

GAO

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Briefing Report to the Ranking Minority
Member, Subcommittee on Military
Construction, Committee on
Appropriations
United States Senate

October 1986

SPACE SHUTTLE

Issues Associated With the Vandenberg Launch Site



131722

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October 31, 1986

The Honorable Jim Sasser
Ranking Minority Member
Subcommittee on Military Construction
Committee on Appropriations
United States Senate

Dear Senator Sasser:

In your letter of June 17, 1986, you asked us to examine several matters associated with the space shuttle program's Vandenberg launch site (VLS), which is being prepared at Vandenberg Air Force Base, California, for launching shuttles into polar orbits. On September 18, we briefed your staff on the results of our work. As requested at that time, this report summarizes and updates the following information from that briefing:

- The Air Force's cost estimates for various VLS operating levels, our comments on its methodology in preparing those estimates, and VLS technical issues identified in the Subcommittee Minority Staff's June 1986 report. (See app. I.)
- Plans for manned spaceflight from VLS, including adjustments made in the wake of the loss of the space shuttle orbiter Challenger on January 28, 1986. (See app. II.)
- The process used by the executive branch to develop its position that a replacement for the Challenger should be procured, and the rationale for that position, including the issue of VLS operations. (See app. III.)
- The membership of two interagency groups that reviewed the programmatic implications of the Challenger's loss. (See app. IV.)
- A history of VLS funding. (See app. V.)

In conducting our work, we met with officials of the Department of Defense (DOD), the Air Force, and the National Aeronautics and Space Administration (NASA) and examined Air Force and NASA documents. We also met with selected

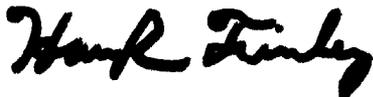
participants in the deliberations leading up to the decision to support replacement of the Challenger.

We obtained documents concerning the cost estimates for the various operating levels at VLS and discussed with VLS officials the rationale used in preparing the estimates. We did not attempt to verify these estimates or to independently develop our own. Much of the discussion of the decisionmaking process and rationale for a replacement orbiter was drawn from interviews with knowledgeable officials within the executive branch. At the completion of our work, we discussed the matters presented in this report with knowledgeable DOD, NASA, Air Force, and National Security Council (NSC) officials. Their comments were incorporated into the text where appropriate. We did not request official comments on this report.

We plan no further distribution of this report until 30 days after its issue date, unless you publicly announce its contents earlier. At that time, we will send copies to the Chairmen, House and Senate Committees on Appropriations and on Armed Services, the Senate Committee on Commerce, Science, and Transportation, and the House Committee on Science and Technology; the Secretary of Defense; the Secretary of the Air Force; the NASA Administrator; the Director, Office of Management and Budget; and other interested parties upon request.

Should you have any additional questions, please feel free to contact me at 275-4268.

Sincerely yours,



Harry R. Finley
Senior Associate Director

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ABBREVIATIONS

DOD	Department of Defense
GAO	General Accounting Office
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NSC	National Security Council
SIG-Space	Senior Interagency Group for Space
VLS	Vandenberg launch site

VLS COST ESTIMATES AND TECHNICAL ISSUES

In June 1986, Senator Sasser received a report concerning the space shuttle launch site at Vandenberg Air Force Base, California, from the Minority Staff of the Subcommittee on Military Construction, House Committee on Appropriations. DOD and NASA had advocated construction of VLS to allow placing shuttles into orbits over the earth's poles. According to agency officials, polar orbit launches from the Kennedy Space Center in Florida would involve launching over land areas and compromising orbiter performance. Senator Sasser, who had requested the report in view of uncertainties raised by the January 28, 1986, loss of the space shuttle orbiter Challenger, subsequently visited VLS to be briefed on several issues raised by the Minority Staff.

COST ESTIMATES

VLS officials presented the Senator with cost estimates for five different VLS operating levels. We later obtained documents concerning the estimates and discussed with VLS officials the rationale used in their preparation. We did not attempt to verify these estimates or to independently develop our own.

