

Instructions For Conducting Audio Frequency Proof-of-Performance Measurements



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Audio Frequency Proof-of-Performance Measurements¹

Introduction

The Commission's Rules require each licensee to make audio performance measurements of both the main and alternate main transmitters at least once each calendar year. The dates between successive sets of measurements must not be more than 14 months. One set of measurements must be made during the four month period preceding the filing date of the application for renewal of the station license. Equipment performance measurements for auxiliary transmitters are not required and any qualified individual may make the required measurements. The data, together with a description of the instruments and procedure utilized in making the measurements, must be signed and dated by the person making the measurements. The data may be kept on file at either the transmitter or remote control point and must be retained for a period of two years. The measurements must be made available for inspection to any duly authorized representative of the Federal Communications Commission.

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What Measurements Are Required

For AM Stations

1. Over-all audio-frequency response from 50 to 7500 Hz for approximately 25, 50, 85, and 100 (if obtainable) per cent modulation.
2. Audio-frequency harmonic content for 25, 50, 85, and 100 per cent modulation for fundamental frequencies of 50, 100, 400, 1,000, 5,000, and 7,500 Hz (either arithmetical or root-sum-square values up to tenth harmonic or root-sum-square values up to tenth harmonic or 16,000) Hz
3. Percentage carrier shift for 25, 50, 85, and 100 per cent modulation with 400 Hz tone
4. Carrier hum and extraneous noise generated within the equipment
5. Spurious radiations including radio-frequency harmonics

For FM Stations (Monophonic)

1. Audio-frequency response from 50 to 15,000 Hz for approximately 25, 50, and 100 per cent modulation. Measurements must be made for at least 50, 100, 400, 1,000, 5,000, 10,000, and 15,000 Hz. (Frequency swing of plus and minus 75 kHz is considered 100 per cent modulation.)
2. Audio-frequency harmonic distortion for 25, 50, and 100 per cent modulation for the fundamental frequencies of 50, 100, 400, 1,000, and 5,000 Hz and audio-frequency harmonic distortion for 100 per cent modulation for the fundamental frequencies of 10,000 and 15,000 Hz. Measurements shall include harmonics to 30,000 Hz.
3. Output noise level (frequency modulation) in the band 50 to 15,000 Hz in decibels below the audio-frequency level representing a frequency swing of 74 kHz.
4. Output noise level (amplitude modulation) in the band 50 to 15,000 Hz in decibels below the audio-frequency level representing 100 per cent amplitude modulation.
5. Each of the above measurements shall be made employing 75 microsecond de-emphasis.

What Equipment Is Required

The Commission does not attempt to set up the procedures or to recommend the equipment to be employed. There are a number of methods of making the required measurements, and numerous makes and models of equipment which are suitable for this purpose are available. In general, however, means must be provided for an audio input signal of known frequency and level and means for measuring the output in the terms desired. The specifications for such equipment must necessarily be considered in connection with the performance standards established by the Commission. It is obvious that the equipment must

have such accuracy as to be well within the limits of the operation specifications for the station.

The following equipment is suggested:

1. **Audio Oscillator.** This instrument should preferably have a fundamental range of 30 to 17,000 Hz or more. The audio-frequency harmonic content over the entire range should not exceed 1 per cent. (Instruments are available where the distortion does not exceed 0.1 to 0.25 per cent.) Accuracy of calibration should be within 3.0 per cent, although much greater accuracy will be found in the higher grade instruments. Both high and low-impedance outputs are desirable.
2. **Attenuator or Pad.** To control the signal fed to the microphone terminals from the audio oscillator an accurate attenuator or pad is required. It must be capable of attenuating the signal from at least 50 to 80 dB. (Some audio oscillators have a suitable attenuator built into the unit.)
3. **Level Indicator.** The purpose of this item is to measure the input level and/or output level. It is usually available at the station in the form of a VU meter or vacuum-tube voltmeter. It is also included in some audio signal generators.
4. **Isolation and Matching Transformer.** This is used to isolate the test equipment from the station circuits and to match the impedances of the two. The requirements for this unit depend on the input impedance (normally 600-ohms) and the output impedance of the attenuator.
5. **Distortion and Noise Meter.** This instrument should have a scale permitting distortion readings as low as 0.5 and as high as 20 to 30 per cent. For carrier noise and hum measurements the meter reading should extend to at least 60 dB (preferably lower) below an audio-frequency signal of 0 dbm (the term dbm means the power level expressed in decibels referred to 1 mw). High and low input impedance must be available, and the low impedance is preferably of the bridging type.
6. **Modulation Monitor.** This item is required by the FCC in each broadcast station and is, therefore, assumed available.
7. **Field-strength Meter or Communications-type Receiver.** With regard to the observations required on the radio-frequency transmissions of the standard stations, the Commission's Rules state that field-strength measurements are preferred but that observations made with a communications-type receiver will be accepted. To conduct such observations considerable care must be exercised in the selection of the receiver as well as in its actual use. As a general rule this receiver should have at least one stage of RF ahead of the first detector. It should be well shielded, and the frequency range should permit observations to at least the tenth or fifteenth harmonic of the fundamental frequency of the station. A means of making comparative signal-strength checks such as an "S meter" is very desirable and almost essential if suitable and meaningful observations are to be made. Amateur communications receivers will often meet these requirements. Although such observations are not required with respect to FM stations, it is a wise precaution to

check spurious and harmonic radiations. Particular attention should be given to the second harmonic to avoid causing interference to television stations.

8. Oscilloscope. Although an oscilloscope is not essential, it is often very useful in analyzing and correcting difficulties which prevent compliance with the requirements.

How to Make Measurements

Detailed instructions for the operation of the particular piece of equipment are normally supplied by the manufacturer and should be followed. Some manufacturers include procedures for making the measurements required by the FCC, but this practice is far from universal. To assist in overcoming this lack and for the benefit of stations assembling the equipment from units purchased from different manufacturers, a step-by-step procedure for making the required measurements is set forth below, together with precautions that should be taken in setting up the equipment and making the measurements.

Precautions

1. All measurements shall be made with the equipment adjusted for normal program operation and shall include all circuits between the main studio microphone terminals and the antenna output, including telephone lines, preemphasis circuits, and any equalizers employed except for microphones, and without compression if a compression amplifier is installed unless otherwise noted.

Where an AM station operates DA-2 or DA-N, it is not required to make measurements under both conditions of antenna operation unless there is reason to believe some unusual condition exists. The practice of making two sets of measurements, however, is considered advisable. If the antenna systems are adjusted so that the transmitter is feeding in exactly the same impedances under both conditions, there should be no difference. (Some difficulty may be experienced at the higher audio frequencies when the common-point impedance(s) for sidebands is greatly different from that at the carrier frequency.)

