MEASUREMENT PROCEDURES AND TEST EQUIPMENT USED

Pursuant to 47CFR 2.947

7A **RF Power Out** – Pursuant to 47 CFR 2.1046(a)

Method of Measurement: Per TIA/EIA-603-1 2.2.1

Before measuring the RF output power, the transmitter is adjusted in accordance with the tune-up procedure outlined in Exhibit 10 to give the value of voltage and current as specified in Exhibit 6A. The transmitter antenna port is then connected through an RF attenuator of the proper power rating to an HP 8901B Modulation Analyzer.

7B **Occupied Bandwidth** – Pursuant to 47 CFR 2.1049(b)

Method of Measurement: Per TIA/EIA-603-1 2.2.11, TIA-EIA-102.CAAB 3.2.5

An audio oscillator is connected to the microphone input. The frequency is set to 2500 Hz and the amplitude is adjusted to a level 16 dB above that required to produce 50% of full system deviation at the frequency of maximum response of the audio modulating circuit, in accordance with FCC rules Part 2.989(a)(1). The transmitter output is connected, via a suitable attenuator, to an HP8568A spectrum analyzer. Spectrum analysis of the transmitter output is performed to at least +/- 2.5 times the channel spacing, first of the unmodulated carrier to establish a 0 dB reference, then with the modulated signal applied.

FCC Limits -- Per 90.210 (a) (1), (2), (3)
Emission Mask B – 25kHz channel bandwidth. For Transmitters that are equipped with an audio low-pass filter.

Measured Data:

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.

(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least $43+10 \log_{10}(P)$ dB.

Emission Mask D - 12.5kHz channel bandwidth. For Transmitters that designed to operate with 12.5Khz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

Measured Data:

(1) On any frequency from the center of the authorized bandwidth f_o to 5.625Khz removed from fo: Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz. At least 7.27 (f_d - 2.88 kHz) dB.

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5Khz: At least $50+10 \log_{10}(P)$ dB or 70 dB, whichever is the lesser attenuation .

7C **Radiated Spurious Emissions** – Pursuant to 47 CFR 2.1053

Test Site:

The site, located at Plantation, Florida, is in a region reasonably free from RF interference and has been approved by the Commission for Spurious Measurements.

Method of Measurement: Per TIA/EIA-603-1 2.2.12

The equipment is adjusted to obtain peak reading of received signals wherever they occur in the spectrum by:

1. Rotating the transmitter under test
2. Adjusting the antenna height

The testing procedure is repeated for both horizontal and vertical polarization of the receiving antenna. Relative strength is indicated on the spectrum analyzer connected to the receiving antenna. To obtain actual radiated signal strength for each spurious and harmonic frequency observed, a standard signal generator with calibrated output is connected to a dipole antenna adjusted to that particular frequency. This dipole antenna is substituted for the transmitter under test. The signal generator is adjusted in output level until a reading identical to that obtained with the actual transmitter is observed on the spectrum analyzer. Signal strength is then read directly from the generator. Actual measurements are recorded on the attached graphs.

The applied limits are those from FCC 90.210, radiated spurious emissions must be

For 25 KHz channel bandwidth: $43 + 10\log_{10}$ (Power out in Watts) dB down from unmodulated carrier or equivalently less than -13 dBm (50 μW) absolute level.

For 12.5 KHz channel bandwidth: $50 + 10\log_{10}$ (Power out in Watts) dB down from unmodulated carrier or equivalently less than -20 dBm (10 μW) absolute level.

7D **Frequency Stability** – Pursuant to 47 CFR 2.1055

Method of Measurement: Per TIA/EIA-603-1 2.2.2

Temperature: Frequency measurements are made at the extremes of the temperature range -30 to +60°C and at intervals of not more than 10°C throughout the range. Sufficient time is allowed prior to each measurement for the circuit components to stabilize.

Power Supply Voltage: The primary voltage was varied from 80% to 120% of the nominal supply voltage. Voltage is measured at the output of the DC Power Supply.

The limits are those from FCC 90.213:

Frequency Stability vs. Temperature: < ±2.5 PPM
Frequency Stability vs. Power Supply Voltage: < ±2.5 PPM

7E **Modulation Limiting --** Pursuant to 47 CFR 2.1047

Method of Measurement: Per TIA/EIA-603-1 2.2.3

The transmitter shall be adjusted for full rated system deviation. Adjust the audio input for 60% of rated deviation at 1000 Hz. Using this level as a reference (0 dB), add 20 dB to the audio input level for modulation frequencies of 300, 1000, and 3000 Hz. The recorded system deviation obtained as a function of the input frequency is shown in Exhibit 6B-3. FCC 2.1047 also calls for curves showing percentage of modulation versus input audio level. The recorded system deviation obtained as a function of the input level is shown in Exhibit 6B-4.

