NASA-STD-3001Technical Brief

Crew Medical Support for Entry, Descent, and Landing

OCHMO-TB-051

Executive Summary

NASA's Flight Medicine Team is responsible for providing crewmember healthcare starting at selection, ongoing throughout training, spaceflight missions, and post-mission reconditioning, and continuing past retirement from the astronaut corps. This comprehensive approach to crewmember health and well-being encompasses screening, preventive health strategies, medical care, contingencies during launch and landing, and post-mission healthcare, reconditioning, and long-term monitoring.

This technical brief addresses the support the Flight Medicine Team provides crewmembers throughout all phases of landing, including preparing for return to Earth, support throughout reentry, descent, and landing, and medical care at the landing site. In providing medical support for landing, it is imperative to consider both the physiological changes that occur during spaceflight and the stressors of landing itself, including extreme heat, high speeds, G-forces, vibrations, and impact forces.

This brief also provides an overview of the medical capabilities necessary to support off-nominal landings that may require emergency services.

Relevant Technical Requirements

NASA-STD-3001 Volume 1, Rev C

[V1 3003] In-Mission Preventive Health Care
[V1 3004] In-Mission Medical Care
[V1 3012] Terrestrial Launch/Landing Medical Support
[V1 3013] DMCF Medical Care
[V1 3014] DMCF Transport
[V1 3015] Certification of Training Plans for Launch/Landing Medical Team
[V1 3016] Post-Mission Health Care
[V1 3017] Post-Mission Reconditioning

NASA-STD-3001 Volume 2, Rev E

[V2 6109] Water Quantity
[V2 7038] Physiological Countermeasures Capability
[V2 7040] Physiological Countermeasure Operations
[V2 7042] Orthostatic Intolerance Countermeasures
[V2 7043] Medical Capability
[V2 12043] Emergency Egress at the Launch Site
[V2 12044] Emergency Egress to Medical Care
[V2 12045] Nominal Timely Egress

Background

Hazards of Landing

Relevant Technical Briefs – Hazards of Landing
OCHMO-TB-038 Decompression Mishaps: Launch, Entry, & Abort (LEA) Suits
OCHMO-TB-039 Mishaps During Entry, Descent, and Landing
OCHMO-TB-024 Occupant Protection

The entry, descent, and landing phases of spaceflight are particularly hazardous due to several critical factors:

- **Extreme Heat**: The spacecraft encounters intense friction as it re-enters Earth's atmosphere, generating temperatures that can exceed 1,650°C (3,000°F). The heat shield must effectively protect the crew from these extreme temperatures.
- **High G-forces**: The spacecraft re-enters the atmosphere at very high speeds, often exceeding 28,000 km/h (17,500 mph). Astronauts experience significant gravitational forces during re-entry, which can be physically taxing and cause discomfort, disorientation, or even loss of consciousness if not properly managed.
- **Vibrations and Shocks:** The spacecraft is subjected to significant vibrations and shocks, which can affect both the vehicle's structural integrity and the crew's well-being.
- **Structural Integrity**: The spacecraft must endure intense vibrations and aerodynamic forces during re-entry. Any structural weakness can lead to catastrophic failure.
- **Communication Blackout**: Ionized gases created by the intense heat can cause a communication blackout, cutting off contact with mission control for several minutes.
- **Guidance and Navigation:** Precise calculations are crucial to ensure the spacecraft enters the atmosphere at the correct angle. A steep angle can cause the spacecraft to burn up, while a shallow angle can result in it skipping off the atmosphere back into space
- **Landing Impact:** The final landing phase, whether on land or water, involves significant impact forces. The crew must be secured properly to avoid injuries during this phase.
- **Post-Landing Hazards:** After landing, there can be additional risks such as exposure to harsh environmental conditions, potential contamination, and the need for immediate medical attention.

The Soyuz TMA-03M spacecraft is seen as it lands with the Expedition 31 crew in a remote area near the town of Zhezkazgan, Kazakhstan, on Sunday, July 1, 2012. Photo Credit: (NASA/Bill Ingalls)

These risks highlight the importance of meticulous planning, robust spacecraft design, and comprehensive safety protocols to ensure the crew's safe return to Earth.

Background

Microgravity Adaptation (NASA: *Commercial Crew Medical Operations*)

Relative to terrestrial normal, the returning deconditioned, microgravity-adapted crew has:

- **Hypovolemia** –12% to 15% less blood volume (like dehydration)
- **Lower RBC** –10% to 12% less red blood cells
- **Neurosensory deconditioning**
- **Aerobic deconditioning** –15% to 20% deficit
- **Decreased strength** (postural muscles)
- **Decreased bone density** (postural joints)
- **Increased spinal length** (about 6%; may affect suit fit)

Relevant Technical Briefs – Deconditioning in Spaceflight
OCHMO-TB-030 Bone Loss
OCHMO-TB-031 Exercise Overview

Expedition 64 NASA astronaut Kate Rubins rests as NASA Flight Surgeon Natacha Chough, left, and Russian Nurse Raksana Batsmanova, right, monitor her condition after she, and Roscosmos cosmonauts Sergey Ryzhikov and Sergey Kud-Sverchkov landed their Soyuz MS-17 spacecraft in a remote area near the town of Zhezkazgan, Kazakhstan on Saturday, April 17, 2021.

