NASA

OFFICE OF THE CHIEF HEALTH AND MEDICAL OFFICER

SPACEFLIGHT MISHAP INVESTIGATION FLIGHT SURGEON HANDBOOK

NASA-SP-2020-5006891

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A Quick Reference Guide for Mishap Investigations

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Introduction

This handbook was developed as a quick reference tool for flight surgeons, occupational health physicians, and other support personnel across NASA when responding to spaceflight and aviation mishaps in which human life is impacted. While NASA has a wide array of documentation, including NASA Policy Directives (NPDs), NASA Procedural Requirements (NPRs), center-specific documentation, contingency action plans, and archived historical reports from previous mishaps, they are not specific to the flight surgeon's role as a member of the Interim Response Team (IRT), Mishap Investigation Team (MIT), Mishap Investigation Board or Mishap Investigator (MI). Membership or participation in these teams/boards is predicated on the type of mishap. They serve as useful tools in support of their role. Relevant documentation is listed in **Appendix A**.

It is our goal that this handbook serves as a tool for flight surgeons, occupational health physicians, and other NASA personnel during a spaceflight or aviation mishap response and investigation process. As such, this guide offers a foundation for understanding MIT assignment and reporting hierarchy, on-scene biohazards, the basics of conducting an interview, and academic tools utilized to generate required mishap investigative reports and deliverables.

This text is not all encompassing, nor does it supplant NASA policy. It is an adjunct to formal instructions that govern mishap investigation at NASA and should be used as a field or instructional guide to prepare NASA flight surgeons for mishap response and investigation.

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1.0 Purpose: Handbook in Support of Human Spaceflight Mishaps

The purpose of the handbook is to serve as a quick and ready reference in the event of a mishap. This guide includes the processes, the necessary points of contact, and necessary forms to support the investigative process. This 'grab and go' guide should be provided to all medical personnel responding to a mishap.

The purpose of a MIT is to serve as the investigating authority following a mishap and to generate the mishap investigation report in accordance with the requirements specified in NPR 8621.1D.

- It is *not* the role of the MIT to determine cause, but rather to act as the fact-gathering arm of a Mishap Investigation Board (MIB), whose charter is to determine cause.
- It is intended that board members and team leads be government employees, but support contractors and commercial partners may play key roles in the gathering and analysis of information after a mishap occurs.

As activation and deployment to a mishap investigation operation may be on short notice, it is important that potential MIT members be prepared.

- Prior to assignment, all MIT team members, including the flight surgeon, will have completed the Office of Safety and Mission Assurance (OSMA) MIT training course, which provides detailed understanding of basic MIT actions.
- Many of the actions and processes taught in the OSMA training course will be superficially addressed herein as a quick reference; however, this handbook is not designed to supplant the existing education and training processes in place for MIT members.
- See NPR 8621.1D Section 1.5: Training for specific courses available to NASA and contract personnel.

The role of the NASA flight surgeon or occupational health physician is to be a key member of the investigating team.

In general, a mishap involving humans will be coordinated by someone other than medical personnel. (The exception to this is a medical mishap (e.g. untoward clinical outcome, wrong medication administered, etc.) in which the flight surgeon may lead the mishap investigation.) In accordance with NPR 8621.1D for Mishap and Close Call Reporting, Investigating, and Recordkeeping:

- A mishap involving significant injury or fatality to an onboard human crew will require the involvement of the NASA Office of the Chief Health and Medical Officer (OCHMO) and assignment of a flight surgeon to the responding Mishap Investigation Team.
- In addition, any mission failure mishap that occurs during any crewmember interaction with the vehicle should include a flight surgeon for evaluation of human factor contributions to the mishap.

The role of the flight surgeon is to act as a group leader and medical/human factors subject matter expert for the MIT Operations and Human Factors group. This may include:

- Identifying and interviewing eyewitnesses and others with special knowledge of the incident
- Interviewing any surviving crewmembers or ground support personnel
- Documenting findings at the mishap scene
- Reviewing medical records, reports from emergency or medical responders, and coroner / medical examiner findings
- Documentation of all interviews
- Acting as an interface to the Armed Forces Medical Examiner Services (AFMES), National Transportation Safety Board (NTSB), Federal Bureau of Investigation (FBI) Forensics Laboratory, or similar facilities/entities as required
- Acquiring crew historical information
- Identifying medical information for collection and impoundment
- Researching and documenting medical/human factor considerations
- Offering basic medical support for investigators/site personnel during on-scene activities

Ultimately, the MIT is an investigative authority and is responsible for collecting the data that informs the MIB in developing a mishap investigation report.

1.1 Contact Personnel

The following contact information (cell phone and email) shall be available to all medical mission personnel on this list for the assigned flight. The individuals on this list will change with each spaceflight mission. **Specific details are provided during the Emergency Medical Services (EMS) Medical Operations Readiness Review (MORR) for each flight.**

- Lead Physician Onsite (NASA or Contractor Physician)
- Chief Health and Medical Officer, OCHMO, NASA Headquarters
- Deputy Chief Health and Medical Officer, OCHMO, NASA Headquarters
- JSC Chief Medical Officer
- JSC Deputy Chief Medical Officer
- Landing Site Center Medical Officer (if required, depending on site)
- JSC SA Director
- JSC SA Deputy Director
- JSC/SD Division Chief
- JSC/SD Deputy Division Chief
- JSC/SD3 Medical Operations Branch Chief
- JSC/SD Mission Manager
- Crew Surgeon Assigned
- International Partner Surgeon (if applicable)
- Commercial Partner Surgeon (if applicable)
- IRT Assigned Flight Surgeon
- Contingency POCs
- Local Emergency Contact Info
- Local Medical Centers
- USAF Medical Examiner
  - Dover Air Force Base

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2.0 Overview and Definitions

A mishap can be defined as an injury, damage to public or private property, an occupational injury or illness, a mission failure, or destruction of property (See inset box). Regardless of the kind of mishap, each must be thoroughly investigated to determine the root cause and take steps to ensure that there is not a reoccurrence.

A full list of definitions is provided in **Appendix B**. Here, types of mishaps, mishap teams/boards, hazards, and privileged information will be discussed for reader familiarity.

NASA Mishap and Close Call Descriptions

A NASA mishap is an unplanned event resulting in at least one of the following:

- Occupational injury or occupational illness to non-NASA personnel caused by NASA operations.
- Occupational injury or occupational illness to NASA personnel caused by NASA operations.
- Destruction of or damage to NASA property, public or private property, including foreign property, caused by NASA operations or NASA-funded research and development projects.
- NASA mission failure before the scheduled completion of the planned primary mission.
- A close call is an event in which there is no injury or only minor injury requiring first aid, no damage or minor damage (less than $20,000) to equipment or property or both, but which possesses the potential to cause a mishap.

- From NPR 8621.1D

2.1 Mishap Teams

There are several different kinds of teams and boards that are activated in the event of a mishap. Activation and roles are dependent up the type of mishap (see Section 2.2). These teams and boards include the following:

2.1.1 Interim Response Team (IRT)

In the event of a type A or B mishap, the IRT will respond immediately to the scene of the incident to secure the scene; document the scene using photography, video, sketches, and debris mapping; identify witnesses; collect written witness statements and contact information; preserve evidence; impound evidence at the scene and other NASA locations as needed; collect debris; implement the chain-of-custody process for the personal effects of the injured and deceased; notify the Public Affairs Office (PAO) about casualties, damages, and potential hazards to the public and

NASA personnel; advise the supervisor if drug testing should be initiated; and provide all information and evidence to the investigating authority.

The team is considered interim because it operates as a short-term response team and concludes its mishap response activities when the official NASA-appointed investigating authority takes control.

2.1.2 Mishap Investigation Team

The MIT is activated for Mishap Types B, C, and D. The purpose of a MIT is to serve as the investigating authority following a mishap and to generate the mishap investigation report in accordance with the requirements specified in NPR 8621.1D.

> It is not the role of the MIT to determine cause, but rather to act as the fact-gathering arm of a MIB, whose charter is to determine cause.

Activation and deployment to a mishap investigation may be on short notice. So the flight surgeon should be prepared.

2.1.3. Mishap Investigation Board

The MIB is activated for a Type A or B Mishap. The purpose of a MIB is to serve as the investigating authority following a mishap and to generate the mishap investigation report in accordance with the requirements specified in NPR 8621.1D. The role is to determine cause

2.1.4 Mishap Interagency Investigation Board (MIIB)

NASA Administrator may activate the MIIB for events involving serious injury, significant public interest, and other serious mishaps. This is usually for Mishap Type A.

MIIB memberships consists of a Chair, appointed by the NASA Administrator and the following: (1) Commander, Naval Safety Center, (2) Director, Aviation Safety (or his/her designate), National Transportation Safety Board, (3) Commander, Air Force Safety Center and USAF Chief of Safety, (4) Department of Transportation (DOT) National Expert on Aviation Human Factors, (5) Federal Aviation Administration (FAA) Office of Accident Investigation, (6) Commander, Space Operations Command (formerly 14th Air Force), and (7) NASA Field Center Director or NASA Program AA (Non-HEOMD or Non-Mission-Related).

2.2 Types of Mishaps

NPR 8621.1D – Mishap Reporting, Investigating and Recordkeeping defines NASA mishaps and outlines the investigative process that follows.

NASA categorizes mishaps in the manner described in **Table 2.1**. All mishaps involving individuals requires OCHMO involvement or, at a minimum, requires that the OCHMO is kept aware of the investigative process. Mishaps are categorized based on the impact on life (death or injury) and loss of property.

How a mishap is classified, and the severity of the mishap, will determine the type and depth of investigation that will be conducted. The kinds of final products are also aligned with the class of mishap. All investigations require a root cause analysis (RCA). The MIB or MIT will note the classification, dollar loss, and type(s) of injuries sustained in its final report.

This handbook focuses specifically on the role of the flight surgeon during a mishap investigation that follows a spaceflight mishap involving significant injury or death of a human crewmember.

The aerospace industry may experience unique types of mishaps that are specific to the environments encountered and the partnerships involved in commercial or international spaceflight operations. Examples of mishaps that may be unique to NASA and its commercial and international partners include:

- Crewed NASA spacecraft mishap
- Un-crewed NASA spacecraft mishap
- Mishap occurring on an international partner spacecraft or facility with U.S. crew
- Mishap occurring on a commercial vendor spacecraft or facility with U.S. crew

Table 2.1. Mishap Classification Levels (Table A, NPR 8621.1D)

Classification Level	Property Damage	Injury
Type A Mishap	Total direct cost of mission failure and property damage is $2,000,000 or more, ***or*** Crewed aircraft or spacecraft hull loss, ***or*** Unexpected aircraft or spacecraft departure from controlled flight for all aircraft except when departure from controlled flight has been pre-briefed (e.g., upset recovery training, high Angle of Attack (AOA) envelope testing, aerobatics, or Out of Controlled Flight (OCF) for training) or mitigated through the flight test process inherent at each Center.	Occupational injury or illness resulting in A fatality ***or*** A permanent total disability.
Type B Mishap	Total direct cost of mission failure and property damage of at least $500,000 but less than $2,000,000.	Occupational injury and or illness resulting in A permanent partial disability ***or*** Hospitalization for inpatient care for three or more people within 30 workdays of the mishap.

Type C Mishap	Total direct cost of mission failure and property damage of at least $50,000, but less than $500,000.	Nonfatal OSHA-recordable occupational injury or illness resulting in days away from work or restricted duty, or transfer to another job beyond the day or shift on which it occurred. ***or*** Hospitalization for inpatient care for one or two people within 30 workdays of the mishap.
Type D Mishap	Total direct cost of mission failure and property damage of at least $20,000 but less than $50,000.	Nonfatal OSHA-recordable occupational injury or illness that does not meet the definition of a Type C mishap.
Close Call	Total direct cost of mission failure and property damage of less than $20,000, but event has the mishap potential using a worst-case estimate.	Injury requiring first aid or less, but event has the mishap potential using a worst-case estimate.

Note: Several field centers have a version of this NPR. See the list in Appendix A.

Such events may require coordination between international or commercial agencies or representatives, coordination with contracting officers, or interaction with local responders, contractors, agencies, or teams. These relationships will be further explored in Section 3.1 - Stakeholder Interfacing.

2.3 Privileged Information

Privileged information is any information provided under promise of confidentiality. Privileged information includes:

- Any statement made under the promise of confidentiality
- Personal health data and records (including photographs) of decedents
- Private analyses, deliberation, conclusions, and recommendations by investigative mishap boards or medical review boards
- Any documentation that reveals the investigative board's deliberative processes

In addition,

- Written witness statements obtained within the first 24 hours of a mishap or close call are privileged and protected if collected by a Federal employee. If needed, Federal employee Incidence Response Team (IRT) members can also grant privilege anytime thereafter.
- Written and verbal witness statements given after 24 hours of a mishap or close call, as part of a NASA mishap investigation, where witnesses are informed their accounts will not be released, are privileged and protected.

> Privileged information should be shared only on an approved need-to-know basis and should be used for safety purposes only.

The purpose of designating information as privileged is to encourage the complete, open, and forthright sharing of information, opinions, and recommendations regarding a mishap. This designation can help to overcome any reluctance arising from application of blame, embarrassment, or negativity surrounding personal or mishap-related details.

Violation of privilege (in other words, inappropriate sharing of privileged information) undermines the credibility of future assurances of privacy and privilege, compromising the ability of an investigator or investigative board to receive a full and accurate disclosure of mishap details or pertinent information.

- Unauthorized release of protected medical information is subject to criminal prosecution.

It is important to note that privilege cannot be granted independently by NASA in the case that an external investigating body will be responsible for investigating a mishap, as would be the case for a catastrophic spacecraft loss. According to NPR 8621.1D Section 2.1.5:

- NASA will not grant privilege to witnesses for written or verbal witness statements when an external investigating body is expected to be the sole mishap investigative authority (e.g., catastrophic aerospace vehicle failure).
- External investigative authorities are not required to comply with NPR 8621.1D, NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping (e.g., a congressionally-appointed mishap investigation board or the NTSB in the conduct of an investigation involving an airplane or catastrophic vehicle loss.) Consequently, NASA cannot guarantee privileged statements will be protected from the investigative or other authorities.

2.3.1 Recognition of Privileged and Protected Information

Privileged information should be marked as such and maintained in confidential conditions (see below). If it is unclear whether information should be considered privileged or protected, investigators should request clarification and permission to utilize or distribute such information from the investigative authority.

- Where possible, written witness statements should be collected on a NASA form that includes the statement of privilege.

Most medical information shall be considered privileged or *protected* in some other way (for example, through the Health Insurance Portability and Accountability Act (HIPAA) and the Privacy Act of 1974) unless otherwise designated by the investigating authority. Such items include:

Documents that are sensitive but unclassified (SBU) must be marked in accordance with NASA policy. (NPR 1600.1)

- Toxicological reports
- Autopsy protocols and reports
- Medical imaging, including radiography and tomography

- Laboratory findings
- Physical examinations
- Medical records and medical telemetry
- Patient data collected during a medical or injurious event
- In-mission patient data transfers
- Photographs of injuries or decedents
- Staged photography or diagrams that indicate safety investigation deliberations or causal chain considerations (See **Appendix C** for NTSB Form)

2.3.2 Handling of Privileged and Protected Information

Privileged and protected information should be stored in such a way as to ensure that only those persons authorized to have such data are able to gain access. This includes:

- Proper management and security of passwords for online files
- Security of tangible documentation would include identification (through physical mark) of items as privileged
- Maintenance of documentation under lock and key
- Destruction of documents when no longer needed (**NOTE: Data should not be destroyed until permission has been obtained.)**

All individuals associated with the mishap response or investigations should protect all information, with any release approved by appropriate management and legal oversight.

- MIT members shall not give witnesses a copy of privileged written statements or transcripts of verbal witness statements. If witness statements or transcripts of witness statements are provided to witnesses, NASA cannot ensure privilege and confidentiality.

2.3.3 Privacy Act and HIPAA Considerations

Medical records are subject to the Privacy Act of 1974, as amended, 5 U.S.C.§ 552A.

The Privacy Act of 1974 mandates that a U.S. Government agency have an administrative and physical security system in place to prevent any unauthorized release of personal records. The Act states:

- "No agency shall disclose any record which is contained in a system of records by any means of communication to any person, or to another agency, except pursuant to a written request by, or with the prior written consent of, the individual to whom the record pertains…"
- Exemptions to this Act that allow the use of personal records include for law enforcement purposes or congressional investigations.

The HIPAA Privacy Rule applies to any identifiable health information for any individual. This includes decedents, with HIPAA continuing to apply to identifiable health information for 50 years following the death of an individual.

- HIPAA additionally recognizes the need for designated public health authorities to access protected health information to ensure public health and safety.
  - The NTSB is considered a "Public Health Authority" per 64 FR 59956 and 45 CFR Part 164.512(b)(1)(i). As such, the NTSB can access and utilize protected health information for the purpose of preventing or controlling disease, injury, or disability through investigating the safety of a flight (or spaceflight) operation.
- HIPAA-protected data may be requested by external entities, such as the NTSB, commercial providers (for example, SpaceX or Boeing), and international partners.
- NASA can access and review protected health information for the purposes of an internal safety review and investigation.
- Health information and other privileged / protected data should be kept to a limited distribution on a need-to-know basis and only for the purposes of safety investigation and analysis.
- Release of information to requestors should only occur after the proper high-level approval has been obtained and with the appropriate legal oversight.

2.4 Hazards

Aviation and spaceflight operations and mishaps can involve unique hazards that must be considered in any response, recovery, or investigative process. Altered pressures, temperatures, and gas mixtures, unique acceleration exposures, and altered physiological adaptation or responses can be associated with specific injury patterns. Here, common hazards including vehicle-specific materials, fuels, and designs will be discussed along with hazards unique to aerospace environments.

While mishap responders and investigators should remain cognizant of these unique materials and environmental considerations when considering insults or injuries to crew, they must also remain wary of their own risk of injury at the mishap site or in any storage facility housing crash debris, biological material, or other hazardous substances. On-scene risks will be specific to the vehicle, type of mishap, and the environment and geography of the site, and many of the hazards listed below can remain injurious following an incident or even after removal from the mishap site.

2.4.1 Vehicle-Specific Hazards

Vehicle Materials and Fuels

While each vehicle may incorporate unique materials into its design and perform within a specific operating envelope, many vehicle-associated hazards are well-known to aerospace practitioners as uniquely, or particularly, hazardous to the vehicle occupants. Some vehicle-specific considerations are described below. Investigators should obtain a vehicle-specific hazard list prior to arrival to an investigation site to ensure that they are aware of potential concerns and health risks.

Vehicle Hazards, Historical Lessons Learned: The Apollo-Soyuz Test Project
An acute toxic atmospheric crew exposure occurred during the Apollo-Soyuz Test Project. During vehicle re-entry, an open pressure relief valve allowed nitrogen tetroxide (N_2O_4) from reaction control system (RCS) thrusters to enter the crew cabin. Total time of exposure to nitrogen tetroxide was four minutes and 40 seconds; the crew subsequently developed chemical pneumonitis and were hospitalized for one week. The estimated average crew N_2O_4 exposure was 250 ppm; the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit is 5 ppm.

Fuels and Oxidizers

Rocket propellants involve the combustion of a fuel source. For most chemical propellants, energy is released through the reaction between an oxidizing agent and a reducing agent in the fuel mixer. Exposure to onboard chemicals can cause specific toxicological patterns Human spaceflight and aviation systems involve a wide variety of chemicals. They will change based on the provider and vehicle. Some common fuel and oxidizers, and associated medical concerns, are provided in **Table 2.2**.

In addition to onboard fuels, vehicle construction and materials can alter the associated hazards for crew and responders. The presence of composite-fiber material may alter impact forces and debris patterns; composite

materials, while extremely strong, are quite brittle and can shatter on impact. Further, epoxy is commonly utilized as a matrix material. Epoxy is combustible and, even when flames are extinguished, epoxy can continue to burn in a smoldering combustion reaction.

Exposure to particulated composite material should be considered a respiratory hazard and treated similarly to fiberglass. Acute exposure can cause skin, ocular, and respiratory irritation. First responders should utilize personal protective equipment.

The likelihood of a significant contamination from hypergolics is generally low but has occurred in previous spaceflights such that a heightened awareness should be maintained.

> The flight surgeon should evaluate materials, such as the spacesuit, for signs of chemical exposure. Care should be taken when removing crew garments after a mishap to prevent additional exposures to either the patient or caregivers/responders.

The NASA Advanced Crew Escape Suit (ACES) and Modified Advanced Crew Escape Suit (MACES) protect crewmembers from hypergolic vapors, but not from liquid hypergolics. The ACES will bleach when exposed to liquid monomethyl hydrazine and turn black when exposed to liquid N_20_4 (see **Figures 2.1 and 2.2**).

Figure 2.1. Samples after exposure to monomethyl hydrazine.

Table 2.2. Common fuels and oxidizers and associated health concerns.

