LAUNCH VEHICLES AND PAYLOAD OPERATIONS

FISCAL YEAR 2000 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE FLIGHT | **SPACE SHUTTLE**

	FY 1998 OPLAN 9/29/98	FY 1999 OPLAN 12/22/98	FY 2000 PRES BUDGET	Page Number
	(Thousands of Dollars)			
Safety and performance upgrades	568,400	571,600	438,800	HSF 3-5
Shuttle operations	2,344,400	2,426,700	2,547,400	HSF 3-20
Total	2,912,800	2,998,300	2,986,200	

Distribution of Program Amount by Installation

	FY 1998	FY 1999	FY 2000
Johnson Space Center	1,637,197	1,737,100	1,745,700
Kennedy Space Center	156,817	162,700	170,900
Marshall Space Flight Center	1,060,118	1,055,700	1,025,600
Stennis Space Center	45,716	31,800	34,000
Dryden Flight Research Center	5,800	4,000	4,000
Ames Research Center	652	2,200	1,600
Langley Research Center	220	200	200
Goddard Space Flight Center	2,669	500	600
Jet Propulsion Laboratory	102	100	100
Headquarters	3,509	4,000	3,500
Total	2,912,800	2,998,300	2,986,200

GENERAL

The Space Shuttle program provides launch services to a diverse set of customers, supporting payloads that range from small hand-held experiments to large laboratories. While most missions are devoted to NASA-sponsored payloads, industry, partnerships, corporations, academia, national and international agencies exercise wide participation. Both NASA and the U.S. and international scientific communities are beneficiaries of this approach. The Space Shuttle is a domestically and internationally sought-after research facility because of its unique ability to provide on-orbit crew operations, rendezvous/retrieval, and payload provisions, including power, telemetry, pointing and active cooling.

The Space Shuttle continues to prove to be the most versatile launch vehicle ever built. This has been demonstrated by: (1) rendezvous missions with the Russian Space Station Mir; (2) advancing life sciences and technology through long-duration Spacelab and Spacehab missions; and (3) repairing and servicing the Hubble Space Telescope, enabling discovery of new astronomical events. The Space Shuttle has also performed rescue and retrieval of spacecraft, and has begun the assembly of the International Space Station. The Space Shuttle services numerous cooperative and reimbursable payloads involving foreign governments and international agencies. The current focus of international cooperation, for which the Space Shuttle is uniquely suited, is the assembly and operational support of the International Space Station (ISS), which began in FY 1999.

The Space Shuttle program participates in the domestic commercial development of space, providing flight opportunities to NASA's Centers for Commercial Development of Space. These non-profit consortia of industry, academia, and government were created to conduct commercially applied research activities by encouraging industry involvement leading to new products and services through access to the space environment. Cooperative activities with the National Institutes of Health (NIH), the National Science Foundation (NSF), the Department of Defense [DoD] and other U.S. agencies are advancing research that is generating new knowledge in health, medicine, science, and technology. Space Shuttle support for the flight of Neurolab in FY 1998, a major cooperative NASA-NIH program, and the Shuttle Radar Topography Mission, a joint DoD/NASA payload in FY 1999, are prime examples.

The Space Shuttle budget is divided into two categories: Safety and Performance Upgrades (S&PU) and Shuttle Operations. It is distributed to the various program elements primarily through the four Human Space Flight Centers, Dryden Flight Research Center, and the Ames Research Center. Safety and Performance Upgrades provide for modifications and improvements to the flight elements and ground facilities, including expansion of safety and operating margins and enhancement of Space Shuttle capabilities as well as the replacement of obsolete systems. Shuttle Operations includes hardware production, ground processing, launch and landing, mission operations, flight crew operations, training, logistics, and sustaining engineering. In addition, this budget includes funding for facilities related to the Space Shuttle.

The restructuring activities of the past seven years have resulted in constant dollar savings of 30% by FY 1998, equating to 32% less workforce since FY 1992. Reliability has improved and since FY 1995, 25 missions have been launched within the first five minutes of the launch window, an 86% success rate. In addition, after 93 successful missions, a significant reduction in operational requirements is continuing. Consolidation of contracts to a single prime contract is progressing successfully since the award of the Space Flight Operations Contract (SFOC) on October 1, 1996. Phase II of the transition is now underway, with the first production hardware contract (Solid Rocket Booster) transferred into SFOC in FY 1998. The total transition is scheduled to be complete by FY 2001.

PROGRAM GOALS

The primary goals of the Space Shuttle program in priority order are: (1) fly safely; (2) meet the flight manifest; (3) improve supportability, and (4) improve the system. Reduction in program costs is a continuing program objective made possible by accomplishment of these four goals.

STRATEGY FOR ACHIEVING GOALS

All decisions regarding program requirements, programmatic changes and budget reductions are guided by the program's goals as stated above. The overall strategy for the Shuttle Operations budget is to request funding levels sufficient to allow the Space Flight Operations Contract to meet the intended flight rates. This includes appropriate contingency planning in both budget and schedule allowances to assure transportation and assembly support to the Space Station program, while at the same time incentivizing the contractor to identify opportunities for reductions in operations costs while still ensuring the safe and reliable operation of the Space Shuttle. The continued transition of activities to the Space Flight Operations Contract represents a key element of this strategy.

This budget is based on an average of seven flights annually with a surge capability to nine flights and remains essentially unchanged from previous years. Although FY 1998 had only four flights, and six flights are planned for FY 1999, an eight-flight year is planned for FY 2000 that includes the third Hubble Space Telescope servicing mission. FY 2001 is a nine-flight year with the X-38 Flight Demonstration, and a research mission which will include the Triana spacecraft. The budgeted flight rate is anticipated to continue at eight per year through FY 2003 and seven flights in FY 2004, although the capability to adjust this flight rate as cionditions warrant is retained. This represents a no change in the total number of flights during this time period from previous submissions. This manifest supports the Nation's science and technology objectives through scheduled Spacehab and other science missions, and commencement of assembly of the International Space Station.

In addition to flying safely, restructuring the program, and conducting a single prime consolidation, NASA is continuing the Safety and Performance Upgrades program. The Space Shuttle program's strategy for the Safety and Performance Upgrades budget is to fund those modifications and improvements which will provide for the safe, continuous, and affordable operations of the Space Shuttle system for the foreseeable future. This is an essential element of the launch strategy required for continuing supportability to the International Space Station. Completion of selected projects, termed "Phase I" upgrades, has improved Space Shuttle safety and increased payload-to-orbit performance by 13,000 pounds. The additional payload-to-orbit performance allows the Orbiter to achieve the orbital inclination and altitude of the International Space Station. The largest of these projects was the Super LightWeight Tank (SLWT) which was successfully flown on STS-91. Completion of the Phase I upgrades has enabled the Space Shuttle to meet the performance requirements of the first Space Station assembly flight, STS-88, in the 1st quarter of FY 1999. "Phase II" upgrades have been added to the program to assure continued mission supportability into the next century.

As noted in the Space Shuttle's FY 1999 Congressional request, the Agency formed a Space Transportation Council (STC) to assess advanced transportation areas in both the Office of Space Flight and the Office of Aeronautics and Space Transportation Technology (now called Aero-Space Technology). Technology need studies were conducted by the Space Shuttle program in FY 1998 and are continuing in FY 1999. In recognition of the value of close collaboration on the technology needs of future reusable launch vehicles, lead responsibility has been consolidated within the Space Transportation Technology program. The Space Transportation Council will provide management oversight and policy direction across the agency's activities in this area. Potential major Shuttle upgrades will be examined under the Future Space Launch industry-led trade studies described in the Space Transportation Technology section. These studies will provide the basis for end-of-decade decisions by NASA and the Administration on pursuing an operational launch system to reduce NASA's launch cost.

