

Raytheon Request for FCC Special Temporary Authorization (STA)

STA File Number 0556-EX-ST-2013

STA Confirmation Number EL164436

June 14, 2013

FAA Coordination Serial Number: NG T130219

Purpose of Operation:

Frequency authorization is being requested for the period of July 8, 2013 – December 23, 2013 in the 9.15 GHz band in order to demonstrate the operation of a prototype radar system. This radar demonstration is intended to show maturity of key technologies designed and developed by Raytheon. It is essential that radar performance be demonstrated in a real-time radar environment similar to the proposed radar system. Testing in real-time environments with realistic target profiles is needed to fully prepare for a demonstration to the customer.

STA Explanation:

The Low Power Radar (LPR) is planned to be operated at the Raytheon Facility in Sudbury, MA over the period of July 8, 2013 – December 23, 2013. The purpose of this request for Special Temporary Authorization is to demonstrate the maturity of our system concept and technology to the customer.

Test Summary:

An experimental license is required to demonstrate the operation of a prototype radar system to our customer. Prototype radar demonstration validation trials and dry runs are planned to start on July 8, 2013.

The system will transmit pulsed Frequency Modulated (Chirp) waveforms. For all waveform types, the maximum pulse duration is 55 μ s and the maximum duty factor is 22%. It is expected that the radar will be operated 24 hours a day, seven days per week for the duration of the testing. This operation time applies to the Sudbury, MA test facilities.

RF Hazard Calculations and Site Safety Measures:

Initial calculations show that general public exposure limits will be reached at a 1 meter distance and occupational exposure limits at 2.2 meters, 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. Raytheon has a Company Policy and an Environmental, Health and Safety Standard which address electromagnetic energy exposure control. It is Raytheon’s policy to ensure that our personnel, the general public and our customers are not exposed to RF levels which exceed applicable standards. To that end, we will have an RF Safety Control Plan in place for the testing. 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:

Francis Lok
System Engineering Lead
Phone: 508-490-2216
Email: francis_lok@raytheon.com

Raytheon Spectrum Manager filing application:

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

Period of Use:

Start date: July 8, 2013
End date: December 23, 2013

Equipment Information:

Indicate all equipment that will be involved in this operation.

Transmitter info:

Manufacturer: Raytheon
Model: Low Power Radar (LPR)
Number of units: 1
Experimental (Y/N): Y

For each frequency band:

RF output at the transmitter terminals:
125 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 492 kW (peak).

Frequency Tolerance:

Less than 0.001 %

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

4M7Q3N - 55µsec FM-Pulsed with a 2 MHz FM chirp, at 9148.5 MHz
7M0Q3N - 6µsec FM-Pulsed with a 2.5 MHz FM chirp, at the 9151.25 MHz

The transmit waveform pulse sequence is programmable. Only single waveform type will be used: FM-Pulsed. The FM-pulses are modulated with a programmable 2 MHz chirp and programmable pulse width from 3µsec to 55µsec. The waveform types operate in the 9.15 GHz band.

The max duty factor for the 55µsec pulse is 22% and for the 6 µsec pulse is 2.3%. The max pulse repetition frequency is 3906.25 Hz for all waveform types.

List as appropriate for the type of modulation:

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 Raytheon facility in Sudbury, MA, is located at North 42°21'57", West 71°25'56" and ground elevation of 50 meters above sea level. The street address is 528 Boston Post Rd, Sudbury, MA 01776. The approximate location of the radar will be at North 42.366019°, West 71.431975°.

Is a directional antenna (other than radar used)?

No. (Although not necessary for this application, additional antenna detail is provided)

If yes, give the following info:

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

1.53° Azimuth, 1.66° Elevation

Orientation in horizontal plane:

+/- 45° Electronically Scanned

Orientation in vertical plane:

0° to 30°, relative to ground horizontal

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)

If Yes,

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:

50m (Sudbury, MA Test Facility)

Distance to nearest aircraft landing area in km:

Sudbury, MA Test Facility:

Marlboro Airport - Marlboro, MA (MXG)

8km

Minute Man Airfield - Stow, MA (MMN)	13km
Waltham Airport - Waltham, MA (WLT)	13km
Laurence G. Hanscom Field - Bedford, MA (BED / KBED)	15.5km
Laurence Hanscom - Burlington, MA (BBF)	15.5km
Boston City Heliport - Boston, MA (JBC)	15.5km
Waltham Hospital Heliport - Waltham, MA (WLM)	15.5km
Route 128 Airport - Route 128, MA (REM)	19.3km
Woburn Airport - Woburn, MA (WBN)	22.5km
Logan International Airport – Boston, MA (BOS/KBOS)	33.8km
Manchester-Boston Regional Airport – Manchester, NH (MHT / KMHT)	61.2km

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.

See the attached figure for a top view of the radar test site.

