

**ENVIRONMENTAL ASSESSMENT
FOR THE 250K HYBRID MOTOR TEST PROJECT**

**JOHN C. STENNIS SPACE CENTER
HANCOCK COUNTY, MISSISSIPPI**

Lead Agency: NASA, John C. Stennis Space Center

Proposed Action: To Test 250,000 Pound Thrust Hybrid Rocket Motors

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Abstract: NASA is planning to test two 250,000 pound thrust hybrid rocket motors at Stennis Space Center. The tests will consist of several short burns of the two motors to promote understanding of hybrid propulsion technology and to enable full scale engineering development of hybrid boosters for future space launch applications. There will be some temporary impacts to local air quality and noise.

Executive Summary

The Hybrid Propulsion Demonstration Program seeks to test 250,000 pound thrust hybrid rocket motors at NASA's John C. Stennis Space Center (SSC). It is proposed that the hybrid rocket motor tests be performed in Test Cell 1 at the E-1 Test Stand. Tests will be 15-20 seconds in duration. The proposed tests will cause rocket motor combustion air emissions consisting of carbon dioxide, carbon monoxide, and nitrogen oxides, and some short term noise. These temporary impacts will not affect the local community and will have minimal impact at the SSC site. No other impacts have been identified. Alternatives considered are hybrid rocket motor testing to be performed at Marshall Space Flight Center (MSFC) or the Test Cell 2 or Test Cell 3 at SSC's E-1 Test Stand, and the "No Action Alternative".

Table of Contents

1.0 Purpose and Need.....1

2.0 Description of Proposed Action and Alternatives.....1

3.0 Existing Environment and Environmental Consequences of Alternatives.....2

 3.1 Air Quality.....2

 3.2 Noise.....3

 3.3 Water Quality.....3

 3.4 Groundwater Resources.....3

 3.5 Wetlands and Flood Plains.....4

 3.6 Biotic Resources.....4

 3.7 Threatened and Endangered Species.....5

 3.8 Archaeological Resources.....5

 3.9 Cultural and Historical Resources.....5

 3.10 Transportation.....5

 3.11 Waste Generation and Treatment.....5

 3.12 Socioeconomics.....6

 3.13 Public and Employee Health and Safety.....6

 3.14 Pollution Prevention and Environmental Justice.....6

4.0 Agencies and Individuals Consulted.....8

5.0 List of Preparers.....8

6.0 References.....9

7.0 Distribution List.....11

1.0 Purpose and Need

The National Aeronautics and Space Administration (NASA) at the John C. Stennis Space Center (SSC) is the Lead Center for Propulsion Testing. As such, SSC plans to test two 250,000 pound thrust (250K) hybrid rocket motors as part of the Hybrid Propulsion Demonstration Program (HPDP). Members of the HPDP Consortium include NASA, Defense Advanced Research Projects Agency (DARPA), Lockheed Martin, Thiokol, Boeing, Pratt & Whitney's Chemical Systems Division, Allied Signal, and Environmental Aeroscience Corporation. The HPDP seeks to mature hybrid propulsion technology to enable full-scale engineering development of hybrid boosters for current and future space launch applications. Hybrid rocket boosters combine the safety features of a liquid propulsion system and the low cost attributes of a solid propulsion system. Following injector cold flow tests of the 250K motor hardware at Marshall Space Flight Center (MSFC), test consolidation activities by NASA's Rocket Propulsion Test Management Board transferred significant facility hardware and all full scale HPDP test activities to SSC. Cold flow activities are expected to resume in December 1998, with hot fire operations to begin in January 1999.

An environmental assessment of the proposed project has been conducted to comply with the requirement of the National Environmental Policy Act (NEPA) and NASA's Procedures and Guidelines for Implementing the National Environmental Policy Act and Executive Order 12114.

