EXHIBIT 2

Exhibit 2 – Technical Exhibit
V3 VMES Terminal

1. Introduction

KVH Industries, Inc. ("KVH") has developed a small aperture, broadband, highly efficient and affordable terminal that can be used in the vehicle-mounted earth station ("VMES") context with its global mobile communications network. This VMES – the KVH TracPhone V3 Land terminal (the "V3") – operates in Ku-band FSS frequencies (14.0-14.5 GHz transmit, 11.7-12.2 GHz receive, 10.95-11.2 GHz and 11.45-11.7 GHz receive). The V3 terminal will automatically search for and acquire the designated satellite, and maintain precise pointing via automatic control of the azimuth, elevation and polarization angles.

The antenna being used in this VMES terminal is 14.5" (37 cm) in diameter, and its main lobe does not conform to the standards specified in Section §25.209(a) and (b). In order to compensate for this performance, KVH will operate with a spread spectrum modulation technique that will bring the off-axis EIRP spectral density of the terminal well within the spectral density limits specified in Section §25.226 of the Commission's rules. This technical exhibit provides the showing required pursuant to Section §25.226, including detailed information regarding the VMES antenna patterns and off-axis emissions, and a summary of the remote VMES to hub link analysis.

2. Description of Antenna

KVH has developed the small aperture, broadband, highly efficient and affordable V3 VMES terminal for use with its global VMES network. The VMES terminal operates in the Ku FSS frequency band, 14.0-14.5 GHz transmit and 10.95-11.2 GHz, 11.45-11.7 GHz and 11.7-12.2 GHz receive. The antenna is a 37 cm parabolic reflector with a rear-fed sub-reflector feed assembly design. The VMES terminal will automatically search for and acquire the designated satellite and maintain precise pointing via automatic control of the azimuth, elevation and polarization angles. The RF equipment is integrated into the base of the terminal and includes a 3 watt block upconverter.

The proposed VMES uplink return transmission (inbound) channel supports data rates of 32 kbit/s, 64 kbit/s, 128 kbit/s, 256 kbit/s, and 512 kbit/s. The VMES uplink transmission utilizes a spread spectrum modulation. This authorization will require channel bandwidths of 18 MHz and 36 MHz. The forward channel (outbound from the hub earth station to the VMES) will be between 3-10 Mbits/s aggregate with individual end user rates at 0.5-2Mbit/s. The forward channel is also spread over the 18 MHz or 36 MHz channel and is overlaid onto the same transponder spectrum using a technique called PCMA.[1]

[1] Paired Carrier Multiple Access is a proprietary technique developed by ViaSat for their spread spectrum ArcLight service.

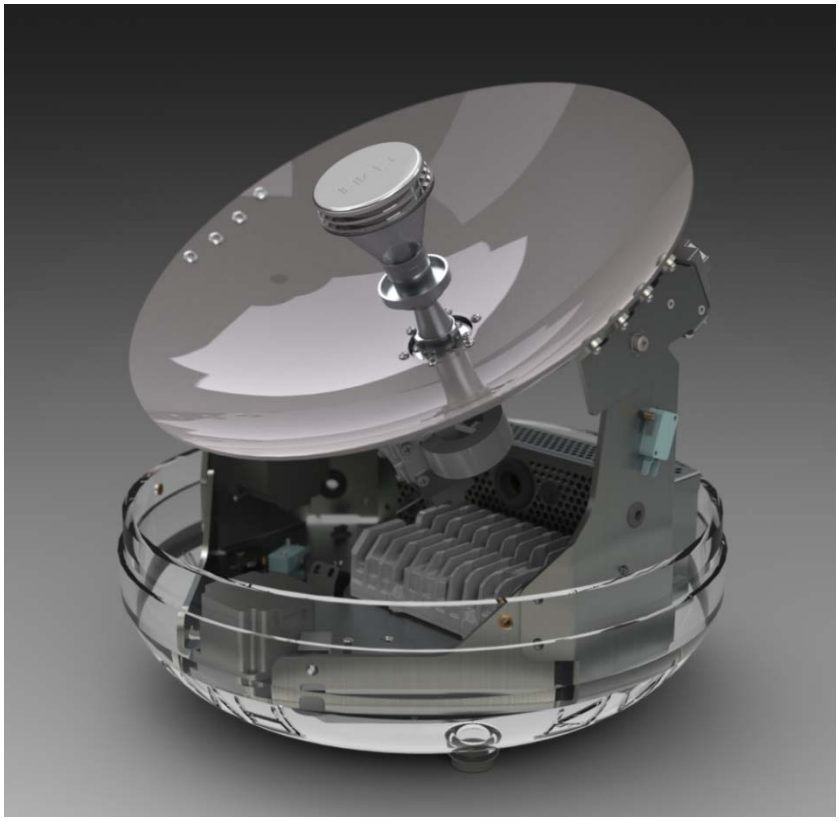

Figure 1 - KVH 37 cm Ku-band antenna

3. Description of Service

As is shown in Figure 2 below, the V3 terminal will be operated within KVH's existing broadband mobile services network authorized for maritime service.[2] Indeed, the V3 terminal was recently licensed by the Commission as a Ku-band earth station onboard vessel ("ESV").[3] KVH is seeking authorization to operate within the continental United States (CONUS), Alaska and Hawaii, as well as U.S. territories and possessions.

KVH would like to operate the terminals with ALSAT (including specifically AMC-15 @ 105° W.L., AMC-21 @ 125º W.L. and GE-23 @ 172º E.L.), as well as in extended Ku-band downlink frequencies with GE-23. The VMESs will communicate using existing hub earth stations in Miami, Florida, Carlsbad, California, and Kapolei, Hawaii.[4] KVH will control all V3 operations using its standard network control capabilities and network management services based in Carlsbad, CA. Additionally, since this service will operate under the control of the KVH VMES network operations center, there will be

[2] *See* File No. SES-LIC-20081104-01450 (Call Sign E090001).

[3] *Id.*

[4] Call Signs E040267, E030131 and E010236, respectively.

a record of the VMES's location and operating parameters as specified in Section 25.226(a)(6).

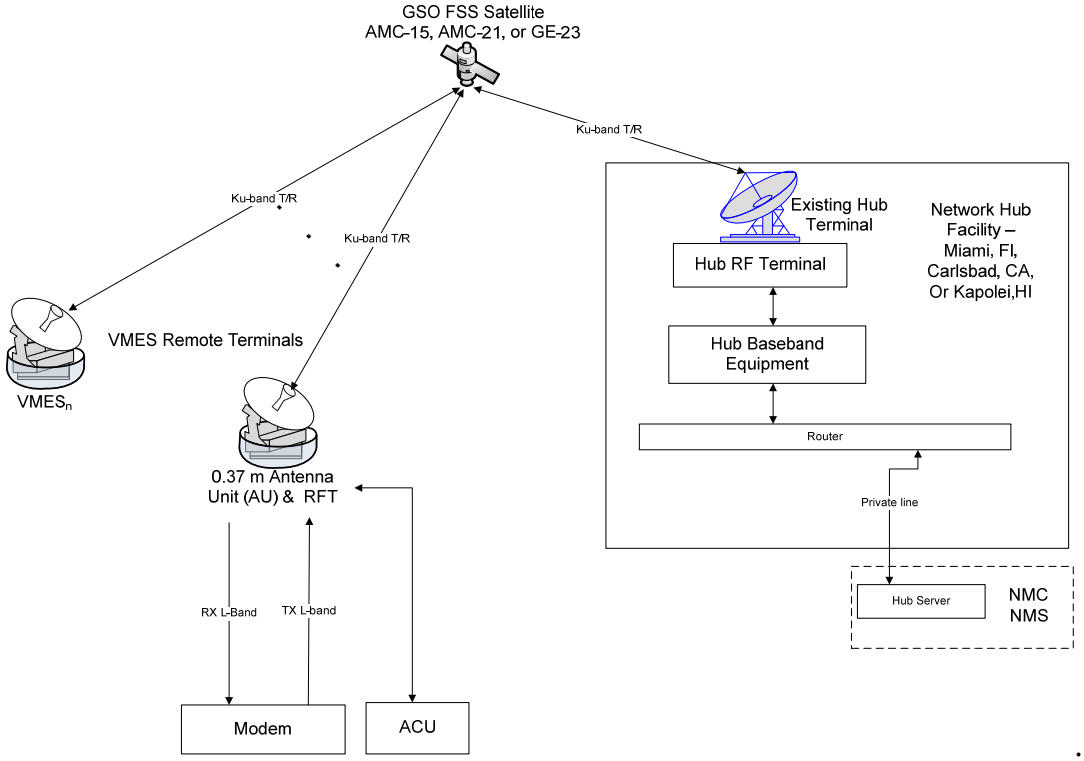

Figure 2 – VMES Network Architecture

The VMES terminal will operate in compliance with KVH's coordination agreement with the National Science Foundation with respect to Radio Astronomy Service ("RAS") sites and will not operate within 125 km of the Tracking and Data Relay Satellite System (TDRSS) sites for space research conducted at White Sands, New Mexico and the U.S. Naval Research Lab at Blossom Point, Maryland.[5]

4. Off-Axis EIRP Analysis

The data rates transmitted from the terminal will vary from 32 kbits/s to 512 kbits/s. Additionally, the VMESs will transmit using CRMA spreading[6] over either an 18 MHz

[5] *See* Coordination Agreement with the National Science Foundation, submitted with a letter dated November 20, 2008 in IBFS File No. SES-LIC-20081104-01450 (being expanded to cover VMES operations subject to the same technical limitations applicable to ESV operations). KVH will accept technical limitations imposed on other Ku-band VMES operations necessary to protect TDRSS operations. *See* 47 C.F.R. § 25.226(c).

[6] CRMA, or Code Reuse Multiple Access, is a ViaSat proprietary spread spectrum technique, similar to CDMA, used in the ArcLight satellite system.

channel bandwidth or a 36 MHz channel bandwidth. KVH acknowledges that the small diameter V3 antenna does not meet the FCC 25.209 antenna pattern. However, KVH certifies that the aggregate EIRP levels do not exceed the limits specified for Ku-band VMESs in Section 25.226 of the Commission's rules. The co-pol off-axis EIRP spectral density levels of the KVH VMES terminal are shown in Figures 3 through 6 below. Note that a calculated worst case aggregate EIRP occurs when N=13 users for the 36 MHz channel and when N=6 users for the 18 MHz channel. Figure 7 below shows the V3 worst case cross-pol off-axis EIRP density plots versus the FCC §25.226 mask.

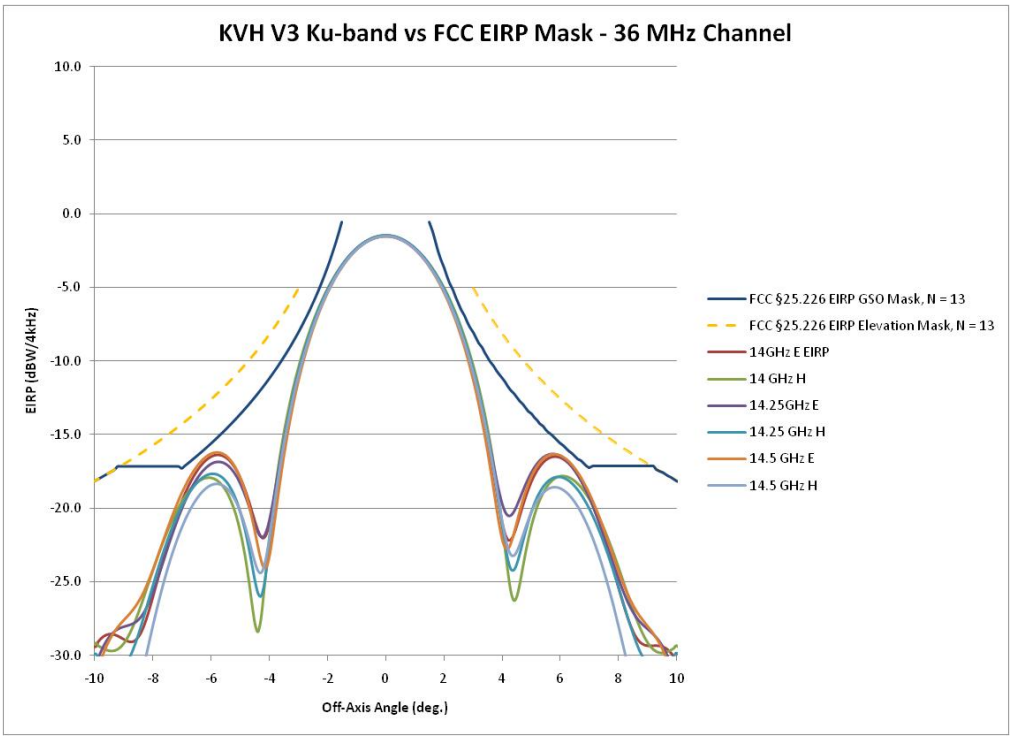

Figure 3 - V3 Off-Axis EIRP Spectral Density – 36 MHz Channel

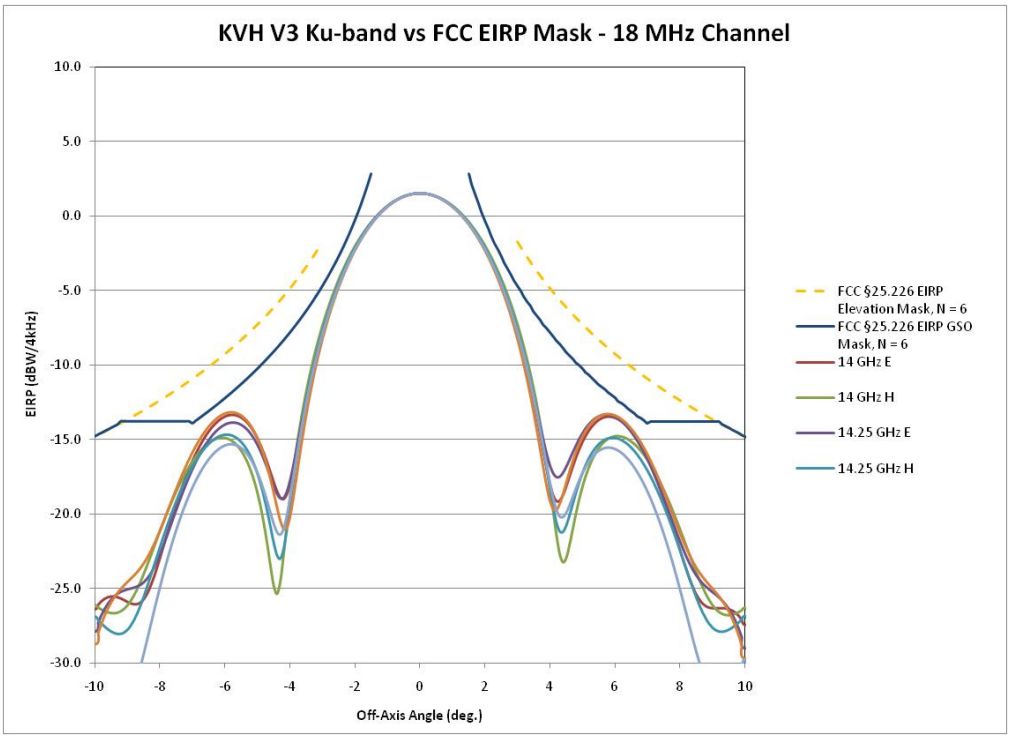

Figure 4 - V3 Off-Axis EIRP Spectral Density – 18 MHz Channel

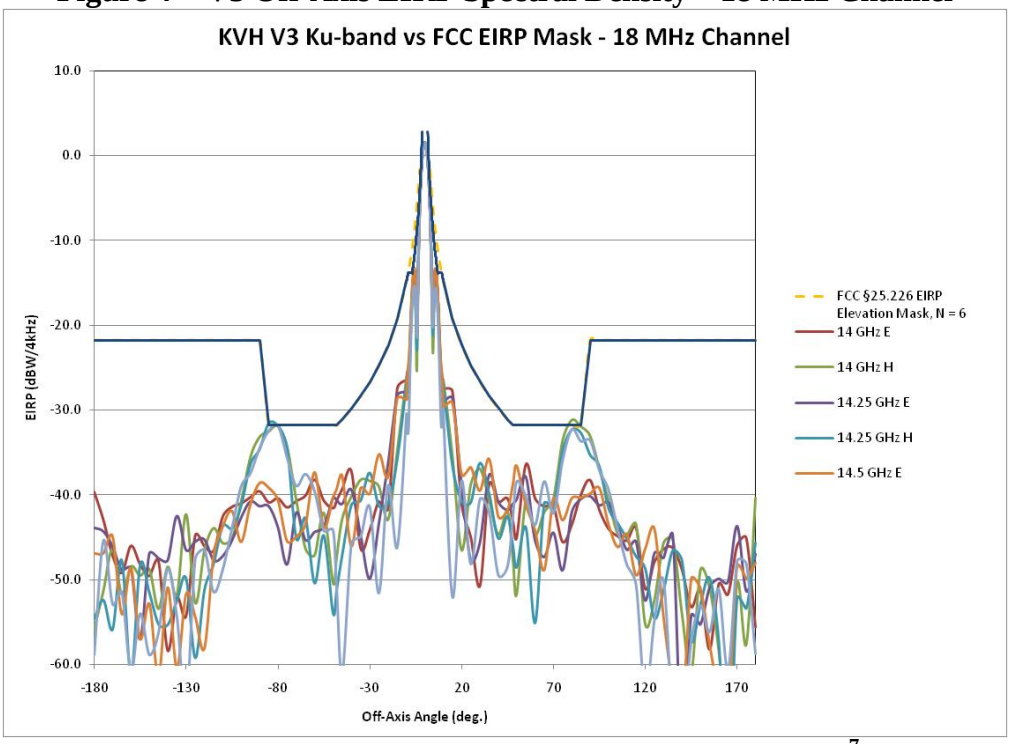

Figure 5 – 18 MHz Off-Axis EIRP Spectral Density[7]

[7] EIRP envelope exceeds mask by as much as 1.55 dB between -75 to -85 degrees and +75 to 85 degrees, <5.7% of sidelobes. Per FCC §25.226(a)(1)(i)(A) for angles greater than 7.0°, the envelope may be exceeded by no more than 10% of the sidelobes, provided no individual sidelobe exceeds the envelope given above by more than 3 dB.

