

FEDERAL AVIATION ADMINISTRATION
REDAC Subcommittee on Aircraft Safety (SAS)
2017 Spring Meeting Minutes
March 8 – 9, 2017

Note taker: Marguerite Thompson

The REDAC Sub-committee on Aircraft Safety (SAS) met on March 8 and 9, 2017 in Oklahoma City, OK, at the FAA Civil Aerospace Medical Institute (CAMI), for its routine spring meeting. This meeting had three specific objectives on its agenda:

1. Review and provide comment on the FAA's FY 2019 safety research plan
2. Continue to explore previously identified emerging issues and trends from an industry perspective that may be helpful for the FAA gaining a deeper understanding of required research
3. Consider what input, if any, should be included in the Agency's internal strategic guidance document for developing the FY 2020 aviation safety research plan.

This meeting minute captures the activities and discussions at the two-day meeting.

The SAS Chair's Meeting Summary report to full REDAC is attached in Appendix I.

The SAS closed out all 2016 Fall SAS Findings and Recommendations (F&R). Hence, there is no outstanding SAS F&Rs from previous meetings.

In addition, the SAS requested three Actions, Appendix II, for the FAA to consider for the 2017 fall meeting, currently scheduled for September 6-7, 2017.

Day 1: March 8, 2017

Introduction/Opening

SAS Chair, Kenneth Hylander began the meeting with opening remarks and introduction of SAS members and attendees.

Research Overview

The Director of the William J. Hughes Technical Center, Shelley Yak, presented the FAA Research and Development National Aviation Research Plan (NARP) redesign. The goal of the NARP redesign briefing was to share the direction and obtain feedback on a research planning framework and draft outcomes/goals/objectives. Ms. Yak explained that the NARP is a 5-year plan intended to advance the Subcommittee's knowledge in technology and safety by providing research and development planning outlook across safety, efficiency, and environmental principles. She also highlighted that the annual investment is located across three appropriation sources: Research, Engineering, and Development

(RE&D); Facilities and Equipment (F&E); and Airport Improvement Program (AIP). The final publication of the NARP redesign is expected February 2019. She explained that there is not an expectation for complete resolution in 2018 but they are hoping for 80% and evaluate what is left for the final publication in 2019. Ms. Yak expressed the importance to engage the REDAC for support for the redesign efforts and opened the floor for discussion and feedback. Some of the items discussed were a standardized definition of infrastructure, the need to measure the outcomes and goals, and the need to look forward and plan for emerging technologies.

Ms. Yak ended the discussion by recommending that the REDAC review the draft NARP objectives and goals and gather additional feedback during the fall meeting. An electronic copy was distributed to the group that evening.

Civil Aerospace Medical Institute (CAMI) Overview

The Deputy Director of the Civil Aerospace Medical Institute (CAMI), Dr. Tom Chidester, welcomed the REDAC subcommittee and provided an overview of CAMI facts and objectives. He stated that CAMI houses over 213 full time employees (FTEs) and over 70 contractors, which includes physicians, engineers, researchers (PhDs), psychologists, geneticists, and administrative personnel. The appropriations needed to run the facility are Operations \$17.1 million, Research and Development \$12.7 million, Facilities and Equipment \$7.5 million, and Facilities and Equipment for FY18 forward \$50.4 million. The increase in appropriations for FY18 is for the upgrade of the underwater egress trainer. Dr. Chidester explained that CAMI houses 5 divisions to carry out various missions, Airman Certification, Aviation Medical Examiner Training, Human Factors Research, Aeromedical Research, and Occupational Health at the Aeronautical Center. He also noted that CAMI missions are critical because human beings provide a weak link in operations; systems can fail and we regulate to maintain and protect them; and people have biological, cognitive, and performance limits.

Opening Comments

Eric Neiderman, FAA SAS designated federal official (DFO), stated that based on previous meetings there was a need to move away from quad charts and individual line items to a more holistic story. He also presented an overview of the Aircraft Safety REDAC subcommittee's roles and responsibilities. He stated that the primary purpose of the REDAC subcommittee is to provide advice to the Administrator regarding needs, objectives, plans, approaches, content, and accomplishments for the FAA research program. The goal is to help the FAA establish the best possible Aircraft Safety RE&D program within the constraints of FAA's available resources. Neiderman also explained the REDAC and subcommittees upcoming meeting goals. During the Summer and Fall of FY17, the goal is to review the FY19 proposed portfolios to provide strategic guidance to the FAA during the preparation of the portfolio. For Winter and Spring of FY18 the objective is to review the FY19 portfolio to provide feedback, advice, and recommendations during the FAA portfolio review.

FAA Budget Update

Mike Gallivan, Manager of the FAA R, E&D Financial Management, presented the overview of FAA budgets via telecon. First, he provided a summary of FY2017 R, E&D budget of \$167.5 million, which is currently under a continuing resolution through April 28, 2017. The continuing resolution was based on FY16 appropriation. He stated that at present, there was not a lot of visible work on the FY17 appropriation. He also discussed the budget plan for FY18. The original target for appropriations is \$171 million. This target was based under the Obama administration. Mr. Gallivan explained that the Trump administration will be submitting a new budget target and it is not expected to match the original. He stated that it is normal for a new administration to adjust targets and to submit the budget request late. The new OMB Director is Mick Mulvaney.

Mr. Gallivan noted that at present there was not an overall FY18 funding agreement. Without a legislative agreement sequester caps will be enacted; the total for FY18 is estimated to be \$1,064,432,000,000, which is \$5.2 billion less than FY17. There is not currently a break down to the agency level. He explained that a "skinny budget" would be submitted and is currently scheduled for March 14, 2017 but the due date could slip a few days. The full budget is expected in late spring. Since there has not been a budget submission, there have not been any Congressional hearings and no Congressional Report language.

