Approved: 2023-07-31

Measurement System Identification:

NASA TECHNICAL HANDBOOK National Aeronautics and Space Administration	NASA-HDBK-8709.25 **Approved: 2023-07-31** **Superseding NASA-HDBK-8709.25 V1.3**

Human Factors Handbook V1.4
Procedural Guidance and Tools

This official draft has not been approved and is subject to modification.
DO NOT USE PRIOR TO APPROVAL.

DOCUMENT HISTORY LOG

Status	Document Revision	Approval Date	Description
Change	4	2023-07-31	Language has been neutralized so it can be used for both negative factors (Red-Light) and positive factors (Green-Light). Updated Agency nanocodes for FY2022. Other editorial changes.

FOREWORD

This NASA technical standard provides uniform engineering and technical requirements for processes, procedures, practices, and methods that have been endorsed as standard for NASA facilities, programs, and projects, including requirements for selection, application, and design criteria of an item.

[The importance and expected impact of the standard and why it was developed.]

This standard establishes… [Who (roles or organizations) were involved in its development]Requests for information, corrections, or additions to this standard should be submitted to the NASA Office of Safety and Mission Assurance by email to Agency-SMA-Policy-Feedback@mail.nasa.gov or via the “Email Feedback” link at https://standards.nasa.gov.

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1. SCOPE

1.1 Purpose

This NASA Handbook defines the NASA Human Factors Analysis and Classifications System (NASAHFACS) tool and provides guidance on the use of NASAHFACS. It illustrates the NASAHFACS model; describes the data gathering, coding, trending, and tracking process; and outlines training and other related resources to support the practice of NASAHFACS throughout NASA.

1.2 Applicability

1.2.1 This NASA Technical Handbook is applicable to NASA Headquarters and NASA Centers, including Component Facilities and Technical and Service Support Centers. It may also apply to the Jet Propulsion Laboratory (a Federally Funded Research and Development Center), other contractors, recipients of grants, cooperative agreements, or other agreements only to the extent specified or referenced in the applicable contracts, grants, or agreements.

1.2.2 This NASA Technical Handbook, or portions thereof, may be referenced in contract, program, and other Agency documents for guidance.

1.2.3 The guidance in this NASA Technical Handbook does not supersede or waive existing guidance found in other Agency documentation. Conflicts between this NASA Technical Handbook and other documents will be resolved by the delegated Technical Authority.

1.2.4 In this NASA Technical Handbook, the terms “may” denotes a discretionary privilege or permission, “can” denotes statements of possibility or capability, “should” denotes a good practice and is recommended but not required, “will” denotes expected outcome, and “are/is” denotes descriptive material.

2. REFERENCE DOCUMENTS

2.1 General

2.1.1 The documents listed in this section provide references supporting the guidance in this NASA Technical Handbook.

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

2.1.3 Reference documents may be accessed at https://standards.nasa.gov or obtained directly from the Standards Developing Body, other document distributors, or the Office of Primary Responsibility for this NASA Technical Handbook.

2.2 Government Documents

2.2.1 NASA

NPD 1000.0	NASA Governance and Strategic Management Handbook
NPD 8700.1	NASA Policy for Safety and Mission Success
NPR 7120.5	NASA Space Flight Program and Project Management Requirements
NPR 7900.3	Aircraft Operations Management
NPR 8621.1	NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping
NPR 8705.6	Safety and Mission Assurance (SMA) Audits, Reviews, and Assessments
NPR 8715.1	NASA Occupational Safety and Health Programs
NASA-HDBK-8709.22	Safety and Mission Assurance Acronyms, Abbreviations, and Definitions

2.2.2 Non-NASA

DOD HFACS 8.0	Guidance and Training
DOE-HDBK-1208-2012	Volume II, Accident and Operational Safety Analysis

2.3 Non-Government Documents

Safety Human Incident & Error Learning Database (SHIELD)

2.4 Order of Precedence

2.4.1 The guidance established in this NASA Technical Handbook do not supersede or waive existing guidance found in other Agency documentation.

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

3. ACRONYMS, ABBREVIATIONS, SYMBOLS AND DEFINITIONS (AS APPLICABLE)

3.1 Acronyms and Abbreviations

HFTF	Human Factors Task Force
MIB	Mishap Investigation Board
NASAHFACS	National Aeronautics and Space Administration Human Factors Analysis and Classification System
NMIS	NASA Mishap Information System
SATERN	System for Administration, Training, and Educational Resources for NASA
STRIVES	Scientific, Technical and Research Information discoVEry System

3.2 Definitions

Human Factors. a. A body of scientific facts about human characteristics, capabilities, and behavior. The term includes, but is not limited to, principles and applications in the areas of human engineering, personnel selection, training, life support, job performance aids, and human performance evaluation.

b. A body of information about human abilities, human limitations, and other human characteristics from a physical and psychological perspective relevant to the design,operations, and maintenance of complex systems*)*

Human Factors Analysis. The study of how people interact with their environment. Physiological, psychological, and organizational behaviors are evaluated. Human factors analysis is an important component of mishap investigation. Determining why, how, and where human behaviors contributed to mishaps and close calls is key to preventing future mishaps.

Human Factors Investigator. An investigator with expertise in human factors and mishap causation who has primary responsibility to assist in data collection and analysis; determine the manner in which human factors caused or contributed to the mishap or close call; evaluate relevant human error and determine its root causes; and generate recommendations to eliminate or reduce error occurrence or minimize the error's negative effects to prevent the occurrence of a similar mishap.

Mishap Investigation Board. A NASA-sponsored board tasked to investigate the mishap or close call and to generate the mishap investigation report in accordance with the requirements specified in this NPR.

4. TRAINING AND TOOLS

4.1 Training Courses

4.1.1 The following one-time training courses are required for all Human Factors Task Force (HFTF) members and recommended for any individual tasked with participating/performing mishap investigations.

4.1.2 NASAHFACS Overview Course: (COURSE SMA-HQ-WBT-227)

This course is a 1-hour overview course that presents an overarching look at Human Factors and the NASAHFACS method. It explains the methodology, concepts, and terms. The course is designed for;

- Executive-level personnel that wish to learn more about the NASAHFACS Program
- The general NASA audience who wants an introduction of NASAHFACS
- HFACS certified personnel who need a refresher or learn about updates to the Program
- A pre-requisite to NASA personnel that want to attend the in-person NASAHFACS Certification (SMA-SAFE-OSMA-4009).

4.1.3 NASAHFACS Certification: (SMA-SAFE-OSMA-4009)

Once a year, a NASA Center will host the NASAHFACS Certification in-person. The instructor led course covers the concepts and information necessary to perform Human Factors analyses and addresses how to code Human Factors and mishaps, how to contribute to the Agency database, and how to use HFACS proactively. Activities consist of case studies and group exercises. Students need to achieve a minimum of 70% to pass the final exam. Renewal of certification is required every five years through the one-hour NASAHFACS Overview (COURSE SMA-HQ-WBT-227) System for Administration, Training, and Educational Resources for NASA (SATERN) course.

Students will receive a copy of the NASA Office of Safety and Mission Assurance Human Factors Handbook along with the Quick Reference Guide, The Human Factors Investigators Checklist, and NASAHFACS Certification of Completion.

Suggested Courses and Readings prior to attendance:

Introduction to Human Factors in Mishap and Close Call Investigation (SMA-001-07). This course is a pre-requisite for the classroom course Human Factors in Mishap and Close Call

Investigation (SMA-SAFE-OSMA-4004). The content provides additional detail to introductory concepts and allows students the opportunity to practice. Students learn about factors that affect human performance, how those factors can cause or contribute to the occurrence of incidents, and how to apply the acquired Human Factors knowledge and skills to relevant investigation activities. Topics covered include internal and external performance-shaping factors; the relationship of performance shaping factors to human events; human error, human conditions; and the different types of human events, errors, and conditions. Also covered is the identification, evaluation, and selection of appropriate barriers, controls, and amelioration methods as they relate to Human Factors.

