

# RADIO TEST REPORT – 430877APFWL

Type of assessment:

**MPE Calculation report**

Applicant:

**FLIR Unmanned Aerial Systems ULC**

Product:

**Ranger R Series Radar 9GHz band**

Model:

**Ranger® R20SS-3D**

Model variant(s):

**Ranger® R20SS**

**Ranger® R20SS-U**

FCC ID:

**2AEYU-R20V3**

Specifications:

- ◆ **FCC 47 CFR Part 1 Subpart I, §§1.1307, 1.1310**
- ◆ **FCC 47 CFR Part 2 Subpart J, §2.1091**
- ◆ **FCC KDB 447498 D01 General RF Exposure Guidance v06**

Date of issue: August 17, 2021

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Prepared by

  
Signature

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SCC File Number: 15064 (Ottawa/Almonte); 151100 (Montreal); 151097 (Cambridge)



## Lab locations

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	ISED:	2040A-4	2040G-5	24676
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Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

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## Table of Contents

<b>Table of Contents</b> .....	<b>3</b>
<b>Section 1 Evaluation summary</b> .....	<b>4</b>
1.1 MPE calculation for standalone transmission .....	4

## Section 1 Evaluation summary

### 1.1 MPE calculation for standalone transmission

#### 1.1.1 References, definitions and limits

##### FCC §2.1091(d)

- (2) (2) For operations within the frequency range of 300 kHz and 6 GHz (inclusive), the limits for maximum permissible exposure (MPE), derived from whole-body SAR limits and listed in Table 1 in paragraph (e)(1) of this section, may be used instead of whole-body SAR limits as set forth in paragraphs (a) through (c) of this section to evaluate the environmental impact of human exposure to RF radiation as specified in §1.1307(b) of this part, except for portable devices as defined in §2.1093 of this chapter as these evaluations shall be performed according to the SAR provisions in §2.1093.

**Table 1.1-1:** Table 1 to §1.1310(e)(1)—Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm <sup>2</sup> )	Averaging time (minutes)
<b>(i) Limits for Occupational/Controlled Exposure</b>				
0.3–3.0	614	1.63	*(100)	≤6
3.0–30	1842 / f	4.89 / f	*(900 / f <sup>2</sup> )	<6
30–300	61.4	0.163	1.0	<6
300–1500			f / 300	<6
1500–100000			5	<6
<b>(ii) Limits for General Population/Uncontrolled Exposure</b>				
0.3–1.34	614	1.63	*(100)	<30
1.34–30	824 / f	2.19 / f	*(180 / f <sup>2</sup> )	<30
30–300	27.5	0.073	0.2	<30
300–1500			f / 1500	<30
1500–100000			1.0	<30

Notes: f = frequency in MHz. \* = Plane-wave equivalent power density.

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density (mW/cm<sup>2</sup> or W/m<sup>2</sup>)  
P = power input to the antenna (mW or W)  
G = power gain of the antenna in the direction of interest relative to an isotropic radiator  
R = distance to the center of radiation of the antenna (cm or m)

1.1.2 EUT technical information

Prediction frequency	9500 MHz
Antenna type	Radar antenna
Antenna gain	9 dBi for R20SS-3D/-U; 17.5 dBi for R20SS
Number of antennas	1
Maximum transmitter conducted power	33/39/45 dBm (2/8/27W)

Prediction distance	As table below				
	Safety Distances				
		Output Power Nominal	Frequency Band	FCC MPE distance (cm)	
				Controlled Exposure	General Population
	R20SS (921-0071-7X-R0X)	2/8/27 Watts	X	50 / 90 / 180	100 / 200 / 400
	R20SS-3D/U (921-0071-6X-R0X) (921-0071-8X-R0X)	2/8/27 Watts	X	25 / 40 / 80	45 / 80 / 180

1.1.3 MPE calculation

1. **For R20SS, controlled exposure, 2W operation**

Fundamental transmit (prediction) frequency: 9500 MHz  
 Maximum measured conducted peak output power: 33.00 dBm  
 Cable and/or jumper loss: 0.0 dB  
 Maximum peak power at antenna input terminal: 33.00 dBm  
 Tx On time: 100.000 ms  
 Tx period time: 100.000 ms  
 Average factor: 100 %  
 Maximum calculated average power at antenna input terminal: 1995.262 mW  
 Single Antenna gain (typical): 17.5 dBi  
 Number of antennae: 1  
 Total system gain (typical): 17.500 dBi  
  