BASIS OF FY 2000 FUNDING REQUIREMENT

SAFETY AND PERFORMANCE UPGRADES

	FY 1998	FY 1999	FY 2000
		(Thousands of Dollars)	
Orbiter improvements	232,500	234,800	196,600
Multifunction-electronic display system	29,100	9,800	--
Other orbiter improvements	203,400	177,000	155,400
Supportability Upgrades	[50,000]	48,000	41,200
Propulsion upgrades	172,000	175,700	118,700
Space shuttle main engine upgrades	170,100	167,700	106,600
[Alternate Turbopump program]	[56,500]	[56,900]	[29,200]
[Large Throat Main Combustion Chamber]	[9,400]	[5,000]	--
[Phase II+ Powerhead Retrofit]	[9,200]	[6,600]	[600]
[Other main engine upgrades]	[95,000]	[99,200]	[76,800]
Solid rocket booster improvements	1,200	2,500	1,600
Super lightweight tank	700	1,500	--
Supportability Upgrades	[4,000]	4,000	10,500
Flight operations & launch site equipment upgrades	155,700	153,500	112,500
Flight operation upgrades	40,300	58,500	34,200
Launch site equipment upgrades	115,400	47,000	30,000
Supportability Upgrades	[41,000]	48,000	48,300
Construction of facilities	8,200	7,600	11,000
Total	568,400	571,600	438,800

GENERAL

The Safety and Performance Upgrade program is measured by the success it has in accomplishing the ongoing projects consistent with approved schedule and cost planning, and also the effect these projects have on the overall operation of the Space Shuttle System. Success depends on developing these projects and getting them implemented to help ensure the Space Shuttle's safe operation, and improve the reliability of the supporting elements. The reductions from FY 1999 to FY 2000 reflect the completion/phasedown of several projects as they near or reach their conclusions. The Alternate Turbopump Program (ATP), the Multifunction Electronic Display System (MEDS) and the Mission Control Center development all have significant reductions in FY 2000 as they near completion.

This budget request includes activities in the following categories: Orbiter Improvements, Propulsion Upgrades, Launch Site Equipment (LSE) Upgrades and Flight Operations Upgrades, as well as specific, Space Shuttle-related Construction of Facilities. This budget also includes Supportability upgrades to develop systems, which will combat obsolescence of vehicle and ground systems in order to maintain the program's viability into the next century. Vendor loss of aging components, high failure rates of older components, high repair costs of Shuttle-specific devices, and negative environmental impacts of some out-dated technologies are areas to be addressed. The following is a brief description of these activities.

Orbiter Improvements

The Orbiter improvements program provides for enhancements of the Space Shuttle systems, produces space components that are not susceptible to damage, and maintains core skills and capabilities required modifying and maintaining the Orbiter as a safe and effective transportation and science platform. These activities are provided by contract arrangements with Boeing North American (formerly, the Rockwell International Space Division) in two major locations: the Downey, California facility provides engineering, manufacturing and testing; and the Palmdale, California operation provides Orbiter Maintenance Down Period (OMDP) support as discussed below. Other activities that support this effort are subsystem management engineering and analysis conducted by Lockheed-Martin Corporation and development and modifications required for support to the extravehicular capability conducted by Hamilton Standard.

Orbiter Maintenance Down Period (OMDP) occurs when an Orbiter is routinely taken out of service (about once every five years) for detailed structural inspections and thorough testing of its systems before returning to operational status. This period also provides opportunities for major modifications and upgrades, especially those upgrades that are necessary for improving performance to meet the International Space Station operational profile.

Propulsion Upgrades

The main engine safety and performance upgrade program is managed by the Marshall Space Flight Center (MSFC) and supports the Orbiter fleet with flight-qualified main engine components and the necessary engineering and manufacturing capability to address any failure or anomaly quickly. The Rocketdyne Division of the Boeing North American Corporation is responsible for operating three locations that provide engine manufacturing, major overhaul, components recycle and test. They are:

(1) Canoga Park, California which manufactures and performs major overhaul to the main engines;
(2) Stennis Space Center (SSC), Mississippi for conducting engine development, acceptance and certification tests; and
(3) Kennedy Space Center (KSC), Florida for engine inspection checkout activities

The Marshall Space Flight Center (MSFC) manages engine ground test and flight data evaluation, hardware anomaly reviews, and anomaly resolution. The Alternate Turbopump project is also managed by the MSFC under contract with Pratt Whitney of West Palm Beach, FL.

The Super Lightweight Tank project is managed by the MSFC and is being accomplished by the Lockheed Martin Corporation at the government-owned Michoud Assembly Facility (MAF) near New Orleans, LA.

Flight Operations and Launch Site Equipment Upgrades

The major flight operations facilities at Johnson Space Center (JSC) include the Mission Control Center (MCC), the flight and ground support training facilities, the flight design systems and the training aircraft fleet that includes the Space Shuttle training aircraft, and the T-38 aircraft.

The major launch site operational facilities at KSC include three Orbiter Processing Facilities (OPFs), two launch pads, the Vehicle Assembly Building (VAB), the Launch Control Center (LCC), and three Mobile Launcher Platforms (MLPs). The most significant upgrade in this account is the Checkout and Launch Control System at KSC.

Construction of Facilities

Construction of Facilities (CofF) funding for Space Shuttle projects is provided in this budget to refurbish, modify, reclaim, replace and restore facilities at Office of Space Flight Centers to improve performance, address environmental concerns of the older facilities, and to ensure their readiness to support the Space Shuttle Operations.

PROGRAM GOALS

NASA policy planning assumes the Space Shuttle will need to be capable of supporting the critical transportation requirements for the assembly of the Space Station and perhaps through 10 years of Space Station operations. In order to maintain a viable, human transportation capability that will operate into the next century and support NASA's launch requirements, specific program investments are required. These investments are consistent with NASA’s strategy of ensuring the Space Shuttle remains viable until a new transportation system is operational.

STRATEGY FOR ACHIEVING GOALS

This budget provides funding required for modifying and improving the capability of the Space Shuttle to ensure its viability as a safe, effective transportation system and scientific platform. It also addresses increasingly stringent environmental requirements, obsolescence of subsystems in the flight vehicle and on the ground, and capital investments needed to achieve reductions in operational costs. Work continues on the Alternate Fuel Turbopump for the planned introduction of the Block II Space Shuttle Main Engine (SSME). The Block IIA engines flew on STS-89 in January 1998 and the Block II will fly in FY 2000.

In the Space Shuttle’s FY 1999 Congressional request the Agency formed a Space Transportation Council (STC) to assess advanced transportation areas in both the Office of Space Flight and the Office of Aeronautics and Space Transportation Technology (now called Aero-Space Technology). Technology need studies were conducted by the Space Shuttle program in FY 1998 and are continuing in FY 1999. In recognition of the value of close collaboration on the technology needs of future reusable launch vehicles, lead responsibility has been consolidated within the Space Transportation Technology program. The Space Transportation Council will provide management oversight and policy direction across the agency’s activities in this area. Potential major Shuttle upgrades will be examined under the Future Space Launch industry-led trade studies described in the

Space Transportation Technology section. These studies will provide the basis for end-of-decade decisions by NASA and the Administration on pursuing an operational launch system to reduce NASA's launch cost.

The major safety and performance upgrades and their initial flight dates are listed on the following chart on the next page.

SCHEDULE AND OUTPUTS

The Safety and Performance Upgrade program is measured by the success it has in accomplishing the ongoing projects consistent with approved schedule and cost planning. Success depends on developing/implementing these projects to help ensure the Space Shuttle's safe operation, improve the reliability of the supporting elements, and improve efficiencies to reduce operational costs. This budget addresses all elements of the Space Shuttle program and is managed through an approval process that ensures that new projects are evaluated, approved and initiated on a priority basis, and that existing projects meet established cost and schedule goals. Significant milestones are listed on the next page:

Orbiter Improvements

Multifunction Electronic-Display System (MEDS) - MEDS is a state-of-the-art integrated display system that will replace the current Orbiter cockpit displays with an integrated liquid crystal display system.