NASA Human Factors in Mishap Investigation (SMA-002-15). This course provides students with basic concepts and information necessary to perform Human Factors analyses in mishap and close call investigations. (SMA-002-15) is an equivalent version of the instructor-led course Human Factors in Mishap Investigation (SMA-SAFE-OSMA-4004), and an expansion of the Web-based course

Human Factors in Mishap Investigation (SMA-SAFE-OSMA-4004). This course provides students with basic concepts and information necessary to perform Human Factors analyses in mishap and close call investigations. It is an expansion of the Web-based Human Factors in Mishap Investigation course (a prerequisite to this course), by providing additional detail to the introductory concepts, and focusing on ensuring students have many opportunities to practice. This is an activity-based course in which students learn about factors that affect human performance, how those factors can cause or contribute to the occurrence of incidents, and how to apply the acquired Human Factors knowledge and skills to relevant investigation activities. Topics covered include internal and external performance-shaping factors; how those relate to human events; human error; human conditions; and the different types of human events, errors, and conditions. Identification, evaluation, and selection of appropriate barriers, controls, and amelioration methods are also covered.

Jens Rasmussen (SRK) (1986)

- Skill-Based Errors
- Rule-Based Errors
- Knowledge-Based Errors

James Reason

- “Human Error” (1990)
- “Managing the Risks of Organizational Accidents” (1997)
- “The Human Contribution” (2008)

Nancy Leveson, Systems-Theoretic Accident Model and Processes (STAMP) (1998)

- Identifies Human Factors in a system and their relationships to one another

Erik Hollnagel (2004)

- Resilience
- Over 350 publications
- Safety II

4.2 Tools

4.2.1 The Quick Reference Guide (QRF) provides practitioners a comprehensive structure of NASAHFACS, including the tiers, categories, sub-categories, and nanocodes. Additionally, the QRF provides high-level category definitions for each of the 19 categories. The Human Factors Investigator Checklist aids mishap investigators in assessing both the positive and negative factors associated with an event. Each category provides areas for “Green-Lights” and “Red-Lights”, as well as definitions for each category within the tiers.