The five operating levels presented to the Senator were identified as (1) four launches per year, (2) one launch per year, (3) operational caretaker, (4) facility caretaker, and (5) mothball. Three possible operating levels were open to the Air Force following the suspension of shuttle launches. Operational caretaker, the first of the three, would retain a critical core of personnel, allow VLS to remain compatible with the launch facility at Kennedy Space Center, and permit a first launch within 18 months of a decision to reactivate. Facility caretaker would eliminate many critical positions, involve only essential maintenance on basic facilities, and require 36 months for reactivation to a first launch. Mothballing VLS would place facilities and equipment in a long-term preservation mode and increase the lead time needed for a first launch to at least 48 months.

VLS officials estimated that the four launches per year operating level would cost \$416.6 million in 1986 dollars for fiscal year 1989. The operational caretaker, facility caretaker, and mothball operating levels were estimated as costing \$200 million, \$150.1 million, and \$25.9 million, respectively, in fiscal year 1989--the first year in which deactivation or testing costs would not be involved.

VLS officials told us that the estimate for the four launches per year operating level, developed for the President's fiscal year 1987 budget submission, had been based on a detailed analysis. The estimates for the other operating levels were developed by estimating reductions to the following major VLS budget items, which had been used in developing the fiscal year 1987 submission.

- Electronic security.
- Technical expertise.
- Payload support.
- Facility operations and maintenance, shuttle processing.
- NASA support.
- Range support.
- Management support.
- Logistics.
- Facilities.

VLS officials told us that the estimated reductions were judgmental and required making numerous assumptions. For example, the Air Force assumed that engineering changes would be made to keep VLS compatible with the Kennedy Space Center if VLS was placed into operational caretaker status, but that no such changes would be made if the facility were to be mothballed.

We were informed that detailed analyses were not prepared for each of the operating levels because VLS officials had only a few days to prepare them before the Senator's visit. Analyses had not been prepared earlier because of uncertainty regarding the date of the first launch from VLS.

In July 1986, the Secretary of the Air Force announced that VLS would be placed in operational caretaker status. The Air Force chose this option to keep critical personnel, allow the modifications needed to keep VLS compatible with the Kennedy Space Center, and regain launch capability with acceptable risk. A first launch is currently planned to take place during the second quarter of 1992.

Air Force officials believe VLS is needed to maintain assured access to space. They told us that the risks associated with the facility caretaker and mothball options were unacceptable because critical personnel would not have been retained and facilities would not have been kept current. Moreover, according to the Air Force, implementation of the mothball option would not have allowed the planned first launch in 1992.

VLS officials also estimated total VLS costs at various operating levels for the period fiscal year 1987 through fiscal year 1991.

These estimates included both the costs for deactivation and/or maintaining the current status and for reactivation (table I.1).

Table I.1: VLS Estimates of Cost to Support Facility at Different Levels for Fiscal Years 1987-1991 (1986 dollars)

<u>Operational level</u>	<u>Deactivate/ maintain status</u>	<u>Reactivate</u>	<u>Total^a</u>
	----- (000,000 omitted) -----		
4 launches per year	\$2,111	\$0	\$2,111
Operational caretaker ^b	1,154	114	1,268
Facility caretaker ^b	963	268	1,231
Mothball ^c	484	657	1,141

^aEstimates do not include costs of possible major modifications resulting from reviews of the Challenger accident or full funding for some possible solutions to the hydrogen entrapment problem (see page 7).

^bAssumes a first launch in 1992.

^cAs noted earlier, the mothball option would not have allowed VLS to meet the planned 1992 launch date.

VLS officials also identified some costs that could offset possible savings. For example, NASA and the Air Force buy certain spare parts and systems together to take advantage of discounts for quantity buys. Without VLS funding, NASA's unit cost for these purchases might rise and increase NASA's overall budget requirements. However, VLS officials did not estimate these potential offsetting costs.