Complete MEDS Qualification Testing	Complete hardware qualification testing and start hardware integration and verification testing.
Plan: 1st Qtr FY 1996 Actual: 1st Qtr FY 1998	The qualification program was extended through this date. No significant impact to initial operating capability is expected. Delay was due to change in glass supplier.
OV-104 Major MOD Plan: 2nd Qtr FY 1998 Actual: 3rd Qtr FY 1998	Installation and checkout of MEDS hardware in OV-104 at Palmdale
MEDS Initial Operational Capability (IOC) Plan: 2nd Qtr FY 1999 Revised: 4th Qtr FY 1999	First flight of a MEDS equipped Orbiter. (OV-104/STS-92)

Global Positioning System (GPS) - GPS will replace the current TACAN navigational system in the Orbiter navigation system when the military TACAN ground stations will be phased out in the year 2000. The planned readiness date for the Space Shuttle's system is FY 1999.

Complete GPS System Requirements Review	Completion of CDR will allow drawings to be released for production to proceed.
Plan: 2nd Qtr FY 1997	Delay is due to the change from the original, single-string GPS, to the three-string GPS System.

Actual: 1st Qtr FY 1998	
TACAN Removal Plan: 3rd Qtr FY 1998 Actual: 3rd Qtr FY 1998	Remove TACAN from OV-104 at Palmdale based on November 1997 go/no go decision.
Orbiter Install Complete Plan: 4th Qtr FY 1998 Revised: 2nd Qtr FY 1999	Installation and checkout of hardware on OV-104 at Palmdale.
Complete GPS operational Capability Plan: 2nd Qtr FY 1999 Revised: Under Assessment	Initial operation of GPS without TACAN system. Due to technical problems, the GPS has been removed from OV-104 and the TACAN system is being reinstalled. Initial operations of GPS without TACN is still under assessment.

Orbiter Maintenance Down Periods (OMDP)

Initiate Atlantis (OV-104) OMDP Plan: 1st Qtr FY 1998 Actual: 1st Qtr FY 1998	Conduct routine maintenance and structural inspection. Also install an external airlock, the MEDS upgrade, and hardware for 3-String GPS capability.
Initiate Columbia (OV-102) OMDP Plan: 1st Qtr FY 1999 Revised: 3rd Qtr FY 1999	Conduct routine maintenance and structural inspection. Also, install the MEDS upgrade, hardware for 3-string GPS capability, and OV-102 scarring mods. Revised due to technical problems causing delays in the launch of AXAF.
Initiate Discovery (OV-103) OMDP Plan: 3rd Qtr FY 2000	Conduct routine maintenance and structural inspection. Also, install the MEDS upgrade, hardware for 3-string GPS capability.

Propulsion Upgrades

Super Lightweight Tank - This performance enhancement is designed to provide 7,500 pounds of additional performance for the Space Shuttle to allow rendezvous and operations with the International Space Station. Development was completed in FY 1997 with the successful proof test of the first unit.

Deliver first SLWT to KSC for flight Plan: 4th Qtr FY 1997 Actual: 2nd Qtr FY 1998	Final assembly and checkout will be conducted at the Michoud Assembly Facility (MAF) in New Orleans, Louisiana. Schedule revision was due to need to perform multiple proof tests to verify welds.
Fly first SLWT Plan: 3rd Qtr FY 1998 Actual: 3rd Qtr FY 1998	Successfully flew first SLWT on STS-91 (June 1998)

Space Shuttle Main Engine Safety Improvements - Introduction of Block I and Block II changes into the Space Shuttle's Main Engine program will improve the margin of safety by a factor of two. The interim Block IIA configuration (Block I without the High-Pressure Fuel Turbo Pump (HPFTP)) implements the safety and performance margins provided by the large throat main combustion chamber (LTMCC) while the HPFTP development problems are solved. The last Block IIA flight is planned for FY 1999.

High Pressure Fuel Turbopump CDR	Completion of Critical Design Review (CDR) will allow production to proceed for implementation of the Alternate Turbopump high-pressure fuel pump into the Block II Engine upgrade.
Plan: 3rd Qtr FY 1996	
Revised: 2nd Qtr FY 1997	Revised due to testing delays
Revised: 1st Qtr FY 1998	Opted for IIA configuration because of HPFTP design delays
Revised: 3rd Qtr FY 1998	Revised due to turbine housing redesign
Revised: 2nd Qtr FY 1999	Turbine housing redesign is still in work.
First flight of Block II engine	The high-pressure fuel turbopump will be combined with the LTMCC and Block I upgrades.
Plan: 4th Qtr FY 1997	
Revised: 1st Qtr FY 1998	Revised due to testing delays
Revised: 2nd Qtr FY 1998	Opted for IIA configuration because of HPFTP design delays.
Revised: 4th Qtr FY 1998	Revised due to turbine housing redesign.
Revised: 1st Qtr FY 2000	Turbine housing redesign is still in work.

Flight Operations and Launch Site Equipment Upgrades- Upgrades to the Mission Control Center were completed in FY 1998 period which improved operations reliability and maintainability and also took advantage of the state-of-the-art technology in displays and controls. In addition, upgrades continued in FY 1998 to the Launch Site Equipment at KSC, which will increase reliability and reduce obsolescence.

CLCS "Redstone" Delivery Plan: 1st Qtr FY 1998 Actual: 1st Qtr FY 1998	The initial delivery of requirements in the CLCS development, Redstone included the Super Light Weight Tanking Test Displays, a Robust Web interface, Four Prototype Consoles for User Evaluation and Initial System and application services.
CLCS "Thor" Delivery Plan: 3rd Qtr FY 1998 Actual: 3rd, 4th Qtr FY 1998	The second scheduled delivery in the CLCS development, Thor included System Services enhancements, System stress testing and end item management services, launch data bus phase 1 support and initial PCM support.
Orbiter Power Up/Down Application S/W Complete Plan: 2nd Qtr FY 1999	Orbiter vehicle power up and power down sequences can be initiated and monitored through the CLCS
CLCS Shuttle Processing Flow Capable Plan: 4th Qtr FY 2000	CLCS will be fully capable of supporting KSC orbiter pre-flight processing.
First Launch Using CLCS Plan: 1st Qtr FY 2001	Launch the first Shuttle from a CLCS – equipped Launch Control Center.
Complete Migration of CLCS to all Firing Rooms and Simulators Plan: 4th Qtr FY 2001	CLCS is fully operational for flight support. This will result in a significant reduction in operating cost, up to 50%, of the current LPS.

Construction of Facilities

Complete Phase I Restore Firex Pumps and Piping at LC-39 Plan: 3rd Qtr FY 1999	Restoration is needed. Pumps are currently inadequate to provide spray coverage during an emergency. This project replaces underrated firex loop piping and components, and provides fire protection for the Orbiter Mid-Body Umbilical Unit (OMBUU) at Pads A and B. Additional work was necessary to complete the associated controls, including control cable installation and termination on Pad B. Final work scheduled to be complete during Pad A modification period in FY 1999.

Complete Phase II Restore Firex Pumps and Piping at LC-39 Plan: 3rd Qtr FY 1999	Restoration is needed. Pumps are currently inadequate to provide spray coverage during an emergency. This project removes and replaces existing Firex pumps, motors, refurbishes diesels, and installs a new underground pipe between the pump station and Pads A and B.
Complete Phase II Replace Component Refurbishment and Chemical Analysis Facility at KSC	This facility was in non-compliance with OSHA standards and overcrowded and insulated with asbestos.
Plan: 4th Qtr. FY 97 Actual : 1st Qtr. FY 98	Complete activation of component refurbishment chemical analysis (CRCA) building.
Complete SSME Processing Facility at KSC Plan: 2nd Qtr. FY 98 Actual: 4th Qtr. FY 98	Project provides for construction of an addition to the east end of the lower level of OPF-3 Annex to provide shop area for SSME processing. The facility will allow for safely and efficiently processing engines.
Rehabilitation of 480V Electrical Distribution System at MAF	External Tank manufacturing building Rehabilitation of the 480V Electrical Distribution System is a 4 phase project. Each phase will be implemented in the main manufacturing areas of building 103. Project Phasing and scope for each phase:
Complete Phase I Plan: 2nd Qtr. FY 99	Phase l, Final Assembly Area Project will upgrade the power distribution system from below the substation to the respective tools (Labor-intensive project working over flight hardware).
Start Phase II Plan: 1st Qtr. FY 98 Actual: 1st Qtr FY 98	Phase II, ET Sub-Assembly Area Project will upgrade the power distribution system from below the substation to the respective tools. Completion of this phase is expected in the 1st quarter of FY 2000
Start Phase III Plan: 1st Qtr. FY 99	Phase III, Substations Nos. 17A/17B will replace the core system, Transformers and switch gear, breakers and oil switches. Include some down stream cable, cable tray, and panel upgrades. Planned completion date for this phase is first quarter of FY 2001.
Start Phase IV Plan: 1st Qtr. FY 00	Phase IV, Substations Nos., 7B, 4 & 5 - core system, transformers and switchgear, breakers and oil switches. Planned completion date for this phase is second quarter of FY 2001.
Complete Pad B Chiller Replacement at LC-39 Plan: 2nd Qtr. FY 99	This project replaces the aged facility chillers at Launch Complex 39, Pad B, and reconfigures the system for more efficient maintenance.

