

**U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON SPACE AND AERONAUTICS**

HEARING CHARTER

***NASA's Space Shuttle and International Space Station Programs:
Status and Issues***

Tuesday, July 24, 2007
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Purpose

On Tuesday, July 24, 2007 at 10:00 a.m., the House Committee on Science and Technology's Subcommittee on Space and Aeronautics will hold a hearing to examine the National Aeronautics and Space Administration's (NASA) Fiscal Year 2008 budget request and plans for the Space Shuttle and International Space Station (ISS) programs, the status of the programs, and issues related to the programs.

Witnesses

Witnesses scheduled to testify at the hearing include the following:

Mr. William Gerstenmaier

Associate Administrator
Space Operations Mission Directorate
National Aeronautics and Space Administration

Mr. Tommy Holloway

Chairman
ISS Independent Safety Task Force

Dr. G. Paul Neitzel

Professor of Fluid Mechanics
Georgia Institute of Technology

Ms. Christina Chaplain

Director

Acquisition and Sourcing Management

Government Accountability Office

Potential Issues

The following are some of the potential issues that might be raised at the hearing:

- *What are the main challenges to successfully flying the Space Shuttle until its planned 2010 retirement? How will NASA ensure the continued safety of Space Shuttle operations in the face of an ongoing labor strike, workforce transition uncertainties, competition with other NASA human space flight programs for resources, and a schedule driven by the need to complete International Space Station (ISS) assembly by the planned 2010 retirement date of the Shuttle?*
- *What are the main challenges to successfully completing the planned Shuttle mission to service the Hubble Space Telescope, and how firm is NASA's launch schedule for the Hubble servicing mission?*
- *What are the main risks to successfully assembling the International Space Station (ISS) by the time the Shuttle is retired? What will NASA do if the actual Shuttle flight rate turns out to be insufficient to complete all of the planned ISS assembly and logistics flights by the end of 2010, and what will be the impact on ISS utilization and operations?*
- *What actions, if any, is NASA taking to respond to the findings and recommendations of the ISS Independent Safety Task Force that raised a number of concerns about the program?*
- *Does NASA have a credible logistics plan for supporting ISS utilization and operations once the Shuttle is retired, and does that plan have adequate backup strategies for contingencies?*

- *What does NASA want to do with the ISS once it is assembled, and does NASA have well defined utilization plans and resource commitments in place that are aligned with those utilization objectives? Given the cuts to the microgravity research community, will a research community be available to effectively utilize the ISS once it is assembled?*
- *What would be required for NASA's ISS National Laboratory concept to become a reality, and what are the main impediments to its success? What will NASA do with the unused capacity and capabilities of the ISS if other agencies decide not to make significant use of it?*

BACKGROUND

Space Shuttle Program

Fiscal Year 2008 Budget Request for the Space Shuttle Program

The FY 08 budget request for the Space Shuttle program is \$4.007 billion. [A multi-year funding chart for the Space Shuttle and ISS programs is included as an attachment to this memo.] Funding for the Space Shuttle program is used to pay for the following:

- (1) **Program Integration**—which includes flight software, system engineering, construction of facilities, safety and mission assurance, etc.
- (2) **Flight and Ground Operations**—pre-flight planning, crew training, operations, mission support for each missions, maintenance and operation of support facilities, final integration and checkout of flight hardware for launch, etc.
- (3) **Flight Hardware**—manufacturing and testing of the Orbiter, Space Shuttle Main Engines, External Tank, Solid Rocket Motors, and Solid Rocket Boosters, as well as any needed design and development activities.

The FY 2007 plans for the Space Shuttle program assumed that four Shuttle missions would be conducted during the current fiscal year. At present, NASA anticipates that it will be able to complete three. NASA's

FY 2008 budget request assumes five Shuttle flights during FY 2008—four to the ISS and one to service the Hubble Space Telescope. Overall, NASA is projecting 12 Shuttle flights to the ISS, one to Hubble, and two ISS “contingency” logistics flights prior to the Shuttle’s retirement.

As part of the President’s Vision for Space Exploration, NASA has been directed to “*focus use of the Space Shuttle to complete assembly of the International Space Station; and retire the Space Shuttle as soon as assembly of the International Space Station is completed, planned for the end of this decade.*” As a result, NASA is also taking steps to begin the transition of the Shuttle workforce and facilities, including identification of assets that will not be needed for follow-on programs and thus can be decommissioned/disposed of by the agency. NASA has submitted some proposed legislative provisions to Congress intended to address Shuttle transition issues. Those legislative proposals will be the focus of a future Subcommittee hearing.