2.0 Description of Proposed Action and Alternatives

NASA at SSC proposes to conduct several tests using 250K hybrid rocket motors at Test Cell 1 of the E-1 Test Stand. One motor will be ignited by a mixture of triethylaluminum and triethylboron (TEA/TEB). The second motor will be ignited by a staged-combustion approach, with igniters that are non-pyrophoric/non-pyrotechnic. The motor to be ignited with TEA/TEB will be longer than the other motor due to an additional segment. The motors weigh approximately 125,000 pounds and are approximately 45 feet long and 6 feet in diameter. The hybrid motors consist of several carbon based materials used for fuel, binders and curative. Liquid oxygen will be used as the oxidizer. Although the motors are designed for 80 second tests, there will be only two 15-20 second tests on each of these motors for this segment of the project. Gaseous nitrogen will be used to purge the system. The motor will be tested in a horizontal configuration with the thermal plume from the motor directed to the south of the E-1 Test Stand.

Alternatives considered include the use of MSFC facilities, the use of Test Cells 2 or 3 at SSC's E-1 Test Stand and the "No Action Alternative". MSFC's Test Stand 116 has been used extensively in the past for propulsion system development. This test stand was the first test stand proposed for the 250K hybrid motor tests, however, due to other testing programs that had priority at Test Stand 116, the 250K hybrid motor testing was delayed. In order for the hybrid motor testing program to

progress, a decision was made by the Rocket Propulsion Test Management Board (RPTMB) to relocate the 250K hybrid motor assets from MSFC to SSC. Since that decision was made in March 1998, Test Cell 1 at SSC's E-1 Test Stand has been readied for this program. Test Cell 1 was selected over alternate sites Test Cells 2 or 3 because of the availability and minimal costs in terms of facility modifications. The environmental effects would be the same for Test Cell 2 and Test Cell 3 as for Test Cell 1.

The "No Action Alternative" would not allow NASA to continue development of hybrid propulsion technology at SSC and impair the progress of the engineering development of hybrid booster for current and future space launch applications.

Inclusion of the "No Action Alternative" is prescribed by the Council on Environmental Quality guidelines implementing the National Environmental Policy Act (NEPA). The "No Action Alternative" provides the benchmark against which the proposed actions are evaluated.

3.0 Existing Environment and Environmental Consequences of Alternatives

There will be some impact on the existing environment at SSC. The following sections describe any possible impacts that may occur during hybrid rocket motor testing. The most notable impacts will be rocket motor air emissions and short term noise from the rocket test. Similar impacts would result if the testing was to be conducted at MSFC.

3.1 Air Quality

Air emissions from hybrid rocket motor testing are included in SSC's State of Mississippi Air Pollution Control Title V Permit to Operate issued February 5, 1998. Emissions from the 250K hybrid rocket motor are primarily carbon dioxide, carbon monoxide, nitrogen oxides and water. Some carbonaceous soot will be formed as a result of incomplete combustion of the fuel. A small amount of TEA/TEB will be combusted during ignition.

For this segment of the HPDP program four tests of the 250K hybrid rocket motors are planned. The maximum duration of any one test will be 20 seconds although the 250K motor is capable of an 80 second burn. The motor consists of a carbon based fuel with binders and curative. The oxidizer will be liquid oxygen used at 600 pounds per second. The total fuel weight per motor is approximately 44,000 pounds although the entire motor will not be burned during any one test. The oxidizer to fuel ratio will be approximately "2.6". For a twenty second test approximately 4,600 pounds of fuel will be burned.

Combustion modeling to estimate total air emissions from hybrid rocket motor tests has been

performed as part of the application process for a Mississippi Department of Environmental Quality (MDEQ) permit to operate. It is estimated, with air entrainment, that 0.04 pounds of nitrogen oxides will be produced per pound of propellant (fuel and oxidizer) and 0.19 pounds of carbon monoxide will be produced per pound of propellant. For the longest test scenario proposed, it is estimated that 664 pounds of nitrogen oxides will be released and 3,157 pounds of carbon monoxide will be released.

