1995121241 N95-27662

SPACE STATION PROGRAM STATUS AND RESEARCH CAPABILITIES

Alan C. Holt
Space Station Program Office
NASA Johnson Space Center
Houston, TX 77058
Phone: 713-244-8316; Fax: 713-244-8294

INTRODUCTION

Space Station will be a permanent orbiting laboratory in space which will provide researchers with unprecedented opportunities for access to the space environment. Space Station is designed to provide essential resources of volume, crew, power, data handling and communications to accommodate experiments for long-duration studies in technology, materials and the life sciences. Materials and coatings for exposure research will be supported by Space Station, providing new knowledge for applications in Earth-based technology and future space missions.

Space Station has been redesigned at the direction of the President. The redesign was performed to significantly reduce development, operations and utilization costs while achieving many of the original goals for long duration scientific research. An overview of the Space Station Program and capabilities for research following the redesign is presented below. Accommodations for pressurized and external payloads are described.

SPACE STATION RESEARCH CAPABILITIES

Space Station has extensive research capabilities for pressurized payloads and unpressurized or external payloads. Resources for the payloads will include power, ranging from 10 kW in year 1998 to 50 kW in 2000, 2 crew members dedicated to payload operations in 1998 and 4 crew members in 2002, and data downlink capability of 43 megabits per sec in 1998 and 57 megabits per sec in 2001. Payload accommodations range from 13 internal, standard laboratory payload racks or mounting locations in 1998 to 33 standard payload racks in 2001, and 4 dedicated, external, attached payload sites on the station truss structure and 10 sites on the Japanese Experiment Module Exposed Facility in 2000.

The United States, European Space Agency, Japan and Russia will all provide pressurized laboratories with the capabilities for the operation of payloads which are equivalent to (or which exceed) those capabilities available for Spacelab payloads. The U.S. Lab will have 13 payload racks available for payloads early in the Space Station assembly sequence (late 1998). These International Standard Payload Racks (ISPRs) have standard interfaces for data, power and cooling which enable them to be easily located in any payload rack mounting location in the U.S., ESA and Japanese Labs. Each ISPR will be capable of accommodating up to 1400 lbs. of payload.

Three U.S. Lab payload racks will provide 12 kWs of power and cooling, five payload racks will provide 6 kWs of power and cooling and five payload racks will provide 3 kWS of power and cooling. Nitrogen is plumbed to all of the payload rack locations. Each payload rack can transmit 43 megabits of date per second to the Ku-band downlink system, can transmit 100 megabits per second between payloads in different racks and receive and output an analog video signal (which is digitized for downlink in the video broadband signal processor). A lower rate data transmission capability of up to 10 megabits per second is also available from each rack. Nine of the thirteen payload racks have access to a vacuum exhaust line to reach 10-3 torr and a vacuum resource line to maintain that vacuum level.

The ESA Attached Pressurized Module (APM) and the Japanese Experiment Module (JEM) have similar International Standard Payload Rack (ISPR) rack capabilities. The ESA APM has five payload racks with 6 kWs of power and cooling and five payload racks with 3 kWs of power and cooling. Nitrogen is plumbed to all of the payload rack locations. Five of these payload racks will be available for U.S. payloads. Each of these racks will have access to a high rate data line capable of transmitting up to 43 megabits of data per second to the KU-band downlink system. The Japanese Experiment Module has four payload racks with 6 kWs of power and cooling and six payload racks with 3 kWs of power and cooling. Nitrogen is plumbed to all of the payload rack locations; in addition, four payload racks also receive carbon dioxide and six payload racks receive helium and argon. Five of these payload racks are available for U.S. payloads. Each of the ESA APM and JEM payload racks have analog video input and output capabilities. Ten of the ESA APM payload racks and six of the JEM payload racks have vacuum exhaust and vacuum resource lines. A JEM Experiment Logistics Module will also be provided and will be located on top of the JEM. The racks in this module will be used for storage.

Russia will provide three Research Modules with the capability to accommodate the equivalent of about 10 double racks of payloads. The racks in these modules will not be built according to International Standard Payload Rack (ISPR) capabilities. The power and data transmission capabilities of these payload racks have not yet been defined. A Russian systems design review in the fall of 1994 should provide most of this data.

To facilitate Earth observations, an optical window is planned and will be installed in the ESA APM or in the U.S. Lab. The window will allow photography and other sensing apparatus to be used inside a pressurized area, which facilitates the removal of film, the changeout of instrumentation and routine maintenance. Access to an optical window also provides a capability to observe and assess unexpected events or targets of opportunity, such as hurricanes, earthquakes, large-scale flooding, and other world events.

A centrifuge of sufficient size to accommodate small animals will also be provided in 2002. Laboratory support equipment (LSE) will be provided to support the centrifuge and other payloads. The LSE will include a life sciences glove box, a microgravity science glove box, refrigerators and freezers, microscope, tools, etc.