2. Audio systems of most broadcast stations use balanced 600-ohm ungrounded circuits. This, however, is not universal, and before attempting to make measurements, the facts in this regard must be determined. Otherwise, the measurements obviously will be in error and serious damage may result to the station equipment, the measuring equipment, or both.

3. It is very important to guard against stray fields affecting the accuracy of the measurements. This is particularly true with respect to use of the distortion and noise meter and of the VTVM when used in the

presence of the transmitter. Difficulties of this nature are usually evidenced by residual readings. It is suggested that:

- Use short power cord and bypass it; also reverse plug for lowest residual reading.
- The chassis of the instrument must be firmly grounded with as short a lead as possible to the station ground bus.
- Use short voltmeter leads with RF chokes, and bypass. It may also be necessary to shield the terminals and the instrument itself. In some cases shielding the front will be adequate.
- In some cases, particularly where a high power transmitter is involved, it will be found impossible to reduce the residual reading (R_R) to zero. In such cases a reasonably accurate corrected reading (R_c) may be found by applying the root-mean-square (RMS) principle to the final reading (R_F) ie, $R_c = \sqrt{R_F^2 - R_R^2}$

Example: If the minimal residual reading is 0.50 and the final reading is 2.50, the corrected value or reading would equal $\sqrt{2.50^2 - 0.50^2} = 2.45$

Procedure for AM Stations

Audio-frequency Response

1. Adjust all equipment from microphone preamplifier input terminals to the antenna for normal program operation.

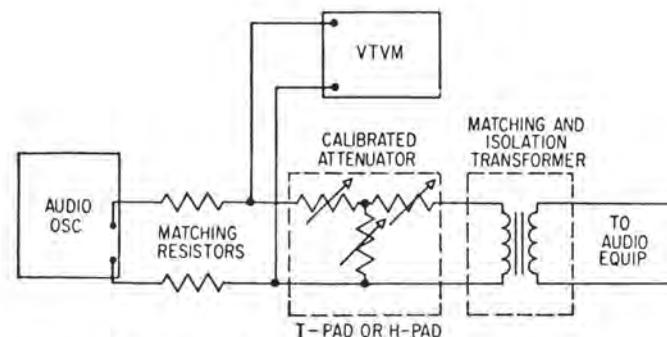


FIG. 1. Basic method of connecting audio-signal-generator equipment.

2. Bypass any limiting amplifiers.
3. Connect the audio-signal-generator equipment as shown in Fig. 1. Details of this will depend on the type and impedances of the oscillator, attenuator, and the station audio circuits. (*Do not connect to input terminals yet.*)
4. Adjust the oscillator to 1,000 Hz.
5. Adjust the oscillator amplitude control until the VTVM reads zero.
6. Adjust the attenuator to approximately 40 or 50 dB.
7. Connect the signal generator to the microphone preamplifier input circuit.
8. Adjust the amplitude control until the VTVM reads approximately 15 dbm.
9. Adjust the attenuator until the station modulation monitor indicates 25 per cent modulation, at the same time making certain that the VTVM still reads the same as step 8. If it does not, readjust the amplitude control and attenuator until the modulation monitor shows 25 per cent at the same time that the VTVM shows the same as in step 8.
10. Record the attenuator setting in all the upper spaces of the form shown on Form AFP-1 for 25 per cent modulation and also in the second space under 1,000 Hz.
11. Adjust the oscillator to 50 Hz.
12. Adjust the amplitude control and attenuator until the modulation monitor reads 25 per cent at the same time the VTVM reads the same as in step 8.
13. Record the attenuator setting in the second space down under 50 Hz in Form AFP-1.
14. Subtract the entry in the second space down from that in the first space, and enter the difference in the third or lower space.
15. Repeat steps 11 to 14 for 100, 400, 5,000, and 7,500 Hz. There should not be more than approximately 0.2-dB difference between any two successive readings. If there is, readings should be taken at intermediate frequencies.
16. Repeat steps 9 through 15 for 50, 85, and 100 per cent modulation. (If 100 per cent modulation is not obtainable, use the highest percentage that is obtainable.)
17. Plot all readings in the lower spaces for each percentage of modulation on the graph sheets on Form AFP-2.
18. If the decibel variation between 100 and 5,000 Hz is greater than 2dB from that at 1,000 Hz, operation is in violation of the Commission's Rules. Appropriate corrective steps should be taken, and the measurements repeated.

Audio-frequency Harmonic Distortion

1. Repeat steps 1 through 9 above.
2. Connect the distortion and noise meter to the output of the transmitter. This connection depends on the instrument employed, and the

instructions of the manufacturer should be followed. In general, there are two principal types: one in which the detector circuit is built into the meter and the other where a separate detector must be provided. In the latter case it is normal to use the detector in the modulation monitor.

3. Following the instructions of the manufacturer of the distortion and noise meter determine the harmonic content for 1,000 Hz and record in the space provided on Form AFP-3.

4. Repeat steps 9 through 12 under Procedure for AM Stations and step 3 above for 50, 100, 400, 5,000 and 7,500 Hz.

5. Repeat steps 4 through 12 under Audio-Frequency Response and steps 3 and 4 above for 50, 85, and 100 per cent modulation.

6. Plot the data on graphs on Form AFP-3.

7. If the harmonic content is greater than 5 per cent from 0 to 84 per cent modulation or 7.5 from 85 to 95 per cent modulation, operation is in violation of the Commission's Rules. Appropriate corrective steps should be taken and the measurements repeated.

Percentage Carrier (Current) Shift

1. Adjust all equipment from the microphone preamplifier input terminals to the antenna for normal program operation.

2. Bypass any limiting amplifiers.

3. Connect the audio signal generator equipment as shown in Fig. 1. Details of this will depend on the type and impedances of the various units and of the station audio circuits. (*Do not connect to the input terminals yet.*)

4. Adjust the oscillator to 400 Hz.

5. Adjust the oscillator amplitude for minimum output.

6. Adjust the attenuator to 40 or 50 dB.

7. Connect to the microphone preamplifier input.

8. Connect a dc voltmeter having a very high input impedance so as to read the dc potential in the detector circuit used in the output of the transmitter as described under Audio Harmonic Distortion.

9. If the detector in the distortion and noise meter is used, adjust the control until maximum dc voltage is obtained.

10. Read and record in the spaces provided on Form AFP-4. (This is the "no-modulation" reading.)

11. Increase the input by adjusting the oscillator amplitude control and the attenuator until the modulation monitor reads 25 per cent.

