NASA ADVISORY COUNCIL
TASK FORCE ON THE SHUTTLE-MIR RENDEZVOUS AND DOCKING MISSIONS
October 11 and 12, 1994
Lyndon B. Johnson Space Center
Houston, Texas

SUMMARY

The NASA Advisory Council Task Force on the Shuttle-Mir Rendezvous and Docking Missions met on October 11 from 3:00 p.m. to 5:00 p.m. and on October 12 from 7:30 a.m. to 5:00 p.m. in Room 966 of Building 1 at the Johnson Space Center (JSC). Attachment A contains the agenda. Attachment B lists the Task Force members, NASA employees, and members of the public in attendance. Attachment C lists the presentation material on file.

MINUTES

October 11, 1994

Introductory Remarks
Gen. Stafford opened the session by thanking each of the Task Force members for returning to JSC for the third meeting of the Task Force. He reviewed the schedule and stressed the importance of holding to it.

Status of the Orbiter Docking System (ODS)
Mr. McClung provided an overview of the current ODS program. He began by first discussing the STS-71 hardware:

- OV-104 (*Atlantis*) airlock and mechanism: ODS base has been mated to the airlock. The integrated checkout started on October 7. All functions will be verified using a passive docking system.
- Qualification testing anomalies have been resolved as follows:
  - -50 degree Centigrade anomaly: Mission profile constraints have been established to prevent similar conditions.
  - Cable failure: Roller single bearing design has been changed and tested.
  - Ball screw housing deformation: This problem resulted from ground handling. Flight unit has been carefully examined and no deformation noted.
  - Loud noise (bang) heard during processing of flight unit at Rockwell Aerospace: Flight hardware inspected and tested; noise source remains undetermined but other sources exist external to flight unit.
- Modifications to support a contingency EVA demate operation have been incorporated:
  - Captive hardware installed
  - Double height bolts are on order; they will be installed at KSC
  - Weightless Environment Training Facility (WETF) tests planned for November to validate EVA tools

Mr. McClung next discussed the OMRSD requirements, which are currently in the review cycle, and OMRSD testing. Testing includes structures and thermal (existing internal airlock and tunnel adapter, new external airlock, vestibule tunnel, truss structure, sill longeron, keel latches, Trajectory Control Sensor thermal blankets); docking aids (CCTV cameras and Trajectory Control System); and mechanical (new hatches in the external airlock and docking mechanism); Environmental Control and Life Support System (pressurization control and ODS air distribution system); avionics and EPD&C (avionics pallet, control panels, docking floodlights, and external airlock interior lighting); and pyrotechnic bolts.

Finally, Mr. McClung discussed the fault tolerance baseline for Shuttle-Mir demating. As he pointed out, current specifications require two fault tolerance (3 demate strings). The original ODS baseline was to meet the requirement for a second level of fault tolerance by using Mir pyrotechnic capabilities; however, NPO-Energia announced in February that pyrotechnic firing capability only exists on the active latches of the Krystall module. This information was different than that originally provided to Rockwell and NASA which indicated that the passive latches also had a pyrotechnic capability. This new information led to the baselining of the EVA removal of the 96 bolts which attach the ODS docking base to the ODS external airlock as the third method available for demating (the second level of fault tolerance). Currently, the feasibility of performing such an operation is being validated. In addition, recapture tests are being planned. The recapture tests are necessary to demonstrate that the Orbiter and Mir could be fully remated after unsuccessful attempts to demate mechanically and using pyrotechnics. This will be necessary to ensure the safety of the astronauts performing the contingency EVA.

Status of EVA Preparations

Mr. Low reiterated the fact that EVA removal of the ODS docking base from the ODS external airlock will be the third method available to demate the Orbiter from the Mir complex. He stated that the EVA will be only accomplished after the both the mechanical latches and pyrotechnic bolts have failed to demate the two vehicles and the docking system has been fully relatched. It will not be a quick response EVA -- the docking system will need to be fully relatched (rerigidized) before the EVA can be conducted.

