# IGSA-STD-1

*INTERNATIONAL GUIDELINES AND STANDARDS FOR SPACE ANALOGS*

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## TABLE OF CONTENTS

## LIST OF APPENDICES

## DOCUMENT HISTORY LOG

| Status | Document Revision | Approval Date | Description |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

## FOREWORD

The purpose of guidelines and standards is to provide a platform for developing practical tools through common understanding and cooperation with all stakeholders. A standard is a document containing practical information and best practices.

IGSA-STD-1 provides guidance related to space analogs. Space analogs are facilities on Earth that are analogous to those in space. Analogs can simulate aspects of a spacecraft, a space habitat or have physical similarities to the extreme extra-terrestrial environments.

The goal of the organizing committee is to propose guidance; facilitate participation in the development process; manage any technical subcommittees; provide a neutral platform for the experts to collaborate and achieve consensus; coordinate the standards development process; make guidance available and increase awareness about the guidelines and standards. The IGSA-STD-1 committee is an international body of professionals and specialists on the topics covered in this document.

In this standard, "**shall**" denotes a mandatory requirement, "**may**" denotes a discretionary privilege or permission, “**can**” denotes statements of possibility or capability, **"should**" denotes a good practice, and "**will**" denotes an expected outcome.

## 1. SCOPE

### 1.1 Purpose

The purpose of this document is to:

1) Improve space analog mission operations and safety
2) Create a more cohesive process across the space analog industry
3) Develop trust and integrity with the public, companies, nonprofit organizations, academia, researchers, innovators and funding agencies
4) Develop a common language to measure and evaluate performance

### 1.2 Objectives

The objectives of this document are to:

1) Protect mission organizers, directors, and analog astronauts by ensuring safety and quality control
2) Allow interoperability of research and missions among habitats
3) Promote international collaboration
4) Improve fidelity of research
5) Improve synergy, eliminate duplication of effort, and optimize resources
6) Maximize funding and education outreach opportunities

### 1.3 Applicability

This document is applicable to habitat owners, individuals, crews, researchers, innovators and mission organizers wanting to participate in or conduct an analog mission as defined in Appendix A.

# 2. APPLICABLE DOCUMENTS

## 2.1 General

**2.1.1** References are provided in Section 9.
**2.1.2** Acronyms, abbreviations, and symbols are provided in Appendix A.

## 2.2 Additional Documents

**2.2.1** The Standard Supplement will include, at a minimum:

1. Information and resources regarding Institutional Review Boards (IRB)
2. An analog toolkit with case studies, best practices, exercise, virtual lectures and videos
3. Guidance related to the Analog Research Database
4. Underwater analog-specific information
5. Threat and vulnerability assessment checklists for directors
6. Risk assessment and “heat map” example for directors
7. Example of research proposal risk assessment and mitigation plan
8. A checklist for Analog Mission Performance
9. Suggested pre-mission training
10. Space analogs and the United Nations Sustainable Development Goals

## 2.3 Order of Precedence

**2.3.1** The recommendations and standards established in this document do not supersede or waive existing requirements and standard practices set by your organization, affiliation, or country of residence.
**2.3.2** Any training referenced in this document is recommended only.

# 3. SAFETY

The safety of personnel, equipment, and the environment is of utmost importance in any analog space mission. The goals of this section are to provide guidance on reducing risk and ensuring the safety of personnel, equipment and the environment during analog missions. This section will cover various aspects of safety including, but not limited to, crew health, emergency response planning, hazardous materials management, and equipment safety.

A safety culture is not just a set of rules; it's a mindset and a commitment to the well-being of individuals and the safe completion of mission tasks. First and foremost, it acts as a shield, safeguarding lives by promoting secure practices and drastically reducing the occurrence of accidents. Moreover, a safety culture is a proactive force, emphasizing prevention. The feeling of safety typically leads to increased crew morale, motivation, and task satisfaction. Economically, a safety culture acts as a financial safeguard, curbing losses attributed to medical expenses, compensation, and legal fees resulting from accidents. Additionally, it enhances an entity's reputation and fosters trust among stakeholders. Lastly, it dovetails with sustainability efforts, ensuring efficient resource utilization, reducing waste, and minimizing environmental impact.

### 3.1 Safety and Quality Assurance for Analogs

The analog must exhibit a commitment to safety and ensure it is an essential part of all analog activities such as planning, budgeting, and operational procedures. Analogs should consider obtaining liability insurance, as it protects the analog financially if responsible for injuries such as falls or burns, and property damage incurred as a result of habitat operations or crew experiments. Depending on the country, a release of liability waiver covers only ordinary negligence. If an organization commits gross negligence or intentional harm, the release of liability waiver may no longer be applicable. The difference between ordinary and gross negligence can be a fine line. In general, ordinary negligence occurs due to accidents or inattention. Gross negligence occurs when an entity fails to use reasonable care to protect inhabitants. Adherence to this standard will help analogs make a compelling argument for why they are not a risk and assist in obtaining necessary insurance.

**3.1.1** Objective: The objective of safety and quality assurance for space analogs **shall** ensure all technical and programmatic risks associated with analog missions are adequately managed through the implementation of an effective safety and quality assurance program.

**3.1.2** General principles: The habitat operator is responsible to demonstrate that a safety and quality assurance program is established, implemented, and maintained. This program will cover the definition, design, development, implementation, and continuous improvement of:

a. Competencies
b. Processes
c. Facilities

The early identification of aspects potentially detrimental to the safety of persons occupying the analog, the quality of service provided by the analog, and effective prevention of any adverse consequence of such aspects, are the basic principles of the analog safety and quality program.

**3.1.3** The analog **shall**:

a. Demonstrate all personnel (employed by the station, volunteers, and crew members) are competent and qualified to perform their assigned tasks.
b. Demonstrate all personnel comply with all safety regulations.
c. Demonstrate that personnel undergoing on-the-job training at the station are properly supervised.
d. Demonstrate any additional technical and key personnel called in during a mission are supervised and competent, and they work in compliance with the analog’s quality and safety management system.
e. Provide the proper safety training to all analog personnel and crew conducting or supporting potentially hazardous operations (all analogs).
f. Perform risk and safety briefings to analog personnel and crew members on potential risks associated with operating equipment, such as rovers and machinery. These briefings must include dry runs of the tasks to be performed and associated emergency actions.

**3.1.4** Accidents, incidents, and emergencies.

The analog safety program **shall** include, as a minimum, the following accident, incident and emergency procedures:

1. The general emergency procedure for the analog
2. The procedures followed in case of accident or incident
3. The clear description of the responsibilities and authorities in all accident, incident and emergency procedures

The emergency procedures **shall** be part of the safety briefing of analog staff and crew members.
(Adopted from ECSS-Q-ST-20-07C DIR1, 28 August 2013)

## 3.2 Emergency Procedures

An emergency is a sudden, unexpected, and often dangerous situation requiring immediate action or attention. Emergencies can encompass a wide range of events, including natural disasters (such as earthquakes, floods, or hurricanes), accidents, medical crises, fires, or any situation posing an immediate threat to life, health, property, or the environment. Responses to emergencies involve rapid decision-making, coordination of resources, and efforts to minimize harm and provide assistance to those affected.

**3.2.1** Clear and concise procedures **shall** be in place to ensure the safety and well-being of all participants in the event of an emergency.