Approximately 500 members of the International Association of Machinists (IAM) have been on strike at the NASA Kennedy Space Center since June 14th of this year as part of a contract dispute with the United Space Alliance (USA), which operates the Space Shuttle for NASA. The IAM strikers have asserted that USA “*has abandoned safety, training, and paperwork requirements they have held us to for years*” during the strike. USA, for its part, has stated that replacement workers were “*properly trained and, where required, certified as proficient to safely perform the task supporting Shuttle processing.*” Without attempting to judge the competing claims, Members may wish to see what steps NASA independently is taking to ensure that Shuttle processing activities are being conducted safely.

The following are a number of the challenges related to the FY 08 budget request and five-year runout for the Space Shuttle program:

- Impact of reduced Space Shuttle reserves to address remaining program threats prior to retirement of the Shuttle
- Feasibility of safely completing the currently planned Shuttle launch schedule prior to the scheduled retirement date in light of the technical issues that have arisen during preparations for several of the missions since the Shuttle returned to flight
- Need to maintain necessary Shuttle workforce and skills through remaining flight schedule

- Potential Space Shuttle program transition and retirement requirements—budget submitted to Congress does not include funds to address these issues past FY 2010, with explanation given that the requirements are not yet well defined

Space Shuttle Servicing of the Hubble Space Telescope

In late October 2006, NASA Administrator Michael Griffin announced plans to conduct a final Shuttle servicing mission to the Hubble Space Telescope. The servicing mission (SM4) will be the fifth Hubble servicing mission since the Hubble was deployed in 1990 and will improve and enable the telescope's continuing operations through 2013. The flight is currently manifested on Shuttle mission STS-125, which is targeted to fly on Atlantis in September 2008. It will be the only non-ISS-related Shuttle mission among the remaining Shuttle flights.

The servicing mission will involve a series of five challenging spacewalks to replace and upgrade components such as batteries and gyroscopes and to install new science instruments---the Cosmic Origins Spectrograph (COS) and Wide Field Camera 3 (WFC3). The COS will allow astronomers to look at the structure and composition of the universe and the WFC3 will look through the infrared, visible, and ultraviolet wavelengths of light to provide insight into planets, the formation of the solar system, the study of early and distant galaxies, and the formation of stars. Astronauts servicing the Hubble will also attempt to repair the Space Telescope Imaging Spectrograph (STIS) instrument installed in 1997, which lost power in 2004. That instrument performs high resolution studies of nearby stars and distant galaxies in visible and infrared wavelengths. Astronauts will also install a Soft Capture Mechanism to allow a vehicle to attach to the Hubble and safely deorbit the spacecraft once it reaches the end of its mission.

The SM4 mission was intended to fly earlier in the decade. After the loss of the space shuttle Columbia in 2003, NASA decided, in January 2004 not to conduct the mission. The cancellation of the servicing mission and expected loss of the Hubble around 2007-2008 prompted an outcry from the public and science community. NASA continued to evaluate options for extending the Hubble's operating lifetime, including a possible robotic servicing mission. The National Academies' *Assessment of Options for*

Extending the Life of the Hubble Space Telescope report recommended “that NASA should commit to a servicing mission to the Hubble Space Telescope that accomplishes the objectives of the originally planned SM-4 mission.”

Aerospace Safety Advisory Panel (ASAP) Report

ASAP recently released its 2006 Annual Report. In that report, the Panel made several observations and recommendations related to the Space Shuttle program. Quoting the report, some of those are as follows:

- *“NASA has shown an appreciation of the persistence of risk associated with the Shuttle, and therefore the continuing need to properly assess it—so that appropriate measures can be taken to mitigate that risk through the remainder of the program.”*
- *“The ASAP has observed that launch decisions are too regularly being elevated to the Administrator level, and the Panel noted the lack of an analytical risk-assessment process that is standardized, comprehensive and well understood throughout the agency.”*
- *“The ASAP said it was concerned about NASA’s shift away from an approach aimed at modifying safety culture to one that appeared to only monitor the status of the culture...Despite these concerns, the ASAP does find signs of improving safety culture, particularly indications that communications have become more open within the Agency.”*
- *“For the Space Shuttle, as with other programs, it is management’s responsibility to set priorities and assess risk—and eliminating all risk is an unrealistic goal. The Agency and the Shuttle Program must guard against developing ‘tunnel vision’ with respect to foam, which could distract them from potential problems developing in other areas.”*

