SPACEX GEN3 NON-GEOSTATIONARY SATELLITE SYSTEM
ATTACHMENT A
TECHNICAL INFORMATION TO SUPPLEMENT SCHEDULE S

A.1. OVERALL DESCRIPTION

Orbital Parameters

The Gen3 System will consist of 100,000 satellites, configured in two bands of thin, closely stacked operational shells with nominal altitudes between 323 and 327.5 kilometers and 473 and 477.5 kilometers. These very-low-Earth-orbit shells allow for ultra-low latency service while the split-layer design leaves ample room around crewed space stations.

Altitude (km)	Inclination (degrees)	Maximum Satellites Per Shell
323.0	26	100,000
323.5	32	100,000
324.0	38	100,000
324.5	43	100,000
325.0	48	100,000
323.5	53	100,000
326.0	60	100,000
326.5	69	100,000
327.0	76	100,000
327.5	96.9	100,000
473.0	26	100,000
473.5	32	100,000
474.0	38	100,000
474.5	43	100,000
475.0	48	100,000
475.5	53	100,000
476.0	60	100,000
476.5	69	100,000
477.0	76	100,000
477.5	96.9	100,000
Maximum Total		**100,000**

Table A.1.1 Gen 3 Orbital Parameters

Technology and Operations

The Gen3 system will use advanced phased array beam-forming and digital processing technologies onboard each satellite payload to make highly efficient use of spectrum resources and share spectrum flexibly with other space-based and terrestrial licensed users. User terminals will employ highly directive, electronically steered antenna beams that track the system's satellites. Gateway earth stations will generate high-gain steered beams to communicate with multiple satellites within the constellation from a single gateway site. SpaceX will implement advanced optical inter-satellite links on the Gen3 system to provide seamless network management and continuity of service while minimizing the spectrum footprint of the system overall and facilitating spectrum sharing with other space-based and terrestrial systems. Broadband service will be available for residential, commercial, institutional, governmental, and other users worldwide.

Consistent with Commission policy, SpaceX has prioritized spectrum in the Ku-, Ka-, V-, E-, W-, and D-bands[1] to deliver gigabit-speed, low-latency broadband and more symmetrical speeds for end users worldwide. This spectrum will enable Gen3 to deliver unprecedented capacity, coverage, and service quality to meet growing global demand for high-speed broadband connectivity and next-generation applications including artificial intelligence, robotics, precision farming, and cloud computing.

Spectrum

SpaceX will utilize the Ku-, Ka-, V-, E-, W-, and D-bands for Gen3 as summarized in Table A.1.2 to deliver gigabit-speed, low-latency broadband and more symmetrical speeds for end

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[1] Engineers refer to sub-terahertz frequencies above the 110 GHz band by several letter names, including D-band, G-band, and H-band. For ease, SpaceX refers to these frequencies collectively as D-band in this application.

users. SpaceX requests authority to launch and operate space stations on up to 100,000 satellites in the Gen3 system.

Transmission Direction	Frequency Ranges (GHz)
Satellite-to-Earth Station	10.7-13.4 17.3-21.2 37.5-42.5 67.0-76.0 122.25-164.0 167.0-174.8 191.8-226.0 231.5-275.0
Earth Station-to-Satellite	13.75-15.35 15.43-15.63 21.4-23.6 24.25-25.25 25.5-31.0 45.5-50.2 50.4-52.4 77.0-86.0 92.0-100.0 102.0-109.5 111.8-114.25 122.25-164.0 167.0-174.8 191.8-226.0 231.5-275.0

Table A.1.2: Gen3 Frequencies

A.2. PREDICTED SPACE STATION ANTENNA GAIN CONTOURS

Satellites in the Gen3 system are being designed with transmit and receive antenna beams that fall within a defined range of minimum and maximum gain. SpaceX provides antenna gain contours for the transmit and receive beams for a representative space station operating at representative altitudes proposed herein embedded in the associated Schedule S.[2]

All downlink spot beams on each SpaceX satellite are independently steerable over the full field of view of the Earth. Yet, earth stations communicate only with satellites above a minimum elevation angle. Figure A.2.1 below illustrates the steerable service range of satellite beams using generalized parameters.

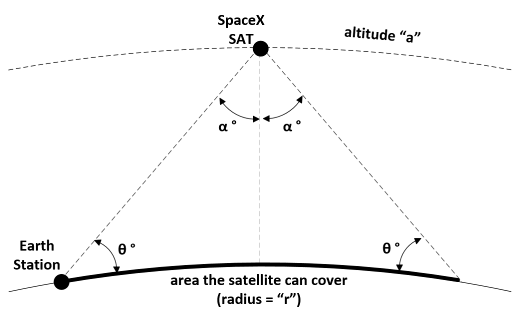


Figure A.2.1: Steerable Service Range of Satellite Beams

altitude "a" [km]	473	473.5	474	474.5	475	475.5	476	476.5	477	477.5
Max steering angle α [deg]	61.02	61.02	61.01	61.00	60.99	60.99	60.98	60.97	60.96	60.96
Coverage radius "r" [km]	999.3	1000.1	1001.0	1001.8	1002.6	1003.5	1004.3	1005.2	1006.0	1006.8

Table A.2.1: Values for 20° Minimum Elevation Angle θ

altitude "a" [km]	323	323.5	324	324.5	325	325.5	326	326.5	327	327.5
Max steering angle α [deg]	69.6	69.6	69.6	69.6	69.6	69.6	69.5	69.5	69.5	69.5
Coverage radius "r" [km]	1156.7	1158.0	1159.2	1160.5	1161.8	1163.1	1164.3	1165.6	1166.9	1168.2

altitude "a" [km]	473	473.5	474	474.5	475	475.5	476	476.5	477	477.5
Max steering angle α [deg]	66.5	66.5	66.4	66.4	66.4	66.4	66.4	66.4	66.4	66.4
Coverage radius "r" [km]	1506.7	1507.8	1508.8	1509.9	1511.0	1512.0	1513.1	1514.2	1515.2	1516.3

Table A.2.2: Values for 10° Minimum Elevation Angle θ

2 As discussed in more detail below, SpaceX has generally provided the contours for satellites at the lowest and highest relevant operating altitudes with the lowest and highest antenna gains in order to illustrate the full range of values. SpaceX can supply the remaining contours to the Commission upon request.

A.3. CHARACTERISTICS OF BEAMS

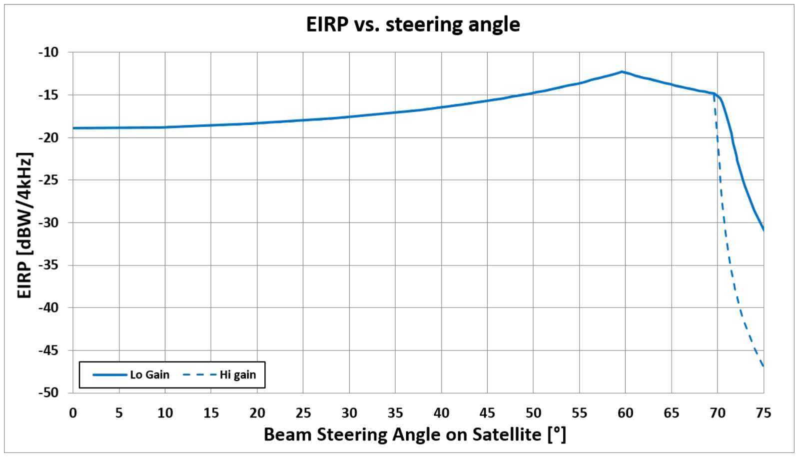
A.3. 1 Ku-Band Beams

The Gen3 System will transmit in Ku-band with a minimum gain of 34 dBi and a maximum gain of 49.1 dBi at boresight. The minimum elevation for the phased array antennas is 10 degrees for satellites operating below 400 km altitude and 20 degrees for those operating between 400 and 500 km altitude.

The antenna beam contours provided in the Schedule S include the uplink and downlink beams and both the minimum and maximum gain for operations at 323 km and 477.5 km at nadir and at 25°, 45°, and maximum slant away from nadir, which are representative of the contours for satellites throughout the proposed operating altitudes. As illustrated in Figure A.3.1--1 below with respect to operations at 323 km and 477.5 km altitude, as the transmitting beam is steered, the power is adjusted to maintain a constant maximum PFD at the surface of the Earth (to the extent allowed by applicable PFD limits), compensating for variations in antenna gain and path loss associated with the steering angle.

SpaceX seeks to operate with a flexible set of technical parameters in the band, including the ability to use any number of co-frequency beams transmitted to or from a particular location, that is consistent with the modernized sharing criteria and considerations for NGSO-NGSO and NGSO-GSO coexistence.

Table A.3.1-1 shows the maximum equivalent isotropically radiated power ("EIRP") density for the minimum nominal altitude shell at 323 km and the maximum nominal altitude shell at 477.5 km.



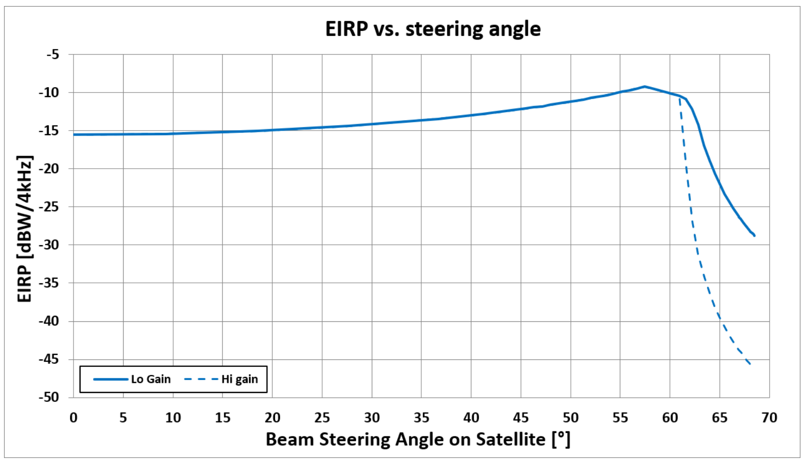


Figure A.3.1-1: EIRP Density Variation by Beam Steering Angle (top figure for 323 km, bottom figure for 477.5 km)

Altitude [km]	Max EIRP [dBW/4kHz]
323.0	-12.3
323.5	-12.3
324.0	-12.3
324.5	-12.2
325.0	-12.2
325.5	-12.2
326.0	-12.2
326.5	-12.2
327.0	-12.2
327.5	-12.2
473.0	-9.3
473.5	-9.3
474.0	-9.3
474.5	-9.2
475.0	-9.2

475.5	-9.2
476.0	-9.2
476.5	-9.2
477.0	-9.2
477.5	-9.2

Table A.3.1-1: Maximum Ku-Band EIRP Density at Various Altitudes

For receiving beams, the antenna gain drops slightly as the beam slants away from nadir. As a result, the maximum G/T at each altitude occurs at nadir, while the minimum G/T occurs at maximum slant.

