

**Exhibit A**  
**TECHNICAL NARRATIVE**  
**BSSNET2A-115W**  
**(Response to Form 312 Question 43)**

## CONTENTS

<b>Section</b>	<b>Page</b>
1 - GENERAL SYSTEM DESCRIPTION.....	4
2 - SPACE SYSTEM OPERATING CHARACTERISTICS.....	5
2.1 FREQUENCY AND POLARIZATION PLAN.....	5
2.2 COMMUNICATIONS PAYLOAD.....	6
2.2.1 Transponder Channel Characteristics - Uplink Antennas and Channel Filters.....	6
2.2.2 Downlink Channel Characteristics .....	9
2.2.3 Transmit Beams and Antennas .....	9
2.3 TELEMETRY, TRACKING & COMMAND (TT&C) SUBSYSTEM.....	10
2.3.1 Command Subsystem .....	10
2.3.2 Telemetry Subsystem.....	11
2.3.3 Beacons.....	13
2.2.3.2 Autotrack Beacons.....	13
2.2.3.3 Rain Fade Downlink Beacon.....	13
2.3.4 Link Margins for GSO Operation.....	13
3 - SERVICES .....	13
4 - LINK ANALYSIS.....	14
5 - EARTH STATIONS .....	14
6 - SATELLITE ORBIT CHARACTERISTICS.....	15
7 - POWER FLUX DENSITY.....	15
7.1 CONUS+ OPERATION (NATIONAL BEAMS).....	15
7.2 PFD VALUES OUTSIDE CONUS.....	16
8 - PHYSICAL CHARACTERISTICS OF THE SPACE STATION.....	17

9 - SPACECRAFT BUS SUBSYSTEM .....	17
10 - SCHEDULE .....	18
11 - INTERFERENCE ANALYSIS.....	18
12 - ORBITAL DEBRIS MITIGATION.....	19
12.1 ORBITAL DEBRIS AND ORBITAL STORAGE .....	19
12.2 SPACECRAFT HARDWARE DESIGN .....	20
12.5 SATELLITE COLLISIONS WITH LARGE OBJECTS .....	23
13 - SAFE FLIGHT PROFILES.....	24
14 - POST-MISSION DISPOSAL .....	25
14 - CONCLUSION .....	26
APPENDIX A - LINK BUDGETS .....	28
APPENDIX B - SPACE PATH INTERFERENCE .....	28

## 1 - GENERAL SYSTEM DESCRIPTION

The BSSNET2A-115W system consists of a geostationary satellite located at the 115.0° W.L. orbital location and its associated ground station network. Even though this orbital location is located at the FCC “on-grid” slot at 115.0° W.L. established in Appendix F of the *BSS R&O*<sup>1</sup> (an “Appendix F slot”), SPECTRUM FIVE proposes to operate at a reduced operating power compared to the maximum levels cited in Section 25.262(b) of the Commission’s rules.

BSSNET2A-115W is designed to provide DTH service in the "Reverse Band" frequency ranges of 17.3-17.7 GHz (Space-to-Earth) and 24.75-25.15 GHz (Earth-to-Space). The Telemetry, Tracking and Control (“TT&C”) functions will also be provided at the edges of these same frequency bands.

The BSSNET2A-115W satellite is capable of supporting 26 "17/24" uplink/downlink "national" transponders (13 LHCP and 13 RHCP channels of 26 MHz nominal bandwidth) providing coverage via a "CONUS+" national beam of all 50 states (CONUS, Alaska and Hawaii). All national programming material will be

---

<sup>1</sup> See *Establishment of Policies and Service Rules for the Broadcasting Satellite Service at the 17.3-17.7 GHz Frequency Band and at the 17.7-17.8 GHz Frequency Band Internationally, and at the 24.75-25.25 GHz Frequency Band for Fixed Satellite Services Providing Feeder Links to the Broadcasting-Satellite Service and for the Satellite Services Operating Bi-directionally in the 17.3-17.8 GHz Frequency Band*, 22 FCC Rcd. 8842 (2007) (“BSS R&O”).

aggregated and uplinked from the SPECTRUM FIVE broadcast center located in the southwest US.

The available 400 MHz of spectrum in CONUS on the downlink will be channelized into 26 transponders (13 channels for each polarization) of 26 MHz nominal bandwidth each, with 29.16 MHz spacing between co-polar channel center frequencies. The cross-polar transponders are not offset relative to the co-polar ones in order to provide the maximum utilization of the operating bandwidth. The uplink is also channelized into matching 26 transponders (13 channels for each polarization) of 26 MHz nominal bandwidth for each polarization, with 29.16 MHz spacing between channel center frequencies. The national broadcast uplink will use the corresponding lowest 400 MHz in the 24.75-25.25 GHz band for distribution of national channels. Full frequency use of both the uplink and downlink spectrum is achieved through the use of the two orthogonal circular polarizations.

## **2 - SPACE SYSTEM OPERATING CHARACTERISTICS**

### **2.1 FREQUENCY AND POLARIZATION PLAN**

Table 2-1 shows the frequency and polarization plan of the BSSNET2A-115W satellite, including the on-station command, autotrack beacon, and TT&C. National programming is broadcast using 400 MHz of each polarization, with a frequency translation of 7,450 MHz between the uplink and downlink center frequencies.

