BROADCAST STATION MEASUREMENTS

HEWLETT-PACKARD COMPANY
Laboratory Instruments for Speed and Accuracy
395 PAGE MILL ROAD • PALO ALTO • CALIFORNIA

RECOMMENDED PROCEDURES FOR MAKING MEASUREMENTS ON BROADCAST TRANSMITTERS

By the addition of amendment (e) to Section 3.46 of the "Standards of Good Engineering Practice, etc." the Federal Communications Commission has required that certain measurements be made on FM broadcast transmitters at least once a year during the four-month period preceding the date of filing applications for renewal of station license.

This manual has been compiled, therefore, to outline procedures for making such measurements with Hewlett-Packard instruments. It is our intent that this manual be a definite aid to the busy broadcast engineer. To this end space has been provided herein for making entries of the results of the measurements and for plotting the required curves. This manual, when filled with the pertinent data, can be filed with the station records in order to comply with the FCC requirement that the results of the measurements be signed by the engineer making the measurements and kept on file at the transmitter.

Questions concerning the performance or use of Hewlett-Packard instruments are invited and are answered promptly.

THIS MANUAL IS ISSUED

FOR THE PERSONAL USE OF:

_____, CHIEF ENGINEER

RADIO STATION_____

HEWLETT-PACKARD COMPANY

Palo Alto, Cal.

CONCERNING MEASUREMENTS

The method for making the measurements covered by this manual is a subject that has been discussed somewhat in the literature and for which several standards have been promulgated. Unfortunately, some of the published material contains conflicting information or requirements.

In issuing this manual it is not our intent to enter into any controversies that may exist on the subject. Rather, this manual is provided with a recommended procedure for making measurements with Hewlett-Packard instruments, and we believe that measurements made in the manner recommended herein will result in accurate and uniform results and that these results will be repeatable.

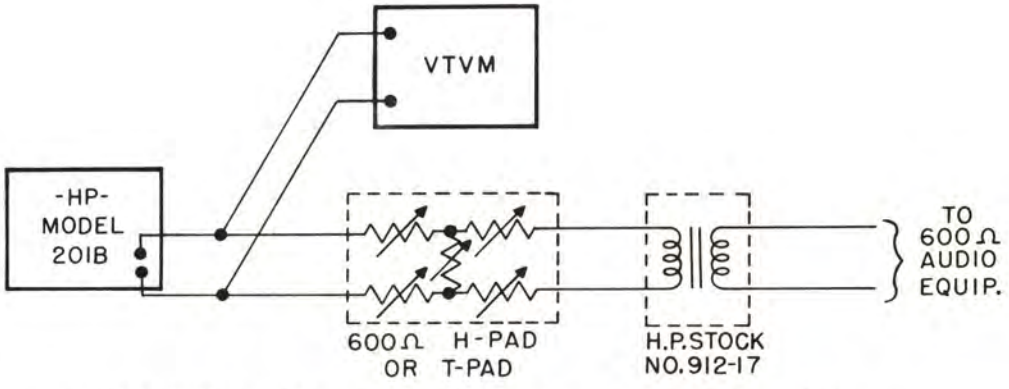
A perusal of the instructions in this manual will show that two -hp- instruments will perform 80% or more of the measurements required by the FCC. Although this statement assumes that a modulation meter is in use in the station as a part of the station equipment, we feel that the fact that two instruments can be so valuable to the broadcast engineer is strong testimony regarding the versatility of -hp- instruments.

The material contained herein is based on the assumption that balanced, ungrounded 600 ohm circuits are used in the audio systems of the station. This standard impedance is widely accepted, and Hewlett-Packard instruments are designed to be used with equipment of this impedance. However, the -hp- Model 206A Audio Signal Generator has a multi-impedance output system so that it can be used with grounded or ungrounded circuits of certain other impedances as well.

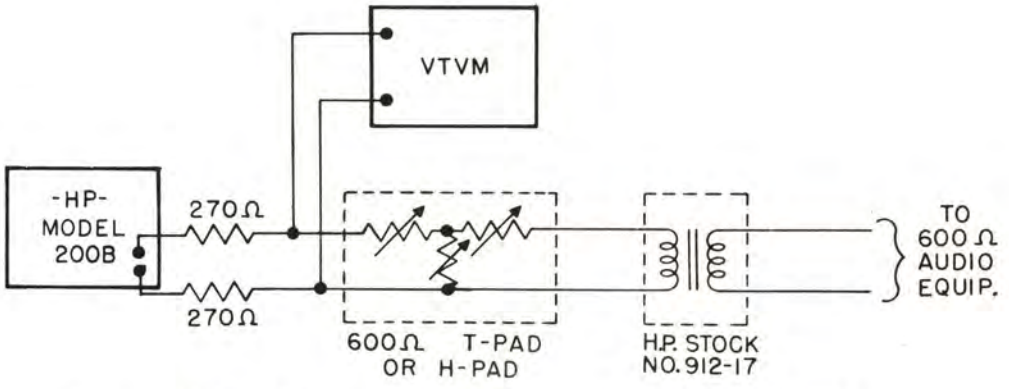
RECOMMENDED EQUIPMENT

The material in this manual assumes the use of a Model 206A Audio Signal Generator. However, it is possible to substitute the use of the Model 200B or 201B for the Model 206A, although an external VTVM, T-pad or H-pad, and balanced isolation transformer are needed. If the Model 200B is used, two 270 ohm resistors are also needed.

Assuming that the input impedance of the station audio equipment is 600 ohms, the -hp- stock number 912-17 balanced isolation transformer can be used with a 600 ohm T-pad or H-pad (not necessarily balanced). The equipment should be connected as shown in the following figures.



CONNECTIONS FOR -HP- MODEL 201B AUDIO OSCILLATOR
(A)



CONNECTIONS FOR -HP- MODEL 200B AUDIO OSCILLATOR
(B)

Figure (A) above shows the method for connecting the Model 201B Audio Oscillator. In operation the ATTENUATOR control on the Model 201B should be set for 20 db or more of attenuation and allowed to remain at that position. The variations in signal level should then be made by varying the setting of the external 600 ohm pad. The -hp- Model 350B 600 ohm T-pad can be used for this application. The reading of the external VTVM should be maintained constant under all conditions by adjusting the AMPLITUDE control on the Model 201B. For best waveform, it is desirable to keep the setting of the AMPLITUDE control below about "50".

Figure (B) above shows the method for connecting the Model 200B Audio Oscillator. It should be noted that the distortion in the output waveform of the Model 200B is of the order of one percent. While this waveform is very good, it is not sufficiently pure to test adequately some of the higher quality transmitters and associated equipment of recent manufacture.

The 270 ohm resistors shown in figure (B) above are used to increase the source impedance of the generator to 600 ohms. Composition resistors should be used for this application. The AMPLITUDE control on the Model 200B should be set at "90" or higher. The reading of the VTVM should be maintained constant during the measurements by making minor adjustments in the setting of the AMPLITUDE control on the Model 200B. The external pad need not be balanced so that the Model 350B 110db laboratory attenuator can be used for this application.

RF SHIELDING

It is important to note that when making low level measurements with the Model 330 in the presence of the transmitter, precautions should be taken to make certain that stray fields or rf pick-up from the transmitter do not cause a residual reading on the voltmeter in the Model 330. The specifications for the Model 330 voltmeter section are given in terms of 100 kc as the maximum frequency. However, the response of the voltmeter section of the Model 330 falls off rather slowly, as in any well-designed amplifier, so that the response is of the order of 30% or more at the higher am broadcast frequencies.

Steps which may be taken to reduce the affects of rf pick-up include:

(a) Orient line plug for lowest residual reading.

(b) Solidly ground chassis of Model 330 to station ground bus.

(c) Use short power cord.

(d) By-pass power cord.

(e) Use rf chokes in voltmeter leads.

(f) Shield voltmeter terminals.

(g) By-pass meter leads (in extreme cases).

(h) Shield meter front (in extreme cases).

S E C T I O N I

PERFORMANCE MEASUREMENTS

OF

AM BROADCAST STATIONS

The material contained in Section I of this manual offers a recommended procedure for performing four of the five measurements required by the FCC on am broadcast stations. The fifth requirement involves the measurement of spurious radiations and -hp- does not offer any equipment for making these measurements. However, such equipment is manufactured by several firms.

FCC REQUIREMENT I

"Data and curves showing overall audio frequency response from 30 to 7500 cps for approximately 25, 50, 85, or 100 (if obtainable) percent modulation. Family of curves should be plotted (one for each percentage above) with db above and below a reference frequency of 1000 cps as ordinate and audio frequency as abscissa."

A. Equipment Required:

(1) -hp- Model 206A Audio Signal Generator.

(2) Station AM modulation meter.

B. Procedure:

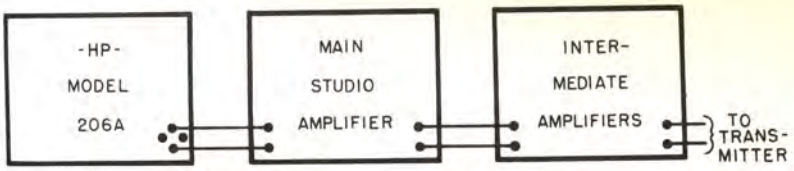
(1) The transmitter, main studio amplifier, and intermediate equipment must be operating for this measurement and the transmitter should be coupled to the antenna so that the test signal can be obtained from the final tank circuit as loaded by the antenna. All equipment should be adjusted for normal program operation.

(2) Any limiting amplifiers in the circuit must be bypassed.

(3) Tune Model 206A to 1000 cps with FREQUENCY and RANGE controls. Turn AMPLITUDE control counterclockwise so that VOLTS - DBM meter reads zero.

(4) Set 0 to 100 db attenuator on Model 206A to about 40 db to prevent overloading of transmitter circuits.

(5) Patch from Model 206A to main studio amplifier as shown in following figure. Assuming that the input impedance of the main studio amplifier is 600 ohms (the present standard), the IMPEDANCE switch on the Model 206A should be set to the 600 ohm position. Ordinarily, the connections should be floating (ungrounded).



(6) Adjust AMPLITUDE control on Model 206A so that VOLTS - DBM meter indicates +15 dbm.

(7) Adjust setting of output attenuators on Model 206A so that station modulation meter indicates 25% modulation. Record setting of output attenuators in space on page 4.

(8) Tune Model 206A to 30 cps. If necessary adjust setting of VOLTS - DBM meter with AMPLITUDE control so that meter reads +15 dbm.

(9) Adjust setting of output attenuators on Model 206A so that station modulation meter indicates 25% modulation. Usually, the attenuation will have to be decreased a db or so from the previous setting. Record setting of output attenuators in space provided on page 4.

(10) Tune Model 206A to 50 cps. If necessary adjust setting of VOLTS - DBM meter with AMPLITUDE control so that meter reads +15 dbm.

(11) Adjust setting of output attenuators on Model 206A so that station modulation meter indicates 25% modulation. Record setting of output attenuators in space provided on page 4.

(12) Repeat steps (10) and (11) for frequencies of 100, 400, 5000, and 7500 cps. Record output attenuator readings for each frequency. In addition, if any reading is 0.2 db different from preceding reading, it is recommended that readings be taken at intermediate frequencies.

