Raytheon Request for FCC Permanent Experimental License Rev A

Confirmation Number: EL475160

25 March 2014

EXHIBIT 1 REV A NARRATIVE

This application is a renewal of WH9XAY, STA File Number 0985-EX-ST-2013

Purpose of Operation:

Frequency authorization is requested for the period of 16 May 2014 – 15 May 2016 in the 905 MHz to 925 MHz 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 Prototype Radar Demonstration System (PRDS) is planned to be operated at the Raytheon Facility in Portsmouth, RI over the period of 16 May 2014– 15 May 2016. The purpose of this request for a Permanent Experimental License is to demonstrate the maturity of our system concept/ technology to the customer and to continue developing its capabilities.

Test Summary:

An experimental STA was used to demonstrate the operation of a prototype radar system. Since November 2013, transmit measurements have been made at low power using a subset of the power amplifier. These measurements were in the operating frequency band 905 MHz to 925 MHz. Following the subset power amplifier, the system was fully assembled, calibrated and tested.

The prototype radar demonstration validation trials and dry runs are planned from June 1st to about 31 December 2014. A permanent experimental license is requested to support testing and followup development. Formal demonstrations for the customer will be conducted between August and September 2014. After the initial trials and dry runs, it is expected that additional testing/modifications will be performed for the remainder of the license period.

The system will transmit pulsed Frequency Modulated (Chirp) waveforms, with a maximum pulse duration is 32µs and the maximum duty factor is 3.82%. It is expected that the radar will be operated 24 hours a day, seven days per week for the duration of the testing at the Portsmouth, RI test facility.

Raytheon's RF safety group is involved in this demonstration to ensure that no personnel are subjected to RF power density levels exceeding the Maximum Permissible Exposure (MPE) limits in Part 1.1310 of the FCC Rules and the guidelines in FCC's OET Bulletin Number 65.

Raytheon has a Company Policy and Environmental, Health and Safety Standard which addresses 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 Plan in place for the testing. The RF Safety 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 and at planned intervals over the course of the activity. All measured levels, where personnel have access, must be below the MPE for uncontrolled environments before testing can proceed.

During the initial planning stages for this system, Raytheon evaluated the potential susceptibility of aircraft and Electro-Explosive Devices (EEDs) in or on aircraft during the operation of the prototype radar. The results show that there are no radiation hazards to personnel, aircraft, aircraft equipment or EEDs, during the testing.

Additional information is also provided in slides (attached) which cover test site layout and transmit scan coverage. Test site layout and transmit scan coverage limitations is addressed for the test facility.

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Period of Use:
Start date: 16 May 2014
End date: 15 May 2016

Equipment Information:
Transmitter info:
Manufacturer: Raytheon

Model: DemoSPS-49
Number of units: 1
Experimental (Y/N): Y
For each frequency band:
RF output at the transmitter terminals: 9.75 kW peak, 372 W average.
(This is the maximum RF output and accounts for losses between the output of the power amplifier and the radiating elements. This does not include front-end losses.)

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 6.9MW peak, 264 kW average.
Frequency Tolerance:
Less than 0.001 %
List each type of emission separately for each frequency (basically list the emission designators)
32usec FM-Pulsed with a 1MHz FM chirp, in the 905 – 925 MHz band
Two waveform types can be commanded: FM-Pulsed, and Non-FM Pulsed (Unmodulated). The FM-pulses are modulated with a 1 MHz chirp and a fixed pulsewidth of 32usec. The Non-FM Pulses have a fixed pulse width of 2us. All waveform types operate in the 905 to 925 MHz band.
The max duty factor is 3.82%, and the max pulse repetition frequency is 1.18 kHz for all waveform types. During development, a partial subset of the transmitter was used – and may be used again. The keep out zones for testing the partial subset of the transmitter is the same as for the full transmitter.

