

Raytheon Missile Systems
Outdoor Antenna Test Range
Application for Renewed Experimental License
Call Sign: WF2XLH
File No: 0284-EX-RR-2012

Explanation of Experiments and Need for Renewed Experimental License

Overview:

Raytheon Missile Systems has been operating an outdoor antenna test range at its Tucson facility since 1993. In 2010, the FCC granted an experimental license for those operations after the expiration of a Frequency Assignment granted by the DoD Area Frequency Coordinator Arizona. This outdoor antenna test range supports all programs and contracts for the Navy, Air Force, and the Army. In addition, Raytheon Missile Systems conducts independent research and development at the same range. The need to determine the characteristics of the antennas installed on Raytheon's missiles and other products is ongoing, and so Raytheon is seeking authorization to renew its experimental license for use of the range.

Description of operations:

The outdoor antenna test range operates two antennas that test by stepping across a range of frequencies. The test range transmit antennas are:

- Q-Par Dual Polarized Quad Ridge Horn: steps across frequency range 2-18 GHz
- Sunol Sciences Quad LP-1 Antenna: steps across frequency range 200 MHz to 2 GHz

The test range transmit antennas are used to conduct tests to determine three-dimensional (3D) far-field radiation patterns with full scale mockups mounted on the motorized Dual-Mount Tower (DMT), and swept in azimuth and roll over a full sphere. For each unique azimuth and roll increment, directional antenna gain relative to that of an isotropic radiator (gain in dBi) is measured.

The horn antennas are mounted on the rooftop of the Outdoor Range. The horn antennas transmit and the Antenna Under Test (AUT) mounted on the DMT receives the signal. Due to the principle of reciprocity, the radiation pattern obtained when the AUT receives the signal is identical to the radiation pattern of the AUT when it transmits. So, testing the receive characteristics provides the required information on the antenna pattern.

In Figure 1 below, we show data for some sample test frequencies, antennas, polarization, azimuth and roll resolutions, and other parameters for a typical 3D far-field pattern test:

Antenna	Frequency Band	Number of points	Az, Roll Resolution	Polarization	Wings folded	Wings extended
Link-16	960-1216 MHz	8 (every 40 MHz)	2° x 4°	V & H	Yes	Yes
FTS	424-426 MHz	5 (every 500 kHz)	2° x 4°	RHCP	Yes	Yes
TM	2.2-2.3 GHz	5 (every 25 MHz)	2° x 4°	RHCP	Yes	Yes
Beacon	5.6 - 5.8 GHz	2 (Trans & Rcv)	2° x 4°	V & H	Yes	Yes
UHF	200 - 260 MHz	5 (200, 222, 232, 242, & 260 MHz)	2° x 4°	V & H	No	Yes
GPS L1	1565 - 1586 MHz	11 (every 2 MHz)	2.5° x 5°	V & H	No	Yes
GPS L2	1217 - 1238 MHz	11 (every 2 MHz)	2.5° x 5°	V & H	No	Yes

Note: GPS antenna testing is not performed outdoors within 10 MHz of center frequency.

Figure 1, Sample test parameters

The sample frequencies shown here describe how testing is conducted. The application requests renewed authorization to conduct tests on discrete frequencies across wide frequency bands so that it is possible to test in accordance with parameters such as those in Figure 1. The tests use very narrow, continuous wave signals with side lobes suppressed. Therefore, the actual spectrum use is far less than the application would seem to request on its face.

The operations proposed here continue to be at a secure facility (campus) with restricted access and even more tightly controlled access to the transmit area.

Tests conducted by the spectrum management staff at Raytheon have shown that there is no interference experienced at the secure facility, not even near the secured area where the antenna tests are being conducted. This minimizes the chances of any entity experiencing harmful interference adjacent to the secured campus. Operational testing under the frequency assignment has been coordinated with nearby facilities such as the Air National Guard, Davis-Monthan Air Force Base, Tucson International Airport, Kitt Peak Observatory, and the University of Arizona. No interference issues have arisen from past and ongoing operations. The operations proposed in this experimental license renewal application are identical to the currently authorized operations, and so there is no anticipated new interference.

Operations are highly directional:

The beamwidth of the antenna is normally narrow, as low as 10 degrees at 18 GHz and is pointed due west into the desert and sparsely populated Indian Reservation. The sidelobes are suppressed by the building and a steel scatter fence, see Figure 2. The scatter fence diffuses the RF energy in many directions, reducing the potential for interference.



The antennas are very directional with a very narrow beam and the transmitters point out over the desert and sparsely populated Indian reservation land.

Figure 2, Outdoor Antenna Test Range

Need for Outdoor Antenna Test Range:

Because of the nature of work being done, it is important to test the characteristics of a number of different antennas operating across a range of frequencies. Those antennas are installed on various pieces of equipment that Raytheon builds. That equipment and the way that its antennas work must be tested in a free space environment. Therefore, it is necessary to operate this outdoor antenna test range.

Given the sensitive nature of the tests, Raytheon transmits on a number of discrete frequencies across a wide range of frequencies. Those tests are limited in time, and for highly sensitive frequencies, Raytheon continues to be willing to operate according to a strict schedule to minimize any potential interference issues.

Limitations on Use:

Low Power testing: Review of the operations of the outdoor antenna test range have shown that the power level of the transmissions is not 10 watts, but it is only 30 milliwatts.

Limited Time of Use of Spectrum: Further study of the operations shows that for each antenna tested on the range, the whole test, across the entire spectrum band on the license, requires 89 hours of test time. However, each frequency is only in use **3.024 minutes**, a very short amount of RF use. Each day of testing normally only tests 15 of the stepped frequencies, so for any given day, the RF usage is minimal.

Conclusion:

Raytheon seeks continued authorization for operations at its outdoor antenna test range. The purpose of the range is to determine the antenna patterns of the Antennas Under Test (AUTs). Those antenna patterns are tested by using transmitters which step across many discrete frequencies, record the receive patterns of the AUTs, and because of reciprocity the testing provides the transmit patterns of the AUTs. The testing is extensive – looking at the AUT in three dimensions. The power is low, and the time on any single frequency is very brief.

If there are any questions, please contact Tom Fagan, Spectrum Manager, Raytheon Missile Systems, 520-794-0227, tjfagan@raytheon.com, or Anne Linton Cortez, 520-360-0925, alc@conspecinternational.com.