Section 9 - Medical Support

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9.1 Introduction

The agreement of 5 October 1992 between the Russian Federation and NASA regarding collaboration in the area of crewed spaceflight, subsequent Russian Federation-U.S. intergovernmental understandings and agreements between the Russian Space Agency (RSA) and NASA, including the contract NAS 15-10110, specified the *Mir*-Shuttle and *Mir*-NASA program of joint crewed space missions.

The initial Phase 1 of the *Mir*-NASA project included the realization of the *Mir*-Shuttle program, and furthermore provided for:

1) Missions of Russian cosmonauts aboard the Space Shuttle;
2) Long-duration missions of American astronauts aboard the *Mir* space station;
3) Space Shuttle and *Mir* joint space missions with rendezvous and dockings, during which a NASA astronaut was rotated into the crew of the basic expeditions aboard the *Mir* station.

These efforts were realized within the scope of the Contract NAS15-10110 between the RSA and NASA.

Considering the considerable differences in the organization of the crew medical health and work fitness support systems in Russia and the U.S., the RSA and NASA medical hierarchies were faced with the complicated tasks of coordinating and integrating the organizational principles, methodology, requirements and medical means of both countries to support the health, work fitness, and professional life of the combined Russian-American crews, and of providing conditions for successful execution of the planned space programs. For this reason, WG-8 (Medical Support) was created in 1994 within the frameworks of Phase 1, which on the Russian side was directed by V.V. Bogomolov (Institute of Biomedical Problems [IBMP]-State Scientific Center) and V.V. Morgun (Gagarin Cosmonaut Training Center, or GCTC), and on the American side by Sam L. Pool and Roger Billica (Johnson Space Center, or JSC).

The main task of WG-8 was to develop the logistics to allow cooperation between the medical organizations that support the medical safety and health maintenance of the joint Russian-American crews in the training stages, during missions aboard the Russian and American transport vehicles (Soyuz TM, *Mir* Space Station, Space Shuttle STS), and after reentry.

9.2 Goals

The combined efforts were basically targeted toward:

– Coordination/approval and practical implementation of medical screening and health certification of the members of the joint crews;
– Biomedical training of the joint Russian-American crews in the mission programs at JSC and GCTC;

– Refinement and approval of joint requirements related to the medical procedures and equipment used to monitor the health of the crew before, during, and after a mission, to prevention of adverse body changes during a long-duration mission, optimizing the crews' diet, and to sanitary-hygienic, toxicologic and radiation monitoring of the crewed spacecraft habitat;
– Coordination, elaboration and refinement of crew on-orbit medical diagnostic procedures and equipment, and rendering medical aid when necessary;
– Coordination and optimization of the crew psychological support system;
– Training of medical personnel (flight surgeons) and their direct participation in the support of the space missions at MCC-Moscow and MCC-Houston (for flight surgeons: - NASA medical personnel when working at the GCTC and, at MCC-Moscow, and Russian medical personnel for flight operations when working at JSC in Houston);
– Development and operation of a material-technical base for gathering and processing the medical information that is obtained in the course of medical support of joint crewed missions, refining the communication facilities for the RSA and NASA medical support group specialists and preparing a basis for the development of telemedicine in the interests of mission on-line medical support.

At the subsequent stages of the work of WG-8, crew medical support on long-duration joint missions also included the implementation of the Space Medicine Program (SMP) -- using American medical equipment and procedures, in special investigations aboard the *Mir* station for the purpose of improving the crew health maintenance system and optimizing the elements of crew medical flight support aboard the ISS (monitoring the crew's habitat and health, means of rendering medical aid, microbiological and toxicological investigations, psychological monitoring and psychological support, radiation monitoring, and so on). From the standpoint of medical operations, Phase 1 of the program provided an opportunity to integrate the medical equipment and skills of both parties to continue preparing for crew health maintenance during and after long-duration spaceflight, and to establish lines of international communication and decision-making procedures, which are extremely important to the efforts within the scope of the ISS program.

9.3 Principles and Structure

The guiding principles of organizing the joint efforts for mission medical support under Phase 1 of the program included:

- Utmost regard and respectful consideration on the part of one partner for the knowledge and experience, and the developed regulations and procedures of the crew health maintenance system of the other partner, the search for acceptable compromises in keeping with the medical responsibility of each party for medical decisions made regarding their own crew members (RSA – in regard to the cosmonauts, NASA – in regard to the astronauts);
- Support of the standards, requirements, and national laws of biomedical ethics when conducting joint operations in different aspects of medical support;

- Striving toward candidness/openness between the parties' responsible medical representatives in regard to issues related to crew safety and health in all phases of executing the joint manned program.

Moreover, the medical support procedures and arrangements for the joint missions of the *Mir* basic expeditions were based primarily on Russian laws, and medical control of flight operations was managed by the Russian mission control in close cooperation with and including active participation of the NASA flight surgeon. Medical support of the Space Shuttle STS joint missions is based on NASA regulations. Mission Control-Houston provides the medical supervision of the flight procedures, which includes the active participation of the Russian flight surgeon, or an RSA medical official. Accordingly, the primary responsibility for the safety of the mission safety and maintenance of crew health during the *Mir* missions lay in the hands of the Russian partner, and during the Space Shuttle (STS) missions – the American partner.

To manage the practical operations related to the different collaborative aspects of crew medical health support during the Phase 1 program**,** work subgroups were created under WG-8 (Working Group 8), for crew biomedical training, crew health monitoring, on-orbit prophylaxis, psychological support, medical diagnostics and aid, nutrition, *Mir* atmospheric monitoring, radiation monitoring, on water supply, on implementing the SMP program, and for communications. Specialists of both parties within the scope of their subgroups coordinated their efforts toward practical implementation of the tasks to support the medical health and work fitness of the joint crews. They also conducted joint investigations, developed recommendations in complicated and off-nominal situations, and when medical problems arose. The leaders of WG-8 participated in the Phase 1 WG-8, and took active part in solving problems of medical safety when defining the scientific research program, in the on-orbit use and resupply of medical equipment and supplies, and drew up medical reports for the next stage of the Phase 1 program. Flight surgeons from both sides played an active role in this work.

9.4 Evaluating Crew Health and Medical Monitoring

The document WG-8/NASA/RSA/-E 8000, "The American-Russian Joint Space Program. Phase 1. Medical Requirements," which was developed and approved by WG-8 on 29 March 1995, is the basic document that stipulates the joint requirements for medical support of joint missions. It includes the basic regulations that govern cooperation between the RSA and NASA medical structures in the training stages, during and after the missions. This document integrates the Russian and American requirements, and the provisions for medical support of spaceflight. It is founded both on the requirements and stipulations of the contract NAS 15 10110, and on prior agreements and understandings within the scope of the Continually Active Working Group on space biology, medicine and microgravitation. This document laid the groundwork for joint decisions regarding the medical flight readiness evaluation of American crew members for the *Mir* station missions. It is based on the provisions contained in the Requirements for Medical Operations aboard the Space Shuttle, JSC 13958, Paragraph E, and the Order of the USSR Ministry of Defense and Ministry of Public Health, No. 390/585, dated 21 October 1989, concerning the adoption of the Instructions for Medical Examination and Monitoring of cosmonaut candidates, cosmonauts, and cosmonaut instructors, and is based on the provisions and manuals that regulate the activities of the RSA and NASA medical support hierarchies.

The Chief Medical Board for Medical Support and Medical Problems performed the health certification of the astronauts to clear them for training at GCTC for *Mir* station missions, on the basis of the medical documentation submitted by JSC and the agreed quantity of examinations.

The JSC Medical Board conducted the health certification of the cosmonauts to clear them for a Space Shuttle mission, on the basis of the medical documentation submitted by the Russian party, and the agreed quantity of medical examinations.

Problems that arose were solved through coordination and discussion (personal meetings, teleconferences, facsimile communications) within the scope of WG-8, inviting the assistance of clinical experts from both countries when necessary. In complicated situations, the medical administrations of RSA and NASA (Joint Commission on Space Medicine) joined in solving medical problems, both before and during a mission.