International Space Station Program

Fiscal Year 2008 Budget Request for International Space Station Program (ISS)

The FY 08 budget request for the International Space Station (ISS) program is \$2.239 billion. [A multi-year funding chart for the Space Shuttle and ISS programs is included as an attachment to this memo.] Funding for the ISS program is used to pay for the following:

- (1) **Flight Hardware**—It should be noted that, according to NASA, all U.S. ISS development activities will be completed with the exception of Habitability upgrades and improvements to the ExPRESS Logistics Carrier
- (2) **ISS Operations Program Integration Activities**
- (3) **ISS Spacecraft Operations Activities**
- (4) **ISS Launch and Mission Operations**
- (5) **Multi-User System Support (MUSS)**
- (6) **ISS Crew-Cargo Services**—To be provided by commercial entities or International Partners (e.g., Europeans, Japanese, Russians) Over the near term, the funding is primarily to pay the Russians for Soyuz and Progress services

The ISS program is currently in the most challenging portion of the assembly phase. In FY 2008, “Node 2” will be launched, which is a key piece of ISS hardware that will allow the European and Japanese pressurized modules to be added to the ISS in 2008. In addition, the truss [“backbone”] of the ISS will be completed and additional solar power added. The European ATV cargo carrier is also scheduled to be launched to the ISS in late 2007 or early 2008. That will provide an additional means of getting cargo to the ISS besides the Space Shuttle and the Russian Progress cargo vehicle.

In addition, under the Commercial Orbital Transportation System [COTS] program, potential commercial cargo services providers will be continuing their development activities in FY 08. NASA is proposing to carry out a competition to award a contract to one or more commercial providers for cargo delivery [and perhaps eventually crew transfer services] to the ISS. The Subcommittee plans to examine the status and issues related to COTS and logistical support of the ISS in a future meeting.

In the NASA Authorization Act of 2005 [P.L. 109-155], Congress directed the establishment of an ISS Independent Safety Task Force to “*review the International Space Station program with the objective of discovering and assessing any vulnerabilities of the International Space Station that could lead to its destruction, compromise the health of its crew, or necessitate its premature abandonment.*” The Task Force delivered its report to Congress earlier this year, and its principal observations and recommendations are listed in the following section of this hearing charter.

The chair of the Task Force will be testifying before the Subcommittee at this hearing.

The following are a number of challenges related to the FY 08 budget request and five-year runout for the ISS program:

- The ISS program has depleted reserves through FY 2008 while facing the most challenging period of ISS assembly.
- According to NASA, there is a \$300 million shortfall in the ISS Crew-Cargo Services budget based on current estimates, with an additional \$600 million shortfall being held as a lien against the Exploration Systems Mission Directorate budget. The ISS Independent Safety Task Force was very concerned about the adequacy of the ISS's post-Shuttle logistics support.
- There are additional threats to reserves related to dealing with the impact of the Shuttle retirement.
- Although two of the remaining Shuttle flights are listed as “contingency” and have not yet been approved by OMB—although NASA says sufficient funds have been included in the budget—NASA indicates that those flights will be needed to deliver spares and logistics in advance of the Shuttle's retirement, i.e., they should not be considered optional flights.
- Current International Traffic in Arms Regulations (ITAR) restrictions on NASA “*are a threat to the safe and successful integration and operations of the International Space Station*”, according to the ISS Independent Safety Task Force.
- Funding for ISS research has been cut back significantly over the last several years, and the research community that was intended to utilize the ISS has been decimated by the reductions in funding. No well defined research and utilization plan yet exists, which raises concerns about the ability of NASA to make productive use of the ISS once it is assembled.

