

Federal Aviation Administration (FAA)

Research, Engineering, and Development Advisory Committee (REDAC)
Subcommittee on Aircraft Safety (SAS)

William J. Hughes Technical Center
Atlantic City International Airport
Atlantic City, NJ 08405

September 9-10, 2015

Meeting Minutes

Federal Aviation Administration (FAA)

Research, Engineering, and Development Advisory Committee (REDAC)
Subcommittee on Aircraft Safety (SAS)

William J. Hughes Technical Center
Atlantic City International Airport
Atlantic City, NJ 08405

September 9-10, 2015
Director's Conference Room

Meeting Minutes

SAS Chair: Ken Hylander – Flight Safety Foundation

Designated Federal Official (DFO): Eric Neiderman, FAA, Manager, Aviation Research Division

Note taker: Dennis Flath

Day 1 – September 9, 2015

Welcome/Opening Comments/Agenda Review

Ken called the meeting to order at 8:47AM and welcomed the SAS members, FAA participants, and all others in attendance or on the phone. Ken initiated an introduction of those present in the room and on the phone. Eric Neiderman added his welcome to the group.

Ken introduced Patricia Culler, Boeing, as a pending member of the SAS. He also made the announcement that Joe Del Balzo has officially retired from the SAS.

Eric presented several slides explaining the planning process for the SAS meeting, including the focus, approach, and key themes: software, system safety, and composites/additive manufacturing. He showed a 6 minute video *Aviation Safety R&D Programs – Strategic Portion*.

Strategic Input (Tab B in Binder)

Presenter: Ken Hylander (SAS Chair)

Ken level-set the meeting expectations by presenting *Subcommittee on Aircraft Safety 2015 Fall Meeting Strategy Refresh*. He reviewed the Findings & Recommendations from the previous Spring meeting and the associated REDAC letter to the Administrator. It was noted the FAA has not officially responded to these F&Rs. Ken also observed that two of the REDAC priorities came from the SAS emerging issues: additive manufacturing and big data. He also referenced a successful meeting with AVS management on April 23, 2015, regarding the FY17 portfolio and the importance of keeping the SAS emerging issues and future opportunities as the backbone for

future SAS deliberations. The objectives are to keep AVS management, the Chief Scientific and Technical Advisors (CSTAs), and the SAS aligned with a focus on research outcomes.

Ken reiterated on Slide 12 of his presentation *Carrying on our Strategy* that the meeting agenda was built with a strong connection to *Emerging and Future* issues:

- Certification of Advanced Materials and Structural Technologies
 - Additive Manufacturing topics
- Dependability of Increasingly Complex Systems
 - SDS Research Plan
 - Cyber Security
- Mixed UAS and Manned Aircraft Operations
 - UAS R&D Plan
- Real Time System-wide Safety Assurance
 - Big Data/ASIAS Lab Tour

Budget Update (Tab C in Binder)

Presenter: Mike Gallivan (FAA on phone)

Mike presented *REDAC Aircraft Safety Subcommittee R&D Budget Status*. Mike's presentation included information about the enacted FY15 RE&D budget and the FY16 RE&D budget request. He reviewed recent language from the House and Senate on the FY16 Budget Request. There is an emphasis on UAS. He reminded the SAS that sequestration is still an issue and that it is likely that FY16 will start under a continuing resolution (CR) and an extension to the current Authorization that expires 9-30-15.

AVS RE&D Portfolio (Tab D in binder)

Presenter: Mark Orr (FAA)

Mark presented *AVS Portfolio Overview*. He addressed modifications to the FY15 portfolio driven by Congressional appropriations and reprogramming by AVS management. Mark presented Finding & Recommendation SAS Spring_2015_2 *Research Roadmap Development* but deferred discussion until after the Administrator releases the official Agency response. His last slide did show a variety of detailed roadmaps and plans within AVS.

Air Force Qualification Pathway (Tab E in binder)

Presenter: Rollie E. Dutton (Air Force Research Laboratory - AFRL)

Rollie presented *The Air Force Qualification Pathway and its Challenges for AM*. He pointed out that advanced manufacturing (AM) technologies are out-pacing structural analysis capabilities. He contrasted between historical or subtractive manufacturing and future or additive manufacturing. Slide 16 *AFRL Additive Manufacturing Strategy* covered risk quantification tools, research targeted to inform qualification of materials and processes, and

advanced modeling and simulation. All three are intended to support engineering judgment, not replace it.