Complete Rehabilitation of High Pressure Industrial Water System at SSC Plan: 2nd Qtr. FY 99	This project initiates the restoration of the High Pressure Industrial Water Plant to ensure system reliability in support of the Space Shuttle Main Engine testing.
Start Restoration of Pad A PCR Wall and Ceiling Integrity at Launch Complex (LC)-39 Plan: 3rd Qtr. FY 98 Actual: 1st Qtr FY 99	This project provides for repair and replacement of damaged Payload Change Out Room (PCR) wall panels (Sides 1, 2, 3, & 4), replacement or elimination of deteriorated and leaking access doors, and other needed replacement and restoration. The modification will eliminate degrading flexducts and filter housings, improve pressurization of the PCR, provide an even distribution of air flow, and provide safe personnel access for maintenance and repair.
Start Pad A Surface and Slope Restoration at LC-39 Plan: 3rd Qtr. FY 98 Actual: 1st Qtr FY 99	This project provides for repair of the Pad A surface concrete, pad slopes, and the crawlerway grid path.
Complete Restoration of Pad A PCR Wall and Ceiling Integrity at Launch Complex (LC)-39 Plan: 1st Qtr. FY 00	
Complete Pad A Surface and Slope Restoration at LC-39 Plan: 1st Qtr. FY 00	This project provides for repair of the Pad A surface concrete, pad slopes, and the crawlerway grid path.
Start Repair of Pad A Flame Deflector & Trench at LC-39 Plan: 1st Qtr. FY 99 Actual: 1st Qtr. FY 99	This project provides for repair of the fire resistant surface of the Main and SRB flame deflector, repair/replacement of damaged and corroded structural members, and repair/replacement of bricks in the Flame Trench wall.
Complete Repair of Pad A Flame Deflector & Trench at LC-39 Plan: 1st Qtr. FY 00	This project provides for repair of the fire resistant surface of the Main and SRB flame deflector, repair/replacement of damaged and corroded structural members, and repair/replacement of bricks in the Flame Trench wall.

Start Pad A FSS Elevator restoration at LC-39 Plan: 1st Qtr. FY 99 Actual: 1st Qtr. FY 99 Completion Plan: 1st Qtr. FY 00	This project modifies the elevator structural on Pad B, and refurbishes the elevator cabs, cables and cableway.
Complete Pad A FSS Elevator restoration at LC-39 Plan: 1st Qtr. FY 00	
Cell E Restoration Start Plan: 3rd Qtr FY 99	This project restores and modifies the common solution return systems and lining for the cell. The cell lining is breaking down and requires restoration work at Michoud Assembly Facility.
Towway Support (Phase II) Start Plan: 2nd Qtr. FY 99	This project is the SSP portion of the Support Facility at the Towway of the SLF. This project will refurbish the SLF Convoy Operations capability at the SLF. Scheduled for completion in the 4th Quarter. of FY 2000.

ACCOMPLISHMENTS AND PLANS

A significant portion of the Safety and Performance Upgrades (S&PU) budget is dedicated to avoiding and preventing deleterious and costly effects of obsolescence, especially at a time when the program is undertaking the challenge of reducing the costs of operations. This portion of the budget contains projects that impact every element of the Space Shuttle vehicle. The S&PU budget will continue to support the replacement of the Orbiters' cockpit displays with Multifunction Electronic Display System (MEDS), replacing Tactical Air Command and Navigation System (TACAN) with Global Positioning System (GPS), and upgrading the T-38 aircraft with maintainable systems. Replacing elements of the launch site complex, upgrading major elements of the training facilities at Johnson Space Center, testing of main engine components at SSC, testing of Orbiter reaction control systems at the White Sands Test Facility, and replacing critical subsystems at the KSC facility complex are also funded.

In addition, this request includes funds for Shuttle Supportability Upgrades, which will maintain availability of the Space Shuttle fleet for the foreseeable future.

The Space Shuttle program rationale for supportability upgrades is founded on the premise that safety, reliability, and mission supportability improvements must be made in the Shuttle system to continue to provide safe and affordable operations into the next century. These will enable safe and efficient Shuttle operations during the Space Station era while providing a robust testbed for advanced technologies and a variety of customers.

The Space Shuttle Upgrade activity will be planned and implemented from a system-wide perspective. Individual upgrades will be integrated and prioritized across all flight and ground systems, ensuring that the upgrade is compatible with the entire program and other improvements. Selection of new upgrades through the review process approved by the Associate Administrator for Space Flight, the Program Management Council (PMC) and the Administrator will be utilized. Implementation authority and responsibility is delegated to the Lead Center Director for the Shuttle Program with the Shuttle Program Manager and the projects. Space Shuttle upgrades will be developed and implemented in a phased manner supporting one or more of the following program goals:

- Fly safely
- Meet the manifest
- Improve supportability; and
- Improve the system

The phasing strategy will be coordinated with the Reusable Launch Vehicle (RLV) project management, and other development projects, to capture common technology developments, while meeting the Shuttle manifest. This phasing strategy should allow the incorporation of additional, more comprehensive upgrades to the Space Shuttle system while benefiting other programs and technologies. Candidate upgrades in the initial phases will utilize state-of-the-art technology and provide safety/reliability, supportability, and/or cost (improvement) advantages. Candidate designs in the initial phases would maintain the current Shuttle mold lines and system/subsystem interfaces.

Orbiter Improvements

Orbiter improvements provide for modifications and upgrades to ensure compatibility of the Space Shuttle vehicles with the new Space Station operational environment. Orbiter weight reductions have been identified where operating experience or updated requirements allow selected items to be changed without impact to crew safety or mission success. These reductions include changing the exterior thermal protection materials on certain portions of the Orbiter; deleting portions of the Orbital Maneuvering and Reaction Control Systems (OMS/RCS) that are no longer required; changing the material on the "flipper doors" that provide a seal between the Orbiter wing and its control surfaces; and development of lighter weight crew seats for the cockpit.

Other Orbiter improvements included new Digital Autopilot (DAP) software designed to reduce fuel consumption in orbit, and new launch trajectory software to increase performance margins and enable the deletion of the Bermuda tracking station for communications during launch.

The Multifunction Electronic Display System (MEDS) upgrade will replace the current Orbiter cockpit displays that are early 1970's technology. The current displays which provide command and control of the Space Shuttle are "single string" electro-mechanical devices that are experiencing life related failures and are maintenance intensive. Difficulty in obtaining parts, some of which are no longer manufactured, is becoming more prevalent. The MEDS upgrade is a state-of-the-art, multiple redundant liquid crystal display (LCD) system. MEDS will enhance the reliability of the cockpit display system, resolve the parts availability problem, and provide a much more flexible and capable display system for the crew. This upgrade will bring the Orbiter up to current aircraft standards, benefiting the training of new astronauts directly. Secondary benefits of MEDS are reductions in the Orbiter's weight and power consumption. The MEDS upgrade includes the design effort and production of modification kits for the four Orbiter vehicles. New MEDS ground support hardware is also being designed. When procured and installed it will upgrade the appropriate simulators, test equipment, and laboratories. MEDS will be installed in the Orbiters and tested during the planned OMDPs.

