

Experimental License Modification Request

1 Purpose of Operation

Raytheon Integrated Defense Systems (IDS) to development of the prototype radar requires the testing of more waveforms, i.e. pulsed Frequency Modulated (FM Chirp) waveforms over the same frequency range 5.4 – 5.5 GHz.

File Number:	0631-EX-CM-2018
- Station Locations:	FIXED/MOBILE
- Effective:	10/21/2018
- Expiration:	10/21/2019

Experiment 1: Summary - Radar operating in C-band, on the ground, low power, chirp waveforms.

Call Sign: WG2XVY,:

Continued development of the prototype radar requires the testing of more waveforms, i.e. pulsed Frequency Modulated (FM Chirp) waveforms over the same frequency range 5.4 – 5.5 GHz.

In addition, experiments are planned that are intended to demonstrate the operability of the radar with varying types of targets. The targets will be presented to a radar via a Synthetic Target Generator. It is essential that radar performance be demonstrated in a real-time radar environment, which allows for the analysis of over-the-air effects that are not easily modeled in simulation.

Synthetic Target Generator (STG) will be used to present the radar with targets with varying characteristics. The STG will receive signals transmitted by the radar and will process them to add simulated targets to the return signal.

Waveforms:

Waveforms will be utilized by the prototype radar / STG:
Frequency Modulated-Pulsed programmable with up to a 75 MHz chirp slope and programmable pulse width from 1.0µsec to 20.0msec, 30.0kHz max rep rate.

Emissions Modulation is 75MF1N (75 MHz Bandwidth, Unmodulated Carrier with varying frequency modulation, single channel (no sub-carrier), No additional information transmitted). Effective Radiated Power of less than 500 watts peak. Transmitter Power less than 5 watts peak. Custom Transmitter.

Experiment 2: Summary – Communications Link Testing, operating in 30 MHz to 2,000 MHz range, Full duplex on the ground, low power, AM, SSB, NBFM, and PSK waveforms.

New experiment to test a ground to ground link using narrow band modulation. Frequency of experiment #2 divided into 3 operating bands:

Band A) 54.0 -> 60.0 MHz

Band B) 420.0 -> 426.0 MHz

Band C) 1,850.0 -> 2,000.0 MHz

Emissions Modulation is 25KD2W (25 kHz, Both Amplitude and Phase modulated, Single channel with modulating subcarrier, with both voice (telephony) and data). Effective Radiated Power of less than 20 watts peak. Transmitter Power less than 10 watts peak. Custom Transmitter.

Experiment 3: Summary – Communications Link Testing, operating in 30 MHz to 2,000 MHz range, Full duplex, ground to Air to ground, low power, AM, NBFM, and PSK waveforms.

New experiment to test a ground to air and air to ground link using narrow band modulation. Frequency of experiment #3 divided into 3 operating bands:

Band A) 54.0 -> 60.0 MHz

Band B) 420.0 -> 426.0 MHz

Band C) 1,850.0 -> 2,000.0 MHz

Emissions Modulation is 25KD2W (25 kHz, Both Amplitude and Phase modulated, Single channel with modulating subcarrier, with both voice (telephony) and data). Ground Effective Radiated Power of less than 20 watts peak. Transmitter Power less than 10 watts peak. Air Effective Radiated Power of less than 5 watts peak. Transmitter Power less than 2 watts peak. Custom Transmitter.

Raytheon Technical Point of Contact regarding this modification:

Stop Buzzer Point of Contact:

Name: Kevin Perry

Title: IPT Lead, Radar Test

Phone: 978-858-9862 (office)

Email: Kevin.Perry@raytheon.com

Raytheon Spectrum Manager filing application:

Karen Dyberg

Spectrum Management/FCC Coordinator

Phone: 978-440-4022

Email: Karen_I_Dyberg@Raytheon.com

Period of Use:

Start Date: 5/15/2018

End Date: 12/15/2019

Equipment Information:

3 Custom Designed Transceivers, 2 identical for the ground and 1 for the air
3 Custom Low power receiver amplifiers with filters
3 Custom Low power transmitter amplifiers with filters
1 RSA5000 Tektronix real time spectrum analyzer
Multiple monopole antennas

For the Air portion of the experiment:

The STG will be mounted on a DJI S900 Hexacopter. The Hexacopter can carry the weight of the transmitter with ease. The hexacopter, when it is flown within 400 feet of the ground, has enough range, altitude, speed and other factors to serve as an ideal platform for the STG to work on the radar system.