AM Update (Tab E in binder)

Presenter: Dr. Michael Gorelik

Michael presented *AM Update per SAS Recommendations*. He discussed the AVS approach towards developing the AM Roadmap and both the internal and external research needs. AM spans a breadth of processes and application domains (Slide 8). Michael included a number of slides that delved into a recent Joint FAA – Air Force Workshop on Qualification / Certification of Additively Manufactured Parts. There was some discussion about the fact that the FAA does not have a process in place or guidance to give in the event of an AM application request from industry, and that R&D alone may not be enough to solve this problem.

SAS members expressed unanimous appreciation for both presentations. The SAS will consider Finding & Recommendation (F&R) on the topic

UAS R&D Update (Tab G in Binder)

Presenters: Claude Jones (FAA) and Sabrina Saunders-Hodge (FAA, on phone)

Claude presented *UAS R&D Update*. He provided an overview on Slide 3 *New Entrants UAS R&D Portfolio*. He mentioned that he expects requirements from the Air Traffic Organization (ATO) in the future. He also covered UAS research inventory mapping (RIM). RIM is a web-based database application that will act as a searchable repository for all on-going and completed UAS research.

Sabrina-Saunders-Hodge presented an overview of the newly established Air Transportation Center of Excellence for UAS – Alliance for System Safety of UAS through Research Excellence (ASSURE). She discussed the ASSURE membership and the initial technical focus areas and planned research for FY15 and FY16. Sabrina initiated discussion about the partnership with NASA. Paul Rumberger (FAA, on phone) spoke more specifically about the UAS Pathfinder Program.

Claude then resumed discussion about the FY16 UAS research requirements.

Software & Digital Systems (Tab H in Binder)

Presenters: Alanna Randazzo, Srinu Mandalapu, John Zvanya (all FAA) and Barbara Lingberg (FAA, on phone)

Alanna presented *Software & Digital Systems Research*. She and Barbara provided an overview of the research team, core research areas, and how recent research accomplishments impact AVS guidance material.

Srini presented *Software Tools and Technologies*. His presentation addressed: Assurance Case Applicability to DO-178C, Multi-core Processors in Avionics, and Software Service History and Airborne Electronic Hardware Service Experience. Srini also presented *System Complexity Research*. This portion of his presentation addressed System Architecture Virtual Integration (SAVI) and Complexity Measurement.

John Zvanya presented *Single Event Effects (SEE)*. John explained the vulnerability of aircraft electronics to cosmic ray secondary neutrons and the need for a cosmic ray neutron simulation facility.

Aircraft Cyber Security (Tab I in Binder)

Isidore Venetos (FAA) presented *Aircraft Systems Information Security Protection (ASISP) Research*. Steve Paasch (FAA) was on the phone.

Isidore identified the root of the ASISP problem statement as the migration to network-centric architectures for aircraft systems. These create vulnerabilities that, if exploited, could impact aircraft airworthiness. Research is needed to assess ASISP risks, explore mitigations, and guide regulatory action to ensure continued operational safety. Isidore identified risk analysis as the key elements for ASISP safety risk assessment research framework (Slide 5). He described a three-phase R&D approach that extends out through FY2020. Steve Paasch added that the FAA certifies the aircraft but does not own or operate the aircraft. Isidore concluded by saying that the R&D does not specifically address UAS but the goal is to build a framework that can address UAS and other risks.

Big Data/ASIAS Laboratory Tour

Tom Tessitore (FAA) presented *High Performance Computing, Big Data, & ASIAS*.

Tom explained that the goal of this effort was to provide a portal for FAA researchers to access FAA data. This includes ASDE-X, radar, and flight plan data as examples. Ideally the portal would provide gate-to-gate data via a threaded track. Tom said that this type data is available outside the FAA but only with permission, not for wide distribution. There are no embedded toolsets for analysis, it is more like a card catalogue of data sets. The ASIAS laboratory tour was cancelled to time constraints.