For long-duration missions aboard *Mir*, the astronauts basically adopted the standard Russian system of medical health monitoring. The procedures and sequence of on-orbit medical examinations of the astronauts were coordinated and approved by the American flight surgeon. The quantity and extent of the tests/investigations are given in Appendix 1 and 2.

Moreover, the American flight surgeons conducted regular confidential medical interviews with the basic expedition astronaut, and also conducted additional approved medical health tests on the astronaut, and evaluated his/her physical fitness within the scope of the American SMP (Appendix 3, SMP).

The NASA flight surgeon at MCC-Moscow was fully informed of the results of standard crew medical monitoring, and likewise provided information to the medical directors at MCC-Moscow concerning the outcome of medical monitoring under the American program. Good working cooperation and mutual understanding were established as a result of the joint efforts of the NASA flight surgeon and the Medical Support Group (ГМО) at MCC-Moscow.

Under Phase 1 of the program, the results of the crew member in-flight medical exam required a special discussion by the medical specialists of both parties with adherence to bioethical standards. Furthermore, it should be noted that the results of crew medical health and physical fitness monitoring adequately reflected the crew members' health dynamics, and permitted necessary adjustments to the medical support program.

The appropriate adjustments were made for female astronauts and certain other astronauts in the medical monitoring program by consent of the American party.

Approval of the Phase 1 medical monitoring flight program by the medical and biomedical subgroup specialists made it possible to:

- Introduce new data collection equipment aboard the *Mir* station, and
- Refine the integrated response procedure of Russian and American ground services to mission medical problems in real time.

Russian cosmonauts among the crew of the Space Shuttle STS, before, during and after a mission, utilized the health monitoring system in effect at JSC with the participation of the Russian flight surgeon. In the process, the medical monitoring and medical examination program at the preflight training stage was modified upon consent of the Russian party to take into account the individual features of age and sex.

On the basis of the knowledge and experience gained during Phase 1, the "NASA and RSA Tentative Approach to Questions of ISS Medical Policies" was developed, and was approved on 21 November 1996, and the Requirements for Medical Examinations and Health Standards (AMERD) were refined later on a multilateral level for the ISS crews. Examination norms that are acceptable to all ISS partners were adopted. The positive outcomes of these documents include the following:

- A clear understanding of the problems of medical ethics in both countries, as well as the population differences;
- Better understanding by American medical operations specialists of the physical and psychological factors characteristic of long-duration spaceflight, including the launch and reentry aboard the Soyuz TM spacecraft, which must be considered in the primary medical examination;
- Establishment of lines of communication among medical specialists of U.S. organizations on the one hand, and organizations of the Russian Ministry of Defense and Ministry of Public Health, on the other, which are currently in use during conversations concerning the ISS joint efforts.

9.5 General Crew Training Overview

All in all, 7 NASA astronauts were trained at the Yuri A. Gagarin Cosmonaut Training Center (GCTC) for long-duration space missions aboard the orbital station *Mir* as flight engineers-2, and 4 astronauts were trained for EVA, under the *Mir*-NASA Program.

To implement the joint Russian-American science program two training sessions were held at the Johnson Space Center and as many at the GCTC involving the primary and backup crews of the *Mir*-21, *Mir*-22, *Mir*-23, *Mir*-24, and *Mir*-25 missions.

Four Russian cosmonauts (Kondakova, Titov, Sharipov and Ryumin) had their training at JSC as members of the American crews in preparation for flights aboard Space Shuttle and performed these flights under the *Mir* NASA program.

Nine Shuttle crews (STS-71, -74, -76, -79, -81, -84, -86, -89, -91) took a week-long training in Russia to study the *Mir* systems for joint activities with the Russian crews. The Russian *Mir*-20-25 primary and backup crews took their week-long training at JSC to study the Shuttle systems and to get orientation in joint activities with the STS crews (altogether, six times). Training of the *Mir*-18 and -19 crews took place in the framework of the joint *Mir*-Shuttle missions.

The biomedical training of NASA astronauts in preparation for space missions aboard the *Mir* research complex was carried out at the GCTC in two stages:

- training specifically programmed for a group of astronauts
- crew training.

9.6 Astronaut Training

Astronaut training included the following areas:

- fundamentals of aerospace medicine;
- medical health monitoring and examination;
- physical training;
- medical tests, studies and exercises;
- preparation for joint activities.

The biomedical training of astronauts and cosmonauts as a group and during the following stages was done with a due account of their background knowledge.

The purpose of biomedical training of astronauts was to ensure a good physical condition, good functional psychophysiological capabilities of the body, and a high level of performance through the following:

- preserve and improve health, maintain high level of fitness and keep the body in good condition,
- organize and conduct medical investigations and training to maintain a good level of stabilization in exposure to spaceflight factors,
- know health monitoring procedures,
- use onboard countermeasures,
- operate life support systems of a specific crewed spacecraft,
- use onboard sanitary, epidemiological, and radiation protection measures,
- acquire skills in disease diagnostics, and using onboard medical supplies and countermeasures.

Biomedical group training program included the following basic issues:

- organization of medical support during human spaceflights,
- effect of spaceflight factors on the human body in lengthy flights,
- psychological aspects of a long-duration spaceflight, and psychological support methods,
- medical monitoring systems of a space vehicle and a space station,
- physical training.

By solving these problems successfully the main objective was attained, that of ensuring a required level of astronauts' professional training that was necessary for continuing crew training.

9.7 Biomedical Crew Training

The purpose of biomedical crew training was to provide a set of medical supplies and countermeasures to ensure the crew's good health status, high performance, readiness to accomplish the biomedical objectives and the mission as a whole.

The basic biomedical goals of crew training are as follows:

- establish dynamic health monitoring and preventive medical treatment measures to preserve and maintain good health and to promote physiologic capability and performance during spaceflight training and realization,
- increase psychophysiological tolerance to exposure to spaceflight factors during training using special stands and simulators,
- adjustment of individual psychological qualities and specific features of crew members' interaction,
- train crew to perform specific biomedical research and experiment procedures,
- in-flight baseline data collection procedures for medical monitoring purposes,
- arrange and perform a set of hygiene and sanitary measures, and a quarantine program.

Data for the extent of biomedical astronaut training is shown in Table 9.1.

Crew training included:

- medical health monitoring,
- increasing tolerance to spaceflight factors,
- study of medical support available on the transfer vehicle and the *Mir*,
- practical lessons and training sessions using simulators and other facilities of the transfer vehicle and the space station,
- getting grounding in the technical aspects of the medical monitoring aids of the crew transfer vehicle and the orbital station,
- *Mir*-NASA research program training,
- physical training.

Medical health monitoring was carried out by the American and Russian specialists in compliance with the "Joint U.S.-Russian Phase 1 Program. Medical Requirements." The quantity and aspects of medical monitoring are shown in Table 9.2.

Training aimed to increase tolerance to spaceflight factors did not involve all areas. By agreement with the American specialists training was performed in pressure chambers and centrifuge with g-loads related to the ascent and descent timelines. In view of the specific features of Soyuz missions, lectures were read on spaceflight factors. The GCTC specialists also carried out medical operations to support the activities of cosmonauts during training in hydrolab and during flights in the IL-76MDK laboratory aircraft for microgravity simulation. The quantity of training in this area is given in Table 9.3.

Training in the medical support of the transfer vehicle and station was conducted in conformity with the data initiated by the RSC-Efor the flight-specific training of the *Mir*-NASA crews. The extent of training in this area is presented in Table 9.4.

Practical experience was gained in operating medical monitoring and preventive measures in the context of learning the MK-1 procedures (bioelectric cardiac activity), MK-4 (lower body negative pressure), and MK-5 (cardiovascular system performance under physical stress), MK-8, MK-108, MK-120, MK-12.

The astronauts have studied the purpose, composition, and location of the medical monitoring facilities and the equipment used to ward off the adverse effects of weightlessness on board the *Mir*. They have acquired stable skills to operate this equipment and also learned to provide maintenance and to control off-nominal situations.

The astronauts have received a fairly thorough grounding in the uses of medical equipment to perform scientific biomedical experiments and they developed and reinforced the skills required to operate them without assistance.

The cosmonauts' physical training consisted of general physical and special physical exercises, and also they have learned to use onboard physical training aids. The results are presented in Table 9.6.

