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Guidance for Medical Screening of Commercial Aerospace Passengers

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GUIDANCE FOR MEDICAL SCREENING OF COMMERCIAL AEROSPACE PASSENGERS

INTRODUCTION

This document provides general guidance for operators of manned commercial aerospace flights (suborbital and orbital) in the medical assessment of prospective passengers. This guidance is designed to identify those individuals who have medical conditions that may result in an inflight medical emergency or inflight death, or may compromise in any other way the health and safety of any occupants (crew members and passengers) onboard a commercial aerospace vehicle.

Space flight exposes individuals to an environment that is far more hazardous than what is experienced by passengers who fly onboard current airline transports. With orbital and suborbital flights, pre-existing medical conditions can be aggravated or exacerbated by exposure to environmental and operational stressors such as acceleration, microgravity, and solar/cosmic radiation, among others.

CATEGORIES OF PASSENGERS

In view of the wide variety of possible approaches that can be used to design and operate manned commercial aerospace vehicles in the foreseeable future, the medical screening guidance described in this document apply differently to two categories of passengers:

1. Passengers Participating in Suborbital Aerospace Flights (or exposed to a G-load of up to $+3G_z$ during any phase of the flight).

These passengers should complete a simple medical history questionnaire (see Appendix A) prior to every suborbital flight (single or multiple). A physician who is experienced or trained in the concepts of aerospace medicine should review the completed questionnaire. These passengers need not be required to undergo a physical examination or complete medical laboratory testing. However, nothing in this guidance should preclude the physical examination of any prospective aerospace

passenger as deemed necessary by the physician who is authorized by a commercial aerospace vehicle operator to conduct medical assessments. Also, if the possibility exists that the G-load profile of any suborbital flight could exceed $+3G_z$, the passenger should be evaluated according to the recommendations for passengers participating in orbital aerospace flights.

2. Passengers Participating in Orbital Aerospace Flights (or exposed to a G-load exceeding $+3G_z$ during any phase of the flight).

These passengers should complete a more comprehensive medical history questionnaire (see Appendix B) and undergo a physical examination with laboratory testing. This recommendation applies to passengers involved in orbital flights of any duration (short or long) or in suborbital flights with high G-load profiles. The medical history, physical examination, and medical tests should be valid for a period of one (1) year. However, one to two weeks prior to each flight it is recommended that passengers should have their medical history updated and undergo an abbreviated physical examination to ensure that no significant medical changes have occurred since the completion of the initial medical screening examination.

This medical screening guidance is based on the assumption of an inflight cabin environment with a barometric pressure not exceeding 8,000 ft (10.91 psi), where passengers are not required to wear a pressurized suit. In addition, passengers are expected to be able to perform an emergency evacuation without assistance and not compromise the safety of other occupants (crew members and passengers).

For passengers who fly onboard an aerospace vehicle that accelerates faster than $+3G_z$, assumptions are made that such a vehicle will not exceed a maximum acceleration load (G-load) of $+4G_z$ (gradual onset) during any phase of the flight, and passengers will not be required

to use an anti-G suit. In general, the acceleration envelope recommended for the aerospace vehicle should not exceed $+4G_z$ ($-2G_z$), $\pm 4G_x$ and $\pm 1G_y$.

ACCELERATION RISKS

The main risks for problems with acceleration in aerospace flight are associated with the neurological, cardiovascular, and musculoskeletal systems. To avoid the potential for compromising neurological function, acceleration forces are preferably applied in the front-to-back ($+G_x$) direction (eyeballs in). An individual is very tolerant to $+G_x$ acceleration, and with the heart and brain located at approximately the same level within the acceleration field there is little risk for acceleration (G)-induced loss of consciousness (G-LOC). Acceleration stress is known to be dysrhythmogenic (changes in cardiac rate, rhythm, and conduction).

Higher and longer exposures to acceleration increase the frequency of dysrhythmias. As long as the head, neck, and spine are stabilized before the acceleration exposure and remain so until the exposure is completed, the potential for musculoskeletal injury is markedly reduced. An individual's tolerance to head-to-foot (eyeballs down) acceleration ($+G_z$) is dependent on the individual's anatomic and physiologic characteristics and the nature of the acceleration profile.