List as appropriate for the type of modulation:
Maximum speed of keying in bauds: Not Applicable, not a communication device
Maximum audio modulating frequency**:** Not Applicable
Frequency deviation of carrier: Not Applicable
Pulse duration and rep rate: 32usec maximum pulse width, 1.18 kHz maximum rep rate (3.82% duty factor maximum at any pulse duration/rep rate combination)
For complex emissions, describe in detail: Non-Linear Frequency-Modulated Pulsed (Chirp)
Non Frequency-Modulated Pulsed (unmodulated/pulsed CW)

Necessary bandwidth. Explain how determined.
The necessary bandwidth was calculated using the equations in Annex J of the NTIA Manual.

The slides at the end of this document provide the details of this calculation.

Locations:
The Raytheon facility in Portsmouth, RI, is located at North 41° 34' 27.06", West 071° 16' 47.96" and ground elevation of 49.08 meters above sea level. The street address is 1847 West Main Rd, Portsmouth, RI 02871. The approximate location of the radar is at North 41° 34' 30.94", West 071° 16' 54.40".
Is a directional antenna (other than radar used)?
No.
Width of beam in degrees at the half-power point:
1.6° Azimuth, 1.7° Elevation
Orientation in horizontal plane:
-60/+46° Electronically Scanned, 360° with Rotating Antenna
(This is the full capability of the system. Orientation is limited via software-defined radiation control zones)
Orientation in vertical plane:
-10° to 55°, relative to ground horizontal
(This is the full capability of the system. Orientation will be limited via software-defined radiation control zones)
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 antenna is mounted on a raised platform, of which the pedestal mounting ring is situated 2.3 meters above the main roof level of Nimitz Building 1W. The highest point of the antenna will be 5.7 meters above the main roof level, and 6.5 meters below the highest point of the building.
Overall height above ground to tip of antenna in meters:
18.45m
Elevation of ground at antenna site above mean sea level in meters:
49.08m (Portsmouth, RI Land Based Test Facility)
Distance to nearest aircraft landing area in km:
Portsmouth, RI Test Facility:
Newport State Airport – Middletown, RI (UUU) 5.0km
T.F Green Airport – Warwick, RI (PVD) 11.3km
Quonset State Airport – North Kingstown, RI (OQU) 12.4KM
New Bedford Regional Airport - New Bedford, RI (EWB) 29.4km
North Central State Airport – Smithfield, RI (SFZ) 40.6km

Martha’s Vineyard Airport – Vineyard Haven, MA (MVY) 57.5km
Norwood Memorial Airport- Norwood, MA (OWD) 66.8k

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

The following describes the attached slides/etc. that show what the site looks like.
The other tables/etc. show the tabular details of most of what was said above in narrative.

Figure 1 is a satellite view of the Free Space Radiation Zone for the Portsmouth Land Based Test Site (PLBTS) which defines the Free Space Radiation Zone and No Radiation Zone, including the True and Relative bearing boundaries for each zone. The Radar Antenna normally rotates through 360 degrees azimuth. Free space radiation sector is 106 degrees (-60 to +46 degrees) centered at 292.0 degrees True bearing. Scan coverage is controlled through the use of software-set radiation control zones with redundant mechanical cam-operated switches mounted in the antenna. The radiation control zones will comply with the agreement reached between
Raytheon and the Town of Portsmouth, RI for rooftop radar installations, to avoid radiating at the near-by buildings to the North and the South of the facility identified by said agreement. The Portsmouth Land Based Test Facility is fenced in, isolating it from public access. Analysis of power density levels at the Portsmouth Land Based Test facility provided in Figures 2-3 ensure personnel safety and aircraft/EMI susceptibility. The results of the analysis define the Keep Out Zones and coverage limitations for the test facility.

Figure 2 is a satellite view of the proposed antenna location on the roof of the Portsmouth Land Based Test Site (PLBTS). This graphic identifies the Azimuth Free Space Radiation and No Radiation Zones, including the True and Relative bearing boundaries for each zone. Also identified are the fenced boundaries of the property.

