THIRD ADDENDUM TO THE 2019 WRITTEN RE-EVALUATION FOR SPACEX'S REUSABLE LAUNCH VEHICLE EXPERIMENTAL TEST PROGRAM AT THE SPACEX LAUNCH SITE

Introduction

Since completing the 2019 Written Re-evaluation (WR; FAA 2019a) and associated addendums (FAA 2019b, 2019c) for SpaceX's proposed reusable launch vehicle experimental test program at the Texas Launch Site, SpaceX has continued to develop its vehicle technology and testing approaches. The proposed experimental test program has progressed to the extent that further operational details can be provided and considered within the context of the 2014 Final Environmental Impact Statement for the SpaceX Texas Launch Site (2014 EIS; FAA 2014). This addendum re-evaluates the potential environmental consequences of the updated operational details, including updates to the experimental test program, within the context of the 2014 EIS. In addition, a mishap from the SN-4 static fire damaged the existing launch pad. SpaceX is proposing to further modify the VLA by adding an additional test pad. The additional test pad will serve as a redundant test pad in the case of an anomaly on the primary test pad.

Proposed Action

The FAA's Proposed Action, which was the subject of the 2019 WR and is described in full in Section 2.1 of the 2014 EIS, is to issue launch licenses or experimental permits to SpaceX to conduct launches of a reusable suborbital launch vehicle from the Texas Launch Site. The Proposed Action also includes the connected action of constructing another launch pad at the Vertical Launch Area (VLA). The details of the Proposed Action are discussed below.

Test Program Updates

SpaceX is proposing to further modify its experimental test program. The November 2019 WR addendum (FAA 2019c) outlined the 17 tests that would comprise the previously proposed experimental test program (**Table 1**). In November 2019, SpaceX was proposing to conduct a total of six static engine fires, three small hops (up to 150 meters), and six medium hops (up to 30 kilometers [km]) of the Starship test vehicle (previously designated Mark 1 and Mark 2).

Table 1. Previously Proposed Phases of SpaceX's Experimental Test Program

Phase	Test	Total # of Events[a]	Description
1 [Starhopper]	Wet Dress	5–10	Verify ground systems and spacecraft by fueling the Starship.
	Static Fire	2	Verify engine ignition and performance by conducting a brief (few seconds) ignition of the Starship's engines.
	Small Hops	1	Verify engine ignition and thrust to lift the Starship a few centimeters off the ground.
	Small Hops	2	Engine ignition and thrust to lift the Starship over 30 cm and up to 150 m.
2 [Mk1]	Static Fire	2	Verify engine ignition and performance by conducting a brief (few seconds) ignition of the Starship's engines.
	Medium Hops	3	Engine ignition and thrust to lift the Starship over 30 cm and up to 30 km.
3 [Mk2]	Static Fire	2	Verify engine ignition and performance by conducting a brief (few seconds) ignition of the Starship's engines.
	Medium Hops	3	Engine ignition and thrust to lift the Starship over 30 cm and up to 30 km.
Total Tests:		**17**	

Notes:
[a] The total number events referred to the entire test program (2–3 years) and did not represent a number of monthly or annual operations.
cm = centimeter; m = meter; km = kilometer; 1 cm = 0.40 inches; 1 m = 3.28 feet; 1 km = 0.62 miles

Due to updates with testing operations, SpaceX is no longer proposing vehicle-specific phased operations, but instead would operate under an annual testing program composed of static fires and suborbital hops. SpaceX is proposing to annually conduct up to 420 seconds of static fire engine tests and 15 hops of the Starship test vehicle. Typical static fire duration is 15 seconds. Suborbital hops would last several minutes and the test vehicle would fly up to 30 km. Following a nominal hop, the test vehicle would land at the landing pad at the VLA. As the test program progresses and the vehicle's flight altitude increases, some vehicles may hop and land downrange in the ocean, similar to the booster landing described in the 2014 EIS.