Quad Chart Review (Tab J in Binder)

Ken Hylander led a discussion about the FY15 Quad Charts that were reviewed by the SAS members. SAS members contributed comments to the Quad charts prior to the meeting. The DFO assembled these comments into a matrix document titled *SAS Member Review of FY15 Quad Charts for Summer 2015 SAS Meeting*. This document was included in the binder. It includes the SAS reviewer, the comment, FAA point of contact (POC), and the FAA resolution of the comment. Each comment and resolution was presented, discussed, and revised as necessary by the SAS. A final e-copy will be made available to the SAS on the KSN web site. The SAS elected to stop discussion for the day and resume in the morning.

Meeting Adjourned at 5:05 PM.

Day 2 – September 10, 2015

Ken Hylander called the meeting to order at 8:30 AM. SAS members agreed to adjust the agenda to continue reviewing the FY15 Quad Charts.

SAS members noted that some of the Sponsor Outcomes appeared to be research outcomes. Mark Orr replied that the FY15 Quad Charts are the product of a AVS Requirements Process that was adopted in FY13. Some of the Quad Charts are still in transition from the pre-FY13 process.

The SAS extended their appreciation for the Quad Chart effort. They suggested that the format is fine but they should include life-cycle and financial elements as well; and be a useful document to the researcher. The Quad Chart is part of a larger view – start with the big picture.

The SAS considered writing an F&R to this topic.

ACTION ITEM #1: Complete and post FAA resolution to all FY15 Quad Charts and FY17 Quad Charts comments from Spring 2015 SAS meeting.

International Research Collaboration – NLR (Tab K in Binder)

Presenter: Michel Piers (National Aerospace Laboratories - NLR - Netherlands)

Michel presented *The Future Sky Safety Program - And Collaboration in Aviation Safety Research*. He briefly explained the history, capabilities, and role of the NLR and the Association of European Research Establishments in Aeronautics (EREA). The balance of the presentation focused on the Future Sky Safety program overview with an emphasis on perspectives on cooperation in safety R&D. It was noted that one of the Future Sky Safety projects *Total system risk assessment* (Slide 18 in presented material) resonates with one the SAS emerging issues *Real-time System-wide Safety Assurance*. Michel ended his presentation with a proposal for a deeper layer of cooperation with the FAA research community through shared resources.

The SAS members expressed great appreciation for this presentation and suggested that the cooperation suggested by Michel could be viewed by the SAS as a *Future Opportunity*. The SAS members considered writing and F&R on this topic.

The NASA/FAA Research Transition Teams presentation and the Ames Safety Case Tools update were postponed till the next SAS meeting.

High Ice Water Content (Tab M)

Presenters: Jim Riley, Chris Dumont, and Stephanie DiVito (All FAA)

Jim initiated the presentation *High Altitude High Ice-Water Content Ice Crystal Flight Research*. John Fisher (FAA) and Tom Bond (FAA CSTA) were on the phone. Jim explained that the number of engine icing events over the last 25 years, including 10 total power losses over the last 3 ½ years, prompted the FAA to issue an Airworthiness Directive in July 2015. Consequently, the atmospheric research program objectives include an evaluation of ice crystal engineering standards, development of simulation methods for ground testing and computational modeling, and development of ice crystal weather tools in support of avoidance strategies.

Chris Dumont presented information about the High Ice Water Content (HIWC) field campaigns I Darwin, Australia, Cayenne, French Guiana, and southern Florida. His presentation material covered logistics, flight profiles, instrumentation, and data collection. Data analysis is in progress.

Stephanie DiVito presented the meteorological aspects of the southern Florida flight campaign, especially the mesoscale convective systems and flight path planning. Stephanie provided insight regarding the weather forecasting and now-casting necessary for target selection in both Atlantic seaboard and Gulf of Mexico target areas

Jim concluded the presentation by stating that analysis of the data will support engineering standards, and simulation methodologies. The FAA priority is to address mitigation strategies for exposure of the current fleet to high altitude, high concentration ice crystal environments.

The SAS requested more clarity regarding the HIWC presentation and the Quad Charts, and the coordination between R&D efforts that support regulation and means of compliance.

ACTION ITEM #2: Provide FAA icing plan.

Alternative Fuels Laboratory Tour and PAFI Update (Tab N in the Binder)

Presenters: Maryfaith Rodgers (FAA) conducted the tour and Ken Knopp (FAA) presented *NextGen Alternative Fuels for General Aviation*.