(13) Repeat steps (8) to (12) for modulation meter readings of 50, 85, and highest modulation obtainable (not over 100%) and for frequencies of 30, 50, 100, 400, 1000, 5000, and 7500 cps. Record all readings in space provided on pages 4 and 5.

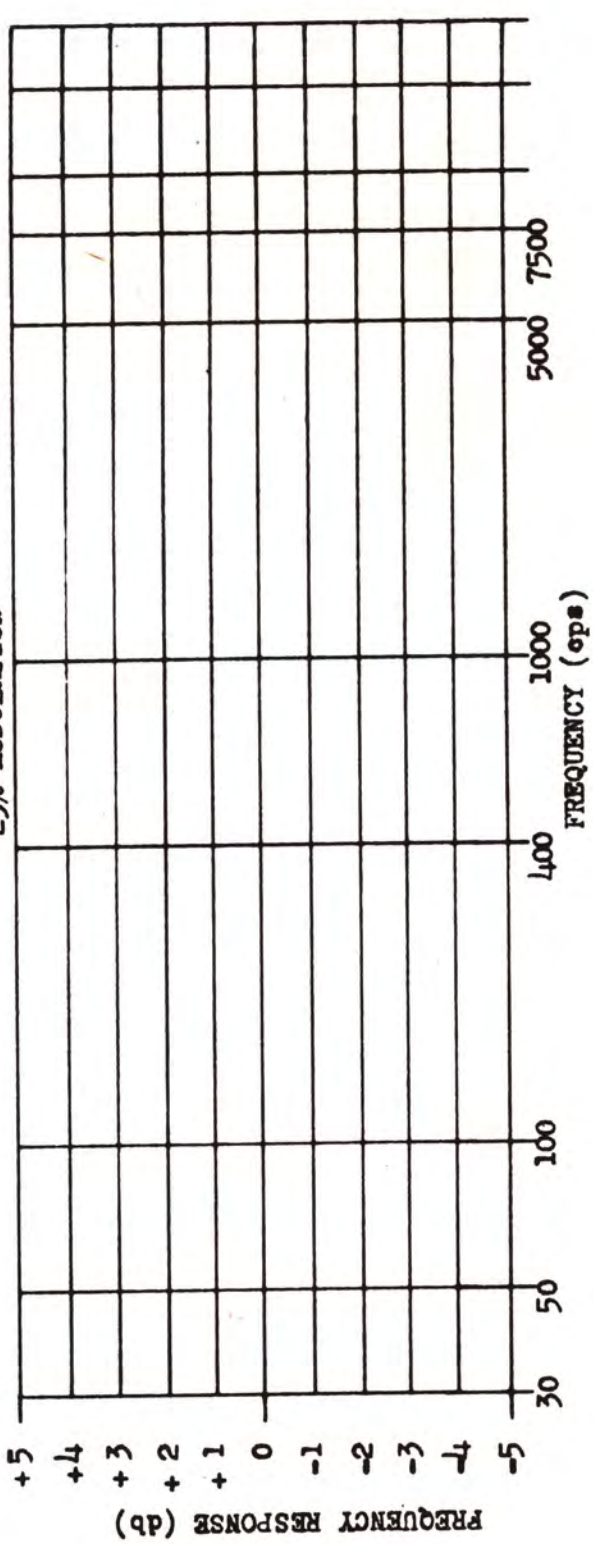
(14) Transfer "Input variation" readings on pages 4 and 5 to graph sheets on pages 6 and 7 of this manual and sketch curves.

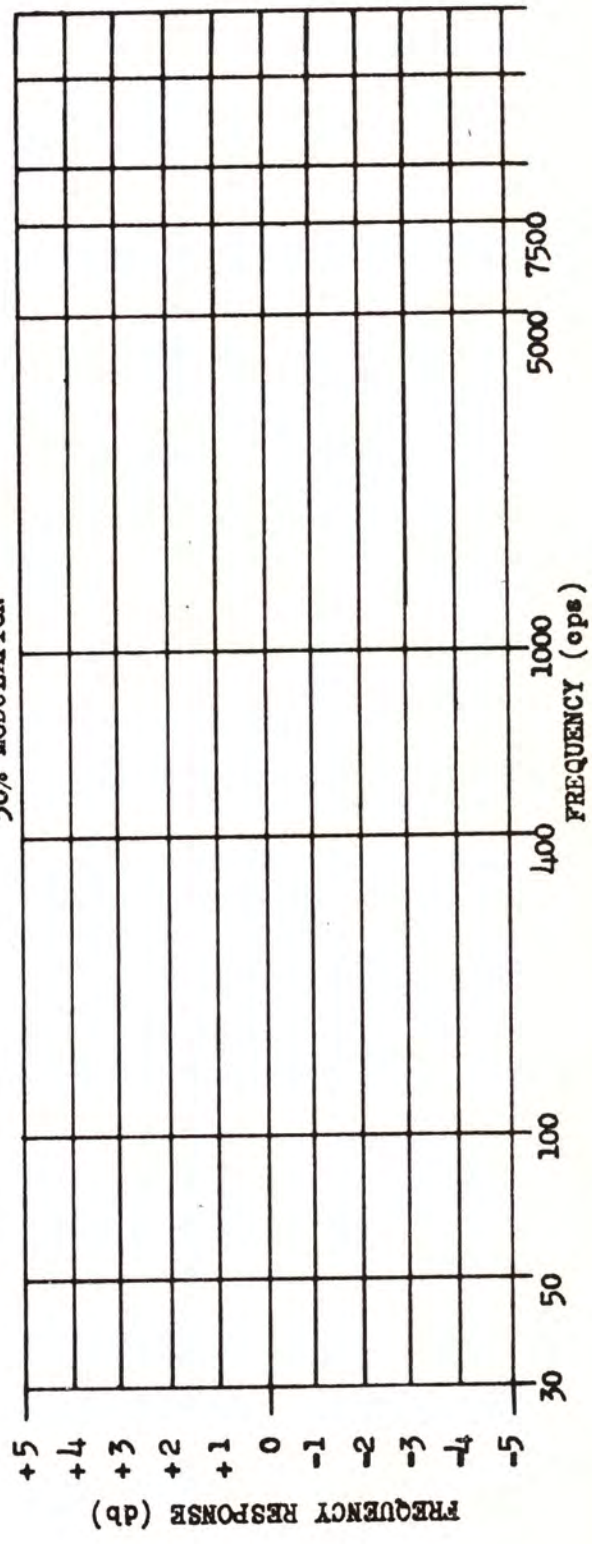
25% MODULATION

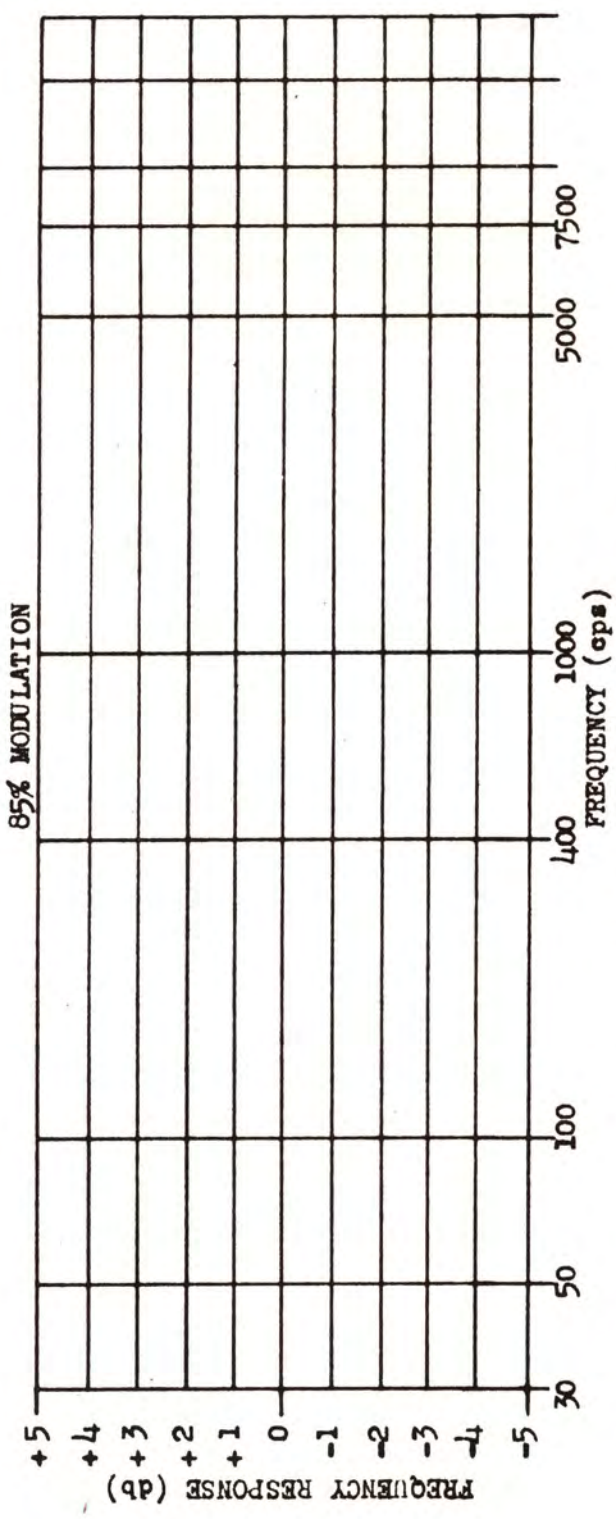
	30 cps	50 cps	100 cps	400 cps	1000 cps	5000 cps	7500 cps	EXAMPLE
ENTER 1000 cps READING (ALL SPACES)								22.6 db
ENTER 206A ATTENUATOR READINGS								22.8db
SUBTRACT READINGS. RESULT IS "INPUT VARIATION"					0			-0.2db

