Audacy Corp.
340 S. Lemon Ave., Suite 8787
Walnut, CA 91789
http://audacy.space
info@audacy.space

April 3, 2017

Subject: Re: Audacy Corporation, IBFS File No. SAT-LOA-20161115-00117 (Call Sign S2982)

Dear Ms. Dortch,

Audacy Corporation ("Audacy") herein responds to the Federal Communications Commission's ("FCC's" or "Commission's") March 10, 2017 letter requesting supplemental information concerning the above-referenced application for a non-geostationary ("NGSO") satellite system. Below please find the Commission's individual questions followed by Audacy responses. Should the Commission staff have further questions or require clarification on any response below, please let me know.

Sincerely,

/s/

James Spicer
Chief Engineer
+1.650.999.0331 | james.spicer@audacy.space

FCC Question 1

Article 22 of the ITU Radio Regulations specifies equivalent power flux-density (epfd) limits applicable in frequency bands in which Audacy proposed to operate. As part of its application, Audacy states that it will comply with the epfd limits for operations in the 19.7-20.2 GHz band set forth in Article 22 of the ITU Radio Regulations, and thus will not cause harmful interference to any existing operations in the band. Audacy further states that it will comply with the applicable epfd limits in Table 22-2 of ITU Radio Regulations in the 29.5-30.0 GHz band. Please provide a showing demonstrating the Audacy satellite system's compliance with the applicable epfd limits specified in Article 22 of the ITU Radio Regulations in these frequency bands.

Audacy Response 1

This answer demonstrates that Audacy's NGSO Network ("Network") will operate in compliance with the single-entry EPFD limits of Nos. 22.5C and 22.5D of the International Telecommunications Union

("ITU") Radio Regulations ("RRs") in specific K and K_a-band segments that are applicable to Audacy's application: 19.7-20.2 GHz (space-to-Earth) and 29.5-30.0 GHz (Earth-to-space).

1. EPFD Validation Software

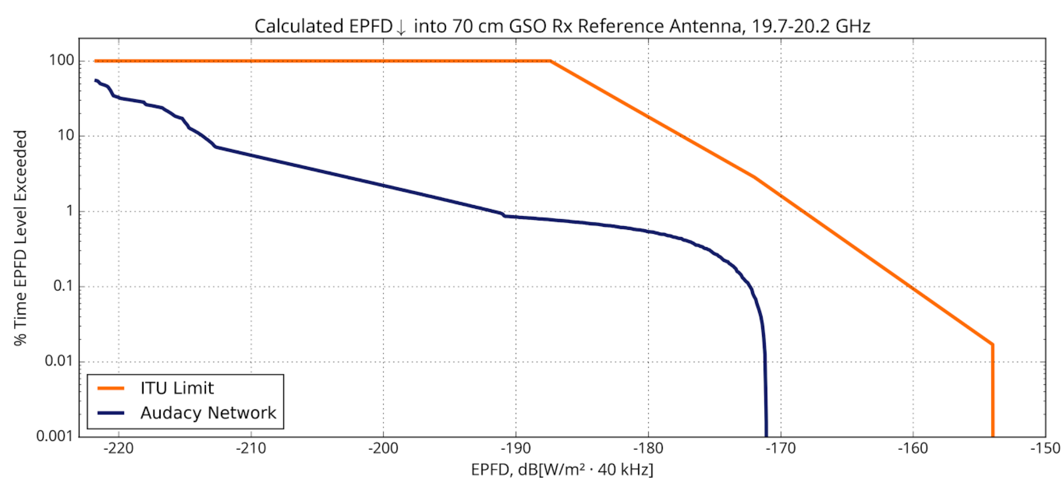
To demonstrate the Audacy NGSO Network is compliant with applicable ITU Article 22 EPFD limits, Audacy used version 1.1 of the ITU's publicly available EPFD validation software, released in November 2016. This software was designed to verify NGSO FSS systems' compliance with the ITU Article 22 single-entry EPFD limits according to ITU-R Recommendation S.1503.

