

International Space Station Medical Operations Requirements Document (ISS MORD)

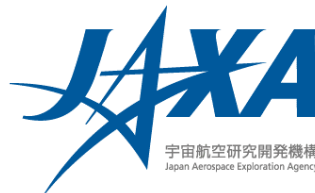
International Space Station Program

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*Russian
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Agency*



National Aeronautics and Space Administration
International Space Station Program
Johnson Space Center
Houston, Texas



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International Space Station Program

**INTERNATIONAL SPACE STATION MEDICAL
OPERATIONS REQUIREMENTS DOCUMENT (ISS MORD)**

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AUGUST 2005

Revision B

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Revision C

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SSP 50260, International Space Station Medical Operations Requirements Document (ISS MORD), has been approved by the authority of SSCD 007768. All future updates to this document will be identified on this change sheet.

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Revision B (Reference SSCD 007768, dated 04-19-03)

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INTERNATIONAL SPACE STATION PROGRAM

**INTERNATIONAL SPACE STATION MEDICAL
OPERATIONS REQUIREMENTS DOCUMENT (ISS MORD)**

AUGUST 2005

PREFACE

**INTERNATIONAL SPACE STATION MEDICAL
OPERATIONS REQUIREMENTS DOCUMENT (ISS MORD)**

The requirements necessary to perform medical operations applicable to the ISS Program are defined and controlled herein. This document delineates the medical operations requirements for all phases of ground, flight, and payload/experiment-related activities. These requirements are in accordance with responsibilities assigned by applicable NASA Policy Directives (NPDs), Code of Federal Regulations (CFRs), ISS Program charters, and Memoranda of Understanding (MOU).

The contents of this document are intended to be consistent with the tasks and products to be prepared by Program Participants. This International Space Station Medical Operations Requirements Document (ISS MORD) will be specific to the ISS Program. Approval authority for this document is delegated to the Mission Integration and Operations Control Board (MIOCB). Control of all technical content for this document is delegated to the Multilateral Medical Operations Panel (MMOP), with coordination through the Multilateral Medical Policy Board and concurrence by the Space and Life Science Directorate (SLSD), Flight Crew Operations Directorate (FCOD), Mission Operations Directorate (MOD), and ISS Program Managers.

William H. Gerstenmaier
Program Manager
International Space Station Program

Date

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OPERATIONS REQUIREMENTS DOCUMENT (ISS MORD)**

CONCURRENCE

AUGUST 2005

Prepared by: _____ SD
Book Manager, ISS MORD Date

Concurred by: _____ SD
Lead, ISS Flight Surgeon Date

Concurred by: _____ SD
Manager, Medical Operations Date

Concurred by: _____ SD
Chief, Space Medicine and Health Care Systems Office Date

Concurred by: _____ SA
Director, Space and Life Sciences Directorate Date

DQA: _____ OL
Configuration Management Representative Date

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AUGUST 2004

Concurred by: _____ CA
Director, Flight Crew Operations Directorate Date

Concurred by: _____ DA
Director, Mission Operations Directorate Date

MULTILATERAL MEDICAL OPERATIONS PANEL APPROVAL NOTICE

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AUGUST 2005

_____ Co-Chair, Multilateral Medical Operations Panel National Aeronautics and Space Administration	_____ Date
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_____ Co-Chair, Multilateral Medical Operations Panel Federal Space Agency	_____ Date
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_____ Member, Multilateral Medical Operations Panel European Space Agency	_____ Date
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_____ Member, Multilateral Medical Operations Panel Canadian Space Agency	_____ Date
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_____ Member, Multilateral Medical Operations Panel Japan Aerospace Exploration Agency	_____ Date
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NASA/FSA
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INTERNATIONAL SPACE STATION MEDICAL
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CONCURRENCE

AUGUST 2005

NASA

FSA

James M Duncan, M.D.
Medicine and
Medicine Health Care Systems Office

Krasnov Alexey B. Chief, Space
Chair of FSA Department of the
Manned Space Programs

Date

Date

FSA

Dr. Grigoriev Anatoly I.
Academician of RAS, Primary
Representative from FSA
Related To ISS Medical
Assurance

Date

NASA/JAXA

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CONCURRENCE

AUGUST 2005

NASA

JAXA

James M Duncan, M.D.
Chief, Space Medicine and
Medicine Health Care Systems Office

Kuniaki Shiraki
JAXA Program Manager

Date

Date

NASA/ESA

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CONCURRENCE

AUGUST 2005

NASA

ESA

James M Duncan, M.D.
Chief, Space Medicine and
Medicine Health Care Systems Office

Hiltrud Pieterek
Head of Operations
Management Division
Operations Department, ESA
Directorate of Human Spaceflight

Date

Date

NASA/CSA

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CONCURRENCE

AUGUST 2005

NASA

CSA

James M Duncan, M.D.
Chief, Space Medicine and
Medicine Health Care Systems Office

Jean-Marc Comtois, BEng, M.D.
Director, Operational Space
Acting-Director, Canadian
Astronaut Office

Date

Date

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CONCURRENCE

AUGUST 2005

Concurred by:

Chair, Mission Integration and Operations
Control Board (MIOCB)

Date

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1.0 INTRODUCTION

The International Space Station (ISS) requires continuous human occupancy on long duration spaceflight missions. Ensuring overall health and safety of the crew to optimize human performance throughout all mission phases is the joint responsibility of the medical support offices of each International Partner (IP) through participation in the Multilateral Medical Operations Panel (MMOP). Requirements are developed and concurred upon by the MMOP for formal input into the ISS Program multilateral Mission Integration and Operations Control Board (MIOCB).

1.1 PURPOSE

This document establishes requirements for the ISS Program relating to Medical Operations in accordance with the responsibilities assigned by applicable NASA Policy Directives (NPDs), Code of Federal Regulations, ISS Program charters, IP Program Directives, and international Memoranda Of Understanding (MOUs). These requirements pertain to the development of medical selection and certification standards; countermeasures definition and implementation; medical monitoring; response capability for in-flight medical events; support of individual and crew behavioral health and performance; environmental monitoring; Emergency Medical Services (EMS) support; establishment of a process for medical training and certification of ISS crewmembers, IP flight surgeons (IP FS), and other medical support personnel; and post-flight activities, including rehabilitation.

1.2 SCOPE

This document delineates the ISS Program level medical operations requirements for all phases of ground, flight, and payload/experiment-related activities. The focus of each requirement is to state “what” is required, not “how”. Supporting information to aid the implementer in understanding a requirement, or existing processes relating to the requirement, is included in the rationale. It is not the intent of this document to repeat ISS requirements contained in other ISS Program specifications. The body of this document reflects what is approved by the ISS Program. Appendix F, Table F-1, contains previously existing requirements that are approved by the ISS Program Office but unfunded or not met. Table F-2 contains new requirements introduced by the current document revision that have not been dispositioned as of the print date by the ISS Program.

This document, SSP 50260, International Space Station Medical Operations Requirements Document (ISS MORD), is specific to the ISS Program Office. Subordinate documents to the ISS MORD outlines specific implementations, such as the SSP 50667 Medical Evaluation Document (MED) <TBS 1.2-1>; JSC 27050, Postflight Rehabilitation Plan; JSC 48522, International Space Station (ISS) Integrated Medical Group (IMG) Medical Checklist – ISS All Expeditions; SSP 50470, Crew Health Care System (CHeCS) Government Furnished Equipment (GFE) Specification; SSP 50480, ISS Joint Medical Operations Implementation Plan (JMOIP); SSP 50261-01, 02, Volumes 1 and 2, Ground Rules Requirements and Constraints; SSP 54101 series,

Increment Definition and Requirements Documents, and selected IP analog documents relating to ISS operations. Similarly, ISS MORD requirements are implemented at NASA sites via site-specific Medical Operations Support Implementation Plans (MOSIPs) and on IP sites via specific implementation plans as appropriate. The ISS MORD and its subordinate documents contain references to SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), as well as SSP 41000, System Specifications for the International Space Station, which contain standards and guidelines governing implementation of medical and habitability requirements. Module-specific specifications and standards for the US and Russian Segment of the ISS are provided in SSP 41162, Segment Specification for the United States On-Orbit Segment, SSP 41163, Russian Segment Specification and SSP 50094, NASA/RSA Joint Specifications Standards Document for the ISS Russian Segment.

Actual procedures and details of the processes for operational medical support of ISS are described in the SSP 50480, ISS Joint Medical Operations Implementation Plan (JMOIP), JSC 28913, Medical Requirements Integration Documents (MRIDs), SSP 540XX-ANX2, Increment Definition and Requirements Document for Increment X, Annex 2: On-orbit Maintenance Plan, SSP 540XX-ANX 3, Increment Definition and Requirements Document for Increment X: Annex 3: Imagery Requirements and SSP 540XX-ANX 4, Increment Definition and Requirements Document for Increment X, Annex 4: Medical Operations and Environmental Monitoring.

1.3 PRECEDENCE

The Program-level medical operations requirements are contained in this document. In the event of conflicting statements regarding medical operations between this document and implementing documents, once approved for an increment, the implementing documents will take precedence. These documents include the GGR&C, IDR D and applicable IDR D Annexes (1, 2, 3, and 4) and Flight Rules.

1.4 APPLICABILITY

Medical Operations requirements baselined in this document are applicable to all ISS and ISS-related flight activities, including those involving Shuttle, Soyuz, and other vehicles that may conduct ISS flight operations.

1.5 LAUNCH READINESS

At approximately L-1 month, the formal MMOP Launch Readiness process begins which consists of a review of the Appendix E: The Launch Readiness Endorsements and the Launch Readiness Checklist, Table E-1. The results of the review are documented in a launch readiness statement to the ISS Program signed by each MMOP agency representative. This statement provides a summary of the findings of the review, lists the status of the crew preparation for their mission, the station environment suitability and/or any medical constraints that may exist.

1.6 REVISIONS

Updates and refinements to operational medical requirements may arise during the life of ISS driving a need for periodic reviews. The MMOP will coordinate reviews of the ISS MORD, initiating changes as needed. Changes to the ISS MORD will be authorized by the MMOP and coordinated with the Multilateral Medical Policy Board (MMPB), with concurrence by the multilateral MIOCB.

1.6.1 Issues and Open Work

Because of the complex and dynamic nature of the ISS development and implementation there can be unresolved issues concerning new or existing requirements. These unresolved issues are identified by a “<TBR x.x>” in the text. Appendix C, Open Work, captures all of the To Be Resolved (TBR) issues associated with this document.

All open work is identified by a “<TBD x.x or TBSx.x>” in the text. Appendix C captures all of the To Be Determined (TBD) and To Be Supplied (TBS) items associated with this document. Once the TBD information is defined and approved, the correct text is inserted in place of the TBD in the document.

1.7 AUTHORITY

The specific provision of medical services is authorized by NPD 8900.1F, Medical Operations Responsibilities in Support of Human Space Flight Programs; NPD 8900.3F, Astronaut Medical and Dental Observation, Study, and Care Program; NPD 1800.2A, NASA Occupational Health Program; JSC Policy Directive (JPD) 1830.1K, Medical Examination of Flight Control Team Members; and SSP 50200-01, Station Program Implementation Plan, Volume 1: Station Program Management Plan; and the International MOUs pertaining to ISS.

1.7.1 Medical Authority Structure

The multilateral medical management groups are established by the MOUs between NASA, the Canadian Space Agency (CSA), the European Space Agency (ESA), the Federal Space Agency (FSA), the Government of Japan Concerning Cooperation On The Civil International Space Station, and by the charters developed for the MMPB, Multilateral Space Medicine Board (MSMB), MMOP, Space Medicine Operations Team (SMOT), Space Medicine Management Team (SMMT), and the Integrated Medical Group (IMG). In general, active participation of medical representatives on ISS mission increments will be reflective of crew representation on that increment. However, all IPs will have insight and inputs into activities affecting overall Medical Operations policies and procedures for the ISS.

1.7.1.1 Multilateral Medical Policy Board (MMPB)

The MMPB is responsible for top-level medical policy and oversight. Each IP will endorse a single medical representative as a member of the MMPB. Selected products

of subordinate medical working groups will be submitted to the MMPB for approval. During the ISS Assembly Phase until Assembly Complete the MMPB will be co-chaired by NASA and FSA representatives. Following Assembly Complete, chairpersonship will rotate among the MMPB members on an annual basis. The MMPB also receives findings and recommendations from the MMOP.

1.7.1.2 Multilateral Space Medicine Board (MSMB)

The MSMB is responsible for crew medical certification for ISS mission increment training and flight. A designated physician from each IP will comprise MSMB membership, which will operate on the principle of consensus. A prime member and an alternate will be endorsed by each IP for MSMB participation. Ad hoc, non-voting consultative members may be added as required for the purposes of specialty consultation. During the ISS Assembly Phase until Assembly Complete the MSMB will be co-chaired by a NASA and an FSA representative. Following Assembly Complete, chairpersonship will rotate among the MSMB members on an annual basis. Results of IPs' independent medical boards will be presented to the MSMB. The MSMB also receives findings and recommendations from the MMOP. Decisions and findings are forwarded to the MMPB and to the Multilateral Crew Operations Panel (MCOP) as appropriate. The MSMB will also approve mission-assigned flight surgeons endorsed by the MMOP based on established credentialing standards. Following any action that alters crew eligibility for flight or training activities, the MSMB may function autonomously for a period of six months in efforts to resolve crewmember flight or training status. After six months, the MSMB must report this action to the MMPB.

1.7.1.3 Multilateral Medical Operations Panel (MMOP)

The MMOP establishes processes for medical training and certification of ISS crewmembers; develops medical selection and certification standards; defines and implements medical monitoring and countermeasures; develops and implements response capability for in-flight medical events; develops requirements for hardware and ground support; develops requirements for human behavior and performance support; develops requirements for the monitoring of the environment; and develops requirements for the EMS. In addition, the MMOP will develop certification guidelines for ISS IP FSs and endorse mission-assigned IP FSs to the MSMB for approval.

MMOP membership consists of medical representatives from all IPs. The MMOP coordinates specialty working groups and assigns working level action items on ISS biomedical issues. The MMOP presents its findings and recommendations to the MMPB and MSMB as required and interfaces with the ISS Program through the multilateral MIOCB. The MMOP operates on the principle of consensus. Until Assembly Complete the MMOP will be co-chaired by the NASA and FSA representatives. Following Assembly Complete, chairpersonship will rotate among the MMOP members on an annual basis. It is the responsibility of the MMOP to coordinate operational medical requirements and other inputs from the various groups and bring these forward to the multilateral MIOCB in compliance with standard formats and procedures.

An MMOP Implementation Team (MIT) will function under the auspices of the MMOP. The MIT is based at JSC and works within the Space Medicine and Health Care

Systems Office (SMHCSO). The MIT is charged with integration and implementation of MMOP approved requirements, medically relevant protocols and procedures, training and logistics flows, timeline inputs, and mission planning and support. The MIT is also tasked with answering questions relevant to medical operations based on MMOP decisions and ISS Program policy. The MIT will provide a mechanism for timely resolution of medical operational issues. The Chair of the MIT is designated by the Chief, SMHCSO.

1.7.1.4 Space Medicine Operations Team (SMOT)

The ISS SMOT is co-chaired by the co-chairs of the MMOP and is a standing multilateral forum of the MMOP for:

- Periodic briefings, status reports, and updates to the ISS management from:
 - The IMG
 - Operational discipline groups/experts as appropriate
- International discussion and resolution of operational issues and concerns pertaining to:
 - ISS crew health, safety, well-being, and performance
 - Working conditions of ISS crew, including work/rest and sleep/wake cycles
 - ISS external and internal environment and habitability
 - ISS Integrated Medical System (IMedS) hardware and operation
 - Medically relevant aspects of vehicles and crews visiting ISS
 - Other medically relevant matters
- Generation of integrated medical input into the ISS Program/ISS Mission Management Team (IMMT) on operational matters, in response to inquiries or as otherwise appropriate

Private medical and/or other sensitive information may be discussed at any time during SMOT teleconferences. Therefore, participation is limited to physicians from ISS IP agencies, essential support personnel, and experts invited for specific topics.

1.7.1.5 Space Medicine Management Team (SMMT)

The ISS SMMT is a standing multilateral forum for:

- Identification of ongoing or recurrent issues and concerns pertaining to:
 - ISS crew health, safety, well-being, and performance
 - Working conditions of ISS crew, including work/rest and sleep/wake cycles
 - ISS external and internal environment and habitability
 - ISS IMedS hardware and operation
 - Medically relevant aspects of missions visiting ISS
 - Other medically relevant matters
- Prioritization of activities directed at resolution of identified issues
- Development of paths for resolution of identified issues
- Consideration of medical support results after each ISS Expedition
- Other relevant matters as deemed appropriate by permanent members

Participation is limited to physicians and essential invited and support personnel, and includes:

- Chief medical officers for ISS of all IP agencies
- Chiefs of medical mission support organizations (medical operations) of all IPs, and other physician managers as appropriate

1.7.1.6 Integrated Medical Group (IMG)

The IMG shall be the primary interface of medical operations with the Flight Control Team. The Expedition Crew Surgeon (CS) shall lead and coordinate the activities of the IMG.

Rationale: Flight Control Group implementation of the medical support program is entrusted to the Integrated Medical Group (IMG). The IMG will be formed from a cadre of International FSs trained to MMOP standards and certified by MSMB as well as Medical Support Specialists at MCC-H, MCC-M or MCC-IP with crewmembers assigned to the mission. Consultants, specialists in medicine and psychology will also be included as needed.

Members of the IMG at the MCC-H consists of:

- Expedition Crew Surgeon,
- Deputy Crew Surgeon
- IP FS
- Expedition Biomedical Engineer (BME)
- Medical representatives of GMO MCC-M at RRGU or (MCC-IP)

Members of the IMG at the MCC-M consists of Lead Specialists of the GMO:

- Medical Support Deputy Flight Director (FD)
- GMO Lead
- GMO Shift Lead

Members of the IMG at ESA Medical Console:

- ESA FS
- ESA BME

Members of the IMG at JAXA Medical Console:

- **<TBD 1.7.1.6-1>**

Members of the IMG at CSA Medical Console:

- **<TBD 1.7.1.6-2>**

The composition and interactions of the IMG are outlined in Figure 1. 7-1 and is detailed below:

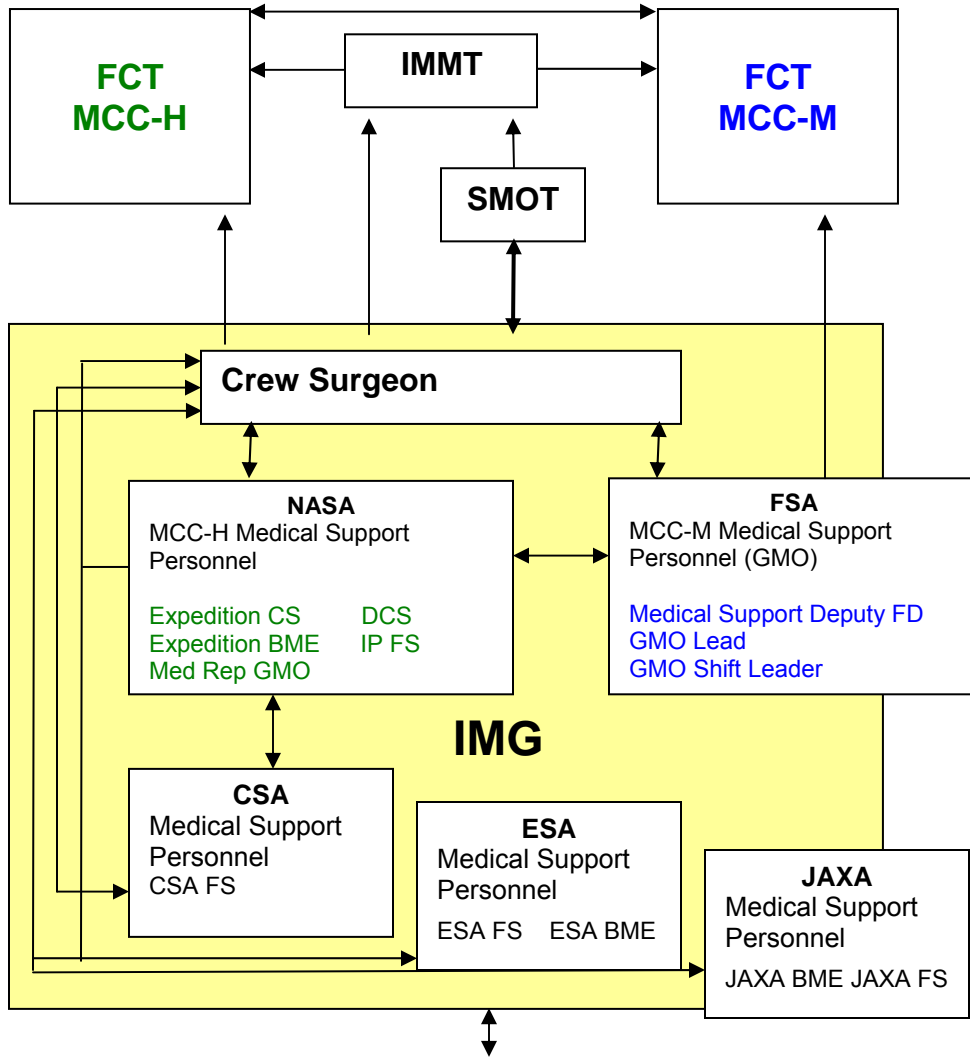


FIGURE 1.7-1 COMPOSITION AND INTERACTION OF THE IMG

Each IP Agency having an assigned crewmember on mission to ISS (Expedition or visiting vehicle) will provide a dedicated IP FS to the IMG.

Specific details concerning the roles of the CS and all IMG specialists are contained in Section 3.0 of this document.

The IMG will represent the integrated medical position of all IP medical organizations. If no medical consensus can be reached in the IMG, then issues will be referred to the SMOT and if need be to the SMMT.

1.7.2 Medical Authority – Staged Operations

Medical authority for ISS medical decision-making lies with the CS. However, except for acute medical contingency situations requiring real-time decisions, medical decision-making will include members of the IMG.

1.7.3 Medical Authority – Docked Operations

During periods of undocked operations, the IP FS responsible for the visiting crew will have medical authority for the crewmembers onboard the visiting vehicle (Shuttle, Soyuz or other) until the vehicle docks to the ISS. At this point, when hatches open, medical authority for all crew onboard the ISS lies with the CS and IMG. The IP FS responsible for the visiting crewmembers will become a member of the IMG and will coordinate crew health care issues with the CS, DCS, and IP FS as part of the IMG. After final hatch closure with ISS, medical responsibility of the visiting vehicle will be returned to the visiting crew IP FS.

1.7.4 ISS Medical Operations Management Structure

Medical Operations management structure is depicted below in Figure 1.7-2. Further explanation of how Medical Operations Management Structure relates to the ISS Program Office structure can be found in the SSP 50200-01, Station Program Implementation Plan, Volume 1: Station Program Management Plan.

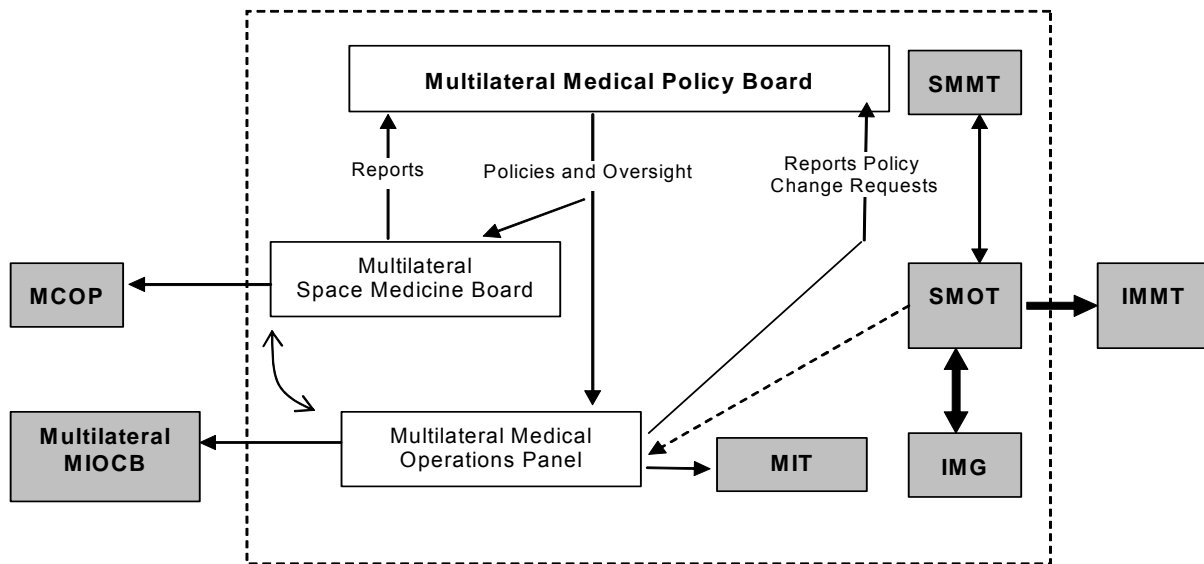


FIGURE 1.7-2 ISS MEDICAL OPERATIONS MANAGEMENT STRUCTURE

1.8 PRIVACY OF MEDICAL INFORMATION

Provisions of the Privacy Act of 1974, as amended, as regarding control of records, information exchange, and release of crewmember health information to the public will be strictly followed. IPs may levy supplemental requirements regarding handling of medical information on their crewmembers. These constraints must be presented to and approved by the MSMB and MMPB prior to the beginning of training for the IP's crewmember. Communications pertaining to an individual's health care will be private as regulated by the controls, regulations, provisions, and penalties of the Privacy Act of 1974.

1.8.1 Handling and Release of Medical Data

Preflight, in-flight, and post-flight operational and research medical data collected on all spaceflight crewmembers will be managed according to the amended Privacy Act of 1974 and JMI 1382.5B, Maintaining the Privacy of Biomedical Research Data.

IP Medical Organizations will have access to crewmember health information and all information that may impact crew health during all phases of training and mission (whether archived or real-time).

Requests for crewmember health status information from outside the nominal working-level medical support or management chain will be coordinated with the JSC Chief, SMHCSO, and the appropriate representative of IP medical management as determined by the MMOP.

Public release of biomedical information or data concerning any flight crewmember will be made only with the prior approval of the crewmember in accordance with the provisions of the Privacy Act of 1974.

2.0 DOCUMENTS

2.1 Referenced DOCUMENTS

The following documents include specifications, models, standards, guidelines, handbooks, and other special publications referenced directly within the body of this document. The documents listed in this paragraph are applicable to the extent specified herein. Inclusion of referenced documents herein does not in any way supersede the order of precedence identified in Paragraph 1.3 of this document.