Current planning

As of early October 1986, the Air Force was evaluating its manpower and budget requirements for the operational caretaker status. On October 3, the Air Force announced that it was postponing Flow A, an integrated test of the orbiter Columbia with VLS facilities, ground systems, procedures, software, and personnel. The test, which had been scheduled for fiscal year

1987, will be conducted when VLS is reactivated. The Air Force estimated that the cost of staging Flow A in fiscal year 1987 would have been \$60 million.

Prior to the announcement, Air Force officials had informed us that postponement of Flow A was being considered because

- current software and procedures would change before the planned first launch in 1992 and
- all of the current work force might not remain until VLS is reactivated.

TECHNICAL ISSUES

According to VLS officials, all technical issues involving operational readiness of the facility have been or are now being addressed. These issues include those directly related to VLS construction that were raised in the Subcommittee Minority Staff's June 1986 report. Studies of VLS technical issues by the Air Force Operational Test and Evaluation Center and an Independent Readiness Review Team also indicate that all technical issues are being addressed.

Hydrogen entrapment

Air Force officials that we spoke with believe that the most significant technical issue is the potential entrapment of hydrogen gas in the pad's enclosed exhaust duct for the orbiter's main engines. Air Force analysis indicates that trapped hydrogen could result in an explosion that would damage the orbiter. The Air Force reviewed 29 options for correcting the problem and has narrowed consideration to two alternatives. The first alternative, called steam inerting, involves injecting steam into the duct to render the gas nonexplosive. The second involves installing a deflector to vent the gas away from the duct. The Air Force is evaluating both alternatives and plans to make a selection by December 1986. Modifications would be made in 1987. Due to the early design stage of each alternative, cost estimates were unavailable.

Ice formation

To combat possible prelaunch formation of ice on the shuttle's external fuel tank (which contains liquid oxygen and liquid hydrogen), an ice suppression system has been installed. Preliminary tests indicate that it will perform as intended. However, additional testing is intended as part of Flow A.

Pad stiffness

Springs have been added to the VLS pad's hold-down posts to compensate for its stiffness relative to the Kennedy Space Center's pads. Additional testing of this feature is expected to be part of Flow A.

Weather

Air Force officials realize there are weather constraints such as fog, but they do not believe that such constraints should preclude using VLS as a shuttle facility.

Launch control center proximity to pad

The launch control center site meets Air Force and DOD siting requirements, and neither the DOD Explosives Safety Board nor the Air Force Safety and Inspection Center have raised the siting as an issue.

MANNED SPACEFLIGHT FROM VLS

As a result of the Challenger loss, the Air Force decided to postpone the first VLS shuttle launch from 1986 to 1992. Also, the Air Force and NASA reevaluated planned shuttle missions and launch dates, including those from VLS. The reevaluation resulted in

- shifting some VLS missions to the Kennedy Space Center,
- shifting some missions to expendable launch vehicles,
and
- delaying some missions.

PLANNING FOR SHUTTLE USE

NASA is responsible for issuing the official manifest for shuttle flights from the Kennedy Space Center and VLS. The Air Force participates in the manifest development process because of its national security missions.

In preparing the first post-accident manifest, the Air Force and NASA each worked on their own planning manifests by prioritizing missions and scheduling launch dates. Air Force and NASA officials informed us that establishing mission priorities after the accident had been a difficult process. As a result, NASA did not issue an official post-accident manifest until October 3, 1986.

The official manifest includes mission data for VLS launches planned from 1992-1994. Air Force and NASA officials informed us that mission priorities and dates could change until shortly before the first launch. Such a change could occur, for example, if an operational satellite were to fail and require quick replacement.

PLANNED VLS USERS

According to the official manifest, nine DOD, NASA, and National Oceanic and Atmospheric Administration (NOAA) payloads will be launched from VLS during 1992-1994.

Department of Defense

According to the official manifest, two DOD payloads will be launched from VLS in 1992, with a third scheduled to go aloft in 1994. We were informed that DOD plans to use VLS-launched shuttles for special classified projects and the Space Test Program. Some Space Test Program experiments will be mounted on

a reusable platform which will take up approximately one-fourth of the shuttle's bay. One Space Test Program experiment will gather data on adverse effects that conditions encountered in polar orbits may have on materials, equipment, and technologies.