The current operational scenario for the EVA is as follows:

- Nominal undocking day
  - Latches fail
  - Pyrotechnic bolts fail
  - Relatch all active latches - rerigidize system
  - Depressurize cabin to 10.2 psi
  - EVA preparations
  - EMU checkout

- Next day
  - Egress airlock with tools
  - Set up worksite and remove thermal blankets
  - Cut cable and ground straps
  - Back out bolts in restraint clamp areas
  - Install restraint clamps
  - Back out remaining bolts
  - Verify that all cables have been cut and bolts backed out
  - Remove clamps on intravehicular crewman go
  - Move to a safe location for separation
  - Clean up payload bay after separation
  - Ingress airlock

Mr. Low then discussed EVA hardware requirements. EVA planning has been based on the assumption that the 96 bolts on the ODS will be double height, captive, 7/16" hex-head bolts with nut plates. Under the current plan, these bolts will be installed at KSC following delivery of the ODS. In addition, a high-fidelity WETF mockup will be required to reflect the flight articles at all EVA interfaces which include bolts, cabling, plumbing, blankets, and restraint interfaces.

The bolt removal tools need to meet the following requirements:

- Bolts are torqued to 100-105 inch lbs.
- Majority of bolts are accessible by power tools
- Some bolts will need to be removed manually.

Given these requirements, the suggested approach involves the use of the Hubble Space Telescope (HST) power tool with new power ratcheting coupler attachment, which delivers 210 inch lbs. at the bolt head, to remove those bolts accessible by power tool. Two of these units and an appropriate number of batteries will be required. For the remainder of the bolts, a 7/16" box end wrench will be used.

As to the restraint clamps, Mr. Low indicated that analysis was still being conducted. It is estimated that approximately 2 - 4 restraints will be required. Other hardware that will be needed includes a short platform pushbutton portable foot restraint, HST tool bag, PFR payload bay attachment clamps (2), large trash bag, pushbutton articulating sockets (2), and equipment tethers.

Mr. Low then addressed EVA procedure development and training. These activities include:

- WETF engineering development run (conducted 7/22/94)
- Hardware and tool requirement evaluation conducted at Rockwell Aerospace, Downey, California on 7/26/94
- High-fidelity WETF engineering development runs will be conducted in mid-November
- Hardware mockups, tools, and initial procedures will be ready for crew training at launch minus six months (11/24/94)

It is anticipated that detailed 1-g training will be required as well as portions of 2 -3 WETF training runs.

Mr. Low summarized by stating that there is a high level of confidence that the EVA demate can be conducted successfully. The EVA is being designed to preclude any significant modifications to the ODS such as additional handholds or portable foot restraint sockets. The ability to perform the EVA without such modifications will be fully tested utilizing high-fidelity WETF tests. The stowage requirements for the EVA hardware is one additional major issue which is still in work.

October 12, 1994

Trajectory Control Sensor: STS-63 and STS-71 Schedules/Preliminary STS-63 Results

Mr. Prather reviewed the schedules for both STS-63 and STS-71. Installation of the TCS unit for STS-63 is scheduled for November 28. Installation of the TCS unit for STS-71 is scheduled for March 13. The STS-63 flight unit will serve as a backup for the two units (one primary, one backup) slated for STS-71.

Mr. Prather then provided preliminary results from the STS-64 mission, the initial flight of a TCS unit in which it was tested using the SPARTAN retrievable satellite. Initial acquisition occurred at 690.4 feet. Multiple reaquisitions occurred through 406.8 feet at which point a solid acquisition occurred. The TCS broke track at 270 feet, but reaquired within 6 seconds. The range data provided by the unit compared favorably with that provided via Ku-band and Hand Held Lidar.