A.3. 2 Ka-Band Beams

SpaceX proposes to operate upgraded space stations in the Gen3 system that will transmit using Ka-band antennas with a minimum gain of 34.8 dBi and a maximum gain of 48.3 dBi at boresight. The minimum elevation for its parabolic and phased array Ka-band antennas is 10 degrees. The antenna beam contours provided in Schedule S include both uplink and downlink beams used with parabolic antennas and phased array antennas at the highest and lowest gain for operations at 323 km and 477.5 km at nadir and at 25°, 45°, and maximum slant away from nadir, which are representative of the contours for satellites throughout the proposed operating altitudes and elevation angles.

SpaceX seeks to operate with a flexible set of technical parameters in the band, including the ability to use any number of co-frequency beams transmitted to or from a particular location, that is consistent with the modernized sharing criteria and considerations for NGSO-NGSO and NGSO-GSO coexistence.

As illustrated in Figures A.3.2-1 through A.3.2-4 below with respect to operations in orbital shells at nominal altitudes of 323 km and 477.5 km altitude, as a satellite steers the transmitting beam, it adjusts the power to maintain a constant PFD at the surface of the Earth (to the extent allowed by applicable PFD limits).

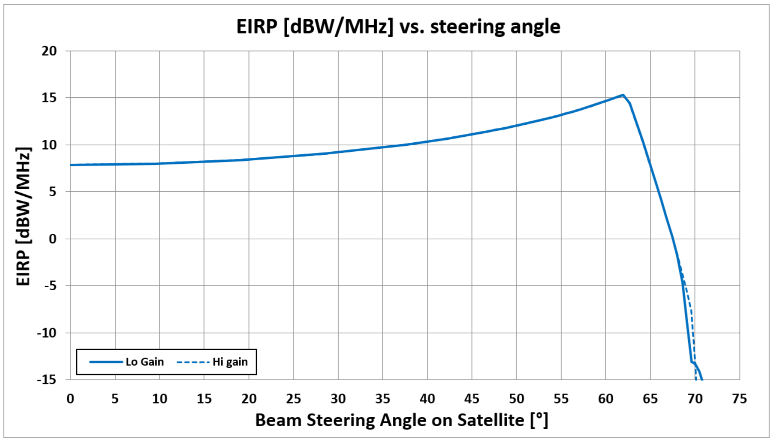


Figure A.3.2-1: EIRP Density Variation by Parabolic Beam Steering Angle (323 km)

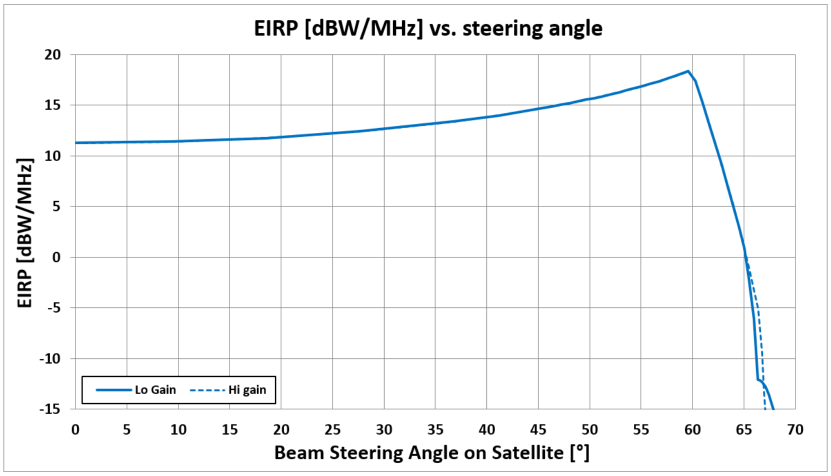


Figure A.3.2-2: EIRP Density Variation by Parabolic Beam Steering Angle (477.5 km)

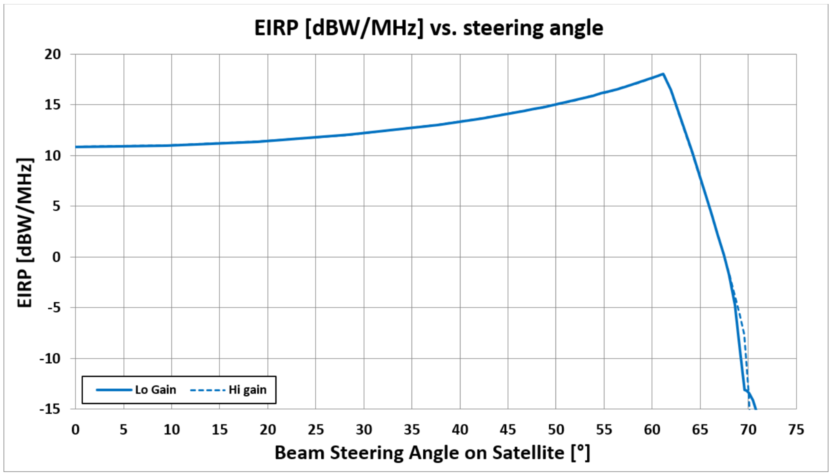


Figure A.3.2-3: EIRP Density Variation by Phased Array Steering Angle (323 km)

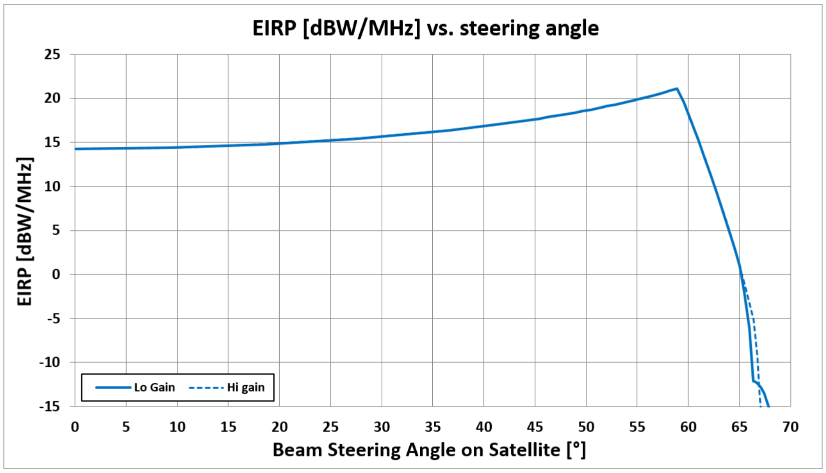


Figure A.3.2-4: EIRP Density Variation by Phased Array Beam Steering Angle (477.5 km)

Table A.3.2-1 shows the maximum EIRP density at each proposed operating altitude.

Altitude [km]	Max EIRP [dBW/MHz] (phased array beams)	Max EIRP [dBW/MHz] (parabolic beams)
323.0	15.3	18.1
323.5	15.3	18.1
324.0	15.4	18.1
324.5	15.4	18.1
325.0	15.4	18.1
325.5	15.4	18.1
326.0	15.4	18.1
326.5	15.4	18.1
327.0	15.4	18.2
327.5	15.4	18.2
473.0	18.3	21.0
473.5	18.3	21.0
474.0	18.3	21.0
474.5	18.3	21.0
475.0	18.3	21.1
475.5	18.3	21.1
476.0	18.3	21.1
476.5	18.3	21.1
477.0	18.3	21.1
477.5	18.4	21.1

Table A.3.2-1: Maximum Ka-Band EIRP Density at Various Altitudes

For parabolic receiving beams, G/T will remain constant depending on antenna gain and frequency (but independent of altitude and steering angle). For phased array receiving beams, the antenna gain drops slightly as the beam slants away from nadir. As a result, the maximum G/T at each altitude occurs at nadir, while the minimum G/T occurs at maximum slant.

A.3. 3 V-Band Beams

Space stations will transmit using V-band antennas with a minimum gain of 41.8 dBi and a maximum gain of 55.3 dBi. SpaceX seeks to operate its V-band enabled parabolic and phased array earth station antennas at a minimum elevation angle of 10 degrees for satellites operating below 400 km altitude and 20 degrees for those operating between 400 and 500 km altitude.

The antenna beam contours provided in Schedule S show the antenna gain contours (for both uplink and downlink beams with the highest and lowest gain) for operations at 323 km and 477.5 km at nadir and at 25°, 45°, and maximum slant away from nadir, which are representative of the contours for satellites throughout the proposed operating altitudes and elevation angles. SpaceX will adjust its operating parameters as needed, including the number of co-frequency beams transmitted to or from a particular location, to comply with any applicable rules.

As illustrated in Figures A.3.3-1 and A.3.3-2 below with respect to operations in its 323 km and 477.5 km nominal altitude shells, respectively, as a satellite steers the transmitting beam, it adjusts the power to maintain a constant PFD at the surface of the Earth (to the extent allowed by applicable PFD limits).

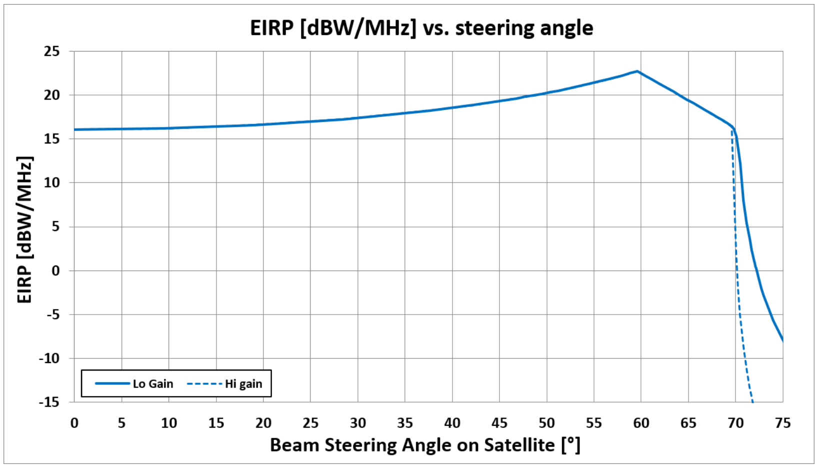


Figure A.3.3-1: EIRP Density Variation by Parabolic/Phase array Beam Steering Angle (323 km, 10° min)

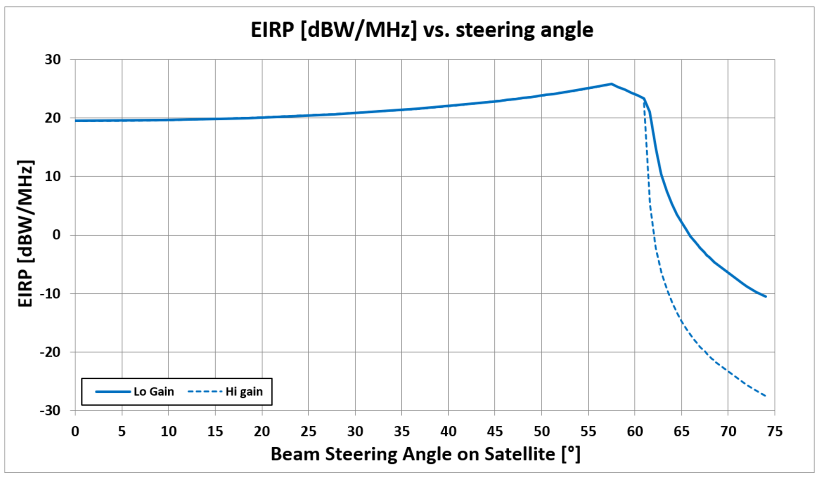


Figure A.3.3-2: EIRP Density Variation by Parabolic/Phase array Beam Steering Angle (477.5 km, 20° min)

Table A.3.3-1 shows the maximum EIRP density at each proposed new nominal operating altitude.

