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OFFICE OF THE CHIEF HEALTH AND MEDICAL OFFICER

NASA SPACEFLIGHT MEDICAL SELECTION, RECERTIFICATION AND MISSION EVALUATION STANDARDS

OCHMO-STD-100.1A, Revision A

APPROVAL PAGE

OFFICE OF THE CHIEF HEALTH AND MEDICAL OFFICER

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DOCUMENT HISTORY LOG

Status	Document Revision	Change Number	Approval Date	Description
Baseline			2021-05-10	Initial Release—This NASA Technical Standard establishes criteria that were initially part of the Astronaut Medical Evaluation Requirements Document **(**AMERD), and has been updated using evidence based medicine by the Aerospace Medical Board.
Revision	A		2024-xx-xx	Addition of Private Astronaut and NASA Suborbital Research Specialist (NSRS) medical standards. Addition of mission specific medical evaluation standards.

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FOREWORD

This NASA Technical Standard is published by the National Aeronautics and Space Administration (NASA) to provide uniform technical requirements for processes, procedures, practices, and methods that have been endorsed as standard for NASA programs and projects, including requirements for selection and annual recertification of NASA astronauts.

This NASA Technical Standard is approved for use by NASA Headquarters and NASA Centers and Facilities, and applicable technical requirements may be cited in contract, program, and other Agency documents.

This NASA Technical Standard provides medical requirements and clinical procedures designed to ensure the health, safety, and longevity of career of NASA astronauts. These technical standards reflect the medical requirements to successfully complete specific mission tasks and the multifaceted training and performance required of an astronaut including, but not limited to, flying in high performance aircraft, exposure to hypobaric and hyperbaric conditions, exposure to unique environments (e.g., microgravity), and conducting specialized operations (e.g., extra- vehicular activities, robotic arm operations).

This NASA Technical Standard also provides medical requirements and clinical procedures for the medical evaluation of private astronauts and NASA Suborbital Research Specialist (NSRS), and mission specific medical evaluations which include both clinical and occupational requirements.

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NASA SPACEFLIGHT MEDICAL STANDARDS

1. SCOPE

1.1 Purpose

This NASA Technical Standard provides medical requirements and clinical procedures designed to ensure crew health and safety and occupational longevity of NASA career astronauts. This NASA Technical Standard used for selection and annual recertification of astronauts reflects the medical requirements to successfully complete specific mission tasks and the multifaceted training and performance required of a NASA astronaut. These include, but are not limited to, flying in high performance aircraft, exposure to hypobaric and hyperbaric conditions, exposure to unique environments (e.g., microgravity), and conducting specialized operations (e.g., extra-vehicular activities, robotic arm operations). NASA policy for establishing standards to protect the health and safety of crew and for providing health and medical programs for astronauts during all phases of space flight is authorized by NPD 1000.3 - The NASA Organization, and by NPD 8900.5B - NASA Health and Medical Policy for Human Space Exploration.

This document includes medical evaluations for private astronauts and NASA Suborbital Research Specialist (NSRS).

Private astronauts are defined as a crew member who is not a NASA career (U.S. government) astronaut or international partner astronaut.

NASA Suborbital Research Specialist is an individual who is employed by NASA or funded by NASA to conduct research, technology testing, training, or other activities onboard a sub-orbital vehicle. This excludes those individuals who are the commercially employed crew of the suborbital vehicle.

This NASA Technical Standard also provides mission specific medical evaluations which include both clinical and occupational requirements that may be tailored for future missions.

1.2 Applicability

This NASA Technical Standard is applicable to NASA career astronaut candidate selection and annual recertification, private astronauts and NSRSs. This Standard is also applicable for mission specific medical evaluations which include both clinical and occupational requirements. For an overview of NASA's medical requirements and acceptance process for NASA career astronauts, please see Table 1 below. For private astronauts, see Section 8 and for NSRS see Section 9. For mission specific medical evaluations see Sections 6 and 7.

Health risk assessment is a complex and dynamic process, and the medical requirements and screening procedures account for the fact that the risk for a medical event increases with mission duration. This NASA Technical Standard retains the flexibility for incorporation of new clinical procedures as a part of the health evaluation process in a preventive, diagnostic, or treatment capacity.

Medical data, information, and records are managed in accordance with the Privacy Act of 1974, as amended, and consistent with the privacy provisions of the Health Insurance Portability and Accountability Act (HIPAA).

This NASA Technical Standard is approved for use by NASA Headquarters and NASA Centers and Facilities, and applicable technical requirements may be cited in contract, program, and other Agency documents.

Verifiable requirement statements are numbered beginning with the section number and indicated by the word "shall." This NASA Technical Standard contains 52 requirements. To facilitate requirements selection, a Requirements Compliance Matrix is provided in Appendix A. Explanatory or guidance text is indicated in italics.

Although the standards listed in this document address medical conditions presently known, it is fully intended that as knowledge accumulates, this NASA Technical Standard will be revised as appropriate. Any standard invalidated by new medical information may be appended by the Aerospace Medicine Board (AMB) with Chief Health and Medical Officer (CHMO) approval.

Table 1 - NASA Medical Requirements, Disqualifying Criteria and Acceptance Process and Waiver Process for recertification for NASA Career Astronauts

Medical Requirements	
Medical Requirements for Selection	**Laboratory Tests** Section 5.1.2, Table 3 **Special Assessments** Section 5.1.3, Table 6
Medical Requirements for Annual Recertification	**Laboratory Tests** Section 5.1.2, Table 5 **Special Assessments** Section 5.1.3 Table 6
Disqualifying Criteria	
Disqualifying Criteria	Section 5.2, Table 7
NASA Review Process	
AMB Chair	Shall make recommendation on NASA astronaut medical status. See Section 4.2 [4003]
CHMO	Shall make the final disposition on NASA astronaut medical status. See Section 4.2 [4004]
MSMB Chair	Determines medical suitability and certification for ISS
Waiver Process – Recertification Only*	
Examining physician	Shall provide a detailed presentation to the AMB of all relevant medical data. See Section 4.3 [4007]
Examining physician	Shall notify the NASA astronaut that his/her medical condition is being considered for waiver or disqualification from flight status. See Section 4.3 [4008]
AMB Chair	Shall make recommendation on NASA astronaut medical waiver status.
CHMO	Shall make the final disposition based on review of the AMB recommendations. See Section 4.3 [4009]

***** No waiver **shall** be granted on selection of NASA astronauts. See Section 4.3 [4006]

2. APPLICABLE DOCUMENTS

2.1 General

2.1.1 The documents listed in this section contain provisions constituting requirements of this NASA Technical Standard as cited in the text.

2.1.2 The latest issuances of cited documents apply unless specific versions are designated; use of a version other than as designated has to be approved by the delegated Technical Authority.

2.1.3 Applicable documents may be accessed at https://standards.nasa.gov, https://nodis3.gsfc.nasa.gov/main_lib.cfm, or obtained directly from the Standards
Developing Body or other document distributors. When not available from these sources, information for obtaining the document is provided.

2.1.4 References are provided in Appendix E.

2.2 Government

Documents Federal

	Privacy Act of 1974, as amended (https://www.justice.gov/opcl/privacy-act-1974)
	Health Insurance Portability and Accountability Act (HIPAA) (https://www.hhs.gov/hipaa/for-professionals/security/laws-regulations/index.html)
	Centers for Disease Control and Prevention, Third National Health and Nutrition Examination Survey (NHANES III) (https://www.cdc.gov/nchs/nhanes/nh3data.htm)
NCRP Reports No. 132	National Council on Radiation Protection and Measurements, Radiation Protection Guidance for Activities in Low-Earth Orbit (https://ncrponline.org/publications/reports/ncrp-reports-132/)

NASA

NPD 1000.3	The NASA Organization
NASA-STD-3001, Volume 1, Revision A	NASA Space Flight Human-System Standard Volume 1, Revision A: Crew Health

2.3 Non-Government Documents

The American Psychiatric Association

Diagnostic and Statistical Manual of Mental Disorders (DSM) – Latest Version

2.4 Order of Precedence

2.4.1 The requirements and standard practices established in this NASA Technical Standard do not supersede or waive existing requirements and standard practices found in other Agency documentation, or in applicable laws and regulations unless a specific exemption has been obtained by the Office of the Chief Health and Medical Officer.

2.4.2 Conflicts between this NASA Technical Standard and other requirements documents will be resolved by the delegated Technical Authority.

3. ACRONYMS, ABBREVIATIONS, SYMBOLS, AND DEFINITIONS

3.1 Acronyms, Abbreviations, and Symbols

º	degree
%	percent
AGE	arterial gas embolism
AIDS	acquired immune deficiency syndrome
ALARA	as low as reasonably achievable
ALP	alkaline phosphatase
ALS	amyotrophic lateral sclerosis
ALT	alanine aminotransferase
AMB	Aerospace Medicine Board
AMERD	Astronaut Medical Evaluation Requirements Document
APC	Activated protein C
ASCAN	astronaut candidate
ASD	atrial septal defect
AST	aspartate aminotransferase
AV	atrioventricular
BCG	bacille Calmette-Guerin
BRCA	breast cancer gene
CDC	Centers for Disease Control and Prevention
CHMO	Chief Health and Medical Officer
Cl	chloride
cm	centimeter
CMO	Crew Medical Officer
CNS	central nervous system
CROM	cervical range of motion
CT	computed tomography
CXR	chest X-ray
D	diameter
DCI	decompression illness
DCS	Decompression sickness
DOD	Department of Defense
DSM	Diagnostics and Statistical Manual
DXA	dual energy X-ray absorptiometry
ECG	electrocardiogram
EEG	electroencephalogram
ENT	ears, nose, and throat
FMC	Flight Medicine Clinic
GGT	gamma-glutamyl transferase
HbA1c	Hemoglobin A1C
hCG	Human chorionic gonadotropin
HCW	health care worker
HDL	high-density lipoproteins
HIPAA	Health Insurance Portability and Accountability Act
HIV	human immunodeficiency virus

hs-CRP	high-sensitivity C-reactive protein
HSV	herpes simplex virus
HUS	hemolytic uremic syndrome
IgA	immunoglobulin A
IgG	immunoglobulin G
IgM	immunoglobulin M
IGRA	Interferon Gamma Releasing Assay
INF-γ	Interferon gamma
IP	International Partner
ISS	International Space Station
ITP	idiopathic thrombocytopenic purpura
JSC	Johnson Space Center
K	potassium
L +/-	launch plus or minus
LASIK	laser-assisted in-situ keratomileusis
LDH	lactate dehydrogenase
LDL	low-density lipoprotein
LROM	lumbar range of motion
LSAH	Lifetime Surveillance of Astronaut Health
LTBI	latent tuberculosis infection
MED	Medical Evaluation Document
MGUS	monoclonal gammopathy of undetermined significance
min	minute
mmHg	millimeters of mercury
MMOP	Multilateral Medical Operations Panel
MMPB	Multilateral Medical Policy Board
MOU	Memorandum of Understanding
MPB	Medical Policy Board
MRI	magnetic resonance imaging
msec	millisecond
MSMB	Multilateral Space Medicine Board
Na	sodium
NASA	National Aeronautics and Space Administration
NBL	Neutral Buoyancy Laboratory
NCRP	National Council on Radiation Protection and Measurements
NHANES III	Third National Health and Nutrition Examination Survey
NPD	NASA Policy Directive
OCHMO	Office of the Chief Health and Medical Officer
PC	point of convergence
PDA	patent ductus arteriosus
PFO	patent foramen ovale
PFT	Pulmonary function tests
PIP	pseudo-isochromatic plates
PRK	Photorefractive Keratectomy
PT	prothrombin time
PTT	partial thromboplastin time

PVC	premature ventricular contractions
QFT-G	QuantiFERON-TB Gold
R +/-	return plus or minus
RPR	rapid plasma reagin
SBU	sensitive but unclassified
SC	sickle hemoglobin-C disease
SI	Système Internationale
SPE	serum protein electrophoresis
SS	sickle cell
SSP	Space Shuttle Program
STD	Standard
SVT	supraventricular tachycardia
TB	tuberculosis
TIA	transient ischemic attack
TMJ	temporomandibular joint
TSH	thyroid stimulating hormone
TST	tuberculin skin test
TTG	Tissue transglutaminase
TTP	thrombotic thrombocytopenic purpura
U.S.	United States
VDRL	venereal disease research laboratory
VSD	ventricular septal defect
VZV	varicella zoster virus
WHO	World Health Organization
WPW	Wolff Parkinson White

3.2 Definitions

None.

4. NASA ASTRONAUTS MEDICAL EVALUATION, SELECTION, AND ANNUAL RECERTIFICATION

4.1 Medical Evaluation – General Considerations

Candidate astronauts undergo a comprehensive medical evaluation as part of their selection and annual recertification.

The medical evaluation process includes an extensive medical history and physical examination by aeromedical physicians and clinical specialists, laboratory screening tests, special diagnostic tests, and psychiatric evaluation. This document defines the medical screening procedures and standards for medical certification upon selection, and annual recertification thereafter.

In compliance with NPD 1382.17, NASA Privacy Policy and the Privacy Act of 1974, as amended, applicants are examined in accordance with approved medical procedures.

4.1.1 Selection Medical Evaluation – General Considerations

Candidates for selection as NASA astronauts are evaluated for early detection of diseases that may interfere with their abilities to perform in mission.

The specific medical evaluation procedures used are designed to select and certify individuals who are free from medical conditions that may:

a. Compromise the astronaut's health and safety,

b. Compromise the completion of mission objectives, and

c. Be seriously aggravated or progress as a result of the performance of duties during training (e.g., in the Neutral Buoyancy Laboratory [NBL] and U.S. Air Force T-38 aircraft) or space flight exposures.

4.1.2 Annual Medical Evaluation – General Considerations

The medical evaluation that is conducted annually for recertification is based on current NASA standards for space flight duties, piloting of NASA aircraft, or participation in flight activities only, as applicable.

4.2 Medical Evaluation and/or Certification by NASA's AMB

[4001] The examining physician **shall** present a candidate's evaluation results to the AMB.

[4002] The AMB **shall** determine if the candidate does or does not meet medical standards or requires further evaluations before disposition can be made.

[4003] The AMB will review the medical records of all NASA astronaut applicants at selection, and of each NASA astronaut annually, and **shall** recommend qualification, disqualification, or conditional qualification (waiver for active astronauts) to the CHMO.

[4004] The Chief Health and Medical Officer (CHMO) **shall** make the final disposition on qualifications and disqualifications of NASA astronauts, based on review of the AMB recommendations.

4.3 Waiver of Medical Standards

A waiver may be requested for a NASA astronaut for recertification, who does not meet a medical standard. The waiver disposition may stipulate conditions for mission assignment (e.g., mission duration, location etc.).

[4005] The term "waiver" **shall** be used when a disqualifying condition is waived and the NASA astronaut is conditionally medically certified.

[4006] No waiver **shall** be granted on selection of NASA astronauts.

[4007] For a NASA astronaut waiver request, the examining physician **shall** provide a detailed presentation to the AMB of all relevant medical data and also address the following:

a. An evidence-based review with data derived from the medical and aeromedical literature, as well as specialist consultant opinions detailing the potential risks associated with the condition, complications, and sequelae.

b. A thorough consideration of the potential consequences of related medical events on mission safety and mission completion and on the potential incremental health risk to the individual in the space environment.

[4008] The examining physician **shall** notify the NASA astronaut that his/her medical condition is being considered for waiver or disqualification from flight status.

[4009] The Chief Health and Medical Officer (CHMO) **shall** make the final disposition based on review of the AMB recommendations. The CHMO may delegate waiver decision authority to the AMB Chair for routine medication waiver renewal.

5. NASA ASTRONAUTS MEDICAL EVALUATION, SELECTION, AND ANNUAL RECERTIFICATION – SPECIFIC CONSIDERATIONS

5.1 Medical Screening of NASA Astronauts

5.1.1 Medical Evaluation Procedures for NASA Astronauts – Overview

[5001] The examining physician **shall** perform medical screening, including the procedures and consultations in Table 2, Medical Evaluation Procedures, at selection and for annual recertification as indicated.

Table 2 – Overview of Medical Evaluation Procedures for NASA Astronauts
- To be applied at selection and annually thereafter.

Overview
1. Comprehensive medical questionnaire[1]
2. Full aeromedical physical examination
3. Special assessments and imaging procedures (as described in Table 6)
4. Laboratory testing (as described in Tables 3, 4, and 5)

[1] - May be completed using the NASA Medical Survey or other similar questionnaire. The following areas should be included: Past medical history and background information; psychosocial and psychiatric history including DWI and drug-related convictions; personal habits/lifestyle issues; travel history (past year); medication review, including non-prescription and herbal medications, food supplements, vitamins, and minerals; systems review; physical activities and sports.

5.1.2 Laboratory Testing

Laboratory testing for selection, shown in Table 3, Laboratory Tests on Selection; Table 4, NASA Astronaut Candidate (ASCAN) First Annual Exam; and Table 5, Laboratory Tests on Annual Recertification, are limited to those tests pertinent to the identification of the presence of, or predilection for disease states, that might compromise individual health, mission effectiveness, or safety.

Clinical laboratory studies and special diagnostic tests are performed to establish baseline values and to aid in the detection of any disease process. Results of these tests are evaluated in the context of other clinical findings.

The specific laboratory tests in Tables 3 and 4 reflect current standards of care.

Table 3 - Laboratory Tests on Selection of NASA Astronauts

Laboratory Tests on Selection of NASA Astronauts
Hematology/thrombophilia screen • Complete Blood Count – To include hemoglobin, hematocrit, red blood cell count, red blood cell indices, white blood cell count, differential count, platelet count • Reticulocyte count • Screening tests for thrombophilia: Prothrombin time (PT) and partial thromboplastin time (PTT) • Hemoglobin evaluation (A, A2, F, S, C, E)
Biochemistry • Liver function - Aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma-glutamyl transferase (GGT), bilirubin, alkaline phosphatase (ALP), lactate dehydrogenase (LDH) • Total serum protein, albumin • Renal function - Urea, creatinine, electrolytes (Na [sodium], Cl [chloride], K [potassium]), uric acid • Endocrine - Thyroid stimulating hormone (TSH), free T4 (thyroxine), anti-thyroid antibodies • Fasting blood glucose, HbA1C • Cardiovascular profile - Fasting total cholesterol, high-density lipoproteins (HDL), low-density lipoprotein (LDL), triglycerides, high-sensitivity C-reactive protein (hs-CRP) • Calcium, magnesium, inorganic phosphate • Ionized calcium • Prostate specific antigen (males over age 40) • Serum ferritin, iron, total iron binding capacity, transferrin saturation
Infectious Disease Screen • Serologic screen for syphilis (VDRL or RPR or equivalent) • Hepatitis B (Hepatitis B surface antigen, Hepatitis B core antibody, Hepatitis B surface antibody) • Hepatitis C • HIV • Tuberculosis (TB) screening utilizing a tuberculin skin test (TST) or interferon gamma releasing assay (IGRA) (either QFT-G or T- SPOT). Refer to Appendix B for detailed Tuberculosis screening and management guidance.

