EXHIBIT 1

PRIOR PRECEDENCE FOR SIMILAR RADIO STATION EXPERIMENTAL AUTHORIZATION

Previous experimental radio station authorization has been issued to ANRO Engineering for similar, but higher radiated power and wider bandwidth transmitting equipment. These prior authorizations have since expired.

In 1993, FCC Call Sign KK2XFH, File Number 3965-EX-PL-93 was issued for a 2.7 GHz transmitter for buried mine detection experimentation. This equipment exhibited a total bandwidth of 1,000 MHz, and a maximum effective radiated power of 400 kW.

Originally issued in 1996, FCC Call Sign KS2XAA, File Number S-2550-EX-96 was issued for a similar transmitter, and a time extension was issued under File Number S-2768-EX-97.

The present application is for a much lower effective radiated power device than either of the above transmitters, with a reduced bandwidth of 300 MHz.

ELECTROMAGNETIC INTERFERENCE CONSIDERATIONS FROM ULTRA-WIDEBAND RF SOURCES

INTRODUCTION

In this note we investigate the problem of interference with narrowband equipment caused by an Ultra-Wideband (UWB) emitter. We first consider the general characteristics of a radiative short pulse source. Then we investigate the frequency characteristics of an S-band UWB source being developed for the U.S. Army and Air Force under independent research and development for which this application is submitted. This source, developed by ANRO Engineering, Inc. (ANRO), emits several cycles of S-band radiation in a 3 ns rms wide pulse. We identify, potentially, susceptible candidate receivers for communications and radar and then consider, individually, the possibility for interference with each type. Finally, we summarize our conclusions regarding interference by UWB sources.

INTERFERENCE BY UWB SOURCE

ANRO's S-band impulse source has a mean carrier frequency near 2.17 GHz. With an approximately 1 ns pulsewidth, it radiates most of its energy in an approximately 3 ns pulsewidth, it radiates most of its energy in an approximately 300 MHz bandwidth centered about 2.17 GHz. The peak power radiated by the ANRO source is in the order of 1 kW. Dividing by the 300 MHz bandwidth yields a peak power per unit bandwidth of approximately $1 \times 3.3 \times 10^{-6}$ W/Hz. The ANRO source operates at a peak pulse repetition rate of 10 kHz, corresponding to a duty cycle of

$$3 \times (10^{-9} \text{ seconds}) \times (10x^{4} \text{ Hz}) = 3 \times 10^{-5}.$$

The average radiated power per unit bandwidth is, therefore,

$$(1 \times 10^{-6} \text{ W/Hz}) \times (10^{-5}) = 10^{-10} \text{ W/Hz}.$$

Mobile communications equipment, such as the Army's SINCGARS radio, operates in the VHF region, significantly below the main frequency components radiated by a 3 ns pulsewidth impulse source. It is unlikely, therefore, that such receivers would be affected by this UWB source. Most airborne radar and semi-active missile guidance equipment operates at X-band (8-12 GHz), far enough above the bandwidth of an S-band carrier UWB radar as to encounter little risk of interference.

Within the bandwidth of S-band carrier UWB radar sources, however, lie certain communications and radar bands, both for military and commercial use. Also found in this band are tracking and data relay satellite (TDRS) up- and down-links and maritime navigation radar. We will first consider the potential for interference with nearby communications receivers, then interference with nearby S-band radars.

INTERFERENCE WITH S-BAND COMMUNICATIONS RECEIVERS.

In Figure 1 we have plotted the signals received by a hypothetical communications receiver as a function of distance from the transmitter for three different average transmitter powers: 10, 100, and 1000 W. The expression used to compute the received power was

$$P_{rec} = G_T\, G_R\, [\lambda / 4\, \pi\, R]^2\, P_0,$$

where G_T and G_R are the gains of the transmitting and receiving antennas (assumed to be 20 dB each), τ is the wavelength (11.1 cm), R is the distance from the transmitter, and P_0 is the transmitted power. The received signal power is expressed in dBm in the figure.

Also plotted in Figure 1 is the interfering received signal from an UWB radar transmitter of 1 kW peak power, 3 ns pulsewidth, 10 kHz pulse repetition rate, and a transmitting antenna gain of 3 dB. A receiver bandwidth of 100 kHz was assumed which represents most communications receivers. Note that even if the UWB radar transmitter were only 100m from the victim receiver, the interfering signal falling within the receiver bandwidth is still 10 dB below that from a narrowband communications receiver 1000 km away and radiating only 10W. It is unlikely, therefore, that such an impulse radar would have much of an effect upon nearby communications equipment, even if it is operating within the bandwidth of the impulse radar.