According to reporting requirements in SSC's Title V Operating Permit, SSC shall monitor and maintain records of the date, time, type and size (including quantity of propellant) of each motor fired and the quantity of propellant fired on a daily and 365-day basis. This information will be reported quarterly to the MDEQ. No ambient air quality standards will be exceeded.

The "No Action Alternative" will result in no air emissions.

3.2 Noise

SSC is surrounded by a large uninhabited Buffer Zone that covers a total of 125,071 acres, extending in a five mile radius around the perimeter of the central, fenced, "Fee Area". It consists of mostly forests and pasture lands. The E-1 Test Stand is located near the center of SSC within the "Fee Area" and is oriented to the south in a manner that will direct sound to the south. Predictions of noise from the rocket motors have been estimated by computer modeling. A level of 129 decibels (dB) or 120 adjusted sound pressure scale decibels (dBA) at a distance of 925 feet from the motor nozzle exit is expected. The test duration will be less than 30 seconds. Hearing protection will be required for personnel in the area of the E-1 Test Stand during testing.

There will be no off-site impact to local communities. The "No Action Alternative" will result in no additional noise.

3.3 Water Quality

A deluge water system is available for protection of the E-1 Test Stand facility in case of fire. The deluge water is drawn from the SSC canal. There is no planned use of this water except in the case of an emergency. The "No Action Alternative" results in no possibility of additional wastewater.

3.4 Groundwater Resources

Water for potable and industrial use at SSC is supplied through six large capacity wells on site. No additional groundwater wells or deep subsurface disturbance is planned for this project. No impact to groundwater resources is expected.

3.5 Wetlands and Flood Plains

The SSC facility straddles the watersheds of two rivers: the East Pearl River on the western Fee Area boundary and the Jourdan River on the eastern Fee Area boundary. Some tributaries at the facility flow west to Harper Bayou and eventually drain into the East Pearl River. Other tributaries flow east into Catahoula Creek, with some intermittent streams flowing south into Devil's Swamp. Catahoula Creek and Devil's Swamp both eventually drain into the Jourdan River. The Pearl River empties into Lake Borgne, while the Jourdan River drains into the Bay of St. Louis. Both Lake Borgne and the Bay of St. Louis discharge into the Mississippi Sound.

As a result of the wetlands hydrology found at and around SSC and the presence of hydric soils and hydrophytic vegetation, a large portion of both the Fee Area and Buffer Zone are considered jurisdictional wetlands by the U.S. Army Corps of Engineers. The E-1 Test Stand is located on previously developed land and therefore motor testing in Cell 1 of the E-1 Test Stand will not have an impact on functional or jurisdictional wetlands.

The floodplain at SSC, according to the Flood Insurance rate Map for Hancock County, Mississippi, includes a 100-year floodplain along the East Pearl River at the western edge of the Fee Area, and a 100-year floodplain along the Wolf Branch and along the Lion Branch of Catahoula Creek in the northeast portion of the Fee Area. The line for the 500-year floodplain extends a little further into the site along the same boundaries. The majority of SSC is classified as Zone "C" meaning an area of minimal flooding. The E-1 Test Stand is not located in the 100-year or 500-year floodplain.

3.6 Biotic Resources

Pine forest communities account for the majority of the vegetation in the uncleared portions of SSC and the surrounding Buffer Zone. Bottomland hardwood communities occur in low, poorly drained soils, which may have standing water. Vegetation and wildlife species that occur at SSC are identified in the SSC Environmental Resources Document.

The proposed test area is located in an area of developed land covered by cement, asphalt, and mowed grass. The site is surrounded by canals and wetlands. The area may be suitable for foraging species of wildlife, however it does not serve as a nesting or roosting habitat. Noise from testing would likely startle wildlife and possibly drive them from the area temporarily. Animals in the vicinity of SSC test stands do not appear to be unduly disturbed by testing activity noise. The thermal plume generated by the 250K motor tests may extend 300 feet beyond the motor exit nozzle. This may cause grasses south of the test stand to burn or be heat stressed. No significant

impacts to the fauna and flora have been recorded in the past during rocket motor testing, nor are any significant impacts expected to be observed during future activities.