**3.2.2** By identifying roles and responsibilities for emergency situations in advance, a chain of command **shall** immediately be established to ensure swift and effective decision-making.

**3.2.3** All participants **shall** be trained on emergency procedures and **shall** have access to emergency communication systems.

## 3.3 Medical Support

**3.3.1** Appropriate medical support and supplies **shall** be provided for the mission, including a fully stocked medical kit.

**3.3.2** Pre-, in- and post-mission medical follow-up should be carried out by an attending physician trained in first aid and the clinical specifics of medicine in extreme environments. If the medical officer is not an attending physician, they shall be supervised and trained prior to the mission by an attending physician with the above qualifications. Medical officers must have appropriate valid medical indemnity in place.

**3.3.3** The medical kit should include medicines for common ailments, basic life support equipment, basic trauma support equipment, basic psychological support, and diagnostic equipment. Medical grade oxygen with a functional delivery system should be available to the crew when applicable (e.g. diving activities, altitude, airtight system, etc.)

**3.3.4** There should be contact with the local emergency response providers so they are aware a mission is taking place, GPS coordinates, and major risks.

**3.3.5** Medical data **shall** be treated as confidential. Storage of medical data **shall** be restricted to doctors/medical officers only. If medical data must be shared during transmissions between analog astronauts and the control center, exchanges **shall** take place over dedicated private channels.

## 3.4 Environmental Monitoring

**3.4.1** The habitat and surrounding environment should be monitored to ensure safe conditions for the mission.

**3.4.2** The habitat environment monitoring environment should include continuous monitoring of temperature, humidity, oxygen, carbon dioxide, carbon monoxide, methane, benzene or other harmful gases, if potential sources of such are present.

**3.4.3** The monitoring systems should have backup systems, alarms, and protocols in place in case of primary system failure.

## 3.5 Location

**3.5.1** The mission should be located in a safe environment for the ground crew, Mission Control Center (MCC), and analog astronauts. The location should be geographically stable, free from natural disasters like earthquakes, active volcanoes, and extreme weather events.

**3.5.2** The location **shall** have access to emergency medical services in case of an emergency.

**3.5.3** The location **shall** also have adequate resources, such as transportation, communication systems, potable water, functional waste management system and electricity to support the mission.

## 3.6 Fire

Due to location, construction and environmental hazards, habitats **shall** have a program for fire prevention, detection, control, and suppression through design, inspection, and training. A fire protection and life safety program consists of fire protection and life safety engineering to minimize the occurrence of fire and fire loss through engineering designs and systems, fire prevention to inspect for analog astronaut-created fire hazards and provide fire safety education and training, and a fire suppression force to minimize losses in the event of a fire.

Facility records for fire protection and life safety systems and building code inspections **shall** be maintained in accordance with the laws and regulations of the jurisdiction.

Analogs may consider the following:

a) Building code analysis (e.g., type of construction, height and area limitations, and building separation or exposure protection).
b) Life safety analysis (e.g. occupancy loads, travel distances, fire separations).
c) Classification of occupancy and identification of hazardous areas.
d) Requirements for fire-rated walls, fire-rated doors, fire dampers with their fire-resistive ratings, smoke compartmentation, and smoke barriers.
e) Analysis of automatic sprinkler and suppression systems and protected areas including analysis of required water demand.
f) Water supplies, water distribution, location of fire hydrants.
g) Smoke control methods and systems.
h) Fire alarm and detection systems, including monitoring.
i) Standpipe systems and fire extinguishers.
j) Interior finish ratings.
k) Coordination with security requirements.

l) Coordination with Fire Department requirements.

*(Adopted from NASA-STD-8719.11B – 2020-08-20, with Change 1,02-24-2021)*

## 3.7 Threat, Vulnerability, and Risk Management

Analogs **shall** have a risk management program, informed by threat and vulnerability assessments. *(Threat plus vulnerability equals risk)*.

**3.7.1 Threat Assessment** *(This section is adopted from NASA Information Technology Threats and Vulnerabilities)*: Analogs **shall** identify which threats apply to their location and mission:

**3.7.1.1 Environmental *(undesirable site-specific chance occurrences)***

a) Wildfire
b) Flood
c) Tsunami
d) Earthquake
e) Volcanic Eruptions
f) Lightning
g) Severe Weather
h) Smoke
i) Dust
j) Insects
k) Rodents
l) Chemical Fumes
m) Sprinkler Activation
n) Water Leakage - pipe breakage, hole in roof, condensation
o) Explosion - nearby gas line, chemical plant, tank farm, munitions depot
p) Vibration - nearby railroad track, jet traffic, construction site
q) Electromagnetic Interference - suggested by poor radio reception or jittery workstation displays
r) Electrostatic Discharge - suggested by "sparking" to grounded objects

**3.7.1.2 Physical *(undesirable site-specific personnel actions)***

a) Unauthorized Facility Access
b) Theft
c) Vandalism
d) Sabotage
e) Terrorism/Bomb Threat
f) Labor Unrest - employees and support contractors
g) War/Civil Unrest
h) Improper Transportation - equipment dropped, submerged, exposed to weather or X-rayed in transit
i) Improper Mounting/Storage - equipment exposed to bumps, kicks or weather
j) Spillage/Droppage - hazardous materials permitted near equipment (e.g. food, liquids)

k) Magnets/Magnetic Tools - can erase data or damage sensitive equipment
l) Collision - forklift, vehicle, rover, drone, wheelchair
m) Trip Hazards/Falls - Structural and other habitat hazards
n) Fire Hazards - flammable materials stored onsite or nearby
o) Improper Operation - operating equipment beyond capacity or outside of manufacturer's constraints
p) Improper Structural Configuration - short term remedies are not in line with accepted codes or practices

**3.7.1.3 Site-Support *(foundational site aspects)***

a) Power Outage
b) Extreme/Unstable Temperatures
c) Extreme/Unstable Humidity
d) Unsafe Environment - unfit for human occupation
e) Facility Inaccessibility - blocked ingress which delays emergency response
f) Inability to Cut Power - during fire, flood, etc.
g) Electrical Noise/Bad Grounding - suggested by flickering lights or jittery workstation displays
h) Improper Maintenance - unqualified support or preventive maintenance behind schedule
i) Personnel Unavailability - inability to contact operations or support personnel
j) Communication Failure - inability to contact the habitat from outside, inability for the habitat to call out, service completely unavailable
k) Fire Suppression - Unavailable or insufficient - water, foam, Purple-K, Halon
l) Delayed Trash Disposal

**3.7.1.4 Technical *(Computers, Servers, Equipment)***

a) Unauthorized Software Use - creating and using copies of licensed software not covered by a valid license
b) Unauthorized Logical Access - acquiring the use of a system for which no access has been authorized (as opposed to gaining physical access to the hardware)
c) Malfeasance (exceeding authorizations) - acquiring the use of a system in excess of that which has been authorized
d) Unsanctioned Use/Exceeding Licensing - utilizing authorized system resources for unauthorized purposes
e) Lack of firewalls and virus detection, protection and mitigation software
f) Communications Failure/Overload - communications structure may stop providing service or is unable to provide service at the requested capacity
g) Protection of data gathered from health experiment questionnaires and other research activities
h) Geo-location - system inadvertently reveals the current physical location of users

*Note: The risks for an underwater analog space mission or underwater activities conducted within the scope of an analog space mission may differ from ones related to surface-based analog space missions. In this regard, please seek adequate training and expertise before commencing such activity.*

#### 3.7.2 Vulnerability Assessment

Understanding vulnerability is critical to the analog's ability to ensure a successful mission and lessen risk of injury, death or damage. Analogs shall conduct a vulnerability assessment.

