stations, AM receiver manufacturers and broadcast equipment suppliers developed a set of standards employing preemphasis and setting an AM audio bandwidth limit of 10 kHz. Then, early in 1987, the NRSC authorized the Electronic Industries Association (EIA) and the National Association of Broadcasters to publish this set of standards, calling it **NRSC-1**. Compliance with these **NRSC-1** standards was – at that time – voluntary.

NRSC-2 came in June of 1988, when the NRSC released further refined standards, setting forth the emission limitations for AM broadcast stations. In April of 1989, the FCC officially adopted **NRSC-2** and subsequently published 73.44, the Rule we live by today.

Quoting section (e) of the Rule, the Commission allowed that *"Licensees of stations complying with the ANSI/EIA-549-1988, NRSC-1 AM Preemphasis/Deemphasis and Broadcast Transmissions Bandwidth Specifications (NRSC-1),*

prior to June 30, 1990 or from the original commencement of operation will, until June 30, 1994, be considered to comply with paragraphs (a) and (b) of this section, absent any reason for the Commission to believe otherwise. Such stations are waived from having to make the periodic measurements required in §73.1590(a)(6) until June 30, 1994."

Thus, on June 30, 1994, the now annual "NRSC Measurement" was born. It should be noted that the years leading up to NRSC-1, NRSC-2, and the adoption of 73.44, were lively. There was a great deal of controversy about AM transmission and its standards.

DECONSTRUCTING 73.44

Let us look at some of Rule Section 73.44 and its requirements. The first paragraph (a) says:

"The emissions of stations in the AM service shall be attenuated in accordance with the requirements specified in paragraph (b) of this section. Emissions shall be measured using properly operated and suitable swept-frequency RF spectrum analyzer using a peak hold duration of 10 minutes, no video filtering, and a 300 Hz resolution bandwidth, except that a wider resolution bandwidth may be employed above 11.5 kHz to detect transient emissions. Alternatively, other specialized receivers or monitors with appropriate characteristics may be used to determine compliance with the provisions of this section, provided that any disputes over measurement accuracy are resolved in favor of measurements obtained by using a calibrated spectrum analyzer adjusted as set forth above."

It is pretty clear that you can use other measureing methods and equipment than a spectrum analyzer for determining compliance with 73.44. But disputes must be resolved by the use of a spectrum analyzer.

It is my opinion that the spectrum analyzer is the most accurate way to make compliance measurements.

Paragraph (a) details the technical "how to" for the spectrum analyzer setup. Paragraph (d) describes the "where," the location at which the measurements should be taken.

We know the antenna system affects the bandwidth of our AM signal and hence it can modify the emission limitation characteristics of our audio processing and our transmitter. That is why we head into the field to make our NRSC measurements.

SETTING UP FOR NRSC

Here is what paragraph (d) says:
"Measurements to determine compliance with this section for transmitter type acceptance are to be made using signals sampled at the output terminals of the transmitter when operating into an artificial antenna of substantially zero reactance. Measurements made of the emissions of an operating station are to be made at ground level approximately 1 kilometer from the center of the antenna system. When a directional antenna is used, the carrier frequency reference field strength to be used in order of preference shall be:

> *(1) The measured non-directional field strength.*
> *(2) The RMS field strength determined from the measured directional radiation pattern.*
> *(3) The calculated field strength that would be expected to radiated by a non-directional antenna at the station's authorized power.*

As a practical matter, the 1 kilometer distance from the center of the antenna system might be changed a bit by the engineer making these annual measurements.

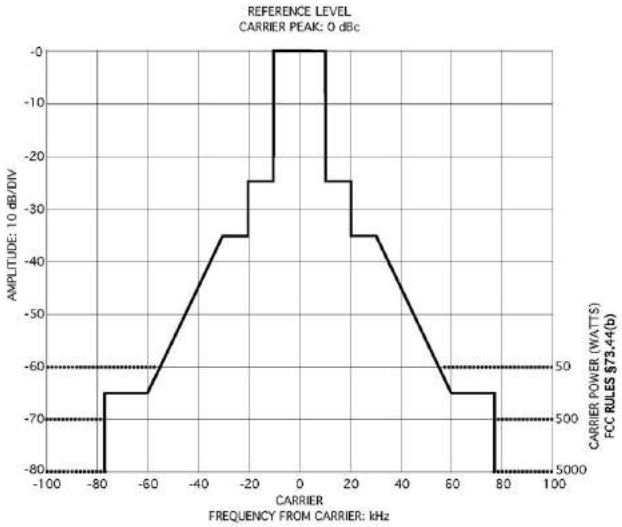
The exact location of the selected measurement point may depend on the power of the station, accessibility of the measurement location and other issues such as overhead power lines or other structures which could modify the field strength at the desired location.