Transponder Channel	DL Freq (MHz) LCP	UL Freq (MHz) RCP	Transponder Channel	DL Freq (MHz) RCP	UL Freq (MHz) LCP
			Autotrack Beacon		24,751.00
			Command 1	24,753.00	
			Command 2	24,755.00	
1	17,325.00	24,775.00	2	17,325.00	24,775.00
3	17,354.16	24,804.16	4	17,354.16	24,804.16
5	17,383.32	24,833.32	6	17,383.32	24,833.32
7	17,412.48	24,862.48	8	17,412.48	24,862.48
9	17,441.64	24,891.64	10	17,441.64	24,891.64
11	17,470.80	24,920.80	12	17,470.80	24,920.80
13	17,499.96	24,949.96	14	17,499.96	24,949.96
15	17,529.12	24,979.12	16	17,529.12	24,979.12
17	17,558.28	25,008.28	18	17,558.28	25,008.28
19	17,587.44	25,037.44	20	17,587.44	25,037.44
21	17,616.60	25,066.60	22	17,616.60	25,066.60
23	17,645.76	25,095.76	24	17,645.76	25,095.76
25	17,674.92	25,124.92	26	17,674.92	25,124.92
Telemetry 1		17,303.00			
Telemetry 2		17,306.00			
Beacon	17,309.00				

**Table 2-1. Frequency Plan for Transponders and TT&C.**

Table 2-2 illustrates the connection of each national programming uplink channel to its corresponding downlink channel.

As can be seen from Table 2-1 and Table 2-2, these 26 transponders that support national coverage are frequency translated from the 24.75-25.15 GHz satellite receive band by 7,450 MHz for re-transmission in the 17.3-17.7 GHz downlink band.

## 2.2 COMMUNICATIONS PAYLOAD

### 2.2.1 Transponder Channel Characteristics - Uplink Antennas and Channel Filters

The maximum receive antenna gain, receive system noise temperature, and maximum G/T of the BSSNET2A-115W satellite are all specified in the accompanying Schedule S.

Downlink Channel	Freq (MHz)	Downlink Polarization	Uplink Channel	Freq (MHz)	Uplink Polarization	Shift (MHz)
1,2	17,325.00	LCP,RCP	1,2	24,775.00	RCP,LCP	7,450.00
3,4	17,354.16	LCP,RCP	3,4	24,804.16	RCP,LCP	7,450.00
5,6	17,383.32	LCP,RCP	5,6	24,833.32	RCP,LCP	7,450.00
7,8	17,412.48	LCP,RCP	7,8	24,862.48	RCP,LCP	7,450.00
9,10	17,441.64	LCP,RCP	9,10	24,891.64	RCP,LCP	7,450.00
11,12	17,470.80	LCP,RCP	11,12	24,920.80	RCP,LCP	7,450.00
13,14	17,499.96	LCP,RCP	13,14	24,949.96	RCP,LCP	7,450.00
15,16	17,529.12	LCP,RCP	15,16	24,979.12	RCP,LCP	7,450.00
17,18	17,558.28	LCP,RCP	17,18	25,008.28	RCP,LCP	7,450.00
19,20	17,587.44	LCP,RCP	19,20	25,037.44	RCP,LCP	7,450.00
21,22	17,616.60	LCP,RCP	21,22	25,066.60	RCP,LCP	7,450.00
23,24	17,645.76	LCP,RCP	23,24	25,095.76	RCP,LCP	7,450.00
25,26	17,674.92	LCP,RCP	25,26	25,124.92	RCP,LCP	7,450.00

**Table 2-2. BSSNET2A-115W Uplink/Downlink Interconnection**

BSSNET2A-115W employs 1.0 m diameter uplink receive antennas with a peak receive G/T of 17.5 dB/°K. Note that the G/T will decrease, dB-for-dB, from the maximum as the uplink location moves away from the beam peak in the Southwest US. The uplink characteristics and location are shown in the accompanying Schedule S.

BSSNET2A-115W will employ input multiplexer ("IMUX") and output multiplexer ("OMUX") filters to limit the bandwidth of received signals. The specified performance for these filters is shown in Table 2-3.

Frequency offset Offset from channel center	Gain relative to channel center frequency (p-p) (dB)		Comments
	Receive	Transmit	
±5 MHz	0.55	0.73	In-Band
±7 MHz	0.8	0.94	
±9 MHz	1.11	1.35	
±11 MHz		2.73	
±12 MHz	1.84	3.56	
±13 MHz	2.47		
±18 MHz	-12	0	Out-of-Band
±21 MHz	-33	-1	
±27 MHz	-38	-10	

**Table 2-3. IMUX / OMUX Filtering**



### 2.2.2 Downlink Channel Characteristics

The national coverage downlink beam uses dual combined output amplifiers (TWTAs) with power amplifier output power of 130 Watts (260 Watts combined). This produces a maximum EIRP in CONUS of 58.5 dBW in the South Florida area, well below that required by FCC maximum PFD requirements. The resultant output power from each of these amplifier assemblies is shown in Table 2-4.

	Transmit Output Power (dBW)	Transmit Output Power (W)	Output Losses (dB)	Transmit Antenna Gain (dBi) Peak	Peak Transp ERP (dBW)
CONUS+ Beam	22.2	260.0	1.9	36.3	58.5

**Table 2-4. TWT Powers and EIRPs**

### 2.2.3 Transmit Beams and Antennas

BSSNET2A-115W will employ two ~2.6m diameter transmit antenna systems for 17/24 GHz BSS service to provide U.S. national coverage (the CONUS+ beam). This antenna system will cover CONUS + Alaska + Hawaii and will be capable of transmitting across the frequency band 17.3-17.7 GHz using LCP and RCP. The peak transmit gain of 36.3 dB, and the antenna gain contour in GXT format, are given in the accompanying Schedule S. The gain contour for CONUS+ beam is graphically depicted in Figure 2-1 below:



**Figure 2-1. CONUS Antenna Gain Contours**

## 2.3 TELEMETRY, TRACKING & COMMAND (TT&C) SUBSYSTEM

### 2.3.1 Command Subsystem

The satellite command function receives, demodulates, processes, decodes, and executes commands. Command signals from the TT&C control center are received via a dual antenna system (spot beam for GSO operation and omni antenna for transfer orbit operations), and the outputs of this system are cross-strapped to dual command decoders. The command system performance is given in Tables 2-7 and 2-8.

