

SPACE ACT AGREEMENT AMENDMENT SEVEN  
BETWEEN  
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
AND  
SPACE EXPLORATION TECHNOLOGIES CORP.  
FOR  
COMMERCIAL ORBITAL TRANSPORTATION SERVICES DEMONSTRATION (COTS)

PURPOSE AND AGENCY COMMITMENT

The purpose of this Amendment is to modify Space Act Agreement NNJ06TA26S to add Milestones that reduce risks associated with the remaining development and timely demonstration of cargo space transportation capabilities. The additional Milestones improve the chance of mission success by (1) augmenting ground and flight testing; (2) accelerating development of enhanced cargo capabilities; or (3) further developing the ground infrastructure needed for commercial cargo capabilities. This amendment also updates the descriptions and completion dates for the existing milestones as well as incorporates some administrative changes.

Article 16 is amended as follows:

ARTICLE 16. TERM OF AGREEMENT

This Agreement becomes effective upon the date of the last signature below and shall remain in effect until the completion of all obligations of both parties hereto, or through December 31, 2012, whichever comes first.

Article 20 is amended as follows:

ARTICLE 20. PRINCIPAL POINTS OF CONTACT

The NASA Administrative Contact is replaced as follows:

Elijah J. Williams  
Agreements Officer

Johnson Space Center  
2101 NASA Parkway, Code BT  
Houston, TX 77058  
Phone: 281-244-1638  
Fax: 281-483-0503  
E-mail: elijah.j.williams@nasa.gov

The SpaceX Technical Contact is replaced as follows:

SpaceX Technical Contact  
David Giger  
Dragon Development Manager  
1 Rocket Road  
Hawthorne, CA 90250  
310.363.6288  
Fax: 310.414.9715  
[David.Giger@spacex.com](mailto:David.Giger@spacex.com)

## APPENDIX 2: SpaceX Milestones and Success Criteria

### Capabilities A-C

The completion dates for the existing milestones are updated per the following:

<p><b>Milestone 18: Demo 2 Readiness Review</b></p> <p>SpaceX shall conduct a Demo 2 Demonstration Readiness Review in accordance with the DRR definition in Appendix 3.</p> <p>Success Criteria: Successful completion of the DRR.</p>	<p>Amount \$5,000,000 Date: September 2011</p>
<p><b>Milestone 19: Demo 2 Mission</b></p> <p>SpaceX shall launch the Demonstration 2 mission and complete a post-flight review.</p> <p>Success Criteria:</p> <ul style="list-style-type: none"><li>- Perform integration and launch</li><li>- Complete post-flight quick-look review (approx. 2 days after mission completion) assessing performance against objectives</li><li>- Identify any anomalies with preliminary assessment of cause</li></ul>	<p>Amount \$5,000,000 Date: November, 2011</p>

**Milestone 21: Demo 3 Readiness Review**

SpaceX shall conduct a Demo 3 Demonstration Readiness Review in accordance with the DRR definition in Appendix 3.

Success Criteria:  
Successful completion of the DRR.

Amount \$5,000,000  
Date: December, 2011

**Milestone 22: Demo 3 Mission**

SpaceX shall launch the Demonstration 3 mission and complete a post-flight review.

Entrance Criteria:

- Primary objectives for the demonstration have been defined by SpaceX with NASA concurrence

Success Criteria:

- Perform integration and launch
- Primary objectives have been met
- Complete the post-flight quick-look review (approx. 2 days after mission completion) assessing performance against objectives
- Identify any anomalies with preliminary assessment of cause

Amount \$5,000,000  
Date: January 2012

The following milestones are added to the SAA:

<p><b>Milestone 30: Thermal Vacuum Tests (System Level)</b></p> <p>SpaceX shall perform testing of the whole Dragon System in a Thermal Vacuum Chamber, including Capsule and Trunk.</p> <p>Entrance Criteria:</p> <ul style="list-style-type: none"><li>• Final update to Test Plan and configuration to be tested, agreed to by NASA</li><li>• Test series defined including objectives and risks</li><li>• Test procedures released and under configuration control</li><li>• Ground systems and data acquisition systems ready to support test</li></ul> <p>Success Criteria:</p> <ul style="list-style-type: none"><li>• All defined tests completed</li><li>• Test data recorded and archived</li><li>• Conduct Quick-look Post-test Review of test data and anomalies (2 days after completion of testing)</li></ul> <p>Provide all planned data and analysis (Test Reports) 30 days after test completion and will be assessed as Entrance Criteria for DRR milestone.</p>	<p>Amount \$20,000,000 Date: July 2011</p>
<p><b>Milestone 31: Test Site Infrastructure Implementation</b></p> <p>SpaceX shall implement enhancements to the test site infrastructure to enhance the execution of the cargo demonstration and operational missions.</p> <p>Entrance Criteria:</p> <ul style="list-style-type: none"><li>• Plans for infrastructure enhancements reviewed and agreed to by NASA</li><li>• Obtain licenses, permits, approvals and agreements as necessary</li><li>• Design and fabricate or acquire new facilities and infrastructure</li><li>• Develop and maintain a schedule of the activities</li></ul> <p>Success Criteria:</p> <ul style="list-style-type: none"><li>• Construction or installation of agreed to enhancements complete or progress made to NASA satisfaction</li><li>• Approvals/agreements executed</li></ul>	<p>Amount \$5,000,000 Date: June 2011</p>

**Milestone 32: Dragon Trunk Acoustic Test**

SpaceX shall perform Acoustic testing of the flight Dragon trunk as workmanship verification for the solar array assemblies and integrated trunk assembly.