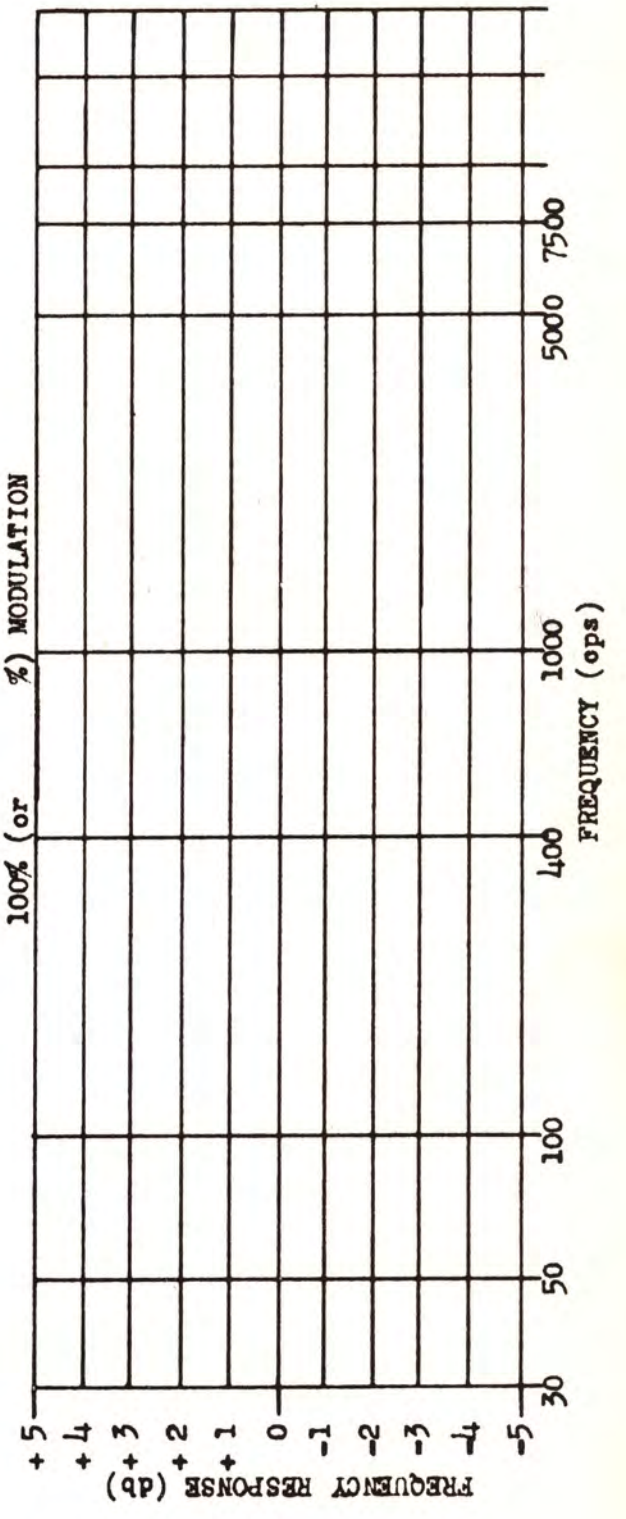
50% MODULATION

	30 cps	50 cps	100 cps	400 cps	1000 cps	5000 cps	7500 cps	EXAMPLE
ENTER 1000 cps READING (ALL SPACES)								16.7 db
ENTER 206A ATTENUATOR READINGS								16.6 db
SUBTRACT READINGS. RESULT IS "INPUT VARIATION"					0			+0.1 db









FCC REQUIREMENT II

"Data and curves showing audio frequency harmonic content for 25, 50, 85, and 100 percent modulation for fundamental frequencies of 50, 100, 400, 1000, 5000, and 7500 cps (either arithmetical or root sum square values up to the tenth harmonic or 16000 cps). Plot family of curves (one for each percentage above) with percent distortion as ordinate and audio frequency as abscissa."

A. Equipment Required:

(1) -hp- Model 206A Audio Signal Generator.

(2) -hp- Model 325B, 330B, 330C, or 330D Noise and Distortion Analyzer.

(3) Station AM modulation meter.

B. Procedure:

(1) The transmitter and main studio amplifier must be operating for these measurements and the transmitter should be coupled to the antenna so that the test signal can be obtained from the final tank circuit as loaded by the antenna. Any limiting amplifiers in the system must be by-passed. All equipment should be adjusted for normal program operation.

(2) Tune Model 206A to 1000 cps with FREQUENCY and RANGE controls. Turn AMPLITUDE control counter-clockwise so that VOLTS - DBM meter reads zero.

(3) Set 0 - 100 DB attenuator on Model 206A to about 40 db to prevent overloading of transmitter circuits.

(4) Patch Model 206A, if necessary, to main studio amplifier as shown in figure on page 9. Assuming that the input impedance of the main studio amplifier is 600 ohms (the present standard), the IMPEDANCE switch on the Model 206A should be set to the 600 ohm position. Ordinarily, the connections should be floating (ungrounded).

(5) Turn AMPLITUDE control on Model 206A clockwise until VOLTS - DBM meter reads +15 dbm.

(6) Adjust output attenuators on Model 206A until station am modulation meter indicates 25% modulation.

(7) There are now two possible methods to follow depending upon the model of Distortion Analyzer in use and convenience. First, the Model 330B and 330D can be coupled to the transmitter and the self-contained am detector circuit in the Distortion Analyzer used for de-modulating the carrier. Second, any of the Models 325B, 330B, 330C, or 330D can be used with the station am modulation meter, using the detector circuit in the modulation meter.

The following procedure is therefore divided into two parts.

(8) USE OF THE MODEL 330B or 330D, USING INTERNAL DETECTOR.

(a) Connect rf terminals on back of Model 330B/330D to monitoring output provided by transmitter manufacturer in final tank circuit. If a voltage in excess of 15 volts rf is provided at this connection, use one-quarter to one megohm resistor to decrease the voltage applied to the Model 330B/330D.

(b) Set AF-RF switch on Model 330B/330D to RF position and set meter selector switch to SET LEVEL position. Set VOLTS - DB switch to 300 volt position. Set INPUT control completely clockwise.

(c) Set rf band selector switch on back of Model 330B/330D to "1" and tune RF control on front of instrument for maximum reading on meter. Reduce setting of VOLTS - DB switch as necessary to obtain readable deflection of meter.

(d) After these adjustments, at least a full-scale reading on meter with VOLTS - DB switch in 100% position should be obtained. If not, it is necessary to increase the coupling between the rf terminals on the back of the instrument and the monitoring output provided on the transmitter.

(e) Adjust setting of INPUT control on Model 330B/330D so that a full-scale reading (1.0) is obtained with the VOLTS - DB switch in the 100% position.

(f) See steps 10 -26 below for remainder of procedure.

(9) USE OF THE MODEL 325B, 330B, 330C, or 330D WITH STATION AM MODULATION METER.

(a) If using a Model 325B or 330C, or if it is desired to use the station am modulation meter with the Model 330B or 330D, the following procedure should be used for connecting the Analyzer to the modulation meter.

(b) Patch from the high-impedance output terminals on the am modulation meter to the af INPUT terminals on the front of the Noise and Distortion Analyzer, making certain that ground terminals are properly connected. Set AF-RF switch to AF position (not used in 325B).

(c) If using a Model 330B, 330C, or 330D Analyzer, set switch to SET LEVEL position. If using a Model 325B Analyzer, set switch to NOISE position.

(d) Set VOLTS - DB switch on Analyzer to +20 DB position.

(e) Adjust INPUT control on Analyzer so that meter on Analyzer reads exactly full scale (1.0) on upper scale.

(f) See steps 10--26 below for remainder of procedure.

(10) Set frequency controls on Analyzer to 1000 cps.

(11) Set switch on Analyzer to DISTORTION position.

(12) The meter reading on Analyzer should now drop. Tune BALANCE and FREQUENCY controls on Analyzer for minimum meter reading. Reduce setting of VOLTS - DB switch as necessary to obtain readable meter deflection. Retune BALANCE and FREQUENCY controls on Analyzer to make certain that minimum reading on meter is obtained.

(13) Distortion can now be read directly in percentage* in terms of original meter reading. For example, if the meter reads 0.5 with the VOLTS - DB switch in the 1% (-20db) position, the distortion is ½ of 1%. Record reading obtained in space provided at top of page 13.

* Distortion can also be read in db by subtracting the new reading from the first reading (+22db). In the above example the distortion reading would be 46 db (below 25% modulation).

(14) Tune Model 206A to 30 cps and, if necessary, adjust setting of VOLTS - DBM meter in 206A to +15 dbm with AMPLITUDE control.

(15) Adjust output attenuators on Model 206A so that am modulation meter indicates 25% modulation.

(16) Set VOLTS - DB switch on Analyzer to +20 db position.

(17) Set switch on Analyzer to SET LEVEL position. If using a Model 325B, set switch to NOISE position.

(18) Adjust frequency controls on Analyzer to 30 cps.

(19) If necessary, adjust INPUT control on Analyzer so that meter reads exactly full scale on the 1.0 scale.

(20) Set switch on Analyzer to DISTORTION position. The meter reading immediately should fall off.

(21) Adjust BALANCE and FREQUENCY controls on Analyzer for minimum meter reading. Reduce setting of VOLTS - DB switch as necessary to obtain readable meter deflection. Retune BALANCE and FREQUENCY controls to make certain that minimum meter reading is obtained.

(22) Read distortion directly in percentage from readings of meter and VOLTS - DB switch. Record reading in space provided at top of page 13.

(23) Repeat steps (14) to (22) for frequencies of 50, 100, 400, 5000, and 7500 cps. Record readings in space provided below. In addition, if any sharp differences in the percentage distortion for two adjacent frequencies is obtained, further readings should be taken to determine the nature and cause of the differences. Such readings can not be taken with the Model 325B.

(24) Repeat steps (14) to (23) for modulation percentages of 50% and for frequencies of 30, 50, 100, 400, 1000, 5000, and 7500 cps. Record readings in space provided on page 13.

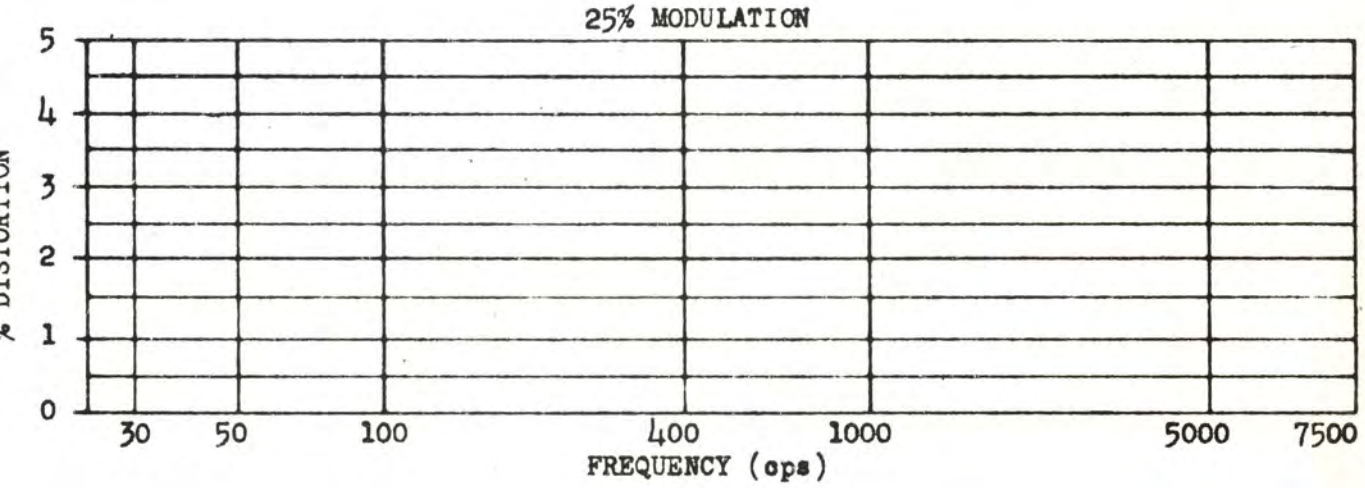
(25) Repeat steps (14) to (23) for modulation percentages of 85% and for frequencies of 30, 50, 100, 400, 1000, 5000, and 7500 cps. Record readings in space provided on page 13.

