

Raytheon Missile Systems
Experimental License Renewal Application
Call Sign: WH2XXE
File Number: 0400-EX-CR-2019

Exhibit 1: Explanation of Experiment

Overview:

Raytheon Missile Systems (Raytheon) designs and builds missiles that it sells to the US Department of Defense and other agencies of the federal government. Raytheon is working on independent research and development, which requires it to use simulated radar signal transmitter to test a new radar receiver system that is under development.

Raytheon is filing this renewal application to continue testing of its radar receiver technology.

Synopsis:

- Spectrum needed: 3.8 GHz to 4.2 GHz
- Signal level: maximum power is 1kilowatt ERP, using 10 watt transmitter
- Location: Raytheon Tucson Headquarters Test Range from Bldg 849 Rooftop
- Time of Use: Mon-Sun 8:00AM – 8:00PM
- Duty Cycle: 10% for two minutes, then 0 % for 8 minutes.
- Antenna Gain: 20dBi
- Antenna 3dB Beamwidth: E-Plane 20deg/H-Plane 20deg

Nature of the Experimentation:

This application proposes to continue experimentation that requires Raytheon to simulate radar signals for Raytheon's radar receiver system to detect. This will allow the program to characterize and fine-tune the radar receiver's performance, improving its detection capabilities and ensuring reliability, accuracy, and effectiveness in the performance of the radar receiver system. The transmitter for this effort simulates various radar waveform characteristics to help test the performance of the radar receiver, highlighting its current functionality and allowing Raytheon to determine if any modifications are needed to meet the performance standards required.

The radar simulator transmitter will located on the roof of Bldg 849, inside a rooftop building structure that has an aperture facing south. It will transmit a signal that will be used to stimulate the radar receiver(s) under test. These receivers will be located south of the tower near the test range towers, see diagram below. Raytheon will be transmitting the radar signal through two antennas simultaneously, partially covering a 70 degree field of regard (FOR). The transmitted signal will radiate toward the south, covering an arc that is centered on azimuth 180, but that will range from azimuth 145 to azimuth 215.

The FCC license is needed for the radar simulator transmitter.

Locations for the testing:

(See Figure 1 below.)

Frequencies to be used, duty cycle, pulse width, and pulse repetition:

Frequencies: The simulated radar signals will be transmitted in the band:

- 3.8-4.2 GHz

Operating across these frequencies will allow Raytheon to characterize a subset of the radar receiver's performance in an outdoor environment.

Duty Cycle: The simulated radar transmitter operations will *not* be continuous. The proposed usage pattern will have the simulated radar transmitter in use for approximately two minutes, operating at a 10 % duty cycle, and then the simulated radar transmitter will be off for eight minutes, with a 0 % duty cycle. The pattern will then be repeated. This will help determine if the radar receivers can detect and process the radar signal appropriately.

Pulse Width and Pulse Repetition: The simulated radar signals for this test will be short pulses. The signals will have a pulse width that ranges from 0.1 to 25 *microseconds*. The pulse repetition rate will be from 10 microseconds to one millisecond. For each test event (2 minutes of transmit time) the frequency will be stable. It will be adjusted between test events. Both antennas will be transmitting for all of the test events and will be sending the same signal.

Time of Use: The program has scheduled its operations after consultation and coordination with the DOD-AFC for Arizona. Raytheon will continue to coordinate its usage to ensure that it complies with the requirements of the DOD AFC. It is important to note that the system will *not* be in use for 100% of the testing time that time. The program is trying to ensure flexibility in scheduling so that the system can be properly tested while avoiding causing any potential interference to any other spectrum users in the area.

The actual likely time of use during any given day is less than four hours per day. The system is expected to be in use less than four days per week.

Power Level:

The 1kW ERP is required to support free space testing with reasonable separation between the transmitter and receiver(s) and to allow adequate testing across the dynamic range of the unit(s) under test. This maximum power will be focused towards the south of building 849 (away from Tucson International Airport).

No likelihood of harmful interference to other users:

Because of the low duty cycle, short pulse width, and narrow spectrum bandwidth, the chance of any nearby interference is extremely low. There have been no instances of interference since testing began several years ago.