Figure 3 is a detailed satellite view of the antenna location on the roof of the Portsmouth Land Based Test Site (PLBTS). This graphic identifies the Keep Out Zone (KOZ) and proposed MPE safe distances for the antenna operating in azimuth in uncontrolled environments.

Figure 4 is a side-view graphic that identifies the elevation radiation pattern of the antenna relative to the Portsmouth Land Based Test Facility and surrounding topography. Depicted in this graphic is the antenna radiation pattern for a fixed elevation angle of +3 degrees and 10 degree beam width. Also depicted in the graphic is the KOZ relative to the fixed elevation angle antenna and the MPE safe zones above and below the radiated beam.

Figure 1. Portsmouth Free Space Radiation Zone (Satellite Image)

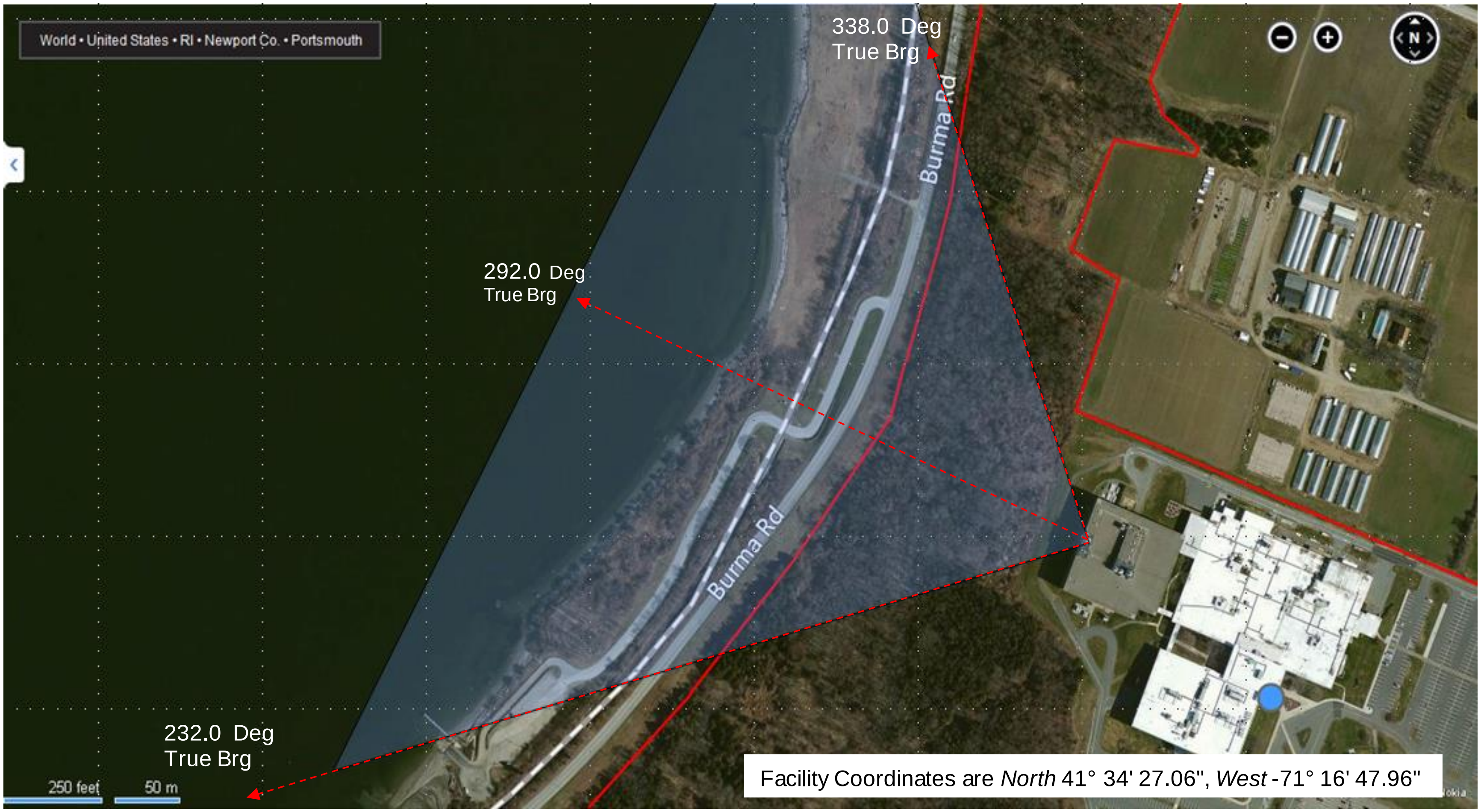

Figure 2. Portsmouth RI Test Facility. **This graphic depicts the location of the radar at the test facility, as well as the intended azimuth coverage area and direction of radiation (blue shaded area). The solid red lines define the fenced boundaries. The dotted red line defines the Radiation Boundaries.**