As detailed in the August 2019 WR addendum (FAA 2019b), after a test operation is completed, liquid oxygen and methane would remain in the test vehicle. After a static fire, up to one ton of methane may remain on the vehicle. After a hop, up to 45 tons of methane may remain. During static fire tests, the vehicle would be connected to ground systems. Residual liquid oxygen and methane would be transferred back to the commodity tanks. During an off-nominal operation, SpaceX may release the residual methane and oxygen to the atmosphere. Following a hop, the remaining liquid oxygen and methane would be released to the atmosphere. Due to risks to personnel, SpaceX is unable to reconnect the vehicle to ground systems when methane remains on the vehicle. In the future, SpaceX may recycle methane back into methane tanks at the VLA as technology and design develops. For the purpose of this re-evaluation, the FAA assumes all residual methane is released to the atmosphere.

The 2014 EIS stated that the majority of operations would be conducted between the hours of 7:00 a.m. and 7:00 p.m., but there could be one nighttime launch of a Falcon 9 or Falcon Heavy. The 2019 WR stated that test launches would not occur at night. However, due to 1) resolving issues leading

up to a test operation during the day and 2) attempting to avoid closing the beach another day, SpaceX has conducted nighttime testing operations. To avoid or minimize the chance of another nighttime test operation, SpaceX will continue to implement operational controls to minimize nighttime activity. To support test operations, SpaceX is proposing a maximum of 140 seconds of the proposed maximum 420 seconds of static fire to occur at night, and one out of the proposed 15 hops to occur at night annually.

Vertical Launch Area Construction

Since publication of the 2014 EIS, SpaceX has constructed various facilities at the VLA. **Figure 1** illustrates the current layout of the VLA. SpaceX is proposing to further modify the VLA by adding an additional test pad. The additional test pad will serve as a redundant test pad in the case of an anomaly on the primary test pad. On May 29, 2020, a test vehicle suffered an anomaly during a static fire on the existing test pad. This anomaly caused damage to the test pad, which halted testing operations until repairs are completed. With a redundant test pad, SpaceX would be able to continue testing operations concurrent with repairing a damaged pad. The redundant test pad is proposed in an area that has already been disturbed and is currently occupied by the methane flare. The redundant test pad would be approximately 120 feet by 140 feet and not higher than the existing test pad. The existing methane flare would be removed and would not be replaced.

Figure 2 illustrates the proposed addition of the redundant test pad and removal of the existing methane flare.

