481 kilometers (260 nmi), transmitting 4 MW using a linear beam twystron. The transmitter control can select any one of 16 frequencies in the range from 2900 to 3100 MHz. It can operate on six different PRR's; the average PRR is 250 Hz using a 6.5 us pulse. The antenna uses six stacked feed horns to determine target height. The TPS-43E is designed for simultaneous long range search and height finding. The radar system is highly mobile and effective in severe weather and/or jamming environments. The radar uses Barker Phase Coded pulses to increase range accuracy and resolution. Pulse-to-pulse frequency diversity is used to decrease vulnerability to jamming. Figure 6a is an extended spectrum of the TPS-43E operating on only one channel. The measured response at 3380 MHz is an emission from the radar. Figure 6b is a graphically created composite produced by using an individual spectrum of each channel. A spectrum illustrating actual operation of all 16 channels could not be made because of operational constraints on the radar.

5. SPECTRA OF L-BAND LONG RANGE RADARS

The radars in this section are all used for long range detection (185 to 555 kilometers, or 100 to 300 nautical miles). Generally, they are used by the FAA for air route surveillance between air traffic control areas and by the military as part of the air defense early warning system. Near U.S. borders these radars are usually cosited with a long range height-finding radar such as the FPS-90. Often the AF and FAA maintain joint surveillance sites (JSS) to satisfy both responsibilities.

Measurement and analysis parameters, plus additional information about the radar spectra presented in this section, are listed in table 2.

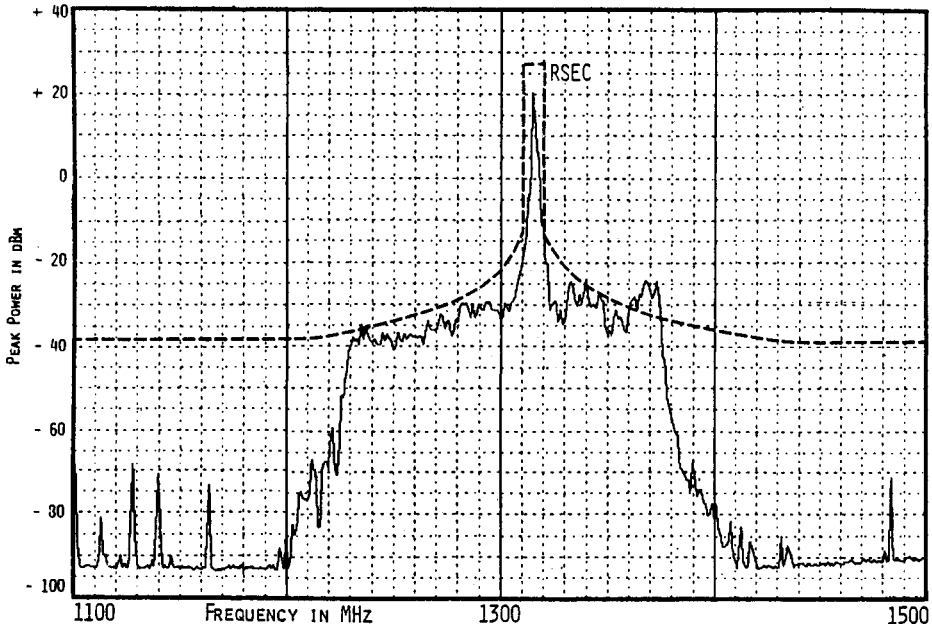
ARSR-1E (Fig. 7a). The ARSR-lE is an FAA two dimensional L-band (1215-1400 MHz) air-route-surveillance radar (ARSR) with a conventional magnetron feeding 400 kW peak power into an amplitron (crossed-field amplifier) to provide an additional 10 dB gain. The amplitron may be switched in or out as required by the operator. Amplitrons are characterized by a very wide noise floor only 40-60 dB below the fundamental. In many ARSR'S, including this one, a bandpass filter has been used to reduce the spurious sidebands outside the 1220-1380 MHz range.

ARSR-1E (Fig. 7b). This ARSR-lE does not use the 1220-1380 MHz bandpass filter often installed with ARSR-lE'S to reduce energy radiated by the crossed-field amplifier (amplitron) outside the frequency of operation. Above 1500 MHz, 7 dB should be added to the measured values to correct for a missing

