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September 26, 2017

FCC Office of Engineering and Technology
445 12th Street SW
Washington, DC 20554

SUBJECT: TEMPEST-D cubesat mission (FCC application # 0573-EX-CN-2017)

Ms. Leann Nguyen,

Please find details on the TEMPEST-D cubesat mission included below.

Date license is required: December 1st, 2017
LV integration date: February 1st, 2018
Launch date: OA-9 March 2018
Date for initiation of on-orbit operations: NET 1 month post launch
Expected mission duration: 12 months

Principle Investigator for the mission.

Point of Contact Name:	Dr. Steve Reising
Organization Name:	Colorado State University
Address:	B113 Engineering Bldg, Fort Collins, CO 80521
E-Mail:	steven.reising@colostate.edu
Telephone Number:	970-491-2228

Technical point of contact for the mission.

Point of Contact Name:	Matt Pallas
Organization Name:	Blue Canyon Technologies
Address:	2425 55th St. Suite A-200, Boulder, CO 80301
E-Mail:	mpallas@bluecanyontech.com
Telephone Number:	720-458-0703

*please also include Steve Reising on any relevant communications.

Point of contact who can terminate ALL satellite transmissions if interference is detected.

Point of Contact Name:	Scott Palo, PhD
Organization Name:	Blue Canyon Technologies
Address:	2425 55th St. Suite A-200, Boulder, CO 80301
E-Mail:	palo@bluecanyontech.com
Telephone Number:	720-458-0703

*please also include Matt Pallas and Steve Reising on any relevant communications.

Point of contact who can terminate ALL Boulder CO ground station transmissions if interference is detected.

Point of Contact Name:	Scott Palo, PhD

Organization Name: Blue Canyon Technologies
Address: 2425 55th St. Suite A-200, Boulder, CO 80301
E-Mail: palo@bluecanyontech.com
Telephone Number: 720-458-0703
*please also include Matt Pallas and Steve Reising on any relevant communications.

Point of contact who can terminate ALL Wallops VA ground station transmissions if interference is detected.

Point of Contact Name: Thomas Johnson
Organization Name: NASA/GSFC Wallops Flight Facility
Address: Bldg U25, Wallops Is., VA, 23337
E-Mail: thomas.e.johnson@nasa.gov
Telephone Number: 757-824-2560
*please also include Matt Pallas, Steve Reising and Scott Palo on any relevant communications.

Point of contact who can terminate ALL Morehead KY ground station transmissions if interference is detected.

Point of Contact Name: Ben Malphrus
Organization Name: Morehead State University
Address: Space Science Center 235 Martindale Drive, Morehead, KY 40351
E-Mail: b.malphrus@moreheadstate.edu
Telephone Number: 606-783-9596
*please also include Matt Pallas, Steve Reising and Scott Palo on any relevant communications.

Point of contact for conjunction alerts.

Point of Contact Name: Matt Pallas
Organization Name: Blue Canyon Technologies
Address: 2425 55th St. Suite A-200, Boulder, CO 80301
E-Mail: mpallas@bluecanyontech.com
Telephone Number: 720-458-0703
*please also include Steve Reising on any relevant communications.

Project Description

The TEMPEST-D (Temporal Experiment for Storms and Tropical Systems - Demonstrator) is a 6U CubeSat mission to provide risk mitigation for the six-satellite TEMPEST mission that will provide the first temporal observations of cloud and precipitation processes on a global scale.

These observations are important to understand the linkages in and between Earth's water and energy balance, as well as to improve our understanding of cloud model microphysical processes that are vital to climate change prediction.

TEMPEST-D consists of one of the proposed TEMPEST 6U CubeSats, to raise the technology readiness level of the system to TRL 9 and to demonstrate its measurement capabilities.

The payload consists of a radiometer developed for the failed RACE mission and a High-frequency Airborne Microwave and Millimeter-wave Radiometer (HAMMR) IIP-10 radiometer.

TEMPEST-D is a science mission lead by Dr. Steve Reising at the Colorado State University. The CubeSat bus is built and operated by Blue Canyon Technologies.

License Details

The TEMPEST-D mission will utilize a Utah State University provided UHF Cadet radio that will operate at with a 15kHz uplink at 450MHz and a downlink at 467.5MHz with a bandwidth of 3MHz. We are requesting a 47 CFR Part 5 - EXPERIMENTAL RADIO SERVICE license for our uplink at 450MHz per footnote US87 in the NTIA MANUAL OF REGULATIONS AND PROCEDURES FOR FEDERAL RADIO FREQUENCY MANAGEMENT which states "US87 - The band 449.75-450.25 MHz may be used by Federal and non-Federal stations for space telecommand (Earth-to-space) at specific locations, subject to such conditions as may be applied on a case-by-case basis. Operators shall take all practical steps to keep the carrier frequency close to 450 MHz". For the downlink, we are requesting operation between 465MHz and 470MHz which is a secondary allocation for the Meteorological-satellite service (space-to-EARTH) in the Federal Table and as such we expect coordination with NTIA is required. Additionally, per footnote 5.289 "Earth exploration-satellite service applications, other than the meteorological-satellite service, may also be used in the bands 460-470 MHz and 1690-1710 MHz for space-to-Earth transmissions subject to not causing harmful interference to stations operating in accordance with the Table". BCT is aware of footnote US201 and will insure that the TEMPEST-D power flux-density produced at the Earth's surface shall not exceed -152 dBW/m²/4 kHz.