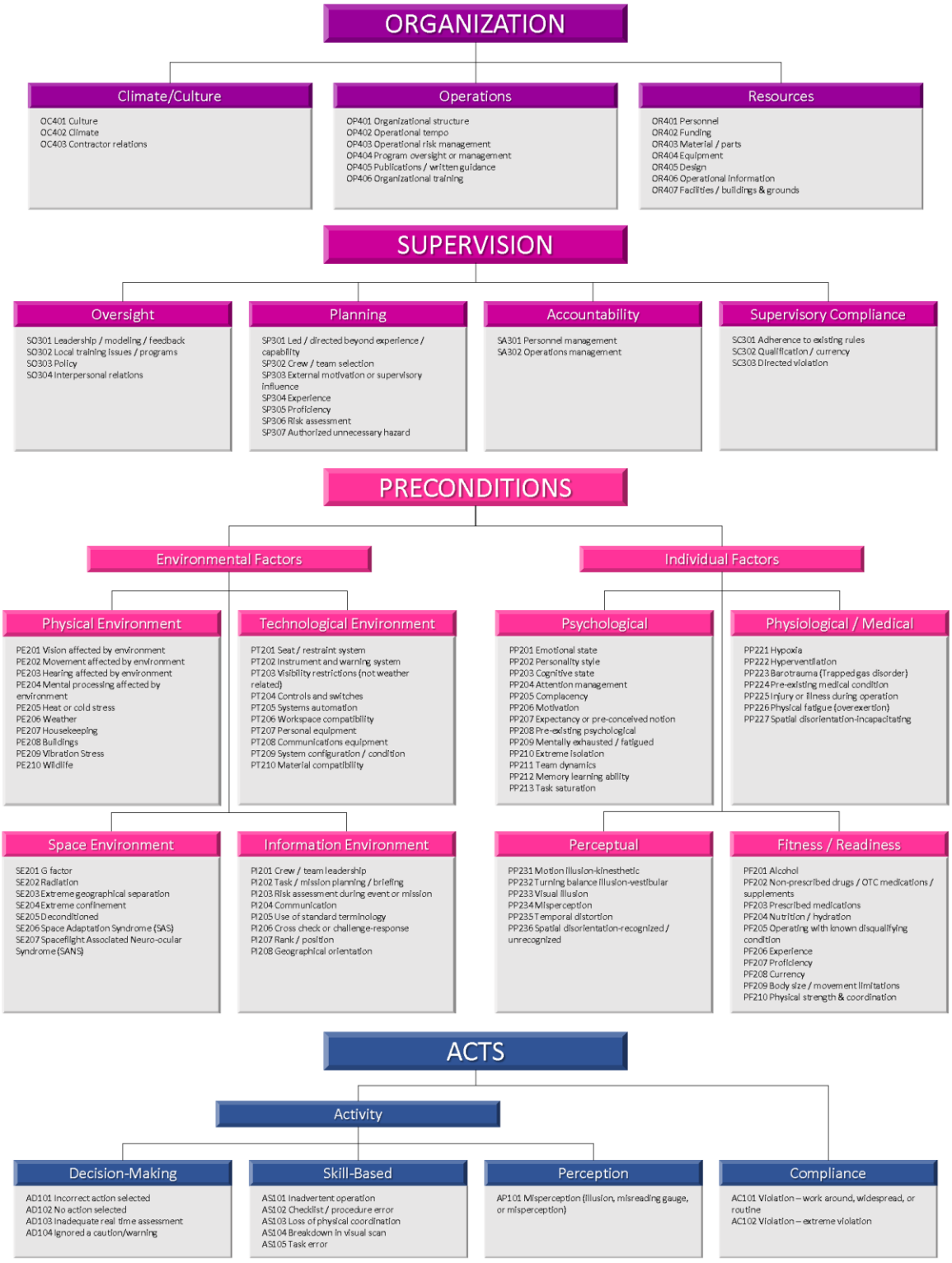

Figure 1: Version 1.4 Quick Reference Guide

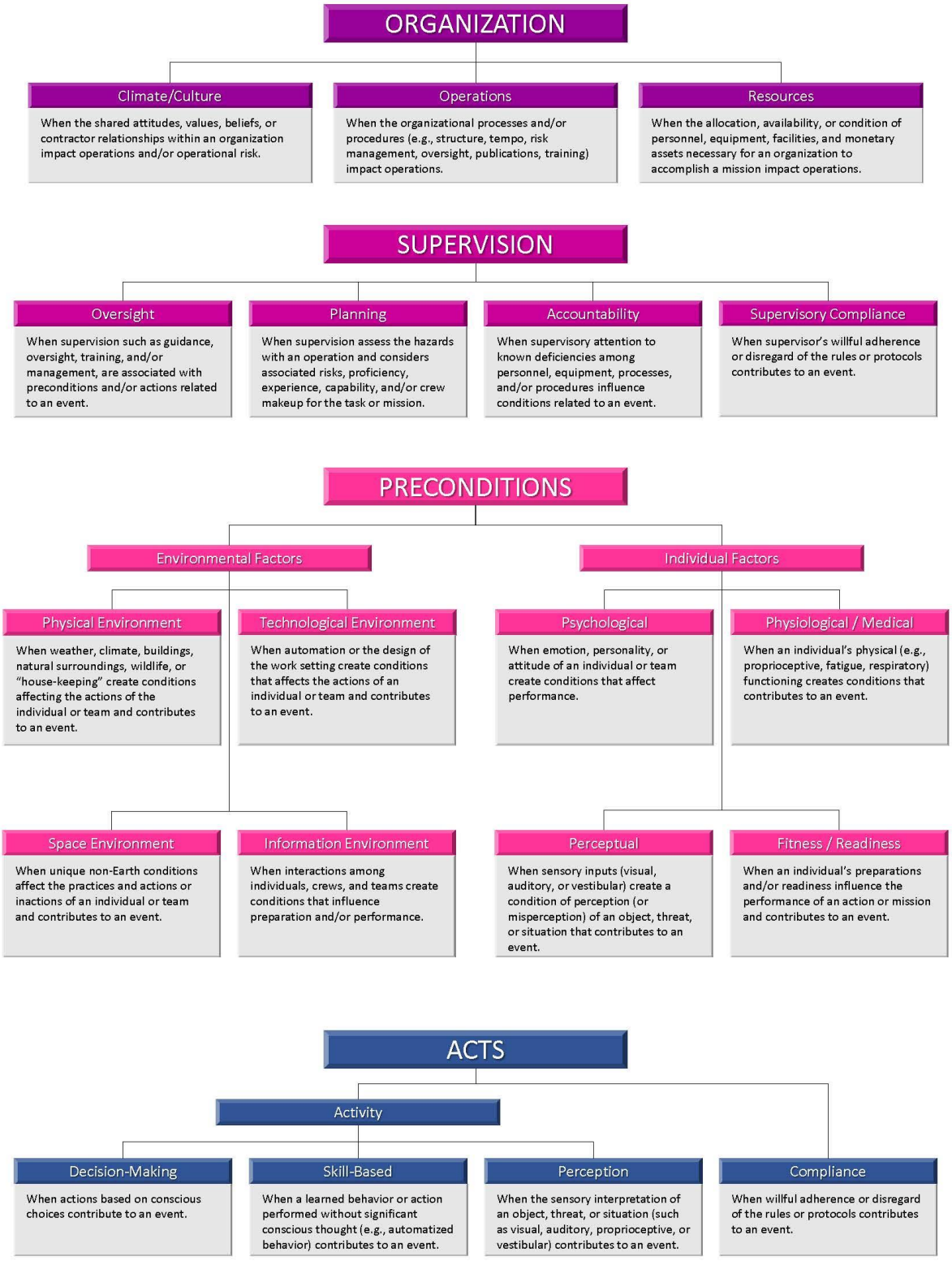

Figure2: Version 1.4 Quick Reference Guide Definitions

Human Factors Investigators Checklist

EVENT:

NAME OF INVESTIGATOR(S):

EVENT DESCRIPTION:

RED-LIGHT FACTORS	ACTS (check all that apply)	GREEN-LIGHT FACTORS
☐	**DECISION-MAKING:** When conscious choices are acted upon and are associated with an event.	☐
☐	**SKILL-BASED:** When a learned behavior or action performed without significant conscious thought (e.g., automatized behavior) is associated with an event.	☐
☐	**PERCEPTION:** When the sensory interpretation of an object, threat, or situation (such as visual, auditory, proprioceptive, or vestibular) is associated with an event.	☐
☐	**COMPLIANCE:** When willful adherence or disregard of the rules or protocol contributes to an event. Compliance or non-compliance is intentional.	☐

RED-LIGHT FACTORS	PRECONDITION (check all that apply)	GREEN-LIGHT FACTORS
☐	**PHYSICAL ENVIRONMENT:** When weather, climate, buildings, natural surroundings, wildlife, or "house-keeping" create conditions affecting the actions of the individual.	☐
☐	**TECHNOLOGICAL ENVIRONMENT:** When automation or the design of the work setting create conditions affecting the actions of an individual or team and contributes to an event.	☐
☐	**SPACE ENVIRONMENT:** When unique non-Earth conditions affect the practices and actions or inactions of an individual or team.	☐
☐	**INFORMATION ENVIRONMENT:** When the interactions among individuals, crews, and teams create conditions that influence the preparation and / or performance of a mission.	☐
☐	**FITNESS / READINESS:** When an individual's preparation and / or readiness influence the performance of an action or mission and contributes to an event.	☐
☐	**PSYCHOLOGICAL:** When emotion, personality, or attitude of an individual or team experiences create conditions that affect performance.	☐
☐	**PHYSIOLOGICAL:** When an individual's physical state (e.g., proprioceptive, fatigue, respiratory) functioning creates conditions that impact an event.	☐
☐	**PERCEPTUAL:** When sensory inputs (visual, auditory, or vestibular) create a condition of perception (or misperception) of an object, threat, or situation.	☐
RED-LIGHT FACTORS	**SUPERVISION (check all that apply)**	**GREEN-LIGHT FACTORS**
☐	**OVERSIGHT:** When supervision such as guidance, oversight, training, and / or management, are associated with preconditions and/or actions related to an event.	☐
☐	**PLANNING:** When supervision assess the hazards of an operation and considers associated risks, proficiency, experience, capability, and / or crew flight makeup for the task or mission.	☐
☐	**ACCOUNTABILITY:** When supervisory attention to known deficiencies among personnel, equipment, processes, and / or procedures influence conditions related to an event.	☐
☐	**SUPERVISORY COMPLIANCE:** When supervisor's willful adherence or disregard of the rules or protocol is associated with an event.	☐
RED-LIGHT FACTORS	**ORGANIZATION (check all that apply)**	**GREEN-LIGHT FACTORS**
☐	**CLIMATE / CULTURE:** When the attitudes, values, beliefs, or morale impact operations and / or operational risk.	☐
☐	**OPERATIONS:** When the organizational processes and / or procedures (e.g., structure, tempo, risk management, oversight, publications, training) impact operations.	☐
☐	**RESOURCES:** When the allocation, availability, or condition of personnel, equipment, facilities, and monetary assets necessary for an organization to accomplish a mission impact operations.	☐

Figure 3: Neutralized HFACS Investigators Checklist

5. EVENT CODE

5.1 How to Code

Several investigative tools exist. Investigators can use this NASA Handbook along with the Quick Reference Guide (QRG) during the analysis. Another tool is the Human Factors Investigators Checklist. Prior to implementation, check the OSMA Human Factors Web page (sma.nasa.gov/sma-disciplines/human-factors) to ensure this is the latest version of the NASA Handbook, the Investigators Checklist, and the QRG. In addition to investigative tools, a list of Center Points of Contact (POCs) is maintained at this Web page. These POCs are trained in NASAHFACS and may assist in performing the analysis, utilizing the NASA Mishap Information System (NMIS), or Human Factors report writing. Enter Human Factors data into NMIS using the NMIS Human Factors module. Events and coding from NMIS are included in the Agency's Annual Human Factors Report. For Type A, Type B, or high-visibility events, a NASAHFACS analysis will be performed by the Human Factors member. If the area of investigation expertise cannot be obtained within NASA, the investigating authorities' members may be appointed from another Agency.

NPR 8621.1, Mishap and Close Call Reporting, Investigating, and Recordkeeping, requires a Human Factors analysis for Type A, B, and high-visibility events. Additionally, NPR 7900.3, Aircraft Operations Management, requires a Human Factors analysis for all aviation Type A, B, C, D, and high-visibility close call events.

5.2 NASA Mishap Investigation System

If you don't already have a NMIS account, contact your Center Mishap Program Manager to gain NMIS access. This allows your entry of event data and analysis to the event. After you join the HFTF and complete certification or are assigned to a Mishap Investigation Board (MIB), initiate a NASA Access Management System request for access to the Human Factors Analyst role. This opens the permissions to code and provide justifications for findings within the event reported in NMIS. NMIS can then produce a report for the identified Human Factors findings. When serving on a MIB, it is helpful to review the latest version of NPR 8621.1 for required SATERN training for Mishap Investigations.