The radar will have line of sight access to the STG at each of the selected mobile operation sites. On clear and not-very-windy days, the program will run flights for 15 minutes apiece from one or more of the selected test sites. The testing is expected to be very sporadic, and the time of use of the spectrum will be limited to the hexacopter's 15 minutes of flight time.

Raytheon has a licensed pilot available to fly the UAV, to stay within the regulations prescribed by the FAA. No flight will take place unless and until the FAA also allows Raytheon to conduct these UAV tests.

Areas of operation:

To exercise the radar system adequately, Raytheon has identified five local test areas at or near its Pelham, New Hampshire facility. Each of these test areas offers the opportunity to examine different aspects of the radar's ability to deal with the geometry of distant object detection.

Site Locations (Lat, Long, & Alt. in ft)

Pelham Site, Site 0: 42-44-13 N, 71-21-15 W, 412

IDS HQ, Site 1: 42-38-13 N, 71-14-59 W, 197

MDC Site, Site 2: 42-31-18 N, 71-08-30 W, 107

Sudbury Site, Site 3 : 42-21-54 N, 71-25-51 W, 159

UAV Test Field, Site 4: 42-37-00 N, 71-30-38 W, 204

The *Figures 1-5* are taken from Google Earth, depicting the site locations with a 100 meter radius from the site coordinates. The radius is for informational purposes only, since the hexacopter will not fly throughout the whole radius. At the MDC and Sudbury sites, operations will be limited to the sectors shown, to ensure additional safety. When the hexacopter is in use, it will fly/hover in a very limited portion of the area shown. These images are presented to allow the reviewer to see that the areas selected are away from people and mostly away from buildings. In those areas, the hexacopter will fly in an oval or figure eight pattern, if it is not simply hovering.



Figure 1. Pelham Site (radius = 100 m)



Figure 2. Raytheon IDS Headquarters – back parking lot, showing potential flight pattern