12. Read the dc voltage and record it in the space provided on Form AFP-4. (This is the reading with 25 per cent modulation.)

13. Enter the difference between the reading without modulation and the reading with modulation in the space provided.

14. Calculate and enter in the space provided in the per cent carrier shift for 25 per cent modulation. Per cent carrier shift is the difference between the readings with and without modulation divided by the reading without modulation and multiplied by 100.

15. Repeat for 50, 85, and 100 per cent modulation.

16. If the carrier shift is greater than 5 per cent at any percentage of modulation, operation is in violation of the Commission's Rules. Appropriate corrective steps should be taken and the measurements repeated.

Carrier Hum and Extraneous Noise

1. Adjust all equipment from the microphone amplifier input terminals to the antenna for normal program operation.

2. Bypass any limiting amplifiers.

3. Connect the audio-signal-generator equipment as shown in Fig. 1. Details of this will depend on the type and impedances of the various units and of the station audio circuits. (*Do not connect to the input terminals yet.*)

4. Adjust the oscillator to 400 Hz.

5. Adjust the amplitude control to 15 dB.

6. Adjust the attenuator to approximately 40 dB.

7. Connect to the input of the microphone preamplifier.

8. Adjust the attenuator until the modulation monitor indicates 100 per cent modulation.

9. Connect the distortion and noise meter to the output of the transmitter. This connection depends on the instrument employed, and the instructions of the manufacturer should be followed. In the event the instrument does not have a detector circuit built into it, the detector of the modulation monitor can be employed provided it has a low hum and noise level, as this will be added to that of the transmitter in the readings.

10. Follow the instructions of the manufacturer, which will be, in general, to adjust the sensitivity so as to obtain a full-scale reading with the output meter set for maximum reading.

11. Disconnect the radio signal generator, and connect a 600-ohm (wire-wound) resistor across the input terminals of the main studio amplifier. If the input impedance is other than 600-ohms, use the corresponding value of resistor. (The signal generator can be turned off and 20 to 30 dB inserted by the attenuator, but the resistor connected across the input is the preferred method.)

12. Increase the sensitivity of the output meter until a reading is obtained. Read and record.

13. Calculate the combined hum and noise. In per cent this is the reading obtained in step 12 divided by the reading in step 10 and multiplied by 100. The hum and noise ratio to the 100 per cent value can be converted to decibels in the usual manner. Both should be recorded on Form AFP-4.

14. If the hum and noise is less than 50 dB below 100 per cent modulation between 150 and 5,000 Hz or less than 40 dB below 100 per cent modulation outside that range operation, it is in violation of the Commission's Rules. Appropriate corrective steps should be taken and the measurements repeated.

Spurious Radiations

1. All equipment, including any limiting amplifiers, should be in normal adjustment with a program or test tone at as high a percentage of modulation as is ever used.

2. With the communications receiver, make observations at a distance of approximately $\frac{1}{2}$ mile from the antenna or closer if possible for spurious emissions including harmonics. With the gain control turned to a maximum, tune around the frequency of the station and on up to the tenth or fifteenth harmonic of the assigned frequency. By means of the S meter determine and record the approximate signal strength of the spurious emissions that are found.

3. In the event any of consequence are found, steps should be taken to eliminate or reduce them as far as possible. In the event that any disagreement arises with the Commission, it may be necessary to take actual field measurements. It is not acceptable for the radiations on other than the assigned frequency to exceed 60 dB below the fundamental, and they should be 70 or 80 dB down.

Procedure for FM Stations (Monophonic)

Audio-frequency Response

1. Repeat the procedure outlined under Procedure for AM Stations *except*: Use audio frequencies of 50, 100, 400, 1,000, 5,000, 10,000, and 15,000 Hz at 25, 50 and 100 per cent modulation.

(These measurements should be made without deemphasis; however, standard 75- sec deemphasis can be employed in the measuring circuit or in the system provided the accuracy of the deemphasis circuit is sufficient to ensure that the measured response is within the prescribed limits.)

2. Record in the space provided on Form AFP-5.
3. Plot the data on Form AFP-6.

Audio-frequency Harmonic Distortion

1. Repeat the procedure outlined under Procedure for AM Stations, Audio-Frequency Harmonic Distortion, for AM stations *except*: Use audio frequencies of 50, 100, 400, 1,000, and 5,000 Hz for 25 and 50 per cent modulation and audio frequencies of 50, 100, 400, 1,000, 5,000, 10,000, and 15,000 Hz for 100 per cent modulation. (These measurements should be made with standard 75- sec deemphasis in the measuring circuit or system and should include harmonics to 30,000 Hz.)

2. Plot the data on Form AFP-7.
3. If this distortion exceeds the following values, operation is in violation of the Commission's Rules and the equipment should be re-adjusted and the measurements repeated: 50 to 100 Hz, 3.5 per cent; 100 to 1,500 Hz, 2.5 per cent; 7,500 to 15,000 Hz, 3.0 per cent.

Output Noise (FM)

1. Repeat the procedure outlined under Carrier Hum and Extraneous Noise for AM stations using FM detection and standard 75- sec deemphasis and VU meter.

2. Records in spaces provided on Form AFP-8.
3. If the noise is in excess of 60 dB down from the audio level representing a frequency swing of ± 75 kHz, operation is in violation of the Commission's Rules and appropriate corrective steps should be taken and the measurements repeated.

Output Noise (AM)

1. Shunt the 600-ohm wire wound resistor across microphone pre-amplifier input.
2. Determine the audio voltage equivalent to 100 per cent modulation. This may be considered as equal to the dc voltage across the meter

determining the power level in the monitor.

3. By use of the distortion and noise meter with standard 75- sec deemphasis and VU meter, determine the audio voltage at the same point for the same carrier level.

4. Compute the per cent AM modulation by dividing the audio voltage by the carrier level voltage and multiply by 100. Convert to decibels down from 100 per cent modulation. Record in spaces provided on Form AFP-8.

5. If the noise is in excess of 50 dB below the audio level representing 100 per cent modulation, operation is in violation of the Commission's Rules. Appropriate corrective steps should be taken and the measurements repeated.

How to Use the Measurements

Compliance with the Commission's Rules in regard to filing the measurements was covered earlier. However, the measurements were required in the first place to determine whether the emissions of the station are satisfactory and in accordance with the Rules and good engineering practice. Obviously, if the distortion, hum, noise, RF harmonics, or other spurious emissions are not within the Rules, appropriate corrective steps must be taken and new measurements made. Even if the measurements are within the requirements, there are very likely adjustments or changes that can be made with little or no expense which would materially improve the operation or correct a weakness or border-line operation which may otherwise cause off-the-air time later.