Mr. Gallivan explained that the full FY19 budget is awaiting the updated target and full development would be delayed pending the FY18 President's submission. Once the FY18 targets are received the FY19 will be on a fast track with submission to OST late June, to OMB mid-September, and President's request to Congress February 5, 2018.

The out year targets were listed as \$171 million for FY18, \$175 million for FY19, \$178 million for FY20, \$182 million for FY21, and \$185 million for FY22. Mr. Orr explained that these targets are expected to change. The current FAA Authorization was approved by Congress July 14, 2016 and signed by the President July 15, 2016, which extended the authorization through the end of FY17. He noted that without any Congressional action we could expect another extension.

Report on REDAC Meeting

Kenneth Hylander, Subcommittee Chairperson, provided an overview of the fall 2016 SAS meeting objectives and reminded the subcommittee of their roles and objectives. Mr. Hylander pointed out three findings and recommendations from the fall 2016 meeting and stated that they would be reviewed in detail on day 2 of the REDAC meeting. He offered some general comments about the fall 2016 meeting stating that there was great discussion between FAA research, aviation safety and SAS regarding fulfilling mutual expectations through the REDAC process. Mr. Hylander also explained that much thought and planning went into the development of the meeting agenda. He also asked the group consider items they would like to discuss with the AVS leadership team, the validity of the current SAS emerging and future issues (are any changes needed), and if there is anything else the group needs to evaluate in the short and long term.

FY 2019 Portfolio Review

Mr. Mark Orr, the FAA AVS R&D Manager, reminded the SAS members and other attendees that the decision was made to no longer use quad charts and there was a need to develop a way to present

budgets and outcomes at a higher level. He presented the AVS RED Program Life Cycle Model and explained the distinction between sponsors and performers. Sponsors are responsible for regulation, safety, and standards, while performers are the FAA people that conduct the program management and execute the research. Performers and sponsors work together to improve the safety and efficiency of the NAS.

Mr. Orr described the new presentation format focusing on portfolios that would replace the quad charts. The portfolios were presented in an excel sheet format with program areas aligned with the budget line items. There were some questions and discussions among the group about what was included in the totals and target line items. Mr. Orr explained the terms of 'Total Actuals', 'Contract Actuals', 'Policy Request', and 'Contract Target' that were used in the excel sheet, where the 'Total' or 'Policy' included both 'Contract' and FAA employees; and the 'Actuals', 'Request', and 'Target' were based on appropriated by the Congress, submitted in the President's budget, and planned based on OMB/OST guidance, respectively. Mr. Orr stated that the new form would also be useful for the budget narratives and not just for SAS use, which would provide consistency.

Mark Orr, Eric Neiderman, and Ken Hylander, jointly led the discussions on FY19 portfolios. The reviews were broken down into groups and discussed. The first group reviewed included: Fire Safety, Propulsion Systems (PS), Structure Integrity – Composite (SIC), and Aircraft Icing (AI). After a brief break the SAS members reconvened and discussed: Digital System Safety/ Aircraft Systems Information Security Protection (SDS/ASISP), Continued Airworthiness – Systems (CASys), Continued Airworthiness – Structures (CAStr), and Catastrophic Failure Prevention (CAFP). The next group of portfolios were: Human Factors (HF), System Safety Management (SSM), Terminal Area Safety (TAS), and Weather (Wx). The final group discussed included: Aeromedical Research (AM) and Unmanned Aircraft Systems (UAS).

All portfolios were sent to SAS members as read-ahead materials prior to the meeting to allow time to review and to provide comments. Hard copies were made available to SAS members at the meeting as well.

SAS members provided several general observations and raised some concerns/issues. Some members explained that they were expecting more breakdowns among three categories: current issues, emerging issues, and important facilities.

During discussions on fire research and safety, members expressed a need to focus on what are the trending issues in fire and certification and testing. The changes coming in propulsion now put pressures on the environment; there is a need to look at what is being done for hybrid technology. Some members felt that funding requests for propulsion was low and were concerned that there is only one FTE listed. There was also some discussion about the need for more balance on resources in propulsion research. The only comment offered for Structure Integrity was a recommendation to include some topics along with the outcome statements. There were many comments regarding the portfolio for Aircraft Icing. There were concerns from David Polland, Boeing, that most of the research was being done with small aircraft and those results would be extrapolated to larger aircraft. The main question posed was whether or not the research design was appropriate to facilitate the rule change that is desired.

Some SAS members felt that the outcomes for Digital System Safety could be reworded. There was some question on whether the outcome would be used to change standards or processes and what were the insights that would be used for the change. The group then discussed Aircraft Systems Information Security Protection. Members felt that there are assumptions that a link is provided by the government, it is secure. There was a question if there was someone in the FAA that could look at the links and ensure their security. There was some concern that the items contained with Continued Airworthiness – Systems was more of a carryover from aging aircraft. It was noted that there is a large area of contractor growth in this program area. In the area of Continued Airworthiness – Structures and Catastrophic Failure Prevention there was discussion about the need for more focus on the airframe side and to develop tools to deal with the impact that is coming from the engine failure analysis.

During the discussion for Human Factors there was some concern that the number of FTEs seemed too large for the amount of output that was coming from the area and there was not enough attention on GA. Historically the focus of System Safety Management has been airplane oriented, but there has been a shift to Air Traffic. Since research in this area cannot produce the actual tool, a prototype is used to validate the findings; members felt that the budget profile was adequate. Discussions surrounding Terminal Area Safety revolved around wet runway performance. Airports are currently conducting studies using subjective pilot data and direct measurements and black box data. They are looking at the conservative estimate used and considering doing flight tests and seeing if the current measurements are valid or if new estimates need to be conducted.