The transmitter modulation must not exceed rated system deviation at any audio frequency input or change in input level.

7F **Audio Low Pass Filtering** -- Pursuant to 47 CFR 2.1047

Method of Measurement: Per TIA/EIA-603-1 2.2.15

Using a dummy microphone to generate a 1000 Hz tone into the unit. The transmitter is connected to an HP 8901B Modulation Analyzer, which sends the demodulated audio to an HP 8532A Spectrum Analyzer. The 1000 Hz audio level is then set as the 0 dB reference and the audio input frequency is swept from 3000 Hz to 16000 Hz. At each discrete audio input frequency, the HP Spectrum Analyzer is used to read the magnitude of the filter response.

The applicable limits are outlined in TIA/EIA-603-1 3.2.15. For frequencies between 3000 and 15000 Hz the attenuation must be at least $40\log_{10}(f/3000)$ dB below the 1000 Hz reference. frequencies above 15000 Hz must be at least 28 dB below the 1000 Hz reference.

7G **Audio Frequency Response** -- Pursuant to 47 CFR 2.1047

Method of Measurement: Per TIA/EIA-603-1 2.2.6

An audio oscillator is connected to the microphone audio input of the transmitter. At a frequency of 1khz, the level is adjusted to obtain 20% of full system deviation, to ensure that limiting does not occur at any frequency in the 300 - 3000 Hz range. A constant input level is then maintained and the oscillator frequency is varied between the range of 100 Hz. to 100 kHz. The transmitter output is monitored with an HP8901B modulation analyzer, whose FM demodulator output is monitored with an audio analyzer. De-emphasis or filtering within the test equipment is not used. The audio oscillator signal is derived from the HP8903B audio analyzer. This response measurements is linear at all frequencies, therefore the response above 3000 Hz is not attenuated as rapidly as would be the case with an in-limit response above 3000 Hz as used in EIA - 152C section 7.3. However, this method does not produce a response discontinuity at 3000 Hz.

FCC Limits: Minimum Standard - The audio frequency response shall not vary more than +1 or -3 dB from 300 to 3000 Hz as referenced to 1000 Hz level (with the exception of a permissible 6 dB/octave roll off from 2500 to 3000 Hz).

7H **Conducted Spurious Emissions** -- Pursuant to 47 CFR 2.1051

Method of Measurement: Per TIA/EIA-603-1 2.2.13

A spectrum analyzer is connected to the transmitter antenna port through an appropriate attenuator to allow the spurious emission level to be measured directly. The transmitter is modulated with a 2500 Hz sine wave at a level 16 dB greater than required to produce 50% of rated system deviation. Measurements must be made from the lowest radio frequency generated in the equipment out to the tenth harmonic of the carrier or as high as the state of the art permits. The only excluded region is that surrounding the carrier by less than or equal to 250% of the authorized bandwidth.

The spurious emissions must be more than $43 + 10\log_{10}$(power out in Watts) dB lower than the carrier for 25 kHz channels. The equivalent attenuation must be $50 + 10\log_{10}$(power out in Watts) dB for 12.5 kHz channels. These limits are in compliance with TIA/EIA-603-1 3.2.13 and the TIA/EIA TSB-102.CAAB.

7I **Transient Frequency Behavior** -- Pursuant to 47 CFR 90.214

Method of Measurement: Per TIA/EIA-603-1 2.2.19

Transient frequency behavior is a measure of the difference, as a function of time, between the actual transmitter frequency and the assigned transmitter frequency. This test is performed during switch on and switch off times of the RF PA. The output port of the transmitter is connected through an isolated coupler to the input of the Modulation Analyzer. The output from the Modulation (Demodulated Audio) is connected to channel 1 of a Tektronix TDS 3032 Digital Storage

Oscilloscope. The oscilloscope is set to trigger on a signal from the directional coupler built in to the RF PA. This directional coupler provides an output that is proportional to the RF Power Out from the transmitter. Also connected to the isolated coupler is the output of an RF signal generator (HP8657A) set to the transmitter frequency at a level 30 dB below the transmitter and modulated with a 1 kHz tone at 25 kHz or 12.5 kHz of deviation. This generator is used to capture the test receiver and lock on to the test frequency. The data shown in Exhibit 6G was created by the oscilloscope and stored to an image file.

The required limits for transient frequency behavior are specified by FCC 90.214 and TIA/EIA-603-1 3.2.19.

7J **Test Equipment List** -- Pursuant to 47 CFR 2.1033(c)

HP 8595E Spectrum Analyzer

HP 8657B Signal Generator

HP 8901B Modulation Analyzer

HP 8903B Audio Analyzer

Tektronix TDS 3032 Oscilloscope

HP 8532A Spectrum Analyzer

HP 6033A DC Power Supply

HP 8665A Signal Generator

HP 35665A Dynamic Signal Analyzer