Orbital Interference Report

1. Conclusions

An interference study considering all existing, proposed and prior coordinated microwave and satellite facilities within the frequency range proposed for the proposed satellite test bed in Herndon, VA demonstrated that the site will operate satisfactorily with other licensed in-band and adjacent systems based upon the operations noted in the results of Section 2.

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2. Summary and Results

Comsearch has performed an interference analysis for the frequency bands summarized in Table I. Orbital's experimental facility is located in Herndon, VA at Latitude: 39 00 56N and Longitude: 77 25 42W with ground elevation of 72.3m. It should be noted that the Orbital's experimental facility will operate at low power levels (worst case) as shown in Table I; also it should be noted that all transmissions will be performed inside the test facility in Herndon, which consist of a fully enclosed metallic building fitted with RF absorbing materials to reduce the RF levels. A conservative value of 70dB is used as the total attenuation between the metallic building and the absorbing material enclosing the transmitter and the receiver. Details of the technical parameters used and a complete analysis details are included in Section 3.

Based on the results of the studies no potential for interference is expected from the facility. The analysis shows that due to the relatively low power levels and the attenuation effects of the test enclosure and metallic building, the resulting power flux density will not cause interference to the environment operating in the frequency ranges shown in Table I.

Table I – Technical Summary of Transmission

Transmit Bands	Start Freq	Stop Freq	Power @ Amp (Watts)	Power @ Amp (dBm)	Losses to Antenna Feed (dB)	Power @ Antenna (dBW)	Antenna Gain (dBi)	ERP at Antenna (dBW)	ERP minus Absorber_Building (dBW)	Modulation	Modulation Rate (Hz)	De
Optus D1	12254.90	12747.10	150	51.76	2.5	19.26	35.15	54.41	-15.59	CW	N/A	
Optus D2	11702.50	12195.00	125	50.97	2.5	18.47	35.15	53.62	-16.38	CW	N/A	
PAS11	10682.00	11170.00	110	50.41	2.5	17.91	37.52	55.43	-14.57	CW	N/A	

Horizons	11702.00	12198.00	90	49.54	2	17.54	36.30	53.84	-16.16	CW	N/A	
Horizons	12024.00	120156.00	154	51.88	1.75	20.13	36.30	56.43	-13.57	CW	N/A	
Thor	11202.125	11447.875	55	47.40	2	15.40	38.40	53.80	-16.20	CW	N/A	
Thor	11768.52	12434.46	150	51.76	2	19.76	33.60	53.36	-16.64	CW	N/A	
MeaSat	12200	12500	120	50.79	2	18.79	38.40	57.19	-12.81	CW	N/A	
Receive Bands												
PAS11	12732.00	13974.00	0.01	10.00	10	-30.00	15.00	-15.00	-85.00	CW	N/A	
Horizons	14002.00	14498.00	0.01	10.00	10	-30.00	15.00	-15.00	-85.00	CW	N/A	
Thor	13002.125	13234.875	0.01	10.00	10	-30.00	15.00	-15.00	-85.00	CW	N/A	
Thor	17368.52	18034.46	0.01	10.00	10	-30.00	15.00	-15.00	-85.00	CW	N/A	
MeaSat	13750	14250	0.01	10.00	10	-30.00	15.00	-15.00	-85.00	CW	N/A	
Individual Frequencies												
CMD												
Optus D1	13986.5		0.01	10.00	10	-30.00	15	-15.00	-85.00	FM	N/A	4
Optus D1	13990.5		0.01	10.00	10	-30.00	15	-15.00	-85.00	FM	N/A	4
Optus D1	13994.5		0.01	10.00	10	-30.00	15	-15.00	-85.00	FM	N/A	4
PAS11	13246.5		0.01	10.00	10	-30.00	15.00	-15.00	-85.00	FM	N/A	4
PAS11	13995.5		0.01	10.00	10	-30.00	15.00	-15.00	-85.00	FM	N/A	4
Horizons	14000.5		0.01	10.00	10	-30.00	15.00	-15.00	-85.00	FM	N/A	4
Horizons	14499.5		0.01	10.00	10	-30.00	15.00	-15.00	-85.00	FM	N/A	4
Thor	13248.0		0.01	10.00	10	-30.00	15.00	-15.00	-85.00	FM	N/A	4
Thor	13249.5		0.01	10.00	10	-30.00	15.00	-15.00	-85.00	FM	N/A	4
MeaSat	14000.5		0.01	10.00	10	-30.00	15	-15.00	-85.00	FM	N/A	4
MeaSat	14499.5		0.01	10.00	10	-30.00	15	-15.00	-85.00	FM	N/A	4
TLM												
Optus D1	12243.25		10.9	40.37	6	4.37	3	7.37	-62.63	BPSK	4800	
Optus D1	12245.25		10.4	40.17	6	4.17	3	7.17	-62.83	BPSK	4800	
Optus D1	12749.5		1.15	30.61	3	-2.39	13	10.61	-59.39	CW	N/A	
PAS11	11448.0		10.5	40.21	5	5.21	3.00	8.21	-61.79	BPSK	4800	

PAS11	11449.0	10.5	40.21	5	5.21	3.00	8.21	-61.79	BPSK	4800
Horizons	12196.0000	10.5	40.21	5	5.21	3.00	8.21	-61.79	BPSK	4800
Horizons	12198.6250	10.5	40.21	5	5.21	3.00	8.21	-61.79	BPSK	4800
Horizons	12198.0000	1	30.00	3	-3.00	13.00	10.00	-60.00	CW	N/A
Horizons	11701.5000	1	30.00	3	-3.00	13.00	10.00	-60.00	CW	N/A
Thor	11701.0	10.5	40.21	5	5.21	3.00	8.21	-61.79	BPSK	4800
Thor	11702.0	10.5	40.21	5	5.21	3.00	8.21	-61.79	BPSK	4800
Thor	10949.5	1.15	30.61	3	-2.39	13	10.61	-59.39	CW	N/A
MeaSat	12196.0	10.5	40.21	5	5.21	3.00	8.21	-61.79	BPSK	4800
MeaSat	12198.6	10.5	40.21	5	5.21	3.00	8.21	-61.79	BPSK	4800

3. Detail Analysis

This section presents a detail interference analysis of each frequency band used at the test bed in Herndon, VA.

