Before the

FEDERAL COMMUNICATIONS COMMISSION

Washington, DC 20554

In the Matter of	)	
	)	
THE BOEING COMPANY	)	
	)	
Amendment to Application to Modify	)	
Authority to Launch and Operate an	)	File No.
Experimental Non-Geostationary	)	
Low Earth Orbit Satellite	)	

AMENDMENT

The Boeing Company ("Boeing") is authorized by the Commission to launch and operate an experimental non-geostationary ("NGSO") low earth orbit ("LEO") satellite, referred to herein as Cubesat Test Bed 1 ("CSTB1"). *See* FCC File No. 0330-EX-PL-2005 (granted 2/23/06). On June 8, 2006, Boeing filed an application to modify its experimental authorization in order to permit the satellite to be launched to a higher orbit. *See* FCC File No. 0068-EX-ML-2006 (filed 6/8/06). Boeing herein amends its pending modification application in order to:

(1) incorporate deployable panels on the satellite to reduce the in-orbit life of the spacecraft;

(2) modify the post-mission disposal plan for the satellite to reflect the use of deployable panels;

(3) report the addition of a new program of experimentation to monitor the performance of the deployable panels;

(4) report a delay in the scheduled launch of Boeing's satellite; and

(5) increase the term of the experimental license to three years (expiring on February 23, 2009) to accommodate a delay in the launch and also to provide sufficient time to complete the additional program of experimentation.

The sections of the narrative that were submitted as part of Boeing's modification application that are impacted by this amendment are identified in the following table and are discussed further in subsequent sections of this document.

SECTION	DESCRIPTION	IMPACT
I. NARRATIVE INFORMATION REQUIRED BY FCC FORM 442		
Question 6A	Description of the nature of the research project being conducted	**CHANGE**
Question 6B	Showing that the communications facilities requested are necessary for the research project	None
Question 6C	Showing that existing communications facilities are inadequate	None
Question 10	Transmitting equipment to be installed, including manufacturer, model number and whether equipment is experimental in nature	None
Question 11A	Is the equipment listed in Item 10 capable of station identification pursuant to Section 5.115	None
Question 4	Antenna Registration Form. Operation of Directional Antenna	None
II. INFORMATION REQUIRED BY PART 5 OF THE COMMISSION'S RULES		
Section 5.63	Orbital Debris Mitigation	
Section 5.63(e)(1)(i)	Limiting the amount of debris released during normal operations	None
Section 5.63(e)(1)(ii)	Limiting the probability of the satellite becoming a source of debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal	**CHANGE**
Section 5.63(e)(2)	Limiting the probability of accidental explosions during and after completion of mission operations	None
Section 5.63(e)(3)	Limiting the probability of the satellite becoming a source of debris by collisions with large debris or other operational space stations	None
Section 5.63(e)(4)	Post-mission disposal plans for the space station at end of life	**CHANGE**
III. RELEVANT INFORMATION ADDRESSED IN SECTION 25.114 OF THE COMMISSION'S RULES		
Section 25.114(c)(4)	General Description of Overall System Facilities, Operations, and Services	N/A
Section 25.114(c)(5)	Radio Frequency Plan	N/A
Section 25.114(c)(6)	Orbital Locations	None
Section 25.114(c)(7)	Predicted Spacecraft Antenna Gain Contours	N/A
Section 25.114(c)(12)	Physical Characteristics of Satellites	N/A
Section 25.114(c)(15)	Schedule	**CHANGE**
Section 25.114(d)(6)	Public Interest Considerations	**CHANGE**

I. NARRATIVE INFORMATION REQUIRED BY FCC FORM 442

Question 6:

A. Description of the nature of the research project being conducted

Commercial and government interests are increasingly employing lightweight and inexpensive satellites or "NanoSats" to accomplish a growing variety of mission objectives. In furtherance of this expanding market segment, a standardized design specification for small satellites has been developed, known as the Cubesat, which enables the inexpensive launch of a large number of small satellites as secondary payloads on commercial launch systems.