 MPE limit for uncontrolled exposure at prediction frequency: 5 mW/cm<sup>2</sup>  
50 W/m<sup>2</sup>  
 Minimum calculated prediction distance for compliance: 42 cm  
  
 Typical (declared) distance: 50 cm  
  
**Average power density at prediction frequency:** 3.571496 mW/cm<sup>2</sup>  
35.71496 W/m<sup>2</sup>  
  
**Margin of Compliance:** 1.46120 dB  
 Maximum allowable antenna gain: 18.96120 dBi

2. **For For R20SS, controlled exposure, 8W operation**

Fundamental transmit (prediction) frequency: 9500 MHz  
 Maximum measured conducted peak output power: 39.00 dBm  
 Cable and/or jumper loss: 0.0 dB  
 Maximum peak power at antenna input terminal: 39.00 dBm  
 Tx On time: 100.000 ms  
 Tx period time: 100.000 ms  
 Average factor: 100 %  
 Maximum calculated average power at antenna input terminal: 7943.282 mW  
 Single Antenna gain (typical): 17.5 dBi  
 Number of antennae: 1  
 Total system gain (typical): 17.500 dBi  
  
 MPE limit for uncontrolled exposure at prediction frequency: 5 mW/cm<sup>2</sup>  
50 W/m<sup>2</sup>  
 Minimum calculated prediction distance for compliance: 84 cm  
  
 Typical (declared) distance: 90 cm  
  
**Average power density at prediction frequency:** 4.388389 mW/cm<sup>2</sup>  
43.88389 W/m<sup>2</sup>  
  
**Margin of Compliance:** 0.56665 dB  
 Maximum allowable antenna gain: 18.06665 dBi

3. **For For R20SS, controlled exposure, 27W operation**

Fundamental transmit (prediction) frequency: 9500 MHz  
 Maximum measured conducted peak output power: 45.43 dBm  
 Cable and/or jumper loss: 0.0 dB  
 Maximum peak power at antenna input terminal: 45.43 dBm  
 Tx On time: 100.000 ms  
 Tx period time: 100.000 ms  
 Average factor: 100 %  
 Maximum calculated average power at antenna input terminal: 34914.032 mW  
 Single Antenna gain (typical): 17.5 dBi  
 Number of antennae: 1  
 Total system gain (typical): 17.500 dBi

MPE limit for uncontrolled exposure at prediction frequency: 5 mW/cm<sup>2</sup>  
50 W/m<sup>2</sup>  
 Minimum calculated prediction distance for compliance: 177 cm

Typical (declared) distance: 180 cm

**Average power density at prediction frequency:** 4.822199 mW/cm<sup>2</sup>  
48.22199 W/m<sup>2</sup>

**Margin of Compliance:** 0.15725 dB  
 Maximum allowable antenna gain: 17.65725 dBi

4. **For For R20SS, general population, 2W operation**

Fundamental transmit (prediction) frequency: 9500 MHz  
 Maximum measured conducted peak output power: 33.00 dBm  
 Cable and/or jumper loss: 0.0 dB  
 Maximum peak power at antenna input terminal: 33.00 dBm  
 Tx On time: 100.000 ms  
 Tx period time: 100.000 ms  
 Average factor: 100 %  
 Maximum calculated average power at antenna input terminal: 1995.262 mW  
 Single Antenna gain (typical): 17.5 dBi  
 Number of antennae: 1  
 Total system gain (typical): 17.500 dBi

MPE limit for uncontrolled exposure at prediction frequency: 1 mW/cm<sup>2</sup>  
10 W/m<sup>2</sup>  
 Minimum calculated prediction distance for compliance: 94 cm

Typical (declared) distance: 100 cm

**Average power density at prediction frequency:** 0.892874 mW/cm<sup>2</sup>  
8.92874 W/m<sup>2</sup>

**Margin of Compliance:** 0.49210 dB  
 Maximum allowable antenna gain: 17.99210 dBi

5. **For R20SS, general population, 8W operation**

Fundamental transmit (prediction) frequency: 9500 MHz  
 Maximum measured conducted peak output power: 39.00 dBm  
 Cable and/or jumper loss: 0.0 dB  
 Maximum peak power at antenna input terminal: 39.00 dBm  
 Tx On time: 100.000 ms  
 Tx period time: 100.000 ms  
 Average factor: 100 %  
 Maximum calculated average power at antenna input terminal: 7943.282 mW  
 Single Antenna gain (typical): 17.5 dBi  
 Number of antennae: 1  
 Total system gain (typical): 17.500 dBi  
  