9.8 Role of Russian Flight Surgeons

Russian flight surgeons provided medical support for training at NASA. Their activities included:

1. Training in the medical operations program for American spaceflights
2. Medical care of the crew members during their training sessions:

   - providing medical assistance;
   - medical monitoring of their health;

- participating in medical lessons on medical equipment and on how to render medical assistance on board;
- monitoring their physical training.

3. Provision of medical assistance to representatives of Russian organizations
4. Performing a liaison role between the management of medical subdivisions at NASA and RSA during the resolution of urgent issues in medical care for Phase 1 and the beginning of Phase 2.

9.9 Conclusions and Recommendations for the Overall Medical Support Program

Joint training with the crew members enabled the astronauts to perform tasks successfully in the training program as part of the crew and to acquire skills at the required level in performing tasks for the biomedical section of the spaceflight program.

In the opinion of the Russian crew members and the American astronauts who worked on the *Mir*-NASA program during the stage of training as part of Russian-American crews, more attention should have been paid to issues of psychological compatibility among the crew members. For this purpose, more prolonged training should be conducted within each crew, with whom one would have to work later on board the *Mir* Space Station. This could also be improved by holding joint training sessions on how to live under extreme conditions.

The results of examination during final simulation training sessions showed that the main objective was achieved, i.e. the crew's level of professional training proved to be sufficient for them to be certified for spaceflight and to carry out the science program on board the *Mir* Space Station.

It would be advisable to use the experience acquired in training crews on the *Mir*-NASA program when the ISS crews are trained.

9.10 Accomplishments and Lessons Learned

9.10.1 Preventing On-Orbit Adverse Changes in the Body

The Russian system of prophylaxis was relied on to protect the crews of long-duration expeditions from the adverse effects of flight conditions in Phase 1. A regular program of prophylaxis was prescribed for the Russian members of the joint crews that basically involved physical exercises with the onboard exercise training equipment (the UKTF physical exercise training complex, and the VB-3) and expanders according to a special 4-day routine, wearing the flight loading suits (Penguin), cyclic administration of pharmaceuticals (cardiotropic, nootropic, eubiotics), a cycle of low body negative pressure exercises, and ingestion of nutritional additives in the final stage of the long-duration mission, ingestion of water-salt additives on the eve and the day of landing, the use of means to protect against g-forces in the descent phase and early on in the postflight period. The use of constrictive femoral cuffs for the Russian crew members is optional in the system of flight prophylaxis.

The flight prophylaxis program for the NASA astronaut crew members of the basic expeditions aboard the *Mir* station, largely consisted of physical exercises on the flight exercise equipment according to regimens that approximated those recommended by the Russian party, and the optional use of the flight loading suit. The American party refused the low body negative pressure exercises in the final phase of the mission, and prophylactic courses of pharmaceuticals. Since the astronauts were returned to Earth aboard the Space Shuttle, following the advice of the NASA physicians, they adhered to the American system of salt-water loading the day of landing, and the American g-force protections (the American flight suit), though the Russian “Centaur” anti-gravity suit was available if necessary in the early postflight period.

All crew members were advised to wear special earphones to protect their hearing.

For the most part, with little exception, the astronaut members of the basic expeditions aboard the *Mir* station attempted to heed the advice of the physical prophylaxis specialists that was conveyed to them directly, or through the American flight surgeon. While the NASA-6 and NASA-7 programs were in progress, the American exercise physiologists and NASA flight surgeons recommended several regimens and systems of physical exercises apart from the Russian ones, which the American party considers as promising for the ISS. The results of these refinements must be reviewed by specialists from both sides.

The general conclusion amounts to the fact that the state of health of the crew of long-duration missions, and not just while on orbit, but also after their completion, depends on how fully the program of preventive measures is followed, particularly the physical preventive measures. This applies both to the Russian cosmonauts, and to the American astronauts of the basic expeditions. The efficacy of the flight prophylaxis must be thoroughly reviewed once the Russian specialists have acquainted themselves with the results of the postflight clinical and physiological tests performed on the astronauts after a long-duration mission.

9.10.2 Rendering Medical Assistance

Throughout Phase 1, the Russian and American specialists carried out a whole array of efforts aimed at formulating and refining the onboard diagnostic equipment and rendering first aid, by incorporating the American medical kits and medical first aid equipment (defibrillator, crew member fixation/immobilization system, medical therapy sets).

The quantitative and qualitative inventory of the American kit (MSMK) and the Russian medical kits was reviewed jointly, and approved. The decision was made to use both the American and Russian medical supplies, which was the practice used to treat individual crew members. The Russian version of the American flight data files for the diagnostic equipment and medical supplies (Medical Checklist) was reviewed and modified/corrected; defibrillator operating instructions (Defibrillator cue cards) were developed.

The expansion of the therapeutic capabilities of the onboard medical equipment and supplies greatly enhances the reliability of the medical aid flight system as a whole. The prospects for refining the diagnostic aids and rendering emergency medical treatment to ISS crew members have been determined.

9.10.3 *Mir* Habitat Monitoring

In the course of implementing Phase 1 of the *Mir*-NASA project, particular attention was paid to evaluating the condition of the habitat of the basic crews aboard the *Mir* station, as determined in part by the length of service of the station, and periodic deviations and failures on the part of the life support systems. Emergency situations occurred as well (ignition of the solid fuel oxygen generator cartridges, depressurization of the Spektr module due to a collision with a Progress cargo vehicle, failures in the complex control system with a power shortage aboard the station). Because of their possible medical consequences, these situations demanded special attention and a quick response of the technical and medical ground services. In 1997, the toxicologic hazard related to ethylene glycol that entered the station atmosphere due to a leak in the thermal control system aroused special concern.

In these situations, the Russian and American specialists maintained regular contact (teleconferences and meetings) to keep one another informed, and to develop consensual decisions regarding medical arrangements (additional medical monitoring and crew health observation, station atmospheric and water supply testing and monitoring, prophylactic and preventive measures for the crew, additional deliveries of medical supplies to the station).

During this time standing commissions of specialists at RSC-E and the IBMP worked to develop and implement recommendations in order to gain control of the off-nominal situations as quickly as possible. These commissions were staffed with a profile of the most competent technical, toxicological, and medical specialists.

Besides the repair equipment, additional Russian and American means for toxicology monitoring, air- and water-quality testing equipment, and therapeutic and protective equipment were also delivered to the *Mir* aboard the Progress and Space Shuttle vehicles.

The results of medical health monitoring of the crew members conducted at these times and on completion of the missions, usually failed to disclose any adverse changes in body health, though the periods of forced limited use of flight prophylactic equipment, and stressful work/rest regimens in such conditions undoubtedly diminished the efficacy of the medical support system.

The basic outcome of these efforts was the unique combined experience gained in addressing medical and medical-technical problems in various off-nominal and emergency situations during a long-duration mission. Moreover, a number of American crewed spacecraft habitat monitoring aids were approbated in long-duration mission conditions, and their positive and negative aspects were identified, which is extremely important for ISS operations.

9.10.4 Nutrition System

The nutrition subgroup of WG-8, including Russian specialists (from the IBMP-State Scientific Center, the Scientific Research Institute GCTC) and specialists from JSC, completed extensive efforts to discuss and adopt the "Food Standards for *Mir*-NASA Program Crews," and to develop and adopt the "Phase 1 Nutrition Plan." The requirements and procedures for microbiological and toxicological quality control of crew member food rations were approved. The acquisition and delivery of joint Russian-American rations to the *Mir* station aboard the Progress and Shuttle vehicles were defined.

Individualized menus were developed for each expedition based on personal preferences. The adoption of a joint Russian-American ration for the crews of Phase 1 greatly expanded the variety of foods and diversified the rations. Using these rations demonstrated that the bodily requirements of the crew members for basic food components and energy were being met. By and large, the crew members of *Mir*-21–*Mir*-25/NASA-1–NASA-7 rated the joint rations favorably, while offering certain suggestions and recommendations, which were taken into consideration in developing the menu for the first ISS crews. The experience and knowledge gained here during Phase 1 made it possible to develop "The Nutritional Plan for ISS Assembly," and the menu list for the first basic crew, which were approved.