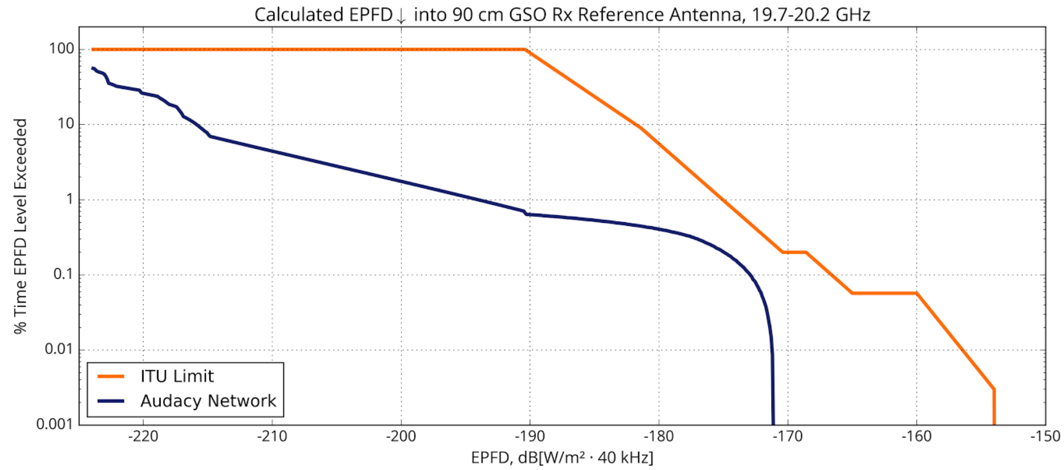
Audacy has concurrently submitted to the Commission, as a supplement to this letter, the input files that allow independent verification that the Network complies with the single-entry EPFD limits of Nos. 22.5C and 22.5D in the applicable frequency band segments. These input files include the Network's orbital elements and transmission characteristics as well as the PFD and/or EIRP masks required by the ITU's software.

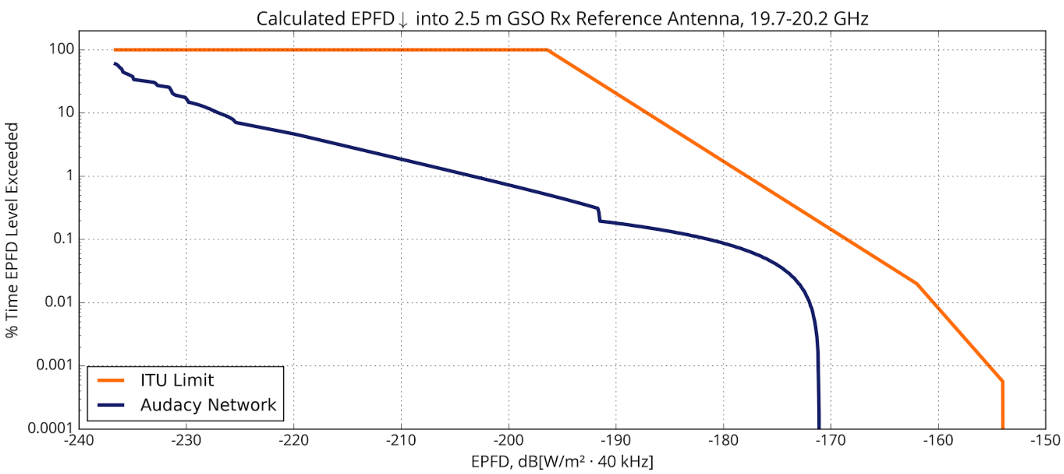
2. EPFD↓

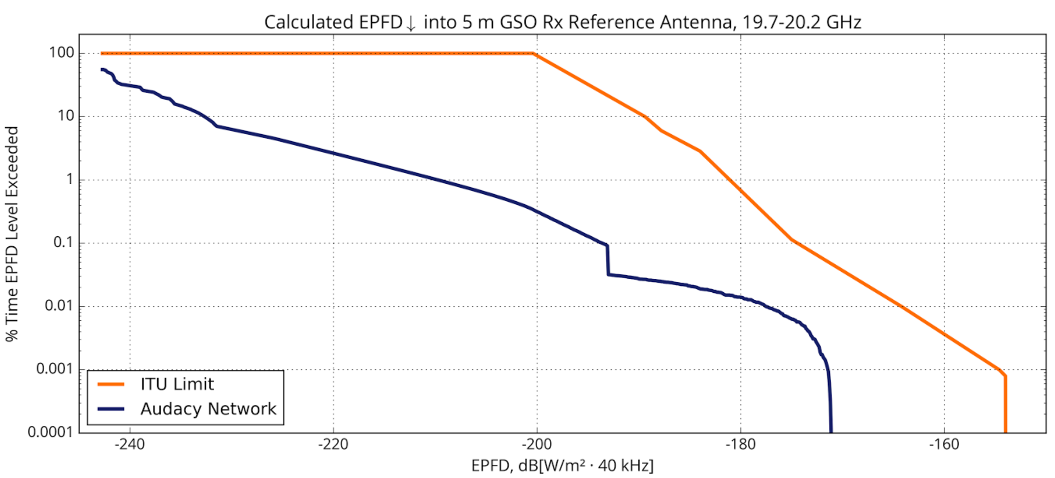
The downlink PDF masks are provided in "Az-El" format, and remain constant regardless of the latitude of the satellites' sub-point. The maximum number of Audacy satellites ("Relays") ever concurrently visible from any single terrestrial location is 2.