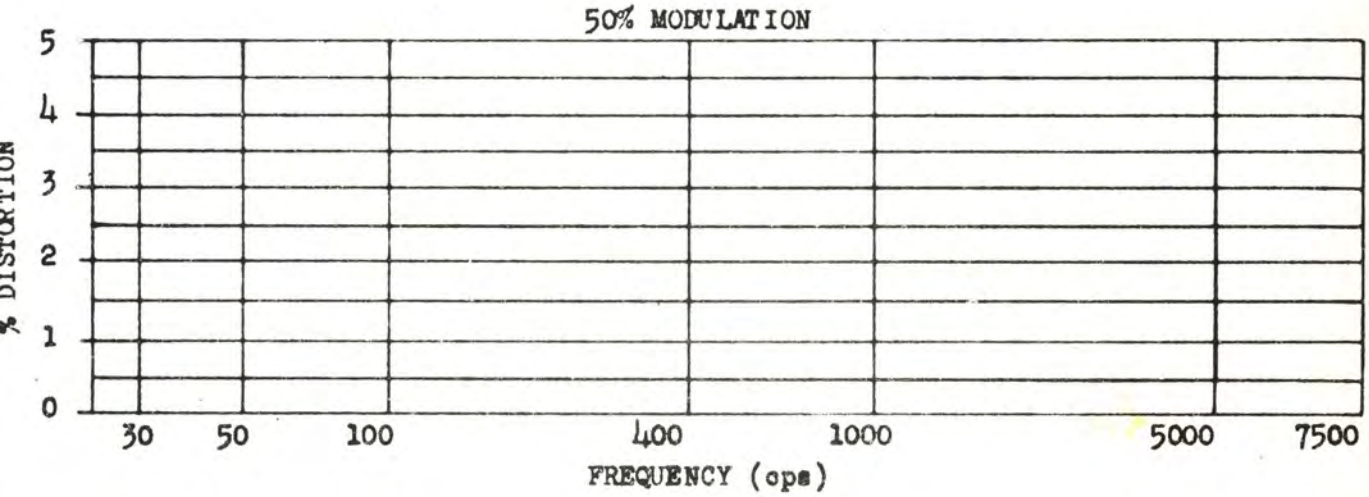
(26) Repeat steps (14) to (23) for the highest modulation

percentages obtainable (but not over 100%) and for frequencies of 30, 50, 100, 400, 1000, 5000, and 7500 cps. Record readings in space provided on page 13. Transfer data to graphs on pages 13 and 14 and sketch curves.

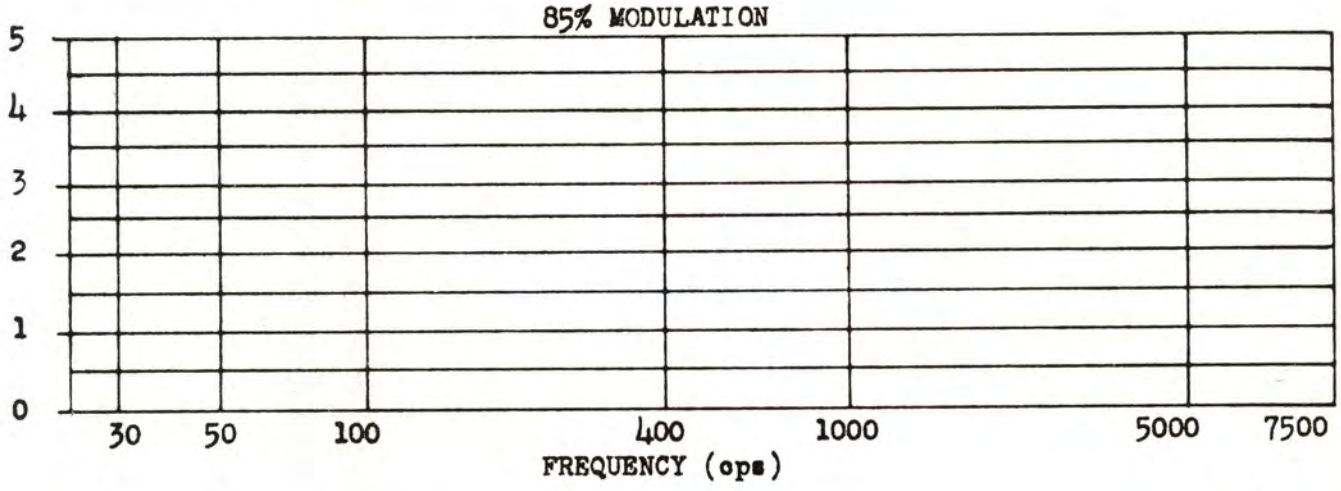
HARMONIC DISTORTION

	30 cps	50 cps	100 cps	400 cps	1000 cps	5000 cps	7500 cps
25% MOD.							
50% MOD.							
85% MOD.							
100% MOD.							

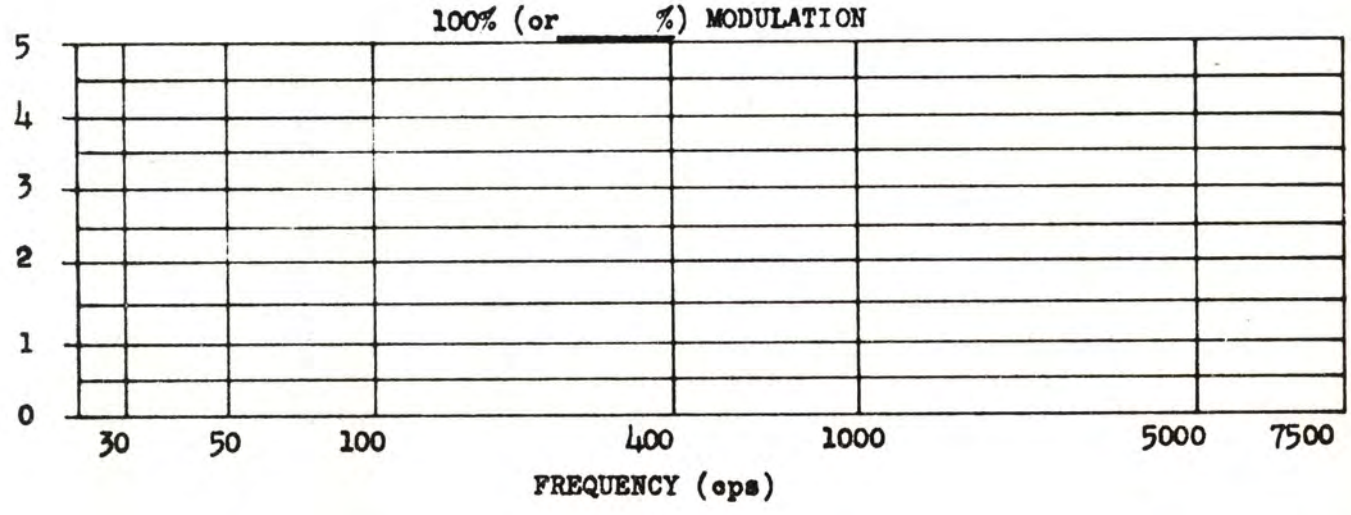




85% MODULATION



100% (or ____ %) MODULATION



FCC REQUIREMENT III

"Data showing percentage carrier shift for 25, 50, 85 and 100 percent modulation with 400 cps tone."

A. Equipment Required:

(1) -hp- Model 206A Audio Signal Generator.

(2) -hp- Model 330B or 330D Noise and Distortion Analyzer.

(3) High impedance dc voltmeter.

B. Procedure:

(1) The transmitter, main studio amplifier, and interconnecting equipment must be operating for this measurement and the transmitter should be coupled to the antenna so that the test signal can be obtained from the final tank circuit as loaded by the antenna. Any limiting amplifiers in the circuit must be by-passed. All equipment should be adjusted for normal program operation.

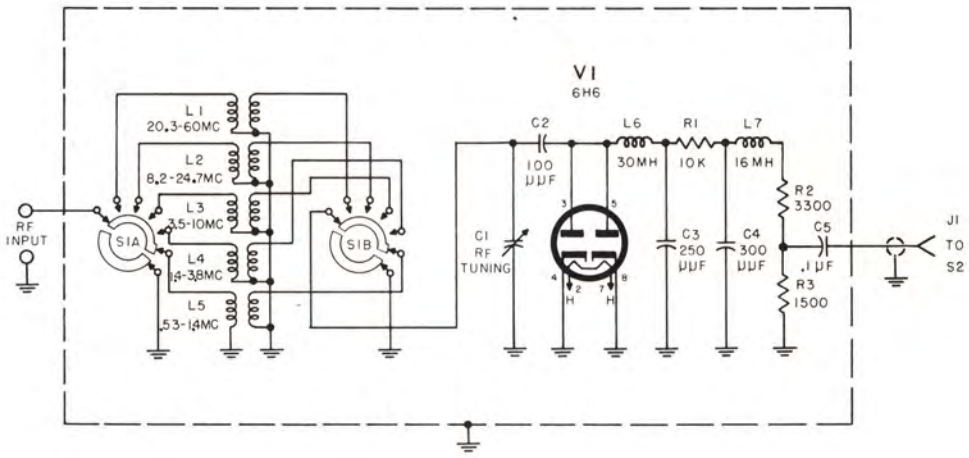
(2) Tune Model 206A to 400 cps. Set output attenuators for zero attenuation and set IMPEDANCE switch to 600 ohm position.

(3) Turn AMPLITUDE control completely counter-clockwise. Patch from the Model 206A to the main studio amplifier input.

(4) Connect the rf terminals on the back of the Model 330B or 330D to the monitoring output provided in the final tank circuit of the transmitter. If a voltage substantially in excess of 15 volts rf is provided at these terminals, use a one-quarter to one-megohm resistor to drop the voltage applied to the Model 330B/330D. Set AF-RF switch on front of instrument to RF position and turn INPUT control completely counter-clockwise.

(5) Connect a dc voltmeter having a high input impedance (preferably at least several megohms) from ground to the input side of condenser C5 in the rf detector circuit of the Model 330B/330D (see diagram). This should be a negative dc voltage.

(6) Tune RF control on front of Model 330B/330D for a maximum reading on dc voltmeter. A voltage of the



SCHEMATIC DIAGRAM OF DETECTOR CIRCUIT OF -HP-
MODEL 330B, 330D

order of 1 to 5 volts dc should be obtained. Record reading obtained in space provided on page 18.

(7) Increase setting of AMPLITUDE control on Model 206A until station modulation meter indicates 25% modulation.

(8) Record on page 18 the new reading obtained on voltmeter. Only a slight change, if any is to be expected in the voltmeter reading.

(9) Advance setting of AMPLITUDE control on Model 206A until station modulation meter indicates 50% modulation. Record new reading obtained on voltmeter. Only a slight change in the voltmeter reading is to be expected.

(10) Advance setting of AMPLITUDE control on Model 206A until modulation meter indicates 85% modulation. Record new reading obtained on voltmeter.

(11) Advance setting of AMPLITUDE control on Model 206A until modulation meter indicates highest modulation obtainable (but not over 100%). Record new reading obtained on voltmeter.

(12) On page 18 calculate the percentage of carrier shift for the various depths of modulation.

FCC REQUIREMENT IV

"Carrier hum and extraneous noise generated within the equipment and measured as the level below 100 percent modulation throughout the audio spectrum or by bands."

A. Equipment Required:

(1) -hp- Model 206A Audio Signal Generator.

(2) -hp- Model 325B, 330B, 330C, or 330D Noise and Distortion Analyzer.

(3) Station AM modulation meter.

B. Procedure with Models 330B or 330D:

(1) The transmitter, main studio amplifier, and interconnecting equipment must be operating for this measurement and the transmitter should be coupled to the antenna so that the test signal can be obtained from the final tank circuit as loaded by the antenna. Any limiting amplifiers in the circuit must be by-passed. All equipment should be adjusted for normal program operation.