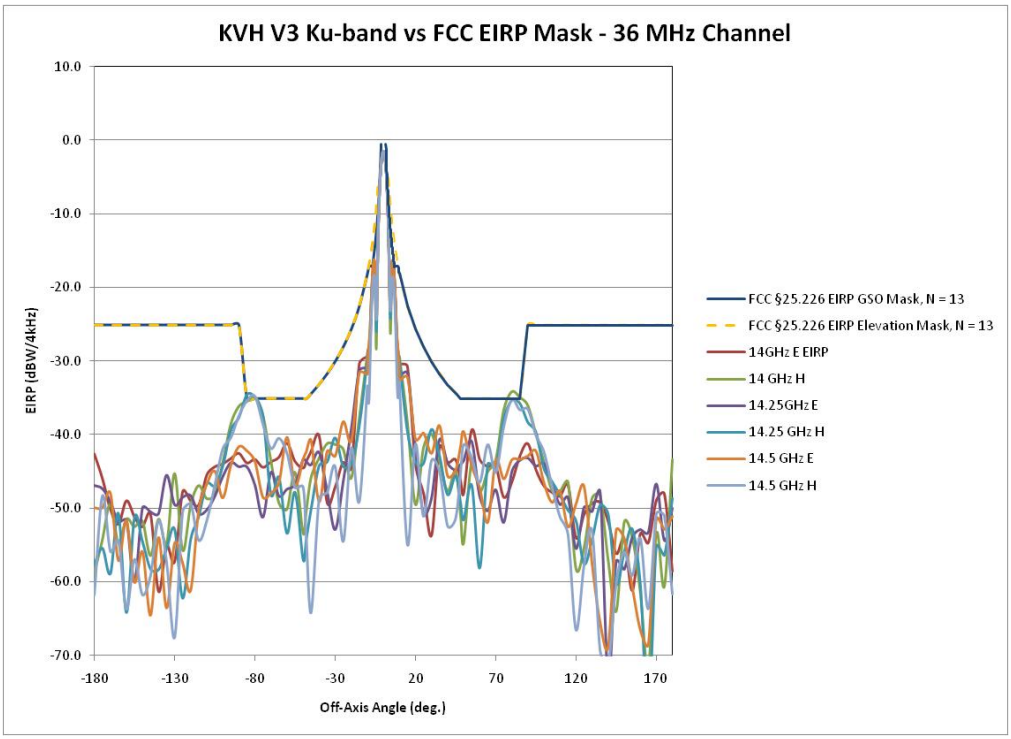

Figure 6 – 36 MHz Channel Off-Axis EIRP Spectral Density

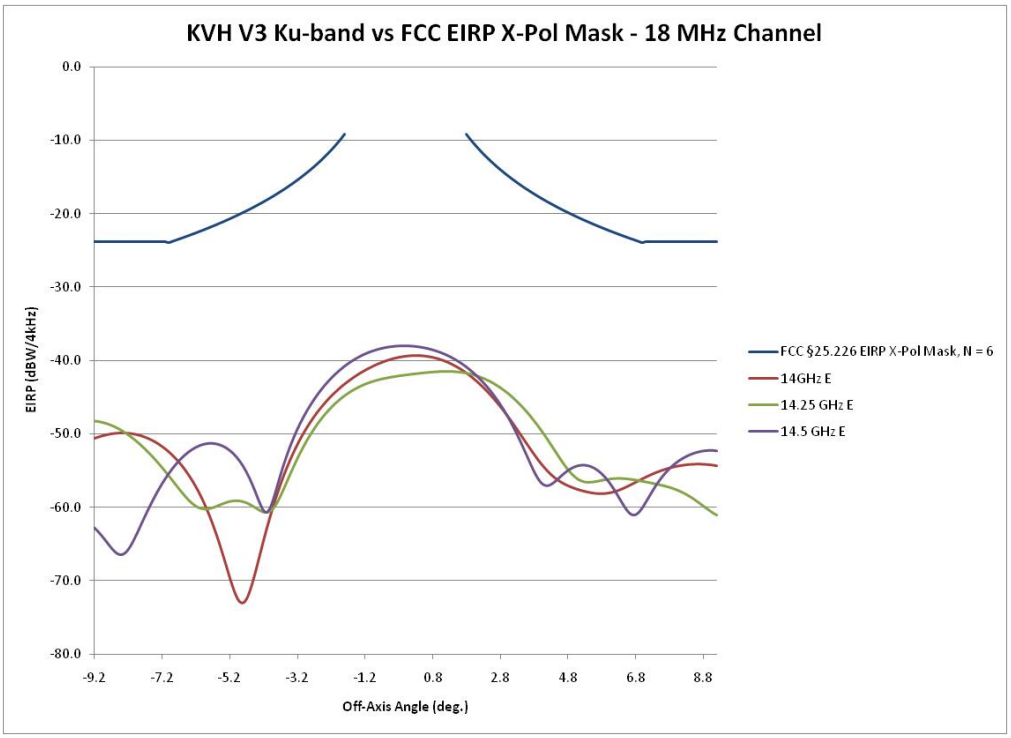

Figure 7 – 18 MHz Channel Cross-Pol Off-Axis EIRP Spectral Density

Per § 25.226(b)(1)(i), Table 1 below provides the co-pol the E and H plane antenna patterns for the parabolic antenna, as well as the E and H plane EIRP charts, and the FCC GSO and Elevation masks. Table 2 below provides the X-Pol E and H plane antenna gain and EIRP charts versus the FCC mask.

Table 1	Antenna Gain (dBi)									VMES EIRP (dBW/4 kHz)							
Off-Axis Angle	14 GHz E	14 GHz H	14.25 GHz E	14.25 GHz H	14.5 GHz E	14.5 GHz H	Off-Axis Angle	FCC §25.209	FCC §25.226 EIRP GSO Mask, N = 6	FCC §25.226 EIRP Elevation Mask, N = 6	14 GHz E	14 GHz H	14.25 GHz E	14.25 GHz H	14.5 GHz E	14.5 GHz H	Meets Mask
-180	-7.9	-24.1	-12.1	-22.8	-15.1	-27.0	-180	0.0	-21.8	-21.8	-39.6	-55.8	-43.9	-54.6	-46.9	-58.8	Y
-175	-11.2	-19.5	-12.5	-20.7	-15.1	-13.6	-175	0.0	-21.8	-21.8	-43.0	-51.3	-44.3	-52.4	-46.9	-45.3	Y
-170	-15.4	-14.6	-14.3	-24.1	-13.2	-21.1	-170	0.0	-21.8	-21.8	-47.1	-46.3	-46.1	-55.9	-44.9	-52.8	Y
-165	-17.4	-19.9	-17.1	-15.9	-22.3	-19.7	-165	0.0	-21.8	-21.8	-49.2	-51.7	-48.9	-47.7	-54.1	-51.4	Y
-160	-14.2	-16.7	-16.9	-29.4	-16.9	-29.0	-160	0.0	-21.8	-21.8	-46.0	-48.4	-48.6	-61.2	-48.6	-60.7	Y
-155	-16.4	-17.7	-25.2	-16.5	-25.2	-22.2	-155	0.0	-21.8	-21.8	-48.2	-49.5	-57.0	-48.3	-57.0	-53.9	Y
-150	-17.8	-17.0	-15.1	-19.8	-21.1	-27.0	-150	0.0	-21.8	-21.8	-49.6	-48.8	-46.9	-51.5	-52.9	-58.8	Y
-145	-16.0	-21.7	-15.7	-23.5	-29.7	-24.5	-145	0.0	-21.8	-21.8	-47.8	-53.4	-47.4	-55.3	-61.5	-56.2	Y
-140	-26.6	-16.7	-15.9	-23.6	-19.2	-16.9	-140	0.0	-21.8	-21.8	-58.3	-48.5	-47.7	-55.4	-50.9	-48.7	Y
-135	-20.4	-20.0	-10.7	-20.7	-28.7	-22.5	-135	0.0	-21.8	-21.8	-52.1	-51.8	-42.5	-52.5	-60.5	-54.3	Y
-130	-22.5	-10.5	-14.7	-18.1	-20.0	-32.8	-130	0.0	-21.8	-21.8	-54.3	-42.3	-46.5	-49.9	-51.7	-64.6	Y
-125	-13.0	-21.0	-13.7	-27.5	-22.7	-15.7	-125	0.0	-21.8	-21.8	-44.8	-52.7	-45.5	-59.2	-54.4	-47.5	Y
-120	-14.3	-14.8	-13.5	-19.5	-26.3	-14.6	-120	0.0	-21.8	-21.8	-46.0	-46.5	-45.2	-51.2	-58.1	-46.4	Y
-115	-14.8	-12.1	-15.9	-16.4	-15.4	-19.6	-115	0.0	-21.8	-21.8	-46.6	-43.9	-47.7	-48.1	-47.1	-51.4	Y
-110	-10.8	-13.9	-15.4	-11.9	-11.9	-16.9	-110	0.0	-21.8	-21.8	-42.5	-45.7	-47.2	-43.6	-43.7	-48.7	Y
-105	-9.6	-13.4	-13.6	-12.2	-10.2	-12.1	-105	0.0	-21.8	-21.8	-41.4	-45.1	-45.3	-44.0	-41.9	-43.9	Y
-100	-9.2	-9.0	-10.9	-9.5	-13.8	-7.2	-100	0.0	-21.8	-21.8	-41.0	-40.8	-42.7	-41.3	-45.6	-38.9	Y
-95	-8.5	-3.8	-9.0	-4.7	-9.4	-5.7	-95	0.0	-21.8	-21.8	-40.3	-35.6	-40.8	-36.4	-41.1	-37.4	Y
-90	-7.8	-1.4	-9.5	-2.9	-6.9	-2.7	-90	0.0	-21.8	-21.8	-39.6	-33.2	-41.3	-34.7	-38.6	-34.5	Y
-85	-9.1	-0.7	-9.6	0.2	-7.4	-0.6	-85	-10.0	-31.8	-31.8	-40.9	-32.5	-41.3	-31.6	-39.2	-32.4	N
-80	-8.6	-0.1	-12.0	-0.2	-8.9	0.0	-80	-10.0	-31.8	-31.8	-40.4	-31.8	-43.8	-31.9	-40.6	-31.8	Y
-75	-9.7	-2.6	-16.4	-2.7	-13.7	-3.8	-75	-10.0	-31.8	-31.8	-41.5	-34.3	-48.2	-34.5	-45.5	-35.5	Y
-70	-9.0	-8.8	-10.3	-13.4	-13.2	-7.1	-70	-10.0	-31.8	-31.8	-40.7	-40.6	-42.1	-45.1	-44.9	-38.9	Y
-65	-8.3	-14.6	-13.5	-11.0	-11.7	-5.7	-65	-10.0	-31.8	-31.8	-40.1	-46.3	-45.3	-42.8	-43.5	-37.5	Y
-60	-6.4	-15.3	-12.6	-18.7	-5.6	-7.8	-60	-10.0	-31.8	-31.8	-38.2	-47.1	-44.4	-50.4	-37.3	-39.5	Y
-55	-8.9	-10.4	-12.0	-13.1	-12.1	-12.4	-55	-10.0	-31.8	-31.8	-40.7	-42.1	-43.7	-44.8	-43.8	-44.2	Y
-50	-9.8	-18.6	-8.6	-22.2	-8.6	-12.3	-50	-10.0	-31.8	-31.8	-41.6	-50.4	-40.3	-54.0	-40.3	-44.1	Y
-48	-8.9	-15.6	-8.8	-19.5	-7.5	-19.2	-48	-10.0	-31.8	-31.8	-40.7	-47.3	-40.6	-51.2	-39.3	-50.9	Y
-45	-7.5	-11.1	-9.3	-15.4	-6.0	-29.4	-45	-9.3	-31.1	-31.1	-39.3	-42.8	-41.0	-47.1	-37.8	-61.2	Y
-40	-5.4	-8.4	-7.6	-9.5	-14.3	-13.9	-40	-8.1	-29.8	-29.8	-37.2	-40.2	-39.4	-41.2	-46.1	-45.7	Y
-35	-14.5	-6.5	-12.9	-8.9	-7.5	-13.1	-35	-6.6	-28.4	-28.4	-46.3	-38.2	-44.7	-40.7	-39.2	-44.9	Y

-30	-12.4	-6.6	-18.1	-5.7	-8.1	-9.6	-30	-4.9	-26.7	-26.7	-44.1	-38.3	-49.8	-37.4	-39.9	-41.4	Y
-25	-9.0	-7.2	-11.6	-9.6	-3.5	-19.8	-25	-2.9	-24.7	-24.7	-40.8	-39.0	-43.3	-41.3	-35.2	-51.5	Y
-20	-9.9	-11.1	-4.5	-9.3	-6.1	-7.1	-20	-0.5	-22.3	-22.3	-41.6	-42.9	-36.2	-41.1	-37.8	-38.8	Y
-15	4.3	-3.0	3.5	-4.0	3.1	-14.3	-15	2.6	-19.2	-19.2	-27.4	-34.7	-28.3	-35.8	-28.6	-46.1	Y
-10	5.3	5.6	3.9	4.8	3.0	1.4	-10	7.0	-14.8	-14.8	-26.4	-26.2	-27.9	-26.9	-28.8	-30.4	Y
-9.9	5.7	5.5	4.5	4.6	3.7	1.0	-9.9	7.1	-14.7	-14.7	-26.1	-26.3	-27.3	-27.1	-28.0	-30.8	Y
-9.8	5.9	5.3	5.0	4.4	4.4	0.6	-9.8	7.2	-14.6	-14.6	-25.9	-26.4	-26.8	-27.4	-27.4	-31.1	Y
-9.7	6.1	5.2	5.4	4.2	4.9	0.3	-9.7	7.3	-14.5	-14.5	-25.7	-26.5	-26.4	-27.6	-26.8	-31.5	Y
-9.6	6.2	5.1	5.8	4.0	5.4	-0.1	-9.6	7.4	-14.3	-14.3	-25.6	-26.6	-26.0	-27.7	-26.4	-31.8	Y
-9.5	6.2	5.1	6.0	3.9	5.8	-0.4	-9.5	7.6	-14.2	-14.2	-25.6	-26.7	-25.7	-27.9	-25.9	-32.2	Y
-9.4	6.2	5.1	6.3	3.8	6.2	-0.7	-9.4	7.7	-14.1	-14.1	-25.6	-26.7	-25.5	-28.0	-25.6	-32.4	Y
-9.3	6.2	5.1	6.4	3.7	6.5	-0.9	-9.3	7.8	-14.0	-14.0	-25.6	-26.6	-25.3	-28.0	-25.3	-32.6	Y
-9.2	6.1	5.2	6.6	3.7	6.7	-1.0	-9.2	8.0	-13.8	-13.9	-25.7	-26.5	-25.2	-28.0	-25.0	-32.7	Y
-9.1	6.0	5.4	6.6	3.8	7.0	-1.0	-9.1	8.0	-13.8	-13.8	-25.8	-26.4	-25.1	-28.0	-24.8	-32.7	Y
-9	5.8	5.6	6.7	4.0	7.2	-0.8	-9	8.0	-13.8	-13.6	-25.9	-26.2	-25.0	-27.8	-24.6	-32.5	Y
-8.9	5.7	5.9	6.8	4.3	7.4	-0.4	-8.9	8.0	-13.8	-13.5	-26.0	-25.9	-25.0	-27.5	-24.4	-32.2	Y
-8.8	5.7	6.3	6.8	4.6	7.6	0.1	-8.8	8.0	-13.8	-13.4	-26.1	-25.5	-24.9	-27.1	-24.2	-31.7	Y
-8.7	5.7	6.7	6.9	5.1	7.8	0.7	-8.7	8.0	-13.8	-13.3	-26.1	-25.1	-24.9	-26.7	-23.9	-31.0	Y
-8.6	5.8	7.2	7.0	5.6	8.1	1.5	-8.6	8.0	-13.8	-13.1	-26.0	-24.6	-24.7	-26.1	-23.6	-30.2	Y
-8.5	6.0	7.7	7.2	6.2	8.4	2.4	-8.5	8.0	-13.8	-13.0	-25.7	-24.1	-24.6	-25.6	-23.3	-29.4	Y
-8.4	6.4	8.3	7.4	6.8	8.8	3.3	-8.4	8.0	-13.8	-12.9	-25.4	-23.5	-24.3	-24.9	-23.0	-28.5	Y
-8.3	6.8	8.8	7.7	7.5	9.2	4.2	-8.3	8.0	-13.8	-12.8	-24.9	-22.9	-24.0	-24.3	-22.6	-27.6	Y
-8.2	7.4	9.4	8.1	8.2	9.6	5.1	-8.2	8.0	-13.8	-12.6	-24.3	-22.3	-23.7	-23.6	-22.1	-26.7	Y
-8.1	8.1	10.0	8.5	8.9	10.1	6.0	-8.1	8.0	-13.8	-12.5	-23.7	-21.8	-23.2	-22.9	-21.7	-25.8	Y
-8	8.8	10.6	9.1	9.5	10.6	6.8	-8	8.0	-13.8	-12.4	-23.0	-21.2	-22.7	-22.2	-21.1	-24.9	Y
-7.9	9.5	11.2	9.6	10.2	11.2	7.7	-7.9	8.0	-13.8	-12.2	-22.2	-20.6	-22.1	-21.6	-20.6	-24.1	Y
-7.8	10.3	11.7	10.2	10.8	11.7	8.5	-7.8	8.0	-13.8	-12.1	-21.5	-20.0	-21.6	-20.9	-20.0	-23.3	Y
-7.7	11.0	12.2	10.8	11.5	12.3	9.3	-7.7	8.0	-13.8	-11.9	-20.8	-19.5	-20.9	-20.3	-19.5	-22.5	Y
-7.6	11.7	12.8	11.4	12.0	12.9	10.0	-7.6	8.0	-13.8	-11.8	-20.1	-19.0	-20.3	-19.7	-18.9	-21.8	Y
-7.5	12.4	13.2	12.0	12.6	13.4	10.7	-7.5	8.0	-13.8	-11.7	-19.4	-18.5	-19.7	-19.2	-18.4	-21.1	Y
-7.4	13.0	13.7	12.6	13.1	13.9	11.3	-7.4	8.0	-13.8	-11.5	-18.7	-18.1	-19.1	-18.6	-17.8	-20.4	Y
-7.3	13.7	14.1	13.2	13.6	14.5	11.9	-7.3	8.0	-13.8	-11.4	-18.1	-17.6	-18.5	-18.1	-17.3	-19.8	Y
-7.2	14.2	14.5	13.8	14.1	15.0	12.5	-7.2	8.0	-13.8	-11.2	-17.5	-17.2	-18.0	-17.7	-16.8	-19.3	Y
-7.1	14.8	14.9	14.3	14.5	15.4	13.0	-7.1	8.0	-13.8	-11.1	-17.0	-16.8	-17.5	-17.2	-16.3	-18.7	Y
-7	15.3	15.3	14.8	15.0	15.9	13.5	-7	7.9	-13.9	-10.9	-16.5	-16.5	-17.0	-16.8	-15.9	-18.2	Y
-6.9	15.8	15.6	15.2	15.3	16.3	14.0	-6.9	8.0	-13.8	-10.8	-16.0	-16.2	-16.5	-16.4	-15.5	-17.8	Y
-6.8	16.2	15.9	15.7	15.7	16.7	14.4	-6.8	8.2	-13.6	-10.6	-15.6	-15.9	-16.1	-16.1	-15.1	-17.4	Y
-6.7	16.6	16.1	16.1	16.0	17.0	14.8	-6.7	8.3	-13.4	-10.4	-15.2	-15.7	-15.7	-15.8	-14.8	-17.0	Y