Table 3 - Laboratory Tests on Selection of NASA Astronauts Continued

Laboratory Tests on Selection of NASA Astronauts
Urinalysis • Routine (specific gravity, glucose, protein, pH, ketones, blood), microscopic • Human chorionic gonadotropin (hCG) (females) (urine)
Special studies • Prolactin • Carbohydrate Deficient Transferrin • Ethyl glucuronide • Tissue transglutaminase (TTG) IgG • Tissue transglutaminase (TTG) IgA
Drug screening, urine • Drug screen in-house for drugs of abuse • Expanded drug screen

Table 4 - NASA Astronaut Candidate (ASCAN) First Annual Exam

NASA Astronaut Candidate (ASCAN) First Annual Exam
ABO Group & Rh Type
Cytomegalovirus IgG Antibody
Epstein-Barr Virus IgG Antibody to Nuclear Antigen
Epstein-Barr Virus IgG Antibody to Viral Capsid Antigen
Herpes Simplex Virus (HSV) Type 1/2 Combined IgG Antibody
Toxoplasma gondii IgG Antibody
VZV IgG Antibody
Immunocap Mouse Epithelium Antibody
Immunocap Mouse Urine IgE Antibody
Lipoprotein (a)
Measles (Rubeola) IgG Antibody
Mumps IgG Antibody
Rubella IgG Antibody
H. Pylori Breath Test
Hepatitis A antibody
G6PD
Serum Protein Electrophoresis
Quantitative Immunoglobulins (IgG, IgA, IgM)
Calculi Risk Assessment, Urine
Venous Thromboembolism Panel: • Cardiolipin IgG Antibody • B2 glycoprotein 1 IgM/IgG Antibody • Activated Protein C (APC) Resistance • Prothrombin Nucleotide 20210 G/A Gene Mutation (Factor II) Protein C • Protein S • Anti-Thrombin • Anti-phospholipid antibodies • Factor V Leiden

Table 5 - Laboratory Tests on Annual Recertification of NASA Astronauts

Laboratory Tests on Annual Recertification of NASA Astronauts
Hematology • Complete Blood Count – To include hemoglobin, hematocrit, red blood cell count, red blood cell indices, white blood cell count, differential count, platelet count • Reticulocyte count
Biochemistry • Liver function - Aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma-glutamyl transferase (GGT), bilirubin, alkaline phosphatase (ALP), lactate dehydrogenase (LDH) • Total serum protein, albumin • Renal function - Urea, creatinine, electrolytes (Na [sodium], Cl [chloride], K [potassium]), uric acid • Endocrine - Thyroid stimulating hormone (TSH), free T4 (thyroxine), • Fasting blood glucose, HbA1C • Cardiovascular profile - Fasting total cholesterol, high-density lipoproteins (HDL), low-density lipoprotein (LDL), triglycerides, high-sensitivity C-reactive protein (hs-CRP) • Calcium, magnesium, inorganic phosphate • Ionized calcium • Prostate specific antigen (males over age 40) • Serum ferritin, iron, total iron binding capacity, transferrin saturation • Vitamin D
Infectious Disease Screen • Hepatitis B (unless immunization has been confirmed with antibody titers) • HIV • Tuberculosis screening utilizing a tuberculin skin test (TST) or IGRA (either QFT-G or T-SPOT). Refer to Appendix B for detailed Tuberculosis screening and management guidance.
Urinalysis • Routine (specific gravity, glucose, protein, pH, ketones, blood), microscopic

5.1.3 Specialist Assessments for Selection and Annual Recertification of NASA Astronauts

Specialty examinations are performed to further detect and identify any potential disorders within a specific area. Throughout the selection and subsequent annual examinations, emphasis is placed on the early detection of latent pathological processes, and suitability for space flight and the physiological effects of reduced-gravity exposure.

Table 6 – Specialist Assessments for Selection and Annual Recertification of NASA Astronauts

Ophthalmology Specialist Assessment (Optometrist)	Selection	Annual
Visual acuity (Snellen or Landolt-C)		
• Near vision	✓	✓
• Distance vision	✓	✓
Color vision (computer-based test, Ishihara, or equivalent pseudo-isochromatic plates [PIPs] to include red-green and blue-yellow)	✓	✓
2 Cycloplegic refraction	✓	✓
Phorias	✓	✓
Tonometry	✓	✓
Perimetry	✓	✓
Fundoscopic examination	✓	✓
Retinal photographs	✓	✓
Corneal topography	✓	
Otolaryngology/ENT	**Selection**	**Annual**
Audiometry (pure tone audiogram and speech audiogram, if indicated)	✓	✓
Tympanogram	✓	✓
Computed tomography (CT) scan or magnetic resonance imaging (MRI) of sinuses	✓	

Table 6 – Specialist Assessments for Selection and Annual Recertification of NASA Astronauts Continued

Dental	Selection	Annual
Special Assessment by Dentist	✓	✓
Full orthopantomogram or full mouth X-ray series)	✓	
Cardiopulmonary	**Selection**	**Annual**
Resting 12-lead electrocardiogram (ECG)	✓	✓
Direct or indirect measurement of cardiorespiratory fitness (CRF) in ml/kg/min or METS) on maximum exercise stress test	✓	✓
Echocardiogram, Doppler, and color flow study	✓	
• Within the last 5 years		✓
24-Hour ECG monitoring	✓	
Pulmonary function testing	✓	
Cardiovascular Risk Prediction (AstroCHARM)	✓	✓
Coronary calcium scoring (>50 yrs old)	✓	
Within the last 5 years		✓

Table 6 – Specialist Assessments for Selection and Annual Recertification of NASA Astronauts Continued

Neurology	Selection	Annual
MRI of brain, MRI angiogram	✓	
Carotid Ultrasound Study (to include intima-medial thickness and/or carotid plaque area)	✓	
• Age 50 and over (Within the last 2 years)		✓
Behavioral Health Evaluation	**Selection**	**Annual**
Psychiatric and Psychological evaluation *Based on the most recent edition ofthe Diagnostic and Statistical Manual of Mental Disorders, the American Psychiatric Association.*	✓	✓
Psychodiagnostic and Psychological Suitability Assessment	✓	
Gynecological	**Selection**	**Annual**
Gynecological Evaluation (Cervical Cancer Screening using Current Guidelines)	✓	✓

Table 6 – Specialist Assessments for Selection and Annual Recertification of NASA Astronauts Continued

Radiological /Ultrasound Procedures	Selection	Annual
Chest X-ray (PA and lateral)	✓	
• Within the last 5 years		✓
Thyroid ultrasound	✓	
• Within the last 5 years		✓
Abdominal and pelvic ultrasound	✓	
• Within the last 5 years		✓
Bone mineral density - dual energy x-ray absorptiometry (DXA) scan	✓	
• Within the last 3 years		✓
Breast Imaging for females beginning at age 40	✓	
• Within the last 2 years MRI should be used in lieu of mammography for female astronauts, if identified to be at high or intermediate risk (based on family history, breast cancer gene (BRCA) positive, heterogeneous, or dense breast tissue).		✓
Radiation	**Selection**	**Annual**
Radiation History Assessment (Includes research exposure, space flight and aviation exposure, and previous occupational exposure)	✓	✓

5.2 Medical Conditions to Consider for Selection and Annual Recertification of NASA Astronauts

Table 7, Disqualifying Medical Standards, details those medical conditions that are medically disqualifying for the selection and retention of NASA astronauts, or that may require further testing and evaluation to assess medical suitability. In general, all conditions are worded as disqualifying. The term "unless" is used when specific exceptions are listed. Annual medical recertification ensures the individual has not developed any new medical conditions that would preclude safe performance of training and/or space flight duties or participation. This section pertains to all NASA astronauts.

[5002] The examining physician **shall** determine the suitability for selection and retention of NASA astronauts, using the conditions for disqualification specified in Table 7.

Table 7 – Disqualifying Medical Standards

7A GENERAL
1. Any medical condition that, in the judgment of the AMB, may compromise mission operations, performance of duties, or crew health or safety.
2. All injuries, contusions, fractures, or surgery unless healed and not associated with functional deficit that could interfere with the performance of duties.
3. History of heat stroke, temperature intolerance, or environmental injuries associated with significant sequelae that could interfere with performance of duties.
4. History of sensitivity or demonstrated allergy of sufficient severity so as to interfere with the performance of duties.
5. Habitual use of tobacco products.
6. Chronic use of any medication requires AMB review.
7. All malignancies or history of malignancies, except those permitted within the medical standards.
8. Any foreign body or implant, unless considered not to be a hazard during the performance of duties.
9. Any condition or situation that precludes completion of the NASA medical evaluation process.
10. Sarcoidosis, all forms.
11. Decompression Illness (DCI): A. Type II decompression sickness (DCS) or Arterial Gas Embolism (AGE) (involving the central nervous system, spinal cord, pulmonary DCS, or cardiovascular collapse) unless all signs and symptoms resolve with treatment. Such cases require specialist evaluation. B. Type I DCS involving joint pain, the peripheral nervous system, or skin is not disqualifying if adequately treated and completely resolved.
12. Presence or history of systemic exertion intolerance disease or myalgic encephalomyelitis (previously known as chronic fatigue syndrome) and fibromyalgia.
13. Autoimmune disorders, including conditions such as systemic lupus erythematosus and dermatomyositis.
14. Any standard invalidated by new medical information may be appended by the AMB with CHMO approval.

7B HEAD, FACE, AND NECK
1. Deformities (e.g., scars, depressions, or exostoses) or chronic muscular contractions or spasms (e.g., torticollis) of the skull/head, face, and neck that interfere with wearing equipment/headgear and/or performance of duties.
2. Loss or congenital absence of bony substance of the skull.
3. Maxillofacial skeletal deformities (e.g., benign tumors, large birthmarks, large hairy moles, extensive scars or mutilations due to injuries or surgery, ulcerations, fistulae, and atrophy or paralysis of part of the face or head) that interfere with the performance of duties or wearing of equipment.
4. Temporomandibular disorders (e.g., chronic temporomandibular joint (TMJ) arthritis, complete or partial ankylosis, recurrent dislocation, or chronic myofascial pain).
5. Congenital branchial cleft or thyroglossal duct cysts, unless greater than 1 year post-surgical resection and without evidence of residual cysts or tracts.
6. Chronic draining fistulae, regardless of cause.
7. Cervical ribs with signs or symptoms of thoracic outlet compression.
7C NOSE, SINUSES, MOUTH, AND THROAT
1. Deformities, injuries, or destructive diseases of the mouth, nose, throat, pharynx, or larynx that interfere with breathing, speech, mastication, and/or the swallowing of ordinary food, unless surgically corrected with normal function restored.
2. Deviation of the nasal septum, enlarged turbinates, or other obstructions to ventilation that significantly restrict nasal breathing, unless medically or surgically corrected with normal function restored.
3. Chronic rhinitis of any cause that may interfere with the performance of duties.
4. Perforation of the nasal septum if accompanied by recurrent epistaxis, an intrusive whistling sound, or if a sign of organic disease.
5. Sino-nasal polyps or a history of sino-nasal polyps, unless at least 1 year after surgical removal and without evidence of recurrence.
6. Anosmia.
7. Chronic sinusitis (persistent sinus infection for more than 3 months), unless treated without evidence of recurrence for at least 3 years.
8. Cleft lip and/or palate unless satisfactorily repaired.
9. Loss or mutilation of a lip in whole or part, unless satisfactorily repaired and does not interfere with the performance of duties or wearing of equipment.
10. Partial loss, atrophy, hypertrophy, benign tumors, or other malformations of the tongue if these conditions interfere with mastication, speech, swallowing, or appear to be progressive.

11. Presence or history of marked stomatitis, leukoplakia, or severe recurrent ulcerations of the mouth that may interfere with the performance of duties.
12. Ranulae, which might interfere with the performance of duties.
13. Salivary fistula, unless surgically corrected.
14. Presence of enlarged tonsils, adenoids, or redundant soft tissue of the oral pharynx that interfere with speech, swallowing, breathing, or are associated with recurrent otitis media.
15. Recurrent calculi of any salivary gland or duct, unless surgically corrected.
16. Obstructive sleep apnea.
17. Any disorder or defect that affects the clarity of speech to the extent that it impairs the performance of duties (e.g., chronic or recurrent laryngitis, vocal cord paralysis).
18. Tracheostomy or tracheal fistula, unless surgically repaired.
19. Recurrent epistaxis, unless from a benign lesion that has been corrected.
20. Any chronic disorder or defect that interferes with normal ventilation of paranasal sinuses or middle ear.
21. Zenker's diverticulum, unless surgically corrected.
7D EARS
1. Any diseases of the ear or mastoid with residual auditory or vestibular dysfunction sufficient to interfere with performance of duties.
2. Congenital deformation of the external meatus or canal that interferes with hearing or performance of duties.
3. Tumors of the external auditory canal, unless benign or surgically removed. Small exostoses are not disqualifying.
4. Chronic external otitis.
5. Chronic otitis media, suppurative or serous.
6. Persistent perforation of the tympanic membrane.
7. History of stapedectomy.
8. Chronic mastoiditis, mastoid fistula, or mastoidectomy, unless complete recovery from simple mastoidectomy.
9. History or presence of abnormal labyrinthine function (e.g., vestibular neuronitis), unless an isolated, remote episode with full recovery.
10. History or presence of Meniere's disease.
11. Chronic inability to equalize the pressure of the middle ear (Valsalva's maneuver).
12. Tinnitus that interferes with the performance of duties.

13. Hearing Standards:
    A. History of acute or sudden sensorineural hearing loss, unless due to trauma with complete recovery.
    B. Inability to meet the pure tone audiometry hearing thresholds in Table 11, Pure Tone Audiometry Hearing Thresholds.

Table 11 - Pure Tone Audiometry Hearing Thresholds

	Frequency Hz	500	1000	2000	3000	4000
Astronaut candidate selection	Both Ears	30	25	25	35	50
Annual examination or mission selection	Better Ear	30	25	25	35	50
	Poorer Ear	35	50	50	75	75

C. Inability to meet above hearing standards in pure tone audiometry on the annual examination requires a word recognition score of 92% or better in the better ear and 88% or better in the poorer ear.

7E EYES

1. Disease, defect, or deformity of either eye or supporting structure that may interfere with the performance of duties.

2. Lids and Ocular Adnexae:
    A. Any condition of the eyelids that impairs normal eyelid function.
    B. Chronic blepharitis
    C. Blepharospasm.
    D. Ptosis, unless a benign etiology that is not progressive and does not interfere with vision in any field of gaze or direction.
    E. Growths on the eyelid unless small, asymptomatic, non-progressive, and benign.
    F. Dacryocystitis or history of dacryocystitis.

3. Conjunctivae:
    A. Chronic or recurrent conjunctivitis requires specialist evaluation.
    B. History of trachoma requires specialist evaluation.
    C. Dry eye syndromes requiring treatment, including xerophthalmia, requires specialist evaluation.
    D. Pterygium that encroaches on the cornea more than 2 millimeters or recurs after two operative procedures (evaluation will be performed no earlier than 6 months post-operatively).

4. Cornea:
    A. Chronic or recurrent keratitis requires specialist evaluation.
    B. History of corneal ulcer or erosion requires specialist evaluation.
    C. Herpetic ulcer or history of herpetic ulcer.
    D. Vascularization, haze, or opacification of the cornea from any cause when it is progressive or interferes with vision.

E. Corneal dystrophy of any type, including keratoconus of any degree. *Form fruste keratoconus requires specialist evaluation.*
F. History of orthokeratology treatments within the previous 6 months.
G. History of penetrating or lamellar keratoplasty.
H. Refractive surgical procedures other than Photorefractive Keratectomy (PRK) (or other excimer laser surface procedures) or laser-assisted in-situ keratomileusis (LASIK). Wavefront guided procedures with a femtosecond laser are preferred. The following criteria apply:
   i. All standard accepted clinical eligibility criteria for the procedure are met (e.g., corneal thickness).
   ii. Pre-operative cycloplegic refractive error is between +4.00 to -8.00 sphere, and astigmatism is 3.00 or less in minus cylinder format.
   iii. At least 6 months since last refractive/augmenting procedure, with no ongoing active ophthalmologic treatment or need for ophthalmic medications.
   iv. Post-operative refraction stable as demonstrated by two separate refractions ≥ 1 month apart differing by ≤ +/-0.50 diameter (D) (sphere) and ≤ +/-0.25 D (cylinder).
   v. Post-operative manifest refractive errors within applicant standards.
   vi. No demonstrated adverse sequelae, including contrast sensitivity, glare, or night vision problems. All other vision standards are met.

5. Uveal Tract:
   A. Acute, chronic, or recurrent inflammation of the uveal tract (iris, ciliary body, choroid).
   B. History of uncomplicated post-traumatic iritis requires specialist evaluation.

6. Retina and Vitreous:
   A. History or evidence of retinal detachment, unless traumatic with no sequelae, retinal tears, or edema.
   B. Retinal hole with presence of fluid or vitreous traction. Other retinal holes require specialist evaluation.
   C. Degeneration or dystrophies of the central or peripheral retina, including lattice degeneration, require specialist evaluation.
   D. Pigmentary degenerations require specialist evaluation.
   E. Retinitis, chorioretinitis, or other inflammatory conditions of the retina, unless single episode that has healed and does not impair central or peripheral vision.
   F. Hemorrhages, exudates, or other retinal vascular conditions that potentially impair vision require specialist evaluation.
   G. Vitreous opacities or conditions that may cause loss of central acuity or peripheral visual field require specialist evaluation.
   H. Previous retinal treatment of any type requires specialist evaluation.

7. Optic Nerve:
   A. Any history of optic nerve disease, including but not limited to, optic nerve inflammation, optic nerve swelling, or optic nerve atrophy.
   B. Any optic nerve anomaly requires specialist evaluation.

8. Lens:
   A. Aphakia.
   B. Lens opacities that interfere with vision or are considered progressive require specialist evaluation.
   C. Lens dislocation, partial or complete.
   D. Intraocular implants or intraocular contact lenses.

9. Malignancy, and Other Defects and Disorders:
   A. History or presence of malignant tumors of the eye or orbit.
   B. Resected basal cell cancers or benign tumors require specialist evaluation.
   C. Exophthalmos, anophthalmos, or microphthalmos.
   D. Pathologic nystagmus.
   E. Abnormal pupil(s) or loss of normal pupillary reflexes requires specialist evaluation.
   F. Coloboma.

10. Refractive standards—inability to meet the following refractive requirements:
   A. Distance or near visual acuity not correctable to 20/20 in each eye.
   B. Refractive error (distant vision):
      1) Cycloplegic refractive error of more than +5.50 or -5.50 diopters in any meridian.
      2) Astigmatism requiring more than 3.00 diopters of cylinder correction.
      3) Anisometropia of more than 3.50 diopters.

11. Visual Fields: Any visual field defect, whether active, inactive, or migrainous requires specialist evaluation.

12. Extraocular muscle balance:
   A. Esophoria greater than 10 prism diopters measured at 6 meters or 20 feet.
   B. Exophoria greater than 10 prism diopters measured at 6 meters or 20 feet.
   C. Hyperphoria greater than 2 prism diopters measured at 6 meters or 20 feet.
   D. Any heterotropia measured at any distance.
   E. Point of convergence (PC) greater than 100 millimeters.
   F. Paralysis of ocular motion in any of gaze.
   G. Diplopia, suppression, or a history of diplopia or suppression.

13. Depth Perception: Lack of adequate depth perception on objective testing, with a minimum of 40 arcseconds.

14. Abnormal night vision, including retinitis pigmentosa, requires specialist evaluation.

15. Color Vision Deficiency: Greater than mild deficiency on red-green or blue-yellow color vision testing.

16. Intraocular Pressure:
   A. History of glaucoma, ocular hypertension, pre-glaucoma, or glaucoma suspect.
   B. Pigmentary Dispersion Syndrome requires specialist evaluation.