Maryfaith and Ken conducted tours of the Propulsion and airPOWER Engineering Research laboratory (POWER lab) at Buildings 292 and Building 211. These buildings house the chemical analysis and engines test cells components, respectively. Maryfaith discussed fuel composition and how it is determined at the POWER lab using gas chromatography combined with mass spectroscopy and flame ionization detectors, and the low temperature viscometer (tool to measure of the “stickiness” of a fluid). She showed the group instrumentation for measuring density, distillation, and vapor pressure of fuels; and the impact of these parameters to aircraft performance like weight and balance, starting, vapor lock, operability and throttle transients.

Ken conducted an informal Q&A with the SAS members at Building 211 regarding the full-scale engine test cells and the relationship between the POWER lab, the fuels program office, and the industry advisory committee. Testing capabilities include engine performance, emissions, and starting, and an altitude system, capable of testing to 25,000 feet altitude.

The SAS returned to the Directors conference room for a formal briefing. Ken showed a path to an unleaded Avgas that began in 2010 when the FAA took on a leadership role to form a public/private partnership. The result was the Piston Aviation Fuels Initiative (PAFI) with a mission to “facilitate development and deployment of an unleaded AVGAS with the least impact on the existing piston-engine aircraft fleet.” He discussed the PAFI process in great detail and the status of testing to date at the William J. Hughes Technical Center. It was mentioned that the intent is to use the existing Avgas infrastructure, including pipelines, trucks, and airports storage facilities.

SAS Strategic Views

Mark presented Overall FY18 Portfolio Schedule. This presentation provides a snapshot on the timeline for the preparation of the FY18 budget narratives beginning with the AVS Strategic Guidance released in May 2015. The SAS expressed an interest in keeping an eye on the emerging issues and how they may influence future iterations of the AVS Strategic Guidance.

ACTION ITEM #3: Engage SAS members prior to preparation of future SAS meeting Agenda and AVS Strategic Guidance.

Wrap Up

SAS members indicated they will prepare Finding& Recommendations on several topics and submit these to the FAA prior to the REDAC meeting scheduled for October 7, 2015. They also approved the Minutes from the Spring 2015 meeting.

The next SAS meeting is scheduled for March 23-24, 2016 at the William J. Hughes Technical Center.

Ken Hylander thanked the FAA and the SAS members for the impressive amount of preparation and effort that went into this meeting.

Meeting adjourned at 4:45 PM.

Appendices

Appendix I: Agenda

Appendix II: Attendance

Appendix III: Findings and Recommendations

Appendix IV: Action Items

APPENDIX I:

FEDERAL AVIATION ADMINISTRATION
REDAC Subcommittee on Aircraft Safety (SAS)
William J. Hughes Technical Center
September 9-10, 2015
Director's Conference Room
Dial in Access: (609) 916-1975, passcode: 890577
[Join WebEx Meeting](#)
WebEx Meeting number: 995 317 582
Meeting password: fall

Wednesday, September 9, 2015

Time	Topic	Speaker(s)
7:45	Arrive at SOC	
8:30 – 8:45	Welcome/Opening comments <ul style="list-style-type: none"> • Introductions (all) • Opening remarks/comments (Chair & DFO) 	Kenneth Hylander (Chair) Eric Neiderman (SAS DFO)
8:45 – 9:00	Welcome	Dennis Filler (REDAC DFO & WJHTC Director)
9:00 – 9:30	Strategic Input/Feedback from Spring 2015	Kenneth Hylander
9:30 – 9:45	Budget Update	Mike Gallivan
9:45 – 10:15	Overview of AVS RE&D Portfolio	Mark Orr
10:15 – 10:30	Break	
10:30 – 11:15	The Air Force Qualification Pathway and its Challenges for AM	Dr. Roland Dutton, Air Force Research Laboratory (AFRL)
11:15 – 11:30	AM Update per SAS Recommendations CSTA Perspective/AM Plan	Michael Gorelik
11:30 – 12:15	UAS R&D Update (Ongoing activities, COE, NASA/UTM, etc.)	Claude Jones Sabrina Saunders-Hodge
12:15 – 1:00	Lunch	Cafeteria
1:00 – 2:00	Software & Digital Systems (SDS) Research	Alanna Randazzo Barbara Lingberg