 MPE limit for uncontrolled exposure at prediction frequency: 1 mW/cm<sup>2</sup>  
10 W/m<sup>2</sup>  
 Minimum calculated prediction distance for compliance: 189 cm  
  
 Typical (declared) distance: 200 cm  
  
**Average power density at prediction frequency:** 0.888649 mW/cm<sup>2</sup>  
8.88649 W/m<sup>2</sup>  
  
**Margin of Compliance:** 0.51270 dB  
 Maximum allowable antenna gain: 18.01270 dBi

6. **For R20SS, general population, 27W operation**

Fundamental transmit (prediction) frequency: 9500 MHz  
 Maximum measured conducted peak output power: 45.43 dBm  
 Cable and/or jumper loss: 0.0 dB  
 Maximum peak power at antenna input terminal: 45.43 dBm  
 Tx On time: 100.000 ms  
 Tx period time: 100.000 ms  
 Average factor: 100 %  
 Maximum calculated average power at antenna input terminal: 34914.032 mW  
 Single Antenna gain (typical): 17.5 dBi  
 Number of antennae: 1  
 Total system gain (typical): 17.500 dBi  
  
 MPE limit for uncontrolled exposure at prediction frequency: 1 mW/cm<sup>2</sup>  
10 W/m<sup>2</sup>  
 Minimum calculated prediction distance for compliance: 395 cm  
  
 Typical (declared) distance: 400 cm  
  
**Average power density at prediction frequency:** 0.976495 mW/cm<sup>2</sup>  
9.76495 W/m<sup>2</sup>  
  
**Margin of Compliance:** 0.10330 dB  
 Maximum allowable antenna gain: 17.60330 dBi



7. **For For R20SS-3D/-U, controlled exposure, 2W operation**

Fundamental transmit (prediction) frequency: 9500 MHz  
 Maximum measured conducted peak output power: 33.00 dBm  
 Cable and/or jumper loss: 0.0 dB  
 Maximum peak power at antenna input terminal: 33.00 dBm  
 Tx On time: 100.000 ms  
 Tx period time: 100.000 ms  
 Average factor: 100 %  
 Maximum calculated average power at antenna input terminal: 1995.262 mW  
 Single Antenna gain (typical): 9 dBi  
 Number of antennae: 1  
 Total system gain (typical): 9.000 dBi

MPE limit for uncontrolled exposure at prediction frequency: 5 mW/cm<sup>2</sup>  
50 W/m<sup>2</sup>  
 Minimum calculated prediction distance for compliance: 16 cm  
 Typical (declared) distance: 25 cm

**Average power density at prediction frequency:** 2.017949 mW/cm<sup>2</sup>  
20.17949 W/m<sup>2</sup>

**Margin of Compliance:** 3.94060 dB  
 Maximum allowable antenna gain: 12.94060 dBi

8. **For For R20SS-3D/-U, controlled exposure, 8W operation**

Fundamental transmit (prediction) frequency: 9500 MHz  
 Maximum measured conducted peak output power: 39.00 dBm  
 Cable and/or jumper loss: 0.0 dB  
 Maximum peak power at antenna input terminal: 39.00 dBm  
 Tx On time: 100.000 ms  
 Tx period time: 100.000 ms  
 Average factor: 100 %  
 Maximum calculated average power at antenna input terminal: 7943.282 mW  
 Single Antenna gain (typical): 9 dBi  
 Number of antennae: 1  
 Total system gain (typical): 9.000 dBi

MPE limit for uncontrolled exposure at prediction frequency: 5 mW/cm<sup>2</sup>  
50 W/m<sup>2</sup>  
 Minimum calculated prediction distance for compliance: 32 cm  
 Typical (declared) distance: 40 cm

**Average power density at prediction frequency:** 3.138124 mW/cm<sup>2</sup>  
31.38124 W/m<sup>2</sup>

**Margin of Compliance:** 2.02300 dB  
 Maximum allowable antenna gain: 11.02300 dBi

9. **For R20SS-3D/-U, controlled exposure, 27W operation**

Fundamental transmit (prediction) frequency: 9500 MHz  
 Maximum measured conducted peak output power: 45.43 dBm  
 Cable and/or jumper loss: 0.0 dB  
 Maximum peak power at antenna input terminal: 45.43 dBm  
 Tx On time: 100.000 ms  
 Tx period time: 100.000 ms  
 Average factor: 100 %  
 Maximum calculated average power at antenna input terminal: 34914.032 mW  
 Single Antenna gain (typical): 9 dBi  
 Number of antennae: 1  
 Total system gain (typical): 9.000 dBi  
  