-6.6	17.0	16.3	16.4	16.2	17.3	15.1	-6.6	8.5	-13.3	-10.3	-14.8	-15.4	-15.3	-15.5	-14.4	-16.6	Y
-6.5	17.3	16.5	16.7	16.5	17.6	15.4	-6.5	8.7	-13.1	-10.1	-14.5	-15.3	-15.0	-15.3	-14.2	-16.3	Y
-6.4	17.6	16.6	17.0	16.7	17.9	15.7	-6.4	8.8	-12.9	-9.9	-14.2	-15.1	-14.7	-15.1	-13.9	-16.1	Y
-6.3	17.8	16.8	17.3	16.8	18.1	15.9	-6.3	9.0	-12.8	-9.8	-14.0	-15.0	-14.5	-14.9	-13.7	-15.9	Y
-6.2	18.0	16.8	17.5	17.0	18.2	16.1	-6.2	9.2	-12.6	-9.6	-13.8	-14.9	-14.3	-14.8	-13.5	-15.7	Y
-6.1	18.2	16.9	17.6	17.0	18.4	16.2	-6.1	9.4	-12.4	-9.4	-13.6	-14.9	-14.1	-14.7	-13.4	-15.5	Y
-6	18.3	16.8	17.8	17.1	18.5	16.3	-6	9.5	-12.2	-9.2	-13.5	-14.9	-14.0	-14.7	-13.3	-15.4	Y
-5.9	18.4	16.8	17.9	17.1	18.5	16.4	-5.9	9.7	-12.1	-9.1	-13.4	-15.0	-13.9	-14.7	-13.2	-15.4	Y
-5.8	18.4	16.7	17.9	17.0	18.6	16.4	-5.8	9.9	-11.9	-8.9	-13.4	-15.1	-13.9	-14.7	-13.2	-15.3	Y
-5.7	18.4	16.5	17.9	17.0	18.5	16.4	-5.7	10.1	-11.7	-8.7	-13.4	-15.3	-13.9	-14.8	-13.2	-15.4	Y
-5.6	18.3	16.3	17.9	16.8	18.5	16.3	-5.6	10.3	-11.5	-8.5	-13.4	-15.5	-13.9	-15.0	-13.3	-15.4	Y
-5.5	18.2	16.0	17.8	16.6	18.3	16.2	-5.5	10.5	-11.3	-8.3	-13.5	-15.8	-14.0	-15.2	-13.4	-15.6	Y
-5.4	18.1	15.6	17.6	16.3	18.2	16.0	-5.4	10.7	-11.1	-8.1	-13.7	-16.1	-14.2	-15.4	-13.6	-15.8	Y
-5.3	17.8	15.2	17.4	16.0	17.9	15.7	-5.3	10.9	-10.9	-7.9	-13.9	-16.6	-14.4	-15.8	-13.8	-16.0	Y
-5.2	17.6	14.6	17.1	15.6	17.6	15.4	-5.2	11.1	-10.7	-7.7	-14.2	-17.2	-14.6	-16.2	-14.1	-16.4	Y
-5.1	17.2	13.9	16.8	15.1	17.3	15.0	-5.1	11.3	-10.5	-7.5	-14.5	-17.8	-15.0	-16.7	-14.5	-16.8	Y
-5	16.8	13.1	16.4	14.5	16.8	14.5	-5	11.5	-10.3	-7.3	-15.0	-18.6	-15.3	-17.3	-14.9	-17.2	Y
-4.9	16.3	12.2	16.0	13.8	16.3	14.0	-4.9	11.7	-10.0	-7.0	-15.4	-19.6	-15.8	-18.0	-15.5	-17.8	Y
-4.8	15.8	11.0	15.4	12.9	15.7	13.3	-4.8	12.0	-9.8	-6.8	-16.0	-20.7	-16.3	-18.8	-16.1	-18.5	Y
-4.7	15.2	9.7	14.9	12.0	14.9	12.6	-4.7	12.2	-9.6	-6.6	-16.6	-22.0	-16.9	-19.8	-16.8	-19.2	Y
-4.6	14.5	8.3	14.2	10.9	14.1	11.8	-4.6	12.4	-9.4	-6.4	-17.2	-23.5	-17.5	-20.9	-17.7	-19.9	Y
-4.5	13.9	6.9	13.6	9.8	13.2	11.1	-4.5	12.7	-9.1	-6.1	-17.9	-24.8	-18.1	-21.9	-18.6	-20.7	Y
-4.4	13.3	6.4	13.1	9.0	12.2	10.5	-4.4	12.9	-8.9	-5.9	-18.5	-25.4	-18.6	-22.8	-19.6	-21.2	Y
-4.3	12.9	7.2	12.8	8.8	11.3	10.4	-4.3	13.2	-8.6	-5.6	-18.9	-24.6	-18.9	-23.0	-20.5	-21.4	Y
-4.2	12.7	8.9	12.8	9.4	10.8	10.7	-4.2	13.4	-8.4	-5.4	-19.0	-22.8	-18.9	-22.4	-21.0	-21.0	Y
-4.1	13.0	10.9	13.2	10.7	10.8	11.6	-4.1	13.7	-8.1	-5.1	-18.7	-20.8	-18.5	-21.1	-21.0	-20.2	Y
-4	13.7	12.9	14.0	12.3	11.5	12.8	-4	13.9	-7.8	-4.8	-18.0	-18.9	-17.8	-19.5	-20.2	-19.0	Y
-3.9	14.7	14.6	15.0	13.9	12.8	14.1	-3.9	14.2	-7.6	-4.6	-17.1	-17.1	-16.8	-17.9	-19.0	-17.6	Y
-3.8	15.8	16.2	16.1	15.4	14.2	15.5	-3.8	14.5	-7.3	-4.3	-15.9	-15.6	-15.7	-16.3	-17.5	-16.3	Y
-3.7	17.0	17.6	17.2	16.9	15.7	16.8	-3.7	14.8	-7.0	-4.0	-14.8	-14.2	-14.5	-14.9	-16.1	-15.0	Y
-3.6	18.2	18.8	18.4	18.2	17.1	18.0	-3.6	15.1	-6.7	-3.7	-13.6	-12.9	-13.4	-13.6	-14.7	-13.7	Y
-3.5	19.3	20.0	19.5	19.4	18.4	19.2	-3.5	15.4	-6.4	-3.4	-12.5	-11.8	-12.3	-12.4	-13.4	-12.6	Y
-3.4	20.3	21.0	20.5	20.4	19.6	20.3	-3.4	15.7	-6.1	-3.1	-11.4	-10.8	-11.3	-11.3	-12.2	-11.5	Y
-3.3	21.3	21.9	21.4	21.5	20.7	21.2	-3.3	16.0	-5.7	-2.7	-10.5	-9.8	-10.3	-10.3	-11.1	-10.5	Y
-3.2	22.2	22.8	22.3	22.4	21.7	22.2	-3.2	16.4	-5.4	-2.4	-9.5	-8.9	-9.4	-9.4	-10.1	-9.6	Y
-3.1	23.1	23.6	23.2	23.2	22.6	23.0	-3.1	16.7	-5.1	-2.1	-8.7	-8.1	-8.6	-8.5	-9.1	-8.7	Y
-3	23.9	24.4	24.0	24.0	23.5	23.8	-3	17.1	-4.7	-1.7	-7.9	-7.4	-7.8	-7.7	-8.3	-7.9	Y
-2.9	24.6	25.1	24.7	24.8	24.3	24.6	-2.9	17.4	-4.3		-7.1	-6.7	-7.0	-7.0	-7.5	-7.2	Y

-2.8	25.3	25.7	25.4	25.5	25.0	25.3	-2.8	17.8	-4.0		-6.4	-6.0	-6.3	-6.3	-6.7	-6.5	Y
-2.7	26.0	26.4	26.1	26.1	25.7	25.9	-2.7	18.2	-3.6		-5.8	-5.4	-5.7	-5.7	-6.0	-5.8	Y
-2.6	26.6	26.9	26.7	26.7	26.4	26.5	-2.6	18.6	-3.2		-5.2	-4.8	-5.1	-5.1	-5.4	-5.2	Y
-2.5	27.2	27.5	27.2	27.3	27.0	27.1	-2.5	19.1	-2.7		-4.6	-4.3	-4.5	-4.5	-4.8	-4.7	Y
-2.4	27.7	28.0	27.8	27.8	27.5	27.6	-2.4	19.5	-2.3		-4.1	-3.8	-4.0	-4.0	-4.2	-4.1	Y
-2.3	28.2	28.5	28.3	28.3	28.0	28.1	-2.3	20.0	-1.8		-3.5	-3.3	-3.5	-3.5	-3.7	-3.6	Y
-2.2	28.7	28.9	28.8	28.8	28.5	28.6	-2.2	20.4	-1.3		-3.1	-2.9	-3.0	-3.0	-3.2	-3.1	Y
-2.1	29.1	29.3	29.2	29.2	29.0	29.1	-2.1	20.9	-0.8		-2.6	-2.4	-2.6	-2.6	-2.8	-2.7	Y
-2	29.5	29.7	29.6	29.6	29.4	29.5	-2	21.5	-0.3		-2.2	-2.1	-2.2	-2.2	-2.3	-2.3	Y
-1.9	29.9	30.1	30.0	30.0	29.8	29.9	-1.9	22.0	0.2		-1.8	-1.7	-1.8	-1.8	-1.9	-1.9	Y
-1.8	30.3	30.4	30.4	30.4	30.2	30.2	-1.8	22.6	0.8		-1.5	-1.3	-1.4	-1.4	-1.6	-1.5	Y
-1.7	30.6	30.7	30.7	30.7	30.6	30.6	-1.7	23.2	1.5		-1.1	-1.0	-1.1	-1.1	-1.2	-1.2	Y
-1.6	31.0	31.0	31.0	31.0	30.9	30.9	-1.6	23.9	2.1		-0.8	-0.7	-0.8	-0.8	-0.9	-0.9	Y
-1.5	31.2	31.3	31.3	31.3	31.2	31.2	-1.5	24.6	2.8		-0.5	-0.4	-0.5	-0.5	-0.6	-0.6	Y
-1.4	31.5	31.6	31.6	31.6	31.5	31.5	-1.4				-0.2	-0.2	-0.2	-0.2	-0.3	-0.3	Y
-1.3	31.8	31.8	31.8	31.8	31.7	31.7	-1.3				0.0	0.0	0.0	0.0	0.0	0.0	Y
-1.2	32.0	32.0	32.0	32.0	31.9	32.0	-1.2				0.2	0.3	0.3	0.3	0.2	0.2	Y
-1.1	32.2	32.2	32.2	32.2	32.2	32.2	-1.1				0.4	0.5	0.5	0.5	0.4	0.4	Y
-1	32.4	32.4	32.4	32.4	32.4	32.4	-1				0.6	0.6	0.7	0.7	0.6	0.6	Y
-0.9	32.6	32.6	32.6	32.6	32.5	32.5	-0.9				0.8	0.8	0.8	0.8	0.8	0.8	Y
-0.8	32.7	32.7	32.7	32.7	32.7	32.7	-0.8				0.9	1.0	1.0	1.0	0.9	0.9	Y
-0.7	32.8	32.8	32.9	32.9	32.8	32.8	-0.7				1.1	1.1	1.1	1.1	1.1	1.1	Y
-0.6	32.9	32.9	33.0	33.0	32.9	32.9	-0.6				1.2	1.2	1.2	1.2	1.2	1.2	Y
-0.5	33.0	33.0	33.1	33.1	33.0	33.0	-0.5				1.3	1.3	1.3	1.3	1.3	1.3	Y
-0.4	33.1	33.1	33.2	33.2	33.1	33.1	-0.4				1.4	1.4	1.4	1.4	1.3	1.4	Y
-0.3	33.2	33.2	33.2	33.2	33.2	33.2	-0.3				1.4	1.4	1.5	1.5	1.4	1.4	Y
-0.2	33.2	33.2	33.3	33.3	33.2	33.2	-0.2				1.5	1.5	1.5	1.5	1.5	1.5	Y
-0.1	33.2	33.2	33.3	33.3	33.2	33.2	-0.1				1.5	1.5	1.5	1.5	1.5	1.5	Y
0	33.3	33.3	33.3	33.3	33.3	33.3	0				1.5	1.5	1.5	1.5	1.5	1.5	Y
0.1	33.2	33.2	33.3	33.3	33.2	33.2	0.1				1.5	1.5	1.5	1.5	1.5	1.5	Y
0.2	33.2	33.2	33.3	33.3	33.2	33.2	0.2				1.5	1.5	1.5	1.5	1.5	1.5	Y
0.3	33.2	33.2	33.2	33.2	33.2	33.2	0.3				1.4	1.4	1.5	1.5	1.4	1.4	Y
0.4	33.1	33.1	33.2	33.2	33.1	33.1	0.4				1.4	1.4	1.4	1.4	1.3	1.3	Y
0.5	33.0	33.0	33.1	33.1	33.0	33.0	0.5				1.3	1.3	1.3	1.3	1.3	1.3	Y
0.6	32.9	33.0	33.0	33.0	32.9	32.9	0.6				1.2	1.2	1.2	1.2	1.2	1.2	Y
0.7	32.8	32.8	32.9	32.9	32.8	32.8	0.7				1.1	1.1	1.1	1.1	1.0	1.1	Y
0.8	32.7	32.7	32.7	32.7	32.7	32.7	0.8				0.9	1.0	1.0	1.0	0.9	0.9	Y
0.9	32.5	32.6	32.6	32.6	32.5	32.5	0.9				0.8	0.8	0.8	0.8	0.8	0.8	Y

1	32.4	32.4	32.4	32.4	32.3	32.4	1				0.6	0.7	0.7	0.7	0.6	0.6	Y
1.1	32.2	32.2	32.2	32.2	32.1	32.2	1.1				0.4	0.5	0.5	0.5	0.4	0.4	Y
1.2	32.0	32.0	32.0	32.0	31.9	31.9	1.2				0.2	0.3	0.3	0.3	0.2	0.2	Y
1.3	31.8	31.8	31.8	31.8	31.7	31.7	1.3				0.0	0.1	0.0	0.0	-0.1	0.0	Y
1.4	31.5	31.6	31.5	31.6	31.4	31.5	1.4				-0.3	-0.2	-0.2	-0.2	-0.3	-0.3	Y
1.5	31.2	31.3	31.3	31.3	31.2	31.2	1.5	24.6	2.8		-0.5	-0.4	-0.5	-0.5	-0.6	-0.6	Y
1.6	30.9	31.1	31.0	31.0	30.9	30.9	1.6	23.9	2.1		-0.8	-0.7	-0.8	-0.8	-0.9	-0.9	Y
1.7	30.6	30.8	30.7	30.7	30.5	30.6	1.7	23.2	1.5		-1.1	-1.0	-1.1	-1.1	-1.2	-1.2	Y
1.8	30.3	30.4	30.3	30.4	30.2	30.2	1.8	22.6	0.8		-1.5	-1.3	-1.4	-1.4	-1.6	-1.5	Y
1.9	29.9	30.1	30.0	30.0	29.8	29.9	1.9	22.0	0.2		-1.8	-1.7	-1.8	-1.8	-2.0	-1.9	Y
2	29.5	29.7	29.6	29.6	29.4	29.5	2	21.5	-0.3		-2.2	-2.0	-2.2	-2.1	-2.4	-2.3	Y
2.1	29.1	29.3	29.2	29.2	29.0	29.1	2.1	20.9	-0.8		-2.6	-2.4	-2.6	-2.5	-2.8	-2.7	Y
2.2	28.7	28.9	28.7	28.8	28.5	28.6	2.2	20.4	-1.3		-3.1	-2.8	-3.0	-3.0	-3.3	-3.1	Y
2.3	28.2	28.5	28.3	28.3	28.0	28.2	2.3	20.0	-1.8		-3.5	-3.3	-3.5	-3.4	-3.7	-3.6	Y
2.4	27.7	28.0	27.8	27.8	27.5	27.7	2.4	19.5	-2.3		-4.0	-3.7	-4.0	-3.9	-4.3	-4.1	Y
2.5	27.2	27.5	27.2	27.3	26.9	27.1	2.5	19.1	-2.7		-4.6	-4.2	-4.5	-4.4	-4.8	-4.6	Y
2.6	26.6	27.0	26.7	26.8	26.3	26.6	2.6	18.6	-3.2		-5.2	-4.8	-5.1	-5.0	-5.4	-5.2	Y
2.7	26.0	26.4	26.1	26.2	25.7	26.0	2.7	18.2	-3.6		-5.8	-5.3	-5.7	-5.6	-6.1	-5.8	Y
2.8	25.3	25.8	25.4	25.5	25.0	25.3	2.8	17.8	-4.0		-6.4	-6.0	-6.3	-6.2	-6.8	-6.4	Y
2.9	24.7	25.2	24.7	24.9	24.3	24.7	2.9	17.4	-4.3		-7.1	-6.6	-7.0	-6.9	-7.5	-7.1	Y
3	23.9	24.5	24.0	24.1	23.5	23.9	3	17.1	-4.7	-1.7	-7.9	-7.3	-7.8	-7.6	-8.3	-7.8	Y
3.1	23.1	23.7	23.2	23.4	22.6	23.2	3.1	16.7	-5.1	-2.1	-8.7	-8.1	-8.5	-8.4	-9.1	-8.6	Y
3.2	22.3	22.9	22.4	22.5	21.7	22.3	3.2	16.4	-5.4	-2.4	-9.5	-8.9	-9.3	-9.2	-10.1	-9.4	Y
3.3	21.3	22.0	21.5	21.7	20.7	21.5	3.3	16.0	-5.7	-2.7	-10.4	-9.7	-10.2	-10.1	-11.0	-10.3	Y
3.4	20.4	21.1	20.6	20.7	19.7	20.5	3.4	15.7	-6.1	-3.1	-11.4	-10.7	-11.1	-11.1	-12.1	-11.2	Y
3.5	19.3	20.1	19.7	19.7	18.5	19.5	3.5	15.4	-6.4	-3.4	-12.4	-11.7	-12.1	-12.1	-13.2	-12.2	Y
3.6	18.2	19.0	18.7	18.6	17.3	18.5	3.6	15.1	-6.7	-3.7	-13.5	-12.8	-13.1	-13.2	-14.5	-13.3	Y
3.7	17.1	17.8	17.7	17.4	16.0	17.3	3.7	14.8	-7.0	-4.0	-14.7	-14.0	-14.1	-14.4	-15.7	-14.4	Y
3.8	15.9	16.5	16.7	16.1	14.8	16.2	3.8	14.5	-7.3	-4.3	-15.9	-15.3	-15.1	-15.7	-17.0	-15.6	Y
3.9	14.7	15.0	15.8	14.8	13.6	15.0	3.9	14.2	-7.6	-4.6	-17.0	-16.7	-16.0	-17.0	-18.2	-16.8	Y
4	13.7	13.5	15.0	13.4	12.6	13.8	4	13.9	-7.8	-4.8	-18.0	-18.3	-16.8	-18.3	-19.2	-18.0	Y
4.1	13.0	11.9	14.5	12.2	12.1	12.8	4.1	13.7	-8.1	-5.1	-18.8	-19.9	-17.3	-19.6	-19.7	-19.0	Y
4.2	12.6	10.3	14.2	11.2	12.0	12.0	4.2	13.4	-8.4	-5.4	-19.2	-21.5	-17.5	-20.6	-19.7	-19.8	Y
4.3	12.6	9.0	14.3	10.6	12.4	11.6	4.3	13.2	-8.6	-5.6	-19.1	-22.7	-17.5	-21.2	-19.3	-20.2	Y
4.4	13.0	8.5	14.5	10.6	13.1	11.6	4.4	12.9	-8.9	-5.9	-18.7	-23.3	-17.2	-21.2	-18.7	-20.2	Y
4.5	13.6	8.8	14.9	11.0	13.8	11.8	4.5	12.7	-9.1	-6.1	-18.2	-23.0	-16.8	-20.8	-17.9	-19.9	Y
4.6	14.3	9.7	15.4	11.7	14.6	12.3	4.6	12.4	-9.4	-6.4	-17.5	-22.1	-16.3	-20.1	-17.2	-19.4	Y
4.7	14.9	10.7	15.9	12.5	15.3	12.9	4.7	12.2	-9.6	-6.6	-16.8	-21.0	-15.8	-19.3	-16.5	-18.9	Y

4.8	15.5	11.8	16.4	13.2	15.9	13.5	4.8	12.0	-9.8	-6.8	-16.2	-20.0	-15.4	-18.5	-15.8	-18.3	Y
4.9	16.1	12.8	16.8	13.9	16.5	14.0	4.9	11.7	-10.0	-7.0	-15.7	-19.0	-14.9	-17.8	-15.3	-17.7	Y
5	16.6	13.6	17.2	14.5	16.9	14.5	5	11.5	-10.3	-7.3	-15.2	-18.2	-14.6	-17.2	-14.8	-17.3	Y
5.1	17.0	14.3	17.5	15.1	17.3	14.9	5.1	11.3	-10.5	-7.5	-14.8	-17.5	-14.2	-16.7	-14.4	-16.8	Y
5.2	17.4	14.9	17.8	15.5	17.7	15.3	5.2	11.1	-10.7	-7.7	-14.4	-16.9	-14.0	-16.2	-14.1	-16.5	Y
5.3	17.6	15.4	18.0	15.9	17.9	15.6	5.3	10.9	-10.9	-7.9	-14.1	-16.4	-13.7	-15.9	-13.8	-16.2	Y
5.4	17.9	15.8	18.2	16.2	18.1	15.8	5.4	10.7	-11.1	-8.1	-13.9	-15.9	-13.6	-15.5	-13.6	-15.9	Y
5.5	18.1	16.2	18.3	16.5	18.3	16.0	5.5	10.5	-11.3	-8.3	-13.7	-15.6	-13.4	-15.3	-13.5	-15.8	Y
5.6	18.2	16.4	18.4	16.6	18.4	16.1	5.6	10.3	-11.5	-8.5	-13.6	-15.3	-13.4	-15.1	-13.4	-15.6	Y
5.7	18.2	16.6	18.4	16.8	18.4	16.2	5.7	10.1	-11.7	-8.7	-13.5	-15.1	-13.3	-15.0	-13.3	-15.6	Y
5.8	18.3	16.8	18.4	16.9	18.4	16.2	5.8	9.9	-11.9	-8.9	-13.5	-15.0	-13.3	-14.9	-13.3	-15.6	Y
5.9	18.3	16.9	18.4	16.9	18.4	16.2	5.9	9.7	-12.1	-9.1	-13.5	-14.9	-13.4	-14.9	-13.3	-15.6	Y
6	18.2	17.0	18.3	16.9	18.3	16.1	6	9.5	-12.2	-9.2	-13.6	-14.8	-13.5	-14.9	-13.4	-15.7	Y
6.1	18.1	17.0	18.2	16.8	18.2	16.0	6.1	9.4	-12.4	-9.4	-13.7	-14.8	-13.6	-14.9	-13.5	-15.8	Y
6.2	17.9	16.9	18.0	16.7	18.1	15.8	6.2	9.2	-12.6	-9.6	-13.8	-14.8	-13.8	-15.0	-13.7	-15.9	Y
6.3	17.8	16.9	17.8	16.6	17.9	15.7	6.3	9.0	-12.8	-9.8	-14.0	-14.9	-14.0	-15.2	-13.8	-16.1	Y
6.4	17.5	16.7	17.6	16.4	17.7	15.4	6.4	8.8	-12.9	-9.9	-14.2	-15.0	-14.2	-15.3	-14.1	-16.3	Y
6.5	17.3	16.6	17.3	16.2	17.5	15.2	6.5	8.7	-13.1	-10.1	-14.5	-15.2	-14.5	-15.5	-14.3	-16.6	Y
6.6	17.0	16.4	17.0	16.0	17.2	14.8	6.6	8.5	-13.3	-10.3	-14.8	-15.3	-14.8	-15.8	-14.6	-16.9	Y
6.7	16.7	16.2	16.6	15.7	16.9	14.5	6.7	8.3	-13.4	-10.4	-15.1	-15.6	-15.1	-16.1	-14.9	-17.3	Y
6.8	16.3	16.0	16.3	15.4	16.5	14.1	6.8	8.2	-13.6	-10.6	-15.5	-15.8	-15.5	-16.4	-15.3	-17.6	Y
6.9	15.9	15.7	15.9	15.0	16.1	13.7	6.9	8.0	-13.8	-10.8	-15.9	-16.1	-15.9	-16.7	-15.6	-18.1	Y
7	15.4	15.4	15.4	14.7	15.7	13.2	7	7.9	-13.9	-10.9	-16.3	-16.4	-16.3	-17.1	-16.0	-18.5	Y
7.1	15.0	15.0	15.0	14.3	15.3	12.7	7.1	8.0	-13.8	-11.1	-16.8	-16.7	-16.8	-17.5	-16.5	-19.0	Y
7.2	14.4	14.6	14.5	13.8	14.8	12.2	7.2	8.0	-13.8	-11.2	-17.3	-17.1	-17.3	-17.9	-16.9	-19.5	Y
7.3	13.9	14.2	13.9	13.3	14.3	11.7	7.3	8.0	-13.8	-11.4	-17.9	-17.5	-17.8	-18.4	-17.4	-20.1	Y
7.4	13.3	13.8	13.4	12.8	13.8	11.0	7.4	8.0	-13.8	-11.5	-18.4	-18.0	-18.4	-18.9	-18.0	-20.7	Y
7.5	12.7	13.3	12.8	12.3	13.3	10.4	7.5	8.0	-13.8	-11.7	-19.1	-18.4	-18.9	-19.4	-18.5	-21.4	Y
7.6	12.1	12.9	12.3	11.8	12.7	9.7	7.6	8.0	-13.8	-11.8	-19.7	-18.9	-19.5	-20.0	-19.0	-22.0	Y
7.7	11.4	12.3	11.7	11.2	12.1	9.0	7.7	8.0	-13.8	-11.9	-20.4	-19.4	-20.1	-20.6	-19.6	-22.7	Y
7.8	10.7	11.8	11.1	10.6	11.6	8.3	7.8	8.0	-13.8	-12.1	-21.1	-19.9	-20.7	-21.2	-20.2	-23.5	Y
7.9	10.0	11.3	10.5	9.9	11.0	7.5	7.9	8.0	-13.8	-12.2	-21.8	-20.5	-21.3	-21.8	-20.8	-24.3	Y
8	9.3	10.7	9.9	9.3	10.5	6.7	8	8.0	-13.8	-12.4	-22.5	-21.1	-21.8	-22.5	-21.3	-25.1	Y
8.1	8.6	10.1	9.4	8.7	9.9	5.8	8.1	8.0	-13.8	-12.5	-23.1	-21.6	-22.4	-23.1	-21.8	-25.9	Y
8.2	8.0	9.5	8.9	8.0	9.4	5.0	8.2	8.0	-13.8	-12.6	-23.8	-22.2	-22.9	-23.8	-22.3	-26.8	Y
8.3	7.3	9.0	8.4	7.4	8.9	4.1	8.3	8.0	-13.8	-12.8	-24.4	-22.8	-23.4	-24.4	-22.8	-27.6	Y
8.4	6.8	8.4	8.0	6.7	8.5	3.3	8.4	8.0	-13.8	-12.9	-25.0	-23.4	-23.8	-25.0	-23.2	-28.5	Y
8.5	6.3	7.8	7.6	6.2	8.1	2.5	8.5	8.0	-13.8	-13.0	-25.4	-23.9	-24.1	-25.6	-23.6	-29.3	Y