(2) Tune Model 206A to 400 cps. Adjust setting of AMPLITUDE control so that output meter in Model 206A reads +15 dbm. Set attenuators to 40 or 50 db of attenuation. Set IMPEDANCE switch to 600 ohm position.

(3) Patch from output terminals on Model 206A to input of main studio amplifier. Adjust setting of Model 206A output attenuators so that modulation meter indicates 100% modulation (or next highest value obtainable).

(4) Connect rf terminals on back of Model 330B/330D to monitoring output provided by transmitter manufacturer in final tank circuit. If a voltage in excess of 15 volts rf is provided at this connection, use a one-quarter to one megohm resistor to decrease the voltage applied to the Model 330B/330D.

(5) Set AF - RF switch on Model 330B/330D to RF position and set meter selector switch to SET LEVEL position.

(6) Set rf band selector switch on back of Model 330B/330D to "1". Set INPUT control completely clockwise and adjust setting of VOLTS - DB switch as necessary to

CARRIER SHIFT DATA (AT 400 cps)

	25% MOD	50% MOD	85% MOD	100% MOD	EXAMPLE
ENTER dc vm READING WITHOUT MOD.					0.55 v
ENTER dc vm READING WITH MOD.					0.50 v
SUBTRACT ABOVE READINGS					0.05 v
COMPUTE SHIFT $\frac{\text{ERENCE}}{\text{ING}}$ x 100 OUT MOD.					$\frac{.05}{0.55} \times 100 =$ 9.1% CARRIER SHIFT

FCC REQUIREMENT IV

"Carrier hum and extraneous noise generated within the equipment and measured as the level below 100 percent modulation throughout the audio spectrum or by bands."

A. Equipment Required:

(1) -hp- Model 206A Audio Signal Generator.

(2) -hp- Model 325B, 330B, 330C, or 330D Noise and Distortion Analyzer.

(3) Station AM modulation meter.

B. Procedure with Models 330B or 330D:

(1) The transmitter, main studio amplifier, and interconnecting equipment must be operating for this measurement and the transmitter should be coupled to the antenna so that the test signal can be obtained from the final tank circuit as loaded by the antenna. Any limiting amplifiers in the circuit must be by-passed. All equipment should be adjusted for normal program operation.

(2) Tune Model 206A to 400 cps. Adjust setting of AMPLITUDE control so that output meter in Model 206A reads +15 dbm. Set attenuators to 40 or 50 db of attenuation. Set IMPEDANCE switch to 600 ohm position.

(3) Patch from output terminals on Model 206A to input of main studio amplifier. Adjust setting of Model 206A output attenuators so that modulation meter indicates 100% modulation (or next highest value obtainable).

(4) Connect rf terminals on back of Model 330B/330D to monitoring output provided by transmitter manufacturer in final tank circuit. If a voltage in excess of 15 volts rf is provided at this connection, use a one-quarter to one megohm resistor to decrease the voltage applied to the Model 330B/330D.

(5) Set AF - RF switch on Model 330B/330D to RF position and set meter selector switch to SET LEVEL position.

(6) Set rf band selector switch on back of Model 330B/330D to "1". Set INPUT control completely clockwise and adjust setting of VOLTS - DB switch as necessary to

obtain readable deflection of meter. Tune RF control on front of instrument for maximum reading on meter.

(7) After these adjustments, at least a full-scale reading on meter with VOLTS - DB switch in 100% position should be obtained. If not, it is necessary to increase the coupling between the rf terminals on the back of the instrument and the monitoring output provided on the transmitter.

(8) Adjust setting of INPUT control on Model 330B/330D so that a full-scale reading (1.0) is obtained with the VOLTS - DB switch in the 100% position.

(9) Turn off power on Model 206A, and if necessary set attenuators for 20 db or more of attenuation.* The meter reading on Model 330B/330D should immediately fall off.

(10) Change setting of meter selector switch in Model 330B/330D from SET LEVEL to NOISE position.

(11) Reduce setting of VOLTS - DB switch until a readable meter deflection is obtained.

(12) Hum and noise can now be read directly from the setting of the meter and the VOLTS - DB switch. However, a correction must be made to take into account the changing of position of the meter selector switch from SET LEVEL to NOISE. This correction consists of adding 20 db to the difference in the two meter readings. For example, if the meter now reads -5 db with the switch in the -20db position, the hum and noise level is 67 db below the level of 100% modulation. (+22 db - -25 db = 47 db. Adding the correction of 20 db gives the result of 67 db).

If the reading is desired in terms of percentage, the percentage value would be approximately 0.04%. (The percentage value read on the meter must be corrected by a factor of 1/10 to allow for the changing of position of the switch. Thus, percentage would be computed in this example as 04/10 x 100% x 1/10 = .04%).

* As an alternate procedure, the Model 206A could be disconnected from the amplifier input and a 600 ohm wirewound resistor connected across amplifier input terminals.

(13) Enter readings in space provided below and calculate hum and noise level.

COMBINED NOISE AND HUM READING

DB	%

C. Procedure with Models 325B or 330C:

(1) If a Model 325B or 330C is in use at the station, it is necessary to use the output from the station AM modulation meter. However, it should be noted that the modulation meter must have a low hum and noise level in itself, as its noise and hum will be added to that of the transmitter in the following measurement.

(2) Adjust Model 206A as described in steps (2) and (3) under "B" above.

(3) Connect the high-impedance output terminals of the modulation meter to the AF INPUT terminals on the Model 325B/330C, making certain that the ground terminals are properly connected.

(4) Set AF - RF switch on Analyzer to AF position. Set meter selector switch to SET LEVEL position(NOISE position on Model 325B).

(5) Set VOLTS - DB switch to +20db position.

(6) Adjust setting of INPUT control so that meter on Model 325B/330C reads exactly full scale (1.0).

(7) Turn off line power switch on Model 206A, and if necessary set attenuators for 20 db or more of attenuation. *

(8) Reduce setting of VOLTS - DB switch until readable meter deflection is obtained.

(9) The noise and hum level can now be read directly either in terms of percentage or in db. On the Model 330C, the meter selector switch can be changed from the SET LEVEL to the NOISE positions to increase the sensitivity of the meter by a factor of 10. If this

* As an alternate procedure, the Model 206A could be disconnected from the amplifier input and a 600 ohm wirewound resistor connected across amplifier input terminals.

is done, 20 db should be added to the hum and noise level, or if calculated in percentage, the percentage figure should be divided by a factor of 10.

(10) Enter calculations in space provided below.

COMBINED NOISE AND HUM READING

DB	%

S E C T I O N II

PERFORMANCE MEASUREMENTS

OF

FM BROADCAST STATIONS

FCC REQUIREMENT I

"Audio frequency response from 50 to 15,000 cycles for approximately 25, 50, and 100 percent modulation. Measurements shall be made on at least the following audio frequencies: 50, 100, 400, 1000, 5000, 10,000, and 15,000 cycles. The frequency response measurements should normally be made without deemphasis; however, standard 75 micro-second deemphasis may be employed in the measuring equipment or system, provided the accuracy of the deemphasis circuit is sufficient to insure that the measured response is within the prescribed limits."

A. Equipment Required:

(1) -hp- Model 335B FM Frequency Monitor and Modulation Meter.

(2) -hp- Model 206A Audio Signal Generator.

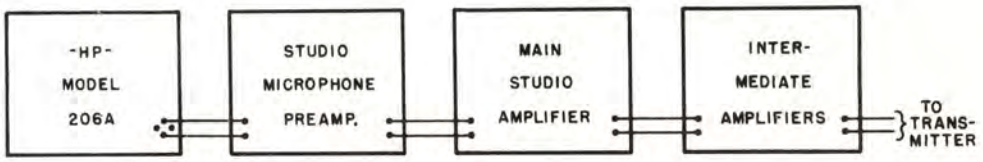
B. Procedure:

(1) The transmitter, main studio amplifier, and intermediate equipment must be operating for this measurement, and the transmitter should be coupled to the antenna so that the test signal can be obtained from the final tank circuit as loaded by the antenna. All equipment should be adjusted for normal program operation. Any limiting amplifiers in the circuit should be by-passed for these measurements.

(2) Tune Model 206A Audio Signal Generator to 1000 cps by means of RANGE and FREQUENCY controls. Set 0 - 100 DB attenuator on Model 206A to about 40 db to prevent overloading of transmitter circuits.

(3) Turn AMPLITUDE control on Model 206A completely counter-clockwise so that VOLTS - DBM meter reads 0.

(4) Patch from Model 206A to studio microphone preamplifier input as shown in following figure. Assuming that the input impedance of the studio preamplifier is 600 ohms (the present standard), the IMPEDANCE switch on the Model 206A should be set to the 600 ohm position. Ordinarily, the connections should be floating.



(5) Adjust AMPLITUDE control on Model 206A so that VOLTS - DBM meter indicates +15 dbm.

(6) Adjust setting of output attenuators on Model 206A so that station modulation meter indicates 25% modulation. Record setting of output attenuators in space provided on page 26.

(7) Tune Model 206A to 30 cps. If necessary adjust setting of VOLTS - DBM meter with AMPLITUDE control so that meter reads +15 dbm.

(8) Adjust setting of output attenuators on Model 206A so that station modulation meter indicates 25% modulation. Usually, the attenuation will have to be decreased one-half db or so from the previous setting. Record setting of output attenuators in space provided on page 26.

(9) Tune Model 206A to 50 cps. If necessary adjust setting of VOLTS - DBM meter with AMPLITUDE control so that meter reads +15 dbm.

(10) Adjust setting of output attenuators on Model 206A so that station modulation meter indicates 25% modulation. Record setting of output attenuators in space provided on page 26.

(11) Repeat steps (9) and (10) for frequencies of 100, 400, 5000, 10,000, and 15,000 cycles. Record output attenuator readings for each frequency. In addition, if any reading is 0.2 db different from preceding reading, it is recommended that readings be taken at intermediate frequencies.

(12) Repeat steps (9) and (10) at frequencies of 50, 100, 400, 1000, 5000, and 10,000 and 15,000 cycles for modulation meter readings of both 50 and 100% modulation. Record all readings in space provided on pages 26 and 27.

(13) Transfer "Input Variation" readings on pages 26 and 27 to graph sheets on pages 28 and 29 of this manual.