Horizons2 – Satellite Transmitter

Frequency: 11702.0 – 12198.0 MHz
Transmitter – Herndon, VA
Latitude: 39 00 56N Longitude: 77 25 42W
Gnd Elevation: 72.3m Antenna Center Line: 6.1m
Antenna: Satellite antenna looking straight into the sky

1. **Interference into Earth Station Receivers** - In the frequency range 11702.0 – 12198.0 MHz we did not find any Earth Station Receivers in a search radio of 3.6 km from the Comsearch Database. Based on the worst case calculation shown in Table I, we find that at 3.6 km the Receiver Signal Level (RSL) is -141.1 dBW at the earth station receiver (assuming a line-of-sight between the tested system and the earth station receiver). The RSL that we need to meet is -154dBW based on the ITU recommendation (ITU-R SF. 1006). The -154dBW is based on a 1MHz of bandwidth. We are short by 14 dB. Based on Comsearch database or the FCC database, we find an earth station with the Call Sign E000126 at 3.64km from the tested satellite. If we include propagation losses between the tested satellite and the earth station E000126 we find the losses to be much greater than 14 dB as shown in the file E000126SKE.tro and summarized in Table-II. Based on this calculation we note that the RSL threshold of the victim receiver is well above -166.4 dBW. Also, in these calculations we have not assumed any antenna discrimination for the satellite transmitter antenna gain even though that the satellite is looking straight into the sky. The conclusion is that the Tested transmitter will not cause any interference to the earth station Call Sign E000126 or any other earth station that is further away than earth station Call Sign E000126.

Table I – Without Over the Horizon Losses (OHLoss)

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
11702.0	3.6	19.54	2.0	36.3	0	70	-16.16	124.9	- 141.1

Table II – With Over the Horizon Losses (OHLoss)

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL dB	OHLoss (dB)	RSL@ input Ant (dBW)
11702.0	3.64	19.54	2.0	36.3	0	70	-16.16	125	25	- 166.2

Horizons2 – Earth Station Transmitter

Frequency: 14002.0 – 14498.0 MHz

Transmitter – Herndon, VA
Latitude: 39 00 56N
Longitude: 77 25 42W
Gnd Elevation: 72.3m
Antenna Center Line: 25m
Earth Station Transmitter: Earth Station Transmitter antenna looking straight down to the ground where the receiver satellite in test is located.

The 14002.0 – 14498.0 MHz frequency is the up-link frequency used from earth station to satellite communication.

Conclusion – It is noted from Table III that the interference power levels are no greater than -200.32 dBW and it is estimated will not cause interference to the satellites. Note also that we did not include any discrimination from the earth station transmitter antenna towards the satellites. We note that the Earth Station Transmitter antenna is looking straight down to the ground where the receiver satellite in test is located.

Table III – Earth Station Transmitter

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc. (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
14002.0	1	-20.00	10	15	0	70	-85	115.32	- 200.32
	10	-20.00	10	15	0	70	-85	135.32	- 220.32
	20	-20.00	10	15	0	70	-85	141.35	- 226.35
	100	-20.00	10	15	0	70	-85	155.32	-240.32

Horizons2 - Telemetry

Transmitter – Herndon, VA
Latitude: 39 00 56N
Longitude: 77 25 42W
Gnd Elevation: 72.3m
Antenna Center Line: 25m
Telemetry Transmitter: Telemetry Transmitter antenna looking straight down to the ground where the receiver satellite in test is located

Table IV - Telemetry

Telemetry	Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc. (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
	14000.5	10	-20	10	15	0	70	-85	135.3	-220.3
CMD1	14000.5	100	-20.00	10	15	0	70	-85	155.3	- 240.3
CMD2	14499.5	100	-20.00	10	15	0	70	-85	155.6	- 240.6

1. **Interference from Earth Station Telemetry to Satellites** – It is noted from Table IV that the interference power levels are no greater than -240.6 dBW at a distance of 100km. The RSL levels will decrease with distance and not cause interference to satellites in this band. Note also that we did not include any discrimination from the earth station transmitter antenna towards the satellites (which is looking down to the ground where the tested satellite is located) which will decrease the RSL level further.
2. **Interference from Earth Station Telemetry to MW links** – In this frequency band we did not find any MW link.

Horizons2 - Telemetry

Transmitter – Herndon, VA
Latitude: 39 00 56N Longitude: 77 25 42W
Gnd Elevation: 72.3m Antenna Center Line: 6.1m
Antenna: Telemetry Transmitter Satellite antenna looking straight into the sky

1. **Interference into Terrestrial Systems** – For the frequencies 12196, 12198.625, and 12198.0 MHz, we did not find any MW link in 45km from the Comsearch database. For the frequency 11701.5 we found a MW link in the frequency range 11620-11635 MHz at about 100m from the test site. The required interference level at the reference plane of the antenna of the MW receiver is about -139dBW of a 1MHz bandwidth (based on the ITU-R SF.1006). The assumptions made are as follows:
    a. Line of sight between the tested transmitter and victim receiver.
    b. We have not assumed any antenna discrimination for the satellite transmitter antenna gain.

    Conclusion - Based on this calculation in Table V, we note that the RSL at the input of the antenna of the victim receiver is very small and is concluded that signal levels of this magnitude could have negligible effects on the referenced terrestrial links.

Table V - Telemetry

Tele	Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
TLM1	12196.000	45	10.21	5	3	0	70	-61.79	147.2	-208.9
TLM2	12198.625	45	10.21	5	3	0	70	-61.79	147.2	-208.9
ULPC1	12198.000	45	0	3	13	0	70	-60.0	147.2	-207.2
ULPC2	11701.500	0.1	0	3	13	0	70	-60.0	93.8	-153.8

2. Interference into Earth Stations – In the frequency 11700.0 - 12200.0 MHz, we did not find any Earth Station Receivers in a search radius of 3km from the Comsearch Database. The assumptions made are as follows:

c. Line of sight between the tested transmitter and victim receiver.
d. We have not assumed any antenna discrimination for the satellite transmitter antenna gain.

Table VI

Tele	Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
TLM1	12196.000	3	10.21	5	3	0	70	-61.79	123.7	-185.5
TLM2	12198.625	3	10.21	5	3	0	70	-61.79	123.7	-185.5
ULPC1	12198.000	3	0	3	13	0	70	-60.0	123.7	-183.7
ULPC2	11701.500	3	0	3	13	0	70	-60.0	123.3	-183.7

Conclusion - Based on this calculation we note that the RSL at the input of the antenna of the victim receiver is very small and is concluded that signal levels of this magnitude could have negligible effects on the referenced earth station receiver. Using Table VI, at 3km we have a RSL of -183.7dBW which is well below the ITU-R SF.1006 recommendation of -154dBW of a 1MHz bandwidth.

MeaSat - Transmit

Frequency: 12200 – 12500 MHz

Transmitter – Herndon, VA

Latitude:	39 00 56N	Longitude:	77 25 42W
Gnd Elevation:	72.3m	Antenna Center Line:	6.1m

Antenna: Satellite antenna looking straight into the sky

1. **Interference into Microwave Links** - In the frequency range 12200 – 12500 MHz we did not find any Microwave Link in a search radius of 40km from the Comsearch Database. Based on the worst case calculation shown in Table I, we find that at 40 km the Receiver Signal Level (RSL) is – 159.0dBW at reference plane of the antenna (before the receiver antenna, assuming a line-of-sight between the tested system and the microwave receiver). Based on the ITU-R SF.1006 recommendation, the receiver threshold for digital MW systems is -139 dBW at reference plane of the antenna (before the receiver antenna). The -139dbW is based on a 1MHz of bandwidth. Therefore the RSL at the input of the victim MW receiver is -159dBW (see Table I) which is below the threshold level of -139dBW. In this calculation we have not assumed any antenna discrimination for the satellite transmitter antenna gain even though that the satellite is looking straight into the sky. The conclusion is that the Tested transmitter will not cause any interference to the terrestrial links.