Figures 1 through 4 show the downlink EPFD results, using the ITU's EPFD validation software, for the 19.7-20.2 GHz frequency band, and for the four geostationary ("GSO") reference receive antenna sizes contained in Table 22-1C of Article 22 of the RRs. These figures demonstrate that in all four cases the Network's calculated EPFD levels are compliant with the applicable downlink limits.




Calculated EPFD↓ into 90 cm GSO Rx Reference Antenna, 19.7-20.2 GHz
% Time EPFD Level Exceeded
100
10
1
0.1
0.01
0.001
-220
-210
-200
-190
-180
-170
-160
-150
EPFD, dB[W/m² · 40 kHz]
ITU Limit
Audacy Network

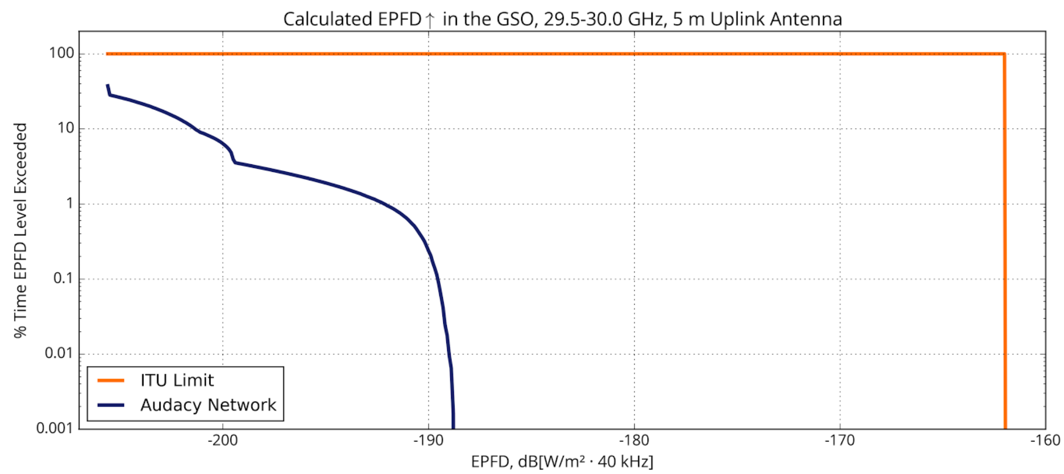

Calculated EPFD↓ into 2.5 m GSO Rx Reference Antenna, 19.7-20.2 GHz
% Time EPFD Level Exceeded
100
10
1
0.1
0.01
0.001
0.0001
-240
-230
-220
-210
-200
-190
-180
-170
-160
-150
EPFD, dB[W/m² · 40 kHz]
ITU Limit
Audacy Network