The design specification for Cubesats, however, does not include standardized active or passive mechanisms to ensure the timely reentry of the spacecraft following the completion of its mission plan. Boeing has therefore developed a passive de-orbit mechanism that can be incorporated onto a Cubesat with negligible loss to the payload area within the spacecraft bus. A description of Boeing's de-orbit mechanism is provided in the next section of this Amendment.

Boeing proposes to modify the program of experimentation for its Cubesat satellite in order to monitor and analyze the post-deployment performance of its de-orbit mechanism. This program of monitoring will enable Boeing to determine whether its passive de-orbit mechanism will perform in a manner that is consistent with the predictive software tools and models that Boeing used to develop the mechanism. The program of monitoring and analysis is anticipated to take nine months and will be initiated following the completion of the nine-month primary program of experimentation that was described in Boeing's original license application, resulting in a total mission life of 18 months for Boeing's Cubesat spacecraft.

II. INFORMATION REQUIRED BY PART 5 OF THE COMMISSION'S RULES

Section 5.63(e)(1)(ii) Limiting the probability of the satellite becoming a source of debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal

As noted above, Boeing is incorporating a satellite de-orbit mechanism on the CSTB1 space vehicle, which is designed to reduce the in-orbit life of Boeing's experimental satellite and permit more timely re-entry following mission operations. The proposed de-orbit mechanism consists of two lightweight deployable panels, which will increase the effective drag area of the satellite. Each of the panels will be roughly the size of one side of the cube.

The panels will be held in place and released from a single actuation point. The deployment of the panels will be initiated by ground command. The de-orbit mechanism, however, has been designed to ensure the deployment of the panels absent a command from the ground. The panels will be secured using a filament that will degrade naturally when exposed to ultraviolet ("UV") radiation. The use of UV-degradable filament will ensure the timely release of the panels in a space environment in the event that deployment cannot be actuated by a command from the ground.

The deployable panels increase the effective area of the vehicle over 30 percent. The average effective area was computed on the basis of the average area projections as viewed from around the satellite. The resulting changes to the spacecraft and orbit life are summarized in the following table:

Parameter	Units	Value
Satellite Drag Area	m^2	***Now:* 0.0196 m^2** *Was:* 0.0145 m^2
De-orbit lifetime (Post Mission)	years	***Now:* 24.7 years** *Was:* 36.0 years
Launch Date	mm/yy	***Now:* 12/06** *Was:* 08/06
Re-enter Date	year	***Now:* 2033** *Was:* 2043

Table 3: Changes to Post-Mission Disposal Plans

Catastrophic system failure due to orbital debris or micrometeoroid impact will not affect the vehicle's ability to de-orbit. Based on the mission orbit of 716 kilometers and lack of any active means to maintain its orbit, the space vehicle is anticipated to re-enter the Earth's atmosphere in less than 25 years after the end of its mission life based on lifetime prediction simulations for the current mission epoch (*i.e.*, launch in calendar year 2006).