25% MODULATION

	50 cps	100 cps	400 cps	1000 cps	5000 cps	10000 cps	15000 cps	EXAMPLE
ENTER 1000 cps READING (ALL SPACES)								22.6 db
ENTER 206A ATTENUATOR READINGS								22.8 db
SUBTRACT READINGS. RESULT IS INPUT VARIATION				0 db				-0.2 db

50% MODULATION

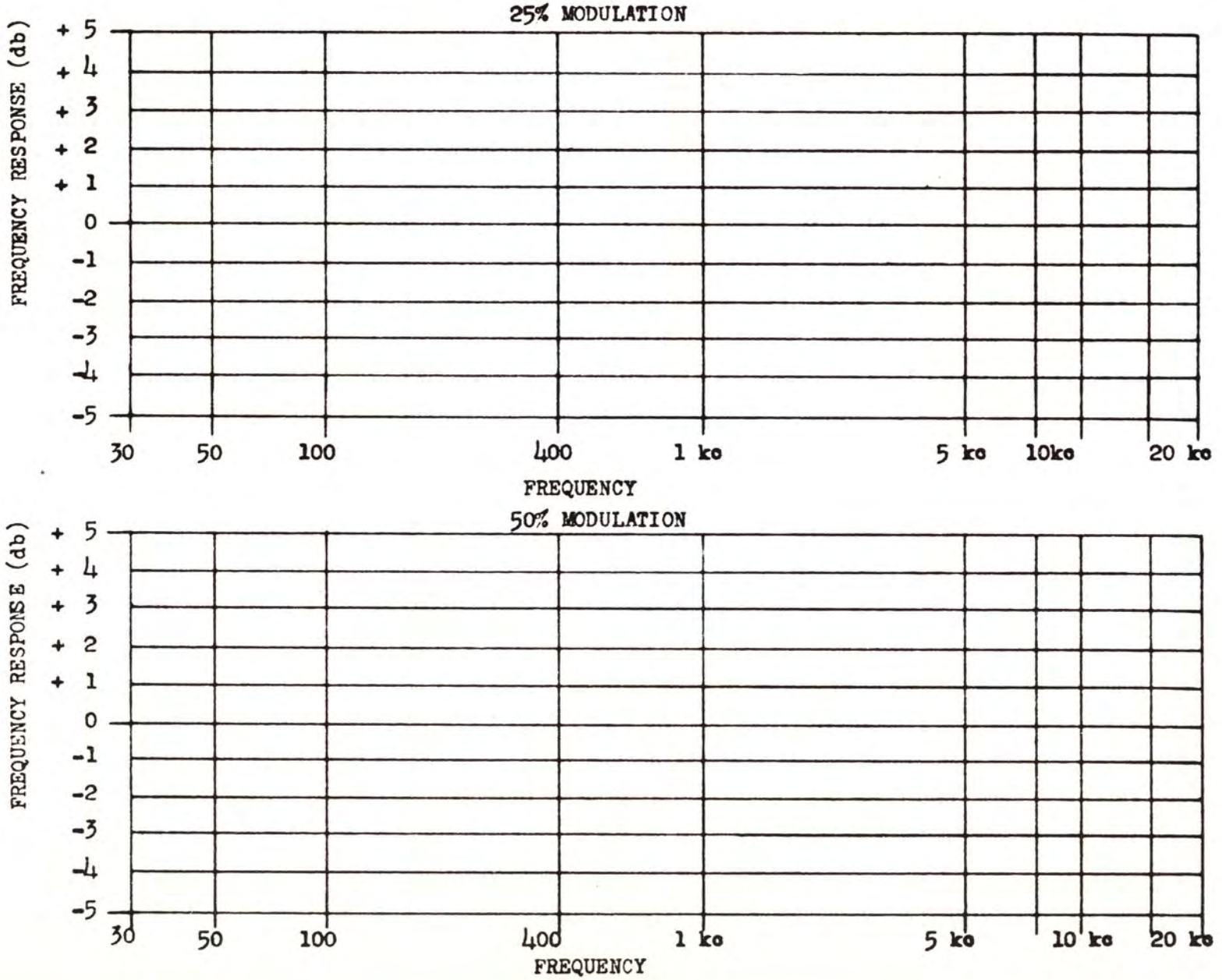
	50 cps	100 cps	400 cps	1000 cps	5000 cps	10000 cps	15000 cps	EXAMPLE
ENTER 1000 cps READING (ALL SPACES)								16.7
ENTER 206A ATTENUATOR READINGS								16.6
SUBTRACT READINGS. RESULT IS INPUT VARIATION				0 db				+0.1 db

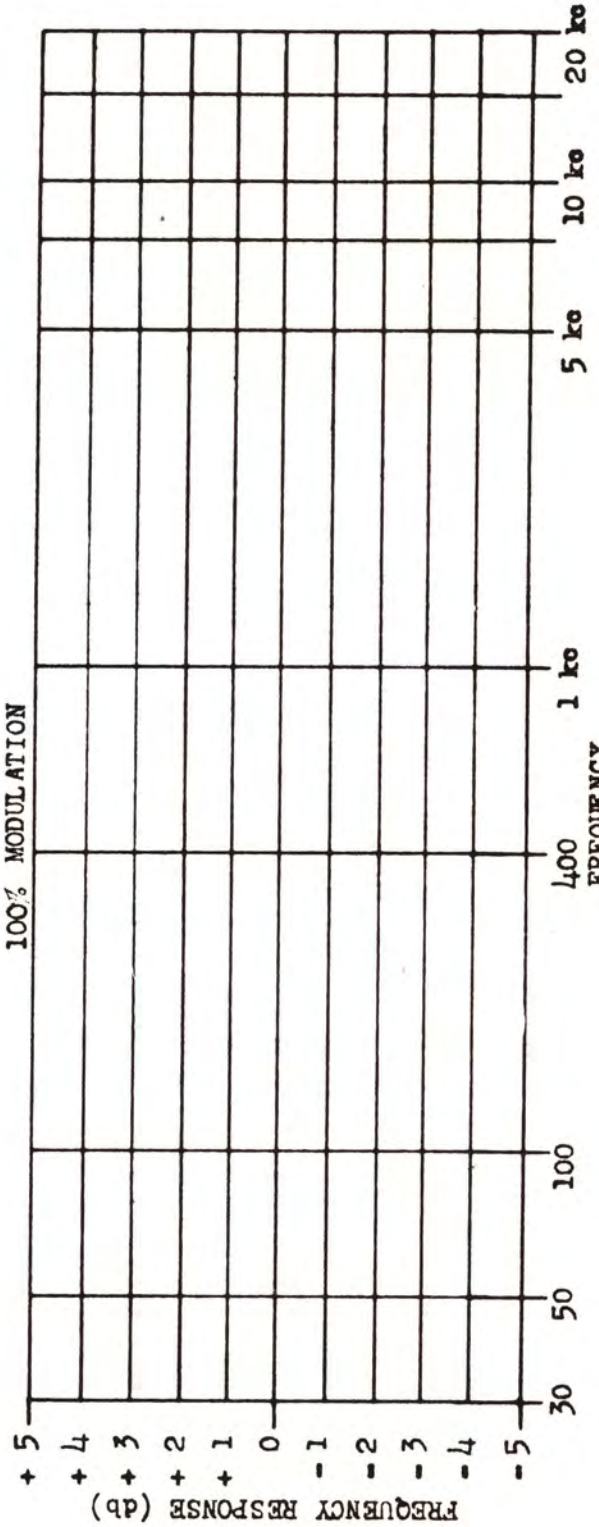
100% MODULATION

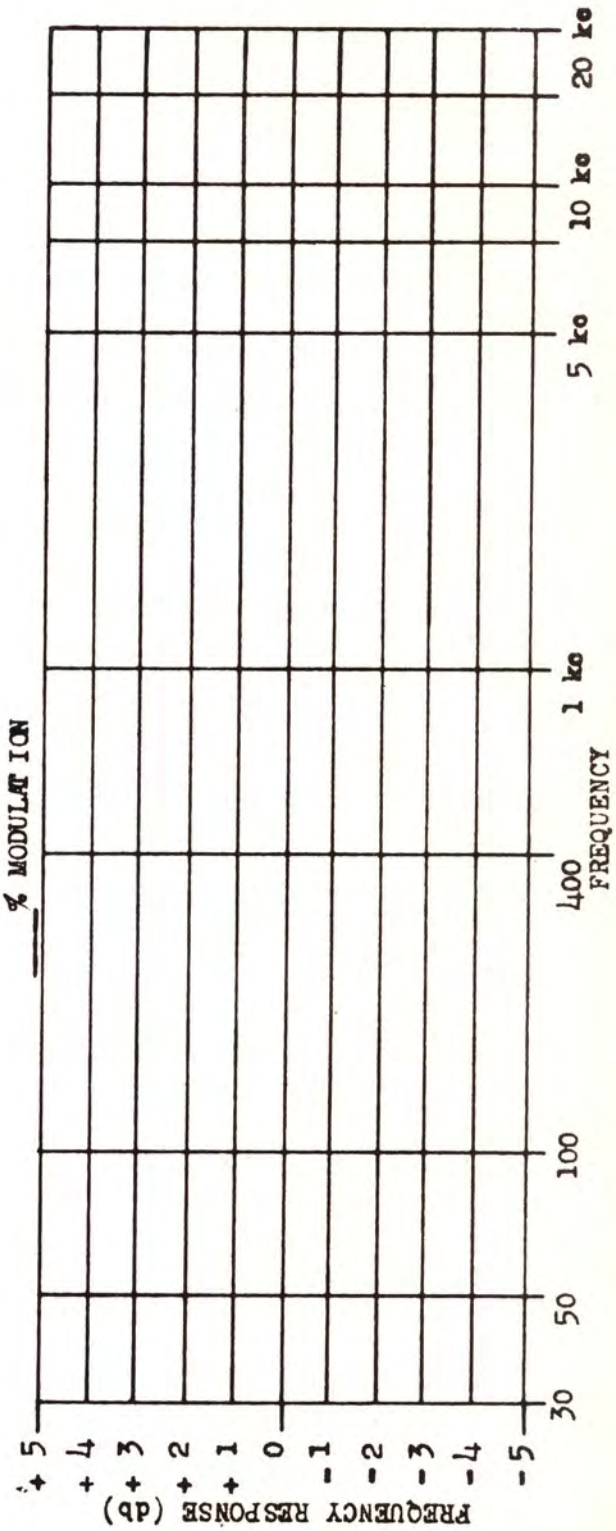
	50 cps	100 cps	400 cps	1000 cps	5000 cps	10000 cps	15000 cps	EXAMPLE
ENTER 1000 cps READING (ALL SPACES)								10.6 db
ENTER 206A ATTENUATOR READINGS								10.5 db
SUBTRACT READINGS. RESULT IS "INPUT VARIATION"				0 db				+0.1 db

_____% MODULATION

	50 cps	100 cps	400 cps	1000 cps	5000 cps	10000 cps	15000 cps	
ENTER 1000 cps READING (ALL SPACES)								
ENTER 206A ATTENUATOR READINGS								
SUBTRACT READINGS. RESULT IS "INPUT VARIATION"								







FCC REQUIREMENT II

"Audio frequency harmonic distortion for 25, 50, and 100 percent modulation for the fundamental frequencies of 50, 100, 400, 1000, and 5000 cycles. Audio frequency harmonics for 100 percent modulation for fundamental frequencies of 10,000 and 15,000 cycles. Measurements shall normally include harmonics to 30,000 cycles. The distortion measurements shall be made employing 75 micro-second de-emphasis in the measuring equipment or system."

A. Equipment Required:

(1) -hp- Model 335B Frequency Monitor and Modulation Meter.

(2) -hp- Model 206A Audio Signal Generator.

(3) -hp- Model 330B, 330C, or 330D Noise and Distortion Analyzer.

B. Procedure:

(1) The transmitter, main studio amplifier, and intermediate equipment must be operating for this measurement, and the transmitter should be coupled to the antenna so that the test signal can be obtained from the final tank circuit as loaded by the antenna. All equipment should be adjusted for normal program operation. Any limiting amplifiers in the circuit should be by-passed for these measurements.

(2) Tune Model 206A to 50 cps by means of RANGE and FREQUENCY controls. Set 0 - 100 DB attenuator to about 40 db to prevent overloading of the circuits.