<u>Document Number</u>	<u>Title</u>
ANSI Z136.1	American National Standard for the Safe Use of Lasers
D528-10051-1	Food Facility Standard Operating Procedures Manual
GOST R 50804-95	Russian State Standards (ГОСТ)
IEEE-C95.1	IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kilo Hertz (kHz) to 300 GH
JMI 1382.5B	Maintaining the Privacy of Biomedical Research Data
JSC 13956	Medical Operations Requirements Document for Space Shuttle
JSC 16888	Shuttle Transportation System Microbial Contamination Control Plan (Replaces JSC-11859A)
JSC 20584	Spacecraft Maximum Allowable Concentrations for Airborne Contaminants
JSC 22538	Health Stabilization Program for the Space Transportation Program
JSC 27050	Postflight Rehabilitation Plan
JSC 27384	Behavioral Health and Performance Program Plan
JSC 27472	Requirements For Submission of Data Needed for Toxicological Assessment of Chemicals and Biologicals To Be Flown on Manned Spacecraft
JSC 27579	Astronaut Exercise Program
JSC 28038	Nutritional Requirements for International Space Station (ISS) Missions up to 360 Days
JSC 28046	International Space Station (ISS) Crew Medical Officer Training Syllabus
JSC 28566	Nutritional Status Assessment for Extended Duration Spaceflight
JSC 28719	Emergency Medical Services Plan for Russia
JSC 28913	Medical Requirements Integration Documents (MRIDs)
JSC 48522	International Space Station (ISS) Integrated Medical Group (IMG) Medical Checklist – ISS All Expeditions
JPD 1830.1K	Medical Examination of Flight Control Team Members
KSC-OMRS-ACOMC	Technical Requirements

<u>Document Number</u>	<u>Title</u>
NHB 1700.1(V-1B)	NASA Safety Policy and Requirements Document, Volume 1B
NHB 8060.1	Replaced by NASA-STD-6001, Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion
NPD 1800.2A	NASA Occupational Health Program
NPD 8900.1F	Medical Operations Responsibilities in Support of Human Space Flight Programs
NPD 8900.3F	Astronaut Medical and Dental Observation, Study and Care Program
NSTS 12820	ISS Generic Operational Flight Rules, Volume B, ISS Generic and Volume C, Joint Shuttle-ISS, Section 13, Aeromedical
NSTS 21426 ICA	Orbiter Crew Compartment Interface Control Annex Spacehab – General Research/Logistics Missions
RSA/IBMP XT-4.160.001	Regulations for Sanitary-Hygienic and Anti-Epidemic Support for Spaceflight at Prelaunch and Postflight Operation Stages
SD-T-0251L	Microbiological Specification and Testing Procedures for Foods which are not Commercially Sterile
SD-T-0252L	Microbiological Specification and Testing Procedures for Commercially Sterile Foods
SE-S-0073	Space Shuttle Specification Fluid Procurement and Use Control
SSP 30573	Space Station Program Fluid Procurement and Use Control Specification, Rev A.
SSP 41000	System Specifications for the International Space Station
SSP 41162	Segment Specification for the United States On-Orbit Segment
SSP 41163	Russian Segment Specification
SSP 50005	International Space Station Flight Crew Integration Standard (NASA-STD-3000/T)
SSP 50094	NASA/RSA Joint Specifications Standards Document for the ISS Russian Segment
SSP 50200-01	Station Program Implementation Plan, Volume 1: Station Program Management Plan
SSP 50261-01	International Space Station Generic Groundrules, Requirements, and Constraints Part 1: Strategic and Tactical Planning
SSP 50261-02	International Space Station Generic Groundrules and Constraints, Part 2: Execute Planning
SSP 50470	Crew Health Care System (CHeCS) GFE Specification
SSP 50480	ISS Joint Medical Operations Implementation Plan (JMOIP)
SSP 541XX (series)	Increment Definition and Requirements Document for Increment X
SSP 541XX-ANX 2 (series)	Increment Definition and Requirements Document For Increment X, Annex 2: On-orbit Maintenance Plan

<u>Document Number</u>	<u>Title</u>
SSP 541XX-ANX 3 (series)	Increment Definition and Requirements Document Increment X, Annex 3: Imagery Requirements
SSP 541XX-ANX 4 (series)	Increment Definition and Requirements Document Increment X, Annex 4: Medical Operations and Environmental Monitoring
SSP 50667	Medical Evaluation Document (MED)
<TBS 1.2-1>	Volume A Medical Standards for ISS Crewmembers Volume B Medical Evaluations for Increment-Assigned Crew Volume C Medical Standards for Space Flight Participants
SSP 57011	Payload Verification Program Plan
No number	MMOP Partner Data Sharing Plan
<TBS 2.1-2>	
No number	Regulations on Microbiological Requirements for Quality and Testing the Food Products for Cosmonauts

3.0 MEDICAL OPERATIONS PERSONNEL

This section identifies the medical operations personnel that will be assigned to support each ISS assigned crew and delineates their roles and responsibilities. These members include the ISS certified, Crew Surgeon (CS), Deputy Crew Surgeon (DCS), IP Flight Surgeons (IP FS), Biomedical Engineers (BME), and Crew Medical Officer (CMO). Ground based medical operations support personnel are also members of the IMG as defined in Section 1.7.1.6.

The roles and responsibilities of the medical operations personnel are based on having a single lead IP FS, referred to in this document as the CS, who will lead all medical operations for the assigned crew. All other members of the team perform their roles and responsibilities in support of the CS.

Assignment of the CS and DCS will be independent of the Increment Crew composition. If an IP has a crewmember assigned to an increment and that IP's FS is not the CS or DCS, then that IP can assign an IP FS to the increment. Every 6 months, a list of proposed CS, DCS, and IP FS assignments will be presented to the MMOP for approval.

Certification and training requirements of key medical operations personnel defined in this section are specified in Section 4.0 of this document.

3.1 ISS INTERNATIONAL PARTNER FLIGHT SURGEON (IP FS)

3.1.1 ISS Certified Flight Surgeon Cadre

The ISS Program shall establish a multilateral cadre of ISS-certified IP FSs.

Rationale: There is a need for a common standard in training and certification for all ISS-certified IP FSs who can serve as CS and DCS for a given increment, thus utilizing the IPs' FS resources in the most efficient way. Based on recommendations from the MMOP: "All members agree with the philosophy that an international medical group will be formed comprised of a cadre of IP FSs, trained to MMOP standards and certified by MSMB, providing multilateral medical support for ISS." (Item #13 of minutes from MMOP meeting, Nov 5-9, 2001.) ISS certified FSs include a FS employed by an IP who has been certified by the MSMB for ISS operations, including independent MCC console activities.

3.1.2 ISS IP FS Assignment

The ISS Program shall allow each IP represented in a given mission's crew to assign a crewmember-specific IP FS certified by the IP FS's home agency. This crew specific FS may or may not be ISS certified.

Rationale: An IP FS is a FS employed by an IP and assigned by that IP to a specific mission in support of that home agency. Each IP may assign its own IP FS. If the assigned crewmember-specific FS is not ISS certified, his/her tasks will exclude

independent MCC console activities. An ISS IP FS who is not ISS certified will be encouraged to seek certification.

3.1.3 IP FS Roles and Responsibilities

The IP FS roles and responsibilities shall include the following activities:

- A. inform their space agency and the CS of any changes in the health, performance, or physical fitness of their crewmember(s) which could impact training or on orbit operations
- B. coordinate their activities with their own MCC.
- C. assist the CS in the performance of his responsibilities (refer to Section 3.2.3) at the discretion of the CS
- D. if the IP FS is ISS certified, he/she can serve as the designee for the CS and work console independently when required

Rationale: An IP FS serves as the liaison between his/her home agency and the ISS Program. The IP FS will assist the CS to monitor medical intervention and care activities for all phases of their crewmember's training, in-flight operations, and post-flight activities, as agreed to by the increment CS.

3.1.4 Accommodation of Flight Surgeons

The host agency shall provide, during pre-, in-, and post-flight activities, any resident IP FSs access to an office work environment, to their crewmember(s), and to host agency medical resources.

Rationale: The host agency must provide any resident IP FS access that will enable the IP FS to follow their crewmember's training, assist the CS in response to medical contingencies, monitor any hazardous activities, and participate in medical evaluations and baseline biomedical data collection, rehabilitation activities, and all other aspects of crewmember health as coordinated with the CS during all phases of the increment. The formal interaction between IP FS and host agency medical support systems is outlined in SSP 50480. Office work environment includes a desk, phone, fax, desktop computer, and email access. The notion of residence is linked to the support of a crewmember and is not dependent on the duration of the stay.

3.2 CREW SURGEON (CS)

3.2.1 Lead and Deputy CS Designation

The MMOP shall designate a Crew Surgeon (CS) and Deputy Crew Surgeon (DCS) for each increment from the cadre of ISS certified flight surgeons independent of the home agency of the CS or DCS.

Rationale: For a given increment, there needs to be a single focal point for medical issues involving that increment crew. The CS and DCS will be ISS-certified IP FSs assigned to a specific increment by the MMOP. The CS and DCS have primary responsibility for the health and well-being of the entire increment crew and will be the focal point for all medical issues and timelined activities for that crew during all mission phases.

3.2.2 CS Authority

The ISS Program shall delegate to the CS and in the absence of the CS to the DCS, or designated IP FS the authority to intervene in any situation that may be deleterious to a flight crewmembers' health.

Rationale: For rapid response to a medical contingency, clear lines of authority must be established. In the absence of the CS, his/her authority is usually delegated to the DCS; however, the CS may assign this authority to the IP FS. During in-flight operations, the CS or his/her designee will be located in the mission's lead MCC or connected via technological means to the MCC which has primary responsibility to respond to in-flight contingencies, including medical contingencies. The CS will advise Mission Operations on the medical aspects of the contingency, along with potential risk(s) to the crewmember(s). For in-flight medical contingencies, Mission Operations will make any decisions regarding de-orbit of the ISS crew, based in part on the recommendations of the IMG led by the CS.

3.2.3 CS Roles and Responsibilities

The CS will be assisted by the DCS and IP FS in fulfilling his/her roles and responsibilities that shall include the following activities:

- A. Provide or manage medical intervention and care of all assigned ISS crewmembers during preflight, in-flight, and post-flight mission phases
- B. Assist in flight crew Space Flight Medical Certification
- C. Supervise medically hazardous training events
- D. Supervise biomedical assessment data collection
- E. Manage development and implementation of in-flight countermeasures
- F. Assess medical hazards of mission payload activities
- G. Monitor biomedical data during crewmember evaluations, countermeasure activities, medical tests, medical related experiments, and medical contingencies in accordance with JSC 24834 and applicable JSC 28913, Medical Requirements Integration Documents (MRIDs)
- H. Monitor in-flight timeline and scheduling constraints
- I. Assist in development of increment-specific aeromedical flight rules and possess thorough knowledge of all aeromedical flight rules
- J. Monitor crew health during launch and landing
- K. Act on behalf of medical management and with the support of specialist groups, providing a point of contact for coordinated input to the FD on issues concerning crew health and safety
- L. Ensure access to a network of specialized medical, dental, and behavioral health and performance consultants.

Rationale: The roles and responsibilities of the CS need to be clearly stated so that their authority, accountability, and responsibilities are clear to all. To maintain the behavioral health and performance of the crewmembers and crews, the crew surgeon is assisted by a behavioral health and performance group. Successful crewmember behavioral health and performance monitoring and intervention require expertise that is not usually part of the CS's training. This expertise is provided by a

behavioral health and performance specialist who has been regularly involved with the crewmember through all phases of the mission. This specialist also provides helpful consultation to the CS and medical support ground team for optimal care of the crewmember. Any deterioration in behavioral health and performance, especially at critical operation points in the mission, will have direct impact on the mission's success/completion. Ineffective medical and behavioral support for crewmembers increases the risk of mission error due to fatigue, task overload, illness, low morale/motivation, or interpersonal frictions within the crew or between crew and ground.

3.2.4 CS Medical Intervention and Care Coordination

The CS and DCS shall coordinate their medical intervention and care activities as follows:

- A. Preflight: through the medical support group (MSG) of the applicable training center
- B. In-flight: through the lead MCC
- C. Post-flight: through the MSG at the site of post-flight rehabilitation and data collection

Rationale: The CS acts on behalf of medical management and with the support of specialists groups, providing a point of contact for coordinated input to the FD on issues concerning crew health and safety. The CS will advise Mission Operations on the medical aspects of the contingency, along with potential risk(s) to the crewmember(s). Communication channels for the CS need to be defined for each flight phase concerning crew medical intervention and care activities and their potential impacts on crew health on training, operations, and rehabilitation and data collection.

3.2.5 CS Medical Supervision Of Hazardous Training, Testing or Life Sciences Experiments On Crewmembers

The CS or designee shall approve of and monitor all testing, training, and human subject experiments involving crewmembers that present risks to their health and safety as identified by the MMOP and the Human Research Multilateral Review Board (HRMRB).

Rationale: There is a need to ensure that the risks to crewmember safety and health are assessed prior to any tests, training, and human experiments involving crewmembers. There is also a need for the CS or designee to monitor these tests, training, or human subject experiments so they can intervene as necessary to mitigate risk to the crewmember or to treat an injury. The CS or designee will determine the readiness of the crewmember for testing and may terminate any test based on an assessment of crewmember health. Decisions on which activities require monitoring will be made by the MMOP and HRMRB. Any in-flight change or potential changes and additions to experiments involving crewmembers as subjects will be discussed with the crew prior to flight to obtain approval and informed consent. This requirement is in accordance with NPD 8900.1.

3.3 ACCESS TO A CREW SURGEON

The ISS Program shall provide, as part of the Flight Control Team (FCT), immediate access to the CS or his designate at all times.

“Immediate access” shall be provided either by physical presence in MCC-H or via technological means (i.e., video, voice, etc.) that would link the CS or designee to the lead MCC and on-orbit crew.

Rationale: Due to the hazardous nature of space operations, there needs to be immediate access to a clinician at all times (full 24/7) to provide emergency response, medical intervention, and care to the ISS crew. This has been recognized by the NASA JSC MOD and the ISS Program by the inclusion of the front room FCR position of “Surgeon” as a member of the FCT. Biomedical Engineers (BMEs) are not trained to offer clinical support.

3.4 BIOMEDICAL ENGINEER

3.4.1 Biomedical Engineer Assignment

The ISS Program shall provide a team of Biomedical Engineers (BMEs) for each increment.

Rationale: The BMEs staff the BME console in the MCC-H 24/5 and are on-call when not on console in the MCC-H. They provide generic support to the CS/DCS and expertise on generic ISS systems, in particular the IMedS.

3.4.2 BME Roles and Responsibilities

The BME roles and responsibilities shall include the following activities:

- A. Provide technical and operational expertise to the CS or designee in ISS Systems
- B. Provide technical and operational expertise to the CS or designee in the IMedS
- C. Provide their specialized knowledge of ISS Aeromedical Flight Rules and other pertinent flight rules
- D. Provide timeline inputs, data management and equipment trouble shooting procedures
- E. Generate and distribute Daily Status Reports
- F. Coordinate private medical, psychological and family conferences
- G. Provide a technical focal point for reaching persons with detailed technical expertise when required by operational problems or contingencies
- H. Coordinate with IP BMEs or equivalent

Rationale: The roles and responsibilities of the BMEs need to be clearly stated so that their authority, accountability, and responsibilities are clear to all.

3.5 CREW MEDICAL OFFICER (CMO)

The ISS Program shall designate and train two CMOs for each Prime and Backup ISS increment.

Rationale: Designating and training two crewmembers as CMOs is necessary in the event one of the CMOs becomes incapacitated. Non-CMOs do not possess the proper skills and are not trained to a level of proficiency to deliver effective and efficient emergency care. In addition, should space to ground (S/G) communications become unavailable, a rescuer must be available to function independently for the first 30-60 minutes of an acute medical emergency.

3.5.1 CMO Roles and Responsibilities

The Prime and Backup crew CMO roles and responsibilities shall include the following activities:

- A. Demonstrate proficiency in all medical procedures contained in JSC-48522, International Space Station (ISS) Integrated Medical Group (IMG) Medical Checklist – ISS All Expeditions.
- B. Conduct in-flight physicals for increment crewmembers
- C. Onboard management of increment crewmembers medical data and records
- D. Coordinate with the CS in all medical intervention and care activities once communication is available.

Rationale: The CMOs will assist the CS in caring for the health and well-being of their increment crew and be first responder for all onboard medical intervention and care activities. Once S/G communications are available, the CMO is required to coordinate all medical intervention and care activities with the CS or designee.

The roles and responsibilities of the CMOs need to be clearly stated so that their authority, accountability, and responsibilities are clear to all.

3.5.2 Physician-Crewmember as CMO

The ISS Program shall assign the role of CMO to any physician-crewmember, assigned to an increment crew.

Rationale: There are many benefits of having a physician-crewmember (with clinical currency) on a crew. There is evidence from the spaceflight environment that the presence of a physician-crewmember has already proven useful in minimizing the mission impacts of a medical contingency. A physician-crewmember provides advanced clinical expertise and judgment as well as enabling more precise and efficient communication between the caregiver and flight surgeon. In addition, with the current limitations on immediate medical support from the FCT, the presence of a clinical expert on orbit would add significant benefit.

4.0 TRAINING AND CERTIFICATION

This section establishes the requirements for medical training and certification criteria for medical operations support personnel and the crew.

4.1 TRAINING AND CERTIFICATION RESPONSIBILITIES AND CRITERIA

- A. The MMOP shall define and approve standardized medical and behavioral training guidelines (including proficiency training) and certification criteria for ISS crewmembers and FSs.
- B. Each IP shall provide training guidelines and certification criteria for their BME and/or medical support specialists.
- C. The ISS Program shall provide flight-like ground based IMedS training hardware for the crew and members of the mission support team to facilitate training efficiency.
- D. The ISS Program shall provide integrated scenario-based simulations in order to familiarize all members of the crew and mission support team with medical contingencies so as to optimize their outcome.

Rationale: Establishes who is responsible for defining standardized medical operations training guidelines and certification criteria for ISS missions. Specific guidelines for training and certification of CSs, DCSs, BMEs and/or medical support specialists and IP FSs need to be clearly defined as part of an overall certification process.

The training and certification of all medical operations personnel and the crew must be standardized in order to provide consistent medical intervention and care standards and a consistent level of training.

Ground based training units are valuable teaching tools and essential for the highest fidelity training for crew and the mission support team. The provision of hands-on training has shown to greatly improve the learner's operational performance. The current use of photographs in training is a less than desirable method of training where the first time the crew sees the actual hardware is onboard while performing a procedure.

Integrated simulations are an essential method to test the crew and ground support personnel's understanding of the training received and their application in a challenging setting. Simulations demonstrate the effectiveness of the training received and the areas where improvement is needed.

4.1.2 IP FS Training and Certification

The MSMB shall ensure that CSs, DCSs and IP FSs endorsed by the MMOP have completed established training guidelines and meet approved certification criteria, including required English language proficiency.

Rationale: To establish the responsibility for training certification.

4.1.3 BME AND/OR MEDICAL SUPPORT SPECIALIST TRAINING AND CERTIFICATION

Each individual partner shall define standardized training guidelines (including proficiency training) and certification criteria for their BME personnel and/or medical support specialist.

Rationale: Establishes who is responsible for defining standardized BME and/or medical support specialist training guidelines and certification criteria for mission control center support. Specific guidelines for training and certification need to be clearly defined as part of an overall certification process.

Training must include integrated simulations that are an essential method to test the BME's and/or medical support specialist understanding of the training received and their application in a challenging setting. Simulations demonstrate the effectiveness of the training received and the areas where improvement is needed.

4.1.3.1 IP BME Working at Host Agency Control Center

BMEs working at a host agency's control center, as the host agency's representative, shall be trained and certified to the defined standardized training guidelines and certification criteria for that host agency's BME personnel.

Rationale: Establishes who is responsible for defining standardized training guidelines and certification criteria for console support of an IP BME at a host agency's control center, if the IP BME is acting as the host agency's representative. Specific guidelines for training and certification of IP BMEs working at a host agency control center as the host agency's representative need to be clearly defined as part of an overall certification process. The standardization ensures that a consistent level of training is provided.

Integrated simulations are an essential method to test the BMEs understanding of the training received and their application in a challenging setting. Simulations demonstrate the effectiveness of the training received and the areas where improvement is needed.

4.1.4 Flight Crew Medical Training and Certification

4.1.4.1 Crew Basic Medical Training

The ISS Program shall provide all Prime and Backup ISS crewmembers with basic medical training of IMedS to include the following areas:

- A. Countermeasures System Operations and Maintenance
- B. Environmental Health System Operations and Maintenance
- C. Health Maintenance System Operations and Maintenance
- D. Behavioral Health and Performance training
- E. Securing of medical resources prior to the evacuation of a module or vehicle

Rationale: Training is provided on all IMedS from all IPs. This hardware and operational procedures are categorized as either countermeasures, environmental or health maintenance. The requirement provides all crewmembers with countermeasures, environmental, and some medical and behavioral health training that may be required to handle normal and emergency medical situations on board ISS. Rapid provision of resuscitation techniques optimizes the medical outcome. Emergency medical care can be delivered in a more efficient and effective manner when two crewmembers are providing assistance to an incapacitated crewmember. All crewmembers require basic medical training in order to provide assistance during medical contingencies where the second CMO may be incapacitated.

4.1.4.2 CMO Training

The ISS Program shall provide CMOs from both the Prime and Backup crews the following additional hands-on training as described in JSC 28046, International Space Station (ISS) Crew Medical Officer Training Syllabus:

- A. Diagnostic and therapeutic techniques to support Advanced Life Support (ALS), Transitional Medical Care (TMC), and Ambulatory Medical Care (AMC)
- B. Training and skill maintenance in pre-hospital, and emergency care
- C. Operating procedures for in-flight medical hardware
- D. Performance of in-flight medical examinations
- E. Familiarity and knowledge of the Medical Operations Checklist procedures and in-flight medical record management
- F. Training in behavioral health and performance issues
- G. Training in use of telemedicine, including remote communication of medical information

Rationale: To ensure that the CMOs have the necessary proficiency to perform their tasks. All CMOs are trained to the same proficiency skill level regardless of their back ground knowledge to ensure uniformity.

4.1.5 Hazardous Training and/or Testing for Crewmembers

The host agency shall ensure the personnel monitoring pre- and post-flight training or testing, that could be hazardous to a crewmember's health are trained in the response

to those hazards. The IP FS shall have the opportunity to participate and provide medical monitoring to the crewmember in training.

Rationale: To ensure medical operations personnel who are monitoring the crew during potentially hazardous activities are trained in the proper medical response in case problems occur. These activities, including rehabilitation, medical testing, and data collection, may contain hazards and constraints not to be found elsewhere; therefore, clinicians require training before they can provide adequate care to crewmembers.

4.1.6 Hazardous Training and Activities for Non Crewmembers

Host agencies shall ensure and provide documentation that non-increment assigned astronauts, cosmonauts, and support personnel are medically fit for participation in ISS operations training, testing, and development activities that could be hazardous to their health.

Rationale: To ensure nonflight crewmembers and support personnel are medically fit to participate in potentially hazardous activities. These personnel are certified by the MSMB according to protocols and procedures defined by the MMOP. Nonflight crewmembers must be screened to ensure that they have no medical conditions that would preclude their safe and successful participation in training activities. Activities include winter and water survival training; diving operations; vacuum chamber operations; and centrifuge training.

5.0 CREWMEMBER MEDICAL EVALUATION, CERTIFICATION, AND MONITORING

This section establishes the requirements for medical evaluation, certification, and monitoring of the state of health and the level of physical fitness of the crewmembers. These requirements apply to all mission phases: preflight, in-flight, and post-flight.

ISS crewmembers are medically evaluated and medically certified for flight based on a standard, internationally approved set of criteria established by the ISS Program per SSP 50667 MED Volume A. Medical standards for space flight participants are located in SSP 50667 MED Volume C. Medical evaluation results are presented in a standard format defined by the MSMB and based on full disclosure of medical information to the MSMB by the MSMB member or designated FS of that IP. The MSMB determines the medical certification of a crewmember and reports the certification status to the MCOP. The MSMB may require the agency sponsoring the crewmember to provide additional medical information or to perform additional medical evaluations. IPs may, at their discretion, levy supplemental requirements for annual certification on their crewmembers, so long as the basic standards as outlined in SSP 50667 MED Volumes A are not compromised. Alternatively, one IP may arrange with another IP to assist in annual medical evaluations.

During the mission, crewmember health is monitored via in-flight medical examinations, evaluations, and conferences with the ISS crewmembers. The lack of crew medical evaluation information could lead to loss of insight into crew health and performance, loss of crew access to advisory resources on the ground and lead to more serious health issues, disruption of crew timeline, loss of crew time, inability of crewmember(s) to perform critical tasks, increased risk to other crewmembers, increased risk in the event of a contingency landing, permanent disability, death, and/or loss of program viability.

The MMOP will coordinate the collection and documentation of health risk information pertaining to crewmembers during in-flight and ground-based medical evaluations. From this data, medical risks of spaceflight are identified, quantified, and tracked. The information is then used to assist in health risk management by recommending selection and certification standards, medical capabilities for spaceflight, and research areas. At all times the CS will keep the FD and IMMT informed of the consequences of any medical conditions that could adversely impact the mission. The IP FS will inform their space agencies and the CS of any changes in the health, performance, or physical fitness of their crewmember(s) that could impact training or on orbit operations.

5.1 CREWMEMBER MEDICAL EVALUATIONS AND CERTIFICATION CRITERIA

The MMOP shall develop and document medical evaluation and certification requirements for ISS crewmembers in SSP 50667, MED, Volumes A and B.

Rationale: A standard set of medical and evaluation certification requirements for all ISS crewmembers needs to be defined and followed.

5.1.1 ISS Program Crewmember Medical Certification

The MSMB shall determine the medical certification of all ISS Program crewmembers.

Rationale: To establish that the MSMB has the final responsibility for the medical certification of all ISS crewmembers. This includes initial certification of crewmember candidates, annual certification of crewmembers in training, and preflight medical certification for flight.

5.1.2 Medical Certification for Selection as an ISS Crewmember

IPs shall conduct the medical screening, testing, and certification required for their crewmember's selection into the ISS Program following the "Selection Criteria" identified in SSP 50667, MED, Volume A.

SSP 50667, MED, Volume A requirements shall constitute common "core" operational medical standards and serve as a basis for crew health certification and monitoring.

Rationale: To ensure IPs are responsible for the medical evaluation and certification, following SSP 50667, MED, Volume A, of crewmember candidates they are planning on entering into the ISS Program.

5.1.3 Annual Certification for an ISS Crewmember

IPs shall conduct annual medical certification exams on their ISS crewmembers, following the criteria identified in SSP 50667, MED, Volume A.

Rationale: To ensure IPs are responsible for periodic medical evaluation and certification of their crewmembers in training for or assigned to an ISS mission. To ensure the ongoing medical fitness of ISS crewmembers for ISS duties, and to provide for standardized medical evaluation and a certification of all ISS crewmembers following the SSP 50667, MED requirements.

5.1.4 Preflight Medical Evaluations

The CS shall coordinate and perform preflight medical evaluations of mission assigned crewmembers, with the assistance of the applicable IP FS, according to SSP 50667, MED Volume B.

Rationale: To insure medical fitness of crewmembers for flight and provide for a standard examination and testing protocol to evaluate medical fitness for flight. The CS is responsible for ensuring all crewmembers are fit for flight. This is determined by a preflight medical evaluation performed by either the CS or IP FS for their particular crewmember, if applicable. Alternatively, an IP may arrange with another IP to assist in preflight evaluations. Host agency facilities will be made available to accommodate these examinations. Near-flight exams (Launch-(L-) 10 days or less) may be conducted at JSC or Kennedy Space Center (KSC) for US launches, or at the Gagarin Cosmonaut Training Center or Baikonur Launch Complex for Russian launches. Other preflight evaluations may be performed at any of the above sites. The CS will report the results of these evaluations to the MSMB.

5.2 IN-FLIGHT MEDICAL EVALUATIONS

Periodic in-flight medical evaluations are to ensure the health and fitness of the crew for current and upcoming activities and to enable medical intervention if problems are determined. These evaluations, defined in SSP 50667 MED Volume B, include but are not limited to: Private Medical Conferences (PMC), Private Psychological Conferences (PPC), Periodic Health Status (PHS) evaluations, Periodic Fitness Examinations, pre- and post- Extravehicular Activity (EVA) examinations, On-Orbit Hearing Assessments, and pre-landing medical evaluations performed by a designated CMO under the supervision of the CS. IPs can schedule additional medical evaluations on their crewmembers per their agency's practices. Examination and conference results are evaluated by the CS and appropriate experts, such as those from the IMG, with analysis/assistance provided by subject experts/consultants. These evaluations are used to:

- A. assess the health and fitness of the crew, including behavioral health and performance,
- B. assess the impacts of degraded physical as well as behavioral health and performance capabilities of the crew due to long duration spaceflight,
- C. assess the workload and work rest schedules of the crew,
- D. evaluate and prescribe appropriate countermeasures and treatment,
- E. predict and enhance tolerance for physical challenges, such as EVA and entry/landing,
- F. provide a basis for in-flight medical certification, such as EVA.