5.3 Human Factors Investigators Checklist

Those without access to the NMIS Human Factors Analyst role may use the Human Factors Investigators Checklist. The Checklist is available on the OSMA Human Factors Web page (sma.nasa.gov/sma-disciplines/human-factors) in the outreach section. The Checklist records factors identified in each Tier, Category, and Nano-Code for tracking and trending purposes. Each block of the Checklist (except NMIS Event Number and Investigator's Name) has a 4,000-character capacity and, when printed, allows for complete reading of the block. This Portable Document Format file may be uploaded as an attachment to the NMIS Event analysis. This

Checklist contains an Executive Summary section to provide context to the Human Factors findings.

5.4 Primary Review

Conduct interviews or review witness statements, Policy and Procedure documents, appropriate checklists, training records, and any other related material associated with the event. Provide appropriate security and confidentiality methods as directed by other NASA requirements. Perform coding of each event by use of this NASA Handbook and the QRG. Record findings on the Human Factors Investigators Checklist to capture results. Provide analysis with an executive summary incorporating all findings. Provide analysis and Human Factors Investigators Checklist to Mishap Board Lead or Center Mishap Program Manager for records keeping. Retain analysis and Checklists as directed by local Center retention guidelines. Utilize the electronic version of this Checklist and upload as an attachment to the NMIS event to include findings in NMIS as part of the record if access to Human Factors module as an analyst is not available.

5.5 Secondary Review

Gather all associated documents (including the written or electronic report, Corrective Action Plan, checklists, etc.) of the incident being analyzed. Review witness statements, Policy and Procedure documents, appropriate checklists or training records, and any other relevant related material associated with event. Provide appropriate security and confidentiality methods as directed by other NASA requirements. Perform coding of the event by use of this NASA Handbook and the QRG. Record findings on the Human Factors Investigators Checklist to capture results. Provide analysis with an executive summary incorporating all findings. Provide analysis and Human Factors Investigators Checklist to Mishap Board Lead or Center Mishap Program Manager for records keeping. Retain analysis and checklists as directed by local Center retention guidelines. Utilize the electronic version of this Checklist and upload as an attachment to the NMIS event to include findings in NMIS as part of the record if access to Human Factors module as an analyst is not available.\

6. ANALYSIS CHARTS FOR TRACKING AND TRENDING

6.1 Tracking and Trending

After coding, transfer the data collected / list generated from the Checklist into a simple bar chart. See the example in Figure 6. This chart provides a graphic record of the factors identified and along with the Checklist Executive Summary, provides a visual context to the factors. Color coding of the chart to match the QRG is beneficial. This chart may be used to report all events within a code, Center, or project / program, or an individual NMIS Event.

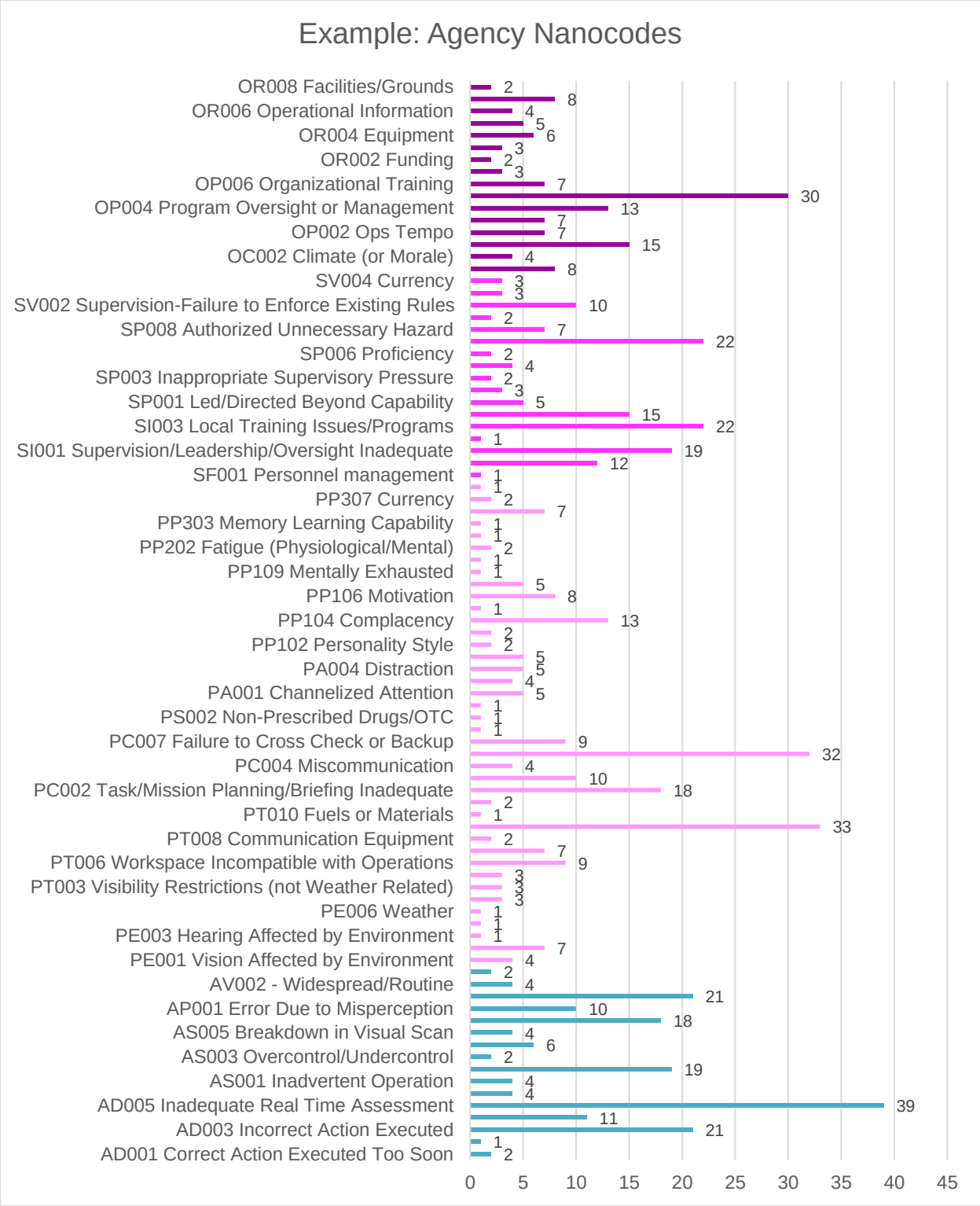

Figure 4: Nanocode Chart

6.2 Reports/Briefs

Remain mindful of Agency and local policy or procedural documents concerning Mishap Investigations, confidentiality, International Traffic in Arms Regulations, etc. Prepare briefs and / or slides, as appropriate, to the target audience. Ensure sanitary efforts to prevent the exposure of Personally Identifiable Information, or other sensitive data to persons or entities outside of NASA.

6.3 The NASA Scientific and Technical Information Program

The NASA Scientific and Technical Information (STI) Program is a critical component in the worldwide activity of scientific and technical aerospace research and development. The NASA STI Program acquires, processes, archives, announces, and disseminates NASA STI and acquires worldwide STI of critical importance to NASA and the Nation.

Collected from U.S. and international sources, STI is organized according to content prior to being added to the **NASA STI Repository** . The STI Repository is a world-class collection of STI that includes over 4.3 million metadata records and over 500,000 full-text documents.

The NASA STI Program uses the Scientific, Technical and Research Information discoVEry System (STRIVES) to standardize STI submission, review, and approval across all 10 NASA field Centers.

