SubTAG Name: System Safety/Health Hazards/Survivability
TAG Meeting Number: 64

SubTAG Chair/co-chair Information

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Number of members present: 21

Organizations represented: PLEASE TAKE FROM SIGN-IN SHEET

Agenda

1.

a. Title of presentation: Insuring Survivability in Extreme Environments

b. Name of presenter(s): Dr. Gordon Vos

c. Agency or organization employing presenter(s): Wyle Integrated Science and Engineering and NASA

2.

a. Title of presentation: The Importance of Human Reliability Analysis in Human Space Flight: Understanding the Risks

b. Name of presenter(s): Dr. Michael A. Stewart

c. Agency or organization employing presenter(s): NASA Johnson Space Center

3.

a. Title of presentation: Human-Rating Implementation for Commercial Space

b. Name of presenter(s): Dr. Mihriban Whitmore

c. Agency or organization employing presenter(s): NASA Johnson Space Center

Abstract Information

Who presented: Dr. Gordon Voss

Abstract:

Human Rating Requirements: NASA STD 3001 – Requirements to Ensure Survivability in Extreme Environments Over the past 40 years NASA has pressed the boundaries of human survivability in extreme environments to the very edges of our world and beyond. Operating in the hard vacuum of space and separated from the rest of humanity by vast distances, astronauts have long relied upon innovative engineering solutions for their health and safety. These hardware designs have always been driven by rigorous engineering standards, including numerous guidelines and requirements associated with human factors. Over the past 10 years there has been a significant move forward in the development and implementation of new human rating requirements and documentation for space systems, most recently culminating in the development of NASA STD 3001.

Who presented: Dr. Michael A. Stewart

Abstract:

The Importance of HRA in Human Space Flight: Understanding the Risks

Human performance is critical to crew safety during space missions. Humans interact with hardware and software during ground processing, normal flight, and in response to events. Human interactions with hardware and software can cause Loss of Crew and/or Vehicle (LOCV) through improper actions, or may prevent LOCV through recovery and control actions. Humans have the ability to deal with complex situations and system interactions beyond the capability of machines. Human Reliability Analysis (HRA) is a method used to qualitatively and quantitatively assess the occurrence of human failures that affect availability and reliability of complex systems. Modeling human actions with their corresponding failure probabilities in a Probabilistic Risk Assessment (PRA) provides a more complete picture of system risks and risk contributions. A high-quality HRA can provide valuable information on potential areas for improvement, including training, procedures, human interfaces design, and the need for automation.

Modeling human error has always been a challenge in part because performance data is not always readily available. For spaceflight, the challenge is amplified not only because of the small number of participants and limited amount of performance data available, but also due to the lack of definition of the unique factors influencing human performance in space. These factors, called performance shaping factors in HRA terminology, are used in HRA techniques to modify basic human error probabilities in order to capture the context of an analyzed task. Many of the human error modeling techniques were developed within the context of nuclear power plants and therefore the methodologies do not address spaceflight factors such as the effects of microgravity and longer duration missions.

This presentation will describe the types of human error risks which have shown up as risk drivers in the Shuttle PRA which may be applicable to commercial space flight. As with other large PRAs of complex machines, human error in the Shuttle PRA proved to be an important contributor (~12 percent) to LOCV. An existing HRA technique was adapted for use in the Shuttle PRA but additional guidance and improvements are needed to make the HRA task in space related PRAs easier and more accurate. Therefore, this presentation will also outline plans for expanding current HRA methodology to more explicitly cover spaceflight performance shaping factors.

Who presented: Dr. Mihriban Whitmore

Abstract:

NASA Human-Rating Implementation

Introduction

In the emerging market of commercial space flight, the question of how to meet the human-rating expectations of NASA needs to be fully expressed. Therefore the intent of this presentation is to explain NASA expectations for protecting the crew of NASA Space Missions and how NASA has been working towards development of human-rating requirements for commercial spaceflight. The pinnacle document for NASA Human-rating certification is NPR 8705.2B, Human-Rating Requirements for Space Systems. NPR 8705.2B defines and expresses the implementation processes, procedures, and requirements necessary to produce human-rated space systems. How this NPR integrates with other NASA directives to provide direction is shown in Figure 1.