BCT is requesting temporary FCC authorization to use the FCC-approved GSP-1720 (FCC ID: J9CGSSDVM) to transmit from a space-based location. The GSP-1720 will be operating exactly as was approved during the FCC equipment approval process; it will be using exactly the same antenna, protocols, dynamic power control mechanisms, authentication, have exactly the same emissions characteristics, etc. as if it were transmitting from the earth's surface.

Additional data required for applications requesting use of federal or shared government frequencies.

Spacecraft: TEMPEST-D

Inclination: 52° [ISS]

Apogee: 400km
Perigee: 400km
Orbital period: 1.62h
Number of satellites in the system: 1
Number of transmitting satellites: 1
Number of transmitting satellites: 1

Transmitter #1 Cadet U/U

- Center Frequency: 468MHz
- Bandwidth: 3MHz
- 3dB beamwidth: 100^{o}
- Maximum Antenna Gain: 5dBi
- Polarization: RCP
- Maximum transmit power: 2W
- Modulation: OQPSK
- ITU emission designator: 3M00G2DAX

Receiver #1 Cadet U/U

- Center Frequency: 450MHz
- Bandwidth: 15kHz
- 3dB beamwidth: 100^{o}
- Maximum Antenna Gain: 5dBi
- Polarization: RCP
- Receiver Sensitivity: -97dBm
- Modulation: FSK
- ITU emission designator: 15K0G2DAX

Transmitter #2 Globalstar GSP-1720 [updated 2/8/18]

- Center Frequency: 1615.65 MHz and 1616.88MHz
- Bandwidth: 1.23MHz
- 3dB beamwidth: 100^{o}
- Maximum Antenna Gain: 0.5dBi
- Polarization: LCP
- Maximum transmit power: 2W
- Modulation: OQPSK
- ITU emission designator: 1M23G7DAF

Receiver #2 Globalstar GSP-1720 [updated 2/8/18]
- Center Frequency: 2483.5MHz to 2495MHz
- Bandwidth: 1.23MHz
- 3dB beamwidth: 100^{o}
- Maximum Antenna Gain: 0.2dBi
- Polarization: LCP
- Receiver Sensitivity: -100dBm
- Modulation: unknown
- ITU emission designator: 1M23G7DAF

Ground Station #1:
- Wallops Island, VA 23337
- 37 51’ 21’’ N 75 30’ 43” W
- Altitude above MSL [m]: 4
- Antenna height above ground [m] : 18
- Elevation: 5-90^{o}
- Azimuth: 0-360^{o}
- Transmitter
  - Center Frequency: 450MHz
  - Bandwidth: 15kHz
  - 3dB beamwidth: 2.9^{o}
  - Maximum Antenna Gain: 35dBi
  - Polarization: RCP
  - Maximum transmit power: 20W
  - Modulation: FSK
  - ITU emission designator: 15K0G2DAX
- Receiver
  - Center Frequency: 468MHz
  - Bandwidth: 3MHz
  - 3dB beamwidth: 2.9^{o}
  - Maximum Antenna Gain: 35dBi
  - Polarization: RCP
  - Receiver Sensitivity: -114dBm @ 1MHz BW
  - Modulation: OQPSK
  - ITU emission designator: 3M00G2DAX

Ground Station #2:

100 Satellite Drive Morehead, KY 40351
38° 11' 30.8" N 83° 26' 19.9" W
Altitude above MSL [m]: 350
Antenna height above ground [m] : 25.6
Elevation: 5-90^{o}
Azimuth: 0-360^{o}
Transmitter
- Center Frequency: 450MHz
- Bandwidth: 15kHz
- 3dB beamwidth: 2.6^{o}
- Maximum Antenna Gain: 32dBi
- Polarization: RCP
- Maximum transmit power: 50W
- Modulation: FSK
- ITU emission designator: 15K0G2DAX

Receiver
- Center Frequency: 468MHz
- Bandwidth: 3MHz
- 3dB beamwidth: 2.6^{o}
- Maximum Antenna Gain: 32dBi
- Polarization: RCP
- Receiver Sensitivity: -100dBm
- Modulation: OQPSK
- ITU emission designator: 3M00G2DAX

Ground Station #3:

2425 55th St, Boulder, CO 80301
40°01'23.8"N 105°13'34.7"W
Altitude above MSL [m]: 1600
Antenna height above ground [m] : 4
Elevation: 5-90^{o}
Azimuth: 0-360^{o}
Transmitter
- Center Frequency: 450MHz

Bandwidth: 15kHz
3dB beamwidth: 17°
Maximum Antenna Gain: 21dBi
Polarization: RCP
Maximum transmit power: 500W
Modulation: FSK
ITU emission designator: 15K0G2DAX

Receiver

None