Summary of Principal Observations and Recommendations of the ISS Independent Safety Task Force

Principal Observations

- The International Space Station Program is currently a robust and sound program with respect to safety and crew health. Safety and crew health issues are well documented and acceptable, and are either currently adequately controlled or mitigations are being developed to maintain acceptable risk levels.
- The International Space Station Program has strong and proactive crosscutting functions that – if continued – should provide advance indications and warnings that will avoid events that might lead to destruction of the Station, loss of the Station crew, abandonment of the Station, or development of untoward crew health issues. The International Space Station Program’s operating procedures and processes are thorough and sound.
- The International Space Station currently has an experienced, knowledgeable, and proactive team, both internally and in its institutional technical checks and balances, that provides the defense for process and management failures that might lead to an ISS safety or major crew health issue. This posture must be maintained to continue the Station’s successful operation.
- Micrometeoroid and orbital debris penetrating the living quarters or damaging critical equipment is a high safety risk to the crew and the Station.
- Spontaneous crew illness is a significant crew risk and may necessitate returning the crew to Earth for specialized medical attention, which would result in temporary abandonment of the Station. International Space Station medical and Program management officials are taking all reasonable precautions to minimize this risk.
- There are significant programmatic risks associated with completing the ISS Shuttle manifest and providing robust post-Shuttle logistics capabilities that threaten the ability to support a viable Station.
- Workforce composition is a growing concern throughout NASA because of the technical and specialized nature of most of the agency’s work and the large-scale program transition now under way. The International Space Station Program is vulnerable to critical

- management losses, making strategic workforce planning as important as ever.
- Design, development and certification of the new Commercial Orbital Transportation System capability for ISS resupply are just beginning. If similar to other new program development activities, it most likely will take much longer than expected and will cost more than anticipated.
 - The current International Traffic in Arms Regulation restrictions on NASA are a threat to the safe and successful integration and operations of the International Space Station.

Principal Recommendations

- The International Space Station Program should place the highest priority on options to decrease the risk of micrometeoroid and orbital debris.
- NASA should develop and implement plans to maintain Station critical skills and experienced managers.
- The Administration, Congress, and NASA should support the completion of the current Shuttle manifest to the International Space Station, including flights ULF-4 and ULF-5, to assemble a viable Station and provide spares for its long term operation.
- The Administration, Congress, and NASA should support a proactive and phased post-Shuttle logistical transportation program, including adequate funding of approximately one billion dollars per year above current allocations to ensure that adequate logistics and spares are available to maintain a viable Station.
- NASA senior management should conduct a comprehensive review of the Automated Transfer Vehicle to ensure agreement of the policies, approach, and technical implementation of the safety strategy for the Automated Transfer Vehicle's demonstration flight. [Note: This review was conducted on January 8, 2007, and met the intent of this recommendation.]
- The Department of State should grant immediate relief from the International Traffic in Arms Regulation restrictions in the form of an exemption to allow NASA contractors direct interaction with the International Space Station's International Partners and their contractors. This must be affected no later than summer 2007 to support Automated Transfer Vehicle operations.

- The ISS Program should carefully consider implementing all IISTF recommendations to improve the overall safeguards and controls against vulnerabilities.

Utilization of the International Space Station

Current Status

NASA's priorities include completing the assembly of the International Space Station (ISS) by 2010 and then retiring the Shuttle. Based on current plans, starting in 2010 NASA intends to utilize the ISS to conduct research that supports mission-enabling objectives for the Vision for Space Exploration. A 2006 report by the National Academies that reviewed NASA's ISS plans states that "*these objectives represent a major shift in research goals compared to earlier versions of ISS plans. It has always been an ISS objective to study and develop countermeasures for the detrimental effects of spaceflight on astronauts. However, ISS plans had also previously included a major focus on basic research in a number of diverse fields of biological and physical sciences, with research projects directed at increasing fundamental scientific understanding as well as eventual terrestrial applications such as understanding disease or improving industrial technologies.*" As part of that shift, NASA severely cut the support of scientists working on basic research and longer-term challenges in space biology and medicine and the physical sciences. According to the January-March 2007 Newsletter of the National Academies' Space Studies Board, the human research program lost 59% of its investigators, fundamental space biology lost 88% of its researchers, and the physical sciences lost 84% of its research community. Correspondingly large cuts were made to NASA's life and physical sciences microgravity research and applications budgets over the past several years.

Only a few years remain before NASA is scheduled to complete assembly of the ISS and focus on utilizing the Station. At present, however, NASA still lacks a well defined utilization plan with schedules, milestones, specific and prioritized research experiments to actually realize the broad research goals outlined by NASA, budgetary profiles and resource commitments (logistics, crew time, funding) needed to execute the plan.