*Rationale:*

*After identifying potential threats, examine each and determine the extent to which you are vulnerable.*

#### 3.7.3 Risk Assessment and Mitigation

After identifying threats and assessing vulnerability, the analog **shall** conduct a risk assessment and undertake mitigation actions.

*Rationale:*

*A best practice is to score each threat based on likelihood of occurrence times impact. For instance, if the habitat is located in an earthquake zone, how often does the area experience tremors? Based on its construction and location, how vulnerable is the habitat to damage and level of impact to crew? For threats to human lives and well-being, the risk of late detection shall be included in the risk assessment (e.g., external vs. internal bleeding). In this case, the risk shall be scored by multiplying likelihood with impact and late detection.*

*Risks are not only a threat to analog mission success, but if not identified and mitigated, they can impact the safety of the crew. The objective of risk management is to identify, manage, monitor and report analog risks in a systematic, proactive, comprehensive manner. This assessment takes into account the analog's technical and programmatic constraints. Risks are ranked according to their likelihood and the severity of impact on the mission and crew safety. There are four ways to mitigate risk: avoidance, reduction, transference, and acceptance. Refer to ISO 31000, Risk Management, ESA ECSS-M-ST-80C 31 July 2008, Space Project Management, and the NASA Risk Management Handbook for guidance in developing a risk assessment program.*

### 3.8 Hazards

A hazard is something which could potentially cause harm. Risk is the degree of likelihood that harm will be caused. Hazard assessment and analysis results in the identification of hazards and the means of controlling or eliminating them. Hazard analysis is an important tool in the design process, requirements validation, and risk management. (Source: NASA Hazard Analysis Process)

#### 3.8.1 Hazard Risk Assessment

The analog facility **shall** perform a hazard risk assessment to identify and characterize safety risks of mission operations.

*Rationale:*

*Human rated spacecraft undergo a rigorous hazard risk assessment during development and operations so risk can be fully understood and addressed. This primarily occurs during the design process but is a continual process for each* *mission. Hazards which are not eliminated are captured and incorporated into procedures, guides and training.*

**3.8.2 Hazard Mitigation and Control**

The analog facility **shall** develop methods of controlling or mitigating hazards identified in the Hazard Risk Assessment.

*Rationale:*

*Every effort should be taken to reduce the likelihood of injury to crew, personnel, or facilities during the mission operations. Each identified hazard should have associated controls to minimize or eliminate its likelihood of occurrence or minimize the severity of the result if it were to occur.*

**3.8.3 Cautions and Warnings**

The analog facility **shall** provide visible notification of hazards to the crew via caution and warning signs, labels, placards, or checklists where necessary throughout the facility.

*Rationale:*

*Analog mission training is often brief and limited therefore the use of visible hazard notifications throughout the facility in the form of signs, labels, placards or checklists are highly recommended.*

**3.8.4 Analog Hazards**

Analogs **shall** consider the following hazard to include, but not limited to the following:

a) Radioactive sources and generators
b) Explosive or pyrotechnic devices
c) Jettisonable devices
d) Mechanical energy
e) Mechanical properties, such as sharp, rough and slippery
f) Physical properties such as confined space or working at heights
g) Pressurized vessels, including vacuum vessels
h) High voltages
i) High intensity light sources and lasers
j) Radio frequency sources
k) Flammable, toxic or aggressive chemicals
l) Outgassing products and components
m) Biological hazards, including regolith replicants
n) Temperatures based on chemical reactions (hot or cold)
o) Noise
p) Other safety hazards not mentioned above

*(Adopted from ECSS-Q-ST-20-07C DIR1, 28 August 2013)*

Underwater habitats include different risks and requirements and are habitat specific. More information and guidance can be found in the National Oceanic and Atmospheric Administration and U.S. Navy diving manuals listed in Section 8.2.3 and the Supplement.

**3.8.5** Analogs shall have a Chemical Hygiene Plan (CHP).

*Rationale:*

*The CHP establishes a formal written program for protecting laboratory personnel against adverse health and safety hazards associated with exposure to potentially hazardous chemicals and must be made available to all station staff and analog* *astronauts working with hazardous chemicals. See this guidance for more information:* https://www.osha.gov/sites/default/files/publications/OSHAfactsheet-laboratory-safety-chemical-hygiene-plan.pdf

### 3.8.6 All-Hazards Approach

Due to limited resources and the variety of space analog stations, the recommended framework for stations to adopt is an all-hazards approach where the set of tools and actions applied in disaster scenarios are as similar as possible to address all types of hazard scenarios. The all-hazards approach is based on the idea that while the causes and types of emergencies can vary widely and be hard to predict, the basic functions needed to respond are relatively similar from one event to the next. There are common actions taken during an emergency, for example command and control, crisis communication, dispatching specific individuals or resources to the location, conducting initial response and life safety activities, performing an initial assessment of the situation, decision to evacuate and returning to normal operations. An all-hazards plan develops these capacities and capabilities.

### 3.8.7 Disaster Management

Analogs **shall** have a disaster management plan for the staff and crew. The basic structure for disaster planning includes the four phases of comprehensive emergency management: mitigation, preparedness, response, and recovery.

a) Mitigation involves preventive measures to address threats and vulnerabilities, lowering risk.
b) Preparedness builds capabilities to manage the impact of hazards and includes drills and exercises, education, and stockpiling supplies.
c) Response is an action to reduce adverse actions during the disaster such as managing damage to structures and equipment, as well as triage of injured crew members and treatment of injuries.
d) Recovery involves actions to restore areas in the habitat affected by the disaster to pre-disaster operations.

The analog and crews should strive to build disaster resilience. Disaster resilience is the ability to adapt to and recover from hazards, shocks or stresses without compromising mission success.

Scenarios for disaster management training can mirror those used to train astronauts for the four main potential emergencies on the International Space Station: fire, toxic leaks, medical emergencies and loss of pressure with a need to evacuate the station. The more realistic the training, the better prepared analog astronauts, mission control and mission support teams will be to manage real life station emergencies.

## 4. CREW SELECTION PROCESS AND PROCEDURES

The selection of crew members for an analog space mission is a critical process that can impact the success and safety of the mission. The goals of this section are to provide guidelines for the selection and training of crew members and mission control for analog space missions. This section will cover the various steps involved in the selection process, including job requirements, medical and psychological evaluations. The aim is to ensure the best-suited individuals are selected for the mission to form a well-coordinated team, and are prepared for the unique challenges of operating in an analog space mission.

Analogs must protect documents gathered during the selection process, such as medical and psychological evaluations. In the United States, HIPAA, or the Health Insurance Portability and Accountability Act, is a U.S. federal law enacted in 1996. It establishes national standards to protect individuals' medical records and other individually identifiable health information, collectively defined as protected health information (PHI). HIPAA regulations ensure the security and privacy of patients' sensitive health information. Compliance with HIPAA is mandatory for healthcare providers, health plans, healthcare clearinghouses, and their business associates who have access to PHI. HIPAA violations can result in significant fines. The Office for Civil Rights within the U.S. Department of Health and Human Services enforces HIPAA rules. The operators of analogs must comply with the laws and regulations of their respective country when securing PHI.