COMPOUND	VEHICLES	CONDITION	HAZARDS / CONSIDERATIONS
Liquid Oxygen	SpaceX Falcon 9, SpaceX Falcon Heavy, Blue Origin's New Shepard and New Glenn rockets, and Russian Soyuz	Cryogenic liquid	• Exposure to cold temperatures and thermal injury • Over-pressurization due to expansion • Oxygen enrichment of the surrounding space which can increase the risk of a combustion event
Kerosene (RP-1)	SpaceX Falcon 9, SpaceX Falcon Heavy, Blue Origin's New Shepard and New Glenn rockets, and Russian Soyuz	Liquid	• Highly flammable • Vapors are explosive. • Inhalation can lead to aspiration, dizziness, drowsiness, headache, euphoria, pneumonitis, cyanosis, and respiratory distress. • Ingestion can cause nausea and vomiting • Eye exposure can cause irritation (though it is pH neutral). • Acute dermal exposures can cause transient pain and superficial burns; over time, skin can dry and crack.
Liquid Hydrogen	Delta IV, Ariane 5	Cryogenic liquid	• Potential for thermal injury • When vaporized, risk of asphyxiation secondary to oxygen displacement • Gaseous/vaporized hydrogen extremely flammable, risk of combustion and explosive events
Liquid Methane	Blue Origin's New Glenn, SpaceX's Starship (planned, in development)	Cryogenic liquid	• Can be an asphyxiant due to oxygen displacement • Flammable gas

Dinitrogen Tetroxide (N_2O_4) / Nitrogen Dioxide (N_2O_2)	Proton rocket, SpaceX reaction control system	Liquid (green-brown) Vapor (clear-to-orange, sweet/acrid smelling – similar to bleach)	• Liquid – highly corrosive • Vapor – heavier than air, does not rise or disperse quickly • Exposure can lead to severe health effects; initially, symptoms may be mild and followed by a symptom-free period of 5-72 hours before development of severe symptoms. • Sequelae include: - Cardiovascular: tachycardia, bradycardia - Respiratory: Pulmonary irritation, cough, dyspnea, pulmonary edema, pneumonitis, respiratory distress and failure - Central Nervous System: headache, narcosis, vertigo, somnolence, fatigue, loss of consciousness - Gastrointestinal: irritation, nausea, vomiting - Dermal: dermatitis, chemical burns - Hematological: methemoglobinemia • Treatment includes decontamination and supportive care with respiratory supplementation as needed; steroids may be helpful. Methylene blue can be used to treat methemoglobinemia.
Hydrazine (N_2H_4) / Monomethyl Hydrazine (MMH)	Proton rocket, U.S. Space Shuttle, SpaceX Dragon propulsion system	Liquid (clear, colorless) Vapor (ammonia-smelling or "fishy")	• Liquid – corrosive • Vapor – heavier than air, does not rise or disperse quickly • Exposure can lead to severe health effects: - Cardiovascular: Hypotension - Respiratory: mucosal irritation, cough, pulmonary edema, respiratory failure

			- Central Nervous System: Headache, dizziness, narcosis, muscular tremors, altered or depressed mental status, and seizures. (Of note, MMH is associated with more lethal seizures than plain hydrazine). - Gastrointestinal: irritation, nausea and vomiting, hematemesis - Ocular: conjunctivitis, corneal damage, chemical burns - Dermal: dermatitis, chemical burns, facial edema, allergic sensitization - Renal: acute kidney injury - Endocrine: hyperglycemia or hypoglycemia - Hematological: red blood cell hemolysis, hyperammonemia (N_2H_4 only), methemoglobinemia (MMH). • Treatment includes decontamination, ocular flushing, and supportive care addressing any liver, lung, and kidney sequelae as well as metabolic abnormalities or hypoglycemia • Seizures can be treated with pyridoxine (Vitamin B6) – 25mg/kg IV over 15-30 minutes for active seizure • Methylene blue can be used to treat methemoglobinemia.

Hydrogen Peroxide (H_2O_2)	Mercury, Jupiter, Redstone rockets; used in turbopumps on first stage of Russian Soyuz and Soyuz reaction control system	Liquid	• Peroxide can be toxic if ingested, inhaled, or through contact with the skin or eyes • Inhalation can cause respiratory distress • Eye exposure can cause ocular irritation and pain
Nitrous Oxide	Attitude control systems	Cryogenic	• Inhalation of nitrous oxide can cause dissociative anesthesia and asphyxiation from oxygen displacement • Exposure of nitrous oxide to hydrocarbons can substantially raise the risk of explosion
Gaseous Hydrogen	Lighter-than-air flight operations, allowed for recreational ballooning	Gaseous	• Extremely flammable
Gaseous Helium	Lighter-than-air flight operations; also used as a pressurizing gas for other propellant and oxidizer systems (inert and non-reactive with such fuel systems)	Gaseous	• Stable, non-combustible gas • Exposure to large quantities can lead to asphyxiation secondary to oxygen displacement • Inhalation can cause dizziness, nausea, vomiting
Jet Fuels / Aviation Turbine Fuels	Gas-turbine powered aviation platforms - Jet A (kerosene-type), Jet A-1 (kerosene-type), Jet B (naphtha-type, better for cold weather performance)	Liquid Hydrocarbon mix	• Acute exposure can cause dermatitis, drowsiness, dizziness, ocular and respiratory irritation • Highly flammable

Commercial crew provider suits may show different color change variations. In general, if the suit is stained or bleached, suspect a contaminant of hypergol until proven otherwise.

Figure 2.3. Commercial provider's suit with stain or bleached out area due to possible hypergol contaminant.

Vapor contamination generally dissipates rapidly, but the air should be sampled for safety if there is a possibility of hypergol off-gassing or liquid fuel release. Liquid contaminants may cause eye/skin/airway irritation when they evaporate. Dousing with water can reduce the evaporation rate and prevent off-gassing until the garments can be contained.

Finally, onboard chemicals may pose a risk to vehicle occupants during flight or to investigators and responders after a mishap. Examples are provided in **Table 2.3**.

Additional hazards include pressure vessels, including fuel tanks, coolants, atmospheric gas containers, or even tires on wheeled vehicles.

Table 2.3. Common chemicals onboard spacecraft.

SUBSTANCE	LOCATION	HAZARDS / CONSIDERATIONS
Ammonia	Cooling systems	• Ammonia is often stored in liquid form, with liquid-gaseous phase change driving cooling. • Vaporized ammonia is corrosive and can be highly irritating with inhalation exposure. • Inhalation can lead to mucosal irritation, bronchiolar and alveolar edema, and airway destruction resulting in respiratory distress or failure.
Freons	Cooling systems	• Inhalation can lead to asphyxia due to oxygen displacement, mucosal irritation, and respiratory distress • Exposure can cause cardiac dysrhythmia
Benzene	Payload or other source	• Vapor is heavier than air and will not disperse quickly. • Vapor exposure to the eye can cause irritation; liquid eye exposure can cause corneal sloughing and permanent damage. • Inhalation can lead to drowsiness, dizziness, rapid heart rate, headache, lightheadedness, nausea, tremors, impaired gait, confusion, loss of consciousness, shortness of breath, respiratory depression, coma, and death. • Ingestion of benzene causes irritation of the gastrointestinal tract, nausea, vomiting, stomach pain, diarrhea, dizziness, sleepiness, seizures, rapid heart rate, and death.

Vehicle Trajectory and Profile Considerations

As each vehicle will utilize different design, materials, and fuels, each vehicle will obtain a different trajectory and flight profile during launch and reentry. Thus, occupants will be exposed to different trajectory-related hazards dependent upon their vehicle. Responders and investigators should be familiar with the dynamic mission envelope and associated hazards for each vehicle involved in a mishap. Some considerations include:

- Fuels, oxidizers, and any cryogenic or pressure vessels (see above section)

- Flight trajectory, orbital mechanics, and capability for down-range correction
- Vehicle-specific acceleration profiles, kinetic and potential energy, dynamic events (for example, vehicle boost stages, stage separation, occupant positioning and seat angles, etc.)
- Abort modes and limitations (for example, plume impingement, thermal exposures, vacuum and altitude tolerance, personal protective equipment and limitations)
- Reliance on survivability capabilities (for example, parachute, vehicular abort capabilities, pad abort capabilities, etc.)
- Time sequencing and event timing (particularly where deviations can affect the environment or forces imposed upon the crew)

2.4.2 Environmental Hazards

The aerospace environment imposes unique hazards on a vehicle's crew; at the same time, on-scene hazards may be unique and unfamiliar to many first responders and investigators. Some considerations for crew are included in **Table 2.4.** Keep in mind each vehicle design is different and hazards while presented here are general, each vehicle will be different.

Table 2.4. Environmental Hazards

ENVIRONMENTAL HAZARD	SPECIAL CONSIDERATIONS
Vibro-acoustic environment	• Noise interference with communication • Vibratory loads and associated injuries
Acceleration Loads and Vehicle Surface Interactions	• Impact and flail injuries • Survivable occupant space • Impact hazards
Thermal environment	• Protective equipment • Exposures and physiological hazards • Reactivity of heated gases, flammability and explosive risks
Micrometeoroid and Orbital Debris	• Pressure vessel concerns • Protective environment (vehicular and extravehicular activity)
Space Radiation Environment	• Acute vs. chronic exposures
Shock-shock interaction	• Interaction between shockwaves produced by various vehicle structures during sonic transitions • Can cause significant localized thermal and aerodynamic insults

	• Exposed individual (for example, during freefall) may experience severe physiological sequelae and injury from shockwave exposure
Hypersonic environment	• Extreme velocities – consider vehicle vs. extravehicular exposure
Depressurization and vacuum exposure	• Decompression syndrome • Ebullism • Aeroembolism • Barotrauma
Landing / Post-mishap terrain	• Ground or sea conditions • Weather • Ocean vs. freshwater landings • National vs. international territories • Crew deconditioning from long-duration spaceflight
Extravehicular activity	• Suit-specific hazards • Extravehicular depressurization or decompression-related injury • Thermal exposures • Trauma
Exposure concerns, on-orbit mishap response	• Potential for crew medical officer exposures • Consider availability of personal protective equipment • Pre-flight vs. just-in-time hazard training
Personal protective equipment (PPE)	• Consider the applicability / availability of PPE to various hazards / exposures • PPE-specific training considerations

Responders and investigators should seek and obtain approval from the on-scene commander before accessing the site and should request a brief overview of potential on-scene hazards. For on-scene responders and mishap investigators, potential hazard considerations are provided in **Table 2.5.**

Table 2.5. On-scene Hazards.

POTENTIAL HAZARD	SPECIAL CONSIDERATIONS
Airborne Exposures	• Consider upwind approach to on-scene debris
Onboard hazards	• Pressure vessels • Cryogenics • Vehicular Hazards (explosives, fuels, etc.)
Personal Protective Equipment (PPE)	• Availability • Proper use, appropriate PPE for various hazards
Thermal / Weather	• On-scene exposures • Heat / cold injuries • Inclement weather concerns

On-scene environmental exposure	• Local flora / fauna • Insects / vector-borne disease (e.g. Lyme) • On-scene noise • Abrasion / laceration hazards • Tetanus (on-scene responders should be vaccinated)
On-scene hazardous terrain	• Appropriate equipment / training for response and investigation teams

Radiation as an exposure deserves special mention. There are a variety of radiation sources in spacecraft. The Soyuz, for example, uses a gamma ray altimeter to trigger the soft-landing rockets just above the ground. The radioactive source is cobalt-60, which is located in the base of the capsule and measures the backscatter of gamma rays as it approaches Earth. If the capsule should come to rest on its side, the ground staff take extra precautions to isolate and cover the source to prevent exposures to the ground crew or flight crew upon extraction.

Prior to any investigative actions at a mishap site, first responders will ensure the safety of the site before an investigation commences. This includes rescuing any survivors and no hazards remain. This will always be a case by case approach.

Although not currently used in human-rated spacecraft, radioisotope thermoelectric generators (RTGs) are a type of nuclear battery that converts the thermal energy released by the decay of the radioactive material to produce electricity for a spacecraft. NASA RTGs have historically been plutonium. For example, the Mars 2020 rover used a plutonium RTG for power. Plutonium dioxide is a highly soluble alpha emitter. Future exploration missions may use RTGs for power supplementation for spacecraft or bases/outposts.

In any spacecraft accident in which a radiation source was onboard, the area should be swept by the appropriate radiation containment team prior to rescuers or investigators being granted access, and appropriate Personal Protective Equipment (PPE) used when in a contaminated area. The radiation accident patient should be decontaminated at the scene, or at a triage area established near the treatment area. During triage, life-threatening emergencies have priority over radiation urgencies. Once life threats are resolved, then consideration may be given to radiological issues. Radiation injury rarely causes immediate signs and symptoms. Therefore, other causes of injury or illness must be considered.

Any assigned flight surgeon should consult with the NASA Radiation Safety Officer and the Oak Ridge Institute-Radiation Emergency Assistance

Center/Training Site (REAC/TS) coordinator for treatment guidelines or questions related to a potential radiation exposure at (865) 576-1005. In general, the Radiation Safety Officer, REAC/TS coordinator, and NASA OCHMO devise treatment guidelines, calculate potential exposure dosages, and coordinate to determine plume direction on any radiation accident involving a NASA spacecraft. An accident scene will be typically rendered inert and sources retrieved before any investigators will be allowed on-site. However, the potential for exposures may exist in the initial emergency response and rescue.

2.4.3 Biohazards

During a spaceflight, biohazards may be potential causal factors for a mishap. For example, inadvertent exposure to a biofilm may lead to infection. Mistakes in handling biological research payloads could lead to contamination and illness or injury. Onboard toxins could cause a crewmember illness or reaction. An onboard / in-flight mishap may be inclusive of all crewmembers or may involve a single crewmember, with other crew responding to support the affected crewmember or cleanup efforts, maintaining documentation and evidence, or assisting in immediate investigative responses.

Use of PPE can reduce these risks; however, an awareness of the type of pathogens, common routes, and similar concerns can be helpful in spreading awareness of this risk.

> Once a mishap has occurred, responders and mishap investigators must remain aware of the potential for their own exposure to blood and bodily fluids, where potential transmission of an infectious pathogen is a concern.

Bloodborne pathogens of the most concern include the human immunodeficiency virus (HIV) and the hepatitis viruses, particularly hepatitis B (HBV) and hepatitis C (HCV). See **Table 2.6.**

Table 2.6: Bloodborne Pathogen Considerations

BLOODBORNE PATHOGEN	CONSIDERATIONS
Human Immunodeficiency Virus (HIV)	• HIV survives in dried blood for less than 24 hours • The risk of HIV transmission from a contaminated penetrating injury is <1%. • Low-likelihood transmission risk, particularly in casual exposure circumstances (e.g. exposure to blood on surfaces or dried blood on vehicle evidence)
Hepatitis B Virus (HBV)	• Survives in dried blood for over a week • Risk of transmission can be as high as 30% from a contaminated penetrating injury • HBV vaccine is protective: Investigators that may be exposed to human remains or contaminated evidence should be up to date on their HBV vaccination, with titers demonstrating immunity
Hepatitis C Virus (HCV)	• Can survive for weeks on surfaces • Relatively low risk (approximately 2% from a contaminated penetrating injury)

Storage conditions can give rise to additional hazards, particularly with the storage of biological material (such as human remains).

- Overgrowth of bacterial or fungal species may pose an infectious risk, particularly if appropriate ventilation or refrigeration facilities are unavailable, as may occur with remote recovery activities.
- Proper cleaning and preservation techniques should be employed to minimize such hazards
- Storage facilities (even temporary shelters) should be designed to ensure good ventilation
- Workers should utilize appropriate personal protective equipment.

2.4.4 Recognition of Hazards

A hazard is anything *within human control* that may be a potential cause of illness, injury, or damage. The goal of a mishap investigation is to identify and mitigate hazards for the future prevention of illness, injury, or additional mishap. Through analysis of mishaps, near-mishaps, and

incidents, hazards may be detected. Mishap investigators must report such hazards to investigative authorities to ensure that actions can be taken to promote safety and prevent additional incidents.

2.4.5 Reporting and Management of Hazards

Mishap reporting occurs as per the pertinent Program Contingency Action Plan (CAP). This process will have taken place prior to arrival of a MIT.

The ultimate product of a mishap investigation is the Mishap Report, which should address all findings, analysis, and safety recommendations to be implemented to prevent further risk or harm. See Chapter 6 for further information regarding the Report.

2.5 Aerospace Injury Patterns

Injury patterns and autopsy findings can provide important information regarding the physical events and the timeline of a mishap. In addition, a thorough understanding of injuries and how they occurred can provide the opportunity to improve upon vehicular safety and occupant survivability.

- Investigators should be aware of common physiological sequelae of spaceflight unrelated to mishap events, as such sequelae can confound autopsy findings or contribute to injury patterns.
- For example, thinning of bone cortex and trabeculae is a common adverse effect of spaceflight and would be expected to be identified in the autopsy of a long-duration crewmember. However, such bony demineralization could increase the risk of fracture.
- In the case of fatality, mechanical injury patterns can assist in establishing a timeline of events. As tissue hemorrhage indicates the presence of circulatory activity, injuries with associated hemorrhage occurred antemortem.

Example of events and physiological sequelae are presented in **Table 2.7** and the subsequent figures.

Table 2.7. Sample events and physiological sequelae.

EVENT TYPE	RISKS	PHYSIOLOGICAL SEQUELAE
Depressurization: Barotrauma	Exposure to high-altitude or vacuum conditions	Barotraumas include: • Tympanic membrane rupture • Pulmonary overpressure injuries - Alveolar hemorrhage - Pneumothorax - Pneumomediastinum - Lung rupture • Various manifestations of decompression syndrome
Depressurization: Ebullism	Exposure to extreme-altitude or vacuum conditions	• Spontaneous evolution of body liquids to vapor at body temperature when ambient pressure is ≤47mmHg (as occurs at altitudes ≥63,000 ft) • Water vapor bubbles can be identified in pulmonary and cardiac tissues and can be associated with other overpressure injuries • Severe cases of ebullism may be associated with subcutaneous distention and collection of gas pockets and gaseous distention of the abdominal cavity with the potential for rupture • Additional gas bubble collections may be identified in the brain or other nervous tissue • See Figure 2.3
Bracing Injuries	Restraint failure	• Bracing injuries occur when an individual attempts to stop body motion through bracing against vehicular structures. • Presence of such injuries imply conscious, voluntary action and awareness (and at least temporary tolerance) of unwanted vehicle motion. • Common injuries include defensive fractures to the wrists, forearms, feet, and ankles as well as joint impact or separation injuries. • See **Figure 2.4**

Loss of upper torso restraint	Upper body strap failure or inertial reel failure	• Without torso restraint, the upper body becomes free to translate forward and rotate downward over any remaining pelvic restraints • Mechanical loading of the lower spine and spinal injuries, such as Chance-type compression fractures (caused by excessive flexion) • Additional injury patterns similar to those seen in forward-impact automobile collisions • See **Figure 2.5**
Submarining	Restraint failure (lack or failure of negative-G strap (“crotch belt”))	• Submarining occurs when an occupant slides beneath a lap belt such that the lap belt rises above the iliac spines • Can lead to abdominal and pelvic injuries to internal organs, spinal fractures, and fractures to the lower extremities due to increased impact with the vehicle structures • See **Figure 2.5**
Flail injury	Restraint failure	• Flail injuries include those sustained through an unrestrained body part striking a vehicular surface or through sudden acceleration/deceleration of a body part • For example, an arm flail leading to a hand impacting a vehicular structure could lead to a hand or forearm fracture or a contusion of the impacting body surface • Most flail-type injuries are located in distal limbs and the parietal skull
Head and Neck Injury	Restraint failure, helmet considerations	• The added weight of a helmet can increase severity of head flail, cervical injuries, and the potential for atlanto-occipital dislocation and distraction fractures • Helmet neck rings can lead to neck injuries, including hyoid bone fractures and injuries to the thyroid cartilage • Non-conformal helmets can lead to unwanted movement of the head within the helmet and skull-helmet-surface impacts, causing contusion, skull fracture, and intracranial injury and hemorrhage. • See **Figures 2.6 and 2.7**
Thermal Injuries	Thermal exposure	• During dynamic phases of flight, such as launch and reentry, space vehicles are exposed to superheated gases.

