Exhibit No. 2
Reradiation Analysis

Approach

The approach taken for this analysis is to meet the NTIA requirements is as follows:

1. Determine the power density required to generate -140 dBm at a GPS input terminal (maximum power allowable) when connected to an isotropic antenna.
2. Determine the power density at 100 ft (~30 m) from our reradiating antenna systems. As each of the antennas will be located near the building wall, this calculation will meet the NTIA requirement showing compliance with the -140 dBm limit 100 feet from the building.
3. Determine the safety margin at 100 ft (~30m) referencing the -140 dBm requirement.

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<u>Maximum Power Allowable</u>

The maximum allowable power at a GPS receiver is -140 dBm when connected to an isotropic antenna.

$-140\ dB_m = \underline{\underline{1x10^{-17}\ W}}$

To determine the maximum allowable power density (P_d) at an antenna, it is known that:

P_d x (Effective Area) = Receiver Power

Therefore,

Maximum P_d = Max Allowable Receiver Power / (Antenna Effective Area)

Given that the Antenna Effective Area of an isotropic antenna is $\lambda^2/4\pi$,

Then for **1574.42 MHz (L1):**

Effective Area = $(0.191m)^2/4\pi = \underline{\underline{2.90x10^{-3}m^2}}$

And for **1277.60 MHz (L2):**

Effective Area = $(0.244m)^2/4\pi = \underline{\underline{4.74x10^{-3}m^2}}$

Therefore, the maximum allowable power density for -140 dBm at a GPS receiver is:

At **1574.42 MHz (L1):**

$(P_d)_{max} = 1x10^{-17}\ W / 2.9x10^{-3}m^2 = \boxed{3.45x10^{-15}\ W/m^2}$

At **1277.60 MHz (L2):**

$(P_d)_{max} = 1x10^{-17}\ W / 4.74x10^{-3}m^2 = \boxed{2.11x10^{-15}\ W/m^2}$

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<u>AGS LRLAP Lab (Bldg NA) Transmit Power Calculations</u>

The calculations apply to all antenna operating in building NA.

The maximum transmit antenna Gain (G) within 30° of horizontal is:

$G = +0.9\ dB_{ic} = \underline{\underline{1.23}}$ (numeric)

[1]The Measured Power (T_x) over 25 MHz at the antenna input is:

For **1574.42 MHz (L1):** $T_{L1} = -99.5\ dB_m = -129.5\ dB_w = \underline{\underline{1.122 \times 10^{-13}\ W}}$

And for **1277.60 MHz (L2):** $T_{L2} = -103.5\ dB_m = -133.5\ dB_w = \underline{\underline{4.47 \times 10^{-14}\ W}}$

The Power Density (P_d)is:

$$P_d = T_x G / 4\pi r^2$$

Therefore, the Power Density at 100 ft (~30 m) and within 30° of horizontal is:

At **1574.42 MHz (L1):**

$$P_d = \frac{(1.122 \times 10^{-13}\ W)(1.23)}{4\pi(30)^2} = \boxed{1.22 \times 10^{-17}\ W/m^2}$$

At **1277.60 MHz (L2):**

$$P_d = \frac{(4.47 \times 10^{-14}\ W)(1.23)}{4\pi(30)^2} = \boxed{4.86 \times 10^{-18}\ W/m^2}$$

Nominal Power Density

The **<u>worst case</u>** maximum transmit antenna Gain (G) at 90° of horizontal is:

$G = +5.0\ dB_{ic} = \underline{\underline{3.16}}$ (numeric)

Therefore, the **<u>worst case</u>** Power Density at 100 ft (~30 m) and at 90° of horizontal is:

At **1574.42 MHz (L1):**

$$P_d = \frac{(1.122 \times 10^{-13}\ W)(3.16)}{4\pi(30)^2} = \boxed{3.14 \times 10^{-17}\ W/m^2}$$

At **1277.60 MHz (L2):**

$$P_d = \frac{(4.47 \times 10^{-14}\ W)(3.16)}{4\pi(30)^2} = \boxed{1.25 \times 10^{-17}\ W/m^2}$$

Worst Case Power Density

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Note 1: Power measurements were taken with a spectrum analyzer using a low noise pre-amplifier and are the maximum power across the 25 MHz Bandwidth. These measurements were taken at the coax terminal that connects to the transmit (or reradiating) antenna.

