NASA

National Aeronautics and
Space Administration

Budget Supplemental

FISCAL YEAR 1980

Research and Development

BUDGET SUPPLEMENTAL
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1980

GENERAL STATEMENT

Supplemental Appropriation for Space Shuttle Program

A supplemental appropriation of $300.0 million is requested to provide the additional funding required for the Space Shuttle Program. The Space Shuttle is the key element of a versatile, economical space transportation system that will provide a wide variety of national and international users with round trip access to space beginning in the 1980's. This supplemental appropriation, when added to the $1,586.0 million appropriated for FY 1980 would provide a total of $1,886.0 million for the Space Shuttle Program within the Research and Development appropriation.

The additional funding is required in FY 1980 to sustain the pace of the Space Shuttle development efforts aimed at a first orbital flight during 1980, while allowing for the buildup of follow-on orbiter production activities on a schedule to meet critical civil and military Space Shuttle operational requirements. The funding requirement is due primarily to increased efforts in completing systems installation and test, particularly TPS, in prelaunch processing of the first orbital vehicle, and in systems qualification and certification testing across all elements of the program. These increased efforts have required more work than was planned resulting in a delay of the first manned orbital flight (STS-1) from the previous schedule of March 1980. Intensive development and testing activity is now proceeding in FY 1980 with the first orbital flight expected in the last half of 1980. Funding is being applied to Design, Development, Test and Evaluation activities at a rate which supports this plan while follow-on orbiter production activities are also proceeding on an orderly buildup. The FY 1980 supplemental appropriation will allow NASA to provide the planned FY 1980 funding for follow-on orbiter production activities. If the requested supplemental appropriation is not approved, it will be necessary to rebalance the program plan by adjusting the FY 1980 development and test activities and the follow-on orbiter production activities resulting in significant delays in the first orbital flight, the initial operational capability, and in the follow-on orbiter deliveries.

The following summary presents a comparison of the funding plan for Space Shuttle Research and Development contained in the FY 1980 budget request with the current plan including the requested supplemental appropriation:

	Millions of Dollars
Total Amount Authorized and Appropriated for FY 1980.....	$1,586 0
Total Current Estimate	$1 886 0
Requested Supplemental Authorization and Appropriation.	$ 300.0

Appropriation summary tables, proposed language for the requested authorization and appropriation and a more specific narrative statement of program requirements follow.

BUDGET SUPPLEMENTAL

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND DEVELOPMENT

BUDGET SUMMARY

(Thousands of Dollars)

	Budget Plan				
		FY 1980			FY 1981
	FY 1979 Actual	Presently Available	Proposed Supplemental	Revised Estimate	Budget Estimate
SPACE TRANSPORTATION SYSTEMS	2,011,600	2,103,300	300,000	2,403,300	2,738,200
Space shuttle	1,638,300	1,586,000	300,000	1,886,000	1,873,000
Space flight operations	299,700	446,600	---	446,600	809,500
Expendable launch vehicles	73,600	70,700	---	70,700	55,700
SPACE SCIENCE	505,400	600,800	---	600,800	668,000
Physics and astronomy	282,900	337,100	---	337,100	438,700
Planetary exploration	182,400	219,900	---	219,900	179,600
Life sciences	40,100	43,800	---	43,800	49,700
SPACE AND TERRESTRIAL APPLICATIONS	283,900	343,900	---	343,900	394,800
Space applications	274,800	331,800	---	331,800	381,700
Technology utilization	9,100	12,100	---	12,100	13,100
AERONAUTICS AND SPACE TECHNOLOGY	376,400	427,100	---	427,100	409,500
Aeronautical research and technology	264,100	308,300	---	308,300	290,300
Space research and technology	107,300	115,800	---	115,800	115,200
Energy technology	5,000	3,000	---	3,000	4,000
SPACE TRACKING AND DATA SYSTEMS	299,900	332,400	---	332,400	359,000
TOTAL RESEARCH AND DEVELOPMENT	3,477,200	3,807,500	300,000	4,107,500	4,569,500
OUTLAYS	3,236,641	3,663,900	200,000	3,863,900	4,234,200

BUDGET SUPPLEMENTAL

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Research and Development
Budget Summary by Subfunction

	Subfunction		1979 Actual	FY 1980 Presently Available	FY 1980 Proposed Supplemental	FY 1980 Revised Estimate	FY 1981 Budget Estimate
253	Space flight	BA	2,011,600	2,103,300	300,000	2,403,300	2,738,200
		O	1,898,025	2,092,000	200,000	2,287,000	2,547,600
254	Space science, applications and technology	BA	901,600	1,063,500	---	1,063,500	1,182,000
		O	810,768	973,400	---	971,400	1,068,400
255	Supporting space activities	BA	299,900	332,400	---	332,400	359,000
		O	292,564	313,100	---	325,100	340,400
250	Subtotal, General Science, Space and Technology	BA	3,213,100	3,499,200	300,000	3,799,200	4,279,200
		O	3,001,357	3,378,500	200,000	3,583,500	3,956,400
402	Air Transportation	BA	264,100	308,300	---	308,300	290,300
		O	235,284	285,400	---	270,400	277,800
	Total	BA	3,477,200	3,807,500	300,000	4,107,500	4,569,500
		O	3,236,641	3.663.900	200,000	3,853,900	4,234,200

BA -- Budget Authority
O -- Outlays

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

AUTHORIZATION BILL

A BILL

To authorize a supplemental appropriation to the National Aeronautics and Space Administration for Research and Development.