		• If these gases are able to enter the crew compartment, exposure could cause burn injuries, material failures, or additional melting of vehicular metal or other materials, causing splattering of the molten materials. • Autopsy may identify surface burns and fine metallic deposits. • Entry of superheated air into occupant space would generally indicate that the crew compartment had undergone a depressurization event and expulsion of atmosphere. • See **Figure 2.8**

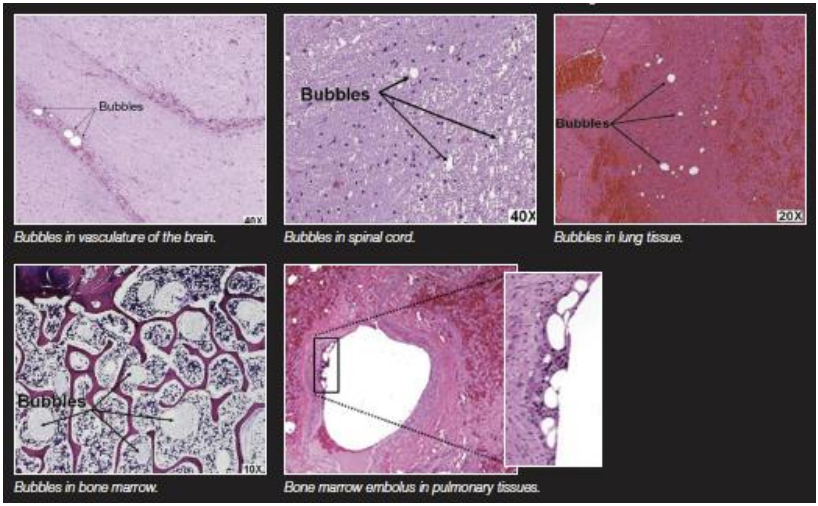

Figure 2.3. Tissue Ebullism: Bubbles identified in various body tissues after exposure to extreme altitude and subsequent ebullism. Image courtesy of Biodynamics Research Corporation, reproduced from Loss of Signal (Stepaniak et. al. 2014).

Figure 2.4. Bracing Injuries: Bracing against structures can cause defensive-type injuries to the extremities. Image courtesy of Biodynamics Research Corporation, reproduced from Loss of Signal (Stepaniak et. al. 2014).

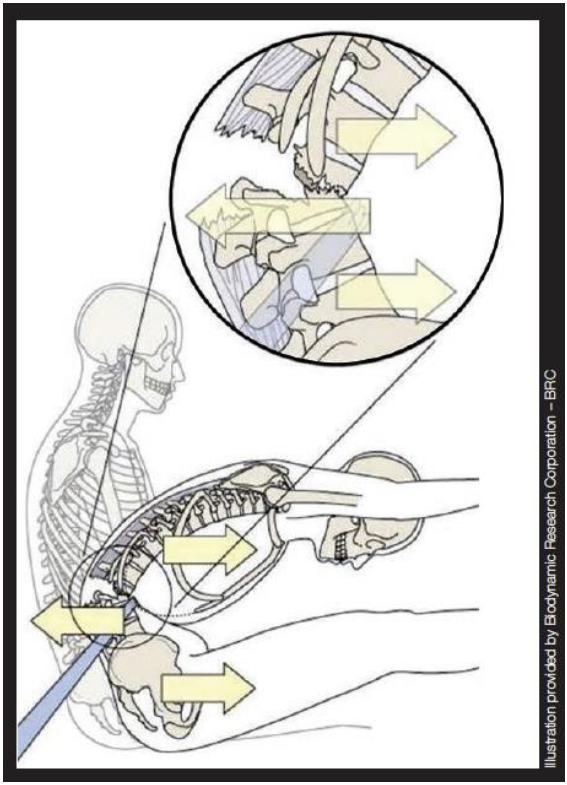

Figure 2.5. Chance Fractures occur with an unrestrained torso, where impact causes a forward and downward rotation of the torso over the lap belt. In this image, note the concurrent *submarining*, where the occupant has slipped below the lap belt such that the restraint strap rises above the iliac spines. Image courtesy of Biodynamics Research Corporation, reproduced from Loss of Signal (Stepaniak et. al. 2014).

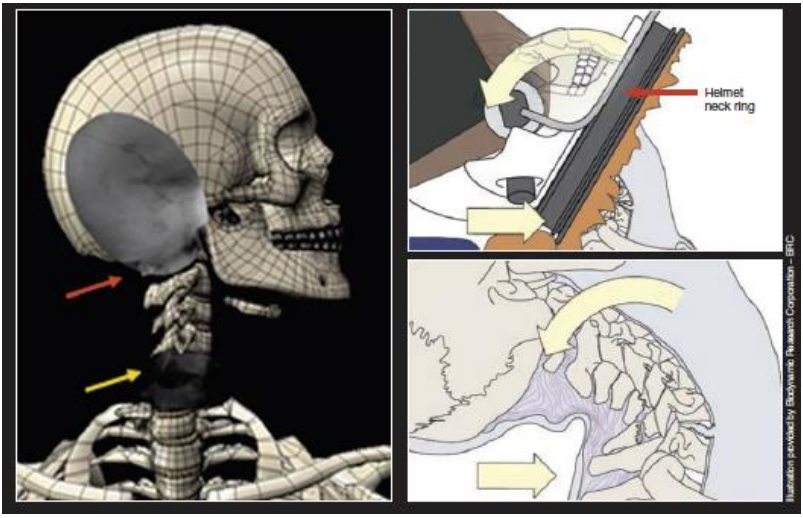

Figure 2.6. Head and Neck Injuries: mechanisms include sudden deceleration with impact against cabin or suit structures, such as the helmet neck ring. Image courtesy of Biodynamics Research Corporation, reproduced from Loss of Signal (Stepaniak et. al. 2014).

Figure 2.7. Impact injury caused by non-conformal helmet. Image courtesy of Biodynamics Research Corporation, reproduced from Loss of Signal (Stepaniak et. al. 2014).

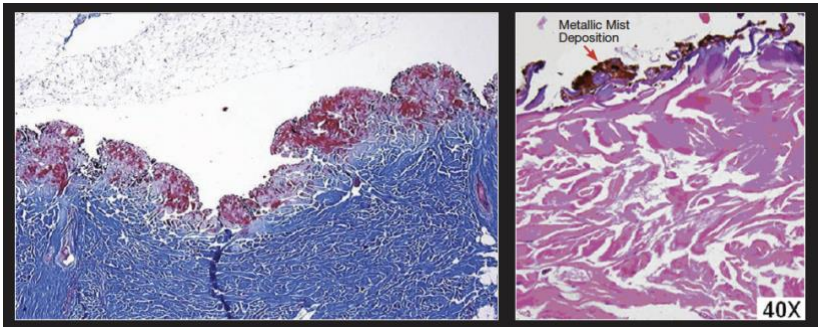

Figure 2.8. Thermal injury: Superficial skin burns are demonstrated in stained tissue samples from the STS-107 Space Shuttle Columbia mishap. In the image to the left, trichrome staining demonstrates burned epidermis (red) and undamaged deeper reticular dermis (blue), characteristic findings from a flash burn. The high-magnification image to the right demonstrates metallic mist deposition on the burned surface of the skin. Image courtesy of Biodynamics Research Corporation, reproduced from Loss of Signal (Stepaniak et. al. 2014).

3.0 Pre-Investigation Planning

Before departing for field operations for an accident investigation board, a pre-investigation plan should be made and outlined in order to adequately prepare for the scene. While most investigative forms will be provided by IRT and MIT, it is important for the flight surgeon to be aware of these forms. Examples of the necessary forms appear in **Appendix C.**

The NASA Flight Surgeon pre-plan should include the following:

- Evaluation of the mishap location – The flight surgeon should know at what altitude the mishap site will be in case mitigation strategies might be needed (for example, packing acetazolamide in the medical bag), or in case high altitude symptoms could impact the members of the investigation team. The temperature and general climate should be understood, and adequate clothing aligned to the climate, typically in layers, should be on hand.
- Federal Resources – Have the numbers for the AFMES, NTSB, FAA, FBI, and the Coast Guard or Department of Defense points of contact numbers available.
- Engineering and computer-aided design (CAD) drawings – Prepare to take either paper or electronic copies of the specific vehicle engineering drawings or CAD drawings, especially as they relate to the human system interface, with you to the investigation.
- Agreements – Bring or have reach-back access to either paper or electronic copies of agreements or MOU's with the FAA, NTSB, FBI, Coast Guard, or DoD regarding authorities for commercial crew mishaps.
- Biological Sample Handing and Chain of Custody – Bring paper or electronic copies of policies or procedures regarding handling, packaging, and chain of custody of biological samples.
- Acquire Perishable Non-Scene Data – Before heading to the scene, ask for and secure all potentially perishable non-scene data such as: surgeon mission control data log and tapes, private medical conferences, psychological conference, identifying medical data (for example, dental records), or any medical data and notes that might potentially be overwritten or be forgotten after weeks of investigation.
- Mishap Investigation Kit (see **Appendix D**)
- Flight Surgeon Medical Kit (see **Appendix D**)

3.1 Stakeholder Interfacing

3.1.1 Roles, Responsibilities, Hierarchies, and Authorities

The agency/agencies responsible for mishap response will vary depending on the type of mishap that has occurred. Table 3.1 below outlines the responsible Agencies that will respond to mishaps occurring at various locations and under the control of different providers.

Table 3.1. Responsibility Matrix for Initial Mishap Response in the United States

		Sponsor Agency	
		NASA	Commercial Spaceflight Provider
Location of Mishap	Federal Installation	Federal Crash/Fire/Rescue	If crewed, joint response. If un-crewed, Commercial Provider.
	Corporate Facility	N/A	Corporate crash/fire/rescue forces (based on corporate posture. Some may have private initial response forces; some may rely on local response)
	Local Populace	Local FD – until/unless incident is Federalized in accordance with National Incident Management System	Local FD – until/unless incident is Federalized in accordance with National Incident Management System

The response Incident Commander will determine when the mishap site is safe and cleared for MIT access. A security response will be in place prior to MIT access; the security protocol, personnel, and structure will likely continue without reorganization during an investigation so as to enable continuity.

> If access to the mishap site is delayed due to ongoing recovery, hazards, or other logistical considerations, MIT personnel may begin reviewing remote telemetry or Mission Control data prior to scene access/investigation.

3.1.2 Existing Agreements and Working Relationships

In addition to NASA and its partner agencies and contractors, various agencies may play roles in a mishap response or investigation. These entities include:

- **Federal Bureau of Investigation (FBI):** In the event of a mishap involving serious injury or loss of life, the role of the FBI is to investigate the accident scene. This includes:

  - Use of appropriate tools to develop and grid, based on longitude and latitude, to ensure the location of evidence

  - Specific interest to medical personnel is ensuring accurate documentation of any recovered dissociated remains of crew, crew hardware, crew belongings, etc.

  - FBI personnel are trained to document and collect human remains and are identified as the prime group designated to perform this function. In practice, however; local law enforcement officials and specialists in local terrain may be involved. Such involvement will be coordinated through the Incident Commander.

  - The flight surgeon may coordinate with the FBI Forensic Laboratory and consult the FBI Forensic Handbook in cases of remote accident sites where the FBI direct presence may be hampered (https://www.fbi.gov/file-repository/handbook-of-forensic-services-pdf.pdf/view).

- **National Transportation and Safety Board (NTSB):** The NTSB will be involved in any commercial spaceflight accident according to the authority granted in 49 U.S.C. § 1131(a)(1).

- **Federal Aviation Administration (FAA):** The FAA licenses all commercial providers. Given this authority, most commercial spaceflight mishaps will include FAA representatives/investigators.

- **Department of Defense (DoD) / U.S. Air Force (USAF):** The USAF and DoD will support all NASA-related launches under contract. Each commercial provider is responsible for their own launch and landing support, though many joint operations between NASA and commercial entities may incorporate DoD support through existing NASA-DoD agreements.

  - The DoD Human Space Flight Support (HSFS) program reports to the Joint Forces Space Component Commander (JFSCC), under the

U.S. Strategic Command (USSTRATCOM) and Air Force Special Command (AFSPC).

- Detachment (DET)-3 resides with the 45th Operations Group (Space Wing) at Patrick Air Force Base (PAFB). DET-3 supports launch, landing and rescue operations for all NASA or NASA-sponsored missions with Pararescuers and ships at sea.

- **Commercial Providers**: Each commercial provider is responsible for their own launch and landing support. In addition, each commercial entity may choose to conduct their own investigation in parallel with those conducted by the NTSB.

Further, according to the NASA Authorization Act of 2005 (Public Law 109-115, Section 821), any vehicular disaster involving significant injury or loss of life to onboard NASA crewmembers mandates the establishment of a Presidential Commission, with federal oversight of mishap response and investigation. As a result, the Presidential Commission may further involve federal agencies or resources during the investigative process.

NASA additionally has memoranda of understanding with each of its international partners in support of the International Space Station and all other international programs.

3.2 International Partners

In the event of a mishap involving an International Partner (IP) crewmember, an IP flight surgeon will participate in the IRT. This role will usually be as an advisor, as the MIB voting member must always be a NASA employee. **Table 3.2** illustrates this point.

Table 3.2. Summary of Appointing Official in Different Types of Mishaps (Chapter 3, Table C, NPR 8621.1D)

<table>
<tr><th>Investigating Authority Federal Employees Functions (1)</th><th>High Visibility Mishap or Close Call</th><th>Type A MIB</th><th>Type B MIB or MIT (2)</th><th>Type C MIT or MI (2)</th><th>Type D MIT or MI (2)</th><th>Close Call MIT or MIB (2)</th></tr>
<tr><td rowspan="5">Voting Members (3)</td><td>Chairperson</td><td colspan="5">Required Except of MIs</td></tr>
<tr><td>Human Factors Investigator</td><td colspan="5">Required</td></tr>
<tr><td>Safety Officer</td><td colspan="5">Required</td></tr>
<tr><td>Medical Doctor</td><td colspan="5">Requires as appropriate for injury or illness (4)</td></tr>
<tr><td>Technical Subject Matter Expert</td><td colspan="5">(5)</td></tr>
<tr><td rowspan="3">Non-Voting Members</td><td>Ex Officio</td><td colspan="5">Required</td></tr>
<tr><td>Executive Secretary</td><td colspan="5">(6)</td></tr>
<tr><td>Legal</td><td colspan="5">Required</td></tr>
<tr><td rowspan="2">Advisors</td><td>Public Affairs</td><td colspan="5">Required</td></tr>
<tr><td>NASA Safety Center (NSC)</td><td colspan="5">Required</td></tr>
<tr><td colspan="7">Center/Program MPCP</td></tr>
</table>

1. Functions are combined when appropriate. The AO obtains concurrence from Chief, SMA, OCE, and CHMO on IA membership for Type A and Type B mishaps and high-visibility mishaps and close calls.
2. An ex officio is not required for investigations by a single mishap investigator where one person becomes injured or ill.
3. The IA consists of an odd number of voting members including the chairperson.
4. For Types A and B and high-visibility mishaps and close calls, the AO requests concurrence from the CHMO to include a medical doctor member. For C/D mishaps and close calls, the AO consults the Center occupational health authority or OCHMO for medical representation and consultation. The IA chairperson may request a medical doctor as an advisor or consultant if one is not an IA member.
5. The AO determines the need for a subject matter expert based on exceptionally large board membership and investigative scope.
6. The AO determines the need for an executive secretary and other advisors such as procurement, import/export control, or others.

3.3 Additional Considerations

3.3.1 Pathogen Transmission: Common routes and concerns

Mishap investigators must remain aware of the potential for their own exposure to blood and bodily fluids, where potential transmission of an infectious pathogen is a concern. Use of personal protective equipment can reduce these risks; however, an awareness of the type of pathogens, common routes, and similar concerns can be helpful in spreading awareness of this risk.

Bloodborne pathogens of the most concern include the human immunodeficiency virus (HIV) and the hepatitis viruses, particularly hepatitis B (HBV) and hepatitis C (HCV) (see Table 2.6).

On-scene investigations occurring in wooded or remote areas raise the risk of vector-borne diseases, such as Lyme disease, or exposure-related infections such as tetanus. Again, vaccination can be preventive for tetanus. Additional geographically-specific infectious concerns should be reviewed, with vaccination as appropriate for any known concerns.

3.3.2 Public Affairs planning

- The investigating flight surgeon must be aware that any major spacecraft mishap will be of high interest to the media and it is possible that they may find themselves in the position of being questioned by journalists.
- Prior to departure to the investigation site, ensure that contact information is obtained for the Public Affairs Office (PAO) representative working with the MIT. Keep this information available to give to anyone outside the MIT asking questions or requesting information about the mishap.

> Ideally, PAO will make all public statements, but it cannot be stressed strongly enough that no statements should be made regarding the mishap or the investigation to anyone outside the MIT without at least obtaining PAO's prior approval.

3.3.3 Security planning

- Security will be arranged by on-scene authorities.
- In the case that additional personnel need access to the mishap scene, this will require coordination with the Incident Commander and on-scene security.

4.0 Immediate Post-Mishap Actions

In the aftermath of a mishap, it is critical that NASA protocols and procedure are followed. Activities, not in priority order, include:

- Data gathering,
- Root cause analysis (RCA),
- Engineering assessments,
- Probabilistic assessments
- NASA Human Factors Analysis and Classification System (HFACS)

Data gathering methods, RCA, and HFACS will be further described in Section 6.0.

Keep copies of appropriate documents and contact information on file with this manual for medical, security, legal and public affairs. Mishap investigations involve a complex range of requirements and priorities both within, and often outside, of NASA. Everyone involved is part of a team, enabling each other and a system that is greater than its parts.

4.1 Search and Recovery

For Type A Mishaps, Collection of deceased and disassociated crew remains will be managed by the proper authorities (The FBI and designated personnel in concert with the MIT and AFMES). Search for remains cannot begin until the area has been deemed safe by the appropriate authority. When this occurs, it will be done in an organized manner by those authorized.

Depending on the geography of the mishap site, or the dispersion of vehicle debris or human remains, the flight surgeon may or may not be directly involved in the search for human remains. It is, however, possible that the flight surgeon may be asked to assist in collection and recovery of remains under appropriate oversight. Appropriate personal protective equipment should be used at all time. Collection and disposition of all remains should be according to direction by the appropriate authorities.

> The AFMES will be responsible for all post-mortem examinations, laboratory/specimen collection, post-mortem documentation, and associated procedures for any remains of NASA crewmembers.

4.2 Management of Decedents and Mortuary Interfacing

For NASA human-rated missions, all human remains are sent to temporary mortuary with transfer to Dover Air Force Base for forensic examination by the AFMES.

- The AFMES examination will, to the extent possible, result in the determination of the cause of death.
- The individuals who are injured or deceased must be treated with respect and dignity.
- Remains are placed in transfer cases and will have a flag of the crewmembers' nationality draped across it.
- **There should be no on-scene speculation of the cause of death or identification of remains.** This is the responsibility of AFMES.
- Following autopsy, remains will be returned in a dignified manner to the families.
- It should be noted that management of remains in commercial spacecraft missions not sponsored by the government may be at the discretion of the local coroner or medical examiner in the jurisdiction in which the mishap has occurred.

Examination of Remains

While it may be apparent what the cause of death is as a result of the mishap, the AFMES autopsy will serve several purposes.

> Examination of remains can provide a cause of death or injury. It also provides evidence that can be used to design better systems to prevent future death or injury.

- Remains will be identified to the greatest extent possible.
- Dissociated remains of individual crewmembers will be collected into a single unit,
- The cause of death and what injuries may have occurred in final period before death,
- Identification of causality can provide lessons pertaining to systems that the crew interacts with, such as suit design, restraint systems, escape systems, and vehicle design.

It is paramount to find the cause of the mishap so that the cause can be addressed in such a way that it does not happen again. This may entail design of systems, changing procedures and protocols, training, etc.

4.3 Ground Operations at the Mishap Site (Field Operations)

4.3.1 On-scene Hazards and Support

While the scene should have been deemed safe prior to MIT arrival, there is the potential for a previously unrecognized hazard to be identified during the investigation. Any such hazards should be reported to the Incident Commander immediately. In the case of injury, the flight surgeon may be asked to provide basic support pending arrival and management by local health resources.

> Actively listening is the key to effective counseling.

Similarly, while support services should be in place for the psychological needs of survivors, family, witnesses, responders, and others, the flight surgeon may be asked to provide basic psychological support needs pending implementation of a more long-term care plan.

4.3.2 Family Support

Assigned Crew Surgeons should be contacted to manage any family medical or psychological support requests. This is done in tandem with NASA's Family Support Office.

4.3.3 Behavioral Health Considerations

General counseling and support should be offered and given to those involved, family members, and others who require it. Having a traumatic reaction to a traumatic event is normal. Extreme events create strong reactions. Symptoms usually manifest within three months of a traumatic event but they may not manifest for years.

- If you feel that an interviewee had a difficult experience, and that they or their family would benefit from additional support, proactively offer to get them in touch with support services.
- Depending on the situation that could be through their work, employee assistance program, insurance, or clergy. If a person is exceptionally distraught, stay with them until appropriate support is available.
- Make sure that individuals understand that any referral is completely voluntary and that the referral engages their HIPAA rights to privacy.

Many people who will eventually develop Acute Stress Disorder or Post-traumatic Stress Disorder (PTSD) begin to experience symptoms within 3 months to one year of a trauma. By definition, Acute Stress Disorder lasts at least 3 days, develops after exposure to one or more traumatic events, and has symptoms similar to those experienced during PTSD.