Altitude [km]	Max EIRP [dBW/MHz]
323.0	22.7
323.5	22.7
324.0	22.7
324.5	22.8
325.0	22.8
325.5	22.8
326.0	22.8
326.5	22.8
327.0	22.8
327.5	22.8
473.0	25.7
473.5	25.7
474.0	25.7
474.5	25.8
475.0	25.8
475.5	25.8
476.0	25.8
476.5	25.8
477.0	25.8
477.5	25.8

Table A.3.3-1: Maximum V-Band EIRP Density at Various Altitudes

SpaceX will adjust power in order to achieve the PFD levels indicated below (see A.4.3).

For parabolic receiving beams, G/T will remain constant depending on antenna gain and frequency (but independent of altitude and steering angle). For phased array receiving beams, the antenna gain drops slightly as the beam slants away from nadir. As a result, the maximum G/T occurs at nadir, while the minimum G/T occurs at maximum slant.

A.3. 4 E-Band Beams

SpaceX seeks authorization to operate space stations transmitting using E-band antennas with a minimum gain of 46.5 dBi and a maximum gain of 60.6 dBi. The minimum elevation for earth stations is 10 degrees for satellites operating below 400 km altitude and 20 degrees for those operating between 400 and 500 km altitude.

The antenna beam contours provided in Schedule S include both uplink and downlink beams with the highest and lowest gain for operations at 323 km and 477.5 km nominal altitudes at nadir and at 25°, 45°, and maximum slant away from nadir which are representative of the contours for space stations throughout the proposed operating altitudes and elevation angles. SpaceX will adjust its operating parameters as needed, including the number of co-frequency beams transmitted to or from a particular location, to comply with any applicable rules.

As illustrated in Figures A.3.4-1 and A.3.4-2 below with respect to operations in shells at 323 and 477.5 km nominal altitude, respectively, as a satellite steers the transmitting beam, it adjusts the power to maintain a constant PFD at the surface of the Earth (to the extent allowed by applicable PFD limits).

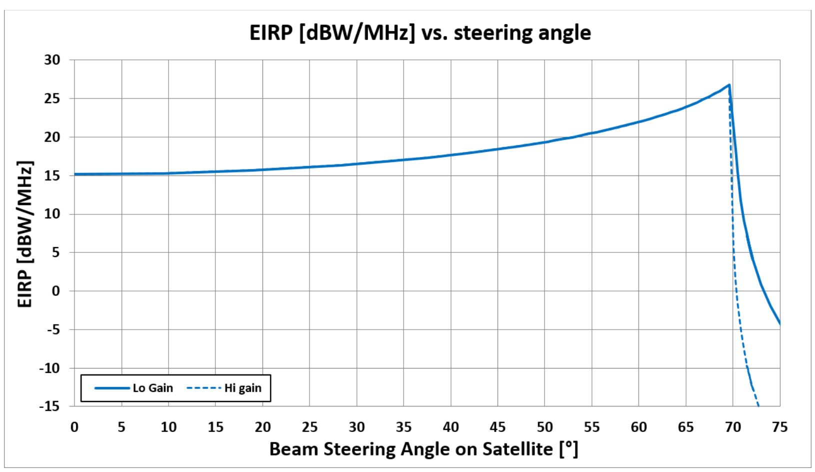


Figure A.3.4-1: EIRP Density Variation by Beam Steering Angle (323 km, 10° min)

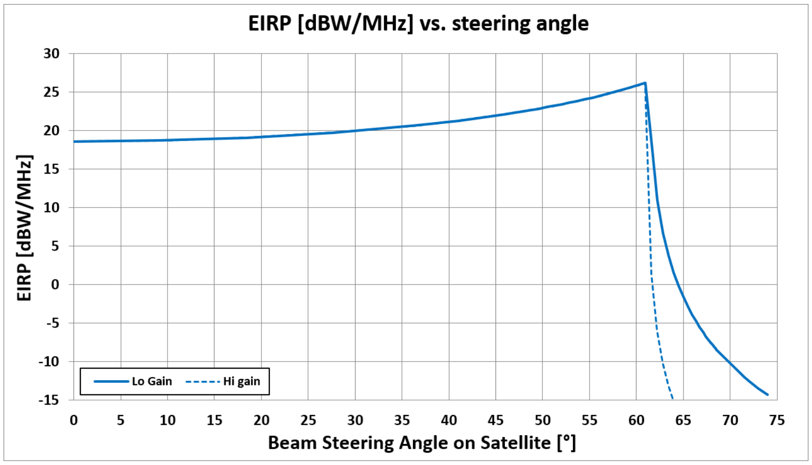


Figure A.3.4-2: EIRP Density Variation by Beam Steering Angle (477.5 km, 20° min)

Table A.3.4-1 shows the maximum EIRP density at each proposed nominal operating altitude.

Altitude [km]	Max EIRP [dBW/MHz]
323.0	26.8
323.5	26.8
324.0	26.8
324.5	26.8
325.0	26.8
325.5	26.8
326.0	26.8
326.5	26.8
327.0	26.9
327.5	26.9
473.0	26.1
473.5	26.1
474.0	26.1
474.5	26.1
475.0	26.1
475.5	26.2
476.0	26.2
476.5	26.2
477.0	26.2
477.5	26.2

Table A.3.4-1: Maximum E-Band EIRP Density at Various Altitudes

SpaceX will adjust power in order to achieve a constant PFD level at the surface of the Earth. For receiving beams, G/T will remain constant depending on frequency and antenna gain (but independent of altitude and steering angle).

A.3. 5 W-Band Beams

Space stations in SpaceX's Gen3 system will only receive in W-band frequencies. W-band antennas have a minimum gain of 49.1 dBi and a maximum gain of 64.4 dBi, depending on frequency. SpaceX seeks to operate its W-band enabled earth stations at a minimum elevation angle of 10 degrees for satellites operating below 400 km altitude and 20 degrees for those operating between 400 and 500 km altitude.

The antenna beam contours provided in Schedule S shows the antenna gain contours (for uplink beams with the highest and lowest gain) for operations at 323 km and 477.5 km at nadir and at 25°, 45°, and maximum slant away from nadir, which are representative of the contours for satellites throughout the proposed operating altitudes and elevation angles. Each W-band beam is used to communicate with a single space station at a time. SpaceX will adjust its operating parameters as needed, including the number of co-frequency beams transmitted from a particular location, to comply with any applicable rules.

For receiving beams, G/T will remain constant depending on antenna gain and frequency (but independent of altitude and steering angle).

A.3. 6 D-Band Beams

Gen3 stations will either transmit or receive in D-band. A single space station will not operate bidirectionally simultaneously. The Gen3 system may use each D-band frequency range for uplink or downlink depending on evolving backhaul demand over time.

SpaceX seeks authorization to operate space stations transmitting using D-band antennas with a minimum gain of 52.9 dBi and a maximum gain of 71.4 dBi. The minimum elevation for earth stations is 10 degrees for satellites operating below 400 km altitude and 20 degrees for those operating between 400 and 500 km altitude.

The antenna beam contours provided in Schedule S include both uplink and downlink beams with the highest and lowest gain for operations at 323 km and 477.5 km nominal altitudes at nadir and at 25°, 45°, and maximum slant away from nadir which are representative of the contours for space stations throughout the proposed operating altitudes and elevation angles. SpaceX will adjust its operating parameters as needed, including the number of co-frequency beams transmitted to or from a particular location, to comply with any applicable rules.

As illustrated in Figures A.3.6-1 and A.3.6-2 below with respect to operations in 122.25-164 GHz band in shells at 323 and 477.5 km nominal altitude, respectively, as a satellite steers the transmitting beam, it adjusts the power to maintain a constant PFD at the surface of the Earth (to the extent allowed by applicable PFD limits).