Time	Topic	Speaker(s)
	Cyber Plan	
3:00 – 3:15	Break	
3:15 – 4:00	Big Data/ASIAS Laboratory Demo [Tour]	Tom Tessitore
4:00 – 5:00	Quad Chart Discussions (SIM, UAS, Cyber, SDS, ES, FC/MS, RS, SSM, TAS) Summary/Actions	Kenneth Hylander/ Eric Neiderman
6:30	Group Gathering: <i>Eric's House, 101 South Suffolk Ave. Ventnor, NJ (New Address)</i>	(609) 414-3470 (cell)

Thursday, September 10, 2015

Time	Topic	Speaker(s)
7:45	Arrive at SOC	
8:30 – 9:15	Quad Chart Discussions	Kenneth Hylander
9:15 – 10:00	International Research Collaboration - NLR	Michel Piers
10:00 – 10:45	Big Data Lab Tour	Tom Tessitore
10:45 – 11:00	Break	All
11:00 – 12:00	High Ice Water Content	Jim Riley Chris Dumont Stephanie DiVito
12:00 – 1:00	Lunch	Cafeteria
1:00 – 2:00	Alternative Fuels Lab/PAFI Update [Tour]	Dave Atwood
2:00 – 2:45	Alternative Fuels Lab / PAFI Update	Dave Atwood
2:45 – 3:00	Break	
3:00 – 4:15	Review of FY15 Quad Charts (FCS, AI, SIC, MI, PS, AM, HF, Wx)	Kenneth Hylander
4:15 – 5:00	SAS Strategic Views/Assessments	Kenneth Hylander
5:00 – 5:15	Wrap up – Homework Assignments, Action Items, F&R	All
6:30	Dinner at Angelo's Fairmount Tavern 2300 Fairmount Ave, Atlantic City	All

Appendix II

Attendance

Chuck Agava	Michael Gorelik	Maria Paine
John Bakuckas	Tony Gurcsik	Jim Patterson
Chris Benich (SAS)	Michel Hovan	John Peace
Daniel Brock	Ken Hylander (SAS Chair)	Michael Piers
Jimmy Bruno	Cliff Johnson	Steve Ramdeen
Angela Campbell	Claude Jones	Alanna Randazzo
John Civolowsky (SAS)	Chuck Kilgore	John Reinhardt
Andrew Cheng	Ryan King	Jim Riley
Daniel Cordasco	Chris Kmetz (SAS)	Chinita Roundtree-Coleman
Bill Crossley	James Knight	Paul Rumberger
John Crowley (SAS)	Ken Knopp	Jolea Russotto
Patricia Culler	Danko Kramar	Rachel Seely
Curtis Davies	Andrew Lacher (SAS)	Chris Seher
Walter Desrosier (SAS, on phone)	John Lapointe	Peter Sparacino
Lyndsay Digneo	Huasheng Li	Danielle Stephens
Stephanie DiVito	Xiaogong Lee	Paul Tan
Chris Dumont	Srini Mandalapu	Isidore Venetos
Rollie Dutton	Jim Mangie (SAS)	Michael Vu
Steve Edgar	Bob McGuire	Pat Watts
Hossein Eghbali	Michael McNeil	Ed Weinstein
Bill Emmerling (on phone)	Sohrob Mottaghi	David Westlund
Jorge Fernandez	Mark Mutchler	Jim White (Minutes)
Jamie Figueroa	Eric Neiderman (FAA DFO)	John White (SAS)
Estrella Forster	Paula Nouragas	Frank Wondolowski
Mike Gallivan (on phone)	Kerin Olsen	Michelle Yeh
	Mark Orr	Dres Zellweger

Appendix III

Findings & Recommendations

Previous¹

Finding: The subcommittee was fully briefed on the UAS safety research plan. We are encouraged by the progress made in the past year regarding organization and networking of different stakeholders. We encourage the continuation of this integrated research planning. There appears to be a focus on real problems and growing consideration of evolving issues.

Recommendation: SAS Spring_2015-1: UAS Portfolio Flexibility

We recommend building flexibility into the FY17 UAS budget that can address emerging issues that may not be understood currently. We also recognize the focus on Beyond Line of Sight (BLOS) operations but recommend consideration of other emerging "long term" issues such as complete autonomous operations. We also recommend that UAS NAS integration R&D focus on sense and avoid technology vs aircraft robustness in case of impending collision.