In the case of extreme trauma, mandating a psychological debrief and counselling session for all providers, witnesses, responders, etc., allows health care professionals to do at least a cursory assessment of individuals and can only provide critical data that may otherwise be missed in the investigative process. If this examination is standard practice, evaluation loses the often-associated stigma of seeking out a mental health professional. At a minimum, those interviewed will know immediately what warning signs should prompt them to seek out help and further identify appropriate resources should they need assistance in the future.

5.0 THE INVESTIGATION PROCESS

The approach to the investigative process is dependent upon the type of mishap, the severity, and where it happened. The NASA flight surgeon must be prepared for sustained field operations when conducting a mishap investigation. Although billeting accommodations will no doubt be given, the location, climate, altitude, and safety of the scene cannot always be adequately forecasted and may impart their own hazards.

> The reporting and investigation when assigned to an accident investigation board must take precedence over all other activities.

5.1 Overview

When a mishap occurs, regardless of which field center or program is affected, a mishap investigation is begun immediately. There are several organizations that become involved in the investigative process, including:

- The FBI
- The NTSB
- The FAA
- The (DoD) / U.S. Air Force (USAF)
- Commercial Providers

The varied roles of these organizations are further detailed in section 3.1.2 above.

Special Circumstances:

1. In the event of a significant and catastrophic NASA mishap (including any NASA vehicle OR any commercial vehicle carrying NASA crew), per Public Law 109-155, the President of the United States must establish a Presidential Commission.

> Presidential Commission – NASA Authorization Act of 2005 (Public Law 109-155, Section 822) – "*…to investigate the loss of a Space Shuttle, the loss of ISS or its operational viability, the loss of any other United States space vehicle carrying humans that is owned by the Federal Government or that is being used pursuant to a contract with the Federal Government, or the loss of a crew member or passenger of any space vehicle described in this subsection*."

2. In the event the NTSB exercises its authority to investigate a NASA aircraft or commercial vehicle mishap, NASA may conduct a separate investigation if determined necessary by the OSMA.

3. Any mishap occurring during a NASA mission, outside of dynamic launch phases (for example, a crewmember illness or injury in orbit) will be subject to a NASA investigation.

    - Exception: a fatality or serious injury to NASA astronauts/crew would fall under the authority of a Presidential Commission.

5.2 Process and Procedures

The investigative process is a safety investigation. The intent is *not* for the identification of civil, criminal, or administrative culpability or liability.

- If the mishap is suspected of being the result of a criminal activity, NASA's Office of General Counsel will develop procedures and requirements.

> The flight surgeon and/or physician's role is to be a key member of the investigative process. The flight surgeon is never the lead investigator, unless the mishap is a specific medical event.

- The role of the flight surgeon or occupational health physician is to serve as a member of the investigative team. ***The flight surgeon investigator seeks ONLY to determine what happened to the individual human in the system and their role in the mishap.***

The **goal** of an investigation is to determine what happened, focusing on FACT-finding, not FAULT-finding. The greatest challenge to the mishap investigation team is to distinguish between accurate and erroneous or mistaken information and focus on the areas that lead to identifying a mishap's causal factors. To do this, investigators should:

- Seek to understand the activity being performed at the time of the incident
- Conduct a walk-through of the mishap scene if possible
- Identify, test, and inspect pertinent components to determine failure modes and physical evidence
- Obtain narrative evidence and corroborate facts through interviews
- Challenge facts inconsistent with other evidence
- Review policies, procedures, and records to determine level of compliance or implementation.

The term **Investigating Authority** refers to:

1. The Mishap Investigator (MI),
2. The MIT, or
3. The MIB

> The MI, MIT, and/or MIB are authorized to conduct the safety mishap investigation. If an individual is injured or killed during a mishap, the flight surgeon will be a member of the MIT or MIB.

For MIT members, there are several important steps in the days and weeks that follow a mishap. These are highlighted in Figure 5.1 and must be completed within 145 days of the mishap.

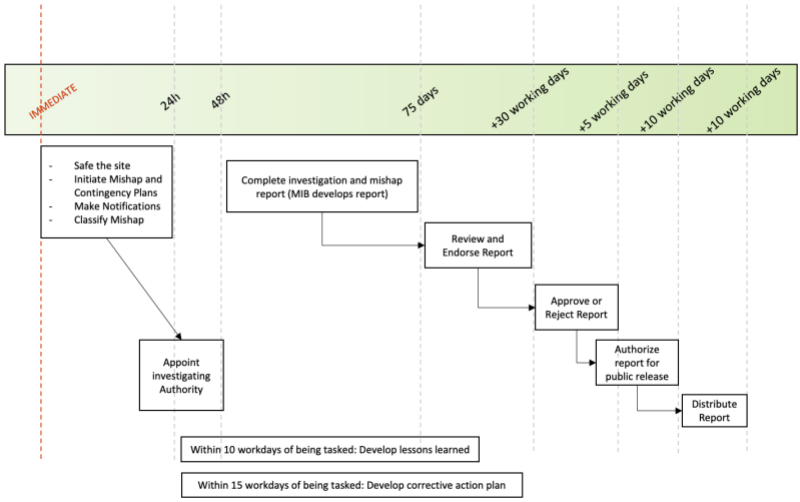

Figure 5.1. Standard timeline for mishap investigations.

Investigation activities can be further classified in the following categories:

1. Pre-Field Phase / Initiation of Fact Finding
   a. Investigative team is assembled and ground rules are stated
   b. In the case of injury or death, flight surgeons may be assigned as a part of the investigative team.

When visiting the scene:

A) Pay close attention to the authority in charge of the scene
B) Wear Personnel Protective Equipment (PPE)
C) Do not take personal photographs
D) Do not remove any items or remains
E) Do not move anything from its location
F) Do not speculate or identify remains
G) Take good notes
H) Maintain the debris field
I) Treat the scene with dignity and reverence.

2. Field Phase
   a. Team visits the mishap site
      - The site must be designated safe by the Incident Commander prior to access by the MIT
      - This is especially important in a spacecraft mishap where toxic chemicals, fuels, unexploded ordinance or other explosive materials may be.
      - This additionally allows for the photographic documentation of the undisturbed mishap scene prior to investigative team arrival.
3. Data Collection Phase (*What* happened)
   a. Rigorous data collection, including:
      - A comprehensive search of hardware, software, procedures, communications, facilities, the environment, all individuals involved, companies and organizations.
      - Categorization as:
        1. Human evidence (witness statements and observations);
        2. Physical evidence (matter related to mishaps, debris, human remains (medical evidence), etc.; and
        3. Documentary evidence (video, photographic, paper and electronic information).
   b. All evidence should be documented and NOTHING is to be discarded.
   c. Human tissues, fluids, and dissociated remains must be collected and preserved intact – DO NOT disturb the location of remains unless directed to do so by the site lead.
4. Analysis and Integration (*Why* did it happen?)
5. Findings and Report

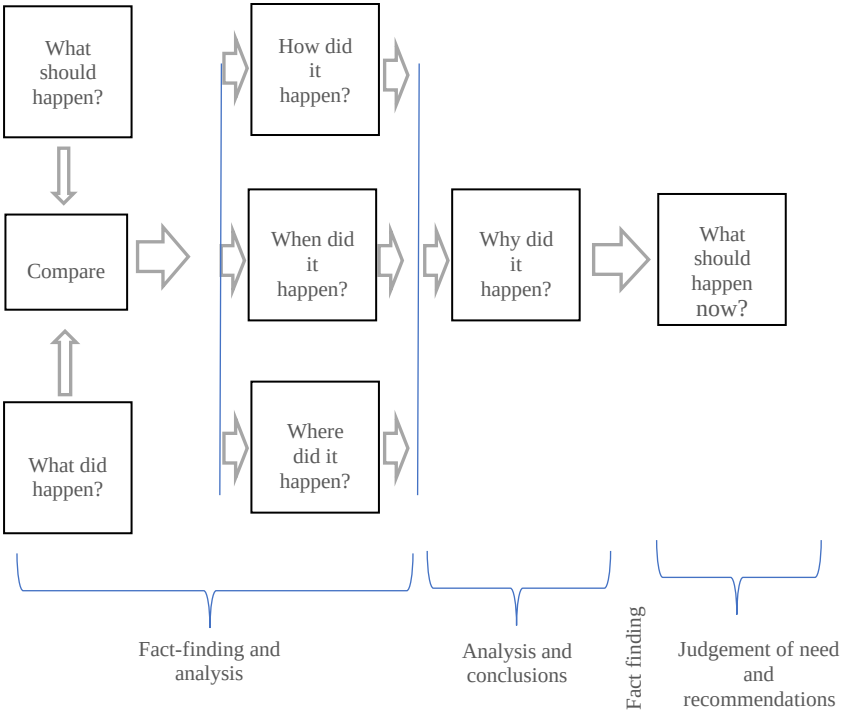

Figure 5.2. Phases of a mishap investigations

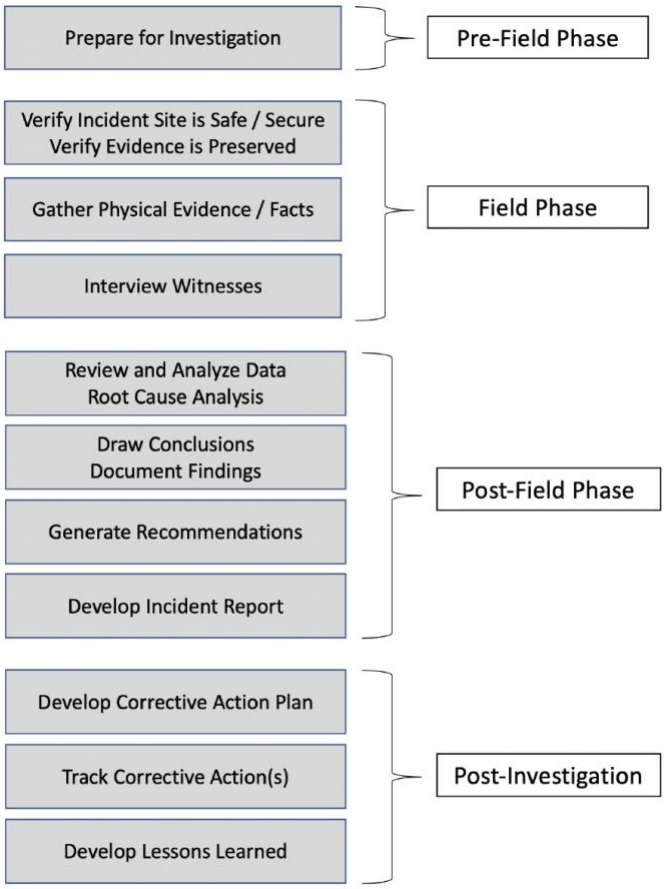

Figure 5.3, Investigative Timeline

5.3 Roles and Responsibilities

The mishap investigation is a complex project that involves a significant workload, time constraints, sensitive issues, cooperation between team members, and dependence on others. Everyone assigned to the MIT/MIB has an important role to play.

Each team member must additionally adhere to common guidelines as a member of the team.

Team Member Dos and Don'ts:

- DO interview witnesses as soon as possible in non-threatening or accusatory manner
- DO work closely with the MIB chair
- DO provide factual data at the discretion of the MIB
- DO NOT distribute witness statements, notes, transcripts of witness testimony
- DO NOT share medical records

5.4 Initial Wreckage Evaluation

Considerations for investigators upon arrival to a mishap scene include:

- The first walk-through should be with your hands in your pockets. Look and witness, do not touch.
- If possible, walk through the scene with subject matter experts that can help to identify damaged vehicle components or equipment.
- Witness and record positions of switches and instruments. Be suspect of switch position – you were NOT the first site visitor.

5.5 Interviews

Interviews with witnesses and survivors are critical in preserving data that will be used to investigate and analyze the mishap. The purpose of an interview is to find out what was observed or done and to determine the witness's opinion on potential causes of the mishap. There are two types of interviews: privileged and non-privileged.

- All written witness statements obtained within the first 24 hours of the occurrence of a mishap or close call shall be considered privileged and protected. Witness Statement Forms (see **Appendix C**).
- All verbal witness statements and written statements given after 24 hours as part of a NASA mishap investigation, where the witness was explicitly informed that his/her account will not be released, shall be considered privileged and protected.
- NASA shall make every effort to keep witness testimony (both written and verbal) confidential and privileged to the greatest extent permitted by law. This privileged information will be strictly limited to only the information provided directly by the witness for the safety investigation.

5.5.1 General Interviewing and Data Gathering

The flight surgeon should work with NASA HQ, the appropriate center(s), law enforcement, and civil authorities.

- Keep appropriate and careful records. Notes and photographs are paramount to recall when writing the report at a later time.

> Photographs taken by individuals is permitted. However, all photographs must be submitted to the MIT. It is NEVER appropriate to take photos for personal use.

- Work with NASA management and center personnel to provide appropriate, timely information to the NASA community.
- Work with appropriate NASA professionals to communicate with the public as needed. Ensure appropriate oversight and permission is obtained before releasing public statements.
- When working on communications, consider context, how to best provide facts, and how the information could be understood / misunderstood or interpreted / misinterpreted by the target audience.

In addition, the flight surgeon should work directly with NASA management and center personnel, potentially including the OCHMO, OSMA, and Astronaut Office, to establish appropriate communications and working relationships with family members.

- Psychological and social factors will play a substantial role for family members. Interviews should be coordinated in such a way that family member needs are met.
- For survivors and their families, being able to communicate, as soon as possible, is often the number one priority.
- In the case of fatalities, information is the number one request of family members. Carefully consider not only the information you wish to communicate, but how it will be received.

5.5.1 Interviewing Basics

1. Who to interview:
   - Anyone who might provide insight regarding causes of the mishap and damage or injury that occurred in the course of the mishap. *CAUTION: Do not base an analysis or conclusions on a single interview.*
   - Crewmembers, spaceflight participants, pilots, passengers

- Air traffic controllers, plane captains, maintenance personnel, ground personnel, flight controllers, etc.
- Witnesses who may have seen or heard events leading to, during, or following the mishap.
  - Local authorities often will have the names of witnesses
  - Public Affairs representatives and the news media may help locate additional witnesses
  - Witnesses may provide additional individuals to interview – determine whether the witness was alone or with other persons at the time of the mishap
- Peers, friends, and families of crewmembers, ground personnel, or others involved.
- Rescuers, first responders, or any other individuals who first made contact with the mishap personnel or vehicle.

2. When to interview:

Data gathering in the first 24 hours preserves important, often critical, detail(s). It is important to account for potential shock and trauma affecting recall. While being sensitive to the medical and psychological state of the survivor / witness / first responder, the sooner information is gathered, the better.

Interviews are confidential
Dos and Don'ts regarding witnesses

Dos
- Interview as soon as possible
- Only 2-3 interviewers in room at one time
- Obtain permission before you start
- Explain purpose
- Establish a rapport
- Start by saying "Can you tell me in your own words what you know about the accident"
- Use neutral questions
- Listen
- Summarize and get agreement from interview

Don'ts
- Don't provide a copy to interviewee
- Never release the statements

- Ideally, initial witness statements should be collected within 24 hours of the mishap or close call. All initial statements are protected.
- Interviews should be conducted as soon as possible after the mishap, before memories have faded or become altered by media coverage,

conferring, etc. Witnesses should be isolated from one another if possible.

- Witnesses may exaggerate or temper responses over time, particularly if testimony is repeated frequently or if a witness has had ample time to reflect on events.
- Further interviews are always needed to confirm, clarify, and elaborate concerns as the investigation matures.
- Written statements may be limited by writing ability or time commitment to document thoroughly. Whenever possible, verbal interviews are preferable.

3. Where to interview:
   - Interviews should preferably occur at the spot where the witness was located at the time of the mishap to stimulate state-dependent memory.
   - If this option is unavailable, interviews should alternatively occur in a quiet, private place.

Required Formal Interview Statement

The purpose of this safety investigation is to determine the proximate causes and root causes of the mishap that occurred on _____ and to develop recommendations toward the prevention of similar mishaps. It is not our purpose to place blame or to determine legal liability. Your statement is entirely voluntary, but we hope that you will assist the investigating authority to the maximum extent of your knowledge in this matter.

Your statement will be documented and retained as part of the mishap record background file but will not be released with your name as part of the mishap investigation report.

The investigating authority will make every effort to keep your statement confidential and privileged to the greatest extent permitted by law.

   - Ensure that you will not be interrupted. Do not take phone calls. Make sure the location is private – for example, no knocks on the door.
4. How to interview:
   - Obtain identifying details: name, position, contact information (double check phone number to ensure follow up is possible). Document level of experience of the witness.
   - Notify witnesses of their right to confidentiality (or absence thereof, depending on the circumstance). Witnesses should NOT be asked to provide information under oath.

- Declare your role, the purpose of the interview, and who will be hearing their testimony.
- **Read the required formal interview statement (see break-out box).**
- **Record the interview**. Inform the witness that they are being recorded.
- Keep the interviewee focused on the subject, not on the interviewer or investigation. Try to allay any discomfort, anxiety, or embarrassment.
- Approach the interviewee as an equal – make eye contact, shake hands. Try not to assume a position above or taller than the interviewee. Use first names, offer refreshments.
- Interviews should be one-on-one if possible.
- A model of the vehicle or a whiteboard may facilitate explanations.
- Do not interrupt or lead the testimony.
- Tell the witness why their input is important and reiterate your need for detail.
- When modeling the detail that you want, pick a neutral experience. To avoid memory or data contamination in your example, do not use anything associated with the mishap.
  - For example, you might say, *"So as an example… I woke up this morning at 6AM when my radio alarm clock went off. It was the start of the news hour and Joe Nelson was giving the weather report – 69 degrees, cloudy with a chance of afternoon rain. I remember thinking, finally I don't have to take my umbrella to work. I stretched, pushed off the covers, sat up quietly so my wife/husband could snooze. I slipped on my slippers and headed off to the bathroom on the North side of the room. I closed the bathroom door, turned on the light and started the hot water in the sink. …"*
  - Tell them you are looking for detail and make sure you **stay interested**.
- Avoid jargon or terminology. Do not assist the witness with terminology. The statement should be in words and terms the witnesses understands.
- Observe non-verbal communication.
- **Tolerate silence**.
- Avoid writing or taking notes. This may lead or distract the witness.
- Focus the witness on facts. Do not be surprised if the witness uses the interview as an opportunity to express opinions or concerns – avoid arguing but try to return the conversation to the topics of interest to the investigation.

- Use open-ended questions and try to prompt a narrative. For example, “What first brought your attention to the vehicle, and what happened from that point on?” Do not interrupt the narrative.
- Express appreciation of time and effort in the narrative.
- It may be helpful to request a second narrative statement immediately after the first, as this may prompt additional information or recall. Consider playing back the recording to stimulate further memory – be sure to begin recording again if the witness adds information.
- Ask questions when possible by using the witness’s own words.
- Try not to get too specific with questions as this may lead the testimony.
- At the end of the interview, ask the witness to think of anything he/she might have missed or would like to add.
- The very last question of the interview should be, “what do you think caused this mishap?” At this stage, the witness is most comfortable with you and least guarded and may give clues regarding his/her own biases.

5. Key points to remember:
   - Focus on clear, direct, unambiguous facts and data
   - Make sure survivors, witnesses, and first responders are assessed and interviewed
     - In addition to receiving information pertaining to the mishap, check on physical and mental health and access to medical, psychological, and social support
   - Challenging witness integrity can be important, but do not antagonize or overplay the “bad guy” role. Do not end an interview on a negative.
   - Immediately after the interview, write down your initial impressions, thoughts, concerns, or observed witness biases.

5.6 Photographs and Documentation

Photographic evidence can be immensely valuable to an investigation. Photographs can illustrate, record, and verify evidence, particularly perishable evidence. The mishap scene will not be released or accessible to investigators prior to initial photographic documentation, including aerial photography and video mapping of the mishap scene.

> Flight surgeons should rely on professional photographic support if available. If photographs are taken using a personal device, these must be turned over to the MIT.

- Medical support and medical investigators are given priority for photographic support at a mishap scene.
- The flight surgeon should work closely with scene/investigation team leaders to ensure appropriate photographic support.

5.7 Diagrams

Diagrams can be a useful tool for mishap investigators and are particularly necessary in a mishap without survivors, witnesses, or in an in-air collision / break-up. There are three primary types of diagrams:

1. Polar diagrams:
   Polar diagrams are best suited when the primary velocity vector is vertical with a concentric scatter pattern of wreckage and debris. The primary impact point is the center of the map, with a compass or tape measure (or walking wheel) used to measure direction and distances of debris or evidence. Polar graph paper should be used if possible.

2. Tear-Drop Diagrams:
   Tear-drop diagrams are useful in the case of an impact occurring along a flight path with horizontal velocity, where the scatter pattern falls along a main flight path vector.

3. Grid Diagrams:
   If a scatter pattern is dispersed, grid diagrams can be useful, particularly with concurrent use of GPS coordinate mapping. An X-Y grid should be used, with documentation of debris relative to grid squares.

