

**Statement of**  
**Michael James McCulley**  
**Chief Operating Officer**  
**United Space Alliance**

**Before the**  
**United States Senate**  
**Committee on Commerce, Science, and**  
**Transportation**  
**Subcommittee on Science, Technology,**  
**and Space**

**Hearing on Shuttle Safety**  
**September 6, 2001**

## Biography

Michael J. (Mike) McCulley is Chief Operating Officer of United Space Alliance (USA) and has primary responsibility for the day-to-day operations and overall management of USA, the prime contractor for the Space Shuttle Program. Mr. McCulley, a former astronaut, was named to this position in November 1999.

Prior to being named COO, Mr. McCulley was Vice President and Deputy Program Manager for the Space Flight Operations Contract (SFOC), where he assisted USA's Vice President and Program Manager in the management of the Space Shuttle Program.

Mr. McCulley also served as the Vice President and Associate Program Manager for USA's Ground Operations at the Kennedy Space Center in Florida. Named to this position on June 1, 1996, he was responsible for directing the integration of all processing activities associated with America's Space Shuttle program to ensure safe and successful fulfillment of all company contractual commitments to NASA.

A retired U.S. Navy captain and a former NASA astronaut who logged more than 119 hours in space, Mr. McCulley piloted the highly successful STS-34 Shuttle mission in October 1989. The crew deployed the Galileo spacecraft on its six-year journey to explore Jupiter.

Following his retirement from NASA and the Navy, Mr. McCulley was employed by Lockheed Martin Space Operations in October 1990 and served as Vice President and Deputy Launch Site Director for the Kennedy Space Center. He was promoted to Director in November 1995.

Mr. McCulley received his Navy commission in 1970, and, following flight training, served tours of duty in the A-4 "Skyhawk" and A-6 "Intruder" aircraft. He also served as a Navy test pilot and has logged over 5,000 hours in more than 50 types of aircraft.

Mr. McCulley is a graduate of the Lockheed Executive Institute and holds numerous governmental awards and decorations including the NASA Public Service Medal and the Legion of Merit from his Naval service. He also is the recipient of the National Management Association's Silver Knight of Management Award. In addition, he received the Child Advocate of the Year Award for the State of Florida from the Children's Home Society, an organization dedicated to services for children and young mothers.

Active in community affairs, he served on the board of governors for the Brevard Community College Foundation, as an advisory board member for Space Camp and currently serves on the curriculum advisory committee for the engineering school at Purdue University.

Mr. McCulley earned both his bachelor and master degrees in metallurgical engineering from Purdue University in Lafayette, Indiana.

Chairman Wyden, Senator Allen, Senator Nelson and Members of the Subcommittee: Thank you for the giving me the opportunity to testify before your subcommittee on a subject that is very important to our nation – Space Shuttle safety.

Good afternoon, I am Mike McCulley, Chief Operating Officer of the United Space Alliance (USA). USA is responsible for the day-to-day management of NASA's Shuttle fleet under a single prime contract, the Space Flight Operations Contract (SFOC), awarded by NASA in 1996. The company employs over 10,000 people, primarily in Texas and Florida. USA's mission is safe operation of the Shuttle and the International Space Station (ISS). We plan the flights, train the astronauts, and prepare all of the hardware and software for launch, mission, and landing of the Space Shuttle as well as support the ISS on orbit.

Prior to joining USA, I managed the Lockheed Martin contract at Kennedy Space Center. I also had the opportunity to pilot the highly successful Galileo mission on STS-34 in 1989. I come before you today with seventeen years of experience on the Shuttle program. Working over 80 Shuttle missions in 8 different jobs from weather pilot to astronaut to manager, I can state with certainty that the Shuttle program today is at the most robust and safest condition in its history.

Together with NASA, the USA Team works continuously to reinforce the "safety first" culture of the Shuttle program. I am very proud that in the past eleven months, the Shuttle team successfully launched and landed 8 missions, which represents the highest flight rate in several years. Those flights have contributed to the establishment of a permanent outpost in low earth orbit.

In order to continue supporting the Nation's Human Space exploration goals, USA and NASA have implemented significant initiatives to further improve Shuttle operations as well as our performance. We have exceeded all of our industrial safety goals by substantial percentages and are performing significantly above the aerospace industry average. Having safely and successfully launched 29 Shuttle

missions since the inception of SFOC in 1996, USA gained invaluable experience and is now working closely with NASA to implement upgrades to the flight hardware, improve our processes and recommend improvements to ground facilities. However, in my opinion, our drive toward efficiency has moved us below sufficient funding for the many years of Shuttle operation ahead of us.