Paragraph (1) of subsection 1 (a) of the National Aeronautics and Space Administration Act, 1980 (Public Law 96-48), is amended by striking out "$1,586,000,000" and inserting in lieu thereof "$1,886,000,000."

APPROPRIATION LANGUAGE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND DEVELOPMENT

For an additional amount for "Research and Development", $300,000,000; to remain available until September 30, 1981.

OFFICE OF SPACE TRANSPORTATION SYSTEMS — SPACE SHUTTLE PROGRAM

PROGRAM STATUS:

The Space Shuttle Program is in the final period of development toward the first orbital flight, targeted for the last half of 1980. All Space Shuttle system flight elements have been delivered to the Kennedy Space Center (KSC) for STS-1, other elements are proceeding in test and manufacture, and major ground test programs are being conducted. Hardware certification is continuing across all Space Shuttle elements.

The Mated Vertical Ground Vibration Test (MVGVT), conducted at the Marshall Space Flight Center (MSFC), was completed early in 1979, and the data has been used to update Space Shuttle system dynamic math models to predict the vehicle response under vibration during the launch and ascent phases of flight. The test elements used in the MVGVT were delivered to KSC for launch facility verification and tests, which were successfully completed. Orbiter 101 (Enterprise) was then returned to Palmdale, CA, where it will be used for future tests, removal of critical flightworthy parts, and possible use as part of a facility verification vehicle for the Vandenberg Air Force Base (VAFB). The Main Propulsion Test (MPT) series, which started in 1978 at the National Space Technology Laboratories (NSTL), continued through 1979. This includes three main engines mounted on an orbiter aft-fuselage, and an external tank. MPT progress has been slowed due to failures in testing and necessary engine modifications, but the test activity is now progressing. The successful full-duration MPT test lasting 550 seconds on December 17, 1979, represented a significant mi estone in the main propulsion development program.

FY 1980 activities support preparations for the first orbital flight. Orbiter 102 (Columbia), which will be used for the Orbital Flight Test (OFT) Program, is in final assembly and checkout in the Orbiter Processing Facility (OPF) at KSC. Thermal protection system (TPS) installation problems have been a major cause for delay in this orbiter final assembly. In 1980, this orbiter will be delivered to the Vehicle Assembly Building (VAB) for assembly with the external tank (ET) and solid rocket boosters (SRB's) to prepare for launch. The orbiter Structural Test Article (STA) testing was completed by Lockheed in 1979, and the STA was transferred back to Rockwell in Palmdale, CA, for modification to become the second flight orbiter, Orbiter 099 (Challenger).

A number of technical problems (i.e., main fuel valve, turbine seal, steerhorn, and suspect weld wire) have occurred in 1979 during various phases of the main engine test program. However, we have now achieved close to 60,000 seconds of test time, and are on our way to the 80,000 second mark, which we expect to reach prior to STS-1. The first phase of the Preliminary Flight Certification (PFC) has been completed with over 5,000 seconds accumulated on one engine, and a second series of PFC testing on a second engine has started. The three engines which will be used for STS-1 have all completed acceptance test firings, are installed and are undergoing checkout in Columbia at KSC. Modifications will be made to these flight engines early in 1980 to correct recent problems detected during engine testing at NSTL.

The first flight ET has been delivered to KSC for use in STS-1, and three other tanks are in various stages of manufacture at the Michoud Assembly Facility (MAF). The fourth solid rocket motor (SRM) development firing and two qualification motor firings were accomplished during 1979, and the third and final qualification firing is planned for early 1980. In addition, the SRB components for the first orbital flight were delivered to **KSC** in 1979.

The flight hardware elements for STS-1 have been delivered to KSC and are progressing well through element processing toward stacking and mating into the overall assembled vehicle. The SRB's are stacked on the mobile launcher awaiting the ET. The ET checkout will be completed, and it will be mated with the SRB's during the first quarter of 1980. Columbia (which has been undergoing manufacturing, modifications, and testing throughout FY 1979) is being prepared for mating. Integrated vehicle processing is planned to continue through a flight readiness firing prior to launch. The primary orbital flight test landing station at Dryden Flight Research Center (DFRC) in California is operational and an alternate landing strip is being prepared at the White Sands Missile Range in New Mexico.

To establish a national fleet of operational orbiters, Space Shuttle production includes fabrication of two additional orbiters complete with flight engines, refurbishment of Orbiter 102 (Columbia) after its use in the orbital flight tests and early operations, and conversion of the orbiter STA to an operational orbiter (Orbiter 099, Challenger). Also included are the second series of launch and ground support equipment (GSE) at KSC for the simultaneous launch processing of two orbiters, systems integration and support, and initial operational spares and equipment. Activities planned in FY 1980 include: orbiter subsystem hardware fabrication for converting the STA to orbital flight capability, structures fabrication for Orbiter 103 (Atlantis), and main engine hardware fabrication. Procurement of GSE required for the "second line" launch capability at KSC, has already been initiated, and will continue.