The signal strength proposed in this application is as low as reasonably possible to be able to transmit the signal across the Raytheon test range. Study of the signal propagation at the proposed power levels and requested frequencies shows that the signal levels off the Raytheon plant site are likely to be below -70 dBm. This is based on the lowest frequency (~4GHz) with an estimated 20dB antenna gain loss (relative to main beam) in the far sidelobe (direction of airport) at a range of 1.7 KM from the airport. The weakness of signals off the Raytheon test range means that those signals will not have the capacity to cause interference to any nearby operators in the relevant spectrum bands.

As required by the FCC, Raytheon will undertake frequency coordination with other licensees.

Hertz Warfare Signal Plot: To provide more information on the signal propagation, Raytheon has run Hertz Warfare software plots to illustrate the theoretical signal strength in the area, for the limited time that the signals will be in use. As noted previously, the Hertz Warfare software only addresses propagation based on terrain; it does not account for the attenuating and signal scatter effect of buildings. Therefore, the plots show greater signal strength than would actually be present when this system is in use.

The plots below show that virtually all the signal above -50 dBm remains on the Raytheon plant. Off the plant site, the signal level drops down (orange and yellow areas) to -60 and -70 dBm respectively. From there, the signal drops off even further. When the short pulse width and low duty cycle are taken into account with the low signal strength off the plant site, the chance of any harmful interference to other users is minimal.

Figure 1 shows the entire Tucson valley, with the Raytheon plant site in the center.

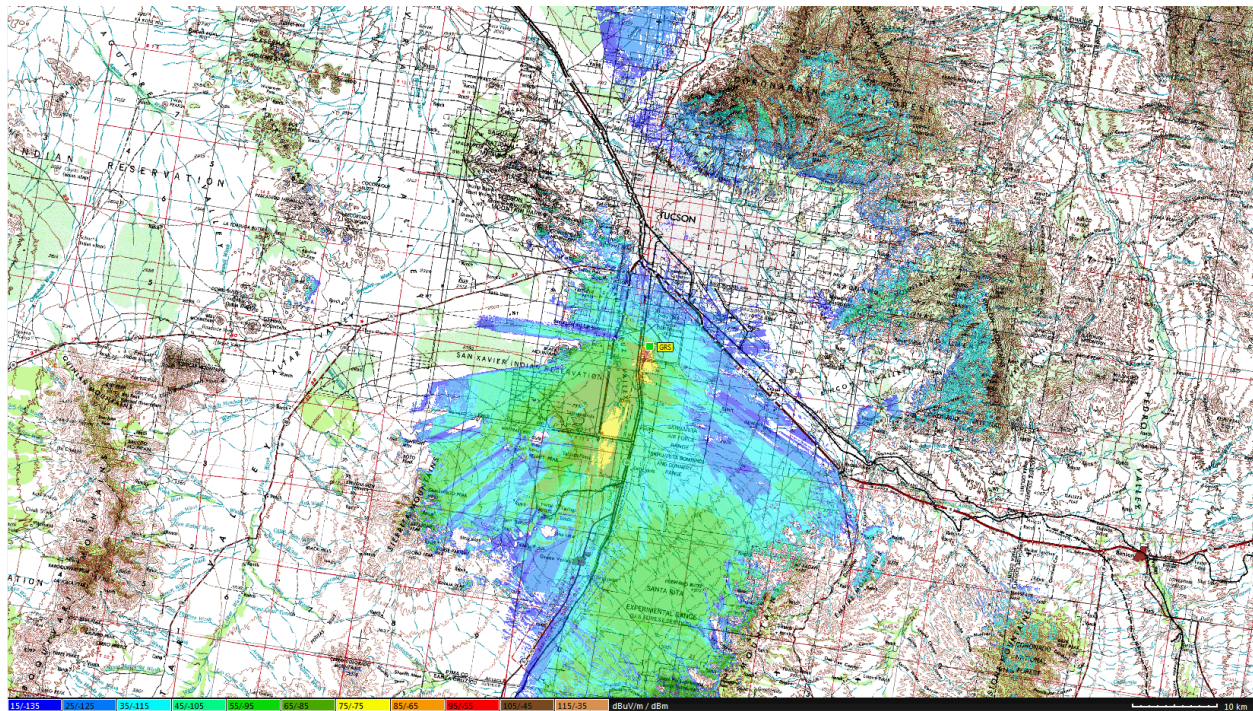


Figure 1. Hertz Warfare Plot Showing Entire Tucson Area

Figure 2 is a close up view of the same plot, which allows a closer analysis of the spectrum levels near the plant site.