The next portfolio discussed was Aeromedical Research. Members were told that research in this area involved evidence-based medicine. All findings are based on real data collected from medical records, toxicology data, and medical reviews of accidents. Discussions then moved to Unmanned Aircraft Systems. Members felt that it was difficult to develop a research road map since the FAA did not have a big picture view of the studies that are being done. There is not a lot of activity from within the FAA and it is difficult to assess the validity of current research. There was also some debate on the amount of focus need for electronic visibility versus making UAS more visible using paint colors or other markings since it is the responsibility of the UAS to avoid collision. The final portfolio area discussed was Weather. The subcommittee agreed that the portfolio for this area was good.

During the portfolio wrap up discussions, it was mentioned that there is a need to research alternative fuels for GA. Lead is the main component in fuel for these aircraft and lead will soon be outlawed. Mark Orr also explained the breakdown of where the budget was allocated: Commercial (65%), GA (8%), Rotorcraft (6%), UAS (6%), and roughly 16% across the remaining areas. The portfolio discussions concluded with an invitation to provide feedback.

FAA organizations Supporting AVS Research Portfolios

Mark Orr presented a breakdown of AVS sponsored research and the organizations conducting the research. He explained that there is a broad range of sponsors and research areas. Commercial Airspace was identified as an emerging issue and there was agreement among subcommittee members for the possibility of a Commercial Airspace R&D subcommittee.

Aviation Research Division

Eric Neiderman provided a brief overview of the Aviation Research Division at the William J. Hughes Technical Center. He described that the mission of the divisions was to develop scientific solutions to current and future air transportation challenges by conducting applied research and development in collaboration with industry, academia, and government. Research conducted within this division includes pavement, airport and terminal, UAS, fire safety, aircraft structures, propulsion, digital systems, weather, and icing. Mr. Neiderman further explained the five R's of good R&D: scientific rigor, responsiveness, relationships domestically and in academia, resources such as human capital, and requirements. He gave a summary of the expertise contained within the division, which includes engineers, professors, PhDs, pilots, adjunct professors, and administrative staff. The division contains 14 labs that are specific to the divisions' mission. In many cases they are the only labs of their type in the world. Mr. Neiderman announced that the tech center completed the expansion of building 245 and in December of 2016 they had a ribbon cutting and dedication of the Structures and Materials Lab. He also highlighted some of the recent training initiatives such as OSHA training, University of Kansas Short Course on Aircraft Icing, FAA Certification Process, KSN Training, SAE Overview of the FAA's Certification Process, and Boeing 787 Familiarization. He also discussed the PEGASAS COE Fellows program.

Homework Assignment

Ken Hylander asked subcommittee members to submit their feedback and comments on the NARP by email to Xiaogong Lee. A slide presentation containing all feedback would be created and discussed on day 2. Mr. Hylander also identified potential areas for further discussion (current research on aircraft icing, the balance between aircraft and propulsion research spending, and UAS big picture) and requested that subcommittee members to be prepared to discuss these areas in more detail on day 2.

CAMI Aerospace Human Factors Research Division (AAM 500)

Dr. Carla Hackworth, Manager of the Aerospace Human Factors Research Division, provided an outline of the research that is conducted in the division. She explained that Human Factors is a multi-disciplinary field, which combines psychology, engineering, physiology, and other areas to generate and apply human performance information to acquire safe, efficient, and effective operational systems. The division is organized into two branches, NAS Human Factors Safety and Flight Deck Human Factors. The emphasis of the division is sponsor-driven research which includes design and optimization of work environments; human capabilities and limitations; human performance, fatigue, attention, user interface, and human error; and understanding how human psychological, social, and biological characteristics affect job performance in aerospace occupations. Dr. Hackworth provided an overview of the expertise and staff within the division. She explained that both branches contain a PhD-level manager and various levels of expertise including PhD level psychologists, MA/MS level psychological technicians, BS level psychological technicians, and student volunteers. The division also houses simulators (Very Light Jet; Unmanned Aircraft; Rotorcraft; Legacy General Aviation; and Enroute, TRACON and Tower Environments) and labs (Colorvision and Fatigue). The Human Factors division establishes relationships with local universities for volunteers and opportunities for future employment. Some current Human Performance research areas include UAS Detect and Avoid, Rotorcraft Safety, LaserEye Protection, Color Palette for ATC, and Tech Ops Strategic Job Analysis. She also explained that the division looks for opportunities outside of the FAA (i.e., Military collaboration) to ensure research efforts are not duplicated and research is enhanced for everyone.

Aerospace Medical Research

Dr. Estrella Forster, Manager of the Aerospace Medical Research Division, provided an overview of the division. She explained that the mission was to develop new and innovative ways to support FAA regulatory and advisory missions to improve the safety of humans in civilian aerospace operations. The contributions of the division include continued operational safety, standards and policy, risk management, and certification. She described the expertise within division which includes scientists, physicians, engineers, technical, and administrative staff. The Medical Research Division houses many labs and simulators such as the B-747 Aircraft Environment Research Simulator, FlexSim Aircraft Cabin Research Simulator, Water Survival Research Tank, B-727 Aircraft In-Flight Firefighting Research Laboratory, Cabin Safety Research Laboratories, SLED – Horizontal Accelerator – Impact Test Bed, Anthropometric Test Device Shop, Machine/Fabrication Shop, Altitude (Hypobaric) Research Chamber, Physiology Research Laboratory, High Performance Computer, Wet and Dry Laboratories, and many other Biochemistry/Physiology/Engineering Equipment and Analytical Software packages. Dr. Forster noted that the division provides services in multiple areas including Aviation Medicine (reports, publications, safety recommendations), Accident Investigation (accident causation, countermeasures), Aircraft Certification (seats, restraints, protective equipment), Flight Standards (evacuation, survival, cabin safety, human factors), and General Counsel (affidavits, court testimony).

Day 2: March 9, 2017

Homework and Feedback

Mr. Kenneth Hylander welcomed everyone back and after introductions he discussed the need to make a decision on future meetings. The next REDAC is scheduled for September 6-7, 2017 at the Tech Center. The 2018 Winter/Spring is tentatively planned for the last week of February.