While primary diagramming responsibilities are not in the flight surgeon's purview, it is helpful to identify the responsible diagramming party and provide them any additional documentation that may be obtained during a scene investigation. In addition, provide the following when possible:

- Date and time of the evidence collection
- Location relative to debris field or point of impact (if identified)
- Identification of individual discovering evidence
- Identification of individual documenting evidence
- Prevailing wind direction / velocity at time of evidence discovery or documentation
- Other factors that may have altered the location or preservation of evidence documented (for example, fire, explosion, inclement weather, etc.)

5.8 Preservation of Evidence and Materials

Information generated by the investigation should be documented, organized, and maintained to be useful to any current or future analyses. A mishap investigation is likely to produce a large volume of information, much of which may be sensitive, privileged, graphic, or protected in some way. All materials should be clearly marked with title, date, version number, author or source, and appropriately categorized for future locating.

5.9 Autopsy

Medical Jurisdiction

In spaceflight mishaps, debris fields can extend across state boundaries, into international waters, or even across international borders. As a result, determining who takes jurisdiction over human remains may be challenging. In the United States, medico legal jurisdiction is dictated by where death is pronounced. Many states have complex systems of county- or municipality-based jurisdictions or a patchwork of coverage by medical examiners and coroners.

Federalization of response and recovery efforts can assist in navigation of these challenges, with jurisdiction yielded to a designated federal authority. There are agreements in place such that the AFMES is likely to assume jurisdiction over human remains in the case of a future federalized mishap response effort.

- Center Director or Executive Director, Office of Headquarters Operations (ED/OHO) is responsible for next-of-kin notification regarding fatalities and injuries. Only the Johnson Space Center (JSC) Center Director will perform astronaut next-of-kin notification.
- Headquarters Office of Communications (OCOM) is responsible for notification of the public for casualties, performed in accordance with local Center Director or ED/OHO protocols.
- In the event a fatality has occurred, it is possible that the flight surgeon, as an on-site medical professional, may be asked to coordinate with the Office of General Counsel, the AFMES, or a local coroner or medical examiner to help coordinate recovery or preservation of remains prior to autopsy.
- All remains are sent to Dover Air Force Base for identification and determination of cause of death.

5.10 Death Certification

Another challenge in a fatal mishap where jurisdiction is not immediately clear is the processing of death certificates. In this circumstance, the flight surgeon may coordinate with the Office of General Counsel, the AFMES, or local coroners or medical examiners for processing and certification of death.

Note that certification of death is NOT identification of causality – AFMES is solely responsible for examination of remains and determination of *cause* of death.

5.11 Reporting

The flight surgeon will coordinate with other members of the MIT to develop and submit a final mishap report. While the flight surgeon will be an active member of the team, they will be assisted in developing pertinent inclusions to the final report and will not be expected to develop the entire report alone. Even so, flight surgeons should be aware of the expectations for a final report such that they can be prepared with appropriate responses to any items that may rely on surgeon expertise.

Reports must be organized with the following sections in accordance with NPR 8621.1D.

- Section 1 – Signature page(s), list of consultants, executive summary, and OSHA summary (when applicable)
- Section 2 – Narrative description and facts (what, when, where, how)
  - Avoid use of an injured/deceased individual's name (use of seat position / role may be an appropriate alternative – for example, "commander" or "seat 1")
  - Avoid inclusion of photographs with details that could identify an injured or deceased individual
- Section 3 – Type of data gathered and data analysis, including:
  - Description of the type of data gathered and evaluated
  - Timeline
  - Description of structured analysis techniques used and how they contributed to determination of findings
  - Event and causal factor tree or similar graphical representation of the mishap
- Section 4 – Findings, including
  - Proximate causes
  - Root causes

- Contributing factors
- Failed barriers
- Observations

- Section 5 – Recommendations
  - The goal of the investigation is to prevent recurrence of the undesired outcome. This section should provide the manner in which recurrence can be prevented.
- Section 6 – Minority reports
  - Any member may develop and attach a minority report for all or part of the items listed above.

After the report has been authorized for release, the following tasks must be undertaken at the direction of the appointing official.

1. Corrective Action Plan (CAP) must be developed, submitted, reviewed and implemented.
   - This CAP is a step-by-step action plan that improves a processes or methodology to address how a mishap occurred, resulting in a more efficient and effective approach that prevents a re-occurrence.
2. Lessons Learned – The responsible organization must develop a list of "lessons learned." This includes:
   - What caused the mishap?
   - What steps or actions need to happen such that there is no recurrence?
3. Retain evidence and files in archives – all evidence and files should be saved and secured.

6.0 Available Investigative Methods and Standardized Processes

There are several methods that NASA utilizes and trains investigators on with regard to investigation of a mishap. These tools and methods include:

- Software, Hardware, Environment, Liveware/Person, Liveware/Group and Documentation (SHELL-D);
- Root Cause Analysis (RCA);
- Event and Causal Factor Tree (E&CFT)

Each of these approaches will be described below. Regardless of approach, the purpose of data collection is to determine the cause of the mishap. Identifying contributory or causal factors can help determine mitigation strategies in design or processes. The ultimate goal is to prevent future mishap.

All members of a NASA MIT will be required to complete training courses that provide an understanding of the mishap investigation process, roles and responsibilities, report completion, root cause analysis, and human factors. The sections below will provide a high-level overview for quick reference during a mishap investigation.

Following a mishap investigation, NASA document NPR 8621.1D provides guidance and requirements for final reporting. At a minimum, final recommendations must:

- Address a specific finding
- Describe corrective actions that should be generated in response to this finding
- Describe how to:
  - Eliminate and mitigate root causes
  - Eliminate proximate causes (at least one)

6.1 SHELL-D

When gathering evidence for a NASA mishap investigation, the preferred method for data collection is the SHELL-D method. Sources of evidence for the SHELL-D approach include:

- Software: computer software, logic
- Hardware: hardware, facility structure, equipment
- Environment: workplace environment (e.g. lighting, noise, ambient conditions), weather environment, natural phenomena

- Liveware (individual): individual person (e.g. worker, supervisor, ground crewmembers, flight crewmembers)
- Liveware (team, company): team attributes
- Documents: guidelines and handbooks, policy, requirements, standards, procedures, training, contracts

This approach ensures consideration and collection of data from all aspects of an operational event. Subsequently, collected data is organized for analysis. A "4-column list" approach is generally used (see **Figure 6.1**). Columns include:

1. What I don't know
2. What data I need
3. What I think I know
4. What I definitely know

This approach allows for the migration of information from one column to another as more is understood about the mishap.

Figure 6.1. Data analysis – the 4 Column approach. As more is understood, items will migrate from left to right as unknowns become understood. (source – NASA Mishap Investigation Handbook, v1.1)

6.2 Causal Chain – Root Cause Analysis

All investigations require root cause analysis.

For all high-visibility mishaps or close calls, NASA requires the use of a structured approach to investigation and analysis of causal factors for the mishap event or undesired outcome. Root Cause Analysis (RCA) is a structured method to identify root causes of a mishap

or close call and actions to prevent recurrence of such causes. The goal of RCA is to identify all events and conditions in a *causal chain*, the chain of events that led to (or enabled) a mishap event. In RCA:

- An *event* is defined as a real-time occurrence of one discrete action (which is identified as an active element in the causal chain)
- A *condition* is defined as any "as-found" state that facilitates the occurrence of an event. Conditions are inactive elements in the causal chain that may have safety, health, quality, security, operational, or environmental implications.
- An *undesired outcome* is an event or condition that is unplanned or not the desired or expected outcome
- The *causal chain* is the sequence of cause-and-effect relationships that leads to the undesired outcome.
- *Contributing factors* are influencing factors that can increase the probability of the event but, if removed, would not prevent the event from occurring.
- An *actual cause* is the event that directly caused the undesired outcome
- A *proximate (direct) cause* is any event that led to the actual cause, or an action that produced foreseeable consequences without intervention. If a proximate cause had been eliminated or modified, this would have prevented the undesired outcome.

Multiple Causal Chains can be interconnected. A *Causal Network* is comprised of interconnected causal chains, and the RCA determines the links in the Network. Graphically, this is represented in an E&CFT.

The RCA process includes the following steps:

1. Identify the undesired outcome
2. Create a timeline of events (*what* happened)
3. Create a fault tree
4. Create the Event and Causal Factor tree
5. Generate recommendations

The process is repeated until all causes have been identified and recommendations have been made to resolve the event.

6.2.1 Fault Tree

After the Challenger accident, NASA began using failure modes and effects analysis (FMEA) and probabilistic risk assessment (PRA).

A fault tree (FT) is a diagram that lays out deductive failure analysis to determine how systems fail. The tree structure (See **Figure 6.2**) begins at the top with mishap or undesired outcome. FT analysis (FTA) is a tool that provides a visual representation of all potential causes of an event. The SHELL-D approach is used to identify potential factors and causes and to populate this diagram. **Figure 6.2** illustrates a FT template with an undesired outcome, proximate cause, intermediate cause and the root cause.

6.2.2 Events and Causal Factor Tree

NASA looks for root causes at all levels – program, center and Agency organization level.

The E&CFT is an analysis tool that builds on the Fault Tree to include and connect all actions and conditions or causal factors. This tool only utilizes existing evidence only. There are different causes that can be related to systems, personnel and organizations. These include:

1. Proximate or direct cause – in the immediate time period of the event (e.g. equipment overheated, person made a mistake in doing something);
2. System / organizational or root causes – effects an entire group or the Agency; and
3. Intermediate causes – an event or condition that create the proximate cause (e.g. maintenance not implemented, drawing was incorrect)

The tree structure, illustrated in **Figure 6.3** can be quite extensive and the questions 'why' could continue until the 'root cause' has been identified. You can also stop asking why when no more information is available.

6.3 Human Factors Analysis and Classification System (HFACS)

The Human Factors Analysis and Classification System (HFACS) framework was developed to be a comprehensive and user-friendly tool for identifying and classifying human causes of aviation accidents. At NASA, this classification system can similarly be applied to identify human factors in spaceflight mishaps. Mishap data are sorted into HFACS *Four Levels of Human Error* categories for organization and analysis (see **Figure 6.4**).

This classification method allows for identification of organizational errors in addition to individual errors, allowing for the identification lessons learned throughout multiple levels of the Agency.

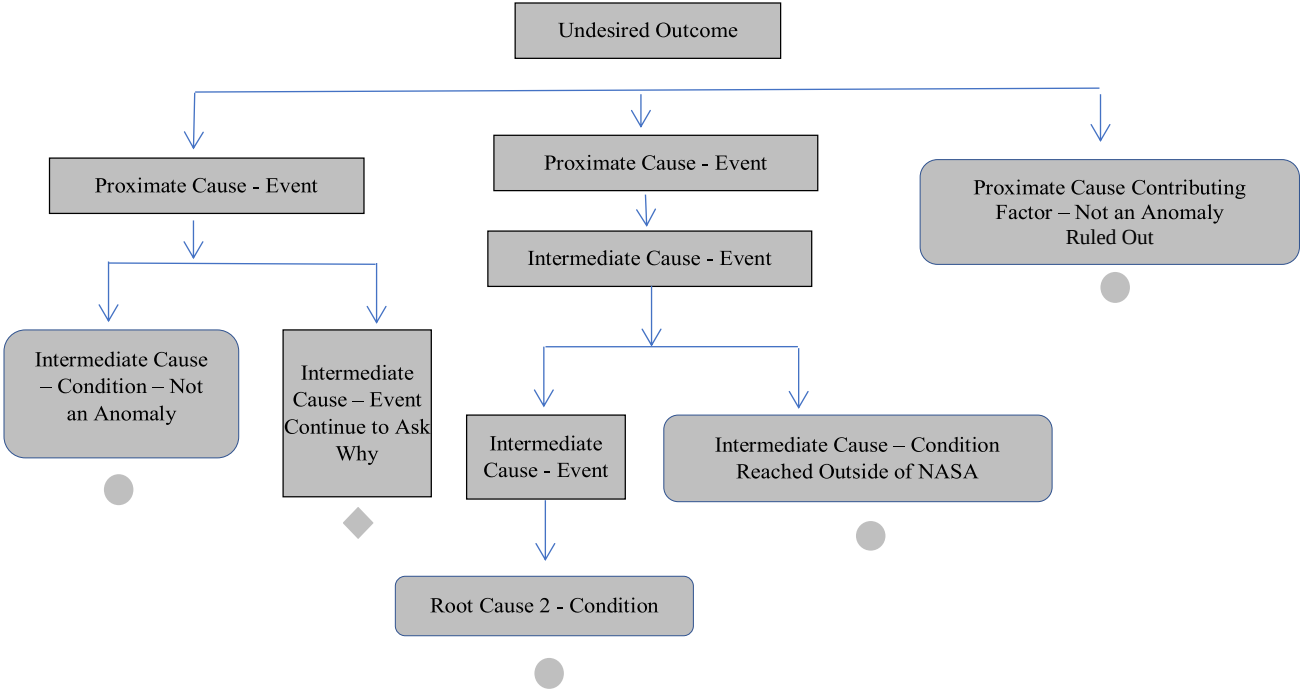

Figure 6.2. Fault Tree

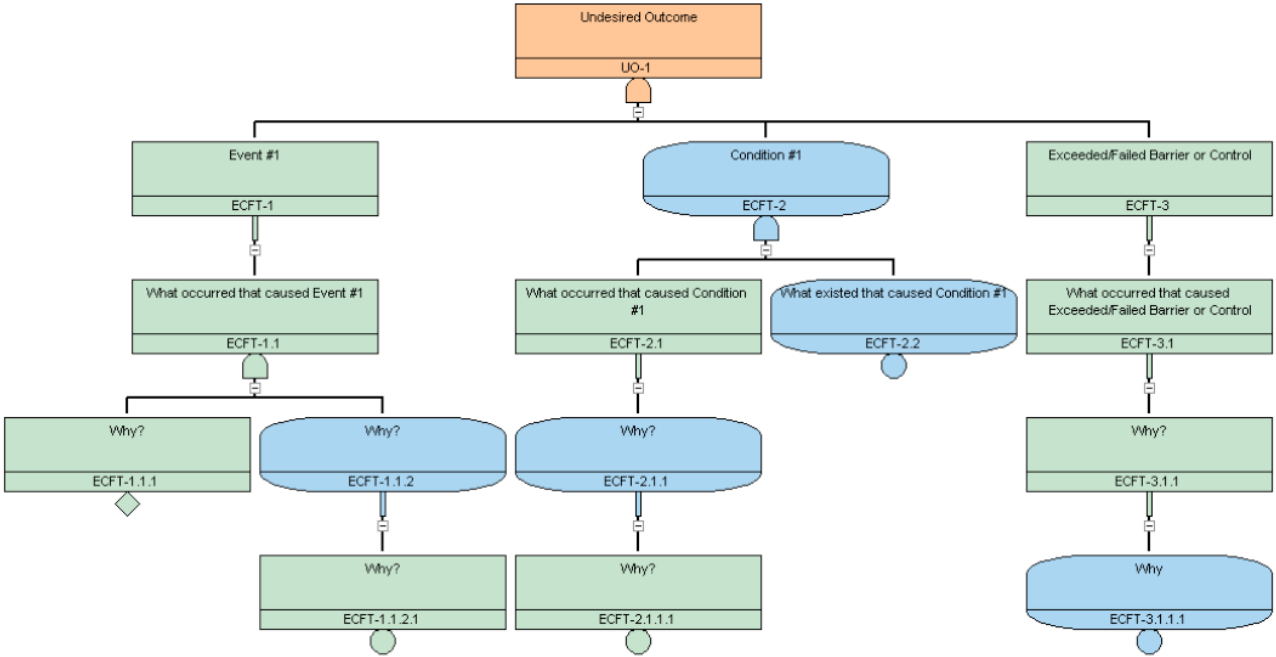

Figure 6.3. Events and Causal Factor Tree

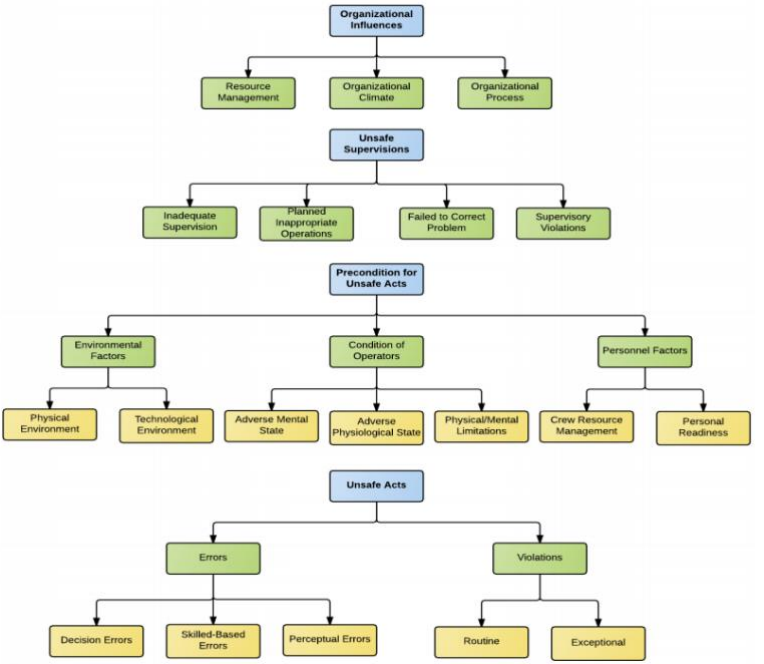

Figure 6.4. Human Factors Analysis and Classification System: Four Levels of Human Error

7.0 Analysis

The full involvement of NASA, integrating the lessons learned from each mishap is critical to the people and mission of NASA. In keeping with root cause analysis, lessons learned need to be incorporated at the level of the individual local organization, center, and Agency as well as within NASA culture. This is especially true with Health and Medical Technical Authority. Changes need to be carefully considered and implemented, including changes to formal and informal processes, general training, and task-specific training.

A full investigation and analysis will require coordination between the flight surgeon and other subject matter experts to identify human-vehicle interactions and potential sources of failure or contributing factors in the mishap. Some potential considerations for the flight surgeon input during the MIT review include:

- Catastrophic and life-threatening events
  - Violation of the pressure environment (hull, suit)
  - Fire or thermal insult
  - Toxic atmosphere
  - Loss of vehicle control
- Seats
  - Ejection seat capability (or lack thereof)
  - Stroking capability
  - Failure modes
- Restraints
  - Multi-point harness and failure modes
  - Inertial reels
  - Application of tension
- Worn gear
  - Flammability
  - Pressure protection
  - Vehicle interactions (catch points, interfacing, hose connections, etc.)
- Helmets
  - Conformal fit vs non-conformal
  - Oxygen interfacing (regulator vs. full in-suit oxygen flow)
  - Communication system interfacing
  - Failure modes (visor, latches, etc.)
- Life support equipment
  - Oxygen equipment
  - Pressure protection
  - Thermal protection
  - Medical capabilities (resources and skillsets)
- Material interactions

  - Anthropomorphic surface interactions
  - Evacuation – structural interference
  - Hatch design and accessibility
  - Flail potential
  - Debris interactions
- Bailout or occupant separation
  - Parachutes (capsule / individual)
  - Occupant protection
- Post-landing environment
  - Triage and recovery response

APPENDICES

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APPENDIX A: Important Document

NASA has developed a comprehensive list of documentation that are required policies and requirements that must be followed in any mishap event. Many of the center-focused documents flow directly down from Agency-level NASA Policy Directives (NPDs) and NASA Procedural Requirements (NPRs).

The following list includes those documents that are related to human health – including occupational health, human spaceflight, and all systems/processes involving humans. There are also several center-specific documents that relate to health and safety. These agency-wide and center-specific documentation relate to the Office of the Chief Health and Medical Office (OCHMO), which is responsible for all occupational health and crew health in support of human spaceflight.

AGENCY LEVEL

- NPR 7120.5 // NASA Space Flight Program and Project Requirements
- NPD 8710.1 // Emergency Management Plan
- NPD 8700.1E // NASA Policy for Safety and Mission Success
- NPD 8710.2 // NASA Safety and Health Program Policy
- NPR 8000.5 // Agency Risk Management Procedural Requirements

Office of the Chief Health and Medical Officer

The following NASA documents apply to this manual. These are under the authority of the Office of the Chief Health and Medical Officer.

Health and Medical Technical Authority

- NPR 7120.11 // NASA Health and Medical Technical Authority (HMTA) Implementation

Medical Quality Assurance

- NPD 1850.1 // NASA Medical System Quality Assurance
- NPR 1850.1 // Quality Assurance of the NASA Medical Care

Occupational Health

- NPD 1800.2 // NASA Occupational Health Program
- NPR 1800.1 // NASA Occupational Health Program Procedures
- NPR 1441.1D // Records Retention Schedules
- NPR 3792.1B // Plan for a Drug-Free Workplace
- NPD 1600.3 // Personnel Security

Office of the Safety and Mission Assurance
The following NASA document apply to this manual. These are under the authority of the Office of the Safety and Mission Assurance (OSMA).