National Aeronautics and Space Administration

Two NASA space station payloads are scheduled to be launched from VLS in 1994. Both NASA and the European Space Agency plan to own and operate a space station polar platform, which would be visited periodically by crews for servicing.

NASA also plans to use VLS-launched shuttles for the Shuttle Radar Laboratory and the International Solar Terrestrial Physics program. The Shuttle Radar Laboratory will be an earth observation satellite for gathering data on polar ice caps, oceans, and land. The International Solar Terrestrial Physics program--a cooperative NASA, Japanese, and European effort--includes a planned VLS launch of a NASA satellite to gather data on the aurora borealis.

National Oceanic and Atmospheric Administration

According to the manifest, two NOAA payloads--a meteorological satellite and an earth land observation satellite --are scheduled for 1993 VLS launches. The meteorological satellite will be used by the National Weather Service. The earth observation satellite will provide data for mapping, mineral exploration, and other uses.

NOAA also plans to use part of the NASA space station platform for meteorological instruments.

REASONS MISSIONS ARE PLANNED FOR VLS

Based on our conversations with DOD, NASA, and NOAA officials about individual missions, most of the polar missions described above are planned for VLS because their payloads were designed for the shuttle. They were so designed because of a prior national policy which called for transitioning all government payloads to the shuttle as expeditiously as practical. Consequently, some of the planned missions were designed to take advantage of the human presence and/or the shuttle's unique capabilities. However, Air Force and NASA officials stated that there may be alternatives to some planned VLS missions. For example, officials responsible for some of these missions are considering use of expendable launch vehicles instead of the shuttle.

On the other hand, if expendable launch vehicles were unable to launch a critical payload, VLS would allow a shuttle to launch it instead (assuming that the payload's design was compatible with both expendable launch vehicles and the shuttle). Accordingly, DOD officials informed us that shuttle operations at VLS, combined with expendable launch vehicles at Vandenberg, would provide assured access to polar orbits.

REPLACEMENT ORBITER

The loss of the Challenger led to investigation of not only the accident's causes but also its impact on the U.S. space program. After several months of executive branch review, the President decided to replace the lost orbiter.

DECISIONMAKING PROCESS

We were informed that in early February 1986, the President's National Security Advisor assigned the task of studying the Challenger accident's programmatic implications to the Senior Interagency Group for Space (SIG-Space). A working group of SIG-Space's Interagency Group was established to study these implications. The working group, co-chaired by DOD and NASA, included officials from the Departments of State, Commerce, and Transportation, as well as other executive branch agencies and offices (see app. IV).

The working group's preparation of a draft report occupied the next 2-1/2 months. During that period, NASA and DOD prepared internal studies supporting acquisition of a replacement orbiter. On April 18, the working group completed work on a draft report that recommended replacement of the Challenger. The draft report was then transmitted to and considered by SIG-Space.

SIG-Space members briefed the President in mid-May. Some executive branch agencies were then asked to further review certain questions, including those concerning a replacement orbiter. The results of their efforts were provided to the President on July 29. On August 15, the President announced his decision to replace the Challenger.

We were informed that a National Security Decision Directive that addresses the Challenger replacement has been drafted and sent to the President. NASA's October 3 shuttle manifest assumes that the replacement orbiter will be first launched in March 1991.

EXECUTIVE BRANCH RATIONALE
FOR REPLACEMENT ORBITER

Our discussions with DOD, Air Force, NASA, and NSC officials, as well as our examination of Air Force and NASA studies, indicated that the executive branch rationale for a replacement orbiter involves two primary considerations: (1) foreign perceptions of U.S. resolve and (2) U.S. space launch needs.

Officials informed us that a replacement orbiter would demonstrate that the United States is committed to a long term manned presence in space. Concern was expressed that continued

Soviet investment in manned space exploration could affect world perception of U.S. leadership in a highly visible aspect of East-West competition and that failure to replace the Challenger would be seen abroad as indicating a loss of U.S. resolve--even after the remaining three orbiters were returned to service. A principal working group official cited the perceived need to demonstrate U.S. commitment to manned space flight as the primary element in the decision to replace the Challenger.