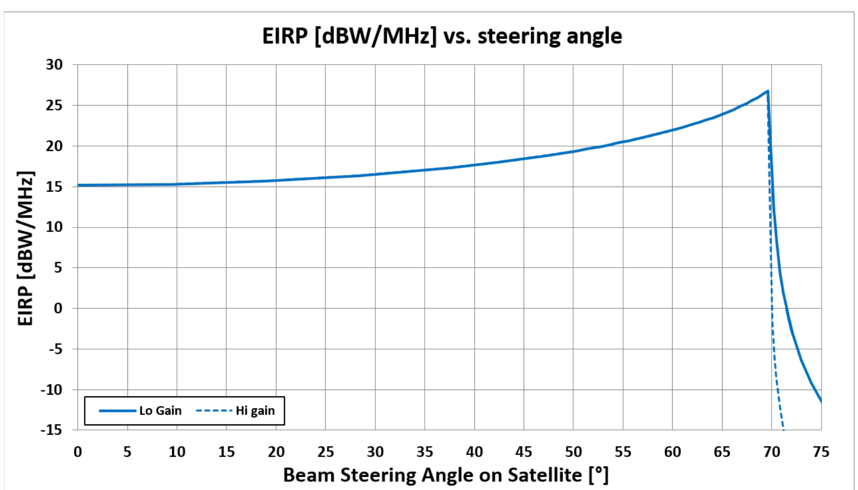


Figure A.3.6-1: EIRP Density Variation by Beam Steering Angle (323 km, 10° min)

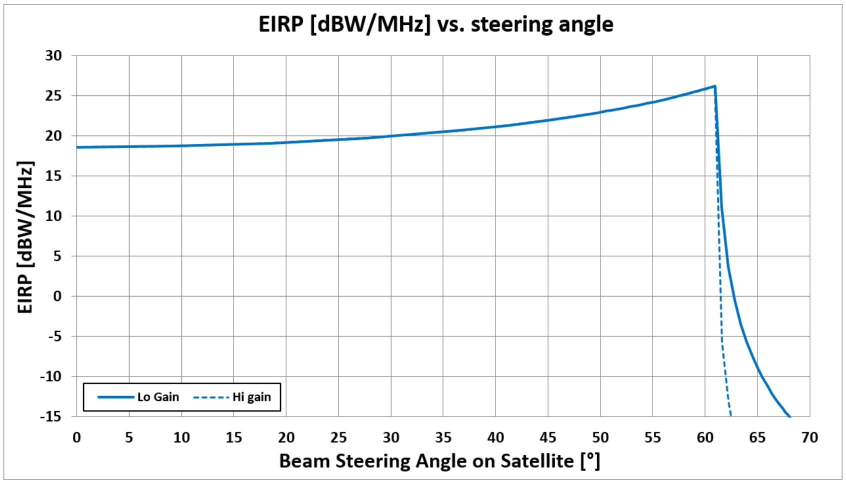


Figure A.3.6-2: EIRP Density Variation by Beam Steering Angle (477.5 km, 20° min)

Table A.3.6-1 shows the maximum EIRP density at each proposed nominal operating altitude.

Altitude [km]	Max EIRP [dBW/MHz]
323.0	26.8
323.5	26.8
324.0	26.8
324.5	26.8
325.0	26.8
325.5	26.8
326.0	26.8
326.5	26.8
327.0	26.9
327.5	26.9
473.0	26.1
473.5	26.1
474.0	26.1
474.5	26.1
475.0	26.1
475.5	26.2
476.0	26.2
476.5	26.2
477.0	26.2
477.5	26.2

Table A.3.6-1: Maximum D-Band EIRP Density at Various Altitudes

SpaceX will adjust power in order to achieve a constant PFD level at the surface of the Earth. For receiving beams, G/T will remain constant depending on frequency and antenna gain (but independent of altitude and steering angle).

A.3. 7 Mapping of Representative Beams

Table A.3.7.1 shows the mapping of space station transmit beams in Schedule S at two different representative operating altitudes.

Altitude [km]	Beams
323	Tx1-Tx52
477.5	Tx101-Tx152

Table A.3.3.1. Tx Beams Mapping in Schedule S

A.4 COMPLIANCE WITH PFD LIMITS

SpaceX hereby provides PFD calculation for the proposed Gen3 system operations, both at maximum slant and at nadir, for Ku-band, Ka-band, and V-band downlink beams from representative orbital altitudes. In each case, the tables reflect operations at the lowest and highest altitudes – and, for the Ku-, Ka- and V-band, the maximum PFD scenario that envelope the actual operational levels. Because SpaceX's satellite downlink transmit power remains adjustable on orbit, SpaceX has the ability to manage the satellites' PFD levels during all phases of the mission, as needed. SpaceX seeks authorization to operate within the United States in accordance with the Commission's PFD limits and internationally in accordance with the ITU's limits in those bands where specific PFD limits apply.

	Nadir	25° ES elev	10° ES elev
EIRP density [dBW/Hz]	-54.9	-48.3	-50.8
EIRP in 4kHz [dBW/4kHz]	-18.9	-12.3	-14.8
EIRP in 1MHz [dBW/MHz]	5.1	11.7	9.2
Distance to Earth [km]	323.0	694.2	1227.2
Spreading loss [dB]	121.2	127.8	132.8
PFD in 4 kHz [dB(W/m^2/4kHz)]	-140.1	-140.1	-147.6
PFD in 1 MHz [dB(W/m^2/MHz)]	-116.1	-116.1	-123.6

Table A.4-1: PFD at the Surface of the Earth Produced by Ku-Band Antenna (323 km)

	Nadir	25° ES elev	10° ES elev
EIRP density [dBW/Hz]	-51.5	-45.2	-46.4
EIRP in 4kHz [dBW/4kHz]	-15.5	-9.2	-10.4
EIRP in 1MHz [dBW/MHz]	8.5	14.8	13.6
Distance to Earth [km]	477.5	990.3	1146.9
Spreading loss [dB]	124.6	130.9	132.2
PFD in 4 kHz [dB(W/m^2/4kHz)]	-140.1	-140.1	-142.6
PFD in 1 MHz [dB(W/m^2/MHz)]	-116.1	-116.1	-118.6

Table A.4-2: PFD at the Surface of the Earth Produced by Ku-Band Antenna (477.5 km)

	Nadir	25° ES elev	10° ES elev
EIRP density [dBW/Hz]	-52.1	-45.5	-67.6
EIRP in 1MHz [dBW/MHz]	7.9	14.5	-7.6
Distance to Earth [km]	323	694.2	1227.2
Spreading loss [dB]	121.2	127.8	132.8
PFD in 1 MHz [dB(W/m^2/MHz)]	-113.3	-113.3	-140.4

Table A.4-3: PFD at the Surface of the Earth Produced by Ka-Band Parabolic Antenna (323 km)

	Nadir	25° ES elev	10° ES elev
EIRP density [dBW/Hz]	-48.7	-42.4	-65.1
EIRP in 1MHz [dBW/MHz]	11.3	17.6	-5.1
Distance to Earth [km]	477.5	990.3	1639.4
Spreading loss [dB]	124.6	130.9	135.3
PFD in 1 MHz [dB(W/m^2/MHz)]	-113.3	-113.3	-140.4

Table A.4-4: PFD at the Surface of the Earth Produced by Ka-Band Parabolic Antenna (477.5 km)

	Nadir	25° ES elev	10° ES elev
EIRP density [dBW/Hz]	-49.1	-42.5	-67.6
EIRP in 1MHz [dBW/MHz]	10.9	17.5	-7.6
Distance to Earth [km]	323.0	694.2	1227.2
Spreading loss [dB]	121.2	127.8	132.8
PFD in 1 MHz [dB(W/m^2/MHz)]	-110.3	-110.3	-140.4

Table A.4-5: PFD at the Surface of the Earth Produced by Ka-Band Phased Array Antenna (323 km)

	Nadir	25° ES elev	10° ES elev
EIRP density [dBW/Hz]	-45.7	-39.4	-65.1
EIRP in 1MHz [dBW/MHz]	14.3	20.6	-5.1
Distance to Earth [km]	477.5	990.3	1639.4
Spreading loss [dB]	124.6	130.9	135.3
PFD in 1 MHz [dB(W/m^2/MHz)]	-110.3	-110.3	-140.4

Table A.4-6: PFD at the Surface of the Earth Produced by Ka-Band Phased Array Antenna (477.5 km)

	37.5-40.0 GHz in the US		40.0-42.5 GHz in the US 37.5-42.5 GHz Outside US	
	Nadir	10° ES elev	Nadir	10° ES elev
EIRP density [dBW/Hz]	-55.9	-55.6	-43.9	-43.6
EIRP in 1MHz [dBW/MHz]	4.1	4.4	16.1	16.4
Distance to Earth [km]	323.0	1227.2	323.0	1227.2
Spreading loss [dB]	121.2	132.8	121.2	132.8
PFD in 1 MHz [dB(W/m^2/MHz)]	-117.1	-128.4	-105.1	-116.4

Table A.4-7: PFD at the Surface of the Earth Produced by V-Band Antenna (323 km)

	37.5-40.0 GHz in the US		40.0-42.5 GHz in the US 37.5-42.5 GHz Outside US	
	Nadir	20° ES elev	Nadir	20° ES elev
EIRP density [dBW/Hz]	-52.5	-48.7	-40.5	-36.7
EIRP in 1MHz [dBW/MHz]	7.5	11.3	19.5	23.3
Distance to Earth [km]	477.5	1146.9	477.5	1146.9
Spreading loss [dB]	124.6	132.2	124.6	132.2
PFD in 1 MHz [dB(W/m^2/MHz)]	-117.1	-120.9	-105.1	-108.9

Table A.4-8: PFD at the Surface of the Earth Produced by V-Band Antenna (477.5 km)

A.4.1 PFD Limits in the Ku-Band

The PFD limits imposed by the Commission and the ITU in the Ku-band apply on a per-satellite basis. However, the Commission and the ITU have adopted different downlink PFD limits for different portions of the Ku-band spectrum used by the Gen3 system. For each of these limits, SpaceX demonstrates compliance by plotting the relevant limit and the worst-case PFD of a satellite operating in the proposed 323 km and 477.5 km nominal altitude shells with earth stations at a minimum elevation angle of 10 degrees and 10 or 20 degrees, respectively, for both the highest and lowest gain transmitting antennas. The first set of limits applies across the 10.7-11.7 GHz band, where the Commission and ITU limits are the same.[3]

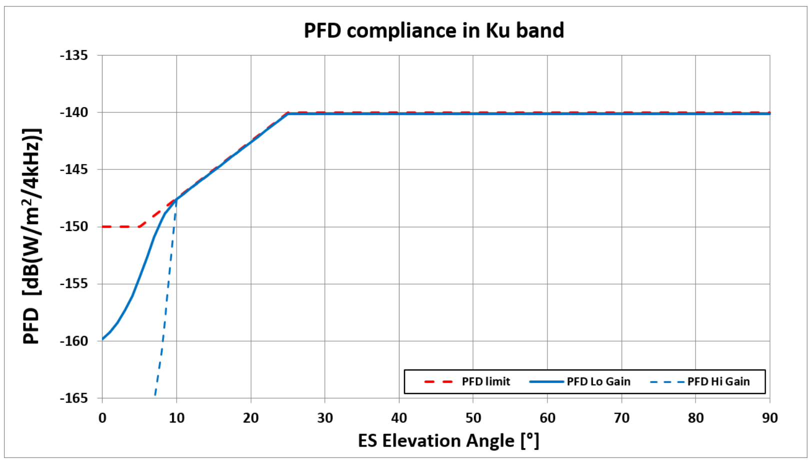


Figure A.4.1-1: Compliance with Downlink PFD Limits in the 10.7-11.7 GHz Band (323 km)

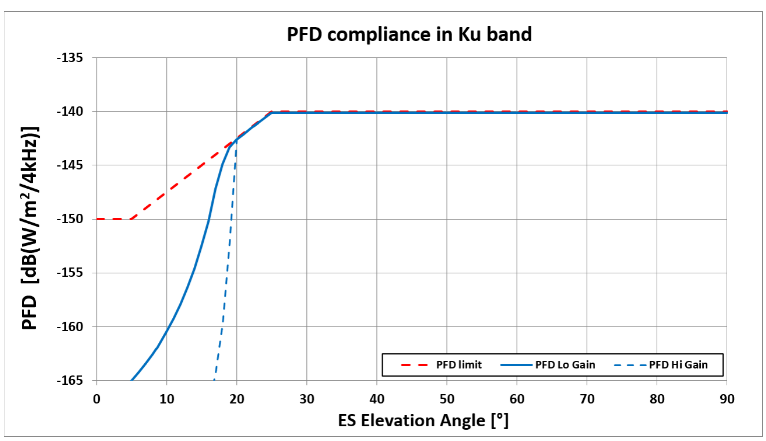


Figure A.4.1-2: Compliance with Downlink PFD Limits in the 10.7-11.7 GHz Band (477.5 km)

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3 *See* 47 C.F.R. § 25.208(b); ITU Radio Regs., Table 21-4.