The CS or his designee communicates the evaluation conclusions and recommendations to the individual crewmember(s) at the next scheduled PMC. Should the crewmember or CMO have issues and questions arising from the periodic evaluations or should the CS or his designee have urgent results to communicate to the crewmember, an unscheduled PMC may be requested.

Scheduling constraints for the in-flight timeline for flight crewmember activities are outlined in the Space Station Crew Planning and Scheduling Groundrules and Constraints, subsection of SSP 50261-02, International Space Station Generic Groundrules and Constraints, Part 2: Execute Planning. Rules governing real-time medical operations are contained in NSTS 12820, ISS Generic Operational Flight Rules, Volume B, Section 13, 14 and 15, Aeromedical, Radiation and EVA, respectively.

5.2.1 Medical Impacts on Mission Operations

The CS shall report to the lead control center's FD any potential impacts on mission operations due to a crewmember's medical condition.

Rationale: To allow for appropriate dissemination of the potential impact of a crewmember medical condition on mission activities, flight planning, early mission termination, flight operations, etc. The CS needs to report results of all in-flight medical conferences and evaluations, providing only general information that may impact mission activity, to the lead control center's FD. Details of in-flight medical conferences and evaluations resulting in significant mission impact need to be

reported to the SMOT. The MMOP through the SMOT will provide coordinated input to the IMMT for medical events significantly impacting crew activities or mission fulfillment.

5.2.2 Return of In-Flight Medical Records

The ISS Program shall return all crewmembers' in-flight medical records, including behavioral health and performance evaluation, to the CS for distribution to the crewmembers' respective home agency medical personnel.

Rationale: To ensure that medical information, including medical monitoring, fitness evaluation, behavioral health and performance evaluation, biomedical investigation data, and contingency medical event data is returned to the CS. To ensure that medical data is received by appropriate medical personnel of the crewmembers' respective home agencies.

5.2.3 Private Medical Conferences (PMC)

The ISS Program shall provide for PMCs between crewmembers and the CS or his designee.

PMCs will be conducted on two-way private voice or video communication, preferably in the crewmember's native language.

Rationale: PMCs are needed during in-flight medical contingencies or any other time when private medical communication is required to assure the availability of private medical discussions for crewmembers, to assure privacy of medical information, and to enable therapeutic confidences between the crew and the medical operations support team. The PMC will provide the required communication between crew and medical support personnel on the ground to access resources unavailable on-board (CS expertise, for example) and to help prevent and manage in-flight medical contingencies. Also, PMCs allow the medical operations team to understand and predict the state of crew readiness for mission planning purposes. A private two-way voice and video communications channel between the crewmember and ground-based medical support personnel will be used for the PMC.

5.2.3.1 PMC Scheduling

The ISS Program shall schedule PMCs per the following schedule:

- A. Daily for the first seven flight days (15 minutes for entire crew)
- B. Weekly after the first seven flight days (15 minutes each crewmember)
- C. Prior to each Extravehicular Activity (EVA); conducted within 24 hours of EVA suit donning
- D. Following each EVA; conducted within 24 hours following EVA suit removal
- E. Daily beginning two days prior to entry and on the morning of entry/landing
- F. At any time during the mission if requested by the FD, Mission Commander or other crewmember, the CS or his designee

Rationale: To provide opportunities for regularly scheduled and unscheduled PMCs. Regularly scheduled PMCs address the case where a crewmember or other personnel may be reluctant to request a special PMC. Flight planners also need this information to best schedule ISS resources. Unscheduled PMCs are needed in cases where a medical condition occurs outside the regularly scheduled PMC impacting crew health and mission operations. Scheduled PMCs are conducted during the crew work day.

5.2.4 PPC

The ISS Program shall provide for PPCs between crewmembers and his/her host agency's PPC designee.

PPCs will be conducted on two-way private voice or video communication, preferably in the crewmember's native language.

Rationale: To address personal psychological and group dynamics issues as well as crew-ground interactions. Elements of psychological support, such as family conferences, personal letters, e-mail, and personal resupply items will be coordinated in part through these conferences. In support of the medical operations support team, the PPC will provide one of the key elements of in-flight monitoring and countermeasures to maintain the crewmember's behavioral health and performance; see Section 8.5.4, In-Flight Behavioral Health and Performance.

PPCs are held regularly to ensure the ongoing behavioral health of each crewmember. These PPCs are conducted by behavioral health specialists who are able to assess behavioral health and on board performance and who will recommend/institute countermeasures when necessary in a timely way to ensure that there will be no mission impact. Although PPCs are scheduled regularly, there will be times when there will be concerns about behavioral health and performance issues. At these times further PPCs will be convened and clarification with a behavioral health specialist will be necessary. PPCs discuss complex and sensitive issues with a behavioral specialist familiar with the crewmember. Effective behavioral health and performance monitoring and intervention requires frequent personal contact with the crewmember. Difficult discussions cannot be helpful between crewmember and behavioral health specialist, when there is no trust between crewmember and specialist or when language prevents communication of complex ideas and problem solving.

5.2.4.1 PPC SCHEDULING

The ISS Program shall schedule PPCs per the following schedule:

- A. Every two weeks following launch with a minimum time allotment of 10 minutes per crewmember
- B. Every other session in conjunction with the Periodic Health Status Evaluation
- C. Any time requested by the crew commander, any crewmember, the CS or his designee, or the FD

Rationale: To provide opportunities for regularly scheduled and unscheduled PPCs. Regularly scheduled PPCs address the case where a crewmember or other personnel may be reluctant to request a special PPC. Flight planners also need this information to best schedule ISS resources. PPCs are held regularly to ensure the ongoing behavioral health of each crewmember. These PPCs are conducted by behavioral health specialists who are able to assess behavioral health and on board performance and who will recommend/institute countermeasures when necessary in a timely way to ensure that there will be no mission impact. Although PPCs are scheduled regularly, there will be times when there will be concerns about behavioral health and performance issues. At these times further PPCs will be convened and clarification with a behavioral health specialist will be necessary.

5.2.5 Extravehicular Activity (EVA)

- A. For EVAs from ISS utilizing the NASA EMU, NASA JSC shall be responsible for ensuring EVA health and safety, for EVA related medical and biomedical monitoring, and for ensuring that EVA prebreathe protocols and safety measures are followed as referenced in the Flight Rules. The EVA controlling MCC shall accommodate IP FSs or designated medical support personnel.
- B. For EVAs from ISS using the FSA Orlan suit, the Russian "Egress" Medical Support Subgroup shall be responsible for ensuring EVA health and safety, for EVA related medical and biomedical monitoring, and for ensuring that proper Orlan prebreathe protocols and safety measures are followed as referenced in the Flight Rules. In cases with participation in an EVA by IP crewmembers utilizing the Orlan suit, the Russian "Egress" MSG shall accommodate the corresponding IP FS, or designated medical support personnel, if requested by the IP, within the MCC-M medical support infrastructure.

Rationale: Medical support during EVA is necessary to ensure the health and safety of the EVA crewmember and to provide appropriate information to the FD. Supervision of the EVA by the responsible MSG, and accommodation of IP medical support personnel will maximize crew resource management for the EVA, and minimize risk for the ISS crewmember.

5.2.5.1 EVA Medical Assessments

The ISS Program shall schedule a pre- and post- EVA medical assessment of each EVA crewmember for all EVAs as follows:

- A. Pre- and Post EVA on or before flight day 21, review of preflight medical examinations and routine PMCs.
- B. Pre-EVA beyond flight day 21, review of crew countermeasure performance and within 24 hours of suit donning a medical assessment will be performed by the CS as detailed in SSP 50667, MED Volume B.
- C. Post-EVA beyond flight day 21, a post-EVA medical assessment will be performed by the CS within 24 hours of suit doffing as detailed in SSP 50667, MED, Volume B.

- D. If a subsequent EVA is to occur within 7 days, the post-EVA medical evaluation fulfills the requirement for the pre-EVA evaluation of that subsequent EVA.

Rationale: To provide a standard medical fitness examination prior to and following EVAs. All EVAs will be preceded by an assessment of EVA crewmember medical fitness with approval of the CS with recommendations from applicable ground medical support personnel.

5.2.5.2 EVA Monitoring

The ISS Program shall ensure the NASA EMU and FSA Orlan EVA suit provide for remote monitoring of the following biomedical parameters:

- A. Oxygen consumption rate (real-time)
- B. Electrocardiogram (ECG) and derived heart rate (real-time)
- C. Suit pressure (real-time)
- D. Suit carbon dioxide partial pressure (real-time)
- E. Radiation exposure dose (recorded)
- F. Body temperature (Russian Orlan suit only, real-time)

Rationale: To ensure health and safety during an EVA. Procedures governing loss of monitoring capability for specific parameters are covered in the mission flight rules. ISS EVAs will be monitored by MCC-H if using EMUs and by MCC-M if using Orlan suits. For prolonged periods of Loss Of Signal (LOS), EVA biomedical data obtained using the EMU will be recorded and downlinked to MCC-H during subsequent available communication coverage.

5.2.5.3 Standardization of Exercise Prescriptions for Prebreathe Denitrogenation Protocols for NASA EMU-EVAs

The ISS Program shall ensure all ISS Crewmembers who perform an EVA in the NASA EMU follow either the Exercise Prebreathe Protocol developed by NASA, 10.2 PSI denitrogenation protocol (overnight campout), or 4-hour in-suit denitrogenation protocol as documented in NSTS 12820, Volume B, ISS Generic Operational Flight Rules.

Rationale: Standardization of the exercise prescription during prebreathe will minimize the risk for decompression sickness due to differences in exercise factors.

5.2.6 Weekly Crew Health Status Report

The CS shall generate a weekly crew health status report.

Rationale: To provide an evaluation and assessment of the crew's health and ability to perform scheduled mission activities. The crew health status reports include relevant environmental data, countermeasures activity, investigational participation, workload and work/rest schedule observance and deviations, and other information pertinent to health and performance. Monitoring of workload and work rest schedules reduces the risk of mission failure due to errors caused by excessive fatigue and task overload of crewmembers. Non-medically-sensitive summary information is transferred to the ISS IMMT. A weekly medical management

conference is held by the SMOT to review general biomedical, environmental, exercise, work/rest, and other relevant issues sufficient to adjust crew countermeasures and make habitability recommendations to the ISS Program. Detailed medical information is not in these reports to the ISS Program.

5.2.7 30 Day Periodic Health Status Evaluation

The ISS Program shall schedule a Periodic Health Status (PHS) evaluation for each crewmember as detailed in, SSP 50667, MED, Volume B.

Rationale: PHS evaluations need to be conducted to assess the crewmember's health. Data from the evaluation shall be downlinked to medical support personnel as soon as possible.

5.2.8 Periodic Fitness Evaluation (PFE)

The ISS Program shall schedule a PFE for each crewmember, in accordance with the individual crewmember's home agency. "The evaluation of NASA crewmembers will be in accordance with SSP 50667, MED Volume B. The evaluation of FSA crewmembers will be in accordance with MO-3."

Rationale: To evaluate the physical fitness of each crewmember. The results of the PFEs will be used to modify the prescription for the crewmember's countermeasure program and assess the crewmember's ability to carry out mission activities.

5.2.9 Prelanding Medical Evaluation

The ISS Program shall schedule a prelanding medical evaluation within two weeks of de-orbit/landing.

Rationale: A prelanding medical evaluation is needed for prognosis of landing and post-landing performance and to implement appropriate countermeasures. If the periodic medical evaluation is conducted within this time frame, it will suffice for the prelanding medical evaluation.

5.3 ENTRY MONITORING FOR CREWS RETURNING ON THE SOYUZ

The Medical Support Group (GMO) in MCC-M shall monitor real-time pulse, ECG waveform, and respiratory rate for crews returning on the Soyuz.

Rationale: The entry and return phases result in significant physiological stresses as the human body is once again exposed to acceleration forces. Monitoring crew biomedical data during the above events is therefore critical so as to monitor crew safety and to determine baseline trends, etc. Biomedical monitoring may warn the IP FS of impending medical problems or identify when a condition requires treatment.

5.4 POST-FLIGHT MEDICAL EVALUATIONS

5.4.1 Post-Flight Medical Evaluation Responsibility

The CS shall be responsible for post-flight medical evaluations of crewmembers with the assistance of:

- A. The JSC SMHCSO and appropriate IP medical experts for crewmembers returning on the Shuttle
- B. The Russian GMO and appropriate IP medical experts for crewmembers returning on the Soyuz

Rationale: To ensure that the medical evaluation is by the CS who has been responsible throughout the increment to ensure continuity of care. The CS needs to have the assistance of the applicable medical support organization to perform these evaluations.

5.4.2 Immediate Post-Flight Crew Examination

The CS shall conduct the immediate post-flight crew examination at the landing site with the assistance of the DCS and IP FS.

Rationale: The medical condition of the returning crewmembers must be assessed immediately in order to prescribe the proper medical intervention and care until a more complete examination can be conducted at an approved facility. This can best be accomplished by the CS who has been the Primary Contact (PC) for the crew throughout the increment and the team who will be available based upon the return vehicle location.

5.4.3 Post Flight Daily Health Status Examinations

The CS or his designee shall schedule and conduct daily health status examinations for the first week in the post-flight period, with the participation of appropriate medical experts, including those from the IP's.

Rationale: Daily health status checks are needed to assess the health condition of the crewmembers and their adjustment back to a 1-g environment.

5.5 MEDICAL DATA MANAGEMENT

The ISS Program shall coordinate the collection, documentation, distribution and management of medical data, including pooled health risk information, pertaining to all ISS crewmembers acquired during ground-based and in-flight medical evaluations in accordance with the Privacy Act of 1974.

Rationale: All medical data should receive confidential status and be handled in accordance with ISS Program medical privacy policies. By using analysis of pooled medical data collected on all ISS crewmembers, the medical risks of spaceflight can better be identified, quantified and tracked. The information will be used to assist in health risk management by recommending selection and certification standards,

medical capabilities for spaceflight, and operational evaluations such as the effectiveness of countermeasures. Conditions of collection, handling and sharing of medical data are documented in the MMOP Partner Data Sharing Plan <TBS 2.1-2> and the respective IP Medical Data Security Policies.

6.0 MEDICAL INTERVENTION AND CARE

This section establishes the requirements for the ISS Program relating to the medical intervention and care provided to ISS crewmembers for all mission phases: preflight, in-flight, and post-flight.

6.1 MEDICAL INTERVENTION AND CARE DURING ALL MISSION PHASES

The ISS Program shall provide medical intervention and care for all ISS crewmembers during all mission phases. To assist the Crew Surgeon, the ISS Program shall provide:

- A. A behavioral health and performance group to maintain the behavioral health and performance of the crewmembers and crews.
- B. A network of specialized medical, dental consultants to maintain crew health.

Rationale: Crewmember health during training, in-flight operations, and post-flight operations is critical to crew performance and mission success for the ISS increment crew. The diagnosis and treatment of illness and injury will promote crewmember health and performance. To date, there have been multiple illnesses and injuries during all mission phases and, in the absence of adequate clinical capabilities, the likelihood of significant negative impact to mission viability due to crewmember illness or injury is increased. Because immediate transport to a clinical facility is not an option on-orbit, in-flight health care is essential. In-flight medical intervention and care will include behavioral health and performance as noted in Section 8.5.4. Behavioral Health and Performance monitoring and countermeasures support the motivation, alertness, cognition, and adaptation of the crewmember during flight.

6.2 MEDICAL INTERVENTION AND CARE DURING PREFLIGHT TRAINING

Host agencies shall provide capabilities and infrastructure, including evacuation to a Definitive Medical Care Facility (DMCF), during preflight training and testing.

Rationale: Due to the hazardous nature of some training activities, it is probable that a medical event could occur and proper response should be available to minimize impact to crewmember and mission.

6.3 IN-FLIGHT MEDICAL INTERVENTION AND CARE

6.3.1 Integration of On-Board Medical Hardware, Supplies, and Procedures

The ISS Program shall integrate all IP's medical hardware, supplies, and procedures on-board ISS.

Rationale: All on-board medical hardware, supplies, and procedures are integrated into a single IMedS. In addition, to the greatest extent possible, the medical kits and training for the Shuttle, Station, and Soyuz programs should be as standardized as possible. This will not only standardize training but also ensure that CSs, DCSs,

CMOs, IP FSs, BMEs and/or medical support specialists are as flexible as possible in providing assistance to all programs.

6.3.2 Primary Responsibility

The ISS Program shall delegate primary responsibility for response to in-flight medical events to the mission's lead MCC.

Rationale: To minimize the response time to on-board medical contingencies, it must be clear which MCC has prime responsibility. There have been and are cases when lead MCC responsibility have been/will be transferred from MCC-H to MCC-M; e.g., 9/11, hurricane, tornadoes, etc.

6.3.3 IP Access to In-Flight Crewmember Medical Operations Data

The ISS Program shall provide full access to crewmember records and downlinked medical operations data to the CS and respective crewmember's medical organization(s).

Rationale: Assigned medical personnel cannot do their jobs in providing appropriate medical intervention and care without this information. IP medical organizations require access to available medical information on their crewmembers because they are responsible to their respective agencies for their agency's crewmembers' health. Having access to the medical information is necessary for the IP FS to effectively support the CS. Additionally, full access to medical history is required to ensure continuity of care post-flight. Conditions of access are documented in the MMOP Partner Data Sharing Plan <TBS 2.1-2> and the respective IP Medical Data Security Policies approved by the MMOP. See Section 1.8.1 Handling and Release of Medical Data.

6.3.4 Access to Medical Capability

6.3.4.1 Communication Priority

The ISS Program shall give top priority to communications between the CS/DCS or his designee and ISS crew in the event of a medical contingency.

Rationale: In the event of a medical contingency, immediate communication between the crew and CS, DCS, or IP FS is critical to optimize the outcome. CMOs may not be physicians and thus have limited expertise to respond to medical contingencies.

6.3.4.2 Availability of Medical Equipment and Consumables

The ISS Program shall assure that immediately required emergency medical equipment can be deployed and available for use within 4 minutes.

Rationale: In the event of a medical emergency on ISS, crewmembers require immediate access to certain medical equipment. It is estimated to require at least 2 minutes for the crew to reach the CHeCS rack in the lab module (LAB), unstow the

Crew Medical Restraint System (CMRS) and the Advanced Life Support Pack (ALSP), remove the means of securing an airway (ILMA, tape), secure the patient, and deploy the defibrillator. It is generally accepted that as little as 4-5 minutes of inadequate perfusion or oxygenation of the brain can lead to irreversible damage. Steps must be taken to minimize this time by ensuring certain emergency medical equipment are immediately available to the ISS crew. Predeployment of certain medical resources (such as the airway management device) would gain critical time in the event of a medical contingency.

6.3.4.3 Use of Non-Medical Hardware

The ISS Program shall assure the crew and medical support team have access to and are familiar with human research and life science experiment hardware items manifested on ISS that may be clinically useful for support of contingency response to medical events.

Rationale: Specific non-medical hardware items that may be clinically useful for support of contingency response to medical events, such as the Human Research Facility (HRF) and life science experiment hardware, will be accessible and available to all crewmembers during a medical event. The requirement is to ensure familiarity with all applicable resources to facilitate diagnosis and medical intervention. Prompt diagnosis and treatment will be facilitated by maximum access to applicable resources, whether medically assigned or not.

6.3.5 Levels of Medical Intervention and Care

6.3.5.1 Advanced Life Support (ALS)

The ISS Program shall provide ALS care for a single crewmember for up to 72 hours following an acute medical event.

Rationale: Based upon the best available retrospective and prospective data, including the extensive experiences of the Federal Space Agency, there will be 1-2 serious medical events over the lifetime of the ISS (for a crew of three), based upon a risk of ~6% per person per year to have a medical event equivalent to requiring a visit to the Emergency Room or hospitalization, and 1-2% per person per year to have a serious medical event, which requires ALS care. It is, unfortunately, impossible to describe what the event will be, when it will occur, or whom it will affect. Examples of conditions which might be categorized as requiring “ALS” would include myocardial infarction (“heart attack”), electrocution, cardiac dysrhythmia, psychosis, severe infection, toxic inhalation, 3rd degree thermal burns, or anaphylaxis. Supplying ALS for one crewmember is based on the assumption that there will be only one serious medical contingency per increment crew.

Although the value of having 72 hours of ALS capabilities on orbit will have the benefits enumerated above, it is important to emphasize that this may not be a sufficient duration to ensure survival or a good outcome in all cases. While 72 hours appears a reasonable compromise between operational constraints and the best

available medical predictions, the deleterious effects of long duration spaceflight may cause crewmembers not to respond to treatment as favorably as expected, and for this reason the ground control team must monitor the patient's condition closely.

6.3.5.2 Basic Life Support (BLS)

The ISS Program shall provide the capability for Cardiopulmonary Resuscitation (CPR), basic airway management, and crew immobilization.

Rationale: BLS is the minimum level of care for medical contingencies on ISS and is the precursor to the implementation of ALS. In the event of a medical emergency, crew members are required to provide CPR, basic airway management and crew restraint for medical treatment.

6.3.5.3 Decompression Sickness

The ISS Program shall provide a treatment plan for Decompression Sickness (DCS).

Rationale: Decompression sickness is a potential hazard of space flight and EVA. Rapid and appropriate intervention is required to optimize the outcome for the affected crewmember(s). The treatment plan must include the crew response for DCS occurring during EVA, diagnostic and therapeutic procedures including the use of the Orlan-M and EMU suits as treatment vessels, guidance for decisions on deorbit contingencies, and plans for terrestrial response after deorbit of the crewmembers(s) with DCS.

6.3.5.3.1 Use of ISS Resources

The ISS Program shall ensure that all available resources on ISS during staged operations are used for treatment of decompression sickness before consideration of deorbit for terrestrial treatment.

Rationale: Due to the inherent risks of return on Soyuz because of lack of ability to define a precise landing location, cabin pressure issues, body position of the crewmember, potential impact G forces, delay in transportation to a hyperbaric treatment facility, all on-orbit treatment efforts should be maximized before attempting a deorbit for terrestrial treatment.

6.3.5.3.2 Decompression Sickness Treatment

For requirement details, see Appendix F, Table F-2, Newly Proposed Requirements.

6.3.5.4 Transitional Medical Care (TMC)

For requirement details, see Appendix F, Table F-2, Newly Proposed Requirements.

6.3.5.5 Stabilization and Transport

The ISS Program shall provide the capability to stabilize and transport an ill or injured crewmember.

Rationale: For ISS missions, medical return transport will not exceed 24 hours should this become necessary. Transportation time begins when the crewmember is medically stable and a decision is made to transport and ends with delivery to a medical care facility.

6.3.5.6 Ambulatory Medical Care (AMC)

The ISS Program shall provide AMC for the entire crew for the duration of the mission.

Rationale: AMC is meant to address not only conditions that had been more serious but are now improving, but also routine minor short lived conditions that are frequently seen but require prompt treatment. Having the capability to provide ambulatory care, including wound care for minor trauma, will permit rapid and adequate treatment of crewmembers and optimize their return to health. Even though the requirement is for a crew of up to 7, provisions need only accommodate the actual crew size for a given increment. The entire mission duration was selected because those conditions that require ambulatory care are generally minor ailments which resolve rapidly and require only minimal in situ supplies. Examples of conditions which might be categorized as requiring “ambulatory care” would include: abrasion, adjustment disorder, rash, frostnip, or upper respiratory infection.

6.3.5.7 Dental Care

The ISS Program shall enable the CMO to respond to a dental emergency.

Rationale: In order to respond appropriately to dental emergencies, the capability to perform appropriate procedures, including those listed below, must exist on-orbit:

- A. Perform mouth irrigation
- B. Contain, collect, and dispose of recovered oral fluids
- C. Repair a cracked tooth, cusp, or fractured tooth
- D. Manage a periapical abscess
- E. Repair of laceration of soft tissue
- F. Re-secure a loose crown
- G. Place a temporary filling

6.3.6 In-Flight Biomedical Monitoring and Diagnostics

The ISS Program shall provide the following in-flight monitoring and diagnostic capabilities:

- A. Diagnostic imaging, including ultrasound
- B. Blood analysis to include blood cell count, specific chemistries, and enzymes
- C. Urinalysis
- D. Monitoring of physiological parameters to include: heart rate, electrocardiogram (ECG), respiratory rate, non-invasive blood pressure, end tidal carbon dioxide, pulse oximetry, sedation level, pulmonary functions
- E. Behavioral health and performance assessment

Rationale: The capability to perform in-flight biomedical monitoring and diagnostics will enhance accuracy of diagnosis and will enable appropriate therapeutic care (when available) to be initiated on orbit, minimize the need for medical evacuation from ISS, provide information for the mobilization of appropriate ground-based resources, optimize conditions under which a medical evacuation from ISS (if necessary) would take place, and enhance the ability of the ill or injured crewmember to recuperate from the medical and behavioral health event on orbit. Specific clinical laboratory testing should reflect terrestrial standards and may include: Sodium, Potassium, Chloride, Glucose, pH, Bicarbonate, PO₂, Creatine Kinase and isoenzymes, liver function tests, thyroid function tests, and troponin.

6.3.7 Telemedicine Capability

For requirement details, see Appendix F, Table F-2, Newly Proposed Requirements.

6.3.8 Early Termination of a Flight for Medical Reasons

The ISS Program shall establish the criteria for termination of a flight for medical reasons.

Rationale: The current operational concept is based on having the capability to treat and/or resolve medical contingencies on the ISS and to mitigate the possible need for medical evacuation. However, if early termination of flight is required due to the seriousness of a crewmember's medical condition, the augmented ISS capabilities will enable care to be given for at least 72 hours. This will enable better preparation by ground control and rescue teams for an unscheduled crew return, as well as permitting the uninjured crewmembers to prepare the ISS for untended operations. Early termination of a flight is an operational decision which must ultimately be made by the ISS Program through the IMMT. Input from all stakeholders must be considered. It is therefore necessary to determine before there is a crisis exactly what would be cause for flight termination and what would and could be done. In the event of a medical contingency, the presence of such criteria would assist both the flight directors and the CS in planning for either an early return from orbit or provision of care on orbit. The criteria for ordering an early termination of a flight due to medical reasons should consider the on-board capabilities for treating an injured or ill crewmember, the availability of a return vehicle, and the suitability of the return vehicle given the nature of the crewmember's injury or illness. This criteria would be documented in NSTS 12820, ISS Generic Operational Flight Rules, Volume B, Section 13, Aeromedical.

6.3.9 Death of an ISS Crewmember

The ISS Program shall define the procedures that will be followed in case of the death of an ISS crewmember.

Rationale: The possibility of a death on orbit exists. Accordingly, it is necessary to identify prospectively what procedures will be followed in such a case. This is important so that all stakeholders (flight surgeons, crew and families, flight directors,

public affairs, etc.) are familiar with what procedures will be undertaken in the event of a death. It is also critical that criteria for pronouncement of death by a non-physician are established prospectively, along with procedures for storage and return of the body.

6.4 POST-FLIGHT MEDICAL CARE AND INTERVENTION

6.4.1 Rehabilitation

The ISS Program shall ensure a post-flight crew rehabilitation program for each increment is developed.