Several DOD, Air Force, NASA, and NSC officials, as well as Air Force and NASA studies, also pointed to the replacement orbiter's projected role in meeting U.S. demand for space launch services. Factors cited in support of this argument included the following.

- A large backlog of missions will have accumulated when orbiter operations resume. Although some missions will be shifted to expendable launch vehicles, a replacement orbiter will be needed to help ensure that the backlog can be reduced and that future DOD and civilian demands, such as the space station, can be accommodated as well. However, two DOD officials questioned the importance of this factor.
- The orbiter is the only system the United States will have to place crews into orbit through the 1990s.
- A four-orbiter fleet is needed to ensure that three operational orbiters will be available at any one time through the 1990s.

NASA officials also told us that a replacement orbiter would be a relatively cost efficient way to meet demand for launch services.

REPLACEMENT ORBITER-VLS RELATIONSHIP

DOD, NASA, and NSC officials informed us that the above rationale for building a replacement orbiter would not be affected if VLS were mothballed. They also stated that a decision to forego a replacement orbiter would weaken the case for opening VLS. Under such conditions, stationing the three remaining orbiters at the Kennedy Space Center would allow a greater overall flight rate than would splitting the fleet between the two launch sites. Restoration of a four-orbiter fleet, one DOD official informed us, would allow more efficient use of VLS.

Although NASA officials informed us that a replacement orbiter would not be dedicated solely to VLS, they indicated that the equivalent of one orbiter would spend most of its time at Vandenberg if three missions a year were launched from VLS.

SENIOR INTERAGENCY GROUP FOR SPACE:
COMPOSITION OF SHUTTLE-RELATED INTERAGENCY AND WORKING GROUPS

<u>Agency/Office</u>	<u>Interagency Group Member/Observer</u>	<u>Working Group Participants</u>
NSC	Director, Space Programs	
NASA	Deputy Administrator; Associate Administrator, Policy	Director, Governmental Affairs Division
DOD	Deputy Under Secretary for Policy	Special Assistant (Space Policy) to Assistant Secretary for C ³ I Air Force Secretariat, Space Systems, staff
Arms Control and Disarma- ment Agency	Assistant Director for Strategic Programs	Assistant Director for Strategic Programs
Central Intelligence Agency	Director, Intelligence Community Staff	Intelligence Community Staff member
Commerce Department	Administrator, National Oceanic & Atmospheric Administration	Deputy General Counsel; Special Assistant to the General Counsel
Joint Chiefs of Staff	Deputy Director, Force & Strategic Plans	Force & Strategic Plans staff
Office of Management and Budget	Deputy Associate Director, National Security & Interna- tional Affairs, Special Studies	Deputy Associate Director, National Security & Interna- tional Affairs, Special Studies; Branch Chief, Energy & Science, Science & Space

<u>Agency/Office</u>	<u>Interagency Group Member/Observer</u>	<u>Working Group Participants</u>
Office of Science and Technology Policy	Assistant Director, Defense Technology and Systems	Assistant Director, Defense Technology and Systems; Assistant Director, Space Science Technology
Office of the President	Assistant for Cabinet Affairs Special Assistant for Policy Development	
Office of the Vice President	Deputy Assistant for National Security Affairs	
State Department	Assistant Secretary, Oceans & International Environmental & Scientific Affairs	Director, Office of Advanced Techno- logy
Transportation Department	Director, Office of Commercial Space Transportation	Director, Office of Commercial Space Transportation

VLS FUNDING HISTORY

<u>Year</u>	<u>Military Construction</u>	<u>Total Funding</u>
	----- (millions) -----	
Prior years	\$240.9	\$585.0
1981	89.9	269.9
1982	67.3	415.8
1983	52.7	409.6
1984	47.2	597.5
1985	16.3	553.4
1986	<u>16.0</u>	<u>453.8</u>
Total	<u>\$530.3</u>	<u>\$3,285.0</u>

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