17. Medically required use of a contact lens.

7F LUNGS AND CHEST WALL
1. Any condition of the lungs, pleura, mediastinum, and chest wall that could interfere with performance of duties.
2. Pneumothorax or pneumomediastinum: A. History of spontaneous pneumothorax or pneumomediastinum unless surgically corrected with apical pleurodesis or pleurectomy and free of complications, with full expansion of lungs on chest X-ray (CXR), normal pulmonary function tests (PFTs), and thin-cut CT showing no pathology predisposing to recurrence. This requires specialist evaluation. B. Presence or history of traumatic pneumothorax, unless total resolution and free of complications, with full expansion of lungs on CXR, normal PFTs, and thin-cut CT showing no pathology predisposing to recurrence. This requires specialist evaluation.
3. Chronic pulmonary processes: A. Chronic obstructive pulmonary disease (chronic bronchitis or emphysema) with evidence of pulmonary dysfunction and causing impairment or increased risk for pulmonary barotrauma. B. Chronic pulmonary processes such as interstitial pneumonias, pulmonary injury, neuropulmonary disorders, hypersensitivity, and pneumoconiosis are disqualifying. C. Abnormal pulmonary function tests require specialist evaluation.
4. Bronchiectasis. History of childhood bronchiectasis requires specialist evaluation.
5. Asthma: A. Current asthma of any degree. B. History of asthma will require provoked bronchoconstriction testing and specialist evaluation.
6. Pulmonary blebs, bullae, or cysts.
7. History of lung abscess requires specialist evaluation.
8. Granulomatous inflammation: A. Non-infectious granulomatous inflammation (such as sarcoidosis, Wegener's, allergic, or bronchocentric). B. History of infectious causes, including mycotic infection (such as coccidioidomycosis, histoplasmosis) or protozoal infection (such as dirofilariasis, pneumocystis) requires specialist evaluation.
9. History of intrathoracic surgery requires specialist evaluation: A. History of lobectomy or multiple segmental resections with normal pulmonary function requires specialist evaluation.

B. Removal of more than one lobe is cause for rejection.
10. Any malignant tumor of the trachea, bronchi, lungs, pleura, or mediastinum: History of a benign tumor requires specialist evaluation.
11. History of suppurative periostitis, osteomyelitis, or necrosis of the ribs, sternum, clavicle, scapulae, or vertebrae with complete resolution and normal lung function requires specialist evaluation.
12. Chronic or recurrent mastitis.
13. Benign tumor or surgery of the breast or chest wall that interferes with the performance of duties.
14. History of unprovoked or recurrent pulmonary embolus. History of single provoked pulmonary embolus requires specialist evaluation.
15. History of empyema or sinus tracts of the chest wall require specialist evaluation.
16. History of surgically corrected tracheoesophageal fistula requires specialist evaluation.
17. History of pleural effusion of unknown etiology.
18. History of hemoptysis requires specialist evaluation.
19. History of breast cancer.
7G CARDIOVASCULAR
1. Any condition of the cardiovascular system that interferes with the performance of duties.
2. Cardiomyopathy such as hypertrophic or right ventricular cardiomyopathy (other than physiologic heart changes). History of acquired cardiomyopathy if recovered and left ventricular ejection fraction is > 50% requires specialist evaluation.
3. Hypertension, as defined by sustained systolic blood pressure of 140 mmHg or greater or diastolic of 90 mmHg or greater.

4. Recurrent syncope or symptomatic orthostatic intolerance (e.g., medication-induced, autonomic dysfunction, or other causes not otherwise specified), excepting post-space flight orthostasis. Recurrent neurally mediated syncope with clear precipitating factors requires specialist evaluation.

5. History of pericarditis, myocarditis, and endocarditis without residual dysfunction requires specialist evaluation.

6. Congenital abnormalities:
   A. History or findings of major congenital abnormalities of the heart and vessels.
   B. History of atrial septal defect (ASD), ventricular septal defect (VSD), or patent ductus arteriosus (PDA), that has been surgically repaired requires specialist evaluation.
   C. A patent foramen ovale (PFO) requires specialist evaluation.

7. Clinical evidence (angiographic, imaging, symptoms, history of prior event) of coronary artery disease.

8. Electrocardiographic abnormalities: Any cardiac dysrhythmia, conduction defect, or other ECG abnormalities on resting ECG, ambulatory ECG monitor, or any monitoring ECG rhythm strips require specialist evaluation.
   A. Supraventricular arrhythmias:
      i. Require AMB review and may be disqualifying:
         (1) Supraventricular tachycardia (SVT) assessed at least 6 months after ablation.
         (2) Atrial fibrillation/flutter assessed at least 6 months after ablation.
         (3) Presence or history of SVT or atrial fibrillation/flutter > 5 seconds.
         (4) Atrial ectopy (premature atrial complexes) > 1% and ≤ 20% of total beats on ambulatory ECG.
         (5) Presence of sustained (> 1 hour) sinus tachycardia at rest > 130 beats/min not related to physical activity during evaluation.
         (1) Disqualifying (other than those due to identifiable, reversible causes):+ Presence or history of SVT or atrial fibrillation/flutter that is recurrent after intervention.
         (2) Presence of SVT with hemodynamic compromise.
         (3) Presence or history of atrial ectopy (premature atrial complexes) > 20% of total beats on ambulatory ECG.
   B. Ventricular arrhythmias:
      i. Require AMB review and may be disqualifying:
         (1) Presence or history of ventricular tachycardia of 11 beats or greater without hemodynamic compromise.
         (2) Presence or history of frequent ventricular ectopy (frequent premature ventricular contractions [PVC]) > 1% and ≤ 20% of total beats on ambulatory ECG.
         (3) Right ventricular outflow tract tachycardia at least 6 months after ablation.
      ii. Disqualifying (other than those due to identifiable, reversible causes), presence or history of:
         (1) Ventricular tachycardia > 11 beats with ventricular dysfunction.
         (2) Ventricular tachycardia > 30 seconds.
         (3) Ventricular tachycardia with hemodynamic compromise.

(4) Ventricular flutter/fibrillation or sudden cardiac arrest requiring resuscitation.
(5) Frequent ventricular ectopy (frequent premature ventricular complexes) > 20% of total beats on ambulatory ECG.

C. Conduction/repolarization defects:
i. Require AMB review and may be disqualifying:
(1) First degree atrioventricular (AV) block > 300 msec.
(2) Right bundle branch block with axis deviation or atrial enlargement.
(3) Left bundle branch block.
(4) Wolff Parkinson White (WPW) ECG pattern.
(5) WPW syndrome after successful ablation.
(6) Prolonged QT > 470 msec for men and > 480 msec for women in the absence of drugs known to prolong QT interval.
(7) Brugada ECG pattern.
(8) Prolonged sinus pause > 3 seconds or heart rate < 30 beats per minute not during sleep.
ii. Disqualifying:
(1) WPW syndrome.
(2) Third-degree AV block and Mobitz type 2 AV block.
(3) Prolonged QT > 500 msec.
ii. Brugada syndrome.

9. Cardiac tumors. Benign cardiac tumors successfully resected and without residual cardiac disease require specialist evaluation.

10. All valvular disorders of the heart require specialist evaluation:
A. Require AMB review and may be disqualifying:
i. Greater than mild mitral, tricuspid, or pulmonic regurgitation.
ii. Aortic valve regurgitation greater than trace.
iii. Mitral valve prolapse with greater than mild mitral regurgitation.
iv. Bicuspid aortic valve.

B. Disqualifying:
   i. Any degree of valvular stenosis other than trivial.
   ii. History of valve replacement or repair.

11. Venous and lymphatic disorders such as chronic venous insufficiency, varicose veins, and lymphedema that impair performance of duties.

12. Abnormalities of the arteries, including aneurysms, atherosclerosis, and arteritis. Includes intermittent claudication or any condition associated with inadequate blood flow to any extremity. Arterial wall thickening (including carotids), focal plaque, or calcifications detected with imaging studies require specialist evaluation.

13. Primary Raynaud's disease or other symptomatic vasospastic disorders require specialist evaluation.

7H HEMATOLOGY

1. Red cell disorders:
   A. Anemias require specialist evaluation.
   B. Hemoglobin sickle cell (SS) and sickle-hemoglobin C (SC) disease.
   C. Hemoglobin S trait with a history of complications such as renal papillary necrosis, pulmonary sequestration, or splenic infarct condition.
   D. Hemoglobinopathies other than hemoglobin SS or SC disease, or S trait (example: thalassemias) require specialist evaluation for physiologic impairment (such as magnitude of anemia, level of anaerobic impairment, splenomegaly).
   E. Hemolytic anemia with laboratory evidence of hemolysis or physiologic impairment.
   F. Polycythemia requires specialist evaluation.
   G. Miscellaneous red cell disorders (example, hereditary spherocytosis) require specialist evaluation for physiologic impairment. Glucose-6-phosphate dehydrogenase deficiency is not disqualifying.

2. White cell disorders:
   A. Absolute leukopenia and absolute leukocytosis require specialist evaluation.
   B. History of leukemia.
   C. History of Hodgkin or non-Hodgkin lymphoma.
   D. History of lymphoproliferative disorders.
   E. Plasma cell dyscrasias, including monoclonal gammopathy of undetermined significance (MGUS), require specialist evaluation.
   F. Lymphadenopathy requires specialist evaluation.

3. Platelet disorders:
   A. Thrombocytopenia requires specialist evaluation.
   B. History of idiopathic thrombocytopenic purpura (ITP), unless isolated episode in childhood with complete recovery.
   C. History of thrombotic thrombocytopenic purpura (TTP) or hemolytic uremic syndrome (HUS).
   D. Thrombocytosis requires specialist evaluation.

4. History of chronic myeloproliferative diseases or myelodysplastic syndromes.

5. Hypercoagulable disorders: A. Vascular thrombosis or embolism requires specialist evaluation. B. Two or more episodes of deep venous thrombosis are disqualifying.
6. Disorders of hemostasis: A. Personal history of bleeding disorder requires specialist evaluation. B. Hemophilias.
7. Splenic disorders: A. Splenomegaly requires specialist evaluation. B. Hyposplenism or post-splenectomy state requires specialist evaluation.
8. Other hematologic or reticuloendothelial disorders that could interfere with the performance of duties.
7I ABDOMEN AND DIGESTIVE SYSTEMS
1. Chronic diseases or disorders of the gastrointestinal tract that interfere with the performance of duties.
2. Wounds, injuries, scars, or weaknesses of the muscles of the abdominal wall sufficient to interfere with function.
3. Abdominal wall hernias other than small asymptomatic umbilical hernias unless surgically corrected. A. Relaxed inguinal ring or a diastasis recti without herniation is not disqualifying. B. Any other herniations of clinical significance require specialist evaluation.
4. Sinus or fistula of the abdominal wall that is associated with underlying disease or is not surgically corrected.
5. Diseases of the esophagus such as strictures or Barrett's esophagus. A. Diverticula, rings, orwebs unless corrected. B. History of mild reflux esophagitis requires specialist evaluation.
6. Chronic abdominal pain is disqualifying unless asymptomatic for 5 years and after specialist evaluation.
7. History of gastric or duodenal ulcers. Medication or H. pylori-induced ulcers, until appropriately treated and must be endoscopically cleared as resolved.
8. Chronic dependence on acid-reduction medication.
9. History of gastrointestinal surgery for malignant or recurrent conditions.
10. Benign gastrointestinal neoplasm that is likely to enlarge or show malignant potential, unless removed.
11. History of intestinal obstruction due to any chronic or potentially recurrent disease. Surgery to relieve childhood pyloric stenosis, intussusception, volvulus, or Meckel's diverticulum is not disqualifying if there are no sequelae.
12. Adhesive disease. Asymptomatic adhesive disease requires specialist evaluation.

13. Inflammatory bowel disease such as Crohn's disease and ulcerative colitis.
14. Functional bowel disorder that interferes with the performance of duties.
15. Malabsorption syndromes: A. Celiac Disease. B. Food sensitivities/intolerances are not considered malabsorption syndromes but require specialist evaluation.
16. Chronic diarrhea.
17. Chronic constipation requiring chronic or continuous medication or therapy.
18. History of diverticulitis. Diverticulosis requires specialist evaluation.
19. Gastrostomy, ileostomy, or colostomy unless surgically corrected and resulting in no postoperative dysfunction.
20. History of gastrointestinal bleeding from any cause except for post-traumatic bleeding, medication-induced gastritis, or minor bleeding (such as hemorrhoids or resolved infectious colitis).
21. Acute or chronic diseases of the rectum or anus. External or internal hemorrhoids that cause marked symptoms that could interfere with the performance of duties.
22. Liver: A. History of non-viral or self-limited hepatitis (e.g., drug-induced) within the previous year requires specialist evaluation. B. Benign liver tumors such as hemangiomas that are under 2 cm and demonstrated to be stable with serial scanning for 2 years require specialist evaluation. C. Disorders of copper and iron metabolism a. History of Hereditary Hemochromatosis requires further evaluation. D. Fibropolycystic diseases of the liver a. Benign non-infectious hepatic cysts require specialist evaluation. E. Any chronic, recurrent, or progressive liver disease. F. See infectious disease conditions in this table (Section 7R INFECTIOUS DISEASE), for hepatitis B and hepatitis C.
23. Pancreas: A. History of acute pancreatitis is disqualifying, unless due to trauma, medication, or due to surgically corrected cholecystitis with no further episodes and requires specialist evaluation. B. Chronic, recurrent, or progressive pancreatic disorders (e.g., pseudocyst).
24. Biliary tract: A. Cholecystitis, cholelithiasis, or acalculous cholecystitis, until surgically corrected and resulting in no postoperative dysfunction. B. Any chronic, progressive biliary tract disorder.
7J ENDOCRINE
1. Any endocrine disease or disorder that may affect the performance of duties.

2. Presence or history of diseases of the hypothalamus or pituitary gland. History of prolactin secreting pituitary adenoma 5 years after surgical resection requires specialist evaluation.
3. Diseases of the thyroid gland: A. Presence or history of multi-nodular goiter, autoantibodies, benign cysts, or palpable nodules of the thyroid require specialist evaluation. B. History of toxic adenoma 1 year after surgical resection requires specialist evaluation.
4. Diseases of the parathyroid gland. Parathyroid adenoma after surgical resection requires specialist evaluation.
5. Diseases of the adrenal medulla or cortex. Adrenal androgen excess requires specialist evaluation.
6. Metabolic disorders: A. Diabetes mellitus, type 1 or 2. B. Presence or history of gout or pseudogout. C. Familial hyperlipidemias. D. Inborn errors of metabolic pathways (except for Gilbert's disease): i. Acquired errors of metabolic pathways with potential pathologic sequelae require specialist evaluation. E. Metabolic syndrome, in accordance with established guidelines.
7. Presence or history of malignant endocrine tumor.
8. Carcinoid syndrome: History of carcinoid tumors requires specialist evaluation.
9. Pancreatic endocrine tumors (e.g., islet cell tumor or gastrinoma).
7K GENITOURINARY
1. Any disorder of the genitourinary tract that may interfere with the performance of duties.
2. Anatomical abnormalities of one or both kidneys and lower urinary tract producing functional impact to the urogenital system: A. A duplicated collecting system is considered a variant of normal anatomy and is not disqualifying unless associated with other pathology (e.g., hydronephrosis, nephrolithiasis, or recurrent episodes of infection). B. Loss or absence of one or both kidneys.
3. Polycystic kidney disease.
4. Acute nephropathy or history of chronic nephropathy (e.g., hypertensive nephrosclerosis, diabetic nephropathy, and glomerulonephritis).
5. Autoimmune parenchymal disorders.
6. Vascular renal disorders.
7. History of tubular necrosis from any cause if associated with residual renal dysfunction that may interfere with the performance of duties.
8. Presence or history of urinary calculus (crystalline concretion within the urine-collecting system).

9. History of recurrent (≥ 3 per year) infections of the urinary tract require specialist evaluation.
10. Bladder, prostate, or urethral diseases that result in urinary retention, or interfere with micturition. History of the above requires specialist evaluation.
11. Hydrocele or varicocele that is symptomatic or interferes with the performance of duties.
12. Any disorders of the testes, genitalia, or associated anatomical structures that interfere with the performance of duties. Penile prosthetic implants.
13. History of primary or secondary neoplastic disorders of the urinary tract (kidneys, ureter, and bladder) and male genitals (testes, scrotal contents, prostate, and seminal vesicles).
7L MUSCULOSKELETAL DISORDERS
1. Any disorder of the bone, joint, muscle, or supporting structure that may interfere with the performance of duties.
2. Arthritic disorders: A. Chronic osteoarthritis with functional disability that may interfere with the performance of duties. B. Presence or history of inflammatory arthropathies requires specialist evaluation.
3. Infections: A. Active infections of bone, joint, muscle, tendon, or supporting structures. B. History of recurrent osteomyelitis.
4. History of non-traumatic avascular necrosis.
5. Presence or history of musculoskeletal malignancy.
6. Benign tumors or cysts of the bone require specialist evaluation.
7. Cartilaginous/Intra-articular disorders: A. Osteochondromatosis or multiple cartilaginous exostoses that interfere with performance of duties. B. History of osteochondromatosis or multiple cartilaginous exostoses that have been successfully surgically excised require specialist evaluation. C. Intra-articular loose bodies in any joint (osteocartilaginous or foreign objects) that interfere with performance of duties. D. History of intra-articular loose bodies in any joint surgically removed with no residual dysfunction requires specialist evaluation.
8. Joint instability: A. Joint instability (recurrent subluxations or dislocations of an articulation). B. History of joint instability that has been medically or surgically corrected requires specialist evaluation.
9. Fractures: A. Non-union of fractures. B. Mal-union of fractures that interferes with performance of duties.
10. Retained orthopedic hardware requires specialist evaluation.

11. Range of Motion: Deviations from the following range of motion or unexplained asymmetry requires specialist evaluation:
    A. Shoulder:
        i. Forward elevation to 170º-180º.
        ii. Abduction to 170º-180º.
        iii. Adduction 30º-40º.
        iv. Extension to 50º-60º.
        v. Internal rotation in abduction to 60º-90º or in neutral to 45º.
        vi. External rotation in abduction to 60º-104º or in neutral to 40º-60º.
    B. Elbow:
        i. Flexion to 135º-150º.
        ii. Extension to 0º in males and ≤ -5º in females.
        iii. Forearm supination in neutral to 80º-90º.
        iv. Forearm pronation in neutral to 80º-90º.
    C. Wrist:
        i. Dorsal extension to 65º-85º.
        ii. Palmar flexion to 70º-80º.
        iii. Ulnar deviation in neutral to 30º-45º.
        iv. Radial deviation in neutral 15º-20º.
    D. Hand/fingers: Any limitation in range of motion, strength, or dexterity that impairs functional performance requires evaluation by a specialist:
        i. Limitation in full composite grip.
        ii. Limitation in full finger extension, i.e., palm flat on table.
        iii. Atrophy of intrinsic hand muscles or thenar eminence.
        iv. Inability to fully oppose thumb and fingers.
    E. Hip:
        i. Flexion to 125º-130º.
        ii. Extension to 10º-20º.
        iii. Abduction to 30º-45º.
        iv. Adduction to 20º-30º.
        v. Internal rotation at 90º hip flexion to 40º-50º.
        vi. External rotation at 90º hip flexion to 30º-45º.
    F. Knee:
        i. Extension to 0º in males and ≤ -10º in females.
        ii. Flexion to 125º-135º.
    G. Ankle:
        i. Dorsiflexion to 10º.
        ii. Plantar flexion to 45º.
        iii. Inversion 50º-60º.
        iv. Eversion 20º-30º.
    H. Spine:
        i. Cervical Range of Motion (CROM):
            (1) Forward flexion between 50º-60º.
            (2) Extension between 65º-75º.
            (3) Lateral bending between 35º-45º.
            (4) Rotation between 70º-80º.

ii. Lumbar Range of Motion (LROM): (1) Forward flexion from the waist to 70º-80º. (2) Extension from the waist to 30º-40º. (3) Lateral bending from the waist to 30º-45º. (4) Rotation from the waist to 25º-40º.
12. Spine disorders: A. Symptomatic disorders of the spine, including but not limited to, herniated nucleus pulposus, spondylolisthesis, spina bifida, fractures and dislocations, scoliosis, kyphosis, or lordosis. B. History of ankylosing spondylitis. C. History of disorders of the spine that are asymptomatic, including but not limited to, osteoarthritis, herniated nucleus pulposus, spondylolisthesis, spina bifida occulta, fractures and dislocations, scoliosis, kyphosis, and lordosis require specialist evaluation. D. Presence or history of herniated nucleus pulposus, fractures, or dislocations of the spine resulting in persistent neurologic deficit. E. History of recurrent mechanical spinal or sacroiliac pain with disabling episodes of pain, muscle spasm, postural deformities, or chronic limitation of motion of the spine (range of motion) or pelvis requires specialist evaluation.
13. Any amputation that interferes with the performance of duties.
14. Hand disorders: A. Hyperdactyly. B. Syndactyly (webbed fingers) that interferes with the performance of duties or wearing of equipment. C. Scars and deformities of the fingers or hand that impair dexterity, grip strength, circulation, are symptomatic, interfere with the performance of duties, or preclude the wearing of equipment.
15. Chronic or recurrent bursitis, tendinitis, and synovitis sufficient to interfere with the performance of duties.
16. Lower extremity disorders: A. Disorders of the foot that compromise the wearing of equipment or are associated with chronic pain, including but not limited to, clubfoot, pes planus, pes cavus, hammer toes, hallux valgus, overriding digits, hallux rigidus, and bunions. B. Varus or valgus deformities that interfere with the performance of duties. C. Leg length discrepancy of more than 3.0 cm (from the anterior superior iliac spine to the distal tip of the medial malleolus).
17. Disqualifications for Abnormal Bone Mineral Density: A. Osteoporosis, defined as the presence or history of a fragility fracture or T-score $\leq$ -2.5 at the femoral neck, total hip, or lumbar spine using the female, white, age 20 -29 years Third National Health and Nutrition Examination Survey (NHANES III) database as the reference population standard. B. Bone mineral density below the expected range for age (Z-score < -2.0) at the femoral neck, total hip, or lumbar spine without evidence of normal bone strength.