During 1979, a number of important reviews of Space Shuttle Program management were held. One of the most important and consistant recommendations from the management reviews was the need for adequate reserves. Such funds have been programmed throughout the Space Shuttle elements for FY 1980, but it is essential that NASA plan for potential changes and systems upgrading required in the Space Shuttle Program to provide necessary modifications resulting from initial flight tests and changes to increase reliability and lower operating costs.

In summary, the technical progress at this critical phase of the development effort has been substantial, but has not sustained the pace necessary to accomplish the prior FY 1980 budget plan, thus making it necessary to adjust program schedules and request a supplemental appropriation. A summary of additional funding requirements by program element follows.

RESEARCH AND DEVELOPMENT
(dollars in millions)

	FY 1980 Appropriation Presently Available	FY 1980 Current Estimate	Additional Funding Requested
Summary by Program Element			
Design, Development, Test, and Evaluation (DDT&E)			
Orbiter	420.8	560.9	140.1
Main Engine	140.6	140.6	-
External Tank	68.4	79.4	11.0
Solid Rocket Booster	57.5	61.2	3.7
Launch and Landing	143.2	188.4	45.2
Total DDT&E	830.5	1,030.5	200.0
Changes and Systems Upgrading	-	**100.0**	**100.0**
Production	755.5	755.5	-
Total	1,586.0	1,886.0	300.0

BASIS OF SUPPLEMENTAL FUND REQUIREMENT

The requirement for the requested supplemental appropriation in FY 1980 is a result of development problems, necessary program changes, the need for more work than was previously planned, particularly in the TPS and systems installation effort on the first orbital vehicle (Orbiter 102) at KSC, and increased systems qualification and certification testing across all elements of the program which have resulted in a delay in the first orbital flight. The impact of such difficulties has been hardware delivery

delays, increased engineering and manufacturing requirements in prime and subcontractor efforts, and significant deferrals of work content into FY 1980. The additional funding requested in the Supplemental Appropriation is required to continue the development efforts on schedule and to proceed with the follow-on orbiter fabrication activities.

DESIGN, DEVELOPMENT, TEST, AND EVALUATION (DDT&E)

	FY 1980 Appropriation Presently Available	FY 1980 Current Estimate	Additional Funding Requested
	(dollars in thousands)		
Orbiter DDT&E	420,800	560,900	140,100

STATUS

The Orbiter Columbia was assembled in Palmdale, CA, checked out, and delivered to the OPF at KSC in March 1979. Considerable open work was transferred with the vehicle. The majority of open work and manufacturing has been completed with the exception of the installation and testing of TPS tiles. Orbiter integrated tests will be completed early in 1980, and the vehicle will be prepared for stacking and prelaunch checkout in mid-1980.

Although the TPS represented the major orbiter problem during 1979, other difficulties were encountered in the auxiliary power units, avionics software, the landing wheels and tires, and structural modifications required by the latest derived loads data.

Tests of the STA, which has a flight type airframe, have been completed by Lockheed at Palmdale, CA. The vehicle has been returned to Rockwell at Palmdale, CA., and is undergoing modifications and updating to become the Challenger flight vehicle configuration. Orbiter 101 (Enterprise) completed full-scale ground vibration tests at MSFC, and was used at KSC for facility interface verification. The Enterprise has been shipped back to Palmdale, where hardware components will be used as test articles or for flight spares. The vehicle will be configured for facility verification at VAFB.

The overall avionics verification testing is underway at the Space Shuttle Avionics Integration Laboratory (SAIL) at the Johnson Space Center (JSC) for ascent, and at the Flight Systems Laboratory (FSL) at Rockwell at Downey, CA, for reentry. Verification tests of various acceptable but off-nominal environment Space Shuttle vehicle equipment conditions, as well as equipment failure conditions, are underway.

Initial testing is being conducted with the latest available flight software for the primary and backup flight control systems, and when the final configuration inspected flight software is received, the avionics flight verification testing will be completed. Engineering real-time simulations are being conducted to investigate flight control problem areas derived from structural and wind tunnel testing. Software modifications will be required to implement the changes resulting from the engineering simulations. Combined systems testing is planned at FSL to demonstrate the flight control actuation systems for the aerosurfaces and the main engine thrust vector controls with the Space Shuttle hydraulic system using the Flight Control Hydraulics Laboratories. Remote Manipulator System (RMS) verification testing on the guidance and control test stations at SAIL is also scheduled for 1980. Overall avionics verification testing will be conducted at SAIL to demonstrate the suitability of flight crew procedures and mission techniques using qualified flight crew members manning the crew station during verification tests. Final flight software initial conditions for the specific launch day data and vehicle configuration will be demonstrated prior to the STS-I flight, and landing simulations on the Ames Research Center new moving base simulation facility are planned to provide further verification of the STS-1 landing capabilities and techniques.

