

# Radiation Hazard Analysis Swarm Gateway Earth Station

## Introduction

This analysis demonstrates compliance with applicable radiation limits for Swarm’s proposed gateway earth station. The calculations performed in this analysis comply with the methods described in Federal Communications Commission Office of Engineering & Technology Bulletin, Number 65 (Edition 97-01) (“OET Bulletin 65”) and demonstrate compliance with the Maximum Permissible Exposure (“MPE”) limits set forth in Section 1.1310 of the Commission’s rules.

## Earth Station Description and Operating Parameters

Section 1.1310 of the Commission’s rules and OET Bulletin 65 specify radiation limits for two different scenarios: occupational/controlled exposures and general population/uncontrolled exposures. The limits for occupational/controlled exposure apply when persons are exposed as a consequence of their employment, provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. General population/uncontrolled exposure limits apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

Swarm’s earth station will be deployed in an occupational/controlled exposure environment which allows access only to authorized and trained personnel and prohibits access to the general public. As such, the analysis below reflects the MPE limit for this class of exposure.

**Table 1.** MPE limits for occupational/controlled exposure for Swarm earth station.<sup>1</sup>

<b>Frequency Range (MHz)</b>	<b>Electric Field Strength (E) (V/m)</b>	<b>Magnetic Field Strength (H) (A/m)</b>	<b>Power Density (S) (mW/cm<sup>2</sup>)</b>	<b>Averaging Time  E <sup>2</sup>,  H <sup>2</sup>, or S (minutes)</b>
30-300	61.4	0.163	1.0	6

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<sup>1</sup> See 47 C.F.R. §1.1310(e) and Federal Communications Commission Office of Engineering & Technology Bulletin, Number 65 (Edition 97-01).

## Analysis

As described in OET Bulletin 65, the following equation predicts RF field strength and power density levels around a radiating antenna:<sup>2</sup>

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

where: S = power density

P = power input to the antenna

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

For the proposed Swarm earth station, the maximum power input to the antenna is 10 W and the maximum gain is 11 dBi.<sup>3</sup> Although unlikely in practice, to conduct the most conservative analysis, the following calculations assume that the earth station transmits at 100% duty cycle. The calculation below shows the minimum permissible distance between an operator and the earth station required to avoid exceeding the MPE limit of 1.0 mW/cm<sup>2</sup>:

$$S_{MPE} = 1.0 \frac{mW}{cm^2} = \frac{10000 mW * 10^{\frac{11}{10}}}{4 * \pi * R^2} \rightarrow R_{min} = 100 cm$$

Appropriate signage will be posted warning of RF exposure risk in the vicinity of the earth station. In addition, access control limitations will be put in place to allow access only to authorized personnel and to ensure that the requisite separation distance of at least 100 cm between personnel and the earth station is maintained. If work needs to be performed within the minimum permissible distance to the earth station, all transmissions will be ceased and power to the earth station will be turned off remotely prior to commencing the work.

As described above, the Swarm earth station will be installed and operated in a manner that ensures that the MPE limit of 1.0 mW/cm<sup>2</sup> for occupational/controlled exposure will not be exceeded.

## Conclusion

As demonstrated in the analysis above, operation of Swarm's gateway earth station will not result in exposure levels exceeding the applicable radiation hazard limits.

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<sup>2</sup> As OET Bulletin 65 notes, "These equations are generally accurate in the far-field of an antenna but will over-predict power density in the near field, where they could be used for making a "worst case" or conservative prediction."

<sup>3</sup> Only a single antenna at the gateway earth station will transmit at any given time.