Photo Credit: (NASA/Bill Ingalls)

Background

Physiological Considerations for Landing

Spaceflight has profound effects on the human body. Upon return to Earth (1G), astronauts may experience:

- **Orthostatic intolerance** (hypovolemia, neurologic ability to sense gravity challenge)
- **Entry Adaptation Syndrome** (inverse of space adaptation sickness)
- **Postural instability and motion disturbances** (neurosensory deconditioning)
- **Increased risk of musculoskeletal injury** (generalized muscular weakness, diminished aerobic capacity, decreased bone density)
- **Fatigue** (sudden substantially increased effort required to move)
- **Circadian Rhythm Disorder** (shift work type sleep shifting to match undocking and landing in a new time zone)

(NASA: *Commercial Crew Medical Operations*)

Relevant Technical Briefs –
Physiological Considerations for Landing
OCHMO-TB-010 Sensorimotor Overview
OCHMO-TB-019 Orthostatic Intolerance
OCHMO-TB-033 Spaceflight Experience and Medical Care
OCHMO-MTB-003 Space Adaptation Sickness (SAS)

Expedition 24 Flight Engineer Tracy Caldwell Dyson is helped out of the Soyuz TMA-18 spacecraft shortly after landing near the town of Arkalyk, Kazakhstan on Saturday, Sept. 25, 2010.
Photo Credit: (NASA/Bill Ingalls)

Application

Relevant Technical Requirements – Landing Preparation
[V1 3004] In-Mission Medical Care,
[V2 6109] Water Quantity,
[V2 7042] Orthostatic Intolerance Countermeasures

Preparing for Return to Earth
Along with the numerous vehicle maneuvers that must occur before descent, reentry, and landing, crewmembers must follow protocols to prepare their bodies to transition back to Earth's gravity.

Orthostatic Intolerance Countermeasures (V2 7042)
Orthostatic protection is needed to minimize medical and operational impacts. Impacts can include loss of consciousness and decreased cognitive function leading to inability to operate controls, pilot mechanics, and egress vehicle without assistance, thus jeopardizing success or safety of the crew during reentry and landing. Examples of methods that have been successfully used to prevent orthostatic intolerance include:

- **Fluid/salt Loading Regimens**

The fluid loading protocol is a countermeasure used to help lessen the effects of orthostatic intolerance (passing out when standing) during and after deorbit. Crewmembers consume water with salt tablets or an alternative solution, amount based on weight, to increase their blood volume. This helps counteract the fluid shift that occurs in microgravity, where fluids move from the lower body to the upper body.

- **Active Cooling**

Active cooling helps prevent peripheral blood pooling and heat injury.

- **Recumbent Crewmember Seating** (V2 7042)

Recumbent seating helps protect cerebral blood flow during Az (head-to-foot) vehicle accelerations (planetary and lunar) and return to gravity (planetary).

- **Orthostatic Intolerance Garments**

Orthostatic intolerance garments (OIGs) are another countermeasure used to help crewmembers manage the transition back to Earth's gravity during the landing phase of spaceflight. These garments apply graduated compression to the lower body, starting from the feet and moving up to the abdomen. The compression helps prevent blood from pooling in the lower extremities, ensuring adequate blood flow to the brain.

- **Launch, Entry, and Abort Suits**

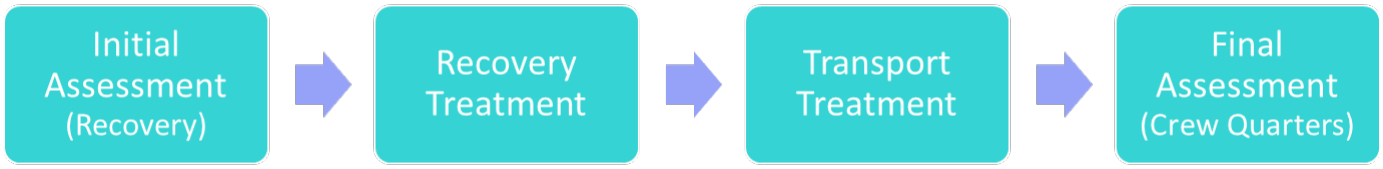
Launch, entry, and abort (LEA) suits are designed to help protect crewmembers in the event of cabin depressurization, small fires, or release of chemical fumes. Their design also includes features to aid in search and rescue efforts and crew survival if an off-nominal landing were to occur.

Application

Medical Support at Landing Site, During Transport, and at Crew Quarters

The Flight Surgeon(s) for each space mission are present at the landing site, monitoring all phases of landing – preparation for landing through egress from the landing vehicle – and performing various assessments from egress through arrival back at crew quarters. The different phases of post-landing medical support are shown in the graphic below.

Phases of Post-Landing Medical Support



An external view of the Expedition 10 crew inflatable medical tent northeast of the town of Arkalyk in Kazakhstan (Monday, April 25, 2005). Photo Credit: (NASA/Bill Ingalls)

Relevant Technical Briefs – Medical:
Landing Prep, Landing Site Support, & Post-Landing Care
OCHMO-TB-033 Spaceflight Experience and Medical Care

Application

Capabilities at Landing

Each launch and landing site must have the medical capability to address nominal operations and launch/landing contingencies, including, but not limited to the following:

a. Health Stabilization Program (HSP) technical requirements for the crew, the crew's family, and supporting personnel for the purpose of disease prevention.

b. Access to the full spectrum of medical capabilities, from routine medical and behavioral health care to advanced trauma life support (ATLS) capabilities, advanced cardiac life support (ACLS), or equivalent.