The ITU Radio Regulations include PFD limits across the 11.7-12.7 GHz band that are effectively 2 dB higher than the PFD limits in the 10.7-11.7 GHz band plotted above. For its operations in the 11.7-12.7 GHz band, SpaceX will comply with the applicable limits.

Section 25.208(o) of the Commission's rules specifies low elevation PFD limits that apply in the 12.2-12.7 GHz band to protect the Multichannel Video and Data Distribution Service ("MVDDS"). Figure A.4.1-3 below shows that satellites in the proposed 323 km nominal altitude shell will comply with these limits as well.

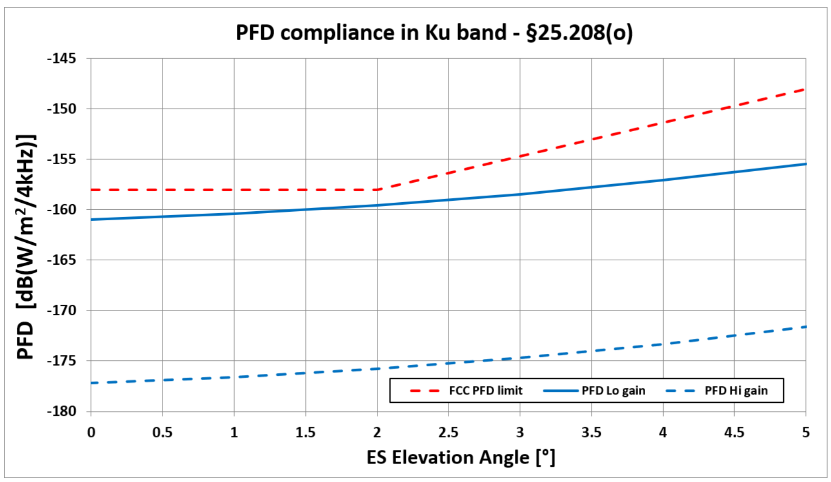

Figure A.4.1-3: Compliance with Downlink PFD Limits in the 12.2-12.7 GHz Band (323 km)

Operations at this lowest nominal altitude shell provide a worst-case PFD scenario, yet still remain compliant over the full range of antenna gains. Accordingly, all amended Ku-band downlink transmissions from SpaceX space stations operating in the proposed orbital configuration will comply with all applicable Commission and ITU PFD limits.

A.4.2 PFD Limits in the Ka-Band

The ITU has adopted a single set of PFD limits for NGSO systems across the entire 17.7-19.3 GHz band, which the Commission has incorporated by reference into its rules.[4] During the 2023 World Radiocommunication Conference ("WRC-23"), the ITU revised these rules and SpaceX hereby provides PFD analyses based on that updated ITU limit.[5]

These limits can be stated as follows:

- $-115-X$ dB(W/m^2) in any 1 MHz band for angles of arrival between 0 and 5 degrees above the horizontal plane;
- $-115-X+((10+X)/20)(\delta-5)$ dB(W/m^2) in any 1 MHz band for angles of arrival δ (in degrees) between 5 and 25 degrees above the horizontal plane; and
- -105 dB(W/m^2) in any 1 MHz band for angles of arrival between 25 and 90 degrees above the horizontal plane.

The function X is defined as a function of the number, N, of satellites in the NGSO satellite constellation in the fixed-satellite service and N_v, as follows:

- $X = 0$ dB for $N \leq 50$
- $X = (5/119)(N - 50)$ dB for $50 < N \leq 288$
- $X = (1/69)(N + 402)$ dB for $288 < N \leq 999$
- $X = \max\{20.3; 10\log_{10}(N_v)\}$ dB for $1000 < N \leq 6000$
- $X = 10\log_{10}(N_v)+1$ dB for $N > 6000$

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4 *See* ITU Radio Regs., Table 21-4; 47 C.F.R. § 25.108(c)(2). Note: SpaceX addresses the intended use of this band in its accompanying waiver request.

5 *See* ITU Radio Regs. 21.16, 21.16.6, and Table 21-4 (WRC-23). These limits are effective as of January 1, 2025.

Where N_v^* is the maximum number of visible satellites—considering a minimum elevation angle equal to 0 degrees—from any location on the surface of the Earth and within the *service* area of the non-GSO system. N_v does not depend on latitude; it encompasses the maximum number of visible satellites across all latitudes within the service area of the relevant NGSO system.

In the frequency band 18.8-19.3 GHz, these limits apply to emissions of any satellite in an NGSO satellite system:

- in the fixed-satellite service for which complete coordination or notification information, as appropriate, has been received by the Radiocommunication Bureau since 17 November 1995 and which was not operational by that date, and
- in the inter-satellite service.

Where N_v is determined as follows:

- $N_v = \text{Max}(N_v(j = 0,1,2...))$ with $N_v(j) = \text{Max}(N_v(j(t)), N_v(j(t-1)))$, where $N_v(j(t))$ represents all visible satellites (with elevation ≥ 0 degrees) at each timestep (t) on any point on the surface of the Earth (j).

For the Gen3 system, the value of N is 100,000, the value of N_v is 4,054, and therefore X is equal to 37.08 dB according to the above formulas. This results in the PFD masks for communications links (with the highest and lowest gain transmitting antennas) shown in Figures A.4.2-1 through A.4.2-4 below. SpaceX demonstrates compliance with the new ITU limits across all figures below. SpaceX will comply with the PFD limits applicable to each band.

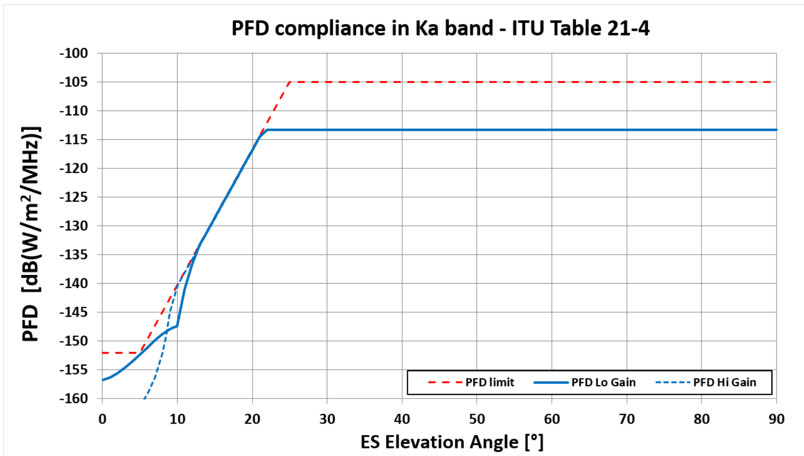

Figure A.4.2-1: SpaceX Parabolic Antenna Compliance with Downlink PFD Limits in the 17.7-19.3 GHz Band (323 km, 10° min)

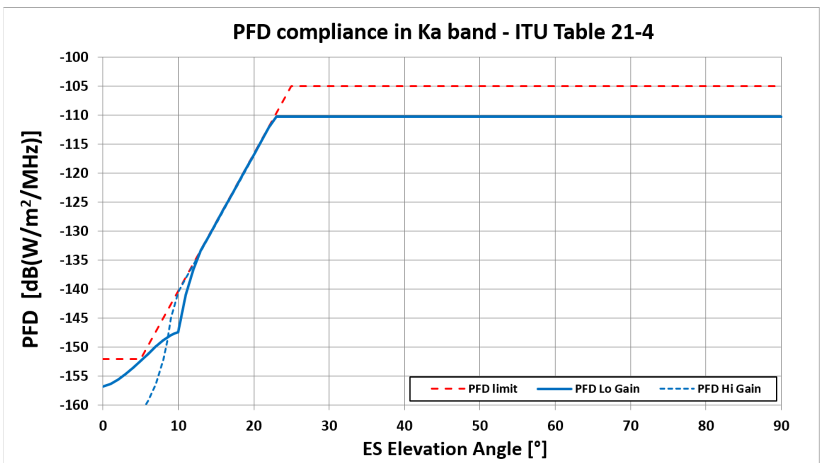

Figure A.4.2-2: SpaceX Phased Array Antenna Compliance with Downlink PFD Limits in the 17.7-19.3 GHz Band (323 km, 10° min)

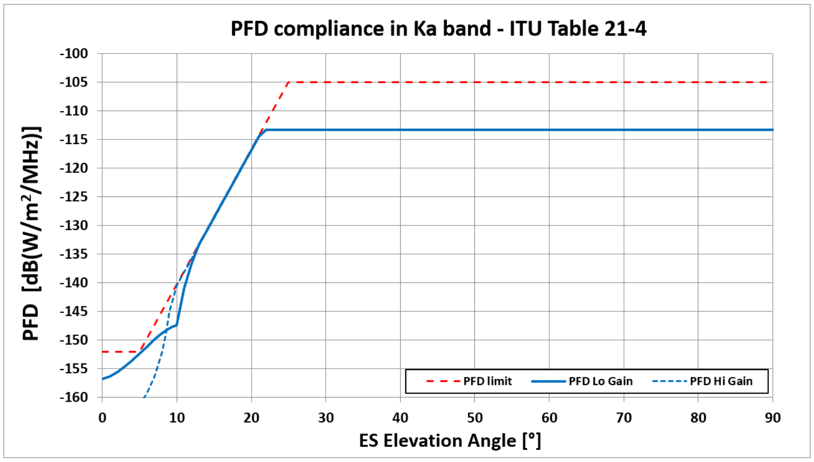

Figure A.4.2-3: SpaceX Parabolic Antenna Compliance with Downlink PFD Limits in the 17.7-19.3 GHz Band (477.5 km, 10° min)

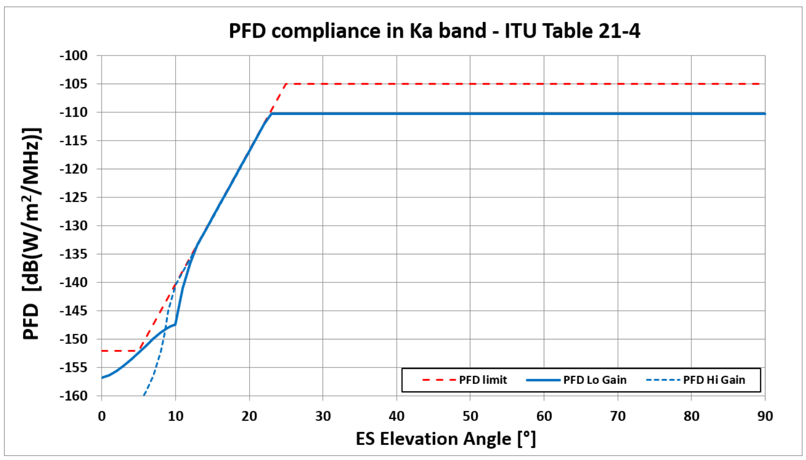

Figure A.4.2-4: SpaceX Phased Array Antenna Compliance with Downlink PFD Limits in the 17.7-19.3 GHz Band (477.5 km, 10° min)

These figures show that the Gen3 system complies with the updated PFD limits specified by the ITU at all elevation angles.