Table I

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
12200	30	20.89	2	38.4	0	70	-12.81	143.70	- 156.5
	40	20.89	2	38.4	0	70	-12.81	146.20	- 159.0
	50	21.76	2.5	35.15	0	70	-15.59	148.11	- 163.7

2. **Interference into DirecTV or Echostar** – In the frequency range 12200 – 12500 GHz the service of DirecTV and Echostar is serving the Washington area. The locations of the receivers are not known therefore we assume as the DirecTV/Echostar receiver threshold for digital systems a -154 dBW (ITU-R SF. 1006) at reference plane of the antenna (before the receiver antenna). The -154dbW is based on a 1MHz of bandwidth.

   The assumptions made in the calculation of Table II are as follows:
   a. The attenuation of the metallic wall is 20 dB and the attenuation of the anechoic chamber is 50 dB with a total attenuation due to the building of 70dB.
   b. Direct LOS between the tested transmitter and victim receivers.
   c. The tested transmitter antenna is looking straight into the sky. The angle from the main beam to the victim receiver is greater than 60 degrees with an antenna discrimination of at least 35dB. In Table II, we are not using any antenna discrimination from the tested transmitter to the victim receiver (DirecTV or Echostar receiver).

   Conclusion – As seen from Table II for distances less than 0.5 km we will need 33 dB to avoid interference. If we consider the discrimination of the tested satellite transmitter towards the DirecTV or Echostar victim earth station receiver we note that at 60 degrees we have more than 35 dB of discrimination. Therefore, the conclusion is that the Tested transmitter will not cause any interference to the earth station receivers.

Table II - Optus D1
Transmit - Band 12.254 – 12.747 GHz

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
12200	0.5	20.79	2	38.4	0	70	-12.81	108.1	-120.91
	1	20.79	2	38.4	0	70	-12.81	114.1	-126.91
	5	20.79	2	38.4	0	70	-12.81	128.1	-143.72
	10	20.79	2	38.4	0	70	-12.81	134.1	- 146.91

MeaSat – Earth Station Transmitter

Frequency: 13750 – 14250 MHz

Transmitter – Herndon, VA
Latitude: 39 00 56N Longitude: 77 25 42W
Gnd Elevation: 72.3m Antenna Center Line: 25m
Earth Station Transmitter: Earth Station Transmitter antenna looking straight down to the ground where the receiver satellite in test is located.

The 13750 – 14250 MHz frequency is the up-link frequency used from earth station to satellite communication.

1. **Interference into Satellites** – It is noted from Table III that the interference power levels are no greater than -200.2 dBW and it is estimated will not cause interference to the satellites. Note also that we did not include any discrimination from the earth station transmitter antenna towards the satellites. We note that the Earth Station Transmitter antenna is looking straight down to the ground where the receiver satellite in test is located.
2. **Interference into MW links** – There are no MW links at least for the first 40km from the test site. Based on this calculation we note that the RSL at the victim receiver is very small and is concluded that signal levels of this magnitude could have negligible effects on the referenced terrestrial links.

Table III – Earth Station Transmitter

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc. (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
13750	1	-20.00	10	15	0	70	-85	115.2	- 200.2
	10	-20.00	10	15	0	70	-85	135.2	- 220.2
	20	-20.00	10	15	0	70	-85	141.2	- 226.2
	100	-20.00	10	15	0	70	-85	155.2	-240.2

MeaSat - Telemetry

Transmitter – Herndon, VA
Latitude: 39 00 56N
Longitude: 77 25 42W
Gnd Elevation: 72.3m
Antenna Center Line: 25m
Telemetry Transmitter: Telemetry Transmitter antenna looking straight down to the ground where the receiver satellite in test is located

Table IV - Telemetry

Telemetry	Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc. (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
	14000.5	10	-20	10	15	0	70	-85	135.3	-220.3
CMD1	14000.5	100	-20.00	10	15	0	70	-85	155.3	- 240.3
CMD2	14499.5	100	-20.00	10	15	0	70	-85	155.6	- 240.6

1. **Interference from Earth Station Telemetry to Satellites** – It is noted from Table IV that the interference power levels are no greater than -240.6 dBW at a distance of 100km. The RSL levels will decrease with distance and not cause interference to satellites in this band. Note also that we did not include any discrimination from the earth station transmitter antenna towards the satellites (which is looking down to the ground where the tested satellite is located) which will decrease the RSL level further.
2. **Interference from Earth Station Telemetry to MW links** – In this frequency band we did not find any MW link.

MeaSat - Telemetry

Transmitter – Herndon, VA
Latitude: 39 00 56N Longitude: 77 25 42W
Gnd Elevation: 72.3m Antenna Center Line: 6.1m
Antenna: Telemetry Transmitter Satellite antenna looking straight into the sky

3. **Interference into Terrestrial Systems** – For the frequencies 12196 and 12198.6 MHz, we did not find any MW link in 45km from the Comsearch database. The required interference level at the MW link based on the ITU-R SF.1006 is about -139dBW of a 1MHz bandwidth. . The assumptions made are as follows:
    a. Line of sight between the tested transmitter and victim receiver.
    b. We have not assumed any antenna discrimination for the satellite transmitter antenna gain.

    Conclusion - Based on this calculation in Table V, we note that the RSL at the input of the antenna of the victim receiver is very small and is concluded that signal levels of this magnitude could have negligible effects on the referenced terrestrial links.

Table V - Telemetry

Tele	Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
TLM1	12196.000	45	10.21	5	3	0	70	-61.79	147.2	-208.9
TLM2	12198.600	45	10.21	5	3	0	70	-61.79	147.2	-208.9

4. **Interference into Earth Stations** – In the frequency 11700.0 - 12200.0 MHz, we did not find any Earth Station Receivers in a search radius of 3km from the Comsearch Database. The assumptions made are as follows:
    a. Line of sight between the tested transmitter and victim receiver.
    b. We have not assumed any antenna discrimination for the satellite transmitter antenna gain.

Table VI

Tele	Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
TLM1	12196.000	3	10.21	5	3	0	70	-61.79	123.7	-185.5
TLM2	12198.600	3	10.21	5	3	0	70	-61.79	123.7	-185.5

Conclusion - Based on this calculation we note that the RSL at the input of the antenna of the victim receiver is very small and is concluded that signal levels of this magnitude could have negligible effects on the referenced earth station receiver. Using Table VI, at 3km we have a RSL of -183.7dBW which is well below the ITU-R SF.1006 recommendation of -154dBW of a 1MHz bandwidth.