c. Incorporation of civilian and/or Department of Defense (DoD) facilities and Emergency Medical Services (EMS). [V1 3012]

At landing, the NASA Flight Surgeon(s) provides:

- Care for nominal crew events
- Post-flight Medical Evaluation
- Treatment for typical re-adaptation issues:
  - orthostatic intolerance/fluid imbalance/volume depletion
  - nausea
  - cardiovascular and muscular deconditioning
  - neurovestibular impairment (NASA: *Commercial Crew Medical Operations*)

Expedition 26 Flight Engineer Oleg Skripochka, left, Flight Engineer Alexander Kaleri, center, and Commander Scott Kelly, sit in chairs outside the Soyuz Capsule just minutes after they landed near the town of Arkalyk, Kazakhstan on Wednesday, March 16, 2011. Photo Credit: (NASA/Bill Ingalls)

Relevant Technical Requirements – Landing Site Support
[V1 3012] Terrestrial Launch/Landing Medical Support, [V1 3014] DMCF Transport, [V1 3015] Certification of Training Plans for Launch/Landing Medical Team, [V2 12045] Nominal Timely Egress

Application

International Space Station Crew Surgeon Landing Assessment

The Flight Surgeon(s) for each space mission are present at the landing site, monitoring all phases of landing – preparation for landing through egress from the landing vehicle – and performing various assessments from egress through arrival back at crew quarters. The ***International Space Station Crew Surgeon Landing Assessment*** provides checklists for the various exams and assessments, as well as a place for the Flight Surgeon(s) to record results. Pages in the guide may include:

- Crew Name, Landing Date, Landing Time, Landing Location, Landing Vehicle, Comments
- Post-Landing Pain/Injury Assessment
- Landing Prep
- Motion Sickness
- Passing Out
- Alertness/Fatigue
- Anxiety
- Initial Assessment (Recovery)
- Recovery Treatment
- Transport Treatment
- Final Assessment (Crew Quarters)

Appendix A:
Example of an International Space Station Crew Surgeon Landing Assessment
Appendix B:
Soyuz Flight Surgeon Observations for Medical Operations (R+0)

Example of *the* ***International Space Station Crew Surgeon Landing Assessment*** can be found in **Appendix A** of this technical brief. Example of the ***Soyuz Flight Surgeon Observations for Medical Operations (R+0)*** can be found in **Appendix B** of this technical brief.

A Russian nurse sits next to Expedition 9 Flight Engineer Michael Fincke while he sleeps inside a Russian search and rescue helicopter on his way to Kustanay, Kazakhstan. The Expedition 9 crew landed in a Soyuz capsule 85 kilometers northeast of Arkalyk in northern Kazakhstan on Sunday, October 24, 2004.
Photo Credit: (NASA/Bill Ingalls)

Application

Relevant Technical Requirements – Landing Site Support
[V1 3012] Terrestrial Launch/Landing Medical Support, [V1 3014] DMCF Transport, [V1 3015] Certification of Training Plans for Launch/Landing Medical Team, [V2 12045] Nominal Timely Egress

NASA Crew Surgeon Landing Medical Kit

The following items are typically available for use by the NASA Flight Surgeon(s) for post-flight crew medical evaluation and care:

- Blood pressure cuff
- Pulse oximeter
- Saline (3L per crewmember minimum)
- IV set up (2 per crewmember)
- Array of intravenous catheters
- Bottled water/drinking straws
- Hand towels
- Emesis bags
- Medications: Promethazine, Ondansetron, Diphenhydramine, Meclizine
- OTC analgesics
- Digital thermometer
- Headlamp
- Handheld ultrasound

(NASA: *Commercial Crew Medical Operations*)

Support teams work on the SpaceX Dragon spacecraft shortly after it landed with NASA astronauts Nick Hague, Suni Williams and Butch Wilmore, and Roscosmos cosmonaut Aleksandr Gorbunov onboard on March 18, 2025, off the coast of Florida. Photo Credit: (NASA/Keegan Barber)

Application

Emergency Medical Care

In case of emergency, a landing site emergency medical cart is available which includes:

- Basic and Advanced airway equipment including suction
- Intravenous access equipment
- Advanced cardiac life support (ACLS) medications
- Medications and equipment to treat known post-landing symptomology (ex. diphenhydramine for dystonic reactions, epinephrine et al. for allergic reaction, urinary catheters for urinary retention, etc.)
- Defibrillator and monitoring equipment (BP, Pulse Ox, end tidal CO_2)
- Trauma equipment – chest tubes, water seal, hemostatic agent, tourniquets, etc.
- Burn supplies (NASA: *Commercial Crew Medical Operations*)

Each landing site (nominal and contingency) must also have medical care agreements with a Definitive Medical Care Facility (DMCF), for emergencies that require medical care beyond what can be provided at the landing site. [V1 3013] A DMCF is an inpatient medical facility capable of comprehensive diagnosis and treatment of a crewmember's injuries or illness. DMCFs are trauma-capable facilities; ideally, such facilities should be capable of managing (per the American College of Surgeons' definitions) Category I, II, and III trauma patients.