8.6	6.0	7.3	7.3	5.6	7.8	1.8	8.6	8.0	-13.8	-13.1	-25.8	-24.5	-24.4	-26.1	-24.0	-30.0	Y
8.7	5.7	6.8	7.1	5.1	7.5	1.1	8.7	8.0	-13.8	-13.3	-26.0	-25.0	-24.7	-26.6	-24.3	-30.7	Y
8.8	5.5	6.3	6.9	4.7	7.2	0.5	8.8	8.0	-13.8	-13.4	-26.2	-25.4	-24.9	-27.0	-24.5	-31.2	Y
8.9	5.5	5.9	6.7	4.4	7.0	0.1	8.9	8.0	-13.8	-13.5	-26.3	-25.8	-25.1	-27.4	-24.8	-31.6	Y
9	5.4	5.6	6.5	4.1	6.7	-0.1	9	8.0	-13.8	-13.6	-26.3	-26.1	-25.2	-27.6	-25.0	-31.9	Y
9.1	5.4	5.4	6.4	4.0	6.5	-0.3	9.1	8.0	-13.8	-13.8	-26.3	-26.4	-25.4	-27.8	-25.3	-32.0	Y
9.2	5.4	5.2	6.2	3.9	6.2	-0.2	9.2	8.0	-13.8	-13.9	-26.3	-26.6	-25.6	-27.9	-25.5	-32.0	Y
9.3	5.4	5.0	5.9	3.9	5.9	-0.1	9.3	7.8	-14.0	-14.0	-26.3	-26.7	-25.8	-27.9	-25.8	-31.9	Y
9.4	5.4	5.0	5.7	3.9	5.6	0.1	9.4	7.7	-14.1	-14.1	-26.4	-26.8	-26.1	-27.9	-26.2	-31.7	Y
9.5	5.4	4.9	5.4	4.0	5.2	0.3	9.5	7.6	-14.2	-14.2	-26.4	-26.8	-26.4	-27.8	-26.6	-31.4	Y
9.6	5.3	5.0	5.0	4.1	4.7	0.6	9.6	7.4	-14.3	-14.3	-26.5	-26.8	-26.7	-27.6	-27.0	-31.1	Y
9.7	5.1	5.1	4.6	4.3	4.2	1.0	9.7	7.3	-14.5	-14.5	-26.6	-26.7	-27.2	-27.5	-27.5	-30.8	Y
9.8	4.9	5.2	4.1	4.5	3.6	1.3	9.8	7.2	-14.6	-14.6	-26.8	-26.6	-27.7	-27.3	-28.1	-30.5	Y
9.9	4.6	5.3	3.5	4.7	2.9	1.6	9.9	7.1	-14.7	-14.7	-27.1	-26.5	-28.3	-27.1	-28.9	-30.1	Y
10	4.3	5.4	2.8	4.9	2.1	2.0	10	7.0	-14.8	-14.8	-27.5	-26.3	-29.0	-26.9	-29.7	-29.8	Y
15	4.0	-3.6	3.2	-4.8	2.6	-20.2	15	2.6	-19.2	-19.2	-27.8	-35.4	-28.6	-36.6	-29.1	-52.0	Y
20	-9.3	-14.7	-7.1	-9.0	-5.8	-6.5	20	-0.5	-22.3	-22.3	-41.0	-46.5	-38.9	-40.7	-37.6	-38.3	Y
25	-13.2	-7.0	-16.0	-9.1	-5.0	-16.3	25	-2.9	-24.7	-24.7	-45.0	-38.7	-47.7	-40.9	-36.8	-48.1	Y
30	-19.0	-5.1	-13.8	-4.5	-7.8	-8.7	30	-4.9	-26.7	-26.7	-50.7	-36.9	-45.6	-36.3	-39.5	-40.5	Y
35	-7.0	-8.8	-5.9	-8.1	-4.0	-10.2	35	-6.6	-28.4	-28.4	-38.7	-40.6	-37.6	-39.9	-35.8	-42.0	Y
40	-9.0	-12.9	-9.1	-13.4	-10.8	-17.6	40	-8.1	-29.8	-29.8	-40.8	-44.7	-40.8	-45.2	-42.6	-49.4	Y
45	-8.6	-10.2	-10.0	-10.8	-10.0	-16.7	45	-9.3	-31.1	-31.1	-40.4	-41.9	-41.8	-42.6	-41.8	-48.4	Y
48	-11.4	-16.0	-9.2	-14.4	-6.9	-10.6	48	-10.0	-31.8	-31.8	-43.2	-47.8	-41.0	-46.2	-38.7	-42.4	Y
50	-13.3	-19.9	-8.7	-16.8	-4.8	-6.6	50	-10.0	-31.8	-31.8	-45.0	-51.7	-40.5	-48.6	-36.6	-38.4	Y
55	-4.6	-8.9	-6.1	-12.1	-9.4	-8.3	55	-10.0	-31.8	-31.8	-36.4	-40.7	-37.9	-43.9	-41.2	-40.1	Y
60	-8.6	-12.9	-13.6	-23.4	-12.4	-11.7	60	-10.0	-31.8	-31.8	-40.4	-44.7	-45.3	-55.1	-44.2	-43.5	Y
65	-9.6	-10.2	-15.5	-9.3	-17.1	-6.6	65	-10.0	-31.8	-31.8	-41.3	-42.0	-47.3	-41.0	-48.9	-38.4	Y
70	-9.6	-8.7	-12.7	-9.6	-8.7	-10.4	70	-10.0	-31.8	-31.8	-41.3	-40.4	-44.4	-41.4	-40.5	-42.1	Y
75	-13.8	-1.8	-17.1	-3.1	-11.2	-4.1	75	-10.0	-31.8	-31.8	-45.5	-33.6	-48.9	-34.8	-43.0	-35.9	Y
80	-11.7	0.6	-10.3	-0.6	-8.6	-0.5	80	-10.0	-31.8	-31.8	-43.5	-31.2	-42.0	-32.3	-40.4	-32.2	N
85	-8.2	-0.2	-8.7	-1.0	-8.6	-1.9	85	-10.0	-31.8	-31.8	-39.9	-31.9	-40.4	-32.7	-40.3	-33.6	Y
90	-6.5	-1.3	-8.4	-3.6	-8.1	-1.8	90	0.0	-21.8	-21.8	-38.2	-33.0	-40.1	-35.3	-39.9	-33.5	Y
95	-10.0	-5.2	-9.4	-4.9	-7.4	-5.3	95	0.0	-21.8	-21.8	-41.8	-36.9	-41.2	-36.6	-39.2	-37.1	Y
100	-12.2	-8.9	-9.1	-9.8	-11.7	-7.6	100	0.0	-21.8	-21.8	-44.0	-40.7	-40.9	-41.6	-43.5	-39.4	Y
105	-13.1	-12.8	-11.9	-11.6	-14.4	-12.2	105	0.0	-21.8	-21.8	-44.9	-44.5	-43.6	-43.4	-46.2	-44.0	Y
110	-13.6	-13.0	-14.7	-13.5	-12.9	-16.4	110	0.0	-21.8	-21.8	-45.4	-44.7	-46.5	-45.2	-44.7	-48.2	Y
115	-12.1	-11.7	-13.8	-15.5	-17.7	-18.8	115	0.0	-21.8	-21.8	-43.9	-43.5	-45.5	-47.3	-49.5	-50.6	Y
120	-19.3	-23.5	-20.7	-17.0	-14.6	-31.8	120	0.0	-21.8	-21.8	-51.1	-55.2	-52.4	-48.7	-46.3	-63.5	Y

125	-16.1	-20.6	-15.1	-22.8	-12.3	-23.0	125	0.0	-21.8	-21.8	-47.9	-52.4	-46.8	-54.6	-44.0	-54.7	Y
130	-14.6	-13.8	-15.6	-19.5	-22.8	-18.4	130	0.0	-21.8	-21.8	-46.4	-45.6	-47.4	-51.2	-54.5	-50.2	Y
135	-14.5	-13.5	-13.0	-14.8	-30.7	-34.6	135	0.0	-21.8	-21.8	-46.3	-45.2	-44.8	-46.6	-62.5	-66.3	Y
140	-17.1	-22.3	-38.2	-16.0	-34.0	-36.5	140	0.0	-21.8	-21.8	-48.8	-54.1	-69.9	-47.8	-65.8	-68.2	Y
145	-21.4	-29.2	-22.4	-25.5	-18.2	-25.4	145	0.0	-21.8	-21.8	-53.2	-61.0	-54.2	-57.3	-49.9	-57.2	Y
150	-19.6	-17.1	-23.5	-21.2	-19.3	-21.2	150	0.0	-21.8	-21.8	-51.3	-48.9	-55.3	-53.0	-51.0	-53.0	Y
155	-26.5	-19.2	-19.1	-18.1	-25.9	-24.4	155	0.0	-21.8	-21.8	-58.2	-50.9	-50.9	-49.8	-57.6	-56.1	Y
160	-18.7	-26.6	-18.1	-25.5	-31.7	-19.3	160	0.0	-21.8	-21.8	-50.5	-58.4	-49.8	-57.2	-63.5	-51.1	Y
165	-19.9	-37.0	-18.5	-43.5	-33.7	-28.9	165	0.0	-21.8	-21.8	-51.7	-68.8	-50.2	-75.3	-65.4	-60.7	Y
170	-14.2	-18.7	-11.9	-20.4	-16.7	-16.0	170	0.0	-21.8	-21.8	-46.0	-50.4	-43.7	-52.2	-48.4	-47.8	Y
175	-13.3	-25.8	-19.6	-21.6	-18.1	-16.3	175	0.0	-21.8	-21.8	-45.1	-57.6	-51.3	-53.4	-49.8	-48.1	Y
180	-23.8	-8.6	-15.2	-13.9	-16.3	-26.9	180	0.0	-21.8	-21.8	-55.6	-40.4	-47.0	-45.6	-48.1	-58.7	Y

Table 2	Antenna Gain X-Pol						VMES EIRP X-Pol				
OffAxis Angle (degree)	14GHz E	14.25 GHz E	14.5 GHz E	OffAxis Angle (degree)	FCC 25.209(b)(1)	§25.226 X-Pol Mask,N=6	14GHz E	14.25 GHz E	14.5 GHz E	Worst case Exceedance EIRP (dB)	Meets Mask
-9.2	-18.83	-16.455	-31.01	-9.2	-2.0	-23.8	-50.6	-48.2	-62.8	26.8	Y
-9.1	-18.67	-16.509	-31.47	-9.1	-2.0	-23.8	-50.4	-48.3	-63.2	26.7	Y
-9.0	-18.53	-16.594	-31.99	-9.0	-2.0	-23.8	-50.3	-48.4	-63.7	26.5	Y
-8.9	-18.41	-16.708	-32.56	-8.9	-2.0	-23.8	-50.2	-48.5	-64.3	26.4	Y
-8.8	-18.3	-16.853	-33.16	-8.8	-2.0	-23.8	-50.1	-48.6	-64.9	26.3	Y
-8.7	-18.22	-17.028	-33.74	-8.7	-2.0	-23.8	-50.0	-48.8	-65.5	26.2	Y
-8.6	-18.15	-17.232	-34.25	-8.6	-2.0	-23.8	-49.9	-49.0	-66.0	26.1	Y
-8.5	-18.11	-17.464	-34.59	-8.5	-2.0	-23.8	-49.9	-49.2	-66.4	26.1	Y
-8.4	-18.09	-17.725	-34.7	-8.4	-2.0	-23.8	-49.8	-49.5	-66.5	26.1	Y
-8.3	-18.09	-18.014	-34.51	-8.3	-2.0	-23.8	-49.9	-49.8	-66.3	26.1	Y
-8.2	-18.12	-18.329	-34.03	-8.2	-2.0	-23.8	-49.9	-50.1	-65.8	26.1	Y
-8.1	-18.18	-18.67	-33.3	-8.1	-2.0	-23.8	-49.9	-50.4	-65.1	26.2	Y
-8.0	-18.26	-19.036	-32.42	-8.0	-2.0	-23.8	-50.0	-50.8	-64.2	26.2	Y
-7.9	-18.36	-19.427	-31.45	-7.9	-2.0	-23.8	-50.1	-51.2	-63.2	26.3	Y
-7.8	-18.49	-19.841	-30.45	-7.8	-2.0	-23.8	-50.3	-51.6	-62.2	26.5	Y
-7.7	-18.65	-20.279	-29.45	-7.7	-2.0	-23.8	-50.4	-52.0	-61.2	26.6	Y
-7.6	-18.84	-20.74	-28.48	-7.6	-2.0	-23.8	-50.6	-52.5	-60.2	26.8	Y
-7.5	-19.06	-21.222	-27.56	-7.5	-2.0	-23.8	-50.8	-53.0	-59.3	27.0	Y
-7.4	-19.31	-21.726	-26.67	-7.4	-2.0	-23.8	-51.1	-53.5	-58.4	27.3	Y
-7.3	-19.59	-22.25	-25.84	-7.3	-2.0	-23.8	-51.4	-54.0	-57.6	27.6	Y
-7.2	-19.91	-22.794	-25.06	-7.2	-2.0	-23.8	-51.7	-54.6	-56.8	27.9	Y
-7.1	-20.26	-23.355	-24.32	-7.1	-2.0	-23.8	-52.0	-55.1	-56.1	28.2	Y
-7.0	-20.64	-23.931	-23.64	-7.0	-2.1	-23.9	-52.4	-55.7	-55.4	28.5	Y
-6.9	-21.07	-24.519	-23.02	-6.9	-2.0	-23.8	-52.8	-56.3	-54.8	29.1	Y
-6.8	-21.53	-25.112	-22.44	-6.8	-1.8	-23.6	-53.3	-56.9	-54.2	29.7	Y
-6.7	-22.04	-25.702	-21.91	-6.7	-1.7	-23.4	-53.8	-57.5	-53.7	30.4	Y
-6.6	-22.6	-26.279	-21.44	-6.6	-1.5	-23.3	-54.4	-58.0	-53.2	31.1	Y
-6.5	-23.21	-26.826	-21.02	-6.5	-1.3	-23.1	-55.0	-58.6	-52.8	31.9	Y
-6.4	-23.87	-27.326	-20.64	-6.4	-1.2	-22.9	-55.6	-59.1	-52.4	32.7	Y
-6.3	-24.59	-27.758	-20.32	-6.3	-1.0	-22.8	-56.3	-59.5	-52.1	33.6	Y
-6.2	-25.38	-28.103	-20.05	-6.2	-0.8	-22.6	-57.1	-59.9	-51.8	34.5	Y
-6.1	-26.23	-28.347	-19.84	-6.1	-0.6	-22.4	-58.0	-60.1	-51.6	35.6	Y
-6.0	-27.16	-28.481	-19.67	-6.0	-0.5	-22.2	-58.9	-60.2	-51.4	36.7	Y

-5.9	-28.17	-28.511	-19.56	-5.9	-0.3	-22.1	-59.9	-60.3	-51.3	37.9	Y
-5.8	-29.28	-28.451	-19.51	-5.8	-0.1	-21.9	-61.0	-60.2	-51.3	39.2	Y
-5.7	-30.47	-28.323	-19.51	-5.7	0.1	-21.7	-62.2	-60.1	-51.3	40.6	Y
-5.6	-31.76	-28.152	-19.57	-5.6	0.3	-21.5	-63.5	-59.9	-51.3	42.0	Y
-5.5	-33.15	-27.962	-19.69	-5.5	0.5	-21.3	-64.9	-59.7	-51.4	43.6	Y
-5.4	-34.62	-27.774	-19.87	-5.4	0.7	-21.1	-66.4	-59.5	-51.6	45.3	Y
-5.3	-36.15	-27.608	-20.13	-5.3	0.9	-20.9	-67.9	-59.4	-51.9	47.0	Y
-5.2	-37.68	-27.477	-20.45	-5.2	1.1	-20.7	-69.4	-59.2	-52.2	48.8	Y
-5.1	-39.12	-27.392	-20.85	-5.1	1.3	-20.5	-70.9	-59.2	-52.6	50.4	Y
-5.0	-40.31	-27.363	-21.34	-5.0	1.5	-20.3	-72.1	-59.1	-53.1	51.8	Y
-4.9	-41.07	-27.394	-21.93	-4.9	1.7	-20.0	-72.8	-59.2	-53.7	52.8	Y
-4.8	-41.22	-27.489	-22.62	-4.8	2.0	-19.8	-73.0	-59.2	-54.4	53.2	Y
-4.7	-40.71	-27.649	-23.42	-4.7	2.2	-19.6	-72.5	-59.4	-55.2	52.9	Y
-4.6	-39.62	-27.868	-24.36	-4.6	2.4	-19.4	-71.4	-59.6	-56.1	52.0	Y
-4.5	-38.13	-28.137	-25.42	-4.5	2.7	-19.1	-69.9	-59.9	-57.2	50.8	Y
-4.4	-36.41	-28.429	-26.58	-4.4	2.9	-18.9	-68.2	-60.2	-58.3	49.3	Y
-4.3	-34.61	-28.707	-27.73	-4.3	3.2	-18.6	-66.4	-60.5	-59.5	47.8	Y
-4.2	-32.83	-28.912	-28.64	-4.2	3.4	-18.4	-64.6	-60.7	-60.4	46.2	Y
-4.1	-31.11	-28.967	-28.91	-4.1	3.7	-18.1	-62.9	-60.7	-60.7	44.8	Y
-4.0	-29.47	-28.798	-28.31	-4.0	3.9	-17.8	-61.2	-60.6	-60.1	43.4	Y
-3.9	-27.94	-28.362	-27.04	-3.9	4.2	-17.6	-59.7	-60.1	-58.8	42.1	Y
-3.8	-26.5	-27.67	-25.49	-3.8	4.5	-17.3	-58.3	-59.4	-57.2	41.0	Y
-3.7	-25.16	-26.783	-23.91	-3.7	4.8	-17.0	-56.9	-58.5	-55.7	39.9	Y
-3.6	-23.91	-25.775	-22.42	-3.6	5.1	-16.7	-55.7	-57.5	-54.2	39.0	Y
-3.5	-22.75	-24.717	-21.06	-3.5	5.4	-16.4	-54.5	-56.5	-52.8	38.1	Y
-3.4	-21.66	-23.657	-19.81	-3.4	5.7	-16.1	-53.4	-55.4	-51.6	37.4	Y
-3.3	-20.65	-22.624	-18.67	-3.3	6.0	-15.7	-52.4	-54.4	-50.4	36.7	Y
-3.2	-19.71	-21.637	-17.62	-3.2	6.4	-15.4	-51.5	-53.4	-49.4	36.1	Y
-3.1	-18.83	-20.703	-16.67	-3.1	6.7	-15.1	-50.6	-52.5	-48.4	35.5	Y
-3.0	-18.01	-19.824	-15.78	-3.0	7.1	-14.7	-49.8	-51.6	-47.5	35.1	Y
-2.9	-17.24	-19.002	-14.97	-2.9	7.4	-14.3	-49.0	-50.8	-46.7	34.7	Y
-2.8	-16.53	-18.233	-14.21	-2.8	7.8	-14.0	-48.3	-50.0	-46.0	34.3	Y
-2.7	-15.86	-17.517	-13.5	-2.7	8.2	-13.6	-47.6	-49.3	-45.3	34.1	Y
-2.6	-15.23	-16.85	-12.85	-2.6	8.6	-13.2	-47.0	-48.6	-44.6	33.8	Y
-2.5	-14.65	-16.229	-12.23	-2.5	9.1	-12.7	-46.4	-48.0	-44.0	33.7	Y
-2.4	-14.1	-15.652	-11.66	-2.4	9.5	-12.3	-45.9	-47.4	-43.4	33.6	Y
-2.3	-13.58	-15.117	-11.13	-2.3	10.0	-11.8	-45.3	-46.9	-42.9	33.5	Y
-2.2	-13.1	-14.622	-10.64	-2.2	10.4	-11.3	-44.9	-46.4	-42.4	33.5	Y