Figure 1. Rendering of the Vertical Launch Area

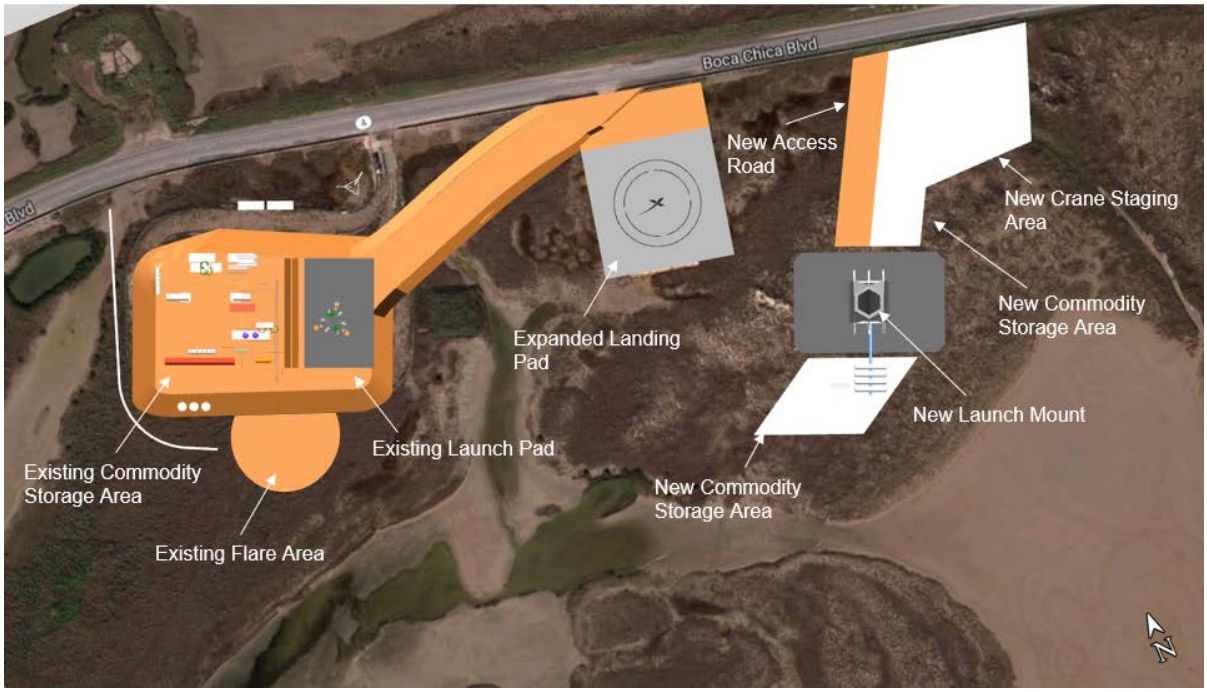
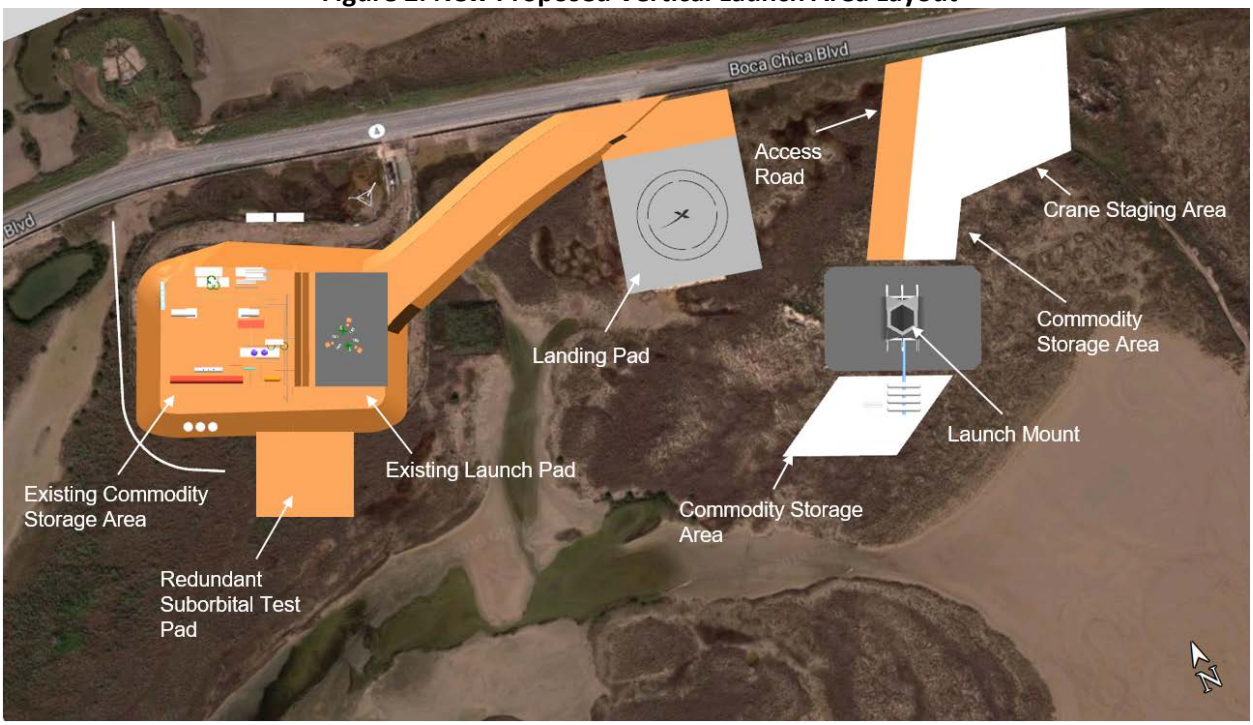


Figure 2. New Proposed Vertical Launch Area Layout



Affected Environment

The existing conditions for the environmental impact categories analyzed in the 2014 EIS are unchanged except with regard to the existing construction and installation of facilities in the VLA (see Figure 1 above). Such changes include alterations to the existing natural and physical conditions at the VLA. The study area for the Proposed Action has not changed.

Re-evaluation of Environmental Consequences

The re-evaluation of environmental consequences focuses on the operational updates: changes to the number of static fires, hops, and closure hours. In addition, SpaceX is also proposing to add an additional launch pad at the VLA. Due to this limited scope, the following environmental impact categories are not included in the re-evaluation because no impacts beyond those discussed in the 2019 WR are expected: coastal resources; farmlands; hazardous materials, solid waste, and pollution prevention; historical, architectural, archeological, and cultural resources; land use; natural resources and energy supply; socioeconomics, environmental justice, and children's environmental health and safety risks; visual effects (including light emissions); water resources (including floodplains, surface waters, groundwater, and wild and scenic rivers); and cumulative impacts.