THE NRSC RF MASK

Finally, we come to the heart of the Rule: the "RF Mask." This is the definition of the amplitude limits of the signals coming from the station in terms of frequency away from the carrier. Here is what the Rule says in paragraph (b):

(b) Emissions 10.2 kHz to 20 kHz removed from the carrier must be attenuated at least 25 dB below the unmodulated carrier level, emissions 20 kHz to 30 kHz removed from the carrier must be attenuated at least 35 dB below the unmodulated carrier level, emissions 30 kHz to 60 kHz removed from the carrier must be attenuated at least [5 + 1 dB/kHz] below the unmodulated carrier level, and emissions between 60 kHz and 75 kHz of the carrier frequency must be attenuated at least 65 dB below the unmodulated carrier level. Emissions removed by more than 75 kHz must be attenuated at least 43 + 10 Log (Power in Watts) or 80 dB below the unmodulated carrier level, whichever is the lesser attenuation, except for transmitters having power less than 158 Watts, where the attenuation must be at least 65 dB below carrier level.

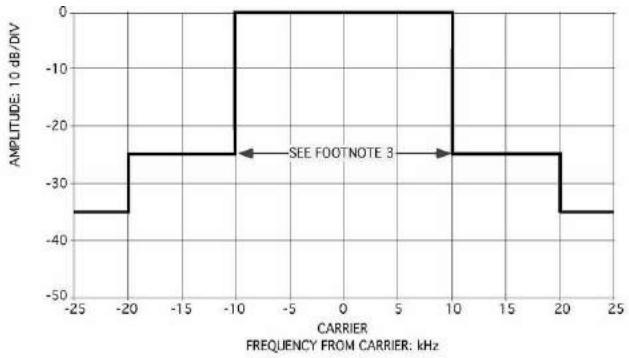
Here is what the NRSC RF Mask "looks like" in an amplitude versus frequency graph:



Analog AM Broadcast RF Emission Limits

(These graphs are courtesy of the NRSC as published in NRSC-2-A.)

Next, we will focus in on the area close to the on-channel carrier itself. This expanded scale will bring us to +/- 25 kHz from the carrier.



Analog AM Broadcast RF Emission Limits (Expanded Scale)

Overall, these limits are not very stringent. Some might draw the conclusion that with modern transmitters and processing, there is little need to worry about whether the station emissions are "in the "mask." But modern transmitters that are not running right can cause several problems.

WHY DO WE MEASURE EVERY YEAR?

Speaking of common problems, the most common problem is consistent overmodulation on negative peaks.

Of course 100% negative modulation is not lawful, but it happens. And when it does – when the carrier "pinches" off – a *lot* of splatter occurs above and below the normal sidebands. More often than not, such splatter rises above the mask.

For the most part today, our audio processors handle most of the work to keep RF emissions within the NRSC RF Mask. However, when things go wrong in a transmitter or antenna system, the emission picture can change radically. And this is one of the reasons the FCC requires these measure-ments to be made annually.

For example: when MOSFETs fail in the final amplifier stage of the transmitter, they can go

unnoticed for some time. The transmitter continues (in most cases) to make full or near full power, but the audio harmonic distortion can rise dramatically, producing splatter that rises above the mask. PDM modulated rigs can have symmetrical spurs at the PDM frequency above the mask if something is wrong with the PDM filters. And it happens more often than you may think.

THE INTERMOD FACTOR

Another challenge that crops up occasionally is intermodulation. If there is another AM station within a few miles of your facility you can be susceptible to intermodulation. Interestingly, modern solid state rigs exhibit the problem more than older tube rigs.

The most common form happens when the other station's signal manages to get back to your transmitter's final amplifier where it mixes with the second harmonic present in the PA stage. What comes out is two times your frequency minus the other transmitter's fundamental, or intermod.