## 4.1 Analog Astronaut Selection Criteria

Analog directors **shall** consider the following criteria when selecting crew (see Supplement for additional guidelines).

**4.1.1** Physical and Mental Fitness: The candidates should have an adequate level of physical and mental fitness defined by the respective habitat facility and corresponding to the specifics of a given analog space mission.

**4.1.2** Medical and health related criteria: The candidates should obtain a medical evaluation during the selection. Previous and current medical issues, as well as risks for arising medical problems should be outlined. Previous and current medical and pharmacological treatment should be recorded. No-Go-criteria, relevant to the specific mission should be identified by the habitat (e.g. cardiovascular, respiratory, heat or cold related abnormalities, skin lesions and infection, etc.). All participants in underwater activities **shall** be considered fit to dive according to applicable fitness to dive standards (see NOAA standards in the reference section and diving guidance in the Supplement).

**4.1.3** Previous Experience and Training: The candidates should have prior experience and training in related fields, such as engineering, science, medical, military operations, leadership, conflict management, intercultural competence, psychology, arts, and diving, as these can be an asset in a space analog mission.

**4.1.4** Psychological conditions should be analyzed prior to the mission. This should include prior and current history of psychiatric disorders, psychotherapeutical and pharmacological treatment. Individual and intrapersonal traits and behaviors should be examined, using psychometric data, interviews or other appropriate approaches. Strongly consider an emotional intelligence assessment.

**4.1.5** Leadership: When possible, those considered for leadership positions (for example, as the commander or XO) should have significant, documented leadership experience from professional, personal and/or prior analog activities. This is essential for decision making, strategic thinking, crew motivation, team building, conflict resolution and managing emergency situations.

**4.1.6** Teamwork: Strong teamwork skills are essential to ensure effective collaboration among the crew in achieving the mission objectives.

**4.1.7** Communication Skills: Effective communication skills are critical in space analog missions to ensure clear, effective, and efficient communication between crew members and with Mission Control.

**4.1.8** Emergency Management: The candidates **shall** demonstrate their ability to manage emergency situations and make quick, decisive decisions in high-pressure environments. This assessment can be made from past professional or personal experiences, or during the interview process.

**4.1.9** The last stage of the crew selection process should include consideration for group composition and merging individual candidates into a cohesive team with a balance of skills and capabilities.

## 5. TRAINING

Upon selection of analog astronauts, mission control and support personnel, it is the responsibility of the mission organizer (typically the habitat director) to ensure the MCC (or the Mission Support Center, MSC) and analog astronauts are properly trained. The goal of this section is to provide guidelines for appropriate training of crew members prior to the analog space mission. This section will cover the areas of training, training delivery, and methods. The aim is to ensure individuals selected for the mission are prepared for the unique challenges of operating in an analog space mission.

Certified trainers should perform training. See the supplement for a list of possible training sources.

### 5.1 Human Performance Training

**5.1.1** Physical Training: Analog astronauts should undergo physical training to improve their strength, physical endurance, stability, and reduce the risk of injury during the mission.

**5.1.1.1** In the event missions require physical exercise activities:

a) Analog astronauts **shall** receive proper movement form training.
b) Analog astronauts **shall** receive training in proper exercise modifications.
c) Analog astronauts should receive training on proper use of exercise equipment.

**5.1.1.2** In the event missions require physical exertion:

a) Analog astronauts **shall** be trained according to those listed in 5.1.1.1.
b) Analog astronauts **shall** receive endurance training.
c) Analog astronauts **shall** receive training in recovery methods.

**5.1.1.3** In the event missions require traversing risky environments such as rocky terrain, underwater, or other environments with little to no visibility or difficult terrain:

a) Analog astronauts **shall** be trained according to those listed in 5.1.1.2.
b) Analog astronauts **shall** receive balance, stability, and fall training.
c) Analog astronauts **shall** receive strength and conditioning training.

*Rationale:*
*All crew members need to be able to perform any planned tasks efficiently and effectively, without risk of injury. Factors leading to serious (acute or chronic) injuries or health concerns include:*

1. *Improper form during exercise or other physical activities; Inappropriate scaling of movements (when an individual performs a movement exceeding their current abilities, which is driven by lack of knowledge, ego, or peer pressure to perform a certain skill or movement); Improper use of equipment.*
2. *Physical overexertion (inability to bear the weight of the spacesuit and/or equipment necessary to conduct research objectives, muscle injuries); cardiovascular overexertion (high blood pressure, dizziness and light-headedness, hyperthermia, hypothermia ).*
3. *Unstable terrain; disproportionately distributed weight (i.e. spacesuit, equipment)*

*Certain injuries and health conditions can cause the analog astronaut to be unable to conduct research objectives and mission tasks, emergency removal from the mission, and/or mission abortion.*

**5.1.2** Psychological and Behavioral Training: Analog astronauts should receive training in coping with the psychological and behavioral challenges of a space analog mission, including isolation and confinement.

**5.1.2.1** Analog astronauts should receive training in stress management, coping strategies, and emotional regulation.

*Rationale:*
*Crew members may underestimate the psychological challenges encountered during an analog mission. It is necessary that analog astronauts have an awareness of challenges and risks, as well as a cognitive toolbox to cope with these challenges. Psychological and behavioral challenges can compromise the mission and put the analog astronaut or other crew members at risk.*

**5.1.3** Team Cohesion: Analog astronauts and mission control **shall** receive training in communication, conflict management, leadership, teamwork, and culture to ensure effective collaboration during the mission, unless the mission requires a pool of candidates who are untrained for the purpose of research.

**5.1.3.1** Analog astronauts **shall** receive training in communication models, effective communication strategies, methods of communication, and listening skills.

**5.1.3.2** Analog astronauts **shall** receive conflict management training and training in conflict resolution strategies.

**5.1.3.3** Analog astronauts, especially those performing the role of commander or other leadership role, should participate in leadership and followership training.

**5.1.3.4** Analog astronauts should participate in several team building-specific activities as a crew, with at least one session in-person.

**5.1.3.5** Analog astronauts should participate in cultural awareness training.

*Rationale:*
*Analog missions are dependent on effective collaboration of its crew, where individuals are required to co-exist in a small space and work together to achieve a common goal. Isolated, confined, and extreme environments can pose a threat to crew cohesion causing tension and conflict, interpersonal relations and social support, and crew autonomy, thus requiring interpersonal skills training. Team building activities during the mission can model Bruce Tuckman's 5 stages of team development - forming, storming, norming, performing and adjourning. It is ideal if the crew can navigate the first three stages of development prior to mission start.*

**5.1.4** Human Factors Training: Analog astronauts should receive training in understanding the basis of human error and the associated environmental threats associated with the mission or mission task. This includes but is not limited to:

**5.1.4.1** Analog astronauts should receive training in understanding human error models such as the Swiss Cheese Model of human error.

