

Explanation of Experimentation

Overview:

Raytheon Missile Systems builds missiles, and other related products, for the US Department of Defense. In the course of that work, Raytheon is called upon to develop new radio technologies that are used on its missile products. To determine how those radio technologies will work, Raytheon has developed a series of tests that will show the characteristics of its radios in simulated operating conditions. To conduct that testing, Raytheon needs experimental licensing from the FCC. This application is for the testing of radio products installed on Raytheon's missile products. The testing will be conducted inside a lab.

Technical Synopsis:

- Spectrum required: 2.0 – 40.0 GHz, inclusive, to ensure effective testing of all antennas under development
- Operating power level: ERP of 100 mW
- **Indoor** testbed has been developed to determine how various antennas on missiles will work when the missile is in flight.
- Power level is low, because testing is in the nearfield - < 1 meters, and indoors
- Signals in use only 400 minutes per day; emission will be undetectable. Not every test covers 2 GHz to 40 GHz. The testing steps across the frequency band so no signal will be on any frequency for more than a millisecond or so. Closed loop system that transmits at automated levels and it steps across the frequencies in milliseconds.

Description of testing:

Raytheon is seeking this experimental license to set up a near field antenna test system to analyze the operations of some of the radio systems that are operating on its products when those radio systems are installed and operating close together, simultaneously. Raytheon's missiles use a number of navigation, telemetry, and radar technologies which are all essential to the proper functioning and performance of its missiles. To ensure that the radio systems all operate harmoniously with one another, it is necessary to test the radio systems prior to deployment.

Furthermore, Raytheon is continually developing new technologies or enhancing the performance of existing radio technologies to improve the performance of its missiles. Those enhancements can

include changes to emissions to lower the risk of receiving radio interference, improving data throughput, minimizing interference potential to other operating radios, and much more.

The proposed near field antenna test system has been designed to allow Raytheon's engineers to put antennas in the test bed and evaluate their operation when they are used a low power in close proximity to one another. The testbed license seeks authorization to use a network analyzer which will be radiating to determine the coupling to the other antenna. This will give information on the characteristics and potential for interference. Control over the test time, frequency steps, and frequencies tested is programmed into the network analyzer.

Required Spectrum:

Because the systems in use on the missiles cover so much radio spectrum, Raytheon must request the entire band specified to ensure that its test bed can examine all of the systems on its missiles. Each of the systems under test is properly licensed for use through the FCC, federal frequency assignments, or both. Furthermore, each of the systems under test have been, or will be, approved through the DOD 1494 process. So, there are authorizations for all of the customary uses of the radios to be tested. It is the test bed, where the interference issues must be resolved, that now needs to have an authorization to explore the interference engineering across all of the licensed frequency bands.

This testbed is to be used internally by Raytheon for the testing and improvement of its radio systems, and so an FCC experimental license is appropriate.

Location of the test:

The proposed location of the near field antenna test system is in a laboratory in a building on the Raytheon facility. All operations will be **indoors**, in the laboratory. The building selected has sufficient fire protection to allow the program to install anechoic RF absorbing materials around the test bed, without creating any hazards.

Therefore, the program has been required to move to this new facility, and a new experimental license, to cover all the operations that will now be conducted at the new site, is required.

Low risk of any interference from testing:

The program has implemented a number of factors to limit any potential for interference to any surrounding radio operations – experimental or operational. First, the program does install anechoic material to absorb as much RF signal as possible to minimize the potential for harmful interference to nearby radio operations. Raytheon is a complex and rich radio environment, and certainly it has an interest in ensuring that this testbed does not cause interference to its own operations. All the

precautions taken to ensure that no harmful interference results also protect any radio licensees off the Raytheon property as well.

For any spectrum where there is interference potential, Raytheon has an internal scheduling mechanism, which it also coordinates with the Tucson International Airport, FAA, Arizona National Guard, and Davis Monthan Air Force Base. When there is a chance of harmful interference, the possibly conflicting spectrum users sign up in discrete time blocks to ensure that they are not operating on the same spectrum at the same time. This time division is an absolute guarantee of avoiding harmful interference.

Locating the testbed inside a building that is situated on the Raytheon site at a distance from the Tucson International Airport was also part of mitigating any potential for interference. The designated test bed site is in a metal building is actually shielded from the airport property (and therefore airport operations and Air National Guard operations) by a number of other metal buildings, and by a distance of nearly ½ kilometer.

The power limits set for the proposed operations will also protect against the possibility of harmful interference. The program has limited all of its operations to no greater ERP than 100 mW. While the program uses antennas that are omnidirectional and directionalized, the systems put in place employ signal attenuators to ensure that the ERP is never greater than 100 mW. Because the spectrum band to be used starts at 2 GHz and goes up, the signal propagation is not great through walls or around obstacles. With an entirely indoor operation, employing anechoic shielding, and operating a low power, the chance of a signal actually being detected outside of the proposed testbed is extremely low.

Coordination of Spectrum Use:

Raytheon is preparing to coordinate the proposed spectrum use with AFTRCC and FAA, in addition to any other entities specified by the FCC or other federal reviewers.

Stop Buzzer Point of Contact:

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Conclusion:

Raytheon is requesting authorization to use the frequencies from 2 GHz to 40 GHz to set up a near field antenna test system. The test bed is to be used to study and mitigate interference issues that may be created when there are too many radio systems located close to one another on a Raytheon missile. The goal is to improve interference-resistant radio systems, improve the control and functioning of the missiles, and to avoid harmful interference. The entire spectrum band is required because the missiles use radio systems across the entire band. Raytheon has tried to use as many techniques as possible to avoid the possibility of harmful interference to any other licensed radio operations by limiting the power used by the near field antenna test system, using anechoic shielding materials, operating only indoors, and otherwise employing sound radio engineering practices.

For any questions about this application, please contact Thomas J. Fagan, Spectrum Manager, Raytheon Missile Systems 520-794-0227 or tjfagan@raytheon.com or Anne Linton Cortez, Washington Federal Strategies, 520-360-0925 or alc@conspecinternational.com.