In FY 1998, Atlantis (OV-104) entered OMDP for normal maintenance, structural inspections, installation of the MEDS upgrade, and was successfully modified for docking with the International Space Station. In FY 1999, Columbia (OV-102) will enter OMDP for routine maintenance and structural inspection and installation of MEDS upgrade. In FY 2000, Discovery (OV-103) will enter OMDP for will be installed routine maintenance and structural inspection and installation of MEDS upgrade.

Expansion of the effort to replace the Orbiter's TACAN landing navigation system with the Global Positioning System (GPS) began in FY 1995. This expansion will include an increased interaction of the GPS receiver with the Orbiter backup flight software, and outfitting two more Orbiters with a GPS test receiver. A number of development flights will take place with increasing GPS capability while still utilizing TACAN navigation. The first flight of a complete GPS system is planned for 1999.

Propulsion Upgrades

The most complex components of the Space Shuttle Main Engine (SSME) are the high-pressure turbopumps. Engine system requirements result in pump discharge pressure levels from 6000 to 8000 psi and turbine inlet temperatures of 2000 Degrees F. In reviewing the most critical items on the SSME that could result in a catastrophic failure, 14 of the top 25 are associated with the turbopumps. The current pumps' dependence on extensive inspection to assure safety of flight have made them difficult to produce and costly to maintain. The Alternate Turbopump Program (ATP) contract with Pratt & Whitney was signed in December 1986 and called for parallel development of both the High Pressure Oxidizer Turbopump (HPOTP) and the High Pressure Fuel Turbopump (HPFTP) to correct the shortcomings of the existing high pressure turbopumps. This objective is achieved by several methods including utilizing design, analytical, and manufacturing technology not available during development of the original components; application of lessons learned from the original SSME development program; and elimination of failure modes from the design. The program also used implementation of a build-to-print fabrication and assembly process; full inspection capability by design; and demonstrated design reliability through increased fleet leader testing to meet this objective. The turbopumps utilize precision castings, reducing the total number of welds in the pumps from 769 to 7. Turbine blades, bearings, and rotor stiffness are all improved through the use of new materials and manufacturing techniques. The SSME upgrades will expand existing safety margins and reduce operational costs. HPFTP production and assembly should be complete in FY 2000.

The SSME Powerhead is the structural backbone of the engine. The Phase II+ Powerhead will reduce the number of welds, improving producibility and reliability. The last Phase II+ Powerhead is expected to be delivered in FY 2000.

The heat exchanger uses the hot turbine discharge gases to convert liquid oxygen in a thin walled coil to gaseous oxygen for pressurization of the external oxygen tank. The current heat exchanger coil has seven welds exposed to the hot gas environment. A small leak in one of these welds would result in catastrophic failure. The new Single Coil Heat Exchanger eliminated all seven critical welds and tripled the wall thickness.

The Large Throat Main Combustion Chamber (LTMCC) first flight was on STS-89 (January 1998) and will result in lower pressures and temperatures throughout the engine system thereby increasing the overall Space Shuttle system flight safety and reliability. The wider throat area accommodates additional cooling channels. Consequently, hot gas wall temperatures are significantly reduced increasing chamber life. The LTMCC design also incorporates new fabrication techniques to reduce the number of critical welds and improve the LTMCC production and assembly.

The development and production of the powerhead, heat exchanger and LTMCC are all being performed under contract with the Rocketdyne division of the Boeing North American Corporation.

The "block" change concept for incorporating changes into the main engine was introduced and baselined during FY 1994. The Phase II+ Powerhead, the Single Coil Heat Exchanger and the new high-pressure oxidizer turbopump comprise Block I. This change was introduced and flown for the first time in July 1995. The Block II engine is scheduled to be flown in FY 2000 and incorporates the alternate high-pressure fuel turbopump with the Block IIA design. The end result of these engine improvements is an increase in the overall engine durability, reliability and safety margin, and producibility. This is consistent with NASA's goals of decreasing failure probability and reducing Space Shuttle costs.

Increased safety margins and launch reliability on the Space Shuttle will also be realized through the implementation of new sensors (temperature, pressure and flow) for use in the SSME. SSME history has shown that the engine is more reliable than the instrumentation system; however, a transducer failure could result in a flight scrub or on-pad abort, failure to detect an engine fault, or an in-flight abort. Sensor upgrade development activities have been completed and will be essential to improving the reliability of the Space Shuttle's launch capability.

The Solid Rocket Booster also received several upgrades designed to reduce the expense of recovering and refurbishing the boosters. Those upgrades include a saltwater activated mechanism to release the parachutes (full implementation STS-95), improvements to the parachutes themselves, and a modification to the aft skirt brackets.

The SLWT program is a result of NASA’s desire to enhance the payload capability of the Space Shuttle System to support the Space Station Program. The SLWT completed final assembly and proof testing in FY 1998 and the first SLWT was successfully flown on STS-91 (May 1998).

Flight Operations and Launch Site Equipment Upgrades

These upgrades support pre-launch and post-launch processing of the Orbiter fleet. Key projects funded in Launch Site Equipment address equipment obsolescence and enhance efficiency. Examples include: replacement of the hydraulic pumping units that provide power to Orbiter flight systems during ground processing; replacement of the 16-year old ground cooling units that support all Orbiter power-on testing; replacement of the test set for the KU-band radar; communications and instrumentation equipment modernization projects.

A new Checkout and Launch Control System (CLCS) was approved for development at KSC in FY 1997. The CLCS will upgrade the Shuttle launch control room systems with state-of-the-art commercial equipment and software in a phased manner to allow the existing flight schedule to be maintained. The CLCS will reduce operations and maintenance costs associated with the launch control room by as much as 50%, and will provide the building blocks to support future vehicle control system requirements. The "Thor" and "Atlas" phases were completed in FY 1998. During these phases, the initial applications for the Orbiter Processing Facility were developed, the math models were validated, Shuttle Avionics Integration Lab interfaces were established, and hardware testing was done. The Titan and Scout phases of CLCS are planned for FY 1999 during which Orbiter automated power-up will be developed, peripheral locations will be upgraded, and selected vertical testing will be done. In FY 2000, the Delta and Saturn phases will be accomplished which includes completion of all launch application development, completion of software certification and validation, and a complete integrated flow demonstration. Since the FY 1999 Budget, software independent validation and verification (IV&V) performed by Ames Research Center was also added to this project. By the end of FY 2000, Operations Control Room-1 will be fully operation, followed by certification in FY 2001. The first Shuttle launch using the CLCS is scheduled for FY 2001 with full implementation to be completed one year later.

The Hardware Interface Modules (HIM), which are electrical command distribution systems that support the launch processing system (LPS) at KSC, are over 25 years old and have experienced an increased failure rate and higher cost of repair over the past several years. The HIM upgrade replaces all chassis and cards with state-of-the-art "off the shelf" hardware to improve system reliability and maintainability. Production and installation will be completed in FY 1999.

A cable plant upgrade at KSC replaces the miles of cables that support a wide variety of Space Shuttle facilities. Many of these cables were installed in the 1960s and are suffering from corrosion and increasing failure rates. Replacement will reduce the potential for disruption to critical Space Shuttle operations as well as have a direct maintenance benefit. This activity will reduce the possibility of launch delays; increase communication system spares availability, and enhances the reliability of data, instrumentation, voice, and video communications. This upgrade will replace the wide-band distribution system and the lead/antimony sheath cables with fiber optics and plastic sheath, gel-filled cable. In addition, many field terminals will be replaced or upgraded. The upgrade should be complete in late FY 1998.

