

Raytheon Request for Special Temporary Authorization

STA File Number: 0043-EX-ST-2016

1/12/2016

Purpose of Operation:

Frequency authorization is being requested to test the performance of six commercial maritime radars. Radars of similar type will be tested together in two different groups; three large fixed site radars and three smaller shipboard radars.

Technical Synopsis:

- Spectrum requested: 9200 – 9500 MHz
- Ten frequencies will be selected from the spectrum granted for each test group
- Power levels requested: 770 kW ERP
- Expected time of use: Between 0000 and 2400, 12-16 hours/day
- Stop buzzer contact: Peter Scarlett (Cell: 519-572-4394)

STA Explanation:

The Special Temporary Authorization is required to quantify the performance of the radars under test in a short time frame in order to meet contractual obligations. This testing will take place as early as 2/4/2016.

Radar Mounting and Direction of Operation:

The radars will be operated from the parking lot of the Holiday Inn, Ponce, Puerto Rico for up to 10 days. They will be mounted on the roof of a small container or other temporary mounting structure at approximately 10 ft above ground level. The antennas are 8 - 21 foot long slotted waveguide with gains of 30 – 38 dBi, and will be mounted close to the roof surface. The radars rotate clockwise between 15 - 30 rpm and will only transmit towards the sea at azimuths between 180 and 270 degrees. Radars of similar type will be tested together in two different groups; three large fixed site radars and three smaller shipboard radars. Ten frequencies are required for each test group.

RF Hazard Calculations and Site Safety Measures:

Initial calculations show that power density will fall below general public exposure limits at less than 2.3 meters distance and occupational exposure limits at less than 1.1 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 and the rotating antenna duty factor.

A safety interlock disables the transmitters unless the antenna is rotating. The radars will be operated in a fenced guarded area at all times.

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 Technical Point of Contact:

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Period of Use:

Start date: 02/04/2016

End date: 07/28/2016

Radar info:

Table 1 below contains the detailed equipment characteristics for each radar.

Table 1 Detailed Equipment Characteristics

	Large Fixed Site Radars			Smaller Ship Radars		
Manufacturer	Terma	GEM	Kelvin Hughes	Terma	GEM	Kelvin Hughes
Model	Scanter 5202	Sentinel 200	SharpEye SBS-900-2	Scanter 6002	Sea Eagle 200	SharpEye DTX-A40
# of units	1	1	1	1	1	1
Experimental	N	N	N	N	N	N
RF output at transmitter	200 W peak	200 W peak	200 W peak	200 W peak	200 W peak	200 W peak
ERP from antenna	770 kW	770 kW	344 kW	193 kW	154 kW	122 kW
Frequency tolerance	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%
Revolutions per minute	15	15	15	20	20	20
Pulse durations	50 us	26 us	25 us	50 us	26 us	25 us
	10 us	5 us	5 us	10 us	5 us	5 us
	0.15 us	0.15 us	0.1 us	0.1 us	0.1 us	0.1 us
Chirp bandw idth	32 MHz	32 MHz	20 MHz	32 MHz	32 MHz	20 MHz
Ristime	0.1 us	0.1 us	0.1 us	0.1 us	0.1 us	0.1 us
Necessary (20 dB) bandw idth, MHz	64.8	65.1	41.1	64.8	65.1	41.1
	65.8	66.5	42.5	65.8	66.5	42.5
	78.6	78.6	57.9	81.9	81.9	57.9
Antenna Gain	38 dBi	38 dBi	34.5 dBi	32 dBi	31 dBi	30 dBi
Antenna length	21 ft	21 ft	18 ft	12 ft	8 ft	8 ft
Suggested frequencies, MHz	9340	9330	9350	9260	9320	9230
	9365	9450	9470	9301	9440	9470
	9390			9342		
	9415			9383		
	9440			9424		
	9465			9465		
PRF	2000 Hz	1500 Hz	2000 Hz	2000 Hz	1500 Hz	2000 Hz
Duty factor	20%	20%	11.40%	20%	20%	11.40%
Rotating duty factor	1%	0.10%	0.13%	0.19%	0.23%	0.28%
Beam el °	11	11	25	30	25	30
Beam az °	0.36	0.36	0.45	0.7	0.85	1

List each type of emission separately:

There are two Terma radars that require six frequencies each. The other four radars only require two frequencies each. Each radar test group requires a total of ten frequencies. Frequencies will be selected to prevent inter-radar interference. The radar's operate similarly. Their transmit waveform is a fixed sequence of short, medium and long chirp pulses alternating between low- and high-band frequencies that are approximately 120 MHz apart. The pulse repetition frequency is either 1500 or 2000 Hz.

All pulses have an FM chirp bandwidth of 32 MHz or 20 MHz with a 100 nsec rise-time and differ only in their pulse duration and necessary bandwidth as shown in Table 1 above. The emissions are Q3N.

The spectrum required for each test group in the 9.2 – 9.5 GHz band is summarized in Table 2 below.

Table 2 Spectrum Summary

	Large Fixed Site Radars	Smaller Ship Radars
ERP from antenna	770 kW	193 kW
Frequency tolerance	0.001%	0.001%
Necessary (20 dB) bandwidth, MHz	65.1	65.1
	66.5	66.5
	78.6	81.9

Necessary bandwidth. Explain how determined.

Using the necessary bandwidth formula for FM-pulsed radars from the NTIA Manual, with a 0.1 µsec rise time:

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

Where

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.

B_c = Bandwidth of the frequency deviation (the total frequency shift during the pulse duration) in MHz

Location:

The radar will be located in the rear parking lot of the Holiday Inn, Ponce, Puerto Rico, within 150 meters of the coordinates below. The address is 3315 Ponce Bypass, Ponce, Puerto Rico, 00731.

The coordinates of this address are: Latitude 17° 58' 42.2" N, Longitude 66° 40' 17.8" W.