Based on homework assigned on day 1, the subcommittee reviewed the 2019 proposed research portfolio related to UAS research. Much of the smaller items presented were questioned for their necessity and safety value in relationship to the understanding of UAS and conflicting research being conducted in the same general area. It is especially difficult to understand the context of this proposed research without viewing the full picture of FAA funded UAS related research given that an overwhelming majority of the UAS research resources are grants to the UAS COE. The final recommendation was to complete, update, and make routinely available to the subcommittee the full UAS implementation plan. Also the group would like to receive routine updates about the research being conducted by ASSURE.

SAS Member, Chris Kmetz, discussed the need to increase funding levels associated with propulsion research. The finding presented stated that as modern aircraft have evolved to employ new and novel materials to improve efficiency and reduce life cycle costs the FAA has appropriately applied increased funding levels to conduct research in the area of advanced materials. The majority of this funding is being directed at aircraft composite structures. Engine manufacturers also continue to push for improvements in fuel economy and provide some of the enabling technologies to the advancements and

benefits observed at the aircraft level. Mr. Kmetz pointed out that funding levels for propulsion research are declining and for FY19 the proposed funding is \$1.1 million. This is about a 50% reduction from 2015 levels. The recommendation presented was the FAA should evaluate the target funding levels for propulsion research with a goal of achieving a proper balance between aircraft and propulsion research spending.

The subcommittee then discussed current icing research. There is some concern that the aircraft size used in current research might not be translatable to a range of other sized aircrafts. The recommendation was it is important to assure that there is good consideration for the applicability of the SLD research being conducted to the range of aircraft sizes and speeds.

FY2020 Strategic Guidance

Mark Orr and Kenneth Hylander presented and led discussion on the AVS R&D strategic guidance for FY20. The goal of the strategic guidance is to emphasize areas of importance to aircraft safety based on hazards, risks, and safety issues that drive AVS research needs. Mr. Orr discussed that they were looking for the outcomes to be data driven and it's about the safety outcomes wanted in the NAS. The strategic guidance is ultimately approved by AVS-1 and then distributed to all AVS services and offices. The current FY20 guidance is under review by the AVS RED group and approval by AVS-1 is expected by the end of April.

The strategic guidance focuses on safety hazard and risk data, provides examples of safety hazard and risk data that drive research, supports SMS implementation plans, gives guidance for sponsoring offices and TCRGs to consider as they develop requirements, and used by sponsor management to apply adequate resources for requirement development. Mr. Orr stressed that it is not a checklist for the AVS RED group. The highlights of the FY20 strategic guidance are aviation safety risks for AVS-wide consideration, risks to aviation safety in the current NAS (i.e., Commercial Aviation (Part 121), General Aviation, Rotorcraft, Unmanned Aircraft), emerging risks to aviation safety (i.e., FAA Part 121, REDAC SAS Emerging Issues and Future Opportunities), significant safety issues (i.e., Risk-Based Decision Making Strategic Initiative), and key technology areas. The area of unmanned aircraft is new in the FY20 strategic guidance. Subcommittee members were advised that there has been a new office set up to look internally for issues due to safety management. Several safety issues, such as lighting on airports, PIREP, and Class B excursions, have been identified and mitigation plans have been created.

Kenneth Hylander opened the floor for discussion on the strategic guidance. There were conversations on how to make it more meaningful to those who read info about REDAC and opportunities to show what the SAS REDAC has accomplished (i.e., manufacturing, certification, engine issues). It was suggested that rather than a list of accomplishments there should be brief descriptions of what has been done in the past three or so years in REDAC. Some members wondered if the guidance would be more meaningful if there were a few items highlighted rather than an exhaustive list. Some also thought it might be beneficial to go back to the last few F&Rs and see what the top three items were and give a summary.

Real Time System-Wide Management Assurance (SAS 2016 Fall F&R No. 1) Discussion

Ken Hylander presented findings and recommendations for real time system-wide management assurance. This issue was identified as an emerging issue by the REDAC in fall 2014. Mr. Hylander stated that NASA is sponsoring a study on real time system wide safety assurance and a committee was formed to review the current processes and goals regarding the advancement of technology and tools. The objective is to outline an agenda for the safety of the NAS. The NASA study is intended to be a 30-year road map broken up into 10 year sections. They are working to establish a project plan with defined technical challenges so there will be usable data in 5 years. This involves design mitigation, operational mitigation, risk identification compared with target level of safety and observations assessments mitigation. There was some discussion on how air traffic management fits into the big picture. There was agreement that research is headed in the right direction but that it would be helpful to develop collaboration with the FAA. Mr. Hylander recommended the possibility of requesting a written deliverable every six months to assess the progress in this research. The subcommittee took an action to review the F&R report from fall of 2014 to ensure that the wording is still valid for the desired outcomes.

Fatigue Knowledge Affecting Aviation Safety (SAS Fall 2016 F&R No. 3) Discussion

Prior to the presentations on fatigue there was some discussion among subcommittee members. There were some concerns that there could be some items that are not addressed in research: commuter time, life away from work, or individual differences. An unintended outcome is you end up with rules that are too strict for some people and not enough for others – they only fit the average person. There is a need for training and education for individual coping strategies. What are the populations that are at risk? Currently scheduled air carriers are the main focus; need more focus on aeromedical transport and general aviation. In a 2012 poll one in five pilots admitted that they made a serious error due to sleep deprivation and NTSB reports indicate accidents in which fatigue was discussed in the narrative. At this time fatigue is not reported as a cause factor but is only discussed in the narrative. The subcommittee discussed some possible general research questions, such as accident trends, policy effectiveness, the need for sleep deprivation research, and strategies for people who are more vulnerable to fatigue or even resistant.