Support activities managed by JSC will continue, including software modifications in the Mission Control Center (MCC), use of crew training simulators, development of government-furnished equipment such as space suits, and the performance of tests to support the orbiter project. The emphasis for FY 1980 is on preparation for the orbital flight tests.

The development of the Manned Maneuvering Unit (MMU) has been accelerated in order to have on-orbit TPS inspection and repair capability. A qualification unit and two flight articles will be produced, and crew training will begin on the contractor's simulator (Martin Marietta Corporation, Denver, CO). The MMU and associated equipment will be required in January 1981. It is not required for the first flight since the flight is designed for a benign environment and each tile will have been verified to safety factors of at least 1.4 times the full operational requirement.

BASIS OF SUPPLEMENTAL REQUEST

The increase in orbiter funding requirements of $140.1 million results largely from additional engineering and subcontractor activity due to problems encountered in the qualification and certification programs, and the additional effort required to complete the application and testing of thermal protection system tiles, and other subsystem installations at KSC. There have been a number of major changes such as on-orbit TPS repair and heads-up display, as well as numerous changes required to make the system operate properly as determined by the comprehensive test programs. In addition, there have been a number of subcontractor cost increases due to development and producibility problems. Examples include TPS tiles, auxiliary power unit, orbiter maneuvering system pod, the KU-band rendezvous radar, and the S-band communications subsystems. Other funding increases have been experienced in support areas caused by schedule delays, and in systems areas due to additional vehicle system testing planned for FY 1980.

	FY 1980 Appropriation Presently Available	FY 1980 Current Estimate	Additional Funding Requested
	(dollars in thousands)		
Main Engine DDT&E.....	140,600	140,600	---

STATUS

During FY 1979, problems with several main engine components continued to delay the test program causing the main engine project to accumulate fewer test seconds than planned. Engine development testing was proceeding at a good pace until a nozzle steerhorn failure (May 14, 1979) destroyed most of the internal parts of an engine. A main fuel valve failure on a Main Propulsion Test Article (MPTA) engine (July 2, 1979) caused a further temporary suspension of testing. During an MPTA test (November 4, 1979), an early shutdown was initiated when a high pressure oxygen turbopump (HPOTP) turbine seal failed on one of the engines. During the shutdown, another nozzle steerhorn failed, destroying most of the internal parts of an engine. Failure modes and causes of these failures (main fuel valve, nozzle steerhorn, HPOTP turbine seal) have been identified, modifications incorporated, and testing resumed. Another engine has been assigned to the MPT Program. The last MPT test (December 17, 1979) was a significant success, lasting for 550 seconds. As a result of the problems, completion of the MPT series in support of STS-1 has slipped to May 1980.

In spite of these problems, progress this year has been significant. The first certification cycle of the PFC Program was completed. Sixteen tests were conducted for a total of 5,245 seconds on one engine. This included four flight mission profile tests of 520 seconds, one flight mission profile over-stress test [102% rated power level (RPL)], and two abort mission simulations of 665 and 823 seconds. A repeat of the PFC certification cycle is now in progress on the same engine. Seven of the thirteen objectives have been accomplished with a total of 3,000 seconds accumulated to date. A total of four PFC certification cycles will be conducted on two or more engines with at least two certifications on one engine. To date, a total of approximately 530 tests have been conducted, accumulating over 60,000 seconds of operation, with about 175 tests and over 28,000 seconds at RPL. This past year we conducted about 130 tests and accumulated over 22,000 seconds of operation with about 100 tests and over 17,000 seconds at RPL. Thus, over 77% of the test seconds accumulated this past year have been at RPL or higher. Much of the time not at RPL is start, transient time and throttling time to various power levels to determine engine performance at the lower power levels.

Testing will continue on flight configured engines during 1980 leading to the main engine flight certification for STS-1. It is planned to accumulate approximately 80,000 seconds of test time prior to flight, including single engine, main propulsion testing, and PFC testing. The MPTA, consisting of a cluster of three engines, a flight-weight external tank, and the aft-fuselage of the orbiter, is maintained in the STS-1 configuration and will continue in testing during the fiscal year. Data from main propulsion testing will constitute a part of engine verification. PFC testing will be completed accumulating approximately 20,000 seconds on two or more engines. Single engine testing will also be intensive to prove the durability of each component of the system. Full power level (FPL, 109% of RPL) testing will start late in FY 1980. By mid-1980, all engine modifications will have been incorporated in the flight engines installed in Orbiter 102 to support the flight readiness firing and the first orbital flight.

In addition to the development and test work by Rocketdyne and the subcontractors, the main engine activities provide the necessary project support efforts. These efforts include the procurement of propellants for test firing the engine and its components, the maintenance of the engine systems hardware simulation laboratory, logistic support, and the evaluation of materials and processes.

	FY 1980 Appropriation Presently Available	FY 1980 Current Estimate	Additional Funding Requested
	(dollars in thousands)		
External Tank DDT&E	68,400	79,400	11,000

STATUS

During 1979, structural testing of the liquid hydrogen tank was successfully accomplished at MSFC. The ground vibration test tank was shipped to KSC where it was mated to a set of inert SRB's and the orbiter Enterprise for a thorough checkout of the launch facilities, ground support equipment, and supporting interface equipment. The tank was then shipped to MAF for storage and eventual reuse as a flight tank after modifications are accomplished.