OptusD1 - Transmit

Frequency: 12.254 – 12.747 GHz

Transmitter – Herndon, VA
Latitude: 39 00 56N
Longitude: 77 25 42W
Gnd Elevation: 72.3m
Antenna Center Line: 6.1m
Antenna: Satellite antenna looking straight into the sky

1. **Interference into Microwave Links** - In the frequency range 12.254 – 12.747 GHz we did not find any Microwave Link in a search radius of 40km from the Comsearch Database. Based on the worst case calculation shown in Table I, we find that at 40 km the Receiver Signal Level (RSL) is -122.39 dBW at the victim receiver (assuming a line-of-sight between the tested system and the microwave receiver). Based on this calculation we note that the RSL threshold of the victim receiver is well above -122.39 dBW. In this calculation we have not assumed any antenna discrimination for the satellite transmitter antenna gain even though that the satellite is looking straight into the sky. The conclusion is that the Tested transmitter will not cause any interference to the terrestrial links.
   Note: The victim receiver antenna gain used was 41.4dBi based on the antenna of the closest victim receiver (Antenna code A12420). The Call Sign for the victim link is WHH831 and WNTR246.

Table I

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)	Gr dBi	Disc@ 5deg (dB)	LLr	RSL (dBW)
12254.9	30	21.76	2.5	35.15	0	70	-15.59	143.70	- 159.29	41.4	0	2	-115.89
	40	21.76	2.5	35.15	0	70	-15.59	146.20	- 161.79	41.4	0	2	-122.39
	50	21.76	2.5	35.15	0	70	-15.59	148.14	- 163.73	41.4	0	2	-124.33

2. **Interference into DirecTV and Echostar** – In the frequency range 12.254 – 12.747 GHz the service of DirecTV and Echostar is serving the Washington area. The locations of the receivers are not known therefore we assume as the RCVR threshold for digital systems a -139 dBW (ITU-R SF. 1006) at reference plane of the antenna (before the receiver antenna). The -139dbW is based on a 1MHz of bandwidth.

   The assumptions made in the calculation of Table II are as follows:
   a. The attenuation of the metallic wall is 20 dB and the attenuation of the anechoic chamber is 50 dB with a total attenuation due to the building of 70dB.
   b. Direct LOS between the tested transmitter and victim receivers.
   c. The tested transmitter antenna is looking straight into the sky. The angle from the main beam to the victim receiver is greater than 60 degrees. In Table II, we are not using any antenna discrimination from the tested transmitter to the victim receiver (DirecTV or Echostar receiver).

   Conclusion – As seen from Table II for distances less than 0.5 km we will need 16dB to 22 dB to avoid interference. If we consider the discrimination of the tested transmitter towards the victim receiver we note that at 60 degrees we have more than 22 dB of discrimination.

Table II - Optus D1
Transmit - Band 12.254 – 12.747 GHz

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
12254.9	0.5	21.76	2.5	35.15	0	70	-15.59	108.14	-123.73
	1	21.76	2.5	35.15	0	70	-15.59	114.16	-130.08
	5	21.76	2.5	35.15	0	70	-15.59	128.14	-143.72
	10	21.76	2.5	35.15	0	70	-15.59	134.16	- 149.75
	20	21.76	2.5	35.15	0	70	-15.59	140.18	- 155.77
	30	21.76	2.5	35.15	0	70	-15.59	143.70	- 159.29
	40	21.76	2.5	35.15	0	70	-15.59	146.20	- 161.79
	50	21.76	2.5	35.15	0	70	-15.59	148.14	- 163.73

OptusD1 – Earth Station Transmitter

Frequency: 14002.9 – 14495.10 MHz

Transmitter – Herndon, VA
Latitude: 39 00 56N
Longitude: 77 25 42W
Gnd Elevation: 72.3m
Antenna Center Line: 25m
Earth Station Transmitter: Earth Station Transmitter antenna looking straight down to the ground where the receiver satellite in test is located.

The 14002.9 – 14495.10 MHz frequency is the up-link frequency used from earth station to satellite communication.

Conclusion – It is noted from Table III that the interference power levels are no greater than -200.32 dBW and it is estimated will not cause interference to the satellites. Note also that we did not include any discrimination from the earth station transmitter antenna towards the satellites. We note that the Earth Station Transmitter antenna is looking straight down to the ground where the receiver satellite in test is located.

Table III – Earth Station Transmitter

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc. (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
14002.9	1	-20.00	10	15	0	70	-85	115.32	- 200.32
	10	-20.00	10	15	0	70	-85	135.32	- 220.32
	20	-20.00	10	15	0	70	-85	141.35	- 226.35
	100	-20.00	10	15	0	70	-85	155.32	-240.32

Optus D1 - Telemetry

Transmitter – Herndon, VA
Latitude: 39 00 56N
Longitude: 77 25 42W
Gnd Elevation: 72.3m
Antenna Center Line: 25m
Telemetry Transmitter: Telemetry Transmitter antenna looking straight down to the ground where the receiver satellite in test is located

Table IV - Telemetry

Telemetry	Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc. (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
CMD1	13986.5	100	-20.00	10	15	0	70	-85	155.31	- 240.31
CMD2	13990.5	100	-20.00	10	15	0	70	-85	155.32	- 240.32
CMD3	13994.5	100	-20.00	10	15	0	70	-85	155.32	- 240.32

Conclusion – It is noted from Table III that the interference power levels are no greater than -240.31 dBW at a distance of 100km. The RSL levels will decrease with distance and not cause interference to satellites in this band. Note also that we did not include any discrimination from the transmitter antenna towards the satellites (which is looking down to the ground where the tested satellite is located) which will decrease the RSL level further.

OptusD1 - Telemetry

Transmitter – Herndon, VA
Latitude: 39 00 56N Longitude: 77 25 42W
Gnd Elevation: 72.3m Antenna Center Line: 6.1m
Antenna: Satellite antenna looking straight into the sky

1.Interference into Terrestrial Systems - In the frequency range 12.2 – 12.7 GHz, we did not find any Microwave Link in a search radius of 40km from the Comsearch Database. Also for the frequency 12749.5 MHz, we did not find any Microwave Link in a search radio of 5km from the Comsearch Database in the frequency range 12.7 – 13.25 GHz. The assumptions made are as follows:

d. Line of sight between the tested transmitter and victim receiver.
e. We have not assumed any antenna discrimination for the satellite transmitter antenna gain.

Conclusion - Based on this calculation we note that the RSL at the victim receiver is very small and is concluded that signal levels of this magnitude could have negligible effects on the referenced terrestrial links.