- NPR 8621.1D // NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating and Recordkeeping – Expires July 6, 2025
- NPD 8700.1 //NASA Policy for Safety and Mission Success
- NASA Mishap Investigation Handbook, Version 1.1 (May 20, 2017)
- NPR 8715.1A // NASA Occupational Safety and Health Programs
- NPR 8715.2A // NASA Emergency Preparedness Procedural Requirements
- NPR 8715.3D // NASA General Safety Program Requirements
- ESD 10010 Rev B // Exploration Systems Development Safety and Mission Assurance Plan
- NASA Mishap Investigation Handbook, Version 1.1 (May 20, 2017)

JSC-65841 // Crew Survival Reference Manual

APPENDIX B: Acronyms and Definitions

Acronyms

ACES	Advanced Crew Escape Suit
AFSPC	Air Force Special Command
AFMES	Air Force Medical Examiner
AMD	Aircraft Management Division
AO	Appointing Official
ARC	Ames Research Center
APG	ARC Policy
APR	ARC Procedural Requirements
ASAP	Aerospace Safety Advisory Panel
CAD	Computer-Aided Design
CAP	Corrective Action Plan
CCP	Commercial Crew Provider or Program
CD	Center Director
CEMP	Comprehensive Emergency Management Plan
CFR	Code of Federal Regulations
COOP	Continuity of Operations Plan
COTR	Contracting Officer's Technical Representative
DET3	Detachment-3 of the 45th Operations Group (Space Wing), Patrick Air Force Base
DHS	Department of Homeland Security
DoD	Department of Defense
DoT	Department of Transportation
E&CFT	Event and Causal Factor Tree
EOC	Emergency Operations Center
EMS	Emergency Medical Services
EPI	Emergency Public Information
EMPC	Emergency Management Planning Committee
EPP	Emergency Preparedness Plan
ESA	European Space Agency
FAA	Federal Aviation Administration
FBI	Federal Bureau of Investigation
FCOD	Flight Crew Office
FD	Fire Department
FEMA	Federal Emergency Management Agency
FMEA	Failure Mode and Effect Analysis
FOIA	Freedom of Information Act

FT	Fault Tree
GFE	Government Furnished Equipment
GSA	General Services Administration
HAZMAT	Hazardous Material
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
HIPAA	Health Insurance Portability and Accountability Act
HIV	Human Immunodeficiency Virus
HFACS	Human Factors Analysis and Classification System
HSFS	Human Space Flight Support
HQ	NASA Headquarters
IA	Investigating Authority
IC	Incident Commander
ICP	Incident Command Post
ICS	Incident Command System
IIT	Incident Investigation Team
IPs	International Partners
IRIS	Incident Reporting Information System
IRT	Interim Response Team
IRT	Incidence Response Team
IT	Information Technology
JFSCC	Joint Forces Space Component Commander
JSC	Johnson Space Center
JPD	JSC Policy Directive
JPR	JSC Procedural Requirements
JWI	JSC Work Instruction
KDP	Kennedy Documented Procedures
KNPR	Kennedy NASA Procedural Requirement
KSC	Kennedy Space Center
LaRC	Langley Research Center
LLIS	Lessons Learned Information System
MACES	Modified Advance Crew Escape Suit
MPCP	Mishap Preparedness and Contingency Plan
MIB	Mishap Investigation Board
MIIB	Mishap Integrating Investigation Board
MIT	Mishap Investigation Team

MI	Mishap Investigator
MISO	Mishap Investigation Support Office
MOA	Memorandum of Understanding
MORR	Medical Operations Readiness Review
MWAR	Mishap Warning-Action-Response
NAARS	NASA Aviation Anomaly Reporting System
NASA	National Aeronautics and Space Administration
NEMO	NASA Emergency Management Operations
NMIS	NASA Mishap Information Systems
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
NRF	National Response Network
NSC	NASA Safety Center
NSSC	NASA Shared Services Center
NTSB	National Transportation Safety Board
OCHMO	Office of the Chief Health and Medical Officer
OCF	Out of Controlled Flight
OCOM	Office of Communications, Headquarters
OHO	Office of Headquarters Operations
OEM	Office of Emergency Management
OSHA	Occupation Safety and Health Administration
OSMA	Office of Safety and Mission Assurance
PAO	Public Affairs Office
PAFB	Patrick Air Force Base
POC	Point of Contact
PPE	Personal Protective Equipment
RCA	Root Cause Analysis
RCS	Reaction Control System
REAC/TS	Radiation Emergency Assistance Center/Training Site
RTG	Radioisotope Thermoelectric Generator
SATERN	System for Administration, Training, and Educational Resources for NASA
SBU	Sensitive but Unclassified
SHELL D	Software, Hardware, Environment, Liveware (individual), Liveware (team), and Documents
S&MA	Safety and Mission Assurance
SMART	Specific, Measurable, Accountable, Relevant, and Timely
SME	Subject Matter Expert

SOP	Standard Operation Procedure
STS	Space Transportation System
UO	Undesired Outcome
USAF	United States Air Force
U.S.C.	United States Code
USSTRATCOM	US Strategic Air Command

Common definitions and terminology used in mishap investigations:

Aircraft – any fixed wing airplane that NASA operates and that its employees, including crew fly aboard. This includes the following NASA operated aircraft - T38, SR71, DC-9, KC135, Beechcraft Super King Air (NASA 8), Boeing 747 (SOFIA), X-Planes, DC-8, and the Supper GuppyT-34, Gulfstream G-3 and G-5. (Not a complete list) – If NASA no longer uses these airframes, this short list can be modified.

Aircraft Flight Mishap – An event that occurs during the flight of an aircraft that results in fatality or serious injury or the aircraft receives substantial damage.

Aircraft Ground Mishap – An event that occurs on the ground involving an aircraft or unmanned aircraft system that results in fatality or serious injury or the aircraft receives substantial damage.

Air Force Medical Examiner – Medical personnel of the USAF responsible for examining and identifying remains and determining cause of death.

Appointing Official – The official authorized to appoint the investigating authority for a mishap or close call; accept the investigation of another authority; receive endorsements and comments from endorsing officials; and approve the mishap investigation report.

Ascent – That period-of-time from when the engines start and the vehicle clears the launch pad structure.

Astronaut – Also known as spaceflight participant - any individual who has flown in space or will fly in space aboard a NASA spacecraft, international spacecraft or commercially-provided vehicle.

Autopsy – A detailed review of human remains to determine cause of death.

Cause – An event or condition resulting in an effect. Anything that shapes or influences the outcome. A cause must precede and be necessary and sufficient on its own to bring about the undesired outcome of a mishap.

Center Emergency Management Plan – A detailed plan implemented at each field center in case of an emergency.

Chain of Command – This is the reporting structure of personnel in the event of a mishap.

Chain of Custody – A process for ensuring that collected evidence is maintained through a highly-controlled process.

Close call – An event that occurs with no injury or a minor injury requiring basic first aid. No damage or minor damage to equipment and/or property that is less than $20,000.

Contractor – A non-civil servant that works for NASA under a contract.

Corrective Action – Any change that results in preventing, minimizing, or limiting the potential for occurrence of an incident (e.g., design processes, work instructions,

workmanship practices, training, inspections, tests, procedures, specifications, drawings, tools, equipment, facilities, resources, material, and so on).

Corrective Action Plan – This plan is developed, usually within 15 workdays after the mishap investigation report has been endorsed. The corrective action plan lays out how the Agency will fix the problem.

Cosmonaut – any individual who has flown in space or will fly in space aboard a Russian spacecraft, international spacecraft or commercially-provided vehicle.

Crewmember – Any member of mission regardless of mission profile or objective.

Dignified transfer – The remains of an individual are treated with respect and transferred in cases that are provided by the Air Force Medical Examiner to Dover Air Force Base.

Death on orbit – A crewmembers dies on orbit.

Disassociated remains – The human body is no longer intact due to the mishap. – On assumes everyone know what this means. I left here.

Event – A real-time occurrence describing one discrete action, typically an error, failure, or malfunction (e.g., pipe broke, power lost, lightning struck, and person opened valve).

Event and Causal Factor Tree – A graphic representation of the mishap or close call that shows the event (accident) at the top of the tree; depicts the logical sequence of events; illustrates all causal factors (including conditions and failed barriers) necessary and sufficient for the mishap or close call occurrence; and depicts the root causes at the bottom of the tree.

Evidence – Everything used to support or refute a hypothesis or finding. For a safety investigation, the types of evidence are physical (e.g., hardware), demonstrable (24 hours in one day), witness interview, and documentary (witness statement, logbooks, and electronic data).

Flight Surgeon – Physicians that are trained in aerospace medicine and support astronauts, cosmonauts, or aircraft pilots.

Ground crew – Any individual who supports a mission on the ground, including processing of the spacecraft for launch and supporting all aspects of flight.

Hazard – A source of damage, harm or adverse effects to animate (human) and inanimate materials (structures, instruments, machinery).

High-Visibility Mishap or Close Call – A mishap or close call, regardless of the amount of property damage or personnel injury, that the Administrator; Chief, Safety and Mission Assurance, Office of Safety and Mission Assurance; Center Director, Executive Director, Office of Headquarters Operations; Aircraft Management Division Director; or Center Safety and Mission Assurance Director judges to possess a high degree of safety risk, programmatic impact or public, media, or political interest including, but not limited to,

mishaps and close calls affecting flight hardware or software, or completion of critical mission milestones.

Human Error – An unintentional action or decision by a human being that leads to an unplanned outcome. Three types (1) slips, (2) lapses, and (3) mistakes. The first two are skill-based and the last are rule-base or knowledge-based.

Human Factors – Application of psychological and physiological principles to the design of products that humans interact with.

Human Systems Integration – An interdisciplinary technical and management process of integrating human considerations and the systems we interact with.

Incident – An occurrence of a mishap or a close call.

Incident Commander – The person responsible for directing or controlling resources by means of explicit legal, Agency, or delegated authority. The incident commander is responsible for all aspects of incident response including developing objectives, managing operations, setting priorities, and defining the Incident Command System organization for the particular response.

Interim Response Team – A team that immediately responds in hours following a mishap.

Incident Response Team – The team that responds to the mishap. This is led by the FBI.

International Partners – National space agencies that partner with NASA in human spaceflight activities.

Laboratory – A site where ground-based experimentation or training takes place and can include a wide variety of places.

Launch pad ops – Processes that take place on the launch pad in preparation for flight, including training.

Launch Accident – A mishap resulting in injury, death and/or damage or destruction to the launch facility.

Launch Incident – An event that occurs during the launch phase, including accent abort (vehicle does not gain enough velocity to reach space).

Lessons Learned – The written description of knowledge or understanding gained by experience, whether positive such as a successful test or mission, or negative such as a mishap or failure.

Life-Threatening Injury – An injury involving a substantial risk of death; loss or substantial functional impairment of a bodily member, organ, or mental faculty likely to be permanent; or an obvious disfigurement likely to be permanent.

Lost Time Injury or Illness – A nonfatal traumatic injury resulting in any loss of time from work beyond the day or shift it occurred; or a nonfatal, non-traumatic illness or disease-causing disability at any time.

Location – This term can be used for where an individual, disassociated remains, vehicle, vehicle parts, debris field, coordinates (longitude and latitude), laboratory, and response personal are at the time or in the immediate aftermath of a mishap.

Medical policy – All policies related to crew health and safety, which is the responsibility of the Office of the Chief Health and Medical Officer.

Mishap – An unforeseen accident resulting in injury, loss of life, loss of assets and/or destruction of property.

Mishap Investigation Board – A group of senior individuals who are assigned the task of investigating unplanned event.

Mishap Investigation Team – A group of individuals who are assigned the task of investigating unplanned event.

Mishap Investigator – The individual who is responsible for the investigative process.

Mishap Preparedness and Contingency Plan – A plan that is implemented following a mishap, including all policies, procedures and processes.

NASA Policies – Policies that are developed and support all NASA activities. Each Center's policies are linked to the Agency policies.

NASA Facilities – Those physical assets own and operated by NASA.

NASA Mishap Information System – A custom-developed system for capturing mishaps, close calls, and hazards, as required in this NPR.

National Flag Draping – Once an international crewmember's remains are ready for transfer, the transfer case will be draped with the individual's national flag.

Property Damage – Damage to any type of Government or civilian property including, but not limited to, flight hardware and software, facilities, ground support equipment, and test equipment.

Proximate Cause – The event that occurred, including any conditions existing immediately before the undesired outcome, directly resulted in its occurrence, and if eliminated or modified, would have prevented it. Also, known as direct cause.

Proximity Ops – Operations that occur near the spacecraft. Specifically this refers to activity between two spacecraft – rendezvous, docking, fly-around.

Occupational injury – An injury or illness that occurs as a result of an individual's occupation.

Occupational Physician – An individual who is trained and supports all medical issues on all NASA installations.

On Orbit Ops – Activities that occur on the spacecraft or outside the spacecraft.

Reentry Accident –An event that occurs during the reentry that impacts the crew and spacecraft in such a way as to be catastrophic.

Reentry Incident – An unplanned event that occurs to the spacecraft and/or the crew during the reentry phase of flight.

Root Cause - An event or condition, primarily associated with organizational factors, which existed before the intermediate cause and directly resulted in its occurrence (indirectly caused or contributed to the proximate cause and subsequent undesired outcome) and, if eliminated or modified, would have prevented the intermediate cause from occurring and the undesired outcome. Typically, multiple causes contribute to an undesired outcome. In the absence of a prevalent organizational factor, the root cause may be identified as undetermined.

Root Cause Analysis – a structure evaluation method that identifies the root causes for undesired outcome and those actions to prevent it from happening again.

SHELL-D – A method of collecting evidence. Software, Hardware, Environment, Liveware (individual), Liveware (team), and Documents

Spacecraft – Any vehicle that achieves flight and goes into orbit.

Timeline. Events and conditions preceding and following a mishap supported by facts and arranged in chronological order.

Transfer cases – Containers that can be sealed and refrigerated to hold human remains until they are properly processed.

Type A Mishap – A mishap resulting in one or more of the following:

- Occupational injury or illness resulting in a fatality or a permanent total disability.
- Total direct cost of mission failure and property damage of $2,000,000 or more.
- Crewed aircraft hull loss.
- Unexpected aircraft departure from controlled flight for all aircraft except when departure from controlled flight has been pre-briefed (e.g., upset recovery training, high AOA envelope testing, aerobatics, or Out of Controlled Flight for training) or mitigated through the flight test process inherent at each Center.

Type B Mishap – A mishap causing an occupational injury or illness resulting in permanent partial disability; hospitalization for inpatient care of three or more people within 30 workdays of the mishap; or a total direct cost of mission failure and property damage of at least $500,000, but less than $2,000,000.

Note: Hospitalization does not include any hospital stay intended only for medical testing, diagnosis, or observation to determine nature or extent of injury or illness.

Type C Mishap – A mishap resulting in a nonfatal OSHA-recordable occupational injury or illness causing days away from work, restricted duty, or transfer to another job beyond the day or shift on which the mishap occurred; hospitalization for inpatient care of one or two people within 30 workdays of the mishap; or a total direct cost of mission failure and property damage of at least $50,000 but less than $500,000.

Type D Mishap – A mishap resulting in a nonfatal OSHA-recordable occupational injury or illness that does not meet the definition of a Type C mishap or a total direct cost of mission failure and property damage of at least $20,000, but less than $50,000.

Undesired Outcome – An event or result that is unwanted and different from the desired and expected outcome. For mishap investigation, an undesired outcome should describe the loss that determined the mishap classification (i.e., property damage, mission failure, fatality, permanent disability, lost-time case, or first-aid case).

Witness – A person who has information, evidence, or proof about a mishap and provides his or her knowledge of the facts to the investigating authority.

Witness Statement – A verbal or written statement from a witness of his or her account including a description of the sequence of events, facts, conditions, and causes of the mishap.

APPENDIX C: Standard Forms

1. NASA Witness Statement
2. Standard NASA Witness Form (Form 08-06)
3. 72-Hour History Questionnaire
4. 14-Day History
5. Impoundment of Records and Evidence
6. Data to Obtain
7. Chain of Custody
8. Mishap Evidence Property Tag
9. Mishap Evidence Log
10. Mishap Evidence Custody Form
11. NASA Mishap Investigation Evidence Property Tag Chain of Custody Tracking Log
12. NASA Mishap Investigation and Property Custody Document
13. Scene Diagram and Sketch Checklist
14. Photographic and Video Physical Evidence
15. NASA Mishap Investigation Imagery Log
16. NTSB Form – Certification of Party Representative

NASA Written Witness Statement

National Aeronautics and Space Administration
Written Witness Statement Form

Written Witness Statement

It is important that witnesses be interviewed as soon as possible after the occurrence of a mishap in order to obtain the best recall of information that might assist in the identification of causal factors. Immediately after a mishap, this form must be completed by the witness. The written statement is intended to describe the witness's account of the mishap including a description of the sequence of events, facts, conditions, and causes of the mishap. The form will be collected by the NASA Center Safety (NSC) Office or the NASA Interim Response Team (IRT).

The purpose of the NASA safety mishap investigation is to identify the proximate causes and root causes of the mishap and to develop recommendations that prevent the occurrence of similar mishaps. The NASA safety mishap investigation process conducted per the NASA Procedural Requirements 8621.1D (NPR 8621.1D) *does not assess blame and is completely separate* from any proceedings the Agency may undertake to determine civil, criminal, or administrative culpability or liability.

Your testimony is entirely voluntary, but we hope that you will assist the investigating authority to the maximum extent of your knowledge of this matter.

Your testimony will be documented and retained as part of the mishap report background files but will not be publicly released with your name as part of the mishap report. The investigating authority will make every effort to keep your testimony confidential and privileged to the greatest extent permitted by law.

Note: There are three circumstances when your testimony may be released from the control of the investigating authority and would no longer be considered privileged:

1. When the investigating authority or NASA is ordered to release the testimony by a court or administrative body outside NASA.

2. When the Inspector General (IG) makes a written request to the NASA Administrator. The IG, by law, is permitted access to all records, reports, audits, reviews, documents, papers, recommendations, or other material available to the applicable establishment which relate to programs and operations. The Office of Inspector General rarely makes this request. The IG respects and, as a general rule, will defer to the disclosure restrictions attendant to NASA mishap investigations. Upon receipt of such testimonial information, the IG will consider it to be confidential witness testimony and will treat it as such to the full extent required by the Inspector General Act of 1978.

3. When NASA experiences the loss of a Space Shuttle, the loss of the International Space Station, or its operational viability, or the loss of any other U.S. space vehicle carrying humans. By law, an independent Presidential Commission will be formed and the contents of this written

statement may be provided to the Commission.

I have read the above information and understand that NASA will make every effort to protect the information provided to the greatest extent permitted by law, and I understand the three circumstances when my testimony may be released.

Signature: _____ **Date:** _____

Note: Reproduced here for education purposes only

C2 - Standard NASA Witness Form (Form 08-06)

National Aeronautics and Space Administration
Written Witness Statement Form 08-06

Witness Statement

Date of Witness Statement: _____

Time of Witness Statement: _____

Witness

Name: _____ Phone: _____

Email: _____

Company/Department: _____

Mail Code: _____ Job Title: _____

Age: _____ Years in Job: _____

Time of Mishap: _____

Your Location at Time of Mishap (If needed, you may draw on the back of this form to show your location in reference to other objects, equipment, or people):

Building and Room: _____

Additional Details About Your Location: _____

Your Activity at Time of Mishap: _____

_____

Please describe to the best of your memory **what happened** at the time of the mishap.

_____
_____
_____
_____
_____

WITNESS GIVES COMPLETED FORM TO NASA CIVIL SERVANT ONLY

The information on this form can be considered privileged only if the form is given directly to a civil servant that is a member of the NASA Center Safety Office or the NASA Interim Response Team. If the form is collected by a contractor, NASA cannot guarantee privilege or ensure that the contractor will not disseminate the information.

Continue description of **what happened** at the time of the mishap. You may write on the back of this form (or request another page) if you need additional space.

Please describe **why** you think the mishap occurred.

Witness Signature

WITNESS GIVES COMPLETED FORM TO NASA CIVIL SERVANT ONLY

The information on this form can be considered privileged only if the form is given directly to a civil servant that is a member of the NASA Center Safety Office or the NASA Interim Response Team. If the form is collected by a contractor, NASA cannot guarantee privilege or ensure that the contractor will not disseminate the information.

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C3 - 72-Hour History Questionnaire

72-Hour History Questionnaire

Name: _____ Date: _____

List in as much detail as you can, in chronological order, EVERYTHING you remember doing, and significant emotions you remember experiencing since you woke up on the day of the incident and for three days prior.
Record this information on the attached pages. Use a separate sheet of paper if needed. Be as **complete** as you can. Take your time.