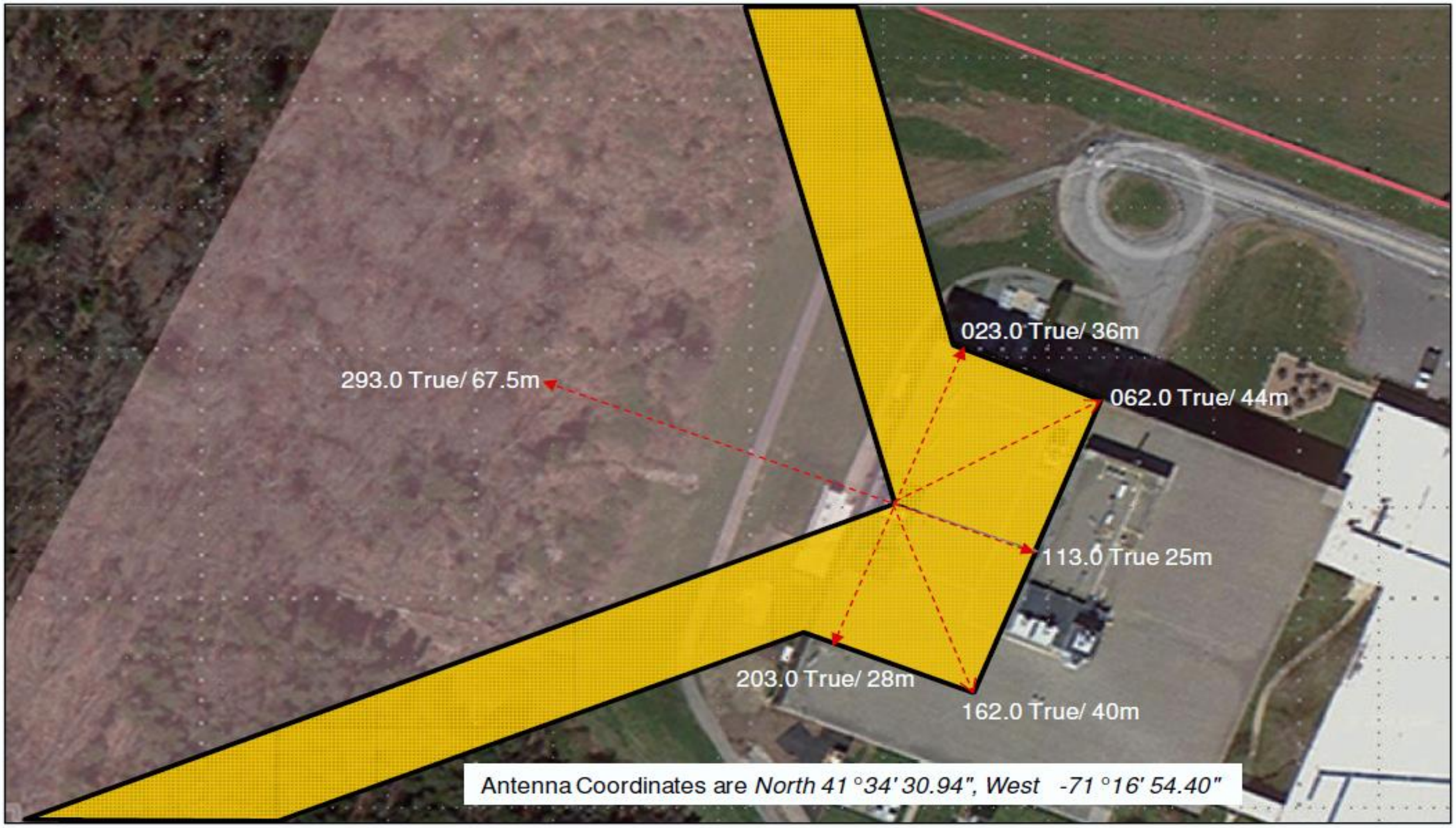

Figure 3 Portsmouth RI Test Facility. This graphic depicts the location of the radar at the test facility, as well as the intended azimuth coverage area and direction of radiation (red shaded areas). The shaded yellow area defines the Keep-Out Zones (KOZ). Beyond the regions of the KOZ, the power density levels are below the limits for uncontrolled environments.