A.4.3 PFD Limits in the V-Band

The PFD limits imposed by the Commission and the ITU in the V-band apply on a per-satellite basis. The Commission and ITU have adopted different downlink PFD limits for different portions of the V-band spectrum used by the Gen3 system. For each of these limits, SpaceX demonstrates compliance by plotting the relevant limit and the worst-case PFD of a satellite operating in the proposed 323 km and 477.5 km nominal altitude shells with earth stations at a minimum elevation angle of 10 degree and 20 degrees, respectively, for both the highest and lowest gain transmitting antennas. SpaceX seeks authorization to operate within the United States in accordance with the Commission's PFD limits and internationally in accordance with the ITU's limits.

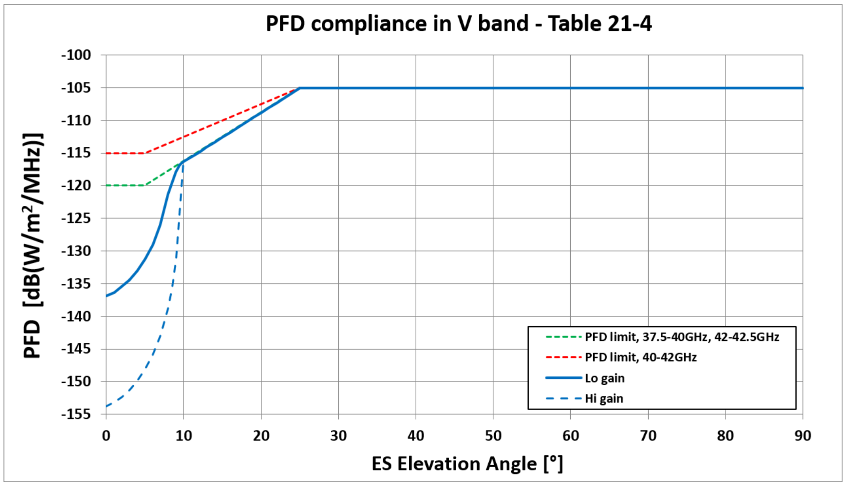

Figure A.4.3-1: SpaceX Compliance with ITU Downlink PFD Limits in V-Band (323 km, 10° min)

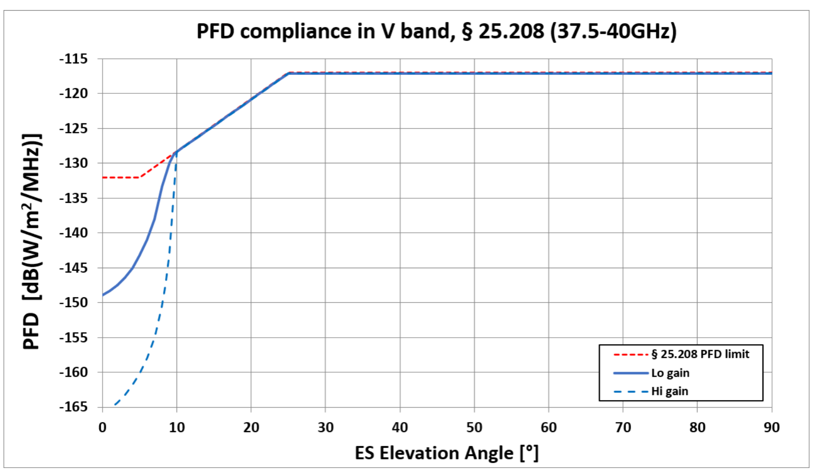

Figure A.4.3-2: SpaceX Compliance with FCC Downlink PFD Limits in the 37.5-40 GHz Band (323 km, 10° min)

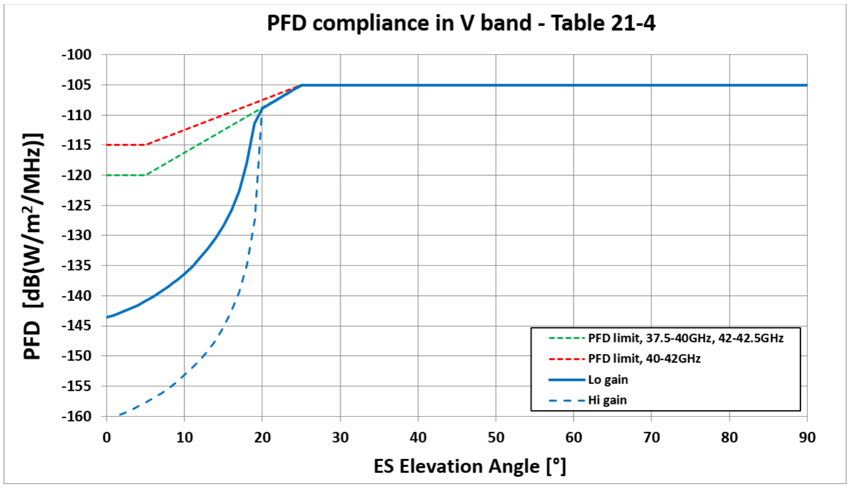

Figure A.4.3-3: SpaceX Compliance with ITU Downlink PFD Limits in V-Band (477.5 km, 20° min)

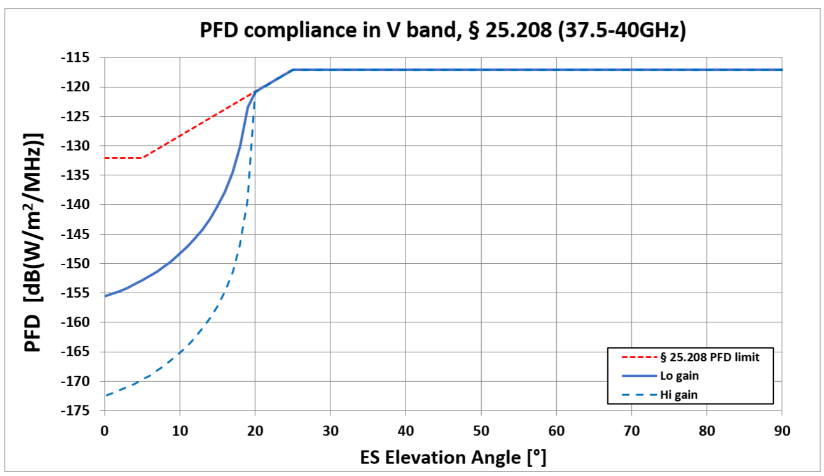

Figure A.4.3-4: SpaceX Compliance with FCC Downlink PFD Limits in the 37.5-40 GHz Band (477.5 km, 20° min)

A.5 INTERFERENCE ANALYSES

A.5. 1 Interference Protection for GSO Satellite Networks

The Commission has adopted modern technical rules for spectrum sharing between NGSO and GSO systems in place of reliance on the ITU Article 22 equivalent power flux-density ("EPFD") framework for GSO protection in the relevant Ku- and Ka-band downlink bands. Consistent with that framework and the Commission's Report and Order on Modernizing

Spectrum Sharing for Satellite Broadband,[6] SpaceX's Gen3 downlink operations in the United States are designed to protect GSO networks operating in the space-to-Earth direction in Ku- and Ka-band spectrum.

Outside the United States, pursuant to Section 25.146 of the Commission's rules and Section 22.5CA of the ITU Radio Regulations, SpaceX will comply with applicable ITU Article 22 EPFD downlink limits in administrations where those limits continue to apply, and with applicable uplink and inter-satellite-link limits globally, unless and until the Commission and/or the ITU modernizes those limits or a national administration permits a different approach within its territory. Should those international limits change, SpaceX requests authority to transmit up to the revised limits upon their adoption. SpaceX will comply with ITU Resolution 770 with respect to V-band frequencies included in this application.

A.5. 2 Interference with Respect to Other NGSO Satellite Systems

SpaceX is engineering its Gen3 system with technical flexibility that facilitates coordination with other NGSO satellite systems. The ITU has procedures for coordination among NGSO systems operating in certain Ku-band, Ka--band, and V-band frequency ranges.[7] The Gen3 system will meet the Commission's NGSO-NGSO spectrum sharing requirements for systems authorized in processing rounds.[8]

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6 *See Modernizing Spectrum Sharing for Satellite Broadband*, SB Docket No. 25-157, Report and Order, FCC 26-26 (2026).

7 ITU Radio Regs. 9.12.

8 47 C.F.R. § 25.261; *Revising Spectrum Sharing Rules for Non-Geostationary Orbit, Fixed-Satellite Service Systems*, IB Docket No. 21-456, Second Report and Order and Order on Reconsideration, FCC 24-117 (2024).

A.5. 3 Interference with Respect to the Radio Astronomy Service

SpaceX will protect the Radio Astronomy Service ("RAS") from any in-band and out-of-band interference from its the Gen3 System operations in accordance with relevant Commission rules and ITU footnotes, resolutions, and recommendations for the protection of RAS. For example, SpaceX has entered into a coordination agreement with the National Science Foundation, under which the parties have develop a cutting-edge boresight avoidance technique to promote efficient sharing between next-generation satellite systems and radio astronomy observatories.