Over the past decade, the Space Shuttle Program has done an outstanding job of continuing safe operations while reducing cost. Under the SFOC contract, USA and NASA have saved the American taxpayers \$1.2B to date. USA has under-run the SFOC contract every year, and POP submissions to NASA reflect under-runs in GFY01 and GFY02. In addition to the savings realized under SFOC, NASA has reduced the Space Shuttle account by 40% since FY90. The Shuttle program succeeded in meeting reduced budget guidelines by achieving operational efficiencies, eliminating program reserves, and reducing its uncosted obligations to a level unacceptable for a program of this complexity. The budget limitations drove the Shuttle program to allow flight hardware upgrades and ground infrastructure projects to remain unfunded.

As you may recall, at the time NASA signed the USA SFOC contract, the agency expected to phase in a Reusable Launch Vehicle (RLV) to ultimately replace the Shuttle fleet in 2004. As a result, NASA's management plans for Shuttle out-year budgets were greatly reduced, and plans for orbiter fleet and ground infrastructure improvements were very limited. Now, the Shuttle program is being asked to fly for many more years, yet the current and out-year budget profiles remain unchanged.

USA believes that both the Congress and the American people support the continuation of the Federal Government's efforts to maintain human presence in space. If we are correct, the Space Shuttle Program is the link to all human space flight initiatives. The next generation launch vehicle is at least a decade away. The safety of our astronauts is paramount to USA and NASA, and it is obvious from the statements made on the Senate Floor by Members of this Committee, this objective is paramount to the Congress as well. USA strongly agrees with the emphasis of the Congress on the need to prioritize funding for the Shuttle program, in particular, the safety upgrades. Moreover, we believe that the long-term budget policy of the Federal Government should reflect a determination to refrain from reducing safety upgrade initiatives and ignoring ground infrastructure requirement. Prudent, timely and pre-planned modifications and upgrades of the Shuttle must be a national priority that transcends the budget limitations of any given year. Affordable upgrades are an essential investment in retaining the value of this indispensable national asset.

Today, I have been asked to focus my remarks on safety upgrades, infrastructure and the Shuttle workforce.

## **SAFETY UPGRADES**

The Space Shuttle is the foundation for our Nation's continued human access to space in the 21<sup>st</sup> Century. It is uniquely capable of carrying humans into space while simultaneously providing the ability for heavy lift, rendezvous, docking, space walking, micro-gravity research, and new technology testing. These capabilities are unmatched elsewhere in the world.

At the direction of Congress, in the FY01 budget, NASA was provided additional funding to initiate the High Priority Safety Upgrades Program. NASA and its industry team have embarked on a systematic approach to upgrading and maintaining the Shuttle system.

Contrary to some perceptions, the Shuttle Upgrades program has done exactly what it was designed to do during project formulation: define requirements, establish project costs and schedules, and produce initial designs. I'd like to take this opportunity to provide the Committee with some information on the outstanding progress that has been made on these projects and the need for their continued development.

New designs for Shuttle steering systems will eliminate the use of explosive and highly toxic hydrazine fuels. These new designs reduce hazards for both astronauts and ground crews. Complete integrated system prototypes of these designs, which could replace the current Auxiliary Power Units (APUs), have been built and tested. I am proud to say that this summer these prototypes have performed full mission simulations that meet and/or exceed current Shuttle capabilities on high fidelity test stands.

The Orbiter APU prototype, known as the Electric APU (EAPU), would eliminate the single largest risk to Orbiter flight safety. The EAPU reduces the APU's contribution to Orbiter flight risk from 30% to less than 5%. This project has advanced the state-of-the-art for spacecraft batteries and demonstrated that they have more than enough energy for their intended usage. Electric motors and pumps have also been built and tested that can provide the hydraulic power necessary to move Shuttle main engine actuators and aerodynamic surfaces. With requirement definition complete and many technical issues solved, the project is ready to produce detailed and cost-efficient designs.

The current APUs on the Solid Rocket Boosters use the same hazardous hydrazine fuel, and, similarly, represent a significant Shuttle safety risk. Multiple prototypes were created for this system, and each met mission requirements. A very simple, low-risk design was selected that uses safe helium gas in a blow-down configuration. The design not only has shown to be effective and efficient, but also has made use of composites technology from the X-34 program to reduce weight.

We have seen significant progress in the formulation and definition of the Cockpit

Avionics Upgrade (CAU) over the last year and a half. The CAU is an important safety upgrade to the Orbiter that will greatly improve the situational awareness of the crew and reduce their workload, particularly in unexpected and critical emergency situations.