Rationale: This program ensures health and safety of returning crew and actively assists the crew's return to flight status and to preflight fitness. This plan follows criteria in JSC 27050, Postflight Rehabilitation Plan. Post-flight rehabilitation starts with crew egress at landing and includes a guided, phased reconditioning protocol. The individualized rehabilitation program will be specific to mission type, duration, and individual crew factors. Travel to the rehabilitation site should occur as soon as possible after landing. The CS will oversee post-flight rehabilitation activities, which will have priority over other post-flight activities.

6.4.2 Post-Flight Medical Care

The ISS Program shall provide post-flight medical intervention and care, as outlined in SSP 50667, MED Volume B and JSC 27050, to all flight crewmembers.

Rationale: To ensure complete and effective post-flight medical care is provided, optimizing the chances of crewmembers returning to preflight health status. Post-flight health care is provided by the JSC SMHCSO for crewmembers returning on the Shuttle and Russian MSG for crewmembers returning on the Soyuz with appropriate international medical representatives at each site. Mission strain continues after landing as crewmember readaptation to Earth requires managing both physiological and psychological burdens. Medical and behavioral health care must be provided to optimize the chances for the crewmember returning to preflight health status.

6.4.3 Host Agency Responsibility

The ISS Program shall assign responsibility to the host agency, in conjunction with the CS, for the medical support, rehabilitation activities, and contingency medical care of the returning ISS crewmembers.

Rationale: For effective operations, who has primary responsibility for the medical, rehabilitation activities, and contingency medical care of returning ISS crewmembers needs to be clearly established. The host agency is defined as the agency providing for landing operations and hosting the early post-flight activities. The formal interaction between IP FSs and host agency medical support systems is detailed in the SSP 50480, JMOIP.

7.0 ENVIRONMENTAL HEALTH

This section contains the requirements for ensuring there is, and continues to be, a living and working environment on ISS suitable for human habitation within all habitable elements of the ISS. These requirements are needed to ensure maintenance of an environment conducive to the crew's health and well being as well as to maximize their productivity in carrying out mission objectives. Environmental areas addressed in this section include water, air, microbiology, ionizing and non-ionizing radiation and acoustics.

7.1 SHARING OF DATA

All IPs need to have access to all ISS environmental data.

7.1.1 Sharing of Environmental Data from In-Flight Monitoring Activities

The ISS Program shall make available all ISS environmental data collected from operational, in-flight monitoring activities to the CS, IP FS, and IPs.

Rationale: Conditions of data sharing will be according to the MMOP Partner Data Sharing Plan ISS Program XXXXX<TBS 2.1-2>. This will ensure all in-flight environment monitoring data will be transmitted to the CS, IP FS, and IPs.

7.1.2 Sharing of Environmental Data from Archive Samples

IPs shall provide the results of environmental archive sample analyses directly to the ISS Program and the MMOP.

Rationale: To ensure that all ISS environmental data are shared with all the IPs.

Sample analysis results showing an out-of-limits condition will be made available to environmental systems experts, in order to take appropriate corrective action. The crew may be exposed to contaminated environment, leading to health problems and loss of productivity. Conditions of data sharing will be according to the MMOP Partner Data Sharing Plan.<TBS 2.1-2> This will ensure all analyses of archive samples data will be transmitted to the CS, IP FS, and IPs. If necessary, the national space agencies may request samples from one another for subsequent analysis by their own research organizations.

7.1.3 Processes and Procedures for Analysis of Operational Environmental Components

IPs shall use instrumentation, processes, and procedures approved by the appropriate MMOP expert working group to perform in-flight operational analysis, archival sampling, and ground-based analysis of archived environmental samples.

Rationale: Environmental components must be analyzed by methods in which technical experts have a high level of confidence, otherwise the data will be suspect and decisions based on the data could be erroneous.

7.1.4 Biosafety Assessment of Biological Materials

The ISS Program shall ensure that potentially biohazardous materials designated for use aboard the ISS are assessed prior to launch by the Biosafety Review Board (U.S.) and by the appropriate IP organizations.

Rationale: To identify biohazardous materials and to ensure such materials are adequately contained, labeled, used, and discarded in accordance with the following:

- A. *“Biosafety in Microbiological and Biomedical Laboratories”, Centers for Disease Control and Prevention/National Institutes of Health*
- B. *“Laboratory Biosafety Manual”, 2nd edition, World Health Organization*
- C. *“CII 1.2.035-95/Procedures for Registration, Storage, Transfer, and Transport of Microorganisms of I-IV Pathogenicity Groups”, Russian Ministry of Health Sanitary Regulations*

Assessment of biohazardous contamination of the ISS modules and hardware may prevent allergic reactions or infectious disease in the crew and/or degradation of station hardware and critical structures.

7.1.5 Environmental Contingency Action Team

The ISS Program shall establish an Environmental Contingency Action Team.

Rationale: To rapidly communicate environmental data that suggests a threat to crew health could be occurring or could occur in the near future. Environmental monitoring can detect any number of conditions that need rapid correction to protect crew health. It is essential that a mechanism be in place to assemble the appropriate experts to deal with such conditions when they are detected through on-board monitoring or analysis of archival samples.

7.2 CHEMICAL WATER QUALITY

Onboard water quality will be monitored throughout the ISS vehicle life. Water quality is assessed by ground analysis of water samples that are collected prior to launch during the ground-based water preparation process and by in-flight and ground analyses of water samples collected in flight during the water reclamation and consumption process onboard the ISS.

7.2.1 Water Quality Specifications

The ISS Program shall meet water quality standards specified in Table D-1, Water Quality Requirements for the ISS Russian Segment, and in SSP 41000, Table XXXII,

Water Quality Requirements for the U.S. On-orbit Segment, for water intended for crew use and consumption.

Rationale: To ensure that a rational definition of acceptable water quality will be available to assess ISS water. Water quality monitoring data will also be used to confirm that all necessary system procedures have been performed.

7.2.2 Water Quality Monitoring

The ISS Program shall perform water quality monitoring during ISS preflight and in-flight periods in accordance with the list of parameters presented in Table D-1, Water Quality Requirements for the ISS Russian Segment, and in SSP 41000, Table XXXII, Water Quality Requirements, for the U.S. On-orbit Segment.

Rationale: On-orbit water quality is critical to the health of the crewmembers. The requirement insures that water of acceptable, defined quality will be available on board ISS by specifying preflight and in-flight water quality monitoring. In-flight monitoring is necessary to get timely results and to evaluate critical parameters that may not be stable in archival samples that are returned for ground analyses.

7.2.2.1 Preflight Water Quality Monitoring

A. US Supplied Water

The Space Shuttle Program shall meet the minimum requirements specified in SE-S-0073, Space Shuttle Specification Fluid Procurement and Use Control, for potable water loaded on the Shuttle for use on ISS.

B. Russian Supplied Water

FSA/IBMP shall meet the minimum requirements specified in engineering specification "Preserved Potable Water," XT.0.045019TY, for ground supplied potable water delivered to ISS by the Russian side.

C. JAXA Supplied Water

JAXA supplied ground water shall meet specifications in **<TBD 7.2.2.1-1>**.

D. ESA Supplied Water

ESA supplied ground water shall meet specifications in **<TBD 7.2.2.1-1>**.

Rationale: Preflight monitoring provides an early warning of potential substandard water quality. To assure that ground-loaded water of acceptable, defined quality will be available on board ISS. Potable water loaded on the Shuttle for use on ISS is sampled and analyzed at the time of servicing 15 days and 3 days before launch. Ground supplied potable water delivered to ISS by the US side is certified by NASA/JSC laboratories on the basis of the documentation used in the US.

Ground supplied potable water delivered to ISS by the Russian side is sampled and analyzed at the time of servicing and before launch, and certified by FSA/IBMP laboratories on the basis of the documentation used in Russia.

7.2.2.2 In-Flight Water Quality Monitoring

The ISS Program shall ensure that in-flight water sampling and analysis is performed with the frequency specified in Table D-2 for the ISS Russian Segment and Table D-3 for the ISS U.S. On-Orbit Segment.

- A. In-flight archival water sample collection from all ports used for drinking purposes in the Russian and U.S. On-orbit Segments for post-flight analysis
- B. In-flight assessment of water quality performed by analyzing samples collected in flight for the following parameters:
 - total organic carbon, total inorganic carbon, total carbon, conductivity, and pH in water samples from the Russian Segment; and
 - total organic carbon, total inorganic carbon, total carbon, conductivity, pH, turbidity, color, iodine, iodide, and iodine compounds in water samples from the U.S. On-orbit Segment.

Rationale: To assure that water of acceptable, defined quality will be available on board ISS by specifying in-flight water quality monitoring parameters, capabilities and frequency of in-flight water sampling and analysis. . On-orbit water quality is critical to the health of the crewmembers. Periodic archival sampling will allow ground personnel to evaluate the quality of water being provided to the crew by performing detailed ground analyses, most of which can not be accomplished in-flight. Ground results can then be compared to in-flight analysis results. In-flight monitoring is necessary to get timely results and to evaluate critical parameters that may not be stable in archival samples. This requirement defines the minimum parameters for in-flight water quality monitoring.

7.2.3 Water Decontamination

The ISS Program shall ensure the cause of any contaminated water is identified and develop a water systems contamination response plan to decontaminate the water and to eliminate the cause of contamination.

Rationale: To assign responsibility for resolution of specific water quality problems in the event that preflight, ground-based, or in-flight analyses of ISS water samples indicate minimum water quality requirements are not being met. The response plan, to be developed by the Environments Contingency Action Team for Water Quality, will establish a capability to decontaminate the water system and include corrective actions to be taken to remove the chemical contaminants and restore water quality. The response plan will also address methods to prevent that specific type of contamination from occurring in the future.

7.2.3.1 Preflight Water Testing

The ISS Program shall perform functional checkout and testing of water supply systems during the flight preparation stage for launch to ISS.

Rationale: To perform preflight functional checkouts on water supply systems.

7.2.3.2 Preflight Water Decontamination Contingency Plan

The host agency Launch Support Team shall develop and provide a contingency plan to the ISS Program and MMOP in case preflight water sample analyses indicate that specified water quality limits are being exceeded.

Rationale: To assign responsibility for preflight resolution of water quality problems. A contingency plan needs to be developed that states the corrective actions that need to be taken in case preflight water samples exceed acceptable limits. This plan will be developed by the appropriate U.S. or Russian Launch Support Team with the assistance of the team of Russian and US water experts to restore water quality. The plan will include the collection of follow-up samples and subsequent analysis prior to launch, as required, to ensure that the corrective actions were successful.

7.2.3.3 In-Flight Water Decontamination

The ISS Program shall ensure in-flight water processing and storage systems can be decontaminated.

Rationale: In-flight water processing and storage systems must be designed such that water can be decontaminated if water samples indicated on-board water exceeds water quality limits.

7.3 AIR QUALITY

This subsection provides requirements for the monitoring and control of toxic trace contaminants contained in the respirable atmosphere.

The parameters for Partial Pressure of Oxygen (ppO₂), Partial Pressure of Nitrogen (ppN₂), Partial Pressure of Carbon Dioxide (ppCO₂), total pressure, and changes in humidity and air temperature that will be maintained in the US and Russian segments are defined in SSP 41162, Segment Specification for the United States On-Orbit Segment, and SSP 41163, Russian Segment Specification.

The requirements for air supplied to replenish ISS are defined in the document, SSP 30573, Space Station Program Fluid Procurement and Use Control Specification, Revision A, Table 4.1-2.2.

7.3.1 Preflight Assessment of Toxic Contaminants

7.3.1.1 Off-gassing Test

The ISS Program shall test and approve as safe, with regard to toxic off-gassing potential, all non-metallic materials and equipment flown to and used on board ISS that may cause contamination of the inhabited atmosphere.

Rationale: Off-gas contaminants can accumulate to unhealthy levels if sources are not controlled. Test 7 in NASA-STD 6001 or the tests listed in the appropriate documents of the Russian Ministry of Public Health dated 2 September 1982 shall be used for off-gassing testing.

7.3.1.2 Toxicological Assessment of Potentially Toxic Substances

The ISS Program shall assess all potentially hazardous substances or materials for toxic effect and submit the results of this assessment to the ISS Safety Review Panel (SRP) for approval prior to approving chemical substances and dispersible materials (dusts) for use on ISS.

- A. The ISS Program shall assure that data for the assessment is provided to the JSC Toxicology Group or the Russian experts in compliance with JSC 27472 (March 1999), Requirements For Submission of Data Needed for Toxicological Assessment of Chemicals and Biologicals To Be Flown on Manned Spacecraft.
- B. The ISS Program shall assure that the final toxicological assessment of compounds, their quantity and location is accessible to the station's crew, MCC medical personnel, and environmental engineers.

Rationale: Potentially hazardous chemical substances and dispersible materials (dusts) to be flown on board ISS need to undergo a toxicological evaluation and be approved with regard to their possible use on ISS. Additionally, all potentially hazardous compounds present aboard the ISS need to be known to air quality experts. These potentially toxic substances may be released into the ISS atmosphere from housekeeping systems, from scientific experiments, from batteries, or from equipment. This accessibility ensures that maximum information is available in the event of a release of potentially hazardous substances in the habitable volume of ISS. This is necessary in order to select effective personal protective equipment and to determine the appropriate operating modes of the purification systems.

7.3.1.3 New Modules and Hardware First Entry Safety

The ISS Program shall monitor, prior to launch, the atmosphere of new modules to be permanently affixed to the ISS for aggregate off-gassing.

Rationale: The ISS Program must take steps to ensure that the ISS modules do not have an unsafe environment when they arrive on orbit (and when crewmembers enter a module for the first time) or do not further contaminate the existing ISS

environment. Approval of levels of contamination by the MMOP Air Quality Subgroup for modules or cargo vehicles going to the ISS will be based on the estimated contaminant levels at the time of first entry and the additional load that will be placed on the environmental control systems by the new addition.

7.3.1.4 Cargo Module Atmosphere

The ISS Program shall monitor, at the processing facility, the atmosphere of cargo vehicles for potentially hazardous chemical substances.

Rationale: The ISS Program must take steps to ensure that cargo vehicles do not have an unsafe environment when they arrive on orbit (and when crewmembers enter a module for the first time) or do not further contaminate the existing ISS environment. Approval of levels of contamination for modules or cargo vehicles by the MMOP Air Quality Subgroup going to the ISS will be based on the estimated contaminant levels at the time of first entry and the additional load that will be placed on the environmental control systems by the new addition.

7.3.2 In-Flight Sampling and Monitoring of the Atmosphere

7.3.2.1 Archival Air Sampling

The ISS Program shall take archival air samples periodically for toxicological assessment of air quality to determine whether ISS air is or has been safe for crew respiration.

Rationale: Crew health and performance depend on safe air. There are many potential sources of air pollution. The atmosphere needs to be monitored by acquiring samples for ground-based analysis. Safe air is defined according to standards established for space vehicles (see Table D-4). In order to calculate the combined effect of a mixture of contaminants on crew health, the method should be used as defined by the Russian State Standard GOST R 50804-95 and the US standard as set forth in document NASA JSC 20584, Spacecraft Allowable Maximum Concentrations for Airborne Contaminants.

7.3.2.2 In-Flight Real-Time Analysis of Trace Contaminants

The ISS Program shall perform real-time monitoring of selected trace contaminants.

Rationale: During nominal operation of the atmospheric purification and regeneration systems, air pollution by human metabolic waste products and off-gassing from non-metallic materials is analyzed by the onboard real-time monitoring system as per the documentation (see Table D-4). In the event of unexpected releases of toxic substances into the ISS atmosphere, medical experts and environmental control engineers need to quickly know which substances have been released in order to prescribe an appropriate response to ensure crew safety. Onboard air monitoring will be useful in assessing the efficiency of the air scrubbing effort after a contingency.

7.4 MICROBIOLOGY

7.4.1 Microbiology Data

The ISS Program shall make information concerning crew, environment (air, surfaces, and water), payloads, and food microbiological findings available to NASA/FSA specialists, flight surgeons, the MMOP, and IPs.

Rationale: To insure adequate information regarding testing and findings with regard to microbiological contamination is available to all interested parties. IPs should have access to microbiology environmental monitoring data during ground-based preparation processes and in-flight monitoring of the ISS, including both crew and cargo transport vehicles.

7.4.2 Preflight Food and Food Production Facility Microbiology Specifications and Monitoring

The ISS Program shall perform preflight microbiological analyses of foods in accordance with the following standards:

- A. SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T)
- B. JSC 16888, Shuttle Transportation System Microbial Contamination Control Plan (Replaces JSC-11859A)
- C. D528-10051-1, Food Facility Standard Operating Procedures Manual
- D. SD-T-0251L, Microbiological Specification and Testing Procedures for Foods Which Are Not Commercially Sterile
- E. SD-T-0252L, Microbiological Specification and Testing Procedures for Commercially Sterile Foods
- F. Russian food standards, Regulations on Microbiological Requirements for Quality and Testing the Food Products for Cosmonauts

Rationale: To determine that preparation and packaging procedures result in products that conform to established microbial standards for flight foods.

7.4.3 Preflight Environmental Microbiology Specifications and Monitoring of Air and Surfaces

The ISS Program shall ensure ISS environmental parameters (air and surfaces), payloads, and associated hardware are in compliance with the standards in accordance with the following:

- A. Table D-5, Preflight Microbial Specifications and Monitoring Requirements of Air and Surfaces
- B. KSC-OMRS-ACOMC Technical Requirements (flight specific),
- C. NSTS 21426, Spacehab – General Research/Logistics Module Carrier Integration Plan (Core),
- D. JSC 16888, Shuttle Transportation System Microbial Contamination Control Plan (Replaces JSC-11859A)
- E. RSA/IBMP XT-4.160.001, Regulations for Sanitary-Hygienic and Anti-Epidemic Support for Spaceflight at Prelaunch and Postflight Operation Stages.

Rationale: To provide standards for microbiological testing and assessment of microbiological contamination. Air and surface samples will be taken inside the flight element before final element closure. Surface samples will be taken from associated hardware for ISS habitable modules before stowage on the launch vehicle.

Preflight monitoring of microbial contaminants and potential generalized contamination of the ISS will protect crew health, and prevent degradation of systems performance.

7.4.4 In-Flight Environmental Microbiology Specifications and Monitoring of Air and Surfaces

The ISS Program shall perform in-flight microbiological monitoring throughout the life of the ISS to evaluate the microbial condition of cabin air and internal surfaces and determine compliance to standards in accordance with the following: Table D-6, In-flight Microbial Specifications and Monitoring Requirements of Air and Surfaces.

Rationale: To provide standards for microbiological testing and assessment of microbiological contamination. Interior surface materials and metals of the flight article will be evaluated for the possible contributions and effects of microorganisms in causing the destruction or corrosion of these materials. Air and surface samples collected during flight shall be returned to ground for completion of analyses.

7.4.5 Microbial Specifications and Monitoring for Water

The ISS Program shall perform preflight, in-flight, and postflight microbiological analyses of water and determine compliance to standards in accordance with the following:

- A. SE-S-0073, Space Shuttle Specification for Fluid Procurement and Use Control
- B. XT. 0.045.019 TY, Preserved Potable Water
- C. GOCT P 50804-95 standard, Cosmonaut Environment in a Manned Space Vehicle
- D. ЭH 3218-064 1000-0 TY, Rodnik System Fill Assembly
- E. Table D-7, Microbial Specifications and Monitoring Requirements for ISS Water

Rationale: On-orbit water quality is critical to the health of the crewmembers. The requirement insures that water of acceptable, defined quality will be available on board ISS. In-flight monitoring is necessary to get timely results and to evaluate critical parameters that may not be stable in archival samples that are returned for ground-based analyses. The NASA/JSC Water Quality Manager is responsible for assuring that water delivered by the U.S. side or recovered onboard the ISS using U.S. hardware meets water quality standards. The FSA/IBMP Water Quality Manager is responsible for assuring that water delivered by the Russian side or recovered onboard the ISS using Russian hardware meets water quality standards. Water quality monitoring data will also be used to confirm that all necessary system procedures have been performed. Water quality is assessed by ground analysis of water samples that are collected prior to launch during the water preparation process and by in-flight and postflight analyses of water samples collected onboard

ISS during the water reclamation and consumption process. Water sample analysis will be performed using hardware belonging to authorized NASA or FSA organizations or others as concurred with the MMOP.

Potable water loaded on Shuttle for use on ISS is sampled and analyzed at the time of servicing, 15 days before launch, and 3 days before launch. Ground-supplied potable water delivered to ISS by the U.S. side is certified by NASA/JSC laboratories on the basis of the documentation used in the U.S.

Ground-supplied potable water delivered to ISS by the Russian side is sampled and analyzed at the time of servicing and before launch. Ground-supplied potable water delivered to ISS by the Russian side is certified by FSA/IBMP laboratories on the basis of the documentation used in Russia.

7.4.6 Microbial Decontamination

The ISS Program shall develop a contingency plan in the event analyses of microbial samples indicate requirements as defined in this section are not being met and in the event microorganisms are identified as a threat to the crew, payloads, or spacecraft systems.

Rationale: To assign responsibility for resolution of microbial contamination issues. The contingency plan, developed by an Action Response Team made up of the appropriate experts required to resolve the issue, shall include corrective actions to be taken to remove the contaminants.

7.5 RADIATION HEALTH AND EXPOSURE MONITORING

This section establishes the medical support requirements for ionizing radiation exposure, including common dose limits, radiation monitoring, record-keeping, and management of radiation exposure through “As Low As Reasonably Achievable” (ALARA) practices through all mission phases. Radiation exposure is limited to prevent short-term effects and to reduce the probability of long-term effects. ALARA practices are mandated or encouraged by the radiation protection authorities of the IPs in order to minimize health risks due to justifiable radiation exposures.

The dynamic, complex, and unique nature of the radiation environment in low Earth orbit is such that radiation health and protection requirements rely upon analytical modeling and continuous measurements of the on-board environment, as well as personal dosimetry that includes analytical assessments of passive dosimeters worn at all times by each crewmember. During the mission, the ionizing radiation environment is monitored to provide sufficiently comprehensive and timely data to:

- A. maintain crew doses below legal limits and to practice ALARA actions to avoid unnecessary levels of exposure;
- B. collect and record information to assess crewmembers’ critical organ and tissue doses for an individual mission and cumulative career records;

- C. initiate immediate countermeasures for transient radiation exposure events, e.g., during EVA, solar particle events, or electron belt enhancements.

Common requirements and requirements of individual agencies are provided in SSP 50667 MED Volume B, MED matrix <TBS 1.2-1>. Consensus process and procedures for ALARA appear in the Joint Medical Operations Implementation Plan (JMOIP, SSP 50480). Detailed real-time rules governing crew exposure to ionizing radiation are contained in the ISS Generic Operations Flight Rules, Volume B, Section B14, Space Environment.

7.5.1 Ionizing Radiation Protection Requirements

7.5.1.1 Consensus Dose Limits

The ISS Program shall prevent unacceptable deterministic effects to critical tissues by ensuring crew exposures do not exceed the dose values given in Table D-8.

- Crew exposures are managed in adherence to the ALARA principle, which directs that exposures always be maintained As Low As Reasonably Achievable.
- Current career limits for each IPs and other agency-specific exposure limits for dose management, including crew selection, are documented in SSP 50667 MED and MED matrix. The linear energy transfer (LET)-dependent quality factor parameterizations provided by the International Commission on Radiological Protection in Publication 60 are used for stochastic risks calculations for charged particles; Publication 60 provides average quality factors that characterize neutron exposures.
- The BFO, or “blood-forming-organs”, refers to bone marrow, spleen, and lymphatic tissues. Active (red) bone marrow is a surrogate for BFO.

Rationale: This requirement ensures that common limits are set for all agencies with regard to deterministic biological response of radiation exposure to ionizing radiation during a single mission. Annual and shorter-term limits are set below the threshold of occurrence of clinically significant medical effects to specific organs and tissues that impair health and function of a crewmember during or immediately after a mission. Maintaining exposures within these limits eliminates induction of symptoms of acute radiation sickness and ensures compliance with applicable national radiation exposure regulations of the various IPs. The consensus limits provide guidance for mission assignment, developing in-flight recommendations for crew and mission termination.

7.5.1.2 ALARA

The ISS Program shall manage crewmembers’ ionizing radiation exposures following the principles of “As Low As Reasonably Achievable” (ALARA).

Rationale: Each crewmember is protected from deleterious effects that may occur during or after a mission by short-term and extended exposure. Consensus limits in Table D-8 are set to prevent deterministic effects, while career limits prevent

unacceptable risks of late effects. In addition, each occupational exposure must be justifiable, limited, and controlled through an optimization process (ALARA) that balances the potential harm of an exposure against the benefits to society. Implementation of an ALARA program is mandated or encouraged by government or agency regulations of all IPs. ALARA practices include a process of action levels for implementing more aggressive crew exposure review, crew counseling and consent, development and implementation of countermeasures, and other actions. Consensus on action levels will be reviewed periodically by the MMOP Radiation Health Working Group.

7.5.2 Crewmember Radiation Dosimetry

Each crewmember is provided with a personal radiation dosimeter for continuous use during a mission. The personal dosimeter serves as the dosimeter of record. When combined with environmental monitoring and analytical calculations, the dosimeter results provide the individual crewmember's exposure record that is used to track against defined exposure limits. Each individual agency or IP organization is responsible for arranging for crew personal dosimetry for its crewmembers.

7.5.2.1 Crew Personal Dosimeters

Each crewmember shall wear a personal radiation dosimeter at all times during a mission, including during IVA and EVA.

Rationale: This requirement provides the necessary data that, when combined with area radiation monitors and analytical calculations, will ensure compliance with mission and career radiation exposure limits. These measurements are mandated by applicable national radiation exposure regulations of various IPs. The personal dosimeter serves as the single "dosimeter of record."

Space agencies will be able to demonstrate that exposures are in compliance with applicable mission and career limits regarding radiation exposure, able to provide crews with adequate assessments of their radiation health risks, and will not be in violation of various agency regulations related to radiation exposure. Uncertainties in risk projections are significantly increased when personnel dosimeters are not worn.

7.5.2.2 Crew Passive Personal Dosimeter Reporting Intervals

Crew passive personal dosimeters shall be nominally changed out on a mission basis. More frequent change outs shall be assessed for missions lasting more than 180 days or following a transient radiation exposure event.

Rationale: The crew personal dosimeters provide radiation exposure data that must be promptly analyzed and reported for accurate health monitoring, effective crewmember counseling, and to ensure complete exposure histories are available for inclusion in the medical records database. Once missions exceed 30 days, the margin between accrued exposure and the annual exposure limit decreases with

time, while the accuracy of exposure projections through modeling will increase with time. Without individual crew measurements, the possibility of an inaccurate dose measurement that exceeds established limits increases with mission duration. Following a transient high-exposure event, recovery of dosimeters may be necessary to monitor the elevated exposure.

7.5.3 Radiation Area Monitoring and Dosimetry

The ionizing radiation environment is monitored by passive and active (powered) instruments and evaluated in order to document crew exposures and to provide data for dose management. The following requirements ensure adequate environmental monitoring of crewmembers' exposure to cosmic rays and onboard-radiation exposure sources of various biological effectiveness.

Area monitors are passive and active detectors placed throughout the ISS to provide additional information about the temporal behavior, biological effectiveness ("radiation quality"), and inhomogeneity of the ambient radiation field. External radiation detection instruments are necessary to provide near real-time information about the dynamic radiation environment experienced by crewmembers during EVA and for verification of models used to evaluate exposures internal and external to ISS.

7.5.3.1 Passive Radiation Area Dosimetry

Passive dosimetry, capable of measuring time-integrated absorbed dose and estimating average quality factor, shall be deployed at designated fixed locations within each pressurized module.