During the summer of 1979, a design change was implemented to prevent the formation of ice on the tank protuberances, which if dislodged during ascent could damage the orbiter TPS. This will be accomplished by a newly designed KSC ground purge system and the addition of spray-on foam insulation (SOFI) and electrical heaters around the potential ice-forming areas. The determination of aerodynamic crossflows

from the SRB's, and newly defined air loads which could exceed the cable trays' structural strength, will be resolved by the addition of large SOFI ramps. The first flight tank, delivered to KSC in mid-1979, is in the process of having these changes incorporated, including the ice/debris and air load SOFI ramps. It is expected that all modifications will be completed in early 1980.

Delivery to **KSC** of the second flight tank is planned for the third quarter of 1980. The third and fourth flight tanks will be structurally assembled, the TPS applied, and readied for shipment to KSC during the year. Deliveries of these two tanks will take place in FY 1981.

During FY 1980, a major engineering effort will be expended on the lightweight tank (LWT) design. The goal of reducing the weight of the tank by 6,000 pounds will be achieved by optimizing the thickness of the basic skin, ribs, and chords of the intertank, liquid oxygen, and liquid hydrogen tanks, with a minimum impact to the basic ET structure and fabrication process. Early in FY 1980, 20 percent of the LWT design had been released for raw material ordering and vendor fabrication of components. A preliminary design review was held during this quarter, and a critical design review is planned for May 1980 which will support the delivery of the first LWT for the seventh (STS-7) orbital flight mission.

In FY 1980, efforts are being undertaken to improve the producibility of the ET. The basic objective is to develop new techniques and processes to build the ET more efficiently and economically. Areas of activity include improved welding techniques and an automated inspection system; an alternate foam material for the liquid hydrogen tank aft dome; and improvements in tank priming, cleaning and protection. In the thermal protection area, SOFI, and ablator improvements are being developed, and improvements in the forming and chemical milling processes have started.

BASIS OF SUPPLEMENTAL REQUEST

The ET estimate for FY 1980 has increased by $11.0 million. This increase was principally caused by changes, particularly to protect against protuberance icing and to accommodate additional air loads data. The ET project cost also grew because of increased estimates to perform weight reduction and the addition of an ET producibility effort to the development program.

	FY 1980 Appropriation Presently Available	FY 1980 Current Estimate	Additional Funding Requested
	(dollars in thousands)		
Solid Rocket Booster (SRB).....	57,500	61,200	3,700

STATUS

The main element in the SRB system is the SRM which is being developed by Thiokol, Wasatch Division, Utah. Other booster system elements such as the recovery system, Thrust Vector Control (TVC), attach structures, forward and aft-skirt, and separation motors are being procured separately. MSFC is performing designated systems integration tasks, and has the responsibility for total systems integration of the SRB effort.

In 1979, the booster separation motor qualification test firings were successfully completed, and the flight motors for the first two OFTs were delivered to KSC. The structural test program, to verify the major structural elements for flight loads, were completed during 1979, and water impact loads testing started. These tests are scheduled for completion early in 1980. Fabrication of the flight structural components is progressing very well, with delivery of the hardware required for the four OFTs completed. Fabrication of the parachutes for the orbital flights is continuing with the flight sets for the first two flight missions delivered to KSC. The TVC systems testing was completed at MSFC to verify the overall performance characteristics. Successful TVC system operation was completed during the SRM motor firings at Thiokol. The TVC systems for STS-1 have successfully completed hot firing and are installed on the flight aft-skirts. The booster assembly contractor has been actively involved with the assembly and checkout of the boosters for STS-1, and they have delivered the hardware to the VAB high bay area for stacking.

The component qualification test program for all the SRB major systems progressed satisfactorily with approximately a 75% completion of the qualification testing required for the first flight. The total test program is scheduled for completion in early 1980. During 1979 the fourth and final development motor was loaded and test fired. Two of the three SRM qualification tests of the flight configuration have been successfully fired, and the third will be tested in early 1980. All SRM segments for STS-1 have been delivered and stacked at KSC.

BASIS OF SUPPLEMENTAL REQUEST

The SRB estimate for FY 1980 has increased by $3.7 million. This additional funding requirement was caused by cost increases in the SRB subsystems, technical changes, and qualification test problems, as well as DDT&E flight hardware delivery delays to support the slipped development flight schedule.

	FY 1980 Appropriation Presently Available	FY 1980 Current Estimate	Additional Requested
	(dollars in thousands)		
Launch and Landing DDT&E.....	143,200	188,400	45,200

STATUS

Activation of the various launch and landing station sets has been paced to match the flight hardware development, certification, and readiness for flight. However, the launch support team has been fully implemented, and all personnel are on board and engaged in prelaunch checkout. The Space Shuttle landing stations at DFRC and KSC, and the OPF and Launch Processing Systems (LPS) at KSC were activated in FY 1979, and were operational at the beginning of FY 1980. The mobile launcher, parachute packing, propulsive element checkout (SRB, ET, SSME), and vehicle assembly stations in the VAB were activated in the first quarter of FY 1980. The launch pad and SRB retrieval and disassembly station are progressing on schedule toward activation and operational status in the third quarter of FY 1980. A second firing room and LPS control set will also be activated in FY 1980 to allow the development and checkout of ground test software in parallel with vehicle testing. During FY 1980 construction of facilities at White Sands is required to support orbiter processing in event of landings at that site.