Air Quality

Air quality impacts under the Proposed Action would be less than those impacts described in the 2014 EIS, which included air emissions associated with construction and operation of the Texas Launch Site, including static fire engine tests and 12 annual Falcon launches. Emissions from the test vehicle's closed-cycle liquid oxygen and methane engine include water vapor, carbon dioxide (CO_2),

carbon monoxide (CO), hydrogen, methane, and oxygen. For the proposed activities, CO would be the only criteria pollutant generated.

Each hop would generate up to 22 tons of CO; 15 hops would generate a total of approximately 329 tons of CO. The 420 seconds of static fires would generate approximately 31 tons of CO. In total, the proposed static fire engine tests and hops would generate approximately 360 tons of CO.

The 2014 EIS projected approximately 2,790 tons per year of CO, the highest quantity of the criteria pollutants. The 2014 EIS concluded that the estimated emissions from construction and operation of the launch site represent an extremely small percentage of the Cameron County regional emissions and would not cause any National Ambient Air Quality Standards to be exceeded. The emissions associated with the proposed experimental test program are within the scope of impacts analyzed in the 2014 EIS. Accordingly, the data and analyses contained in the 2014 EIS remain substantially valid, and the Proposed Action would not result in a significant impact on air quality.

Biological Resources

Biological resource impacts under the Proposed Action would be similar to those impacts described in the 2014 EIS for VLA construction. In accordance with Section 7 of the Endangered Species Act (ESA), the FAA prepared a Biological Assessment (BA) and entered into formal consultation with U.S. Fish and Wildlife Service (USFWS) to address potential effects to ESA-listed species and critical habitat. Based on the analysis presented in the BA, the FAA determined the Proposed Action "may affect and is likely to adversely affect" the following species: piping plover and its critical habitat, red knot, northern aplomado falcon, Gulf Coast jaguarundi, ocelot, and Kemp's ridley, hawksbill, leatherback, loggerhead, and green sea turtles. The FAA determined the Proposed Action "may affect, but is not likely to adversely affect" the West Indian manatee. Consultation with USFWS was completed with issuance of a Biological Opinion (BO) on December 18, 2013. The BO concurred with the findings in the BA and concluded no jeopardy to any species and no adverse modification to critical habitat. The BO specified non-discretionary terms and conditions that are necessary to avoid or minimize effects to listed species and critical habitat. The FAA and SpaceX are committed to implementing the conservation measures and terms and conditions outlined in the BO to minimize potential effects to ESA-listed species and critical habitat. Additional best management practices and storm water controls would be implemented to avoid any additional impacts from drainage to the surrounding habitat. All construction would be done in accordance with TCEQ's Construction General Permit. The Proposed Action would not introduce any additional construction-related effects that are outside the scope of impacts analyzed in the 2014 EIS and the USFWS BO. Accordingly, the data and analyses contained in the 2014 EIS remain substantially valid and the Proposed Action would not result in a significant impact on biological resources.

Climate

Greenhouse gases (GHGs) are gases that trap heat in the atmosphere. The primary GHGs of concern are CO_2, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. These emissions occur from natural processes and human activities. Each GHG is assigned a global warming potential. The global warming potential is the ability of a gas or aerosol to trap heat in the

atmosphere. The global warming potential rating system is standardized to CO_2, which has a value of one. For example, methane has a global warming potential of 21, which means that it has a global warming effect 21 times greater than CO_2, on an equal-mass basis. The equivalent CO_2 rate (CO_2e) is calculated by multiplying the emission of each GHG by its global warming potential and adding the results together to produce a single, combined emission rate representing all GHGs.

The 2014 EIS (Appendix L) estimated that construction and operation of the Texas Launch Site would emit 9,206 tons of CO_2e emissions per year. In the event methane is not transferred back to the methane storage tanks, up to one ton of methane would be released to the atmosphere per static fire operation. The CO_2e of one ton of methane is approximately 21 tons of CO_2e. Accordingly, SpaceX predicts up to 588 tons of CO_2e would be released under the proposed 420 seconds of static fires per year. After each hop, up to 45 tons of methane would remain on the vehicle; thus, each hop would generate 945 tons of CO_2e. The proposed 15 hops would be expected to generate 14,175 tons of CO_2e annually.