9.10.5 Flight Medical Equipment

The opportunity to gain experience in joint operations aboard the *Mir* station required the development of a new American medical kit, which was better and more complete than any of its U.S. aerospace predecessors.

The systems specialists and their partners supported the work of 7 meetings on flight equipment integration that took place from 1994 through 1997, with each new mission expanding the volume of American equipment aboard *Mir*.

A unified training program for ISS missions was developed in order that the Russian cosmonauts and American astronauts would receive identical training for work on the ISS medical equipment.

- The contribution of the astronauts, cosmonauts, and Russian flight surgeons to the training and use of medical kits is being applied to improve the American medical supplies and procedures for the ISS.
- Within the scope of the Phase 1 program, the American and Russian specialists trained all *Mir* station crew members in the use of flight medical equipment and procedures, thereby ensuring reliable mutual familiarity with the medical supplies in accordance with the training objectives, so that the resources of both sides might to used to the fullest, including all pharmaceuticals, diagnostic, and therapeutic equipment.
- An important step forward in the development of American flight operations support facilities was the decision to procure and deliver a defibrillator and a crew member medical immobilization/fixation system to the *Mir* station for the NASA-5 mission. The experience acquired in the process of this effort will be utilized in providing the ISS with medical material, and in the possible use of such material by the ISS crews.
- Experience from Phase 1 made it possible for the U.S. ground medical support services to acquire the skills for rapid innovation of medical equipment and supplies. The mutual confidence and experience gained in the implementation of the Phase 1 program afforded the development of procedures to effectively rate the safety of onboard medical equipment. For instance, when *Mir*'s Spektr module was damaged during NASA-5, the medical operations specialists, in conjunction with their Russian partners, expeditiously replaced the American medical system damaged in the Spektr module. The new equipment was produced, outfitted and certified by the American medical operations specialists within 24 hours. The new medical equipment was processed and shipped to Russia for delivery to the *Mir* station aboard a Progress cargo vehicle. Representatives of the IBMP and RSC-E ensured that these American medical kits were delivered quickly and smoothly to the Russian launch site.
- The onboard availability of both the Russian and American medical kits dictated the need for a spare medical kit, which should be used as a "central supply."

- This dialog greatly broadened the knowledge and experience of the NASA medical specialists in regard to the anticipated medical risk of long-duration spaceflight. The Russian medical operations service has presented an extensive list of the medical problems, which occurred during the Salyut and *Mir* programs, helping the American party to finalize the development of the medical kits and to train the ground support services for Phase 2 operations.

9.10.6 Behavior and Work Fitness

Practical psychology and psychiatry evolved as the Russian and American specialists together supported the condition of the crew aboard the *Mir* orbital station and Space Shuttles. A broad range of behavioral and work-fitness problems was studied at NASA in support of the long-duration missions in which U.S. astronauts participated, namely:

- A permanent behavior modification and work-fitness program was established within the hierarchies of the NASA medical service. This service was charged with the task of developing and implementing all means necessary to support the psychic health, work-fitness and well-being of an American astronaut aboard *Mir*, and to provide for the needs of the ISS crew members.

- The Russian and American psychological support services reached mutual understandings in the methods and mission culture. An American psychological support program that continued the existing Russian program was established. It included:

  – Two-way audio and video links between JSC (NASA), GCTC, and the *Mir* station;
  – Uplinks of local and national news from the U.S. through Mission Control;
  – A personal collection of books, musical recordings, CDs and video tapes for rest and relaxation;
  – An e-mail system between the *Mir* station and the astronaut's home and workplace;
  – Regular delivery of personal packages from families, friends and the psychology service aboard a Progress cargo vehicle;
  – Informational, emotional, and substantial support of families and close friends and associates of astronauts aboard the *Mir* station;
  – The addition of a short-wave ham radio as means of support for families and crew members;
  – A feedback procedure based on computerized programs introduced by the American party as a means of observing and supporting the state of the crew, and also of monitoring the efficacy of the psychological support and better understanding the influence of these measures on the psychological state.

- The parties shared information and offered mutual support to facilitate social adaptation of the crew and reciprocal understanding of all crew members.
- The American party developed a crew psychological training program to familiarize them with the flight conditions, adaptation techniques and psychology lessons of past Russian and U.S. missions, and with similar activities in polar, underwater and other remote, self-contained situations. The American training program also included a course on Russian culture.
- The American party developed the computerized Spaceflight Cognitive Assessment Tools (SCAT), which allowed the astronaut to evaluate his own cognitive functions. This instrument was deemed necessary in view of the peculiarities of the habitat in long-duration spaceflight, where exposure to toxic substances, adverse atmospheric changes in an enclosed volume, and head trauma are possible.
- The behavior modification and work fitness experts also had direct access to the experience of our Russian colleagues, and experience of the mission as a whole, in regard to:

  – Preflight training and establishing a routine;
  – On-orbit crew member medical support and behavior modification;
  – Interaction and operation of ground services;
  – Direct daily interaction with the Russian medical and psychological support group;
  – Postflight re-adaptation and establishing an activity routine. (One of these experts was also a NASA Flight Surgeon of the Phase 1 Program)

The Russian psychological support system aboard the *Mir* space station, which was used in Phase 1 of the *Mir*-NASA project, is depicted in the diagram in Appendix 4. The psychological support logistics for NASA 1–7 are presented in the Table in Appendix 5.

9.10.7 Postflight Readaptation

The Phase 1 program afforded the American party the opportunity to utilize the extensive Russian experience in developing a postflight readaptation program. On the whole, this program rather effectively facilitated the returned crew members' continuation of an active lifestyle in normal Earth gravity. Though all American astronauts who flew aboard the *Mir* were returned to Earth aboard Shuttles, Russian flight surgeons were present at the landing site after each Shuttle/*Mir* mission. Because of the cooperation between Russian and American exercise physiologists throughout the execution of Phase 1, the program of rehabilitation measures for the ISS crews include the appropriate modifications for the reentry phase. Examples of the most important lessons of our cooperation include:

- The fact that the program of mandatory physical exercises before and during a mission is critical to the maintenance of physical shape in space, and at the same time affects the rate and entirety of complete readaptation to ground conditions after a mission;
- The use of loads/weights in an aquatic medium as a conservative, safe method of restoring the muscles, bones and ligaments for the return to intense activity on Earth;
- The importance of the crew members spending long vacations with their families prior to another mission appointment.

9.11 Summary of the Medical Support Group's Accomplishments

On the whole, one of the most important positive results of the Phase 1 program, which by the way is rather difficult to measure, is the experience in cooperation that was gained by the RSA and NASA ground medical services during the missions. Both parties now are more effectively maintaining bilateral and multilateral (with other international partners) dialogs, which is crucial to solving on-orbit off-nominal situations. With the help of the Russian colleagues and through the use of Russian experience, the American medical operations specialists have learned much during the implementation of Phase 1 in regard to the preparation for and real-time response to complicated situations that are more likely to occur in long-duration spaceflight.

- Another important outcome of the medical support of joint long-duration missions is the preservation of the health and functional reserves of members of the basic expeditions, which ensured both the execution of the mission, and the relatively favorable course of the readaptation processes after the completion of the missions.

- The tasks charged to Phase 1 WG-8 at this time are finished; a joint discussion and review of the clinical and physiological aspects of the completed operations still remains for the work to be finalized. It is best if the experiences of the combined efforts for the crew medical health support of Phase 1 are utilized to the utmost in order to solve the medical problems of ISS deployment and operation.