For example if you are on 1240 kHz and there is a station on 1410 kHz located a few miles away, an unwanted intermod signal may appear on 1070 kHz. Another signal result from this kind of mix could be on 3980 kHz.

MAKING SURE ABOUT INTERMOD

A Potomac Instruments FIM-41 is commonly used to track down these problem mixes. You might hear such a mix on your car radio, but always double-check with the FIM. The reason is that car radios can – and do – generate these kinds of products on their own when in fact they may not actually be transmitted.

If the offending signal mix is less than 43 + 10 X Log of the station power in Watts or 80 dB (whichever attenuation is less) below the unmodulated carrier level, steps must be taken to suppress the product to this level or greater. This usually involves designing and installing a notch filter to remove the station before it gets to the transmitter.

THE ACTUAL NRSC MEASUREMENT

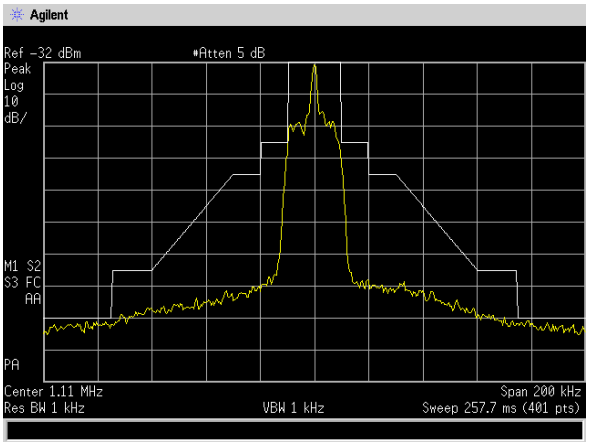
Let us conclude our discussion with a brief "how to" make the NRSC measurements. Even if you do not do this yourself, it will help you to understand the report and what it means.

First, the station pattern is checked; if the station is a directional the shape of the pattern is checked (this data usually shows up on the FCC AM Query database). A site is chosen *in the main lobe* of the station at *a distance of about 1 kilometer* from the antenna site. The location chosen should be away from power lines.

Next the NRSC test antenna is setup and pointed toward the station. For the best accuracy, reducing radiation from adjacent stations, it is desirable to use a shielded loop antenna.

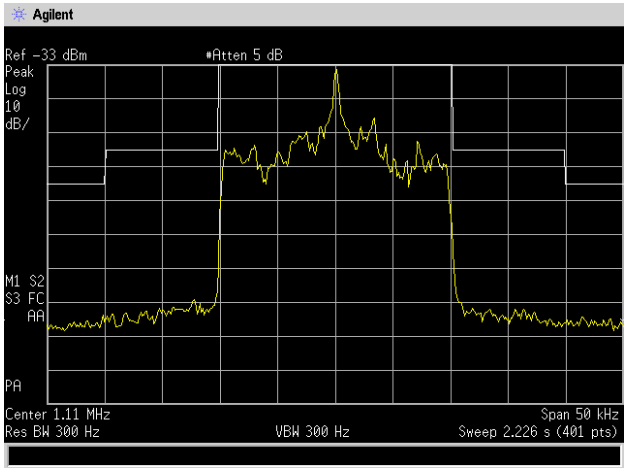
After the spectrum analyzer has been turned on and stabilized, a *measurement with a frequency span of 200 kHz and a resolution bandwidth of 1 or 3 kHz* or is made. The instrument is set for peak hold, so that the highest peaks in the measured band during the test period can be easily seen. After *collecting the data for 10 minutes*, the display is checked to see if it is in the mask. If the station is in the mask, the data is saved for importing into a written report later.

As an example, here is one such display.



LOOKING MORE CLOSELY

Next, the *span is reduced to 50 kHz* and the *resolution bandwidth is set to 300 Hertz*. Again, with the peak hold feature on, *the data is collected for ten minutes* and then saved for the report. As noted earlier, these two plots are detailed in paragraph (a) of the FCC Rule.



If the station has more than one mode of operation, for example non-directional daytime and directional at night, measurements are made for the other modes of operation. In some cases, such as when there is a directional pattern day and night but different parameters, it may be necessary to find another measurement location for the other mode of operation.