Additionally, static fire tests and hops would both directly generate CO_2 when the engines burn fuel. The 420 seconds of static fire would generate an estimated 380 tons of CO_2 annually. Each suborbital hop would generate an estimated 294 tons of CO_2; therefore, the 15 hops would generate an estimated 4,410 tons of CO_2. In total, the proposed static fires, hops, and associated methane releases would result in approximately 19,553 tons of CO_2 (see Table 2).

Table 2. Experimental Test Program Greenhouse Gas Emissions (Tons)

Test	CO_2	Methane CO_2 Equivalent	Total GHG Emissions
Static Fires (420 seconds annually)	380	588	968
Hops (15 annually)	4,410	14,175	18,585
Total			19,553

Notes:
CO_2 = carbon dioxide; GHG= greenhouse gas

Although the total amount of GHG emissions is higher than that calculated in the 2014 EIS, the amount is minor compared to total U.S. GHG emissions, and these emissions would not cause any appreciable global warming that may lead to climate change. Accordingly, the data and analyses contained in the 2014 EIS remain substantially valid.

Department of Transportation Act Section 4(f)

Impacts on Section 4(f) properties from construction would be similar to those impacts described in the 2014 EIS for construction. The 2014 EIS determined VLA construction would not result in a physical or constructive use of any Section 4(f) property. The Proposed Action would not result in any potential construction-related impacts on Section 4(f) properties which would be considered outside the scope of impacts analyzed in the 2014 EIS.

As described in the 2014 EIS, operations at the VLA would have temporary, intermittent impacts on the use of the public parks, wildlife refuges, management areas, and historic resources identified as Section 4(f) properties. During the proposed activities, public access to Boca Chica State Park, Brazos Island State Park, the South Bay Coastal Preserve, and major portions of the Lower Rio Grande

Valley National Wildlife Refuge and Palmito Ranch Battlefield National Historic Landmark would be closed for safety and security reasons during testing operations and to alleviate concerns regarding the potential impacts to public lands from the viewing public. Monitoring for unauthorized individuals within the closure area by SpaceX personnel would not include ground sweeps. Therefore, the closure of the Section 4(f) properties would not cause harm to protected 4(f) resources.

In addition to closures, SpaceX modeled noise levels from the proposed static fires and suborbital hops to determine whether noise levels were similar to 2014 levels. Noise modeling confirms that there would be no additional noise impacts beyond those previously disclosed in the 2014 EIS. Additionally, the Section 4(f) properties would be closed to the public when the noise is generated; thus, increases in noise would not affect the 4(f) resource's quiet setting for the visiting public. In conclusion, the FAA has determined the Proposed Action would not result in a use of Section 4(f) properties.

Noise and Noise-Compatible Land Use

The 2014 EIS concluded significant noise impacts would occur from construction and operation of the Texas Launch Site, particularly to Boca Chica Village (a residential area) and the surrounding public lands. The Proposed Action would not generate noise or result in compatible land use impacts beyond the noise levels and impacts discussed in the 2014 EIS. SpaceX will limit testing activities to daylight hours to the greatest extent possible.

SpaceX is proposing 140 seconds of static fire and one hop that may occur annually during nighttime hours. The 2014 EIS assessed three launch scenarios to estimate noise impacts from Falcon launches. The scenario that had the greatest noise impact included ten daytime Falcon 9 launches, one daytime Falcon Heavy launch, and one nighttime Falcon Heavy launch. The results of this scenario showed the Day-Night Average Sound Level (DNL) 65 A-weighted decibel (dBA) contour extending 2.8 miles from the launch pad. SpaceX's noise analysis for the Proposed Action, which considers 140 seconds of static fire and one hop annually during the night, shows the DNL 65 dBA contour extending the same distance as the most conservative scenario analyzed in the 2014 EIS (see Table 3).