**5.1.4.2** Physical Environmental Threats

a) Analog astronauts should receive awareness training in the Extra Vehicular Activity (EVA) environment to include terrain, weather, visibility, and proximity to the nearest hospital.
b) Analog astronauts should receive awareness training in the habitat environment to include workspace, hygiene, housekeeping, privacy, hazardous materials, and waste.

**5.1.4.3** Psychosocial Environmental Threats

a) Analog astronauts should receive awareness training of individual threats such as lack of situational awareness, hazardous attitudes, and excessive workload.
b) Analog astronauts should receive awareness training of interpersonal threats such as conflict, miscommunication, and team deterioration.

*Rationale:*
*Dr. James Reason, an expert in the field of aviation safety and human error, developed the Swiss Cheese Model to identify hazards and active failures resulting in a loss. Understanding this model may enable the crew to better assess and manage risks. Awareness of environmental threats may reduce the likelihood of mishaps by allowing individuals to recognize them before they occur. Once a threat is recognized, the individual or crew can assess and correct. Source:*
https://www.engineeringforhumans.com/systems-engineering/the-swiss-cheese-model-designing-to-reduce-catastrophic-losses/

## 5.2 Health and Safety Training

**5.2.1** All participants **shall** receive comprehensive safety training, including crisis management.

**5.2.2** All analog astronauts **shall** receive comprehensive training on emergency procedures, including evacuation, basic life support, trauma support and first aid. They **shall** also receive additional training relevant to the setting of the analog station, for example remoteness and distance from medical care, climate extremes, flora and fauna. First aid training **shall** include circulation management, cardiopulmonary resuscitation (CPR) and treatment for shock.

**5.2.3** Participants **shall** be trained in the proper use of medical equipment, and supplies in the medical kit.

**5.2.4** Participants should be trained in Psychological First Aid (PFA). PFA is an evidence-informed approach built on the concept of human resilience. PFA aims to reduce stress symptoms and assist in a healthy recovery following a traumatic event, natural disaster, public health emergency, or even a personal crisis.

## 5.3 Habitat Systems and Operations Training

**5.3.1** Nominal Systems Training
The analog facility **shall** provide training on nominal use of all systems, whether there are plans for them to interact with the system during the mission or not.
*Rationale:*
*Training on all systems will lessen the potential risk of injury to crew or damage to facilities over the course of the mission. This training should cover the systems the crew are expected to interact with in detail but also should cover the systems the crew are not expected to use so they are aware of and understand expected boundaries. During off-nominal situations, crew may be asked to undertake an activity outside their normal duties, thus the need for training on all systems.*

**5.3.2** Off-Nominal Systems Training
Off-nominal means that an event or condition is abnormal, unexpected, or outside the planned operating range. The analog facility **shall** provide training for the response to off-nominal systems conditions.
*Rationale:*
*Training the crew to respond to off-nominal conditions will equip the crew to recover from initial systems failures without having to compromise an experiment or break the simulation. This provides resiliency for mission success.*

**5.3.3** Training Reinforcement
In addition to in-person on-site training, the analog facility should provide written training material in an adequate amount of time prior to the mission so participants can familiarize themselves with the resources and ask clarifying questions.
*Rationale:*
*In-person training before an analog mission is often very brief. Providing written reference material in the form of summary sheets, checklists, guides and manuals prior to crew arrival at the site will provide reinforcement for the crew and mission control/support teams to improve mission success.*

**5.4** The analog habitat **shall** create and maintain a log tracking completion of training. This repository should demonstrate the rationale for the development of the training material and training processes, as well as the integration of lessons learned to improve training after each mission. This repository should be accessible for all concerned parties.
*Rationale:*
*Keeping a log to track completion of training ensures everyone receives the required training. The log protects everyone involved in the event of a mishap.*

# 6. RESEARCH

Every analog space mission should have a clear research focus. Ideally, analog research should be clearly defined by a hypothesis or research question seeking to answer a real research gap that will advance human spaceflight, although some stations may allow other types of research. This may include testing of habitat functionality, testing equipment/technology for quality improvement, or habitat maintenance work.

Any research involving human subjects must be approved by an IRB prior to the analog space mission. Refer to the Supplement for specific information related to obtaining Institutional Review Board (IRB) review and approval, which is required for projects involving human subjects and include any interaction or intervention with human subjects or involve access to identifiable private information.

## 6.1 Selection and Procedures

**6.1.1** Pre-mission approvals should account for ethics, environment, import regulations, data protection laws, export control, human research (IRB), transportation of biological and geological material, national, regional and local laws, and regulations

**6.1.2** Checklists with specific essential research tasks should be included.

**6.1.3** Research proposals should include these sections:

- **6.1.3.1** Coherence with the analog mission statement
- **6.1.3.2** Feasibility, ease of conducting the research
- **6.1.3.3** Variables being measured and data collection methods
- **6.1.3.4** Safety, how the researcher will protect crew members from injury
- **6.1.3.5** Each research proposal should include a risk assessment and mitigation plan; an example is found in the Supplement
- **6.1.3.6** Connection of the research to human spaceflight endeavors, if applicable
- **6.1.3.7** Space Mission Feature Approximation: how specific features of the space mission and environment being simulated will be approximated in the analog environment
- **6.1.3.8** Novelty, or unique qualities of the research (for example, building upon past research instead of duplicating). Replication of previous research is acceptable if it leads to verification of results and expansion of the research database.
- **6.1.3.9** Timetable for research activities before, during, and after the mission
- **6.1.3.10** Logistical requirements expected to be provided by the station
- **6.1.3.11** Technical requirements (power, bandwidth etc.)
- **6.1.3.12** Complexity of the task and training required before the mission
- **6.1.3.13** Materials that will be brought to the station, along with storage requirements
- **6.1.3.14** Ethics, including crew members' voluntary participation, informed consent, anonymity, and confidentiality; limiting potential for harm
- **6.1.3.15** Cost of the research
- **6.1.3.16** Sustainability, the judicious use of station resources such as energy, water, transportation, and leaving the station and its environment unimpaired

**6.2** Research Preparation

**6.2.1** Procedure Verification

Every research procedure intended to be performed during the mission should be verified by the principal investigator before the mission.

*Rationale:*

*To improve the likelihood of mission success each research procedure should be verified. Verification will ensure the procedure is feasible, complete and adequately supported by the analog with the materials/equipment expected to be on hand. Verification can be accomplished by rehearsing or practicing the procedure before the mission using the same or similar equipment as will be used during the mission, to the extent possible. The duration of the procedure should be verified during the same activity. Additionally, the habitat director should review the procedure and ensure the procedure is feasible for completion within the constraints and capabilities of the analog .*

**6.2.2** Research Timeline Validation

Research timelines should be developed and validated prior to the mission.

*Rationale:*

*Developing a timeline before the mission establishes a choreography to ensure all research procedures will fit within the constraints of the mission. Procedure durations should be verified during validation. Adequate time should also be allocated for gathering equipment before the activity and clean up and equipment re-stow after the activity. Generally speaking, determine the time to perform a task with preparation and clean-up and then add a factor x2. Add spare time in case of a failure of the system or delay in the schedule. Additionally, since multiple research activities during a mission often use the same space or equipment, those constraints should be factored into the timeline so conflicts do not occur. Once all the activities can be shown in a mission timeline without time, space, resource or equipment conflicts, the research timeline can be considered validated.*

### 6.3 Analog Astronaut Community Research Database

The Analog Astronaut Research Database was developed to avoid duplication of research projects, facilitate the continuation of past research efforts and support ongoing research at NASA, ESA, and other space agencies and organizations. The database will identify research gaps and assist analog astronauts in defining a hypothesis and research questions to frame their research project. The database also provides past research data (IRB rules and data protection rules/restrictions apply) for members to access. Refer to the Supplement for more information regarding the database.

