CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

6810.2 CHG 1

12/21/92

SUBJ: **VERY HIGH FREQUENCY (VHF) OMNIRANGE TEST (VOT) SITING CRITERIA**

1. PURPOSE. This change provides additional siting guidance and reference material to site the VOT to meet the signal level requirements of Order OA P 8200.1, United States Standard Flight Inspection Manual.

2. DISTRIBUTION. This change is distributed to branch level in the office of the Program Director for Navigation and Landing and the Systems Maintenance Service; to branch level in the regional Airway Facilities divisions; to branch level in the Communications/Navigation/Surveillance Division at the FAA Technical Center; and to branch level in the FAA Logistics Center, and the FAA Academy at the Mike Monroney Aeronautical Center.

3. EXPLANATION OF CHANGES. This change adds Appendix 2, Reference Point Power, and Appendix 3, Monitor Loop Bypass. Use appendix 2 to estimate the reference point power level as a function of the VOT antenna height above ground and the distance to the reference point. If the signal level at the VOT reference point cannot be attenuated to 15 - 20 uV as required by Order OA P 8200.1, paragraph 202, then appendix 3 provides guidance on how to bypass the antenna monitor loop and attenuate the power output to obtain the required signal level.

4. DISPOSITION OF TRANSMITTAL. After filing the revised page, this transmittal should be retained.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
		Appendix 2, 1-4	12/21/92
		Appendix 3, 1-2	12/21/92

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APPENDIX 2. REFERENCE POINT POWER

This appendix can be used to determine theoretically whether a given VOT site can meet the requirements of Order OA P 8200.1, paragraph 202, for 15 - 20 uV signal level at the reference point. If the VOT cannot be sited to meet this requirement, the antenna monitor loop must be bypassed as described in Appendix 3, Monitor Loop Bypass.

1. GRAPH 1, TRANSMIT POWER, can be used to determine the amount of attenuation required to theoretically achieve an 18 uV signal level at the VOT reference point for a given antenna height above ground and distance in miles to the reference point. The following procedure provides guidance on how to use the graph to determine whether a site will support the 15 to 20 uV requirement.

a. Using an airport map, determine the line-of-site distance from the antenna site to the reference point. Typically, the reference point is the furthest point on the taxiway from the VOT antenna.

b. Determine the height, from ground level, of the transmit antenna in feet.

c. If the Transmit Antenna Height (h_t) falls between plotted heights, extrapolate the antenna height and draw a line parallel to the h_t lines.

d. Follow the point from the distance in miles across to the transmit antenna height line.

e. At their intersection, read the required VOT transmit power at the antenna.

The scale in the middle of the graph labeled "Transmit Antenna Plus Cable Loss" starts at 2.0 W (2000 mW) and adds the maximum attenuation (18 dB) allowable by the system design (3 dB line loss plus 15 dB attenuator loss). If the required VOT transmit power at the antenna is within the scale, theoretically, the site will support the 15 to 20 uV requirement. The actual site may vary as much as 3 dB. If the antenna siting cannot be located to provide the required coverage, siting characteristics, and power level at the reference point, then bypass the antenna monitor loop as shown in Appendix 3 to obtain the required attenuation. For calculations beyond the graph limits or to understand the theory behind the graph, refer to figures 1 and 2.