Rationale: Passive area monitors provide a time-integrated measure of the spatial distribution of exposure rates inside the ISS. The exposure rates change with rack and stowage reconfigurations and throughout ISS assembly. Knowledge of the spatial distribution of exposure rate is necessary to identify areas that have a relatively high exposure rate (i.e. avoidance areas) and to reconstruct a crewmember's exposure in the event of a lost or otherwise unrecordable personal dosimeter. Passive dosimeters collect data even during situations when power is lost to other instruments. Periodic review of the monitoring locations shall be performed by the MMOP Radiation Health Working Group.

7.5.3.2 Active Radiation Area Monitoring

Active radiation area monitoring on ISS is necessary to provide continuous information to ground controllers and to the crewmembers for the purpose of maintaining crew exposures ALARA.

7.5.3.2.1 Internal Active Radiation Area Monitoring

Instrumentation shall monitor the environment in habitable volumes of the ISS and provide information for estimating organ doses.

Rationale: Active monitoring throughout the habitable areas identifies high dose rate areas to be avoided by the crew, reduces uncertainty in final calculated crew risk assessments, and supports ALARA practices through verification of numerical spacecraft shielding model.

7.5.3.2.1.1 TIME-RESOLVED LET OR Y SPECTRUM MONITORING

Instrumentation shall monitor the time-resolved LET spectrum, or as a surrogate, the lineal energy (y) spectrum.

Rationale: LET is a radiation parameter used to interpret the biological significance of absorbed dose from energetic ions and is used to derive the regulatory quantities equivalent dose and effective dose. The LET spectrum varies with position in orbit and with local solar weather conditions. Active, or powered instruments are required to report time-resolved LET or the surrogate lineal energy (y) spectral distributions.

7.5.3.2.1.2 INTERNAL TIME-RESOLVED CHARGED-PARTICLE MONITORING

Instrumentation shall monitor the time-resolved energy- and direction-dependent distribution of charge-identified particles inside ISS.

Rationale: Measured charged-particle energy spectra are necessary for validating analytical models of the radiation flux environment inside ISS. These data contain sufficient information to estimate crew equivalent dose and resulting risk. All other physical quantities (such as LET spectra and absorbed dose) are not singular, and therefore result in ambiguity and hence increased uncertainty in estimates of crew health risk.

7.5.3.2.1.3 NEUTRON MONITORING

Radiation monitoring instruments shall provide the capability to characterize the neutron contribution to crew exposures.

Rationale: Results from scientific research demonstrate that secondary neutrons may contribute 10-30% of the total radiation effective dose received by astronauts inside a space vehicle such as ISS. Since neutrons represent an important fraction of the crew's effective dose, it is necessary that this contribution be monitored for accurate reporting (as required by agency regulations) and accurate risk assessment determination.

7.5.3.2.2 External Radiation Area Monitoring

External active radiation area monitoring shall monitor the time-resolved direction- and energy-dependent charged-particle spectra immediately exterior to the vehicle.

Rationale: Measurements of the external direction- and energy-dependent charged particle spectra are used with radiation transport codes and models of the vehicle's mass distribution to calculate the radiation environment inside the vehicle as part of the crew health risk assessment process. In addition, instruments inside the vehicle

cannot monitor a significant portion of the external radiation environment that is important to EVA crew exposures.

7.5.4 Radiation Contingency Monitoring

High range, high rate dosimeters shall be present on board in order to measure high dose-rate contingency events.

Rationale: Extreme space radiation environmental conditions are possible that greatly exceed levels that can be accurately measured by LET or charged particle spectrometers. High rate dosimeters that can be read by the crew are specifically designed to accurately measure under such extreme conditions.

During extreme space radiation environment enhancements, the radiation instrument data monitored by flight controllers will significantly under-represent actual exposure conditions, leading to erroneous recommendations regarding crew safety.

7.5.5 Ionizing Radiation Survey

7.5.5.1 LET or γ Spectrum Survey

Instrumentation shall be relocated every 14 to 21 days to complete surveys of the entire habitable volume once each ISS increment or every 3-6 months.

Rationale: This requirement provides for the possibility to measure LET in different locations using the same instrument. It facilitates intercomparison with data from other radiation instruments, thereby enhancing the collective value of all data sets. The local radiation environment may change significantly as equipment, stowage items, and consumable items are relocated.

7.5.5.2 Charged-particle Survey Coverage

Time-resolved measurements of the energy-and direction-dependent distribution of charge-identified particles shall be made in each habitable module. Instrumentation shall be capable of surveying the majority of each module.

Rationale: Charged-particle energy spectra are necessary for validating models of the radiation environment inside ISS. These data contain sufficient information to estimate crew organ exposures and resulting risk.

7.5.5.3 Charged-particle Survey Instrument Relocation Interval

Mobile instruments for internal charged-particle surveys shall be relocated to a new location approximately every 14 to 28 days.

Rationale: The charged-particle spectra at a given location within the vehicle are strongly affected by the amount and type of material between the detector and the external environment. Because the distribution and type of material varies significantly throughout the spacecraft, charged-particle measurements need to be

made at numerous locations throughout the habitable volume. A minimum of 14 days is necessary to provide an accurate sampling of the charged particle environment at a given location.

Relocating the instruments too frequently increases the uncertainty in the measurement statistics and may lead to accidental damage of the devices. Relocating the instruments too infrequently reduces the accuracy and precision and coverage of vehicle-wide surveys.

7.5.6 Data Downlink

7.5.6.1 Internal Charged-Particle Data Down-link

Detailed data from time-resolved energy- and direction-dependent charged-particle detector shall be down-linked daily or more frequently for analysis on a time scale that precludes loss of data or to support contingency evaluation for real-time flight support.

Rationale: Due to the volume of detailed particle data which will be acquired and the finite quantity of instrument data storage onboard, it is necessary to frequently download the charged particle data to the ground to ensure data will not be lost. The detailed particle data will also be used periodically to update the estimated crew cumulative exposure risk.

7.5.6.2 Internal Charged-Particle Dose Rate Down-link

Dose rate from charged-particle monitoring equipment shall be continuously transferred to the ground for operational evaluation and real-time flight support.

Rationale: The requirement provides flight control personnel with an accurate insight into the radiation environment experienced by the crew, especially during periods of enhanced space environment conditions. Dose rate data transferred to the ground serves as the basis for implementation of immediate dose management actions. Although this requirement is not the primary purpose for charged-particle monitoring equipment, it provides a measure of redundancy for dose rate monitoring.

7.5.6.3 LET or γ Spectrum Data Downlink

Time-resolved data from at least one LET monitoring instrument shall be transferred to the ground as required for operational evaluation.

Rationale: The requirement provides flight control personnel with an accurate insight into the radiation environment experienced by the crew, especially during periods of enhanced space environment conditions.

7.5.6.4 External Time-resolved Charged-particle Data Down-link

Detailed time-resolved particle spectra shall be down-linked on a timescale that precludes loss of data.

Rationale: Due to the volume of detailed particle data that will be acquired, and the finite quantity of instrument data storage, it is necessary to frequently down-link or download the charged particle data to the ground to ensure data will not be lost. The detailed particle data will also be used for periodically updating the estimated crew cumulative exposure risk.

7.5.6.5 External Dose Rate Data Down-link

Dose rate data characterizing the local radiation environment outside the ISS shall be continuously transferred to the ground for operational evaluation and real-time flight support.

Rationale: The requirement provides flight control personnel with an accurate insight into the status of the external radiation environment, especially during enhanced periods associated with space weather activity. External dose rate data transferred to the ground serves as part of the information used to make EVA go/no-go recommendations.

7.5.7 Alarm Capability

At least one onboard active instrument shall have the ability to alert the crew when exposure rates exceed a set threshold.

Rationale: An onboard radiation alarm/warning system enables the crew to implement immediate countermeasures for transient high-radiation events. Without an alarm, the crew will not be able to apply immediate countermeasures. Reliance on crew alerts via ground-based monitoring or model predictions requires continuous communication coverage, which is not always available.

7.5.8 Exposure Management for Extravehicular Activity

The ISS Program shall ensure that EVA's are scheduled in such a way that radiation exposure, including that obtained during passes through the South Atlantic Anomaly (SAA) and other regions containing elevated levels of radiation, is maintained as low as reasonably achievable (ALARA).

Rationale: This requirement ensures that crew exposure to ionizing radiation is minimized during EVA in accordance with ALARA principles (see 7.5.1.2).

7.5.9 Biodosimetry

Biodosimetry data that is available shall be included in the crewmembers medical record.

Rationale: While not to be used for dose estimation; this data must be available as a biological measure of radiation exposure, individual radiosensitivity, and for screening for potential post-mission health effects for individual crewmembers.

7.5.10 Crew Exposure Records and Health Risk Assessments

The objectives of the record-keeping program are to:

- A. aid in the protection of crewmembers
- B. facilitate evaluation of the effectiveness of the radiation protection program
- C. enhance the collection of data that are accurate, reliable, confidential, and retrievable
- D. provide a uniform set of records

The Radiation Health Officer (RHO) of each IP maintains, at a minimum, the crew personal dosimeter exposure records for each of the Agency's crewmembers. The NASA RHO provides a report of mission exposure and risk estimates to the IP whose crewmembers are participating in that mission.

7.5.10.1 Exposure Record-Keeping

Dosimetry records for each crewmember shall be compiled by the RHO of the applicable IP.

Rationale: Radiation exposure records are necessary for several purposes; examples include:

- A. to inform crewmembers of their mission and cumulative radiation doses
- B. to make decisions on crew selection and to provide forecasting for planned missions
- C. to provide information for making decisions for flight planning
- D. to evaluate the operational radiation safety program for effective program operation
- E. to demonstrate compliance with action levels and dose limits
- F. to provide data for epidemiological studies
- G. to provide information for making or contesting claims for radiation-induced injury

Radiation exposure records are required by federal regulations for radiation workers, and must be available for crew assignments for planned missions, ALARA practices can be effectively developed, practiced, or evaluated.

7.5.10.2 Pre-flight Exposure Management

Pre-flight, crew radiation exposure histories shall be reviewed and the current mission exposures and risks shall be predicted based on planned mission activities. A minimum buffer dose of 0.1 Sv shall be included in the projected dose calculations for assignment of a crewmember to an ISS flight.

Rationale: The purpose of the requirement is compilation of crew radiation exposure histories to evaluate past and predicted crew exposures against exposure guidelines and to meet other regulatory requirements. A buffer dose accounts for uncertainties

in a crewmember's exposure history, including unrecorded occupational exposures, as well as uncertainties in projected exposure and unanticipated events.

7.5.10.3 In-flight Exposure Management

In-flight, radiation exposures and health risk assessments shall be evaluated in order to minimize exposure.

Rationale: The purpose of the requirement is to monitor crew exposure to ensure adherence to exposure limits and to identify opportunities to implement ALARA practices.

7.5.10.4 Post-flight Exposure Management

Post-flight, radiation exposure from each mission shall be evaluated by the Radiation Health Officer of the Space Agency that provided the crew personal dosimeter. Results, along with the crewmember's cumulative exposure history, will be used for health risk assessment and recorded in the crewmember's medical records.

Rationale: The purpose of the requirement is compilation of crew radiation exposure histories to calculate the amount of radiation exposure received during a completed mission and all previous occupational radiation exposures. Records of each crewmember's exposure history are compiled and held indefinitely as part of their medical records.

7.6 NON-IONIZING RADIATION

The ISS Program shall limit exposure to non-ionizing radiation, including radio frequency, electromagnetic fields, infrared, optical, laser radiation, and incoherent ultraviolet radiation, to the values published in SSP-50005C, International Space Station Flight Crew Integration Standard (NASA –STD-3000/T).

7.7 ACOUSTIC ENVIRONMENT

7.7.1 Pre-Flight Assessments

7.7.1.1 Pre-Flight Assessment of Acoustic Environment

The ISS Program shall assess for each stage, pre-flight, the safety of the acoustic environment in the ISS compared to the ISS Acoustic limits defined in Paragraph 7.7.2.

Rationale: To provide for the safety of the crew, the acoustic environment to which the crew will be exposed must be anticipated, evaluated, and controlled. Acoustic measurements of flight hardware and test-correlated analytical models should be applied to predict the proposed mission's acoustic environment with reasonable accuracy. Predictions of the acoustic environment in each ISS Segment will include noise generated by module, payloads, and other equipment sources. The results of this analysis will be presented as part of the Flight Readiness Review process.

7.7.1.2 Pre-Flight Assessment of Flight Hardware

The ISS Program shall assess, pre-flight, the impact due to the addition and operations of any new modules, payloads, and other flight hardware to the existing ISS acoustic environment and disposition waivers and exceedances.

Rationale: In order to control the ISS acoustic environment, the noise levels of noise generating flight hardware, including new modules, payloads, and other equipment, must be controlled and accounted for. Acoustic requirements are specified by the ISS Program according to classification of hardware (module, payload, GFE, etc.), and in some cases to the relation of the hardware to other hardware. In order to control the ISS acoustic environment, each piece of flight hardware will be reviewed and approved or rejected based on acoustic analysis or testing results and any resulting waivers, exceedances and exceptions.

7.7.2 ISS Acoustic Limits

7.7.2.1 Continuous Noise Levels

The paragraphs in this section define ISS Continuous Noise requirements in each Segment, including the noise generated by module, payload complement, and other equipment sources, as applicable.

7.7.2.1.1 U.S. Segment

The ISS Program shall limit the sound pressure levels of continuous noise in the U.S. Segment, for both work and sleep areas, to the levels specified for each octave frequency band in Table D-9.

Rationale: To know whether or not Sound Pressure Levels are acceptable, noise limits must be specified. These work area requirements are the result of the combination of the module requirements in SSP 41000 (NC-50) and the payload complement requirements in SSP 57011 (NC-48, Payload Verification Program Plan), in modules where a payload complement exists. These sleep area requirements are given in SSP 50005 (NC-40).

The sleep requirement ensures the crew obtains adequate sleep/rest.

7.7.2.1.2 Russian Segment

The ISS Program shall limit the sound pressure levels of continuous noise in the Russian Segment, for both work and sleep areas, to the levels specified for each octave frequency band in Table D-10.

Rationale: These limits are the official ISS limits for the Russian Segment, were agreed upon by both the U.S. and Russian sides and are documented in SSP 50094 (Table 6.5.2.4.1).

The sleep requirement ensures the crew obtains adequate sleep/rest.

7.7.2.1.3 Other Segments

The ISS Program shall limit the sound pressure levels of continuous noise in all ISS Segments other than the U.S. Segment and Russian Segment, for both work and sleep areas, to the levels specified for each octave frequency band in Table D-9.

Rationale: To know whether or not Sound Pressure Levels are acceptable, noise limits must be specified. These work area requirements are the result of the combination of the module requirements in SSP 41000 (NC-50) and the payload complement requirements in SSP 57011 (NC-48). The sleep area requirements are given in SSP 50005 (NC-40).

7.7.2.2 Noise Exposure Levels

The ISS Program shall limit the crew noise exposure to a 24-hour equivalent of 65 a weighted decibel (dBA).

Rationale: To know when the crew's noise exposure is acceptable, noise exposure limits must be specified. The glossary (Appendix B) defines the concept of 24-hour equivalent noise. At 67 dBA, hearing protection is required to be worn per flight rule.

7.7.2.3 Maximum Sound Level at Any ISS Location

The ISS Program shall limit the A-weighted overall sound pressure level at any location within the habitable volume of the ISS for any period of time exceeding one second to 85 dBA.

Rationale: To know when dangerous acoustic levels occur, maximum sound level limits must be specified. This limit is from SSP 50005. The A-weighted overall sound pressure level is defined in the glossary.

7.7.2.4 Maximum Impulsive Noise Level

The ISS Program shall limit the overall sound pressure level at any location within the habitable volume of the ISS, caused by an impulsive noise of duration one second or less, to 140 dB.

Rationale: To know when acoustic trauma to the crew's hearing organs may occur, maximum impulsive noise limits must be specified. This limit is from SSP 50005 and is to prevent acoustic trauma. This limit is also the same limit as required by OSHA .

7.7.3 Acoustic Noise Monitoring

7.7.3.1 Sound Level Meter Survey

The ISS crewmembers shall measure the sound pressure level of continuous noise in the octave frequency bands given in Table D-9 in all ISS modules at least once every two months.

Rationale: In order to protect the crewmembers' hearing and ensure a safe working environment, the continuous noise throughout the ISS needs to be monitored. Continuous noise is the underlying noise that is always present on the ISS, and includes continuous noise contributions from modules, payloads that are activated, and other continuous sources. All other noise will be superimposed upon this underlying noise. Understanding of continuous noise is critical to understanding overall crew exposure levels and is important to all noise reduction and noise mitigation efforts.

Noise levels may be such that the general habitability of the ISS is negatively impacted. High noise levels can result in degradation of crew communications, loss of crew sleep; headaches or other negative physiological effects; and temporary or permanent hearing loss.

7.7.3.2 Crew-Worn Acoustic Dosimetry

ISS crewmembers shall measure the A-weighted Equivalent Overall Sound Pressure Level, averaged over an approximate 24-hour period, within 12 inches of the ear at least once every two months.

Rationale: In order to protect the crew from excessive noise exposure, the 24-hour noise exposure experienced by the crew in the ISS needs to be understood. Noise

exposure includes inputs from the underlying continuous noise sources as well as other intermittent and impulsive sources to give a comprehensive value for the entire noise exposure of the crewmember. Understanding of noise exposure is critical to the protection of crew hearing, and helps determine the degree of remedial actions, including moving to a different environment, hardware shutdown, or proper implementation of countermeasures.

7.7.3.3 Static Acoustic Dosimetry

The ISS crewmembers shall measure the A-weighted Equivalent Overall Sound Pressure Level, averaged over an extended period of time, longer than four hours but less than 25 hours, at specified (static) locations at least once every two months.

Rationale: In order to protect the crew from excessive noise exposure, the multiple-hour noise exposure experienced at specific locations in the ISS needs to be understood. These dosimetry measurements provide definitive data on the total noise levels at a specific location including contributions from continuous noise sources as well as other intermittent and impulsive sources. Locations will be determined based on the results of the Sound Level Meter surveys, for example to obtain further information on noise levels at locations where there is a high continuous noise level. Understanding of this composite noise environment is critical to protection of crew hearing and helps determine the degree of remedial actions, including moving to a different environment, hardware shutdown, or proper implementation of countermeasures.

7.7.4 Acoustic Countermeasures and Remedial Action Requirements

7.7.4.1 Hearing Protection

The ISS Program shall provide the ISS crew with JSC-approved Hearing Protection devices.

Rationale: To ensure hearing protection is available to crewmembers in case noise level limits are exceeded thus alleviating possible temporary or permanent threshold shifts (PTS) of the crew's auditory system.

7.7.4.1.1 Exceedance of Maximum Exposure for 24 Hour Period

ISS crewmembers shall don hearing protection whenever the 24-hour crew noise exposure reaches the limit of 67 dBA.

Rationale: In order to address acoustic problems that occur on the ISS and protect the crew from excessive noise exposure, 24-hour exposure levels need to be taken to ensure noise dosage is acceptable. Whenever a crewmember measures levels at or above 67 dBA using a crew worn Acoustic Dosimeter for a 24-hour time period, hearing protection needs to be donned for time periods based upon measured dBA levels defined in Flight Rule B13 152, and these levels need to be reported to ground personnel.

7.7.4.1.2 Exceedance of Maximum Sound Level at Any Location

ISS crewmembers shall don hearing protection whenever any A-weighted overall sound pressure level measurement is in excess of 85 dBA.

Rationale: The purpose of this requirement is to take action when a dangerous level of acoustic noise is present on the ISS. Failure to take action may put the crew at risk. Specific actions for the crew to take will be addressed in the ISS Flight Rules. The crew will wear the hearing protection until the noise situation can be resolved or until they are physically removed from the noisy area such that the A-weighted overall sound pressure level is reduced to less than 85 dBA.

7.7.4.1.3 High Noise Levels Perceived by the Crew – Hearing Protection

ISS crewmembers shall don hearing protection whenever they perceive noise levels to be excessive.

Rationale: To protect the crew from excessive noise exposure, they must don hearing protection whenever they perceive excessive noise levels. They will continue to wear the hearing protection until the noise situation can be resolved or until they are physically removed from the noisy area.

7.7.4.1.4 High Noise Levels perceived by the Crew – Reporting

ISS crewmembers shall measure and report noise levels whenever they perceive noise levels to be excessive.

Rationale: In order to address acoustic problems that occur on the ISS and protect the crew from excessive noise exposure, sound level data must be available to perform analysis. Whenever a crewmember perceives excessive noise levels during activation of any hardware or because of any developing situation, they will use a Sound Level Meter or Acoustic Dosimeter to take A-weighted overall sound pressure level measurements at the location and report the results to ground personnel.

8.0 COUNTERMEASURES FOR LONG DURATION SPACEFLIGHT

This section contains the program-level requirements that consist of countermeasures for long duration spaceflight.

Prolonged exposure to weightlessness and conditions of prolonged confinement and isolation are associated with a range of physiological and behavioral health responses and adjustments that impact crew health, safety, and performance. In general, these effects alter regulation and function of all organ systems, and include loss of bone mineral content, muscle mass, strength and endurance, sensory system deficiencies and motor control system (postural, locomotion, all types of visual tracking, manual control of objects), aerobic and anaerobic work capacity, balance and locomotion, digestive motility, immune response and function, kinesthetic awareness, motivation, mood, and cognitive sharpness.

Countermeasures are needed to address issues such as physical fitness, general crew health and well-being. These countermeasures include considerations for hygiene, privacy, nutrition, crew schedule, workload, Earth observation, and entertainment.

8.1 CREW COUNTERMEASURE PLAN DEVELOPMENT AND IMPLEMENTATION

The ISS Program shall develop, implement and validate a countermeasure plan for ISS crewmembers and crews to counter the deleterious physical, physiological, as well as behavioral health and performance effects due to long-duration spaceflight.

Rationale: A program-level integrated plan is needed that defines, implements, monitors, and validates operational in-flight countermeasures to mitigate adverse physical, physiological, as well as behavioral health and performance effects of long-duration spaceflight upon crewmembers and crews. ISS crewmembers are subjected to prolonged exposure to various environmental and social factors such as weightlessness, small volume for living quarters, isolation from social support, confinement, restriction to small team daily interaction, family separation, imposed circadian rhythm shifts, imposed workload, constant threat for life-threatening contingency, artificial atmospheric gases, and high radiation exposures that require these countermeasures.

8.2 MISSION DURATION LIMITATIONS

The ISS Program shall plan the mission durations and crew duty rotations with consideration to biomedical as well as behavioral health and performance factors. Due to current countermeasure constraints, a nominal duty rotation will be 180 days or less.

Rationale: Mission durations and crew duty rotations must be planned with consideration to biomedical and behavioral health and performance factors that result from long-duration spaceflight as well as mission training requirements and the availability of appropriate countermeasures. The maximum mission duration of 180 days is used in consideration of the following factors: to minimize the adverse consequences of extended exposure to weightlessness and the radiation exposure of space, living and working in a remote and hazardous environment; to limit time

away from family; to meet the need for current training for critical assembly tasks and new science experiments; and to comply with recommendations from crewmember debriefs. Note: This requirement to meet a defined mission duration goes beyond countermeasures and includes food, water, clothing, medical diagnostic and therapeutics supplies, environmental monitoring and intervention equipment, etc.

8.3 PREFLIGHT COUNTERMEASURES

8.3.1 Preflight Behavioral Health and Performance (BHP) <TBR 8.3-1>

1. The ISS Program shall implement individually tailored behavioral health and performance countermeasures for the ISS crewmembers, key ground personnel, and crewmember families throughout the mission.
2. Preflight BHP Training shall include:
 - A. Preflight briefings and/or training which reflect the psychophysiological, social, psychological and cultural aspects of ISS crew performance shall be differentially provided by the ISS Program to the crew commander, crew medical officer, crewmembers, key ground personnel, and crew families
 - B. Training of significant behavioral health and performance phenomena and in-group interactions through out all phases of the mission
 - C. Periodic behavioral observations of the astronaut during professional training with crewmember feedback
3. Monitoring, Assessment and interventions, as defined in SSP 50667, MED Vol. B
4. Delivery of family support services during all phases of the mission to the crewmembers and their families.

Rationale: The training should reflect the psychophysiological, social, psychological and cultural aspects of ISS crew training as well as address significant behavioral health and performance phenomena and in-group interactions throughout all phases of the mission. These briefings and training sessions improve crewmember's skills necessary to manage negative interactions, interpersonal disagreements, alteration in mood, fatigue, workload management, performance decrements and crew versus ground team error, all of which are expected occurrences during long duration missions. They further contribute to crew, ground team and family preparation for possible behavioral health problems arising during the mission.

8.3.2 Preflight Exercise

The ISS Program shall ensure an individualized preflight physical fitness (cardiovascular and resistance)-training regimen is performed by all crewmembers.

- A. Beginning one year prior to launch for crewmembers assigned to long duration flights, preflight training timelines shall accommodate a minimum of two periods of two hours of scheduled physical training per week with two additional hours planned if necessary, depending on the condition of the crewmember.

Rationale: Preflight physical fitness training contributes to preflight and in-flight crew health and performance. This requirement implies the infrastructure needed to perform the prescribed regimens will be made available, including facilities, equipment, personnel to implement this program as well as crew time allocation within a reasonable workday in the training schedule to allow crew preparation for flight and on-orbit duties. Details of the U.S. program are located in JSC 27579, Astronaut Exercise Program. Details of the Russian program are located in <TBS 8.3.2>, Cosmonaut Exercise Program. See also Section 4.1 for additional training requirements.

8.3.3 Preflight Medical Assessment Tests (MAT)

ISS crewmembers shall participate in preflight medical assessment activities as specified in SSP 50667, MED Volume B Section III “Medical Examinations for Long Duration Space Flight.”

Rationale: Preflight medical assessment of physical fitness and behavioral and performance data is necessary for comparison with similar in-flight and post-flight measures. Comparison of test data for preflight, in-flight, and post-flight phases will allow interpretations and statements to be advanced regarding the health and performance capability of the crewmember. This information will be important in determining continuation of mission goals and objectives, as well as determining the proper course of action during the post-flight rehabilitation to 1-g earth environment. A comparison of preflight fitness and behavioral health and performance data with in-flight and post-flight measures will improve the accuracy of countermeasures provided to support the fitness and behavior and performance of crew and crewmember while on orbit and after return to Earth.

8.3.4 Health Stabilization Program

The ISS Program shall implement a Health Stabilization Program (HSP) for all crewmembers.

Rationale: A Health Stabilization Program minimizes crew exposure to preflight illness and reduces the chance of launch delays, crew replacement, or decrements in in-flight performance due to crew illness. As part of this program, a health awareness campaign (HAC) is initiated 30 days prior to launch to make nonflight crewmembers, families, and co-workers aware of the provisions of the HSP to help guard against the spread of infectious disease during the HSP period. Program details for crewmembers launching on the Shuttle are located in JSC 22538, Health Stabilization Program for the Space Transportation Program. Program details for crewmembers launching on the Soyuz are located in <TBS 8.3.4>.

8.4 CIRCADIAN ENTRAINMENT

The ISS Program shall provide crewmembers circadian entrainment to accommodate the increment pre- and in-flight timeline.

Rationale: The requirement ensures appropriate circadian shifting to accommodate mission goals and work schedules. Circadian entrainment includes lighting systems, work/rest schedules, special activity schedules, and selected pharmacological agents as appropriate depending on mission requirements. Circadian shifting can occur both preflight and during the mission. All circadian shifting activities will be approved by the CS. Detailed groundrules and constraints for sleep and circadian shifting are contained in the crew scheduling groundrules and constraints section of SSP 50261-02, International Space Station Generic Ground Rules and Constraints, Part 2: Execute Planning and NSTS 12820, ISS Generic Flight Rules Vol B Section 13, Aeromedical.