In other words, these measurements should not be considered just a necessary nuisance to comply with the Commission's requirements but should be used for station improvement. If the station purchases the equipment, a procedure should be established for making the measurements at regular intervals and the measurements kept on file, together with a record of the adjustments that have been made from time to time to maintain proper operation. This will often indicate potential sources of complete failure at inopportune times, particularly in bad weather, when lines and equipment are more prone to fail and more difficult to repair.

Procedure for FM Stations (Stereo)

An FM Station that operates in a Stereo manner, whether on a full time or part time basis, must perform an annual Stereo Proof of Performance. This Stereo Proof is in *addition* to the required annual monaural Proof required of all FM Stations. Both modes of operation must meet the requirements of FCC Rules, Parts 73.254, 73.313, 73.322.

Required Measurements:

1. Audio frequency response measurements on the Left and Right audio channels separately at 90 + 10 per cent pilot, 40 + 10 per cent pilot, 15 + 10 per cent pilot per cent main channel modulation. As a minimum, these measurements should be made at the fundamental audio frequencies of 50, 100, 400, 1,000, 5,000, 10,000, 15,000 Hz. 1,000 Hz is used as a reference. No de-emphasis used during measurements.

More measurements may be made, particularly above 1,000 Hz, which will help in drawing the graph of the response curve and give a more realistic view of the system.

Limits: The system audio response must fit within the FCC Standard Pre-emphasis curve.

2. Audio Frequency Distortion Measurements on the Left and Right audio channels at 100, 50, 25 per cent (includes 10 per cent pilot) modulation of the main channel for fundamental audio frequencies of 50, 100, 400, 1,000, 5,000 Hz. At 100 per cent modulation, fundamental frequencies of 10,000 and 15,000 Hz. 75 sec de-emphasis used in measurements.

Limits: 50 to 100 Hz, 3.5 per cent; 100 to 7,500 Hz, 2.5 per cent; 7,500 to 15,000 Hz, 3 per cent.

3. Output Noise level (FM) in the band 50 to 15,000 Hz in decibels below the level representing 100 per cent main carrier modulation. 75 sec de-emphasis used.

Limits: - 60 dB. Each channel.

4. Output Noise level (AM) in the band 50 to 15,000 Hz in decibels below the level representing 100 per cent amplitude modulation of the carrier. 75 sec de-emphasis used.

Limits: - 50 dB. Each channel.

5. Separation Measurements of the Left and Right audio channels in the band 50 to 15,000 Hz in decibels at a level representing 90 per cent (+10 per cent pilot) main carrier modulation.

Limits: - 29.7 dB for each channel.

6. Cross-talk measurements of main channel into subchannel when main channel is modulated 90 per cent (+10 per cent pilot) with 400 Hz, while subchannel is unmodulated.

Cross-talk measurement of subchannel into the main channel while the subchannel is modulated 100 per cent with 400 Hz, modulating the

main channel to 90 per cent (+10 per cent pilot) and net audio modulation on main channel.

Limit: -45 dB for both the main and the subchannel.

7. Subcarrier suppression measurements with no audio modulation on the main channel, subchannel modulated by 5,000, 7,500, 10,000, 15,000 Hz, subchannel modulating the main channel to 90 per cent (+10 per cent pilot).

Subcarrier suppression measurement without modulation on the main channel, subchannel or pilot.

Limit: 1 per cent main channel modulation (-40 dB).

Equipment Needed:

1. The same basic equipment required for the monaural proof.

2. A Stereo Modulation Monitor. This is required as an operational instrument by the FCC Rules. All modern monitors incorporate the required circuits, switches, pads, and metering to make the specialized stereo measurements.

3. An oscilloscope, although not entirely necessary, is a useful instrument for determining if the system phasing is correct.

4. Some device for feeding the monaural audio signal generator into the left and right audio channels, maintaining correct phasing and impedance matching. This may be built up of various resistors and switches. If the input to the stereo system is on an audio patch panel, a simpler method can be used, provided there are three sets of jacks that are multiplied together. The audio generator is fed to one of the multiple jacks, while two identical length patch cords feed the left and right channels. Each plug should be adequately marked for phasing and which channel.

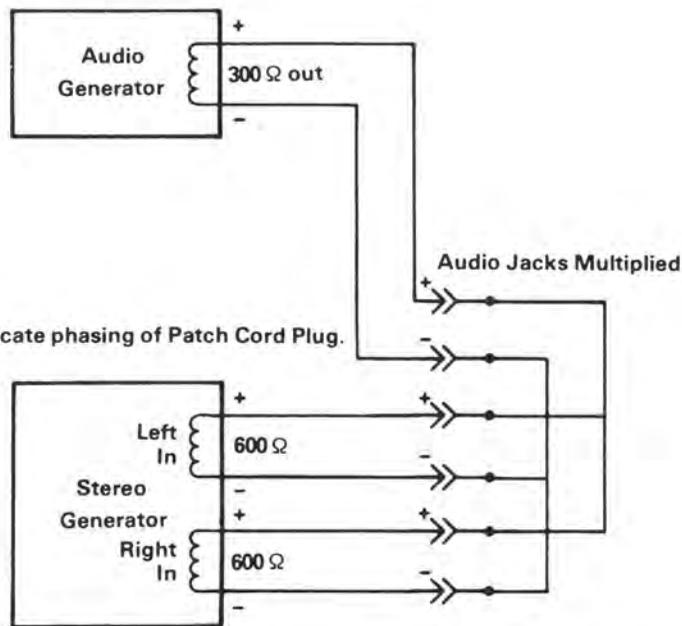
Precautions:

Before making the measurements, certain checks should be made and precautions taken.

1. *Identical* circuit paths and levels are most important. The matrix in the Stereo Generator algebraically adds and subtracts the Left and Right audio channels to provide the main channel modulation and the subchannel modulation. The matrix in the receiver reverses the process to restore the Left and Right audio channels. Should the Left and Right audio channels not be identical in both amplitude response and phase of all passing audio frequencies, complete addition and subtraction cannot take place. What remains will appear in the opposite channel as reduced separation.

2. System should be checked for 180° phasing. Whenever equipment has been removed for repairs, it is possible that the leads were inadvertently reversed when the equipment was replaced. Such a shift in phase will reverse the Left and Right audio channels.

Figure #2



NOTE:

+/- signs indicate phasing of Patch Cord Plug.

Simple setup to feed Left and Right audio channels with the monaural signal generator.