Status of the Loads Technical Area

Mr. Lange began the presentation with a discussion of the approach used in conducting joint Shuttle-Mir engineering analysis. The basic elements of that approach are as follows:

- Each party (NASA/RSA) supplies vehicle math models; vehicle, system, and subsystem data; and applied loads environments to the other party as required. This is documented in joint documents.
- Each party calculates the induced effects on their vehicle from their own and the other vehicle's operations.
- The two parties exchange and review the results of their analyses -- results will be documented in the joint documents as required and mutually agreed upon.
- Based on the documented data, environments, and analysis results, both parties sign a joint flight readiness statement, or Certificate of Flight Readiness (CoFR), that signifies that the vehicles are mutually capable of safely performing the planned mission.

Mr. Lange then discussed this model as it has been applied to plume impingement induced loads.

Mr. Sandars followed Mr. Lange. He began his portion of the presentation by providing preliminary results from the Shuttle Plume Impingement Flight Experiment (SPIFEX) flown on STS-64. The final tally after four flight days of operations was 100 test points as compared to the 86 which were planned. Of the 86 original test matrix points, 81 were made while 19 out of 27 auxiliary points were made. Performance of the instrument system, which includes the Load Measurement System (LMS), Plume Impingement Characterization System (PICS), and Position/Orientation Verification System (POVS) performance was nominal with one exception. The prime PICS dropped out for 5 points; however, the backup unit functioned properly.

The initial "quick-look" of measurements indicates that the SPIFEX measured loads are bounded by the existing models. The POVS data analysis will be completed by October 31 (missions permitting); PICS data analysis will be completed by December 30.

Mr. Sandars next reviewed the Mir mission on-orbit loads analysis schedules for STS-63, STS-71, STS-74, and STS-77 and discussed the probabilistic method used in developing piloting techniques and constraints. This method is used because it matches what is expected in flight without stacking failures unreasonably deep and it minimizes the engineering workload by preventing worst case assessments of all failure conditions in all combinations.

Mr. Sandars then went on to address the status of piloting simulations, STS-63 plume loads status, STS-71 plume loads, STS-74 plume loads, docking loads tool development/validation, STS-71 docking loads, STS-74 docking loads, STS-71 mated loads, STS-74 mated loads, Shuttle loads model verification, and Mir loads model verification. In addition to these efforts, a mated vehicle dynamics test for STS-71 has been developed to increase confidence in loads predictions and flight control. This test is most critical to loads and control during Primary Reaction Control System (PRCS) control. Ten tests are planned. Five of the tests are single pulse tests using two primary jets simultaneously to excite loads and control system critical natural frequencies. During these tests Shuttle IMU and Mir accelerometer data will be acquired. The five other tests involve dual pulses using two primary jets simultaneously to validate the jet firing separation time. The tests are scheduled early in the mated flight schedule to reduce risk from vernier failure. The test data will be reduced in near real-time in order to allow uplink of new control notches and firing separation times if required -- the engineering process will take anywhere from several hours to approximately one-half of a day. A similar test plan during STS-74 is under development.

The major items which remain open work are as follows:

- Assess Mir close approach plume loads during STS-63
- Assess STS-71 approach plume and docking loads for orbiter nose-out-of-plane scenario
- Develop and baseline an STS-74 mated loads model validation DTO similar to STS-71
- Assess docking loads with Mir control system active
- Assess plume loads for SPIFEX derived plume model
- Assess shuttle mated loads for the STS-71 configuration without Spektr using the new jet selection logic
- Assess mated loads for Mir control
- Measure high fidelity treadmill loads on zero-g aircraft

Mr. Sandars summarized current status by stating that the loads and dynamics technical area has converged well at this point in the engineering preflight phase. Nominal mission vehicle performance is well defined and acceptable for current prime configurations and flight attitudes. Additional effort, however, is needed for potential Mir configuration changes; sun angle and launch date protection of Mir power options; failed docking capture scenarios; failed vernier load combination constraints; and separation procedures development completion. New changes resulting from these or other considerations could impact the schedule necessary to accomplish all required work. In addition, follow-through on model verification through DTOs, Russian Mir dynamics test data transmission to NASA, and zero-g aircraft treadmill data acquisition is anticipated and required. Finally, integration at the personal level has worked very well, i.e., plume models, control systems, flight operations, docking hardware, piloting simulations, and Russian working relationships/communications are excellent.