SAS Member, Captain Jim Mangie, discussed ongoing fatigue research at Delta. He explained that there have been significant Part 117 changes: standardized definitions were set, flight time and flight duty period limitations were created, rest period of 10 hours off duty with 8 hours of uninterrupted sleep required, and implementation of a Fatigue Risk Management System (FMRS). The FMRS is a data driven means of continuously monitoring and managing fatigue related safety risk based upon scientific principals and knowledge as well as operational experience that aims to ensure relevant personnel are fit for duty. Captain Mangie explained that the rules are science based. There is some concern that the science may not be applied correctly or if rules are actually mitigating fatigue to an acceptable level. Currently every air carrier is required to have a fatigue risk management plan that is approved by the FAA. An FMRS would allow operations outside of the prescriptive limits.

Fatigue and Aviation Research Issues (US army)

SAS member, Dr. John Crowley, Science Program Director of US Army Aeromedical Research Laboratory (USAARL), discussed fatigue research needs and Army aeromedical research initiatives. The goal of the research is to bring attention to fatigue issues that the FAA may be overlooking. The concern is that things get incorporated into rules and guidelines are things that are easy to measure (i.e., how many hours did you sleep, tasks before a shift to gauge fatigue, how many time zones crossed). This generally results in flight/duty limits. He challenged that there could be other concerns that current research is not addressing. One major concern is that most medications were not reported by airman that could be potentially affecting alertness. He also mentioned that there are medical conditions and other factors that can influence fatigue. He also challenged that we need to continue to look at sleep deprivation in fatigue, effectiveness of policy (mandated and voluntary), looking individual differences (is there a need to look at different work cycles, jet lag, napping etc). The question was posed whether military handles fatigue differently. Mr. Crowley explained that there are some differences but they are similar to civilian policies. There was also some discussion on whether the cabin environment in newer planes could influence fatigue. Right now we know that the quality of the rest facility makes a difference but there is not sufficient data to give feedback on the plane itself (i.e., cabin pressure).

FAA CAMI Fatigue Research Overview

Dr. Tom Nesthus presented on fatigue studies completed at CAMI. The studies cover Air Traffic Control, Technical Operations, Flight Attendants, Pilots, Maintenance, and Genomics. Dr. Nesthus presented a timeline of fatigue research that began in 1990. He discussed that the Flight attendant research in 2005 resulted in 6 recommendations: survey of field operations, field research on the effects of fatigue, validation of models for assessing flight attendant fatigue, focused study of incident reports, international carrier policies and practices, and training. This resulted in the FY08 Omnibus Spending Bill which directed CAMI to conduct analysis in the six areas. He then discussed fatigue mitigation in flight operations. In 2010 a mandate from Airline Safety and FAA Extension Act requiring all Part 121 air carriers to adopt a Fatigue Risk Management Plan (FRMP) was enacted. The objectives of an FRMP are to mitigate and manage day to day flight crew fatigue from within the regulatory structure. He then discussed Fatigue Risk Management System (FRMS) as an optional approach to safely conduct specific flight operations that are currently under rule 117.7. The FRMS provides the carrier with flexibilities not found in the prescriptive regulations and the implementation process identifies and reduces the risk of fatigue associated with specific operational circumstances. The FRMS authorization process consists of pre-application, planning, and assessment; formal application; documentation and data collection plan; demonstration and validation; and authorization, implementation, and monitoring. Each application for an FRMS is entered into a database. Dr. Nesthus then discussed research concerning maintenance and cargo load supervisors. A study conducted in 2001 showed that maintenance technicians only sleep an average of 5:05 hours a night. A follow-up study was conducted in 2016. He explained that data were collected from 215 participants across parts 121, 135, and 91. Maintenance fatigue research with maintenance technicians has shown that there is sufficient evidence for a need for policy. An advisory circular was published in December of 2016 describing the basic concepts of fatigue as it relates to maintenance organizations and individual personnel. The circular also outlines the benefits of a FRM program for maintenance organizations and provides guidance for integrating FRM into SMS. There was some discussion among subcommittee members about what data could be used to test the effectiveness of an FRMS.

Developing Objective Metrics for Fatigue Impairment

Dr. Hilary Uyhelji, Aerospace Medical Research Division, presented the genome research conducted at CAMI. She explained that there is a need for improved fatigue metrics. Currently metrics are inferred from time of day, time on task, or work schedule. Since fatigue impairs performance for most people, RNA markers are being studied since these markers respond to stress associated with impairment levels. Early findings show that the RNA for SPDY/RINGO can be used to measure fatigue but more studies need to be conducted. A study planned for 2018 will compare four study groups: well-rested, total sleep deprivation for 62 hours, chronic sleep deprivation – nighttime sleep of ~5 hours, and chronic sleep deprivation – daytime sleep of ~5 hours. The outcome of this study is to validate RNA metrics across multiple types of sleep loss and multiple measures of performance (attention, decision making, responses to feedback). Dr. Uyhelji also discussed a study of gene expression patterns in response to modafinil. The study will include 30 people that will participate in two study runs: 36 hours total sleep deprivation and 36 hours total sleep deprivation with modafinil. The outcome is to discover how RNA metrics are affected by the presence of a fatigue drug countermeasure. The ultimate goal of both studies is to develop a “black box” for the human body, aid in accident prevention, and to diagnose impairment due to fatigue prior to duty. The end goal is not to ground a pilot because they didn’t get enough sleep, but because they are cognitively impaired.

Some committee members felt that fatigue needs to be highlighted as a causal factor in accidents so the importance is not diminished. There was also some discussion that there is still a gap in fatigue research. The recommendation was to close the current F&R and draft one that is more in-depth to bridge the gaps.