7M SKIN DISORDERS
1. Presence or history of disorders of the skin or nails, acute or chronic, that is severe enough to interfere with the performance of duties or the wearing of flight equipment.
2. Extensive or deep scars, burns, keloids, or body piercings that interfere with muscular movements or with the wearing of equipment or that show a tendency to break down.
3. Acne, furunculosis, atopic dermatitis, eczema, or other chronic dermatitis that interferes with the wearing of equipment.
4. Cysts, nevi, or benign tumors of the skin of a size or location that interfere with the wearing of equipment, unless surgically corrected.
5. Hyperhidrosis, if chronic or severe that may interfere with the performance of duties.
6. Infections of the skin if communicable, extensive, or not amenable to treatment. Chronic tinea pedis and onychomycosis require specialist evaluation.
7. Primary malignancies of the skin or secondary cutaneous manifestations of systemic malignancies: A. Basal cell carcinoma that has been adequately excised is not disqualifying. B. Squamous cell carcinoma that has been adequately excised requires specialist evaluation.
8. Neurofibromatosis.
9. Pilonidal sinus: A. History of inflammation or discharging sinus in the preceding 2 years. B. History of pilonidal sinus with surgery without postoperative signs or symptoms indicative of residual disease for > 6 months requires specialist evaluation.
10. Presence or history of psoriasis, unless limited to < 1% total body surface area and asymptomatic.
11. Presence or history of pemphigus vulgaris, bullous pemphigoid, dermatitis herpetiformis, or other bullous disorders: History of secondary bullous disorders that are resolved require specialist evaluation.
7N NEUROLOGICAL
1. Any neurological disorders that may interfere with the performance of duties.
2. Primary or secondary malignancies of the nervous system. Benign tumors or history of benign tumors of the nervous system, including acoustic neuromas, require specialist evaluation.
3. Vascular disorders of the nervous system (e.g., arteriovenous malformation, intracranial aneurysms, Moya-Moya disease). Cavernous angiomas require specialist evaluation.
4. History of a cerebrovascular accident (stroke, transient ischemic attack [TIA], subarachnoid hemorrhage). Asymptomatic disease of the carotid or vertebral arteries requires specialist evaluation.

5. History of infection of the nervous system within 2 years, or with residual neurologic defects that may compromise performance of duties: A. Uncomplicated viral meningitis and other central nervous system infections without residual neurologic sequelae are evaluated on a case-by-case basis. B. History of encephalitis is disqualifying.
6. Peripheral or central nervous system demyelinating disease (e.g., multiple sclerosis). Acute inflammatory demyelinating polyneuropathy without neurologic sequelae after 5 years requires specialist evaluation.
7. History of metabolic, toxic, or nutritional disorders of the nervous system without residual neurologic sequela requires specialist evaluation.
8. History of elevated intracranial pressure.
9. Congenital or developmental abnormalities of the nervous system that interfere with the performance of duties.
10. Personal history of diseases of hereditary neurologic disorders or hereditary disorders with neurologic features (e.g., neurofibromatosis, Huntington's chorea, hepato-lenticular degeneration, spinocerebellar ataxia, muscular dystrophy, familial periodic paralysis, and congenital lower spastic paraparesis). Family history of neurologic disorders or hereditary disorders with neurologic features such as the above unless it is determined that such disorders have not been transmitted to or will not be expressed in a given subject and requires specialist evaluation.
11. History of seizure disorders: A. Febrile convulsions before the age of 5 years are not disqualifying. B. History of single seizure without neurologic sequelae after 5 years requires specialist evaluation. C. Benign age-related seizures (e.g., Juvenile Myoclonic Epilepsy) require specialist evaluation.
12. History of craniotomy or skull defects that interfere with the performance of duties. Craniotomy performed more than 5 years earlier with no skull defects requires specialist evaluation.
13. History of traumatic brain injury associated with any of the following: A. Any loss of consciousness or amnesia requires specialist evaluation. B. Intracerebral and/or subdural hemorrhage. C. Penetrating injuries or laceration of the brain. D. Skull fractures require specialist evaluation. E. Imaging evidence of retained intracranial metallic or bony fragments. F. Absence of bony substance of skull. G. Parenchymal central nervous system injury with persistent neurologic deficits. H. Cerebral leptomeningeal cysts, aerocele, brain abscess, traumatic central nervous system (CNS) infections, or arteriovenous fistula. I. Transient cerebrospinal fluid rhinorrhea or otorrhea requires specialist evaluation. J. Post-traumatic syndrome manifested by changes in personality, deterioration of higher intellectual functions, anxiety, headaches, or disturbances of equilibrium for more than 3

months is disqualifying, and for less than 3 months may be disqualifying and requires specialist evaluation.
14. Migraine headache with visual or motor involvement, or any continuous or incapacitating headache: A. History of acephalgic migraine requires specialist evaluation. B. History of chronic headaches without recurrence for 10 years requires specialist evaluation.
15. History of electroencephalogram (EEG) abnormalities with historical, clinical, or supporting laboratory evidence of a neurologic abnormality requires specialist evaluation.
16. Disorders or injuries of peripheral nerves that interfere with performance of duties: A. Uncomplicated Bell's palsy without sequelae after 6 months is considered on a case-by-case basis. B. Cervical or lumbar radiculopathy. History of cervical or lumbar radiculopathy requires specialist evaluation.
17. Movement disorders (e.g., Tourette's syndrome, dystonia, or chorea). Essential tremor requires specialist evaluation.
18. Disorders of neuromuscular transmission (e.g., myasthenia gravis) and myopathies.
19. Neurodegenerative disorders (e.g., Parkinson's and related disorders or amyotrophic lateral sclerosis [ALS]).
20. History of chronic pain syndromes requiring medical intervention or medical therapy within last 10 years is disqualifying; if greater than 10 years prior, requires specialist evaluation.
7O PSYCHIATRIC DISORDERS AND SUITABILITY FOR SPACE FLIGHT
1. The NASA Clinical Psychiatrist/Psychologist ensures, based on available data, that a past or present diagnosis of a psychiatric disorder meets the criteria established in the most recent edition of DSM-5, Diagnostic and Statistical Manual of Mental Disorders (DSM): A. Any behavior or mental condition that, in the opinion of the examiner, makes or is likely to make, the individual a hazard to flight safety, crew coordination, or mission execution. B. Neurodevelopmental disorders that interfere with social or occupational functioning or that require ongoing treatment. C. Presence or history of schizophrenia spectrum and other psychotic disorders. D. Presence or history of bipolar and related disorders. E. Presence or history of depressive disorders. F. Presence or history of anxiety disorders. G. Presence or history of obsessive-compulsive and related disorders. H. Presence of trauma- and stressor-related disorders, or history of trauma- and stressor-related disorders that may interfere with the performance of duties. I. Presence or history of dissociative disorders.

J. Presence or history of somatic symptom and related disorders.
K. Presence or history of feeding and eating disorders.
L. Presence of sleep-wake disorders or a history of sleep-wake disorders that may interfere with the performance of duties.
M. Presence of dysphoria, affective distress, or other affective states (e.g., elevated mood) of any etiology that may interfere with the performance of duties.
N. Presence or history of disruptive, impulse-control and conduct disorders, present or history of substance-related and addictive disorders.
O. Presence of neurocognitive disorders or history of neurocognitive disorders if there is a likelihood of recurrence or evidence of residual deficits of cognition, memory, judgment, insight, or behavior.
P. Presence or history of personality disorders (an inflexible, maladaptive, and enduring pattern of personal interaction that has been present since early adulthood).
Q. Presence or history of paraphilic disorders.
R. Presence or history of abuse or neglect of a child or adult.
S. Other conditions that may be a focus of clinical attention (V-Codes) that may interfere with the performance of duties.

2. The NASA Psychologist/Psychiatrist ensures, based on available evidence from comprehensive assessment of mission-relevant space flight psychological competencies such as performance under stress, group living, self-management, teamwork, communication, judgment, and decision-making that an individual is deemed suitable for space flight:
   A. An individual can be deemed unsuitable for space flight for characterological behaviors or personality traits that represent lower levels of signs and symptoms than those required for a diagnosed disorder, if in the opinion of the examiner, such characteristics present risks to crew cohesion, flight safety, or mission execution. A determination of unsuitability is not a medical diagnosis.
   B. Difficulties functioning as a team member or crewmate in an operational setting. A history of poor or unstable work or interpersonal relationships or personality traits that interfere with the forming and maintenance of social connections or functioning cooperatively with others as a teammate or astronaut. This may include personality traits or characteristics such as self-centeredness (egocentrism), lack of concern for others, arrogance, entitlement, lack of empathy, insensitivity, and social avoidance or withdrawal.
   C. Poor self-management or regulation. A pattern of behavior or traits that suggest poor impulse control. Examples may include a history of arrests, illicit drug use, social "acting out," or other misconduct or irresponsible behaviors that indicate poor impulse control, lack of judgment, difficulty with authority, or disregard for social norms and rules; maladaptive internalizing behaviors such as self -damaging behaviors, and substance misuse.
   D. Limited or poor stress tolerance. A history of physical or psychological problems when under stress, evidence of poor stress-coping skills or resilience, emotional instability, or other traits or behaviors that suggest an impaired capacity to adapt to stressful situations.
   E. Poor self-awareness or emotion management. Poor insight or awareness into one's impact on others such as deficiencies in self -knowledge and emotional awareness, or in

the ability to understand or manage emotions that disrupt personal relationships or team or crew cohesion and effectiveness.
7P OBSTETRICS AND GYNECOLOGY
1. Any disorder of the gynecologic system that may interfere with the performance of duties.
2. Any acute or chronic disorder of the uterus and/or adnexa that may interfere with the performance of duties (e.g., endometriosis). History of any chronic disorder of the uterus and/or adnexa that is adequately managed requires specialist evaluation.
3. Dysmenorrhea or other irregularities of the menstrual cycle such as premenstrual syndrome that may interfere with performance of duties.
4. History of recurrent abnormal uterine bleeding or menorrhagia may require specialist evaluation.
5. Chronic or recurrent infections or inflammation of the endopelvic organs. History of a single episode of pelvic inflammatory disease requires specialist evaluation.
6. History of gynecological malignancies. History of carcinoma in situ of the cervix requires specialist evaluation.
7. History of recurrent, symptomatic ovarian cysts or history of recurrent corpora hemorrhagica unless definitively resolved.
8. Any menstrual abnormality caused by polycystic ovarian conditions, anovulation, or disorders of the hypothalamic-pituitary-ovarian axis requires specialist evaluation.
9. Any chronic dermatologic condition of the vulva and/or vestibule requires specialist evaluation.
10. Obstetrical: A. All candidates are examined while not pregnant. Pregnancy itself will not be cause to deny appointment as a candidate. B. Pregnancy is disqualifying for space flight until complete post-partum recovery.
7Q DENTAL
1. Any dental defects that interfere with clear speech or cause changes in the contours of the face that interfere with the performance of duties.
2. Complete edentulism in either the mandible and/or maxilla or insufficient number of natural healthy teeth to masticate a normal diet or enunciate clearly.
3. Dental prostheses: A. Any removable dental prosthesis, which if lost or broken, would not leave enough natural healthy teeth to masticate a normal diet or enunciate clearly. B. Any unilateral removable dental prosthesis that could be swallowed.

4. Diseases and abnormalities of the jaws or associated structures, including periodontal disease, that are not easily remedied or may interfere with the performance of duties.
5. Severe malocclusion that interferes with the mastication of a normal diet or clear enunciation.
6. Any dental defects such as dental caries, dental dysplasia, enamel dysplasia, symptomatic cracked teeth, defective restorations, defective prosthesis, and defective implants until resolved.
7. Partially erupted or impacted third molar teeth with the potential to cause erosion of adjacent teeth, pericoronitis, or periodontal defect until corrected.
8. Infections of endodontic or periodontic origin until resolved.
9. Active orthodontic treatment requires dental consultation. Active orthodontic treatment is disqualifying for space flight duties.
7R INFECTIOUS DISEASE
1. Acute or chronic infectious disease until appropriately treated that might compromise mission operations, performance of duty, or crew health and safety.
2. Tuberculosis: A. Active tuberculosis. B. History of active tuberculosis, unless 2 years have elapsed following appropriate therapy (as per current Centers for Disease Control and Prevention [CDC] guidelines) and evaluations show the individual free from active disease. C. Documented conversion of the Tuberculin Skin Test or positive Interferon Gamma Releasing Assay (IGRA). Specialist evaluation required following treatment with anti-tuberculosis drugs as per current CDC guidelines.
3. History of malaria or other blood-borne parasites, unless adequately treated and cured.
4. Clinical or laboratory evidence of HIV infection or Acquired Immune Deficiency Syndrome (AIDS).
5. Lyme disease, unless adequately treated.
6. Viral hepatitis: A. History of hepatitis B, unless laboratory evidence of seroconversion and at least 1 year has passed since full recovery. Chronic hepatitis B carrier state is disqualifying. B. History of hepatitis C until 1 year after completion of CDC-approved treatment with eradication of viral load.
7. Herpes simplex virus type I or type II that may interfere with performance of duties or compromise crew health.
8. History of Herpes zoster, unless resolved for greater than 1 month and without post-herpetic neuralgia.
9. H. pylori carrier state, until adequately treated. No repeat testing is required.

10. Syphilis, gonorrhea, and chlamydia, unless adequately treated without sequelae.

11. Non-immune status or lack of documented vaccination status against the following: Measles, mumps, rubella, tetanus, polio, diphtheria, pertussis, meningococcus, and pneumococcus.

7S RADIATION

1. Per NASA-STD-3001, Volume 1, Revision A, section 4.2.10, the short-term radiation exposure limits shown in Table 12, NASA Short-term Ionizing Radiation Exposure Limits, have not been exceeded for any NASA astronaut. The current values are based on the use of Gray-Equivalents (Gy-eq) and relative biological effectiveness values provided by the National Council on Radiation Protection and Measurements (NCRP) Reports No. 132, Radiation Protection Guidance for Activities in Low-Earth Orbit.

Table 12 - NASA Short-term Ionizing Radiation Exposure Limits

Organ-Specific Exposure Limits (Gy-eq)			
Exposure Interval	**Bone Marrow**	**Eye**	**Skin**
30 Days	0.25	1.0	1.5
Annual	0.50	2.0	3.0

Short-term exposure limits are designed to prevent deterministic effects resulting from acute exposure. Each planned exposure is managed in adherence to the as low as reasonably achievable (ALARA) principle, which directs that exposures always be maintained as low as reasonably achievable.

2. Per NASA-STD-3001, Volume 1, Revision C, section 4.8.2, An individual crewmember's total career effective radiation dose due to spaceflight radiation exposure shall be less than 600 mSv. This limit is universal for all ages and sexes.

7T ANTHROPOMETRY CRITERIA

1. Failure to satisfy anthropometric criteria, including height and weight, which should be compatible with human factors for crewed space vehicles.

6. MISSION MEDICAL EVALUATIONS FOR NASA ASTRONAUTS ASSIGNED TO > 30 DAY SPACEFLIGHT MISSIONS

This section defines the mission specific medical evaluation requirements for crewmembers assigned to missions greater than 30 days. The following evaluations assume the astronaut has completed the NASA annual recertification testing/requirements described in this document.

- The pre-flight medical evaluation will be coordinated with the annual medical examination when the schedules coincide.
- The evaluation components stipulated in this section are required for each crewmember assigned to a spaceflight mission; however, the Crew Surgeon (CS) has the authority to prescribe additional tests or increase the frequency of testing, if clinically indicated.
- The timing of requirements is designated as pre-flight, in-flight, and/or post-flight. Requirements may also be designated ACI – As Clinically Indicated.
- The information acquired from all testing shall be provided in a timely manner to the Crew Surgeon for inclusion in the individual crewmember's medical records.

Requirements in the chart are defined as:
Medical (M) – tests and procedures based on clinical medical requirements to assess the health, medical status and functional capabilities of the individual crewmember.
Occupational Monitoring (OM) – tests and procedures designed to acquire data defining the health, medical status, and functional capabilities of the cohort of long duration crewmembers. This information may be used to validate or alter countermeasures, as part of the Clinical Status Evaluation.

The information provided in Table 8. Medical Examinations for Assigned Crew on > 30-day Missions is based on 180 day or greater missions and shall be tailored based on specific mission duration.