3.7 Threatened and Endangered Species

There are a significant number of threatened, endangered, and ranked species with ranges overlapping the SSC Fee Area and Buffer Zone. Listed and State-ranked species that potentially occur in the project area are identified in the SSC Environmental Resources Document. The proposed testing activities will not affect any threatened and endangered species or critical habitat that may exist in the SSC Fee Area. If a listed or ranked species is identified, the appropriate agencies will be consulted.

3.8 Archaeological Resources

Historically, the land at SSC has been severely disturbed by timber harvesting and the associated naval stores industry during the late nineteenth and early twentieth centuries. More recently, the land was disturbed by the construction of the SSC facility during the 1960's, making it unlikely that undisturbed archaeological sites would be found. In the Fee Area, only the townsite of Gainesville may require future archaeological considerations if land disturbing activities are proposed for the Fee Area. This project is not located near the Gainesville townsite and is on previously disturbed land. There are no archaeological impacts resulting from this project.

3.9 Cultural and Historical Resources

The A-1, A-2 and B-1/B-2 Test Stands at SSC have been designated as National Historic Landmarks and appear on the National Register of Historic Places. These test stands and associated control centers have been so designated because of their importance in the testing of Saturn rockets, and the importance of the Saturn rocket in landing men on the moon. This project will not alter the historical attributes of the test stands.

3.10 Transportation

Interstates 10 and 59 (I-10 and I-59), U.S. Highway 90, and Mississippi 607 serve the SSC area. Direct access to and through SSC from I-10 and I-59 is provided by Mississippi Highway 607. Highway 607 also connects with U.S. Highway 90 approximately 9 miles (13.5 km) southeast of SSC. There will be no impact to transportation by this project.

3.11 Waste Generation and Treatment

The solid waste generated at SSC is recycled or placed in the site Class A landfill. Unacceptable wastes, such as hazardous waste, paint products, and fuels are excluded from disposal in the landfill and will be shipped off-site to pre-approved facilities for treatment or disposal.

The remainder of the unburned portion of the 250K motors will be transported to MSFC for inspection and disassembly. TEA/TEB remaining from testing activities reacts immediately with air and must be burned to allow safe entry into the facility after testing. The "No Action Alternative" will produce no wastes.

3.12 Socioeconomics

The proposed test program will not require any additional employees. There will be no socioeconomic impact.

3.13 Public and Employee Health and Safety

The SSC test areas are designed with consideration of the hazardous nature of the operations and provide for the protection of employees. The hazardous operations take place in areas safely isolated from the general public. A hazards analysis will be completed prior to initial testing.

The first test of the 250K motor will be restricted to second shift or on Saturday, when the presence of non-essential personnel will be minimal. Building 4010 will be vacated of all non-essential personnel prior to testing. During the first test, sound levels will be measured and a determination will be made on the amount of protection that will be necessary for following tests. Personnel will be allowed to view the test at a southeast location from the test stand along the railroad tracks with personal hearing protection. No personnel will be allowed south of the Propellant Road entrance to the E-2 Test Facility without proper hearing protection.

SSC adheres to Occupational, Health, and Safety Administration (OSHA) standards for protection of employees on site. Procedures are in place to monitor and protect employees as necessary during operations. In addition a specific plan has been developed for this project: HPDP Safety and Health Plan, Rev. A, March 7, 1996 - DCN:95-HPDP-076-A. The SSC Integrated Contingency Plan (SPG 4130.3C) details specific emergency procedures to respond to natural and man-made emergencies. There are on-going training programs to ensure emergency preparedness.