-2.1	-12.64	-14.163	-10.18	-2.1	10.9	-10.8	-44.4	-45.9	-41.9	33.6	Y
-2.0	-12.22	-13.74	-9.747	-2.0	11.5	-10.3	-44.0	-45.5	-41.5	33.7	Y
-1.9	-11.81	-13.35	-9.349	-1.9	12.0	-9.8	-43.6	-45.1	-41.1	33.8	Y
-1.8	-11.43	-12.992	-8.979	-1.8	12.6	-9.2	-43.2	-44.8	-40.7	34.0	Y
-1.7	-11.08	-12.664	-8.639	-1.7			-42.8	-44.4	-40.4		Y
-1.6	-10.74	-12.365	-8.324	-1.6			-42.5	-44.1	-40.1		Y
-1.5	-10.42	-12.093	-8.036	-1.5			-42.2	-43.9	-39.8		Y
-1.4	-10.12	-11.846	-7.773	-1.4			-41.9	-43.6	-39.5		Y
-1.3	-9.835	-11.624	-7.533	-1.3			-41.6	-43.4	-39.3		Y
-1.2	-9.568	-11.424	-7.316	-1.2			-41.3	-43.2	-39.1		Y
-1.1	-9.318	-11.244	-7.12	-1.1			-41.1	-43.0	-38.9		Y
-1.0	-9.084	-11.084	-6.946	-1.0			-40.8	-42.8	-38.7		Y
-0.9	-8.866	-10.941	-6.792	-0.9			-40.6	-42.7	-38.6		Y
-0.8	-8.663	-10.814	-6.657	-0.8			-40.4	-42.6	-38.4		Y
-0.7	-8.477	-10.7	-6.541	-0.7			-40.2	-42.5	-38.3		Y
-0.6	-8.307	-10.599	-6.443	-0.6			-40.1	-42.4	-38.2		Y
-0.5	-8.152	-10.507	-6.362	-0.5			-39.9	-42.3	-38.1		Y
-0.4	-8.015	-10.425	-6.297	-0.4			-39.8	-42.2	-38.1		Y
-0.3	-7.894	-10.35	-6.249	-0.3			-39.7	-42.1	-38.0		Y
-0.2	-7.791	-10.28	-6.217	-0.2			-39.6	-42.0	-38.0		Y
-0.1	-7.705	-10.215	-6.201	-0.1			-39.5	-42.0	-38.0		Y
0.0	-7.637	-10.153	-6.199	0.0			-39.4	-41.9	-38.0		Y
0.1	-7.588	-10.095	-6.213	0.1			-39.3	-41.9	-38.0		Y
0.2	-7.557	-10.038	-6.242	0.2			-39.3	-41.8	-38.0		Y
0.3	-7.546	-9.983	-6.286	0.3			-39.3	-41.7	-38.0		Y
0.4	-7.554	-9.93	-6.345	0.4			-39.3	-41.7	-38.1		Y
0.5	-7.582	-9.879	-6.42	0.5			-39.3	-41.6	-38.2		Y
0.6	-7.63	-9.831	-6.511	0.6			-39.4	-41.6	-38.3		Y
0.7	-7.699	-9.787	-6.618	0.7			-39.5	-41.5	-38.4		Y
0.8	-7.789	-9.748	-6.742	0.8			-39.5	-41.5	-38.5		Y
0.9	-7.901	-9.714	-6.884	0.9			-39.7	-41.5	-38.6		Y
1.0	-8.034	-9.688	-7.044	1.0			-39.8	-41.4	-38.8		Y
1.1	-8.19	-9.67	-7.223	1.1			-40.0	-41.4	-39.0		Y
1.2	-8.368	-9.662	-7.421	1.2			-40.1	-41.4	-39.2		Y
1.3	-8.568	-9.666	-7.641	1.3			-40.3	-41.4	-39.4		Y
1.4	-8.792	-9.682	-7.882	1.4			-40.6	-41.4	-39.6		Y
1.5	-9.039	-9.712	-8.145	1.5			-40.8	-41.5	-39.9		Y
1.6	-9.31	-9.758	-8.433	1.6			-41.1	-41.5	-40.2		Y

1.7	-9.605	-9.821	-8.744	1.7			-41.4	-41.6	-40.5		Y
1.8	-9.923	-9.901	-9.082	1.8	12.6	-9.2	-41.7	-41.7	-40.8	32.5	Y
1.9	-10.27	-10	-9.446	1.9	12.0	-9.8	-42.0	-41.8	-41.2	32.3	Y
2.0	-10.63	-10.119	-9.839	2.0	11.5	-10.3	-42.4	-41.9	-41.6	32.1	Y
2.1	-11.03	-10.259	-10.26	2.1	10.9	-10.8	-42.8	-42.0	-42.0	31.9	Y
2.2	-11.44	-10.42	-10.71	2.2	10.4	-11.3	-43.2	-42.2	-42.5	31.9	Y
2.3	-11.88	-10.604	-11.2	2.3	10.0	-11.8	-43.6	-42.4	-43.0	31.8	Y
2.4	-12.35	-10.81	-11.72	2.4	9.5	-12.3	-44.1	-42.6	-43.5	31.8	Y
2.5	-12.84	-11.04	-12.28	2.5	9.1	-12.7	-44.6	-42.8	-44.0	31.9	Y
2.6	-13.36	-11.295	-12.87	2.6	8.6	-13.2	-45.1	-43.1	-44.6	32.0	Y
2.7	-13.9	-11.574	-13.51	2.7	8.2	-13.6	-45.7	-43.3	-45.3	32.1	Y
2.8	-14.47	-11.879	-14.18	2.8	7.8	-14.0	-46.2	-43.6	-45.9	32.3	Y
2.9	-15.06	-12.209	-14.91	2.9	7.4	-14.3	-46.8	-44.0	-46.7	32.5	Y
3.0	-15.67	-12.565	-15.68	3.0	7.1	-14.7	-47.4	-44.3	-47.4	32.7	Y
3.1	-16.3	-12.948	-16.5	3.1	6.7	-15.1	-48.1	-44.7	-48.3	33.0	Y
3.2	-16.95	-13.358	-17.37	3.2	6.4	-15.4	-48.7	-45.1	-49.1	33.3	Y
3.3	-17.62	-13.795	-18.3	3.3	6.0	-15.7	-49.4	-45.6	-50.1	33.6	Y
3.4	-18.29	-14.26	-19.27	3.4	5.7	-16.1	-50.1	-46.0	-51.0	34.0	Y
3.5	-18.98	-14.754	-20.28	3.5	5.4	-16.4	-50.7	-46.5	-52.0	34.4	Y
3.6	-19.66	-15.276	-21.32	3.6	5.1	-16.7	-51.4	-47.0	-53.1	34.7	Y
3.7	-20.33	-15.827	-22.36	3.7	4.8	-17.0	-52.1	-47.6	-54.1	35.1	Y
3.8	-20.99	-16.406	-23.34	3.8	4.5	-17.3	-52.7	-48.2	-55.1	35.5	Y
3.9	-21.62	-17.014	-24.19	3.9	4.2	-17.6	-53.4	-48.8	-55.9	35.8	Y
4.0	-22.22	-17.648	-24.83	4.0	3.9	-17.8	-54.0	-49.4	-56.6	36.1	Y
4.1	-22.78	-18.308	-25.2	4.1	3.7	-18.1	-54.5	-50.1	-57.0	36.4	Y
4.2	-23.28	-18.99	-25.28	4.2	3.4	-18.4	-55.0	-50.8	-57.0	36.7	Y
4.3	-23.74	-19.689	-25.12	4.3	3.2	-18.6	-55.5	-51.4	-56.9	36.9	Y
4.4	-24.14	-20.399	-24.8	4.4	2.9	-18.9	-55.9	-52.2	-56.6	37.0	Y
4.5	-24.49	-21.109	-24.4	4.5	2.7	-19.1	-56.2	-52.9	-56.2	37.1	Y
4.6	-24.79	-21.805	-23.97	4.6	2.4	-19.4	-56.5	-53.6	-55.7	37.2	Y
4.7	-25.04	-22.471	-23.57	4.7	2.2	-19.6	-56.8	-54.2	-55.3	37.2	Y
4.8	-25.27	-23.085	-23.22	4.8	2.0	-19.8	-57.0	-54.8	-55.0	37.2	Y
4.9	-25.46	-23.627	-22.93	4.9	1.7	-20.0	-57.2	-55.4	-54.7	37.2	Y
5.0	-25.63	-24.077	-22.71	5.0	1.5	-20.3	-57.4	-55.8	-54.5	37.1	Y
5.1	-25.79	-24.423	-22.56	5.1	1.3	-20.5	-57.5	-56.2	-54.3	37.1	Y
5.2	-25.92	-24.659	-22.48	5.2	1.1	-20.7	-57.7	-56.4	-54.2	37.0	Y
5.3	-26.05	-24.794	-22.48	5.3	0.9	-20.9	-57.8	-56.6	-54.2	36.9	Y
5.4	-26.15	-24.842	-22.56	5.4	0.7	-21.1	-57.9	-56.6	-54.3	36.8	Y

5.5	-26.24	-24.824	-22.71	5.5	0.5	-21.3	-58.0	-56.6	-54.5	36.7	Y
5.6	-26.31	-24.762	-22.94	5.6	0.3	-21.5	-58.1	-56.5	-54.7	36.6	Y
5.7	-26.35	-24.676	-23.26	5.7	0.1	-21.7	-58.1	-56.4	-55.0	36.4	Y
5.8	-26.36	-24.582	-23.65	5.8	-0.1	-21.9	-58.1	-56.3	-55.4	36.2	Y
5.9	-26.33	-24.493	-24.13	5.9	-0.3	-22.1	-58.1	-56.3	-55.9	36.0	Y
6.0	-26.27	-24.417	-24.69	6.0	-0.5	-22.2	-58.0	-56.2	-56.5	35.8	Y
6.1	-26.18	-24.359	-25.33	6.1	-0.6	-22.4	-57.9	-56.1	-57.1	35.5	Y
6.2	-26.05	-24.324	-26.05	6.2	-0.8	-22.6	-57.8	-56.1	-57.8	35.2	Y
6.3	-25.89	-24.311	-26.82	6.3	-1.0	-22.8	-57.7	-56.1	-58.6	34.9	Y
6.4	-25.71	-24.32	-27.6	6.4	-1.2	-22.9	-57.5	-56.1	-59.4	34.5	Y
6.5	-25.5	-24.349	-28.34	6.5	-1.3	-23.1	-57.3	-56.1	-60.1	34.2	Y
6.6	-25.28	-24.396	-28.93	6.6	-1.5	-23.3	-57.0	-56.2	-60.7	33.8	Y
6.7	-25.05	-24.457	-29.25	6.7	-1.7	-23.4	-56.8	-56.2	-61.0	33.4	Y
6.8	-24.81	-24.529	-29.25	6.8	-1.8	-23.6	-56.6	-56.3	-61.0	33.0	Y
6.9	-24.57	-24.61	-28.91	6.9	-2.0	-23.8	-56.3	-56.4	-60.7	32.6	Y
7.0	-24.34	-24.696	-28.31	7.0	-2.1	-23.9	-56.1	-56.5	-60.1	32.2	Y
7.1	-24.11	-24.785	-27.58	7.1	-2.0	-23.8	-55.9	-56.5	-59.3	32.1	Y
7.2	-23.89	-24.876	-26.79	7.2	-2.0	-23.8	-55.7	-56.6	-58.6	31.9	Y
7.3	-23.68	-24.97	-26.02	7.3	-2.0	-23.8	-55.4	-56.7	-57.8	31.7	Y
7.4	-23.49	-25.066	-25.28	7.4	-2.0	-23.8	-55.3	-56.8	-57.0	31.5	Y
7.5	-23.31	-25.167	-24.61	7.5	-2.0	-23.8	-55.1	-56.9	-56.4	31.3	Y
7.6	-23.15	-25.275	-24	7.6	-2.0	-23.8	-54.9	-57.0	-55.8	31.1	Y
7.7	-23	-25.394	-23.46	7.7	-2.0	-23.8	-54.8	-57.2	-55.2	31.0	Y
7.8	-22.86	-25.526	-22.97	7.8	-2.0	-23.8	-54.6	-57.3	-54.7	30.8	Y
7.9	-22.74	-25.676	-22.54	7.9	-2.0	-23.8	-54.5	-57.4	-54.3	30.7	Y
8.0	-22.64	-25.846	-22.16	8.0	-2.0	-23.8	-54.4	-57.6	-53.9	30.6	Y
8.1	-22.55	-26.039	-21.83	8.1	-2.0	-23.8	-54.3	-57.8	-53.6	30.5	Y
8.2	-22.48	-26.257	-21.54	8.2	-2.0	-23.8	-54.2	-58.0	-53.3	30.5	Y
8.3	-22.42	-26.502	-21.29	8.3	-2.0	-23.8	-54.2	-58.3	-53.1	30.4	Y
8.4	-22.38	-26.774	-21.08	8.4	-2.0	-23.8	-54.1	-58.5	-52.8	30.4	Y
8.5	-22.35	-27.07	-20.9	8.5	-2.0	-23.8	-54.1	-58.8	-52.7	30.3	Y
8.6	-22.33	-27.389	-20.75	8.6	-2.0	-23.8	-54.1	-59.1	-52.5	30.3	Y
8.7	-22.33	-27.725	-20.63	8.7	-2.0	-23.8	-54.1	-59.5	-52.4	30.3	Y
8.8	-22.35	-28.071	-20.55	8.8	-2.0	-23.8	-54.1	-59.8	-52.3	30.3	Y
8.9	-22.37	-28.418	-20.49	8.9	-2.0	-23.8	-54.1	-60.2	-52.3	30.4	Y
9.0	-22.42	-28.753	-20.47	9.0	-2.0	-23.8	-54.2	-60.5	-52.2	30.4	Y
9.1	-22.48	-29.064	-20.48	9.1	-2.0	-23.8	-54.2	-60.8	-52.2	30.5	Y
9.2	-22.56	-29.335	-20.53	9.2	-2.0	-23.8	-54.3	-61.1	-52.3	30.5	Y

5. Pointing Accuracy

The VMES V3 terminal will utilize a motion stabilized tracking antenna and a direct sequence spread spectrum (DSSS) burst modem manufactured by ViaSat to access the satellite. The VMES terminal uses a common spreading code and a random access method called code reuse multiple access ("CRMA") to access the satellite. CRMA is closely analogous to the more generally understood code division multiple access (CDMA) multiple access method, but differs in that all terminals use a common spreading code rather than a number of individual codes for each transmitter. Individual bursts are distinguished by time difference of arrival. The use of this spreading technique allows the RF spectral density for each VMES to be significantly lower that typical TDMA systems operating at Ku-band.

The antenna system utilizes a conical scanning function and rate gyros to stabilize the antenna and keep it pointed properly at the desired satellite. The conscan is currently set to worst case 0.6º from boresight. The mean dynamic pointing error for the vehicle accelerations expected during testing operation is expected to be 0.2º, with a standard deviation of 0.8º. Thus the total expected mean pointing error for each vehicle while in motion, including both conscan and dynamic error, is 0.8º with a declared maximum pointing error of 1.5º.

During the small percentage of time when conditions cause the antenna pointing error to exceed the specified maximum pointing error limit of 1.5º, the antenna system will send a message to the modem, and the modem will inhibit transmission until the aggregate conscan plus dynamic pointing error value is back to within 0.8º. The time lag from detection of exceedance of mispointing to time when transmit is inhibited will be less than 100 ms. This error limit of 1.5º is the declared maximum antenna pointing error as described in §25.226(b)(1)(iv)(A).

As described above, the VMESs in this network use a spread spectrum multiple access technique whereby the individual off-axis EIRP density of each VMES terminal is well below the maximum aggregate network limit. Thus, each antenna individually will not generate harmful levels of interference – even if the antenna was pointed directly at an adjacent satellite. Random pointing errors across this VMES network will not cause objectionable levels of adjacent satellite interference because the antenna on each VMES will be pointing in a different direction with a different error component. There is an extremely low probability that multiple antennas will be mispointed at an adjacent satellite at the same time in such a way that their power results in harmful interference levels. Because the pointing error is random and momentary, each VMES antenna actually has a higher likelihood of being pointed away from the geostationary satellite arc than at an adjacent satellite in the arc.

The following plots show how random pointing error adds up for several cases. In the first plot, Figure 8, a number of different standard deviations of pointing error are plotted: 1.666º, 1.0º, 0.666º, 0.5º, 0.333º and 0.166º. Each plot represents a long term statistical

sampling of 1,000,000 random errors for the specified standard deviation. The FCC mask is shown as adjusted to account for the spreading used by each terminal.

The ±12.8º of topocentric angle used for theta represent ±10º of geostationary satellite arc. The reference dBi plot on the charts is representative of the average of the antenna pattern for the topocentric angles to the geostationary arc from various locations across CONUS.

The second plot, Figure 9, shows the same reference dBi plot representing the aggregate population of terminals with no pointing error. A single VMES with 2º of pointing error is shown. It can be seen that even when the VMES is pointed directly at an adjacent satellite, the power density is well below the FCC off-axis EIRP density mask. In this case the VMES's input power density has been reduced by an additional 11.8 dB from the network aggregate – equivalent to a population of 15 co-frequency VMESs transmitting simultaneously.