BEYOND THE SPECTRUM ANALYZER

I use a Potomac Instruments FIM-41 to look at the spectrum from 540 kHz to 5.0 MHz and checking signals to see if they are related, either harmonically or by intermodulation, to the station being measured.

Any signal discovered which is related is carefully measured with the FIM and compared to the FIM reading of the station fundamental frequency. During such measurements, it is important to have the FIM aligned toward the station antenna array. Occasionally, harmonics may be generated by nearby power lines or other re-radiating sources.

In a nutshell, this is the process for these annual measurements – required annually by definition in FCC Rule 73.1590. While it can be some rather dry reading, Section 73.1590 and Section 73.44 are printed below for your reference. They are good things to know to stay in compliance with the Rules and to avoid heavy fines.

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boyd.broadcast@comcast.net

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Do you need to have your NRSC done for this year? Remember, it must be within 14 months of your last measurement (Section 73.1590 (a)(6)).

You can locate and contact some well-qualified NRSC services by clicking here.

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Reference information:

§73.1590 Equipment performance measurements.

(a) The licensee of each AM, FM, TV and Class A TV station, except licensees of Class D non-commercial educational FM stations authorized to operate with 10 watts or less output power, must make equipment performance measurements for each main transmitter as follows:

(1) Upon initial installation of a new or replacement main transmitter.

(2) Upon modification of an existing transmitter made under the provisions of §73.1690, Modification of transmission systems, and specified therein.

(3) Installation of AM stereophonic transmission equipment pursuant to §73.128.

(4) Installation of FM subcarrier or stereophonic transmission equipment pursuant to §§73.295, 73.297, 73.593 or 73.597.

(5) Installation of TV stereophonic or subcarrier transmission equipment pursuant to §§73.669 and 73.1690.

(6) Annually, for AM stations, with not more than 14 months between measurements.

(7) When required by other provisions of the rules or the station license.

(b) Measurements for spurious and harmonic emissions must be made to show compliance with the transmission system requirements of §73.44 for AM stations, §73.317 for FM stations and §73.687 for TV stations. Measurements must be made under all conditions of modulation expected to be encountered by the station whether transmitting monophonic or stereophonic programs or providing subsidiary communications services.

(c) TV visual equipment performance measurements must be made with the equipment adjusted for normal program operation at the transmitter antenna sampling port to yield the following information:

(1) Field strength or voltage of the lower sideband for a modulating frequency of 1.25 MHz or greater, (including 3.58 MHz for color), and of the upper sideband for a modulating frequency of 4.75 MHz or greater.

(2) Data showing that the waveform of the transmitted signal conforms to that specified by the standards for TV transmissions.

(3) Photographs of a test pattern taken from a receiver or monitor connected to the transmitter output.

(4) Data showing envelope delay characteristics of the radiated signal.

(5) Data showing the attenuation of spurious and harmonic radiation, if, after type acceptance, any changes have been made in the transmitter or associated equipment (filters, multiplexer, etc.) which could cause changes in its radiation products.

(d) The data required by paragraphs (b) and (c) of this section, together with a description of the equipment and procedure used in making the measurements, signed and dated by the qualified person(s) making the measurements, must be kept on file at the transmitter or remote control point for a period of 2 years, and on request must be made available during that time to duly authorized representatives of the FCC.

§73.44 Emission limitations.

(a) The emissions of stations in the AM service shall be attenuated in accordance with the requirements specified in paragraph (b) of this section. Emissions shall be measured using properly operated and suitable swept-frequency RF spectrum analyzer using a peak hold duration of 10 minutes, no video filtering, and a 300 Hz resolution bandwidth, except that a wider resolution bandwidth may be employed above 11.5 kHz to detect transient emissions. Alternatively, other specialized receivers or monitors with appropriate characteristics may be used to determine compliance with the provisions of this section, provided that any disputes over measurement accuracy are resolved in favor of measurements obtained by using a calibrated spectrum analyzer adjusted as set forth above.