SLEEP	**Day of incident**	**Day before**	**Two days before**
1. How many hours did you sleep per day, including naps?			
	Day before	**Two days before**	**Three days before**
2. How would you describe the way you fell asleep compared with usual? a. More difficult than usual b. Easier than usual			
3. How would you describe the quality of your sleep compared with normal? a. More restless than usual b. Calmer than usual			
4. How would you describe your awakening in comparison to usual? a. More difficult than usual b. Easier than usual			
5. How did you feel when you woke up? a. Tired b. Alert			
6. How would you describe your balance and coordination upon awakening? a. More disrupted than usual b. Less disrupted than usual			

WORK			
7. What activities did you do at work?			
8. How many hours did you work?			
MEALS|			
9. What exactly did you eat?			
10. Any dietary changes?			
11. Any missed meals?			
12. What were the times of meals			
13.			

RECREATIONAL ACTIVITIES	Describe what you did. Include important family or personal telephone calls or emails.

EXERCISE	Describe any exercise and the duration of the workout.

ALCOHOL/MEDICATION	

How much alcohol?	
What type?	
What medications (prescription or over-the-counter) or nutritional supplements did you take?	
SIGNS OF PHYSICAL ILLNESS	
Symptoms you felt?	
Unusual fatigue or weakness?	
SIGNIFICANT EMOTIONS/STRESSES	With whom (spouse, children, "significant other," parent, supervisor, etc.?
ANYTHING OUT OF THE ORDINARY THAT OCCURRED	

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14-Day History

Name: _____ Date: _____

Please check if you experienced any of the following events during the 14 days prior to the incident:

_____Death of a spouse
_____Divorce
_____Marital separation
_____Death of a close family member
_____Personal injury or illness
_____Began or ended school
_____Marriage
_____Marital reconciliation
_____Change in family member's health
_____Pregnancy
_____Gain a new family member
_____Business readjustment
_____Change in financial state
_____Death of a close friend
_____Change to a different line of work
_____Change in sleeping habits
_____Change in frequency of arguments
_____Major mortgage purchase
_____Change in work responsibilities
_____Child leaving home
_____Trouble with in-laws
_____Outstanding personal achievement
_____Spouse started or stopped work
_____Began or ended school
_____Change in living conditions
_____Change in personal habits
_____Trouble with supervisor
_____Change in work hours/conditions
_____Change in residence
_____Change in recreation
_____Change in church activities
_____Minor mortgage or loan
_____Change in sleeping habits
_____Change in eating habits
_____Vacation
_____Major holiday
_____Minor law violation

Please note anything significant in your 14-day history here and on the reverse of this page if necessary.

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Impoundment of Records and Evidence

Responsible Party	Center Safety Office; IRT Leader; Security Office; Impound Coordinator; Supervisor
Resource	Mishap Preparedness and Contingency Plan; Impound Coordinator; Impoundment Storage Area

Actions

1. Impound all appropriate data, records, equipment, and facilities that may be involved in the mishap to prevent their unauthorized use or modification.
   - Formally designate a civil servant IRT Impound Coordinator to manage impoundment and access control.
   - Designate sufficient locked storage space equipped to maintain evidence and records without damage.
   - Data and records, regardless of format, may include, but are not limited to, the list of pre-identified items.
   - Ensure all evidence is tagged for identification with, as a minimum, the date, location, description, and name of person who collected the evidence. The NASA Mishap Investigation Evidence Tag in 3d of this appendix may be used. Where evidence is known to contain hazardous materials, ensure the tag is marked accordingly and a material safety data sheet (MSDS) is attached.
   - Maintain an inventory of impounded records and evidence. The NASA Mishap Evidence Log is provided for this purpose. For large amounts of documents and material, employ a searchable database.
   - Control personal effects and sensitive information related to injured or deceased individuals per the NASA Mishap Investigation Chain of Custody Process in 3c of this appendix.

Responsible Party	Center Safety Office; IRT, Impound Coordinator
Resource	Mishap Preparedness and Contingency Plan; Impound Coordinator; Impoundment Storage Area

Actions

1. Control access to all impounded items until they are released by the Investigating Authority per the procedures in the Center Mishap Preparedness and Contingency Plan.
   - Maintain a log of any records released to the investigating board or other personnel supporting the investigation.
   - Except for direct support of continued flight operations and to the extent permitted by law, release no property, information, or data to any person without a need-to-know (as determined by the IRT impound coordinator, Chair, or designee) until such time as the Mishap Board Chair for the investigation is appointed and releases the data. Pre-approved authorized personnel requiring access into impounded areas must be authorized by management memorandum. All other personnel can be admitted by submitting an Avoid Verbal Orders (AVO) directed to the IRT Chair or designee, stating the justification and signed by an investigation board member.
   - Call upon NASA security to aid in the protection of data and to grant and preclude access/egress of secured areas.
   - Protect impounded property associated with the contingency or operation per its

sensitivity, criticality, and national security requirements. Original documents are those that could not be duplicated if lost. Examples of original documents are real- time strip chart data, telemetry data, and printer plotter data. Copied data are defined as that generated from master recording media and reproduced as recorded media or printed material.	
Responsible Party	Center Safety Office
Resource	Mishap Preparedness and Contingency Plan; Impound Coordinator; Impoundment Storage Area (see Appendices 3d and e)
Actions	
3. Specific onsite (Center) and Offsite Procedures (including foreign country) • Provide the Investigating Authority with a list of NASA personnel who will perform or assist withimpoundment procedures. • Provide a list of pre-identified electronic libraries and databases, and the activity-specific procedures required to impound them. • Provide transportation arrangements from offsite to Center storage facilities.	

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Data to Obtain

The Mishap Preparedness and Contingency Plan (MPCP) should include location of information such as databases, Web sites, project documentation, drawings, basic system operation and procedures, and points-of- contact for information. Examples are shown in the following table:

Data Type: Human Data	**Local Source**
Work experience in the job	
Training records	
Certification records	
Time cards	
Three-day sleep cycle	
Health history (recent sickness, injuries, medications)	
Medical records and/or coroner's report (where appropriate)	
Drug test results	
Education	
Personnel records (e.g., Mission/Launch/Test team personnel records)	
Safety violation history	
Physical or mental disabilities or limitations	
Size (build of person), weight, height	
Personnel protective equipment used	
Personnel clothing (damage/stain patterns or lack thereof)	
Data Type: Environment (Facility)	
Temperature	
Humidity	
Lighting	
Ambient noise level	
Acoustics	
Vibration	
Air quality	
Electromagnetic energy sources	
Kinetic energy sources	
General cleanliness	
Crew habitat	
Workstation/workplace layout	
Water quality	
Data Type: Environment (Natural Phenomena)	
Animal or plant life activity	
Earthquake	
Gravity	
Landslide	
Meteoroid/meteorite	
Radiation	

Solar flare	
Volcanic activity	
Data Type: Environmental Conditions (Weather)	
Barometric pressure data	
Cloud cover data	
Fog/haze data	
Flooding	
Tidal wave	
Hurricane	
Tornado	
Tsunami	
Ice	
Lightning	
Microburst	
Pollution	
Precipitation	
Sun glare	
Water spout	
Wind/wind shear	
Data Type: Processes and Procedure Documents	**Local Source**
Configuration management	
Customer service	
Diversity and equal opportunity	
Education	
External relations	
Function allocation	
Infrastructure and administration	
Inspections	
Legal	
Legislative affairs	
Logistics	
Maintenance, calibration (prevention and corrective)	
Operations	
Packing, handling, shipping, transfer	
Problem analysis	
Procurement	
Public affairs	
Records retention	
Receiving	
Repair	
Requirements development	
Reviews	
Scheduling	

Security	
Storage	
Trending	
Troubleshooting	
Data Type: Safety, Risk Assessment, and Quality Assurance Documents	**Local Source**
Audits	
Inspections	
Quality check documentation	
Nondestructive evaluation reports	
Nonconformance/problem reports	
Surveys	
Supplier data	
Corrective action closure records	
Failure analysis	
Fault tree	
Failure mode and effects analysis	
Lock out / tag out procedures and records	
Process failure mode and effects analysis	
Hazard analysis	
Modeling	
Mishap/incident/problem reporting	
Probabilistic risk assessment	
Human reliability assessment	
Software reliability assessment	
Reliability planning	
Risk acceptance documentation	
Risk analysis/assessment	
Safety assessment/analysis	
Simulation	
Independent assessments	
Trending action	
Data Type: Hardware and Software Data and Documentation	**Local Source**
Hardware	
Debris	
Design drawings (equipment, facilities)	
Assembly, integration, operational procedures used at the time of accident/incident	
Maintenance records/work orders	
Calibration records	
Standardization/certification records	
Test procedures and test records (magnetic tapes, software, log books)	
Vehicle and payload instrument/telemetry data	
Range instrument/telemetry/tracking data	

Work authorization documents for ground support equipment, test equipment, and flight hardware	
All control/user/firing room log books	
All waivers/deviations/exceptions documentations	
All associated acceptance data packs	
All associated lab samples and lab reports	
Hardware and software design certification, status, and history	
All associated facilities operations and maintenance processing documents	
Shift change records	
Design simulations/models	
Measurement unit systems	
All associated red streamer logs and entry control logs	
All associated daily inspection reports/logs	
All associated time cycle data	
All data packages and certifications for vehicle and payload readiness for flight (certification of flight readiness, flight readiness review, launch readiness review, etc.)	
Integrated data systems and records	
Measurement systems and records	
Vehicle system/subsystem records	
Master copies of all system and applications software for all electronic/computer systems used in processing the associated flow	
All hardware/software configuration data for the associated flow	
All x-rays for the associated flows	
All mate/demate records for the associated flow	
All associated mission review board and any other waiver/deviation/exception activity	
Data Type: Records	**Local Source**
Video and photographic records and systems (NASA, internal/external facility surveillance, internal/external security surveillance, Webcams, personal audio/video recordings, public media, other government agencies)	
Voice recordings (mission control room, launch control room, test control room, flight deck, readiness reviews)	
Voice recordings (ambulance, paramedic, 911)	
Telemetry data	
All original associated microfilm reels	
All associated ground operations magnetic, analog, and digital tape	
DVDs, CDs, and other electronic storage media including originals and /or backup copies	

Note: Reproduced here for education purposes only.

Chain of Custody

When NASA is in charge of debris and evidence collection, the Center or Project Mishap Preparedness and Contingency Plan describes the Chain of Custody procedures to be used for personal effects and sensitive information related to injured or deceased individuals. For some mishap situations, NASA will be in charge of the physical mishap scene and, therefore, in charge of debris and evidence collection, but personal effects may be under the control of non-NASA organizations (such as first responders, the local hospital, or the coroner). The Chain of Custody procedures account for these scenarios.

Responsible Party	Chain of Custody Designees
Resource	Mishap Preparedness and Contingency Plan
Actions	
1. Establish Custody. Designated NASA custodians establish a paper trail showing the seizure, custody, control, transfer, analysis, and disposition of physical and electronic evidence. Note: Although similar to general "impoundment of records," "chain of custody for personnel effects and sensitive information" requires 100-percent accountability of custody documented on the "NASA Mishap Investigation Evidence Custody Document" form.	
2. Transaction of Custody. Note who is in possession. These transactions, and every succeeding transaction between the collection of the evidence, its use for the mishap, and the disposal of the evidence should be completely documented chronologically. Documentation shall include the following: 1. Conditions under which the evidence is gathered 2. Identity of all evidence handlers 3. Duration of evidence custody 4. Security conditions while handling or storing the evidence 5. Manner in which evidence is transferred to subsequent custodians each time such a transfer occurs	
3. Document Evidence Receipt. When using this form as an evidence receipt, prepare an original and three copies. Present the original and first copy to the evidence custodian; give the second to the person from whom the evidence was received, and place the third in the report file. When items of evidence gained during one transaction exceed the space allotted on a single form, continue the list on additional forms.	
4. Evidence Custody Form. The original chain of custody form becomes a voucher and is given a voucher number when it is presented to the evidence custodian. Number evidence vouchers consecutively for each calendar year. Write these numbers in the margin at the bottom right corner of the form. Pencil in the location of the evidence accounted for with the voucher on the bottom left margin of the form and erase and change it whenever the location of the evidence changes (for example, located in evidence room safe, items 1 and 2 in safe, items 3 and 4 in evidence bin No. 6). Complete the chain of custody section on the form whenever any part of the evidence leaves the office, the evidence is returned, or a new evidence custodian assumes control. The original evidence voucher should not leave the office except for submission in court. Maintain a duplicate copy in the voucher file to show the disposition of the	

original. Use a copy of the chain of custody form as a sub-voucher to accompany evidence and record any change of custody that may occur while the evidence leaves the evidence room. Use a copy of the original evidence voucher or make an extract of the original. Always prepare sub-vouchers in duplicate with the original accompanying the evidence. Number sub-vouchers consecutively; for example, SV-1 and SV-2. Add this number to the number of the original voucher. When only part of the items listed on a voucher is to be removed from the evidence room, prepare an evidence sub voucher. A sub voucher shall be prepared exactly as the original voucher, but includes only those items being released in the description of evidence
5. Evidence Receipt Form. Upon initial impoundment of evidence, issue the Evidence Receipt form to the owner of the evidence as applicable for training records, tapes, and other stored data (typically this does not include wreckage). Upon release of evidence by the Investigating Authority, the owner may show the receipt to the Impoundment Coordinator for return of property.

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8 – Mishap Evidence Property Tag

Mishap Evidence Property Tag

NASA Mishap Investigation Evidence Property Tag	**Log Number:**
NASA Person Who Collected Item	
Name: **Center: Phone No.:**	**Date Collected** (mm/dd/yyyy): **Time Collected:** **Time Zone:**
Found Location of Found Item (Latitude/Longitude and/or distance/magnetic bearing from reference point)	**Description of Item** (model no., serial no., identifying marks, condition, and value if known)
Owner of Item	
Name: Company: Phone No.:	**Address: City: State:**
Hazards Associated with Item 1. Is the item hazardous? ¨ Yes ¨ No 2. If yes, are MSDS sheets attached? ¨ Yes ¨ No 3. Does the item require special PPE for handling? ¨ Yes ¨ No 4. If yes, what PPE is required? 5. How does the item have to be stored to ensure safety and preservation of evidence? (Please describe any special precautions (e.g., cold dark room, away from ignition sources or flammable products).	
Is this item NASA Sensitive But Unclassified because of the following? (Please select appropriate categories.) ☐ Privileged Testimony ☐ Proprietary Information ☐ International Traffic in Arms Regulations (ITAR) ☐ Export Administration Regulations (EAR) information ☐ Privacy Act Information ☐ Personal Effect of Injured or Deceased	
Additional comments or notes	

Mishap Evidence Log

NASA Mishap Investigation Evidence Log					Date Collected: Sheet ____ of ____	
Evidence Custodian (Name, Organization, Telephone)					**Incident Identification**	
Log #	**Date Received**	**Source's Name**	**Location Evidence Obtained (Bldg., City, State)**	**Evidence Collected By**	**Location Evidence Stored**	**Item Description (model no., serial no., identifying marks, condition, and value if known)**

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Mishap Evidence Custody Form

<table>
<tr><td colspan="4"> 
NASA Mishap Investigation Evidence and Property Custody Document
NOTE: To be used for personal effects and sensitive information related to injured or deceased individuals. Chain of Custody to be performed by NASA Personnel Only.</td></tr>
<tr><td colspan="3">CONTROL NUMBER</td><td>RECEIVING ACTIVITY NAME, LOCATION</td></tr>
<tr><td colspan="3" rowspan="3">LOCATION WHERE PROPERTY OBTAINED</td><td>NAME AND TITLE OF PERSON FROM WHOM RECEIVED
□ OWNER
□ OTHER</td></tr>
<tr><td>ADDRESS (include ZIP)</td></tr>
<tr><td>WORK PHONE</td></tr>
<tr><td colspan="3">PURPOSE FOR WHICH OBTAINED

□ FOUND □ EVIDENCE
□ IMPOUNDED □ OTHER</td><td>DATE OBTAINED NUMBER</td></tr>
<tr><td>ITEM</td><td>QUANTITY</td><td>DISPOSAL ACTION</td><td>DESCRIPTION OF ITEM (model no., serial no., identifying marks, condition,
and value if known)</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

NAME AND SIGNATURE OF WITNESS (IF AVAILABLE)	NAME AND SIGNATURE OF RECEIVING PERSON

Chain of Custody Continued

CHAIN OF CUSTODY

ITEM	DATE and TIME	RELEASED BY	RECEIVED BY
		NAME	NAME
		ORGANIZATION	ORGANIZATION
		SIGNATURE	SIGNATURE
		NAME	NAME
		ORGANIZATION	ORGANIZATION
		SIGNATURE	SIGNATURE
		NAME	NAME
		ORGANIZATION	ORGANIZATION
		SIGNATURE	SIGNATURE

REMARKS

FINAL DISPOSAL ACTION

FINAL DISPOSAL AUTHORITY

NAME (TYPED OR PRINTED) ORGANIZATION

PERSONS RECEIVING ITEMS OR WITNESSING DESTRUCTION
NAME, ORGANIZATION AND SIGNATURE

1. _____

2. _____

3. _____

CONTINUE IN REMARKS IF NECESSARY

INDICATE IN DISPOSAL ACTION COLUMN (ON FRONT) BY NUMBER AND LETTER CODE PERSON(S) RECEIVING OR WITNESSING ACTION AND TYPE OF ACTION.

RETURNED TO INDIVIDUAL OWNER (I), PERMANENT INVESTIGATION ARCHIVE (P), DESTROYED (D), OTHER METHOD (M) (EXPLAIN IN REMARKS.)

NASA Mishap Investigation Evidence Property Tag Chain of Custody Tracking Log

Chain of Custody to be performed by NASA Civil Service Personnel Only

- Evidence Property Tag Form 07-10 (page 1-2) must be attached to each "personal effect" or "personal belonging" that is collected as part of a mishap investigation. This Form is used in combination with the "Chain of Custody Tracking Log" (page 3) to ensure that the item is protected, analyzed (as necessary), and then returnedto the rightful owner.
- Evidence Property Tag Form 07-10 (page 1-2) must be attached to any item collected as part of a mishap investigation that is deemed hazardous, so that handlers of the item are aware of the hazards and handling instructions.

ITEM CONTROL NUMBER (From Evidence Tag)	**CHAIN OF CUSTODY - LOG NUMBER**
INCIDENT TITLE	**DATE - TIME COLLECTED**
INCIDENT DATE	
FROM	**TO**

Month	**Day**	**Year**	**Time**	**Time Zone**

FINDER OF ITEM	**FIRST RECEIVER OF ITEM – NASA CIVIL SERVICE**
Name:	Name:
Organization:	Organization:
Address:	Address:
City: State:	City: State:
Country:	Country:
Phone Number: ( )	Phone Number: ( )

LOCATION ITEM WAS FOUND OR OBTAINED	**LOCATION WILL BE STORED**
Longitude	Center:
Latitude:	Building:
Address:	Address:
City: State:	City: State:
Country:	Country:
REASON ITEM OBTAINED	Contact Phone Number: ( )

☐ Found ☐ Impounded ☐ Other_____				
Item Description	Model No. Serial No.	Identifying Marks/ Condition	Quantity	Value (If Known)

HAZARDS ASSOCIATED WITH ITEM

1. Is there a possibility that the item has blood on it?
2. Is the item hazardous?
3. If hazardous, are MSDS sheets attached?

4. Does the item require special PPE for handling?
5. If yes, what PPE is required?
6. How does the item have to be stored to ensure safety and preservation of evidence? (Please describe any special precautions (e.g., cold dark room, away from ignition sources or flammable products).

IS ITEM NASA SENSITIVE BUT UNCLASSIFIED (SBU)?

To the best of your knowledge, please select all appropriate categories for item

□ Personnel Document of Injured or Deceased	□ Infrastructure or Security Vulnerabilities Information
□ Privileged Testimony	□ Inter or Intra-Agency Memoranda or Letters
□ Personally Identifiable Information (Personnel, Medical or Similar Files (PII))	□ Internal Personnel Rules or Practices
□ Proprietary Information	□ Investigative Records
□ International Traffic in Arms Regulations (ITAR)	□ NASA Information Technology/Internal Systems Data
□ Export Administration Regulations (EAR) information	□ NASA Sensitive Information
□ Business or Company Confidential	
□ Emergency Contingency or Continuity of Operations Information	□ Patent Information
□ Financial Institution Information	□ Space Act (Sec. 303B)
□ Geological or Geophysical Information	□ Subject to Trade Secrets Act
□ Other (Specify)	□ System Security Data Information

If any of the boxes above have been marked indicating that this is NASA Sensitive But Unclassified (SBU), the NASA Form 1686 should be attached to the top of the item and it should be protected in accordance with NASA Procedural Requirements 1600.1.