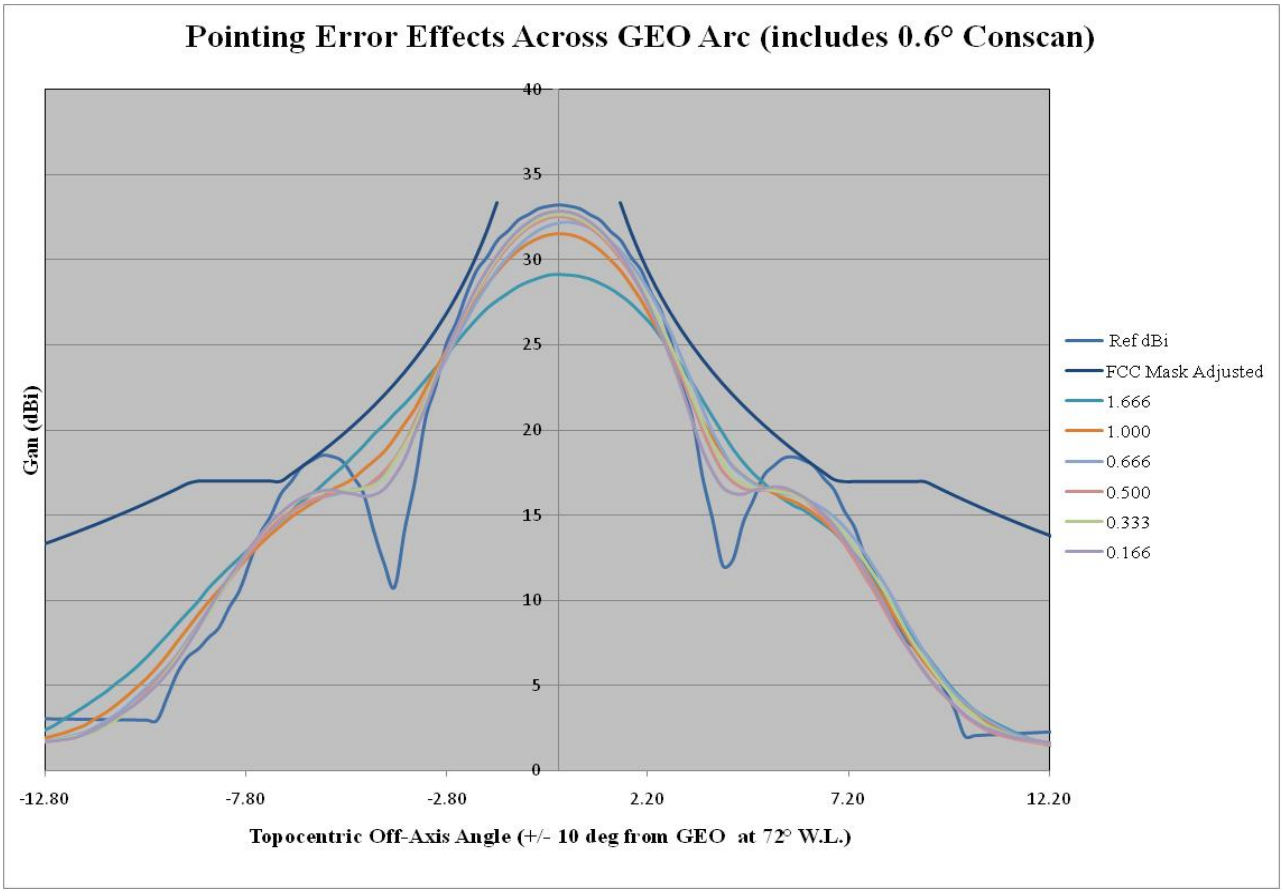

Figure 8– Aggregate pointing error for several standard deviations

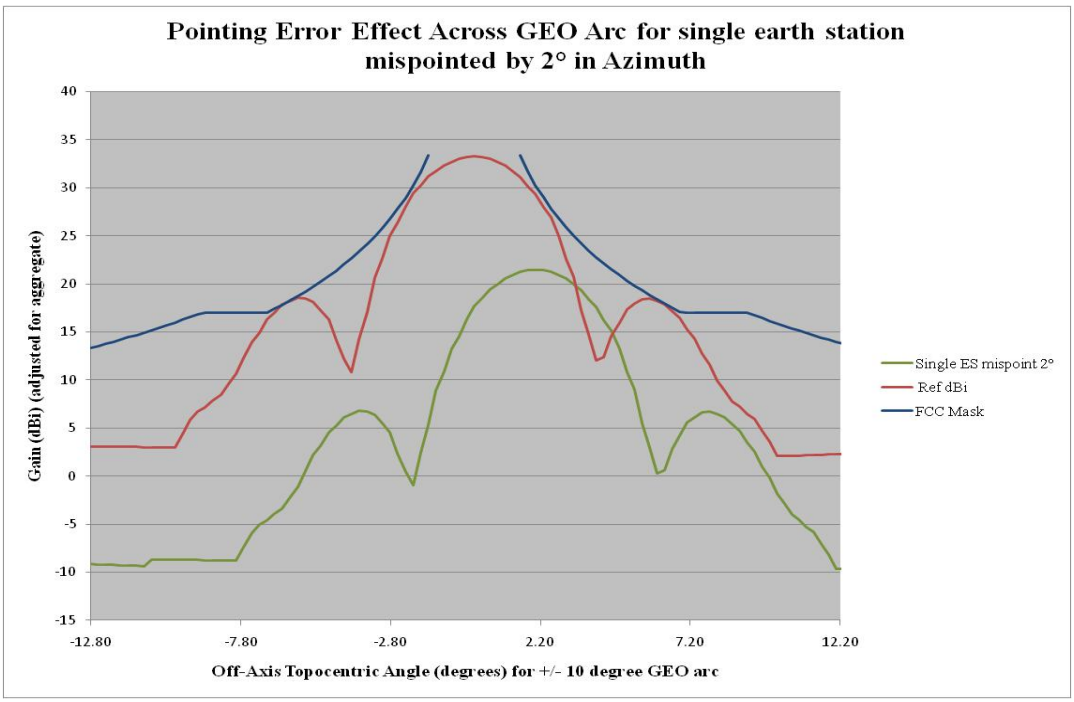

Figure 9– Impact of a single VMES with 2º of pointing error

Figure 10 shows 15 co-frequency VMESs transmitting simultaneously, each with random error and with conscan active. The aggregate power summation of all 15 VMESs is also plotted along with the reference dBi and adjusted FCC mask.

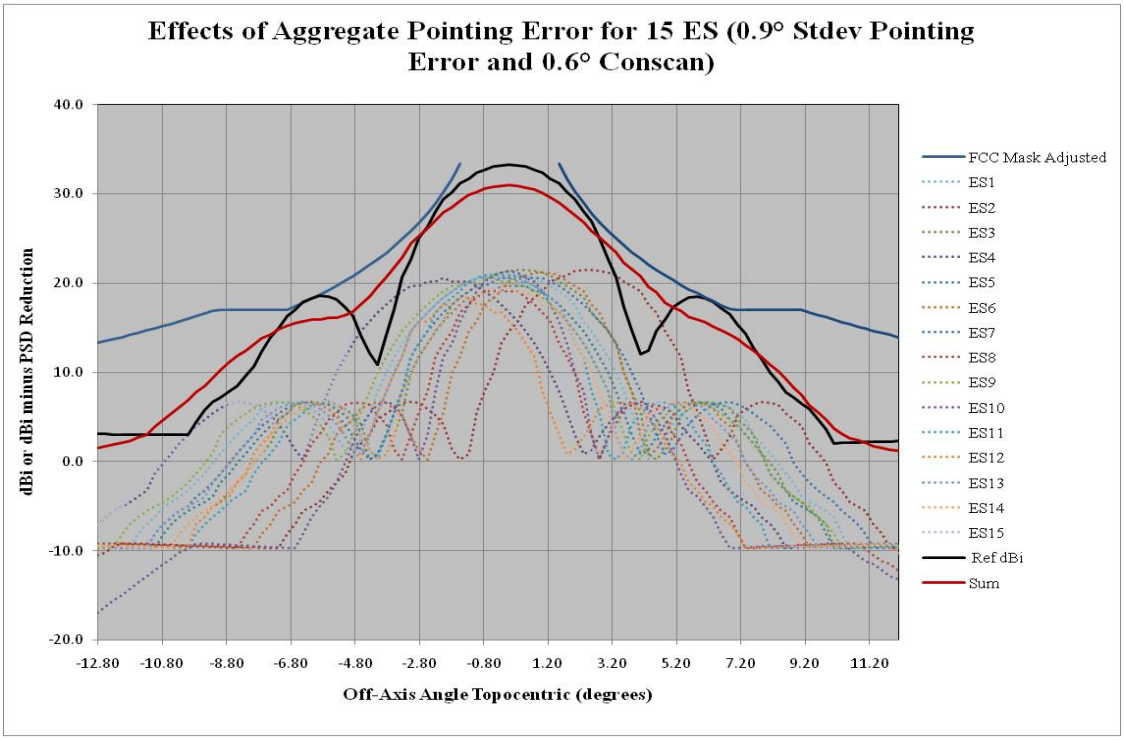

Figure 10 – Aggregate pointing error for 15 co-frequency VMESs

In summary, the V3 will maintain a deliberate conscan of 0.6º, assumes additional pointing error of 0.2º for a mean pointing accuracy of 0.8º (within which it will resume transmission after automated shut-down) and a declared maximum pointing error of 1.5º (beyond which it will automatically cease transmissions within 100ms). Even considering worst case excursions and additional conservative assumptions, the analysis shows that the VMES system will not cause adjacent satellite interference due to the very low RF power density of the spread spectrum return link.

6. Summary of Technical Parameters

The return link channel will support data rates for of 32 kbit/s, 64 kbit/s, 128 kbit/s, 256 kbit/s, and 512 kbit/s. The forward channel will be operated with data rates of 3-10 Mbits/s aggregate with individual end user rates between 512- 2Mbit/s. A summary of the V3 operating parameters is shown in the tables below:

Antenna diameter	37 cm
Type of Antenna	Parabolic rear-fed
Peak Power (SSPA)	3 watts
Transmit Bandwidth	18, 36 MHz
Transmit Gain	33 dBi at 14 GHz
EIRP	38 dBW
Transmit Data Rate	32 kbps to 512 Mbps
Transmit Polarization	Horizontal or Vertical
Transmit Max PSD	<10 dBW/4kHz
Transmit Azimuth, Elevation Beamwidth	3.5 degrees
Receive G/T	10 dB/K minimum
Receive Bandwidth	500 MHz
Receive Polarization	Dual Vertical and Horizontal

V3 VMES Terminal Parameters

Azimuth	continuous coverage over full 360º
Elevation	10 to 80º antenna elevation
Position accuracy	Static pointing error 0.6º RMS (AZ); 0.8º RMS (AZ) in-motion, Declared Maximum Pointing Error 1.5º)
Dynamic Tracking capability	Roll: +/-25° at 8 second period Pitch: +/-15° at 5 second period Yaw: +/-8° at 50 second period Azimuth Turn rate: 12°/s and 15°/s^2 acceleration

Antenna Control Parameters

Power a feed Flange	3	Watts
Channel; Bandwidth	36	MHz
RF Power Density at Flange	-34.8	dBW/4,kHz
Maximum Horizon EIRP Density (10° Elevation Angle)	-3.79	dBW/MHz
Maximum Horizon EIRP	11.77	dBW
Maximum Number Simultaneous Users N	13	

Uplink Transmission Parameters - 36 MHz Channel

Power a feed Flange	3	Watts
Channel; Bandwidth	18	MHz
RF Power Density at Flange	-31.8	dBW/4 kHz
Maximum Horizon EIRP Density (10° Elevation Angle)	-0.78	dBW/MHz
Maximum Horizon EIRP	11.77	dBW
Maximum Number Simultaneous Users N	6	

Uplink Transmission Parameters - 18 MHz Channel

7. FCC §25.226 Compliance Matrix for the V3 Terminal

	FCC Part 25 Vehicle Mounted Earth Stations (VMES) Rules for Ku-Band	Complies	Comments
§ 25.226	§ 25.226 Blanket licensing provisions for domestic, U.S. Vehicle-Mounted Earth Stations (VMESs) receiving in the 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth), and 11.7-12.2 GHz (space-to-Earth) frequency bands and transmitting in the 14.0-14.5 GHz (Earth-to-space) frequency band, operating with Geostationary Satellites in the Fixed-Satellite Service.		
§ 25.226(a)	(a) The following ongoing requirements govern all VMES licensees and operations in the 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth)11.7-12.2 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space) frequency bands receiving from and transmitting to geostationary orbit satellites in the fixed-satellite service. VMES licensees shall comply with the requirements in either paragraph (a)(1), (a)(2) or (a)(3) of this section and all of the requirements set forth in paragraphs (a)(4) through (a)(9) and paragraphs (c), (d), and (e) of this section. Paragraph (b) of this section identifies items that shall be included in the application for VMES operations to demonstrate that these ongoing requirements will be met.	Complies	Complies with (a)(1) and remaining provisions
§ 25.226(a)(1)	(1) The following requirements shall apply to a VMES that uses transmitters with off-axis EIRP spectral-densities lower than or equal to the levels in paragraph (a)(1)(i) of this section. A VMES, or VMES system, operating under this section shall provide a detailed demonstration as described in paragraph (b)(1) of this section. The VMES transmitter also shall comply with the antenna pointing and cessation of emission requirements in paragraphs (a)(1)(ii) and (a)(1)(iii) of this section.		

§ 25.226(a)(1)(i)	(i) A VMES system shall not exceed the off-axis EIRP spectral-density limits and conditions defined in paragraphs (a)(1)(i)(A) through (D) of this section.	Complies	Section 4
§ 25.226(a)(1)(i)(A)	(A) The off-axis EIRP spectral-density emitted from the VMES, in the plane of the geostationary satellite orbit (GSO) as it appears at the particular earth station location, shall not exceed the following values:	Complies	Section 4
	15-10log(N)-25logTH dBW/4kHz for 1.5DEG <= TH <= 7DEG		
	-6 -10log(N) dBW/4kHz for 7DEG < TH <= 9.2DEG		
	18 -10log(N)-25logTH dBW/4kHz for 9.2DEG < TH <= 48DEG		
	-24 -10log(N) dBW/4kHz for 48DEG < TH <= 85DEG		
	-14 -10log(N) dBW/4kHz for 85DEG < TH <= 180DEG		
	where theta (TH) is the angle in degrees from the line connecting the focal point of the antenna to the orbital location of the target satellite, the plane of the GSO is determined by the focal point of the antenna and the line tangent to the arc of the GSO at the orbital location of the target satellite. For VMES networks using frequency division multiple access (FDMA) or time division multiple access (TDMA) techniques, N is equal to one. For VMES networks using multiple co-frequency transmitters that have the same EIRP, N is the maximum expected number of co-frequency simultaneously transmitting VMES earth stations in the same satellite receiving beam. For the purpose of this section, the peak EIRP of an individual sidelobe shall not exceed the envelope defined above for TH between 1.5DEG and 7.0DEG. For TH greater than 7.0DEG, the envelope shall be exceeded by no more than 10% of the sidelobes, provided no individual sidelobe exceeds the envelope given above by more than 3 dB.		
§ 25.226(a)(1)(i)(B)	(B) In all directions other than along the GSO, the off-axis EIRP spectral-density for co-polarized signals emitted from the VMES shall not exceed the following values:	Complies	Section 4

	18 -10log(N) -25logTH dBW/4kHz for 3.0DEG <= TH <= 48DEG		
	-24 -10log(N) dBW/4kHz for 48DEG < TH <= 85DEG		
	-14 -10log(N) dBW/4kHz for 85DEG < TH <= 180DEG		
	where TH and N are defined in paragraph (a)(1)(i)(A) of this section. This off-axis EIRP spectral-density applies in any plane that includes the line connecting the focal point of the antenna to the orbital location of the target satellite with the exception of the plane of the GSO as defined in paragraph (a)(1)(i)(A) of this section. For the purpose of this subsection, the envelope shall be exceeded by no more than 10% of the sidelobes provided no individual sidelobe exceeds the gain envelope given above by more than 6 dB. The region of the main reflector spillover energy is to be interpreted as a single lobe and shall not exceed the envelope by more than 6 dB.		
§ 25.226(a)(1)(i)(C)	(C) In all directions, the off-axis EIRP spectral-density for cross-polarized signals emitted from the VMES shall not exceed the following values:	Complies	Section 4
	5 -10log(N) -25logTH dBW/4kHz for 1.8DEG <= TH <= 7.0DEG		
	-16 -10log(N) dBW/4kHz for 7.0DEG < TH <= 9.2DEG		
	where TH and N are defined as set forth in paragraph (a)(1)(i)(A) of this section. This EIRP spectral-density applies in any plane that includes the line connecting the focal point of the antenna to the target satellite.		
§ 25.226(a)(1)(i)(D)	(D) For non-circular VMES antennas, the major axis of the antenna shall be aligned with the tangent to the arc of the GSO at the orbital location of the target satellite, to the extent required to meet the specified off-axis EIRP spectral-density criteria.		
§ 25.226(a)(1)(ii)	(ii) Each VMES transmitter shall meet one of the following antenna pointing requirements:		

§ 25.226(a)(1)(ii)(A)	(A) Each VMES transmitter shall maintain a pointing error of less than or equal to 0.2° between the orbital location of the target satellite and the axis of the main lobe of the VMES antenna, or	NA	
§ 25.226(a)(1)(ii)(B)	(B) Each VMES transmitter shall declare a maximum antenna pointing error that may be greater than 0.2° provided that the VMES does not exceed the off-axis EIRP spectral-density limits in paragraph (a)(1)(i) of this section, taking into account the antenna pointing error.	Complies	Section 5
§ 25.226(a)(1)(iii)	(iii) Each VMES transmitter shall meet one of the following cessation of emission requirements:		
§ 25.226(a)(1)(iii)(A)	(A) For VMESs operating under paragraph (a)(1)(ii)(A) of this section, all emissions from the VMES shall automatically cease within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the VMES antenna exceeds 0.5°, and transmission shall not resume until such angle is less than or equal to 0.2°, or	NA	
§ 25.226(a)(1)(iii)(B)	(B) For VMES transmitters operating under paragraph (a)(1)(ii)(B) of this section, all emissions from the VMES shall automatically cease within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the VMES antenna exceeds the declared maximum antenna pointing error and shall not resume transmissions until such angle is less than or equal to the declared maximum antenna pointing error.	Complies	Section 5; resumes transmissions at 0.8° offset even though declared maximum point error is 1.5°
§ 25.226(a)(2)	(2) The following requirements shall apply to a VMES that uses off-axis EIRP spectral-densities in excess of the levels in paragraph (a)(1)(i) of this section. A VMES, or VMES system, operating under this subsection shall file certifications and provide a detailed demonstration as described in paragraph (b)(2) of this section.	NA	
§ 25.226(a)(2)(i)	(i) The VMES shall transmit only to the target satellite system(s) referred to in the certifications required by paragraph (b)(2) of this section.		

§ 25.226(a)(2)(ii)	(ii) If a good faith agreement cannot be reached between the target satellite operator and the operator of a future satellite that is located within 6 degrees longitude of the target satellite, the VMES operator shall accept the power-density levels that would accommodate that adjacent satellite.		
§ 25.226(a)(2)(iii)	(iii) The VMES shall operate in accordance with the off-axis EIRP spectral-densities that the VMES supplied to the target satellite operator in order to obtain the certifications listed in paragraph (b)(2) of this section. The VMES shall automatically cease emissions within 100 milliseconds if the VMES transmitter exceeds the off-axis EIRP spectral-densities supplied to the target satellite operator.		
§ 25.226(a)(3)	(3) The following requirements shall apply to a VMES system that uses variable power-density control of individual simultaneously transmitting co-frequency VMES earth stations in the same satellite receiving beam. A VMES system operating under this subsection shall file certifications and provide a detailed demonstration as described in paragraph (b)(3) of this section.	NA	
§ 25.226(a)(3)(i)	(i) Except as defined under paragraph (a)(3)(ii) of this section, the effective aggregate EIRP-density from all terminals shall be at least 1 dB below the off-axis EIRP-density limits defined in paragraphs (a)(1)(i)(A) through (C) of this section. In this context the term "effective" means that the resultant co-polarized and cross-polarized EIRP-density experienced by any GSO or non-GSO satellite shall not exceed that produced by a single VMES transmitter operating 1 dB below the limits defined in paragraphs (a)(1)(i)(A) through (C) of this section. A VMES system operating under this section shall file certifications and provide a detailed demonstration as described in paragraphs (b)(3)(i) and b)(3)(iii) of this section.		