8.5 IN-FLIGHT COUNTERMEASURES

8.5.1 Crew In-Flight Work Day Requirements

The ISS Program shall plan the general crew work day as follows:

- A. 8.5 hour sleep period
- B. 1.5 hour post-sleep period (includes 1.0 hour for morning meal)
- C. 0.5 hour for daily planning conferences (morning and evening)
- D. 1.5 hours for work preparation and plan familiarization
 - a. 1.0 hour – Daily plan review/report preparation
 - b. 0.5 hours – Work preparation
- E. 6.5 hours consisting of scheduled assembly, systems and utilization operations*
- F. 1.0 hour for the midday meal
- G. 2.5 hours exercise period (includes time for setup, cardiovascular/resistive exercise, stowage, hygiene (cool down and cleanup)
- H. 2.0 hour pre-sleep period (includes 1 hour for evening meal)

*For the first 2 weeks of a crew's stay on the ISS (post undocking), the crew day will be changed to the following:

- A. 5.5 hours consisting of scheduled assembly, systems, and utilization operations
- B. 1.0 hour of new crew familiarization with ISS systems.

Rationale: A general crew work day requirement is needed during planning activities for overall timelining of mission activities. Time needs to be allocated for crew rest and countermeasures. The general crew workday will, in nominal circumstances, adhere to the above generic scheduling template framework.

8.5.2 Physical/Physiological In-Flight Countermeasures

8.5.2.1 Available In-Flight Countermeasures

The ISS Program shall provide the following in-flight countermeasures:

- A. In-flight (General)
 - 1. Exercise (including treadmill, cycle ergometer, and resistive exercise devices)
 - 2. Lower Body Negative Pressure (LBNP)
 - 3. Loading suits
 - 4. Thigh cuffs
 - 5. Pharmacologic preparations
 - 6. Electromyostimulation
 - 7. Hearing protection devices
- B. In-flight (End Of Mission)
 - 1. Fluid/salt loading regimens
 - 2. Anti-G garments
 - 3. Active cooling
 - 4. Recumbent seating following increments greater than 30 days
 - 5. Pharmacologic preparations

Rationale: The targets for maintenance of physiological functions while on orbit include: aerobic and anaerobic capacity, muscular strength and endurance, preservation of bone mineral and morphology, and locomotor stimulation of sensorimotor coordination. Having the above listed in-flight countermeasure hardware allows for effective selection and implementation of an individualized in-flight countermeasures protocol for each crewmember. Crewmembers need adequate training, equipment, and time scheduled for implementation. The program and application of the in-flight countermeasures is prescribed by the CS with inputs from appropriate medical specialists based on unique mission needs and specific crewmember considerations. The in-flight countermeasure program is monitored to validate effectiveness of the countermeasures and to make changes to the prescription, if needed, via a periodic physical fitness examination.

8.5.2.2 Crew Participation in Daily Physical Exercise

ISS crewmembers shall participate in physical exercise, consisting of aerobic, anaerobic and resistive exercise as prescribed by medical specialists.

Rationale: Physical exercise is a major in-flight countermeasure needed to maintain crew health and physical performance capabilities during long-duration missions. It has been determined by medical experts that the most effective exercise regimen consists of locomotor stimulation, aerobic and anaerobic conditioning, and resistive exercise. Specific durations and types of exercise will be defined in crewmember specific exercise protocols. The time allocated as part of the crew workday for crew exercise includes time for equipment setup, reconfiguration, exercise, and stowage as well as crewmember cool down and cleanup. The ability to define and monitor

acceptable in-flight physical and physiological parameters, while providing physical and pharmacological countermeasures to maintain these parameters, is provided by SSP 50667 MED Volume B. The major components of the exercise program are detailed in Medical Requirements Integration Document (MRID) 082L, Inflight Exercise. <TBS 8.5.2.2>

8.5.2.3 End of Mission Exercise Countermeasures

The ISS Program shall provide crewmembers returning on the Shuttle methods and opportunity for prescribed physical (aerobic and resistive) exercise.

Rationale: Long-duration crewmembers returning from the ISS need to continue their end of mission exercise regimen while based in the Shuttle using available exercise equipment. The ISS Program will work with the Shuttle Program to ensure Shuttle exercise equipment, which includes a cycle ergometer and a resistive exercise device, are made available. While based in the Shuttle, the exercise protocol for each crewmember will be approved by the CS.

8.5.3 General Health and Well-Being

8.5.3.1 Nutrition

The ISS Program shall develop an ISS Food Plan <TBD 8.5.3.1> to manage nutrition and food for the ISS crewmembers.

Rationale: Adequate nutrition, food provisions, standards, and crew food system training need to be defined and implemented for ISS missions. Food operational and nutritional requirements will be defined in SSP XXXX <TBD 8.5.3.1>. The plan needs to allow for selection of foods based on individual crewmember food preferences and to aid in the development of individualized in-flight menus by consultation with appropriate nutritional and medical specialists. In addition, the plan needs to include food quality, microbiological, and toxin standards to certify food for flight by the U.S., Russia, and other IPs. The plan will be coordinated with the MMOP Nutrition Working Group and approved by the MMOP.

8.5.3.1.1 Preflight Food Familiarization

The ISS Program shall provide each crewmember the opportunity, preflight, to taste test all individual food items.

Rationale: A food familiarization session is needed in order to obtain crewmembers' recommendations for development of an initial in-flight menu. In addition, crewmembers may participate in food training consisting of food items from the complete menu cycle (i.e., approbation – official approval). The results of the approbation sessions will be used to complete a final menu. These sessions are conducted at such a time that the results may influence menu selection, specifically, no less than 8 months prior to launch of the food for a particular crew. If approbation is not conducted during the time period described here, the final menu will be based

on the food familiarization session. Participation in approbation will be based on crew preference, prior flight experience, and consultation with appropriate nutritional and medical specialists. This activity will be coordinated by the MMOP Nutrition Working Group.

8.5.3.1.2 Nutritional Status Assessment

The ISS Program shall use the protocol for nutritional assessment for long-duration missions described in JSC 28566, Nutritional Status Assessment for Extended Duration Space Flight.

Rationale: The requirement provides a standard for evaluation of the nutritional status of crewmembers. JSC 28566 will be used as the initial plan until an ISS Program plan can be developed and approved by all IPs.

8.5.4 In Flight Behavioral Health and Performance

The ISS Program shall implement individually tailored behavioral health and performance countermeasures for the ISS crewmembers, key ground personnel, and crewmember families throughout the mission. These countermeasures shall include the following:

- A. Monitoring, assessment and interventions as defined in SSP 50667, MED Vol. B
- B. Delivery of family support services during all phases of the mission to the crewmembers and their families.

Rationale: In-flight countermeasures are needed to prevent and ameliorate the deleterious effects of living in a space vehicle in which humans are subjected to weightlessness, small volume for living quarters, isolation from social support, confinement, restriction to small team daily interaction, family separation, imposed circadian rhythm shifts, imposed workload, constant threat for life-threatening contingency, artificial atmospheric gases, and potential for high radiation exposures. The behavioral health and performance countermeasures are necessary for both maintaining individual behavioral health and performance as well as maintaining performance and functioning of the entire crew as a unit. To be effective, countermeasures must be available that are consistent with mission duration and crew duty periods.

8.5.4.1 Behavioral Health and Performance: Psychological Adaptation Countermeasures

The ISS Program shall implement:

- 1. Psychological countermeasures for individual and crew adaptation (for motivation, individual and group behavior, crew-ground interactions).
- 2. Private Family Conferences (PFC):
 - a. Scheduled weekly with a minimum duration of 15 minutes per crewmember.

- b. Two-way voice and (preferably) video communication shall be scheduled using private communication methods from ISS to ground control center. Privacy shall be provided by excluding monitoring of this loop, and excluding others in the room without family approval.
3. Delivery of personal packages to the crewmembers (one package from family members and one package from home agency BHP group) at the minimum frequency of one package every three months.
4. Access to onboard amateur radio for recreational ham radio contacts.
5. Access to audio, text, video and e-mail uplink and downlink capabilities:
 - a. Uplink of audio news in native language no less than once per week.
 - b. Uplink of written news summaries, no less than every other day.
 - c. Uplink of video for recreational and leisure purposes (such as sports, news, or cultural activities) no less than once per week.
6. Delivery of materials for a wide variety of individually determined leisure activities (such as videotapes, books, recorded music, and recreational software).

Rationale: In-flight countermeasures are needed to prevent and ameliorate the deleterious effects of living in a space vehicle in which humans are subjected to weightlessness, small volume for living quarters, isolation from social support, confinement, restriction to small team daily interaction, family separation, imposed circadian rhythm shifts, imposed workload, constant threat for life-threatening contingency, artificial atmospheric gases, and potential for high radiation exposures. The behavioral health and performance countermeasures are necessary for both maintaining individual behavioral health and performance as well as maintaining performance and functioning of the entire crew as a unit. To be effective, countermeasures must be available that are consistent with mission duration and crew duty periods.

8.5.4.2 Behavioral Health and Performance: Human-to-System Interface Countermeasures

The ISS Program shall provide to the IMG:

- A. Expert assessment of the impact of workload, task sequence, and countermeasures to maintain crewmember performance.
- B. Expert assessment of the impact of work environment, habitability and countermeasures to maintain crewmember performance.

Rationale: In-flight countermeasures are needed to prevent and ameliorate the deleterious effects of living in a space vehicle in which humans are subjected to weightlessness, small volume for living quarters, isolation from social support, confinement, restriction to small team daily interaction, family separation, imposed circadian rhythm shifts, imposed workload, constant threat for life-threatening contingency, artificial atmospheric gases, and potential for high radiation exposures.

The behavioral health and performance countermeasures are necessary for both maintaining individual behavioral health and performance as well as maintaining performance and functioning of the entire crew as a unit. To be effective, countermeasures must be available that are consistent with mission duration and crew duty periods.

8.5.4.3 Behavioral Health and Performance: Sleep and Circadian Countermeasures

The ISS Program shall provide to the IMG:

- A. Expert assessment of the impact of work and rest schedules and countermeasures to maintain crewmember circadian and sleep cycles.
- B. Expert consultation to provide individual crewmember countermeasures for fatigue and sleep problems.

Rationale: In-flight countermeasures are needed to prevent and ameliorate the deleterious effects of living in a space vehicle in which humans are subjected to weightlessness, small volume for living quarters, isolation from social support, confinement, restriction to small team daily interaction, family separation, imposed circadian rhythm shifts, imposed workload, constant threat for life-threatening contingency, artificial atmospheric gases, and potential for high radiation exposures. The behavioral health and performance countermeasures are necessary for both maintaining individual behavioral health and performance as well as maintaining performance and functioning of the entire crew as a unit. To be effective, countermeasures must be available that are consistent with mission duration and crew duty periods.

8.5.4.4 Behavioral Health and Performance: Behavioral Health Countermeasures

The ISS Program shall provide expert consultation to provide individual crewmember countermeasures to maintain effective cognition, mood and behavioral health.

Rationale: In-flight countermeasures are needed to prevent and ameliorate the deleterious effects of living in a space vehicle in which humans are subjected to weightlessness, small volume for living quarters, isolation from social support, confinement, restriction to small team daily interaction, family separation, imposed circadian rhythm shifts, imposed workload, constant threat for life-threatening contingency, artificial atmospheric gases, and potential for high radiation exposures. The behavioral health countermeasures are necessary for both maintaining individual behavioral health and performance as well as maintaining performance and functioning of the entire crew as a unit. To be effective, countermeasures must be available that are consistent with mission duration and crew duty periods.

8.5.5 In-Flight Data Collection and Downlink

The ISS Program shall collect and download data relevant to the fitness, cardiovascular, neurovestibular, nutritional, visual and auditory health status, and behavioral health and performance of all ISS crewmembers.

Rationale: The In-flight countermeasures and human systems data is essential to the understanding of the crewmembers state of fitness and performance level, as well as the effectiveness of the countermeasures hardware and program. This data will be utilized to maximize the health and performance of the crew on-orbit, as well as for validating existing countermeasures, which affects the design and implementation of countermeasures for future crews, as is inherent in the clinical status evaluation project. Some of this data will also be used to evaluate preparation for future exploratory class missions.

8.6 POST-FLIGHT RE-ADAPTATION COUNTERMEASURES

This section contains requirements specifically dealing with re-adaptation countermeasures. Post-flight medical evaluations are addressed in Section 5.4.

8.6.1 Post-Flight Rehabilitation Program

The ISS Program shall implement a post-flight rehabilitation program as described in Rehabilitation Document (SSP xxxxxx <**TBD 8.6.1**>).

Rationale: To develop a post-flight rehabilitation program that will provide the facilities, equipment and personnel to allow crewmembers to participate in the program. This plan will also ensure there is sufficient post-flight crew time in the schedule to allow crewmembers to fully rehabilitate to pre-flight baseline status. During long-duration space-flight there are a number of physiological changes that occur in the human body, in order to adapt to the 0-g space-flight environment, despite the performance of in-flight countermeasures. On returning to the Earth, crewmembers will need to readapt to the 1-g environment. They may experience significant distortions in their neurovestibular system during this transition. Typically their muscular strength and endurance and cardiovascular system are impaired. They have been isolated from family, friends, and their usual terrestrial lifestyle for many months. In addition they may have losses of bone mineral and joint/ligament strength. All of these and other conditions need to be assessed and progressively rehabilitated, before it is safe for a crewmember to return in a step-wise fashion to the usual activities of daily living, work duty and flight status. This process after a long duration flight takes a minimum of 45-days and may take even longer to return a crewmember back to their pre-flight baseline. It is critical that a crewmember's schedule be protected to allow the full rehabilitation program to be implemented.

8.6.2 Post-Flight Medical Assessment Test (MAT)

ISS crewmembers shall participate in post-flight medical assessment activities as defined in SSP 50667 MED Volume B.

Rationale: Post-flight physiological measures of physical performance capabilities are necessary for comparison with similar in-flight and preflight measures. The data will be used to determine functional and performance capacity of the body as a whole and of its various systems. Comparison of test data for preflight, in-flight, and post-flight phases will allow interpretations and statements to be advanced regarding the health of the crewmember. These statements will be important in determining the proper course of action during the rehabilitation to a 1-g earth environment.

8.6.3 Post-Flight Behavioral Health and Performance

The ISS Program shall implement post-flight behavioral health and performance debriefings and support programs for the crew, key ground personnel, and crew families, including:

- A. Monitoring, assessment and interventions as defined in SSP 50667, MED, Vol B
- B. Delivery of family support services during all phases of the mission to the crewmembers and their families

Rationale: The requirement ensures that behavioral health and performance support services will be available for the crew, key ground personnel, and crew families.

9.0 EMERGENCY MEDICAL SERVICE

This section establishes the specific ISS Program requirements for launch and/or landing site emergency medical intervention and care following a medical contingency for ISS crewmembers. The MMOP administers the launch and landing site emergency medical intervention and care requirements for the ISS Program. However, the individual Agencies responsible for the launch or landing areas will be responsible for plans to support at these sites.

Emergency Medical Services (EMS) forces are required to provide immediate medical care to flight crewmembers, preventing aggravation of physical or behavioral health and performance conditions and/or loss of life during contingency launch/landing scenarios. The EMS forces are made up of personnel who render medical care (including behavioral health and performance), facilitate communications, stabilize the crewmember, and transfer the crewmember(s) to medical facilities. EMS also includes the necessary supplies and equipment to provide stabilization and treatment at the scene and en route to the DMCF or Intermediate Medical Care Facility (IMCF).

Detailed requirements for Shuttle and/or Soyuz contingency launch or landing scenarios are not addressed in this section, but are addressed in existing Shuttle and Soyuz documentation. ISS crewmembers launching or landing on the Shuttle will adhere to the EMS requirements detailed in JSC 13956, Requirements Document for Space Shuttle Medical Operations. For ISS crewmembers launching or landing on the Soyuz, requirements are outlined in <TBD 9.0> Russian documents. The landing vehicle site EMS implementation plan includes a list of hospitals, which may be used as a DMCF, IMCF or equivalent and include helicopter landing capability, if it exists.

9.1 HOST AGENCY EMS

The host agency for the return vehicle shall provide EMS to ISS crewmembers.

Rationale: EMS are needed to provide immediate emergency medical care to ISS crewmembers. EMS includes recovery, stabilization, and transport by qualified EMS personnel to either an IMCF or DMCF or equivalent. Stabilization includes standard advanced life support (ALS) capabilities as defined in the glossary (Appendix B). Transport will be provided in accordance with the existing EMS plans for Shuttle or Soyuz. The landing vehicle site EMS implementation plan shall include a list of hospitals that may be used as a DMCF or IMCF with helicopter landing capability. Medical Evacuation (MEDEVAC) of U.S. astronauts beyond Moscow will be in accordance with JSC 28719, Emergency Medical System (EMS) Plan for Russia. . MEDEVAC of other ISS crewmembers beyond Moscow will be coordinated between the host agency and the crewmember's home agency.

9.2 REQUIREMENTS AND IMPLEMENTATION PLANS

The ISS Program shall ensure that Shuttle and Soyuz requirements documents and their supporting implementation plans shall be made available for the ISS Program and the MMOP to review in an unclassified format.

Rationale: Information on both Shuttle and Soyuz requirements and implementation plans is needed so that in the event of a medical contingency all parties understand the plan of action. This information includes a list of hospitals, which may be used as a DMCF, IMCF or equivalent, and helicopter landing capability at those facilities.

9.3 COMMUNICATIONS CAPABILITY

The ISS Program shall ensure the CS or designee staffing the Surgeon console in MCC-H can communicate with the crew and on-scene EMS medical personnel. This communications capability shall be documented in the JMOIP or vehicle specific documentation that is available to the ISS Program.

Rationale: The clinician (CS, DCS, or IP FS) staffing the Surgeon console in MCC-H has the responsibility to provide medical information to the first response medical support for the flight crew and keep the FCT informed at all times. In order to provide this support, the clinician needs to have a communications capability with the crew or first response personnel throughout the contingency. Communication is also needed with on-scene EMS medical personnel to keep them informed of the current medical situation prior to landing.

9.4 TRANSPORTATION OF CS AND IP FS

The vehicle host agency shall provide transportation for the CS or designee and IP FS with crewmembers on the vehicle to the landing site and to the emergency treatment site.

Rationale: The CS or designee and IP FS need to be present to direct and monitor the crew's treatment and to accompany the crewmembers as appropriate. The CS or designee and IP FS will have been involved in the medical contingency diagnosis and treatment while the crewmember was on-board ISS, and have the most expertise concerning the medical contingency. This transportation will include assistance with any customs or other clearances for any IP-specific medications. All documentation will be completed at least 60 days prior to a scheduled launch/landing. In the event of an early mission termination or contingency mission abort, the host agency will include the IP FS(s) in all phases of crew recovery and transport. For contingency landing, a process will be documented in the JMOIP that will allow the IP FS to accompany the host agency to the landing site with IP-specific medications and equipment.

9.5 CREWMEMBER FATALITY

The vehicle host agency shall be responsible for the recovery assistance, treatment (secure, analyze, and identify), and transportation of the remains of a deceased crewmember during space flight operations. The IP FS shall be allowed to participate in the recovery assistance and treatment of the crewmember.

For space flight operations within CONUS or other sites under U.S. jurisdiction, this responsibility belongs to the ISS Program, through coordination with the Department of Defense Manned Spaceflight Support Office (DDMS) and/or NASA Aircraft Operations Directorate (AOD).

Rationale: To provide the IPs a clear understanding of their responsibilities and duties in the event of a fatality situation. The IP FSs are allowed to participate in the recovery assistance and treatment of the crewmember. Movement following analysis and identification is the responsibility of the crewmember's agency and will be conducted in accordance with existing international agreements/arrangements. For example, at NASA the AA/Office of External Relations and the OSF Chief Medical Officer assists the AA/OSF with the necessary activities, as required. The general details of the procedures are outlined in the JMOIP for each agency.

9.6 CONTINGENCY REPORT

The ISS Program shall ensure that the responsible agency shall provide a report on the overall effectiveness and any issues that arose during a contingency at launch/landing. The report shall be available to personnel in the ISS Program and the MMOP.

Rationale: A report is needed in order to fully document the process implemented and to show any problems or issues that need to be worked for future contingencies.

9.7 MEDICAL RECORD KEEPING

The ISS Program shall ensure a record of all medical services provided to any crewmember during a contingency situation is maintained and provided to the CS and the CS will ensure it is added to the crewmember's records.

Rationale: Without a medical record of the care provided, the CS or IP FS will not be aware of the complete treatment protocol.

APPENDIX A – ACRONYMS AND ABBREVIATIONS

ACIH	American Conference on Industrial Hygienists
ALARA	As Low As Reasonably Achievable
ALS	Advanced Life Support
ALSP	Advanced Life Support Pack
AMC	Ambulatory Medical Care
ANSI	American National Standard Institute
BFO	Blood Forming Organs
BHP	Behavioral Health and Performance
BLS	Basic Life Support
BME	Biomedical Engineer
CFR	Code of Federal Regulations
CFU	Colony Forming Unit
CHeCS	Crew Health Care Systems
CM ²	Centimeters Squared
CMO	Crew Medical Officer
CMRS	Crew Medical Restraint System
CMS	Countermeasure System
CONUS	Continental United States
CPR	Cardiopulmonary Resuscitation
CS	Crew Surgeon
CSA	Canadian Space Agency
dB	Decibel
dBA	A-weighted decibel
DCN	Document Change Notice
DCS	Deputy Crew Surgeon
	Decompression Sickness
DMCF	Definitive Medical Care Facility
DDMS	Department of Defense Manned Spaceflight Support Office
ECG/EKG	Electrocardiogram
EHS	Environmental Health System
EMS	Emergency Medical Service
	Emergency Medical System
EMU	Extravehicular Mobility Unity
ESA	European Space Agency
EVA	Extravehicular Activity
FCOD	Flight Crew Operations Directorate
FCR	Flight Control Room
FCT	Flight Control Team
FD	Flight Director
FS	Flight Surgeon
FSA	Federal Space Agency
GFE	Government Furnished Equipment
GHz	Giga Hertz
GMO	Group of Medical Support at MCC-M

HB&PS	Human Behavior and Performance Specialists
HMS	Health Maintenance System
HPS	Human Patient Simulator
HRF	Human Research Facility
HRMRB	Human Research Multilateral Review Board
HSP	Health Stabilization Program
IEEE	Institute of Electrical and Electronic Engineers
IMCF	Intermediate Medical Care Facility
IMedS	Integrated Medical System
IMG	Integrated Medical Group
IMMT	ISS Mission Management Team
IP	International Partner
ISS	International Space Station
JAXA	Japan Aerospace Exploration Agency
JMOIP	Joint Medical Operations Implementation Plan
JPD	JSC Policy Directive
JSC	Johnson Space Center
kHz	kilo Hertz
KSC	Kennedy Space Center
L-	Launch Minus
LAB	Laboratory Module
LBNP	Lower Body Negative Pressure
LET	Linear Energy Transfer
L_{eq}	Equivalent Sound Pressure Level
LOS	Loss Of Signal
m^3	Milligrams per Cubic Meter
MCC	Mission Control Center
MCC-H	Mission Control Center – Houston
MCC-M	Mission Control Center – Moscow
MCC-IP	Mission Control Center-International Partner
MCOP	Multilateral Crew Operations Panel
MED	Medical Evaluation Document
MEDEVAC	Medical Evacuation
MFU	Multi-filtration Unit
Mg	Milligram
MIT	MMOP Implementation Team
MIOCB	Mission Integration and Operations Control Board
MMIOCB	Multilateral Mission Integration and Operations Control Board
MMPB	Multilateral Medical Policy Board
MMOP	Multilateral Medical Operations Panel
MOD	Mission Operations Directorate
MORD	Medical Operations Requirements Document
MOSIP	Medical Operations Support Implementation Plan
MOU	Memoranda Of Understanding
MOUCB	Multilateral Operations and Utilization Control Board
MPLM	Multi-Purpose Logistics Module

MPSR	Multipurpose Support Room
MRID	Medical Requirements Integration Document
MSMB	Multilateral Space Medicine Board
MST	Medical Support Team
NASA	National Aeronautics and Space Administration
NC	Noise Criteria
NHB	NASA Handbook
NPD	NASA Policy Directive
Pa	Pascal
PC	Primary Contact
PFC	Private Family Conference
PHS	Periodic Health Status
PMC	Private Medical Conference
PPC	Private Psychological Conference
ppCO ₂	Partial Pressure of Carbon Dioxide
ppO ₂	Partial Pressure of Oxygen
ppN ₂	Partial Pressure of Nitrogen
PRP	Personnel Reliability Program
PTS	Permanent Threshold Shift
RM	Research Module
RRGU	Russian Regional Control Center
SAA	South Atlantic Anomaly
S/G	Space to Ground
SLSD	Space and Life Sciences Directorate
SM	Service Module
SMAC	Spacecraft Maximal Allowable Concentrations
SMHCSO	Space Medicine and Health Care Systems Office
SMOT	Space Medicine Operations Team
SMMT	Space Medicine Management Team
SRP	Safety Review Panel
SSCD	Space Station Change Directive
SSK	Surface Sampler Kit
SVO-ZV	Hygiene Station Water Port
TBD	To Be Determined
TBR	To Be Resolved
TBS	To Be Supplied
TLVs	Threshold Limit Values
TMC	Transitional Medical Care
TOCA	Total Organic Carbon Analyzer
TsUP	Center for Controlled Guided Flight
TTS	Temporary Threshold Shift
US	United States
WMK	Water Microbiology Kit

APPENDIX B – GLOSSARY OF TERMS

24-HOUR EQUIVALENT NOISE EXPOSURE LEVEL

Equivalent Sound Pressure Level (L_{eq}) to which the crewmembers are exposed over a 24-hour period; expressed in dBA re 20 μ Pa.

A-WEIGHTING

Adjustments typically made to acoustic measurements to approximate the response of the human ear.

A-WEIGHTED OVERALL SOUND PRESSURE LEVEL

Same as the Overall Sound Pressure Level except that the fluctuating acoustic pressure is weighted, based on the A-weighting scale, according to frequency; expressed in dBA re 20 μ Pa.

ACOUSTIC DOSIMETER

A device for measuring Noise Exposure Levels; averages over an extended period of time.

ADVANCED LIFE SUPPORT (ALS) IN THE ISS SETTING

Criteria for ALS in the ISS setting are defined as a crewmember with any of the following:

- A. Unstable vital signs (heart rate <42 or >100, respiratory rate <8 or >30, systolic blood pressure <90 or >200, pulse oximetry <90% on room air, signs of confusion, pallor, extreme pain, or altered mental status)
- B. Use of an artificial airway, assisted breathing device, or ventilator
- C. Need for any intravenous drug infusion(s)
- D. Recent or anticipated use of defibrillator, cardioversion, or transcutaneous pacing
- E. Need for continuous physiological monitoring
- F. Need for continuous monitoring and care by another crewmember
- G. Failure of one or more organ system(s)

AMBULATORY MEDICAL CARE (AMC)

For the ISS, “ambulatory care” is defined as that level of medical care which a crewmember can independently provide to himself or herself. While the flight surgeon might be consulted, no complex interventions or assistance from other crewmembers are needed. Many of the conditions which require “ambulatory care” are minor ailments which would be likely to resolve eventually even in the absence of treatment, but may still in the interim have significant mission impact. In addition, it should be noted that if a minor ailment is not properly diagnosed and treated in its initial stages, it may progress to a much more severe condition; e.g., bronchitis if untreated may become pneumonia,

a bladder infection if untreated may lead to a kidney infection (pyelonephritis) or sepsis. Criteria for “ambulatory care” are defined as:

- A. Administration of oral or topical medications
- B. No more than one procedure required for resolution of condition (example: single dose of intravenous medication or reduction of dislocation)
- C. Ability to perform the majority of scheduled mission tasks

APPROBATION

The act of approving formally or officially.