## 7. MISSION PLANNING AND OPERATIONS

### 7.1 Mission Planning

Directors **shall** have a program or project management methodology that meets a relevant project management standard or policy. See the reference section for space project management guidelines.

#### 7.1.1 Pre-Mission Communication

Analogs **shall** provide critical information to the crew no later than one month prior to the mission start date. This information consists of, but is not limited to, pre-mission medical requirements such as immunizations or quarantine; training; equipment and materiel requirements; physical requirements or limitations and travel logistics. Habitat managers and mission organizers should have at least one call with the crew to address questions and concerns.

*Rationale:*

*Crews must have all necessary information early enough to prepare adequately. Last minute crew substitutions are disruptive and challenging. Proper preparation is critical for mission success.*

#### 7.1.2 Mission Timeline Development

Planning for each analog mission or expedition should include a documented timeline including all expected activities for each crew member for each day of the mission.

*Rationale:*

*The act of creating a timeline before the mission is a valuable exercise to ensure mission success. The timeline should include expected activities occurring each day and for each member of the mission, including events such as preparing lunch and rest periods. Without a timeline and structure, there is a higher level of uncertainty about roles, responsibilities, time management and the path towards meeting the objectives of the mission. This uncertainty can lead to higher levels of crew stress, anxiety, and conflicts.*

#### 7.1.3 Mission Equipment List

Planning for every analog mission **shall** include a documented list of required equipment, materials and consumables, parties responsible for each item and storage location in the habitat. The mission equipment list should also include back-ups/spares. Should there be several packages, each must contain a detailed packing list, enabling the crew and operations support teams to locate each item. Should any material or equipment have to be transported across borders, the packing lists must be available for customs inspection and clearance.

*Rationale:*

*Analog missions are often hampered by lost or forgotten supplies and equipment, and searching for items. Crew morale is degraded by poor planning for consumables like food and water, and the simulation may be interrupted to recover. To avoid these issues, materials necessary to equip the mission for success should be tracked in a structured manner. Assign a point of contact for each item (equipment, materials and consumables) and document the stowage location in the analog.*

#### 7.1.4 Mission Logistics Plan

Planning for every analog mission **shall** include a Logistics Plan if resupply missions are to be simulated. A default Logistics Plan should be documented before the mission. The content and timing of resupply should be built from this plan. The plan should be managed by mission control and shared with the crew. Delta to the plan can be requested by crew or mission control and the plan revised accordingly.

*Rationale:*

*Estimating consumables to include in simulated "resupply missions" during an analog mission can be difficult. Errors in these estimates can hinder the mission. Accurate calculation and planning will eliminate and minimize incorrect assumptions and surprises.*

#### 7.1.5 Simulation Start and End

Planning for every analog mission **shall** include negotiation and agreement on exact start and end times for the simulation.

*Rationale:*

*To avoid uncertainty and inadvertent breaks in the simulation, exact start and end times, down to the day and time-of-day, should be agreed to by all stakeholders, including principal investigators, crew and mission control.*

### 7.2 Mission Operations

Directors **shall** have a program or methodology for operations at their habitat.

#### 7.2.1 Simulation Start and End Protocol

Protocols and procedures for the start and end of the simulation **shall** be documented and made available to crew and mission control prior to the mission.

*Rationale:*

*The starting and ending of an analog mission can be confusing transitions; protocols and procedures will ensure proper coordination and limit non-simulation communication.*

#### 7.2.2 Communication Protocols

Communication protocols and procedures **shall** be documented and made available to the crew and mission control prior to the mission. The communication protocols and procedures should address nomenclature (what terms are used) and communication methods (intercoms, email, text messaging), as well as when communication can and cannot occur. The communication protocol should also address if a time delay in communication will be simulated during the mission and how to manage it.

*Rationale:*

*Analog missions have frequently been the victim of inadequately coordinated communication protocols between mission control and crew, mission control and crew families, and crew and outside entities. These issues waste time and add confusion, which can negatively affect morale.*

#### 7.2.3 Simulation Abort Protocols

Simulation Abort Protocols and procedures **shall** be documented and made available to crew and mission control prior to the mission. These **shall** include boundary conditions for decision-making.

*Rationale:*

*Understanding when, why, and how a mission can be aborted by mission control or crew is important to ensure crew safety during emergencies.*

#### 7.2.4 Routine Analog Procedures

Procedures documenting all routine analog facility activities **shall** be documented and made available to the crew and mission control prior to the mission.

*Rationale:*

*Errors and injuries are often made when only training is relied upon for the crew to complete activities during the mission. Documented procedures to be available as a reference will limit these issues. Additionally, if issues arise with the analog facility, these procedures provide a common ground for communication with mission control. Examples of routine procedures included air filter replacement,* *water management, food preparation, bathroom use if special systems are provided, cabin temperature control and power system management.*

**7.2.5** **Procedure Change Control:** Changes to procedures should be under revision control to help all parties to reference the correct version of the procedures.

# 8. ETHICS AND COMMUNITY STANDARDS

The purpose of ethics and community standards for space analog missions is to ensure missions and experiments are conducted in a responsible and respectful manner, both towards the participants and the environment in which they take place.

Firstly, having clear ethical guidelines can help ensure that the well-being and safety of the participants are prioritized. These can include guidelines on physical and mental health, adequate training and preparation, fair compensation, and clear communication between the participants and the mission organizers.

Secondly, having community standards can help establish a culture of respect and collaboration among the participants. This can include guidelines on respectful communication, teamwork, and cultural sensitivity.

Thirdly, ethical and community standards can help ensure the mission does not have a negative impact on the environment and the community in which it takes place. This can include guidelines on waste management, responsible use of resources, and minimizing any disruption to local ecosystems.

Overall, having clear ethics and community standards can help ensure space analog missions are conducted in a way that is safe, respectful, and responsible, both towards the participants and the environment.

## 8.1 Ethics Standards

**8.1.1** Safety First: The safety and well-being of all participants and the crew **shall** be the top priority in all decisions and actions taken during the analog mission.

**8.1.2** Respect for Human Dignity: All participants **shall** be treated with respect, dignity, and consideration for their individual and group needs as well as differences.

**8.1.3** Scientific Integrity: All scientific research conducted during the analog mission **shall** be conducted with integrity and adherence to established scientific methods.

**8.1.4** Environmental Responsibility: All participants should be mindful of their impact on the environment and take steps to minimize their environmental footprint.

**8.1.5** Cultural Sensitivity: Participants **shall** be sensitive to cultural differences and strive to foster a culture of inclusivity and understanding.

**8.1.6** Ethical Research: Any research with human subjects or privacy concerns must have appropriate valid ethical approval from an IRB.

**8.1.7** Data Protection: All data **shall** be protected by applicable national or regional standards, e.g. General Data Protection Regulation (GDPR). If a host country lacks these protections, default to the GDPR guidance.