§ 25.226(a)(3)(ii)	(ii) The following requirements shall apply to a VMES that uses off-axis EIRP spectral-densities in excess of the levels in paragraph (a)(3)(i) of this section. A VMES system operating under this section shall file certifications and provide a detailed demonstration as described in paragraphs (b)(3)(ii) and (b)(3)(iii) of this section.		
§ 25.226(a)(3)(ii)(A)	(A) If a good faith agreement cannot be reached between the target satellite operator and the operator of a future satellite that is located within 6 degrees longitude of the target satellite, the VMES shall operate at an EIRP-density defined in paragraph (a)(3)(i) of this section.		
§ 25.226(a)(3)(ii)(B)	(B) The VMES shall operate in accordance with the off-axis EIRP spectral-densities that the VMES supplied to the target satellite operator in order to obtain the certifications listed in paragraph (b)(3)(ii) of this section. The individual VMES terminals shall automatically cease emissions within 100 milliseconds if the VMES transmitter exceeds the off-axis EIRP spectral-densities supplied to the target satellite operator. The overall system shall be capable of shutting off an individual transmitter or the entire system if the aggregate off-axis EIRP spectral-densities exceed those supplied to the target satellite operator.		
§ 25.226(a)(3)(ii)(C)	(C) The VMES shall transmit only to the target satellite system(s) referred to in the certifications required by paragraph (b)(3) of this section.		
§ 25.226(a)(3)(iii)	(iii) The VMES shall file a report one year following license issuance detailing the effective aggregate EIRP-density levels resulting from its operation, in compliance with paragraph (b)(3)(iii) of this section.		
§ 25.226(a)(4)	(4) An applicant filing to operate a VMES terminal or system and planning to use a contention protocol shall certify that its contention protocol use will be reasonable.	NA	

§ 25.226(a)(5)	(5) There shall be a point of contact in the United States, with phone number and address, available 24 hours a day, seven days a week, with authority and ability to cease all emissions from the VMESs.	Complies	Narrative Section II.E.3
§ 25.226(a)(6)	(6) For each VMES transmitter, a record of the vehicle location (i.e.,latitude/longitude), transmit frequency, channel bandwidth and satellite used shall be time annotated and maintained for a period of not less than one (1) year. Records shall be recorded at time intervals no greater than every five (5) minutes while the VMES is transmitting. The VMES operator shall make this data available upon request to a coordinator, fixed system operator, fixed-satellite system operator, NTIA, or the Commission within 24 hours of the request.	Complies	Narrative Section II.E.3
§ 25.226(a)(7)	(7) In the 10.95-11.2 GHz (space-to-Earth) and 11.45-11.7 GHz(space-to-Earth) frequency bands VMESs shall not claim protection from interference from any authorized terrestrial stations to which frequencies are either already assigned, or may be assigned in the future.	Complies	Narrative Section II.E.3
§ 25.226(a)(8)	(8) A VMES terminal receiving in the 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth) and 11.7-12.2 GHz (space-to-Earth) bands shall receive protection from interference caused by space stations other than the target space station only to the degree to which harmful interference would not be expected to be caused to an earth station employing an antenna conforming to the referenced patterns defined in § 25.209(a) and (b) and stationary at the location at which any interference occurred.	Complies	Narrative Section II.E.3
§ 25.226(a)(9)	(9) Each VMES terminal shall automatically cease transmitting within 100 milliseconds upon loss of reception of the satellite downlink signal.	Complies	Narrative Section II.E.3

§ 25.226(b)	(b) Applications for VMES operation in the 14.0-14.5 GHz (Earth-to-space) band to GSO satellites in the fixed-satellite service shall include, in addition to the particulars of operation identified on Form 312, and associated Schedule B, the applicable technical demonstrations in paragraphs (b)(1), (b)(2) or (b)(3) of this section and the documentation identified in paragraphs (b)(4) through (b)(8) of this section.	Complies	Complies with (b)(1) and remaining provisions
§ 25.226(b)(1)	(1) A VMES applicant proposing to implement a transmitter under paragraph (a)(1) of this section shall demonstrate that the transmitter meets the off-axis EIRP spectral-density limits contained in paragraph (a)(1)(i) of this section. To provide this demonstration, the application shall include the tables described in paragraph (b)(1)(i) of this section **or** the certification described in paragraph (b)(1)(ii)of this section. The VMES applicant also shall provide the value N described in paragraph (a)(1)(i)(A) of this section. A VMES applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(A) of this section shall provide the certifications identified in paragraph (b)(1)(iii) of this section. A VMES applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(B) of this section shall provide the demonstrations identified in paragraph (b)(1)(iv) of this section.		
§ 25.226(b)(1)(i)	(i) Any VMES applicant filing an application pursuant to paragraph (a)(1) of this section shall file three tables showing the off-axis EIRP level of the proposed earth station antenna in the direction of the plane of the GSO; the co-polarized EIRP in the elevation plane, that is, the plane perpendicular to the plane of the GSO; and cross polarized EIRP. Each table shall provide the EIRP level at increments of 0.1° for angles between 0° and 10° off-axis, and at increments of 5° for angles between 10° and 180° off-axis.	Complies.	Section 4

§ 25.226(b)(1)(i)(A)	(A) For purposes of the off-axis EIRP table in the plane of the GSO, the off-axis angle is the angle in degrees from the line connecting the focal point of the antenna to the orbital location of the target satellite, and the plane of the GSO is determined by the focal point of the antenna and the line tangent to the arc of the GSO at the orbital position of the target satellite.		
§ 25.226(b)(1)(i)(B)	(B) For purposes of the off-axis co-polarized EIRP table in the elevation plane, the off-axis angle is the angle in degrees from the line connecting the focal point of the antenna to the orbital location of the target satellite, and the elevation plane is defined as the plane perpendicular to the plane of the GSO defined in paragraph(b)(1)(i)(A) of this section.		
§ 25.226(b)(1)(i)(C)	(C) For purposes of the cross-polarized EIRP table, the off-axis angle is the angle in degrees from the line connecting the focal point of the antenna to the orbital location of the target satellite and the plane of the GSO as defined in paragraph (b)(1)(i)(A) of this section will be used.		
§ 25.226(b)(1)(ii)	(ii) A VMES applicant shall include a certification, in Schedule B, that the VMES antenna conforms to the gain pattern criteria of § 25.209(a) and (b), that, combined with the maximum input power density calculated from the EIRP density less the antenna gain, which is entered in Schedule B, demonstrates that the off-axis EIRP spectral density envelope set forth in paragraphs (a)(1)(i)(A) through (a)(1)(i)(C) of this section will be met under the assumption that the antenna is pointed at the target satellite.	NA	

§ 25.226(b)(1)(iii)	(iii) A VMES applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(A) of this section shall provide a certification from the equipment manufacturer stating that the antenna tracking system will maintain a pointing error of less than or equal to 0.2° between the orbital location of the target satellite and the axis of the main lobe of the VMES antenna and that the antenna tracking system is capable of ceasing emissions within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the VMES antenna exceeds 0.5°.	NA	
§ 25.226(b)(1)(iv)	(iv) A VMES applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(B) of this section shall:	Complies	
§ 25.226(b)(1)(iv)(A)	(A) Declare, in its application, a maximum antenna pointing error and demonstrate that the maximum antenna pointing error can be achieved without exceeding the off-axis EIRP spectral-density limits in paragraph (a)(1)(i) of this section; and	Complies	Section 5
§ 25.226(b)(1)(iv)(B)	(B) Demonstrate that the VMES transmitter can detect if the transmitter exceeds the declared maximum antenna pointing error and can cease transmission within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the VMES antenna exceeds the declared maximum antenna pointing error, and will not resume transmissions until the angle between the orbital location of the target satellite and the axis of the main lobe of the VMES antenna is less than or equal to the declared maximum antenna pointing error.	Complies	Section 5
§ 25.226(b)(2)	(2) A VMES applicant proposing to implement a transmitter under paragraph (a)(2) of this section and using off-axis EIRP spectral-densities in excess of the levels in paragraph (a)(1)(i) of this section shall provide the following certifications and demonstration as exhibits to its earth station application:	NA	

§ 25.226(b)(2)(i)	(i) A statement from the target satellite operator certifying that the proposed operation of the VMES has the potential to create harmful interference to satellite networks adjacent to the target satellite(s)that may be unacceptable.		
§ 25.226(b)(2)(ii)	(ii) A statement from the target satellite operator certifying that the power density levels that the VMES applicant provided to the target satellite operator are consistent with the existing coordination agreements between its satellite(s) and the adjacent satellite systems within 6DEG of orbital separation from its satellite(s).		
§ 25.226(b)(2)(iii)	(iii) A statement from the target satellite operator certifying that it will include the power-density levels of the VMES applicant in all future coordination agreements.		
§ 25.226(b)(2)(iv)	(iv) A demonstration from the VMES operator that the VMES system is capable of detecting and automatically ceasing emissions within 100 milliseconds when the transmitter exceeds the off-axis EIRP spectral-densities supplied to the target satellite operator.		
§ 25.226(b)(3)	(3) A VMES applicant proposing to implement VMES system under paragraph (a)(3) of this section and using variable power-density control of individual simultaneously transmitting co-frequency VMES earth stations in the same satellite receiving beam shall provide the following certifications and demonstration as exhibits to its earth station application:	NA	

§ 25.226(b)(3)(i)	(i) The applicant shall make a detailed showing of the measures it intends to employ to maintain the effective aggregate EIRP-density from all simultaneously transmitting co-frequency terminals operating with the same satellite transponder at least 1 dB below the EIRP-density limits defined in paragraphs (a)(1)(i)(A) through (C) of this section. In this context the term "effective" means that the resultant co-polarized and cross-polarized EIRP-density experienced by any GSO or non-GSO satellite shall not exceed that produced by a single VMES transmitter operating at 1 dB below the limits defined in paragraphs(a)(1)(i)(A) through (C) of this section. The International Bureau will place this showing on public notice along with the application.		
§ 25.226(b)(3)(ii)	(ii) An applicant proposing to implement a VMES under paragraph (a)(3)(ii) of this section that uses off-axis EIRP spectral-densities in excess of the levels in paragraph (a)(3)(i) of this section shall provide the following certifications, demonstration and list of satellites as exhibits to its earth station application:		
§ 25.226(b)(3)(ii)(A)	(A) A detailed showing of the measures the applicant intends to employ to maintain the effective aggregate EIRP-density from all simultaneously transmitting co-frequency terminals operating with the same satellite transponder at the EIRP-density limits supplied to the target satellite operator. The International Bureau will place this showing on public notice along with the application.		
§ 25.226(b)(3)(ii)(B)	(B) A statement from the target satellite operator certifying that the proposed operation of the VMES has the potential to create harmful interference to satellite networks adjacent to the target satellite(s) that may be unacceptable.		

§ 25.226(b)(3)(ii)(C)	(C) A statement from the target satellite operator certifying that the aggregate power density levels that the VMES applicant provided to the target satellite operator are consistent with the existing coordination agreements between its satellite(s) and the adjacent satellite systems within 6DEG of orbital separation from its satellite(s).		
§ 25.226(b)(3)(ii)(D)	(D) A statement from the target satellite operator certifying that it will include the aggregate power-density levels of the VMES applicant in all future coordination agreements.		
§ 25.226(b)(3)(ii)(E)	(E) A demonstration from the VMES operator that the VMES system is capable of detecting and automatically ceasing emissions within 100 milliseconds when an individual transmitter exceeds the off-axis EIRP spectral-densities supplied to the target satellite operator and that the overall system is capable of shutting off an individual transmitter or the entire system if the aggregate off-axis EIRP spectral-densities exceed those supplied to the target satellite operator.		
§ 25.226(b)(3)(ii)(F)	(F) An identification of the specific satellite or satellites with which the VMES system will operate.		
§ 25.226(b)(3)(iii)	(iii) The applicant shall acknowledge that it will maintain sufficient statistical and technical information on the individual terminals and overall system operation to file a detailed report, one year after license issuance, describing the effective aggregate EIRP-density levels resulting from the operation of the VMES system.		
§ 25.226(b)(4)	(4) There shall be an exhibit included with the application describing the geographic area(s) in which the VMESs will operate.	Complies	Narrative Section II.E.3
§ 25.226(b)(5)	(5) Any VMES applicant filing for a VMES terminal or system and planning to use a contention protocol shall include in its application a certification that will comply with the requirements of paragraph (a)(4) of this section.	NA	
§ 25.226(b)(6)	(6) The point of contact referred to in paragraph (a)(5) of this section shall be included in the application.	Complies	Narrative Section II.E.3

§ 25.226(b)(7)	(7) Any VMES applicant filing for a VMES terminal or system shall include in its application a certification that will comply with the requirements of paragraph (a)(6) of this section.	Complies	Narrative Section II.E.3
§ 25.226(b)(8)	(8) All VMES applicants shall submit a radio frequency hazard analysis determining via calculation, simulation, or field measurement whether VMES terminals, or classes of terminals, will produce power densities that will exceed the Commission's radio frequency exposure criteria. VMES applicants with VMES terminals that will exceed the guidelines in § 1.1310 of this chapter for radio frequency radiation exposure shall provide, with their environmental assessment, a plan for mitigation of radiation exposure to the extent required to meet those guidelines. All VMES licensees shall ensure installation of VMES terminals on vehicles by qualified installers who have an understanding of the antenna's radiation environment and the measures best suited to maximize protection of the general public and persons operating the vehicle and equipment. A VMES terminal exhibiting radiation exposure levels exceeding 1.0 mW/cm^2 in accessible areas, such as at the exterior surface of the radome, shall have a label attached to the surface of the terminal warning about the radiation hazard and shall include thereon a diagram showing the regions around the terminal where the radiation levels could exceed 1.0 mW/cm^2 . All VMES licensees shall ensure that a VMES terminal ceases transmission upon encountering an obstruction that degrades the VMES downlink signal.	Complies	Exhibit 4

§ 25.226(c)(1)	(c)(1) Operations of VMESs in the 14.0-14.2 GHz (Earth-to-space) frequency band within 125 km of the NASA TDRSS facilities on Guam (latitude 13DEG36'55" N, longitude 144DEG51'22" E) or White Sands, New Mexico (latitude 32DEG20'59" N, longitude 106DEG36'31" W and latitude 32DEG32'40" N, longitude 106DEG36'48" W) are subject to coordination with the National Aeronautics and Space Administration (NASA) through the National Telecommunications and Information Administration (NTIA) Interdepartment Radio Advisory Committee (IRAC). Licensees shall notify the International Bureau once they have completed coordination. Upon receipt of such notification from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party has opposed the operations.	Complies	Narrative Section II.E.4
§ 25.226(c)(2)	(2) When NTIA seeks to provide similar protection to future TDRSS sites that have been coordinated through the IRAC Frequency Assignment Subcommittee process, NTIA will notify the Commission's International Bureau that the site is nearing operational status. Upon public notice from the International Bureau, all Ku-band VMES licensees shall cease operations in the 14.0-14.2 GHz band within 125 km of the new TDRSS site until the licensees complete coordination with NTIA/IRAC for the new TDRSS facility. Licensees shall notify the International Bureau once they have completed coordination for the new TDRSS site. Upon receipt of such notification from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party has opposed the operations. The VMES licensee then will be permitted to commence operations in the 14.0-14.2 GHz band within 125 km of the new TDRSS site, subject to any operational constraints developed in the coordination process.		

§ 25.226(d)(1)	(d)(1) Operations of VMESs in the 14.47-14.5 GHz (Earth-to-space) frequency band in the vicinity of radio astronomy service (RAS) observatories observing in the 14.47-14.5 GHz band are subject to coordination with the National Science Foundation (NSF). The appropriate NSF contact point to initiate coordination is Electromagnetic Spectrum Manager, NSF, 4201 Wilson Blvd., Suite 1045,Arlington VA 22603, fax 703-292-9034, e-mail esm@nsf.gov . Licensees shall notify the International Bureau once they have completed coordination. Upon receipt of the coordination agreement from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party has opposed the operations.	Complies	Narrative Section II.E.4
§ 25.226(d)(2)	(2) Table 1 provides a list of each applicable RAS site, its location, and the applicable coordination zone.		
	Table 1--Applicable Radio Astronomy Service (RAS) Facilities and Associated Coordination Distances Observatory Latitude (north) Longitude (west) Radius (km) of coordination zone		
	Arecibo, Observatory, Arecibo, PR 18DEG20'37" 66DEG45'11" Island of Puerto Rico.		
	Green Bank, WV 38DEG25'59" 79DEG50'23" 160.		
	Very Large Array, near Socorro, NM 34DEG04'44" 107DEG37'06" 160.		
	Pisgah Astronomical Research Institute, Rosman, NC 35DEG11'59"82DEG52'19" 160.		
	U of Michigan Radio Astronomy Observatory, Stinchfield Woods, MI42DEG23'56" 83DEG56'11" 160.		
	Very Long Baseline Array (VLBA) stations:		
	Owens Valley, CA 37DEG13'54" 118DEG16'37" 160*.		
	Mauna Kea, HI 19DEG48'05" 155DEG27'20" 50.		
	Brewster, WA 48DEG07'52" 119DEG41'00"		
	Kitt Peak, AZ 31DEG57'23" 111DEG36'45"		
	Pie Town, NM 34DEG18'04" 108DEG07'09"		

	Los Alamos, NM 35DEG46'30" 106DEG14'44"		
	Fort Davis, TX 30DEG38'06" 103DEG56'41"		
	North Liberty, IA 41DEG46'17" 91DEG34'27"		
	Hancock, NH 42DEG56'01" 71DEG59'12"		
	St. Croix, VI 17DEG45'24" 64DEG35'01"		
	*Owens Valley, CA operates both a VLBA station and single-dish telescopes.		
§ 25.226(d)(3)	(3) When NTIA seeks to provide similar protection to future RAS sites that have been coordinated through the IRAC Frequency Assignment Subcommittee process, NTIA will notify the Commission's International Bureau that the site is nearing operational status. Upon public notice from the International Bureau, all Ku-band VMES licensees shall cease operations in the 14.47-14.5 GHz band within the relevant geographic zone (160 kms for single-dish radio observatories and Very Large Array antenna systems and 50 kms for Very Long Baseline Array antenna systems) of the new RAS site until the licensees complete coordination for the new RAS facility. Licensees shall notify the International Bureau once they have completed coordination for the new RAS site and shall submit the coordination agreement to the Commission. Upon receipt of such notification from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party opposed the operations. The VMES licensee then will be permitted to commence operations in the 14.47-14.5 GHz band within the relevant coordination distance around the new RAS site, subject to any operational constraints developed in the coordination process.		
§ 25.226(e)	(e) VMES licensees shall use Global Positioning Satellite-related or other similar position location technology to ensure compliance with paragraphs (c) and (d) of this section.	Complies	Narrative Section II.E.4

8. Sample Link Analysis

SYSTEM PARAMETERS			
Uplink Frequency	14.18	GHz	
Forward Uplink Availability	99.75%		
Return Uplink Availability	99.75%		
Downlink Frequency	11.88	GHz	
Forward Downlink Availability	99.75%		
Return Downlink Availability	99.75%		
Mobile Site	Var - Seattle		
Hub Site	Carlsbad		
Vehicle Inclination	0	°	
F/R Transponder Input Ratio	18.4	dB	
alpha_power	0.01432		
PCMA Cancellation C/I	25	dB	
Forward Link			
Data Rate	4.00E+06	bps	4000000
Bit Error Rate	1 x 10E-7	QPSK 1/3	
Eb/No Required	1.7	dB	
C/No Required	67.72	dB-Hz	
Modulation Type	QPSK DSSS	=I/2 BPSK 3	
FEC Factor	Rate 1/3 Turbo		
Spread Factor : Spread Signal Rate	2	28800	kcps
Carrier Spacing: Authorized BW	1.2	36000	kHz
Bits per symbol	0.3333	VSAT Proprietary FL	
Signal Rate	14400	kbaud/s	
Return Link			
Data Rate	128000	bps	
Packet Error Rate	1 x 10E-3		
Eb/No Required	2.25	dB	
C/No Required	53.32	dB-Hz	
Modulation Type	GMSK DSSS		
FEC Factor	Rate 1/3 TC		
Alpha_MAI	0.859		
Beta_MAI	0.712	108	
Spread Factor : Spread Signal Rate	88	33792	kcps
Carrier Spacing	1		
Bits per symbol	0.3333		
Transponder Bandwidth	24060	kHz	
Occupied Bandwidth	29027	kHz	
Signal Rate	384.0	kbaud/s	
Number of Return Links	10		1.00E+01

Fwd Link Total Availability	**99.50%**		
Return Link Total Availability	**99.50%**		
LINK STATUS	**Clear Sky**	**U/L Rain**	**D/L Rain**
Forward Link Margin	**4.4**	**4.4**	**3.1**
Return Link Margin	**2.05**	**0.13**	**1.98**
Regulatory Limits	**Performance**	**Rqmt.**	
Return Agg. Ant. Flange Pwr Density	-23.78	-23.02	dBW/4kHz
Return Uplink Off-axis Pwr Density	4.0	16	dBW/40kHz
Forward Downlink Pwr Density at Peak	11.93	13	dBW/4kHz

Mobile Antenna Transmit Characteristics (Return Uplink)		
Antenna Type	KVH	
Uplink Frequency	14.18	GHz
Antenna Diameter	0.37	m
	17.5	wavelengths
Aperture efficiency	68%	
Antenna peak gain	33.1	dB
CW Sat Transmit Power	3	W
Transmission losses	-1.3	dB
Antenna Ohmic Losses	-0.1	dB
Radome Loss	-0.8	dB
CW Sat EIRP at peak	35.7	dBW
OBO	0.00	dB
Pointing loss, etc.	-0.07	dB
EIRP (not including pointing loss)	**35.71**	**dBW**
Clear-Sky PFD	**-127.07**	**dBW/m2**
Available UPC Boost	0.0	dB
UPC Error	0	dB
HPA Suppression	0.0	dB
Antenna Crosspol Discrimination	15.0	dB
Pointing Error (Tx and Rx)	0.31	deg

