life support systems (and breathing systems in particular) will always be a compromise between performance, cost, reliability, physical size and complexity. Where this compromise lies will depend largely on the use to which the system is put (for example in transport aircraft vs fighters; the acceptability of these compromises is encapsulated in performance standards that are the result of years of research and operational experience. Typical documents include NATO STANAGs, AFIC Air Standards, U.S. DoD MIL-STDs and UK MOD Def Stans. A key feature of these standards is that they consider performance of the system as a whole, and so when requirements are examined in isolation they may appear overly demanding. However, when a series of requirements all achieve minimum acceptable performance, the whole system should still offer adequate physiological protection. For a breathing system, the fundamental goals are to deliver adequate flow of gas to meet respiratory demand, and for the composition of the gas delivered to the respiratory tract to be appropriate. To achieve this, we need adequate knowledge of the physiological demands likely to be made by the aviator, and what may happen to performance or flight safety if those demands are not met. For example, failure to meet breathing flow during stressful periods of flight in a fighter may lead to physiological symptoms that are not present when the system is tested under normal conditions. If performance-based specifications are used, care must be taken to ensure such issues are addressed. This presentation will highlight some of these performance requirements and give examples of real-life issues encountered in aircraft development programs. **APPLICATION:** The need for adequate life system support testing should be considered early during aircraft acquisition phases and can be improved by applying agreed standards to the requirement. Whole system tests are an essential component of this assurance.

Learning Objective:
1. The participant will be able to understand the critical role that aeromedical standards play in the assessment and delivery of safe and effective aircrew life support systems to front line military aircraft.

11:15 AM
[130] EXPLAINING THE INCREASE IN REPORTED PHYSIOLOGICAL EPISODES: PERCEPTIONS AMONG NAVAL JET AVIATORS

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(Original Research)

INTRODUCTION: Since 2010, naval jet aviators have dramatically increased their reported experience of physiological episodes (PEs). Extraordinary efforts have been undertaken by numerous organizations (including the Navy, DOD, other federal agencies, and defense contractors) to determine root causes and work toward elimination of PEs. To provide structure to this process, PMA-265 and PMA-273 developed failure trees specifying several hundred unique systems requiring further investigation, ranging from aircraft components to aircrew behaviors. Our study asked aviators directly, based on their experience, what factors they consider to be responsible for the increase in reported PEs. **METHODS:** In January 2018, all active U.S. Navy and Marine Corps F/A-18 and T-45 aircrew and F/A-18 maintainers (~6,500 personnel) were invited via email to participate in an online survey regarding PEs and aircraft system performance. The survey consisted primarily of rating scale items addressing issues ranging from flight gear, to training procedures, to command culture considerations. The first and last questions of the survey, however, were open-ended, and asked specifically: "Based on your personal or second-hand knowledge of PEs, why do you think there has been a recent increase in reported episodes?" **RESULTS:** Valid data were received from 788 aviators and 435 maintainers (19% response rate). Among the respondents, 191 F/A-18 and 23 T-45 aviators had personally experienced a PE at some point in their careers. Content analysis of the open-ended data yielded 15 categories of response. The most common explanations for the increase in reported PEs included increased awareness and improved reporting procedures; aging/deteriorating airframes; changes to maintenance standards; inadequately designed

systems; and a hypersensitivity to report any physiological symptom as a PE. **DISCUSSION:** Our results provide insights into the beliefs and perceptions that are shared among naval jet aviators and maintenance personnel regarding the casual factors associated with PE reporting. Explanations for the increase in reported PEs vary, with some respondents indicating PEs have always existed and that aviators are just now more comfortable reporting them (increase in true positives), while others suggest aviators may be over-reporting events that are not PEs (increase in false positives). Applications and limitations to these data within the larger failure tree investigation will be discussed.

Learning Objectives:
1. The audience will learn about the reasons naval jet aviators and maintenance personnel attribute to the increased in reported physiological episodes.
2. The audience will be able to describe ways in which self-report survey data can and cannot be used to inform failure tree close-out processes.
3. The audience will learn about applications of human systems integration within the context of the physiological episodes.

11:30 AM
[131] DETECTION OF MULTIPLE LEVELS OF HYPOXIA THROUGH NOVEL FEATURE ANALYSIS AND MACHINE LEARNING

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(Original Research)

Reliable and consistent induction of cognitive impairment is important to the experimental study of human operator performance (i.e., commercial aviation pilots). The specific purpose of this study was to investigate the use of normobaric hypoxia induction as a method to induce mild cognitive impairment in human operators. The current analyses examine the potential for improved prediction of hypoxia category. Professional pilots served as test subjects (n=57, 49 males) in the study involving simulated altitudes of sea level (21.0% O2) and 15,000 feet (11.2% O2) induced by an Environics, Inc. Reduced Oxygen Breathing Device. Each subject experienced both non-hypoxic and hypoxic exposures while performing three 10-minute tasks (computerized neuropsychology tests, computerized multi-tasking battery, and fixed-based flight simulation). The analyses of the physiological data (EEG, EKG, Respiratory Effort, GSR, pilot age, pilot BMI) recorded from the test subjects included statistical methods and machine learning techniques: Multinomial Logistic Regression, K-Nearest Neighbor (KNN), and Random Forest. Levels of hypoxia experienced were categorized based on peripheral SPO2 as follows for ground truth labeling purposes: completely non-hypoxic state (100-95%), indifferent hypoxia (95-85%), compensatory hypoxia (75-85%), and critical hypoxia (<75%). Prediction Accuracy for the four levels of hypoxia using EEG features derived from activation complexity analysis was compared to traditional spectral power analysis. Analyses of features from activation complexity analysis of EEG resulted in higher classification accuracy (80.2%) of hypoxia category than features from traditional spectral power analysis of EEG (71.3% accuracy). Examining the implications of subject-specific models vs. general models of hypoxia classification indicated that accuracy was 80.2% and 51.8% respectively. These results indicate that improved classification accuracy for determining a subject's level of hypoxia can be accomplished using only EEG data through advanced feature engineering approaches that capture activation complexity. The contrast between classification accuracy for general models and subject-specific models indicates that models trained specifically for the test subject outperform the generally trained model. Further implications of these results, specifically analyses for classification of cognitive impairment due to the induced hypoxia, will be presented and discussed.

Learning Objective:
1. Discover how mild hypoxia exposure can impact operator performance.