Douglas Young

From: Douglas Young
Sent: Friday, August 4, 2017 10:12 AM
To: 'cwilkins@spacex.com'
Subject: Request for Info - File #0298-EX-CN-2016
Attachments: SpaceX_Microsat-2_comments.docx

Please address the attached concerns of the FCC's International Bureau/Satellite Division.

The items indicated above must be submitted before processing can continue on the above referenced application. Failure to provide the requested information within 30 days of August 4, 2017 may result in application dismissal pursuant to Section 5.67 and forfeiture of the filing fee pursuant to Section 1.1108.

IB has reviewed the subject request (API files/Form 442/Exhibits) and has the following questions.

Orbital Debris Assessment Report (ODAR)

Can SpaceX provide additional information concerning human casualty risk resulting from satellite disposal, such as outcomes based on higher fidelity analysis, or any risk or loss mitigation strategies under development?

In the original Exhibit 1, SpaceX indicate use of an inter-satellite optical link transmitter. Will SpaceX use this optical link in this demonstration test?

Cost Recovery letter

Please update Cost Recovery letter with SpaceX cover letter and have it signed by the signatory and send us a PDF copy of the signed letter.

Power Flux Density/Equivalent Power Flux Density calculations:

We also calculated the PFD/EPFD using the data provided in the Form 442, API and Exhibit documents and we have the following comments:

X-band downlink

For the X-band downlink, we assume an antenna gain of 4 dBi at nadir based on antenna pattern provided in exhibit 5; our calculation shows that the PFD limit would be exceeded for emissions 5K80G1D, 1M16G1D, 2M90G1D and 5M80G1D at 514 km altitude and for emissions 5K80G1D and 1M16G1D at the slant angle of 5 degrees and we assume an off-axis antenna gain of zero dBi; moreover, our calculation shows that the limited is exceeded for two emissions 5K80G1D and 1M16G1D at altitude 1125 km from nadir and also emission 5K80G1D at angle 5 degrees assuming the same antenna gains describe as above. We also want to note that emissions 5K80G1D, 1M16G1D, 2M90G1D and 5M80G1D generate the following EIRP density respectively -20.6 dBW/Hz, -43.6 dBW/Hz, -47.6 dBW/Hz and -50.6 dBW/Hz. However, exhibit 2, page 12, figure 6 show that the ITU PFD limit is met. It would be helpful to understand all the assumptions made in this calculation which meets the ITU PFD limit; please review our comments and provide us with additional information on what assumptions were made to meet the ITU PFD limit. In our calculation, we used the RF characteristics provided in the satellite application (Form 442, SpaceCap API filing and Exhibit documents).

We also note that exhibit 2, section 5, table 7, shows an EIRP density of -49.61 dBW/Hz; however, our calculation shows that emissions 5K80G1D and 1M16G1D generates a higher EIRP densities. Please review our comments and provide any additional information that will help us with our calculation.

X-band PFD at the GSO arc

For the X-band towards the GSO arc, our calculation shows that the ITU PFD (RR 22.5) at the GSO arc may be exceeds by emissions 5K80G1D and 1M16G1D; we assume a zero dBi off axis antenna gain; our calculated EIRP density for both emissions are provided respectively for your convenience, -20.6 dBW/Hz, -and 43.6 dBW/Hz. Exhibit 2, Table 7 shows a EIRP density of -49.61 dBW/Hz; we don't know how this value was derived nor what

off-axis antenna gain was assumed to generate this eirp density of -49.61 dBW/Hz; we would like to understand how this value was derived so please provide us with additional information on how this eirp density was generated and if this will be the maximum eirp density.

Ku-band downlink

For the Ku-band downlink (12150-12250 MHz band), our Power Flux Densty calculation at 514 km altitude (nadir), at 5 degrees' slant angle, at 1125 km from Nadir and at 5 degree slant angle of 1125 km altitude exceed the ITU limit for emissions 67K0D7W, 675KD7W and 1M35D7W. However, exhibit 2, page 6, under the Nadir column, it shows an EIRP density of -54.71 dBW/Hz. We would like to know how this EIRP density value of -54.71 dBW/Hz was derived; Can SpaceX please provide additional information on the assumptions of how -54.71 dBW/Hz eirp density value was derives and will this be the maximum eirp density for this band?

Also, it would be very helpful to have a front-to-back ratio (F/B) antenna patterns in the horizontal and vertical (in Polar Coordinates) for the Ku-band downlink (12150-12250 MHz band) instead of the antenna pattern provided in Exhibit 4.

