

Raytheon Request for FCC Special Temporary Authorization (STA)

STA File Number 0971-EX-ST-2014

October 23, 2014

FAA Coordination Serial Number: NG T140454

Purpose of Operation:

Frequency authorization is being requested for the period of November 17, 2014 – May 17, 2015 in X-band at frequencies between 9.0 – 9.2 GHz, 9.3 – 9.5 GHz, and at 9.55 – 9.65 GHz, in order to test prototype radar arrays in a relevant environment. Outdoor testing, across multiple frequencies as noted above is required to assess hardware compliance with requirements. Only one unit will be tested at a time.

STA Explanation:

The Raytheon Low Power Radar 2 (LPR2) array is planned to be tested at the NTIA-ITS Table Mountain Antenna Fields Site in Boulder, Co, over the period of November 17, 2014 – May 17, 2015. The purpose of this request for Special Temporary Authorization is to test array compliance to RF performance requirements in a relevant environment.

Test Summary:

An STA is required to test array compliance to RF performance requirement in a relevant environment.

The system will transmit pulsed Frequency Modulated (Chirp) waveforms. For all waveform types, the maximum pulse duration is 55µs and the maximum duty factor is 22%. It is expected that the radar will be operated periodically during the STA period, < 8 hours a day, Mon - Sat, for the duration of the STA. These operating times corresponds to the Boulder, Co test facilities.

RF Hazard Calculations and Site Safety Measures:

Initial calculations show that general public exposure limits will be reached at a 2.25 meters distance and occupational exposure limits at 1.0 meter, using formula (7) from FCC OET Bulletin 65 “Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields”, dated August 1997. These calculations take into account the highest duty factor of 22% and the raster scan pattern utilized by the radar.

Raytheon’s RF safety group is involved in all testing that requires free space radiation to ensure that no personnel are subjected to RF power density levels exceeding the Maximum Permissible Exposure (MPE) limits of the Part 1.1310 of the FCC Rules and the guidelines in FCC’s OET Bulletin Number 65. An RF Safety Control Plan will be in place for the tests. The Plan will define the procedures and controls required to prevent personnel exposure to levels which exceed the MPE. To verify the safety of personnel, an RF survey will be performed at the initial turn-on of the system. All measured levels, where personnel have access, must be below the MPE limits before testing can proceed.

Raytheon Technical Point of Contact:

Jerry M. Grimm

System Engineering I&T Lead
Phone: 972-344-8206
Email: jerry_grimm@raytheon.com

Raytheon Spectrum Manager filing application:

Karen Dyberg
Spectrum Management/RF Safety
Phone: 978-440-4022
Email: karen.dyberg@raytheon.com

Period of Use:

Start date: November 17, 2014
End date: May 17, 2015

Equipment Information:

Indicate all equipment that will be involved in this operation.

Transmitter info:

Manufacturer: Raytheon
Model: LPR2
Number of units: 6
Experimental (Y/N): Y

For each frequency band:

RF output at the transmitter terminals:
160 Watts peak

Effective radiated power from the antenna (if pulsed emission, specify peak power):

The effective radiated power from the antenna, including antenna transmit gain and front-end losses, is 953.4 kW (peak power).

Power * gain = EIRP, gain = 39.9 dBi, EIRP = 160 * 9772.37 = 15635972 W
ERP = EIRP/1.64 = 953402 W or 953.4 kW

Frequency Tolerance:

Less than 0.001 %

List each type of emission separately for each frequency (basically list the emission designators)

The LPR2 can tune at 1 MHz intervals within the band(s) authorized. For 9.6 GHz operation, Ftune is 9.6 GHz.

For each tunable frequency authorized, the LPR2 has the following emission designators:

4M7Q3N - 55µsec FM-Pulsed (LP) with a 2 MHz LFM chirp, centered at Ftune – 1.5 MHz

7M1Q3N - 6µsec FM-Pulsed (SP) with a 2.5 MHz NLFM chirp, centered at Ftune + 1.25 MHz

The transmit waveform chain-pulse sequence transmits a Long Pulse (LP) then a Short Pulse (SP) for each pulse repetition interval (PRI). The PRI for a pulse sequence is 256 usec (PRF = 3906.25 Hz). The Long Pulse (LP) is 55 usec pulse length using a 2 MHz linear FM chirp at a 22% duty factor. The Short Pulse (SP) is a 6 usec pulse length using a 2.5MHz non-linear FM chirp at a 2.3% duty factor.