Parameter	Performance
Modulation	PCM/PSK/FM
Carrier Deviation	$\pm 400$ kHz
Command Sub-Carrier Frequency	16 kHz
Bit Rate	$\geq 250$ bits per second

Telemetry Verification	Each command verified via telemetry prior to execution
Polarization	RHCP

**Table 2-7. Command Subsystem Performance**

Parameter	Performance
Frequency	
Receiver #1	24,753 MHz
Receiver #2	24,755 MHz
Polarization	RHCP
Carrier Modulation	FM, deviation $\pm 400$ kHz
Baseband	16 kHz subcarrier or ranging tones
Dynamic Range	$\geq 52$ dB
Ranging	Routed to the associated telemetry transmitter on command for turn-around ranging operations

**Table 2-8. Command Subsystem Receiver Performance**

### 2.3.2 Telemetry Subsystem

Two redundant telemetry signals can be transmitted from the satellite, with routing of either or both of these signals through the CONUS+ antenna for nominal GSO operation, or through an omni antenna for transfer orbit operations. The telemetry subsystem also includes a ranging mode with multiple ranging tones that can be modulated onto the uplink command carrier, demodulated by the satellite command receiving subsystem, and re-modulated and transmitted to the control facility via the downlink telemetry carriers. The telemetry subsystem performance requirements are summarized in Tables 2-9 and 2-10. Each satellite shall have a unique telemetry address assigned and transmitted in each frame.

Parameter	Performance
Data Word Size	8 bits
Frame Format	256 Words per Frame, 32 Minor Frames
Bit Rate	4800 bits per second
Carrier Stability	$\leq \pm 10$ PPM
Subcarrier Stability	$\leq \pm 30$ ppm
Output Data:	
Nominal Telemetry	Bi-Phase L on 48 kHz Subcarrier
Dwell Telemetry	Bi-Phase L on 72 kHz Subcarrier
Polarization	RHCP

**Table 2-9 Telemetry Subsystem Performance**

Parameter	Performance
Frequency Transmitter #1 Transmitter #2	17,303 MHz 17,306 MHz
Modulation Characteristics Type Indices	Phase 1.0 radian, peak, for single subcarrier 0.7 radians per subcarrier for 2 subcarriers 0.6 radians per subcarrier for 3 subcarriers
Control Functions	Transmitter On/Off Ranging Modulation On/Off Telemetry Modulation On/Off
EIRP Omni (Transfer Orbit) CONUS+ Beam (GSO)	> 0 dBW > 12 dBW
Spurious Outputs	-62 dBc in-band (excluding DC/DC converter frequencies), < -50 dBc out-of-band
Stability	< 2.0 dB, P-P, over life

**Table 2-10 Telemetry Subsystem RF Performance****2.3.3 Beacons****2.2.3.2 Autotrack Beacons**

Uplink signals (beacons) from all uplink sites are required to allow autotracking of downlink antennas. The autotrack beacon uplink operating frequency and polarization are 24,751 MHz and LHCP, respectively. Incident flux density (SFD) will be maintained between  $-84 \text{ dBW/m}^2$  (max) to  $-104 \text{ dBW/m}^2$  (min) by use of rain fade control at the uplink site.

**2.2.3.3 Rain Fade Downlink Beacon**

A downlink beacon will be transmitted through the CONUS+ beam antenna to enable measurement of rain attenuation and alignment of subscriber antennas. The downlink operating frequency and polarization are 17,309 MHz and LHCP, respectively.

**2.3.4 Link Margins for GSO Operation**

The key parameters for the command and telemetry links in normal GSO operation are shown in the attached Schedule S.

**3 - SERVICES**

SPECTRUM FIVE will use the BSSNET2A-115W satellite to transmit digital video and audio entertainment, educational and informational programming to subscribers throughout the United States, including Alaska and Hawaii.

## 4 - LINK ANALYSIS

Representative communication link budgets for the BSSNET2A-115W satellite are shown in Appendix A (Tables A-1 to A-4). There is one link budget for a city in each of the CONUS downlink power flux density (“PFD”) regions defined by the Commission’s rules, and one for a non-CONUS region (Hawaii). These budgets include an entry for adjacent satellite interference (“ASI”) from neighboring 17/24 GHz BSS satellites nominally spaced at  $-8.0^\circ$ ,  $-4.0^\circ$ ,  $+4.0^\circ$ , and  $+8.0^\circ$  relative to BSSNET2A-115W at  $115.0^\circ$ . The link budgets also take into account station keeping accuracies of  $\pm 0.05^\circ$  for both satellites which reduces the worst case spacing by  $0.1^\circ$ .

SPECTRUM FIVE will utilize station antennas with equivalent circular diameter in the 65 cm range, providing shows availability exceeding 99.7% over a majority of CONUS, and  $> 99.5\%$  throughout CONUS when operating the link with a high spectral efficiency modulation scheme. Outside CONUS, a slightly larger antenna may be used. This includes the effects of adjacent satellites operating at maximum power per Commission rules at the four locations discussed above.

## 5 - EARTH STATIONS

There are three types of earth stations to be used with the BSSNET2A-115W satellite: subscriber terminals with small antennas (65cm), large feeder-link stations using for uplinking the video content (13m), and a large TT&C station antenna (9m). Subscriber terminals for reception outside CONUS may need to be somewhat larger, typically 1 meter.

## 6 - SATELLITE ORBIT CHARACTERISTICS

The BSSNET2A-115W satellite will be maintained in geosynchronous orbit at the 115.0° W.L. orbital location with a maximum North-South drift of  $\pm 0.05^\circ$ , and a maximum East-West station keeping of  $\pm 0.05^\circ$ .

