

May 20, 2020

Mr. Brandon Roberts
Executive Director, Office of Rulemaking

Mr. Jeff Gardlin
Senior Technical Specialist
Federal Aviation Administration
800 Independence Avenue SW.
Washington, DC 20571

Dear Mr. Gardlin and Mr. Roberts:

On behalf of the Emergency Evacuation Standards Aviation Rulemaking Committee (ARC), we are pleased to provide you with the attached Evacuation ARC report and its 27 recommendations covering airplane design and certification standards, operational and training requirements as well as airport rescue and firefighting.

The ARC found overall safety in aircraft evacuations is very high, considering evacuation events are extremely infrequent when compared to the total number of flights, although there are areas where improvements can be made as indicated by the recommendations provided. These recommendations reflect a significant level of work by the ARC on an accelerated timeline from September 2019 to May 2020, and represent careful deliberation by the members and observers representing various segments of the air carrier industry and regulatory environment.

In the enclosed ARC report, there was one dissent (EES-12). The dissent could have been understood to indicate that events beyond 10 years ago, and recommendations based on a review of the regulatory language itself, were outside the scope of the charter. However, during the December 2019 meeting when ARC's list of evacuation events were established, there were a few events beyond the 10 years that because of their significance and amount of data available, were included in our examination. Specifically, a 2005 Air France A330 accident in Toronto was included and results from this accident were deemed relevant to the ARC's recommendations. The ARC charter also specifically includes a review of the current regulations as one of the tasks. You will find this linkage in the Finding section of the EES-12 subject.

We trust these recommendations will be helpful in your decision making process.

Sincerely,

A handwritten signature in black ink that reads "Tony Pope". The signature is written in a cursive, flowing style.

Mr. Tony Pope
Discipline Chief Engineer – Systems
Collins Aerospace
EES-ARC Co-Chair

Emergency Evacuation Standards
Aviation Rulemaking Committee
Final Report

May 20, 2020

The ARC would like to extend its thanks to NACA and ALPA for their efforts in making a professional technical writer available to the committee. This enabled the committee to complete its work sooner than it otherwise would have and improved the overall quality of this report.

Executive Summary

The Emergency Evacuation Standards Aviation Rulemaking Committee (ARC), was chartered to assist the Federal Aviation Administration (FAA) in carrying out the requirements of the FAA Reauthorization Act of 2018, Public Law 115-254, §337 to review aircraft evacuation certification with regard to emergency evacuation system designs and crew evacuation procedures.

The ARC carried out its task by first reviewing and understanding the regulatory standards that apply to emergency evacuation. The next phase of activity was to review in-service events whether they were classified as ‘accidents’ or not, and review issues that have been raised by the National Transportation Safety Board (NTSB), the public, and Congress, to identify those issues that are the most impactful in an emergency evacuation. Finally, the ARC correlated the issues identified in the review, with the requirements to determine if there are gaps, omissions, deficiencies or if there are requirements that do not appear necessary.

The ARC is making [27 recommendations](#) covering airplane design and certification standards, operational and training requirements as well as airport rescue and firefighting.

The ARC found overall safety in evacuations is very high, considering evacuation events are extremely infrequent with regard to the total number of flights. Nonetheless, there are areas for improvement both in terms of requirements and data gathering to assess requirements.

May 12, 2020

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I. Summary of Issue and Task

The Emergency Evacuation Standards Aviation Rulemaking Committee (ARC), was chartered to assist the Federal Aviation Administration (FAA) in carrying out the requirements of the FAA Reauthorization Act of 2018, Public Law 115-254, §337 to review aircraft evacuation certification with regard to emergency evacuation system designs and crew evacuation procedures. This included a review of available data from accidents and incidents resulting in a passenger evacuation. The complete charter is in Appendix 1.

The ARC charter did not include impacts into water, because this had been recently addressed by another Aviation Rulemaking Advisory Committee (ARAC) working group, the Transport Airplane Crashworthiness and Ditching Working Group (TACDWG). ARAC submitted the TACDWG recommendation report to the FAA on October 22, 2018. The ARC charter also excluded consideration of seat spacing and size, because the FAA's Civil Aerospace Medical Institute (CAMI) was carrying out an experimental study of these parameters, the results of which would be available to the ARC. A description and high-level summary of the CAMI study is included at the end of section II, "ARC Activities." In addition, the charter did not initially include passenger demographics, because this was also included in CAMI's experimental study. However, because the experimental study had practical limitations on demographics, the charter was amended to remove this exclusion, so there would be no ambiguity, should the ARC find demographics were a significant issue.