### 8.2 Community Standards

**8.2.1** Clear Communication: All participants **shall** communicate clearly and respectfully with one another to ensure effective collaboration and avoid misunderstandings. All the participants **shall** avoid the use of words or expressions that can be misinterpreted or deemed inappropriate by the general public or in a specific cultural context.

**8.2.2** Professionalism: All participants **shall** conduct themselves in a professional and respectful manner at all times, even in challenging or stressful situations.

**8.2.3** Collaborative Spirit: Participants **shall** work together as a team, sharing knowledge, skills, and resources to achieve mission objectives. Analog missions are not an individual activity, the collaborative spirit should be reflected in recognizing all the actors involved in the mission at public events, during interviews or social media posts.

**8.2.4** Conflict Management: In the event of conflicts or disagreements, participants **shall** strive to address issues through constructive dialogue or other appropriate actions, always maintaining mutual respect.

**8.2.5** Fair and Equitable Treatment of Contracted Support: Analog director and operators, staff, and analog mission crew **shall** treat individuals or entities providing contracted services (including “sponsors”) in a just, unbiased, and impartial manner. Contracted support providers should be given equal opportunities, fair compensation, and just treatment in line with the terms and conditions outlined in the contract. Any decisions, actions, or policies related to the contract should be made objectively and without favoritism, ensuring that all parties are treated equitably. Violating this principle could lead to legal issues, damaged relationships, or contractual disputes. Therefore, adhering to the fair and equitable treatment principle is essential for maintaining trust, fostering healthy business relationships, and upholding the integrity of contractual agreements.

**8.2.6** Confidentiality: Participants **shall** respect the confidentiality of information shared before, during and after the mission, and will not share information without the consent of all parties involved.

**8.2.7** Common Language: English is the recommended working language within space analogs, similar to other international governmental space agencies. If the entire crew and support personnel are of one native language, that language may be the working language; however English will be the standard language used in the research database and global collaborations and missions. Although social and informal interactions between international crewmembers could take place in any language, be cognizant that culture and language can be used to inadvertently create subgroups or outgroups within a crew, and therefore can act as a contributor to crew separation and exclusion.

## 9. APPLICABLE AND REFERENCED DOCUMENTS

### 9.1 Applicable Documents

The documents listed in this section contain provisions that constitute requirements of this standard and are adopted by reference.

### 9.1.1 European Space Agency documents

ESA ECSS-M-ST-10-01C - Space Management
http://www.las.inpe.br/~perondi/29.06.2009/ECSS-M-ST-10C_Rev.1(6March2009).pdf

ESA ECSS-M-ST-80C – Risk Management
https://ecss.nl/standard/ecss-m-st-80c-risk-management/

ESA ECSS-Q-ST-20-07C – Quality and Safety Assurance for Space Test Centres
https://ecss.nl/standard/ecss-q-st-20-07c-quality-and-safety-assurance-for-space-test-centres-1-october-2014/

ESA ECSS-S-ST-00-01C – Glossary of Terms
https://ecss.nl/standard/ecss-s-st-00-01c-rev-1-glossary-of-terms-11-october-2023/
or http://everyspec.com/ESA/ECSS-S-ST-00-01C_47906/

ESA ECSS-M-30-01A - Space Project Management: Organization and Conduct of Reviews https://sci.esa.int/documents/34923/36148/1567254180098-ecss-m-30-01a.pdf

ESA Standards
https://ecss.nl/standards/

### 9.1.2 National Aeronautics and Space Administration (NASA) documents

NASA Hazard Analysis Process
https://ntrs.nasa.gov/api/citations/20100040678/downloads/20100040678.pdf

NASA Information Technology Threats and Vulnerabilities
https://www.hq.nasa.gov/security/it_threats_vulnerabilities.htm

NASA-HDBK-8709.22. Safety & Mission Assurance Acronyms, Abbreviations, & Definitions
https://standards.nasa.gov/standard/NASA/NASA-HDBK-870922

NASA NPR 8705.2C - Human-Rating Requirements for Space Systems, Appendix A, definitions
https://nodis3.gsfc.nasa.gov/displayDir.cfm?Internal_ID=N_PR_8705_002C_&page_name=AppendixA

NASA Program and Project Management
https://appel.nasa.gov/program-project-management/

NASA Risk Management Handbook, NASA/SP-2011-3422 Version 1.0 November 2011
https://ntrs.nasa.gov/api/citations/20120000033/downloads/20120000033.pdf

NASA Safety Culture Handbook
https://standards.nasa.gov/standard/NASA/NASA-HDBK-870924

NASA Standard for Fire Protection and Life Safety
https://standards.nasa.gov/standard/NASA/NASA-STD-871911
https://standards.nasa.gov/sites/default/files/standards/NASA/B/1/nasa-std-871911b_with_change_1.pdf

NASA Standards
https://standards.nasa.gov/all-standards?page=1

NASA-STD-8719.11B, with Change 1 Standard for Fire Protection and Life Safety
https://standards.nasa.gov/standard/NASA/NASA-STD-871911

### 9.1.3 Additional references

ISO/IEC Guide 2:2004, Standardization and related activities
https://www.iso.org/home.isoDocumentsDownload.do?t=QwIB_Vvjs-5J2JFvYx5pKiT04oSL2vVKsK7By_Ejuuk-g180r2lQIKuR783U3IgG&CSRFTOKEN=0CJF-B0R7-BKF2-WWAN-21SO-HVV4-UURJ-1M3J

ISO 31000, Risk Management https://www.iso.org/iso-31000-risk-management.html

ISO Project, Programme and Portfolio Management
https://www.iso.org/committee/624837/x/catalogue/p/1/u/0/w/0/d/0%20PMI%20PMBOK

Occupational Safety and Health Administration (OSHA) Chemical Laboratory Safety Chemical Hygiene Plan (CHP)
https://www.osha.gov/sites/default/files/publications/OSHAfactsheet-laboratory-safety-chemical-hygiene-plan.pdf

Schwartz, B. The Swiss cheese model: Designing to reduce catastrophic losses. Engineering for Humans. July 21,2019. https://www.engineeringforhumans.com/systems-engineering/the-swiss-cheese-model-designing-to-reduce-catastrophic-losses/

Stein, J. *Using the Stages of Team Development.* Massachusetts Institute of Technology.
https://hr.mit.edu/learning-topics/teams/articles/stages-development

## 9.2 Supplemental References

The reference documents listed in this section are not incorporated by reference within this standard, but may provide further clarification and guidance.