The maximum $+G_z$ level, exposure duration, and the rate of onset of the $+G_z$ are important determinants of the risk of neurologic compromise, cardiac rhythm disturbances, and musculoskeletal (especially neck) injury. Onset-rates greater than 0.1G/second are considered rapid, since they exceed the ability of the cardiovascular system to fully respond to preserve adequate central nervous system blood flow. Rapid-onset rates of 1.0G/second and greater can result in G-LOC without visual warning symptoms.

Conservative relaxed, unprotected tolerance of completely healthy humans to $+G_z$ acceleration is considered approximately $+3G_z$ (normal range 3.1 to 4.0) for rapid-onset profiles and increases to approximately $+3.5G_z$ (normal range 3.7 to 5.6) with gradual-onset profiles.

Individuals with compromised cardiovascular anatomy or function may have reduced tolerances. Care should be exercised with rapid-onset profiles to $+3G_z$ or more, sustained for 5 seconds or longer.

Medical Conditions That May Contraindicate Passenger Participation in Suborbital or Orbital Flights

In general, medical conditions that may be contraindicated for aerospace flights include:

Any deformities (congenital or acquired), diseases, illnesses, injuries, infections, tumors, treatments (pharmacological, surgical, prosthetic, or other), or other physiological or pathological conditions that:

1. may result in an inflight medical emergency,
2. may result in an inflight death,
3. may compromise the health and safety of the passenger or other aerospace vehicle occupants, and/or the safety of the flight,
4. may interfere with the proper use (don and doff) and operation of personal protective equipment, or
5. may interfere with inflight emergency procedures or emergency evacuation, or
6. may have a negative effect on the passenger's health as a result of exposure to aerospace flight. Any medical condition that may result in an unexpected inflight medical emergency represents a potential risk to the safety of the flight.

An established clinical diagnosis or finding of any of the following conditions may contraindicate participation in aerospace flight and should be further evaluated on a case-by-case basis:

- Acute or chronic use of any medication (prescription and/or non-prescription), drug, or substance
- Cancer
- Severe trauma or invasive medical procedures (diagnostic or therapeutic) associated with significant functional deficit

- Severe acute or chronic infections or communicable/contagious diseases (including blood borne infectious diseases)
- History of individual exposure to ionizing radiation (single dose or cumulative) that exceeds the maximum exposure limit of 5 mSv in 5 years recommended by the International Commission on Radiological Protection
- Current pregnancy, recent post-partum (less than 6 weeks), or recent spontaneous or voluntary termination of pregnancy
- Any psychiatric, psychological, mental, or behavioral disorder that would cause an individual to become a potential hazard to him/herself or to others
- Any other diseases, illnesses, deformities, injuries, infections, tumors, or treatments that may result in significant functional impairment or that may be aggravated by exposure to environmental or operational stress factors of aerospace flight

Disposition of Prospective Aerospace Passengers Who Have Medical Conditions That May Contraindicate Participation in Aerospace Flight

Prospective aerospace passengers who have medical conditions that may contraindicate participation in aerospace flight could be given medical clearance, on a case-by-case basis, by a physician retained by the operator and who is trained or experienced in aerospace medicine.

Based on the specific nature of the medical condition, an individual should be temporarily prohibited from participation in aerospace flight until the medical condition resolves or until it can be effectively brought under medical control and it is no longer likely to result in:

1. Inflight medical emergency
2. Inflight death
3. Compromising the health and safety of the passenger or other aerospace vehicle occupants, and/or the safety of the flight
4. Interference with the use (don and doff) and operation of personal protective equipment
5. Interference with inflight emergency procedures or emergency evacuation
6. Having a negative effect on the passenger's health as a result of exposure to aerospace flight. Prospective passengers should be cautioned on the potential hazards to health of aerospace flight, including the hazards of exposure to solar and cosmic radiation, acceleration, and microgravity. It must also be recognized that no conclusive data exist concerning the potential adverse physiologic and pathologic effects of space flight on infants or young children. For this reason, operators may wish to establish a minimum age for passengers participating in aerospace flights.

