AeroCube-5 Test.

The purpose of the operation is to conduct research regarding the space application of microelectronic technologies. The operation includes a demonstration of principles of the physics of the low-earth-orbit space environment and its effects on microelectronics. Two AeroCube-5 satellites comprise this flight to study the physics of formation flying.

The AeroCube-5 is a PICOSAT class satellite, weighs less than 2.2 KG and is 4x4x6 inches in dimension. It is being launched on NROL-39, slated for December, 2013. The orbit is 469 x 972 km with 120 degree inclination. Orbital debris analysis predicts a lifetime 23 years (see "**AC5_Lifetime**" Exhibit). A space collision probability analysis shows that the AC5 satellites are below the 0.001 threshold required in AFI 91-217 (see "**AC5_collision_prob_v3**" Exhibit). To assess ground casualties and to double check the orbit lifetime and space collision probabilities calculated by The Aerospace Corporation experts, the NASA DAS2.02 program was utilized. The input and outputs are provided as exhibits (see "**NASA DAS2.02 input for AC5**" and "**NASA DAS2.02 output for AC5**").

The AeroCube-5 satellite has two radios for redundancy. The first is the Freewave Technologies, Inc. FGRM radio inside which outputs 2 Watts. It has a fixed frequency (i.e. not hopping or spread spectrum) at 914.7 MHz (see "**AC5 Freewave FGRM bandwidth**" Exhibit) so that the ground station can quickly link up with the satellite rather than waiting for the hopping sequence to sync up. The second radio is the AdvRadio built by The Aerospace Corporation around a Texas Instruments CC1101 transceiver chip. It also operates at a fixed 914.7 MHz frequency (see "**AC5 AdvRadio bandwidth**" Exhibit) and outputs 1.5W. The satellite chooses which radio to use - both are not used at the same time. Both radios attach to an omni-directional patch antenna on the AeroCube-5. We have the pattern calculated and tested but use -10dB as the gain for 90% of the sphere area (see "**AC5 antenna pattern simulations**" Exhibit).

When the AeroCube-5 satellite is ejected, it will power-on. However the radio will be in receive-mode only. As the satellite flies over a ground station, the station will be continuously beaconing upwards towards the satellite. When the satellite radio hears the beacon, along with the proper serial number code, it will respond and a link will be established. At that point, the ground station will ask the satellite for whatever information it wants, typically state of health log files, images from the cameras or other onboard telemetry. The satellite will respond by down-loading the requested information. When the link is lost due to the satellite passing out of view while the satellite was transmitting, the satellite will try 256 times to complete the last packet transmitted. If each packet is 72 bytes long and the radio data rate is 38.4 Kbaud, then it will try for only a couple of seconds before the 256 attempts are exceeded. At that point the satellite will go back into a passive receive mode again and again wait for the next beacon from a ground station with the correct serial number.

We would like to use two types of ground stations to communicate with the AeroCube-5 satellite. The first is a fixed 16" dish antenna at The Aerospace Corporation in El Segundo, CA, near LAX airport. It has 30 dB gains, 5 deg beam width and also would use a 2W Freewave FGRM radio or an AdvRadio on the feed horn. The second ground station is a portable 2-meter diameter dish. This has 22 dB gain, a 15 deg beam width and would use a Freewave FGRM radio or an AdvRadio with the output passed through a

9W amplifier. This portable station we would like to use somewhere that is RF quiet and also advantageously located for maximum satellite coverage. A typical satellite pass is 5 minutes long, twice per day - so the system spends a lot of time not in use. The antenna parameters and ground station locations are shown in the exhibit "**AC5 FAA sketch and antenna figures v1**."