Entrance Criteria:

- Develop the configuration of the test, including a list of components and subsystems to be included in test, agreed to by NASA
- Submit Test Plan and configuration to be tested, agreed to by NASA
- Test series defined including objectives and risks
- Test procedures released and under configuration control
- Flight trunk assembled with solar arrays and solar array covers
- Ground systems and data acquisition systems ready to support test including facility under contract

Success Criteria:

- All defined tests completed
- Evaluate and verify solar array integrity post test
- Test data recorded and archived
- Conduct Quick-look Post-test Review of test data and anomalies (2 days after completion of testing)

Provide all planned data and analysis (Test Reports) 30 days after test completion and will be assessed as Entrance Criteria for DRR milestone.

Amount \$10,000,000  
Date: June 2011

**Milestone 33: LIDAR Sensors 6 Degree of Freedom Test (closed loop)**

SpaceX shall fabricate a flight-like Dragon LIDAR and install in a simulated sensor bay with representative sensor field of view and conduct testing of the systems at a 6 Degree Of Freedom (DOF) test facility to characterize the systems performance over a wide range of angles of attack and lighting conditions in a closed loop control configuration. The Parties agree that the data/items furnished by SpaceX in this LIDAR testing shall not be considered "Proprietary Data" as that term is defined in Article 12.

**Entrance Criteria:**

- DragonEye LIDAR and control system installed on test stand in a simulated Dragon sensor bay configuration and ready for test
- Test Plan/ Procedure reviewed by NASA and released
- Acceptable ranges for key performance parameters defined
- Data acquisition system tested and ready to support test
- Data and analysis to be provided to NASA defined and agreed

**Success Criteria:**

- All defined tests completed
- Test data recorded and archived
- Conduct Quick-look Post-test Review of test data and anomalies (2 days after completion of testing)

Provide all planned data and analysis 30 days after test completion and will be assessed as Entrance Criteria for DRR milestone.

Amount \$5,000,000

Date: August 2011

**Milestone 34: Design Review of Enhanced Powered Cargo accommodations**

SpaceX shall conduct a System Critical Design Review (CDR) for Enhanced Powered Cargo Accommodations inside the Dragon capsule, in accordance with an agreed upon subset of a CDR from Appendix 3 of the SAA.

**Entrance Criteria**

- NASA defines minimum level of desired enhanced cargo (power, control and data interfaces) and agreed to by SpaceX
- Design trades and preliminary supporting analysis completed

**Success Criteria**

- Design review chart package submitted and presented to NASA; Designs provided as requested
- Updated power budget delivered to NASA
- Updated thermal handbook delivered to NASA
- Updated ECS analysis delivered to NASA
- Updated pressurized cargo volume and packaging design delivered to NASA
- Updated early and late access operational analysis delivered to NASA
- Updated mass properties delivered to NASA
- Updated Qualification/Acceptance test plans delivered to NASA

Amount \$5,000,000  
Date: August 2011

**Milestone 35: Design Review of Pressurized Cargo Volume Increase**

SpaceX shall perform the design and critical supporting analysis for increased volume of pressurized cargo accommodations as well as maintaining the viability of the Powered Cargo Locations, Early and Late Access capability.

**Entrance Criteria**

- Design trades and preliminary supporting analysis completed
- At least one concept for cargo volume increase agreed to by NASA

**Success Criteria**

- Design review chart package submitted and presented to NASA; Models provided as requested
- Provide analysis for volume increase and loading procedures
- Provide design and analysis details for non-standard cargo containers
- Provide analysis for thermal and vehicle mass/CG implications from increased cargo

Amount \$5,000,000  
Date: August 2011

**Milestone 36: Full Dragon EMI/EMC Test, Second Flight-Like HTIL (Dragou Force)**

SpaceX will perform an EMC System Test of the Dragon C2 spacecraft and Trunk, during HITL (hardware in the loop) operation of the spacecraft. Testing will consist of RS03 (radiated susceptibility testing) and RE02

Amount \$10,000,000  
Date: July 2011

(radiated emissions testing). The RS03 tests will verify immunity to the launch Range and ISS transmit radar environments to the full specified power levels in the COTS CRS EMC Control Plan and ISS VID's 1085 and 1119. The RE02 test will verify compliance with the radiated emissions limits specified in the same ISS requirement documents. Testing will be performed in a portable Faraday Cage constructed to meet the RF isolation limits necessary for Range operation and for adequate dynamic range for RE02 measurements. The tests will be performed in the CCAFS SL-40 Hangar.

