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November 5, 2020

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SUBJECT: PFD Analysis Revision C

Mr. Sangani:

Please find below our analysis of power-flux density for the Canary Hatchling downlink band (468.45-469 MHz) at the Earth's surface and the results of our search for other operators in this band.

1. **Power Flux Density at the Surface of the Earth in the 468.45-469 MHz Band**

The power-flux density limit at the Earth's surface for satellites operating in the meteorological satellite service located in the 460-470 MHz band is given in the FCC frequency tables under footnote US289, which states, "*The power flux density produced at the Earth's surface by any space station in this band shall not exceed −152 dBW/m2/4 kHz.*"

Canary Hatchling will only be operated above the continental United States. Canary Hatchling does not transmit unless it receives an uplink transmission from Care Weather's ground station. This uplink transmission can include transmit power configuration settings for the downlink response. At Canary Hatchling's maximum altitude of 575 km, it will transmit at the maximum filing power of 1 W, but at lower altitudes, Canary Hatchling's transmit power will be pre-configured before downlink transmission to follow the compliance plan of Table 1 and Figure 1. The derivation of the power-flux density used in these calculations is given as an attachment at the end of this document. 550kHz is used as a constant bandwidth and the gain of Canary Hatchling's dipole antenna is 2.15dBi. Canary Hatchling will not be operated when it has dropped below an orbit of 200 km, shortly after which it will burn up.

With power-flux density maintained below the maximum specified in US289 at the surface of the Earth, Canary Hatchling is compatible with terrestrial operators in the 468.45-469 MHz band.

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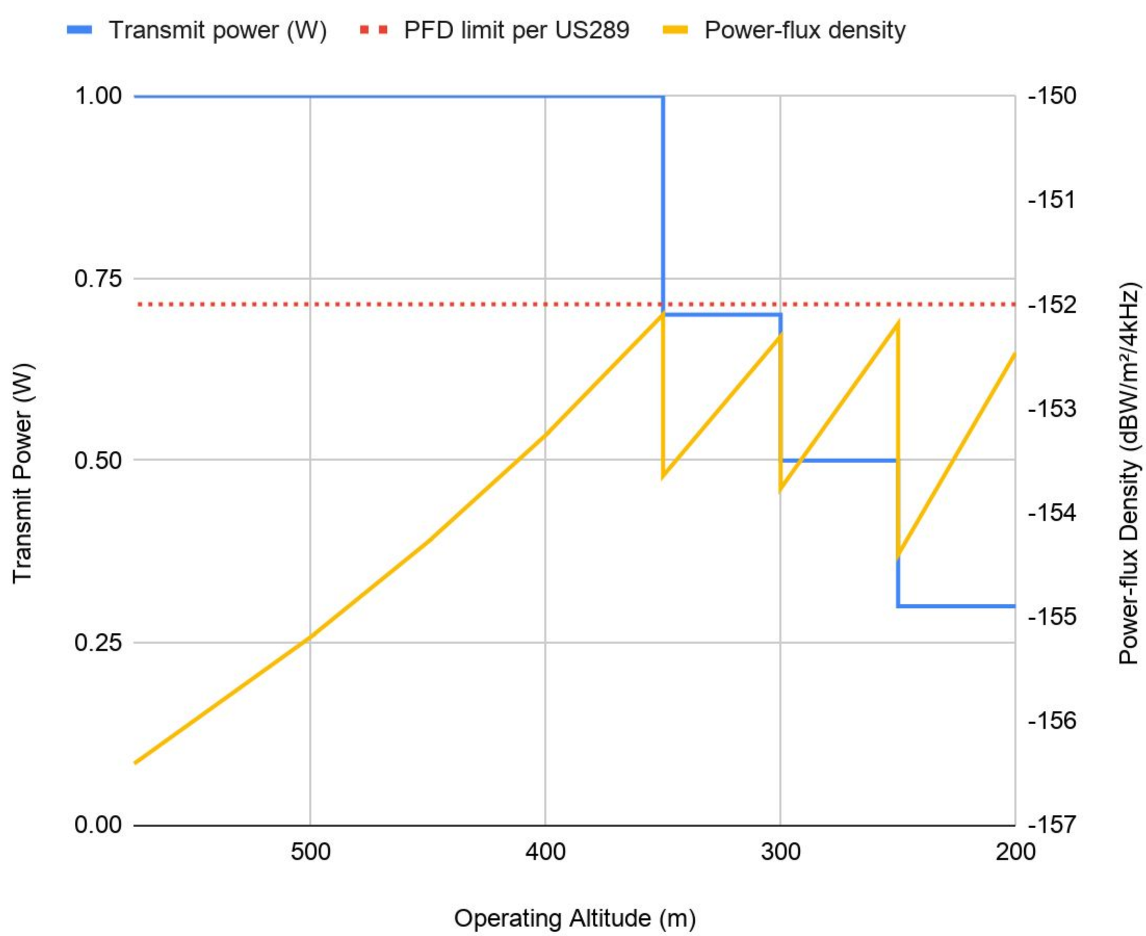
Table 1. Plan for Step Reductions in Transmit Power to Assure Compliance with US289.