II. ARC activities

A. Meetings

The FAA issued the ARC charter on April 24, 2019. Due to administrative challenges involved with identifying, inviting, and approving membership, the ARC first met virtually on September 18, 2019. During its first meeting, the ARC reviewed its charter and developed an approach to meeting its objectives. The ARC subsequently met face to face on:

- October 22-24, 2019 to review the regulatory standards applicable to evacuation and discuss in more depth the approach the ARC would take,
- December 11-13, 2019 to witness tests being conducted at CAMI and establish the list of events to be reviewed,
- January 28-30, 2020 to identify key issues emerging from the event review and begin to look at how they relate to regulatory requirements, and
- February 25-27, 2020 to finalize the key issues and formulate recommendations.

Approximately 6 additional virtual meetings were held during the months of April and May to finalize the recommendations and complete the report.

1. Methodology.

The ARC organized its work into four main activities:

1. Reviewing and understanding the regulatory standards that apply to emergency evacuation (in aircraft certification and operation-see Appendix 2.)

2. Reviewing in-service events, as well as issues that have been raised by the National Transportation Safety Board (NTSB), the public, and Congress, to identify those issues that are the most impactful in an emergency evacuation. See Appendix 3 for the in-service events reviewed and Appendix 4 for the NTSB recommendations.
3. Correlating the issues identified in the review, with the requirements to determine if there are gaps, omissions, deficiencies or if there are requirements that do not appear necessary.
4. Making recommendations based on the overall review.

(a). Regulatory review.

There are numerous regulatory requirements and associated guidance that address evacuation safety. Each of the requirements is independent. For example, the number of passengers is limited by the type and number of exits, regardless of how many passengers might evacuate in a given time. The requirements are summarized in Appendix 2, but are generally in one of three categories:

- Provide the ability to evacuate
- Provide as much time as possible for egress
- Be able to egress as fast and safely as possible

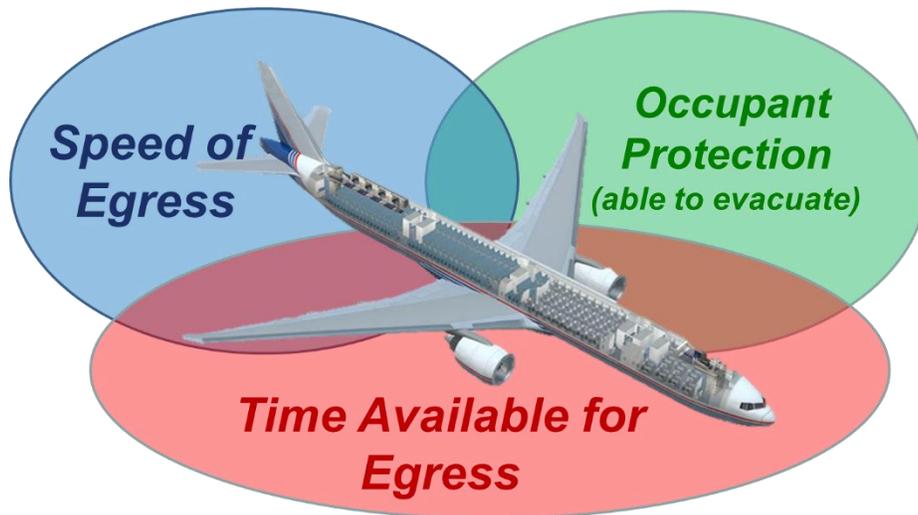


Figure 1

Requirements intended to protect occupants are those that apply to crashworthiness of seats, restraints, and design of the interior. Requirements intended to extend the time available for evacuation are those that apply to materials flammability and aircraft buoyancy in a ditching. Requirements intended to make egress as fast and safe as possible are those that apply to emergency exits, egress paths between each seat and emergency exits, egress assist means and emergency lighting, as well as the training and operational procedures of crewmembers. In addition, there is a requirement to show that, under specific conditions, an airplane can be

evacuated within 90 seconds. This requirement applies to airplanes that have more than 44 passengers and must be satisfied by a full-scale demonstration unless the same information could be obtained by “a combination of analysis and testing”¹ based on previously conducted demonstrations. The FAA provides guidance on compliance with this requirement in Advisory Circular (AC) 25.803-1A. See Appendix 2 for the history of the full-scale evacuation requirements. There are regulatory requirements that must be met either by the airplane manufacturer or by the operator/airline or are a shared responsibility of both. A high-level summary of these requirements is provided below:

- Design requirements
 - Exits
 - Escape systems
 - Lighting
 - Interior arrangement
- Limitations
 - Seat installations
 - Uniform distribution with respect to emergency exits
 - Stay-out zones (e.g. exit passageway)
 - Cabin crew
 - Minimum number and distribution
- Training
 - Equipment
 - Procedures
- Procedures
 - Passenger briefings
 - Evacuation management
 - Inflight emergencies
- Maintenance
 - Escape slides
 - Exits
 - Lighting