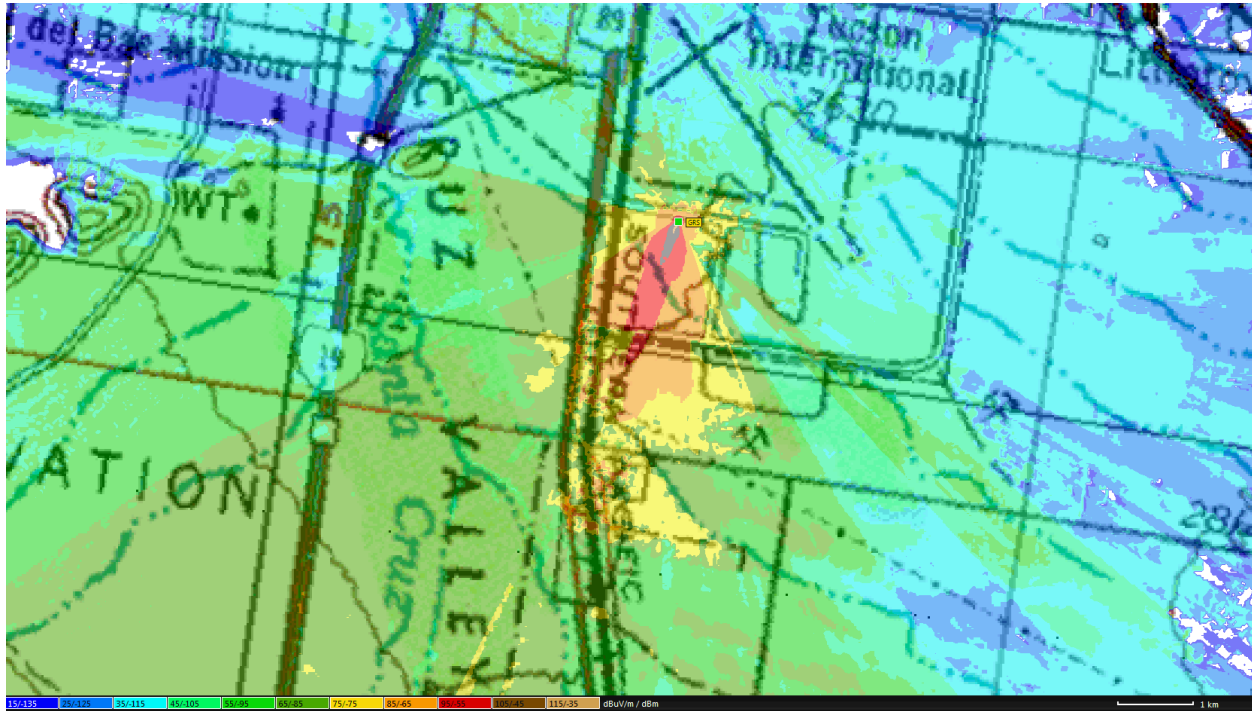


Figure 2. Hertz Warfare Plot Close Up View.
(South edge of Raytheon's Tucson Plant Site is at bottom of red area on plot.)

Stop Buzzer Point of Contact:

Raytheon's Stop Buzzer point of contact is:

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Conclusion:

Raytheon is seeking to renew its experimental license to continue testing to work on advancements to its radar receiver technology. The program must continue to deliver reports on technology advancement in the radar.

Raytheon's work will advance the performance of the radar receiver technology proving how it can deliver performance in the proposed environment. The time of use will be limited. The proposed power levels are as low as possible to achieve the goals of the system.

If there are any questions about this application or if any additional information is needed, please contact Anne L. Cortez, Washington Federal Strategies, 520-360-0925 or alc@conspecinternational.com.