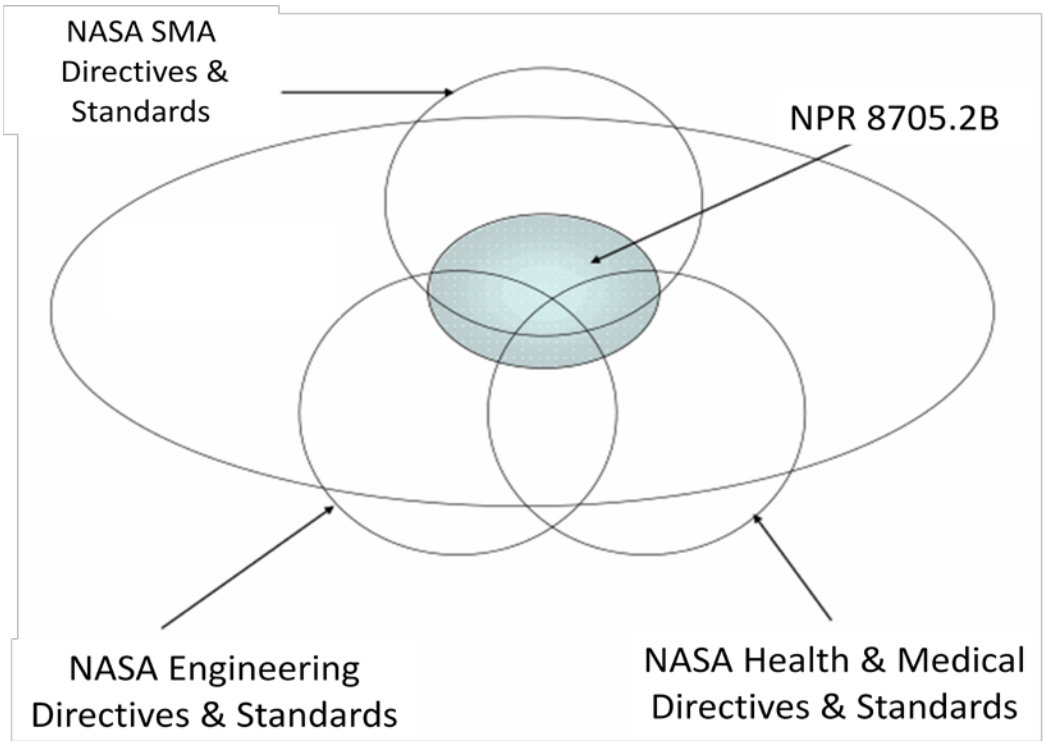

Figure 1: Program Requirements Based on NASA Directives and Standards

Background

NPR 8705.2B provides the roadmap for Program-specific requirements to be derived for each NASA Program. In addition, the NPR defines a core set of mandatory standards: NASA Standard 3001, Volume 1; NASA Standard 3000 (which will be superseded by NASA-STD-3001, Volume 2 when approved), FAA Human Factors Design Standard, and MIL-STD-1472 Department of Defense Design Criteria Standard - Human Engineering.

For each new NASA spaceflight Program, these core mandatory standards, as well as the directives and standards depicted above, are carefully considered to determine how they apply to the scope and philosophy of the Program. The Human Integration Design Handbook (HIDH, NASA/SP-2010-3407), as the companion document to NASA-STD-3001, Volume 2, provides specific information to support derivation of Program requirements. Derivation of Program

requirements from a NASA standard includes adding Program-specific content to requirements, expanding rationales to include expectations for design implementation, and developing verifications for each requirement. Figure 2 represents a document flow-down model for human health and performance Program requirements in support of NASA human-rating.