## 7 - POWER FLUX DENSITY

### 7.1 CONUS+ OPERATION (NATIONAL BEAMS)

The allowable PFD levels in the 17.3-17.7 GHz band are defined in Section 25.208(w) of the Commission's rules on a regional basis for all conditions, including clear sky, and for all methods of modulation as:

1. In the region of the contiguous United States, located south of 38° North Latitude and east of 100° West Longitude: -115 dBW/m<sup>2</sup>/MHz;
2. In the region of the contiguous United States, located north of 38° North Latitude and east of 100° West Longitude: -118 dBW/m<sup>2</sup>/MHz;
3. In the region of the contiguous United States, located west of 100° West Longitude: -121 dBW/m<sup>2</sup>/MHz; and
4. For all regions outside of the contiguous United States including Alaska and Hawaii: -115 dBW/m<sup>2</sup>/MHz.

As discussed in Section 2.2.2 above, the maximum downlink EIRP for BSSNET2A-115W will be 58.5 dBW / 25.8 MHz channel. The maximum power

flux density/MHz on the Earth's surface from this emission is calculated as follows:

$$\text{Peak PFD (dBW/MHz)} = \text{EIRP(dB)} - \text{Spreading Loss (dB)} - \text{BW(dB)}$$

where the bandwidth factor BW(dB) corresponds to the allocated bandwidth of the 8PSK downlink emissions for a transponder (25.8 MHz). The maximum EIRP of 58.5 dBW for the CONUS+ beam occurs in South Florida. The maximum allowed PFD in this region for "non-offset" operation is -115.0 dBW/m<sup>2</sup>/MHz. This would allow a maximum ERP value of  $(-115.0 + 162.4 + 10 \cdot \log(25.8)) = 61.5$  dBW for a slot with no offset from the 100° WL grid location.

As discussed in Section 2.2.3.1 above, the downlink national beam antenna gain pattern for BSSNET2A-115W shows (1) that the antenna gain north of 38° North latitude and east of 100° W.L. is at least 3 dB below peak gain, and (2) that the antenna gain west of 100° W.L. is at least 6 dB below peak gain. As a result, the maximum PFD for the CONUS+ beam on the earth's surface complies with Section 25.208(w) for the national beams in each of the applicable regions within CONUS defined in the Commission's rules.

## 7.2 PFD VALUES OUTSIDE CONUS

Schedule S requires a presentation of PFD maximum values at low elevation angles. These values may be calculated by using the maximum ERP for the CONUS+ beam and calculating the spreading loss at each elevation angle, as shown in Table 7-1 below. In all cases the maximum PFD values are below the



required  $-115.0 \text{ dBW/m}^2/\text{MHz}$  limit for operation outside CONUS with elevation angles between  $0^\circ$  and  $25^\circ$ .

25M8G7W (US CONUS+ Beam)						
Elevation Angle (deg)	0	5	10	15	20	25
Peak EIRP (dBW)	58.5	58.5	58.5	58.5	58.5	58.5
Spreading Loss(dB)	163.4	163.3	163.2	163	162.9	162.8
Occupied BW (MHz)	25.8	25.8	25.8	25.8	25.8	25.8
Density (dBW/m <sup>2</sup> /MHz)	-119.0	-118.9	-118.8	-118.6	-118.5	-118.4
(dBW/m <sup>2</sup> /MHz)	-115	-115	-115	-115	-115	-115
Margin (dB)	4.0	3.9	3.8	3.6	3.5	3.4

**Table 7-1. Maximum PFD Outside CONUS at Low Elevation Angles**

## **8 - PHYSICAL CHARACTERISTICS OF THE SPACE STATION**

SPECTRUM FIVE has not yet settled upon exact specifications for the physical characteristics of the satellite as it has not yet contracted for the construction of the BSSNET2A-115W satellite. Accordingly, the payload envelope has been estimated to allow more than one spacecraft currently available with extensive heritage and fully qualified technology to serve as the design platform. SPECTRUM FIVE anticipates that the key spacecraft characteristics for BSSNET2A-115W are as summarized in the appropriate sections of the accompanying Schedule S

## **9 - SPACECRAFT BUS SUBSYSTEM**

As discussed above, SPECTRUM FIVE has not yet contracted with a manufacturer for the construction of the BSSNET2A-115W satellite and does not

wish to show a preference by providing data specific to any one manufacturer. As such, it is difficult to discuss any specific characteristics of what may comprise the spacecraft bus subsystem beyond that already specified in the accompanying Schedule S.

SPECTRUM FIVE will provide the Commission with full spacecraft physical characteristics once a final spacecraft design has been adopted.

## **10 - SCHEDULE**

SPECTRUM FIVE will contract for, begin construction of, and launch and operate BSSNET2A-115W in accordance with the milestones specified in Section 25.164(a) of the Commission's rules.

## **11 - INTERFERENCE ANALYSIS**

In order to achieve maximum compatibility between diverse networks, the Commission has established coordination thresholds for earth station off-axis EIRP density and spacecraft PFD in Sections 25.223 and 25.208, respectively. SPECTRUM FIVE has assumed for the purposes of this application regional maximum downlink PFD values from neighboring systems consistent with Section 25.208(w), maximum feeder link earth station off-axis transmit power density consistent with Section 25.223, and receive earth station compliance with Section 25.224 (Recommendation ITU-R BO.1213 with antenna diameter = 0.65m). The

interference analyses that are included in this application were performed in conjunction with the end-to-end link performance analyses. Abbreviated link budgets are presented in Tables A-1 through A-4 in Appendix A, *i.e.*, one budget for each of the PFD regions defined in Section 25.208(w). In each case, the analysis includes the effects of adjacent satellite interference from satellites nominally located "on-grid" at  $-7.9^{\circ}$ ,  $-3.9^{\circ}$ ,  $+3.9^{\circ}$ , and  $+7.9^{\circ}$  relative to BSSNET2A-115W (located at  $115.0^{\circ}$ ) in evaluating whether the system accommodates the various data rates at acceptable  $C/(N+I)$  thresholds. Additionally, the adjacent satellite interference calculated (including  $0.05^{\circ}$  station-keeping of the interfering satellites) demonstrates that the BSSNET2A-115W satellite design described in this application is compatible with the aforementioned transmission parameters and interference environment. Accordingly, the proposed 17/24 GHz BSS satellite would operate successfully in such an environment.