SpaceX completed the noise modeling using a combined industry-standard and heritage approach for predicting launch vehicle acoustics during both static fire and liftoff to develop source acoustic levels for various Starship operations. This approach and acoustic magnitudes are grounded in data collected at engine test sites and during operation of the Starhopper test vehicle. An A-weighting was applied to acoustic levels and simple distance propagation techniques to predict far-field environments. Expected annual operations were combined to create the standard annualized DNL levels. The predicted noise levels are within the scope of the 2014 EIS. Accordingly, the data and analyses contained in the 2014 EIS remain substantially valid. SpaceX is currently notifying the public in advance of launch operations to help minimize noise disturbances to nearby residents.

Table 3. Proposed Action Predicted Day-Night Average Sound Levels

Distance (miles)	Day-Night Average Sound Level (dBA)
0.3	84
0.6	78
0.9	75
1.2	72
1.5	70
1.9	69
2.2	67
2.5	66
2.8	65
3.1	64
3.4	63
3.7	63
4.0	62

Wetlands

Impacts on water resources under the Proposed Action would be similar to those impacts described in the 2014 EIS for VLA construction. There would be no impacts to wild and scenic rivers. The 2014 EIS concluded construction of the VLA would result in approximately 6.19 acres of wetland impacts, including direct impact to approximately 3.34 acres of wetlands and the indirect impact to approximately 2.85 acres of wetlands. The U.S. Army Corps of Engineers (Corps) issued SpaceX a permit (SWG-2012-00381) on September 9, 2014, which authorized the placement of fill material in 3.3 acres of waters of the U.S. SpaceX requested modifications to the permit to add an additional 2.13 acres of wetland fill. As analyzed in the 2017 WR, the installation of the security fence and road in the VLA would impact approximately 0.08 acres of wetlands bringing the total direct impacts to 5.5 acres. In the 2019 WR, SpaceX proposed changes to the wetlands impact area. As analyzed in the 2019 WR, small areas of the delineated wetlands that were previously identified as being impacted would now be avoided, and areas that were previously identified as being avoided would now be impacted. The newly proposed VLA construction would not increase the amount of wetlands impacted.

The launch site is located within the 100-year floodplain. The 2014 EIS determined approximately 4.22 acres of floodplain Zone V10 and 4.37 acres of Zone A8 would be filled in the VLA. The EIS concluded that based on the expected notable adverse impacts on some of the natural and beneficial floodplain values, the Proposed Action would result in a significant floodplain encroachment per Department of Transportation Order 5650.2. In the 2014 EIS, the FAA determined there were no practicable alternatives that would totally avoid impacts to wetlands and floodplains. Accordingly, the data and analyses contained in the 2014 EIS remain substantially valid.

Conclusion

The 2014 EIS examined the potential for significant environmental impacts and defined the regulatory setting for impacts associated with the FAA issuing launch licenses and/or experimental permits to SpaceX that would allow SpaceX to conduct launches of the Falcon 9 and Falcon Heavy orbital vertical launch vehicles and a variety of reusable suborbital launch vehicles from a private launch site in Cameron County, Texas. The 2014 EIS included constructing a launch site and launching reusable suborbital vehicles.

Based on the above review and in conformity with FAA Order 1050.1F, Paragraph 9-2.c, the FAA has concluded that the issuance of launch licenses and/or experimental permits to SpaceX to conduct reusable launch vehicle experimental tests (static engine fires and hops) conforms to the prior environmental documentation, that the data contained in the 2014 EIS remain substantially valid, that the addition of the proposed redundant test pad would result in no significant environmental changes, and that all pertinent conditions and requirements of the prior approval have been met or will be met in the current action. Therefore, the preparation of a supplemental or new environmental document is not necessary to support the FAA's action.

Responsible FAA Official: Howard Searight for Daniel Murray Howard Searight

Location and Date Issued: Washington, D.C. June 12, 2020

References

FAA (Federal Aviation Administration). 2014. Final Environmental Impact Statement for the SpaceX Texas Launch Site. May.

FAA. 2019a. Written Re-Evaluation of the 2014 Final Environmental Impact Statement for the SpaceX Texas Launch Site. May.

FAA. 2019b. Addendum to the Written Re-Evaluation for SpaceX's Reusable Launch Vehicle Experimental Test Program at the SpaceX Launch Site. August.

FAA. 2019c. Second Addendum to the Written Re-Evaluation for SpaceX's Reusable Launch Vehicle Experimental Test Program at the SpaceX Launch Site. November.