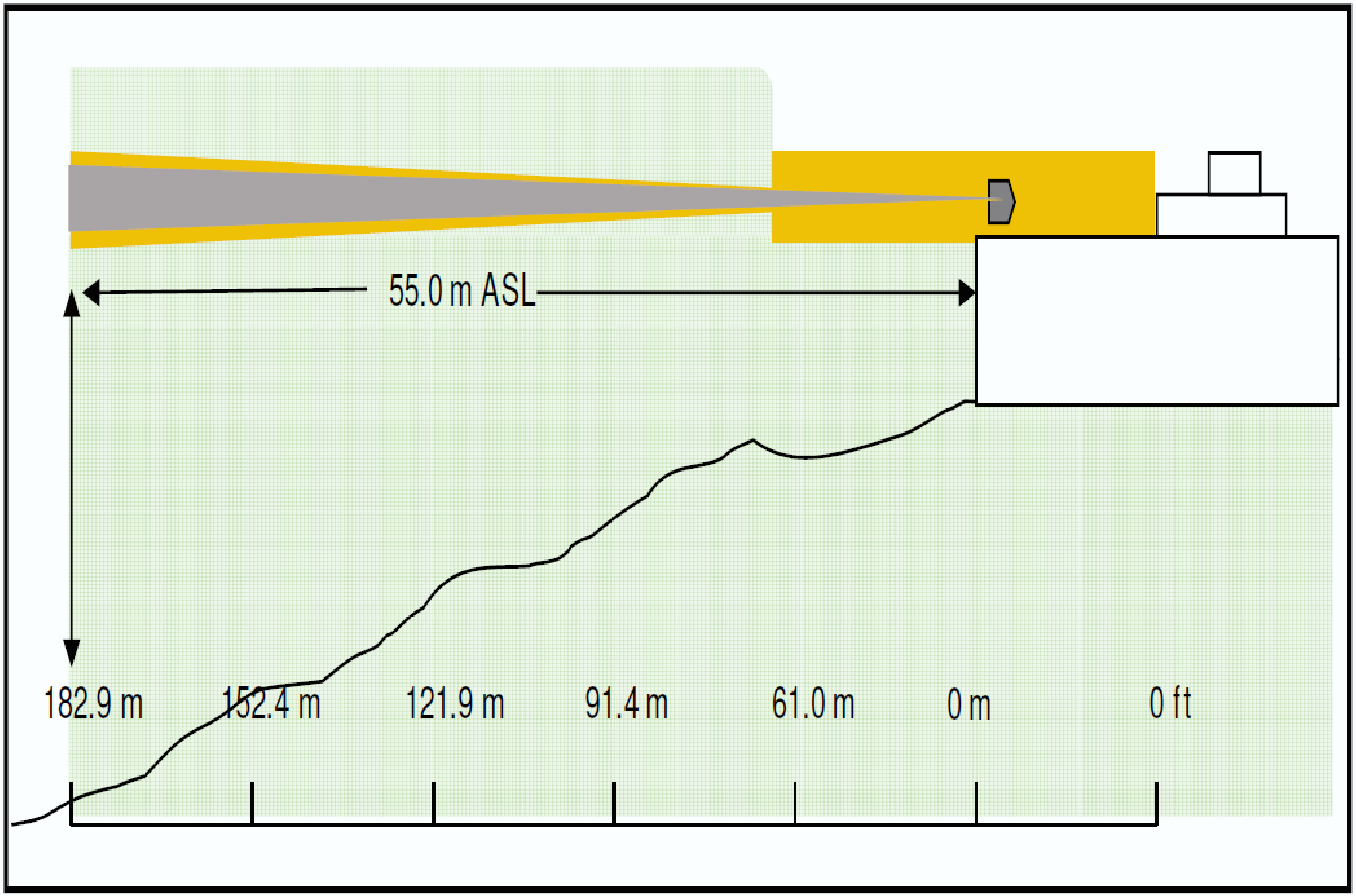

Figure 4 Portsmouth RI Test Facility. This graphic depicts the location of the radar at the test facility, as well as the intended elevation radiation and coverage areas. The shaded yellow area defines the Keep-Out Zones (KOZ). Beyond the regions of the KOZ, the power density levels are below the limits for uncontrolled environments.

Mode Table

Transmitter Waveform Modes											
Mode Emissions Designator	Center Frequency (MHz)	Azimuth Scan Coverage (degrees)	Elevation Coverage (degrees)	Azimuth Beam Width (degrees)	Elevation Beam Width (degrees)	Pulse Width (μsec)	Max Duty Factor %	Peak ERP (kW)	Average ERP (kW)	Max FM Chirp BW (MHz)	Necessary BW (MHz)
	905 - 925	0 - 360	+30	3.3	10	32	3.82	6,900	264	1	2.71
	905 - 925	0 - 360	+30	3.3	10	2	0.24	6,900	16.6	N/A	2.83

Necessary bandwidth calculation Table

FM-Pulsed Radar		
Pulse Width (μsec)	32	
Rise Time (μsec)	0.2	
Fall Time (μsec)	0.2	
Chirp BW (MHz)	1	
Necessary BW (MHz)	2.71	
Designator		

Non-FM Pulsed Radar		
Pulse Width (μsec)	2	
Rise Time (μsec)	0.2	
Fall Time (μsec)	0.2	
[Pulse Width]/[Rise Time]	10	
Necessary BW (MHz)	2.83	
Designator		

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.*

Non-FM Pulsed Radar:

If $\frac{t}{t_r} \langle 12.6$, then:

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

Otherwise:

$$B_n = B(-20dB) = \frac{6.36}{t}$$

**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.*

Phase Coded Pulsed Radars:

If $\frac{t}{t_r} \langle 12.6$, then:

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

Otherwise:

$$B_n = B(-20dB) = \frac{6.36}{t}$$

**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.*

***For phase coded pulse signals the pulse width and rise times are those associated with a single sub-pulse. If the rise tim of a single sub-pulse is not available, assume it is 40 % of the time to switch from one phase or sub-pulse to the nex*

*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.

**For phase coded pulse signals the pulse width and rise times are those associated with a single sub-pulse. If the rise time of a single sub-pulse is not available, assume it is 40 % of the time to switch from one phase or sub-pulse to the next