Mobile Antenna Receive Characteristics (Forward Downlink)		
Antenna Type	KVH	
Downlink Frequency	11.88	GHz
Antenna Diameter	0.37	m
	14.7	wavelengths
Aperture efficiency	60%	
Antenna peak gain	31.0	dB
LNB Noise Figure	0.94	dB
Reference Temperature	290	K
Antenna Ohmic Losses	-0.1	dB
Radome Ohmic Loss	-0.10	dB
Clear-sky Antenna Temperature	30	K
Clear-sky Tsys	117.0	K
Radome non-ohmic loss	-0.10	dB
Antenna non-ohmic loss	0.0	dB
Pointing Loss	-0.1	dB
Clear-sky G/T	**10.20**	**dB/K**
Antenna Crosspol Discrimination	15.0	dB

Spacecraft Transponder		
Spacecraft	AMC-15	
Satellite Longitude	255	deg E
Transponder Total Bandwidth	36	MHz
Transponder Allocated Bandwidth	36	MHz
Forward CW Sat EIRP	46	dBW
Forward G/T	1.25	dB/K
Return CW Sat EIRP	48.4	dBW
Return G/T	2	dB/K
Forward Min SFD	-92.94	dBW/m2
Return Min SFD	-93.69	dBW/m2

Hub Antenna Transmit Characteristics (Forward Uplink)		
Uplink Frequency	14.18	GHz
Antenna Diameter	4.5	m
	212.7	wavelengths
Antenna efficiency	65%	
Antenna peak gain	54.6	dB
Max HPA Transmit Power	400	W
Transmission losses	-2.53	dB
Antenna Ohmic Losses	0	dB
Radome Loss	0	dB
CW EIRP	78.1	dBW
OBO	-12.6	dB
Pointing loss, etc.	-0.5	dB
EIRP (not including pointing loss)	**65.05**	**dBW**
Clear-sky PFD	**-97.94**	**dBW/m2**
Available UPC Boost	12.6	dB
UPC Error	0.0	dB
HPA Suppression	0.0	dB
Antenna Crosspol Discrimination	30.0	
Half-power beamwidth	0.3	deg

Hub Antenna Receive Characteristics (Return Downlink)		
Downlink Frequency	11.88	GHz
Antenna Diameter	4.5	m
	178.2	wavelengths
Antenna efficiency	66%	
Antenna peak gain	53.2	dB
LNB Noise Figure	0.94	dB
Input Losses	0	dB
Antenna Ohmic Losses	0	dB
Radome Loss	0	dB
Clear-sky Antenna Temperature	35	K
Clear-sky Tsys	105.1	K
Pointing loss, etc.	-0.5	dB
Antenna non-ohmic loss	0.0	
Clear-sky G/T	**32.4**	**dB/K**
Half-power beamwidth	0.4	deg
Antenna Crosspol Discrimination	30.0	dB
Desired Transponder OBO point	-2	dB
Additional Forward Link Backoff	0	
IBO - Clear Sky Uplink	-5.0	dB
IBO - Rain Uplink	-5.0	dB
OBO - Clear Sky Uplink	-2.0	dB
OBO - Rain Uplink	-2.0	dB
Fwd Transponder Suppression	-0.51	dB
Rtn Transponder Suppression	-1.75	dB
Fwd EIRP- Clear Sky Uplink	43.5	dBW
Rtn EIRP - CS U/L - Single Carrier	16.3	dBW
Uplink Interfering Transponder G/T	2	dB/K

Forward Link Parameters	Uplink	Downlink
Site	Carlsbad	Var - Seattle
Frequency, GHz	14.18	11.88
Availability	99.75%	99.75 %
Antenna Size, m	4.5	0.37
Modulation	QPSK DSSS	
Coding	Rate 1/3 Turbo	
Data rate (kbps)	4000	

EndtoEnd Link Budget	Clear Sky	Rain U/L Rain D/L	Rain U/L Clear Sky D/L	Clear Sky U/L Rain D/L
Uplink C/No	89.2	89.2	89.2	89.2 dBHz
Uplink C/Io	91.9	91.9	91.9	91.9 dBHz
Downlink C/No	76.6	73.7	76.6	73.7 dBHz
Downlink C/Io	74.2	74.2	74.2	74.2 dBHz
Total C/(No+Io)	72.1	70.8	72.1	70.8 dBHz
Required C/(No+Io)	67.7	67.7	67.7	67.7 dBHz

Uplink C/No budget	Clear Sky	Rain U/L
Uplink EIRP (incl. UPC compensation)	65.5	66.9 dBW
Hub Pointing Loss	0.5	0.5 dB
Path Loss	207.0	208.3 dB
Spacecraft G/T	1.25	1.25 dB/K
Boltzmann's constant	228.6	228.6 dBW/K/Hz
Uplink C/No Transponder input	87.93	87.9 dBHz
Carrier Suppression	0.51	0.51 dB
Noise Suppression	1.74	1.74 dB
Uplink C/No Transponder output	89.2	89.2 dBHz

Downlink C/No budget	Clear Sky	Rain	Rain U/L Clear Sky D/L	Clear Sky U/L Rain D/L
Downlink EIRP	43.49	43.5	43.5	43.5 dBW
Path Loss	205.71	206.9	205.7	206.9 dB
Mobile Clearsky G/T	10.20	10.2	10.2	10.2 dB/K
Rain Noise Temperature Increase	0	1.7	0	1.7 dB
Boltzmann's constant	228.60	228.6	228.6	228.6 dBW/K/Hz
Downlink C/No	76.58	73.7	76.6	73.7 dBHz

Uplink C/Io terms	Clear Sky	Rain U/L
ASI	93.9	93.9 dBHz
CrossPol	94.6	94.6 dBHz
Uplink HPA IM	100	100 dBHz
Uplink C/Io Transponder input	90.7	90.7 dBHz
Carrier Suppression	0.51	0.51 dB
Noise Suppression	1.74	1.74 dB
Uplink C/Io Transponder output	91.9	91.9 dBHz

Downlink C/Io terms	Clear Sky	Rain U/L Rain D/L	Rain U/L Clear Sky D/L	Clear Sky U/L Rain D/L
ASI	74.50	74.50	74.50	74.50 dBHz
CrossPol	88.06	88.06	88.06	88.06 dBHz

Uplink Path Loss	Clear Sky	Rain U/L
Freespace Path Loss	206.87	206.9 dB
Gaseous Attenuation	0.10	0.10 dB
Rain Attenuation	0	1.2 dB
Cloud Attenuation	0	0.15 dB
Scintillation	0	0.16 dB
Total Attenuation	207.0	208.3 dB

Downlink Path Loss	Clear Sky	Rain D/L
Freespace Path Loss	205.60	205.6 dB
Gaseous Attenuation	0.11	0.11 dB
Rain Attenuation	0	1.0 dB
Cloud Attenuation	0	0.16 dB
Scintillation	0	0.25 dB
Total Attenuation	205.7	206.9 dB

Uplink Propagation Model	
Frequency	14.18 GHz
Availability	99.75%
Satellite Longitude	255.0 °E
Site Location	Carlsbad
Site Latitude	33.2 °N
Site Longitude	242.7 °E
Site Altitude	0.0 km
Antenna efficiency	65%
Antenna diameter	4.5 m
Polarization	V
Slant Range	37141.4 km
Elevation Angle	49.21 °
Rain Height	3.2 km
Rain Intensity @ 0.01%	25.1 mm/hr
Total Columnar Content of Liquid @ 0.01	0.6 kg/m2
Wet term of refraction coindex	45.3
Temperature	289.6 K
Water Vapor Content	7.2 g/m3
Polarization Angle	18.1 °

Downlink Propagation Model	
Frequency	11.88 GHz
Availability	99.75%
Satellite Longitude	255.0 °E
Site Location	Var Seattle
Site Latitude	46.6 °N
Site Longitude	237.8 °E
Site Altitude	0.0 km
Antenna efficiency	60%
Antenna diameter	0.4 m
Polarization	H
Slant Range	38293.1 km
Elevation Angle	33.8 °
Rain Height	2.5 km
Rain Intensity @ 0.01%	40.0 mm/hr
Total Columnar Content of Liquid @ 0.01	0.7 kg/m2
Wet term of refraction coindex	35.0
Temperature	279.0 K
Water Vapor Content	5.2 g/m3
Polarization Angle	74.4 °
Tsys, clear sky	117.0 K
Tsys, rain	173.9 K

Return Link Parameters	Uplink	Downlink
Site	Var - Seattle	Carlsbad
Frequency, GHz	14.18	11.88
Availability	99.75%	99.75 %
Antenna Size, m	0.37	4.50
Modulation	GMSK DSSS	
Coding	Rate 1/3 TC	
Data rate (kbps)	128	
Signal rate (kbaud/s)	384.0	
Transponder Bandwidth (kHz)	24060	

Uplink C/No budget	Clear Sky	Rain U/L
Uplink EIRP (incl. UPC compensation)	35.71	35.71 dBW
Terminal Pointing Loss	0.07	0.07 dB
Path Loss	207.27	209.2 dB
Spacecraft G/T	2	2 dB/K
Boltzmann's constant	228.6	228.6 dBW/K/Hz
Uplink C/No Transponder input	58.98	57.06 dBHz
Carrier Suppression	1.75	1.75 dB
Noise Suppression	1.74	1.74 dB
Uplink C/No Transponder output	58.97	57.05 dBHz

Uplink C/Io terms	Clear Sky	Rain U/L
ASI	65.0	63.0 dBHz
CrossPol	65.6	63.7 dBHz
Uplink HPA IM	100	100 dBHz
Uplink C/Io Transponder input	62.3	60.4 dBHz
Carrier Suppression	1.75	1.75 dB
Noise Suppression	1.74	1.74 dB
Uplink C/Io Transponder output	62.3	60.3 dBHz

Uplink Path Loss	Clear Sky	Rain U/L
Freespace Path Loss	207.14	207.1 dB
Gaseous Attenuation	0.13	0.13 dB
Rain Attenuation	0	1.7 dB
Cloud Attenuation	0	0.22 dB
Scintillation	0	0.27 dB
Total Attenuation	207.3	209.2 dB

EndtoEnd Link Budget		Clear Sky	Rain U/L Rain D/L	Rain U/L Clear Sky D/L	Clear Sky U/L Rain D/L
Uplink C/No		58.97	57.05	57.05	58.97 dBHz
Uplink C/Io		62.26	60.34	60.34	62.26 dBHz
Downlink C/No		71.90	67.77	69.98	69.69 dBHz
Downlink C/Io	55.9662923	62.19	60.27	60.27	62.19 dBHz
Multiple Access Interference		64.27	62.35	62.35	64.27 dBHz
Total C/(No+Io)		55.37	53.38	53.45	55.30 dBHz
Required C/(No+Io)		53.32	53.32	53.32	53.32 dBHz
Margin		**2.0**	**0.1**	**0.1**	**2.0 dB**

Downlink C/No budget	Clear Sky	Rain U/L Rain D/L	Rain U/L Clear Sky D/L	Clear Sky U/L Rain D/L
Downlink EIRP	16.27	14.4	14.4	16.3 dBW
Path Loss	205.41	206.2	205.4	206.2 dB
Hub Clearsky G/T	32.44	32.4	32.4	32.4 dB/K
Rain Noise Temperature Increase	0.00	1.4	0.0	1.4 dB
Boltzmann's constant	228.60	228.6	228.6	228.6 dBW/K/Hz
Downlink C/No	71.9	67.8	70.0	69.7 dBHz

Downlink C/Io terms	Clear Sky	Rain U/L Rain D/L	Rain U/L Clear Sky D/L	Clear Sky U/L Rain D/L
ASI	78.77	76.85	76.85	78.77 dBHz
CrossPol	73.44	71.52	71.52	73.44 dBHz
Transponder IM	63.51	61.59	61.59	63.51 dBHz
PCMA C/Io	70.01	68.09	68.09	70.01 dBHz

Downlink Path Loss	Clear Sky	Rain
Freespace Path Loss	205.3	205.3 dB
Gaseous Attenuation	0.08	0.08 dB
Rain Attenuation	0	0.7 dB
Cloud Attenuation	0	0.11 dB
Scintillation	0	0.15 dB
Total Attenuation	205.41	206.2 dB

9. Antenna Gain Data

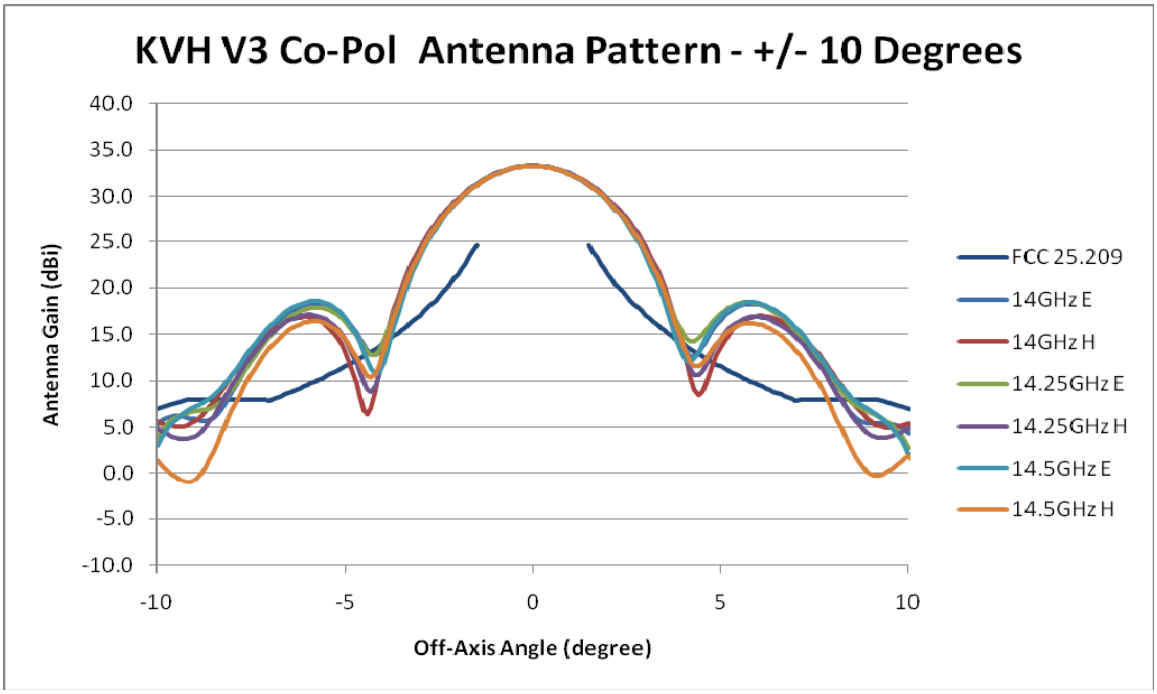

Figure 11 – C0-Pol Gain +/- 10 dgrees

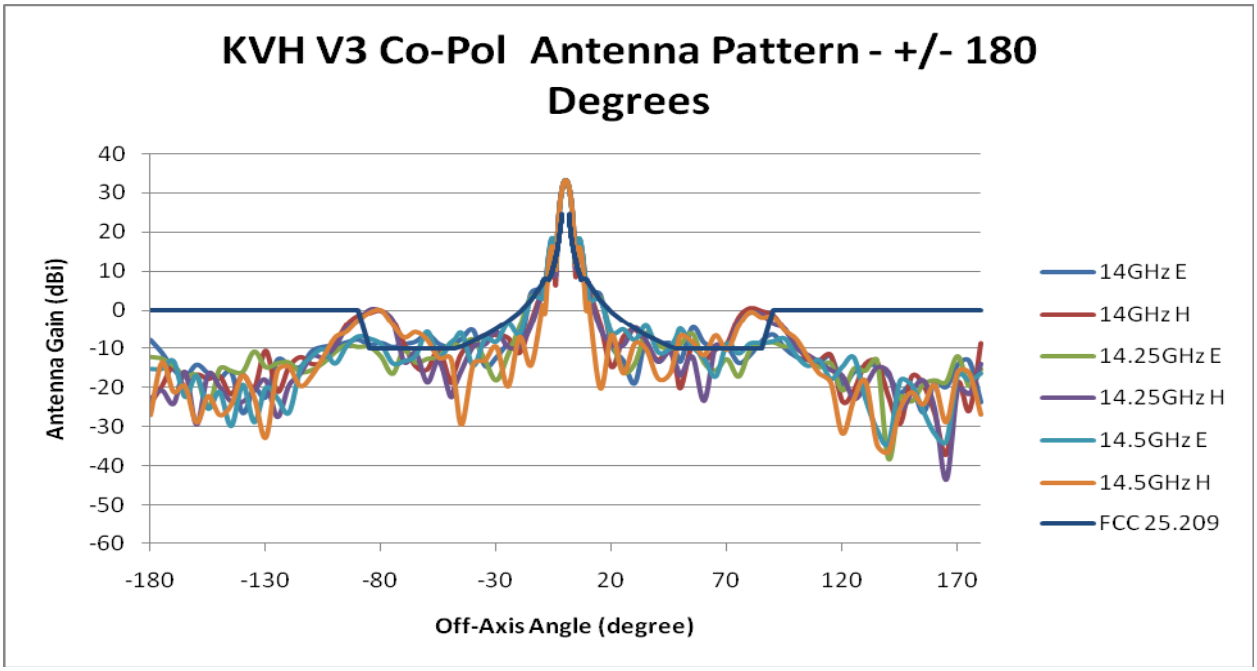

Figure 12 – Co-Pol Gain +/- 180 dgrees

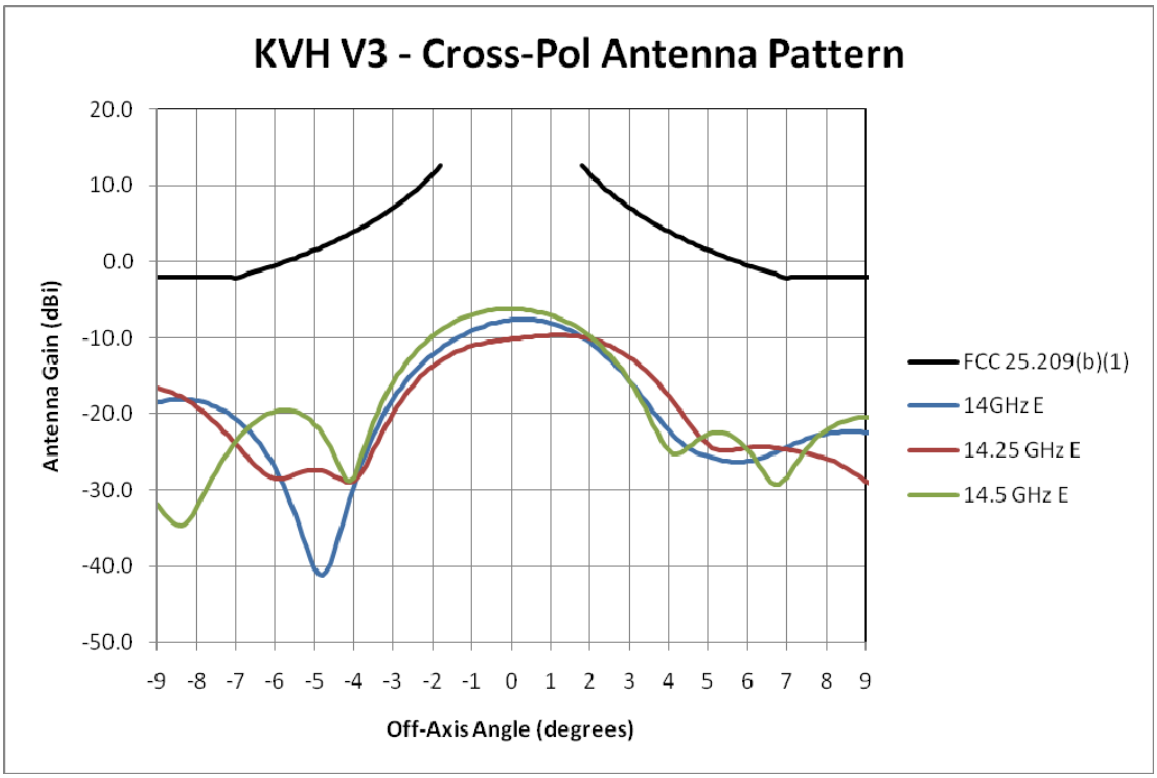

Figure 13 – Cross-pol Gain Pattern +/- 9 degrees