Status of Task Force and Administrator Recommendations

Mr. O'Laughlin provided status on the various recommendations based on a scheme composed of 7 categories: management, planning, safety, engineering, rendezvous/docking, training, and operations. Appendix D provides the responses to each recommendation, as presented by Mr. O'Laughlin, in tabular format.

Phase 1 Program Management Plan

Mr. Holloway, the newly appointed Phase 1 Program Manager, provided an overview of the Phase 1 organizational structure, joint working structure, roles and responsibilities, and top-level plan to develop and execute the Phase 1 program. The major points made by Mr. Holloway in his presentation are as follows:

Structure

The Phase 1 Program Management Plan establishes a Phase 1 Program Manager, Mr. Tommy W. Holloway, with a small staff located at the Johnson Space Center who will have overall responsibility for Phase 1. Mr. Holloway's sole responsibility will be as the Phase 1 Program Manager and he will not have dual responsibilities in any other organization. He is accountable for the implementation of Phase 1 and he represents and reports directly to the Associate Administrator for Space Flight. He will ensure that management of full-time Mir operations as well as Shuttle-Mir operations and cargo integration is adequately addressed. Additional responsibilities include:

- Chair the Phase 1 Management Group, which will establish a Phase 1 Manifest and a Resource Allocation Plan.
- Chair the Phase 1 Program Review Control Board (PRCB).
- NASA Chair of the Joint Management Working Group.
- Chair of the Orbit Mission Management Team for Phase 1 flights.

  The JSC Russian Projects Office has been matrixed to support the Phase 1 Program Manager with the Director of the JSC Russian Projects Office, Mr. Frank Culbertson, serving as the Phase 1 Deputy Program Manager. The Director of the JSC Russian

Projects Office will continue to coordinate the administrative activities of the Joint Working Groups which have also been matrixed operationally to the Phase 1 Project Manager .

The International Space Station Program Office (ISSA) will manage the ISSA risk mitigation program and provide requirements to the Phase 1 Program Manager. In addition, the ISSA Russian Programs-Phase 1 Office will be matrixed to the Phase 1 Program Manager. In this capacity, it will monitor, administer, and be responsible for the conduct of the Phase 1 portion of the $400 million contract with RSA. ISSA's Manager, Russian Programs-Phase 1, is the Program Manager for the contract. The Deputy Manager, Russian Programs-Phase 1, is the Contracting Officer's Technical Representative (COTR) for the contract.

The Office of Life and Microgravity Sciences and Applications (OLMSA) will constitute and manage a Payload Steering Committee (PSC) that will identify all Level 1 science, research, and associated risk mitigation requirements. It will provide resources for science and technology hardware development, associated experiments, and mission management. Level II management and implementation responsibility for the Phase 1 OLMSA program has been delegated to the JSC Space and Life Sciences Directorate (SLSD). SLSD will be responsible for maintaining OLMSA cognizance via the PSC of all EVA, risk mitigation, and medical operations requirements under consideration for Phase 1.

The Office of Space Flight Chief Medical Officer will chair the Medical Policy Board for the development of medical support for ISSA risk mitigation and all NASA/RSA joint development of medical support for Phase 1.

The Phase 1 program integration between NASA and the Russians will continue to be done through the joint working groups. These working groups are co-chaired by RSA and NASA management who are responsible for the management of their respective area.

<u>Program Control</u>

The Phase 1 Program Review Control Board (PRCB) will be responsible for baselining and controlling the requirements and documents for the Phase 1 Program. Top Level Phase 1 schedules will be developed and controlled by the Phase 1 Program Manager (Phase 1 PRCB). The normal Shuttle mission preparation production schedule, however, will be used to schedule the shuttle activities, modified as required to support joint Mir/Shuttle flights.