Depending on the location of the launch/landing contingency, transport capabilities may involve evacuation via ground, water, or air by prepositioned civilian and/or DoD assets. All rescue vehicles are to have advanced trauma life support (ATLS) or equivalent capabilities to sustain the crewmember until transfer to a DMCF. [V1 3014]

Teams from NASA, the Department of Defense Human Space Flight Support and SpaceX conduct a joint medical triage and medical evacuation (medevac) training exercise at NASA's Kennedy Space Center in Florida. Source: NASA/Kim Shifflet

Application

Reference OCHMO-TB-007 Mission Duration
OCHMO-TB-031 Exercise Overview

Post-Flight Healthcare

The duration of a space mission significantly affects the readjustment process for astronauts upon their return to Earth. Some key factors include:

- **Muscle Atrophy and Bone Density Loss**: Longer missions result in greater muscle atrophy and bone density loss. Astronauts on extended missions may require more intensive and prolonged rehabilitation to regain their strength and bone health.
- **Cardiovascular Deconditioning**: The heart and blood vessels adapt to the microgravity environment, leading to cardiovascular deconditioning. Longer missions exacerbate this effect, making it more challenging for astronauts to readjust to Earth's gravity.
- **Neurovestibular Impairments**: The longer the mission, the more pronounced the neurovestibular effects on the body. This can lead to more severe balance and coordination issues upon return.
- **Psychological Impact**: Extended periods in space can increase the psychological strain on astronauts, including feelings of isolation and confinement. This can affect their mental health and make the readjustment process more complex.
- **Radiation Exposure**: Longer missions expose astronauts to higher levels of space radiation, which can have long-term health implications and require ongoing medical monitoring.
- **Recovery Timeline**: While most astronauts can return to normal activities within about 45 days, those who have been on longer missions may need additional time and support to fully recover.

Overall, the longer the mission, the more extensive the readjustment process tends to be, requiring a comprehensive and tailored approach to ensure astronauts' health and well-being.

NASA Astronaut Strength, Conditioning, and Rehabilitation (ASCR) Specialists are responsible for assisting with the overall physical health of the astronaut corps. ASCRs supervise and administer the physical training of all crewmembers during their preassigned, pre-flight, in-flight and post-flight phases of spaceflight. Source: NASA

Application

Post-Flight Healthcare

The key phases of post-flight recovery for crewmembers include:

Immediately Post-Landing:

- Initial Medical Checks: After landing, astronauts undergo thorough medical evaluations to assess their immediate health and address any urgent issues.
- Assistance with Mobility: Due to muscle weakness and balance issues, astronauts often need assistance with basic movements.

First Week:

- Reconditioning Program: Astronauts start a structured reconditioning program, which includes physical therapy and exercises to help regain strength and coordination.
- Restricted Activities: Crew are usually advised against driving or performing tasks that require significant physical effort to avoid accidents.

First Month:

- Gradual Increase in Activity: The intensity of physical activities is gradually increased as their bodies readjust to Earth's gravity.
- Ongoing Medical Monitoring: Regular health checks continue to monitor recovery progress and address any emerging issues.

45 Days and Beyond:

- Return to Normal Activities: Most astronauts can return to their normal activities within 45 days, although some may require additional time depending on the duration of their mission and individual health.

This comprehensive recovery process ensures that astronauts can safely and effectively readjust to life on Earth.

Relevant Technical Requirements – Post-Landing Care
[V1 3016] Post-Mission Health Care,
[V1 3017] Post-Mission Reconditioning

Back-Up

Referenced Technical Requirements

View the current versions of NASA-STD-3001 Volume 1 & Volume 2 on the OCHMO Standards website

NASA-STD-3001 Volume 1 Revision C

[V1 3003] In-Mission Preventive Health Care All programs shall provide training, in-mission capabilities, and resources to monitor physiological and psychosocial well-being and enable delivery of in-mission preventive health care, based on epidemiological evidence-based probabilistic risk assessment (PRA), individual crewmember needs, clinical practice guidelines, flight surgeon expertise, historical review, mission parameters, and vehicle derived limitations. These analyses consider the needs and limitations of each specific vehicle and design reference mission (DRM) with particular attention to parameters such as mission duration, expected return time to Earth, mission route and destination, expected radiation profile, concept of operations, and more. In-mission preventive care includes, but is not limited to: *(See NASA-STD-3001 Volume 1 Rev C for full technical requirement.)*

[V1 3004] In-Mission Medical Care All programs shall provide training, in-mission medical capabilities, and resources to diagnose and treat potential medical conditions based on epidemiological evidence-based PRA, individual crewmember needs, clinical practice guidelines, flight surgeon expertise, historical review, mission parameters, and vehicle-derived limitations. These analyses consider the needs and limitations of each specific vehicle and design reference mission (DRM) with particular attention to parameters such as mission duration, expected return time to Earth, mission route and destination, expected radiation profile, concept of operations, and more. In-mission capabilities (including hardware and software), resources (including consumables), and training to enable in-mission medical care, and behavioral care, are to include, but are not limited to: *(See NASA-STD-3001 Volume 1 Rev C for full technical requirement.)*

[V1 3012] Terrestrial Launch/Landing Medical Support All programs shall have medical capability at the site of terrestrial launch and landing to address nominal operations and launch/landing contingencies, including, but not limited to the following:

- HSP technical requirements for the crew, the crew's family, and supporting personnel for purpose of disease prevention.
- Access to the full spectrum of medical capabilities, from routine medical and behavioral health care to advanced trauma life support (ATLS) capabilities, advanced cardiac life support (ACLS), or equivalent.
- Incorporation of civilian and/or Department of Defense (DOD) facilities and Emergency Medical Services (EMS).