In the face of these realities, issues that Members may wish to examine are whether a world-class research community that can support investigations to achieve NASA's utilization objectives will be available in 2010 under NASA's current approach, and whether experiments that contribute to NASA's mission-enabling objectives will be mature and ready for flight. Another issue is what the implications of the reductions to fundamental life and physical science research will be for NASA's ability to achieve its longer term exploration goals as well as its ability to deliver the terrestrial benefits of ISS research that the Agency had long used to help justify the ISS program. According to a National Academies report, *An Assessment of Balance in NASA's Science Programs*, published in 2006, "*Analysis of the NASA FY 2007 budget suggests that funds will not be provided for the physical and biological research necessary to identify and define problems that are critical to human survival and function in long-term spaceflight or to develop new technologies and countermeasures to overcome these challenges.*"

The ISS as a National Laboratory

The NASA Authorization Act of 2005, apart from establishing requirements for NASA-supported exploration and non-exploration ISS research, designates the ISS as a national laboratory. The Act seeks to increase the utilization of the ISS by other Federal agencies and the private sector. NASA prepared a report for Congress, *International Space Station National Laboratory Application Development*, dated April 2007, as required under the Act. According to the report, NASA's primary strategy for the ISS national laboratory is "*early efforts on identifying qualified end-users from the public and private sectors.*" To that end, NASA has taken the following steps:

- led an interagency task force to explore how ISS might be used for science, technology, engineering, and math (STEM) activities;
- entered into discussions on a Memorandum of Understanding with the National Institutes of Health on use of the ISS;
- issued a Sources Sought announcement seeking commercially-provided water generation services on the ISS.

The report indicates that NASA will support the operations and maintenance of the ISS. Public and private sector partners seeking to use the ISS will

most likely be required to pay for transporting any experiments, equipment, and supplies supporting their utilization to the ISS. According to the report, NASA identifies the “*availability of cost-effective transportation services*” as the most significant risk factor in the success of the national laboratory. NASA plans to begin managing the operations and utilization of the ISS national laboratory internally. If non-governmental interests in using the ISS grow, NASA may develop an institute to manage non-governmental utilization.

In exploring the opportunities for using the ISS National Laboratory for potential educational activities, a NASA-led task force produced the *International Space Station National Laboratory Education Concept Development Report*. The task force concluded “*that there is significant interest among other Federal agencies in the opportunity to further develop the ISS as an asset for education.*” The report discusses potential educational projects that non-NASA users could conduct on the ISS national laboratory and also discusses the opportunities for American students to participate in international projects and benefit from the international cooperative environment that the ISS offers.

According to NASA’s ISS National Laboratory report, the success of the ISS National Laboratory concept will, in part, determine how long NASA plans to operate the ISS. As described in the report, the ISS has a 15-year design lifetime, based on the launch of the first element in February 2001, and NASA’s budget for ISS operations reflects the 15-year period. NASA has therefore estimated FY 2016 as the end of the operations of the ISS. The report notes that NASA will allow four years, FY 2011 – FY2014, to assess the “value” of the ISS as a national laboratory, at which point NASA would need to extend the “certified design lifetime.” That process could involve tests and analyses that would require lead time and decisions on costs versus benefits.

Alpha Magnetic Spectrometer (AMS)

The Alpha Magnetic Spectrometer (AMS) is a particle physics experiment proposed by Dr. Samuel Ting of the Massachusetts Institute of Technology to search for antimatter in the universe. AMS, which is sponsored by the Department of Energy (DOE), is designed to be flown on the Space Shuttle and attached to the exterior of the ISS. Some 16 international partners are involved in the project and have funded and

performed the majority of its construction. In 1995, NASA entered into an agreement with the DOE to provide AMS with three years of operation on the ISS. Space Shuttle Discovery flew a prototype of the experiment in 1998.

Following the Space Shuttle *Columbia* accident, NASA focused on the return-to-flight of the Shuttle and completion of the ISS consistent with the Vision to Space Exploration. In a 2005 letter from NASA to DOE, NASA stated that it “cannot commit to a Shuttle flight for AMS to the International Space Station (ISS) given current constraints.” In a 2006 letter from the NASA Administrator to Senator Kay Bailey Hutchinson, NASA maintained its position that it could not commit to a Shuttle flight for AMS and noted that “NASA intends to proceed with the payload integration process within the existing AMS budget in order to preserve the option of a future launch.” NASA personnel have indicated that they believe that alternatives to a Shuttle launch, including launch on a foreign launch vehicle, would require significant and costly modifications to the payload and launch vehicle. Thus, at this point, NASA has no plans to fly the AMS to the ISS.