ARCHIVE SAMPLES

Archive Samples are environmental samples taken during flight by the crew and then analyzed upon return to ground.

AS LOW AS REASONABLY ACHIEVABLE (ALARA)

ALARA is an internationally recognized radiation protection philosophy that requires reducing the total radiation detriment from justifiable activities or practices to as low as is reasonably achievable, economic and social factors being taken into account. The ALARA principle is a legal requirement intended to ensure astronaut safety. An important function of ALARA is to ensure that astronauts do not approach dose limits and that such limits are not considered as “tolerance values.” ALARA is especially important for space missions in view of the large uncertainties in cancer and other risk projection models. Manned-mission programs and terrestrial occupational procedures resulting in radiation exposures to astronauts are required to find cost-effective approaches to implement ALARA.

AUDIO DOSIMETER

Same as Acoustic Dosimeter.

BASIC LIFE SUPPORT

For the ISS, “basic life support” is defined as that level of medical care which provides the capability for Cardiopulmonary Resuscitation (CPR), basic airway management, and crew immobilization.

BEHAVIORAL HEALTH AND PERFORMANCE GROUP (BHPG)

The necessity of this group has been internationally agreed upon by the ISS partner countries. The focus of the BHPG is to provide expert consultation on four behavioral factors that shape astronaut and crew performance on long duration missions: psychological adaptation factors, human-to-system interface factors, sleep and circadian rhythm factors, and behavioral health factors. Within each Agency, this group provides expert consultation to maintain astronaut and crew behavioral health and performance.

BIOMEDICAL ENGINEER (BME)

The BMEs staff the BME console in the MCC and provide technical and operational support for medical operations in-flight activities. The BMEs provide support to the CS/DCS and serve as a member of the FCT. BMEs are physically located in the MCC – Houston in the Flight Control Room (FCR) and in the BME Multipurpose Support Room (MPSR) for support of ISS operations.

COUNTERMEASURE SYSTEM (CMS)

The Countermeasures subsystem of CheCS provides the equipment and protocols for the performance of daily and alternative regimens (e.g., exercise) to mitigate deconditioning effects of living in a microgravity environment, for monitoring the crew during exercise regimens, to reduce vibrations during the performance of these regimens, and for periodic fitness evaluations.

CONTINUOUS NOISE

A significant noise source, which exists for a cumulative total of eight hours or more in any 24-hour period.

CREW HEALTH CARE SYSTEM (CHECS)

The purpose of CheCS is to provide the medical and environmental capabilities necessary to ensure the health and safety of the ISS crewmembers. The CheCS suite of hardware provides the capability to intervene in medical contingencies, to provide medical care to the crew, to monitor crew health, to perform microgravity countermeasures and exercise, and to monitor the crew environment. CheCS hardware is distributed throughout ISS elements. CheCS is divided into three subsystems: Health Maintenance System (HMS), Environmental Health System (EHS) and Countermeasures System (CMS).

CREW MEDICAL OFFICER (CMO)

Two members of an ISS crew are trained to function independently of ground support during the first 30 – 60 minutes of an on-board medical contingency. When a medical doctor is a member of the ISS crew, he/she will be one of the CMOs.

CREW SURGEON (CS) (DEPUTY CS)

An ISS-certified IP FS assigned to a specific increment by the MMOP. The CS and DCS have primary responsibility for the health and well-being of the entire increment crew and will be the focal point for all medical issues and timed activities for that crew during all mission phases. Assignment of the CS and DCS to an increment will be independent of the home agency of the CS or DCS and the ISS crew.

CONTINENTAL UNITED STATES (CONUS)

Geographical areas within the jurisdiction of the United States government.

dB

Decibel, used as a convenient logarithmic scale to express sound levels since the human auditory range spans many orders of magnitude of pressure fluctuations when expressed in a linear range; expressed in dB re 20 μ Pa.

dB(A)

A-weighted decibel.

DEFINITIVE MEDICAL CARE FACILITY (DMCF)

AN INPATIENT MEDICAL CARE FACILITY CAPABLE OF COMPREHENSIVE DIAGNOSIS AND TREATMENT OF A FLIGHT CREWMEMBER'S INJURIES OR ILLNESS WITHOUT OUTSIDE ASSISTANCE. EMERGENCY MEDICAL SERVICES (EMS)

Services required to provide immediate medical care to flight crewmembers. This service includes personnel, facilities, and equipment for the immediate and coordinated delivery of emergency health care services. EMS involves rescue, recovery, stabilization and transport by qualified EMS personnel to either an IMCF or DMCF.

ENVIRONMENTAL HEALTH SYSTEM (EHS)

The Environmental Health subsystem monitors the atmosphere for gaseous contaminants (i.e., from nonmetallic materials off-gassing, combustion products, and propellants) and microbial contamination levels from crew and station activities. This subsystem also monitors water quality, acoustics and radiation levels.

EQUIVALENT SOUND PRESSURE LEVEL (L_{EQ})

Measured average Sound Pressure Level over a specified time period; resulting Sound Pressure Level is that of an equivalent steady sound field; expressed in dB re 20 μ Pa.

FLIGHT CONTROL TEAM (FCT)

The ISS Flight Control Team (FCT) is responsible for all aspects of ISS real-time operations and planning, and conducts operations in accordance with Program-approved ISS Operational Flight Rules. The following disciplines are included, but not limited to, in the FCT: Flight Director, Communication and Tracking, Computer and Data Handling, Environmental Control and Life Support, Electrical Power System, Motion Control Systems, Thermal Control Systems, Robotics, Extra Vehicular Activity, Maintenance, Structures and Mechanical, Operations Planning, Assembly Operations, Trajectory, Surgeon, and BME.

HABITABLE VOLUME

For the purposes of radiation monitoring, habitable volume refers to locations inside the ISS that are frequently occupied by crewmembers.

HEALTH MAINTENANCE SYSTEM (HMS)

The Health Maintenance subsystem provides in-flight Advanced Life Support, Transitional Medical Care, and Ambulatory Medical Care, as well as monitoring and diagnostic capabilities, for the majority of medical conditions expected to be encountered onboard the Space Station.

HOST AGENCY

The host agency is defined as the country containing the pre flight or post flight landing operations and hosting the early post-flight activities.

HUMAN PATIENT SIMULATOR (HPS)

A high-fidelity manikin used in clinical scenarios.

IMPULSIVE NOISE

A noise that is at least 10 dB above the background noise, which exists for one second or less.

INCREMENT

This is a specific time period which combines different operations such as assembly, scientific research, test, logistics, maintenance, and other ISS systems and utilization operations. During the assembly phase, an increment is defined as a period supporting crew rotation. The duration of an increment is the time period from the launch of a designated flight crew to the undocking of the return vehicle for that crew.

INTEGRATED MEDICAL GROUP (IMG)

The IMG consists of IP representatives at all active MCCs (i.e. MCC-H, MCC-M and national active MCCs). This functional group manages real-time flight support with personnel from the active MCCs.

INTEGRATED MEDICAL SYSTEM (IMedS)

IMedS represents the concept that the individual IP's medical systems, i.e. currently the US Crew Health Care System (CHeCS) and the Russian Medical Support System, must be integrated with respect to one another as much as possible in order to enhance training, resupply processes, and benefit from a commonly organized system.

INTERMEDIATE MEDICAL CARE FACILITY (IMCF)

An inpatient medical care facility capable of initial stabilization and treatment of a flight crewmember's injuries or illness. Category I and some Category II trauma patients will be transferred to a DMCF, and some Category II and Category III trauma patients may remain in an IMCF.

INTERMITTENT NOISE

A significant noise source, which exists for a cumulative total of less than eight hours in any 24-hour period.

ISS MISSION MANAGEMENT TEAM (IMMT)

The IMMT consists of representatives from the IPs in the areas of Management, Operations, and Engineering Support. The IMMT, chaired by the Director of ISS Operations, includes senior program and operations managers of all IPs who have the corresponding authority to make decisions and issue official findings in their area of responsibility. The IMMT director makes decisions based on proposals and recommendations of the corresponding representatives.

INTERNATIONAL PARTNER (IP)

A member of CSA, ESA, JAXA, NASA, or FSA.

INTERNATIONAL PARTNER FLIGHT SURGEON (IP FS)

An IP FS is a flight surgeon employed by an IP and assigned by that IP to a specific mission in support of that home agency excluding independent MCC console activities.

IONIZING RADIATION

Ionizing radiation is radiation with sufficient energy to remove electrons from the orbits of atoms resulting in charged particles. It is this type of radiation that is evaluated for purposes of radiation protection and countermeasures against acute and long-term health effects including cataractogenesis, carcinogenesis, and genetic effects. Ionizing radiations of greatest concern to radiation protection for low-Earth Orbit include protons, helium nuclei and heavier charged particles, and secondary neutrons.

LEAD MISSION CONTROL CENTER (LEAD MCC)

The Lead MCC is MCC-Houston unless transferred to MCC-Moscow. MCC-Houston has the overall authority for Station operations for all phases of the program. MCC-Moscow and MCC-Houston provide vehicle control functions for their respective segments, and each has the capability to back up the other control center for critical functions, if required. MCC-Houston is responsible for leading the execution of multisegment procedures and overall execution leadership.

LINEAR ENERGY TRANSFER (LET)

LET is the average amount of energy lost by an ion per unit path length traveled by the ion. The LET of an energetic ion, weighted by a radiation “quality factor”, is used in regulatory standards as a relative measure of biological effectiveness for harm resulting from ionizing radiation exposures.

MEDICAL SUPPORT TEAM (MST)

Members consist of CS, DCS, IP FS and HB&PS Team.

MISSION CREW

Refers to ISS increment and/or visiting crews on Soyuz or Shuttle.

MISSION CRITICAL PERSONNEL

Per JSC Security Management Directive, No 500-9, Rev A, the definition of mission critical positions includes any JSC Personnel Reliability Program (PRP) position, status, and/or duties, which, if performed by employees in a faulty, negligent, or malicious manner could jeopardize mission-critical space systems and/or delay a mission (i.e., the operation and maintenance of all NASA aircraft will be considered as mission critical).

MORBIDITY

The relative incidence of disease.

MULTILATERAL CADRE OF ISS-CERTIFIED FLIGHT SURGEONS

An ISS-certified IP FS includes a FS employed by an IP who has been certified by the MSMB for ISS operations, including independent MCC console activities.

MULTILATERAL MEDICAL POLICY BOARD (MMPB)

The MMPB is responsible for top-level medical policy and oversight. Selected products of subordinate medical working groups are submitted to the MMPB for approval. The MMPB also receives findings and recommendations from the MMOP.

MULTILATERAL SPACE MEDICINE BOARD (MSMB)

The Multilateral Space Medicine Board (MSMB) is responsible for crew medical certification for ISS mission increment training and flight. Results of IPs' independent medical boards will be presented to the MSMB for approval. The MSMB also receives findings and recommendations from the MMOP. Decisions and findings of the MSMB are forwarded to the MMPB and to the Multilateral Crew Operations Panel (MCOP) as appropriate. The MSMB also ensures mission-assigned flight surgeons endorsed/selected by the MMOP have completed established credentialing standards.

MULTILATERAL MEDICAL OPERATIONS PANEL (MMOP)

The MMOP develops common medical standards, certification criteria, medical care requirements, preventive medicine guidelines, operational countermeasures, medical hardware responsibilities, environmental monitoring requirements, and operational procedures. In addition, the MMOP will develop training certification guidelines for ISS credentialed flight surgeons and endorse mission-assigned flight surgeons to the MSMB who will ensure they meet the training certification guidelines established by the MMOP. The MMOP coordinates specialty subgroups as appropriate and assigns working level action items on ISS biomedical issues. The MMOP presents its findings and recommendations to the MMPB and MSMB as required and interfaces with the ISS Program through the Multilateral Operations and Utilization Control Board (MOUCB). It is the responsibility of the MMOP to coordinate approved operational medical requirements and inputs from the various groups and bring these forward to the MOUCB in compliance with standard formats and procedures.

NOISE EXPOSURE LEVEL

Equivalent Sound Pressure Level to which a human is exposed; is usually measured over an extended period of time which must be specified for the value to be usable; expressed in dBA re 20 μ Pa.

NON-IONIZING RADIATION

Radio frequency, electromagnetic fields, optical laser radiation, and incoherent ultraviolet optical radiation.

OCTAVE BAND SOUND PRESSURE LEVEL

Logarithmic representation of fluctuating acoustic pressure within a given Octave Frequency Band, expressed in dB re 20 μ Pa.

OCTAVE FREQUENCY BAND

One standard division of the audible frequency range into discrete frequency ranges that are related to one another logarithmically.

OVERALL SOUND PRESSURE LEVEL

Logarithmic representation of fluctuating acoustic pressure across all frequencies in general; however, the practical frequency range is limited by the acoustic measurement hardware, is expressed in dB re 20 μ Pa, and can be calculated, for example, by combining octave band sound pressure levels.

Pa

Pascal, unit of pressure equal to one Newton per square meter.

PARTNER

A member of CSA, ESA, JAXA, NASA, or FSA.

PERIODIC HEALTH STATUS (PHS)

An assessment of the crew's health that is determined every thirty days of elapsed flight time. The CMO assists in the PHS by conducting physical examinations and by taking and processing samples, as needed.

PERMANENT THRESHOLD SHIFT (PTS)

Permanent change in the sensitivity of a human's auditory system.

POTABLE WATER

Potable water is deiodinated Shuttle galley water to which silver and minerals are added during transfer to the ISS. Potable water is mainly used for drinking, food rehydration, and hygiene, but may occasionally be used for toilet flushing depending on inventory.

SPACE MEDICINE/SPACE MEDICINE TEAM

Space Medicine consists of the medical operations and management personnel that work towards the common goal of optimizing the health, fitness, and well being of flight crews.

SPACECRAFT MAXIMUM ALLOWABLE CONCENTRATION (SMAC)

SMACs are intended to provide guidance on chemical exposures during normal operations of spacecraft as well as emergency situations. Short-term SMACs refer to concentrations of airborne substances (such as gas, vapor, or aerosol) that will not compromise the performance of specific tasks by crewmembers during emergency conditions or cause serious or permanent toxic effects. Such exposures might cause reversible effects, such as mild skin or eye irritation, but they are not expected to impair judgment or interfere with proper responses to emergencies. Long-term SMACs are intended to avoid adverse health effects (either immediate or delayed) and to prevent detrimental change in crew performance under continuous exposure to chemicals in the closed environment of the space station for as long as 180 days. (From Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants: Volume 2 (1996) <http://www.nap.edu/books/0309054788/html/1.html>.)

SOUND LEVEL METER

Device for measuring Sound Pressure Levels.

SOUND PRESSURE LEVEL

Logarithmic representation of fluctuating acoustic pressure within a given frequency range, which must be specified; expressed in dB re 20 μ Pa.

SOUND PRESSURE OF 20 μ Pa

Smallest acoustic pressure fluctuation that an average 18-year old human adult can hear, also used as decibel reference for acoustic measurements.

SPACE MEDICINE OPERATIONS TEAM (SMOT)

The SMOT is a standing forum of the MMOP for discussion of operational issues and concerns relating to crew health, safety, habitability, medical hardware, and other medically relevant matters. Participation in the SMOT is limited to physicians from ISS IP agencies, essential support personnel, and experts invited for specific topics.

TECHNICAL WATER

Technical water is deiodinated Shuttle galley water to which silver is added during transfer to the ISS. Technical water is mainly used for toilet flushing and electrolytic oxygen generation.

TEMPORARY THRESHOLD SHIFT (TTS)

Temporary change in the sensitivity of a human's auditory system.

THRESHOLD LIMIT VALUES (TLVS)

Threshold Limit Values, as used in this document, are limiting values of the level of exposure to infra-red, visible, or ultraviolet wavelengths of light that crewmembers can experience. Threshold Limit Values are developed by the American Conference of Governmental Industrial Hygienists as guidelines to assist in the control of health hazards for typical workers. The ACGIH® TLVs® may have been adjusted for use as standards for human spaceflight. These values are not fine lines between safe and dangerous exposure levels, rather, they are used as guidelines to control health hazards from non-ionizing radiation exposure.

TOXIC CONTAMINATES

Toxic contaminants are chemical impurities in the air or water that may cause an adverse effect in a biological system.

TRANSITIONAL MEDICAL CARE (TMC)

For the ISS, "transitional care" is needed for those conditions that impair the crewmember's ability to perform his/her scheduled tasks, yet are not so incapacitating as to require ALS. These conditions do not need continuous, close observation but do

require care beyond what the crewmember can give himself/herself. Criteria for “transitional care” would include:

- A. Need for periodic supervision or “checks”
- B. Provision of intermittent parenteral medication, such as intramuscular or intravenous injections
- C. Use of a splint or other device that limits mobility or activity level
- D. Assistance with the activities of daily living, such as catheterization in order to empty the bladder
- E. Inability to perform the majority of scheduled mission tasks
- F. Inability to eat normal diet or perform regular exercise
- G. Need for intermittent physiological monitoring and/or assessment
- H. Need for frequent (example: daily) private medical and/or psychological conferences

APPENDIX C – OPEN WORK

C.1 MATRIX OF ISSUES TO BE RESOLVED

Table C-1 lists To Be Resolved (TBR) issues in the document. Each issue is given a TBR number using the section of the document that contains the issue as the first digit and a consecutive number for the second digit. The TBR number is listed along with the affected section and a description of the issue. As each TBR issue is resolved, the correct text is inserted in place of the TBR in the document and the entry is removed from this table.

TABLE C-1 TO BE RESOLVED ISSUES

TBR	Section	Description
8.3.1	8.3.1	SHBPWG: Wording was removed from Section 8.1.1 and a TBR was added to Section 8.3.1. The SHBPWG is asked to revise this requirement to better define what is proposed.
D-1	Appendix D	Environmental Health System: Suggestion to delete cyanide requirement. Change requirement (columns 2,3,5,6) to Ni 0.3 mg/L, Phenol 4 mg/L, and add chloroform, 6.5 mg/L.

C.2 MATRIX OF INFORMATION TO BE DETERMINED OR SUPPLIED

Table C-2 lists To Be Determined (TBD) and To Be Supplied (TBS) items in the document. Each item is given a TBD/TBS number using the section of the document that contains the item as the first digit and a consecutive number for the second digit. The TBD/TBS number is listed along with the affected section and a description of the item. As each TBD/TBS item is resolved, the correct text is inserted in place of the TBD/TBS in the document and the entry is removed from this table.

TABLE C-2 TO BE DETERMINED/TO BE SUPPLIED ITEMS

TBD/TBS	Section	Description
1.2-1	1.2	SSP 50667, Medical Evaluation Document (MED), Volumes A and B are in development and have not been published. Volume C has been published.
1.7.1.6-1	1.5.1.6	Members of the IMG at JAXA Medical Console will be provided
1.7.1.6-2	1.5.1.6	Members of the IMG of CSA Medical Console will be provided
2.1-2	2.0, 5.5, 6.3.3, 7.1.1	MMOP partner Data Sharing Plan: Need document number.
7.2.2.1-1	7.2.2.1	JAXA supplied ground water specifications: Need specification location.
7.2.2.1-2	7.2.2.1	ESA supplied ground water specifications: Need specification location.
8.3.2	8.3.2	Preflight Exercise: Need Russian reference for Cosmonaut Exercise Program document exists.
8.3.4	8.3.4	Health Stabilization Program: Obtain the title of the document containing Russian Soyuz launch HSP details.
8.5.2.2	8.5.2.2	Crew Participation in Crew Daily Physical Exercise: Need Russian reference for their exercise countermeasure program.
8.5.3.1	8.5.3.1	Nutrition: The ISS Food Plan is TBD. Per the Nutrition group, the document is in signature cycle, and a document number will be assigned upon formal document approval. The number remains TBD for now.
8.6.1	8.6.1	Post-Flight Rehabilitation Program: Need document number if there is a document,

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		otherwise the document needs to be developed.
9.0	9.0	Emergency Medical Services: Need Russian requirement references for launching or landing on the Soyuz
D-6	D	In-Flight Microbiology Monitoring Requirements: No agreements made on the hardware to be used for the GEM and Columbus Module
F-1	F	Non-ionizing Radiation: Need new flight rules implementation time frame

APPENDIX D – ENVIRONMENTAL HEALTH DETAILED SYSTEM REQUIREMENTS

TABLE D-1 WATER QUALITY REQUIREMENTS FOR THE ISS RUSSIAN SEGMENT
<TBR D-1>

Water Parameter	Units	Russian Ground-Supplied potable, SVO-ZV*	Regenerated Potable, SRV-K	Hygiene	Shuttle-Supplied Potable, CWC	Shuttle-Supplied Technical, CWC
Total Dissolved Solids	mg/L	1000	100, 1000 ⁽¹⁾	1000	4, 1000 ⁽¹⁾	4
Color	degree	20	20	20	20	20
Taste	grade	2	2	N/A	2	2
Odor	grade	2	2	2	2	2
pH	pH units	5.5 - 9.0	5.5 - 9.0	5.5 - 9.0	5.5 - 9.0	5.5 - 9.0
Turbidity	mg/L	1.5	1.5	1.5	1.5	1.5
Total Gas @ 1 atm, 20degC	%	5	5	N/A	5	5
Ammonia (NH ₃ -N)	mg/L	2	2	10	2	0.2
Arsenic	mg/L	0.01	0.01	N/A	0.01	0.01
Barium	mg/L	1	1	N/A	1	1
Cadmium	mg/L	0.005	0.005	N/A	0.005	0.005
Calcium	mg/L	100	100	N/A	100	0.2
Chloride	mg/L	250	250	350	250	0.3
Chromium	mg/L	0.1	0.1	N/A	0.1	0.1
Copper	mg/L	1	1	N/A	1	1
Fluoride	mg/L	1.5	1.5	N/A	1.5	1
Iodine-total	mg/L	0.05	0.05	N/A	0.05	0.05
Iron	mg/L	0.3	0.3	N/A	0.3	0.3
Lead	mg/L	0.05	0.05	N/A	0.05	0.05
Magnesium	mg/L	50	50	N/A	50	0.05
Manganese	mg/L	0.05	0.05	N/A	0.05	0.05
Mercury	mg/L	0.002	0.002	N/A	0.002	0.002
Nickel	mg/L	0.1	0.1	N/A	0.1	0.1
Nitrate (NO ₃ -N)	mg/L	10	10	N/A	10	0.1
Selenium	mg/L	0.01	0.01	N/A	0.01	0.01
Silver	mg/L	0.5	0.5	2	0.5	0.5
Sulfate	mg/L	250	250	N/A	250	0.2
Zinc	mg/L	5	5	N/A	5	5
Total Hardness ⁽²⁾	meq/L	7	7	N/A	7	0.01
Ethylene Glycol	mg/L	N/A	12	N/A	N/A	N/A
Cyanide	mg/L	0.2	0.2	N/A	N/A	N/A
Phenol	mg/L	1	1	N/A	N/A	N/A
Total Organic Carbon ⁽³⁾	mg/L	20	20	40	20	10
Chemical Oxygen Demand	mg/L	50	100	250	N/A	N/A

The table consists of maximum allowable concentrations, with the exception of pH, which is an allowable range.

NOTE:

⁽¹⁾ The 100 and 4 mg/L limits apply to the water before mineralization. Following mineralization this parameter will not exceed 1000 mg/L.

⁽²⁾ Total hardness is calculated as the sum of Ca and Milligram (Mg) concentrations in meq/L.

⁽³⁾ This limit does not include the mineral counter-ion, formate (excludes CWC technical water).

* Hygiene Station Water Port (SVO-ZV) standards also apply to Russian grade water delivered by ATV.

N/A = not applicable

TABLE D-2 ISS RUSSIAN SEGMENT WATER SAMPLING AND ANALYSIS SCHEDULE

	Samples for TOCA Analysis			Chemical Archive Samples		
	SRV-K hot	SRV-K cold	SVO-ZV CWC	SRV-K hot	SRV-K cold	SVO-ZV CWC
Mature Phase II Operations (Weeks 13 and Beyond)	One per month + after MFU change outs	One per two months + after MFU change outs	One per month	One per month	One per two months	One per month
NOTES:						

Chemical and microbiological water samples will be collected at the same time from a given port and coordinated with the collection of microbiological and toxicological air samples to the degree possible.
Real-time changes to the sampling schedule and frequency depending upon real-time flight necessities and water systems operability will be made from recommendations of the team of U.S. and Russian water experts.

TABLE D-3 ISS U.S. ON ORBIT SEGMENT WATER SAMPLING AND ANALYSIS SCHEDULE

ISS Period			Chemical Sample from Storage Tanks	Chemical Sample from Use- Points	Total Water Chemical In-flight Analyses	Water Chemical Archive Samples
Node 3 Launch of U.S. Water System (20A) and subs:						
First 90 days			1 every day	1 every 2 days	135 /90 days	1 /week
After 90 days			1 /week	1 /week	26 /90 days	1 /month

NOTE: When water chemical analyses are performed and water chemical archive samples are collected, they are always done at the same time as the water microbiological analyses and archive samples.