Dates and Quantity of NASA Astronaut Training

Table 9.1

Mission, Astronaut (backup)	*Mir* Operation Start/Finish Dates	Training With Russian Crew (backup)	Astronaut Training Dates (generic/crew)	Total Biomedical Training Hours
NASA-2 Shannon Lucid (John Blaha)	⇑STS-76 03/24/96 ⇓STS-79 09/26/96 (188 days)	*Mir*-21 Onufrienko, Usachev (Tsibliev, Lazutkin)	01/03/95 - 06/24/95 06/26/95 - 02/26/96	273
NASA-3 John Blaha (Jerry Linenger)	⇑STS-79 09/16/96 ⇓STS-81 01/22/97 (129 days)	*Mir*-22 Korzun, Kalery (Manakov, Vinogradov)	02/23/96 - 07/01/96 05/29/95 - 07/19/96 (4/14 months)	337
NASA-4 Jerry Linenger (Michael Foale)	⇑STS-81 01/12/97 ⇓STS-84 05/24/97 (132 days)	*Mir*-23 Tsibliev, Lazutkin (Musabaev, Budarin)	09/23/96 - 06/12/96 11/29/95 - 12/20/96 (2.5/13 months)	388
NASA-5 Michael Foale (James Voss)	⇑STS-84 05/15/97 ⇓STS-86 10/07/97 (145 days)	*Mir*-24 Solovyev, Vinogradov (Padalka, Avdeev)	01/13/97 - 04/09/97 03/04/96 - 04/30/97 (3/14 months)	277
NASA-6 David Wolf (Wendy Lawrence)	⇑STS-86 09/26/97 ⇓STS-89 01/31/98 (128 days)		09/02/96 - 08/27/97 09/02/96 - 08/12/97 (12/11.5 months)	410
NASA-7 Andrew Thomas (James Voss)	⇑STS-89 01/22/98 ⇓STS-91 06/11/98 (139 days)	*Mir*-25 Musabaev, Budarin (Afanasiev, Treshchev)	01/16/97 - 12/05/97 09/08/97 - 12/05/97 (10.5/3 months)	402

Listing and Quantity of NASA Astronaut Health Monitoring

Table 9.2

Mission (Prime, Backup)	Chief Medical Board	Physiologic Clinical Examination	Phased Medical Examination	Medical Diagnostics & Therapeutics	Training Sessions
NASA-2 (Lucid, Blaha)	6	32	3	2	8
NASA-3 (Blaha, Linenger)	4	16	0	2	-
NASA-4 (Linenger, Foale)	4	32	2	2	-
NASA-5 (Foale, Voss)	4	32	2	2	-
NASA-6 (Wolf, Lawrence)	4	32	3	6	-
NASA-7 (Thomas, Voss)	6	32	2	6	9

Areas and Quantity of Astronaut Training in Spaceflight Factors (hours)

Table 9.3

Mission, Astronaut (backup)	Theory of Spaceflight Factors	Diving Physiology and Medicine (Lecture and Credit)	Centrifuge g-loads Training	High-Altitude Training and EVA Medical Monitoring (pressure chamber)
NASA-2 Shannon Lucid (John Blaha)	2	-	-	11
NASA-3 John Blaha (Jerry Linenger)	2			11
NASA-4 Jerry Linenger (Michael Foale)	2	3	1	14
NASA-5 Michael Foale (James Voss)	2	3	1	23
NASA-6 David Wolf (Wendy Lawrence)	2	3	1	17
NASA-7 Andrew Thomas (James Voss)	2	3	-	17

Biomedical Mission Program Training (hours)

Table 9.4

Mission, Astronaut	Psychological Training	Medical Support Aids	Mission Science Program
NASA-2 Shannon Lucid	2	6	39
NASA-3 John Blaha	8	21	101
NASA-4 Jerry Linenger	8	13	116
NASA-5 Michael Foale	2	4	65
NASA-6 David Wolf	8	23	160
NASA-7 Andrew Thomas	6	21	160

NASA Astronaut Technical Training (hours)

Table 9.5

Mission, Astronaut	Nominal Medical Monitoring and Countermeasures Equipment on Board	Science Hardware (NASA)
NASA-2 Shannon Lucid	4	6
NASA-3 John Blaha	4	18
NASA-4 Jerry Linenger	4	7
NASA-5 Michael Foale	4	3
NASA-6 David Wolf	4	13
NASA-7 Andrew Thomas	4	4

Astronaut Physical Training (hours)

Table 9.6

Mission, Astronaut	General Physical Training	Special Physical Training	Onboard Countermeasures
NASA-2 Shannon Lucid	100	40	12
NASA-3 John Blaha	102	40	8
NASA-4 Jerry Linenger	110	60	10
NASA-5 Michael Foale	80	40	12
NASA-6 David Wolf	90	30	14
NASA-7 Andrew Thomas	90	30	10

Appendix 1

GENERAL INFORMATION

on Medical Support of *Mir*-NASA Phase 1 Joint Crew Flight
on *Mir* (NASA 1-7)

Program	NASA-1	NASA-2		NASA-3	NASA-4	
Astronaut	N. Thagard	S. Lucid		J. Blaha	J. Linenger	
Mission	*Mir*-18 V. Dezhurov G. Strekalov	*Mir*-21 Yu. Onufrienko Yu. Usachev	*Mir*-22 V. Korzun A. Kaleri	*Mir*-22 V. Korzun A. Kaleri	*Mir*-22 V. Korzun A. Kaleri	*Mir*-23 V. Tsibliyev A. Lazutkin
NASA Surgeon	M. Barratt D. Ward	G. Johnson		P. McGinnis	T. Marshburn	
Launch	03/14/95 Soyuz-TM-21	03/22/96 *Atlantis*		09/16/96 *Atlantis*	01/12/97 *Atlantis*	
Mir Docking	03/16/95	03/24/96		09/19/96	01/15/97	
Mir Undocking	07/04/95	09/24/96		01/19/97	05/21/97	
Return to Ground	07/07/95 *Atlantis*	09/26/96 *Atlantis*		01/22/97 *Atlantis*	05/24/97 *Atlantis*	
Total Flight Duration	115 days 8 hrs 43 min	188 days 4 hrs		128 days 5 hrs 28 min	132 days 4 hrs	
Aboard *Mir*	109 days 4 hrs 25 min	183 days 23 hrs		122 days 23 hrs 01 min	126 days 21 hrs 09 min	
Medical Monitoring						
MK-1 (ECG at rest)	2	4		3	3	
MK-4 (LBNP Test)	1	2		1	-	
LBNP Training	2	-		-	-	
MK-5 (Graded Physical Load on VB-3 Cycle Ergometer)	1	3		2	2	
MK-6 (Body Mass)	14	11		9	7	
MK-7 (Calf Volume)	3	9		8	6	
EVA Medical Monitoring	-	-		-	1	

Appendix 1 Cont.

Program	NASA-5		NASA-6	NASA-7	
Astronaut	M. Foale		D. Wolf	A. Thomas	
Mission	*Mir*-23 V. Tsibliyev A. Lazutkin	*Mir*-24 A. Solovyev P. Vinogradov	*Mir*-24 A. Solovyev P. Vinogradov	*Mir*-24 A. Solovyev P. Vinogradov	*Mir*-25 T. Musabayev N. Budarin
NASA Surgeon	T. Taddeo		C. Flynn	P. McGinnis	
Launch	05/15/97 *Atlantis*		09/26/97 *Atlantis*	01/23/98 *Endeavour*	
Mir Docking	05/17/97		09/28/97	01/24/98	
Mir Undocking	10/04/97		01/29/98	06/8/98	
Return to Ground	10/07/97 *Atlantis*		02/01/98 *Endeavour*	06/12/98 *Discovery*	
Total Flight Duration	144 days 13 hrs 47 min		127 days 20 hrs 01 min	140 days 15 hrs 12 min	
Aboard *Mir*	139 days 14 hrs 55 min		123 days 20 hrs 50 min	134 days 19 hrs 47 min	
Medical Monitoring					
MK-1 (ECG at rest)	3		3	3	
MK-4 (LBNP Test)	-		1	1	
LBNP Training	-		-	-	
MK-5 (Graded Physical Load on VB-3 Cycle Ergometer)	1		2	2	
MK-6 (Body Mass)	6		8	9	
MK-7 (Calf Volume)	4		7	8	
EVA Medical Monitoring	1		1	-	