The NASA Mishap Investigation Evidence Tag is required to be attached to each "personal effect" or "personal belonging" that is collected by the NASA Interim Response Team (IRT) or IRT support staff during their activities to support a NASA Mishap Investigation. *Please complete the box on the right to indicate the owner of the personal effect or personal belonging. The third page documents the handling of the item until its disposal. The Chain of Custody Log should be maintained by Civil Service Personnel in charge of the impound process.*	**OWNER of ITEM (IF APPLICABLE)** *Name:* *Organization:* *Address:* *City:* *State:* *Country:* *Phone Number: ( )*

ITEM	RELEASED BY	RELEASED TO	DATE & TIME	PURPOSE

FINAL DISPOSAL ACTION

DISPOSAL AUTHORITY	DISPOSAL ACTION
Name:	Returned to Owner
Organization:	Placed in Permanent Investigation Archive

Address:			Destroyed
City: State:			Other Method (Describe):
Country:			
WITNESS TO FINAL DISPOSAL			
Print Name	Organization	Phone	Signature
Additional Comment or Notes:			

Note: Reproduced here for education purposes only

NASA Mishap Investigation Evidence and Property Custody Document			
NOTE: To be used for personal effects and sensitive information related to injured or deceased individuals. Chain of Custody to be performed by NASA Personnel Only.			
CONTROL NUMBER		RECEIVING ACTIVITY NAME, LOCATION	
LOCATION WHERE PROPERTY OBTAINED		NAME AND TITLE OF PERSON FROM WHOM RECEIVED □ OWNER □ OTHER	
ADDRESS (include ZIP)			
WORK PHONE			
PURPOSE FOR WHICH OBTAINED □ FOUND □ EVIDENCE □ IMPOUNDED □ OTHER		DATE OBTAINED	NUMBER
ITEM	**QUANTITY**	**DISPOSAL ACTION**	**DESCRIPTION OF ITEM** (model no., serial no., identifying marks, condition, and value if known)
NAME AND SIGNATURE OF WITNESS (IF AVAILABLE)		NAME AND SIGNATURE OF RECEIVING PERSON	

Chain of Custody Continued

CHAIN OF CUSTODY				
ITEM	**DATE and TIME**	**RELEASED BY**	**RECEIVED BY**	**PURPOSE**
		NAME	**NAME**	
		ORGANIZATION	**ORGANIZATION**	
		SIGNATURE	**SIGNATURE**	
		NAME	**NAME**	
		ORGANIZATION	**ORGANIZATION**	
		SIGNATURE	**SIGNATURE**	
		NAME	**NAME**	
		ORGANIZATION	**ORGANIZATION**	
		SIGNATURE	**SIGNATURE**	

REMARKS

FINAL DISPOSAL ACTION
FINAL DISPOSAL AUTHORITY
NAME (TYPED OR PRINTED) ORGANIZATION

PERSONS RECEIVING ITEMS OR WITNESSING DESTRUCTION

NAME ORGANIZATION SIGNATURE

1. _____
2. _____
3 _____
4. _____

CONTINUE IN REMARKS IF NECESSARY

INDICATE IN DISPOSAL ACTION COLUMN (ON FRONT) BY NUMBER AND LETTER CODE PERSON(S) RECEIVING OR WITNESSING ACTION AND TYPE OF ACTION.

RETURNED TO INDIVIDUAL OWNER (I), PERMANENT INVESTIGATION ARCHIVE (P), DESTROYED (D), OTHER METHOD (M). (EXPLAIN IN REMARKS.)

Scene Diagram and Sketch Checklist

Responsible Party	IRT/MIB
Resource	Go-Kit
Actions	
1. Prepare to sketch the scene. – Use the full size of paper to sketch the scene allowing for measurements and marking the location of objects. – Use a separate sheet of paper to list measurements for a large number of items. – To establish a rough scale, take the longest measurement at the scene and divide it by the longest measurement of the paper or the number of squares on graph paper. For example, if the longest wall of a room to be shown in the sketch is 80 ft., and there are 40 squares on the long side of the graph paper, each square can represent 2 ft. If the length of the paper is 10 in., then the scale becomes 1 in. equals 8 ft.	
2. Mark visual signposts on the sketch. – In a free corner of the sketch paper, write information about the incident—the date, time, place, nature of the incident—and names of the persons measuring and sketching the scene. – Mark the position of North on the drawing, not always at the top. Sketches are more easily understood if the point of entry to the area or room is at the bottom of the page. – Include the notation "Not to Scale" because the sketch will not be 100 percent to scale.	
3. Start with an obvious feature, perhaps the position of the injured worker, and work either clockwise or counterclockwise, or from one end to another so that nothing is overlooked. – Show the location of people, equipment, or materials involved in the incident. – Show the distribution of debris including major components and significant tracks or scars on the ground or on structures. Note liquid spills, skid marks, dust or footprints as they can change or disappear quickly. – Show critical distances and compass angles from geographic references (roads, easily recognized terrain features, and the like). Note: Most of the evidence found at the scene is on the ground. Be careful not to walk or drive over it when entering the area.	
4. Include a legend with the following minimum information: – Location (NASA Center, building, road name, or coordinates) – Name of diagrammer – Scene description (e.g., second-floor stairwell). Include weather and lighting conditions observed. – Scale used, or "Not drawn to scale." – Evidence list (e.g., 1. South handrail. 2. Cracked stair tread.)	

5. Verify necessary information is included**.** Helpful questions include these:
   - Is a debris distribution plot needed?
   - Does the debris distribution plot show location of all debris components in their post-incident position relative to the energy path just prior to the incident?
   - Are civil engineers needed to plot debris?
   - Does the debris distribution plot show a plan view and profile view?
   - Does the debris distribution plot show all marks made by vehicle/equipment in the mishap event sequence (earth gouge depth, length and width, debris pushed in front of the component, etc.)?
   - Have all components, terrain marks, obstacles, witnesses, terrain features been surveyed to give distance and azimuth from the main debris concentration?
   - Does the debris distribution plot show the primary impact area of the aircraft/vehicle or equipment (geographic location where most impact damage occurred)?
   - Does the debris distribution plot show the secondary impact(s) of the aircraft/vehicle?
   - Does the debris distribution plot show the location of eyewitnesses?
   - Have the locations of all vehicle occupants been determined and noted?
   - Have vehicle controls and settings been determined and noted?
   - Has vehicle attitude prior to impact been determined?
   - Have G forces at vehicle impact been determined?
   - Has the speed at vehicle impact been determined?
   - Has the angle of impact been determined?
   - Has the angle from obstacle to initial ground impact been determined?
   - Has the distance of travel and of structural displacement from initial impact been accurately measured?

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PHOTOGRAPHIC AND VIDEO PHYSICAL EVIDENCE

Photographic Priorities

The IRT lead should direct the activities of photographers at the mishap scene, bearing in mind that the medical member has priority for photographic support until all fatalities have been recovered or satisfactorily documented. After the medical member has no further immediate need for the photographer, the IRT lead supervises photography for all other IRT members. The following is a good, all-purpose list of photographs that should be taken as soon as possible.

Responsible Party	Photographer
Resource	Go-Kit (see Appendix B2)
Actions	
1. Photograph the overall scene, shot from at least four different locations at ground level (include positions of personnel where possible), preferably with reference markers of some type in place (advise civil engineering surveyors if specific cultural features are used to reference pictures; e.g., road signs, fences, silos, etc.). Use the maximum resolution setting available for the digital cameras in use.	
2. Obtain aerial (or at least elevated) photographs of the scene and all signs of initial impact (cuts in foliage, severed power lines, etc.).	
3. Photograph all fatalities and human remains prior to removal from found position (if not previously accomplished).	
4. For crewed aerospace vehicles, photograph life support equipment (ejection seat, parachute, survival vest/kit, oxygen mask, helmet, etc.) or PPE.	
5. Image all impact marks on the ground, trees, buildings, poles, etc.	
6. Photograph vehicle switch positions and instrument indications.	
7. Position and condition of any control surfaces, hydraulic actuators, emergency exits, panels.	
8. Significant parts of any vehicle wreckage, both at and separated from the site as appropriate. To be more useful, items should be photographed in perspective view, out of bags, with registration marks, preferably in an area with proper lighting, and background. Furthermore, at a minimum, both top and bottom views of a part should be photographed as well as other unique features. Position lighting as needed to capture hardware surface features and cracks.	
9. If video camera is available, videographer should accompany IRT Leader during initial assessment and obtain video of overall area, environmental conditions, sounds, and IRT comments. After assessment, videotape details as directed by IRT Leader.	
10. Maintain an Imagery Log (see below)	

15 – Mishap Investigation Imagery Log

Mishap Investigation Imagery Log

SHEET__ OF _____
DATE COLLECTED_ _____

IINCIDENT IDENTIFICATION

PHOTOGRAPHER
Name_____
Organization_____
Telephone _____

IMAGE #	AZIMUTH	TIME	MEDIA	SUBJECT

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NTSB Investigation No._____

Date of Accident: _____

Accident Location: _____

CERTIFICATION OF PARTY REPRESENTATIVE[1]

I acknowledge that I am participating in the above-referenced accident or incident investigation, on behalf of my employer who has been named a party to the National Transportation Safety Board (NTSB) safety investigation, for the purpose of providing technical assistance to the NTSB's evidence documentation and fact-finding activities. I understand that as a party participant, I and my organization shall be responsive to the direction of NTSB personnel and may lose party status for conduct that is prejudicial to the investigation or inconsistent with NTSB policies or instructions. No information pertaining to the accident, or in any manner relevant to the investigation, may be withheld from the NTSB by any party or party participant.

I further acknowledge that I have familiarized myself with the attached copies of the NTSB Accident/Incident Investigation Procedures (49 C.F.R. Part 831) and "Information and Guidance for Parties to NTSB Accident and Incident Investigations," and will comply, and, if the party coordinator for my party, take all reasonable steps to ensure that the employees and participants of my organization comply, with these requirements.. This includes, but is not limited to, the provisions of 49 C.F.R. §§ 831.11 and 831.13, which, respectively, specify certain criteria for participation in NTSB investigations and limitations on the dissemination of investigation information.

No party coordinator or representative may occupy a legal position or be a person who also represents claimants or insurers. I certify that my participation is not on behalf of either claimants or insurers, and that, although factual information obtained as a result of participating in the NTSB investigation may ultimately be used in litigation (at the appropriate time, and in a manner that is not inconsistent with the provisions of 49 C.F.R. § 831.13 and 49 U.S.C. § 1154), my participation is to assist the NTSB safety investigation and not for the purposes of preparing for litigation. I also certify that, after the NTSB Investigator-in-Charge (IIC) releases the parties and party participants from the restrictions on dissemination of investigative information specified in 49 C.F.R. § 831.13, neither I nor my party's organization will in any way assert in civil litigation arising out of the accident any claim of privilege for information or records received as a result of my participation in the NTSB investigation.

_____

Signature Date

_____

Name & Title

_____

Party Organization/Employer

[1] In aviation investigations this form may also be referred to as "Statement of Party Representatives to NTSB Investigation."

NTSB, August 2010

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APPENDIX D: GO-KIT / MISHAP SURGEON'S TOOL KIT

Flight surgeons assigned an Interim Response Team for a mishap investigation should bring a go-kit for any on-scene response. Table D.1-D.3 provides a list of potential go-kit inclusions. The majority of equipment to support a mishap investigation will be provided by the FBI or other organizations. Items in Table D.2 will be the responsibility of the flight surgeon supporting the investigation.

If the investigation is a remote area and/or there is the potential for prolonged deployment, consideration should be given to the inclusion of remote operational gear such as:

- Potable water or filtration systems
- Toilet paper
- Clothing for inclement weather and conditions
- Additional sunscreen
- Nutrition bars
- Non-scented toiletries
- Quick-dry towel
- Phone charger
- Pen and paper

Table D.1. Basic contents of Go-Kit

Items to Include in Go-Kit	Quantity
Audio Recorder	2
Spare batteries for recorder	12-hr operation time
Bag with supply of clean clothes, personal medications, prescription drugs, extra contacts and/or glasses, and toiletries	1 / investigator
Boots: Work boots (ANSI Z41 steel toe and shank recommended)	1 / investigator
Case for Go-kit contents	1
Computer thumb drive 1 gigabyte, USB connector (approved and secure)	1
Ear plugs (for investigations near airfields)	1 set / investigator
First Aid Kit / Medical bag	1
Flashlight with belt clips or forehead bands and extra bulbs and batteries	1 / investigator
Flashlight batteries	1 set / investigator
Gloves: Leather work gloves	1 / investigator
Gloves: Nitrile disposable gloves	10 / investigator
Gloves: Rubber gloves (kitchen style is fine)	2 sets
Goggles / safety glasses for both impact and chemical	1 / investigator
Hand cleaner / sanitizer	1 gal
Hat for sun or cold protection	1 / investigator
Index cards	10 package
Insect repellent (stick better than spray)	1 / investigator
Markers: Permanent magic markers (fine point)	10
Mask (paper disposable masks to filter smells and dust) – do they need to be N95 or similar	20
Notebook: Small memorandum notebook (preferably graph paper style)	10
Pens and pencils (lead and grease)	10 sets
Phone: Cell phone	1 / investigator
Phone charger: Car	1 / investigator
Phone charger: Wall	1-2 / investigator
Plan: Copy of Mishap Preparedness and Contingency Plan (consider electronic)	1
Plastic bags: Sealable plastic bags (assorted sizes)	10
Rain Gear: Disposable poncho or coat	1 / investigator
Sun block: Sun Protection Factor (SPF) 40+	1 / investigator
Sunglasses (recommend impact-resistant ANSI Z87)	1 / investigator
Tool: Multipurpose hand tool (Leatherman, Gerber, Buck tool)	1

Towels: Disinfecting wipes	1 package
Water bottle (personal)	1 / investigator
Waterproof matches	2 boxes

Medical kit contents should reflect the skill set and comfort of the provider, geographical considerations (i.e. access to local medical resources and pharmacies), and types of exposures or the potential for injury at a given site. For example, rough terrain may prompt the inclusion of more musculoskeletal stabilization supplies, and remote operations far from populated areas may prompt the inclusion of increased quantities of over-the-counter (OTC) medications. A basic first aid kit should always be part of the Go Kit. Table #.2 list items that should be included.

Table D.2. Basic contents of the First Aid Kit

Medical Kit – items to consider
Bandaids (size assortment)
Gauze (size assortment, basic gauze, ABD pads, etc.)
Bandage wraps
Hemostatic dressings (QuickClot, Celox)
Ace Wraps (size assortment)
Wound tape
Paper tape
Heavy-duty tape / occlusive tape
Tourniquet
Pocket mask
Needles (+/- catheter, various sizes)
OTC medications (famotidine, diphenhydramine, pseudoephedrine, acetaminophen, ibuprofen, liquid tears, Pepto-Bismol, loratadine, diphenoxylate/atropine (Lomotil), topical antibiotic ointment, topical steroid cream/ointment, aspirin)
EpiPen / epinephrine
Antiemetics (ondansetron, promethazine, scopolamine, Dramamine)
Prednisone / dexamethasone
Ocular Tetracaine
Albuterol metered dose inhaler (MDI)
Tweezers / splinter removal kit
Forceps / small scissors
Wound / eye irrigation supplies
SAM Splint
Cold Packs

Warm packs / hand warmers
Sports tape
Personal protective equipment (gloves, mask, goggles)
Sunscreen
Aloe vera
Insect repellent
Contact lens supplies
Cotton Swabs
Cotton balls
Eye patch (hard shell)
Rubbing alcohol / alcohol wipes

In addition, the MIT and support operations may supply further items for investigator use (See Table D.3). If these items are specifically needed, the investigator should confirm their availability or plan to pack them. Investigators should be familiar with the use of the items below.

Table D.3. Items supplied the MIT.

Items to be supplied by MIT
Audio Recorder
Spare batteries for recorder
Binoculars: Water resistant binoculars with laser range finder, 8x
Biohazard bags w/document pouch, 8- by 10-inch
Bottles: Fluid sample bottles; for oil, hydraulic fluid or fuel, should be 2- to 4-oz Nalgene or plastic bottles with labels
Brushes: Small nylon brushes (stiff and soft bristled)
Brushes: Small wire brushes
Calipers
Chalk
Clipboard
Compass: Lensatic compass (w/azimuth finder)
Cord: 300-lb test braided paraline
Cord: Extension cord, 100 foot- triple tap, 12/3 American Wire Gauge (AWG), for outdoors
Floor Wax: If burned composites are present, liquid floor wax as fixative (cut 10:1 with water); tank sprayer to apply diluted fixative
Global Positioning System (GPS): Handheld WAAS-enabled with 100-foot or better accuracy, barometric altimeter, and compass heading display

GPS batteries
GPS car charger
Hat: Hard hat with white reflective tape on all sides
Labels: Self-adhesive, white and colored
Light sticks, 12-hr duration each, yellow
Lubricant: Spray lube
Magnet (small pocket type)
Magnifier: Pocket magnifier, 3X-6X diopters
Maps (grid, country, aviation, road); largest scale is best (1:25,000 or lower)
Marker: White board
Marker: Paint marker pen set (minimum white, black, red, yellow, green)
Markers: Permanent magic markers (fine point)
Mask (paper disposable masks to filter smells and dust)
Measuring tape (100 feet); steel preferred
Meter: Digital, handheld weather meter—wind speed, temperature, humidity, dew point, heat index/wind chill
Mirror: Inspection mirror (small – like dentist)
Notebook: 3-ring binder to hold forms and plan
Paint: Neon spray paint
Paper - 8 ½ by 11 (polar and grid) paper
Pens and pencils (lead and grease)
Phone: Satellite (Required. Many locations do not have cell coverage.)
Plan: Copy of Mishap Preparedness and Contingency Plan (consider electronic)
Plastic bags: Sealable plastic bags (assorted sizes)
Plastic sheets: Sterile 5- by 10-ft opaque
Plotter (serves as a ruler, protractor, and inclinometer)
Postage-paid return envelopes (for public eyewitness)
Rope: Light rope or heavy cord, marked at 50-ft intervals
Ruler: 1-foot steel ruler with large index
Ruler: Clear plastic ruler (marked mm and inches)
Scale model of vehicle or hardware
Sign: Biohazard
Sign: Blank
Stakes: Red flagged (surveyor's) wire stakes
String and plumb bob (turns plotter into an inclinometer)

Suit: Biohazard protective suits
Suit: Tyvek suit, hood, booties
Tags: DO NOT OPERATE
Tags: Parts tags (with string or wire)
Tape: Barrier tape, red, “DANGER”
Tape: Barrier tape, yellow, “CAUTION”
Tape: Biohazard
Tape: Duct Tape (100 feet roll)
Tape: Warning flag tape (1000-ft roll)
Ties: Cable ties, 14 in.
Tool: Hatchet, 12 in.
Tool: Saw, small wood saw
Tool: Saw, hacksaw with spare blades
Tool: Shovel, hand
Tool: Shovel, large
Tool: Socket set (SAE); Phillips, Allen, flat tips, ¼-inch sockets
Tool: Vice grip pliers; Locking vice grip pliers; 5-inch curved jaw with wire cutters
Tool: Vice grips; Locking vice grip pliers; 7-inch curved jaw with wire cutters
Tool: Vice grips; Locking vice grip pliers; 9-inch long nose jaw
Tool: Wrench, 8-inch crescent wrench
Tool: Knife, single-edge, one-piece 4- to 6-inch blade survival knife
Tool: Chisel, ¾-inch tempered chisel, with safety hand guard
Tool: Circuit alert tester, 50 to 600 volts
Tool: Crowbar
Tool: Hammer, 7-pound sledge
Tool: Hammer, straight peen
Tool: Wire cutters, 6-inch diagonal
Towels: Disinfecting wipes
Towels: Paper towels
Toxicology mailing kit (tox box with proper mailing label)
Tweezers: 6-inch stainless steel tweezers

Water jug (sport team size to refill smaller jugs)
Water jug (100 oz)
White board
Windsock (portable)

APPENDIX E: CONTACT LIST

There are many organizations within NASA and its field centers, and each has a role in mishap investigations as outlined in Agency or center-specific documentation. In addition, there are a number of other organizations that play a role. These include the Federal Bureau of Investigation (FBI), the National Transportation Safety Board (NTSB), the Federal Aviation Administration (FAA), USAF Medical Examiner, the USAD DET3, the Department of State, the Commercial Crew Program (CCP) and the International Partners (IPs). In the event of a mishap at the launch complex at KSC, agreements are in place for local emergency medical services, a temporary mortuary, and command and control.

- Lead Physician Onsite (NASA or Contractor Physician)
- Chief Health and Medical Officer, OCHMO, NASA Headquarters
- Deputy Chief Health and Medical Officer, OCHMO, NASA Headquarters
- JSC Chief Medical Officer
- JSC Deputy Chief Medical Officer
- Landing Site Center Medical Officer (if required, depending on site)
- JSC SA Director
- JSC SA Deputy Director
- JSC/SD Division Chief
- JSC/SD Deputy Division Chief
- JSC/SD3 Medical Operations Branch Chief
- JSC SD Mission Manager
- Crew Surgeon and Deputy Crew Surgeon Assigned
- International Partner Surgeon (if applicable)
- Commercial Partner Surgeon (if applicable)
- IRT Assigned Flight Surgeon
- Contingency POCs
- Local Emergency Contact Info
- Local Medical Centers
- USAF Medical Examiner
  - Dover Air Force Base

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