As shown, the Stereo Generator is being fed an in-phase ($L=+R$) signal.

To feed out of phase ($L\neq-R$), reverse the polarity of plug into Right channel.

Since the two 600 ohm input impedances are effectively strapped in parallel, the generator will not see 600 ohms. Therefore, its output should be set as near to 300 ohms as possible, according to the impedances available on the generator.

3. System should be checked for lesser degrees of phase error. Smaller amounts of phase error will cause reduced separation.

4. The demodulator switching action of the monitor should be the same as that used in the Stereo Generator. The monitor should be adjusted or modified as directed in its instruction manual to make the monitor correspond with the generator. Should one unit be square wave switching while the other is sine wave switching, reduced separation measurements will result.

5. Impedance matching of the inputs is most important, as a mismatch will effect both amplitudes and frequency response.

6. Proper terminations are important. This is especially true when only one channel is measured. During such times, the input to the other channel should be terminated with a resistor of a value equal to the input impedance. If the channel is left open and unterminated, open circuit hum may be introduced that will effect the measurements taken.

Techniques:

There are several types of modulation monitors available. Although none are identical, each performs the required functions in its own way. It is beyond the scope of this section to discuss individual monitors. It is assumed that the engineer making the proof is familiar with operation of the monitor in use. Methods for performing the measurements differ from one type monitor to another.

A check for the correctness of phasing should be done as the first step. Unless the phasing is correct, all the measurements will be in error.

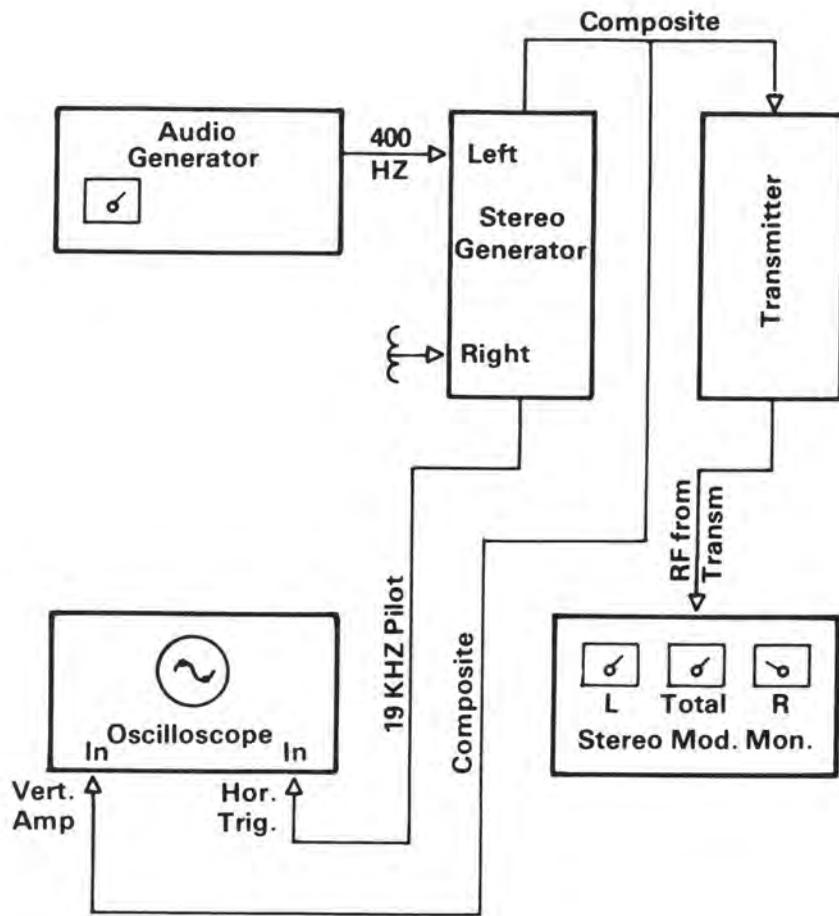
Set up the equipment as shown in Figure 3. Composite signal from the output of the stereo generator is coupled to the vertical amplifier input of the oscilloscope. At the same time, 19 KHz pilot is fed to horizontal trigger input of the oscilloscope. Using the 19 KHz as a trigger will help stabilize the CRO display. Next, adjust the horizontal sweep controls so that only one cycle is displayed on the CRO.

Feed a small amount of 400 Hz audio into the left channel only, the right channel input terminated in 600-ohms. If the phasing is correct, the 400 Hz modulation will appear in the 1st and 3rd quadrants of the cycle displayed on the CRO. At the same time, the Left audio meter on the Stereo Monitor will be indicating modulation. This test verifies that both the Stereo Generator and Monitor are correctly phased.

The right channel may now be checked. Simply feed the 400 Hz audio to the right channel, terminate the left channel. The 400 Hz modulation should now appear in the 2nd and 4th quadrants of the cycle displayed on the CRO, and the Right meter on the monitor should be indicating. The 180° phasing is now verified.

Lesser degrees of phase error may now be checked. Leave the equipment set up as for the previous test, but with this exception. Feed 400 Hz out of phase ($L = - R$) to both left and right audio channels. Modulate for 90 + 10 per cent pilot total modulation. Adjust the

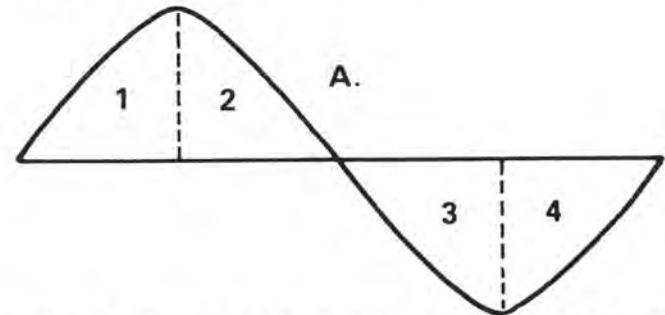
Figure #3



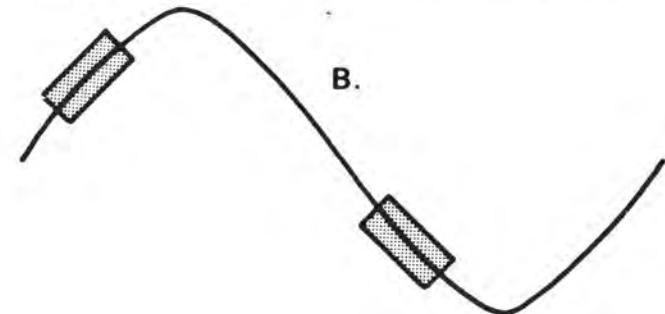
Equipment set up for checking system phasing.
As shown, system is being checked for 180° phasing using Left channel.