Table 8 – Mission Medical Examinations for Assigned Crew on > 30-day Mission

Clinical Assessment and Monitoring	Med Eval Requirement	Annual ***	PRE-FLIGHT (including Annual)	IN-FLIGHT	POST-FLIGHT	ACI	M	OM
CLINICAL ASSESSMENT AND MONITORING								
Pre- and Post-flight Physical Exam for Long Duration Crews	[6001]	Table 2	AME L-9/6 m, L-21/14 d, L-2/1 d		R+0 d, R+3 d, R+7/14 d, R+60 d	+√	√	
CMO Health Status Evaluations	[6002]			L+14/21, L+90, L+180, and L+270; R-21/14 d		+√	√	
Private Medical Conference	[6003]			L+1-7 d, weekly, pre/post EVA, R-5 d, daily to R-0 d		+√	√	
Neurological Assessment	[6004]	Table 2	AME L-9/6 m		R+0 d, R+3 d, R+7/14 d	+√	√	√
Neurovestibular Platform Test	[6005]		AME L-9/6 m, L-90/30 d		R+7/10 d	+√	√	√
Resting ECG	[6006]	Table 6	AME L-9/6 m to L-10 d		R+0/3 d	+√	√	
24-hour Ambulatory ECG			L-365/330 d		R+0, R+10/14 d	+√		
Hearing Assessment	[6007]	Table 6	L-90/30 d	On or before FD21, then every 3 months regardless of mission length	R+3 d, If abnormal, R+10/14 d, R+60 d		√	√
Hearing Protection	[6008]		L-27/18 m					
Dental Examination	[6009]	Table 6	L-90/30 d			+√	√	
Dental Orthopantomogram or Full Mouth X-Ray Series	[6010]	Table 6	AME L-21/18 m					
Ophthalmology/Optometry	[6011]	Table 6	L-90/30 d AME L-21/18 m - Retinal photographs and OCT		R+0/1 d, R+3 d and ACI R+1/10 d - Retinal photographs and OCT	+√	√	√

Clinical Assessment and Monitoring	Med Eval Requirement	Annual ***	PRE-FLIGHT (including Annual)	IN-FLIGHT	POST-FLIGHT	ACI	M	OM
Specialized Ocular Assessments	[6012]	Table 6	AME L-21/18 m, AME L-9/6 m,	L+ 30 d, L+90 d, L+180 d, L+270 d, R- 30 d and ACI	R+1/3 d, follow abnormal findings as clinically indicated	√	√	√
Bone Densitometry	[6013]	Table 6	AME L-21/18 m, L-180/30 d		R+ <30, then ACI to assess BMD recovery	+√	√	√
Ultrasound Imaging (Sonography)	[6014]	Table 6	AME L-21/18 m				√	
Body Mass Measurement	[6015]	Table 2		L+7d, Monthly		+√	√	
Photodocumentation of skin	[6016]				R+0/1 d	+√		√
MRI Brain and MR angiography	[6017]	AME L-21/18 m	AME L-21/18 m				√	
MRI Cervical and Lumbar Spine (non-contrast)	[6018]	AME L-21/18	AME L-21/18 m		R+1-14 d, then ACI; consider R+180 d and R+360 d	√	√	
LABORATORY								
Laboratory Testing	[6019]	Table 5	L-90/30 d	Blood and Urine L+ 180 d and ACI	R+0/1 d, (R+3/7 d), (R+14/30 d)	+√	√	
H. pylori Screen		Table 4						
MRSA	[6020]		L-9/6 m		R+0 d (Repeat at R+3 d if initial sample is unsatisfactory)		√	
GABHS	[6021]		L-90/30 d				√	
RADIATION								
Personal dosimetry	[6022]	Table 6		√			√	√
CARDIOVASCULAR								
Orthostatic tolerance Active postural stand test	[6023]				R+0 then daily to stable	√	√	

Clinical Assessment and Monitoring	Med Eval Requirement	Annual ***	PRE-FLIGHT (including Annual)	IN-FLIGHT	POST-FLIGHT	ACI	M	OM
Screening for deep vein thrombosis and venous flow anomalies	[6041]			L+30 days; L+60 days; R-42 days		√	√	√
EXERCISE & FITNESS								
Functional Fitness Assessment	[6024]	AME L-9/6 m, L-90/30	AME L-9/6 m, L-90/30 d		R+5/7, R+30 d		√	√
On-Orbit Strength & Conditioning Monitoring	[6025]			Recurrent; ARED PTV within L+14 days (NET 3rd session) and then at least every 30 days thereafter. ARED real-time audio/video instruction sessions up to 3 times (and ACI) in conjunction with ARED PTV; PEC (Private Exercise Conference) – NET 5 d following 1st ARED P/TV, then monthly		√	√	√
Isokinetic Assessment	[6026]	AME L-9/6 m	AME L-9/6 m, L-90/30 d		R+5/7 d, R+14d R+30 d		√	√
Cycle Ergometer Test for Aerobic Functional Capacity	[6028]	AME L-12m	AME L- 12 m; L-90/30 d	FD14, FD75, FD165, FD255, R-14 d	R+5 d, R+30 d	√	√	√
EVA								
Pre/post EVA CMO med exam	[6029]			√			√	

Clinical Assessment and Monitoring	Med Eval Requirement	Annual ***	PRE-FLIGHT (including Annual)	IN-FLIGHT	POST-FLIGHT	ACI	M	OM
Monitoring during EVA	[6030]			ECG and heart rate during EVA			√	
PSYCH/BEHAVIORAL								
Pre-flight psychiatric/ psychological status check	[6032]	Table 6	L-12 m, L-240/180 d, L-90/30 d			+√	√	
Private psychological conference	[6033]			Every 14 days		+√	√	
Post-flight psychiatric/ psychological status check	[6034]				R+3 d, R+10 d, R+14 d, R+30/60 d	+√	√	
Cognitive assessment	[6035]		Training (3 sessions): L-390 d, L-330 d, L-270 d; Baseline: L-210 d, L-150 d, L-90 d	Monthly	R+30 d	+√		√
Behavioral Observation of Training	[6036]		At least 2 sessions between crew assignment and launch					
NUTRITION								
Vitamin D Testing and Treatment Protocol	[6037]							
Nutritional Status Assessments	[6038]	AME L-21/18 m, L-90/30	AME L- 21/18 m, L-90/30	In-flight Activities FIT-weekly, MMD-monthly or ACI, shared from [6015]	R+0, R+20/30d, DXA at R=5/7d, shared from [6013]			
FATIGUE COUNTERMEASURES								
Objective Measure of Sleep	[6039]	AME L-21/18 m	Baseline (2 weeks): AME L-21/18 m, Begin L-7 d	Continuously throughout mission	End R+7 d			
Sleep Medication Ground Testing	[6040]		Any time before L-30 d					

ACI = As Clinically Indicated m= months d= days y= year L= launch R= return AME – Annual Medical Evaluation ***Annual Tests - Table 3 Overview of Medical Evaluation Procedures for NASA, Table 4 Overview of Medical Evaluation Procedures for NASA Astronauts to be applied annually, Table 5 Laboratory Tests on Annual Recertification, and Table 7 Special Assessments for Recertification

6.1 Clinical Assessment and Monitoring

6.1.1 Pre- and Post-flight Physical Examination for > 30 days Crews

[6001] Requirement: Crewmembers **shall** undergo clinical examinations with the Crew Surgeon (CS), Deputy Crew Surgeon (DCS), or Partner Flight Surgeon (FS) according to the specifications and schedule described below.

***Rationale**: To assess the medical status and flight readiness of crewmembers for long-duration missions before flight and medical status after landing.*

Description: Clinical examinations include medical interview, interval history since the previous evaluation and basic vital signs (pulse and blood pressure, body temperature, respiratory rate) and may also include some or all of the following, per the discretion of the examining surgeon:
Clinical History
Physical Examination
Vital signs: height, weight, pulse and blood pressure recumbent, sitting, standing, body temperature, respiratory rate.
Head and face (nares/nasal mucosa, sinuses, maxillary and frontal), oropharynx
Ears (external meatus, tympanic membrane, and response to Valsalva)
Eyes (general appearance, extra-ocular movements, pupil reactivity, ophthalmoscopic exam)
Neck (thyroid, vascular exam, motion)
Heart and lungs (cardiovascular exam, including cardiac auscultation, carotid and venous upstrokes and peripheral pulses)
Abdomen (auscultation, palpation of major organs and herniations)
Rectum/anus (to include prostate exam for males, rectal vault and occult blood testing)
Genitourinary exam (appearance, general exam, and herniations)
Breast/chest exam
Pelvic exam (for female crewmembers)
Extremities (to include range of motion and general strength assessments on a 1-5 scale)
Spine (general appearance and mobility)
Skin (includes lymphatics and identifying body marks)
Neurological (may include [6004])
Schedule: AME L- 9/6 m, L- 21/14 d, L- 2/1 d, R+ 0 d, R+ 3 d, R+ 7 /14 d, R+ 60 d (return to duty), and as clinically indicated

6.1.2 Crew Medical Officer (CMO) Health Status Evaluations

[6002] Requirement: Crewmembers **shall** complete periodic health status evaluations in-flight.

***Rationale**: To assess the medical status of the crewmember in-flight and report the findings to the CS.*

Description: Health Status Evaluation (HSE), to include medical history and physical exam by CMO, including vital signs. May also include blood labs – See [6019].
Schedule: L+ 14/21 d, L+ 90 d, L+180 d, L+270 d, R- 21/14 d, and as clinically indicated.

6.1.3 Private Medical Conference

[6003] Requirement: Crewmembers **shall** participate in private medical conferences with a mission assigned FS.

Rationale*: The primary purpose of private medical conferences is to monitor crewmember's health. Private communication between the FS and crewmember enables medical consultation and provides an opportunity to discuss human support and habitability factors.*

Description: Dedicated private communications link between Space vehicle and console.
Schedule: L+1-7, weekly, pre/post EVA, R- 5 d, daily to R-0 d and as clinically indicated

6.1.4 Neurological Assessment

[6004] Requirement: Crewmembers **shall** undergo a neurological assessment before and after flight.

Rationale*: Because of the neurovestibular problems often associated with spaceflight, a standardized assessment is obtained pre-flight for comparison with post-flight status.*

Description: A brief standardized clinical neurological assessment (example below) will be completed by either the Crew Surgeon or a neurology specialist.
Schedule: AME L- 9/6 m, R+ 0 d, R+ 3 d, R+ 7/14 d, and as clinically indicated

6.1.5 Neurovestibular Platform Test

[6005] Requirement: Crewmembers **shall** undergo an objective assessment of neuro-vestibular function before and after flight.

Rationale*: To perform functional assessments regarding neuro-vestibular re-adaptation to Earth gravity following prolonged weightlessness. Results will be used to establish a more precise return-to-normal daily activities (stairs, driving a car, showering, etc.) criteria and return-to-duty criteria.*

Description: Balance control performance and sensory integration performance are measured using Equitest Posture Platform, Optotrak Motion Analysis System, and Subject Safety Restraint System.
Schedule: AME L- 9/6 m; L- 90/30 d, R+ 7/10 d, and as clinically indicated until stable

6.1.6 Resting ECG

[6006] Requirement: Each crewmember **shall** complete a resting ECG prior to launch to

provide a baseline study.

Rationale: *A 12-lead electrocardiogram (ECG) is used to establish a baseline study for comparison with subsequent studies obtained in-flight and post-flight.*

Description: Subject lies supine for 15 minutes while ECG tracings are recorded from 10 electrode sites using chest and limb leads.
Schedule: AME L- 9/6 m to L- 10 d, R+0/3 d, and as clinically indicated. (Also see FSA Matrix: Monthly in-flight MO-1 for FSA crewmembers).

6.1.7 Hearing Assessment

[6007] Requirement: Crewmembers **shall** be tested with conventional audiometry before and after flight. Crewmembers shall also conduct pre-flight and in-flight hearing assessments using the On-Orbit Hearing Assessment (OOHA).

Rationale*: To monitor crewmember hearing sensitivity before, during, and after long-duration flights, in order to identify changes caused by the onboard environment.*

Conventional Audiometry Description: Hearing sensitivity is determined with pure-tone, air conduction audiometry, using a calibrated audiometer in a quiet room.
Schedule: **Conventional Audiometry**: L- 90/30 d, R+ 3 d, (If abnormal, R+ 10/14 d, 60 d)
OOHA Description: Hearing sensitivity is determined with pure-tone audiometry, using a calibrated audiometer with earphones that can attenuate noise levels found on the Space vehicle. The condition of the middle ear and mobility of the eardrum (tympanic membrane) is determined with tympanometry, an objective test of middle-ear function.
OOHA Schedule: On or before FD 21, then every 3 months regardless of mission length, with supplemental OOHA's as requested by crewmember or crew surgeon based on noise environment or other medical concerns. All OOHAs will be scheduled within 24 hours following acoustic dosimetry measurements.

6.1.8 Hearing Protection

[6008] Requirement: Crewmembers **shall** be fitted for and provided with custom molded hearing protection earwear.

Rationale*: Noise levels, in some areas of the space vehicle may exceed accepted noise thresholds. Hearing protection is required to ameliorate the risks associated with excessive noise exposure which may include temporary or permanent threshold shifts as well as possible behavioral health issues. To adequately protect crewmembers from excessive noise, crewmembers will be provided with two types of custom fitted hearing protection earwear. Crewmembers may use electronic molded earplugs with personal listening devices while exercising and non-electronic flat-attenuating custom earplugs as desired.*

Description: Each Crewmember will be personally fitted with custom molded hearing protection. This requires two appointments, a minimum of 30 days apart, to make ear impressions and to fit check the custom hearing protection.

Schedule: L- 27/18 m

6.1.9 Dental Examination

[6009] Requirement: The dental health of each crewmember **shall** be assessed before launch.

Rationale*: To assess general dental health and flight readiness, identify and mitigate dental health risks, obtain baseline measurements, and address needs/changes over time.*

Description: Brief dental examination.
Schedule: L- 90/30 d, (R+ 0/1 d FSA), and as clinically indicated

6.1.10 Dental Orthopantomogram or Full Mouth X-Ray Series

[6010] Requirement: A full dental orthopantomogram x-ray or full mouth x-ray series **shall** be performed within two years of launch

Rationale: *To fully assess the underlying dental health of the Crewmember in order to correct any potential dental problems well in advance of mission launch*

Description: An orthopantomogram (e.g., Panorex) is a panoramic scanning x-ray of the maxilla and mandible. (Full mouth x-ray series can be used as an alternative for dental screening.)
Schedule: AME L- 21/18 m

6.1.11 Ophthalmology/Optometry Examinations

[6011] Requirement: Each crewmember **shall** undergo ophthalmological exams before and after flight in addition to regular annual checkups.

Rationale*: To establish baseline measurements for comparison to post-flight measurements, measure changes, assess future flight readiness, and assist in planning for in-flight healthcare.*

Description: Examination at L- 90/30 d and R+ 3 d will be conducted by an eye specialist. Examination at R+0/1 d will be conducted by the flight surgeon and includes an ophthalmoscopic exam. Retinal photographs and optical coherence tomography (OCT) will be taken at L-21/18 m and at R+1/10 d.
Schedule: L- 90/30 d, R+ 0/1 d, R+ 3 d, and as clinically indicated

6.1.12 Specialized Ocular Assessments

[6012] Requirement: To assess the effects of exposure to the space-flight environment on ocular health, Crewmembers **shall** undergo specialized eye examinations pre-flight, in-flight, and post-flight.

***Rationale**: Medical eye examinations on returning Crewmembers have demonstrated the presence of significant changes in ocular structure and function. Additional specific testing is required for Crewmembers to document baseline ocular status and to assess changes which may occur during the mission with early post-flight status assessment and continuing follow-up for Crewmembers who demonstrate mission-related ocular changes.*

Description: The following ocular assessments will be performed on all Crewmembers. Crewmembers will require training on specific ocular tests which they will perform in-flight. These ocular assessments are in addition to the standard tests required of all Crewmembers detailed in [6011].
Pre-flight
AME L-21/18 m
➢ MRI brain and orbits [Spaceflight Associated Neuro-Ocular Syndrome (SANS) protocol]
AME L-21/18 m and AME L-9/6 m
➢ Ocular questionnaire
➢ Visual acuity, distance and near
➢ Refraction – manifest and cycloplegic
➢ Threshold visual fields
➢ Amsler grid
➢ Contrast sensitivity
➢ Pupil reflexes
➢ Extraocular muscle balance
➢ Biomicroscopy (slit lamp)
➢ Dilated fundoscopic examination
➢ Retinal photography
➢ Tonometry
➢ Optical coherence tomography (high resolution) including Spontaneous Venous Pulsations (SVP) videography
➢ Optical biometry
L-9/6 m
➢ 2-D imaging ultrasound
In-flight
L+30; L+90, L+180, L+270; R-30
➢ Ocular questionnaire
➢ Visual acuity distance and near
➢ Amsler grid
➢ Threshold visual fields
➢ Fundoscopy
➢ 2-D imaging ultrasound
➢ Optical coherence tomography (high resolution)
Post-flight
R+1/3, follow abnormal findings as clinically indicated
➢ Ocular questionnaire

➢ Visual acuity, distance and near
➢ Refraction – manifest and cycloplegic
➢ Threshold visual fields
➢ Amsler grid
➢ Contrast sensitivity
➢ Pupil reflexes
➢ Extraocular muscle balance
➢ Biomicroscopy (slit lamp)
➢ Dilated fundoscopic examination
➢ Retinal photography
➢ Tonometry
➢ Optical coherence tomography (high resolution) including SVP videography
➢ Optical biometry
➢ 2-D imaging ultrasound
➢ MRI brain and orbits [special visual impairment and intracranial pressure (VIIP) protocol]
Schedule: Pre-flight: AME L-21/18 m; AME L- 9/6 m
In-flight: L+30; L+90; L+180d, L+270 d, R-30; and as clinically indicated
Post-flight: R+1/3; follow abnormal findings as clinically indicated

6.1.13 Bone Densitometry

[6013] Requirement: Bone densitometry evaluations **shall** be performed to assess skeletal integrity and to document bone mineral density (BMD) changes as an index of fracture risk, and to guide countermeasures.

Rationale*: Bone densitometry measures are needed to track individual skeletal integrity (loss and recovery). This is particularly important for long-duration flights. This information will aid in targeting rehabilitation efforts and facilitating a timely recertification for long-duration missions. These data also will be analyzed to evaluate the efficacy of in-flight exercise countermeasures and post-flight rehabilitation programs.*

Description: BMD is measured by Dual Energy X-ray Absorptiometry (DXA). The two energies allow the machine to distinguish between soft tissue and hard tissue (bone). In each testing session, a crewmember receives scans of whole body, lumbar spine, proximal femora, calcanea, and forearms. The whole-body scan allows lean and fat tissue mass to be determined from a soft tissue rendering and is a very accurate measure of body composition. The effective dose equivalent (EDE) for the radiation dose of one set of six scans is roughly ½ that of a chest X-ray. Because of variation in standardization, the results of DXA scans vary from one location to another, so baseline and post-flight DXA studies must be done on the same machine at the same location.
Schedule: AME L- 21/18 m; L- 180/30 d (as close to launch as feasible), within first 30 days of return, then as clinically indicated to assess BMD recovery.

6.1.14 Ultrasound Imaging (Sonography)

[6014] Requirement: Ultrasound imaging **shall** be conducted for each crewmember.

***Rationale**: To evaluate health status using ultrasound.*

Description: Assessment is conducted using abdominal/retroperitoneal/pelvic ultrasound, and thyroid ultrasound. A heart ultrasound (echocardiogram) is obtained periodically as part of the annual physical examination. Carotid artery ultrasound utilizes ultrasound techniques to assess for atherosclerosis, and should include assessment of intima-medial thickness (IMT) and carotid plaque burden (volume or area)
Schedule: Thyroid – AME L- 21/18 m
Abdominal/retroperitoneal/pelvic – AME L- 21/18 m
Carotid ultrasound – AME 21/18 unless completed within the previous 5 years. (R+ 1/3 d FSA) Other imaging applications may be used on an "as required" basis in-flight.

6.1.15 Body Mass Measurement

[6015] Requirement: Crewmembers **shall** complete a body mass measurement evaluation periodically while in-flight.

***Rationale**: To monitor body mass changes in-flight as part of a general crew health assessment.*

Description: Body mass is measured in-flight using the Russian Mass Measurement Device (MMD).
Schedule: During the first week, (baseline), then monthly and as clinically indicated

6.1.16 Photodocumentation of Skin

[6016] Requirement: The Crew Medical Officer or Crew Surgeon **shall** document, through photographic imaging, the condition of the crewmember's skin, including any signs of skin disease or injury.

***Rationale**: To provide objective evidence of the condition of the skin, particularly injuries and/or disease, such as reactions to allergens or chemicals for diagnostic and follow-up purposes.*

Description: Assessment using a digital camera and ruler.
Schedule: As clinically indicated and R+ 0/1 d

6.1.17 MRI Brain and MR Angiography

[6017] Requirement: Each Crewmember **shall** undergo an MRI study of the brain and MR angiographic study of the supra-aortic and intracranial vessels.

***Rationale**: To assess for vascular and structural abnormalities that might lead to*

crewmember incapacitation or performance decrements during a long-duration mission. An MRI and MR angiogram is obtained at selection. The pre-flight study will assess for interval changes that might have developed since selection

Description: MRI/MRA protocols and imaging sequences, selected for this testing, including the use of gadolinium-based contrast agents, may vary depending on available capability. Testing must follow best current neuroimaging practices to characterize intracranial and cerebrovascular anatomy with sufficient depth and detail to address all conditions identified in MED Volume A standards.
Schedule: AME L- 21/18m if greater than 2 years since astronaut selection MRI/A

6.1.18 MRI Cervical and Lumbar Spine Imaging

[6018] Requirement: Each Crewmember **shall** undergo pre- and post-flight non-contrast MRI studies of the cervical and lumbar spine.