FIGURE 1. GRAPH 1. TRANSMIT POWER

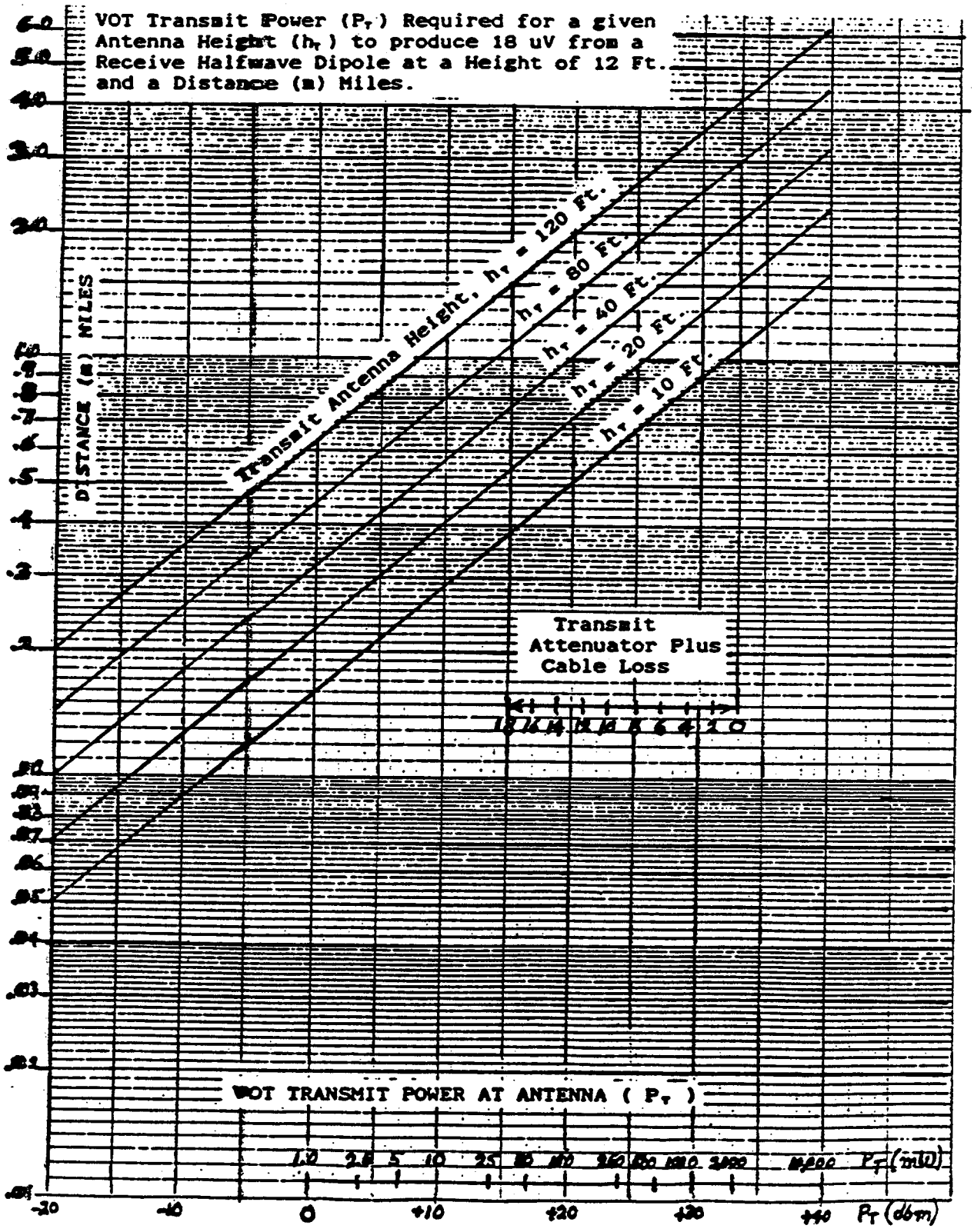


FIGURE 2. TRANSMIT POWER

The power required to be transmitted into the antenna to achieve a desired signal can be determined as follows:

$$V_R = \frac{3.677 h_T h_R (P_T)^{1/2}}{d^2} \quad ==> \quad P_T = \frac{V_R^2 \, d^4}{3.677^2 \, h_T^2 \, h_R^2}$$

V_R: Received Voltage h_T: Transmitter Height

P_T: Transmitter Power h_R: Receiver Height

d: Distance

Converting transmitter power to decibel milliwatts (dBm)

$$P_T(\text{dBm}) = 10 \log (1000 P_T)$$

$$= 10 \log 1000 + 20 \log V_R + 40 \log d - 20 \log 3.677 - 20 \log h_T - 20 \log h_R$$

$$P_T(\text{dBm}) = 20 \log V_R + 40 \log d - 20 \log h_T - 20 \log h_R + 18.69$$

The desired signal is 18 uV (15 - 20 uV), and the receiver antenna height is 12 feet in the tail of the Beechcraft KingAir.

$$P_T(\text{dBm}) = -93.89 + 40 \log d - 20 \log h_T - 21.58 + 18.69$$

$$P_T(\text{dBm}) = 40 \log m - 20 \log h_T + 52 \text{ dB}$$

P_T(dBm) = Transmitter Power (dBm) at Antenna
m = Distance in Statute Miles
h_T = Transmitter Antenna Height in Feet