Finding: There has been visible progress in terms of developing a process to prioritize research based on priorities and need. Review of the 2017 strategic guidance, quad charts, and list of emerging issues highlighted a need to provide greater linkage between the proposed and funded research and the FAA's strategic plan. The strategic plan should not be a static document; it will require regular updates to address the changing needs of the FAA and the NAS and to ensure that the research is appropriately targeted.

Recommendation: SAS Spring_2015-2: Research Roadmap Development

SAS understands and recognizes the ongoing need for research focused on operational safety of the current fleet. Notwithstanding, focused research must be conducted to address emerging issues. The FAA should develop and implement a process to produce 5 to 10 year research roadmaps to guide sponsors in the development of research requirements and to assist in prioritizing and focusing research on strategically significant elements. The roadmaps should define the FAA's vision for the future, quantify success measures to the greatest extent possible, and identify the research areas necessary to support the roadmap vision. It is further recommended that the FAA make available and use the roadmaps as the basis for its comprehensive strategic research plan, research needs, program initiatives, and intended outcomes for aviation safety.

Finding: There have been significant developments in additive manufacturing technologies and capabilities that are expected to rapidly proliferate in aviation applications due to many potential benefits including reduction in material cost, fewer part details, and enabling of more complex designs. However, additive manufacturing technologies have a number of technical risk factors that could have significant impact on design, production, and maintenance. The FAA must be prepared to address these factors in order to ensure appropriate airworthiness and certification standards and methods of compliance. The subcommittee received a briefing from the FAA

¹ The Administrator's response to these F&Rs was not released prior to the SAS meeting.

fatigue and damage tolerance Chief Scientific and Technical Advisor (CSTA) on the establishment of an FAA Additive Manufacturing Steering Group to address these issues. The SAS strongly supports the high level of coordination with other government and industry initiatives and development of a detailed roadmap identifying near-term and strategic areas that focus FAA's activities on the safe implementation of these technologies. Current planning is to develop the additive manufacturing roadmap over the next 18-24 months. This roadmap will inform regulatory, policy, and R&D program needs. The subcommittee also noted and strongly endorsed the addition of additive manufacturing materials into the Metallic Materials Properties Development and Standardization (MMPDS) process and handbook (under research requirement A11E.SIM.4) to provide standardized and acceptable design and compliance data and tools.

Recommendation: SAS Spring 2015-3: Additive Manufacturing Research Acceleration

There is significant activity across all major aviation industry sectors in the application of additive manufacturing technologies affecting current production systems and new product designs. The subcommittee recommends that the FAA accelerate the development of the additive manufacturing roadmap over the next 12 months in order to inform FAA's existing regulatory, policy, and R&D program needs. In addition, the subcommittee recommends that the FY17 and FY18 R&D portfolio includes consideration of proactive research necessary to ensure an understanding of key properties/characteristics of additive manufacturing to identify hazards and mitigations necessary to establish the appropriate standards and methods of compliance necessary to enable safe implementation of these technologies.

Observation: The Subcommittee continues to emphasize the importance of human factors research in all aspects of aviation safety. The Subcommittee also recognizes the importance of the human factors issues that AVS has identified for funding and further research. Human factors research covers a broad spectrum of regulations and guidance. Unfortunately, this significance and importance has not always been consistently recognized. As a result of this observation, the Subcommittee previously recommended that AVS closely align human factors research requirements with the other research areas they supported, even though those issues fell outside of the traditional human factors portfolio.

The committee is pleased to hear that FAA human factors specialists are closely involved (rather than just consulting) with many research efforts throughout the portfolio. The committee also sees value in human factors specialists' involvement during the requirements phase of research efforts and is pleased to be advised that this is happening.

Observation: Based on the feedback received from multiple REDAC subcommittees, it is evident that crosscutting capabilities should be engaged at earlier stages of setting requirements and concept development. As operational concepts are explored, experts from all research disciplines should work jointly to establish operational requirements and objectives. Earlier coupling across multiple disciplines may result in reduced development time and costs.