Rationale*: To assess for spinal or pathology that:*

a) May pre-dispose crewmembers to in-flight changes on long-duration missions that could lead to crewmember pain, dysfunction, or performance decrements during the mission.
b) Will inform decision making of management and exercise prescriptions for pre-flight and in-flight conditioning tailored to the needs of the crewmember based on their unique baseline.
c) Will assess for space related changes and inform decision making of exercise prescription for post-flight conditioning to rehabilitate crewmembers and minimize risk of post-flight injury.

Description: MRI protocols and imaging sequences should characterize normal and pathological anatomy with sufficient depth and detail to address all conditions of spinal related pathology identified in MED Volume A standards. Testing must follow current spinal imaging practices, but may vary depending on available capability
Schedule: AME L- 21/18 m; R+1-14 d, and ACI thereafter (Consider at R+180, R+360 to confirm resolution and prevent injury related to spaceflight-related changes)

6.1.19 Laboratory Testing

[6019] Requirement: A clinical laboratory assessment **shall** be completed for each crewmember before and after flight.

Rationale*: To evaluate crewmember medical fitness for flight and to determine post-flight recovery by analysis of clinical specimens.*

Description: **L- 90/30 days:**
Blood: Hematology – Complete Blood Count (CBC) w/differential, reticulocytes; Chemistry profile – glucose, HbA1C, BUN, creatinine, AST, ALT, GGT, alkaline phosphatase, total bilirubin, total protein, electrolytes, calcium, ionized calcium, chloride (CL), potassium (K), magnesium, phosphorus, LDH, uric acid, albumin ; Thyroid function – free T4, TSH; Iron profile – iron, iron binding capacity, transferrin saturation, ferritin; Special

chemistry – C-reactive protein (High Sensitivity assay), serum lipids (total cholesterol, LDL, HDL, Triglycerides); Serum HCG on females Archive tube (agency-specific), TB Screen(unless covered during annual recertification)
Urine: Urinalysis (specific gravity, glucose, protein, pH, ketones, blood), microscopic
In-flight:
Blood and urine testing L+180 and as clinically indicated, including pre- and post- EVA
R+ 0/1 day:
Blood: Hematology – CBC w/differential, i-Stat: Na, K, glucose, ionized calcium, pH;
Urine: Urinalysis
R+ 3/7 days
Blood: Hematology – CBC w/differential, reticulocytes; Chemistry profile – glucose, BUN, creatinine, AST, ALT, GGT, alkaline phosphatase, total bilirubin, total protein, electrolytes, calcium, magnesium, phosphorus, LDH, uric acid, albumin; Iron profile – iron, TIBC, % saturation, ferritin; Special chemistry – C-reactive protein; Thyroid profile -TSH, FT4
R+14/30 days
Blood: Hematology – CBC w/differential, reticulocytes; Chemistry profile – glucose, BUN, creatinine, AST, ALT, GGT, alkaline phosphatase, total bilirubin, total protein, electrolytes, calcium, magnesium, phosphorus, LDH, uric acid, albumin, Iron profile – iron, TIBC, %saturation, ferritin; Special chemistry – C-reactive protein, HbAlC; serum lipids (total cholesterol, LDL, HDL, Triglycerides)
Schedule: See above

6.1.20 Methicillin Resistant Staphylococcus aureus (MRSA) Screening and Suppression

[6020] Requirement: Nasal cultures for Staphylococcus aureus **shall** be performed during L-9/6 months medical screening on all Crewmembers.

Rationale*: MRSA may cause skin or other infections in Crewmembers onboard which would be difficult to treat with manifested medications. Screening for individuals who are carriers will reduce the risk for active infection or transmission.*

Description: Using a single swab, both nostrils will be sampled and cultured for MRSA organisms. Crewmembers identified as MRSA positive will undergo topical treatment with mupirocin intranasal three times daily for 5 days. Crewmembers who are MRSA positive will also require anti-staphylococcal body washes daily for 5 days. MRSA culture and sensitivity will be repeated after the course of eradication, and if positive, appropriate antibiotics will be manifested.
Schedule: L-9/6 m, R+0 d (Repeat at R+3 d if initial sample is unsatisfactory)

6.1.21 Group A Beta-Hemolytic Streptococcus (GABHS, Strep pyogenes) carrier state

[6021] Requirement: Throat swab for Group A Beta-Hemolytic Streptococcus carriage **shall** be conducted on all Crewmembers at L-90/30 days medical screening.

Rationale: *Group A Streptococcus can cause both pharyngitis as well as a variety of highly*

aggressive soft tissue infections such as cellulitis and necrotizing fasciitis which in terrestrial settings may proceed to surgical intervention even when appropriate antibiotics are given.

Description: Testing by pharyngeal swab, either classic throat culture or "rapid strep" testing using ELISA (Enzyme Linked Immunosorbent Assay) shall be performed to identify the carrier state. If identified and confirmed it will be treated with antibiotics and re-testing performed to confirm clearance of the carrier state.
Schedule: L-90/30 d

6.2 Radiation

6.2.1 Radiation Monitoring/Personal Physical Dosimetry

[6022] Requirement: In-flight radiation monitoring **shall** be performed with crew personal dosimetry according to the specifications and schedule described below.

Rationale: *To monitor, limit, and document crew exposure to radiation and to keep crew exposures "as low as reasonably achievable (ALARA)". To monitor crew exposure to radiation and perform risk assessment. Comprehensive risk assessment for a crewmember requires detailed monitoring of the radiation exposure during a mission and analytical evaluation of the history of all radiation exposures before, during, and after a mission.*

6.3 Cardiovascular

6.3.1 Active postural stand tests

[6023] Requirement: Each crewmember **shall** undergo orthostatic tolerance testing by means of an active stand test.

Rationale: *Orthostatic intolerance is a common feature of re-adaptation to gravitational fields following microgravity exposure. A standardized clinical procedure helps to document the degree of intolerance, to follow return to stability, and to provide standardized data for cohort comparison.*

Description: Baseline blood pressure and pulse are obtained in the supine position, then at one-minute intervals in the seated position over a period of five minutes, and then at one-minute intervals over a period of 10 minutes on transition to the standing position.
Schedule: R+ 0 d, then daily until orthostatic stability.

6.3.2 Screening for deep vein thrombosis and venous flow anomalies

[6041] Requirement: Every crewmember **shall** be screened for deep vein thrombosis (DVT) of the internal jugular veins.

Rationale:

- *Primary DVT of the left internal jugular vein has been observed at elevated rates in microgravity. Flow anomalies are observed in a significant subset of crewmembers examined for both research and surveillance purposes, and likely represent a risk for DVT development.*
- *DVT is associated with significant mission impact and poses an acute risk to crewmember health.*
- *Early diagnosis of abnormality will help identify crewmembers at risk for DVT formation and may allow the provisioning of early treatment before DVT becomes symptomatic or results in a life- or mission- threatening complications such as pulmonary embolism.*

Description: Using an onboard ultrasound device, duplex ultrasound of the bilateral extracranial internal jugular veins, with breathing and compression maneuvers, is performed with teleguidance and/or autonomously with just-in-time training.
Schedule: L+30 days; L+60 days; R-42 days

6.4 Exercise and Fitness

6.4.1 Functional Fitness Assessments

[6024] Requirement: Each crewmember **shall** complete a series of tests designed to establish functional fitness before and after flight.

Rationale: *Physical fitness is assessed to establish flight readiness and baseline individual norms. Assessments are done pre- and post-flight to guide individual physical training and to determine individual responses to training countermeasures, and to assess a crewmember's ability to perform strength and endurance tasks. Testing provides information regarding musculoskeletal and neuromotor deficits and helps identify crewmembers who may be at risk for injury, and to guide reconditioning.*

Description: Functional fitness will be assessed by simple, "in the gym" exercises that measure flexibility, strength, endurance, muscle power, sensorimotor integration/agility, and balance. These may include Sit & Reach, Push-Ups, Pull-Ups, Bench, Crunches, Leg-Press, Agility, Stand Test, Hand Grip.
Schedule: AME L-9/6 m; L-90/30 d, R+5/7 d, R+30 d

6.4.2 On-Orbit Strength and Conditioning Monitoring

[6025] Requirement: Each crewmember **shall** undergo strength and conditioning monitoring during flight. To prevent injury and to optimize performance, real-time audio/video instruction sessions **shall** be performed for ARED. A private exercise conference (PEC) **shall** be scheduled to allow for direct, efficient, and comprehensive exchange of information between ground exercise specialists and crewmembers.

Rationale: *Based on the information derived from the assessments, recommendations will be provided regarding in-flight exercise and conditioning programs.*

Description: Individual exercise data and video are downlinked from activities on TVIS, CEVIS, T-2 and ARED. This information is evaluated by ground exercise specialists and crewmembers are provided with individual recommendations regarding strength and conditioning exercises. Implementation of ARED real-time audio/video instruction sessions will closely consider/take into account console resources and Ku-availability.
Schedule: Strength and conditioning monitoring - Recurrent in-flight; ARED PTV within L+14 days (NET 3rd session) and then at least every 30 days thereafter.
ARED real-time audio/video instruction sessions – up to 3 times (and as clinically indicated) in conjunction with ARED video session.
Private exercise conference (PEC) – no earlier than 5 days following the first ARED PTV session, then monthly.

6.4.3 Isokinetic Assessment

[6026] Requirement: Each crewmember **shall** complete an isokinetic test to objectively assess muscle strength and endurance, before and after flight.

Rationale: *Isokinetic testing is needed to assess flight readiness and provide a baseline measure of pre- and post-flight muscle strength and endurance in select muscle groups for the evaluation of in-flight countermeasures and post-flight rehabilitation.*

Description: Muscle performance testing will be administered using an isokinetic dynamometer on upper and lower extremity muscle groups, as well as back.
Schedule: AME L- 9/6 m, L- 90/30 d, R+ 5/7 d, R + 14 d, R+ 30 d

6.4.4 Cycle Ergometer Test for Aerobic Functional Capacity

[6028] Requirement: Each crewmember **shall** complete incremental-load cycle ergometer tests to assess aerobic functional capacity and exercise induced arrhythmias before flight, periodically in-flight and post-flight. Prior to an EVA or at any point during the mission, this test may be requested by the crew surgeon.

Rationale: *The cycle ergometer test provides data for assessment of crewmember aerobic capacity. The interpretation of the test results is used to establish a baseline of crewmember cardiovascular health before flight, monitor it during the flight, and to assess post-flight recovery. A maximal load cycle ergometer protocol is conducted pre-flight to define the crewmember's maximum heart rate, maximum workload, and maximum oxygen consumption (VO_2 max). If ventilatory threshold can be derived from the data, it will be provided. The assessment of aerobic capacity at specified intervals before, during, and after flight is used to develop individual exercise conditioning prescriptions and determine individual responses to exercise countermeasures. The assessments also provide data for analyzing the effectiveness of exercise countermeasures and rehabilitative programs.*

Description: The peak cycle ergometer tests are performed to establish a max HR and VO_2 max. If ventilatory threshold can be derived from the data, it will be provided. All pre-, in-, and post-flight peak cycle test will be done in the upright position using the same incremental load protocol.

Schedule: AME L-12 m, L-90/30 d, FD14, FD75, FD 165, FD 255, R-14 d, R+ 5 d, R+ 30 d, as clinically indicated.

6.5 EVA

6.5.1 Pre- and Post-EVA Medical Examinations

[6029] Requirement: All EVAs **shall** be preceded and followed by an assessment of medical fitness.

Rationale: *The primary focus of a pre-EVA medical evaluation is to identify medical issues that would constrain an EVA or potentially harm a crewmember (CM) during EVA. A post-EVA medical evaluation is necessary to ensure continued CM health and identify potential decompression sickness (DCS) and suit-related medical issues.*

Description: The Pre-EVA Medical Exam shall include a review by the CS of countermeasure performance.
Within 48 hours of suit donning and 24 hours of suit doffing the medical evaluation will consist of a review of systems (ROS) by the expedition crew surgeon, a brief skin and extremity examination by the crew medical officer (CMO) and a urinalysis. On the day of EVA, vital signs (BP, body temp) are measured, and an ECG-DS is performed (for Orlan only) as part of nominal suit check-out. The crew surgeon may direct a specific medical exam based on ROS findings.
Schedule: Pre- and Post-EVA

6.5.2 Monitoring during EVA

[6030] Requirement: Crewmembers **shall** undergo EVA monitoring.

Rationale: *To monitor crew health during the EVA, identify any possible crew health concerns, and provide immediate feedback to the EVA Flight Director.*

Description: ECG and derived heart rate
Suit pressure
Suit CO_2 partial pressure
Passive personal radiation dosimetry and when possible, real-time personal dosimetry
Body temperature in Russian Orlan suit
Schedule: During EVA

6.6 Psychiatric/Psychological Evaluation

6.6.1 Pre-flight Psychiatric/Psychological Status Check

[6032] Requirement: The following **shall** be performed by a specialist.

a. Psychiatric/Psychological Assessment of behavioral readiness for flight
b. Specialist review of individual and crew psychological support

c. Check of life events that would have an impact on the astronaut's fitness for launch.
d. Baseline assessments needed for in-flight monitoring to be completed between L-12 months and launch:
    i. Neurocognitive baseline
    ii. Behavioral health baseline

Rationale: *Confirmation of behavioral readiness for flight*

Description: Self-Explanatory
Schedule: L-12 m, L- 240/180 d, L- 90/30 d

6.6.2 Private Psychological Conference

[6033] Requirement: Crewmembers **shall** participate in a private psychological conference, performed by a specialist, according to the specifications and schedule described below.

Rationale: *These conferences will address behavioral health, mood and performance issues, such as personal and group dynamics issues, and ground-crew interactions. Elements of the behavioral health countermeasures will be coordinated in part through these conferences. In support of the CS, the private psychological conferences will provide one of the key elements of in-flight monitoring and countermeasures to maintain crewmember behavioral health and performance.*

Description: Self-Explanatory
Schedule: In-flight every 2 weeks, and as clinically indicated.

6.6.3 Post-flight Psychiatric/Psychological Status Check

[6034] Requirement: The following **shall** be performed by a specialist.
(a) Initial clinical interview by a specialist regarding behavioral re-adaptation, [30 min each crewmember at R+3]
(b) Initial review of behavioral health and performance mission support, [30 min each crewmember at R+3]
(c) Review of behavioral health and performance mission support, [60 min each crewmember at R+10]
(d) Clinical Interview by specialist regarding behavioral re-adaptation, [60 min each crewmember at R+14]
(e) Supplemental assessment as clinically indicated
(f) Psychiatric/Psychological assessment regarding behavioral re-adaptation, [60 min each crewmember at R+30]

Rationale: *Post-flight psychiatric/psychological evaluation of the crewmembers*

Description: Self-explanatory
Schedule: R+ 3 d, R+ 10 d, R+ 14 d, R+ 30/60 d, or as clinically indicated

6.6.4 Cognitive Assessment

[6035] Requirement: Crewmembers **shall** undergo a cognitive assessment before, during, and after flight.

Rationale: *The main purpose of a cognitive assessment is to evaluate the impact of specific events including, but not limited to, head injury, decompression sickness with Central Nervous System involvement, atmosphere contamination, high CO_2 levels, a change in normal behavior and any other indication of a reduced performance state. In order to maintain test proficiency and to obtain an in-flight baseline, regular in-flight assessments are required.*

Description: Performance functions to be assessed include, but are not limited to memory, attention, reasoning, and spatial processing. Assessments will consist of agency-specific cognitive assessment tests that require 30 minutes to complete (not including pre- and post-test activities).
Schedule: L- 390 d, L- 330 d, L- 270 d, L- 210 d, L- 150 d, L- 90 d
In-flight: 1/month and as indicated
Post-flight: R+ 30 d, and as indicated.

6.6.5 Behavioral Observation of Training

[6036] Requirement: Training events of CMs (preferably of whole assigned crews) **shall** be observed by behavioral specialists.

Rationale: *Behavioral observation provides important data about individual behavior and crew interactions. These data are necessary for: (1) providing consultation and recommendations to CMs pre-flight in order to optimize behavior and team performance and (2) providing baseline data for support and consultation of CMs in-flight.*

Description: The preferred training events include, but are not limited to, field training, simulations and any other training events that provide the opportunities to collect the data described in the rationale. Observations may also include self-report data and peer feedback. All data related to crew observation will be treated as medically confidential.
Schedule: At least two training events will be observed between time of crew assignment and launch.

6.7 Nutrition

6.7.1 Vitamin D Testing and Treatment Protocol

[6037] Requirement: Crewmembers **shall** be evaluated and treated prior to a long-duration mission. The timing of the testing will be at the discretion of the Crew Surgeon. The optimal/desired range for 25-OH Vitamin D is 35-90 ng/ml. The recommended maintenance dose of Vitamin D3 is 1,000 I.U. daily or 5000 I.U. once a week.

If 25-OH Vitamin D results are:	Vitamin D3 Treatment

35 ng/ml or higher	• Prescribe 1000 I.U. daily or 5,000 I.U. weekly (Maintenance dose)
20 to 34 ng/ml	• Prescribe 50,000 I.U. once a week or 5000 I.U. once a day for 4 weeks, and then revert to maintenance dosing (1,000 I.U. daily or 5000 I.U. once a week). May recheck 25-OH Vitamin D levels in 3 months.
Less than 20 ng/ml	• Prescribe 50,000 I.U. once a week or 5000 I.U. a day for 6 to 9 weeks, and then revert to maintenance dosing (1,000 I.U. daily or 5000 I.U. once a week). • Recheck 25-OH Vitamin D levels in 3 months • Note: Rule out other causes such as celiac sprue or other malabsorption maladies.

6.7.2 Nutritional Status Assessments

[6038] Requirement: Crewmembers **shall** undergo nutritional assessment testing on an agency-specific basis according to the specifications and schedule described below.

Rationale: *On-orbit dietary assessments may help assure adequate nutrient intake during the mission. Assessment of nutritional patterns of crewmembers may help guide adjustments to nutrient and micronutrient dietary composition for future missions.*

Description: Nutritional assessment may include determination of typical dietary intake using a standard dietary assessment questionnaire. Blood samples and 24-hour void-by-void (VxV) urine pools will be collected for determination of nutritional status including: body mass and composition, protein status, calcium/bone status, antioxidant status, water-soluble vitamin status, iron status, mineral status, general blood chemistry, fat-soluble vitamin status, and renal stone risk.
Body composition assessment will include height and DXA. Data will be examined, and the necessity/details of a diet prescription will be assessed.
In-flight, food intake is estimated using an electronic data collection system. If a crewmember displays signs of unexpected changes in weight, he may be required to use the electronic FIT on a contingency basis.
Schedule: AME L- 21/18 m, L-90/30 d, R+0 d, R+20/30 d
DXA at R+5/7 d, shared from [6013]
In-flight Activities:
FIT – weekly
MMD – monthly or as clinically indicated, shared from [6015]

6.8 Fatigue Countermeasures

6.8.1 Sleep Assessment

[6039] Requirement: Each crewmember **shall** provide a daily assessment of sleep quality and quantity for a 2-week pre-flight period, 1 week pre-launch, in-flight, and 1-week post-flight to supply daily sleep data to the crewmember and crew surgeon.

Rationale*: Assessment of sleep quality and quantity will be utilized by the crewmember and*

crew surgeon to assess operational sleep duration requirements prior to critical events, to adjust crewmember countermeasures (timeline work rest scheduling, photic manipulation, medications).

Description: Sleep can be assessed by several different methods, including a simple rating scale (suggested range: 1 – very poor quality to 7 – excellent quality sleep) and the number of hours slept completed on a daily basis on awakening, Actimetry sensor, or other technologies. Actimetry sensor is an accelerometer-based device that measures motion and translates that into a graphic analysis of sleep patterns. Actimetry data, if available, can be downloaded remotely. Just-in-time downloading capability is required for the Crew surgeon based on operational need.
Schedule: AME 21/18 2-week baseline period, L-7 days continuously until R+7 days. Analog data will be discussed at the weekly PMC with the Crew Surgeon. Other data, if available, will be downloaded periodically on a just-in-time basis for operational crewmember and Crew Surgeon use.