TABLE 1. TRANSMIT POWER REQUIRED (dBm)

m \ h_T	2	5	8	10	18	20	30	40	60	80	100
.2	18	10	6	4.0	-1.0	-2	-5.5	-8	-11.5	-14	-16
.4	30	22	18	16.0	11	10	6.5	4.0	0.5	-2	-3.9
.6	37.1	29.1	25	23.1	18	17.1	13.6	11	7.5	5	3.1
.8		34.1	30	28.1	23	22.1	18.6	16	12.5	10	8.1
1.0			34	32	26.9	26	22.4	20	16.4	14	12
1.2				35	30	29.1	25.6	23.1	19.6	17.1	15.2
1.4					32.7	31.8	28.3	25.8	22.2	19.8	17.8
1.6						34.1	30.6	28.1	24.6	22.1	20.2
1.8							32.7	30.17	26.6	24.1	22.2
2.0								32	28.5	26	24

$$P_T(\text{dBm}) = 40 \log m - 20 \log h_T + 52 \text{ dB}$$

Power required at the transmit antenna to produce 18 μV of signal from a receive 1/2 wave dipole antenna, at a distance m miles and at a height of 12 feet. The transmit antenna is at a height of h_T feet. See plot, Figure 1, Graph 1, Transmit Power.

NOTE:

$$P_T(\text{mw}) = \log^{-1}\left[\frac{P_T\ (\text{dbm})}{10}\right]$$

Use the above to convert power in dbm to power in mw.

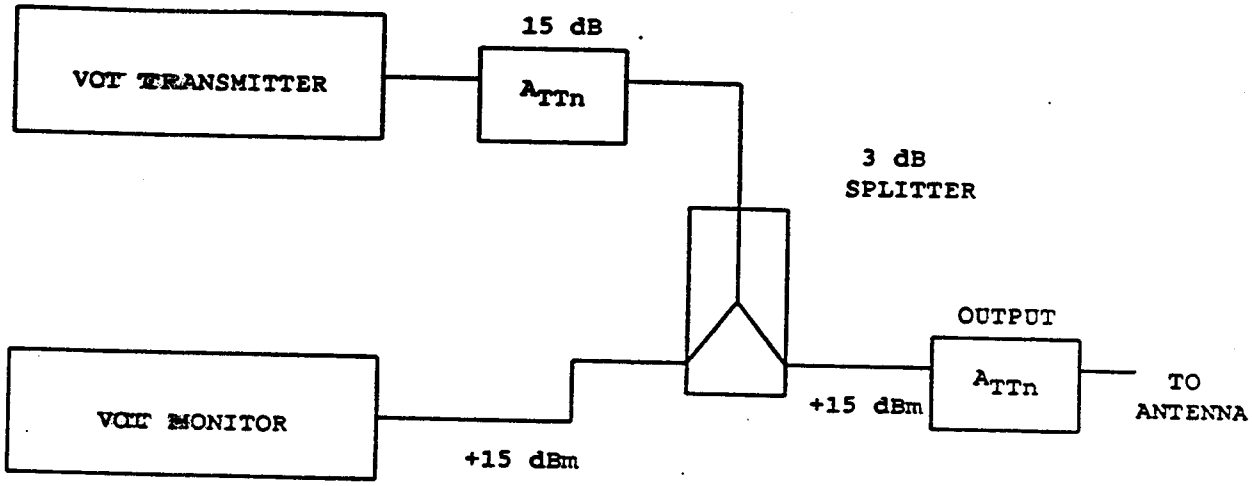
APPENDIX 3. MONITOR LOOP BYPASS

This appendix provides instructions on how to bypass the antenna monitor loop to obtain more than the total of 18 dB attenuation allowed by the FA-10235 VOT system design. Bypass the antenna monitor loop when a site cannot be located to provide the required coverage, siting characteristics, and power level at the reference point.

Figure 3, Monitor Loop Bypass, provides instructions on how to bypass the antenna monitor loop by using a splitter and additional attenuation to feed the transmitter output directly into the monitor. To avoid damage to the monitor, at least 4 dB attenuation must be applied to the signal in addition to the 3 dB of the splitter. The actual attenuation levels required vary according to the location, but appendix 1 can be used to estimate the total amount of attenuation required.

FIGURE 3. MONITOR LOOP BYPASS

The VOT may be operated at lower levels by bypassing the antenna loop using a splitter.



1. Set the VOT attenuator to 15 dB and connect the splitter as shown.
2. The signal available to the antenna is +15 dBm.
3. Set the output attenuator to reduce the signal as desired.
4. If more than +15 dBm is required then reduce the VOT attenuator, but DO NOT SET TO LESS THAN 4 dB AS DAMAGE TO THE MONITOR MAY RESULT. (+26 dBm at monitor)
5. Adjust R2 of the FLM board as necessary.