(b) Emissions 10.2 kHz to 20 kHz removed from the carrier must be attenuated at least 25 dB below the unmodulated carrier level, emissions 20 kHz to 30 kHz removed from the carrier must be attenuated at least 35 dB below the unmodulated carrier level, emissions 30 kHz to 60 kHz removed from the carrier must be attenuated at least [5 + 1 dB/kHz] below the unmodulated carrier level, and emissions between 60 kHz and 75 kHz of the carrier frequency must be attenuated at least 65 dB below the unmodulated carrier level. Emissions removed by more than 75 kHz must be attenuated at least 43 + 10 Log (Power in watts) or 80 dB below the unmodulated carrier level, whichever is the lesser attenuation, except for transmitters having power less than 158 watts, where the attenuation must be at least 65 dB below carrier level.

(c) Should harmful interference be caused to the reception of other broadcast or nonbroadcast stations by out of band emissions, the licensee may be directed to achieve a greater degree of attenuation than specified in paragraphs (a) and (b) of this section.

(d) Measurements to determine compliance with this section for transmitter type acceptance are to be made using signals sampled at the output terminals of the transmitter when operating into an artificial antenna of substantially zero reactance. Measurements made of the emissions of an operating station are to be made at ground level approximately 1 kilometer from the center of the antenna system. When a directional antenna is used, the carrier frequency reference field strength to be used in order of preference shall be:

(1) The measured nondirectional field strength.

(2) The RMS field strength determined from the measured directional radiation pattern.

(3) The calculated expected field strength that would be radiated by a nondirectional antenna at the station authorized power.

(e) Licensees of stations complying with the ANSI/EIA-549-1988, NRSC-1 AM Preemphasis/Deemphasis and Broadcast Transmissions Bandwidth Specifications (NRSC-1), prior to June 30, 1990, or from the original commencement of operation will, until June 30, 1994, be considered to comply with paragraphs (a) and (b) of this section, absent any reason for the Commission to believe otherwise. Such stations are waived from having to make the periodic measurements required in §73.1590(a)(6) until June 30, 1994. However, licensees must make measurements to determine compliance with paragraphs (a) and (b) of this section upon receipt of an Official Notice of Violation or a Notice of Apparent Liability alleging noncompliance with those provisions, or upon specific request by the Commission.

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Broadcast Operations

How the NRSC Benefits Your Station

By Norm Laramee

[May 2024] Since 1994, the FCC requires AM stations to take a look at the effect of its transmissions on the broadcast spectrum every year. Some see this as a burden, but as Norm Laramee points out, the procedure has some real benefits that make it, in effect, cheap insurance.

The requirement for an annual NRSC measurement was placed in the Rules by the FCC on June 30, 1994.

FCC Rule 73.1590 states the requirement to make measurements, while FCC Rule 73.44 explains invery specific detail how the measurements must be performed.

Since then, each AM station must do an NRSC measurement each year, not more than 14 months apart. Many stations consider this an expensive burden, but there are some real benefits to complying with the requirement – not the least of which is avoiding a fine.

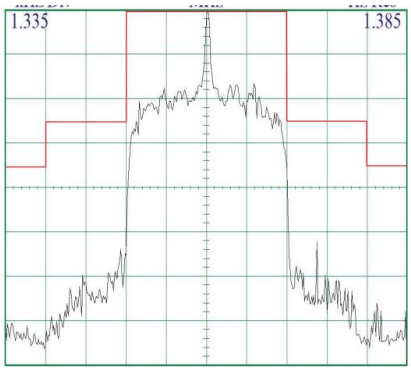
MULTIPLE ASPECTS OF NRSC

While one might focus solely on the measurement itself, by completing the regulatory compliance, stations can also gain important information on how well their RF system is working.

You might compare the NRSC measurement it to what happens when you take your vehicle in for its periodic service. Those inspection and maintenance fees are not insignificant, but you will get warnings about potential problems – or something that is already needing immediate attention.

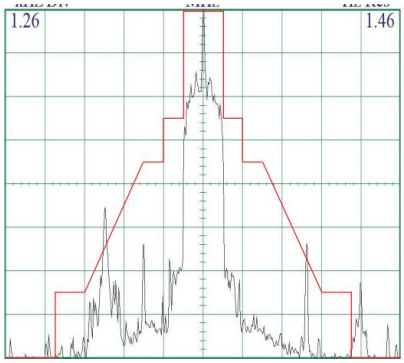
Similarly, your NSRC measurement may provide an early warning sign of pending component failure. It may also give you information regarding your program audio or potential interference from other stations that might limit your coverage.