Russian - U.S. Joint Contributions to the Phase 1 Medical Program

Parameter	Russian Medical Control	United States Contribution	Implementation
CARDIOPULMONARY			
Defibrillator / CMRS		Defibrillator / CMRS	*Mir* 23 / NASA 5
EKG at rest	MK-1		*Mir* 18
EKG with ergometer	MK-5		*Mir* 18
Hematocrit	MK-120	MO-9; Portable Clinical Blood Analyzer / Venipuncture	*Mir* 18
Holter Monitoring	MK-44-4		*Mir* 18
LBNP	MK-4	MSD008; Automatic Blood Pressure Cuff	*Mir* 18
ENVIRONMENTAL			
Acoustic Noise Measurements		MSD084; *Mir* Acoustic Dosimeter	*Mir* 25 / NASA 7
Air Quality assessment	MK-40-5	MO-14 / MSD007 Solid Sorbent and Grab Air Samplers; Formaldehyde Monitors	*Mir* 18
Air / Surface Microbiology	MK-35	MSD022; Microbial Air Sampler, Surface Sampling Kits	*Mir* 18
Crew Microbiology	MK-10	MSD021	*Mir* 18
In-flight Radiation Monitoring	Area Dosimeters	MO-12 / MSD004 Tissue-Equivalent Proportional Counter (TEPC), Area Dosimeters, Personal Dosimeters	*Mir* 18
Special Environmental Assessment	Drager Tubes	Combustion Products Analyzer, Real Time and Archival Sampling Kits for Ethylene Glycol and Carbon Monoxide	STS-84, *Mir* 23 / NASA 5
Water Quality: Chemical assessment Microbiological assessment		MSD022, MAD053 Water Experiment Kits, Refrigerated samples, Microbial Capture Devices	*Mir* 18
MEDICAL			
Blood Chemical Analysis	MK-12	MO-9; Portable Clinical Blood Analyzer	*Mir* 18
Crew Status and Support Tracker (CSST)	Review of questions contained in CSST	CSST software	NASA 3
Cognitive Assessment		MO-6 / MSD085 SCAT software	*Mir* 25 / NASA 7
Photodocumentation of Skin Injuries		MSD076	*Mir* 23 / NASA 4
Urinalysis	MK-27, Mk-28	MO-9 (Human Life Sciences project contributed Dried Urine Chemistry capability)	*Mir* 18
PHYSICAL FITNESS			
Arm Ergometry	MK-8		NASA 4
Body Mass Measurement	MK-6		*Mir* 18
Physical Training Assessment	MK-108-2	MSD077 Heartwatch, Automatic Blood Pressure Cuff, Cycle Ergometer	*Mir* 18

Appendix 3

SMP *Mir*-NASA Phase 1 Research Content

CODE	EXPERIMENT DESCRIPTION	OPERATIONAL CONTENT
MO-1	Private Medical Conferences	Astronaut communication with NASA surgeon on closed loop
MO-9	Physical	a) self-evaluation of physical condition (Russian Form 20) b) blood chemical analysis using PSBA
MO-10	Urine Sample Analysis	Biochemical blood (sic!) analysis using indicator strips
MO-11	Radiation Data Download from TEPC	Once a month - TEPC data download to MIPS hard drive - data reduction and creation of a small file for TLM-downlink - data transfer to optical disks Once a week - TEPC display data report during comm pass
MO-12	Radiation Monitoring	- a personal dosimeter is worn by an astronaut from launch to landing - 18 passive dosimeters are installed on panels inside the station's modules (Passive dosimeters are replaced during NASA mission handover)
MO-14	Environmental Anomalies Affecting Health	Air sampling for formaldehyde levels using - personal (located on astronaut clothing - 12 hrs); and - local (station panels - 24 hrs) samples
MO-8	Record of MSMK Pharmaceutical Intake	Bar code logger is used to read the bar code of any pharmaceutical from the kit
MO-2	Download of General MSMK Utilization Data from Bar Code Reader	- Download of Bar Code Logger data on the use of the medical kits into MIPS - transfer to optical disks - TLM data downlink
MO-6 (CSST)	CSST Name changed as of NASA-5: Assessment of Crew Psychological Condition and Effectiveness of Psychological Support Measures	Completion of computerized questionnaire
MSD053 (WATER)	Archive Water Sample Analysis	Condensate Sampling (into Russian samplers) *Mir* Potable Water Sampling
MSD021 (Crew)	Crew Microbial Assessment	Crew sample collection. Swab samples are taken from different parts of the body (skin and mucous membranes). Samples are frozen in microbial medium.

Appendix 3 Cont.

CODE	EXPERIMENT DESCRIPTION	OPERATIONAL CONTENT
MSD021 (MICRO)	*Mir* Microbial Assessment	- Water, air, and surface sample collection for in-flight microbial analysis - colony count at 2 and 5 days (occasional photography and video filming) - count reporting (starting with NASA-5)
MSD021 SSAS/GSC	Toxicological Assessment of Airborne Volatile Compounds	Air sampling - into a solid sorbent air sampler (SSAS - 24 hours); and - grab sampler container (GSC)
Defib	Defibrillator and *Mir* Medical Restraint System	defibrillator checkout CMRS checkout
MSD011	Nutritional Status Evaluation	- completion of questionnaire on meal frequency - TLM questionnaire data downlink - body mass measurement (for MK-6)
MSD008	In-Flight Orthostatic Tolerance Testing	During the Russian LBNP test the astronaut uses the ABPM monitor; approximately every minute entries are made in the SMP log of the heart rate, arterial pressure, Chibis pressure
MSD008	Physical Fitness Assessment	- PT recording in a log following every session - use of HRM to monitor heart rate during PT - weekly download of HRM onto MIPS - graded effort test on cycle
	Special *Mir* Environment Evaluation	- collection of condensate samples (into U.S. samplers) - CPA reading Contingency - air sampling for ethylene glycol Contingency - free water collection
MSD084 (MAD)	*Mir* Acoustic Noise Measurements	24-hr acoustic measurements in *Mir* modules and by crew members
MSD071	In-Flight Holter	Daily Monitoring (24 hr.)
MSD085	Neurocognitive Assessment	Completion of short version of SCAT on MIPS

SMP Research *Mir*-21/NASA-2

Appendix 4

Experiment	Planned	Completed	Notes
MO-1 Private Medical Conferences	first 7 days - daily weekly after that	first 7 days - daily weekly after that + additional PMC*	* At the request of the NASA surgeon because of IMMUNITY experiment
MO-9 Physical	chemical blood analysis using PSBA monthly (Days 30, 60, 90, 120) or for medical reasons	04/18/98 not performed* 05/08/96** 06/19/96***	*PSBA not found **BTS PSBA used *** PSBA cartridges were not stored in a refrigerator causing the data to be compromised and the experiment to be canceled
M-10 Urine Sample Analysis	Once a month	04/09, 05/05, 06/05, 07/02, 08/02/96 Monthly until August (in conjunction with MK-27), subsequently not performed*	*As recommended by the NASA surgeon because MO-10 results were identical to MK-27 results
MO-11 Radiation Level Data Upload from TEPC	Once biweekly	performed monthly* 04/02, 16, 05/14, 06/18, 07/23, 08/27/96	*As recommended by NASA CG
MO-12 Radiation Monitoring	Continuous monitoring	Continuous monitoring 03/31 - 09/25/96	Completed
MO-14 Environmental Health Anomalies	Monthly	Monthly 04/30-05/01, 05/20-21, 06/19-20, 06/27-28, 07/17-18	Completed
MO-8 Record of MSMK Pharmaceutical Intake	Performed as needed	Performed using an alternative method - entry in MSMK log	Completed
MO-2 Download of General MSMK Utilization Data from Bar Code Reader	Once biweekly	No work was performed	MIPS downlink was not available: the cable required to download data from bar code reader to MIPS could not be located

SMP Research *Mir*-22/NASA-3

Appendix 5

Experiment	Planned	Completed	Notes
MO-1 Private Medical Conferences	first 7 days - daily weekly after that	first 7 days - daily weekly after that	Completed
MO-9 Physical	monthly or for medical reasons	Monthly 10/14, 11/19, 12/13/96	Completed
M-10 Urine Sample Analysis	Once a month	Monthly - early into the flight (in conjunction with MK-27) 10/10, 11/11/96, subsequently not performed*	*As recommended by NASA surgeon since MO-10 results are identical to those of MK-27
MO-11 Radiation Level Data Upload from TEPC	MIPS download - monthly, display reporting - weekly	Downloads: 10/3-4, 10/21-22; 11/20-21/96, 01/10-11/97 display reporting - weekly	Completed
MO-12 Radiation Monitoring	Continuous monitoring	Continuous monitoring 09/25/96 - 01/16/97	Completed
MO-14 Environmental Health Anomalies	Monthly	Monthly 09/26-27, 10/7-8, 11/15-16, 12/15-16/96, 01/7-8/97	Completed
MO-8 Record of MSMK Pharmaceutical Intake	Performed as needed	Performed as needed.	
MO-2 Download of General MSMK Utilization Data from Bar Code Reader	Monthly or for medical reasons	10/4/96 11/15/96 12/16/96*	Corrupt data received in all downloads
MO-6 CSST	Weekly	Weekly	Completed