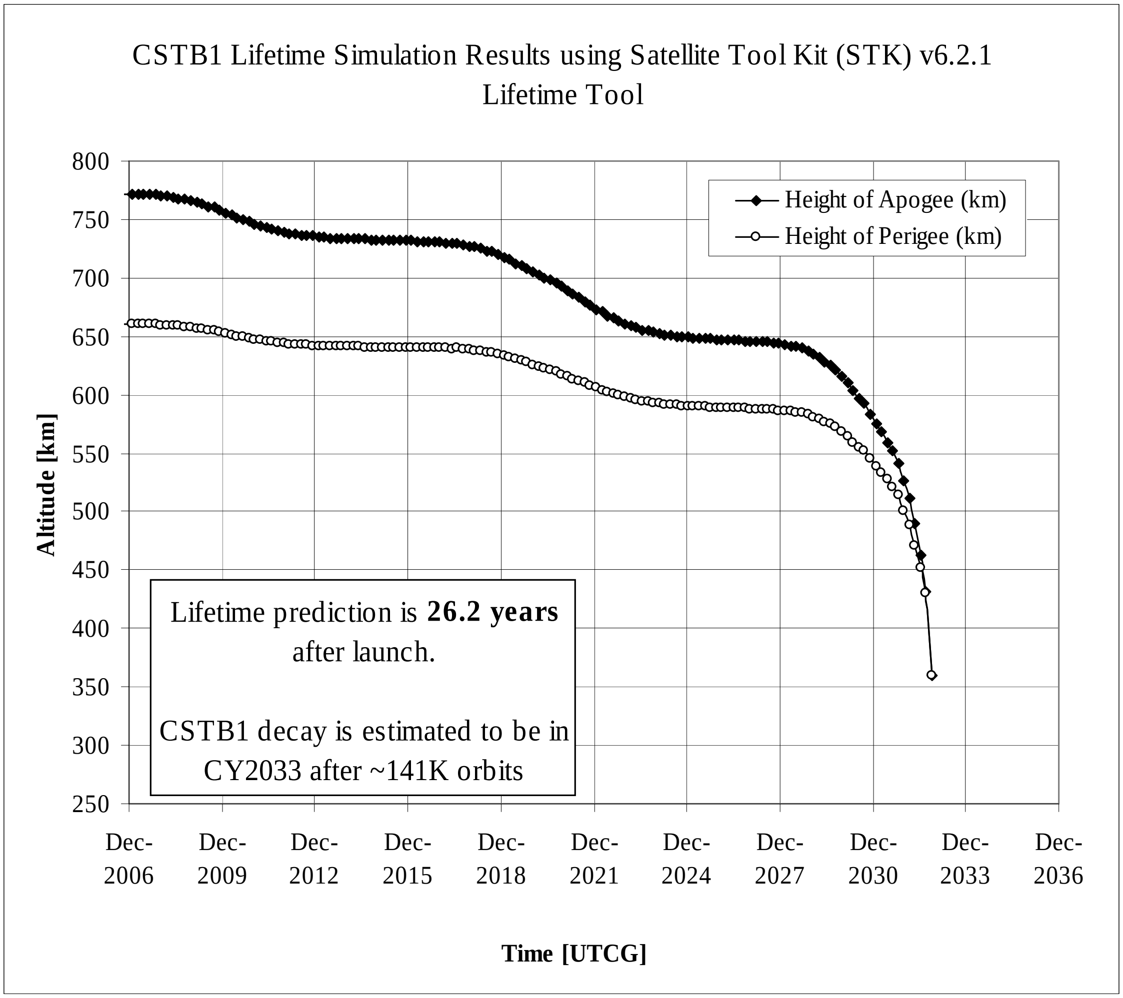
Lifetime prediction was computed using a commercial off-the-shelf simulation package developed by Analytical Graphics, Inc. called Satellite Tool Kit ("STK") version 6.2.1. The simulation module used for lifetime prediction is based on algorithms developed by NASA's Langley Research Center. Drag effects are computed by applying a high-accuracy Jacchia 1971 atmospheric model, initial orbit state and epoch, and space vehicle ballistic coefficient. Orbital perturbations are computed with effects of Earth oblateness (through J5), solar and lunar gravity, and solar radiation pressure.

The set of assumptions used to determine de-orbit lifetime predictions for the CSTB1 vehicle are described in the following table.

Parameter	**Value**
Orbit Apogee Altitude	795.2 km
Orbit Perigee Altitude	659.0 km
Inclination	98 deg
Orbit Epoch	Dec 2006
Satellite Mass	860 grams
Satellite Drag Area	0.0196 m^2 (Computed by looking at the average area projections as viewed from around the satellite)
Coefficient of Drag	2.0
Atmospheric Density Model	Jacchia 1971
Simulation	Satellite Tool Kit version 6.2.1 LifeTime Predictor

Table 2: Simulation Input Parameters Used for Lifetime Prediction

The simulation predicted an orbital re-entry following 24.7 years of post-mission operations (26.2 years after injection into the mission orbit), with an estimated re-entry date of 2033. The following plot shows the change in orbit parameters as a function of universal time code generator ("UTCG") time and assumes a launch in December 2006.