## **12 - ORBITAL DEBRIS MITIGATION**

### **12.1 ORBITAL DEBRIS AND ORBITAL STORAGE**

This section is consistent with the requirements specified in the FCC's Second Report & Order, IB Docket 02-54, Released June 21, 2004, Part 25.114 of the FCC Rules and Public Notice DA -2698 "Disclosure of Orbital Debris Mitigation Plans, Including Amendment of Pending Applications". Spectrum Five's spacecraft procurement will be initiated during 2008, and have a construction contract in one year after license award. The new spacecraft, BSSNET2A-115W, a Satellite Operations Center, SOC, Network Operations, Center, NOC and feeder

link earth stations will be fully defined by specifications, statement of work, test plans and contract. These documents will contain the FCC requirements and objectives described in the Orbital Debris Second Report and Order. In addition, design reviews will include consideration of these requirements and how they will be specifically implemented by the manufacturer and by the SOC operator, including a requirement to cooperate and exchange vital information with both operators and the SOCs of neighboring satellites.

## **12.2 SPACECRAFT HARDWARE DESIGN**

The Spectrum Five satellites will not be a source of debris either during the launch, drift or operating mode; no debris are planned to be released. All separation and deployment mechanisms, and any other potential source of debris will be retained by the spacecraft or launch vehicle. The spacecraft TT&C system, vital for orbit raising, will be extremely rugged with regard to meteoroids smaller than 1 cm, by virtue of its redundancy, shielding, separation of components and physical characteristics. Omni-directional antennas are mounted on opposite sides of the spacecraft. These antennas, each providing greater than hemispherical coverage patterns are extremely rugged and capable of providing adequate coverage even if struck and bent or otherwise damaged by a small or medium sized particle. Either omni-directional antenna, for either command or telemetry, is sufficient to enable orbit raising. The command receivers and decoders and telemetry encoders and transmitters will be located within a shielded

area and will be totally redundant and physically separated. A single rugged thruster and shielded propellant tank provide the energy for orbit raising. Otherwise, there are no single points of failure in the system. SPECTRUM FIVE will continue to review these aspects of on-orbit operations with the spacecraft manufacturer and will make such adjustments and improvements as appropriate to assure that its spacecraft will not become sources of debris during operations or become derelicts in space due to a collision with a small, medium or large object.

To accomplish these and the following objectives SPECTRUM FIVE plans to incorporate the material of this document into its satellite Technical Specifications, Statement of Work and Test Plans. The Statement of Work will include provisions to review orbit debris mitigation as part of PDR and CDR and to incorporate its requirements, as appropriate, into its Test Plan, including a formal Failure Mode Verification Analysis, FMVA, for orbital debris mitigation involving particularly the TT&C, propulsion and energy systems.

At the appropriate time, SPECTRUM FIVE intends to contract with an appropriate agency that can supply information regarding large orbital debris that may pose a threat to SPECTRUM FIVE's satellites. With the situation as described in this paragraph, only normal station-keeping regimens are necessary to avoid collisions. Frequency and physical coordination during orbital drift cannot be undertaken until license authorization and until the spacecraft and launch vehicle manufacturers are selected and a Launch Plan, launch vehicle and launch

scenario developed. No pre-operational orbits requiring STA authority are now anticipated.

### **12.3 LIMITATION ON RELEASE OF ORBITAL DEBRIS DURING NORMAL OPERATIONS AND FROM COLLISIONS WITH SMALL DEBRIS OR METEOROIDS.**

Spectrum Five has assessed the likelihood of the release of debris during normal operations and, based on the present design, believes that there will not be any planned release of debris during normal operations of the Spectrum Five satellites. The spacecraft will be designed with full redundancy for all active components, with shielding where appropriate. Location of critical components will minimize exposure to small debris or meteoroids that might cause catastrophic failure of the spacecraft control system or prevent orbital storage at the end of spacecraft life. SPECTRUM FIVE will continue to review these aspects of on-orbit operations with the spacecraft manufacturer and will make such adjustments and improvements as appropriate to assure that the spacecraft is not the source of debris during operations or becomes derelict in space due to collision with a small object. The following items are those that will be embodied in the procurement, launch and operational documents.

### **12.4 MINIMIZING ACCIDENTAL EXPLOSIONS**

SPECTRUM FIVE will contract for a spacecraft design that limits the probability of accidental explosions that might fragment the satellite during and after completion of mission operations. All batteries and fuel tanks will be monitored for pressure and temperature. Excessive battery charging or

discharging will be limited by a monitoring and control system that will automatically limit the possibility of fragmentation. Corrective action, if not automatically undertaken, will be immediately undertaken by the SOC to avoid destruction and fragmentation. Thruster temperatures, impulse and thrust duration are carefully monitored; any thruster may be turned off via redundant valves. Consequently, there is no possibility of explosion during the operating mission. All TWTAs will be outgassed prior to post-mission disposal. After post-mission disposal, all residual fuel is will be consumed, all fuel latch valves will be placed in an "open" position and any pressurized system will be vented. Spacecraft battery trickle charge and all automatic battery charging sequences will be disabled. Consequently, via its spacecraft documentation, design reviews, FMVA, test plans and testing, SPECTRUM FIVE will assess and limit the possibility of accidental explosions during mission operations and assure that all stored energy at the end of the spacecraft's mission operation will be removed.

## **12.5 SATELLITE COLLISIONS WITH LARGE OBJECTS**

SPECTRUM FIVE has considered the possibility of its spacecraft becoming a source of debris by collisions with large debris other than spacecraft. Extensive damage may be done, perhaps rendering it inoperative with respect to its communications mission yet enabling the TT&C and propulsion systems to function sufficiently to permit the achievement of a parking orbit. This capability is due to the inherent ruggedness, shielding and redundancy of the TT&C and propulsion system. The preservation of this capability will be emphasized in

SPECTRUM FIVE's procurement documents, design reviews, test plans and FMVA, as described above. Through these methods, SPECTRUM FIVE intends to limit the probability of its spacecraft becoming a source of debris by collisions with large debris or other operational space stations.