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Reradiation Analysis

AGS LRLAP Portable (Dynamics Lab) Transmit Power Calculations

The maximum transmit antenna Gain (G) within 30° of horizontal is:

$G = +0.9\ dB_{ic} = \underline{\underline{1.23}}$ (numeric)

[1]The Measured Power (T_x) over 25 MHz at the antenna input is:

For **1574.42 MHz (L1):** $T_{L1} = -99.5\ dB_m = -129.5\ dB_w = \underline{\underline{1.122x10^{-13}\ W}}$

And for **1277.60 MHz (L2):** $T_{L2} = -101.5\ dB_m = -131.5\ dB_w = \underline{\underline{7.08x10^{-14}\ W}}$

The Power Density (P_d)is:

$P_d = T_x G/4\pi r^2$

Therefore, the Power Density at 100 ft (~30 m) and within 30° of horizontal is:

At **1574.42 MHz (L1):**

$$P_d = \frac{(1.122x10^{-13}\ W)(1.23)}{4\pi(30)^2} = \boxed{1.22x10^{-17}\ W/m^2}$$

At **1277.60 MHz (L2):**

$$P_d = \frac{(7.08x10^{-14}\ W)(1.23)}{4\pi(30)^2} = \boxed{7.70x10^{-18}\ W/m^2}$$

Nominal Power Density

The **<u>worst case</u>** maximum transmit antenna Gain (G) at 90° of horizontal is:

$G = +5.0\ dB_{ic} = \underline{\underline{3.16}}$ (numeric)

Therefore, the **<u>worst case</u>** Power Density at 100 ft (~30 m) and at 90° of horizontal is:

At **1574.42 MHz (L1):**

$$P_d = \frac{(1.122x10^{-13}\ W)(3.16)}{4\pi(30)^2} = \boxed{3.14x10^{-17}\ W/m^2}$$

At **1277.60 MHz (L2):**

$$P_d = \frac{(7.08x10^{-14}\ W)(3.16)}{4\pi(30)^2} = \boxed{1.98x10^{-17}\ W/m^2}$$

Worst Case Power Density

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Transmit Power Calculation Summary

From Page 1 of this exhibit, we identified that the Antenna Effective Area of an isotropic antenna is $\lambda^2/4\pi$,

Then for **1574.42 MHz (L1):**

Effective Area = $(0.191\text{m})^2/4\pi$ = $\underline{\underline{2.90\text{x}10^{-3}\text{m}^2}}$

And for **1277.60 MHz (L2):**

Effective Area = $(0.244\text{m})^2/4\pi$ = $\underline{\underline{4.74\text{x}10^{-3}\text{m}^2}}$

Therefore, the **worst case** maximum equivalent isotropically radiated power at a distance of 100 feet (30 meters) from the building where the test is being conducted is as follows:

At **1574.42 MHz (L1):**

$(3.14\text{x}10^{-17}\ \text{W/m}^2)(2.90\text{x}10^{-3}\text{m}^2) = 9.11\text{x}10^{-20}$ W or $-190\ \text{dB}_\text{w}$ => $\boxed{-160\ \text{dB}_\text{m}}$

At **1277.60 MHz (L2):**

$(1.98\text{x}10^{-17}\ \text{W/m}^2)(4.74\text{x}10^{-3}\text{m}^2) = 9.39\text{x}10^{-20}$ W or $-190\ \text{dB}_\text{w}$ => $\boxed{-160\ \text{dB}_\text{m}}$

Both of which are no greater than the requirement of -140 dBm/24 MHz at a distance of 100 feet (30 meters) from the building where the test is being conducted.