Delivery and installation of most of the required KSC GSE was completed during FY 1979 and early FY 1980. About 98% of the required KSC provided GSE (approximately 290 models) and 90% of the contractor provided GSE (approximately 680 models) have been delivered and installed in the processing stations. Both GSE and flight systems replacement spares are being laid in, processing fluids are being supplied to support checkout and testing, and propellants are being accumulated for the first launch.

The processing station activation remaining for FY 1980 includes the completion of activation of the launch pad and SRB retrieval and disassembly stations. The fuel cell and hypergolic propellant loading systems are still in the test certification phase, an ice protection and purge swing arm is being installed at the launch pad, and the remaining GSE is being implemented on schedule.

The major portion of launch and landing work now is the operation of the station sets and the processing and launch of the flight vehicles. Processing includes test and checkout of the individual flight elements; stacking and mating of the elements to assemble the overall space vehicle; and testing, servicing, and launching the vehicle. The development contractors which provide on-site launch support includes Rockwell International, Martin Marietta, United Space Boosters, Inc. and Thiokol.

The Orbiter Columbia has been in processing in the OPF since its delivery to KSC in March 1979. It was delivered without some flight systems and TPS tiles installed and has since been undergoing manufacturing completion in parallel with systems testing. Most systems have now been tested. Some qualification and certification tests have been performed, and some performance and integration tests remain to be completed. The first flight ET was delivered in July 1979, and it is now being processed in the VAB. The first set of flight SRBs, which were delivered in November and December 1979, have undergone subassembly of skirts and nose frustrums to motor segments and stacking on the mobile launcher in the vehicle assembly station in the VAB.

The vehicle processing still to be accomplished in FY 1980 includes completion of fabrication and testing of the Orbiter Columbia; mating the ET, orbiter, and SRBs; and processing the mated vehicle through vehicle interface test, flight readiness firing, countdown, and launch. After launch, the SRBs will be retrieved and disassembled for refurbishment and reprocessing. The orbiter will land at DFRC after the STS-1 mission, be deserviced, then mated with the carrier aircraft and ferried back to KSC where it will be inspected repaired, and reprocessed, including the replacement of a number of TPS tiles. Other flight elements will be processed for STS-2 during FY 1980, and work on the turnaround of Columbia will be initiated immediately after STS-1.

BASIS OF SUPPLEMENTAL REQUEST

The primary reason for the *$45.2* million additional funding in the launch and landing project for FY 1980 is the additional time and effort required to prepare for the launch of STS-1. This additional effort impacted the funding requirements because Orbiter 102 has been in processing in the OPF longer than planned, while the test and checkout phase of launch preparation is being completed. In addition, the test and checkout phase is proving to be more complicated and require more manpower than had originally been estimated. The capacity of the LPS computers required expansion, and many changes necessary to make the ground system operate properly continued to be required to prepare GSE for operational use.

CHANGES AND SYSTEMS UPGRADING

	FY 1980 Appropriation Presently Available	FY 1980 Current Estimate	Additional Funding Requested
		(dollars in thousands)	
Changes and Systems Upgrading Total...	---	100	100

BASIS OF SUPPLEMENTAL REQUEST

Recent management and cost reviews at various levels throughout the Space Shuttle Program at NASA and with major contractors have emphasized the need for an adequate allowance for likely changes and potential systems modification to achieve improved performance. Such funds are necessary, particularily at this time, to provide for the modificatons which are most likely to result from the test programs, necessary changes to increase reliability and safety, and changes designed to lower operating costs of the space transportation system.

Space Shuttle system areas in which these changes and upgrading efforts are likely to be required include the elevon actuators, the radiator door configuration, the launch processing system, plus changes in the fuel cells, inertial measurement unit, and the auxiliary power unit. As these requirements develop and are approved, they will impact the funding estimates for either development or production and the funding will be applied accordingly.

PRODUCTION
(dollars in millions)

	FY 1980 Appropriation Presently Available	FY 1980 Current Estimate	Change in Funds Required
Summary by Production Elements			
Orbiter	570.6	572.6	+2.0
Main Engine	109.9	123.6	+13.7
KSC Second Line	20.0	16.4	-3.6
Spares and Equipment	55.0	42.9	-12.1
Total	755.5	755.5	-

STATUS

Space Shuttle production provides for modification of the orbiter structural test article (STA) to orbital flight configuration (Orbiter 099), refurbishment of Orbiter 102 after the orbital flight test program (OFT) and early operations period, and the fabrication and assembly of two additional orbiters to establish a national fleet of operational orbiters. Production activities also include fabrication of main engines, preparation of the second series ("second line") of Space Shuttle ground processing and launch suppcrt equipment at KSC to permit simultaneous processing of two Space Shuttle vehicles, and the necessary Space Shuttle spares and equipment required to establish the initial inventory to support the operational flight rate capability of the Space Shuttle.