3.14 Pollution Prevention and Environmental Justice

In accordance with Executive Order (EO) 12856, "Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements, SSC (NASA/SSC, 1995) has written a pollution prevention

strategy into their Pollution Prevention Plan. This plan encourages elimination or reduction of the use and purchase of toxic chemicals, energy efficiency, solid waste reduction and recycling, water conservation, and hazardous waste and oil spill prevention. In order to meet the goals of the Pollution Prevention Plan, SSC has initiated projects affecting both the physical infrastructure and the program/project operations.

In accordance with EO 12898, SSC's Environmental Justice Implementation Plan reflects agency policy established in "Environmental Justice Strategy", March 1995. Any adverse effects of programs at SSC on low income or minority populations will be identified and, if necessary, remedies will be provided through implementation of these plans. Because of the size of the SSC Buffer Zone surrounding the Fee Area, any environmental justice concerns for this project insignificant.

4.0 Agencies and Individuals Consulted

No agencies or individuals have been consulted for this environmental assessment. Information on environmental concerns from agencies and individuals on SSC activities has been addressed in previous environmental assessments and environmental impact statements.

5.0 List of Preparers

Terry Abel	Lockheed Martin Astronautics, MSFC - HPDP Program Manager	Program Overview and Test Planning
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Carolyn Kennedy	Johnson Controls World Services, SSC - Environmental Engineer	Environmental Impacts and Compliance
Ronald G. Magee	NASA, SSC - Environmental Officer	Environmental Concerns
Pete Markopoulos	Lockheed Martin Astronautics, MSFC - Propulsion Engineer	Test Article Performance Predictions
Jared Sass	NASA, SSC - Mechanical Engineer	Lead Project Mechanical Engineer
William B. Nail	NASA, SSC - Electrical Engineer	Lead Project Electrical Engineer

6.0 References

Abel, T.M. and R.J. Harwell. 1997. A Status Update for the Hybrid Propulsion Demonstration Program (HPDP). 33rd AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, July 6-9, 1997, Seattle, Washington.

Federal Emergency Management Agency, Flood Insurance Rate Map, Hancock County, Revised Map, September, 1987.

Federal Interagency Committee for Wetlands Delineation. 1989. Federal Manual for Identifying and Delineating Jurisdictional Wetlands, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S. Department of Agriculture Soil Conservation Service, Washington, D.C., Cooperative Technical Publication.

Keiser, E.D. and P.K. Lago. 1991. Survey of the Amphibians, Reptiles, Birds, and Mammals on the 3,000 acre Stennis Space Center, ASRM Site Final Report, University of Mississippi, University, Mississippi.

NASA/MSFC/SSC. 1996. Draft Environmental Impact Statement of Engine Technology Support for NASA's Advanced Space Transportation Program.

NASA/Stennis Space Center. 1992. Environmental Resources Document, John C. Stennis Space Center.

NASA/Stennis Space Center. 1997. Environmental Assessment for the Aerospike: Reusable Launch Vehicle Program, John C. Stennis Space Center.

NASA/Stennis Space Center. 1995. Historic Preservation Plan, John C. Stennis Space Center.

NASA/Stennis Space Center. 1995. Pollution Prevention Plan, John C. Stennis Space Center.

NASA/Stennis Space Center. 1998. Integrated Contingency Plan (SPG 4130.3C), Stennis Space Center.

Smith, W., P. Nichols Jr., and L. Walton. 1978. Soil Survey of Hancock County, Mississippi, United States Department of Agriculture, Soil Conservation Service.

Sulyma, P.R. Hybrid Propulsion Demonstration Program (HPDP) 250Klbf Motor Plume Environments at the E1 Test Facility, Memo to F. Douglas and C. Stewart, August 21, 1998.

Wooten, J.W. 1990. A Fall Botanical Survey of a portion of the National Aeronautics and Space Administration Installation Stennis Space Center Mississippi, John C. Stennis Space Center.

7.0 Distribution List

Maury Oceanographic Library, Building 1003, Stennis Space Center, MS

Hancock County Library, Highway 90, Bay St. Louis, MS

Margaret Reed Crosby Library, Picayune, MS

St. Tammany Parish Library, Slidell, LA