List as appropriate for the type of modulation:

LP: Linear Frequency-Modulated Pulsed (Chirp)

SP: Non-Linear Frequency-Modulated Pulsed (Chirp)

Necessary bandwidth. Explain how determined.

The necessary bandwidth was calculated using the equations in Annex J of the NTIA Manual.

Locations:

The outdoor test facility at Table Mountain Antenna Fields Site in Boulder, Co is located at North 40°07'58", West 105°14'42" and ground elevation of 1698 meters above sea level. The approximate location of the radar will be within a 2 km radius of the location stated.

Is a directional antenna (other than radar used)?

No.

If yes, give the following info: (Although not necessary for this application, additional antenna detail is provided below)

Width of beam in degrees at the half-power point:

1.98° Azimuth, 2.1° Elevation at boresight

Orientation in horizontal plane:

+/- 45° Electronically Scanned

Orientation in vertical plane:

0° to 30°, relative to ground horizontal, electronically scanned

Will the antenna extend more than 6 meters above ground, or if mounted on an existing building, will it extend more than 6 meters above the building, or will the proposed antenna be mounted on an existing structure other than a building?

No, the entire radar and antenna are installed on a small mobile trailer or cart. (Although not necessary for this application, additional detail related to height and location relative to airports is provided)

Overall height above ground to tip of antenna in meters:

Approximately 2 meters

Elevation of ground at antenna site above mean sea level in meters:

1698 m (Table Mountain Antenna Farms, Boulder, Co)

Approximate distances to various aircraft landing areas in km:

From test site coordinates to:

Boulder Model Airport	5.3 km
Colorado Antique Field	6.3 km
Longmont Vance Brand Municipal Airport	7.7 km
Boulder Municipal Airport	11.2 km
Denver ARTCC	11.7 km
Rocky Mountain Metropolitan Airport	27.2 km
Fort Collins-Loveland Municipal Airport	40 km
Denver International Airport	53.3 km
Buckley Air Force Base	64 km

Note: This is not a complete list.

List any natural formations of existing man-made structures (hills, trees, water tanks, etc) which in the opinion of the applicant would tend to shield the antenna from aircraft and thereby minimize the aeronautical hazard of the antenna:

None.

Necessary Bandwidth Calculation Table

FM-Pulsed Radar		
Modulation	LFM	NLFM
Pulse Width (μsec)	55	6
Rise Time (μsec)	0.128	0.128
Fall Time (μsec)	0.128	0.128
Chirp BW (MHz)	2	2.5
Necessary BW (MHz)	4.7	7.1
Designator	4M7Q3N	7M1Q3N

Necessary BW Formula

Symbols:

t = Emitted pulse duration at 50% amplitude (voltage) points. The 100% amplitude point is the nominal peak level of the pulse.

t_r = Emitted pulse rise time in μsec from the 10% to the 90% amplitude points on the leading edge.

t_f = Emitted pulse fall time in μsec from the 90% to the 10% amplitude points on the trailing edge.

$$B_n = B(-20dB) = \frac{1.79}{\sqrt{t_r t}} + 2B_c$$

FM-Pulsed Radar:

*If t_f is less than t_r , then t_f is to be used in place of t_r when performing the necessary bandwidth calculations.

Designators

FM-Pulsed Radar

Designators (NTIA)			
Prefix	Necessary Bandwidth	##M#	Megahertz with M at decimal
Emissions	Type of Modulation Main Carrier	Q	In which the carrier is angle-modulated during the period of the pulse (i.e. chirp, FM).
Emissions	Nature of signals modulating	3	A single channel containing analogue information.
Emissions	Type of Info transmitted	N	No Information Transmitted.