Operating Altitude Range (km)	Transmit Power (W)	Maximum Power-flux Density in Range (dBW/m²/4 kHz)
575*-350	1*	-152.10
350-300	0.7	-152.31
300-250	0.5	-152.19
250-200	0.3	-152.47
Below 200	Powered Off	NA

* Maximum altitude and transmit power of Canary Hatchling filing.



With questions and comments, please contact Patrick Walton at patrick@careweather.com.

Figure 1. Plan for Step Reductions in Transmit Power to Assure Compliance with US289.

2. Power Flux Density at the Geostationary Satellite Orbit in the 468.45-469 MHz Band

From a 575 km maximum operational orbit, with a 1 W transmit power and 2.15 dBi gain, the maximum power-flux density at the geostationary Earth orbit is less than -192.1 dBW/m^2/4 kHz.

With power-flux density (up) of less than -192.1 dBW/m^2/4 kHz at geostationary Earth orbit, Canary Hatchling is expected to be compatible with geostationary satellites in the 468.45-469 MHz band.

3. Interference with Earth Exploration Satellite Service and Meteorological Satellite Service

Interference between Canary Hatchling satellites and those of other systems is very unlikely because Earth exploration satellite and meteorological satellite systems operating in the 468.45-469 MHz band normally transmit only in short periods of time while visible from the dedicated receiving earth stations. For the interference to happen, satellites belonging to different systems would have to travel through the antenna beam of the receiving earth station and transmit at the same time. In such a very unlikely event, the interference can still be avoided by coordinating the satellite transmissions so that they do not occur simultaneously.

PFD Analysis

M. Patrick Walton

November 2020

The power-flux density (per Hz) is

$$PFD = \frac{P_t G_t}{L_p B_t} \ , \tag{1}$$

where P_t is the transmit power, G_t is the gain, L_p is the path loss, and B_t is the transmit bandwidth.

The power-flux density per 4 kHz is

$$PFD_{(4\text{kHz})} = PFD \frac{4000\,(\text{Hz})}{(4\text{kHz})} \tag{2}$$

The minimum path loss resulting in the maximum power-flux density occurs along a distance equal to the orbital altitude at the spacecraft zenith, so the minimum path loss is

$$L_p = (4\pi h)^2 \ , \tag{3}$$

where h is the altitude of the orbit.

Substituting Eq.3 into Eq.2 gives the power-flux density per 4 kHz as a function of parameters given in ITU SpaceCap and the FCC form 442 filing

$$PFD_{(4\text{kHz})}(P_t, G_t, L_p, h) = 4000 \frac{P_t G_t}{(4\pi h)^2 B_t} \ . \tag{4}$$