For instance, a failing capacitor can cause one or many spurs, depending upon the slice of bandwidth you are measuring. Or, the test can show that you have no current problems.



A sample plot showing the NRSC mask

At the same time, as you look at the wider band, to show compliance with the emission limitations, it might look like there is a problem. An experienced engineer will note the location and size of the display, and do extra tests, if necessary to identify carriers from adjacent stations that might have impact.



A display showing several adjacent stations

As seen, there are a few stations whose carriers can be seen. Their levels, especially seen over several years, can identify potential interference issues.

Given the importance of this measurement, and a number of ways it might not be done properly by inexperienced persons, finding a competent engineer to do the measurement is essential. Let us see why.

THINGS THAT MIGHT MAKE YOUR NRSC LESS VALUABLE

As with any test measurement, the NRSC should be done with the right gear – and someone who knows how to use it!

For example, when the test is made can be critical. Although not stated specifically under the NRSC rules, just as if you were to make any AM RF field measurements for other purposes, particularly at a distance, you must be aware of the potential for skywave interference.

It is generally understood that as a rule of thumb, do not make measurements until two hours *after* sunrise and two hours *before* sunset. While sometimes you can fudge a little since atmospheric conditions can change from time to time, in my experience I have never been able to get much closer than one hour before and after and still get interference free readings.

WHAT ABOUT WEATHER?

Here is a variable that can greatly affect the measurement, but cannot always be predicted ahead of time.

Static discharge from electrical storms even hundreds of miles away will completely ruin any NRSC measurement in the field. This is particularly true when measuring the 200 kHz bandwidth measurement. Over the course of the 10 minutes that it takes to make the measurement, atmospheric noise can definitely raise the noise floor to the point of making the measurement useless.

Depending on the time of the year, traveling across the country to measure many stations at a time can turn into a game of whack-a-mole if you do not plan weeks ahead, weather-wise. Even then, flexibility on the part of the engineer and the station may be essential. Together, you should always check the weather and look for blue skies.

ANOTHER POINT WHERE EXPERIENCE CAN BE CRUCIAL

Where the test is made can be a real balance of distance and test integrity.

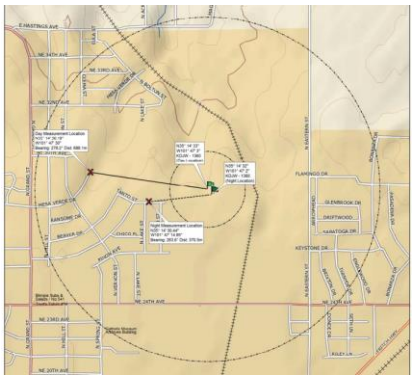
The FCC Rules clearly state, *"Measurements made of the emissions of an operating station are to be made at ground level approximately 1 kilometer from the center of the antenna system."*

In practice, I found early on that this is entirely impractical. The AM noise floor in the real world is much higher today than when the Rules were first implemented – and continue to increase incrementally every year. At least that has been by my personal continued observation.

For that reason, this is the only part of the NRSC Rules that I have not always been able to fully comply with and at the same time obtain bandwidth measurements that are meaningful. Instead, depending on the power level of a given station, I have to find a location clear of any electromagnetic generators or obstructions that is close enough to the antenna site to give me a useable S/N ratio to satisfy the rest of the NRSC measurement rules.

Such a location invariably ends up being much closer than the 1-kilometer point called for in the Rules.

To help illustrate this, you look at this graphic from an NRSC report. You will see the Site Location Map, which shows two circles centered around the geographic center of the antenna array.



Sometimes the 1-kilometer points may or may not be useful

The outer circle indicates where the 1-kilometer point is located and the inner circle shows the distance to the wavelength point. Sometimes it is prudent to use two separate points to ensure the results are valid. At the same time, you never want to get closer than one wavelength, as you will end up with a distorted and inaccurate measurement of the radiated signal.