### **13 - SAFE FLIGHT PROFILES**

SPECTRUM FIVE will assess and limit the probability of BSSNET2A-115W becoming a source of debris by collisions with large debris or other operational space stations through detailed and conscientious mission planning. In addition to reviewing the existing on-orbit operational satellites near 115° W.L. (Viasat-1 at 115.1° W.L., and several satellites serving Mexico (Satmex 5, Solaridaridad and Mexsat at 114.9 W.L. may also be located at this position). SPECTRUM FIVE has also reviewed the networks for which a request for coordination has been published by the ITU at the ITU within  $\pm 0.15^\circ$  of 115° W.L. The Eutelsat 115 West satellite has also been filed to operate at the nominal 115.0° W.L. location, but its status is uncertain. Based on these reviews, while there are no other operational satellites within  $\pm 0.1^\circ$  of 115.0° W.L. Moreover, with respect to published ITU filings, there no 17/24 GHz networks licensed to operate at 115.0° W.L. by the USA (FCC).



Therefore, there should be no overlap of the station-keeping volumes of these spacecraft with BSSNET2A-115W operating at 115.0° W.L with +/-0.05° W.L station keeping.

SPECTRUM FIVE can find no evidence that satellite construction contracts have been awarded for any of these networks, nor does the most recently available Federal Aviation Administration Commercial Space Station Report show any pending satellite launches for these networks.

Given the current absence of a construction contract for BSSNET2A-115W, it is difficult to assess what future satellites will actually be operating at the nominal 115.0° W.L. position at the time that the satellite is to be launched. As such, SPECTRUM FIVE will certainly revisit this issue once a satellite construction contract is in place. However, it does appear at this time that there will not be a need for physical coordination with other satellite systems at 115.0° W.L .

## **14 - POST-MISSION DISPOSAL**

Consistent with the requirements of Section 25.283(a) of the Commission's rules, at the end of the operational life of the satellite, SPECTRUM FIVE will maneuver BSSNET2A-115W into a disposal orbit with an altitude no less than that calculated using the IADC formula:

$$36,021 \text{ km} + (1000 \cdot C_R \cdot A/m).$$

SPECTRUM FIVE anticipates that, once the satellite's actual characteristics have been determined, this calculation will lead to a disposal orbit with a minimum perigee of somewhat less than 300 km above the normal GSO operational orbit. Accordingly, SPECTRUM FIVE currently anticipates that it will maneuver BSSNET2A-115W to an altitude 300 km above GSO orbit at the end of its operational life, which should provide additional margin above the results of the IADC formula.

SPECTRUM FIVE currently intends to allocate and reserve approximately 10 kg of propellant for final orbit raising maneuvers to this altitude. In addition, SPECTRUM FIVE has assessed fuel-gauging uncertainty and this budgeted propellant provides an adequate margin of fuel reserve to ensure that the disposal orbit will be achieved despite such uncertainty.

## **14 - CONCLUSION**

The proposed space station will provide SPECTRUM FIVE with a highly capable 17/24 GHz BSS satellite that will enhance its ability to provide high quality multichannel video service to millions of Americans. For these reasons, SPECTRUM FIVE submits that the proposed satellite will serve the public interest and respectfully requests that the Commission expeditiously grant this request.

Respectfully submitted,

**SPECTRUM FIVE LLC**

---

By: /s/

Dr. Thomas E. Sharon

COO

## **APPENDIX A - LINK BUDGETS**

<b>Downlink :</b>			<b>LA</b>			<b>CONUS</b>			<b>99.9%</b>		
<b>Satellite Location:</b>			<b>115.0WL</b>			<b>Downlink</b>			<b>Clear Rain</b>		
<b>Uplink</b>											
UL Freq	GHz	25.0	DL Freq	GHz	17.5	17.5					
ES Ant Dia	m	13.0	ES Ant Dia	inches	26.0	26.0					
ES Ant Gain	dBW	67.6	Satellite EIRP	dBW	52.0	52.0					
ES Tx Power	dBW	12.0	ES ptg loss	dB	-0.2	-0.2					
ES OBO	dBW	-3.0	Free space loss	dB	-208.7	-208.7					
ES Output Losses	dBW	-1.5	Atmos/Scint loss	dB	-0.5	-0.5					
ES ptg loss	dB	-0.5	Rain & Other loss	dB	0.0	-2.9					
ES EIRP (Clear)	dBW	74.6	Wetting loss	dB	0.0	-0.5					
Free space loss	dB	-211.9	Total loss	dB	-209.4	-212.9					
Sat G/T	dB/K	17.5	ES G/T	dB/K	19.6	16.4					
C/N (thermal)	dB	34.7	Bandwidth	dB-Hz	74.1	74.1					
Uplink Power Control	dB	7.4	C/N (thermal)	dB	16.7	10.0					
UL Spot Beam Interf	dB	35.0	DL Spot Beam Interf	dB	50.0	50.0					
Adj Carr Interf	dB	30.0	Adj Carr Interf	dB	30.0	30.0					
Adj Sat Interf	dB	50.0	Adj Sat Interf	dB	23.8	23.8					
Cross Pol	dB	30.0	Cross Pol	dB	25.0	25.0					
Total UL C/I	dB	26.3	Total DL C/I	dB	20.8	20.8					

### SUMMARY

<b>Clear</b>			<b>Rain</b>		
UL C/N (thermal)	dB	34.7	UL C/N (thermal)	dB	34.7
DL C/N (thermal)	dB	16.7	DL C/N (thermal)	dB	10.0
Total UL C/I	dB	26.3	Total UL C/I	dB	26.3
Total DL C/I	dB	20.8	Total DL C/I	dB	20.8
Total C/(N+I)	dB	14.9	Total C/(N+I)	dB	9.5
Req'd C/(N+I)	dB	7.1	Req'd C/(N+I)	dB	7.1