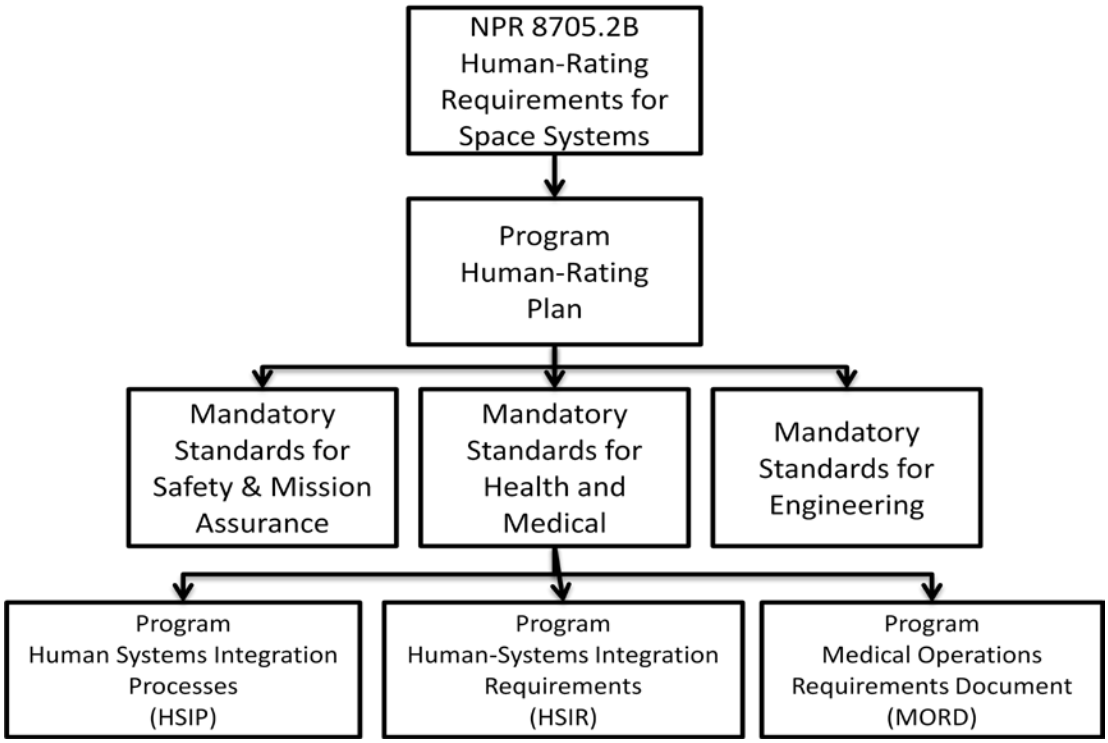

Figure 2: Flow-Down Model for Health and Medical Program Requirements

Implications for Commercial Human Spaceflight

For commercial crew transport missions, the health and medical mandatory standards can be met via three Program-specific documents: a Human Systems Integration Processes (HSIP) document, a Human-Systems Integration Requirements (HSIR) document, and a Medical Operations Requirements Document (MORD).

An HSIP document describes the human-centered design process which ensures a human-rated vehicle, including expectations for each process mapped to systems engineering milestones. For NASA, following an iterative, human-centered design process early and often throughout the design cycle is essential in meeting human-rating compliance. An HSIR document provides design requirements to ensure integration of human-to-system interfaces. A MORD provides requirements that pertain to the development of medical operations and concepts. Together, an HSIP, an HSIR and a MORD ensure that design is centered on the needs, capabilities, and limitations of the human. By following human-centered design processes in the HSIP, requirements in HSIR and MORD are applied to spacecraft and mission systems design to ensure human health and performance throughout the system's life cycle.

NASA has been working to develop these documents, and leverage their content into a set of commercial human system integration requirements for commercial spaceflight. The history of this process to date will be presented with a prospective outlook for the future.

Please also attach a copy of each presentation on the provided CD (if it is unclassified and can be posted on the TAG website): Attached.

Session Highlights
Issues or concerns discussed during the meeting, the results of the discussion and recommendations for action, if any: None.

The results of any elections held (if none, please state “n/a”): N/A
Candidates nominated for position
Name, organization, phone number, address, and email of incoming chair(s)

SubTAG open actions, if any, and the target date for completion: None
Title of concern/problem
Advocate or organization that raised the issue
Group discussion summary related to the topic
Actions to be taken, if necessary
Target date for issue resolution
Changes made to the subTAG, other than the chair
Name change
Charter change
Other changes
Please also state if you will be meeting at the next TAG. We plan to meet.