New

(DRAFT VERSION)

The REDAC Subcommittee on Aircraft Safety met on September 9, 10, 2015 at the FAA Technical Center in Atlantic City, NJ for its fall meeting. The objectives of the meeting included review of FY15 R,E&D aviation safety portfolio; targeted deep dives of program areas with previously identified emerging issues; early input for FY2018 research plan; and development of any findings and recommendations. The deep dives included such topics as Certification of Advanced Materials and Structural Technologies; Dependability of Increasingly Complex Systems; Mixed UAS and Manned Aircraft Operations; Real Time System-wide Safety Assurance and General Aviation Alternative Fuels. Below are the Findings and Recommendations from the committee, which should be used to consider improvements in current research programs, their controls and to also inform the 2018 Research Plan as it develops. Thank you to the committee members for their engaged participation and dedicated time. Also a strong thank you to all at the FAA that made the meeting a success through their support by providing research details, tours and immediate responses to committee questions.

Title: Improved Clearer Link between Research Activities and Overarching Safety Objectives and Goals

Finding: The SAS committee is spending considerable time and energy trying to understand the big picture of the FAA's research programs as they relate to aviation safety. In 2015 there are over 70 research requirements with a total budget expenditure for the safety portfolio on the order of \$90 million. This size of investment in research warrants a clear picture into the programs including overall research objectives, sponsor outcomes, financial commitments over multiple years, research exit criteria, etc. Good progress has been made in producing individual research program quad charts describing specific targeted contract research efforts. However, visibility to the comprehensive research picture is still lacking and confused by the presentation of the material in individual Budget Line Item (BLI) format and focused on contracted dollars only versus a total dollar view. Program documentation is also apparently produced for the use of SAS committee only, which, while appreciated, seems counter to good program management techniques. Lacking clear line of sight to the higher program level makes providing SAS committee input into overall research programs fragmented and incomplete at best.

Recommendation: FAA should create a comprehensive program description for safety research that clearly identifies, and communicates, the higher level research objectives, by topic, (icing, fire safety, structural technologies, etc.) as well as provides connectivity to the comprehensive set of specific targeted research objectives in each area. This description needs to clearly communicate how individual research supports the overall objectives. The description should be easily updateable and designed so that it primarily adds FAA management value as well as supports the SAS Committee objectives.

Title: Enhanced International Collaboration on Safety Research

Finding: The subcommittee received an overview presentation on the Association of European Research Establishments in Aeronautics (EREA) Future Sky Safety program. We were pleased to see that the FAA Aviation Safety organization will be engaged in the activity by being part of the Advisory Board. The program's four themes are addressing issues, which align with many of the FAA's aviation safety priorities.

Recommendation: Given that Aviation Safety issues span international borders, the FAA should consider taking a leadership role in deepening US-European collaboration on Aviation Safety research by initially focusing on one or two specific areas of common interest. One potential is big data analytics associated with aviation safety data exploration. Both the FAA and NASA have significant on-going investments in this area, which aligns nicely with the Future Sky Safety project on Emergence Detection and Big Data, which is intended for a start in 2017. Through joint efforts we are likely to be able to magnify the safety impact of research investments of all parties.

Title: Immediate Needs for Additive Manufacturing Certification Support

Finding: There has been continued progress accelerating the development of a FAA Additive Manufacturing Roadmap and the identification of focused Additive Manufacturing research. In parallel, industry is continuing to accelerate efforts to incorporate additive manufacturing technologies as full-scale production processes. The subcommittee was presented with an update on Additive Manufacturing research activities ongoing at the Air Force Research Laboratory and the identified design, manufacturing and inspection challenges associated with this technology. In July 2015 the Air Force issued an Airworthiness Bulletin to its Program Offices highlighting the process steps to be followed to insert Additive Manufacturing technologies. This near term action is seen as a positive step to assure implementation is consistent with strategic planning with respect to qualification of new materials and processes. The subcommittee also received a briefing from the FAA Fatigue and Damage Tolerance Chief Scientific and Technical Advisor (CSTA) on recent progress including collaboration with the Air Force Research Laboratory on the qualification and certification of parts produced via Additive Manufacturing processes. The subcommittee finds that a near term strategy is required to help the certification directorates assess type designs or type design changes which incorporate parts produced utilizing additive / advanced manufacturing methods.

Recommendation: The subcommittee recommends that the FAA develop guidelines describing the considerations, which should be assessed relative to the incorporation of parts produced by Additive Manufacturing. Target for implementation of these guidelines should be immediate (on the order of 3 months). The subcommittee further recommends that the FAA assess the need for additional research to supplement the initial guidelines for the potential longer-term codification of Additive Manufacturing guidance.