(3) Turn AMPLITUDE control on Model 206A completely counter-clockwise, so that VOLTS - DBM meter reads zero.

(4) Patch Model 206A to input of studio microphone preamplifier. Assuming that the input impedance of the amplifier is 600 ohms, set the IMPEDANCE switch on the Model 206A to the 600 ohm position.

(5) Advance setting of AMPLITUDE control so that VOLTS - DBM meter reads +15 dbm. Adjust setting of output

attenuators so that modulation meter indicates 25% modulation.

(6) Connect AF INPUT terminals on Model 330 to high-impedance output terminals on back of FM Frequency Monitor and Modulation Meter. Set AF-RF switch on Model 330 to AF position.

(7) Set meter selector switch on Model 330 to SET LEVEL position.

(8) Set VOLTS - DB switch on Model 330 to 100% position. Adjust setting of INPUT control so that meter reads exactly full scale (1.0) on uppermost scale.

(9) Turn meter selector switch to DISTORTION position.

(10) Using RANGE and FREQUENCY controls on Model 330, tune instrument to 50 cps. The meter reading should fall off.

(11) Minimize meter reading by tuning BALANCE and FREQUENCY controls. Reduce setting of VOLTS - DB switch as necessary to obtain readable meter deflection.

(12) Distortion can now be read directly in percentage from the settings of the VOLTS - DB switch and the meter. For example, if the meter reads "1.5" with the switch in the "3%" position, the distortion is 1.5%. Record reading obtained in space provided on page 33.

Distortion readings in db also can be read directly For example, in the above example the distortion would be approximately 36 db below the audio level.

(13) Tune Model 206A to 100 cps. If necessary, set meter to +15 dbm by means of AMPLITUDE control. Adjust output attenuators so that modulation meter indicates 25% modulation.

(14) Set VOLTS - DB switch on Model 330 to 100% position. Set meter selector switch to SET LEVEL position. If necessary, make slight adjustment of INPUT control so that meter reads exactly full scale.

(15) Tune Model 330 to 100 cps. Set meter selector switch to DISTORTION position. The meter reading immediately should fall off somewhat.

(16) Minimize Model 330 meter reading with BALANCE and FREQUENCY controls. Reduce setting of VOLTS - DB switch as necessary to obtain readable meter deflection.

(17) Enter distortion reading in space provided on page 33.

(18) Repeat steps (13) to (17) for frequencies of 400, 1000,and 5000 cycles. Enter readings in space provided on page 33.

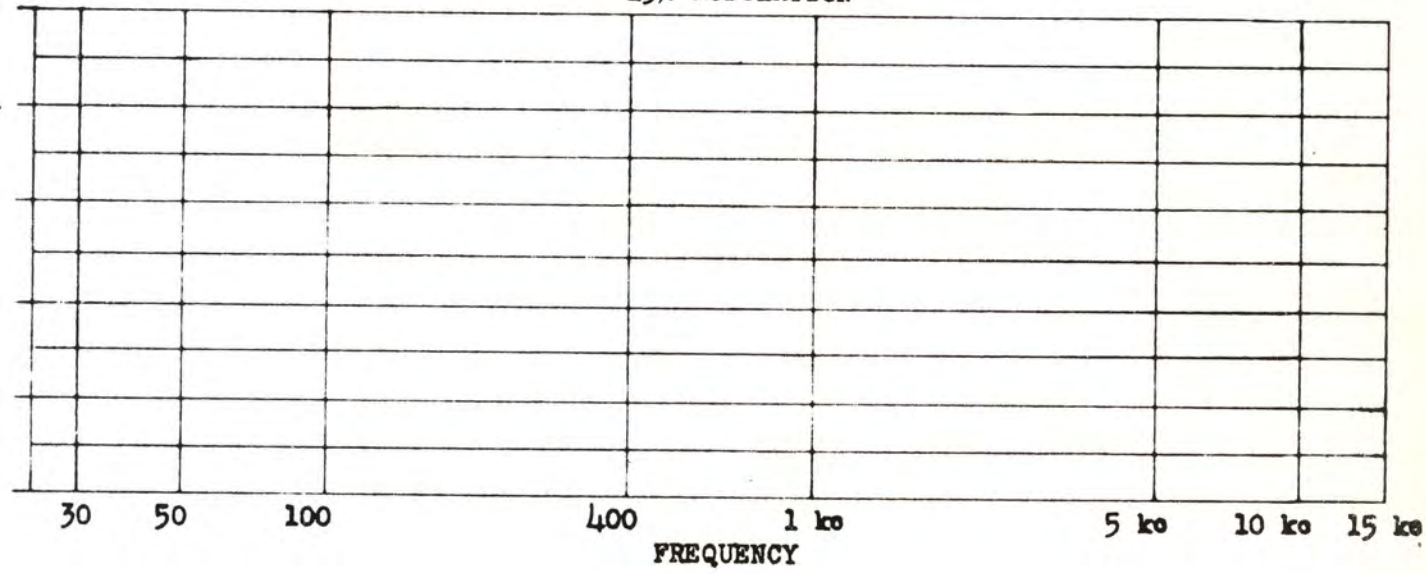
(19) Repeat steps (13) to (18) for modulation percentages of 50 to 100%. Measurements should be made for frequencies of 50, 100, 400, 1000, and 5000 cycles for 50% modulation. For 100% modulation the measurements should be made at 50, 100, 400, 1000, 5000, and 10,000 and 15,000 cycles. Enter all measurements in space provided on page 33.

(20) Sketch curves in space provided on pages 33 and 34.

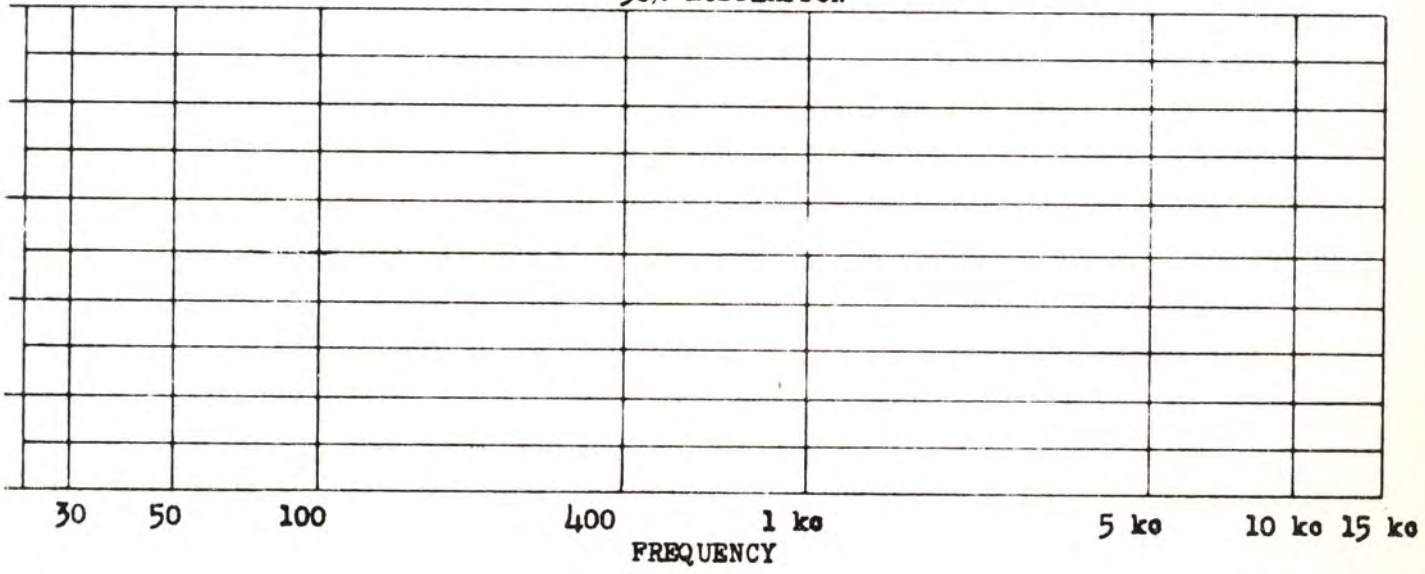
HARMONIC DISTORTION

	50 cps	100 cps	400 cps	1000 cps	5000 cps	10000 cps	15000cps
25% MOD.							
50% MOD.							
100% MOD.							