Figure #4

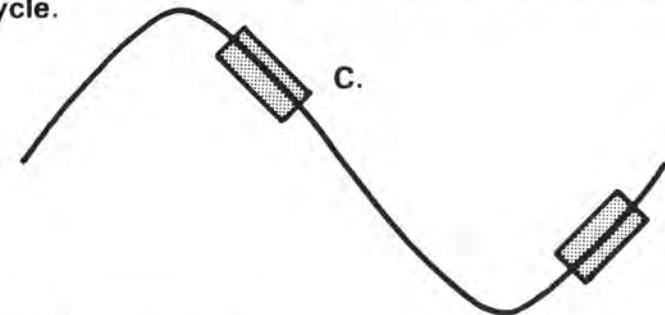
One cycle of 19 KHz displayed on CRO, and modulation, and correct 180° phasing.



A. One full cycle divided in 4 quadrants, a zero base line drawn in.

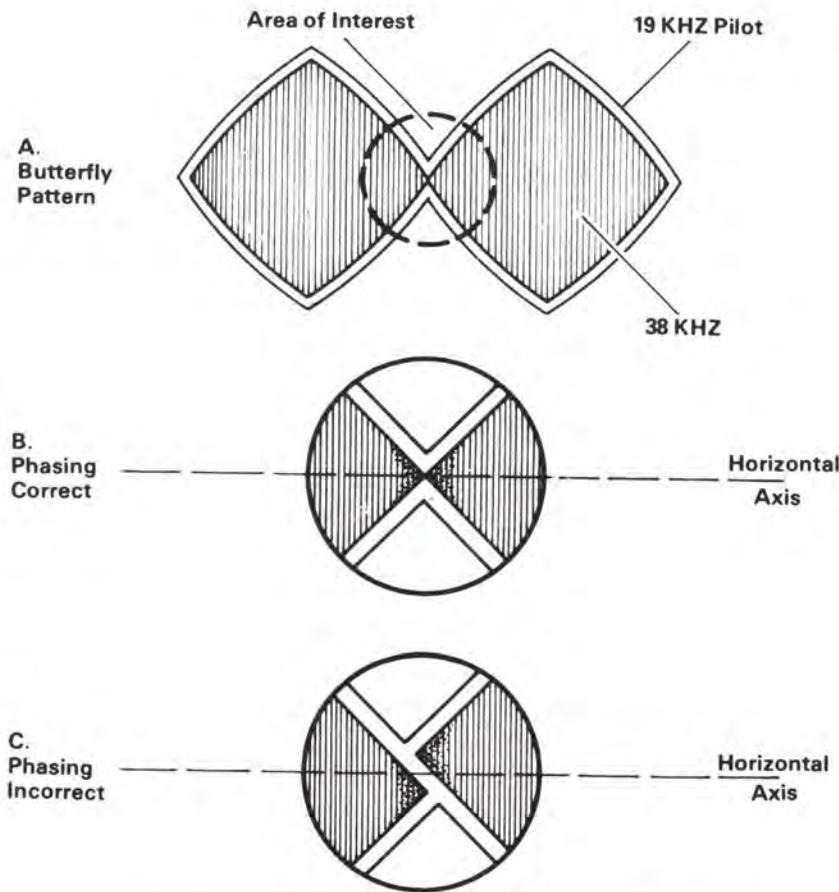


B. Small amount of 400 Hz fed to Left channel only. Modulation appears in 1st and 3rd quadrants of the cycle.



C. Small amount of 400 Hz fed to Right channel only. Modulation appears in 2nd and 4th quadrants of the cycle.

Figure #5



Butterfly pattern of oscilloscope. Used for checking smaller amounts of phase error.

horizontal sweeps on the oscilloscope for the butterfly pattern.

Careful observation of the CRO pattern will show that both wings are filled with fine vertical lines (38 kHz), a dual outer envelope (19 kHz pilot). The central crossover point where the wings join together is the main point of interest. The CRO display should now be expanded so the central area can be observed better. Phasing is correct when the two points of the wings are on the same horizontal axis. Incorrect phasing will be indicated when the two points are on opposite sides of the horizontal axis. How far apart and which side of the line the points are located, will depend upon the direction and amount of phase error. If incorrect phasing is indicated, adjust the phasing control on the Stereo Generator so the points are on the same axis.

The audio response, distortion and noise measurements are basically the same as those taken during the monaural proof, with the exception of the dual channels and the Stereo section of the monitor.

The stereo proof will require a considerable number of measurements to be taken. Motion economy will make the work proceed faster and required less switching actions. One can combine the response, distortion, and separation measurements on one channel and at the three main carrier modulation percentages. For example, with the audio signal set to feed 1,000 Hz to the left audio channel, the distortion analyzer will be attached to the Left output. Adjust the input to modulate the main channel 100 per cent (includes 10 per cent pilot). Enter this level onto the appropriate sheet, then measure distortion and enter that reading on the distortion sheet. Next, measure the separation of the Right channel sheet. Next, drop the input level so total modulation is 50 per cent, again check distortion and enter on appropriate sheets. Do the same with 25 per cent modulation. Separation measurements are made at 100 per cent modulation only.

When combining measurements in this way, the work will go faster, but there are possibilities for entering the results in the wrong columns or on the wrong sheets. But if done with care, the work will be performed in a shorter period of time.

Preparing the Results:

Whether one uses the charts as given in this manual or those of his own design, here are a few suggestions:

Graphs should be prepared of the audio response and distortion so as to give a quick overall view of the system. The Left and Right Channels should be plotted on the same graph and on the same reference points. Such an overlay will quickly show where the two channels differ. As a further suggestion, each channel can be drawn in with a color different than the opposite channel, or one channel may be drawn in a solid curve while the other is drawn in a dashed curve. In either case, and differences in channels will be very evident.