The Phase 1 PRCB will responsible for and delegate to the Phase 1 Change Board (CB) certain responsibilities. The CB will manage and control the U.S. resource allocations on Russian launch vehicles and on the Mir. This includes managing NASA input to the Russian launch vehicle manifests and providing configuration control of the U.S. hardware on Mir. It will provide support to the Russians for hardware processing, checkout, installation, long term sustaining engineering, and certification of flight readiness for NASA hardware deployed on the Mir, Spektr, and Priroda. It will also manage, integrate, and provide operations requirements and real time support to the Russians for the Mir operations which do not involve Shuttle. Top level Mir support schedules will be developed and controlled by the Phase 1 CB.

The Phase 1 CB will also be responsible to the Phase 1 Program Manager for flight readiness determination and will sign certificate of flight readiness's (CoFR) for each Mir increment and applicable Shuttle flights for NASA supplied hardware for Spektr, Priroda, and Mir, Mir integration support to RSA, and NASA supplied operational requirements for Mir.

The existing Space Shuttle Program Requirements Control Board (PRCB), Mission Integration Control Board (MICB), Systems Integration Review (SIR), and Orbiter Change Control Board (CCB) will continue to manage Shuttle hardware and implementation of Shuttle missions to support joint operations.

Phase 1 Mission Program

Mr. Hutchins first reviewed the background of the Phase 1 Program. This included the primary objective of the program which is to "provide an early opportunity for NASA and RSA to jointly conduct a Space Program which lays the foundation for the development and construction of the International Space Station Alpha (ISSA)". He then discussed the specific goals of the program which involves NASA and RSA learning how to work with each other; conducting risk mitigation activities which can provide meaningful results in a timely manner to have application to ISSA; multiple long duration visits on Mir by an astronaut with an associated crew exchange plan to provide life sciences and medical data to NASA in preparation for ISSA operations; and early research opportunities.

The next topic for discussion was the specific number of Shuttle flights to Mir. As Mr. Hutchins pointed out, 3 of the 10 missions originally planned were undefined in terms of cargo bay configuration. No specific payload requirements had been identified for the missions while Spacelab module demand and processing constraints limited Mir manifesting opportunities. The requirements for specific missions were then reviewed as were the various options available for providing the necessary payload capability. The major conclusions based on this information, as presented by Mr. Hutchinson, were as follows:

- Empty shuttle cargo bay flights should not be flown
- Shuttle microgravity science can best be supported on a dedicated 16 day OV-102 (*Columbia*) mission to a 28.45 degree inclination and 160 nautical mile orbit
- Spacelab capability to 28.45 degree inclination should be maintained -- provides program and manifesting flexibility as well as widespread support to maintain Spacelabe science capability
- Mir science and logistics commitments can be supported with 7 Shuttle flights to Mir

In the period between May and July 1994, manifest studies for a program of 7 Shuttle-Mir flights had determined that 7 flights could satisfy the stated Phase 1 program objectives and goals as well as the Phase 1 transportation requirements. In the period since July 1994, planning has focused on flying all 7 Shuttle-Mir missions utilizing OV-104 (*Atlantis*); all risk mitigation, early science, and Mir logistics requirements are being worked within this 7 flight plan. Planning has been impacted by other manifest inputs, particularly the budget direction for a reduction in Shuttle flights from 8 to 7 per year and the definition of Shuttle OMDP durations. One final point that Mr. Hutchins stressed was the fact that the plan maintains the capability and option to fly one, two, or three additional flights to Mir using OV-103 (*Discovery*) if that becomes necessary.