6.8.2 Sleep Medication Ground Testing

[6040] Requirement: Each crewmember **shall** undergo a baseline assessment of program [4009] approved sleep medications prior to in-flight use.

Rationale*: Crewmembers may utilize sleep medications in-flight as a fatigue countermeasure. To assess the potential for delayed performance decrements, each crewmember shall undergo a baseline assessment to rule out significant performance side effects of such medication use on emergent awakening.*

Description: Sleep medications designated for use by a specific crewmember shall be tested by the crewmember prior to flight to assess efficacy and adverse effects. This baseline assessment should be monitored by the crewmember's Flight Surgeon (or Flight Surgeon designate – e.g., Fatigue Management Team member) regarding the efficacy of the medication and any significant side effects.
Schedule: Any time before L-30 d

7. MISSION MEDICAL EVALUATIONS FOR CREW ASSIGNED TO < 30 DAY SPACEFLIGHT MISSIONS

Section 7 defines the medical evaluation requirements for crewmembers assigned to missions less than 30 days. The following evaluations assume the astronaut has completed the NASA annual recertification testing/requirements described in this document.

Table 9 provides the required medical evaluations for NASA crew for missions less than 30 days. Details of each evaluation may be found in Section 6.

- The pre-flight medical evaluation will be coordinated with the annual medical examination when the schedules coincide.
- The evaluation components stipulated in this section are required for each crewmember assigned to a spaceflight mission; however, the CS has the authority to prescribe additional tests or increase the frequency of testing, if clinically indicated.
- The timing of requirements is designated as pre-flight, in-flight, and/or post-flight. Requirements may also be designated ACI – As Clinically Indicated.
- The information acquired from all testing shall be provided in a timely manner to the Crew Surgeon for inclusion in the individual Crewmember's medical records

Table 9 – Mission Medical Examinations for Short Duration (< 30 days) Missions

Clinical Assessment and Monitoring	Med Eval Requirement	Annual ***	PRE-FLIGHT (L-)	IN-FLIGHT	POST-FLIGHT (R+)	ACI	M	OM
CLINICAL ASSESSMENT AND MONITORING								
Pre- and Post-flight Physical Exam for Short Duration Crews	[6001]	Table 2	AME L-12/6 m, L-21/14 d, L-2/1 d		R+0 d and R+3/7 d, PEX ACI - Labs and PEX ID Swab	+√	√	
CMO Health Status Evaluations	[6002]			Mid Mission, ACI		+√	√	
Private Medical Conference	[6003]			L+1-7 d, weekly, pre/post EVA, R- 5 d, daily to R-0 d		+√	√	
Neurological Assessment	[6004]		AME L-12/6 m		R+0 d and R+3/7 d ACI	+√	√	√
Neurovestibular Platform Test	[6005]	Table 2	AME L-9/6 m, L-90/30 d		R+7/10 d	+√	√	√
Resting ECG	[6006]	Table 6	AME L-12/6 m		ACI	+√	√	
24-hour Ambulatory ECG			On Record			+√		
Hearing Assessment	[6007]	Table 6	AME L-12/6 m	ACI	R+3 d, If abnormal, R+10/14 d, R+60 d		√	√
Hearing Protection	[6008]		L-12/6 m					
Dental Examination	[6009]	Table 6	AME L-12/6 m			+√	√	
Dental Orthopantomogram or Full Mouth X-Ray Series	[6010]	Table 6	AME L-12/6 m					
Ophthalmology/Optometry	[6011]	Table 6	AME L-12/6 m Retinal photographs and OCT On Record		R+0/1, R+3 d and ACI R+1/10 d - Retinal photographs and OCT	+√	√	√
Specialized Ocular Assessments	[6012]	Table 6	AME L-12/6 m	ACI	R+1/3 d, follow abnormal findings every 30 days until clinically stable or as clinically indicated	√	√	√
Bone Densitometry	[6013]	Table 6	ACI		ACI	+√	√	√
Ultrasound Imaging (Sonography)	[6014]	Table 6	AME L-12/6 m				√	

Clinical Assessment and Monitoring	Med Eval Requirement	Annual ***	PRE-FLIGHT (L-)	IN-FLIGHT	POST-FLIGHT (R+)	ACI	M	OM
Body Mass Measurement	[6015]	Table 2		ACI		+√	√	
Photodocumentation of skin	[6016]		ACI	ACI	ACI	+√		√
MRI Brain and MR angiography	[6017]	AME L-21/18 m	On Record				√	
MRI Cervical and Lumbar Spine (non-contrast)	[6018]	AME L-21/18 m	ACI		ACI	√	√	
LABORATORY								
Laboratory Testing	[6019]	Table 5	AME L-12/6 m, per MED A Appendix D	ACI	ACI	+√	√	
H. pylori screen		Table 4	On Record					
MRSA	[6020]		L-90/30 d		R+0/7 d		√	
GABHS	[6021]		L-90/30 d				√	
RADIATION								
Personal dosimetry	[6022]	Table 6		√			√	√
CARDIOVASCULAR								
Orthostatic tolerance Active postural stand test	[6023]	Table 6			R+0 d, then daily to stable	√	√	
EXERCISE AND FITNESS								
Cycle Ergometer Test for Aerobic Functional Capacity	[6028]					+√	√	
Functional Fitness Assessment	[6024]	AME L-9/6 m, L-90/30 d	L-90/30 d		R+5/7 d		√	√
On-Orbit Strength & Conditioning Monitoring	[6025]			FD3 through the day prior to undock. Resistance: 3x/wk (60 min) Aerobic: 3x/wk (30 min)		√	√	√
Isokinetic Assessment	[6026]	AME L-9/6 m					√	√
EVA								
Pre/post EVA CMO exam	[6029]			√			√	

Clinical Assessment and Monitoring	Med Eval Requirement	Annual ***	PRE-FLIGHT (L-)	IN-FLIGHT	POST-FLIGHT (R+)	ACI	M	OM
Monitoring during EVA	[6030]			√			√	
PSYCH/BEHAVIORAL								
Pre-flight psychiatric/ psychological status check	[6032]	Table 6	L-180 d, L-90 d			+√	√	
Private psychological conference	[6033]			Every 14 days or Mid Mission		+√	√	
Post-flight psychiatric/ psychological status check	[6034]				R+7 d	+√	√	
Cognitive Assessment	[6035]		AME L-12/6 m Training (3 sessions): Baseline (3 sessions).	ACI	ACI	+√		√
Behavioral Observation of Training	[6036]		Observe 1 session between assignment and flight					
NUTRITION								
Nutritional Status Assessments	[6038]	AME L- 21/18 m, L-90/30	AME L- 21/18 m, L-90/30	In-flight Activities FIT-weekly, MMD-monthly or ACI, shared from [6015]	R+0, R+20/30d, DXA at R=5/7d, shared from [6013]	+√		
FATIGUE COUNTERMEASURES								
Objective Measure of Sleep	[6039]	AME L-21/18 m	L-12/6 m, L-14 d	Continuously throughout mission	End R+7 d			
Sleep Medication Ground Testing	[6040]		Any time before L-30 d					

ACI = As Clinically Indicated m= months d= days y= year L= launch R= return AME – Annual Medical Evaluation ***Annual Tests - Table 3 Overview of Medical Evaluation Procedures for NASA, Table 4 Overview of Medical Evaluation Procedures for NASA Astronauts to be applied annually, Table 5 Laboratory Tests on Annual Recertification, and Table 7 Special Assessments for Recertification

8. MEDICAL EVALUATIONS FOR PRIVATE ASTRONAUTS

8.1 Medical Evaluation – General Considerations

Private astronauts are Crew Members who are not a U. S. Government Astronaut, or an International Partner Astronaut. They undergo a comprehensive medical evaluation as part of their mission selection. Private astronauts' medical evaluations are determined by duties and mission duration as per the table below. Critical duties are considered but not limited to piloting the vehicle, performing robotic operations, performing an EVA or any other task that is critical to the mission safety and success. The term spaceflight participant has been used in the past for this category of crew.

The medical evaluation process includes an extensive medical history and physical examination by aeromedical physicians and clinical specialists, laboratory screening tests, special diagnostic tests, and psychiatric evaluation. This document defines the medical screening procedures and standards for medical certification.

In compliance with NPD 1382.17, NASA Privacy Policy and the Privacy Act of 1974, as amended, private astronauts are examined in accordance with approved medical procedures.

Table 10 – NASA Medical Requirements for Private Astronauts

	Private Astronauts	**Private Astronauts without critical duties and ≤ 30-day missions**
Medical Requirements for Selection	Laboratory Tests Section 5.1.2, Table 4 Special Assessments Section 5.1.3, Table 5	Appendix D D.1.1 Medical Evaluation D.1.2 Laboratory Tests D.1.3 Specialist Assessments
Disqualifying Criteria	Section 5.3, Table 6	Section 5.3, Table 6
AMB Chair	Shall make recommendation on medical status Section 4.2 [4003]	
CHMO	Shall make the final disposition on medical status Section 4.2 [4004]	
MSMB Chair	Determines medical suitability and certification	

9. MEDICAL EVALUATIONS FOR NASA SUBORBITAL RESEARCH SPECIALISTS

9.1 Medical Evaluation – General Considerations

This section provides medical testing requirements for NASA Suborbital Research Specialists (NSRS). NSRS are defined as an individual who is employed by NASA or contracted by NASA to conduct research, technology testing, training, or other activities onboard a sub-orbital vehicle. This excludes those individuals who are the commercially employed crew of the suborbital vehicle.

Medical Evaluation Procedures for NASA Suborbital Research Specialists

FAA Class III Exam or equivalent
plus: EKG, Standard Blood (CBC, BMP) & Urine Analysis,
Valid for 1 year

Exam findings and doctor's recommendation on fitness must be forwarded to the AMB.

APPENDIX A. REQUIREMENTS COMPLIANCE MATRIX

A.1 Purpose

Due to the complexity and uniqueness of space flight, it is unlikely that all of the requirements in a NASA technical standard will apply. The Requirements Compliance Matrix below contains this NASA Technical Standard's technical authority requirements and may be used by programs and projects to indicate requirements that are applicable or not applicable. Follow the process for waiver in section 4.7 in this NASA Technical Standard. Enter "Yes" in the "Applicable" column if the requirement is applicable to the program or project or "No" if the requirement is not applicable to the program or project. The "Comments" column may be used to provide specific instructions on how to apply the requirement or to specify proposed waiver.

Requirement	Description	Requirement in this Standard	Applicable (Enter Yes or No)	Comments
[4001]	AMB Evaluation and Certification	The examining physician **shall** present a candidate's evaluation results to the AMB.		
[4002]	AMB Evaluation and Certification	The AMB **shall** determine if the candidate does or does not meet medical standards or requires further evaluations before disposition can be made.		
[4003]	AMB Evaluation and Certification for NASA (career) Astronauts	The AMB will review the medical records of all NASA (career) astronaut applicants at selection, and of each NASA (career) astronaut annually, and **shall** recommend qualification, disqualification, or conditional qualification (waiver for active astronauts) to the CHMO.		
[4004]	CHMO Final Disposition for NASA (career) Astronauts	The Chief Health and Medical Officer (CHMO) **shall** make the final disposition on qualifications and disqualifications of NASA (career) astronauts, based on review of the AMB recommendations.		
[4005]	Waiver of Medical Standards	The term "waiver" **shall** be used when a disqualifying condition is waived and the NASA (career) astronaut is conditionally medically certified.		
[4006]	No Waiver on Selection	No waiver **shall** be granted on selection of NASA astronauts.		

[4007]	Waiver of Medical Standards	For a NASA (career) astronaut waiver request, the examining physician **shall** provide a detailed presentation to the AMB of all relevant medical data and also address the following: a. An evidence-based review with data derived from the medical and aeromedical literature, as well as specialist consultant opinions detailing the potential risks associated with the condition, complications, and sequelae. b. A thorough consideration of the potential consequences of related medical events on mission safety and mission completion and on the potential incremental health risk to the individual in the space/microgravity environment must be conducted.		
[4008]	Waiver of Medical Standards	The examining physician **shall** notify the NASA (career) astronaut that his/her medical condition is being considered for waiver or disqualification from flight status.		
[4009]	Waiver of Medical Standards	The Chief Health and Medical Officer (CHMO) **shall** make the final disposition based on review of the AMB recommendations. The CHMO may delegate waiver decision authority to the AMB Chair for routine medication waiver renewal.		
[5001]	Medical Screening NASA Astronauts	The examining physician **shall** perform medical screening, including the procedures and consultations in Table 2, Medical Evaluation Procedures, at selection and for annual recertification as indicated.		
[5002]	Medical Conditions to Consider for Selection and Annual Recertification of NASA Astronauts	The examining physician **shall** determine the suitability for selection and retention of NASA astronauts, using the conditions for disqualification specified in Table 7.		
[6001]	Pre- and Post-flight Physical Examination for > 30 Days Crews	Crewmembers **shall** undergo clinical examinations with the Crew Surgeon (CS), Deputy Crew Surgeon (DCS), or Partner Flight Surgeon (FS) according to the specifications and schedule described below.		
[6002]	Crew Medical Officer Health Status Evaluations	Crewmembers **shall** complete periodic health status evaluations in-flight.		
[6003]	Private Medical Conference	Crewmembers **shall** participate in private medical conferences with a mission assigned FS.		
[6004]	Neurological Assessment	Crewmembers **shall** undergo a neurological assessment before and after flight.		
[6005]	Neurovestibular Platform Test	Crewmembers **shall** undergo an objective assessment of neuro-vestibular function before and after flight.		

[6006]	Resting ECG	Each crewmember **shall** complete a resting ECG prior to launch to provide a baseline study.		
[6007]	Hearing Assessment	Crewmembers **shall** be tested with conventional audiometry before and after flight. Crewmembers **shall** also conduct pre-flight and in-flight hearing assessments using the On-Orbit Hearing Assessment (OOHA).		
[6008]	Hearing Protection	Crewmembers **shall** be fitted for and provided with custom molded hearing protection earwear.		
[6009]	Dental Examination	The dental health of each crewmember **shall** be assessed before launch.		
[6010]	Dental Orthopantomogram or Full Mouth X-Ray Series	A full dental orthopantomogram x-ray or full mouth x-ray series **shall** be performed within two years of launch		
[6011]	Ophthalmology/Optometry Examinations	Each crewmember **shall** undergo ophthalmological exams before and after flight in addition to regular annual checkups.		
[6012]	Specialized Ocular Assessments	To assess the effects of exposure to the space-flight environment on ocular health, Crewmembers **shall** undergo specialized eye examinations pre-flight, in-flight, and post-flight.		
[6013]	Bone Densitometry	Bone densitometry evaluations **shall** be performed to assess skeletal integrity and to document bone mineral density changes as an index of fracture risk, and to guide countermeasures.		
[6014]	Ultrasound Imaging (Sonography)	Ultrasound imaging **shall** be conducted for each crewmember.		
[6015]	Body Mass Measurement	Crewmembers **shall** complete a body mass measurement evaluation periodically while in-flight		
[6016]	Photodocumentation of Skin	The Crew Medical Officer or Crew Surgeon **shall** document, through photographic imaging, the condition of the crewmember's skin, including any signs of skin disease or injury.		
[6017]	MRI Brain and MR Angiography	Each Crewmember **shall** undergo an MRI study of the brain and MR angiographic study of the supra-aortic and intracranial vessels		
[6018]	MRI Cervical and Lumbar Spine Imaging	Each Crewmember **shall** undergo pre- and post-flight non-contrast MRI studies of the cervical and lumbar spine		
[6019]	Laboratory Testing	A clinical laboratory assessment **shall** be completed for each crewmember before and after flight		
[6020]	Methicillin Resistant Staphylococcus aureus (MRSA) Screening and Suppression	Nasal cultures for Staphylococcus aureus **shall** be performed during L-9/6 months medical screening on all Crewmembers.		

[6021]	Group A Beta-Hemolytic Streptococcus (GABHS, Strep pyogenes) carrier state	Throat swab for Group A Beta-Hemolytic Streptococcus carriage **shall** be conducted on all Crewmembers at L-90/30 days medical screening.		
[6022]	Radiation Monitoring/Personal Physical Dosimetry	In-flight radiation monitoring **shall** be performed with crew personal dosimetry according to the specifications and schedule described below.		
[6023]	Active postural stand tests	Each crewmember **shall** undergo orthostatic tolerance testing by means of an active stand test.		
[6024]	Functional Fitness Assessments	Each crewmember **shall** complete a series of tests designed to establish functional fitness before and after flight.		
[6025]	On-Orbit Strength and Conditioning Monitoring	Each crewmember **shall** undergo strength and conditioning monitoring during flight. To prevent injury and to optimize performance, real-time audio/video instruction sessions shall be performed for ARED. A private exercise conference (PEC) **shall** be scheduled to allow for direct, efficient, and comprehensive exchange of information between ground exercise specialists and crewmembers.		
[6026]	Isokinetic Assessment	Each crewmember **shall** complete an isokinetic test to objectively assess muscle strength and endurance, before and after flight.		
[6028]	Cycle Ergometer Test for Aerobic Functional Capacity	Each crewmember **shall** complete incremental-load cycle ergometer tests to assess aerobic functional capacity and exercise induced arrhythmias before flight, periodically in-flight and post-flight. Prior to an EVA or at any point during the mission, this test may be requested by the crew surgeon.		
[6029]	Pre- and Post-EVA Medical Examinations	All EVAs **shall** be preceded and followed by an assessment of medical fitness.		
[6030]	Monitoring during EVA	Crewmembers **shall** undergo EVA monitoring.		
[6032]	Pre-flight Psychiatric/Psychological Status Check	The following **shall** be performed by a specialist: (a) Psychiatric/Psychological Assessment of behavioral readiness for flight (b) Specialist review of individual and crew psychological support (c) Check of life events that would have an impact on the astronaut's fitness for launch. (d) Baseline assessments needed for in-flight monitoring to be completed between L-12 months and launch: i. Neurocognitive baseline ii. Behavioral health baseline		

[6033]	Private Psychological Conference	Crewmembers **shall** participate in a private psychological conference according to the specifications and schedule described below. (a) Performed by specialist Schedule: Every two weeks		
[6034]	Post-flight Psychiatric/Psychological Status Check	The following **shall** be performed by a specialist: (a) Initial clinical interview by a specialist regarding behavioral re-adaptation, [30 min each crewmember at R+3] (b) Initial review of behavioral health and performance mission support, [30 min each crewmember at R+3] (c) Review of behavioral health and performance mission support, [60 min each crewmember at R+10] (d) Clinical Interview by specialist regarding behavioral re-adaptation, [60 min each crewmember at R+14] (e) Supplemental assessment as clinically indicated (f) Psychiatric/Psychological assessment regarding behavioral re-adaptation, [60 min each crewmember at R+30]		
[6035]	Cognitive Assessment	Crewmembers **shall** undergo a cognitive assessment before, during, and after flight.		
[6036]	Behavioral Observation of Training	Training events of CMs (preferably of whole assigned crews) **shall** be observed by behavioral specialists.		
[6037]	Vitamin D Testing and Treatment Protocol	Crewmembers **shall** be evaluated and treated prior to a long-duration mission. The timing of the testing will be at the discretion of the Crew Surgeon. The optimal/desired range for 25-OH Vitamin D is 35-90 ng/ml. The recommended maintenance dose of Vitamin D3 is 1,000 I.U. daily or 5000 I.U. once a week. See [6037] for associated table.		
[6038]	Nutritional Status Assessments	Crewmembers **shall** undergo nutritional assessment testing on an agency-specific basis according to the specifications and schedule described below.		
[6039]	Sleep Assessment	Each crewmember **shall** provide a daily assessment of sleep quality and quantity for a 2-week pre-flight period, 1 week pre-launch, in-flight, and 1 week post-flight to supply daily sleep data to the crewmember and crew surgeon.		
[6040]	Sleep Medication Ground Testing	Each crewmember **shall** undergo a baseline assessment of program [4009] approved sleep medications prior to in-flight use.		
[6041]	Screening for deep vein thrombosis and venous flow anomalies	Every crewmember **shall** be screened for deep vein thrombosis (DVT) of the internal jugular veins.		