STI Program Mission

- Supports the advancement of aerospace knowledge
- Contributes to U.S. competitiveness in aerospace research and development (R&D) by helping to show the value of R&D funding and accomplishment
- Implement STI policy and align procedures with U.S. laws and NASA organizational requirements
- Collects STI from all NASA Centers

What is STI?

STI (scientific and technical information) is defined as a paper, abstract, journal article, presentation, etc. that contains and delivers the results (the analyses of the data, facts, and resulting conclusions) of basic and applied scientific, technical, and related engineering research and development.

All Human Factors Annual Reports are in the STRIVES system for archival use.

7. TAXONOMY

7.1 Acts

These influences or factors describe behavioral omissions and commissions committed by an individual or team and contribute to an event.

7.1.1 Decision-Making Events

When actions based on conscious choices contribute to an event.

- **AD101 Incorrect action selection.** A factor when an individual mis-prioritizes and executes the wrong course of action to accomplish a task and this contributes to an event.
- **AD102 No action selection.** A factor when an individual does not take the necessary action as dictated by the situation and this contributes to an event.
- **AD103 Inadequate real time assessment.** A factor when an individual fails to adequately evaluate the risks associated with a course of action, and this contributes to an event.
- **AD104 Ignored a caution / warning.** A factor when a caution or warning is perceived and understood but is ignored and this contributes to an event.

7.1.2 Skill-Based Events

When a learned behavior or action performed without significant conscious thought (e.g., automatized behavior) contributes to an event.

- **AS101 Inadvertent operation**. A factor when movements inadvertently activate or deactivate equipment, controls, or switches without intent to operate the equipment, controls, or switches and this contributes to an event. This action may or may not be noticed.
- **AS102 Checklist / procedural error.** A factor when an individual or team accomplishes the wrong written procedure / checklist or fails to accomplish the correct written procedure / checklist or any portion of the written procedure / checklist and this contributes to an event.
- **AS103 Loss of physical coordination.** A factor when a temporary failure of physical coordination, such as losing grip during a task or procedure, contributes to an event.
- **AS104 Breakdown in visual scan.** A factor when a failure to effectively execute learned / practiced internal or external visual scan patterns contributes to an event.

- **AS105 Task error**. A factor when an individual or team accomplishes a task or function in the wrong sequence or by using the wrong technique, tool, equipment, control (overcontrol or undercontrol), or switch and this contributes to an event. This includes inadequate Anti-G Straining Maneuver (AGSM), which is a factor when the individuals AGSM is improper, inadequate, poorly timed, or non-existent and this leads to adverse neuro-circulatory effects. This includes correct action execution, a factor when an individual selects the actions as dictated by the situation but performs these prematurely or belatedly.

7.1.3 Perception Events

When the sensory interpretation of an object, threat, or situation (such as visual, auditory, proprioceptive, or vestibular) contributes to an event.

- **AP101 Error due to misperception (illusion, misreading gauge, or misinterpretation).** When an individual acts or fails to act based on an illusion, misinterpretation of appropriate information, misperception of the environment, or a disorientation state and this contributes to an event.

7.1.4 Compliance

When willful adherence or disregard of the rules or protocol contributes to an event. Compliance or non-compliance is intentional.

- **AC101 Violation – work around, widespread, or routine.** A factor when the individual, crew, or team recognized the consequences / risk of violating published procedures and consciously assessed and honestly determined the best course of action. Habitual violations of a single individual or small group of individuals within a unit can constitute a routine / widespread violation if the supervisors did not routinely discipline the violators or condoned the actions. This is known as “Normalization of Deviance.”

- **AC102 Violation – extreme violation.** A factor when an individual, crew, or team intentionally violates procedures or policies without cause or need. These violations are unusual or isolated to specific individuals rather than larger groups. There is no evidence of leadership condoning these violations or lack of discipline. These violations may also be referred to as “exceptional violations” and violate accepted / taught professional expectations.

7.2 Preconditions

When environmental factors or conditions of individuals affect performance.

7.2.1 Environmental Factors

When physical, technological, spatial, or informational factors affect the practices, conditions, and actions or inactions of an individual or team.

7.2.1.1 Physical Environment

When weather, climate, buildings, natural surroundings, or “house-keeping” create conditions affecting the actions of an individual or team and contributes to an event.

- **PE201 Vision affected by environment.** A factor when environmental conditions affect an individual’s vision, and this contributes to an event. Example: Vision could be impacted by lighting, smoke, haze, weather, dust, laser, snow, brownout, etc.

- **PE202 Movement affected by environment.** A factor when environmental conditions affect an individual’s movement, and this contributes to an event. Example: Movement can be impacted by maneuvering forces, vibration, windblast, animals, icy ground, uneven ground, roadway, terrain, etc.

- **PE203 Hearing affected by environment.** A factor when environmental conditions affect an individual’s ability to hear, and this contributes to an event. Example: Hearing can be impacted by any type of noise, vibration, windblast, etc.

- **PE204 Mental processing affected by environment.** A factor when environmental conditions affect an individual’s ability to mentally process or think about information and this condition contributes to an event. Example: Mental processing can be impacted by any type of noise, vibration, temperature, etc.

- **PE205 Heat or cold stress.** A factor when an individual’s exposure to heat or cold impacts the individual’s performance capabilities and contributes to an event.

- **PE206 Weather.** A factor when weather conditions such as high winds, lighting / storms within pre-declared restrictive limits, or high / low temperatures contributes to an event.

- **PE207 Housekeeping.** A factor when upkeep or organization of workspaces, equipment, and materials contributes to an event.

- **PE208 Buildings.** A factor when the condition, capability, or maintenance of building contributes to an event.

- **PE209 Vibration Stress.** A factor when an individual’s exposure to vibration impacts physical or cognitive performance and contributes to an event. Examples: Excessive exposure to blast, repeated exposure to equipment frequency (i.e., helicopters).

- **PE210 Wildlife.** When animals or other non-human life contributes to an event (e.g., bird strikes).

7.2.1.2 Space Environment

When unique non-Earth conditions affect the practices and actions or inactions of an individual or team and contributes to an event.

- **SE201 G-Factor.** A factor when forces acting on a body as a result of acceleration or gravity (informally described in units of acceleration equal to one g) and this contributes to an event. These forces may be either positive or negative.

- **SE202 Radiation.** A factor when radiation, either ionizing or non-ionizing, contributes to an event.

- **SE203 Extreme geographical separation.** A factor when distances of a vehicle or crew in space prevent timely aid, communications, or other assistance and this separation contributes to an event.

- **SE204 Extreme confinement.** A factor when humans experience lengthy periods of time together in a small space with no ability to exit the space or proximity to others, and this contributes to an event.

- **SE205 Deconditioned.** A factor when the effect of long-term weightlessness creates or contributes to an event or condition.

- **SE206 Space Adaptation Syndrome (SAS).** A factor during weightlessness in orbit. Symptoms may include nausea, vomiting, anorexia, headache, malaise, drowsiness, lethargy, paleness, and sweating, which may contribute to an event.

- **SE207 Spaceflight Associated Neuro-ocular Syndrome (SANS)**. A factor when changes to body fluids during long-term exposure to microgravity on the structure of the eye, along with changes in distance and near vision of crew members, contributes to an event or condition.

7.2.1.3 Technological Environment

When automation or the design of the work setting create conditions affecting the actions of an individual or team and contributes to an event.

- **PT201 Seat / restraint System.** A factor when the design of the seat or restraint system, the ejection system, or seat comfort contributes to an event.

- **PT202 Instrument and warning system.** A factor when instrument factors such as design, reliability, lighting, location, symbology, size, display systems, auditory or tactile situational awareness, or warning systems contributes to an event.