Shuttle-Mir Mission Requirements: Risk Mitigation

Mr. Nguyen identified the two main ISSA goals for Phase 1. These goals and their subsidiary elements are as follows:

- Risk mitigation for ISSA Phases 2 and 3
  - U.S. hardware development, operations, crew procedures, and crew health.
  - Experiments addressing:
    - ISSA control and Automated Rendezvous and Docking (AR&D).
    - The environment at 51.6 degree inclination (micrometeoroids, debris, and contamination).
    - EVA assembly and maintenance tasks.
    - Crew health and life support.
    - Structural dynamics characterization and vibration isolation.
    - Operational techniques.
- Working processes involving joint U.S. and Russian technical teams
  - Mir lifetime extension: Photovoltaic array replacement.
  - Technology demonstration: Solar dynamics prototype.

As described by Mr. Nguyen, responsibility for selecting the experiments necessary to meet these requirements was assigned to the Phase 1 Integrated Product Team (IPT). The Phase 1 IPT created a very methodical experiment review and evaluation process to assess the proposals for risk mitigation experiments submitted to it. The IPT evaluated and ranked each experiment both on technical merit and cost/payback benefit.

At the end of the review and evaluation process, the IPT had determined that 25 percent of the proposed experiments were directly applicable to ISSA risk. The baselined experiments thus selected went through an extensive review process which included the ISSA Phase 2 Analysis Integration Team (AIT), Space Station Program Office management, JSC/Space and Life Sciences Directorate (peer review), the NASA Administrator, and an independent Phase 1 risk mitigation assessment team at NASA Headquarters.

Those experiments which survived this rigorous process have been tentatively assigned to specific Shuttle-Mir missions or Shuttle missions. Only those experiments which require extended durations or presence on Mir have been assigned to the Mir rendezvous and docking missions.

Shuttle-Mir Mission Requirements: Science

Dr. Sullivan opened his presentation by listing the assumptions on which the Phase 1 science program has been based. These include 7 Shuttle flights to Mir (including STS-71), 5 long duration flights on Mir (including Mir 18), and long-duration crew exchange on Shuttle for all three Mir 18 crewmembers (1 U.S., 2 Russian). Negotiations for the remaining long duration crews are currently in work. The program priorities are learning to work with the Russians; ISSA Phase 2/3 risk mitigation; long duration flight and joint integrated operations; and early science and technology research on Mir. The science and technology disciplines involved include human life sciences; fundamental biology; microgravity sciences; earth observation and remote sensing; ISSA technology demonstrations; advanced concepts and technology; and space science.

Dr. Sullivan next discussed the Mir-18 and STS-71 mission constraints which include:

- NPO-Energia suggested 300 kg. as mass constraint for hardware to be launched via Progress in the July 1993 timeframe.
- Use of Spektr module increased this to over 1000 kg; 2000 kg total with Priroda)
- Crew in-flight time constraints a major factor
- Limited time available for crew training

He also indicated that the short lead time involved dictates that the majority of the hardware involved be reflown items and the majority of the experiments be mature efforts.

The STS-71 mission science objectives are to retrieve the data and samples collected during the 90 day Mir mission onto the Shuttle for postfight analysis; to collect data and samples from the long duration crew members which will improve our understanding of the effects of long duration space flight on the human body; to compare U.S. and Russian hardware and protocols within the same investigation to obtain a mutual understanding of scientific approach and equipment; and to obtain postflight life sciences data on the long duration crew to understand physiologic recovery mechanisms and the effects of the countermeasures.

The selection of Mir-18 and STS-71 science proposals was a rigorous process. The first external peer review completed in November 1993. The internal review of the proposals was completed in March 1994 with the results sent on to NASA Headquarters. External peer review was performed by NASA Headquarters and the AIBS. The panel met the week of June 6, 1994 and its report was issued in late August. Three proposals were rejected while selected portions of four proposals were modified.

The next topic presented by Dr. Sullivan was the schedule for the additional Mir modules. Spektr launch has slipped to May 10, 1994. A minimum of 23 days is required to prepare for Shuttle docking after Spektr arrives. Because of the schedule slip, Spektr will not be able to support the current Mir-18 schedule; however, a portion of the equipment originally slated for Spektr will be launched on two Progress missions (February 15 and April 15, 1995). To accommodate these schedule changes, impacted experiments are being moved to post-STS-71 missions. Dr. Sullivan indicated that the schedule will be tight to meet the Progress launches while the hardware schedule for the Priroda, slated for launch on September 15, 1995, is already very tight.