**Table A-1**

### Link Margin (Los Angeles)



<b>Downlink :</b>			<b>ORLANDO</b>			<b>CONUS</b>			<b>99.5%</b>		
<b>Satellite Location:</b>			<b>115.0WL</b>								
<b>Uplink</b>						<b>Downlink</b>			<b>Clear Rain</b>		
UL Freq	GHz	25.0	DL Freq	GHz	17.5	17.5					
ES Ant Dia	m	13.0	ES Ant Dia	inches	26.0	26.0					
ES Ant Gain	dBW	67.6	Satellite EIRP	dBW	58.1	58.1					
ES Tx Power	dBW	12.0	ES ptg loss	dB	-0.2	-0.2					
ES OBO	dBW	-3.0	Free space loss	dB	-208.8	-208.8					
ES Output Losses	dBW	-1.5	Atmos/Scint loss	dB	-0.6	-0.6					
ES ptg loss	dB	-0.5	Rain & Other loss	dB	0.0	-5.6					
ES EIRP (Clear)	dBW	74.6	Wetting loss	dB	0.0	-0.5					
Free space loss	dB	-211.9	Total loss	dB	-209.7	-215.8					
Sat G/T	dB/K	17.5	ES G/T	dB/K	19.5	15.4					
C/N (thermal)	dB	34.7	Bandwidth	dB-Hz	74.1	74.1					
Uplink Power Control	dB	7.4	C/N (thermal)	dB	22.4	12.2					
UL Spot Beam Interf	dB	35.0	DL Spot Beam Interf	dB	50.0	50.0					
Adj Carr Interf	dB	30.0	Adj Carr Interf	dB	30.0	30.0					
Adj Sat Interf	dB	50.0	Adj Sat Interf	dB	23.6	23.6					
Cross Pol	dB	30.0	Cross Pol	dB	25.0	25.0					
Total UL C/I	dB	26.3	Total DL C/I	dB	20.7	20.7					

### SUMMARY

<b>Clear</b>			<b>Rain</b>		
UL C/N (thermal)	dB	34.7	UL C/N (thermal)	dB	34.7
DL C/N (thermal)	dB	22.4	DL C/N (thermal)	dB	12.2
Total UL C/I	dB	26.3	Total UL C/I	dB	26.3
Total DL C/I	dB	20.7	Total DL C/I	dB	20.7
Total C/(N+I)	dB	17.7	Total C/(N+I)	dB	11.4
Req'd C/(N+I)	dB	7.1	Req'd C/(N+I)	dB	7.1

Table A-3

### Link Margin (Orlando)

<b>Downlink :</b>	<b>Hawaii</b>		<b>CONUS</b>		<b>99.0%</b>	
<b>Satellite Location:</b>	<b>118.8 WL</b>					
<b>Uplink</b>			<b>Downlink</b>		<b>Clear</b>	<b>Rain</b>
UL Freq	GHz	25.0	DL Freq	GHz	17.5	17.5
ES Ant Dia	m	13.0	ES Ant Dia	inches	36.0	36.0
ES Ant Gain	dBW	67.6	Satellite EIRP	dBW	45.7	45.7
ES Tx Power	dBW	12.0	ES ptg loss	dB	-0.4	-0.4
ES OBO	dBW	-3.0	Free space loss	dB	-208.9	-208.9
ES Output Losses	dBW	-1.5	Atmos/Scint loss	dB	-0.7	-0.7
ES ptg loss	dB	-0.5	Rain & Other loss	dB	0.0	-3.3
ES EIRP (Clear)	dBW	74.6	Wetting loss	dB	0.0	-0.5
Free space loss	dB	-211.9	Total loss	dB	-210.0	-213.9
Sat G/T	dB/K	17.5	ES G/T	dB/K	22.2	18.9
C/N (thermal)	dB	34.7	Bandwidth	dB-Hz	74.1	74.1
Uplink Power Control	dB	7.4	C/N (thermal)	dB	12.4	5.2
UL Spot Beam Interf	dB	35.0	DL Spot Beam Interf	dB	50.0	50.0
Adj Carr Interf	dB	30.0	Adj Carr Interf	dB	30.0	30.0
Adj Sat Interf	dB	50.0	Adj Sat Interf	dB	26.3	26.3
Cross Pol	dB	30.0	Cross Pol	dB	25.0	25.0
Total UL C/I	dB	26.3	Total DL C/I	dB	21.9	21.9
	<b>SUMMARY</b>					
<b>Clear</b>			<b>Rain</b>			
UL C/N (thermal)	dB	34.7	UL C/N (thermal)	dB	34.7	
DL C/N (thermal)	dB	12.4	DL C/N (thermal)	dB	5.2	
Total UL C/I	dB	26.3	Total UL C/I	dB	26.3	
Total DL C/I	dB	21.9	Total DL C/I	dB	21.9	
Total C/(N+I)	dB	11.7	Total C/(N+I)	dB	5.1	
Req'd C/(N+I)	dB	7.1	Req'd C/(N+I)	dB	7.1	