A. 6 COORDINATION WITH U.S. GOVERNMENT NETWORKS

Footnote US334 of the U.S. Table of Frequency Allocations requires SpaceX to coordinate its NGSO system with U.S. government satellite networks, both GSO and NGSO, in portions of the Ka-band spectrum. SpaceX's current Gen2 authorization also requires SpaceX to coordinate with government agencies for its operations in certain Ku-, Ka-, V-, E-, and W-band spectrum subject to heightened completed coordination obligations to protect national security and safety-of-life obligations.[9] SpaceX will similarly coordinate the proposed Gen3 system with all applicable government systems and scientific missions operating in these spectrum bands. For the reasons discussed above, SpaceX is confident that the characteristics of its proposed system will facilitate an operational approach that will allow efficient sharing of this spectrum with government systems.

[9] *E-band Authorization*, ¶ 22.

A.7 ITU Filings for SpaceX

SpaceX has not yet submitted system information for ITU publication. SpaceX will submit information relevant for its ITU filing at the appropriate time and will accept consequent ITU cost-recovery responsibility for the filing.

A.8 Orbital Debris Mitigation Plan

SpaceX provides below its orbital debris mitigation plan for the system in the Commission's recommended format.

Mission Overview and Spacecraft Information	
A statement describing the extent of satellite maneuverability, including whether or not the space station design includes a propulsion system. *§25.114(d)(14)(iv)(A)(4).* Indicate the components required for the propulsion system to operate reliably, including communications with the satellite.	Each satellite will have a robust and redundant propulsion system with enough delta-v to orbit raise to the operational altitude, station-keep, perform collision avoidance maneuvers with conservative thresholds, and complete disposal. All propulsion components will rely on Starlink heritage for high operational reliability and high reliability in maintaining communications.
A statement describing the accuracy, if any, with which orbital parameters will be maintained, including apogee, perigee, inclination, and the right ascension of the ascending node(s). If a system is not able to maintain orbital tolerances, *e.g.,* its propulsion system will not be used for orbital maintenance, that fact must be included in the debris mitigation disclosure. Such systems must also indicate the anticipated evolution over time of the orbit of the proposed satellite or satellites. *§ 25.114(d)(14)(iv)(A)(4)*	SpaceX's satellites are capable of maneuvering to ensure appropriate shell spacing and operate in accordance with authorized altitudes and inclinations, as well as orbital tolerances.
A statement addressing the trackability of the space station(s), including whether the smallest dimension of the spacecraft is 10 cm or Space station(s) operating in LEO will be presumed trackable if each individual space	SpaceX's satellites will be larger than 10 cm in their smallest dimension and are therefore presumed to be trackable.

station is 10 cm or larger in its smallest dimension, excluding deployable components. *§ 25.114(d)(14)(v)*	SpaceX's satellites autonomously estimate their own position using GNSS and other sensors and regularly report that information to accelerate cataloging and enhance active tracking.
A statement describing how the operator plans to identify the space station(s) following deployment and whether space station tracking will be active or passive. Active tracking involves the use of instruments or devices that emit signals or radiation which are detected by sensors on the space station or other tracking systems. Passive tracking relies on detecting naturally occurring emissions or reflections off the surface of the space station or radio signals emitted by the station itself. Operators should also indicate if they plan to use enhanced tracking services and whether the information gathered by such services will be available to other operators. *§ 25.114(d)(14)(v)(A)*	Following deployment, SpaceX identifies its satellites using a network of ground stations. SpaceX certifies that each of its space stations have a unique telemetry marker allowing it to be distinguished from other satellites or space objects. Furthermore, prior to launch, SpaceX assigns each satellite a temporary nine-digit number that is coordinated with USSPACECOM (18 Space Defense Squadron - SDS) and published on Space-Track.org. Within several hours of deployment, SpaceX uploads propagated ephemerides (position and velocity predictions) and covariance (prediction uncertainty) to Space-Track.org for use by USSPACECOM for conjunction assessment screening and for identification. Once the satellites are cataloged by USSPACECOM, they transition to using their assigned NORAD catalog identification number.
A statement indicating whether, prior to deployment, the space station(s) will be registered with the 18th Space Control Squadron (http://www.space-track.org/) or successor entity. *§ 25.114(d)(14)(v)(B)*	Prior to deployment, SpaceX registers its satellites with the USSPACECOM Space Office.
A statement describing the extent to which the space station operator plans to share information regarding initial deployment, ephemeris, and/or planned maneuvers with the 18th Space Control Squadron or successor entity, other entities that engage in space situational awareness or space traffic management functions, and/or other operators. § *25.114(d)(14)(v)(C)*	SpaceX shares contact information with all registered satellite owner/operators on Space-Track.org both for routine and urgent 24/7/365.25 coordination. Furthermore, SpaceX shares propagated ephemerides and covariance, that include planned maneuvers, with 18SDS, other entities and satellite owner/operators on Space-Track.org. SpaceX also makes

	ephemerides and covariance available publicly via a company website.
Satellite Operations and Collision Risk	
For non-geostationary satellites, a statement identifying the characteristics of the space station(s)' orbits that may present a collision risk, including any planned and/or operational space stations in those orbits. This statement must indicate what steps, if any, have been taken to coordinate with the other spacecraft or system, or what other measures the operator plans to use to avoid collision. *§ 25.114(d)(14)(iv)(A)(2).* If the space station operator is relying on coordination with another system, the statement must indicate what steps have been taken to contact and ascertain the likelihood of successful coordination of physical operations with the other system. *§ 25.114(d)(14)(iii)*	SpaceX regularly conducts physical coordination with other satellite owner/operators that operate in or near its operational shells and those that also regularly transit through its shells and whose shells SpaceX satellites transit through. In addition, SpaceX works with other launch providers to coordinate when satellites are deployed in or near its operational shells. Where coordination is not possible, SpaceX satellites will take maneuver responsibility to mitigate the risk of conjunctions with probability above its conservative threshold.
For geostationary satellites, assess whether there are any known satellites located at, or reasonably expected to be located at, the requested orbital location, or assigned in the vicinity of that location, such that the station keeping volumes of the respective satellites might overlap or touch. *§ 25.114(d)(14)(iii).* If relevant, the statement must include the identities of those parties and the measures that will be taken to prevent collisions. *§ 25.114(d)(14)(iv)(B)*	N/A
A certification that upon receipt of a space situational awareness conjunction warning, the operator will review and take all possible steps to assess the collision risk and will mitigate the collision risk if necessary. As appropriate, steps to assess and mitigate the collision risk should include but are not limited to: contacting the operator of any active spacecraft involved in such a warning; sharing ephemeris data and other appropriate operational information with any such	SpaceX certifies that upon receipt of a space situational awareness conjunction warning, it will review and take all possible steps to assess the collision risk and will mitigate the collision risk if necessary. As appropriate, steps to assess and mitigate the collision risk may include but are not limited to: contacting the operator of any active spacecraft involved in such a warning; sharing ephemeris data and other appropriate operational

operator; and modifying space station attitude and/or operations. *§ 25.114(d)(14)(iv)(A)(5)*	information with any such operator; and modifying space station attitude and/or operations. SpaceX assesses collision risk and takes appropriate action to mitigate conjunction risks for all conjunctions that meet conservative collision probability and miss distance thresholds. Furthermore, in the rare case that a SpaceX satellite is not able mitigate the risk of a conjunction, SpaceX makes every effort to coordinate with the secondary object owner/operator.
Collisions with Large Objects	
A statement that the space station operator has assessed and limited the probability of the space station becoming a source of debris by collisions with large debris or other operational space stations. *§ 25.114(d)(14)(iii), § 25.114(d)(14)(iv)*	SpaceX takes seriously the responsibility of deploying satellites into space and intends to lead the way in space sustainability, setting a positive example and continuing to evolve best practices for others to follow. Through detailed and conscientious mission planning, SpaceX has carefully assessed and limited the probability of its system becoming a source of debris by collisions with large debris or other operational space stations.
A demonstration that the space station operator has assessed and limited the probability of collision between any space station of the system and other large objects (10 cm or larger in diameter) during the total orbital lifetime of the space station, including any de-orbit phases, to less than 0.001 (1 in 1,000). The probability shall be calculated using the NASA Debris Assessment Software (DAS) or a higher fidelity assessment tool. To obtain DAS, one must request NASA's Debris Assessment Software. Please ensure ample time to receive DAS and that you are using the latest version of DAS. *§ 25.114(d)(14)(iv)(A)(1)*	SpaceX will assess and limit the probability of collision between its satellites and other large objects to ensure it remains below 0.001 during all mission phases. See table below showing DAS results.
The collision risk may be assumed zero for a space station during the period of time when	SpaceX confirms that it intends to perform collision avoidance procedures, including

the satellite or space station is able to effectively conduct avoidance maneuvers. As a guideline, effective avoidance maneuvers reduce the probability of collision (Pc) by at least 1.5 orders of magnitude from the mitigation threshold (recommended to be 1E-4) while not creating any additional conjunctions with a Pc value above the mitigation threshold. The NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook utilizes this metric and can serve as a useful resource. In individual cases where there is evidence that a particular system or operator is unable to effectively conduct avoidance maneuvers or is only maneuvering at a risk threshold that raises reasonable questions about its ability to meet the 0.001 collision risk threshold, this assumption will not be applied, and further analysis would be necessary. *§ 25.114(d)(14)(iv)(A)(1)*	conjunction assessment, execution of avoidance maneuvers, trajectory planning and conjunction assessment for any planned alteration of satellite trajectory, and notification to other potentially affected operators of any planned alteration of a trajectory. SpaceX will perform conjunction screening and avoidance maneuvers for all phases of operations, including any planned alteration of satellite trajectory, prior to passive disposal. SpaceX will observe a risk threshold of less than or equal to 0.001% (1e-5) as the trigger for a collision avoidance maneuver, which is an order of magnitude more conservative than industry standards and those suggested in NASA's Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook. All satellites will have sufficient propellant and capability to perform any avoidance maneuvers required for all phases of the mission from deployment to disposal. The collision risk for active satellites in the system may be assumed to be zero, as SpaceX's collision avoidance system mitigates conjunctions with collision probability above a maximum of 1e-5 with mitigation target at 1e-6 or lower.
If there is a planned tether deployment, an assessment of large object collision risk with the tether deployment, the impact on deorbit time, and a statement as to whether the tether can be retracted.	SpaceX’s satellite system will not deploy tethers.
Collisions with Small Objects	
A statement that the operator has assessed and limited the probability of the space station becoming a source of debris by collisions with small debris or meteoroids that could cause loss of control that would prevent post mission disposal. A statement	Rather than provide a lower-fidelity analysis using NASA’s Debris Assessment Software (“DAS”), SpaceX performs a higher-fidelity small debris collision risk assessment using the European Space Agency’s Debris Risk Assessment and