APPENDIX A

MEDICAL HISTORY ASSESSMENTS OF PASSENGERS IN SUBORBITAL AEROSPACE FLIGHTS

These prospective aerospace passengers should complete a questionnaire about their medical history of any of the following conditions:

- Otitis, sinusitis, bronchitis, asthma, or other respiratory disorders
- Dizziness or vertigo
- Fainting spells, or any other loss of consciousness
- Seizures
- Tuberculosis
- Surgery and other hospital admissions
- Visits to physicians in the last 3 years
- Recent significant trauma
- History of decompression syndrome (DCS)
- Anemia or other blood disorders
- Heart or circulatory disorders, including implanted pacemaker or defibrillator
- Mental disorders
- Claustrophobia
- Attempted suicide
- Use of medications
- Alcohol or drug dependence or abuse
- Date of last menstrual period, current pregnancy, recent post-partum (less than 6 weeks), or recent spontaneous or voluntary termination of pregnancy
- Diabetes
- Cancer
- Rejection for life or health insurance

APPENDIX B

MEDICAL HISTORY ASSESSMENTS OF PASSENGERS IN ORBITAL AEROSPACE FLIGHTS

Prospective orbital aerospace passengers should complete a questionnaire about their medical history if they have a history of any of the following conditions:

- Otitis, sinusitis, bronchitis, asthma, upper respiratory infections, or other respiratory disorders
- Allergies
- Dizziness or vertigo
- Significant motion sickness requiring medication
- Fainting spells or any other loss of consciousness
- Seizures, convulsions, epilepsy, stroke, muscular weakness, or paralysis
- Tuberculosis, hepatitis, AIDS, or other chronic infectious disorder
- Surgery, recent or remote, or other admission to hospital
- Recent significant trauma
- Anemia or other blood disorders
- Heart or circulatory disorders, including implanted pacemaker or defibrillator
- Uncontrolled high or low blood pressure
- Mental disorders (including depression, anxiety, fear of flying, fear of heights, fear of closed spaces, fear of open spaces, etc.)
- Attempted suicide
- Use of medications
- Alcohol or drug dependence or abuse
- Date of last menstrual period, current pregnancy, recent post-partum (less than 6 weeks), or recent spontaneous or voluntary termination of pregnancy
- Severe hay fever or allergies
- History of pneumothorax (collapsed lung)
- Kidney stones or blood in urine
- Gallstones or gallbladder disease
- Diabetes
- Cancer
- History of radiation treatment or occupational exposure to radiation
- Rejection for life or health insurance
- History of decompression syndrome (DCS)
- History of previous space flights

Physical Examination Assessments of Passengers in Orbital Aerospace Flights

Prospective aerospace orbital passengers should receive a general physical examination that includes:

- Vital signs (heart rate, respiratory rate, temperature, blood pressure)
- Head, face, neck, and scalp
- Nose, sinuses, mouth, throat, ears (including eardrum integrity and function, Eustachian tube function)
- Ophthalmological evaluation (including pupil function, ocular motility)
- Lungs and chest
- Heart (including precordial activity, rhythm, sounds, murmurs)
- Peripheral vascular system
- Abdomen and viscera (including hernia)
- Genitourinary system
- Upper and lower extremities
- Spine
- Lymphatics
- Rectal, pelvic, and breast examination should be performed only if indicated by medical history
- General neurological evaluation
- General psychiatric evaluation (appearance, behavior, mood, communication, and memory)

Medical Testing of Passengers in Orbital Aerospace Flights

Prospective passengers in Orbital Aerospace Flights should complete the following general medical tests:

- Routine hematology
- Clinical chemistry (serum)
- Urinalysis
- Resting EKG
- Chest X-rays (PA & lateral)
- Visual acuity (corrected)
- Pregnancy testing (optional)
- Hearing (conversational voice at 6 ft)
- Tympanometry and/or tonometry (if clinically indicated)
- Pulmonary function testing (if clinically indicated)

Pre-Flight Medical Interview and Physical Examination Requirements for Passengers in Orbital Aerospace Flights

Prior (within one to two weeks) to the actual departure of an orbital commercial aerospace flight, all passengers should be subjected to an abbreviated pre-flight medical interview and physical examination. The purpose of this pre-flight medical screening is to ensure that these passengers have not developed medical conditions that may have occurred since the last medical clearance was issued. Such a pre-flight medical screening should include vital signs and a brief medical history and physical examination concentrating on the following: eye, ear, nose, throat, cardiopulmonary, gastrointestinal tract, musculoskeletal, and neurological systems. A brief mental status assessment should also be obtained. Because of the potential hazards of aerospace flight (including exposure to solar and cosmic radiation, acceleration, and microgravity), it is recommended that a female of child-bearing age be offered a pregnancy test. Operators may wish to consider excluding pregnant women from participating in aerospace flights.