Additive Manufacturing (SAS 2016 Fall F&R No.2) Discussion

SAS Member, Chris Kmetz, Vice President of Engineering at Pratt Whitney, discussed additive manufacturing. He explained the importance to understand how additive manufacturing adds value by reducing cost. As of right now there is not a time to market. The critical drivers to future success are developing requirements for material design space, process development and controls, and establishment of quality control capabilities. The final outcome is a robust process for airworthiness. Mr. Kmetz stressed that the process is important for quality products. There is not a need to create a unique design process. Additive manufacturing allows for a unique capability but use the same quality control that would be used on any other material. He explained that additive manufacturing is appealing but very difficult. The challenge is the control of the materials, process, and powder. The control of these materials is necessary for a good product. He concluded by stating that existing development and validation methodologies are being utilized, extensive characterization of the relevant processes and materials is a set of standards and specifications that provide process control, and involvement with industry standards committees is key to future certification.

FAA Additive Manufacturing Roadmap Update

Dr. Michael Gorelik, FAA Chief Scientist and Technical Advisor (CSTA) for Fatigue and Damage Tolerance, presented the progress of the FAA roadmap for additive manufacturing. Progress since September 2016 includes development of the roadmap framework and process, interim review with FAA management, feedback from other government agencies and industry, and an additive manufacturing “version 1.0” scheduled to be delivered to management in September 2017. The roadmap will be divided into six

“swimlanes,” four regulatory (certification process, production/QA, maintenance/MROS, COS) and two training and education (workforce education (FAA+designees+industry), research and development). Dr. Gorelik explained that they want to populate a vision for the future but we may not currently have enough internal knowledge and experience to address some of the key items of the roadmap. He presented options that are being considered to address the current knowledge gaps, such as industry engagement, research and development (internal / external), CSTA and other targeted workshops, FAA additive manufacturing certification projects benchmarking, and coordination with NAAs. The current additive manufacturing national team research plan involves five tasks: partner with AM consortia – ongoing research with KART and CMU, static special factors, powder reuse for static strength applications, sensitivity study for fatigue behavior of anomalies and assessment of NDI methodologies, and evaluation of life prediction methodologies for AM.

FAA FY2016 Fall F&R Responses as discussed above:

The subcommittee felt that the written FAA responses and actions taken based presented and discussed were sufficient to close out all of the three FY2016 Fall F&Rs.

General Aviation Safety and Emerging Challenges – SAS/Industry Perspective in FAA Research Needs

Greg Bowles, GAMA, discussed GA safety and emerging challenges. He explained that we care about accidents but we really care about fatal accidents. If someone dies or is seriously injured this is a big issue. The biggest issue facing GA is loss of control. In years past controlled flight into terrain was the largest factor in fatality accidents. Since hand held GPS came on the market in 2004-2005 there has been a steady decline in CFIT accidents. The vision in the next 5 years is to solve loss of control. This is where CAMI comes in; we need to know what the fatal variables are in otherwise preventable crashes. He also discussed the need to focus on increased automation. We are approaching a time of self-driving cars and the next step will be self-piloting planes. Future needs will be how to license these pilots, or operators and standards for licensing electric planes. What are the short-term or long-term plans? Mr. Bowles also explained that companies are starting to use UAS for light package delivery and we need to look at higher flight restrictions for UAS so there is room to use parachutes.

Mr. Bowles introduced Mark Moore of Uber to discuss the future of electric aircraft. Mr. Moore explained that Uber is attempting to set up the ecosystem for on-demand air transportation. Their goal is not to create the aircraft but provide the market for use of the aircraft. He noted that there is a lot of venture capital for on-demand vertical takeoff and land vehicles and that companies such as Airbus are jumping into this market. This type of transportation can provide an energy cost reduction since electricity price is about half the cost of current fuels. He concluded that there is going to be an evolution of autonomy but we will need pilots. The question is do we need commercial pilots with many hours or can we train pilots that can map to the autonomy and have reduced pilot requirements?

FAA Perspectives – GA Safety with Emerging Technology

Wes Ryan, FAA Small Airplane Directorate, discussed the FAA perspective on GA safety with emerging technology. He explained that much of the aging GA fleet couldn't take advantage of new technology due to the cost. He showed that loss of control is now the number one cause of fatality accidents. In the US someone dies from loss of control every 2-3 days. In the past some research and development and policy changes have helped bring affordable technology to the GA fleet. He explained that auto land and

auto takeoff are in the near future. The main research question here is can automation replace the pilot? The key areas to focus on are certification and human factors.

The subcommittee expressed concern that there was no discussion of autonomous air traffic control to go along with automated aircraft. They were assured that it was part of the discussion but just not mentioned during the presentation. There was discussion for the need to look at opportunities from other technologies and unmanned aircraft that could contribute to the research in these emerging issues. The recommendation was to revisit this topic. There is not a current need for an F&R at this point just more thought and review.

Wrap up and Final Discussion

Ken Hylander thanked the subcommittee for their attendance and discussed new FY2017 Spring F&Rs and action items. He asked John Cavalowski to help with wording for national resource for the portfolio as part of his Summary Report to the full REDAC. He encouraged the subcommittee to continue discussions and feedback on the new portfolio. Mr. Hylander felt the need to revisit the GA safety and emerging technology issues in September.

Mr. Hylander summarized that, based on discussions and feedback of SAS members, there would be three (3) new FY2017 Spring Findings and Recommendations. He assigned these F&Rs to SAS members to draft up the corresponding F&Rs to be distributed to full membership for comments and concurrence as:

1. SAS Member, Chris Kmetz, would draft a F&R on funding priority/distribution of aircraft propulsion systems R&D program;
2. SAS Member, Andy Lacher, to draft/update the UAS F&R as submitted as part of the Day-1 homework;
3. SAS Members, Captain Jim Mangie and Dr. John Crawley, to draft a F&R on Fatigue.

In addition, there were three (3) actions that the SAS would like the FAA to prepare to be addressed at the next SAS meeting, 2017 Fall.

The SAS Chair and FAA DFO jointly adjourned the meeting.