Modernization of the Operational Television System (OTV) is based upon a phased engineering design and implementation strategy, which should enhance and automate the visual surveillance capability at KSC. A key element of the plan includes the design of a camera control system beginning in FY 1996 through FY 2000 which allow the installation of new digital video cameras and their associated elements with minimal impact to operations. Other key elements of the design approach, beginning in FY 1997 are the phased transition to a high bandwidth digital switch, switched digital recording, integrated monitoring stations and a high priority subset of CCD cameras, utilizing a unified control over the entire television environment. Continual effort over the life span of the project, FY 1995 to FY 2004, to phase out existing tube cameras with new CCD cameras, provide functional camera station control and record capability to the new OCR's, sustain existing firing room support, and replace obsolete switching and recording hardware.

The Complex Control System (CCS) is used to monitor and control processing and institutional facilities systems at KSC. The obsolescence of the current CCS makes it difficult and costly to incorporate new measurements and control points as new facilities are build or existing ones are upgraded. CCS infrastructure conversion is scheduled for completion in FY 2001.

Radio Frequency (RF) communications modernization replaces the existing KSC radio communications system with a combination of digital and conventional mobile, portable and fixed stations, and associated off-the-shelf equipment. RF modernization is scheduled for completion in FY 2001.

Funds for other activities include implementing required modifications and upgrades on the T-38 aircraft used for space flight readiness training, capability improvements for weather prediction, and enhancements on information handling to improve system monitoring, notably for anomaly tracking.

Construction of Facilities (CoF)

FY 1998 CoF provided for improvements for facilities at KSC and MAF. At MAF, this project is Phase II of IV to rehabilitate the 480-volt electrical distribution system that is critical to the manufacturing of the external tank. At KSC, one project was restoring the walls and ceiling that provides a controlled environment to perform pre-flight services of Space Shuttle hardware at Pad A/LC-39 Payload Change-Out Room (PCR). The other project at KSC was to restore the concrete surfaces and slope of Pad A/LC-39 structure.

FY 1999 CoF funding will provide for improvements for facilities at KSC and MAF. At KSC, there are two projects which are both at Launch Complex Pad A - the restoration of the Fixed Support Structure Elevator System and the repair of the fire resistant surface of the Main and SRB flame deflector, repair/replacement of damaged and corroded structural members, and repair/replacement of bricks in the Flame Trench wall. At MAF, there are two projects, Phase III of IV for the rehabilitation of the 480-volt electrical distribution system and Repair Cell E Common solution return and lining. For additional details on these projects, please refer to the Mission Support - Construction of Facilities budget.

FY 2000 CoF funding will provide for improvements for facilities at KSC, MAF and SSC. At KSC, there are two projects at Launch Complex Pad B - the restoration of the Pad B concrete surfaces and slope and the restoration of the walls and ceiling that provide a controlled environment to perform pre-flight services of Space Shuttle hardware at Pad B/LC-39 Payload Change-out Room (PCR). A third project at KSC is the refurbishment of the Convoy Operations capability at the SLF. At MAF, the rehabilitation of the 480-volt electrical distribution system will be completed with the funding of Phase IV of IV. The SSC project will be Phase I of the rehabilitation of the A-2 Test Stand used for Space Shuttle Main Engine testing.

BASIS OF FY 2000 FUNDING REQUIREMENT

SHUTTLE OPERATIONS

	FY 1998	FY 1999	FY 2000
	(Thousands of Dollars)		
Orbiter and integration	507,900	608,000	709,400
Propulsion	1,021,800	1,051,200	1,133,200
[External tank]	[336,000]	[358,600]	[359,200]
[Space shuttle main engine]	[173,400]	[196,600]	[218,000]
[Reusable solid rocket motor]	[360,200]	[344,000]	[421,200]
[Solid rocket booster]	[152,200]	[152,000]	[134,800]
Mission and launch operations	814,700	767,500	704,800
Total	2,344,400	2,426,700	2,547,400

GENERAL

Space Shuttle operations requirements are met through a combination of funds received from appropriations and reimbursements received from customers whose payloads are manifested on the Space Shuttle. The reimbursements are applied consistent with the receipt of funds and mission lead times and is subject to revision as changes to the manifest occur. The FY 1998 standard services reimbursements totaled $11.9 million. The FY 1999 reimbursements are assumed to be $35.9 million, and FY 2000 reimbursements are assumed to be $27.4 million (the majority of FY 1999 and FY 2000 reimbursements are due to the Shuttle Radar Topography Mission). These standard services reimbursements offset the total budget for the Space Shuttle, and have been assumed in the NASA direct funding requirements identified above for the FY 2000 budget request.

The Space Shuttle operations budget includes sustaining engineering, hardware and software production, logistics, flight and ground operations, and flight crew operations for all elements while continuing to pursue environmentally necessary operations and manufacturing improvements. The single, prime contract is the Space Flight Operations Contract (SFOC) held by United Space Alliance comprising one-half of the Operations budget. As development items are completed, additional effort will be transitioned into SFOC.

Increases from FY 1998 to FY 1999 and FY2000 are caused by a number of factors, including: a significant reduction in beginning of fiscal year balances of uncosted prior year budget authority in FY 1998; understatement of requirements in FY1999 due to anticipated reimbursement from the National Imagery and Mapping Agency (NIMA) for the launch of the Shuttle Radar Topography Mission (SRTM); and the reductions in both 1998 and 1999 due to deferral of launches into the future which were documented in the Operating Plans for those years.

Orbiter and Integration

The Orbiter project element consists of the following items and activities:

(1) Orbiter logistics: spares for the replenishment of Line Replacement Units (LRUs) and Shop Replacement Units (SRUs) along with the workforce required to support the program; procurement of liquid propellants and gases for launch and base support;
(2) Production of External Tank (ET) disconnect hardware;
(3) Flight crew equipment processing as well as flight crew equipment spares and maintenance, including hardware to support Space Shuttle extravehicular activity;
(4) The sustaining engineering associated with flight software;
(5) Various Orbiter support hardware items such as Pyrotechnic-Initiated Controllers (PICs), NASA Standard Initiators (NSI's), and overhauls and repairs associated with the Remote Manipulator System (RMS); and
(6) The sustaining engineering associated with the Orbiter vehicles.

The major contractors for these Orbiter activities are United Space Alliance for operations; and Hamilton Standard for extravehicular mobility unit (EMU) operations.

Other support requirements are also provided for in this budget, including tasks that support flight software development and verification. The software activities include development, formulation, and verification of the guidance, targeting, and navigation systems software in the Orbiter. The Flight Software Contract with Lockheed Martin transitioned into the Phase II of the SFOC in FY 1998.

System integration includes those elements managed by the Space Shuttle Program Office at the Johnson Space Center (JSC) and conducted primarily by United Space Alliance, including payload integration into the Space Shuttle and systems integration of the flight hardware elements through all phases of flight. Payload integration provides for the engineering analysis needed to ensure that various payloads can be assembled and integrated to form a viable and safe cargo for each Space Shuttle mission. Systems integration includes the necessary mechanical, aerodynamic, and avionics engineering tasks to ensure that the launch vehicle can be safely launched, fly a safe ascent trajectory, achieve planned performance, and descend to a safe landing. In addition, funding is provided for multi-program support at JSC.

Propulsion

Lockheed Martin Corporation produces external Tanks in the Government-Owned/Contractor-Operated (GOCO) facility near New Orleans, LA. This activity involves the following:

(1) Procurement of materials and components from vendors;
(2) Engineering and manufacturing personnel and necessary environmental manufacturing improvements;
(3) Support personnel and other costs to operate the GOCO facility; and
(4) Sustaining engineering for flight support and anomaly resolution.

The program began delivering Super Lightweight Tanks to KSC in support of the performance enhancement goal required by the Space Station in FY 1998. All recurring costs associated with the Super Lightweight Tank are included in this account. Non-recurring activities were complete in 1998, and costs were accounted for in the Safety and Performance Upgrades budget. The External Tank contract is scheduled to be transitioned into Phase II SFOC in FY 2000.