System level engineering tests for RS03, RE02, CS01/02, CS06 (conducted susceptibility) and CE01/03 (conducted emissions) and power transients will be performed on the Dragon C2 simulator in Hawthorne, also in a Faraday Cage. These tests will verify unit interface compatibility, also during HITL operation.

SpaceX will also build a second complete HITL simulator, DragonForce.

**Entrance Criteria:**

- Develop the configuration of each test, including a list of components and subsystems to be included in test, agreed to by NASA
- Final update to Test Plan and configuration to be tested, agreed to by NASA
- Test series defined including objectives and risks
- Test procedures released and under configuration control
- Ground systems and data acquisition systems ready to support test

**Success Criteria:**

- All defined tests completed
- Test data recorded and archived
- Conduct Quick-look Post-test Review of test data and anomalies (2 days after completion of testing)
- Second DragonForce in operation.

Provide all planned data and analysis (Test Reports) 30 days after test completion and will be assessed as Entrance Criteria for DRR milestone.

**Milestone 37: Dragon Cargo Racks and Hatch Simulator**

SpaceX shall fabricate a flight-like Dragon cargo rack structure with cargo accommodations and crew interfaces. This will also include a dragon hatch simulator

**Entrance Criteria:**

- Agreed upon configuration and deliverable list
- Fabrication of flight-like Dragon articles complete

**Success Criteria:**

- Fabrication of flight-like Dragon simulators complete
- Units delivered to JSC (or other agreed location)
- Bench review of simulators shows them acceptable for training, on orbit support and development

Amount \$3,000,000  
Date: August 2011

**Milestone 38: Demonstration of Enhanced Powered Cargo (ground)**

SpaceX shall conduct an enhanced powered cargo demonstration using a sample manifest of cargo simulators. The demonstration shall include physical stowage of cargo simulators in Dragon, provision of power, thermal and data to cargo where required, and verification of stowage procedures.

Entrance Criteria

- Test plan developed and agreed to for enhanced powered cargo demonstration
- Flight-like hardware procured
- Qualification Testing of new components complete for the 2X capability (threshold)
- Engineering units built for 3X (objective) capability
- Sample powered cargo delivered from NASA to SpaceX

Success Criteria

- Enhanced pressurized powered cargo demonstration executed on flight-like test bed with data using qualified units (for threshold requirements) and engineering units (for objective requirements)
- Test results delivered to NASA

Amount \$5,000,000  
Date: September 2011

**Milestone 39: Launch Site Infrastructure Implementation**

SpaceX shall implement enhancements to the launch site and/or spacecraft recovery site infrastructure to enhance the execution of the cargo demonstration and operational missions per agreed to plan.

Entrance Criteria:

- Plans for infrastructure enhancements reviewed and agreed to by NASA
- Obtain licenses, permits, approvals and agreements as necessary
- Design and fabricate or acquire new facilities and infrastructure
- Develop and maintain a schedule of the activities

Success Criteria:

- Construction or installation of agreed to enhancements completed or progress made to NASA satisfaction
- Approvals/agreements executed

Amount \$5,000,000  
Date: September 2011

**Milestone 40: Production Infrastructure Implementation**

SpaceX shall implement enhancements to the production site infrastructure to enhance the execution of the cargo demonstration and operational missions.

Entrance Criteria:

- Plans for infrastructure enhancements reviewed and agreed to by NASA
- Obtain licenses, permits, approvals and agreements as necessary

Amount \$5,000,000  
Date: September 2011

- Design and fabricate or acquire new facilities and infrastructure
- Develop and maintain a schedule of the activities

Success Criteria:

- Construction or installation of agreed to enhancements completed or progress made to NASA satisfaction
- Approvals/agreements executed

## APPENDIX 5: Government Furnished Equipment to SpaceX

Appendix 5 is amended as follows:

1) Up to One Hundred and Sixty (160), flight, NASA Standard Detonators (NSDs) for use on SpaceX Dragon and Falcon 9 vehicles through completion of three (3) Cargo Demonstration flights, including development and qualification testing of the system.

ARTICLE 28. SIGNATURE BLOCK

The terms and conditions of SAA NNJ06TA26S, as modified by this Amendment, are hereby incorporated herein.

NATIONAL AERONAUTICS AND  
SPACE ADMINISTRATION

SPACE EXPLORATION  
TECHNOLOGIES CORP.

BY: Douglas R. Cooke  
Douglas R. Cooke  
Associate Administrator,  
Exploration Systems Mission Directorate

BY: Elon Musk  
Elon Musk  
Chief Executive Officer

Date: 5/17/2011

Date: 5/5/11