Prototyping activities for the CAU software and hardware have clearly proven the safety benefits of this upgrade as well as the major modification required to the heritage onboard computers. Display prototypes have been evaluated by flight crewmembers against established criteria and have improved the increased response and performance by the crew in life critical situations. A hardware prototype of the new direct access capability to the onboard computers has proven the ability for all parameters contained in those computers to be available for display to the crew, thereby further enhancing their ability to have full control and reaction capability. Not only do these prototypes demonstrate the feasibility of key architectural components of CAU, they also reduce the risk associated with the development of the system

Designs for the Advanced Health Monitoring System (AHMS) for the Space Shuttle Main Engines continue to achieve greater definition, and a prototype is planned for a ground experiment in spring 2002. New engine controllers, new software and added computer power will "see" trouble coming a split second before it can do harm, thus allowing either a safe engine shut down or commanding a reduced utilization of the engine thereby increasing landing and/or orbit options.

A number of smaller improvements also add significantly to overall Shuttle safety. A new tire has been tested that will support higher landing speeds and provide greater safety margins. Likewise, new welding technology has been developed that can increase weld strength and fracture toughness on the External Tank. Finally, a modification to the Orbiter's radiators and wing leading edges that substantially reduces their susceptibility to orbital debris penetrations has nearly been completed across the Shuttle fleet.

There are other product-improvement efforts that can further enhance the safety and operability of the Space Shuttle, particularly if it is to fly for an additional 10 years or more. Delaying the implementation of these improvements will expose flight crews to higher levels of risk for longer than necessary.

Also under consideration is the slippage of scheduled Orbiter Major Modifications [OMM's]. This slippage may initiate a damaging trend, as budgets at NASA are not expected to improve. Delayed maintenance will delay incorporation of the upgrades creating detrimental fleet-wide implications. We prudently conduct scheduled OMM's, which we believe are essential to ensuring the integrity of the vehicle. On-schedule, fleet-wide modifications are necessary and prudent - consistency in configuration of the Orbiters is a must for training, safety, and reliability of operations.

USA believes that proposed cancellations or reductions in the Space Shuttle

upgrades budget are due to shortfalls in available NASA budgets, and are not the result of the projects' lack of contribution to overall Shuttle safety improvements. USA believes that NASA policy should be to dedicate the entire amount of funds provided by the Congress for safety upgrades to the highest priority Space Shuttle safety upgrades initiatives. If technological challenges make it impossible to move aggressively forward on one project, NASA should revise its timetable for implementation or redirect to the next project, rather than reprogramming the funds for other purposes.

The continued, safe operation of the Space Shuttle is paramount until its replacement vehicle is in place.

## **INFRASTRUCTURE**

Space Shuttle ground facilities are essential to safe and reliable operation of the Shuttle fleet. Crumbling equipment has already begun to adversely affect program performance and safety. Necessary upgrades to the infrastructure supporting the Shuttle program at the four Human Space Flight Centers (KSC, JSC, MFSC, SSC) can no longer be ignored.

NASA's own Space Flight Advisory Committee (SFAC), a Subcommittee of the NASA Advisory Council, recently reported that the Shuttle might be operational for at least a decade beyond its originally predicted 2012 lifetime. Two quotes from the 2000 SFAC Report are apropos at this point: *"For a system that will go well beyond the 2012 timeframe, attention must be given to this infrastructure. This should be a separate budget initiative";* and, *"Flight hardware upgrades alone won't keep Shuttles operating into the 2020's without ground upgrades also."*

Unfortunately, for years the NASA budget has not included funding for critical Shuttle infrastructure projects. Infrastructure revitalization appears to have become the "unwanted stepchild" of the budget process. The need to address infrastructure is a well-documented issue and represents a glaring deficiency in the NASA budget. Eroding infrastructure is creating long-term issues of reliability and supportability. There have been incidents where eroding infrastructure has created serious safety concerns and launch delays. Some of the infrastructure impacts and concerns include:

In the Launch Control Center (LCC), operators have had to change firing rooms for each of the last two launches because of computer interface failures.

Within the last six months, the Vehicle Assembly Building (VAB) had to shut down during stacking because of antiquated load breaker switches, which have a

potential to explode and burn.

Although NASA has spent millions of dollars to crutch the crumbling 8-acre VAB roof and corroded exterior paneling on the facility, paneling designed to withstand winds in excess of 100 mph, is being blown off the facility at winds of half the design load.

The corrosive salt air environment of the Florida coast and launch plume impingement on the Shuttle launch pads result in a continuing battle against corrosion. Although the launch pads are periodically refurbished, the extensive amount of structure and operational activity restrictions has resulted in serious corrosion problems that need attention.

There are also corrosion and obsolescence issues with respect to the crawler/transporters and the mobile launch platforms that have been in service since Apollo.

Power, water, high-pressure gas, steam, and communications cabling distribution systems are suffering increasing failures due to age degradation and obsolescence. These basic utility distribution systems, at multiple operational locations, have outlived their design life.

One-of-a-kind test equipment used for flight hardware repairs and spare parts production have been in service since the early 1970's and are not expected to last through the now-extended Shuttle program life.

At JSC, outdated, unsupported computer systems operated by obsolete computer languages are performing critical flight software validation. In some cases, these systems are still loaded with punch cards.