TABLE D-4 TRACE CONTAMINANTS FOR AIR QUALITY

Compound ^a	Russian 360-d ^b LPC (mg/m ³)	U.S. 180-d ^c SMAC (mg/m ³)
Hydrogen ^d	1600	340
Methane ^d	3300	3800
Pentane	10	590 (7d)
Hexane	5	180 (7d)
Heptane	10	200 (7d)
Formaldehyde	0.05	0.05
Acetaldehyde	1.0	4.0
Aliphatic aldehydes (benzaldehyde)	1.0	4.0 to 8.0
Propenal	0.02	0.03
Methanol	0.2	9.0
Ethanol	10.0	2000
2-propanol	1.5	150
1-butanol	0.8	40
Acetone	2.0	50
2-butanone	0.25	30
Benzene	0.2 (180d)	0.2
Toluene	8.0	60
Xylenes	5.0	220
Styrene	0.25	43 (7d)
Isopropyl benzene ^d	0.5	49 (7d)
Furan	0.05	0.025
Ammonia	1.0	7.0
Ethyl acetate	4.0	----
Carbon monoxide	5.0	10.0
Polymethylcyclsiloxanes	0.2	9-15
Dichloromethane	5.0	10.0
1,2-dichloroethane	0.5	1.0
Freon 218	150	85,000
^a Compounds are grouped by structural classes		
^b Russian limits listed in GOST P 50804-95		
^c U.S. limits documented in Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants (V1 to V4, 1994-2000 and in JSC 20584		
^d Monitored for engineering operations only		

**TABLE D-5 PREFLIGHT MICROBIAL SPECIFICATIONS AND MONITORING
REQUIREMENTS OF AIR AND SURFACES**

SPECIFICATIONS		
	Maximum for Bacteria	Maximum for Fungi
Air	300 CFU/m ³	50 CFU/m ³
Internal Surfaces	500 CFU/100 cm ²	10 CFU/100 cm ²
MONITORING REQUIREMENTS		
US Modules	Russian Modules	Other IP Modules
Node 1	FGB	Japanese Experiment Module (JEM)
Node 2	Service Module	European Laboratory – Columbus Module
Node 3	Docking Compartment-1 (DC-1)	European Automated Transfer Vehicle (ATV)
US Laboratory	Universal Docking Module (UDM)	Japanese H-II Transfer Vehicle (HTV)
Centrifuge Accommodation Module (CAM)	Docking Compartment-2 (DC-2)	Japanese Experiment Logistics Module Pressurized Section (ELM-PS)
Multi-Purpose Logistics Modules (MPLM)	Docking and Stowage Module (DMS)	
SPACEHAB Single and Double Cargo Modules	Research Module 1	
US Airlock	Research Module 2	
Shuttle	Progress	
	Soyuz	

TABLE D-6 IN-FLIGHT MICROBIAL SPECIFICATIONS AND MONITORING REQUIREMENTS OF AIR AND SURFACES

SPECIFICATIONS		
	Maximum for Bacteria	Maximum for Fungi
Air	1000 CFU/m ³	100 CFU/m ³
Internal Surfaces	10,000 CFU/100 cm ²	100 CFU/100 cm ²
IN-FLIGHT MONITORING REQUIREMENTS –US Hardware(1)		
Sampling Location	Surface Monitoring: # of Locations/Frequency	Air Monitoring: # of Locations/Frequency
Node 1	2 sample sites/module	1 sample site/module
US Laboratory Node 2	once during the first 6 weeks that module is in flight, then once every 90 days	once during the first 6 weeks that module is in flight, then once every 90 days
Node 3		
IN-FLIGHT MONITORING REQUIREMENTS – Russian Hardware(2)		
Sampling Location	Surface Monitoring: # of Locations	Air Monitoring: # of Locations
FGB	2 sample sites/module	1 sample site/module
Service Module	8 sample sites/module	6 sample sites/module
Research Module 1		
Research Module 2		
IN-FLIGHT MONITORING REQUIREMENTS (3)		
Sampling Location	Surface Monitoring: # of Locations	Air Monitoring: # of Locations
JEM Columbus Module	<TBD D-6>	<TBD D-6>

- (1) To be performed using the U.S.-supplied Surface Sampler Kit (SSK) and Microbial Air Sampler (MAS) Kit
 (2) To be performed using the Russian-supplied Sample Tube Kit and Ecosphera Kit
 (3) To be performed using <TBD D-6> hardware

TABLE D-7 MICROBIAL SPECIFICATIONS AND MONITORING REQUIREMENTS FOR ISS WATER

SPECIFICATIONS						
Water Parameter	Units	Russian Ground-Supplied potable, SVO-ZV*	Regenerated Potable, SRV-K	Hygiene	Shuttle-Supplied Potable, CWC	Shuttle-Supplied Technical, CWC
Bacteria Count	CFU/mL	50	50	1000	50	50
Coliform Bacteria Count	CFU/100mL	Non-detectable	Non-detectable	Non-detectable	Non-detectable	Non-detectable
Protozoa	N/A	TT	TT	TT	TT	TT
N/A = not applicable TT = Treatment Technique. Source water shall be filtered through a one micron filter. No analysis is required. * SVO-ZV standards also apply to Russian grade water delivered by ATV.						
IN-FLIGHT MONITORING REQUIREMENTS FOR ISS RUSSIAN SEGMENT (1)						
In-flight Processing and Analysis (2)			Archive Sample Collection (3)			
SRV-K/Hot	SRV-K/Warm	SVO-ZV/CWC	SRV-K/Hot	SRV-K/Warm	SVO-ZV/CWC	
Once every 3 months	Once every 3 months	Once every 3 months	Once with each Shuttle return	Once with each Shuttle return	Once with each Shuttle return	
(1) To be performed using the U.S.-supplied Water Microbiology Kit. (2) Microbiological and chemical water samples will be collected at the same time from a given port and coordinated with the collection of microbiological and toxicological air samples to the degree possible. (3) Collection times of microbiological archival samples will be adjusted to minimize the time between collection and recovery of samples on the ground. Real-time changes to the sampling schedule and frequency depending upon real-time flight necessities and water systems operability shall be made from recommendations of the team of U.S. and Russian water experts.						
ARCHIVE SAMPLE COLLECTION REQUIREMENTS FOR ISS RUSSIAN SEGMENT (4)						
SRV-K/Hot			SRV-K/Condensate			
Once with each Soyuz return			Once per Multi-Filtration Unit change-out			
(4) To be performed using Russian-supplied hardware. Sample for microbial analysis is an aliquot from chemical sample. Real-time changes to the sampling schedule and frequency depending upon real-time flight necessities and water systems operability shall be made from recommendations of the team of U.S. and Russian water experts.						
IN-FLIGHT MONITORING REQUIREMENTS FOR U.S. ON-ORBIT SEGMENT (5)						
ISS Period	Sample from Storage Tanks	Sample from Use- Points	Total In-flight Analyses	Archive Sample Collection (6)		
Node 3 Launch of U.S. Water System (ISS Flight 20A) and subs:						
First 90 days	17/90 days**	13/90 days**	30/90 days	Once with each Shuttle return		
After 90 days	1/month	1/month	6/90 days	Once with each Shuttle return		
(5) To be performed using the U.S.-supplied Water Microbiology Kit. (6) Collection times of microbiological archival samples will be adjusted to minimize the time between collection and recovery of samples on the ground. ** One sample to collected every 3 days from a storage tank OR use-point. Microbiological and chemical water samples will be collected at the same time from a given port. Real-time changes to the sampling schedule and frequency depending upon real-time flight necessities and water systems operability shall be made from recommendations of the team of U.S. and Russian water experts.						

TABLE D-8 CURRENT IONIZING RADIATION EQUIVALENT DOSE LIMITS

Organ Specific Equivalent Dose Limits	
Exposure Interval	BFO (Sv)
30 Days	0.25
Annual	0.50

**TABLE D-9 ACOUSTIC NOISE LIMITS IN THE U. S. AND OTHER IP SEGMENTS
(NOT INCLUDING RUSSIAN SEGMENT)**

Note: Limits are Octave Band Sound Pressure Levels with units of dB re 20 μ Pa

Octave Frequency Band, Hz	63	125	250	500	1000	2000	4000	8000
Work Area (NC-50)	71	64	59	54	51	49	48	47
(NC-48 + NC-50) where payload complement applies	73	66	60	56	53	51	50	49
Sleep Area (NC-40)	64	56	50	45	41	39	38	37

TABLE D-10 ACOUSTIC NOISE LIMITS IN THE RUSSIAN SEGMENT

Note: Limits are Octave Band Sound Pressure Levels with units of dB re 20 μ Pa

Octave Frequency Band, Hz	63	125	250	500	1000	2000	4000	8000
Work Area	79	70	63	58	55	52	50	49
Sleep Area	71	61	54	49	45	42	40	38

As per SSP 50094

APPENDIX E – LAUNCH READINESS

The MMOP conducts a review of the ISS Medical Operations readiness status for the launch of all vehicles traveling to the ISS based on the MMOP-approved Launch Readiness Checklist and the ISS Program Requirements. The requirements in the MMOP-approved Launch Readiness Checklist specified in Table E-1 are encompassed into six global launch readiness endorsements. Listed below are the six endorsements.

E.1 Crew Medical Certification

The crew is medically certified for long-duration space flight by the ISS MSMB.

E.2 Crew Training

The crew has satisfied all applicable biomedical and IMedS training requirements.

E.3 Evaluation and Monitoring of Crew Health and Performance

Acceptable capabilities are present to perform basic evaluation and monitoring of crew health and performance.

E.4 Diagnosis and Treatment Capabilities

Capabilities are present to adequately diagnose and treat routine medical and dental conditions and to provide Basic Life Support (BLS).

E.5 ISS Environment

Based on most recent analyses, the ISS environmental data are nominal. Plans have been accepted for continued environmental monitoring.

For each flight, the MMOP, through the Environmental Health Working Group, establishes a list of items for obligatory return with the ISS crew, which includes samples (air, water, microbiological and radiation dosimeters) and equipment necessary to adequately estimate the environmental conditions aboard the ISS.

E.6 Sustaining Human Health

Capabilities are present to implement and monitor operational in-flight measures for sustaining human health and mitigating undesirable effects of space flight. Food provisions on-orbit are sufficient to meet the crew nutritional needs.

TABLE E-1 LAUNCH READINESS CHECKLIST

ISS MORD Revision C paragraph	Launch Readiness (ISS MORD Revision C)	Requirement met?
4.1.4.1	The ISS Program shall provide all Prime and Backup ISS crewmembers with basic medical training of IMedS to include the following areas A. Countermeasures System Operations and Maintenance B. Environmental Health System Operations and Maintenance C. Health Maintenance System Operations and Maintenance D. Behavioral Health and Performance training E. Securing of medical resources prior to the evacuation of a module or vehicle.	
5.1.4	The CS shall coordinate and perform preflight medical evaluations of mission assigned crewmembers, with the assistance of the applicable IP FS, according to SSP 50667, MED Volume B.	
5.2.3	The ISS Program shall provide for PMCs between crewmembers and the CS or his designee.	
5.2.5.1	The ISS Program shall schedule a pre- and post- EVA medical assessment of each EVA crewmember for all EVAs as follows: A. Pre- and Post EVA on or before flight day 21, review of preflight medical examinations and routine PMCs. B. Pre-EVA beyond flight day 21, review of crew countermeasure performance and within 24 hours of suit donning a medical assessment will be performed by the CS as detailed in SSP 50667, MED Volume B. C. C. Post-EVA beyond flight day 21, a post-EVA medical assessment will be performed by the CS within 24 hours of suit doffing as detailed in SSP 50667, MED, Volume B. D. If a subsequent EVA is to occur within 7 days, the post-EVA medical evaluation fulfills the requirement for the pre-EVA evaluation of that subsequent EVA.	
5.2.5.2	The ISS Program shall ensure the NASA EMU and FSA Orlan EVA suit provide for remote monitoring of the following biomedical parameters: A. Oxygen consumption rate (real-time) B. Electrocardiogram (ECG) and derived heart rate (real-time) C. Suit pressure (real-time) D. Suit carbon dioxide partial pressure (real-time) E. Radiation exposure dose (recorded) F. Body temperature (Russian Orlan suit only, real-time)	
6.1	The ISS Program shall provide medical intervention and care for all ISS crewmembers during all mission phases. To assist the Crew Surgeon, the ISS Program shall provide: A. A behavioral health and performance group to maintain the behavioral health and performance of the crewmembers and crews. B. A network of specialized medical, dental consultants to maintain crew health.	
6.3.5.2	The ISS Program shall provide the capability for Cardiopulmonary Resuscitation (CPR), basic airway management, and crew immobilization.	
6.3.5.5	The ISS Program shall provide the capability to stabilize and transport an ill or injured crewmember.	
6.3.5.6	The ISS Program shall provide AMC for the entire crew for the duration of the mission.	

ISS MORD Revision C paragraph	Launch Readiness (ISS MORD Revision C)	Requirement met?
6.3.5.7	The ISS Program shall enable the CMO to respond to a dental emergency.	
6.3.6	<p>The ISS Program shall provide the following in-flight monitoring and diagnostic capabilities:</p> <ul style="list-style-type: none"> A. Diagnostic imaging, including ultrasound B. Blood analysis to include blood cell count, specific chemistries, and enzymes C. Urinalysis D. Monitoring of physiological parameters to include: heart rate, electrocardiogram (ECG), respiratory rate, non-invasive blood pressure, end tidal carbon dioxide, pulse oximetry, sedation level, pulmonary functions. E. Behavioral health and performance assessment 	
7.1.3	IPs shall use instrumentation, processes, and procedures approved by the appropriate MMOP expert working group to perform in-flight operational analysis, archival sampling, and ground-based analysis of archived environmental samples.	
7.2.1	The ISS Program shall meet water quality standards specified in Table D-1, Water Quality Requirements for the ISS Russian Segment, and in SSP 41000, Table XXXII, Water Quality Requirements for the U.S. On-orbit Segment for water intended for crew use and consumption.	
7.2.2.1	<p>A. US Supplied Water The Space Shuttle Program shall meet the minimum requirements specified in SE-S-0073, Space Shuttle Specification Fluid Procurement and Use Control, for potable water loaded on the Shuttle for use on ISS.</p> <p>B. Russian Supplied Water FSA/IBMP shall meet the minimum requirements specified in engineering specification "Preserved Potable Water," XT.0.045019TY, for ground supplied potable water delivered to ISS by the Russian side.</p> <p>C. JAXA Supplied Water JAXA supplied ground water shall meet specifications in <TBD 7.2.2.1-1>.</p> <p>D. ESA Supplied Water ESA supplied ground water shall meet specifications in <TBD 7.2.2.1-2>.</p>	
7.2.2.2	<p>The ISS Program shall ensure that in-flight water sampling and analysis is performed with the frequency specified in Table D-2 for the ISS Russian Segment and Table D-3 for the ISS U.S. On-Orbit Segment.</p> <p>A. In-flight archival water sample collection from all ports used for drinking purposes in the Russian and U.S. On-orbit Segments for post-flight analysis</p>	
7.2.3.1	The ISS Program shall perform functional checkout and testing of water supply systems during the flight preparation stage for launch to ISS.	
7.2.3.2	The host agency Launch Support Team shall develop and provide a contingency plan to the ISS Program and MMOP in case preflight water sample analyses indicate that specified water quality limits are being exceeded.	
7.2.3.3	The ISS Program shall ensure in-flight water processing and storage systems can be decontaminated.	
7.3	The requirements for air supplied to replenish ISS are defined in the document, SSP 30573, Space Station Program Fluid Procurement and Use Control Specification, Revision A, Table 4.1-2.2.	

ISS MORD Revision C paragraph	Launch Readiness (ISS MORD Revision C)	Requirement met?
7.3.1.1	The ISS Program shall test and approve as safe, with regard to toxic off-gassing potential, all non-metallic materials and equipment flown to and used on board ISS that may cause contamination of the inhabited atmosphere.	
7.3.1.2	<p>The ISS Program shall assess all potentially hazardous substances or materials for toxic effect and submit the results of this assessment to the ISS Safety Review Panel (SRP) for approval prior to approving chemical substances and dispersible materials (dusts) for use on ISS.</p> <ul style="list-style-type: none"> A. The ISS Program shall assure that data for the assessment is provided to the JSC Toxicology Group or the Russian experts in compliance with JSC 27472 (March 1999), Requirements For Submission of Data Needed for Toxicological Assessment of Chemicals and Biologicals To Be Flown on Manned Spacecraft. B. The ISS Program shall assure that the final toxicological assessment of compounds, their quantity and location is accessible to the station's crew, MCC medical personnel, and environmental engineers. 	
7.3.1.3	The ISS Program shall monitor, prior to launch, the atmosphere of new modules to be permanently affixed to the ISS for aggregate off-gassing.	
7.3.1.4	The ISS Program shall monitor, at the processing facility, the atmosphere of cargo vehicles for potentially hazardous chemical substances.	
7.3.2.1	The ISS Program shall take archival air samples periodically for toxicological assessment of air quality to determine whether ISS air is or has been safe for crew respiration.	
7.3.2.2	The ISS Program shall perform real-time monitoring of selected trace contaminants.	
7.4.1	The ISS Program shall make information concerning crew, environment (air, surfaces, and water), payloads, and food microbiological findings available to NASA/FSA specialists, flight surgeons, the MMOP, and IPs.	
7.4.3	<p>The ISS Program shall ensure ISS environmental parameters (air and surfaces), payloads, and associated hardware are in compliance with the standards in accordance with the following:</p> <ul style="list-style-type: none"> A. Table D-5, Preflight Microbial Specifications and Monitoring Requirements of Air and Surfaces B. KSC-OMRS-ACOMC Technical Requirements (flight specific) C. NSTS 21426, Spacehab – General Research/Logistics Module Carrier Integration Plan (Core) D. JSC 16888, Shuttle Transportation System Microbial Contamination Control Plan (Replaces JSC-11859A) E. RSA/IBMP XT-4.160.001, Regulations for Sanitary-Hygienic and Anti-Epidemic Support for Spaceflight at Prelaunch and Postflight Operation Stages. 	
7.4.4	The ISS Program shall perform in-flight microbiological monitoring throughout the life of the ISS to evaluate the microbial condition of cabin air and internal surfaces and determine compliance to standards in accordance with the following: Table D-6, In-flight Microbial Specifications and Monitoring Requirements of Air and Surfaces.	

ISS MORD Revision C paragraph	Launch Readiness (ISS MORD Revision C)	Requirement met?
7.4.5	The ISS Program shall perform preflight, in-flight, and postflight microbiological analyses of water and determine compliance to standards in accordance with the following: <ul style="list-style-type: none"> A. SE-S-0073, Space Shuttle Specification for Fluid Procurement and Use Control B. XT. 0.045.019 TY, Preserved Potable Water C. GOCT P 50804-95 standard, Cosmonaut Environment in a Manned Space Vehicle D. ЭH 3218-064 1000-0 TY, Rodnik System Fill Assembly E. Table D-6, Microbial Specifications and Monitoring Requirements for ISS Water 	
7.5.1.1	The ISS Program shall prevent unacceptable deterministic effects to critical tissues by ensuring crew exposures do not exceed the dose values given in Table D-8.	
7.5.1.2	The ISS Program shall manage crewmembers' ionizing radiation exposures following the principles of "As Low As Reasonably Achievable" (ALARA).	
7.5.2.1	Each crewmember shall wear a personal radiation dosimeter at all times during a mission, including during IVA and EVA.	
7.5.3.2.1	Instrumentation shall monitor the environment in habitable volumes of the ISS and provide information for estimating organ doses.	
7.5.10.2	Pre-flight, crew radiation exposure histories shall be reviewed and the current mission exposures and risks shall be predicted based on planned mission activities. A minimum buffer dose of 0.1 Sv shall be included in the projected dose calculations for assignment of a crewmember to an ISS flight.	
8.1	The ISS Program shall develop, implement and validate a countermeasure plan for ISS crewmembers and crews to counter the deleterious physical, physiological, as well as behavioral health and performance effects due to long-duration spaceflight.	
8.5.2.1	The ISS Program shall provide the following in-flight countermeasures: <ul style="list-style-type: none"> B. In-flight (End Of Mission) 4. Recumbent seating following increments greater than 30 days 	
8.5.3.1	The ISS Program shall develop an ISS Food Plan <TBD 8.5.3.1> to manage nutrition and food for the ISS crewmembers.	

APPENDIX F – UNMET REQUIREMENTS

The Table F-1 contains requirements from Revision B that are currently unmet, partially met or require new resources. These requirements have been carried forward to Revision C and are reflected in the table. Because most are partially met, the unmet portion of the requirement is identified in the Status column.

TABLE F-1 PREVIOUSLY UNMET REQUIREMENTS

No	ISS MORD Rev	Paragraph	Requirement	Status
1	Rev C	3.1.1	The ISS Program shall establish a multilateral cadre of ISS-certified IP FSS.	Partially Met – Efforts have begun by NASA to develop this plan.
2	Rev C	4.1.C	C. The ISS Program shall provide flight-like ground based IMedS training hardware for the crew and members of the mission support team to facilitate training efficiency.	Partially Met - There is a lack of specific flight-like training units to train the crews, flight surgeons and BMEs. In some cases, photos are used. A partial list includes: VOA, TEPC, IVCPDS, EVCPDS.
3	Rev C	6.3.5.1	The ISS Program shall provide ALS care for a single crewmember for up to 72 hours following an acute medical event.	Partially Met – The implementation of this requirement will be reviewed with the Partners.
4	Rev C	6.3.5.5	The ISS Program shall provide the capability to stabilize and transport an ill or injured crewmember.	Partially Met - The Soyuz does not support HMS equipment and the Station defibrillator is not certified for use on the Shuttle.
5	Rev C	6.3.8	The ISS Program shall establish the criteria for termination of a flight for medical reasons.	Not Met - A definite criteria does not exist and this reasonable criteria needs to be developed.
6	Rev C	7.2.2	The ISS Program shall perform water quality monitoring during ISS preflight and in-flight periods in accordance with the list of parameters presented in Table D-1, Water Quality Requirements for the ISS Russian Segment, and in SSP 41000, Table XXXII, Water Quality Requirements, for the U.S. On-orbit Segment.	Not Met in-flight - Loss of Shuttle return capability has resulted in a temporary reduction in planned chemical archival sampling frequency from monthly to quarterly until Return to Flight. Smaller sample bags are being used and sample volume has been temporarily reduced from 750 to 250 ml. No working TOCA is onboard presently. No TOCA 2 exists for the analysis of water from the US Water Processor.
7	Rev C	7.3.1.2	A. The ISS Program shall assure that data for the assessment is provided to the JSC Toxicology Group or the Russian experts in compliance with JSC 27472 (March 1999), Requirements For Submission of Data Needed for Toxicological Assessment of Chemicals and Biologicals To Be Flown on Manned Spacecraft.	Partially Met - Pending Russian communication.
8	Rev C	7.3.2.2	The ISS Program shall perform real-time monitoring of selected trace contaminants.	Not Met - VOA not functional at this time. A 2nd VOA is in work. VOA repairs are planned for Increment 12.

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No	ISS MORD Rev	Paragraph	Requirement	Status
9	Rev C	7.4.5	<p>The ISS Program shall perform preflight, in-flight, and postflight microbiological analyses of water and determine compliance to standards in accordance with the following:</p> <ul style="list-style-type: none"> A. SE-S-0073, Space Shuttle Specification for Fluid Procurement and Use Control B. XT. 0.045.019 TY, Preserved Potable Water C. GOCT P 50804-95 standard, Cosmonaut Environment in a Manned Space Vehicle D. ЭH 3218-064 1000-0 TY, Rodnik System Fill Assembly E. Table D-6, Microbial Specifications and Monitoring Requirements for ISS Water 	Partially Met - No on-orbit hardware is available that can provide detection of bacteria at levels of the newly revised standard of 50 CFU/ml. Engineering has initiated investigations to determine hardware and costing needs. Loss of Shuttle return capability has resulted in a suspension in planned microbiology archival sampling until Return to Flight.
10	Rev C	7.5.3.2.1	Instrumentation shall monitor the environment in habitable volumes of the ISS and provide information for estimating organ doses.	Partially Met - IVCPDS meets less than 1/2 of requirement; TEPC not always available; IVCPDS not certified for Service Module
11	Rev C	7.5.3.2.1.3	Radiation monitoring instruments shall provide the capability to characterize the neutron contribution to crew exposures.	Partially Met - No neutron monitoring capability; Russians do not have the capability to monitor this; no funds for the instrumentation.
12	Rev C	7.5.4	High range, high rate dosimeters shall be present on board in order to measure high dose-rate contingency events.	Requires New Resources - Replacements High Rate Dosimeters (HRD) have been procured. Certification is not complete for new HRDs. Old HRDs were obsolete and permission was provided to dispose of old hardware.
13	Rev C	7.5.5.2	Time-resolved measurements of the energy- and direction-dependent distribution of charge-identified particles shall be made in each habitable module.	Partially Met - Russian instruments not directional but requirement to be relaxed; IVCPDS never waived for use on Russian Side and not certified for use in Russian vehicles; no funds to complete the cert; no waiver is in the system; IVCPDS not measuring all habitable modules.
14	Rev C	7.6	The ISS Program shall limit exposure to non-ionizing radiation, including radio frequency, electromagnetic fields, infrared, optical, laser radiation, and incoherent ultraviolet radiation, to the values published in SSP-50005C, International Space Station Flight Crew Integration Standard (NASA – STD-3000/T).	Partially Met - Exposure limits are being reviewed by IPs management plan initiated; new flight rules/ implementation <TBD F-1>.

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No	ISS MORD Rev	Paragraph	Requirement	Status
15	Rev C	8.4	The ISS Program shall provide crewmembers circadian entrainment to accommodate the increment pre- and in-flight timeline.	Partially Met - Flight Rule B 13-103 to address crew work day and circadian entrainment for real-time decision making was approved by the FRCB but not signed by the Russians. Approval was received from the MMOP. DA8/Joel Montalbano is expecting Russian signature in July 2005.
16	Rev C	8.5.3.1	The ISS Program shall develop an ISS Food Plan <TBD 8.5.3.1> to manage nutrition and food for the ISS crewmembers.	Partially Met - Draft signed Oct 2004, implementation in work (but will be slow to fully resolve).
17	Rev C	8.5.3.1.3	The ISS Program shall use the protocol for nutritional assessment for long-duration missions described in JSC 28566, Nutritional Status Assessment for Extended Duration Space Flight.	Partially Met - Funding is inconsistent. FY05 was nominal, and hopefully FY06 and beyond will be as well.

Table F-2 contains newly proposed requirements introduced by the current document revision that are, as of the print date, unfunded by the ISS Program Office. ISS Program Change Requests will be submitted for disposition for each requirement listed.

TABLE F-2 NEWLY PROPOSED REQUIREMENTS

No	ISS MORD Rev	Paragraph	Requirement	Rationale	Status
1	Rev C	6.3.5.3.2	The ISS Program shall provide treatment capability for DCS on ISS to terrestrial standards that requires a hyperbaric facility on ISS capable of delivering recurrent 2.8 ATA hyperbaric oxygen treatments by crewmembers(s) who have been adequately trained and who have maintained competency in operation of the facility.	Regardless of the efficacy of prebreathe protocols, the risk of serious DCS will never be zero in EMU or Orlan EVA suits. Suit leak considerations from an industrial accident or micrometeorite impact could cause serious DCS. Operation of a hyperbaric facility on ISS must include appropriate training for ISS crewmembers. Implementation of an inadequately designed hyperbaric treatment system or inadequate training for crewmember/operators may result in injury to crewmembers being treated.	Various expert Committees tasked by NASA to address the risk of DCS on ISS have supported a recommendation that the ISS be equipped with a hyperbaric facility. The CSA Cost-Consequences Analysis supports the requirement for a hyperbaric facility both in terms of health benefits for ISS crewmembers and costs to the ISS Program. Ref: MMOP Meeting #48, June 16-20, 2003.
2	Rev C	6.3.5.4	The ISS Program shall provide TMC for a single crewmember for up to 45 days.	In the event that provision of ALS care for up to 72 hours allows the crewmember to improve sufficiently that transitional care is subsequently required, resources should be available, either in situ or via resupply vehicles, to support that level of care for up to 45 days on orbit and avoid a preventable medical evacuation. Forty-five days is selected because it represents the maximum time required either to stabilize a sick or injured crewmember for safe evacuation (Shuttle or Soyuz) or to resolve the medical condition. (As documented in the Safe Haven TIM, 45 days is also the maximum estimated time for an unscheduled	31 May 05 - Implementation details of the Transitional Medical Care for ISS is currently under review by the medical community.

				<p>Shuttle to reach the ISS on a rescue mission.) Because the goal of treatment is to improve the condition, it is therefore assumed that most conditions will, with appropriate care, shift from requiring transitional care (with its associated resources) to needing only ambulatory care well within the 45 day period. Examples of conditions which might be categorized as requiring “transitional care” would include: diverticulitis, kidney stone, severe gastroenteritis, abdominal pain (of unknown etiology), depression, or a fractured wrist.</p>	
3	Rev C	6.3.7	<p>The ISS Program shall provide the following functionality to allow remote monitoring, evaluation, and care for an ISS patient:</p> <ul style="list-style-type: none"> A. Diagnostic scopes that permit downlink of images and/or sounds B. Real-time downlink of medical data (including sound and video) without the need for crew intervention. C. Real-time video downlink of the patient 	<p>Newer diagnostic scopes (stethoscope, ophthalmoscope, otoscope) permit the capture of image and sound files, which can then be downlinked to medical personnel, thus verifying findings and diagnoses made by the CMO. In addition, these files could be sent in a secure fashion to expert consultants around the globe and/or shared with IP FSSs. In order to provide the data to the experts who are best able to utilize it and to minimize the need for crew time (since their time may be required elsewhere on the ISS), the patient medical information should be transmitted to the ground as quickly and seamlessly as possible. Automatic real-time download (with store and forward capability during loss of signal) would therefore be ideal. The flight medicine community recommends</p>	<p>31 May 05–Prototype research and development efforts have partial funding. Full development efforts with program and Engineering efforts are unfunded. IRMA Risk 5094 has been generated to capture this risk.</p>

				that the ISS Program develop a communications infrastructure that will facilitate networking among the ISS, MCC, and IP medical consoles and medical centers in order to provide a technically advanced means of telemedicine assistance on board.	
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