All-in-all, if you add the variables of weather, long distances between measurement locations, *and* local sunrise/sunset times, now you can be talking whack-a-mole on steroids. Nevertheless, with experience

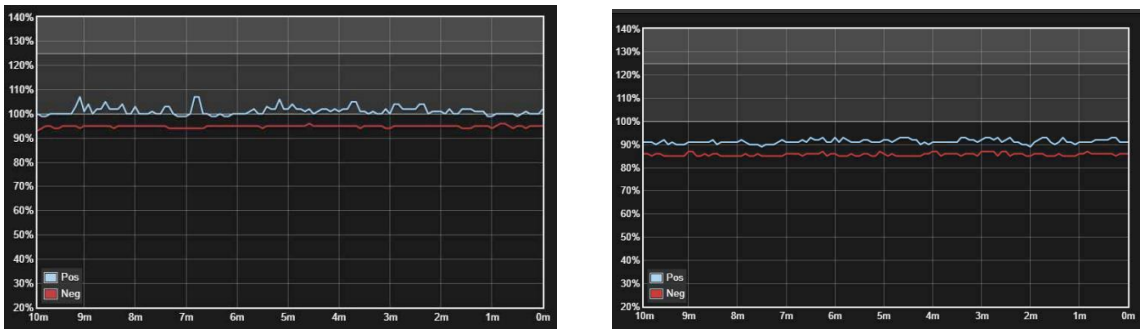
an accurate measurement can be made – one that will allow a station to really know how the RF system is operating.

SOMETHING ELSE TO CONSIDER

There is a service that I provide that you may not have seen before.

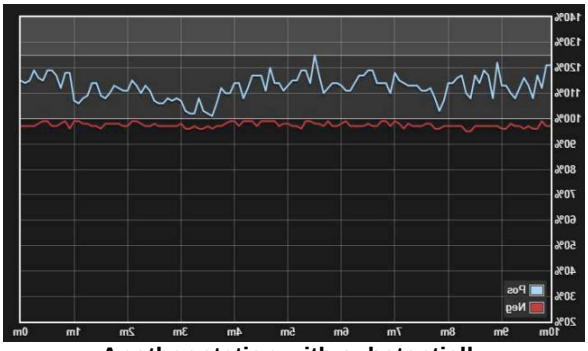
That is the 10-minute modulation snapshot. Although not required as part of the NRSC Rules, modulation limits are prescribed elsewhere in the FCC Rules. Regardless, I added this feature to my NRSC measurement reports because it was easy to do and could possibly provide some degree of education to station managers and newbie local engineers. It also provides me with a tool for additional insight when measuring a station. Oftentimes I am able to easily correlate overmodulation with out of band emissions when looking at the RF spectrum measurements.

From what I have seen over the years, many stations are grossly in violation of both the positive and negative limits, and yet do not have a clue (sadly, in some cases, they do not even care.)



Sometimes, a station's level of modulation changes substantially between day (l) and night (r)

Also, apart from absolute levels displayed, if you understand how to read the graphic display, you can easily see an approximation of the audio density (compression/loudness) and other aberrations caused by transmitter modulator and/or antenna system issues.



Another station with substantially more compression/limiting

TIME AND EXPERIENCE

By way of reference, I have been doing NRSC measurements for well over 20 years, for stations in at least 13 states.

With a client list that has grown (and fluctuated) over the years, it was important to develop both a well-planned procedure and travel route to provide the best services possible at the best possible price.

At the same time, as you can well imagine, the jump in fuel and hotel prices in the last several years have been challenging, but those are not the only challenges to providing what is really a very important

diagnostic in a time when many stations do not have the staff nor test gear to know for sure they are in compliance.

THE "WHEN" AGAIN

Given the large number of measurement destinations scattered over thousands of miles, a finite window of opportunity (in hours) between local sunrise & sunset each day, and the need to minimize weather related interference by looking for a time of the year that balances all of these concerns, I have established an annual period of NRSC measuring that begins on or about Labor Day.

Without belaboring the mechanics of it all, over the years this has turned out to be overall the best time of the year to "git er done."

Bottom line: find an engineer that is recommended to you to trust and do your NRSC measurements each year. If you do this, you may well find it was cheap insurance – not to mention being in full compliance with the FCC.

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Norm Laramee is a radio engineer based in Broken Arrow, OK. He has over 60 years of experience in fulltime engineering, studio and transmitter construction, and as Director of Engineering for several companies. You can contact Norm at norm@diproservices.com

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