ATTACHMENT 1**FY 08 NASA Budget Request - Space Operations**

<i>(Budget authority, \$ in millions)</i>	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012
SPACE OPERATIONS	6,108.3	6,791.7	6,710.3	6,625.7	3,036.6	2,978.0
Space Shuttle	4,017.6	4,007.5	3,650.9	3,634.5	116.2	
Space Station	1,762.6	2,238.6	2,515.1	2,609.2	2,547.5	2,600.8
Space Flight Support	328.1	545.6	544.3	382.0	372.9	377.2
Year to Year Change		11.2%	-1.2%	-1.3%	-54.2%	-1.9%

ATTACHMENT 2



National Aeronautics
and Space Administration

LAUNCH SCHEDULE

Consolidated Launch Manifest

Space Shuttle Flights and ISS Assembly Sequence

Launch Target	Assembly Flight	Launch Vehicle	Element(s)
Aug. 7, 2007	13A.1	Endeavour STS-118	<ul style="list-style-type: none"> • SPACEHAB Single Cargo Module • Third starboard truss segment (ITS S5) • External Stowage Platform 3 (ESP3)
Oct. 20, 2007	10A	Discovery STS-120	<ul style="list-style-type: none"> • Node 2 • Sidewall - Power and Data Grapple Fixture (PDGF)
Dec. 6, 2007	1E	Atlantis STS-122	<ul style="list-style-type: none"> • Columbus European Laboratory Module • Multi-Purpose Experiment Support Structure - Non-Deployable (MPESS-ND)
Feb. 14, 2008	1J/A	Endeavour STS-123	<ul style="list-style-type: none"> • Kibo Japanese Experiment Logistics Module - Pressurized Section (ELM-PS) • Spacelab Pallet - Deployable 1 (SLP-D1) with Canadian Special Purpose Dexterous Manipulator, Dextre
April 24, 2008	1J	Discovery STS-124	<ul style="list-style-type: none"> • Kibo Japanese Experiment Module Pressurized Module (JEM-PM) • Japanese Remote Manipulator System (JEM RMS)
Sept. 10, 2008	N/A	Atlantis STS-125 (HST-SM4)	<ul style="list-style-type: none"> • N/A
Under review	15A	Endeavour STS-119	<ul style="list-style-type: none"> • Fourth starboard truss segment (ITS S6) • Fourth set of solar arrays and batteries

Under review	ULF2	Discovery STS-126	<ul style="list-style-type: none"> Multi-Purpose Logistics Module (MPLM)
Under review	2J/A	Endeavour STS-127	<ul style="list-style-type: none"> Kibo Japanese Experiment Module Exposed Facility (JEM EF) Kibo Japanese Experiment Logistics Module - Exposed Section (ELM-ES) Spacelab Pallet - Deployable 2 (SLP-D2)
Under review	17A	Discovery STS-128	<ul style="list-style-type: none"> Multi-Purpose Logistics Module (MPLM) Lightweight Multi-Purpose Experiment Support Structure Carrier (LMC) Three crew quarters, galley, second treadmill (TVIS2), Crew Health Care System 2 (CHeCS 2)
Establish Six Person Crew Capability			
Under review	ULF3	Endeavour STS-129	<ul style="list-style-type: none"> EXPRESS Logistics Carrier 1 (ELC1) EXPRESS Logistics Carrier 2 (ELC2)
Under review	19A	Discovery STS-130	<ul style="list-style-type: none"> Multi-Purpose Logistics Module (MPLM) Lightweight Multi-Purpose Experiment Support Structure Carrier (LMC)
Under review	*ULF4	Endeavour STS-131	<ul style="list-style-type: none"> EXPRESS Logistics Carrier 3 (ELC3) EXPRESS Logistics Carrier 4 (ELC4)
Under review	20A	Discovery STS-132	<ul style="list-style-type: none"> Node 3 with Cupola
Under review	*ULF5	Endeavour STS-133	<ul style="list-style-type: none"> EXPRESS Logistics Carrier 5 (ELC5) EXPRESS Logistics Carrier 1 (ELC1)

* Two shuttle-equivalent flights for contingency