The Electrical Power Systems Laboratory (EPSL), a one-of-a-kind replica of the Space Shuttle Electrical Power Distribution and Control System, is over 20 years old. Trends indicate major maintenance costs in the near term unless major updates in test equipment, facilities, and maintenance of this unique Shuttle asset are made.

At Stennis Space Center, propellant barges are in dire need of having their old mechanical and electrical systems replaced as well as having their hulls overhauled in dry dock. The barges operate in a harsh, corrosive atmosphere on a continuous basis. Barge overhaul has not occurred in over 15 years, yet, the Coast Guard recommends every 5 years. Additionally, recent operating experience and inspection of the barges indicate a loss or compaction of vessel insulation.

Large High Pressure Industrial Water (HPIW) Pumps that provide water for flame bucket cooling and deluge water to the Shuttle main engine test stands are in need of refurbishment. These pumps were installed at Stennis Space Center in the mid-

1960's. The rotating elements of the pumps and gearboxes need to be replaced to assure reliable service.

One half of annual maintenance budgets are spent band-aiding systems that are failing and then maintaining the band-aids, which becomes an additional maintenance burden. Expensive makeshift fabrications are a common occurrence as obsolescent spare parts and replacement units become harder and harder to acquire.

We believe infrastructure improvements can wait no longer. The Federal Government must begin to budget annual funds to address NASA's prioritized list of infrastructure projects.

## **SHUTTLE OPERATIONS**

USA has become increasingly concerned that NASA will resort to reductions in the number of Shuttle flights as a stopgap method of accounting for anticipated shortfalls in its budget. Reduction of the number of Shuttle flights presents serious erosion in the capability of NASA to engage in human space flight activities. USA does not believe that a reduction in space flights is in the best interest of the Nation. Moreover, such an approach fails to recognize the impact of flight rate on program costs.

The Shuttle program's extraordinary achievement in operational efficiencies was driven by NASA's desire to help sustain the Shuttle program, thus assuring that the workhorse of the nation's Human Space Flight programs would be available to meet the full demands of research and human development of space. Reducing the number of flights as a budgetary tool wipes out years of developing these operating efficiencies. At some point, reduced activity eliminates operating efficiencies and results in unjustifiable increased operating costs on a per mission basis. A flight schedule of at least six flights per year must be maintained to sustain the efficiency of the Shuttle Program. Flight reductions also threaten to seriously erode and irreparably harm the entire Human Space Flight program. Reducing the flight schedule below six flights per year will force a delay in the pace of the Space Station assembly thereby driving further ISS cost growth as the assembly process stretches in time. A decision to limit Shuttle flights would also severely limit opportunities for space based scientific research, which remains a top priority for the Congress.

## **SHUTTLE WORKFORCE**

The Shuttle workforce is at the lowest number of personnel it has ever been, and yet, through numerous efficiencies, it is achieving the aggressive goals of the Space Shuttle Program with the best record in its history of on-time launches (Excluding weather, the last 6 missions launched without delays.) and lowest number of in-flight

anomalies (IFA) (averaged 20 IFAs in FY92 and steadily decreased to an average of 4 in FY00). The workforce total has stabilized over the past two years and morale is high. Even with the prospect of a lower flight rate, the demands on the workforce are increasing due to aging hardware, upgrades implementation, and normal lifecycle modifications. We need to be ever watchful that this very talented and dedicated workforce is protected and augmented when necessary. The experience of our management, engineering, and technician personnel will keep an aging Shuttle program at its highest level of efficiency. The dedication and skill of this workforce is the cornerstone of Shuttle safety.

## **SUMMARY**

Mr. Chairman and Members of the Subcommittee, USA is proud to operate this unique and indispensable national asset. The Space Shuttle is a critical part of the Nation's space infrastructure and must continue to fly safely for at least another decade, possibly longer. To ensure continued safe and efficient operation of the Nation's Shuttle fleet, NASA and USA must pursue vehicle hardware, processing and ground facility improvements. Safety, maintainability and obsolescence issues must not be allowed to cripple the progress of our Nation's human space flight program while next generation systems are being developed. Given the likely lead times associated with the definition, funding and development of a new human-rated space vehicle, the Space Shuttle should be acknowledged and supported as the primary method for humans to reach the ISS throughout the Station's life.

Over the past decade, the Space Shuttle program has done an outstanding job of continuing to fly the Shuttle safely and reliably while reducing costs. The Space Shuttle program is now under-funded. If we hope to continue our world leadership role in human space flight, it is imperative that adequate funding be provided to keep the Shuttle flying safely and reliably, including specific funding for Shuttle upgrades and infrastructure revitalization.

Thank you for this opportunity to testify before your Subcommittee. I will be happy to answer any questions you might have.