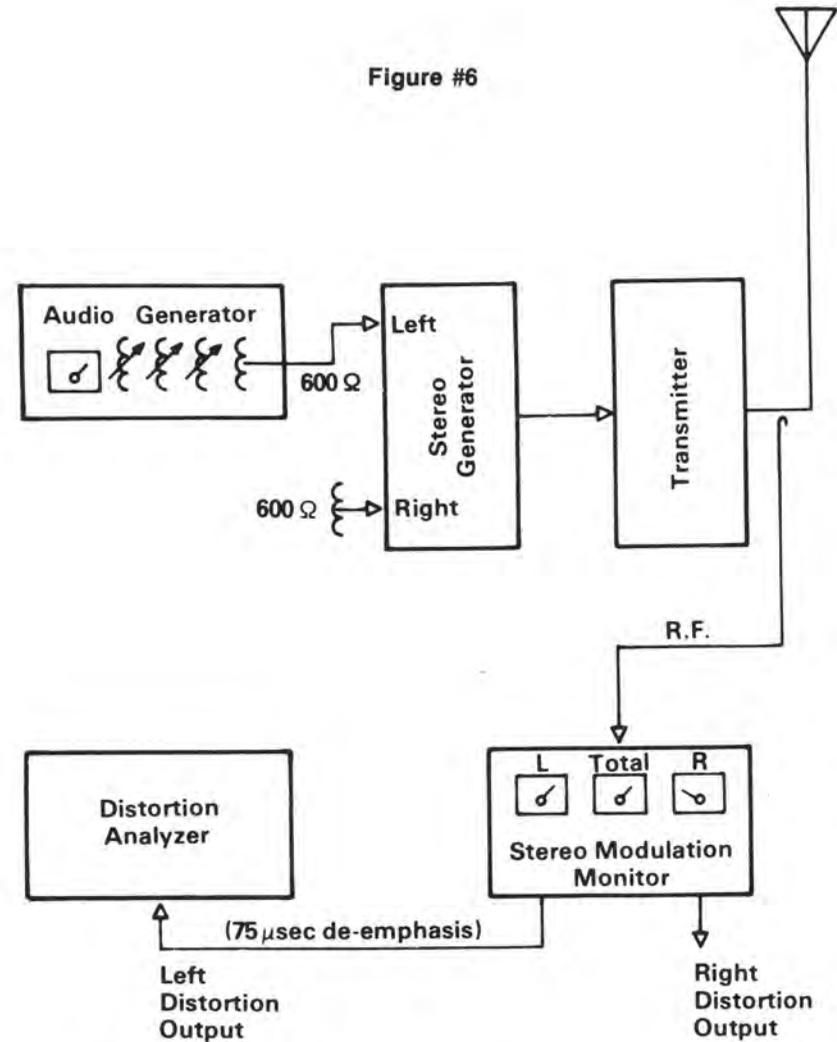
A graph should also be drawn for the distortion measurements, again

plotting both curves on the same sheet and reference points. As a quick aid in viewing the overall system distortion performance, draw in the limits of distortion permitted.

Since a monaural proof must also be made, both the stereo and monaural proofs should be combined in the same folder or other packaging. This will provide a single volume showing the total results of the Station overall technical performance. File in the usual manner as done with proofs.

* * *

Figure #6



Equipment setup for measuring audio response and distortion in the system. As shown, equipment is ready to measure the left channel. To measure the right channel, the feed is to the right channel, and the distortion meter is moved to the right distortion output of monitor.

Station

KC, City

State

OVERALL AUDIO FREQUENCY RESPONSE
DATA

25% MODULATION

CPS	30	50	100	400	1000	5000	7500
(1)							
(2)							
(3)							

50% MODULATION

CPS	30	50	100	400	1000	5000	7500
(1)							
(2)							
(3)							

85% MODULATION

CPS	30	50	100	400	1000	5000	7500
(1)							
(2)							
(3)							

100%(or %) MODULATION

CPS	30	50	100	400	1000	5000	7500
(1)							
(2)							
(3)							

(1) RECORD THE ATTENUATOR READING FOR THE 1000 CPS REFERENCE SIGNAL IN EACH SPACE IN THIS ROW.

(2) RECORD THE ATTENUATOR READINGS FOR THE SPECIFIED FREQUENCIES IN THIS ROW.

(3) RECORD THE AUDIO FREQUENCY RESPONSE VARIATION IN THIS ROW WHICH IS OBTAINED BY SUBTRACTING ROW (2) FROM ROW (1). THESE FINAL FIGURES ARE TO BE USED IN PLOTTING THE GRAPHS.

19

Engineer

Form No. AFP-1

Form AFP-1.

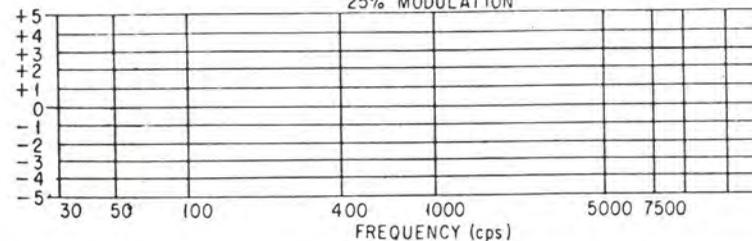
Station

KC, City

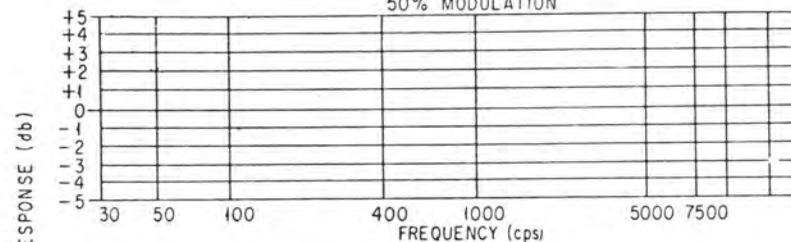
State

OVERALL AUDIO FREQUENCY RESPONSE
CURVES

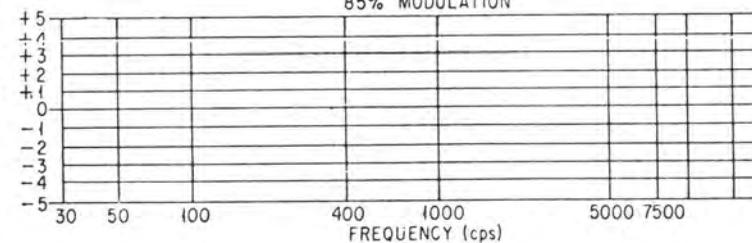
25% MODULATION



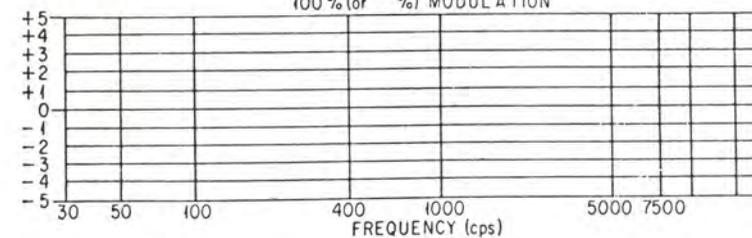
50% MODULATION



85% MODULATION



100%(or %) MODULATION



19

ENGINEER

Form No. AFP-2

Form AFP-2.