### 9.2.1 European Space Agency (ESA) documents

ECSS-M-ST-10-01C – Organization and conduct of reviews (15 November 2008)
https://ecss.nl/standard/ecss-m-st-10-01c-organization-and-conduct-of-reviews/

ECSS-M-ST-10C Rev.1 – Project planning and implementation (6 March 2009)
https://ecss.nl/standard/ecss-m-st-10c-rev-1-project-planning-and-implementation/

### 9.2.2 National Aeronautics and Space Administration (NASA) documents

NASA Behavioral Health and Performance, OCHMO-TB-016 Rev A
https://www.nasa.gov/sites/default/files/atoms/files/behavioral_health_technical_brief_ochmo.pdf

NASA Human Exploration Research Analog (HERA) Experiment Information Package
https://www.nasa.gov/wp-content/uploads/2015/08/hrp-hera-experiment-information-package.pdf

NASA Human Exploration Research Analog (HERA) Analog Assessment Tools
https://www.nasa.gov/sites/default/files/atoms/files/analog_assessment_tools.pdf

NASA Space Flight Human System Standard Volume 2: Human Factors, Habitability, and Environmental Health
https://standards.nasa.gov/standard/NASA/NASA-STD-3001-VOL-2

NASA Space Flight Human-System Standard Volume 1, Revision A: Crew Health
https://standards.nasa.gov/standard/NASA/NASA-STD-3001-VOL-1

### 9.2.3 Additional references

National Oceanic and Atmospheric Administration (NOAA) Diving for Science and Technology, 6th Edition, Best Publishing Company; 6th edition (July 31, 2017)

National Oceanic and Atmospheric Administration (NOAA) Diving Standards & Safety Manual
http://www.omao.noaa.gov/sites/default/files/documents/NDSSM%20Final_041217.pdf

Posselt, B. N., Velho, R., O'Griofa, M., Shepanek, M., Golemis, A., & Gifford, S. E. (2021). "Safety and healthcare provision in space analogs." *Acta Astronautica*, *186*, 164–170. https://doi.org/10.1016/j.actaastro.2021.05.033

Tuckman, B. W. Developmental Sequence in Small Groups. Psychology Bulletin. 1965 Jun;63:384-99. doi: 10.1037/h0022100. PMID: 14314073.

United States Navy Diving Manual, 0910-LP-115-1921, Revision 7, December 1, 2016.
https://www.navsea.navy.mil/Portals/103/Documents/SUPSALV/Diving/US%20DIVING%20MANUAL_REV7.pdf?ver=2017-01-11-102354-393

# APPENDIX A
# DEFINITIONS AND ACRONYMS

## A.1 PURPOSE

This Appendix provides guidance regarding acronyms and definitions listed below:

### A.11.1 ACRONYMS

| | |
|---|---|
| **EVA** | Extravehicular Activity |
| **CPR** | Cardiopulmonary Resuscitation |
| **GDPR** | General Data Protection Regulation |
| **IRB** | Institutional Review Board |
| **LSS** | Life Support Systems |
| **MCC** | Mission Control Center |
| **MSC** | Mission Support Center |
| **PFA** | Psychological First Aid |
| **PHI** | Protected Health Information |

### A.12.1 DEFINITIONS

**Analog/Analogue Specific Definitions**

Space Analog/Analogue: A facility located on Earth to simulate aspects of a spacecraft/habitat or have physical similarities to the extreme extra-terrestrial environments for the purposes of benefiting human spaceflight.

Space Analog/Analogue Mission: These are missions analogous to actual space missions and their environments.

Space Analog/Analogue Astronaut: Analog astronauts perform activities in a space mission analog during a minimum consecutive 24 hours with the goal of advancing human spaceflight.

*Rationale for the 24 hour length – this matches the aquanaut definition for the length of a space analog, one full day and one full night. As space analog missions are meant to "benefit human spaceflight" they exclude tourist or commercial-oriented habitat activities, as they have a different purpose and goal.*

**OTHER DEFINITIONS**

Accident: A severe perturbation to a mission or program, usually occurring in the form of a sequence of events, which can cause safety adverse consequences, in the form of death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment.

Catastrophic Incident: An emergency resulting in loss of life or life-threatening, permanently disabling injury or occupational illness; loss of an analog facility or causing severe, detrimental environmental effects.

Extravehicular Activity: Activities performed by analog astronauts wearing a spacesuit, spacesuit simulator or spacesuit equivalent outside the habitat.

Emergency Egress: Capability for a crew to exit the station and leave a hazardous situation or catastrophic event within a specified timeline. Crew emergency egress can be unassisted or assisted by analog personnel

Emergency Equipment and Systems: A set of components (hardware and/or software) used to mitigate or control hazards, after an occurrence, which presents an immediate threat to the crew or the habitat. Examples include fire suppression systems and extinguishers, emergency breathing devices, and crew escape systems and procedures.

Emergency Medical: The life preserving and lifesaving capability to respond to crew illness or injury in order to prevent death or permanent disability. This includes either an inherent capability on a vehicle for timely transfer to another location for treatment, or a vehicle that can provide a higher level of medical care.

Environment: Natural conditions and induced conditions that constrain habitat operations**.** Examples of natural conditions are weather, climate, ocean conditions, terrain, vegetation, dust, light and radiation. Examples of induced conditions are electromagnetic interference, heat, vibration, pollution and contamination.

Fail-Safe: Preventing the failure of an item from resulting in catastrophic or critical consequences.

Hazard analysis: A structured process to identify, classify, and manage risks.

Hazard: Existing or potential condition that can result in a mishap. This condition can be associated with the design, manufacturing, operation or environment. Hazards are not events but potential threats to safety.

Hazardous event: A mishap resulting from a hazard.

Human factors: Individual, environmental, and organizational factors that influence behavior during a mission in a way that can affect human performance and well-being. Model of observed human physical and psycho-physiological behavior and emotional response in relation to environment and product.

Incident: Unexpected event that might be, or could lead to, an operational interruption, disruption, loss, emergency, crisis or accident. Record incidents for further assessment.

Life support systems: Portable or stationary unit/s supplying a habitat or an analog astronaut with breathing gasses, electricity, communication, heating and cooling.

Mishap: Undesired event arising from operation of any project-specific item resulting in:

a) Human death or injury
b) Loss of, or damage to, project hardware, software, data, facilities or experiments that can then affect the accomplishment of the mission
c) Loss of, or damage to, public or private property, or
d) Detrimental effects on the environment or community

Mission Control Center: - a group of functional experts, external to the habitat, formed to provide oversight and directly manage the mission.

Mission Support Center: - a group of functional experts, external to the habitat, formed to monitor and provide consultation during long duration missions which are more autonomous due to time delays and other factors. The MSC concept field-forwards decision-making and autonomy away from Earth during simulations.

Physical Exercise Activities: Physical exercises for the purpose of fitness with the objective of health or performance.

Risk: A situation or circumstance that has both a likelihood of occurring and a potential negative consequence on a mission. Risks are inherent to any project, and can arise at any time during the mission. Predictability and control of events (mitigation) facilitate risk reduction.

Risk Management: Control measures are taken for risks to accept, transfer, lessen or eliminate the risk. The control measure is evaluated to reveal issues and risks that may arise from activating the measure. Once implemented, the control measure is monitored to ensure it is being implemented correctly.

Safety: State where an acceptable level of risk is not exceeded. This risk relates to:

a) Fatality.
b) Injury or occupational illness.
c) Damage to equipment or site facilities.
d) Pollution of the environment or atmosphere.
e) Damage to public or private property.

Standard: A document established by consensus and approved by a recognized body that provides for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. Source: ISO/IEC Guide 2:2004

Threat: A threat is an event that has the potential to impact a valuable resource in a negative manner.

Threat Assessment: A threat assessment is a process for evaluating and verifying actual and perceived threats, including assessment of their likelihood.

Vulnerability: A vulnerability is a quality of a resource or its environment allowing a threat to materialize.

## NOTICE AND DISCLAIMER OF LIABILITY

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(Note: Language adopted from International Organization for Standardization (ISO) publications)

## TRANSLATION OF IGSA-STD-1

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