SMP Research *Mir*-23/NASA-4

Appendix 6

Experiment	Planned	Completed	Notes
MO-1 Private Medical Conferences	first 7 days - daily weekly after that	first 7 days - daily then once a week	
MO-9 Physical	monthly or for medical reasons	02/06/97 - incorrect data received, subsequently not performed	Portable Blood analyzer (PCBA) software incompatible with delivered cartridges
M-10 Urine Sample Analysis	Once a month	Survey not performed	As recommended by NASA surgeon. Astronaut performed MK-27
MO-11 Radiation Data Download from TEPC	MIPS download - monthly, display reporting - weekly	Download monthly: 02/13-14, 03/19-20, 04/17-18, 05/14-15/97 voice reporting - weekly	Completed
MO-12 Radiation Monitoring	Continuous monitoring	Continuous monitoring 01/16/97 - 05/19/97	Completed
MO-14 Environmental Health Anomalies	Monthly	Monthly: 01/23-24; 02/20-21*; 04/16-17; 05/12-13/97 Additionally: 02/23/97	No research was performed in March since all the formaldehyde monitors were used up during the *Mir* fire. Operations continued following delivery of new hardware aboard Progress.
MO-8 Record of MSMK Pharmaceutical Intake	Performed as needed	Performed as needed	
MO-2 Installation of Coded BDL Software		01/23/97	Completed
MO-2 Download of General MSMK Utilization Data from Bar Code Reader	Monthly or for medical reasons	02/14; 03/25/97*	Both the files contained corrupt data
MO-6 CSST	Weekly	Weekly	Completed
Archive Water Sample Analysis	Condensate sampling - 2 sessions Water sampling prior to and after MFU replacement, during mated flight (3 sessions)	Condensate sampling - 3 sessions: 02/1-4, 05/13-16, 05/16-19/97 Water sampling - 3 sessions: 01/18, 01/30, 05/05/97	Completed

Appendix 6 Cont.

Experiment	Planned	Completed	Notes
MSD021 Crew Microbial Assessment	Monthly, NASA Astronaut	3 sessions - NASA Astronaut: 01/30, 03/05, 05/05/97* One session each per *Mir* crew member	* Not performed in April since 2 kits were used by mistake in the course of the first session (cosmonaut samples were taken)
MSD021 *Mir* Microbial Assessment	Monthly, air and surface sampling	Monthly: 01/18, 01/30, 03/05, 04/01, 05/05/97	Completed
MSD021 Toxicological Assessment of Airborne Volatile Compounds	SSAS sampling - 5 sessions GSC sampling - 4 sessions	SSAS sampling: 01/21-22, 02/12-13 (02/23-24/97*), subsequently not performed* GSC sampling: 01/21, 02/12, (02/23-24*), 04/16, 05/12/97	On 02/23-24/97 because of the *Mir* contingency the NASA flight engineer decided to use up all SSAS and GSC to evaluate the dynamic of the condition of the station's atmosphere. Additional samplers (GSC only) were delivered by Progress following which the experiment was continued.

SMP Research *Mir*-23/NASA-5

Appendix 7

Name of monitoring activity	Planned	Implemented	Comments
MO-1 Private medical conferences	first 7 days - daily, then - once a week	first 7 days - daily, then - once a week	Completed
MO-9 Physical examination	once a month or per medical indications	6/13/97	* Completed
MO-10 Urine sample analysis	once a month	was not conducted	Per NASA flight surgeon recommendation. Astronaut completed MK-27 (Biochemical study of urine)
MO-11 Radiation data download from TEPC hardware	MIPS loading - once a month display data download - once a week	Loading: 6/8-9/97 voice downlink - weekly	* Completed
MO-12 Radiation monitoring	Continuous monitoring	Continuous monitoring 5/19/97 - 10/3/97	* 12 dosimeters out of 18, since 6 dosimeters remained in Spektr
MO-14 Environmental Health Anomalies	5 sessions	2 sessions 5/29-30/97, 6/18-19/97	* Completed
MO-8 Record of MSMK pharmaceutical intake	Performed as needed		*
MO-2 Download and downlink of total General (MSMK) utilization data from Bar Code Reader	once a month or per medical indications		* Completed
MO-6 CSST Name changed as of NASA-5: Assessment of Crew Psychological Condition and Effectiveness of Psychological Support Measures	once a week	once a week til August**	** Was not conducted after that - astronaut's request

Appendix 7 Cont.

Name of monitoring activity	Planned	Implemented	Comments
Water archive sample test	Condensation sample collection - 2 sessions - Water sample collection during the docked period, before and after Purification Column Unit (БКО) replacement (3 sessions)	- Condensation collection - 2 sessions: 5/20/97**, 8/4-7/97 - Water sample collection - 1 session during the docked period 5/19/97	* ** Out of two Potable Water Tanks (ЕДВ) there were taken samples of atmospheric humidity condensate (KAB) which was collected at the time of ethylene glycol leaks
MSD021 Crew microbial assessment	once a month of NASA astronaut and cosmonauts	1 session for each crew member	*
MSD021 *Mir* microbial assessment	once a month	2 sessions 5/18/97, 5/28/97 (surface) 6/2/97 (air)	*
MSD021 Toxicological assessment of volatile organic compounds in the atmosphere	SSAS sample collection - 5 sessions GSC sample collection - 4 sessions	SSAS sample collection - 2 sessions: 5/29-30/97, 6/18-19/07 GSC sample collection - 1 session: 6/18/97	*
Defibrillator and *Mir* Medical Restraint System	defibrillator checkout - once in 45 days CMRS checkout - one time	defibrillator checkout - 5/24/97, 8/5/97 CMRS checkout - 6/3/97	
CPA readings	Every 5 days	Every 5 days with an interval from 7/3/97 to 7/24/97**	** Due to a limited battery charge
Air sample ethylenglycol test	If required	6/9/97, 6/16/97, 6/23/97, 6/30/97, 7/24/97, 7/30/97, 8/4/97, 8/23/97, 9/1/97 - 9 sessions**	** Due to ethylene glycol leaks

* The studies were terminated because part of the hardware became unavailable due to the Spektr failure.

SMP Research *Mir*-24/NASA-6

Appendix 8

Name of monitoring activity	Planned	Implemented	Comments
MO-1 Private medical conferences	first 7 days - daily, then - once a week	first 7 days - daily, then - once a week	Completed
MO-9 Physical	once a month or per medical indications	(11/13/97, 12/21/97)*	*Form 020 report on health status. Blood test from PCBA was not conducted, because cartridges were stored in БХ-2 where temperature exceeded +8°C
MO-11 Radiation data download from TEPC	MIPS loading - once a month display data download - once a week	Loading - once a month 10/9-10/97, 11/13-14/97, 12/22-23/97 + 12/30/97*, 01/21-22/98 voice downlink - weekly	TEPC replacement - 9/30/97 * Due to TEPC transfer back to PRIRODA. From 12/23/97 to 12/30/97 it was located in the KRISTALL module
MO-12 Radiation monitoring	Continuous monitoring	Continuous monitoring 10/3/97 - 1/27/98	Completed
MO-14 Environmental Health Anomalies	5 sessions	5 sessions 10/13-14/97, 10/30-31/97, 11/20-21/97, 12/18-19/97, 1/12-13/97	Completed
MO-6 CSST Name changed as of NASA-5: Assessment of Crew Psychological Condition and Effectiveness of Psychological Support Measures	once a week	once a week till 1/3/98	* Was not conducted after that - astronaut's request
Archive Water Sample Analysis	Condensation sample collection (into Russian sample collectors) - 2 sessions 1 session - water sample collection during the docked period	- Condensation collection - 3 sessions: 11/13-17/97, 1/16-19, 25-28/98 - Water sample collection - 1 session during the docked period 10/1/97	Completed
MSD021 *Mir* microbial assessment	3 sessions of water collection (before, after multifiltration unit (БКО) replacement, at the end of the flight) 4 sessions of air and surface sample collection	Water collection - 3 sessions: 11/17/97, 11/27/97, 1/19/98 Air and surface samples - 4 sessions: 10/2/97, 10/22/97, 11/17/97, 1/2/98	Completed