APPENDIX I

SAS CHAIR'S MEETING SUMMARY REPORT TO REDAC

2017 Spring Meeting Findings and Recommendations

Meeting Summary:

The Subcommittee on Aircraft Safety (SAS) met on March 8 and 9, 2017 in Oklahoma City, OK, at the FAA Civil Aerospace Medical Institute, for its routine spring meeting. This meeting had three specific objectives on its agenda:

- 1) Review and provide comment on the FAA's 2019 safety research plan
- 2) Continue to explore previously identified emerging issues and trends from an industry perspective that may be helpful for the FAA gaining a deeper understanding of required research
- 3) Consider what input, if any, should be included in the agencies internal strategic guidance document for developing the FY 2020 aviation safety research plan

To assess the 2019 research plan, a new approach was developed which greatly assisted our efforts. Rather than the traditional quad charts we have historically reviewed the FAA staff prepared a Research Program Area Review. This review bundled current and proposed research into 15 major program areas. We then had an opportunity to gain a higher-level insight into the research outcomes, tasks and anticipated 2019 deliverables. Additionally, we were provided visibility to more comprehensive funding information which enabled a broader picture of the research efforts. All SAS members agreed that this method of review was far superior to prior efforts and that the Subcommittee dialogue was greatly enhanced. SAS continued its practice of engaging both Subcommittee members and agency expertise to inform our discussions. Findings and Recommendations related to advanced propulsion materials, fatigue and UAS are attached to this report.

The Subcommittee was pleased to note progress on several of our prior recommendations. Specifically, we were provided an update on the agencies efforts to refresh the National Aviation Research Plan (NARP) and enhance its connection to the specific safety research of the agency. As a Subcommittee, we were provided an opportunity to discuss the specific goals and objectives being considered in future versions of the NARP. We were also quite pleased to see significant progress on the development of comprehensive research related to Additive Manufacturing. This has been a topic for which the SAS has issued four previous findings and recommendations. We have closed our prior Findings and Recommendations in this area. Subcommittee members were encouraged to individually provide specific feedback on the NARP goals and objectives direct to the FAA. The Subcommittee members provided this feedback prior to the close of the meeting.

SAS believes that there is value in considering the existing and planned research against a set of emerging and future issues, which may have an impact on aviation safety. We continue to keep these previously developed issues in mind in our reviews and in fact they drive the formulation of our meeting agendas with deep dive presentations. Of note at this meeting was a briefing on General Aviation safety and the impact of the convergence of distributed electric propulsion and autonomy. This is an area that we will continue to watch closely. With these future issues in mind the SAS has made a general recommendation that, once again, our emerging issues get a broader audience within the AVS community by including them in the FY 2020 strategic guidance document.

The SAS will meet next on September 6 and 7, 2017 in Atlantic City, NJ for our fall 2017 meeting.

Respectfully Submitted,

Ken Hylander

Chair, REDAC Subcommittee on Aviation Safety

APPENDIX II: 2017 SAS SPRING MEETING REQUESTED ACTIONS2017 Spring Meeting Actions

1. The Subcommittee indicated that it is important to assure that there is good consideration for the applicability and whether extrapolation of the SLD research being conducted to the range of aircraft sizes and speeds is reasonable.
 2. The Subcommittee would like more details on how the funding for the A11G budget line is allocated, i.e., what is the number of FTEs supported, and what are their roles (subject matter experts, research staff, program managers, etc.)
 3. The committee requests a briefing to understand how all the funding in the A11G budget is used to support AVS and their role in aviation safety.
The Subcommittee also requests that, in one year, the FAA brief back their plan for addressing fatigue as a safety hazard across the spectrum of US civil aviation, or explain why this is not felt to be a medical/human factors research priority.
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SAS 2017 SPRING MEETING AGENDA

Dress code: *Business Casual*

Location: FAA Civil Aerospace Medical Institute (CAMI)
Mike Monroney Aeronautical Center (MMOC)
Auditorium, Building 13
Oklahoma City, OK

Wednesday, March 8, 2017

Time	Topic	Presenter(s)
7:30 – 8:15	Security Check in and badging	MMAC Visitor Center
8:15 – 8:20	Site Intro/Logistics	Estrella Forster
8:20 – 8:30	Group Photo	All
8:30 – 8:45	Introduction/Welcome/Opening remarks (MMAC Director)	Michelle Coppedge
8:45 – 9:15	FAA Director of Research Overview	Shelley Yak
9:15 – 9:45	CAMI Overview	Tom Chidester
9:45 – 10:00	SAS Chair Opening & Report on REDAC meeting	Erick Neiderman (DFO) Ken Hylander (Chair)
10:00 – 10:15	Break	
10:15 – 10:35	FAA Budget Update	Mike Gallivan
10:35 – 11:05	FY2019 Portfolio Review: Fire, PS, SIC, & AI ¹	Mark Orr/Eric Neiderman
11:05 – 11:35	FY2019 Portfolio Review: SDS/ASISP, CASys, CAStr, & CAF ²	Mark Orr/Eric Neiderman
11:35 – 1:00	Lunch & Bookstore visit https://www.ebookstore.com/store/	
1:00 – 1:30	FY2019 Portfolio Review: HF, SSM, TAS, & Wx ³	Mark Orr/Eric Neiderman
1:30 – 2:00	FY2019 Portfolio Review: AM, & UAS ⁴	Mark Orr/Eric Neiderman
2:00 – 2:10	FAA organizations supporting AVS research portfolios	Mark Orr
2:10 – 2:35	Aviation Research Division – Technical Center	Eric Neiderman
2:35 – 2:50	Break	
2:50 – 3:15	CAMI – Aerospace Human Factors Research Division	Carla Hackworth
3:15 – 3:50	CAMI – Aerospace Medical Research Division	Estrella Forster
3:50 – 4:10	NextGen Technology Development Directorate (HF/UAS/Wx)	TBD
4:10 – 5:00	CAMI Lab Tour (Aerospace Medical Research Division)	Estrella Forster
6:00	Group Dinner – Charleston’s Restaurant, 3000 S Meridian Ave, OKC	