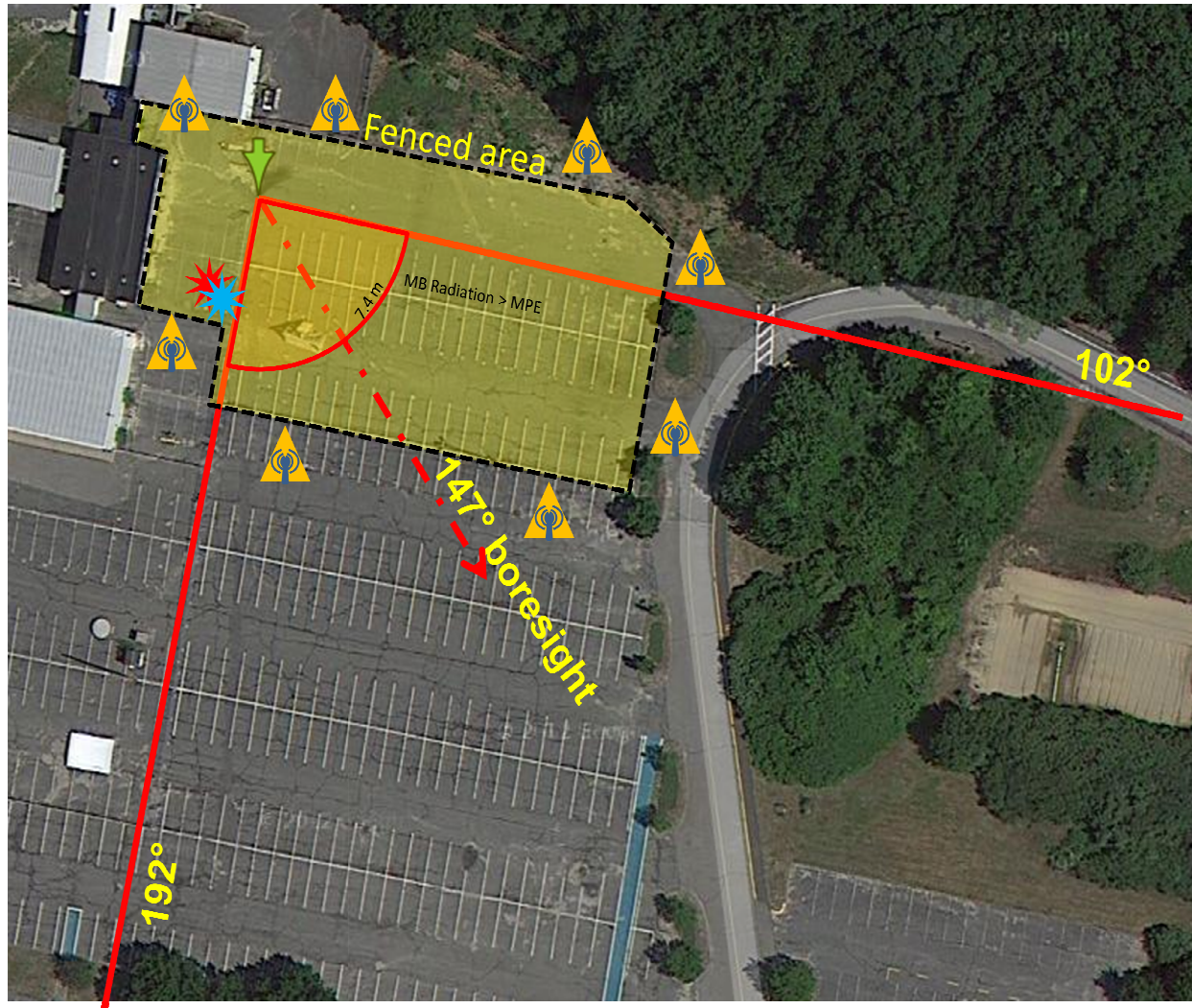


Figure 1: Sudbury, MA Test Facility. This graphic depicts the location of the radar at the test facility, as well as the intended azimuth coverage area and direction of radiation. The shaded yellow area defines the Keep-Out Zones (KOZ). Beyond the regions of the KOZ, the power density levels are below limits for uncontrolled environments.

Transmission Mode Table

Transmitter Waveform Modes											
Mode Emissions Designator	Center Frequency (GHz)	Azimuth Scan Coverage (degrees)	Elevation Scan Coverage (degrees)	Azimuth Beam Width (degrees)	Elevation Beam Width (degrees)	Pulse Width (μsec)	Max Duty Factor %	Peak ERP (kW)	Avg ERP (kW)	Max FM Chirp BW (MHz)	Necessary BW (MHz)
4M7Q3N	9.1485	+/- 45	(0 to 30)	1.53	1.66	55	22	492	108.4	2	4.7
7M1Q3N	9.15125	+/- 45	(0 to 30)	1.53	1.66	6	2.4	492	11.3	2.5	7.1

Necessary Bandwidth Calculation Table

FM-Pulsed Radar		
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.

FM-Pulsed Radar:

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

*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.