The Space Shuttle Main Engine (SSME) operations budget provides for overhaul and repair of main engine components, procurement of main engine spare parts, and main engine flight support and anomaly resolution. In addition, this budget includes funding to the Department of Defense for Defense Contract Management Command (DCMC) support in the quality assurance and inspection of Space Shuttle hardware; and funds for transportation and logistics costs in support of SSME flight operations. Rocketdyne, a division of Boeing North American Corporation, provides the bulk of the engine components for flight as well as sustaining engineering, integration, and processing of the SSME for flight.

USA is the prime contractor on the Solid Rocket Booster (SRB) project and conducts SRB retrieval, refurbishment and processing at KSC. In FY 1998, the SRB contract was the first major element transitioned into Phase II SFOC. The Solid Rocket Booster (SRB) project supports:

(1) Procurement of hardware and materials needed to support the flight schedule;
(2) Work at various locations throughout the country for the repair of flown components;
(3) Workforce at the prime contractor facility for integration of both used and new components into a forward and an aft assembly; and
(4) Sustaining engineering for flight support.

Thiokol of Brigham City, Utah is the prime contractor for the Reusable Solid Rocket Motor (RSRM) project that includes:

(1) Purchase of solid rocket propellant and other materials to manufacture motors and nozzle elements.
(2) Workforce to repair and refurbish flown rocket case segments, assemble individual case segments into casting segments and other production operations including shipment to the launch site;
(3) Engineering personnel required for flight support and anomaly resolution; and
(4) New hardware to support the flight schedule required as a result of attrition.

Mission and Launch Operations

Launch and Landing Operations provides the workforce and materials to process and prepare the Space Shuttle flight hardware elements for launch as they flow through the processing facilities at the Kennedy Space Center (KSC). The primary contractor is United Space Alliance. This category also funds standard processing and preparation of payloads as they are integrated into the Orbiter. It also provides for support to landing operations at KSC (primary), Dryden Flight Research Center (back-up) and contingency sites.

Operation of the launch and landing facilities and equipment at KSC involves refurbishing the Orbiter, stacking and mating of the flight hardware elements into a launch vehicle configuration, verifying the launch configuration, and operating the launch processing system prior to lift-off. Launch operations also provides for booster retrieval operations, configuration control, logistics, transportation, inventory management, and other launch support services. This element also provides funds for:

(1) Maintaining and repairing the central data subsystem, which supports Space Shuttle processing as an on-line element of the launch processing system;
(2) Space Shuttle-related data management functions such as work control and test procedures;
(3) Purchase of equipment, supplies and services; and
(4) Operations support functions including propellant processing, life support systems maintenance, railroad maintenance, pressure vessel certification, Space Shuttle landing facility upkeep, range support, and equipment modifications.

Mission and Crew Operations include a wide variety of pre-flight planning, crew training, operations control activities, flight crew operations support, aircraft maintenance and operations, and life sciences operations support. The primary contractor is USA. The planning activities range from the development of operational concepts and techniques to the creation of detailed systems operational procedures and checklists. Tasks include:

(1) Flight planning;
(2) Preparing systems and software handbooks;
(3) Defining flight rules;
(4) Creating detailed crew activity plans and procedures;
(5) Updating network system requirements for each flight;
(6) Contributing to planning for the selection and operation of Space Shuttle payloads; and
(7) Preparation and plans for International Space Station assembly.

Also included are the Mission Control Center (MCC), Integrated Training Facility (ITF), Integrated Planning System (IPS), and the Software Production Facility (SPF). Except for the SPF (Space Shuttle only), these facilities integrate the mission operations requirements for both the Space Shuttle and International Space Station. Flight planning encompasses flight design, flight analysis, and software activities. Both conceptual and operational flight profiles are designed for each flight, and the designers also help to develop crew training simulations and flight techniques. In addition, the flight designers must develop unique, flight-dependent data for each mission. The data are stored in erasable memories located in the Orbiter, ITF Space Shuttle mission simulators, and MCC computer systems. Mission operations funding also provides for the maintenance and operation of critical mission support facilities including the MCC, ITF, IPS and SPF. Finally, Mission and Crew Operations include maintenance and operations of aircraft needed for flight training and crew proficiency requirements.

PROGRAM GOALS

The goal of Space Shuttle Operations is to provide safe, reliable, and effective access to space. This budget is based on an average of seven flights annually with a surge capability to nine flights and remains essentially unchanged from previous years. Although FY 1998 had only four flights, and six flights are planned for FY 1999, an eight-flight year is planned for FY 2000 that will include the third Hubble Space Telescope servicing mission. FY 2001 is a nine-flight year with the X-38 Flight Demonstration, and a research mission which will include the Triana spacecraft. The flight rate is anticipated to continue at eight per year through FY 2003 and seven flights in FY 2004 without any significant increase in this budget. This represents a no change in the total number of flights during this time period from previous submissions. This manifest supports the Nation's science and technology objectives through scheduled Spacehab and other science missions, and commencement of assembly of the International Space Station.

STRATEGY FOR ACHIEVING GOALS

The Space Shuttle program is aggressively continuing to reduce the cost of operations. Since FY 1992, cost reduction efforts have been successful in identifying and implementing program efficiencies and specific content reductions. Space Shuttle project offices and contractors have been challenged to meet reduced budget targets.

United Space Alliance (USA) was awarded the Space Flight Operations Contract (SFOC) on October 1, 1996. It includes a phased approach to consolidating operations into a single prime contract for operational activities. The first phase began in late 1996 with 12 operational and facility contracts being consolidated from the majority of the effort previously conducted by Lockheed Martin and Boeing North American (the two corporations which comprise the USA joint venture). The second phase will add other operations work to the contract after the contractor has had an appropriate amount of time to evolve into its more responsible role in phase I. Transition will take another 1-2 years and employ approximately 7300 equivalent persons at steady state. All transitions will be completed in FY 2001. The reasons for this phased approach are:

1. The ongoing major development projects will be completed.
2. The transition to the prime can occur at a more measured pace.

The roles and missions of the contractor and government under this contract have been defined to ensure program priorities are maintained and goals are achieved. The SFOC contractor is responsible for flight, ground, and mission operations of the Space Shuttle. The accountability of its actions and those of its subcontractors will be evaluated and incentivized through the use of a combined award/incentive fee structure of the performance-based contract. NASA, as owner of assets, customer of operations services, and director of launch/flight operations, is responsible for (a) surveillance and audit to ensure compliance with SFOC requirements, and (b) internal NASA functions. Further, NASA retains chairmanship of control boards and forums responsible for acceptance/rejection/waiver of Government requirements while the SFOC contractor is responsible for requirement implementation. The SFOC contractor is required to document and maintain process/controls necessary to ensure compliance with contract requirements and to sign a certification of flight readiness (CoFR) to that effect for each flight.

SCHEDULE AND OUTPUTS

Since the Space Shuttle program has both an operational and development component, performance measures related to the Space Shuttle program reflect a number of different activities ranging from missions planned and time on-orbit in Shuttle Operations, to development milestones planned for the Safety and Performance Upgrades program. The following sets of diverse metrics can be utilized to assess program performance.