Note: At the frequencies 12243.25 and 12245.25, the victim receiver antenna gain used is 41.4dBi based on the antenna of the closest victim receiver at a distance below 50km (Antenna code A12420, the Call Sign for the victim link is WHH831 and WNTR246). The victim receiver antenna gain at frequency 12749.5 used is 48.8dBi based on the antenna of the closest victim receiver at a distance below 10km (Antenna code AA1103, the Call Sign for the victim link is WLY595 and HERNDO).

Table V - Telemetry

Tele	Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)	Gr	Disc@ 5deg (dB)	LLr	RSL (dBW)
TLM1&3	12243.25	40	10.37	6	3	0	70	-62.63	146.2	- 208.83	41.4	0	2	-165.4
TLM2	12245.25	40	10.17	6	3	0	70	-62.83	146.2	- 209.03	41.4	0	2	-169.6
UPC	12749.5	5	0.61	3	13	0	70	-59.39	128.5	- 187.9	48.8	0	2	-141.1

2.Interference into DirecTV and Echostar – In the frequency range 12.254 – 12.747 GHz the service of DirecTV and Echostar is serving the Washington area. The locations of the receivers are not known therefore we assume as the RCVR threshold for digital systems a -139 dBW (ITU-R SF. 1006) at reference plane of the antenna (before the receiver antenna). The -139dbW is based on a 1MHz of bandwidth.

The assumptions made in the calculation of Table-VI are as follows:

a. The attenuation of the metallic wall is 20 dB and the attenuation of the anechoic chamber is 50 dB with a total attenuation due to the building of 70dB.
b. Direct LOS between the tested transmitter and victim receivers.
c. The tested transmitter antenna is looking straight into the sky. The angle from the main beam to the victim receiver is greater than 60 degrees. In Table VI, we are not using any antenna discrimination from the tested transmitter to the victim receiver (DirecTV or Echostar receiver).

Conclusion – As seen from Table VI for distances less than 0.25 km the interference signal level is much lower than -139dBW required by the ITU-R SF.1006. Also, note that we have not used any antenna discrimination from the transmitter to the victim receiver. Therefore there is no interference cause to the victim receivers.

Table VI - Telemetry

Tele	Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc. @ 60deg (dB)	Build. &Absorber (dB) Loss	EIRP (dBW)	FSL (dB)	RSL @ input Ant (dBW)
TLM1&3	12243.25	0.25	10.37	6	3	0	70	-62.63	102.1	- 164.73
TLM2	12245.25	0.25	10.17	6	3	0	70	-62.83	102.1	- 164.73
UPC	12749.5	0.25	0.61	3	13	0	70	-59.39	102.5	- 161.86

OptusD2 - Transmit

Frequency: 11702.5 – 12195.0 MHz
Transmitter – Herndon, VA
Latitude: 39 00 56N Longitude: 77 25 42W
Gnd Elevation: 72.3m Antenna Center Line: 6.1m
Antenna: Satellite antenna looking straight into the sky

1. **Interference into Earth Station Receivers** - In the frequency range 11702.5 – 12195.0 MHz we did not find any Earth Station Receivers in a search radio of 3.6 km from the Comsearch Database. Based on the worst case calculation shown in Table I, we find that at 3.6 km the Receiver Signal Level (RSL) is -141.3 dBW at the reference plane of the earth station receiver antenna (assuming a line-of-sight between the tested system and the earth station receiver). The RSL that we need to meet is -154dBW based on the ITU recommendation (ITU-R SF. 1006). The -154dBW is based on a 1MHz of bandwidth. We are short by 14 dB. Based on Comsearch database or the FCC database, we find an earth station with the Call Sign E000126 at 3.64km from the tested satellite. If we include propagation losses between the tested satellite and the earth station E000126 we find the losses to be much greater than 14 dB as shown in the file E000126SKE.tro and summarized in Table-II. Based on this calculation we note that the RSL threshold of the victim receiver is well above -166.4 dBW. Also, in these calculations we have not assumed any antenna discrimination for the satellite transmitter antenna gain even though that the satellite is looking straight into the sky. The conclusion is that the Tested transmitter will not cause any interference to the earth station Call Sign E000126 or any other earth station that is further away than earth station Call Sign E000126.

Table I – Without Over the Horizon Losses (OHLoss)

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
11702.5	3.6	20.97	2.5	35.15	0	70	-16.38	124.9	- 141.28

Table II – With Over the Horizon Losses (OHLoss)

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL dB	OHLoss (dB)	RSL@ input Ant (dBW)
11702.5	3.64	20.97	2.5	35.15	0	70	-16.38	125	25	- 166.4

OptusD2 – Earth Station

Frequency: 17302.5 – 17795.0 MHz
Transmitter – Herndon, VA
Latitude: 39 00 56N Longitude: 77 25 42W
Gnd Elevation: 72.3m Antenna Center Line: 25m
Earth Station Transmitter: Earth Station Transmitter antenna looking straight down to the ground where the receiver satellite in test is located.

1. **Earth Station Transmitter into Satellites** - The 17302.5 – 17795.0 MHz frequency is the up-link frequency used from earth station to satellite communication.
   Conclusion – It is noted from Table III that the interference power levels are not greater than -211.32 dBW and it is estimated will not cause interference to the satellites. Note also that we did not include any discrimination from the transmitter antenna towards the satellites, which is looking down to the ground where the tested satellite is located.

2. **Interference into Microwave Links** - In the frequency range 17302.5 – 17795.0 MHz we did not find any Microwave Link Receivers in a search radio of 2.9 km from the Comsearch Database. Based on the worst case calculation shown in Table III, we find that at 2.9 km the Receiver Signal Level (RSL) is -211.4 dBW at the reference plane of the receiver MW antenna (assuming a line-of-sight between the tested system and the microwave receiver). Also, in these calculations we have not assumed any antenna discrimination for the earth station transmitter antenna gain even though that the earth station is looking straight down to the ground where the receiver satellite in test is located. The RSL that we need to meet is -133.55dBW based on the ITU recommendation (ITU-R SF. 1006). The -133.55dBW is based on a 1MHz of bandwidth. The conclusion is that the Tested transmitter will not cause any interference at the 17302.5 – 17795.0 MHz frequency

Table III – Earth Station Transmitter

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc. (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
17302.5	2.9	-20.00	10	15	0	70	-85	126.4	- 211.4
	50	-20.00	10	15	0	70	-85	151.1	- 236.1
	100	-20.00	10	15	0	70	-85	157.2	-242.2

Optus D2 - Telemetry

Transmitter – Herndon, VA
Latitude: 39 00 56N
Longitude: 77 25 42W
Gnd Elevation: 72.3m
Antenna Center Line: 25m
Telemetry Transmitter: Telemetry Transmitter antenna looking straight down to the ground where the receiver satellite in test is located

Table IV - Telemetry

Telemetry	Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc. (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
CMD1	13988.5	100	-20.00	10	15	0	70	-85	155.31	- 240.31
CMD2	13992.5	100	-20.00	10	15	0	70	-85	155.32	- 240.32
CMD3	13994.5	100	-20.00	10	15	0	70	-85	155.32	- 240.32

Conclusion – It is noted from Table IV that the interference power levels are no greater than -240.31 dBW at a distance of 100km. The RSL levels will decrease with distance and not cause interference to satellites in this band. Note also that we did not include any discrimination from the transmitter antenna towards the satellites (which is looking down to the ground where the tested satellite is located) which will decrease the RSL level further.