[V1 3013] DMCF Medical Care The program shall establish medical care agreements with DMCF(s) for each launch and landing (nominal and contingency) location.

[V1 3014] DMCF Transport The program shall have the capability to transport crewmembers to a DMCF for each launch and landing (nominal and contingency) location.

Referenced Technical Requirements

View the current versions of NASA-STD-3001 Volume 1 & Volume 2 on the OCHMO Standards website

NASA-STD-3001 Volume 1 Revision C

[V1 3015] Certification of Training Plans for Launch/Landing Medical Team The organization responsible for crewmember health shall certify training plans for internal NASA medical support personnel who work launch/landing and concur on training plans for external organizations that have a specific medical support training plan in support of a NASA spaceflight program. Training includes, but is not limited to: *(See NASA-STD-3001 Volume 1 Rev C for full technical requirement.)*

[V1 3016] Post-Mission Health Care Post-mission health care shall be provided to minimize occurrence of deconditioning related illness or injury, including but not limited to:

a. Physical examinations by a flight surgeon or designated medical support personnel immediately following landing and periodically thereafter, until crewmember status is stable.
b. (*See NASA-STD-3001 Volume 1 Rev C for full technical requirement.*)

[V1 3017] Post-Mission Reconditioning All programs shall provide the planning, coordination, and resources for an individualized post-mission reconditioning program, specific to each crewmember, mission type, and mission duration. The post-mission reconditioning starts with crew egress at landing and includes a guided, phased reconditioning protocol. The goals of the reconditioning program include the following:

- To ensure the health and safety of returning crew.
- To actively assist the crew's return to full functional abilities and return-to-flight status.
- To actively assist in the crew's return to pre-mission fitness

NASA-STD-3001 Volume 2 Revision E

[V2 6109] Water Quantity The system shall provide a minimum water quantity as specified in Table 6.3-1— Water Quantities and Temperatures, for the expected needs of each mission, which are considered mutually independent.

[V2 7038] Physiological Countermeasures Capability The system shall provide countermeasures to meet crew bone, muscle, sensorimotor, thermoregulation, and aerobic/cardiovascular requirements defined in NASA-STD-3001, Volume 1.

[V2 7040] Physiological Countermeasure Operations The physiological countermeasure system design shall allow the crew to unstow supplies, perform operations, and stow items within the allotted countermeasure schedule.

[V2 7042] Orthostatic Intolerance Countermeasures The system shall provide countermeasures to mitigate the effects of orthostatic intolerance when transitioning from weightlessness to gravity environments and during Az (head-to-foot) vehicle accelerations defined in the sustained acceleration limits.

Referenced Technical Requirements

View the current versions of NASA-STD-3001 Volume 1 & Volume 2 on the OCHMO Standards website

NASA-STD-3001 Volume 2 Revision E

[V2 7043] Medical Capability A medical system shall be provided to the crew to meet the medical requirements of NASA-STD-3001, Volume 1.

[V2 12043] Emergency Egress at the Launch Site The system shall be designed such that the spaceflight crew and ground support personnel can egress within the time required to preserve the health and safety of all spaceflight crew and ground support personnel in the event of an emergency.

[V2 12044] Emergency Egress to Medical Care The system shall be designed to ensure spaceflight crew and ground support personnel can egress to a location providing advanced pre-hospital life support.

[V2 12045] Nominal Timely Egress Following a post mission nominal landing, launch scrub, or abort scenario, crew egress from the system shall be expedited to ensure crew health.

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Appendix A


International Space Station
Crew Surgeon
Landing Assessment

Appendix A

Crew Name	write in
Landing Date?	
Landing Time	
Landing Location:	
Landing Vehicle	
Comments	

Note: set a timer at landing, and use the post-landing elapsed time for documenting assessments and interventions

Appendix A

Post-Landing Pain/Injury Assessment

Crew Report

Are you in any pain? (Circle) YES NO

Describe

Any injuries? (Circle) YES NO

Describe

Surgeon Findings

HEENT (Circle) Injuries No Injuries

Describe

Trunk/Abdomen (Circle) Injuries No Injuries

Describe

Upper Extremities (Circle) Injuries No Injuries

Describe

Lower Extremities (Circle) Injuries No Injuries

Describe

Appendix A

Landing Prep

Pre-Landing Medications? (circle)	**YES** **NO**
Medication Name(s) Dose(s)	
Fluid Loading	
Fluid Type	
Amounts	
# Salt tabs	
Compression Garments Worn? (circle)	**YES** **NO**
Type compression garment worn	
Compression garment fit (circle)	
Too Loose **Adequate** **Too Tight**	

Appendix A

What is your current Level of MOTION SICKNESS?

0 – No symptoms

1 – Symptoms noticeable, but no impact or restriction of movements

2 – Symptoms bothersome, but still able to complete tasks normally

3 – Symptoms causing extended time to complete tasks

4 – Symptoms causing deliberate restriction of motion. Some tasks not attempted

5- Incapacitated

Motion Sickness

Motion Sickness

Crewmember	Write in						
Time since landing	Motion Sickness Score (Circle)						
0-2 hours	Did Not Ask	0	1	2	3	4	5
2-4 hours	Did Not Ask	0	1	2	3	4	5
4-8 hours	Did Not Ask	0	1	2	3	4	5
8-12 hours	Did Not Ask	0	1	2	3	4	5
12-16 hours	Did Not Ask	0	1	2	3	4	5
16-20 hours	Did Not Ask	0	1	2	3	4	5
20-24 hours	Did Not Ask	0	1	2	3	4	5
24-28 hours	Did Not Ask	0	1	2	3	4	5
28-32 hours	Did Not Ask	0	1	2	3	4	5
32-36 hours	Did Not Ask	0	1	2	3	4	5

Appendix A

Right now, how likely do you feel you might PASS OUT while walking/standing?