The structural test program performed at Palmdale, CA, utilizing the orbiter STA airframe, was completed in 1979. The test data is being used to certify the structural capability of the orbiter. After completion of the planned structural testing, the STA was returned to the Rockwell plant at Palmdale to be converted to an orbital configuration (Orbiter 099, Challenger). The modifications which have been started consist of the removal of specific elements and instrumentation required during testing; installation of a flight-type crew module; addition of functional subsystems such as the orbital maneuvering system, the reaction control system, the atmospheric revitalization system, and the flight control and communications systems; and the application of the TPS.

Fabrication and assembly of the major subsystems of Orbiter 103 (Atlantis), which is scheduled for delivery late in 1983, has begun at Rockwell International and at the major structural subcontractors. The crew module and the forward and aft-fuselage elements are in assembly at Rockwell; and the wings, vertical stabilizer, and mid-fuselage are in assembly at Rockwell's subcontractors. Some long lead ordering of critical parts was also accomplished for Orbiter 104 (Discovery) during FY 1979. During 1979 NASA defined a weight reduction program for implementation on Orbiters 099, 103, and 104. Funds appropriated for FY 1979 to maintain the option for possible fabrication of a fifth orbiter were used to begin procurement of critical long lead time items. NASA only ordered items which are common to a four or five orbiter program and not specifically for a fifth orbiter.

FY 1980 funding provides for continuation of long lead time material and component procurements for the flight engines required for the operational orbiter fleet. Engine component procurements include hot gas manifold and preburner body forgings, turbopump castings, main combustion chamber parts, and selected raw materials and plate stock for engine component fabrication. In addition, fabrication of liquid hydrogen and liquid oxygen high and low pressure turbopump components has been initiated, and assembly of the first set of production engines will begin during FY 1980.

In order to provide the "second-line" capability required at KSC during the operational years, the procurement of necessary ground and launch support equipment was initiated during FY 1979. This equipment will be installed in the OPF and the Launch Control Center at KSC. NASA has also initiated the procurement of flight crew equipment for the extravehicular mobility unit (spacesuit), communications equipment, and the portable oxygen system. In addition, procurements for ET and SRB rate tooling will be initiated in FY 1980.

The current FY 1980 estimates are the same in total as projected in the FY 1980 budget. There has been a rebalancing to reflect the revised delivery schedules and the acceleration of engines to provide backup hardware to support the development program.

Program and Financing (in thousands of dollars)

Research and Development

Identification Code: 80-0108-4-1-999	Budget Plan (amounts for research and development actions programmed)			Costs and Obligations		
	1980	1980	1980	1980	1980	1980
Program by activities:	Presently available	Revised estimate	Proposed supplemental	Presently available	Revised estimate	Proposed supplemental
Direct program:						
1. Space transportation systems:						
(a) Space shuttle	1,586,000	1,886,000	300,000	1,601,000	1,851,000	250,000
(b) Space flight operations	445,600	445,500	---	412,100	412,100	---
(c) Expendable launch vehicle development and support	35,100	36,100	---	41,490	41,490	---
2. Scientific investigations in space:						
(a) Physics and astronomy	339,200	339,200	---	337,400	337,400	---
(b) Planetary exploration	219,900	219,900	---	209,300	209,300	---
(c) Life sciences	43,800	43,800	---	46,500	46,500	---
3. Space and terrestrial applications:						
(a) Space applications	354,300	354,300	---	362,110	362,110	---
(b) Technology utilization	12,100	12,100	---	9,200	9,200	---
4. Space research and technology	115,800	115,800	---	117,100	117,100	---
5. Aeronautical research and technology	308,300	308,300	---	279,700	279,700	---
6. Energy technology	3,000	3,000	---	3,700	3,700	---
7. Supporting activity:						
(a) Tracking and data acquisition	332,400	332,400	---	323,200	323,200	---
Total direct program	3,807,500	4,107,500	300,000	3,743,400	3,993,400	250,000

Program and Financing (in thousands of dollars)

Research and Development

Identification Code:	Budget Plan (amounts for research and development actions ogramned)			Costs and Obligations		
80-0108-4-1-999	1980	1980	1980	1980	1980	1980
Reimbursable program:	Presently available	Revised estimate	Proposed supplemental	Presently avai1able	Revised estimate	Proposed supplemental
1. Space transportation systems:						
(a) Space shuttle	22,820	22,820	---	25,990	25,990	---
(b) Space flight operations	91,660	91,660	---	84,940	84,940	---
2. Scientific investigations in space:						
(a) Physics and astronomy	610	610	---	790	790	---
(b) Planetary exploration	---	---	---	4	4	---
(c) Life sciences	233	233	---	230	230	---
3. Space and terrestrial applications:						
(a) Space applications	162,330	162,330	---	168,340	168,340	---
(b) Technology utilization	13,460	13,460	---	17,800	17,800	---
4. Space research and technology	-20	-20	---	719	719	---
5. Aeronautical research and technology	12,240	12,240	---	15,750	15,750	---
6. Energy technology	224,430	224,430	---	213,370	213,370	---
7. Supporting activity:						
(a) Tracking and data acquisition	4,410	4,410	---	4,240	4,240	---
Total, reimbursable program	532,173	532,173	---	532,173	532,173	---
Total program costs, funded	4,339,673	4,639,673	300,000	4,275,573	4,525,573	250,000
Change in selected resources (undelivered orders and stores)	---	---	---	488,991	538,991	50,000
10.00 Total	4,339,673	4,639,673	300,000	4,764,564	5,064,564	300,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Program and Financing (in thousands of dollars)