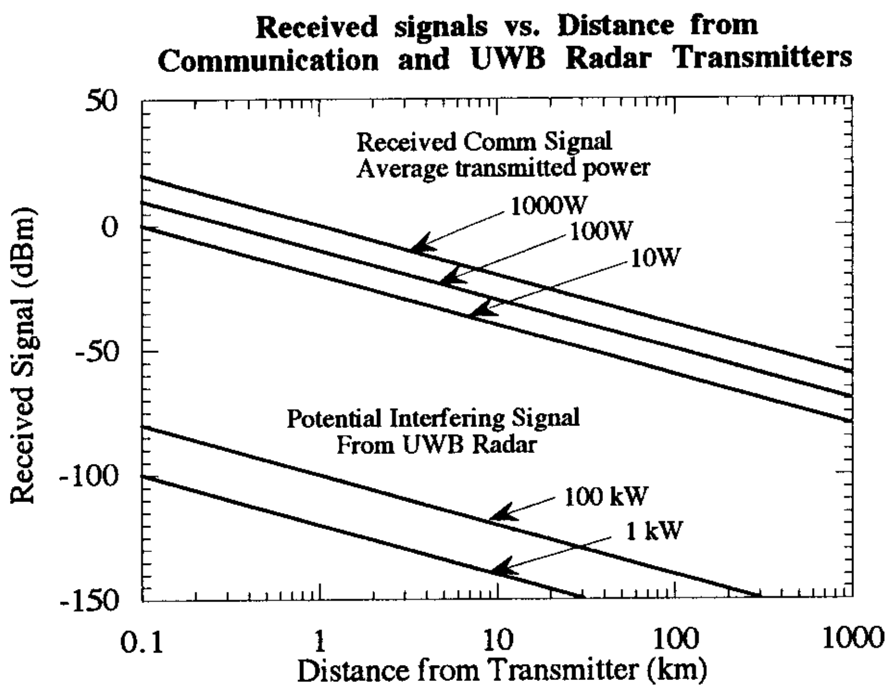

Figure 1. Signals received by communications receiver vs distance from transmitter for three different transmitter powers. For comparison, the received signal from the interfering impulse radar transmitter radiating 10 mW average power is also shown as a function of its distance from the communications receiver.

INTERFERENCE WITH S-BAND RADARS

We now turn our attention to possible interference with a nearby radar receiver operating within the UWB source. We assume the same impulse radar transmitter characteristics as in the calculations for interference with communications receivers. We assume the interfering signal enters the radar antenna through a sidelobe of gain 5 dB, 30 dB down from the mainlobe gain of 35 dB. The radar receiver IF bandwidth is assumed to be of order (radar pulsewidth)$^{-1}$, which, for a typical radar with 1 μs pulsewidth, is 1 MHz.

The average radiated power in the interfering signal falling within a 1 MHz bandwidth is

$$P_i = (1 \times 10^{-11} \text{ W/Hz}) \times (10^6 \text{ Hz}) = 1 \times 10^{-5} \text{ W}.$$

The pertinent radar antenna effective areas at 2.7 GHz, given by $\lambda^2 G / 4\pi$), are

3.1×10^{-3} m^2 (for the 5 dB sidelobe), and

3.1 m^2 (for the 35 dB mainlobe).

The interfering signal power density (average) within the 1MHz radar receiver bandwidth as a function of distance R is

$$PD = G_i P_i / (4\pi R^2) = (2)\ (1 \times 10^{-5} \text{ W}) / [4\pi R^2] = (1.6 \times 10^{-6}) / [R(m)]^2 \text{ W/m}^2,$$

where, as before, we assume a peak gain for the broadband source of 3 dB. The average interfering power received through the 5dB sidelobe by the radar receiver is

$$(P_{rec})_i = (1.6 \times 10^{-6} / R^2) \times (3.1 \times 10^{-3} \text{ m}^2) = 4.9 \times 10^{-9} / [R(m)]^2 \text{ W}.$$

At a distance of 100 m, the interfering signal is 4.9×10^{-13} W, or -93 dBm; at 500 m it is -107 dBm. The thermal noise floor at a temperature $T_0 = 290$K in a receiver with 1 MHz bandwidth and a noise figure of 7 dB is

$$kT_0BF = (4 \times 10^{-21} \text{ W/Hz})\ (10^6 \text{ Hz})\ 10^{0.7}) = -107 \text{ dBM}.$$

Thus, the interfering signals when the impulse radar is located greater than 500m away from the radar receiver are lower than the receiver noise floor under the above assumptions.

Figure 2 plots the radar return signal for the victim radar from a 1 m^2 target (typical of fighter aircraft nose or tail) as a function of range for three different average transmitter powers: 0.1, 1.0, and 10 kW (corresponding to peak powers of 0.1, 1.0, and 10 MW, respectively, with a .001 duty cycle). Also shown (horizontal lines) are the average interfering signals in the victim radar from the UWB radar at 100m and 500m distances between the impulse radar and the victim, as well as the receiver noise floor. Thus, as long as the impulse radar operates no closer than 500m to the victim radar, interference should not be a problem, since the interfering signal is below the receiver noise floor.

