

# **Raytheon Request for FCC New License Authorization**

Prototype Radar Design, Development, and Test

Form 442 File Number: 0065-EX-PL-2014

Date: 22 January 2014

**This request is related to STA Call Sign WH9XBT (STA file Number 0861-EX-ST-2013)**

## **Purpose of Operation:**

Frequency authorization for 5.150 – 5.35 GHz, 5.46 – 5.59GHz and 5.65 to 6.0 GHz band (C-Band) is being requested for the period of 4 February 2014 to 3 February 2016. The authorization will be used to perform measurements on various radar systems at different stages of design, development, and manufacture at a Raytheon facility. These measurements may include calibration, evaluation, verification, and integration type tests. The intent of the project is the demonstrate a low cost, easily re-configurable radar using a software defined radio and commercial off the shelf parts.

## **License Explanation:**

The purpose of this request for a New License Authorization is to perform low power measurements on radar systems or parts of radar systems, outside of a shielded anechoic chamber, in order to meet internal and external customer commitments.

## **Test Summary:**

Transmit measurements will be made at low power using a directional antenna. These measurements will be in the operating frequency range as listed above..

These measurements will require transmission of pulsed CW waveforms. The pulse duration range from 0.1  $\mu$ sec to 12.8 $\mu$ sec and the maximum duty factor is 50%. These transmissions will occur between the radar antenna and local objects. It is expected that the radar will be operated 24 hours a day, seven days per week for up to 6 times per year.

See Attachment 1 Prototype Radar Test Parameters for an overhead view of the site.

## **Site Safety Measures:**

Calculations show that general public exposure limits will be reached at about a 2.5 meters distance using formula (6) from FCC OET Bulletin 65 “Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields”, dated August 1997. The distance shown is based on 100% reflection because it is on a rooftop pointing down.

Raytheon’s RF safety group is involved in this test 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 was performed at the initial turn-on of the system. All measured levels, where personnel have access, were below the MPE limits before testing commenced.

**Raytheon Technical Point of Contact:**

Name: Raymond Roberge  
Title: Engineering Fellow, Systems Lead  
Phone: Cell: 978-397-5731 Office: 978-897-5226  
Email: [roberge@raytheon.com](mailto:roberge@raytheon.com)

**Raytheon Spectrum Manager filing application:**

Richard Haycook  
Spectrum Management/RF Safety  
Phone: 978-858-4101  
Email: Richard .A.Haycook@raytheon.com

**Period of Use:**

From: 4 February 2014  
To: 4 February 2016

**Equipment Information:**

**Prototype Radar Transmitter:**

Manufacturer: Raytheon Company  
Model: Prototype C-Band Radar  
Number of units: One  
Experimental (Y/N): Yes

**For each frequency:**

RF output at the transmitter terminals:  
Prototype Radar: 4 W peak, 2 W average

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

Prototype Radar: 191W

**List each type of emission separately for each frequency**

The transmit waveform of the prototype radar is programmable is a pulsed CW waveform type on any one frequency.

| Type of signal | Emission Designator |
|----------------|---------------------|
| Pulsed CW      | 25M3P0N             |
|                |                     |

**List as appropriate the type of modulation:**

|                                     |                                                                                                                    |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| Maximum speed of keying in bauds:   | <i>Not Applicable, not a communication device</i>                                                                  |
| Maximum audio modulating frequency: | <i>Not Applicable</i>                                                                                              |
| Frequency deviation of carrier:     | <i>Not Applicable</i>                                                                                              |
| Pulse duration and rep rate:        | 0.1 -12.8μsec maximum pulse width, up to 50%<br>duty factor maximum at any pulse duration/rep rate<br>combination) |

**Necessary bandwidth. Explain how determined.**

The necessary bandwidth was calculated using the equations in Annex J of the NTIA Manual (see below).

**Location:**

The Raytheon facility in Tewksbury, MA, is located at North 42° 38' 25" West 71° 14' 37" with a ground elevation of 50 meters above sea level. The street address is 50 Apple Hill Drive, Tewksbury, MA 01876. The approximate location of the radar will be at North 42° 38' 18" West 71° 14' 43".

**Is a directional antenna (other than radar used)?**

No

**If yes, give the following info:**

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

**Orientation in horizontal plane:**

**Orientation in vertical plane:**

**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

**If Yes,**

**Overall height above ground to tip of antenna in meters:**

N/A

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

70m (Tewksbury, MA Test Facility)

**Distance to nearest aircraft landing area in km:**

Tewksbury, MA Test Facility:

|                                                                  |        |
|------------------------------------------------------------------|--------|
| Boire Field - Nashua, NH (ASH / KASH)                            | 40.0km |
| Lawrence Municipal Airport - Lawrence, MA (LWM / KLWM)           | 16.1km |
| Manchester-Boston Regional Airport – Manchester, NH (MHT / KMHT) | 57.7km |
| Laurence G. Hanscom Field - Bedford, MA (BED / KBED)             | 33.9km |

|                                                       |        |
|-------------------------------------------------------|--------|
| Minute Man Airfield - Stow, MA (MMN)                  | 39.8km |
| Waltham Airport - Waltham, MA (WLT)                   | 43.3km |
| Fitchburg Municipal Airport - Fitchburg, MA (UXO)     | 52.6km |
| Beverly Municipal Airport - Beverly, MA (BVY / KBVY)  | 27.9km |
| Logan International Airport – Boston, MA (BOS / KBOS) | 43.8km |
| Boston City Heliport - Boston, MA (JBC)               | 31.7km |
| Waltham Hospital Heliport - Waltham, MA (WLM)         | 30.1km |
| Woburn Airport (Cummings Park) - Woburn, MA (WBN)     | 28.9km |
| Marlborough Airport, Marlborough MA                   | 60.1km |

**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

| Waveform  | Center Frequency (GHz)                             | Az Scan Coverage (deg) | El Scan Coverage (deg) | Pulse Width (us) | Pulse Rise/Fall Time (us) | Max Duty Cycle (%) | Transmitter Output, Peak | ERP, Peak | Necessary BW / pulse | Emission Designator |
|-----------|----------------------------------------------------|------------------------|------------------------|------------------|---------------------------|--------------------|--------------------------|-----------|----------------------|---------------------|
| Pulsed CW | 5.15 to 5.35 GHz, 5.46-5.59GHz, and 5.65 to 6.0GHz | Fixed                  | Fixed                  | 0.1 us           | 0.05                      | 50                 | 4 W                      | 200 W     | 25.3 MHz             | 25M3P0N             |

### 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<sub>r</sub> = Emitted pulse rise time in µsec from the 10% to the 90% amplitude points on the leading edge.

t<sub>f</sub> = Emitted pulse fall time in µsec from the 90% to the 10% amplitude points on the trailing edge.

CW-Pulsed Radar:

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

\*If t<sub>f</sub> is less than t<sub>r</sub>, then t<sub>f</sub> is to be used in place of t<sub>r</sub> when performing the necessary bandwidth calculations

### Emission Designators (NTIA)

#### Linear and FM Pulsed Radar

|                                 |   |                                                          |
|---------------------------------|---|----------------------------------------------------------|
| Type of Modulation Main Carrier | P | Sequence of unmodulated pulses.                          |
| Nature of signals modulating    | 0 | No modulating signal, excluding time-division multiplex. |
| Type of Info transmitted        | N | No Information Transmitted.                              |