OptusD2 - Telemetry

Transmitter – Herndon, VA
Latitude: 39 00 56N Longitude: 77 25 42W
Gnd Elevation: 72.3m Antenna Center Line: 6.1m
Antenna: Satellite antenna looking straight into the sky

1.Interference into Terrestrial Systems - In the frequency range 12.2 – 12.7 GHz, we did not find any Microwave Link in a search radius of 40km from the Comsearch Database. The assumptions made are as follows:

a. Line of sight between the tested transmitter and victim receiver.
b. We have not assumed any antenna discrimination for the satellite transmitter antenna gain.

Conclusion - Based on this calculation we note that the RSL of -208.83 dBW at the reference plane of the victim MW receiver antenna is very small and is concluded that signal levels of this magnitude could have negligible effects on the referenced terrestrial links. Note also, that the RSL that we need to meet at the reference plane of the receiver MW antenna is -139dBW based on the ITU recommendation (ITU-R SF. 1006). The -139dBW is based on a 1MHz of bandwidth.

Table V - Telemetry

Tele	Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
TLM1&3	12243.25	40	10.37	6	3	0	70	-62.63	146.2	- 208.83
TLM2	12245.25	40	10.17	6	3	0	70	-62.83	146.2	- 209.03
UPC	12200.1	40	0.61	3	13	0	70	-59.39	146.2	- 205.59

2.Interference into DirecTV and Echostar – In the frequency range 12.254 – 12.747 GHz the service of DirecTV and Echostar is serving the Washington area. The locations of the receivers are not known therefore we assume as the RCVR threshold for digital systems a -154 dBW (ITU-R SF. 1006) at reference plane of the antenna (before the receiver antenna). The -154dbW is based on a 1MHz of bandwidth.

The assumptions made in the calculation of Table-VI are as follows:

c. The attenuation of the metallic wall is 20 dB and the attenuation of the anechoic chamber is 50 dB with a total attenuation due to the building of 70dB.
d. Direct LOS between the tested transmitter and victim receivers.
e. The tested transmitter antenna is looking straight into the sky. The angle from the main beam to the victim receiver is greater than 60 degrees. In Table VI, we are not using any antenna discrimination from the tested transmitter to the victim receiver (DirecTV or Echostar receiver).

Conclusion – As seen from Table VI for distances less than 0.25 km the interference signal level is much lower than -154dBW required by the ITU-R SF.1006. Also, note that we have not used any antenna discrimination from the transmitter to the victim receiver. Therefore there is no interference cause to the victim receivers.

Table VI - Telemetry

Tele	Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc. @ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL @ input Ant (dBW)
TLM1&3	12243.25	0.25	10.37	6	3	0	70	-62.63	102.1	- 164.73
TLM2	12245.25	0.25	10.17	6	3	0	70	-62.83	102.1	- 164.73
UPC	12200.1	0.25	0.61	3	13	0	70	-59.39	102.1	- 161.49

Pas11 - Transmit

Frequency: 10682 – 11170 MHz

Transmitter – Herndon, VA
Latitude: 39 00 56N
Longitude: 77 25 42W
Gnd Elevation: 72.3m
Antenna Center Line: 6.1m
Antenna: The transmitter Satellite antenna looking straight into the sky.

1. **Interference into Terrestrial Systems** - In the frequency range 10682 – 11170 MHz we did find in the Comsearch Database a Microwave Link (MW) at a distance 0.15 km away from the tested satellite transmitter. The MW link has the Call Sign WPQR467 – WPQR468 and belongs to Orbital Communications. Based on the ITU-R SF.1006 recommendation, we assume as the RCVR threshold for digital systems a -139 dBW at reference plane of the antenna (before the receiver antenna). The -139dbW is based on a 1MHz of bandwidth. Using the antenna pattern of the tested transmitter Satellite we find that the discrimination in the direction of the closest MW site is greater than 35dB at a discrimination angle of 60 degrees. Therefore the RSL at the input of the victim MW receiver is -143.6dBW (see Table I) which is below the threshold level of -139dBW. The conclusion is that the tested satellite transmitter will not cause any interference to the MW link.
   Note: Besides the MW link at a distance 0.15km from the tested transmitter, we did not find any other MW link in a radius of 7.3km.

Table I

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
10682	0.1	17.91	2.5	37.52	0	70	-14.57	93	- 107.6
	0.1	17.91	2.5	37.52	35	70	-50.59	93	- 143.6

2. **Interference into Earth Stations** – In the frequency range 10682 - 11170 MHz we did not find any earth station in this frequency range.

Pas11 – Earth Station Transmitter

Frequency: 12732.0 – 13974.0 MHz

Transmitter – Herndon, VA
Latitude: 39 00 56N
Longitude: 77 25 42W
Gnd Elevation: 72.3m
Antenna Center Line: 25m
Earth Station Transmitter: Earth Station Transmitter antenna looking straight down to the ground where the receiver satellite in test is located.

The 12732.0 – 13974.0 MHz frequency is the up-link frequency used for earth station to satellite communication.

1. **Interference from Earth Station to Satellites** – It is noted from Table II that the interference power levels are no greater than -200.32 dBW and it is estimated will not cause interference to the satellites. Note also that we did not include any discrimination from the transmitter antenna towards the satellites, which is looking down to the ground where the tested satellite is located.
2. **Interference from Earth Stations to Microwave (MW) Links** – Using the Comsearch Database we did not found any MW links at a radius less than 9km. Using Table II, at 9km the RSL is well below the ITU requirement of -139dBW for a 1MHz of bandwidth.

Table II – Earth Station Transmitter

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc. (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
12732	1	-20.00	10	15	0	70	-85	114.5	-199.5
	9	-20.00	10	15	0	70	-85	133.6	-218.6
	20	-20.00	10	15	0	70	-85	140.5	-225.5
	100	-20.00	10	15	0	70	-85	154.5	-239.5

Pas11 - Telemetry

Transmitter – Herndon, VA
Latitude: 39 00 56N
Longitude: 77 25 42W
Gnd Elevation: 72.3m
Antenna Center Line: 25m
Telemetry Transmitter: Telemetry Transmitter antenna looking straight down to the ground where the receiver satellite in test is located

Table III - Telemetry

Telemetry	Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc. (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
	13246.5	9	-20	10	15	0	70	-85	133.9	-218.9
CMD1	13246.5	100	-20.00	10	15	0	70	-85	154.8	- 239.8
CMD2	13995.5	100	-20.00	10	15	0	70	-85	155.3	- 240.3

1. **Interference from Earth Station Telemetry to Satellites** – It is noted from Table III that the interference power levels are no greater than -240.3 dBW at a distance of 100km. The RSL levels will decrease with distance and not cause interference to satellites in this band. Note also that we did not include any discrimination from the transmitter antenna towards the satellites (which is looking down to the ground where the tested satellite is located) which will decrease the RSL level further.
2. **Interference from Earth Station Telemetry to MW links** – In this frequency band we did not find any MW link at a distance of 9km from the Comsearch database. Using Table III, at 9km we have a RSL of -218.9 which is well below the ITU-R SF.1006 recommendation of -139dBW of a 1MHz bandwidth. The conclusion is that the tested earth station transmitter will not cause any interference to the MW links.