Figure 3. Missile Defense Center (MDC), showing potential flight pattern

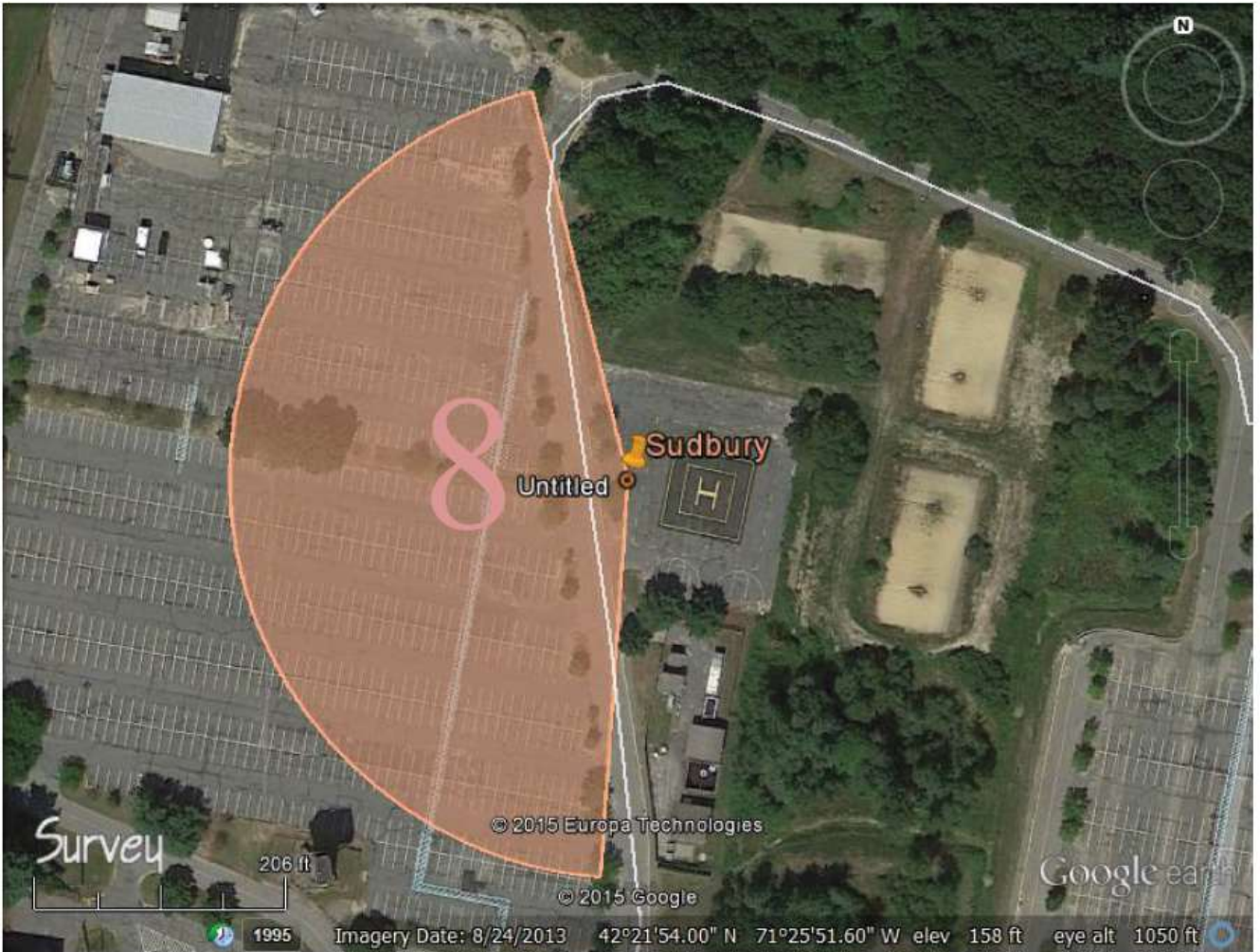


Figure 4. Sudbury location, showing a potential flight pattern

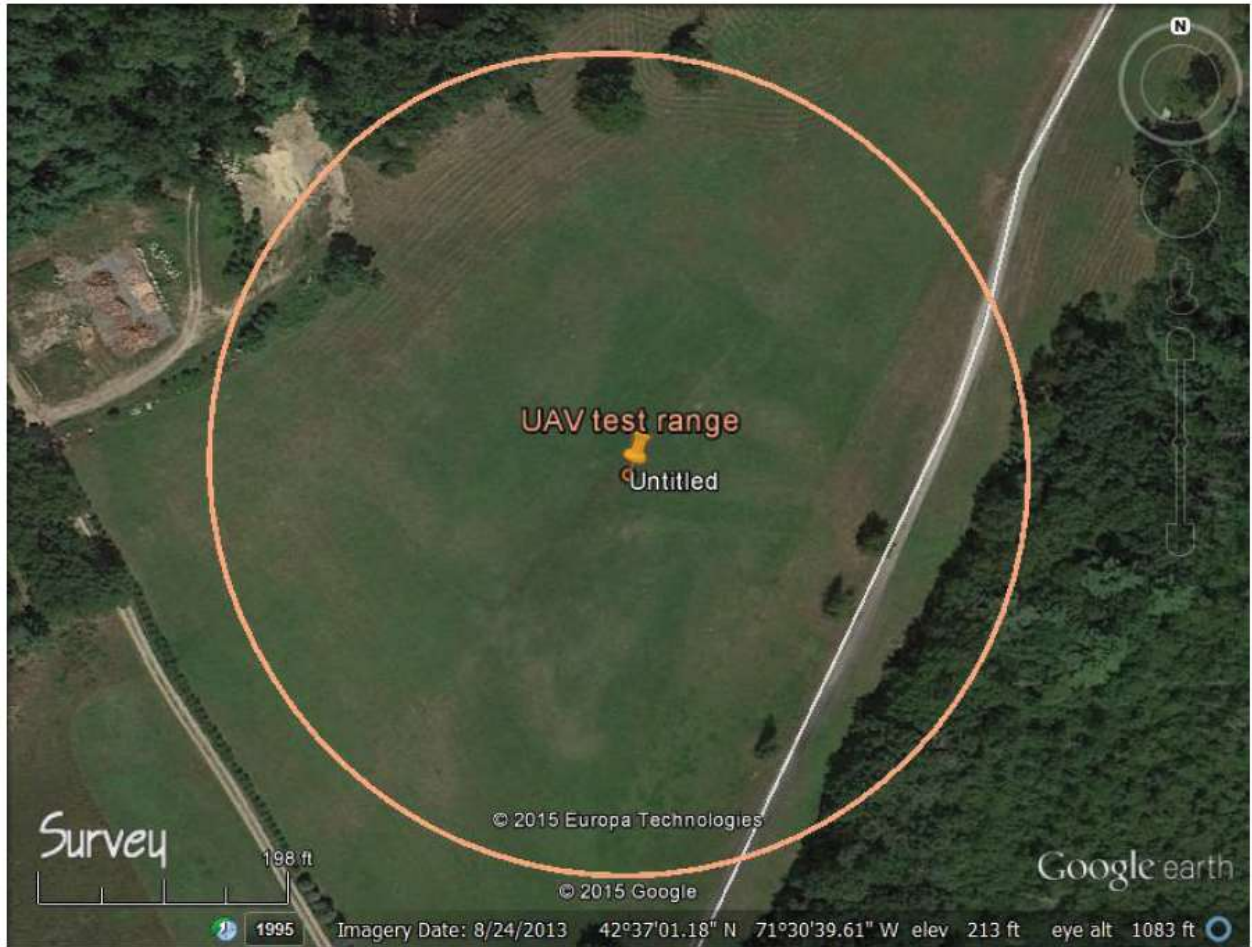


Figure 5. UAV test range

The diagram in *Figure 6* shows the position of the various test sites in relation to each other. The terrain at the Pelham site has the highest site elevation. Therefore, with the radar using some downtilt, it will be able to have line-of-sight to each of the other test areas when the UAV is in flight there, even though the flight altitude will be below 400 feet.

RF Laydown

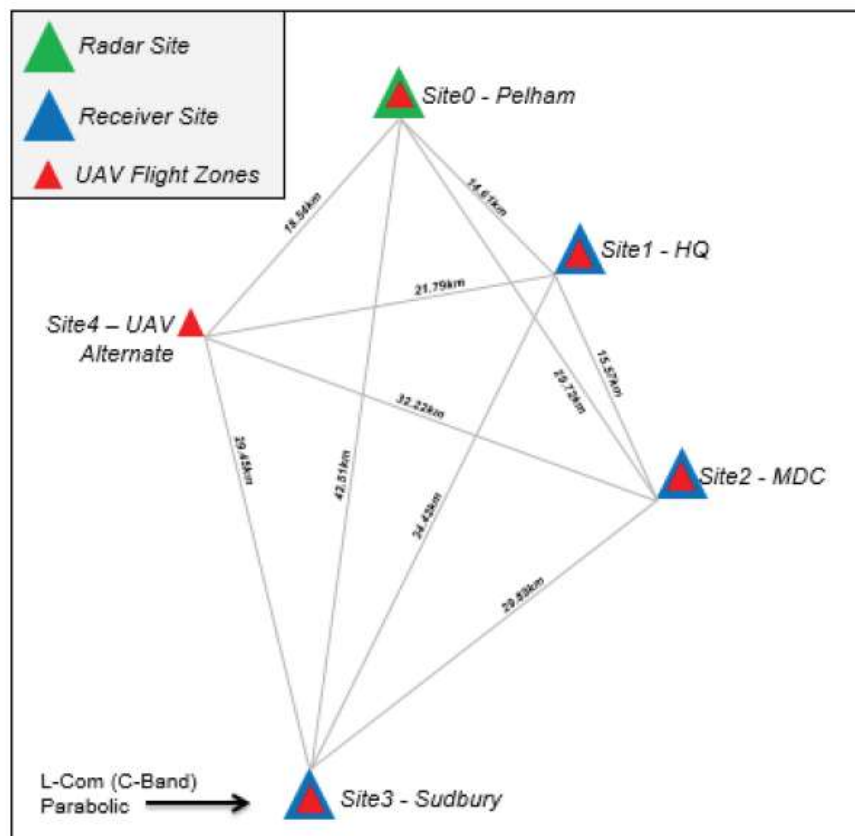


Figure 6. Overview of mobile test sites in relation to radar and each other

These 3 experiments enable to develop ground to ground, ground to air communications and advanced radar systems. This Modification

application seeks authority to add a mobile synthetic target generator to the existing radar license WG2XVY. The operations will be limited to very small areas at selected spots on or near Raytheon property that are ideal for the use of a UAV which can exercise the radar in ways that will advance the radar development. The time of use is highly limited. The geographic scope of operations is also very limited. The grant of this modification will significantly speed up the development of the radar system, creating significant savings for the US military.