	FY 1998		FY 1999		FY 2000
Operations Metrics	Plan	Actual	Plan	Revised	Plan
Number of Space Shuttle Flights	6	4	8	6	8
Shuttle Operations Workforce (Prime Contractor (equivalent personnel))	16,023	16,519	15,550	16,023	15,550
Space Shuttle Processing Overtime Required	3%	3%	3%	3%	3%
Number of Days On-orbit	68	50	90	59	80
Number of Primary Payloads Flown	8	5	9	6	8

Space Shuttle Missions and Primary Payloads

FY 1998		Plan	Actual/Revised
STS-87/Columbia	Microgravity Payload (USMP-04)/Spartan 201-04	November 1997	November 1997
STS-89/Endeavour	Russian Space Station Mir (Mir-8)/Spacehab	January 1998	January 1998
STS-90/Columbia	Neurolab	April 1998	April 1998
STS-91/Discovery	Russian Space Station Mir (Mir-9)/Spacehab	May 1998	June 1998

FY 1999		Plan	Actual/Revised
STS-95/Discovery	Hubble Orbital System Test (HOST)/Spacehab	October 1998	October 1998
STS-88/Endeavour	Space Station #1 (Node 1) (ISS-01-2A)	July 1998	December 1998
STS-93/Columbia	AXAF	August 1998	3rd Qtr FY 1999
STS-96/Discovery	Space Station #2 Spacehab Cargo Module (ISS-02-2A.1	December 1998	3rd Qtr FY 1999
STS-101/Atlantis	Space Station #2A Spacehab Cargo Module (ISS-02-2A.2)	January 1999	4th Qtr FY 1999
STS-99/Endeavour	Shuttle Radar Topography Mission (SRTM)	September 1999	4th Qtr FY 1999

FY 2000		Plan	Revised
STS-92/Discovery	Space Station #3 (ITS-Z1) (ISS-03-3A)	October 1999	1st Qtr FY 2000
STS-97/Atlantis	Space Station #4 (PV Module) (ISS-04-4A)	April 1999	1st Qtr FY 2000
STS-98/Endeavour	Space Station #5 (US Lab) (ISS-05-5A)	May 1999	2nd Qtr FY 2000
STS-102/Discovery	Space Station #6 (MPLM) (ISS-06-5A.1)	June 1999	2nd Qtr FY 2000
STS-100/Atlantis	Space Station #7 (MPLM-1) (ISS-07-6A)	August 1999	3rd Qtr FY 2000
STS-103/Endeavour	Space Station #8 (Airlock) (ISS-08-7A)	July 2000	4th Qtr FY 2000
STS-104/Columbia	Hubble Space Telescope (HST)	August 2000	4th Qtr FY 2000
STS-105/Atlantis	Space Station #9 (MPLM-2) (ISS-09-7A.1)	August 2000	4th Qtr FY 2000

The Space Shuttle program currently provides launch support for space science missions accommodating universities and industry as a space laboratory and technology research vehicle. Beginning in FY 1999, its primary mission will be to support the on-orbit assembly and operations of the International Space Station. The Shuttle is also the only U.S. vehicle that provides human transportation to and from orbit. In FY 1998, 26 crew members flew approximately 574 days, including time spent by an American astronaut aboard Mir. In FY 1999, 38 crew members are planned to fly approximately 372 days with the first docking of the International Space Station planned on STS-96. This will be followed by approximately 56 crew members flying 840 crew days in FY 2000, including time spent by Americans aboard the International Space Station.

To supplement the network of management reviews and government oversight functions, NASA continues to seek specific objective measurements of overall performance of the Space Shuttle program. In order to permit rapid review by the program managers, the Shuttle program has devised a series of "stoplight" metrics. The metrics are devised whereby certain program aspects are measured against established limits or program parameters and then translated into the appropriate green, yellow or red indicators. Among the metrics displayed in this manner are in-flight anomalies, monthly cost rate, Shuttle processing monthly mishaps, Orbiter systems and line replaceable unit (LRU) problem reports, Shuttle processing contract overtime percentage, and KSC quality surveillance error rate. The Shuttle program also tracks its launch history, monitoring the number of liftoff attempts per mission, and characterizing any delays or scrubs as to technical, weather or operational-related reasons.

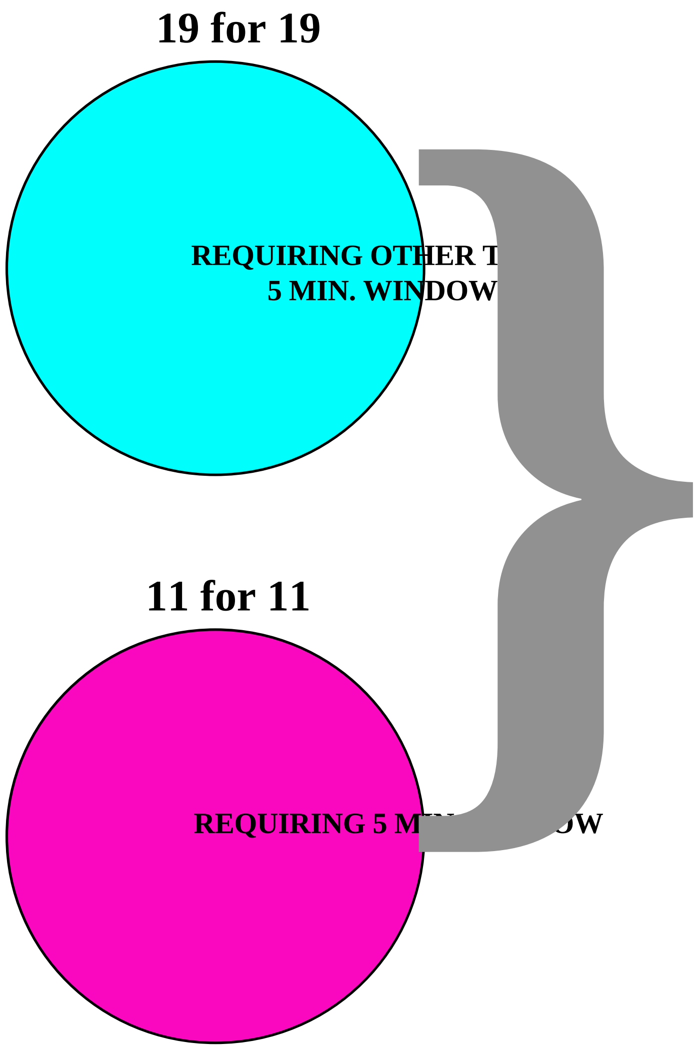
ACCOMPLISHMENTS AND PLANS

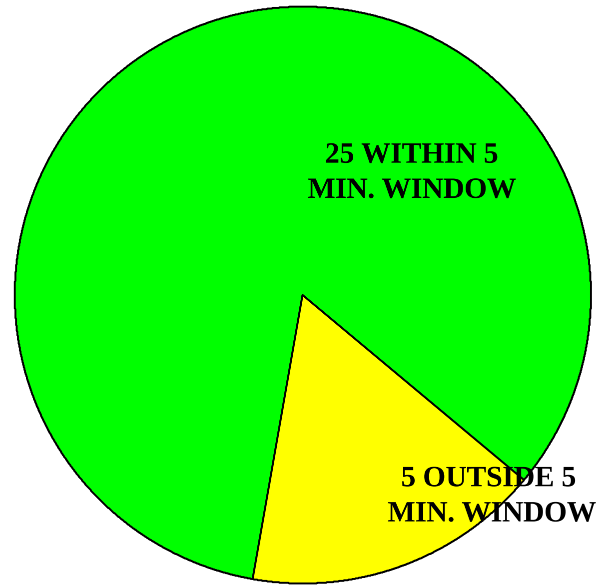
In FY 1998, the Space Shuttle launched four flights successfully. Flights included the last Spacelab mission (Neurolab), two re-supply flights to the Russian Space Station Mir, and the United States Microgravity Payload (USMP) with a Spartan payload. The Alpha Magnetic Spectrometer (AMS) investigation was also conducted on the second Mir mission.

Six flights are manifested for FY 1999. The first mission included a Spartan payload, the Hubble Orbital Systems Test (HOST) platform, a series of experiments by the National Institute on Aging, and the return to space of Senator John Glenn. The Space Shuttle will support the International Space Station with three flights this year, including the initial assembly flight. The Shuttle will also fly the Shuttle Radar Topography Mission (SRTM), a joint DOD/NASA payload to study the earth. Finally, the Space Shuttle plans to deploy the last of the “Great Observatories” when it launches the Advanced X-Ray Astrophysics Facility (AXAF).

Eight flights will be flown during FY 2000, including seven International Space Station assembly flights and the third Hubble Space Telescope servicing mission.

30 for 30 LAUNCHES MEETING OUR COMMITMENT
(STS-64 thru STS-88)





STS-64 : Weather in the RTLS area
STS-72 : Computer communication problem
STS-83 : Late tanking & hatch closeout cover
STS-94: Weather at KSC
STS-95: Intruder aircraft

12/4/98