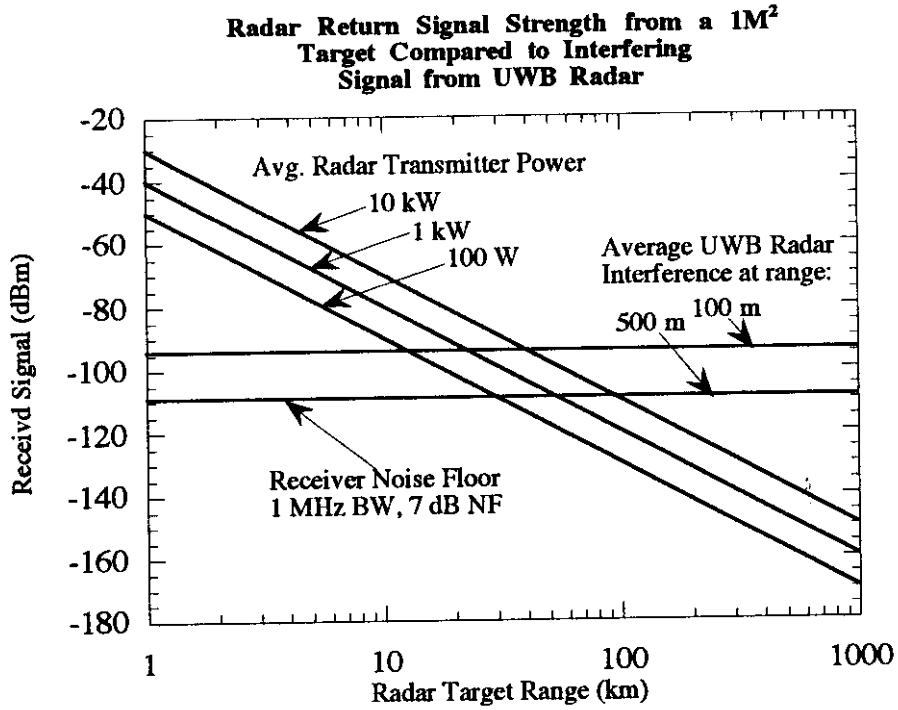

Figure 2. Radar return signals from a 1 m^2 target vs radar range for three different average radar transmitter powers. The horizontal lines represent the received signals from an interfering impulse radar radiating 10 mW average power and located at 100m and 500m from the victim radar receiver. In this case the victim receiver noise floor is the same as the interfering signal when the UWB radar transmitter is located 500m from the receiver.

The reader should note that we have demonstrated that interference with the radar receiver is unlikely, even under some very conservative assumptions:

- The 5 dB side lobe gain assumed for the victim radar antenna would be justified only when the UWB radar was located in the sidelobe; this would be an exceptional case.
- We assumed that the UWB radar was pointed directly at the victim radar antenna, again an exceptional case, particularly for ground radar applications.
- The 7 dB noise figure assumed for the victim receiver may be high. Exceptional cases could be handled by operational constraints for both radars, if necessary.

CONCLUSIONS

We have specifically investigated the potential for electromagnetic interference by a modulated S-band carrier impulse radar transmitter with narrowband communications and radar receivers. The conclusions are as follows:

- VHF communications equipment and X-band radars will probably not be affected because they operate far enough away from the main frequency components of the UWB radar.
- The received UWB radar signals appear to be too low to cause interference with communications equipment operating within the bandwidth of the UWB radar for typical transmitter powers and distances.
- The received impulse radar signals appear to be too low to cause interference with nearby radar receivers, except possibly under rare circumstances in which the impulse radar is pointed at the victim radar receiver, enters through a victim antenna sidelobe, and is situated very close to the radar. These exceptional cases could be removed by operational constraints.
- The use of the UWB radar in a ground surveillance mode at very low elevations should prevent interference with any receivers in the immediate area.

EXHIBIT 3

GOVERNMENT REQUIREMENTS FOR THIS DEVICE

This ultra-wideband (UWB) radar is being developed for use by the United States Air Force and Army, and potentially the other services, as a low-cost, portable perimeter intrusion detection sensor. The sensor may be used around the perimeter of overseas deployment locations, as a temporary security sensor for an aircraft on an airfield in a potentially unfriendly environment such as Haiti or Bosnia, or in permanent installations. The sensor may become an integral sensor component of the Air Force Tactical Automated Sensor System (TASS).

This sensor is currently being developed under Independent Research and Development (IR&D); a contract has not yet been issued by a DoD agency, although indications are that several units may be ordered for evaluation purposes in the next few months.

This sensor is a derivative of over 5 years development of UWB radar sensors funded by the government for other applications, such as mine detection, ship navigation, and long-range intrusion detection. Exhibit 2 contains a description of the waveform to be used for this sensor.

This sensor will utilize a novel, low-cost adaptive radar clutter compensation technique that allows it to operate in areas of wind-blown grass and bushes, as well as over water. In addition, intrusion detection logic is employed to recognize only targets that are moving in the direction of the sensor, eliminating false alarms caused by incidental traffic. The sensor will be battery operated, lightweight, and deployable by a single person in less than one minute.