Pas11 - Telemetry

Transmitter – Herndon, VA
Latitude: 39 00 56N Longitude: 77 25 42W
Gnd Elevation: 72.3m Antenna Center Line: 6.1m
Antenna: Satellite antenna looking straight into the sky

1.Interference into Terrestrial Systems - In the frequency 11448.0 and 11449.0 MHz, we did not find any Microwave Link in a search radius of 3km from the Comsearch Database. The assumptions made are as follows:

a. Line of sight between the tested transmitter and victim receiver.
b. We have not assumed any antenna discrimination for the satellite transmitter antenna gain.

Conclusion - Based on this calculation we note that the RSL at the input of the antenna of the victim receiver is very small and is concluded that signal levels of this magnitude could have negligible effects on the referenced terrestrial links. Using Table IV, at 3km we have a RSL of -184.9dBW which is well below the ITU-R SF.1006 recommendation of -139dBW of a 1MHz bandwidth.

Table IV - Telemetry

Tele	Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorb (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
TLM1	11448.0	3	10.21	5	3	0	70	-61.79	123.1	-184.9
TLM2	11449.0	3	10.21	5	3	0	70	-61.79	123.1	-184.9

2. Interference into Earth Stations – In the frequency 11448.0 and 11449.0 MHz, we did not find any Earth Station Receivers in a search radius of 3km from the Comsearch Database. The assumptions made are as follows:

c. Line of sight between the tested transmitter and victim receiver.
d. We have not assumed any antenna discrimination for the satellite transmitter antenna gain.

Conclusion - Based on this calculation we note that the RSL at the input of the antenna of the victim receiver is very small and is concluded that signal levels of this magnitude could have negligible effects on the referenced earth station receiver. Using Table IV, at 3km we have a RSL of -184.9dBW which is well below the ITU-R SF.1006 recommendation of -154dBW of a 1MHz bandwidth.

ThorT1 - Transmit

Frequency: 11202.125 – 11447.875 MHz

Transmitter – Herndon, VA
Latitude: 39 00 56N
Longitude: 77 25 42W
Gnd Elevation: 72.3m
Antenna Center Line: 6.1m
Antenna: The transmitter Satellite antenna looking straight into the sky.

1. **Interference into Terrestrial Systems** - In the frequency range 11202.125 – 11447.875 MHz we did find in the Comsearch Database a Microwave Link (MW) at a distance 0.15 km away from the tested satellite transmitter. The MW link has the Call Sign WPQR467 – WPQR468 and belongs to Orbital Communications. The frequencies of operation of this MW link are : 11620.625 – 11635.625 and 11130.625 – 11145.625. As we could see the frequencies of operation of this link is outside of the frequencies required by the test transmitter satellite. The other MW links found in the Comsearch database in the frequency range 11202.125 – 11447.875 MHz are at a distance greater than 5km from the test site. At a distance of 5km the RSL at the reference plane of the MW antenna is -143.6 dBW. Based on the ITU-R SF.1006 recommendation, the receiver threshold for digital MW systems is -139 dBW at reference plane of the antenna (before the receiver antenna). The -139dbW is based on a 1MHz of bandwidth. Therefore the RSL at the input of the victim MW receiver is -143.6dBW (see Table I) which is below the threshold level of -139 dBW. The conclusion is that the tested satellite transmitter will not cause any interference to the MW link.

Table I

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
11202.125	5	17.40	2	38.40	0	70	-16.2	127.4	- 143.6

2. **Interference into Earth Stations** – In the frequency range 11202.125 – 11447.875 MHz we did not find any earth station in this frequency range.

ThorT1 – Earth Station Transmitter

Frequency: 13002.125 – 13234.875 MHz

Transmitter – Herndon, VA
Latitude: 39 00 56N
Longitude: 77 25 42W
Gnd Elevation: 72.3m
Antenna Center Line: 25m
Earth Station Transmitter: Earth Station Transmitter antenna looking straight down to the ground where the receiver satellite in test is located.

The 13002.125 – 13234.875 MHz frequency is the up-link frequency used for earth station to satellite communication.

1. **Interference from Earth Station to Satellites** – It is noted from Table II that the interference power levels are no greater than -199.7 dBW and it is estimated will not cause interference to the satellites. Note also that we did not include any discrimination from the transmitter antenna towards the satellites, which is looking down to the ground where the tested satellite is located.
2. **Interference from Earth Stations to Microwave (MW) Links** – Using the Comsearch Database we did not found any MW links at a radius less than 9km. Using Table II, at 9km the RSL of -218.8 is well below the ITU-R SF.1006 requirement of -139dBW for a 1MHz of bandwidth. The conclusion is that the tested earth station transmitter will not cause any interference to the MW links at a distance less than 9km.

Table II – Earth Station Transmitter

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc. (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
13002.125	1	-20.00	10	15	0	70	-85	114.7	-199.7
	9	-20.00	10	15	0	70	-85	133.8	-218.8
	20	-20.00	10	15	0	70	-85	140.7	-225.7
	100	-20.00	10	15	0	70	-85	154.7	-239.7

ThorT2&T3 - Transmit

Frequency: 11768.52 – 12434.46 MHz

Transmitter – Herndon, VA

Latitude:	39 00 56N	Longitude:	77 25 42W
Gnd Elevation:	72.3m	Antenna Center Line:	6.1m

Antenna: The transmitter Satellite antenna looking straight into the sky.

1. **Interference into Terrestrial Systems** - In the frequency range 11768.52 – 12434.46 MHz we did find in the Comsearch Database a Microwave Link (MW) at a distance 45 km away from the tested satellite transmitter. At a distance of 45km the RSL at the reference plane of the MW antenna is -163.54 dBW. Based on the ITU-R SF.1006 recommendation, the receiver threshold for digital MW systems is -139 dBW at reference plane of the antenna (before the receiver antenna). The -139dbW is based on a 1MHz of bandwidth. Therefore the interference RSL at the input of the victim MW receiver is -163.54dBW (see Table III) which is below the threshold level of -139dBW. The conclusion is that the tested satellite transmitter will not cause any interference to the MW link.

