# EXECUTIVE SUMMARY

# ORBITAL SPACE PLANE
# LEVEL 2 REQUIREMENTS

**September 2003**

The Orbital Space Plane (OSP) Program is committed to strategic support of the International Space Station (ISS), the initial OSP System customer. The OSP will also provide a bridge to the future by serving as a foundation for future exploration missions. Chartered as an orbiting science laboratory, ISS capability for fully performing its mission has been limited by the size of its crew.. Realization of the full scientific research capabilities of the ISS is therefore dependent upon U.S. support for additional crew transfer and rescue, if an emergency arises on the Station. This potential for increasing ISS crew capacity and resultant scientific returns, without depending on the Space Shuttle, warrants acceleration of the anticipated 2010 initial capability of the OSP crew rescue vehicle to as early as 2008 or sooner. The spacecraft will be designed for the rescue missions, as well as routine crew transfer missions. These missions will be initiated after the crew rescue vehicle becomes operational, but no later than 2012. Therefore, the Program is focusing on developing *capability* rather than dictating design solutions.

During the System Requirements Review (SRR) activities, the OSP Program defined clear, concise requirements that reflect the true needs of the astronauts who live and work aboard the ISS, and their operational support teams, in terms of OSP System *capabilities* for crew rescue and crew transfer. The system will be designed with crew in mind and will accommodate cargo as the capability allows. Requirements were coordinated across the programs inherent in manned space flight; reviewed and agreed upon by government, contractor, and independent review teams; published in OSP Program documents; and provided to the current contractors. The SRR verified that the system-level (Level II) requirements and constraints meet the OSP Mission Need Statement, Level I Requirements, and Operations Concept Vision so that the Program can proceed to the System Definition Review.

The overall OSP System will be subjected to human-rating requirements tailored to ensure safety and reliability of the total system. The process addresses all critical functions, design criteria, systems designs, software designs, test and verification requirements and procedures, human factors engineering, and other program elements required for an OSP System capability. Human-rating focuses on safety—in all phases of space flight—to protect the health and safety of humans involved in and exposed to space flight activities. This includes the crew, ground processing personnel, and the public.

Where crew is concerned, human rating is focused on failure tolerance and crew safety measures, such as abort *and* escape capabilities. Requirements dictate that no two failures of the OSP system can result in permanent disability or loss of life. In addition, the system must be designed so that the crew can quickly exit the spacecraft after boarding, while still on the launch pad. In the event of an anomaly that precludes mission continuance after lift-off, an *abort* command can be initiated so that the crew returns safely to Earth *inside the spacecraft*. Safe recovery of the crew is mandatory. The capability to recover and, if applicable, re-use the spacecraft is governed by the vehicle failure tolerance requirements in the System Requirements Document. On re-entry, “mission continuance” refers to the capability of the spacecraft to safely land at the targeted site.

Crew *escape* requires the crew to exit the spacecraft using an escape system—e.g., extraction, ejection, escape pod—or a specially designed crew compartment that maintains its integrity when no longer an integral part of the spacecraft element designed for nominal re-entry and landing. Crew escape capability cannot be considered as a level of fault tolerance. An effective escape system provides a means for the crew to leave a vehicle in distress during some or all of its flight phases and return safely to Earth. The intent is to ensure crew survival, even if the spacecraft is lost. Since physiological impacts vary according to the length of time (duration) at specific acceleration rates and the health of the crew, system requirements also bound the crew environment and acceptable gravitational loads during ascent and re-entry.

The time-of-flight for the OSP to reach the ISS is bounded at three days; this fosters a first day rendezvous with the Station but allows a two-day margin for the successful docking. In a related requirement, the spacecraft must be able to approach and attempt docking with the ISS at least twice, allowing it the flexibility to stand-off from the station and try again if the first attempt to dock is unsuccessful. It must also be capable of autonomous flight and docking, but allow manual control by the crew; both capabilities are beneficial, especially in the event the ISS is not inhabited.

Once docked, the system must be able to support the crew rescue mission on both the Node 3 Port and Starboard locations without requiring swapping ports. The crew rescue mission is deemed a long-term stay for the spacecraft of up to six months duration, with a three to six month contingency margin. The OSP spacecraft requirements also take into account certain ISS contingency scenarios, such as a 2-degree rotation rate of a malfunctioning Station, fire on Node 3, or more than two vehicles mated to the Station.

While attached, the OSP must be capable of providing safe isolation from the ISS for up to 12 hours, i.e., it can be environmentally separated from the Station while still physically attached. This offers a safe-haven in the event a situation onboard the Station warrants leaving for a short time while the situation is remedied. In an emergency evacuation condition, the crew will be required to get into the spacecraft and isolate from the ISS within 3 minutes of the decision to evacuate. If the decision is made to return the crew to Earth, the spacecraft must be capable of safely separating from the Station within 10 minutes of safe isolation. During such separation, the spacecraft must be able to disengage without further damaging the Station or impacting any other vehicle also attached to the Station.

Requirements focus on the spacecraft's capability for ensuring the safety of the crew. While the OSP will not be designed so that extra-vehicular activity (EVA) can be performed from it, outside handholds may be required so that an EVA from the ISS can be performed to inspect the spacecraft for damage. Based upon the current crew requirements for the ISS, four crew transfer missions are expected per year; probabilistic risk analyses indicate an expectation of one rescue mission per four years.

Representatives from the OSP Program Office and its Elements, in conjunction with NASA Procurement, Safety and Mission Assurance, the Astronaut Office, ISS Program, and Launch Services Provider (LSP) Program agreed upon the overall system requirements.

These were then subjected to external review and comment by the Aerospace Safety Advisory Council, Human Rating Independent Review Team, External Program Assessment Team, and contractor teams. Subsequently, the following OSP Program documents were baselined and released for internal distribution:

- System Requirements Document
- Human Rating Plan, Volume 1
- Operations Concept Document
- ISS to OSP Interface Requirements Document
- OSP to ELV Interface Definition Document
- Natural Environment Definition Document
- System Verification Plan, Volume 1

As a set, these documents guide the design and development of the OSP spacecraft as a critical life-support system capable of ensuring the safety of the ISS crew during a station emergency, as well as returning them to Earth.