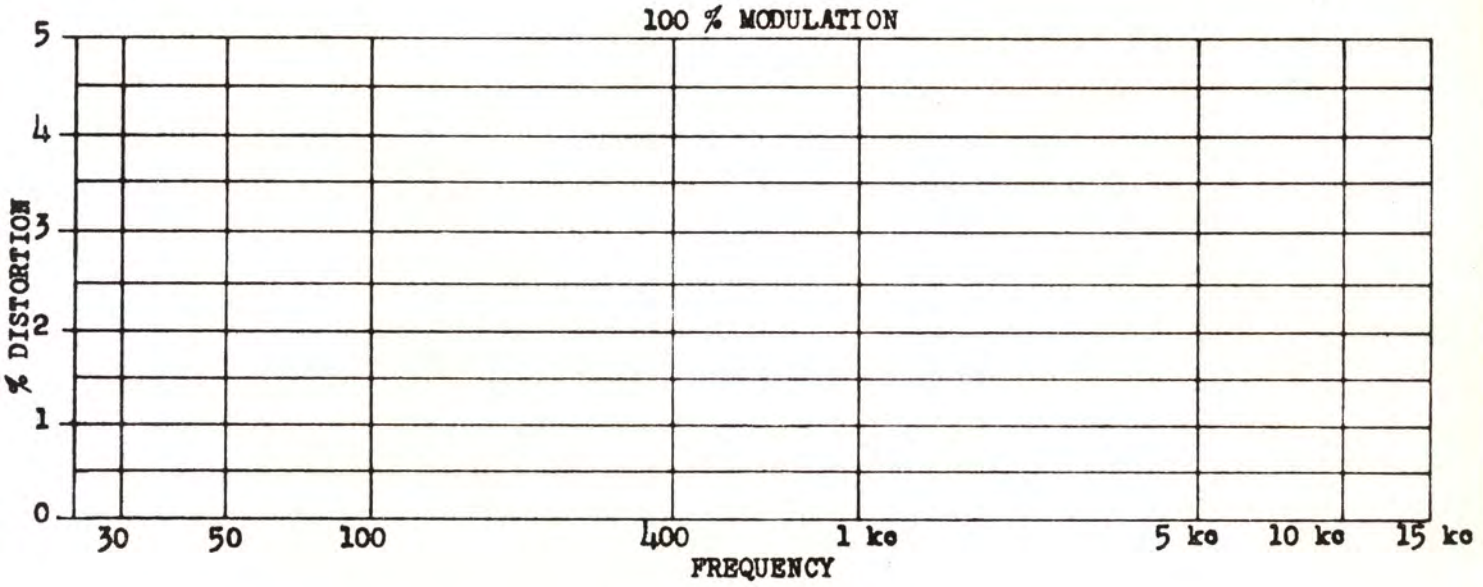
25% MODULATION



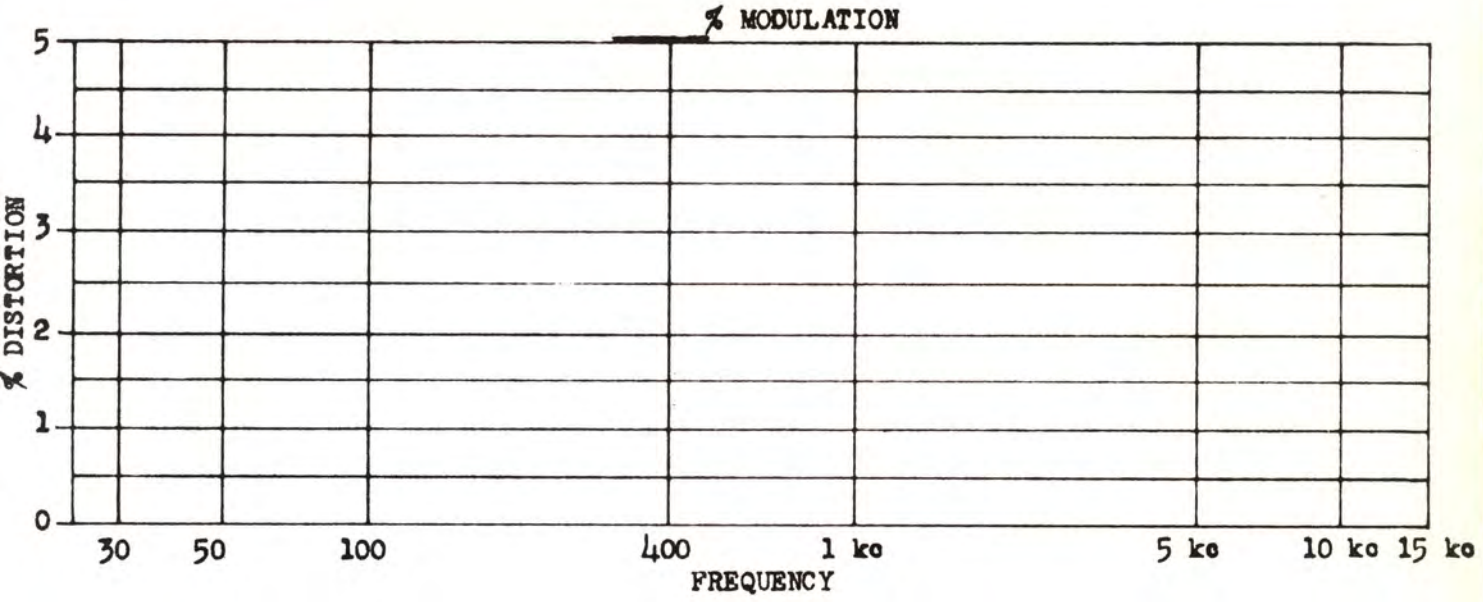
50% MODULATION



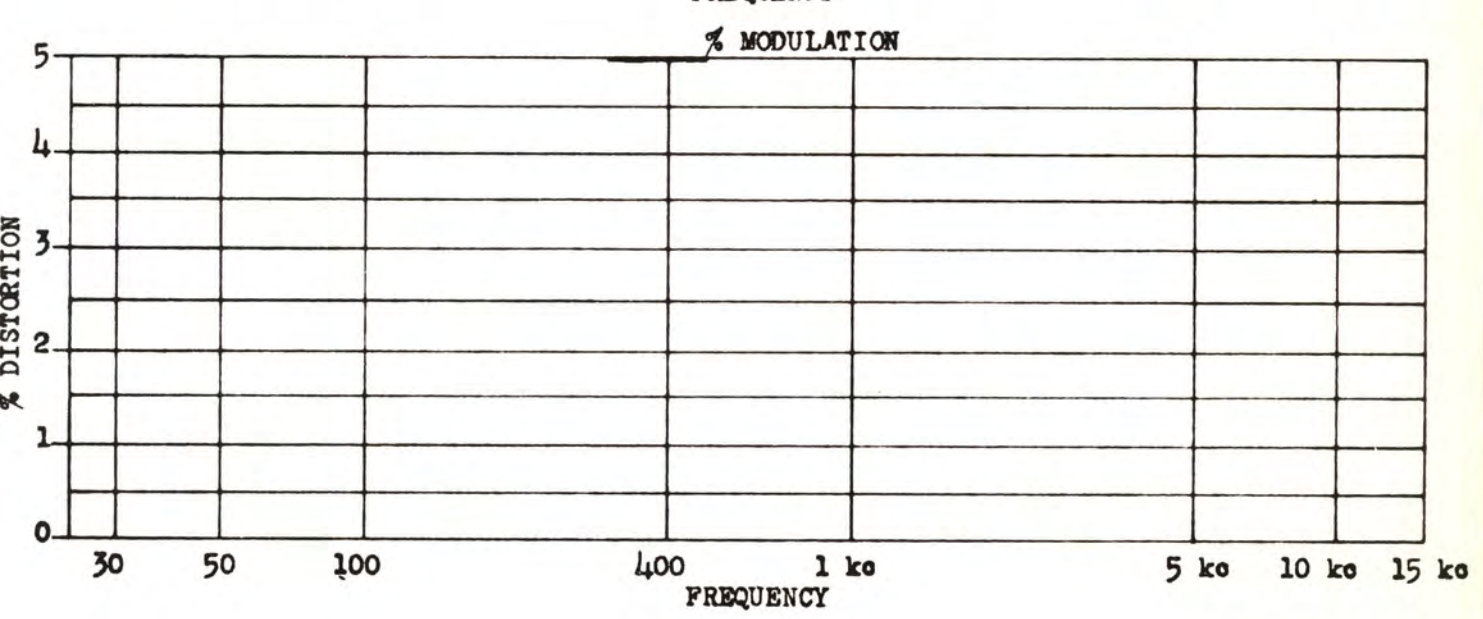
100 % MODULATION



% MODULATION



% MODULATION



FCC REQUIREMENT III

"Output noise level (frequency modulation) in the band of 50 to 15,000 cycles in decibels below the audio frequency level representing a frequency swing of 75 kilocycles. The noise measurements shall be made employing 75 microsecond de-emphasis in the measuring equipment or system.

A. Equipment Required:

(1) -hp- Model 335B FM Frequency Monitor and Modulation Meter.

(2) -hp- Model 206A Audio Signal Generator.

(3) -hp- Model 330B, 330C, or 330D Noise and Distortion Analyzer.

B. Procedure:

(1) The transmitter, studio microphone preamplifier, and intermediate equipment must be operating for this measurement, and the transmitter should be coupled to the antenna so that the test signal can be obtained from the final tank circuit as loaded by the antenna. All equipment should be adjusted for normal program operation. Any limiting amplifiers in the circuit should be by-passed for these measurements.

(2) Tune Model 206A Audio Signal Generator to 1000 cps by means of RANGE and FREQUENCY controls. Set 0 - 100 DB attenuator on Model 206A to about 40 db to prevent overloading of transmitter circuits.

(3) Turn AMPLITUDE control on Model 206A completely counter-clockwise so that VOLTS - DBM meter reads 0.

(4) If necessary, patch from Model 206A to studio microphone preamplifier input. Assuming that input impedance of amplifier input is 600 ohms, set IMPEDANCE switch to 600 ohm position.

(5) Adjust AMPLITUDE control on Model 206A so that VOLTS - DBM meter indicates +15 dbm.

(6) Adjust setting of output attenuators on Model 206A so that modulation meter indicates 100% modulation.

(7) Patch from high-impedance output terminals (#3 and 5) on Model 335B to AF INPUT terminals on Model 330, making certain that ground terminals are properly connected.

(8) Set meter selector switch on Model 330 to SET LEVEL position. Set VOLTS - DBM switch to 100% (+20 db) position. Set AF - RF switch to AF position.

(9) Adjust INPUT control on Model 330 so that meter reads 0 on db scale.

(10) Pull power cord on Model 206A from power source and make certain that output attenuators on Model 206A are set for at least 20 db of attenuation. *

(11) The meter reading of the Model 330 should immediately fall off. Change setting of meter selector switch from SET LEVEL to NOISE position.

(12) Reduce setting of VOLTS - DB switch until a readable meter deflection is obtained.

(13) Determine the difference in db between the initial and final readings of the Model 330 meter and add 20 db to account for the change in the setting of the meter selector switch. For example, if the final meter reading is -4 db with the switch in the -20 db position, the noise is 64 db below the level representing a frequency swing of 75 kcs (+20 db - -24 db = 44 db. Adding 20 db to this reading to account for the change in the setting of the meter selector switch gives a result of 64 db).

(14) Enter result in space provided below.

330 Reading	
Initial Reading	= +20 db
Final Reading (switch at NOISE)	=_____
Difference	=
Correction Factor	= 20 db
Noise Level	= - db

* As an alternate procedure, the Model 206A can be disconnected from the preamplifier input and a 600 ohm wirewound resistor connected across the preamplifier input terminals.

FCC REQUIREMENT IV

"Output noise level (amplitude modulation) in the band of 50 to 15,000 cycles in decibels below the level representing 100 percent amplitude modulation. The noise measurements shall be made employing 75 microsecond de-emphasis in the measuring equipment of the system."

A. Equipment Required:

(1) -hp- Model 335B FM Frequency Monitor and Modulation Meter.

(2) -hp- Model 330B, 330C or 330D Noise and Distortion Analyzer.

B. Procedure:

(1) The transmitter, studio microphone preamplifier, and intermediate equipment must be operating for this measurement, and the transmitter should be coupled to the antenna so that the test signal can be obtained from the final tank circuit as loaded by the antenna. All equipment should be adjusted for normal program operation. Any limiting amplifiers in the circuit should be by-passed for these measurements.

(2) Connect a 600 ohm resistor (preferably wirewound) across the input terminals of the studio microphone preamplifier.

(3) Set the CALIBRATE - USE - CARRIER LEVEL switch on the Model 335B to the CARRIER LEVEL position and note the reading obtained on the MODULATION meter. It is desirable that this reading be above at least 80%. Record the reading obtained in the space provided below.

(4) Connect the METER terminals of the Model 330 to jack J3 on the back of the Model 335B.

(5) Connect a 2-megohm resistor across the METER terminals of the Model 330 so that the resistor is shunting the line to the back of the Model 335B.

(6) Set the meter selector switch on the Model 330 to the METER position and adjust the VOLTS - DB switch

so that a readable meter deflection is obtained. Record the reading obtained in the space provided below.

(7) Since the reading of the MODULATION meter of the Model 335B is approximately proportional to voltage (100% = 10 volts rf), it is possible to compute the equivalent audio level required for 100% am modulation at the rf level in the monitor. For example, if the MODULATION meter read 80%, approximately 8 volts af would be required.

(8) Substitute the readings obtained in the following formula:

$$\%AM = \frac{\text{Audio Voltage x 1000}}{\text{carrier reading in \%}}$$

(9) Knowing the percentage from step (8) above, the decibel level can easily be computed:

$$db = 20 \log \frac{100}{\%\ AM}$$

Reading on 335B Mod. Meter =		%
$\%\ AM = \frac{\text{335B Reading x 1000}}{\text{Mod. Meter reading}}$	=	x 1000
% AM	=	
Output Noise Level in DB $= 20 \log \frac{100}{\%AM}$	= -	db

* * * * * * * * * * * * *

Every effort has been expended to make the material in this manual as accurate as possible. However, the Hewlett-Packard Company can assume no responsibility or liability whatsoever for the information contained herein or for actions arising as a result of the information contained herein.