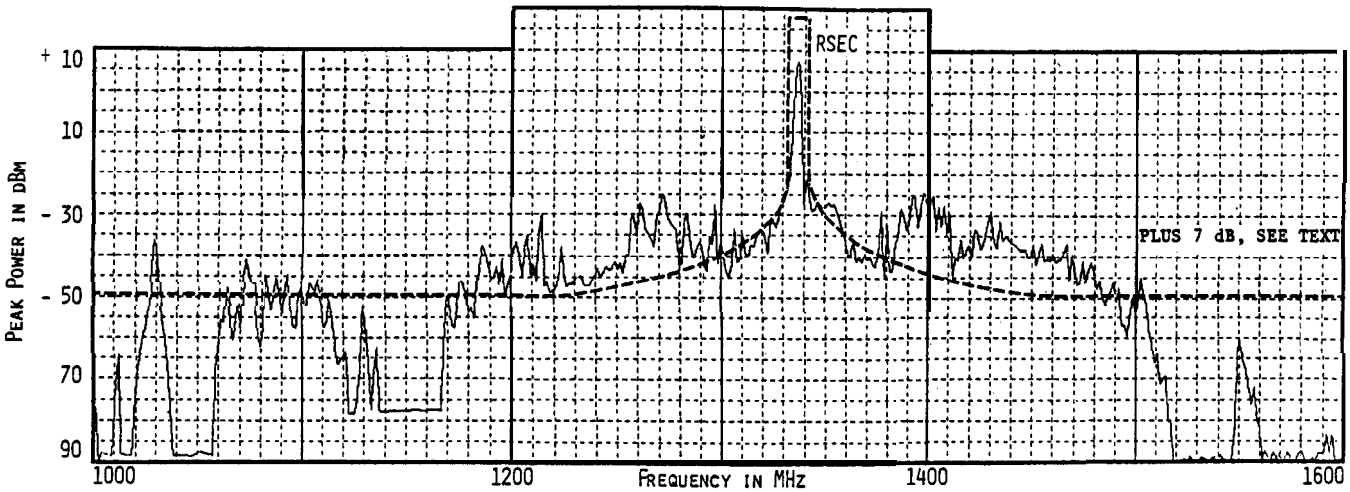
Table 2. Selected Operational and Measurement Parameters for L-band Long-Range Radars

Radar Equipment	Amplifier Type	Operating Frequency (MHz)	Pulse Repetition Rate (pps)	Pulse Duration (μs)	Pulse Rise Time (ns)	Peak Power (dBm)	Measurement Bandwidth(s) (kHz)	Figure Number
ARSR-1E	Amplitron (Filtered)	1315 [M]	359 [M]	2 [E]	300 [E]	96 [G]	1000	7a
ARSR-1E	Amplitron (Unfiltered)	1336 [M]	350 [M]	2 [E]	300 [E]	96 [E]	1500	7b
ARSR-1E	Amplitron (Filtered)	1316 [M]	348 [M]	2 [E]	300 [E]	96 [G]	1000 300	8
FPS-107	Klystron	1290 [M]	241 [M]	6.8 [M]	600 [M]	100 [G]	1000	9a
ARSR-3	Klystron	1268 [M]	340 [M]	2.2 [M]	150 [M]	77 [G]	3000	9b

[M] - Measured
[E] - Estimated
[G] - From Government Master File



a. ARSR-lE, Amplitron With Waveguide Filter.



b. ARSR-lE, Amplitron, Unfiltered (1030/1090 MHz Interrogator Beacon and TACANS below 1120 MHz).

Figure 7. Long-range air route surveillance radar, ARSR-lE.

calibration factor. The peaks at 1000 MHz, 1010 MHz, and 1030 MHz are from TACAN and interrogator beacons. The responses around 1090 MHz represent interrogator beacon replies.

ARSR-lE (Fig. 8). The spectrum shown here was selected from among the worst of the filtered amplitron ARSR-lE spectra that were measured. Figure 8b shows more detail in the middle 20 MHz of spectrum; note the decrease in measured amplitude caused by the more narrow 300 kHz measurement bandwidth.

FPS-107 (Fig. 9a). The FPS-107 is a two dimensional L-band long-range search radar designed for ground-controlled-intercept (GCI) applications in the air defense system. The FPS-107 uses a klystron, providing 10 MW peak power, and a 481 kilometer (260 nmi) range. The klystron, as illustrated here, is an impressive example of spectrum conservation.

ARSR-3 (Fig. 9b). The ARSR-3 is a two dimensional L-band air-route-surveillance radar with a detection range of 444 kilometers (240 nmi)--when operating in the diplex mode. Its klystron output provides 5 MW peak power with 3.3 kW average power. The radar can be operated in a non-stagger or stagger mode with 5, 7, or 8 discrete periods about the selected average PRR. When measured, the radar was still in a developmental stage and only one channel was operational.

6. SPECTRA OF HEIGHT-FINDING RADARS

All of the radars in this section are long-range, high-power, air-transportable, height-finders with a maximum range near 370 kilometers (200 nmi) and a height-finding capability of about 22,500 m (75,000 ft). They are normally collocated with an L-band search radar of comparable range--an ARSR-lE, for example. The height-finding radars operate in the 2700-2900" MHz band and in many areas contribute substantially to the spectrum crowding in this band. The older height-finders used conventional magnetrons, but many are being equipped with newer coaxial magnetrons whenever a major overhaul is scheduled. Several examples of conventional and coaxial magnetron radars are included in this section for comparison. The RSMS has been used to measure radar spectra for both types of output tube and in one case was able to measure the same radar both before and after it was converted from conventional to coaxial magnetron. The before-and-after measurements were made on an FPS-90, and care was taken to ensure that all measurement parameters were the same for each example including the measurement site location of the RSMS. Figure 10a shows the conventional magnetron radar spectrum, and figure 12a shows the coaxial magnetron spectrum for comparison. The conventional magnetron clearly displays the characteristic "porch" just prior to