 MPE limit for uncontrolled exposure at prediction frequency: 5 mW/cm<sup>2</sup>  
50 W/m<sup>2</sup>  
 Minimum calculated prediction distance for compliance: 66 cm  
  
 Typical (declared) distance: 80 cm  
  
**Average power density at prediction frequency:** 3.448341 mW/cm<sup>2</sup>  
34.48341 W/m<sup>2</sup>  
  
**Margin of Compliance:** 1.61360 dB  
 Maximum allowable antenna gain: 10.61360 dBi

10. **For R20SS-3D/-U, general population, 2W operation**

Fundamental transmit (prediction) frequency: 9500 MHz  
 Maximum measured conducted peak output power: 33.00 dBm  
 Cable and/or jumper loss: 0.0 dB  
 Maximum peak power at antenna input terminal: 33.00 dBm  
 Tx On time: 100.000 ms  
 Tx period time: 100.000 ms  
 Average factor: 100 %  
 Maximum calculated average power at antenna input terminal: 1995.262 mW  
 Single Antenna gain (typical): 9 dBi  
 Number of antennae: 1  
 Total system gain (typical): 9.000 dBi  
  
 MPE limit for uncontrolled exposure at prediction frequency: 1 mW/cm<sup>2</sup>  
10 W/m<sup>2</sup>  
 Minimum calculated prediction distance for compliance: 36 cm  
  
 Typical (declared) distance: 45 cm  
  
**Average power density at prediction frequency:** 0.622824 mW/cm<sup>2</sup>  
6.22824 W/m<sup>2</sup>  
  
**Margin of Compliance:** 2.05635 dB  
 Maximum allowable antenna gain: 11.05635 dBi

**11. For For R20SS-3D/-U, general population, 8W operation**

Fundamental transmit (prediction) frequency: 9500 MHz  
 Maximum measured conducted peak output power: 39.00 dBm  
 Cable and/or jumper loss: 0.0 dB  
 Maximum peak power at antenna input terminal: 39.00 dBm  
 Tx On time: 100.000 ms  
 Tx period time: 100.000 ms  
 Average factor: 100 %  
 Maximum calculated average power at antenna input terminal: 7943.282 mW  
 Single Antenna gain (typical): 9 dBi  
 Number of antennae: 1  
 Total system gain (typical): 9.000 dBi

MPE limit for uncontrolled exposure at prediction frequency: 1 mW/cm<sup>2</sup>  
10 W/m<sup>2</sup>  
 Minimum calculated prediction distance for compliance: 71 cm  
 Typical (declared) distance: 80 cm

**Average power density at prediction frequency:** 0.784531 mW/cm<sup>2</sup>  
7.84531 W/m<sup>2</sup>

**Margin of Compliance:** 1.05390 dB  
 Maximum allowable antenna gain: 10.05390 dBi

**12. For For R20SS-3D/-U, general population, 27W operation**

Fundamental transmit (prediction) frequency: 9500 MHz  
 Maximum measured conducted peak output power: 45.43 dBm  
 Cable and/or jumper loss: 0.0 dB  
 Maximum peak power at antenna input terminal: 45.43 dBm  
 Tx On time: 100.000 ms  
 Tx period time: 100.000 ms  
 Average factor: 100 %  
 Maximum calculated average power at antenna input terminal: 34914.032 mW  
 Single Antenna gain (typical): 9 dBi  
 Number of antennae: 1  
 Total system gain (typical): 9.000 dBi

MPE limit for uncontrolled exposure at prediction frequency: 1 mW/cm<sup>2</sup>  
10 W/m<sup>2</sup>  
 Minimum calculated prediction distance for compliance: 149 cm  
 Typical (declared) distance: 180 cm

**Average power density at prediction frequency:** 0.681154 mW/cm<sup>2</sup>  
6.81154 W/m<sup>2</sup>

**Margin of Compliance:** 1.66755 dB  
 Maximum allowable antenna gain: 10.66755 dBi

1.1.4 Verdict

The calculation is below the limit; therefore, the product is passing the RF Exposure requirements for the declared distance.

**End of the test report**