NS-Not Sure

0 – Not likely at all

1 – Possibly

2 – Very likely

3 – Definitely

Passing Out

Passing Out

Crewmember	Write in					
Time since landing	Passing Out Score (Circle)					
0-2 hours	Did Not Ask	Not Sure	0	1	2	3
2-4 hours	Did Not Ask	Not Sure	0	1	2	3
4-8 hours	Did Not Ask	Not Sure	0	1	2	3
8-12 hours	Did Not Ask	Not Sure	0	1	2	3
12-16 hours	Did Not Ask	Not Sure	0	1	2	3
16-20 hours	Did Not Ask	Not Sure	0	1	2	3
20-24 hours	Did Not Ask	Not Sure	0	1	2	3
24-28 hours	Did Not Ask	Not Sure	0	1	2	3
28-32 hours	Did Not Ask	Not Sure	0	1	2	3
32-36 hours	Did Not Ask	Not Sure	0	1	2	3

Appendix A

What is your current level of ALERTNESS/FATIGUE?

0 – Feeling active, alert, wide awake

1 – Functioning at a high level, but not fully alert

2 – Awake, relaxed, responsive, but not fully alert

3 – Foggy, losing interest, slowed down

4 – Sleepy, woozy, fight sleep

5 – Sleep onset, having dream-like thoughts

6 – Asleep

Alertness/Fatigue

Alertness/Fatigue

Crewmember	Write in							
Time since landing	Alertness/Fatigue Score (Circle)							
0-2 hours	Did Not Ask	0	1	2	3	4	5	6
2-4 hours	Did Not Ask	0	1	2	3	4	5	6
4-8 hours	Did Not Ask	0	1	2	3	4	5	6
8-12 hours	Did Not Ask	0	1	2	3	4	5	6
12-16 hours	Did Not Ask	0	1	2	3	4	5	6
16-20 hours	Did Not Ask	0	1	2	3	4	5	6
20-24 hours	Did Not Ask	0	1	2	3	4	5	6
24-28 hours	Did Not Ask	0	1	2	3	4	5	6
28-32 hours	Did Not Ask	0	1	2	3	4	5	6
32-36 hours	Did Not Ask	0	1	2	3	4	5	6

Appendix A

What is your CURRENT level of ANXIETY?

0 – Very Calm, Chill

1 – Neither Calm nor anxious

2 – Some nervous feeling, but not bothersome

3 – Anxiety bothersome, not interfering with thought/activities

4 – Anxiety is intrusive, affecting what I'm doing

5 – Bad anxiety! I've got to get out of here!

6 – Uncontrolled agitation

Anxiety

Anxiety

Crewmember	Write in							
Time since landing	Anxiety Score (Circle)							
0-2 hours	Did Not Ask	0	1	2	3	4	5	6
2-4 hours	Did Not Ask	0	1	2	3	4	5	6
4-8 hours	Did Not Ask	0	1	2	3	4	5	6
8-12 hours	Did Not Ask	0	1	2	3	4	5	6
12-16 hours	Did Not Ask	0	1	2	3	4	5	6
16-20 hours	Did Not Ask	0	1	2	3	4	5	6
20-24 hours	Did Not Ask	0	1	2	3	4	5	6
24-28 hours	Did Not Ask	0	1	2	3	4	5	6
28-32 hours	Did Not Ask	0	1	2	3	4	5	6
32-36 hours	Did Not Ask	0	1	2	3	4	5	6

Appendix A

Initial Assessment (Recovery)

Arrival Time at Recovery Site (hours since landing)	< 1 hour	1-2 hours	>2 hours
Crew Name	Write in		
Disability Rating (Circle)	0	1	2	3
Vomiting (Circle)	0	1	2	M
Head Movements (Circle)	0	1	2	
Gait (Circle)	0	1	2	NT

Apparent Disability

0 – No apparent discomfort
1 – Appears uncomfortable, but not impaired
2 – Some apparent impairment
3 – Incapacitated

Vomiting

0 – None
1 – Once
2 – Twice
M – Multiple

Gait

NT – Not Tested
0 – Steady
1 – Unsteady, walks independently
2 – Very Unsteady, Needs Support

Head movement

0 – No apparent head movement limits (nods/shakes head, looks around room)
1 – Some limited head movement
2 – Head locked to shoulders, head tilted down

Appendix A

Recovery Treatment

Crew Name write in
Oral Medication Given? (Circle) YES NO
Oral Medication Name(s), Dose(s)
IV fluid Administered? (Circle) YES NO
IV Fluid Type, Amount (ml)
IV/IM Medication Given? (Circle) YES NO
IV/IM Medication Name(s) Dose(s)
Urinary Catheter Inserted? (Circle) YES NO
Catheter Type? (circle) In-and-Out Indwelling **Output** (circle) <100cc 100-500cc >500cc N/A
Oral Fluid Intake (circle) None <250cc 250cc-I liter 1-2 liters >2 liters
Comments