Table III

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
11768.52	2.9	21.76	2	33.6	0	70	-16.64	123.1	-139.7
11768.52	2.9	21.76	2	33.6	25	70	-41.64		-164.7
11768.52	45	21.76	2	33.6	0	70	-16.64	146.9	-163.54

2. **Interference into Earth Stations** – In the frequency range 11768.52 – 12434.46 MHz we did find in the Comsearch Database an Earth Station Receiver at a distance 2.9 km away from the tested satellite transmitter. At a distance of 2.9km the RSL at the reference plane of the earth station receiver antenna is – 139.7dBW. Base on the ITU-R SF.1006 recommendation, the receiver threshold for digital ES systems is -154 dBW at reference plane of the antenna (before the receiver antenna). The -154dbW is based on a 1MHz of bandwidth. To meet the ITU recommendation we need 15dB. If we assume the satellite antenna discrimination to the victim earth station receiver, we find that the discrimination angle is greater than 60 degrees which make a discrimination value greater than 25dB. As seen from Table III, using a 25 dB of discrimination the RSL level at the reference plane of the victim earth station receiver is -164.7 which is well below the -154dBW required by the ITU recommendation. The conclusion is that the tested satellite transmitter will not cause any interference to the victim earth station.

ThorT2&T3 – Earth Station Transmitter

Frequency: 17368.52 – 18034.46 MHz

Transmitter – Herndon, VA
Latitude: 39 00 56N Longitude: 77 25 42W
Gnd Elevation: 72.3m Antenna Center Line: 25m
Earth Station Transmitter: Earth Station Transmitter antenna looking straight down to the ground where the receiver satellite in test is located.

The 17368.52 – 18034.46 MHz frequency is the up-link frequency used for earth station to satellite communication.

1. **Interference from Earth Station to Satellites** – It is noted from Table IV that the interference power levels are no greater than -202.2 dBW and it is estimated will not cause interference to the satellites. Note also that we did not include any discrimination from the transmitter earth station antenna towards the satellites. The Earth Station transmitter antenna is looking straight down to the ground where the receiver satellite in test is located.
2. **Interference from Earth Stations to Microwave (MW) Links** – Using the Comsearch Database we did not found any MW links at a radius less than 2.9km. Using Table IV, at 2.9km the RSL of -211.4 is well below the ITU-R SF.1006 requirement of -139dBW for a 1MHz. The conclusion is that the tested earth station transmitter will not cause any interference to the MW links at a distance less than 2.9km.

Table IV – Earth Station Transmitter

Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc. (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
17368.52	1	-20.00	10	15	0	70	-85	117.2	-202.2
	2.9	-20.00	10	15	0	70	-85	126.4	-211.4
	10	-20.00	10	15	0	70	-85	137.2	-222.2
	20	-20.00	10	15	0	70	-85	143.2	-228.2
	100	-20.00	10	15	0	70	-85	157.2	-242.2

Thor - Telemetry

Transmitter – Herndon, VA
Latitude: 39 00 56N
Longitude: 77 25 42W
Gnd Elevation: 72.3m
Antenna Center Line: 25m
Telemetry Transmitter: Telemetry Transmitter antenna looking straight down to the ground where the receiver satellite in test is located

Table V - Telemetry

Telemetry	Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc. (dB)	Build. &Absorbers (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
	13248.0	9	-20.00	10	15	0	70	-85	133.9	-218.9
CMD1	13248.0	100	-20.00	10	15	0	70	-85	154.8	- 239.8
CMD2	13249.5	100	-20.00	10	15	0	70	-85	154.8	- 239.8

1. **Interference from Earth Station Telemetry to Satellites** – It is noted from Table V that the interference power levels are no greater than -239.8 dBW at a distance of 100km. The RSL levels will decrease with distance and not cause interference to satellites in this band. Note also that we did not include any discrimination from the transmitter antenna towards the satellites (which is looking down to the ground where the tested satellite is located) which will decrease further the RSL level.
2. **Interference from Earth Station Telemetry to MW links** – In this frequency band we did not find any MW link at a distance of 9km from the Comsearch database. Using Table V, at 9km we have a RSL of -218.9 which is well below the ITU-R SF.1006 recommendation of -139dBW of a 1MHz bandwidth. The conclusion is that the tested earth station transmitter will not cause any interference to the MW links.

Thor - Telemetry

Transmitter – Herndon, VA
Latitude: 39 00 56N Longitude: 77 25 42W
Gnd Elevation: 72.3m Antenna Center Line: 6.1m
Antenna: Satellite antenna looking straight into the sky

1. **Interference into Terrestrial Systems** - We did not find any Microwave Link in a search radius of 7km from the Comsearch Database operating at the frequencies 11701.0, 11702.0 and 10949.5 MHz. The assumptions made are as follows:
    a. Line of sight between the tested transmitter and victim receiver.
    b. We have not assumed any antenna discrimination for the satellite transmitter antenna gain.

    Conclusion - Based on this calculation we note that the RSL at the input of the antenna of the victim receiver is very small and is concluded that signal levels of this magnitude could have negligible effects on the referenced terrestrial links. Using Table VI, at 7km we have a RSL of -189.5dBW which is well below the ITU-R SF.1006 recommendation of -139dBW of a 1MHz bandwidth.

Table VI - Telemetry

Tele	Freq. (MHz)	d (km)	Pt (dbW)	LLt (dB)	Gt (dBi)	Disc.@ 60deg (dB)	Build. &Absorb (dB) Loss	EIRP (dBW)	FSL (dB)	RSL@ input Ant (dBW)
TLM1	11701.0	7	10.21	5	3	0	70	-61.79	130.7	-192.5
TLM2	11702.0	7	10.21	5	3	0	70	-61.79	130.7	-192.5
UPC1	10949.5	7	0.61	3	13	0	70	-59.39	130.1	-189.5
TLM1	11701.0	3	10.21	5	3	0	70	-61.79	123.3	-185.1
TLM2	11702.0	3	10.21	5	3	0	70	-61.79	123.3	-185.1
UPC1	10949.5	3	0.61	3	13	0	70	-59.39	122.7	-182.1

2. **Interference into Earth Stations** – We did not find any Earth Station Receivers in a search radius of 2.8km from the Comsearch Database operating at the frequencies 11701, 11702, and 10949.5 MHz. The assumptions made are as follows:
    c. Line of sight between the tested transmitter and victim receiver.
    d. We have not assumed any antenna discrimination for the satellite transmitter antenna gain.

Conclusion - Based on this calculation we note that the RSL at the input of the antenna of the victim receiver is very small and is concluded that signal levels of this magnitude could have negligible effects on the referenced earth station receiver. Using Table VI, at 3km we have a RSL of -182.1dBW which is well below the ITU-R SF.1006 recommendation of -154dBW of a 1MHz bandwidth radio.