Table A-4

## Link Margin (Hawaii)



**TELEMETRY LINK MARGIN**

<b>SPACE STATION to LA TT&amp;C CENTER</b>	<b>GSO CONUS+</b>	<b>Common Parameters</b>	
SS Tx Power, dBW	-8.0	Freq, GHz	17.30
OBO	-3.0	Wavelength, in	0.68
Output Loss, dB	-2.0	Bandwidth,MHz	0.80
SS Tx Pwr, dBW	-13.0	Bandwidth,dB-Hz	59.03
SS Tx Pwr, W	0.05	Slant Range,kM	40,100
SS Peak Antenna Gain, dBi	28.7		
SS Tx EIRP, dBW	15.7		
Pointing Loss, dB	-0.5		
Eirp, dBW	15.2		
Pwr Density, dBW/Hz	-72.0		
Spreading Loss, dB	-163.05		
PFD, dBW/m <sup>2</sup> /MHz,	-148.2		
Space Loss, dB	-209.3		
Ptg Loss, dB	-0.5		
Rain & Atmos Atten, dB, 99.9%	-3.4		
Total Loss, dB	-213.2		
ES Dia, m	9.0		
ES Gain, dB	61.2		
ES Rx Temp, deg K	100.0		
G/T, peak, dB/K	41.2		
C/T, dB/K, Clear	-156.2		
Bandwidth,MHz, dB	-1.0		
DL C/I, dB	30.0		
DL CNR, dB	13.3		
DL C/N+I, dB	13.2		

Table A-5

**Telemetry Link Margin**

## COMMAND LINK LINK MARGIN

EARTH TO SPACE	GSO		Common Parameters	
	Clear	Rain		
ES Transmitter Power,per ch, dBW	30.0	30.0	Freq, GHz	24.75
OBO	-23.0	-4.0	Wavelength, in	0.48
Output Loss, dB	-1.5	-1.5	Bandwidth,MHz	0.80
ES Tx Pwr, dBW	5.5	24.5	Bandwidth,dB-Hz	59.03
ES Tx Pwr, W	3.5	281.8		
ES Antenna, meters	9.0	9.0	Slant Range,kM	40,100
ES Peak Antenna Gain, dBi	64.4	64.4		
ES Tx ERP, dBW	69.9	88.9		
Pointing Loss, dB	-0.5	-0.5		
Eirp, dBW	69.4	88.4		
Pwr Density, dBW/Hz	-53.5	-34.5		
SFD, dBW/m^2,	-83.7	-83.7		
Space Loss, dB	-212.4	-212.4		
Ptg Loss, dB	-0.5	-0.5		
Rain & Atmos Atten, dB, 99.99%	-1.0	-20.0		
Total Loss, dB	-212.9	-232.9		
G/T, peak, dBi/K	17.5	17.5		
Sat. Temp., K	28.1	28.1		
Sat Antenna Gain, 1m, dBi	46.5	46.5		
C/T, dB/K	-125.5	-126.5		
Bandwidth,MHz, dB	-1.0	-1.0		
Uplink C/I, dB	50.0	50.0		
Uplink CNR, dB	44.0	43.0		
Uplink C/N+I, dB	43.1	42.2		
Sat Received Signal, dBW	-97.0	-98.0		
Rx Losses, dB	-20.0	-20.0		
Input to RX, dBm	-87.0	-88.0		

Table A-6

## Command Link Margin

## APPENDIX B - SPACE PATH INTERFERENCE ANALYSIS

Pursuant to Section 25.264(a) of the Commission's rules and the 17/24 GHz BSS Second R&O,<sup>2</sup> SPECTRUM FIVE submits the predicted transmitting antenna off-axis gain information for BSSNET2A-115W, a geostationary satellite in the 17/24 GHz Broadcasting Satellite Service BSSNET2A-115W is applying to operate at the nominal 115.0° W.L. orbital location. Section 25.264(a) requires submission of predicted transmitting antenna off-axis antenna gain information:

- (1) In the X-Z plane, i.e., the plane of the geostationary orbit, over a range of 30 Degrees from the positive and negative X-axes in increments of 5 degrees or less.
- (2) In planes rotated from the X-Z plane about the Z-axis, over a range of up to 60 degrees relative to the equatorial plane, in increments of 10 degrees or less.
- (3) In both polarizations.
- (4) At a minimum of three measurement frequencies determined with respect to the entire portion of the 17.3-17.8 GHz frequency band over which the space station is designed to transmit: 5 MHz above the lower edge of the band; at the band center frequency; and 5

---

*1 Establishment of Policies and Service Rules for the Broadcasting-Satellite Service at the 17.3- 17.7 GHz Frequency Band and at the 17.7-17.8 GHz Frequency Band Internationally, and at the 24.75-25.25 GHz Frequency Band for Fixed Satellite Services Providing Feeder Links to the Broadcasting-Satellite Service and for the Satellite Services Operating Bi-directionally in the 17.3- 17.3-17.8 GHz Frequency Band, 26 FCC Rcd. 8927 (2011) ("17/24 GHz BSS Second R&O")*

MHz below the upper edge of the band.

(5) Over a greater angular measurement range, if necessary, to account for any planned spacecraft orientation bias or change in operating orientation relative to the reference coordinate system.

SPECTRUM FIVE submits the requested antenna data predictions for its space station in the attached technical materials. The required information is produced for the CONUS beam serving the US including Alaska and Hawaii. Consistent with the new rule, for the CONUS beam, the predictions were made in both polarizations (i.e., RHCP and LHCP) at three measurement frequencies in the 17.3-17.7 GHz frequency band over which its proposed space station is designed to transmit.

Because SPECTRUM FIVE does not plan for any spacecraft orientation bias or change in operating orientation relative to the reference coordination system, it does not provide predictions over a greater angular measurement range as specified in Section 25.264(a)(5).

See 47 C.F.R. § 25.264(a). Similarly, because the power flux density of SPECTRUM FIVE's proposed space station will not exceed the coordination trigger of -117 dB

W/m/100 kHz at the location of any prior-filed U.S. DBS space station. SPECTRUM FIVE

will maintain the maximum orbital eccentricity to less than  $3.1 \times 10^{-4}$ .

Section 25.264(a) requires submission of predicted transmitting antenna off-axis antenna gain information: of the range) or lower (at the high end of the range) than specified in Section 25.264(a)(4).

For detailed antenna off-axis gain plots see Part I (-X axis) and Part II (+X axis) of the attached Appendix B pdf files.