Regarding the current status of Mir-18 and STS-71 experiments, Dr. Sullivan stated that science experiment training is currently being conducted for the Mir-18 and Mir-19 crews. A series of experiments launched on Progress in August have been activated and are operating. The Mir-16 crew will be returning data from those experiments in early November. As stated earlier, the science program for Mir-18 is being replanned based on peer review and Spektr launch slip.

Dr. Sullivan next addressed the status of planning for post-STS-71 Shuttle-Mir missions. The NASA Headquarters Payload Steering Committee is currently defining detailed requirements. In parallel, a Payload Information and Planning System (PIPS) is being developed to manage the integrated science requirements. Under the system, the disciplines will submit their science requirements in a standard format. PIPS will then be used to help manage requirements versus available resources. Shuttle delivery and resupply a part of the planning system. In addition, the requirement for 3,500 kg of Mir logistics is being evaluated against the planned science requirements; the requirement to supply Mir with 3,600 kg of water is currently being negotiated -- the preferred approach is to provide the water from Shuttle fuel cell operation rather than launching it as cargo.

Dr. Sullivan then reviewed the science proposals for post-STS-71 missions. This included human life sciences and fundamental biology; microgravity sciences; ISSA risk mitigation and technology demonstrations; advanced concepts and technology; Earth observation and remote sensing; and space science.

Dr. Sullivan summarized the material presented in his presentation by stating the following:

- Some science hardware is already on orbit
- Mir-18 and STS-71 is being replanned as a result of the Spektr launch slip
- Potential post-STS-71 science is being identified through appropriate NASA Research Announcement processes and is currently being integrated into a doable program considering Mir resource constraints
- The process of outfitting Spektr and Priroda with science facilities hardware is progressing; however, schedules are extremely tight.

<u>OV-103 (*Discovery*) Post-Orbiter Maintenance Down Period (OMDP) Phase 1 Call Up Capability and Configuration Options</u>

(Note: Due to a potential conflict of interest, Mr. Glynn Lunney left the meeting prior to this presentation.)

Mr. Hutchins started her presentation by providing basic background information. The configuration of *Discovery* following OMDP will involve removal of the internal airlock and installation of the external airlock in the location necessary to support ISSA location. In addition, a fifth set of cryogenic tanks will be installed as will the tubing necessary to accept four additional nitrogen tanks. This configuration will be able to support the Mir Phase 1 program with the installation of the following hardware:

- 1 tunnel adapter (2 are available)
- 1 Spacelab transfer tunnel forward adapter (2 are available)
- Orbiter electrical and plumbing modification kit which has been funded

Mr. Hutchins pointed out, however, that the Hubble Space Telescope Second Servicing Mission (HST SM-02) payload complement does physically fit with the external airlock in the ISSA location. It does not fit if *Discovery* is modified to the Phase 1 configuration. In addition, new hardware and certification would be required to utilize the Spacehab module with the ISSA airlock configuration. New hardware is also required to utilize Spacehab with the Phase 1 airlock configuration.

Mr. Hutchins next addressed the process involved in selecting the optimum OV-103 post-OMDP configuration. The basic assumptions involved are that the OMDP process would be performed at the Rockwell facility and that a four orbiter fleet would be in operation. The major considerations include the airlock configuration to support HST SM-02, potential Mir flights, nominal Shuttle flight, and ISSA as well as aft fuselage ballasting capability.