- **PT203 Visibility restrictions (not weather related**). A factor when the lighting system, windshield / windscreen / canopy design, or other obstructions contributes to an event. This includes glare or reflections on the windshield / windscreen / canopy. Visibility restrictions due to weather or environmental conditions are captured under PE206.

- **PT204 Controls and switches.** A factor when the location, shape, size, design, reliability, lighting, or other aspect of a control or switch contributes to an event.

- **PT205 Systems automation.** Is a factor when the design, function, reliability, symbology, logic, or other aspect of automated systems contributes to an event.

- **PT206 Workspace compatibility.** A factor when the workspace (e.g., size, layout) contributes to an event.

- **PT207 Personal equipment.** A factor when the individual's personal equipment contributes to an event. Example: Helmets, suits, gloves, etc.

- **PT208 Communication equipment.** A factor when the adequacy or availability of communication equipment contributes to an event. This includes electronically or physically blocked transmissions. Communications can be voice, data, or multi-sensory.

- **PT209 System configuration / condition.** A factor when the integration, configuration, or condition of a system contributes to an event. Red-light example: components are incomplete, incorrect, inadequate, or degraded.

- **PT210 Material Compatibility.** A factor when Petroleum, Oil, Lubricant's "POL," and / or other material interactions are incorrect and contributes to an event.

7.2.1.4 Information Environment

When interactions among individuals, crews, and teams create conditions that influence the preparation and / or performance of a mission.

- **PI201 Crew / team leadership.** A factor when the ability of group / task leaders to establish and maintain an accurate and shared understanding of the mission or actively manage the distribution of tasks contributes to an event.

- **PI202 Task / mission planning / briefing.** A factor when individual, crew, or team preparation associated with planning and / or briefing the task / mission contributes to an event.

- **PI203 Risk assessment during event or mission.** A factor when a team members' ability to adequately communicate changes during mission execution and adjust their work accordingly contributes to an event.

- **PI204 Communication.** A factor when information is misspoken, misread, or misheard, and this condition contributes to an event. This includes putting forth with proper persistence. Examples: Lack of assertiveness; information not entered in maintenance logbook, engineering order, or work card; poor shift turnover.

- **PI205 Use of standard terminology**. A factor when the use of clear and concise terms, phrases, hand signals, etc., as defined by standards and training, contributes to an event.

- **PI206 Cross check or challenge-response.** A factor when a crew member(s) efforts to actively monitor or back-up other crew members' actions or decisions contributes to an event.

- **PI207 Rank / position imbalance.** A factor when the differences in rank or position of the team or crew leader influences performance (e.g., intimidation), and contributes to an event.

- **PI208 Geographical Orientation.** A factor when the individual is at a different location from where believed.

7.2.2 Individual Factors

When factors of psychological, physiological, perceptual, or fitness affect practices, conditions, or actions of individuals or teams and contribute to an event.

7.2.2.1 Psychological

When emotion, personality, or attitude of an individual or team experiences create conditions that affect performance.

- **PP201 Emotional state.** A factor when the individual is under the influence of a strong positive or negative emotion, and that emotion contributes to an event.

- **PP202 Personality style.** A factor when the individual's personal interaction with others contributes to an event. Examples are authoritarian, over-conservative, over-confident, impulsive, invulnerable, submissive, or other personality traits that result in degraded performance.

- **PP203 Cognitive State.** A factor when the individual's ability to maintain a cohesive awareness of events and required actions contributes to an event. Example: a state characterized by confusion or lack of clear thinking.

- **PP204 Attention management**. A factor when the individual focuses all attention on a limited number of cues and excludes other cues of an equal or higher priority, or when the individual has a degraded state of alertness or readiness to process information, and this contributes to an event. Examples of this include **distraction**, **channelized attention**,

or **habit pattern interference**, e.g., when performing a highly automated / learned task and distracted by another cue / event that results in the interruption and subsequent failure to complete the original task or results in skipping steps in the original task.

- **PP205 Complacency.** A factor when reduced vigilance results in a false sense of security in abilities or decreased awareness of hazards associated with a task or operation and this contributes to an event.

- **PP206 Motivation.** A factor when the individual's willingness or drive to accomplish a task / mission contributes to an event.

- **PP207 Expectancy or pre-conceived notion.** A factor when an individual's mental framework anticipates a specific course of action regardless of other cues, and this contributes to an event.

- **PP208 Pre-existing psychological.** A factor when an individual's history includes a qualified professional determining they met Diagnostic and Statistical Manual of Mental Disorders criteria for a personality, psychological, or psychosocial disorder / problem, and this psychological condition contributes to an event.

- **PP209 Mentally exhausted / fatigued.** A factor when diminished mental capability, restricted or shortened sleep, or exhaustion associated with the effects of high operational tempo and / or lifestyle contributes to an event. Fatigue may additionally be described as acute, cumulative, or chronic.

- **PP210 Extreme isolation.** A factor when long-term separation or delayed communication contributes to an event.

- **PP211 Team dynamics.** A factor when a group, team, or organization work towards consensus and conformity over independent critical analysis and decision-making (e.g., "group think"), and this condition contributes to an event.

- **PP212 Memory / learning ability.** A factor when capacity to learn or remember past experiences or training affects performance and contributes to an event.

- **PP213 Task saturation.** A factor when the quantity or complexity of information exceeds mental ability to process and act, and this contributes to an event.

7.2.2.2 Physiological / Medical

When an individual's physical (e.g., proprioceptive, fatigue, respiratory) functioning creates conditions that contribute to an event.

- **PP221 Hypoxia**. A factor when insufficient oxygen supply to the body causes an impairment of function and contributes to an event. This code includes hypoxic, hypemic, stagnant, and histotoxic.

- **PP222 Hyperventilation**. A factor when rapid breathing "over breathing" exceeds the physiological ability of the body resulting in a drop of carbon dioxide causing the individual's performance capabilities to degrade and contributes to an event.

- **PP223 Barotrauma (Trapped gas disorder)**. A factor when gasses in the middle ear, sinuses, teeth, or intestinal tract expand or contract on ascent or descent contributing to an event.

- **PP224 Pre-existing medical condition**. A factor when an individual's pre-existing physical illness, disease, disorder, syndrome, or injury contributes to an event.

- **PP225 Injury or illness sustained during operation.** A factor when a physical illness or injury occurs during a task or mission that causes an unsafe situation and contributes to an event.

- **PP226 Physical fatigue (overexertion)**. A factor when an individual's diminished physical capability is due to overuse and contributes to an event.

- **PP227 Spatial disorientation – incapacitating.** Type 3 (Incapacitating) spatial disorientation is when an individual is unable to make proper control inputs for safe operation of the aircraft or system due to an extreme conflict (often extreme) between the sensory systems. See Perceptual Factors (PP236) for Type 1 or Type 2.

- *Spatial disorientation is when an individual's ability to correctly sense a position, motion, or attitude of a vehicle or of oneself within the fixed coordinate system provided by the surface of the Earth and the gravitational vertical contributes to an event. Spatial disorientation can be Type 1, 2, or 3.

7.2.2.3 Perceptual Factors

When sensory inputs (visual, auditory, or vestibular) create a condition of perception (or misperception) of an object, threat, or situation that contributes to an event.

- **PP231 Motion illusion—kinesthetic.** A factor when physical sensations of the ligaments, muscles, or joints affects the individual's perception of orientation, motion, or acceleration and contributes to an event.

- **PP232 Turning balance illusion—vestibular.** A factor when stimuli acting on the balance organs in the middle ear affects the individual's perception of orientation, motion, or acceleration and contributes to an event.