Ku-band uplink

For the Ku-band uplink (13.75-14.5 GHz band), our the EPFD calculation towards the GSO arc shows that the ITU limit may be exceeded for all of the four earth stations ES-B, ES-C, and ES-D; however, our calculation used the main beam gain boresight of the antenna; we need the antenna patterns or representative antenna patterns for each earth station ES-B, ES-C, and ES-D to determine the appropriate an off-axis antenna gain to calculate the EPFD limit and determine if the limit is met or not. Please provide the antenna patterns information to the FCC.

Form 442 review:

In the 8027.5-8087.5 MHz downlink band, we calculated the ERP value for all emissions. However, we are not sure which the antenna gain value was used. Applicant please provide the antenna gain value used in your ERP calculation for this band. We also noted that emission 5K80G1D **is not in the API file**. If there are plans to use this emission, please add this emission to the API file or provide an explanation why this emission is not listed.

In the 10.7-12.2 GHz downlink band, Form 442 indicates a directional antenna is being used, yet the ERP value is set as "N/A"; applicant please provide the ERP value in watts and let us know what the antenna gain value was used for this calculation. We also noted that emission **41M4D7W** is not included in this form; however, in Exhibit 1, page 8, title "reception" in the column "Model SpaceX Telem", this emission is listed. If there are plans to use this emission, please add this emission to this form or provide an explanation why it is not listed.

In the 12.15-12.25 GHz downlink band, the ERP value is set as "N/A"; applicant please provide the ERP value in Watts and let us know what the antenna gain value was used in this calculation.

In the 18.545-18.605 GHz downlink band, it indicates a directional antenna is being used, yet the ERP value is set as "N/A"; applicant please provide the ERP value in Watts and let us know what the antenna gain value was used for the ERP calculation.

In the 2077.5-2105.5 MHz UPLINK band in **Redmond**, our calculation shows an EIRP of (17 + 35) = **52** dBW; convert to ERP subtract 2.15 dB = 49.85 dBW then convert to watts; 96.6 kW ERP; currently Form 442 shows ERP value of 122 kW ERP.

We note that Exhibit 1, Table 2: X/S band also has an ERP values of 53 W (or EIRP of 122 dBW) for various antenna gain including the 35 dBi gain and transmit power ranging between 50 W to 300 W. Please review this table and Form 442 and confirm the ERP values or explain why these have the same ERP values.

Also, there are two emission designators that are listed in the API file (2M32G1D and 1M16G1D) which are not included in Form 442. Please explain why these two emission are not listed or add these emission designators in Form 4442 if there are plans of using them.

In the 13.85-14.0 GHz UPLINK band in **Brewster**, it indicates that a directional antenna is being used yet the ERP value is "N/A"; applicant please provide the ERP value in Watts and the antenna gain value used for the ERP calculation.

We note that Exhibit 1, table 1 (BR1/USA) has an antenna gain of 56 dBi and output power of 40 W; however, our calculation of the EIRP/ERP shows a 72 dBW/9706 kW versus 70dBW/6100 kW in this table 1. Please review all the parameters in both calculations and update as appropriate.

In the 13 – 13.25 and 14 - 1450 GHz UPLINK bands, it only shows one earth station (ES-D) 1.8-meter dish antenna; however, there are three other earth station being tested (ES-A, ES-B, ES-C) that needs to be included in Form 442.

For earth station names TV1, TV2, and TV3, please provide a justification why these earth stations need to operate throughout CONUS. Also, these earth stations have a station class of mobile; are these stations operating while in motion or are they transportable and will only operate in a fixed position?

<u>API File for S-band and X-band:</u>

In Beam XE01, the antenna gain is listed as 4 dBi; however, the API indicates a ND-SPACE which is implies an omnidirectional antenna; applicant, we should reference the antenna pattern provided instead.

In Beam XE01, the minimum elevation angle is not provided. Please provide this value.

In Beam XE01, Group ID 2 and 3, there is an emission designator 580KG1D which is not listed in Form 442; however, there is an emission 5K80G1D in Form 442 which is not listed in the API; could this be a typo? Please review and update as appropriate.

API File for Ku-band and Ka-band:

Exhibit 1 Document:

We found some inconsistencies with EIRP/ERP values with associated TX power and TX antenna gains for Tables 1 and Table 2. Perhaps some clarification would be useful if the parameters listed are different from ERP/EIRP values; however, the Form 442 needs to have the TX power and TX antenna gain used to derive the ERP value. Please review this information and update as appropriate.

We note that Exhibit 1, table 1, the latitude for Norway/TR1 should be **positive** not negative.

Exhibit 2 Document:

Our PDF and EPFD calculations were incomplete because the we did not have antenna information for some of the frequency bands. Please provide the antenna patterns to help us calculate that the FCC and ITU PFD/EPFD limits are being met by this experimental satellite request.