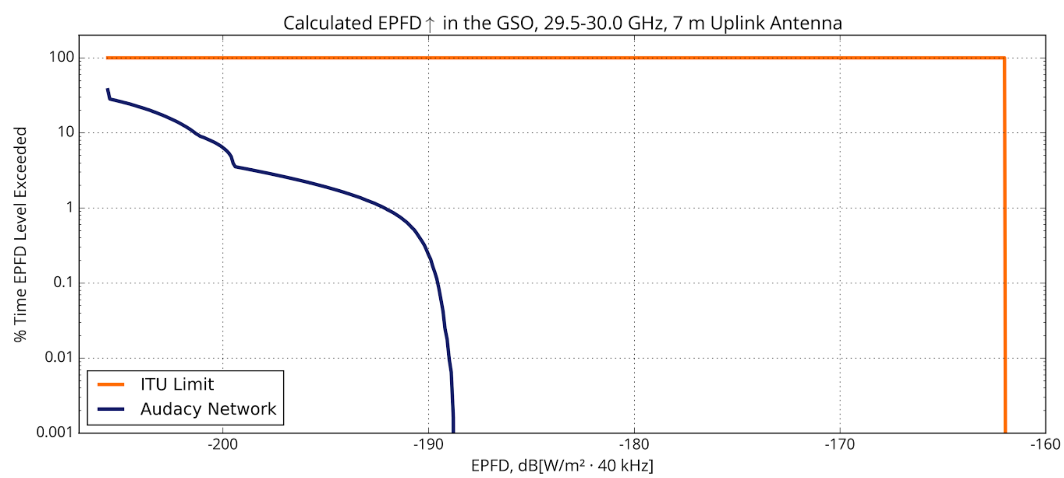

Calculated EPFD↓ into 5 m GSO Rx Reference Antenna, 19.7-20.2 GHz
% Time EPFD Level Exceeded
100
10
1
0.1
0.01
0.001
0.0001
-240
-220
-200
-180
-160
EPFD, dB[W/m² · 40 kHz]
ITU Limit
Audacy Network

3. EPFD↑

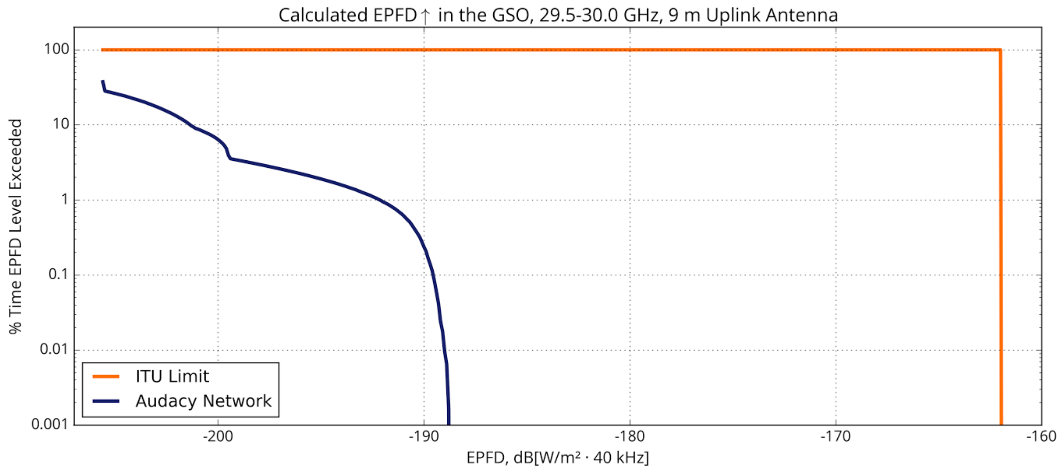
Like the PFD masks, the earth station EIRP masks do not vary with latitude. As described in Audacy's application, the Network ground segment will consists of three earth stations spaced around the globe. The maximum number of Earth stations visible from any single individual point in GSO is 2. No ground station will transmit below 5° above the topocentric horizon.

Figures 5 through 7 show the uplink EPFD results, using the ITU's EPFD validation software, for the 29.5-30.0 GHz frequency band. Three representative uplink antenna diameters have been used for the analysis of each band: 5, 7, and 9 meters, the latter case showing that even antennas larger than those planned by Audacy remain compliant[1]. These figures demonstrate that in all three cases the Network's calculated EPFD levels are compliant with the applicable uplink EPFD limits.





[1] A typical Network uplink antenna is 7 m in diameter, with a boresight EIRP of 35 dB[W/m^2 · 40 kHz]. As described in its Application, Audacy is baselining 3 uplink facilities spaced evenly around the globe.



4. EPFD Input Files Provided to the Commission

In order to allow independent verification of the Network's compliance with the applicable ITU EPFD limits, Audacy has concurrently provided the Commission with the following input files required by the ITU's EPFD validation software:

- Zipped folder containing the following masks in .xml format:
    1. PFD - Relay downlink.
    2. EIRP - 5 m uplink.
    3. EIRP - 7 m uplink.
    4. EIRP - 9 m uplink.
- Mask database in .mdb format containing the masks above.
- Examination database in .mdb format, which contains the Network satellite and Earth station information to which the masks can be associated for EPFD validation.

FCC Question 2

Please provide information regarding the accuracy - if any - with which the parameters of satellite orbits will be maintained, including apogee, perigee, inclination, and the right ascension of the ascending node(s).