about whether this probability for an individual space station is 0.01 (1 in 100) or less, as calculated using the NASA DAS or a higher fidelity assessment tool. *§ 25.114(d)(14)(i), § 25.114(d)(14)(ii)*	Mitigation Analysis ("DRAMA") tool. Such submission is consistent with the Commission's rules that require applicants to state whether "the space station operator has assessed and limited the probability that the space station(s) will become a source of debris by collision with small debris or meteoroids that would cause loss of control and prevent disposal," indicating "whether this probability for an individual space station is 0.01 (1 in 100) or less, as calculated using the NASA Debris Assessment Software or a higher fidelity assessment tool." To provide a higher fidelity small object collision risk probability than NASA's DAS allows, SpaceX uses ESA's DRAMA to assess the collision probability of small debris rendering a satellite unable to complete planned disposal. SpaceX is applying a design criterion for its satellites that will keep the individual satellite small debris collision probability below 1e-4 over the design life of the satellite, which is two orders of magnitude below the Commission's requirement.
Proximity Operations	
Satellites conduct proximity operations when they are intentionally located or maneuvering near another spacecraft or other large objects in space. A statement disclosing planned proximity operations, if any, and addressing debris generation that will or may result from the proposed operations, including any planned release of debris, the risk of accidental explosions, the risk of accidental collision, and measures taken to mitigate those risks. *§ 25.114(d)(14)(vi)*	Satellites in SpaceX's system do not conduct proximity operations.
Debris Released and Intentional Breakup	

A statement that the space station operator has assessed and limited the amount of debris released in a planned manner during normal operation. *§ 25.114(d)(14)(i)*	SpaceX has assessed and eliminated any debris from being released during normal operations.
Where applicable, this statement must include an orbital debris mitigation disclosure for any separate deployment devices (such as rings or other deployment vehicles, sometimes referred to as "free-flyers," but not including launch vehicles) used to deploy the spacecraft. *§ 25.114(d)(14)(i)*	SpaceX's system will not use any separate deployment devices.
Explosion Risk and End of Life Passivation	
A statement that the operator has assessed and limited the probability of accidental explosions during and after the completion of mission operations. *§ 25.114(d)(14)(ii), § 25.114(d)(14)(iii)*	SpaceX has designed its satellites in a manner that limits the probability of accidental explosion. The key areas reviewed for this purpose include rupture of propellant tanks and batteries. The basic propulsion design, propulsion subsystem component construction, preflight verification through both proof testing and analysis, and quality standards have been designed to ensure a very low risk of tank failure. During the mission, batteries and various critical areas of the propulsion subsystem will be instrumented with fault detection, isolation, and recovery (similar or in many cases identical to flight-proven methods utilized onboard the SpaceX Dragon capsule for its missions to ISS) to continually monitor and preclude conditions that could result in the remote possibility of energetic discharge and subsequent generation of debris.
This statement must include a demonstration that debris generation will not result from the conversion of energy sources on board the spacecraft into energy that fragments the spacecraft. Energy sources include chemical, pressure, and kinetic energy. *§ 25.114(d)(14)(ii), § 25.114(d)(14)(iii).*	SpaceX has assessed and limited the probability of accidental explosions during mission operations by means of failure mode analysis confirmed by operating over 12,000 satellites over the course of 7 years with only two low-velocity debris generating events which have been

The Space Bureau generally will consider as sufficient a statement that the operator has assessed and limited the probability of accidental explosions during mission operations by means of a failure mode verification analysis or similar process.	thoroughly analyzed and additional mitigations have been developed and put into place.
This statement should address whether stored energy will be removed at the spacecraft's end of life, by depleting residual fuel and leaving all fuel line valves open, venting any pressurized system, leaving all batteries in a permanent discharge state, and removing any remaining source of stored energy, or through other equivalent procedures specifically disclosed in the application. *§ 25.114(d)(14)(ii), § 25.114(d)(14)(iii)*	SpaceX does not deplete energy sources prior to or during disposal because satellites are controlled to as low of an altitude as possible so its satellites can continue to perform collision avoidance risk mitigation maneuvers until just before atmospheric reentry starts.
A statement about whether the spacecraft will contain any liquids that if released either intentionally or unintentionally will persist in droplet form. In particular, the operator should identify any ionic liquids. If the operator identifies any such liquids that would not evaporate or sublimate if released, the statement should also address the length of time such liquid would remain in orbit, any natural processes that would result in dispersion of the droplets, how effectively the liquid is contained, and whether the propulsion system is shielded from micrometeoroid and debris strikes that may result in leakage are all relevant considerations and the type of information that could be included as part of this disclosure. *§ 25.114(d)(14)(iii)*	SpaceX's satellites do not contain liquids that if released will persist in droplet form.
Post-Mission Disposal	
A statement detailing the disposal plans for the space station, including the quantity of fuel, if any, that will be reserved for disposal maneuvers. *§ 25.114(d)(14)(iv), § 25.114(d)(14)(vii)*	SpaceX's satellites will retain enough propellant to lower for atmospheric reentry while conducting collision risk reduction maneuvers during transit.

For geostationary orbit space stations, the statement must disclose the altitude selected for a disposal orbit and the calculations that are used in deriving the disposal altitude. *§ 25.114(d)(14)(vii)(A)*	N/A
For space stations terminating operations in an orbit in or passing through the low- Earth orbit region below 2,000 km altitude, the statement must disclose whether the spacecraft will be disposed of through atmospheric re-entry, specifying if direct retrieval of the spacecraft will be used. The statement must also disclose the expected time in orbit for the space station following the completion of the mission. *§ 25.114(d)(14)(vii)(B).* Please note whether re-entry of the spacecraft will be completed as soon as practicable, but no later than five years following completion of the mission. *§ 25.114(d)(14)(vii)(D)(1).*	SpaceX plans to use atmospheric reentry for disposal.
For non-GSO satellites and satellites NOT terminating operations in an orbit in or passing through the low-Earth orbit region below 2,000 km altitude, the statement must indicate whether disposal will involve use of a storage orbit or long-term atmospheric re-entry and rationale for the selected disposal plan. *§ 25.114(d)(14)(vii)(C).*	N/A
For non-GSO satellites, a statement demonstrating that the probability of success of the chosen disposal method will be 0.9 or greater for any individual space station. For space station systems consisting of multiple space stations, the demonstration should include additional information regarding efforts to achieve a higher probability of success, with a goal, for large systems, of a probability of success for any individual space station of 0.99 or better. *§ 25.114(d)(14)(vii)(D)(1).*	SpaceX has demonstrated a greater than 99% planned disposal success probability for its satellites.
If at any time during the space station(s)' mission or de-orbit phase the space station(s)	SpaceX actively coordinates with both NASA and the Chinese Manned Space

will transit through the orbits used by any inhabitable spacecraft, including the ISS, the statement must describe the design and operational strategies, if any, that will be used to minimize the risk of collision and avoid posing any operational constraints to the inhabitable spacecraft. *§ 25.114(d)(14)(iv)(A)(3)*	Agency when its satellites transit through orbits used by ISS and CSS. SpaceX will continue to coordinate to ensure the safety of inhabited stations and spacecraft that visit inhabited stations.
A disclosure indicating whether the atmospheric re-entry will be an uncontrolled re-entry or a controlled targeted re-entry. *§ 25.114(d)(14)(vii)(D)(2)(i)*	In the unlikely case where a satellite a reenters due to early mission failure or atmospheric reentry is used for disposal, SpaceX will attempt controlled reentry, but the fallback will be an uncontrolled re-entry.
Atmospheric Re-Entry Hazard	
If planned disposal is by atmospheric re-entry, the statement must also include: An assessment as to whether portions of any individual spacecraft will survive atmospheric re-entry and impact the surface of the Earth with a kinetic energy in excess of 15 joules, and that the calculated casualty risk for an individual spacecraft using the NASA DAS or a higher fidelity assessment tool is less than 0.0001 (1 in 10,000). § 25.114(d)(14)(vii)(D)(2)(ii). If the estimated human casualty risk is not zero, applicants should address whether design-for-demise approaches as well as other measures like targeted re-entry away from landmasses to further reduce re-entry human casualty risk were considered.	SpaceX satellites are designed such that no components impacting the surface of the Earth will have kinetic energy > 15 joules and in many cases, components are designed to have < 3 joules of energy and therefore the human casualty risk for its satellites is zero.

DAS results for a 2,000 kg satellite with 300 m^2 area and a tumbling area-to-mass ratio of 0.075 using version 3.2.6 with 3/26/2026 Solar Flux Table.

Altitude (km)	Inclination (deg)	Passive Decay Time (days)	Passive Decay Large Debris PC
323	26	8.6	7.18E-05
323.5	32	8.8	7.23E-05

324	38	9.1	7.32E-05
324.5	43	9.3	7.39E-05
325	48	9.6	7.50E-05
325.5	53	9.8	7.61E-05
326	60	10.1	7.81E-05
326.5	69	10.3	8.19E-05
327	76	10.4	8.71E-05
327.5	96.9	10.2	9.47E-05
473	26	247.3	3.50E-04
473.5	32	252.1	3.74E-04
474	38	257.1	3.24E-04
474.5	43	262.0	3.45E-04
475	48	266.0	3.61E-04
475.5	53	270.4	3.84E-04
476	60	274.6	4.17E-04
476.5	69	277.9	4.67E-04
477	76	279.6	5.42E-04
477.5	96.9	272.2	5.88E-04

DAS results for a 2,500 kg satellite with 400 m^2 area and a tumbling area-to-mass ratio of 0.08 using version 3.2.6 with 3/26/2026 Solar Flux Table.

Altitude (km)	Inclination (deg)	Passive Decay Time (days)	Passive Decay Large Debris PC
323	26	8.1	9.57E-05
323.5	32	8.4	9.64E-05
324	38	8.6	9.76E-05
324.5	43	8.8	9.85E-05
325	48	9.0	1.00E-04
325.5	53	9.2	1.01E-04
326	60	9.4	1.04E-04
326.5	69	9.6	1.09E-04
327	76	9.8	1.16E-04
327.5	96.9	9.5	1.26E-04
473	26	233.0	4.12E-04
473.5	32	237.3	4.39E-04
474	38	242.3	4.60E-04
474.5	43	247.0	5.10E-04
475	48	250.8	5.46E-04
475.5	53	254.9	5.78E-04
476	60	258.8	5.13E-04
476.5	69	262.1	5.79E-04

477	76	263.9	6.64E-04
477.5	96.9	256.8	7.16E-04