Station _____ KC, City _____ State _____

AUDIO FREQUENCY HARMONIC CONTENT
DATA AND CURVES

HARMONIC DISTORTION

CPS	30	50	100	400	1000	5000	7500
25							
50							
85							
100							

% MOD.

25% MODULATION

50% MODULATION

85% MODULATION

100% (or %) MODULATION

Engineer

19____

Form No. AFP-3

Form AFP-3.

Station _____ KC, City _____ State _____

CARRIER SHIFT AND COMBINED
NOISE AND HUM DATA

CARRIER SHIFT DATA (at 400 cps)

% MOD.	25	50	85	100
(1)				
(2)				
(3)				
(4)				

(1) RECORD DC VOLTMETER READING WITHOUT MODULATION IN EACH SPACE IN THIS ROW.
 (2) RECORD DC VOLTMETER READINGS WITH MODULATION IN THIS ROW.
 (3) SUBTRACT ROW (2) FROM ROW (1) AND RECORD DIFFERENCE IN THIS ROW.
 (4) COMPUTE CARRIER SHIFT BY EQUATION: $\frac{\text{ROW (3)}}{\text{ROW (1)}} \times 100$, AND RECORD RESULTS IN THIS ROW.

COMBINED NOISE AND HUM READING

DB	%

Engineer

19____

Form No. AFP-4

Form AFP-4.

OVERALL AUDIO FREQUENCY RESPONSE DATA

25% MODULATION

CPS	50	100	400	1000	5000	10000	15000
(1)							
(2)							
(3)							

50% MODULATION

CPS	50	100	400	1000	5000	10000	15000
(1)							
(2)							
(3)							

100% MODULATION

CPS	50	100	400	1000	5000	10000	15000
(1)							
(2)							
(3)							

_____% MODULATION

CPS	50	100	400	1000	5000	10000	15000
(1)							
(2)							
(3)							

- (1) RECORD THE ATTENUATOR READING FOR THE 1000 CPS REFERENCE SIGNAL IN EACH SPACE IN THIS ROW.
- (2) RECORD THE ATTENUATOR READINGS FOR THE SPECIFIED FREQUENCIES IN THIS ROW.
- (3) RECORD THE AUDIO FREQUENCY RESPONSE VARIATION IN THIS ROW WHICH IS OBTAINED BY SUBTRACTING ROW (2) FROM ROW (1). THESE FINAL FIGURES ARE TO BE USED IN PLOTTING THE GRAPHS.

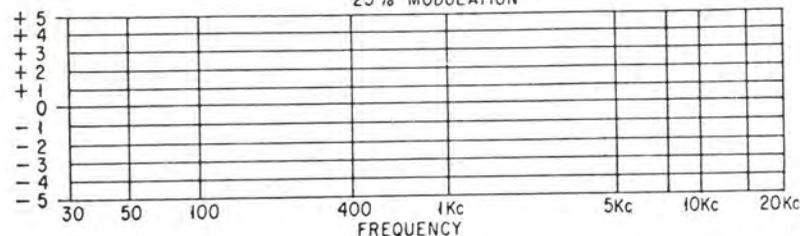
Engineer _____ 19____

Form No. AFP-5

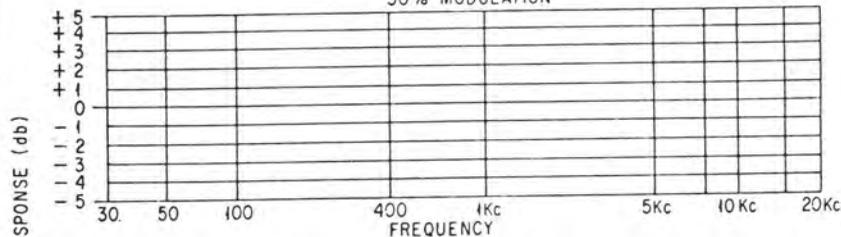
Form AFP-5.

OVERALL AUDIO FREQUENCY RESPONSE CURVES

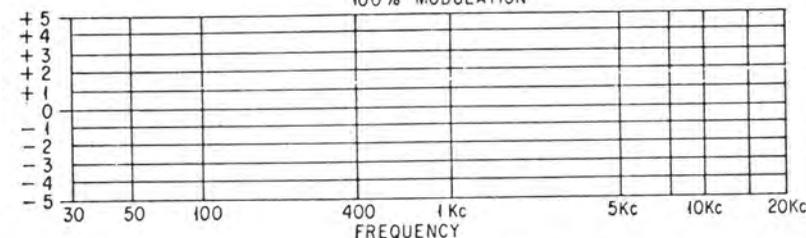
25% MODULATION



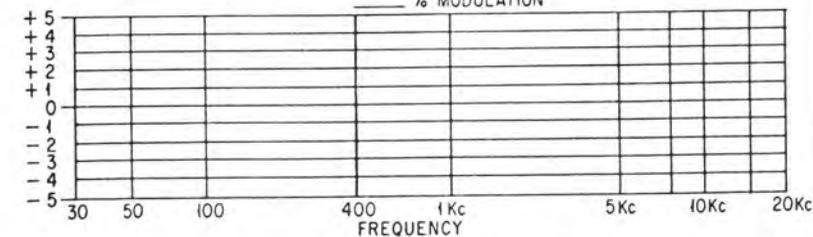
50% MODULATION



100% MODULATION



_____% MODULATION



Engineer _____ 19____

Form No. AFP-6

Form AFP-6.

Station _____ Ch. _____ City _____ State _____

AUDIO FREQUENCY HARMONIC CONTENT DATA AND CURVES

HARMONIC DISTORTION

CPS	50	100	400	1000	5000	10000	15000
25							
50							
100							

% MOD.

25% MODULATION

50% MODULATION

100% MODULATION

— % MODULATION

Engineer _____ 19____

Form No. AFP-7

Form AFP-7.

Station _____ Ch. _____ City _____ State _____

OUTPUT NOISE LEVEL DATA

OUTPUT NOISE LEVEL (Frequency modulation)

VM READING AT 100% MODULATION	NOISE VOLTAGE	% NOISE: $\frac{\text{COLUMN 2}}{\text{COLUMN 1}} \times 100$	DB DOWN

OUTPUT NOISE LEVEL (Amplitude modulation)

VM READING AT 100% MODULATION	NOISE VOLTAGE	% NOISE: $\frac{\text{COLUMN 2}}{\text{COLUMN 1}} \times 100$	DB DOWN

Engineer _____ 19____

Form No. AFP-8

Form AFP-8.