Audacy Response 2

Audacy will maintain the orbital parameters of its non-geostationary satellites with at least the following accuracy:

Orbital Parameter	**Maintenance Accuracy**
Inclination	±1°
Apogee	±15 km

Perigee	±15 km
Right Ascension of the Ascending Node	±1°

FCC Question 3

A statement and/or analysis with respect to the long-term stability or instability of post-mission storage orbits. Such analysis should address any measures, such as selection of orbital parameters, that may affect the long-term evolution of orbital parameters, with particular attention to addressing any such evolution that would result in the satellites entering the geostationary protected region, i.e.*, the area defined by the geosynchronous altitude, plus or minus 200 kilometers, and plus or minus 15 degrees from the equatorial plane, or the LEO protected region,* i.e.*, the area below 2000 km.*

Audacy Response 3

Audacy is committed to eliminating any danger that Network satellites might pose to current or future operators. However like MEO navigation constellations and GEO spacecraft, complete debris mitigation by direct re-entry is not feasible due to the satellites' high orbits. IADC guidelines for post-mission disposal of GEO spacecraft are to increase altitude by at least 235 km. Audacy has committed to a similar relocation procedure in anticipation of future use of Network orbit by future operators. The following analysis shows that Network satellites pose no threat to either GEO or LEO operators.

As described in Audacy's application and in compliance with IADC Space Debris Mitigation Guidelines [2], Network satellites will be safely retired at the end of their orbital lifetime, venting excess propellant, discharging batteries, and relieving all pressure vessels.

It is a mathematical impossibility for Network satellites to enter the geostationary protected region ("GEO"), as the orbital energy of their disposal orbit is lower than the minimum required to enter GEO.

A satellite's specific orbital energy is defined as $-\mu/2a$ or $-\mu/(r_a + r_p)$, where μ is the gravitational parameter of the orbit's central body and a, r_a, and r_p are the orbit's semimajor axis, radius of apoapsis, and radius of periapsis respectively.

Each Relay operates in a circular orbit with a radius of 20,270 km, and with an orbital energy (from the equations above) of -9.83 km^2/s^2. The lowest-energy orbit that could enter GEO would have an apogee just inside the protected region (r_a = 41,964 km), and a perigee as low as possible (r_p = 6478 km). An orbit with these parameters would have an orbital energy of -8.21 km^2/s^2. Given that the

[2] IADC Space Debris Mitigation Guidelines, Inter-Agency Space Debris Coordination Committee, September 2007. Available at http://www.unoosa.org/documents/pdf/spacelaw/sd/IADC-2002-01-IADC-Space_Debris-Guidelines-Revision1.pdf

Relays have no means of gaining orbital energy through onboard propulsion, they will never reach the higher energy level required to enter GEO.

IADC Space Debris Mitigation Guidelines do not provide detailed recommendations for post mission disposal of MEO spacecraft, only stating that satellites not in the geosynchronous or LEO regions should be "relocated if they cause interference with highly utilized orbits." In paragraph 88 of *Mitigation of Orbital Debris*[3], the Commission notes that the paucity of IADC guidelines, and also that technical studies are ongoing to evaluate the long-term stability of MEO disposal orbits.

Chao and Gick (2004)[4] analyzed the long-term evolution of navigation satellite orbits including GPS, GLONASS, and GALILEO. Although the orbits of these navigation systems are 25%-45% higher than that of Network satellites, the perturbations analyzed in the report (Earth's gravity model, solar radiation pressure, atmospheric drag, sun/Moon gravitational attractions) will act similarly at the Relays' MEO altitude. The authors concluded that it would take roughly 40 years for non-operational GLONASS satellites to enter the GPS constellation, even though the two constellations differ in operational altitude by only 1000 km. The paper's 200-year propagation of these MEO orbits found no instances in which satellite perigees entered the protected LEO region. A further conclusion was that higher-inclination orbits with inclinations above 52° are more susceptible to perturbing forces leading to significant increases in eccentricity.

Given these results, the 25° Relay orbit inclination, and even allowing for the slightly lower Network orbital altitude, Audacy estimates that Network satellites will not enter the LEO protected region for at least a century, more probably two, after their post mission disposal. Such an event would require natural perturbing forces to decrease orbit altitude by 12,000 km or increase eccentricity from 0 to 0.59, neither of which are indicated as remotely likely in the foreseeable future by the model described above.

[3] 19 FCC Rcd 11567 (para. 88) (2004).
[4] C.C. Chao and R.A. Gick, "Long-Term Evolution of Navigation Satellite Orbits: PS/GLONASS/GALILEO" (COSPAR02-A-02858)(PEDAS1-B1.4-0051-02).