Title: Research to Mitigate the Impact of Cockpit Laser Strikes

Finding: The potentially negative effects of laser beams striking the human eye and interfering with flight operations are well documented by previous research conducted by the FAA, among others. The frequency of reported laser strikes has increased more than 10 fold since 2006; that year, FAA reported 384 such events. In 2014, the agency reported 3,894 laser strikes and, unfortunately, the number of reported strikes this year has spiked about 35% higher than last year with more than 2,625 reported as of June 2015. Whereas low-powered handheld lasers were previously in common use, more powerful lasers that pose a greater threat to the pilot are becoming available to potential offenders. While considerable research has been conducted within the military, much of this work is classified, focused on specific threats, and therefore will not provide a complete solution for the civilian sector. To date the FAA's approach to mitigate the impact of a laser illumination event is to document and characterize these events, and educate flight crews on how to recognize an event and then respond in a manner to help identify and prosecute offenders. Despite these efforts and others, the number of laser strikes is expected to continue to rise and there has yet to be identified a robust, reliable countermeasure that will protect pilots' vision and preserve flight safety. Currently, there is no funding in the FAA R&D portfolio of activities to investigate and/or develop potential technical solutions to mitigate the impact of a laser strike. Achieving a workable, affordable technical solution to this problem, rather than relying primarily on law enforcement and education campaigns to mitigate the risk, would represent a significant safety accomplishment that would benefit the traveling public and cockpit flight crews.

Recommendation: The SAS Committee recommends that the FAA include within its R&D portfolio the resources to conduct research aimed at identifying a technical, onboard solution to prevent or greatly reduce the potential for a laser strike against aircraft and mitigate its impact. The extensive R&D conducted within the DoD should be leveraged to the maximum extent possible considering security and intelligence concerns. As envisioned, the solution would:

- Require no action by the flight crew that would disrupt or unduly complicate normal operations
- Be effective against a high percentage of laser strikes
- Be capable of being used on any aircraft, but the primary focus should be for aircraft in FAR Part 121 and/or Part 135 services
- Not impair pilots' visual acuity or ability to correctly interpret colors of messages, warnings, etc., on cockpit displays at any time, or otherwise degrade performance, while operating the aircraft
- Be affordable within FAA analysis results of safety risk benefits versus cost criteria

Appendix IV

Action Items

Carry-over Action Items:

Spring 2014 Action Item 7: Eric Neiderman will provide an explanation of SDSS core capability at the next SAS meeting. **CLOSED**

Spring 2014 Action Item 8: Eric Neiderman will provide information regarding the NASA Ames tool to track safety cases. **REMAIN OPEN** (The NASA/FAA Research Transition Teams presentation and the Ames Safety Case Tools update were postponed till the next SAS meeting.)

Spring 2015 Action Item 1: Provide FY17 BLI to requirements mapping (Rosetta Stone) showing full funding for BLIs. **CLOSED**²

Spring 2015 Action Item 2: Provide deep-dive presentations on SSM and DSS requirements as they relate to SAS emerging issues. **CLOSED**

Spring 2015 Action Item 3: Provide UAS presentation with focus on Pathfinder implications. **CLOSED**

Spring 2015 Action Item 4: Provide human factor presentation on operator fatigue issues. (Action – Mark Orr)³ **REMAIN OPEN**

Spring 2015 Action Item 5: Provide requirements list with Mendoza Line and items below in advance of future Spring meetings. (Action – Mark Orr)⁴ **REMAIN OPEN**

New Action Items:

Action Item 1: Complete and post FAA resolution to all FY15 Quad Charts and FY17 Quad Charts comments from Spring 2015 SAS meeting. (Action – Xiaogong Lee)

Action Item 2: Provide FAA icing plan⁵. **CLOSED**

Action Item 3: Engage SAS members prior to preparation of future SAS meeting Agenda and AVS Strategic Guidance. (Action – Mark Orr/Eric Neiderman)

² Action Completed on April 8, 2015.

³ Mark Orr will prepare AFS plan and forward to SAS.

⁴ Mark will provide AVS approved FY17 list to SAS this May.

⁵ FAA Icing Plan distributed at meeting and available on SAS KSN site.