The two options identified through this process are as follows:

- Option 1
  - Remove internal airlock
  - Install external airlock in the ISSA location
- Option 2
  - Leave internal airlock installed
  - Modify (scar) vehicle to accept external airlock electrical connections
  - Do not install external airlock

Mr. Hutchins then discussed the two options in detail as follows:

<u>Option 1</u>

- Modifications
  - Internal airlock removed
  - External airlock installed in the ISSA location
  - Fifth set of cryogenic tanks installed
  - Plumbing for four additional nitrogen tanks installed
  - If OV-103 Mir flight(s) required:
    - External airlock
    - 33 day impact to Orbiter processing flow
- Pros
  - Airlock modification can be performed during second OMDP; no additional modification period would be required
  - Provides backup vehicle to support ISSA First Element Launch

- Cons
  - Cannot support full HST SM-02 requirements
  - Lose full cargo bay capability on maximum performance vehicle
  - Lose approximately 4000 lbs of payload capability and 3 inches of the vehicle Center of Gravity
  - Spacehab is not compatible with the ISSA external airlock without new integration hardware; new hardware requirement is under review

Option 2

- Modifications
  - Internal airlock remains installed as the primary airlock
  - Modify (scar) vehicle for external airlock electrical connections
  - Do not install external airlock
  - If OV-103 Mir flight(s) required:
    - External airlock can be dropped into Orbiter and used with internal airlock -- similar to OV-104 (*Atlantis*)
    - 15 day impact to Orbiter processing flow
- Pros
  - Supports full HST SM-02
  - Maintains maximum cargo bay and ascent capability on a maximum performance vehicle
- Cons
  - Requires an additional 11 month ISSA modification period at KSC to remove the internal airlock and install the external airlock at some point prior to ISSA flights
  - Could create overlapping orbiter modification periods
  - Additional ground support equipment may be required to remove internal airlocks from 2 vehicles during overlapping modification periods at two different sites
  - Threat of a reduced flight rate in FY 1998

Mr. Hutchins concluded with the following recommendations:

- Defer final decision on OV-103 post-OMDP configuration until April 1995 -- this meets the Orbiter Project schedule for a decision
- Determine cost and schedule of including aft fuselage ballast capability as part of the OV-103 OMDP
- Retain current OV-103 post-OMDP baseline, as it relates to the removal of the internal airlock and the installation of the external airlock, for planning purposes
- Determine the operational impacts of a 6 person crew on HST SM-02

At the conclusion of Mr. Hutchins presentation, Gen. Stafford thanked the members once again for their participation. He advised them that the results of the meeting would be incorporated into a draft report which would be submitted to them within two weeks for their review. He then adjourned the meeting.

1-3-94

Mr. William L. Vantine
Executive Secretary
Task Force on the Shuttle-Mir Rendezvous and Docking Missions

1-4-94

Lt. Gen. Thomas P. Stafford, USAF Ret.
Chairman
Task Force on the Shuttle-Mir Rendezvous and Docking Missions

ATTACHMENT A

NASA Advisory Council
Task Force on the Shuttle-Mir Rendezvous and Docking Missions
Building 1, Room 966
Lyndon B. Johnson Space Center
Houston, Texas

October 11, 1994

3:00 - 3:10	Introductory Remarks	Gen. Stafford
3:10 - 4:15	Status of the Orbiter Docking System (ODS)	Stu McClung
4:15 - 5:00	Status of EVA Preparations	David Low
5:00	Adjourn	

October 12, 1994

7:30 - 7:50	Preliminary Results of Trajectory Control Sensor Testing During STS-63	Joseph Prather
7:50 - 9:15	Status of Loads Analysis	Gregory Lange/George Sandars
9:15 - 11:15	Status of Task Force and Administrator Recommendations	John O'Loughlin
11:15 - 12:00	Phase 1 Management Plan	Tommy Holloway
12:00 - 12:30	Lunch	
12:30 - 1:30	Phase 1 Mission Program	Scott Hutchins
1:30 - 2:30	Shuttle-Mir Mission Requirements: Risk Mitigation	Tri Nguyen
2:30 - 3:30	Shuttle-Mir Mission Requirements: Science	Rick Nygren
3:30 - 5:00	Requirements to Modify Second Orbiter	Suzan Voss and Scott Hutchins
5:00	Adjourn	