Name of monitoring activity	Planned	Implemented	Comments
MSD021 Toxicological assessment of volatile organic compounds in the atmosphere	SSAS sample collection - 5 sessions GSC sample collection - 5 sessions	SSAS sample collection - 5 sessions: 10/13-14/97, 10/30-31/97, 11/20-21/97, 12/18-19/97, 1/12-13/98 GSC sample collection - 6 sessions: 10/30/97, 11/20/97, 12/18/97. 12/21/97*, 1/12/98, 1/24/98	* Additionally, due to Freon leak
Defibrillator and *Mir* Medical Restraint system	defibrillator checkout - once in 45 days CMRS checkout - one time	defibrillator checkout - 10/10/97, 1/22/98 CMRS checkout - 1/22/98	Completed
MSD011 Nutritional Status Assessment	Once a week	Once a week	Completed
MSD008 In-flight orthostatic tolerance test	two times during the flight (during Russian LBNP test - MK-4)	once during the flight (12/25/98)*	* MK-4 was conducted, astronaut did not find equipment to execute U.S. ABPM protocol
MSD008 Physical Fitness Assessment	- Daily - recording of the execution of physical exercises and heart rate monitoring during physical exercises - once a week - heart rate monitor data loading - once a month - graded cycle ergometer test	- Daily recording of the execution of physical exercises and heart rate monitoring during physical exercises from 10/4/97 (the 7th day) - Heart rate monitor data loading - weekly Graded cycle ergometer test 10/9/97, 12/2/97, 1/23/98*	* Was not conducted in November due to TM unavailability (Medical Support Team requirement)
Special assessment of *Mir* environment	- 4 sessions - Condensation sample collection (into U.S. sample collectors) - once in 5 days - CPA readings - For contingency situations - Air sample ethylenglycol test - For contingency situations - Free water collection	Condensation collection - 3 session: 11/27-28/97, 1/17-19, 26-28/98 CPA - every 5 days - 12/4/98* - 1/19/98	Upon IBMP request due to current heating loop activities

SMP Research *Mir* - 25/NASA - 7

Appendix 9

Name of Monitoring Activity	Planned	Implemented	Comments
MO-1 Private Medical Conferences	Daily during first 7 days, then weekly	Daily during first 7 days, then weekly	Closed
MO-9 Physical	Monthly, or following medical data	Monthly: 02/23, 03/12, 04/24, 05/26/98	Closed
MO-11 Radiation Data Download from TEPC	Monthly MIPS Inputs, Weekly Display Information Reports	Monthly Inputs: 02/10-11, 03/12-13, 04/23-24, 05/13-14, 05/28-29/98; Weekly Voice Downlink	Closed
MO-12 Radiation Level Monitoring	Continuous Monitoring	Continuous Monitoring since 01/27/98	Completed as planned
MO-14 Environment Health Anomalies	5 Sessions	5 Sessions: 02/5-6, 03/6-7, 03/27-28, 04/28-29, 05/25-26	Closed
MO-6 CSST	Weekly	Weekly	Closed
Archive Water Samples Analysis	2 Sessions - Condensate Sample Collection (in Russian Samplers) 1 Session - Waster Sample Collection in Mated Flight	Condensate Collection - 3 Sessions: 04/26, 05/08, 06/3-7/98 Water Sample Collection - 2 Sessions in Mated Flight 01/26, 06/07/98	*STS-89 and STS-91
MSD021 *Mir* Microbial Assessment	3 Sessions of Water Collection (Before and after Multifiltration Unit Replacement, at the end of flight) 5 Sessions of Air and Interior Surface Sample Collection	Water Collection - 3 Sessions: 0.4/09, 04/23, 05/21/98. Air and Interior Surface Samples - 5 sessions: 01/26, 03/05, 04/09, 05/20, 06/05/98.	Closed
MSD021 Toxicologic Assessment of Volatile Organic Compounds in the Atmosphere	SSAS Uses - 5 Sessions GSC Uses - 5 Sessions	SSAS Sampling - 5 Sessions: 02/5-6, 03/6-7, 03/27-28, 04/28, 29, 05/25-26/98 GSC Sampling - 7 Sessions: 02/28,*03/06, 03/27, 04/29, 05/25, 05/29, *06/04/98	* Additional sessions taken on recommendation of Consultants' Group

Appendix 9 Cont.

Name of Monitoring Activity	Planned	Implemented	Comments
Defibrillator and *Mir* Medical Restraint System	Defibrillator Checkout - Every 45 Days CMRS Checkout - once	Defibrillator Checkout - 02/06, 03/18, 04/30/98 CMRS Checkout - 02/24/98	Closed
MSD011 Nutritional Status Assessment	Weekly	Weekly	Closed
MSD008 In-Flight Orthostatic Tolerance Test	Daily - Exercise Registry and Pulse Rate Monitoring During Exercises Once a week - Pulse Rate Monitor Data Input Once a month - Ergometer Graded Load Test	- Exercise Data Recording and Pulse Rate Monitoring During Exercises daily from 01/31/98 (the 7th day) - Weekly Pulse Rate Monitor Data Input Ergometer Graded Load Test: 02/25, *05/18/98;	* Suspended in March and April at NASA flight surgeon's recommendation due to a large number of load samples taken under Russian Medical Operations Program
Special *Mir* Environment Assessment	- 2 Sessions - Condensate Sample Collection (in American Samplers) - Every 5 days - CPA Data Collection Air Samples for Ethylene Glycol at ONS Free Floating Water Collection at ONS	Condensate Collection - 3 Sessions: 04/27, 05/08, 06/3-7/98 CPA - Every 5 Days 02/24/98*	*In CTV at IMBP recommendation
MSD084 *Mir* Acoustic Noise Measurement	In Modules -2 Sessions in Each Module (12 Sessions) Crew Members -2 Sessions by Each Crew member	02/2-3, 4-5, 9-10, 23-24, 27-28; 03/6-7, 9-10, 12-13, 16-17, 20-21, 26-27; 03/31-04/01; 04/8-9, 13-14, 21-22, 27-28; 05/5-6, 13-14, 19-20/98	*The cosmonauts have not performed this research
MSD071 In-Flight Holter Monitoring	Every month	02/23-24, 04/24-25, 05/26-27/98	
MSD085 Neurocognitive Assessment	Every month	03/26, 04/25/98	

INFORMATION
Concerning Psychological Support of American Astronaut Missions on the *Mir*
Mir-NASA Program

Appendix 10

	Psychological Support Activities								Monitoring	
Mission	Parcels, Surprise Packages	Conferences With Relatives and Friends		TV and Radio	Packet and Radio Ham Comm	Radio News and Entertain-ment Program	News Program (daily)	Conferences With Consultant Group	Neuropsycho-logical Status (daily)	Work and Rest Mode (daily)
		TV Sessions	Phone Convers.	Conferences With Guests						
NASA - 1 Thagard	1	3	5	3		5	+	+	+	+
NASA -2 Lucid	3	8	17	13	+	8	+	+	+	+
NASA - 3 Blaha	2	5	10	7	+	7	+	+	+	+
NASA - 4 Linenger	1	3	14	5	+	6	+	+	+	+
NASA - 5 Foale	2	2	14	12	+	28	24	+	+	+
NASA - 6 Wolf	1	6	13	9	+	19	24	+	+	+
NASA - 7 Thomas	1	5	9	13	+	7	+	+	+	+

NASA 6 astronaut David Wolf and NASA 7 astronaut Andy Thomas during a handover session