- **PP233 Visual illusion.** A factor when visual stimuli affect perception of orientation, motion, or acceleration and contributes to an event.
- **PP234 Misperception.** A factor when an individual's perception of altitude, separation, speed, closure rate, road / sea conditions, and / or aircraft / vehicle location contributes to an event.
- **PP235 Temporal distortion.** A factor when the individual experiences a compression or expansion of time relative to reality and contributes to an event. This is often associated with a "fight or flight" response.
- **PP236 Spatial disorientation—unrecognized / recognized.** Type 1 (Unrecognized) is when a person's cognitive awareness of one or more of the following varies from reality: attitude, position, velocity, direction of motion, or acceleration. Proper control inputs are not made because the need is unrealized. Type 2 (Recognized) is when recognized perceptual confusion is induced through one or more of the following senses: visual, vestibular, auditory, tactile, proprioception, or kinesthetic. Proper control inputs are still possible.
- *Spatial disorientation is a factor when an individual's ability to correctly sense a position, motion, or attitude of a vehicle or of oneself within the fixed coordinate system provided by the surface of the Earth and the gravitational vertical contributes to an event. Spatial disorientation can be Type 1, 2, or 3.

7.2.2.4 Fitness / Readiness

When an individual's preparation and / or readiness influence the performance of an action or mission and contributes to an event.

- **PF201 Alcohol.** A factor when the acute, residual, or chronic effects of alcohol affect performance, and this contributes to an event.
- **PF202 Non prescribed drug / OTC medications / supplements.** A factor when an individual takes any drug, other than prescribed, that affect performance, and this contributes to an event. Example: nicotine or caffeine in sufficient quantities to cause impairment of normal function.
- **PF203 Prescribed medications.** A factor when an individual takes any prescribed drug, medication, or supplement that affects performance, and this contributes to an event.
- **PF204 Nutrition / hydration.** A factor when an individual's nutritional state, diet, or hydration condition contributes to an event.

- **PF205 Operating with known disqualifying condition.** A factor when an individual intentionally performs duties with a known disqualifying medical condition, and this condition contributes to an event.

- **PF206 Experience.** A factor when an individual has limited practice which affects the ability to execute the task or mission, and this condition contributes to an event.

- **PF207 Proficiency.** A factor when an individual's capability to accomplish a task or mission does not meet the performance levels expected from the individual's certification level, and this condition contributes to an event.

- **PF208 Currency.** A factor when an individual has not met the general training or recurring training requirements for the job / weapon system and is considered non-current, which contributes to an event.

- **PF209 Body Size / movement limitations.** A factor when the size, strength, dexterity, mobility, or biomechanical constraints of an individual contributes to an event. Note: It must be expected that the average individual qualified for that duty position could accomplish the task in question.

- **PF210 Physical strength & coordination.** A factor when the relative physical strength and / or coordination of an individual contributes to an event. Note: It must be expected that the average individual qualified for that duty position could accomplish the task in question.

7.3 Supervision

Factors in a mishap if the methods, decisions, or policies of the supervisory chain of command directly affect practices, conditions, or individual actions and contributes to an event.

7.3.1 Oversight

When supervision such as guidance, oversight, training, and / or management, are associated with preconditions and / or actions related to an event.

- **SO301 Leadership / Modeling / Feedback.** A factor when the availability, competency, quality, behavior, or timeliness of leadership or supervision contributes to an event. Examples: Direct feedback to employees; delegating authority improperly; setting positive examples; creating an environment where people can speak up.

- **SO302 Local Training Issues / Programs.** A factor when one-time or recurrent training programs, upgrade programs, transition programs, or any other local training contributes to an event. (Note: The failure of an individual to absorb the training material in an

adequate training program does not indicate a training program problem, see Precondition - Psychological category).

- **SO303 Policy.** A factor when policy or guidance or lack thereof results in undesired outcomes and contributes to an event.

- **SO304 Interpersonal Relations.** When the ability to exchange thoughts, ideas, and perspectives between a supervisor and their employee contributes to an event.

7.3.2 Planning

When supervision assess the hazards of an operation and consider associated risk, proficiency, experience, capability, and / or crew make up for the task or mission.

- **SP301 Led / directed beyond experience / capability.** A factor when supervisor / management assigns personnel beyond their skill level or capabilities.

- **SP302 Crew / team selection.** A factor when the makeup / composition of the crew or team affects the collective ability to accomplish the mission or task.

- **SP303 External motivation or supervisory influence.** A factor when supervisory demands cause an individual to feel obligated to perform a task or mission despite concerns about the task or mission.

- **SP304 Experience.** A factor when the supervisor selects an individual whose recent experience or total experience for a specific maneuver, event, or scenario affects safe mission execution.

- **SP305 Proficiency.** A factor when a supervisor assigns an individual or team whose proficiency in a task, operation, or event affects safe mission execution.

- **SP306 Risk assessment.** A factor when supervisory evaluation of risks associated with a mission affects safe execution of operations. This includes the implementation of risk assessment tools.

- **SP307 Authorized unnecessary hazard.** A factor when supervision authorizes a mission or mission element that is unnecessarily hazardous without sufficient cause or need.

7.3.3 Accountability

When supervisory attention to known deficiencies among personnel, equipment, processes, and / or procedures influence conditions related to an event.

- **SA301 Personnel Management.** A factor when a supervisor is aware of pre-existing conflicts between operators, maintainers, or aviators who exhibit recognizable risky behaviors or unsafe tendencies and fails to institute remedial actions.

- **SA302 Operations Management.** A factor when a supervisor's awareness of pre-existing hazardous practices, conditions, or guidance allows for hazardous practices within the scope of the supervisor's authority.

7.3.4 Supervisory Compliance

When a supervisor's willful adherence or disregard of the rules or protocols contributes to an event.

- **SC301 Adherence to existing rules.** A factor when supervision / leadership allows employees to deviate from the rules or when supervision allows unwritten rules to become standard.

- **SC302 Qualification / Currency.** A factor when supervision / leadership allows an individual to perform duties who has not met the established training requirements or qualifications for the task, mission, or process and is considered non-qualified or non-current.

- **SC303 Directed violation.** A factor when supervision / leadership directs a subordinate to violate existing regulations, instructions, or technical guidance.

7.4 Organization

When the shared attitudes, values, beliefs, or contractor relationships within an organization impact operation and / or operational risk.

7.4.1 Climate / Culture

When the attitudes, values, beliefs, or morale impact operations and / or operational risk.

- **OC401 Culture**. A factor when attitudes, beliefs, or values that are shared by the people and groups of an organization drive behavior by employees in particular situations and control the behavior of organizational members towards one another. Use this code when these attitudes, beliefs, or values impact mission demands and / or operational risk.

- **OC402 Climate (or morale)**. A factor when the perception of stress and / or morale within an organizational climate reflects the pride or disgrace a member feels in working in his or her organization and the sense of the individual's cohesiveness within the organization. Use this code when this stress or morale affects the environment and / or operational risk.

- **OC403 Contractor relations.** A factor when relationships, communications, or inter-operability between the organization and contractors (prime or sub) is affected and impacts the working relationship. This includes the oversight and insight.

7.4.2 Operations

When the organizational processes and/or procedures (e.g., structure, tempo, risk management, oversight, publications, training) impact operations.

- **OP401 Organizational structure.** A factor when the organizational structure is confusing, unwritten, or inadequate, and contributes to an event.

- **OP402 Operational tempo**. A factor when the pace of deployments, workload, additional duties, and / or ancillary requirements impact operational risk.

- **OP403 Operational risk management**. A factor when the potential risks of a large program, operation, or process are improperly, inadequately, or incompletely assessed and this contributes to an event.