Transport Treatment

Crew Name write in
Time Arrival in Aircraft (hours since landing) (Circle) 1-2 hours 2-4 hours 4-6 hours 6-8 hours >8 hours
Oral Medication Given? (Circle) YES NO
Oral Medication Name(s), Dose(s)
IV fluid Administered? (Circle) YES NO
IV Fluid Type, Amount (ml)
IV/IM Medication Given? (Circle) YES NO
IV/IM Medication Name(s) Dose(s)
Urinary Catheter Inserted? (Circle) YES NO Already Present
Catheter Type? (circle) In-and-Out Indwelling **Output** (circle) <100cc 100-500cc >500cc N/A
Oral Fluid Intake (circle) None <250cc 250cc-I liter 1-2 liters >2 liters
Comments

Appendix A

Final Assessment (Crew Quarters)

Arrival Time at Crew Quarters (hours since landing)	(2-4)	(4-8)	(8-12)	(12-24)	(>24)
Crew Name	Write in				
Disability Rating (Circle)	**0**	**1**	**2**	**3**	
Vomiting (Circle)	**0**	**1**	**2**	**M**	
Head Movements (Circle)		**0**	**1**	**2**	
Gait (Circle)	**0**	**1**	**2**	**NT**	

Apparent Disability

0 – No apparent discomfort
1 – Appears uncomfortable, but not impaired
2 – Some apparent impairment
3 – Incapacitated

Vomiting

0 – None
1 – Once
2 – Twice
M – Multiple

Gait

NT – Not Tested
0 – Steady
1 – Unsteady, walks independently
2 – Very Unsteady, Needs Support

Head movement

0 – No apparent head movement limits (nods/shakes head, looks around room)
1 – Some limited head movement
2 – Head locked to shoulders, head tilted down

Appendix B

Soyuz Flight Surgeon Observations for Medical Operations (R+0)

R+0 Date	Expedition #
Crewmember	Position
Crew Surgeon	Deputy Crew Surgeon

This form is intended to capture key information collected in the post-landing period for use by medical operations for the care of this crewmember and future crew. These data will be added to the crewmember's medical record.

SECTION 1: RE-ETNRY PREPARATIONS

FLUID LOADING

Please indicate the crewmembers prescribed and actual fluid load in the table below.

	Amount (oz)	# Salt Tablets	Comments (include fluid type, timing, voiding, etc.)
Prescribed			
Actual			

☐No fluid loading

Was general fluid intake increased the week prior to return?	☐Yes	☐No	☐Unknown
Were fluids consumed in the capsule after undock?	☐Yes	☐No	☐Unknown

Additional comments related to fluid administration:

MEDICATION ADMINISTRATION

Please record all medications taken (including any taken in preparation for landing) in the 72 hours prior to undock.

Medication	Route	Dose	Time (GMT) Day (R-x)	Comments (include side effects, reason for taking, etc.)

Appendix B

Additional comments related to medication administration:

SLEEP

Were any sleep or fatigue concerns noted in the week prior to landing?	☐Yes ☐No ☐Unknown

Additional comments related to sleep:

The space below can be used for additional details related to this phase of flight. Include suggestions for key questions to be added to a later revision of the form.

Appendix B

SECTION 2: RE-ENTRY AND LANDING

RE-ENTRY CONDITIONS

Did the crewmember experience overheating?	☐Yes ☐No ☐Unknown
Were suit / capsule habitability issues noted (Depressurization, elevated CO2, etc.)?	☐Yes ☐No ☐Unknown
Were there any suit fit issues?	☐Yes ☐No ☐Unknown
Were there any seat fit issues?	☐Yes ☐No ☐Unknown
Were straining maneuvers / isometrics performed?	☐Yes ☐No ☐Unknown
Was the Kentaver fitted and worn according to the protocol?	☐Yes ☐No ☐Unknown
Was a MAG worn?	☐Yes ☐No ☐Unknown
Was the MAG used?	☐Yes ☐No ☐Unknown

Additional comments on re-entry conditions (include comments regarding landing weather, ground condition (e.g. frozen), and landing location):

VEHICLE DYNAMICS

Type of re-entry	☐Nominal ☐Ballistic ☐Unknown
Capsule orientation	☐Upright ☐On its side ☐Unknown
For side landings: Crewmember's orientation at motion stop?	☐N/A ☐Suspended ☐Unknown ☐Supine ☐Lateral
Was capsule re-orientation required for crewmember extraction?	☐Yes ☐No ☐Unknown
Parachute operation	☐Main ☐Backup ☐Unknown
Soft-landing engine operation	☐Nominal ☐Off-nominal ☐Unknown
Seat-stroking mechanism	☐Nominal ☐Off-nominal ☐Unknown
Capsule dynamics after initial ground impact (check all that apply)	☐Bounce ☐Slide ☐Unknown ☐Tumble ☐No dynamics

Appendix B

Additional comments related to landing dynamics (include known entry and landing events with potential impact to crew health (for example, known anomalies, failures, and reported peak-G levels sustained):

_____

_____

_____

RE-ENTRY AND LANDING SIGNS, SYMPTOMS, AND INJURIES

In the table below, please document any symptoms experienced or injuries sustained during re-entry and landing. Symptoms occurring in the post-landing period will be documented in a separate section of the form.