¹ Fire, PS, SIC, & AI: Fire Safety, Propulsion Systems, Structure Integrity – Composite, Aircraft Icing

² SDS/ASISP, CASys, CAStr, & CAF: Digital System Safety/Aircraft Systems Information Security Protection, Continued Airworthiness – Systems, Continued Airworthiness – Structures, & Catastrophic Failure Prevention

³ HF, SSM, TAS & Wx: Human Factors, System Safety Management, Terminal Area Safety, & Weather

⁴ AM & UAS: Aeromedical Research & Unmanned Aircraft Systems

Thursday, March 9, 2017

Time	Topic	Presenter(s)
8:00 – 8:30	Review Day-1 homework, feedback, etc.	Ken Hylander, Eric Neiderman, & Mark Orr
8:30 – 9:00	FY2020 Strategic Guidance & SAS input	Mark Orr & Ken Hylander
9:00 – 9:15	SAS Emerging Issues Overview and Expectations	Ken Hylander
9:15 – 10:00	Real-Time System-Wide Safety Management Assurance (SAS 2016 Fall F&R No. 1) Discussion	Ken Hylander, SAS John Cavalowski, SAS/NASA
10:00 – 10:15	Break	
10:15 – 10:45	Fatigue Knowledge Affecting Aviation Safety (SAS 2016 Fall F&R No. 3)	Jim Mangie/John Crowley, SAS
10:45 – 11:45	FAA Research Initiatives in Fatigue & Human Factors – coherent & holistic views	Carla Hackworth & Hilary Uyhelji
11:45 – 12:45	Lunch	
12:45 – 1:45	CAMI Lab Tour (Human Factors Research Division)	Carla Hackworth
1:45 – 2:00	Break	
2:00 – 2:15	Additive Manufacturing (SAS 2016 Fall F&R No. 2)	Chris Kmetz, SAS/P&W
2:15 – 3:00	FAA roadmap update, R&D plan, and research activities	Michael Gorelik & Ken Knopp
3:00 – 3:45	General Aviation Safety and Emerging Challenges – SAS/Industry Perspective in FAA research needs	Greg Bowles, GAMA
3:45 – 4:00	FAA perspectives – GA safety with emerging technologies	Wes Ryan, FAA SAD
4:00 – 4:30	Break-out sessions: AAM-600 Conference Room 102	Participants
4:30 – 5:00	Closing remarks SAS F&R discussions and feedback	Tom Chidester, CAMI Deputy Director Ken Hylander, Eric Neiderman & Mark Orr
5:00	Adjourn	

LISTS OF ATTENDEES

Attendees - March 8th

In-Person

Attendee	Company
Eric Neiderman	FAA Aviation Research
Ken Hylander	Flight Safety Foundation
Mark S. Orr	FAA, AVP-300 AVS R&D Manager
Greg Bowles	GAMA
Chris Kmetz	Pratt & Whitney
John A. Cavolowsky	NASA Aeronautics
David Polland	Boeing Commercial Airplanes
Tom Chidester	Deputy Director Aerospace Medical Institute
Jim Mangie	Delta Airlines
Andrew Lacher	MITRE
Mike Greco	FAA
Maureen Molz	FAA
Shelley Yak	FAA
Paige Williams	FAA
Suzanne Thomas	Cherokee CRC (FAA contractor)
Robert Irons	Boeing
Joseph Jaworski	Cherokee CRC (FAA contractor)
Michelle Yeh	FAA
Daniel Brock	FAA
Bill Crossley	PEGASAS
Ryan King	FAA
Ken Knopp	FAA
Jackie Simmons	FAA
Estrella Forster	FAA AAM-600
Carla Hackworth	FAA AAM-500
Esther Devanney	Cherokee CRC (FAA contractor)
Katina Avers	FAA AAM-510
Mike Paglione	FAA ANG-E27
Jorge Fernandez	FAA ANE-110
Tim Evans	FAA
Xiaogong Lee	FAA
Chinita Roundtree-Coleman	FAA

On Phone

Attendee
Bill Lemmerling
Frank Wondowlowski
Jimmy Bruno
Dave Atwood
Mark Muchler
Steve Edgard
John White
Angela Campbell
Isidore Venetas

Attendees - March 9th**In-Person**

Attendee	Company
Eric Neiderman	FAA Aviation Research
Ken Hylander	Flight Safety Foundation
Mark S. Orr	FAA, AVP-300 AVS R&D Manager
Greg Bowles	GAMA
John A. Cavolowsky	NASA Aeronautics
Jim Mangie	Delta Airlines
Andrew Lacher	MITRE
Maureen Molz	FAA
Shelley Yak	FAA
Paige Williams	FAA
Suzanne Thomas	Cherokee CRC (FAA contractor)
Joseph Jaworski	Cherokee CRC (FAA contractor)
Michelle Yeh	FAA
Daniel Brock	FAA
Bill Crossley	PEGASAS
Ryan King	FAA
Ken Knopp	FAA
Jackie Simmons	FAA
Estrella Forster	FAA AAM-600
Carla Hackworth	FAA AAM-500
Esther Devanney	Cherokee CRC (FAA contractor)
Katina Avers	FAA AAM-510
Mike Paglione	FAA ANG-E27
Jorge Fernandez	FAA ANE-110
Tim Evans	FAA
Xiaogong Lee	FAA
Chinita Roundtree-Coleman	FAA
Dennis Burian	FAA AAM-612

Attendee	Company
Hilary Uyhelji	FAA
Thomas Nesthus	FAA

On Phone

Attendee	Company
Michael Gorelik	FAA
Mark D. Moore	Uber
Wes Ryan	FAA
John White	ALPA