Research and Development

Identification Code: 80-0108-4-1-999	Budget Plan (amounts for research and development actions programmed)			Costs and Obligations		
	1980	1980	1980	1980	1980	1980
Financing:	Presently available	Revised estimate	Proposed supplemental	Presently available	Revised estimate	Proposed supplemental
Offsetting collections from:						
11.00 Federal funds	-412,130	-412,130	---	-412,130	-412,130	---
14.00 Non-Federal sources	-120,043	-120,043	---	-120,043	-120,043	---
Budget Authority:						
21.40 Unobligated balance available, start of year:						
For completion of prior year budget plans:						
Direct	---	---	---	-239,006	-239,006	---
Reimbursable	---	---	---	-185,885	-185,885	---
40.00 Budget authority (appropriation)	3,807,500	4,107,500	300,000	3,807,500	4,107,500	300,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Program and Financing (in thousands of dollars)

Research and Development

Identification Code:	Budget Plan (amounts for research and development actions programmed)			Costs and Obligations		
80-0108-4-1-999	1980	1980	1980	1980	1980	1980
Relation of obligations to outlays:	Presently available	Revised estimate	Proposed supplemental	Presently available	Revised estimate	Proposed supplemental
71.00 Obligations incurred, net				4,232,391	4,532,391	300,000
72.40 Obligated balance, start of year				785,812	785,812	---
74.40 Obligated balance, end of year				-1,364,303	-1,464,303	-100,000
90.00 Outlays				3,653,900	3,853,900	200,000

Note: Reconciliation of budget plan to obligations:			1980 estimate	
			Revised estimate	Proposed supplemental
Total budget plan		4,339,673	4,639,673	300,000
Add obligations of prior year budget plans		424,891	424,891	---
Total obligations		4,764,564	5,064,564	300,000

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
RESEARCH AND DEVELOPMENT
OBJECT CLASSIFICATION (in thousands of dollars)

Identification code 80-0108-4-1-999	1980 Presently Available	1980 Revised Estimate	1980 Proposed Supplemental
Direct obligations:			
~~11.1 Permanent positions~~			
~~11.3 Positions other than permanent~~			
~~11.5 Other personnel compensation~~			
~~11.8 Special personal services payments~~			
~~Total personnel compensation~~			
Personnel benefits:			
~~12.1 Civilian~~			
~~13.0 Benefits for former personnel~~			
~~21.0 Travel and transportation of persons~~			
22.0 Transportation of things	8,130	8,807	677
23.1 Standard level user charges	209	209	---
23.2 Communications, utilities and other rent	54,391	58,430	4,039
24.0 Printing and reproduction	2,600	2,790	190
25.0 Other services	3,722,066	3,998,100	276,034
26.0 Supplies and materials	161,060	173,010	11,950
31.0 Equipment	95,920	103,030	7,110
32.0 Lands and structures	1,050	1,050	---
~~33.0 Investments and loans~~			
41.0 Grants, subsidies, and contributions	1,080	1,080	---
~~42.0 Insurance claims and indemnities~~			
~~43.0 Interest and dividends~~			
~~44.0 Refunds~~			
99.0 Total direct obligations	4,046,506	4,346,506	300,000

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
RESEARCH AND DEVELOPMENT
OBJECT CLASSIFICATION (in thousands of dollars)

A-11-34

Identification code 80-0108-4-1-999	1980 Presently Available	1980 Revised Estimate	1980 Proposed Supplemental
Reimbursable obligations:			
~~11.1 Permanent positions~~			
~~11.3 Positions other than permanent~~			
~~11.5 Other personnel compensation~~			
~~11.8 Special personal services payments~~			
~~Total personnel compensation~~			
Personnel benefits:			
~~12.1 Civilian~~			
~~13.0 Benefits for former personnel~~			
~~21.0 Travel and transportation of persons~~			
22.0 Transportation of things	910	910	---
~~23.1 Standard level user charges~~			
23.2 Communications, utilities and other rent	2,330	2,330	---
24.0 Printing and reproduction	230	230	---
25.0 Other services	690,338	690,338	---
26.0 Supplies and materials	12,860	12,860	---
31.0 Equipment	10,660	10,660	
32.0 Lands and structures	730	730	---
~~33.0 Investments and loans~~			
~~41.0 Grants, subsidies, and contributions~~			
~~42.0 Insurance claims and indemnities~~			
~~43.0 Interest and dividends~~			
~~44.0 Refunds~~			
Total reimbursable obligations	718,058	718,058	---
99.0 Total obligations	4,764,564	5,064,564	300,000

* U.S. GOVERNMENT PRINTING OFFICE : 1968 O—296-692