- **OP404 Program oversight or management**. A factor when acquisitions management, design analysis (e.g., design review boards, Safety and Mission Success Review, Flight Readiness Reviews, etc.), and program oversight or management affect a program's ability to obtain the correct quantity / quality of equipment.

- **OP405 Publications / written guidance**. A factor when the quality, quantity, acquisition / supply, or updating of publications, procedures, and / or written guidance affect operational risk. Examples: Vehicle operating manuals, instructions, directives, technical manuals, etc.

- **OP406 Organizational training.** A factor when the quality, quantity, or availability of training provided by the organization affect operational risk. Examples: One-time or initial training programs, upgrade programs, transition programs, or other training that is conducted outside the local unit.

7.4.3 Resources

When the allocation, availability, or condition of personnel, equipment, facilities, and monetary assets necessary for an organization to accomplish a mission impact operations.

- **OR401 Personnel**. A factor when the quality, quantity, or selection of personnel affect operational risk. Examples: Unit under-manned based on manning documents, selection of personnel based on lower standards than appropriate for adequate performance, staffing, or personnel placement appropriate for mission demands.

- **OR402 Funding**. A factor when the category, quantity, allocation, or acquisition of money (financial resources) affect operational risk. Examples: Too much money for operations and maintenance, but not enough money to procure new equipment; a decrease in funds provided by the organization with the expectation to maintain current mission requirements; when an organization allocates the correct funds to mitigate a known risk or manage growth.

- **OR403 Material / Parts**. A factor when the quality, quantity, or acquisition / supply of consumable material affect operational risk. Examples: Availability of expendable, consumable, or replacement parts.

- **OR404 Equipment**. A factor when the quality, quantity, or acquisition / supply of equipment affect operational risk.

- **OR405 Design.** A factor when the design of equipment, tools, workspace, or hardware / software affect operational risk.

- **OR406 Operational Information.** A factor when the quality, quantity, or acquisition / supply of information affect operational risk. Examples: Weather briefings / forecasts, intelligence, operational planning material, deployment site surveys, or other information necessary for safe operations.

- **OR407 Facilities / Buildings & Grounds**. A factor when the quality or quantity of facilities, roads, sidewalks, outside training areas, parking lots, common areas, etc., affect operational risk.

8. DIRTY DOZEN

The OSMA Human Factors Dirty Dozen initiative is an awareness campaign that is a byproduct of the Agency Human Factors Annual Report. In the spirit of Gordon Dupont's contribution of the same name to the aviation safety community, OSMA has expanded its application to address Human Factors contributing to mishaps Agency-wide. The Dirty Dozen is a top twelve list that highlights the most common factors contributing to mishaps and close calls within NASA over the previous fiscal year. The monetary and lost time impact is an immediately addressable issue relevant to current Agency operations.

To broaden the campaign, OSMA is issuing monthly Human Factors messages with case studies focused on contributing factors identified in the Dirty Dozen. The case studies are developed with the intent to equip Agency stakeholders with information and mitigation strategies for factors found to be the leading contributors to loss at NASA.

Figure 5: Dirty Dozen Example

9. RED-LIGHT / GREEN-LIGHT: MISHAP INVESTIGATION AND RISK ASSESSMENT

9.1 Mishap Investigation:

Learning from accidents and incidents remains a vital component of a mature safety system. Sometimes called “Safety I”1, traditional analysis focuses on understanding the underlying

factors associated with adverse events. Those findings drive actions and recommendations to reduce their recurrence.

9.2 New Approach:

NASA's newly created HF approach is more comprehensive regarding Human Factors by examining the factors that impact consequences in a positive way. This latter approach to safety utilizes a method colloquially referred to as a "green-light (GL)" analysis. GL analysis identifies positive aspects of a safety system to promote resilient behaviors and processes, in addition to a traditional "red-light (RL)" analysis that seeks to eliminate errors of commission or omission. This GL approach reflects a more robust and rigorous safety analysis that current safety programs lack. This more comprehensive system supports resilient systems, what is currently referred to as "Safety II"1.

9.3 From lagging to leading indicators:

Beginning in 2023, the NASA Safety Culture Program uses RL/GL for analysis for its Safety Culture Survey (SCS) comments. In addition to the traditional sentiment analysis, comments are distributed in their proper HF category. Below is a notional example of RL/GL from the NASA SCS comments. It moves Human Factors analysis into identification of leading indicators for prevention purposes. Resilient systems use leading (e.g., survey) along with lagging (e.g., mishap) data for mission success. We believe this new taxonomy and approach has many future applications within NASA and outside of NASA in government, academia, and industry.

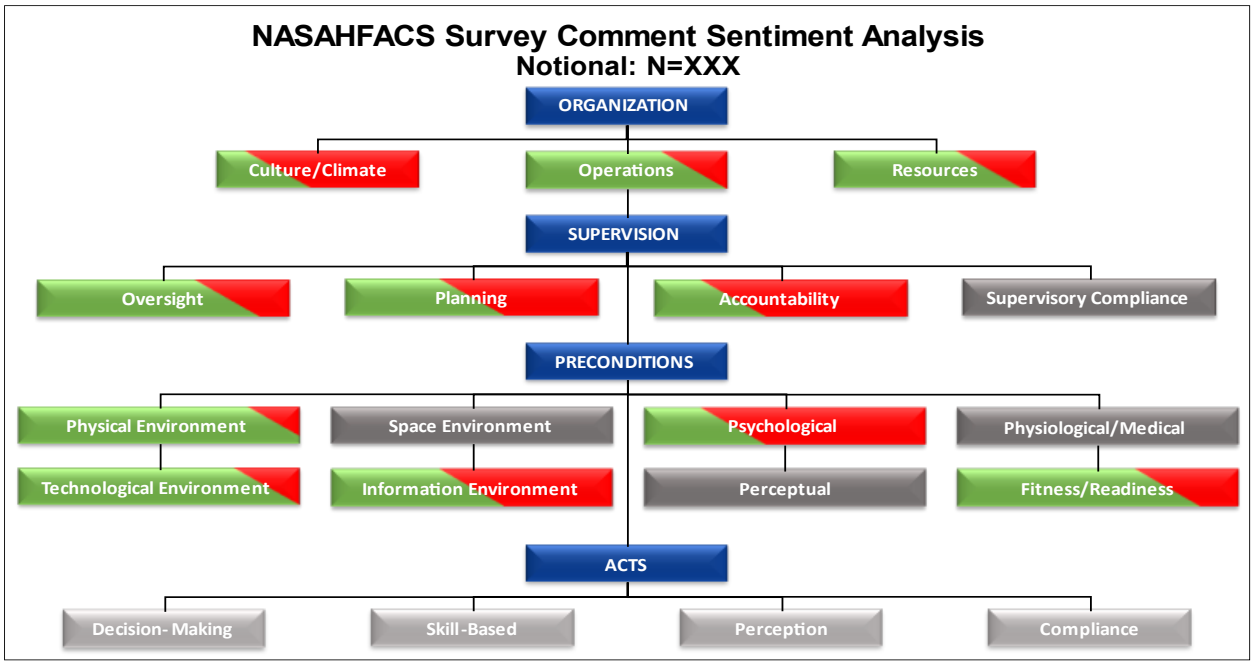

Figure 6: Notional RL/GL SA HF Overview

9.4 Implementation of RL/GL:

The Human Factors Program extends beyond mishap investigation. The multi-year effort from 2021-2023 by the HFTF to “neutralize” the taxonomy created a structure to understand areas for mitigation and reinforcement. The NMIS system includes an updated Human Factors module, allowing for RL/GL coding. Starting in 2022, all NASA Human Factors annual reports include RL/GL analysis of operational cases in the NASA Mishap Database. These annual reports are in the NASA STRIVES system, available to those with required permissions.

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APPENDIX.B REFERENCES

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