APPENDIX B. TUBERCULOSIS (TB) TESTING

B.1 Purpose

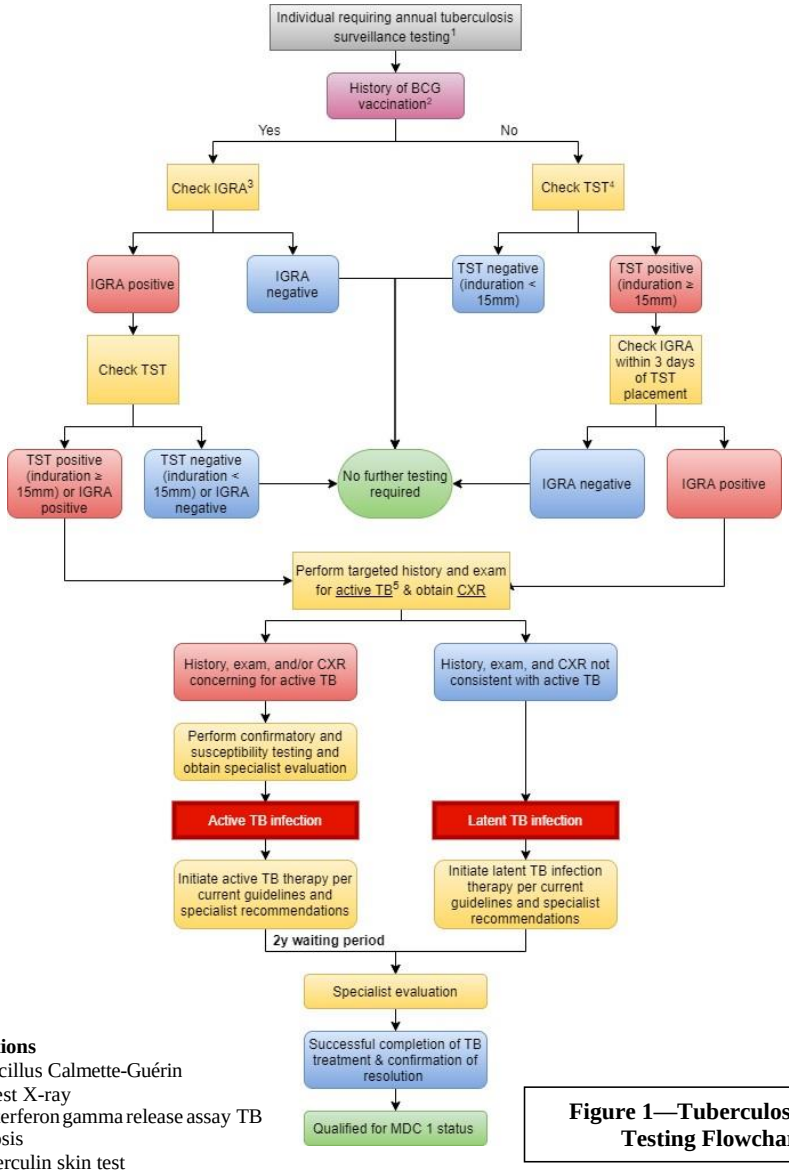
This Appendix provides guidance regarding tuberculosis (TB) testing and a flowchart summarizing the recommendations. This includes guidance on BCG vaccination information, IGRA and TST considerations, and recommendations on TST and IGRA.

B.2 Tuberculosis Screening & Management Guidance

IGRA assays detect the secretion of interferon-γ (INF-γ) by T-lymphocytes which are stimulated by TB-specific antigens. Every effort should be made to confirm positivity (i.e., latent or active TB) before undertaking a treatment regimen.

- If prior BCG vaccination, the initial screening test should be with IGRA, not TST.
- If no prior BCG, initial screening test can be with either TST or IGRA.
- If the initial IGRA is positive, to rule out a false positive (and thus avoid unnecessary treatment), a follow-up with TST or a different IGRA is required.
- If the initial TST is positive, perform a confirmatory IGRA to rule out false positives from non-tuberculous mycobacterial infection within 3 days of TST placement. (This timing is to prevent boosting and false positives on the post-TST IGRA).

B.3 Tuberculosis Screening & Management Flowchart



Abbreviations
BCG – Bacillus Calmette-Guérin
CXR – chest X-ray
IGRA – Interferon gamma release assay TB – tuberculosis
TST – tuberculin skin test

Figure 1—Tuberculosis (TB) Testing Flowchart

B.4 Assumptions

- Astronauts are comparable to health care workers (HCWs) in the articles addressing the challenges of latent tuberculosis infection (LTBI) testing in these low-risk populations.
- Astronauts are unlikely to be infected with Mycobacterium TB.
- Astronauts will be undergoing serial testing in the absence of known exposure.
- The majority of newly positive TSTs and IGRAs are due to false positive tests[3].

B.5 BCG Vaccination

- Consensus is to use IGRAs for determining TB infection status in BCG-vaccinated individuals because BCG vaccination reduces the specificity of TST[11].

B.6 IGRA Considerations

- Among health care workers tested serially for LTBI, conversions from negative to positive and reversions from positive to negative are more commonly identified with IGRA than with TST[1,5,11].
    - Routine serial testing of HCWs at low risk for TB infection is likely to result in FP conversions, which occur 6-9 times more frequently with IGRAs than with TST and must be balanced against any logistical advantages from using IGRAs[3].
    - More concerned about false positive seroconversion in low-risk populations[6] sub-bullet.
    - Instability of IGRA results in annual retesting of HCWs and other low-risk cohorts[2,4].

B.7 TST Considerations

- Cut-off matters: TST specificity is 99.3% when using the 15-mm cut-off for positive test results recommended by the CDC for persons at low risk of exposure or 96.8% when using the 10-mm cut-off[7].

B.8 Diagnosis

- The diagnosis of pulmonary TB should be suspected in patients with relevant clinical manifestations (cough > 2 to 3 weeks' duration, lymphadenopathy, fevers, night sweats, weight loss) and relevant epidemiologic factors (history of prior TB infection or disease, known or possible TB exposure, and/or past or present residence in or travel to an area where TB is endemic).

B.9 Recommendations on TST and IGRA

- Annual or serial testing of astronauts: To standardize the interpretation of results, the same test should be used for the baseline and the later tests.
- Unless astronaut has had BCG immunization, recommend TST for serial testing because of decreased likelihood of false positive conversions[8].

  - Use a 15-mm cut-off for a positive TST[7].
- Because the prevalence of LTBI is very low in our populations, all positive TST and IGRA tests should be confirmed to reduce the likelihood of a false positive test diagnosis.
  - If initial test is IGRA and the result is positive, either repeat IGRA or perform a TST to confirm positive results before initiating treatment for LTBI.
  - If initial test is a TST and the result is positive, perform IGRA within 3 days of the TST to minimize boosting the IGRA results. The person is considered infected only if both tests are positive[2,6].
  - Modify the up-to-date table "Approach to diagnosis of latent tuberculosis infection (tuberculosis screening) in individuals who require serial testing"[8]
    - If TST is positive with > 15 mm induration.
    - Perform IGRA within 3 days of the TST.
    - If IGRA is positive, treat for LTBI after excluding active TB.
    - If IGRA is negative, the TST is most likely a false positive result.

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APPENDIX C. MEDICAL CERTIFICATION SPECIFIC TO MISSIONS TO THE INTERNATIONAL SPACE STATION

The following is provided for informational purposes as an overview of the international medical certification process that is followed when NASA (career) astronauts or private individuals sponsored for flight by a government space agency, fly to the International Space Station (ISS).

A set of international medical policy boards govern international space flight medical oversight activities. These boards and their organization are described in the Memorandum of Understanding (MOU) between NASA and the International Partners (see Article 11.4).

The Multilateral Medical Operations Panel (MMOP) develops the medical requirements for selection and certification of all ISS astronauts (NASA career astronauts and International Partner government astronauts), space flight participants (SFPs), and astronauts training at international facilities. Please note that the definition of space flight participant as used in these international documents is different from its definition in this standard. This standard uses the term private astronaut.

"ISS SFPs are individuals who are transported either by Soyuz or Space Transportation System (STS, Space Shuttle) to the ISS for commercial visitation or other purposes for short-term habitation (less than 30 days). Such individuals are generally fare-paying passengers. SFPs will not have primary operational duties or assignments, but may, in conjunction with supporting ISS agencies, be involved in short-term research activities. They will be trained in all applicable emergency and egress procedures".

The following standards and requirements are used for international medical selection and evaluation for the ISS:

a. SSP 50667, Medical Evaluation Document (MED), Volume A, Medical Standards for ISS Crewmembers—an international document that contains the ISS selection and retention standards for government career astronauts (NASA or International Partner).

b. SSP 50667, Medical Evaluation Document (MED), Volume B, Preflight, In-flight, and Postflight Medical Evaluation Requirements for Increment-Assigned ISS Crewmembers—the international document that contains the pre-, in-, and postflight medical testing and evaluations for long-duration missions.

c. SSP 50667, Medical Evaluation Document (MED), Volume C, Medical Standards and Certification Procedures for Space Flight Participants—the international document that contains the medical standards and certification procedures for short-duration space flight participant missions.

OCHMO-STD-100.1A, Revision A

The Multilateral Space Medicine Board (MSMB) reviews the pertinent medical information for all individuals assigned to or visiting the ISS or training at international facilities and determines individual medical certification.

A waiver or restriction may also be assigned, if appropriate.

All International Partners (IPs) may follow their own procedures in conducting selection, annual, and pre- and post-flight medical evaluations for ISS astronauts and long-duration candidates, as long as the evaluation requirements and standards outlined in SSP 50667, MED, Volumes A, B, and C, are followed.

Medical certification by the MSMB is valid for a period of 1 year following the last medical examination. Temporary extensions of MSMB medical certification may be authorized for a period of up to 90 days by CHMO.

APPENDIX D. MEDICAL EVALUATIONS FOR PRIVATE ASTRONAUTS WITH NO CRITICAL DUTIES AND MISSIONS 30 DAYS OR LESS

D.1 Purpose

This Appendix provides the medical evaluations for testing of private astronauts that do NOT perform safety critical tasks (e.g., piloting of a vehicle, EVAs, robotic operations etc.) and are in mission planned for a limited time period (i.e., 30 days or less).

D.2 Overview

Medical Evaluation Procedures for Private Astronauts with NO critical duties and on missions ≤ 30 days:

Space Flight Participants Overview
1. Comprehensive medical questionnaire[1]
2. Full aeromedical physical examination (per FAA guidance or equivalent regulatory body)
3. Special assessments and imaging procedures (as described in D.2.2)
4. Laboratory testing (as described in D.2.1)

[1] - May be completed using the NASA Medical Survey or other similar questionnaire. The following areas should be included: Past medical history and background information; psychosocial and psychiatric history including DWI and drug-related convictions; personal habits/lifestyle issues; travel history (past year); medication review, including non-prescription and herbal medications, food supplements, vitamins and minerals; systems review; physical activities and sports.

D.2.1 Laboratory Tests for Private Astronauts with NO critical duties and on missions ≤ 30 days

The following are recommended for Private Astronauts with NO critical duties and on missions ≤ days:

Hematology/Thrombophilia Screen	Initial	Periodic
Complete Blood Count – To include hemoglobin, hematocrit, red blood cell count, red blood cell indices, white blood cell count, differential count, platelet count	✓	✓
Screening tests for thrombophilia: Prothrombin time (PT), Activated Partial Thromboplastin time (aPPT)	Rcc/ACI	Rcc/ACI
ABO blood type	Rcc/ACI	Rcc/ACI
Biochemistry	**Initial**	**Periodic**
Liver function -Aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma-glutamyl transferase (GGT), bilirubin, alkaline phosphatase (ALP)	Rcc/ACI	Rcc/ACI
Renal function - Urea, creatinine, electrolytes (Na [sodium], Cl [chloride], K [potassium]), uric acid	Rcc/ACI	Rcc/ACI
Endocrine – TSH	Rcc/ACI	Rcc/ACI
Prostate specific antigen (PSA) (males over age 40)	Rcc/ACI	Rcc/ACI
HbA1C	✓	✓
Cardiovascular profile - Fasting total cholesterol, high-density lipoproteins (HDL), low-density lipoprotein (LDL), triglycerides, high-sensitivity C-reactive protein (hs-CRP)	Rcc/ACI	Rcc/ACI
Calcium, magnesium, inorganic phosphate	Rcc/ACI	Rcc/ACI
Ionized calcium	Rcc/ACI	Rcc/ACI

Checkmark (✓) = required test/evaluation Rcc/ACI = recommended or As Clinically Indicated test/evaluation

Initial indicates testing that shall be performed for the first NASA medical risk assessment and approval. *Periodic* indicates testing that shall be performed at subsequent presentations to the AMB. All evaluations shall be performed within 6-12 months of flight.

The following are laboratory tests recommended for Private Astronauts with NO critical duties and on missions ≤ 30 days:

Infectious Disease Screen	**Initial**	**Periodic**
Hep A	Rcc/ACI	Rcc/ACI
Hepatitis B (Hepatitis B surface antigen, Hepatitis B core antibody, Hepatitis B surface antibody)	Rcc/ACI	Rcc/ACI
Hepatitis C—one time	✓	Rcc/ACI
Serologic screen for syphilis (VDRL or RPR or equivalent)	Rcc/ACI	Rcc/ACI
HIV	✓	Rcc/ACI
Tuberculosis (TB) screening utilizing a tuberculin skin test (TST) or interferon gamma releasing assay (IGRA) (either QFT-G or T- SPOT). Refer to Appendix B for detailed Tuberculosis screening and management guidance	✓Within 12/6 m of mission	✓Within 12/6 m of mission
Vaccine immune status	Rcc/ACI	Rcc/ACI
MRSA	✓Within 90/30d of mission	✓Within 90/30d of mission
GABHS	✓Within 90/30d of mission	✓Within 90/30d of mission
H. Pylori breath test	✓	Rcc/ACI
Urinalysis	**Initial**	**Periodic**
Routine (specific gravity, glucose, protein, pH, ketones, blood), microscopic reflex	✓	✓
Human chorionic gonadotropin (hCG) (females) (urine)	✓	✓
Drug screen for drugs of abuse	✓	✓

Checkmark (✓) = required test/evaluation Rcc/ACI = recommended or As Clinically Indicated test/evaluation

Initial indicates testing that shall be performed for the first NASA medical risk assessment and approval. *Periodic* indicates testing that shall be performed at subsequent presentations to the AMB. All evaluations shall be performed within 6-12 months of flight.

D.2.2 Specialist Assessments for Private Astronauts with NO critical duties and on missions ≤ 30 days

The following are specialist assessments recommended for Private Astronauts with NO critical duties and on missions ≤ 30 days:

Ophthalmology Specialist Assessment (Optometrist)	Initial	Periodic
Visual acuity (Snellen or Landolt-C)		
• Near vision	✓	✓
• Distance vision	✓	✓
Color vision (computer-based test, Ishihara, or equivalent pseudo-isochromatic plates [PIPs] to include red-green and blue-yellow)	✓	✓
Cyclopegic refraction	Rcc/ACI	Rcc/ACI
Tonometry	Rcc/ACI	Rcc/ACI
Perimetry	Rcc/ACI	Rcc/ACI
Fundoscopic exam	Rcc/ACI	Rcc/ACI
Otolaryngology/ENT	**Initial**	**Periodic**
Functional hearing test	✓	✓
Audiometry (pure tone audiogram and speech audiogram, if indicated)	Rcc/ACI	Rcc/ACI
Tympanogram	Rcc/ACI	Rcc/ACI
Dental	**Initial**	**Periodic**
Special Assessment by Dentist	✓	✓
Full orthopantomogram or full mouth X-ray series)	✓	Rcc/ACI

Checkmark (✓) = required test/evaluation Rcc/ACI = recommended or As Clinically Indicated test/evaluation

Initial indicates testing that shall be performed for the first NASA medical risk assessment and approval. *Periodic* indicates testing that shall be performed at subsequent presentations to the AMB. All evaluations shall be performed within 6-12 months of flight.

The following are specialist assessments recommended for Private Astronauts with NO critical duties and on missions ≤ 30 days:

Cardiopulmonary	**Initial**	**Periodic**
Resting 12-lead electrocardiogram (ECG)	✓	✓
Aerobic Capacity. Direct or indirect measurement of cardiorespiratory fitness (CRF) in ml/kg/min or METS) on maximum exercise stress test	Rcc/ACI	Rcc/ACI
24-Hour ECG monitoring	Rcc/ACI	Rcc/ACI
Coronary calcium scoring (>50 yrs old)	✓	Rcc/ACI
Transthoracic echocardiogram (TTE)	Rcc/ACI	Rcc/ACI
Astro-CHARM	✓	✓
GI Evaluation	**Initial**	**Periodic**
Colonoscopy	Rcc/ACI	Rcc/ACI
• At or over 45: within the last 5 years	Rcc/ACI	Rcc/ACI
• At or over 40 within the last 5 years if family history positive for colon cancer	Rcc/ACI	Rcc/ACI

Checkmark (✓) = required test/evaluation Rcc/ACI = recommended or As Clinically Indicated test/evaluation

Initial indicates testing that shall be performed for the first NASA medical risk assessment and approval. *Periodic* indicates testing that shall be performed at subsequent presentations to the AMB. All evaluations shall be performed within 6-12 months of flight.

The following are specialist assessments recommended for Private Astronauts with NO critical duties and on missions ≤ 30 days:

Neurology	**Initial**	**Periodic**
MRI of brain, MRI angiogram	Rcc/ACI	Rcc/ACI
Carotid Ultrasound Study (to include intimamedial thickness and/or carotid plaque area)	Rcc/ACI	Rcc/ACI
Behavioral Health Evaluation	**Initial**	**Periodic**
Psychiatric and psychological evaluation *Based on the most recent edition ofthe Diagnostic and Statistical Manual of Mental Disorders, the American Psychiatric Association)*	✓	✓
Psychological Suitability and Psychodiagnostic Assessment	✓	✓
Radiological /Ultrasound Procedures	**Initial**	**Periodic**
Chest X-ray (PA and lateral)	✓	Rcc/ACI
Thyroid ultrasound	Rcc/ACI	Rcc/ACI
Abdominal and pelvic ultrasound	Rcc/ACI	Rcc/ACI
Mammogram	Rcc/ACI	Rcc/ACI
Bone mineral density - dual energy x-ray absorptiometry (DXA) scan	Rcc/ACI	Rcc/ACI

Checkmark (✓) = required test/evaluation Rcc/ACI = recommended or As Clinically Indicated test/evaluation

Initial indicates testing that shall be performed for the first NASA medical risk assessment and approval. *Periodic* indicates testing that shall be performed at subsequent presentations to the AMB. All evaluations shall be performed within 6-12 months of flight.

APPENDIX E. REFERENCES

Purpose

This Appendix provides references to guidance documents related to this NASA Technical Standard.

References

Memorandum of Understanding (MOU) between NASA and the International Partners (Article 11.4)

NPD 1382.17, NASA Privacy Policy

SSP 50667, Medical Evaluation Document (MED), Volume A, Medical Standards for ISS Crewmembers

SSP 50667, Medical Evaluation Document (MED), Volume B, Preflight, In-flight, and Postflight Medical Evaluation Requirements for Increment-Assigned ISS Crewmembers

SSP 50667, Medical Evaluation Document (MED), Volume C, Medical Standards and Certification Procedures for Space Flight Participants