Section 5.63(e)(4) Post-mission disposal plans for the space station at end of life

The post-mission disposal plans for the CSTB1 spacecraft include the transition of all vehicle systems to a "sleep" state, which includes the cessation of all radio operations (*i.e.*, transmission and receipt). CSTB1 energy storage devices will be held at a minimal charge state at the vehicle end-of-life. The CSTB1 satellite is predicted to re-enter within 24.7 years following mission operations based on its mission orbit, vehicle mass, geometry, and mission epoch (*i.e.*, launch in calendar year 2006 – solar min). These changes are summarized in the following table:

Parameter	Units	Value

De-orbit Lifetime (Post Mission)	Years	***Now:* 24.7 years** *Was:* 36.0 years

Table 3: Changes to Post-Mission Disposal Plans

Re-entry debris and probability of human casualty will be negligible. The materials used on the vehicle include aluminum and PCB material, which have a relatively low melting temperature compared to other materials such as titanium or stainless steel.

III. RELEVANT INFORMATION ADDRESSED IN SECTION 25.114 OF THE COMMISSION'S RULES

25.114(c)(15) Schedule

Boeing requests in this Amendment that the term of its experimental license be extended to a full three years following the date of its initial grant (February 23, 2006). As a result, the experimental license would expire on February 23, 2009.

Boeing is requesting this extension to accommodate: (1) a delay in the scheduled launch, which was outside of Boeing's control; (2) the possibility of further delays in the launch resulting from the investigation into the recent loss of a Dnepr launch vehicle; and (3) the completion of the additional program of experimentation described in previous sections of this Amendment.

The launch date and schedule for Boeing's Cubesat have already been pushed back roughly six months, from a March 2006 to December 2006. The CSTB1 mission schedule has been extended by a corresponding amount. The new project timeline and major milestones for the launch and operations of the CSTB1 space vehicle are provided in the following table. The dates are approximate and contingent upon the exact launch date ("Time of Launch" or "To"), orbit parameters, and unforeseen events during on-orbit operations.

Milestone	Date	Notes
Delivery for Launch Integration	***Now:* Sep 2006** *Was:* Jun 2006	To – 3 months
Launch	***Now:* Dec 2006** *Was:* Aug 2006	To = Time of Launch
Release from Launch Adapter	***Now:* Dec 2006** *Was:* Aug 2006	To + 0hr 30min
On-orbit Check	***Now:* Dec 2006** *Was:* Aug 2006	To + 2hr 00 min
Start of Experiments	***Now:* Jan 2007** *Was:* Sep 2006	To + 5 days
Decommissioning	***Now:* Sep 2007** *Was:* Jun 2007	To + 9 months
Re-entry	***Now:* 2033** *Was:* 2043	To + 26.2 years

Table 4: CSTB1 System Major Milestones

25.114(d)(6) Public Interest Considerations

The public interest benefits of Boeing's proposed Cubesat operations remain generally the same as described in Boeing's original experimental license application and in its currently pending application to modify Boeing's experimental license.

In addition to the public interest benefits described in those applications, Boeing's Amendment proposes additional public interest benefits through the addition of a program of experimentation to test a low-profile, passive de-orbit mechanism for Cubesat spacecraft. As the Commission is aware, a significant problem exists with respect to the abandonment of debris for unnecessarily long periods of time in various Earth orbits.[1] In order to address this concern, Boeing has developed a de-orbit

[1] *See Mitigation of Orbital Debris*, FCC 04-130 (June 21, 2004).

mechanism that could be used by operators of Cubesat spacecraft to greatly reduce the time that the spacecraft remain in orbit following their designated mission plans. Boeing anticipates that its de-orbit mechanism will function in a manner that is consistent with the predictive modeling tools that Boeing employed in its development. The program of experimentation proposed in this Amendment is intended to verify Boeing's hypothesis, resulting in the development of a low-cost and low-profile de-orbit mechanism that can substantially reduce the post-mission life of Cubesat spacecraft, while not inhibiting the efficacy of Cubesat spacecraft through a significant loss in payload capacity. Boeing therefore requests that the Commission grant Boeing's application to modify its experimental license, as amended herein.