Sign, Symptom, or Injury	Time (GMT) or Setting	Anatomic Location	Severity/Discomfort	Comments

Additional comments related to landing sings, symptoms, or injuries (include comments regarding exacerbation of any pre-existing injuries):

_____

_____

_____

In your opinion, could the crewmember have performed the following emergency egress procedures **without** assistance?

☐Yes	☐No	Open the hatch
☐Yes	☐No	Egress through the side hatch
☐Yes	☐No	Egress through an overhead hatch
☐Yes	☐No	Move a safe distance from the vehicle following egress
☐Yes	☐No	Assist other crewmembers with egress
☐Yes	☐No	Don/doff survival gear

Appendix B

Additional comments related to ability to perform egress procedures (include crewmember's impression of own abilities, if possible):

EXTRACTION

Landing Time (GMT)	Crew Surgeon on Scene (GMT)
Time of Extraction (GMT)	Extraction Order (1st, 2nd, or 3rd)

Additional comments regarding extraction (if available, include information regarding extraction methods and crewmember response):

The space below can be used for additional details related to this phase of flight. Include suggestions for key questions to be added to a later revision of the form.

Appendix B

SECTION 3: POST-LANDING

MEDIVAL EVENTS AND INTERVENTIONS

In the table below, please provide details for post-landing medical events (signs, symptoms, or injuries. If a symptom is experienced more than once, please enter each occurrence on a separate line. Please document all events and interventions [including all oral and intravenous fluids and medications] in the post-landing period (from capsule egress to arrival at Ellington Field).

Event/ Indication	Time (GMT) or Setting	Severity/ Discomfort	Fluid/ Medication/ Intervention	Route	Amount (indicate units)	Vitals & Exam Findings	Other Comments
Nausea	*1850 GMT Med Tent*	*2*	*IV insertion*			*SpO2: 98%; HR: 85; BP: 106/78 (supine) Nystagmus present*	*IV placed on first by SOS nurse on first attempt.*
Nausea	*Med Tent*	*2*	*Phenergan*	*PO*	*25mg*		
Nausea	*Med Tent*	*2*	*Normal Saline*	*IV*	*500ml*	*HR: 90 BP: 102/76*	*Crewmember reported symptom improvement at approx. 1900 GMT*
Void	*Med Tent*				*-250ml*		*Assisted to toilet*
Sleep	*Helo*				*2 hours*		

Appendix B

Did the crewmember require assistance with ambulation <24 hours?	☐Yes ☐No
Did the crewmember require assistance with ambulation >24 hours?	☐Yes ☐No

Other comments related to ambulation in the post landing period:

Please describe the crewmember's scheduled activities (science, hat ceremony, press conferences, etc.) in the post landing period. Comment on crew health concerns affecting crewmember's participation:

Time / Setting of Suit Removal
Time / Setting of Kentaver Removal

Comments related to suit / Kentaver removal:

Was clinical ultrasound performed in the post landing period?	☐Yes ☐No

Comments related to ultrasound:

The space below can be used for additional details related to this phase of flight. Include suggestions for key questions to be added to a later revision of the form.

Appendix B

Common Re-Entry & Landing Symptoms/Injuries:

Abrasion	Ecchymosis
Laceration	Pain
Nausea	Emesis
Dizziness	Lightheadedness
Diaphoresis	Palpitations

Common Post-Landing Events/Indications

Prophylaxis	Orthostasis
Nausea	Emesis
Trip	Fall
Pre-syncope	Syncope
Urination/Void	Sleep
IV Insertion	Kentaver Removal
Nystagmus	Shower

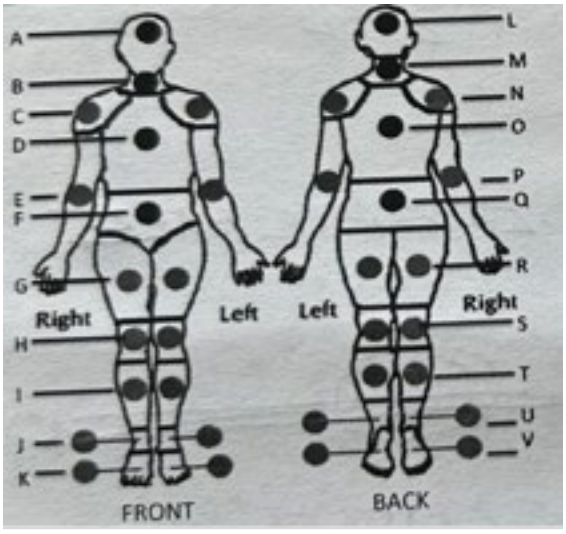
Common Re-Entry & Landing Symptoms/Injuries:

Capsule Ingress	Undock
Braking Impulse	Module Separation
Entry Interface	Drogue Deployed
Main Chute Deployed	Descent Under Chute
Landing Impact	Post Landing Dynamics
Capsule (awaiting egress)	

Common Post-Landing Settings

Egress	Capsule → Chair
Chair	Chair → Med Tent
Med Tent	Med Tent → ATV
ATV	ATV → Helo
Helo	Helo → 992
992 (indicate flight leg)	Refueling Stop (indicate city)
Shower	992 → Shower/Toilet
Toilet	Ellington

Anatomic Location Map



Severity/Discomfort Score

0	No symptom awareness/discomfort
1	Symptom awareness/mild discomfort without performance impact
2	Symptom present/moderate discomfort without performance impact
3	Symptom present/moderate discomfort and interferes with performance
4	Discomfort present/severe discomfort and interferes with performance