EXTERNAL PAYLOAD ACCOMMODATIONS

Both the U.S. and Japan are providing unpressurized, external attached payload capabilities. The U.S. is providing six sites on the truss for single, large attached payloads or multiple small to medium sized payloads. Each site has a 15x6x10 ft envelope capability - 4 sites on segment S3 and 2 shared sites on segment P3 (shared between unpressurized logistics carriers (ULCs) and attached payloads). The attached payload sites have viewing directions in the zenith, nadir, ram (into the velocity vector) and wake (opposite to the velocity vector). Each U.S. attached payload site will provide up to 3 kWs of power, a high rate link capability to support the transmission of up to 43 megabits of data to the Ku-band downlink system and a MIL-STD-1553B low rate data capability (200 kilobits per second). Each site can accommodate a single payload of up to

11500 lbs. or multiple payloads up to that amount using a multiple payload mounting structure.

Japan will provide an Exposed Facility (EF) with 10 sites for attaching small to medium sized payloads. Each EF attached payload site provides 3 kWs of power and active cooling and low rate date up to 1 megabits per second of data from each site. Each site can accommodate 1100 lbs of payload. Two of the ten sites will provide 6 kWs of power and eight sites will provide high rate data (up to 43 megabits per second) and analog video output.

The Space Station has a manipulator arm provided by Canada which can be used to install (and remove) external or attached payloads on the truss. The manipulator can also be used to temporarily position sensing packages at various station sites. These packages can remain attached to the manipulator if sensing or observing time for a package is relatively short. The Japanese Experiment Module has its own manipulator arm and an equipment airlock which provides the capability to retrieve equipment from the Exposed Facility external sites (or install equipment on the sites) and bring it into the pressurized environment in the module. Thus, materials processing samples, film or exposed samples and materials can be retrieved without the use of EVA and can be studied in near-real time.

RESEARCH PLANS AND PROGRAM STATUS

The current Space Station assembly sequence results in the U.S. Lab being installed and checked out for payload operations in late 1998. The first Utilization Flight (UF), a flight dedicated to carrying up experiment equipment and resupplies, is scheduled for early 1999. After that first utilization flight, extensive payload operations in the U.S. Lab can be initiated. The U.S. and the other partners will have percentage allocations of the onboard payload accommodations (payload racks and attached payload sites); resources such as power, crew time and data; and Shuttle and other transportation services.

The U.S. payload accommodation and resource allocation will be sub-allocated among the NASA/U.S. users such as the Office of Life and Microgravity Sciences and Applications (OLMSA), Office of Advanced Concepts and Technology (OACT), Office of Mission to Planet Earth (OMPE), Office of Space Science (OSS) and the Office of Space Flight (OSF). Each of these disciplines will have an opportunity to sponsor one or more payloads which will be flown to the station and installed in payload racks or on attached payload site in 1998 or 1999. The truss attached payload capabilities will be available beginning in late 1999.

The first Russian Research Module will be installed at the station in late 1998; the Japanese Experiment Module (JEM) will be installed in early 2000, the JEM Exposed Facility (EF) will be installed in late 2000, the ESA Attached Pressurized Module (APM) will be installed in early 2001 and two additional Russian Research Modules will be installed in late 2001. The payloads installed in these modules and on the attached payload sites will be brought up primarily on the Shuttle in the Mini-Payload Logistics Module (MPLM), which can carry up to 8 payload racks at a time, and in mid-deck lockers for payloads requiring late access (or installation) prior to launch (Launch-40 hours).

The station will have the capability to support a permanent crew of 3 from mid-1998 on. A capability to support a permanent crew of 6 will be available in mid-2002. Six dedicated Utilization Flights are planned from early 1999 through early 2002. Some experiment logistics and resupply will also be able to be accommodated in mid-deck lockers on other Shuttle assembly flights or in unused volume in the cargo bay (assuming mass and center-of-gravity constraints are met).

The U.S., Canada, European Space Agency and Japan have all signed Inter Governmental Agreements (IGAs) and Memoranda of Understanding (MOUs) which provide guidance and direction to this major space infrastructure partnership. NASA and the partners will soon begin extensive negotiations with Russia which will result in a Russian MOU and a modified set of other partner MOUs. With the MOU guidance and a description of the station payload accommodations, station payload resources and transportation capabilities to the station, a long-term international plan for the utilization of the station will be developed (the Consolidated Operations and Utilization Plan).

CONCLUSION

The Space Station will have a wide range of research accommodations and resources. With the increased payload power capabilities, ten times greater than Spacelab and five times greater than the Russia MIR space station, and extensive opportunities for attached external payloads, Space Station will provide excellent opportunities for innovative and challenging research in new and improved materials, new applications of materials and advanced technologies in many key space and ground systems areas.

The International Space Station Alpha (ISSA) will enable significant research in a broad range of scientific and technical disciplines. It will provide our civilization with a significant next step towards the exploration and settlement of our moon and Mars and eventually our planetary neighborhood. ISSA will provide a means for many nations to unite together in a challenging and exciting, space technology and research endeavor - the benefactors will be all of mankind.