Requirements related to evacuation have both performance-based and prescriptive elements. Although performance-based standards are generally preferred over standards that are prescriptive, there are conditions envisioned in service that would be difficult to substantiate solely based on performance. This is because the conditions are hazardous and the only way to measure performance at present is with human test subjects. Thus, requirements for things like aisle and passageway width are defined with dimensional minimums because the conditions under which the aisle and passageway sizes are most critical are those that are not safe to test. Conversely, requirements to prevent the deformation of seats in crash from impeding egress are stated objectively, since the post-deformation condition can be assessed without occupants experiencing the crash. In either case, the central challenge is understanding the elements that make up the standard, and what changes in service would trigger an update to the requirement, or the guidance on how to comply with it.

¹ 14 CFR §25.803(c)

Reviewing the relevant requirements provided the ARC members a more uniform understanding of how the regulations dealt with evacuation, including which requirements were performance-based and which requirements were prescriptive based.

(b). Review of in-service events

In order to get an accurate picture with respect to the significant factors in actual evacuations, the ARC attempted to review as many in-service events as practicable, given the time constraints of the charter, and the variability of airplane build-standards in the fleet. To perform an effective review, the events identified were from approximately the last 10 years². Ten years was identified in the ARC charter and is a suitable timeframe for two reasons. First, the total number of events is large, but manageable. Second, the airplanes in the fleet within the last 10 years are mainly those that have the latest safety requirements embodied. Events with airplanes that do not have the latest safety enhancements would require an additional assessment as to how the outcome might have been different, had those enhancements been in place. Even with these criteria, there were 290 events identified (see Appendix 3).

Over the past ~10 years there were 55 fatalities in the events assessed, with the majority of those coming in a single event³. Most of the remainder occurred as a result of occupants not wearing their restraint system. In the events reviewed, 169 serious injuries were identified as occurring during the evacuation. The available data is limited, so the actual numbers may be somewhat different.

Although approximately 28% of the events involved a fire and another 11% were based on the belief there could be a fire, most events were not, at least in retrospect, an emergency. The fact that in so many events, a decision was made to use the emergency escape systems to unload the airplane at a modest rate was an unexpected, but significant, finding. Most ARC members were unaware of this practice, and it is not generally something that is included in training. In addition, the emergency equipment is designed to perform under conditions of high urgency, whereas for an event with a considered decision to use emergency escape systems to unload the airplane at a modest rate, safety would be the main concern. This is something the ARC did not have time to thoroughly analyze but believes should be investigated further. Further discussion of “rapid disembarkation” or “non-urgent evacuations” is captured in a recommendation in section IV.

B. Event Assessment Groups

In order to efficiently and consistently review the large number of events, the entire ARC first reviewed a few events as a group exercise to identify the parameters of interest and get a sense of what information may be available. The spreadsheet categories identified in this group

² There are a small number of accidents slightly older than 10 years included in the review because of their significance and the amount of data available. The oldest accident is the Air France A340 in Toronto in 2005.

³ May 5, 2019, An Aeroflot Sukhoi Superjet 100-95, registration RA-89098 flight SU-1492 from Moscow Sheremetyevo to Murmansk (Russia) with 73 passengers and 5 crew; 41 fatalities following a crash during landing.

exercise are captured in Appendix 8. From there the ARC was divided into 5 groups, with 4-5 persons per group. Each person was asked to review about 10 events. With a similar understanding of the information to be gathered, each person could start review of their designated events. This resulted in a spreadsheet with approximately 290 entries.

Table of key issues by major category

From the event reviews, key issues were identified that resulted in a group of findings/observations. The ARC divided its review, observations, and findings into categories. The categories identified were airplane design/condition, Part 25 type certification, Part 121 type certification, procedures and training, and external environment. Additional review items identified by the FAA from other review forums were added as a separate category. And finally, toward the end of the review, an “Other Recommendations” category was added to capture additional observations and their associated recommendations. The findings/observations are discussed in more detail in section III.

NTSB recommendations

The NTSB has made several recommendations related to evacuation, some of which have been closed with an unacceptable disposition. The ARC reviewed these evacuation-related NTSB recommendations to assess whether the recommendations were being addressed by the ARC’s recommendations or findings. Some of the issues identified by the NTSB were not addressed by this ARC. One example was a NTSB recommendation for Part 135 flights to train cabin personnel in multiple areas of emergency duties if the personnel could be perceived by passengers as equivalent to a qualified flight attendant. This NTSB recommendation was outside the scope of the ARC.

The ARC determined some of the other NTSB recommendation topics were relevant and identified in some of the events it reviewed. For example, the ARC identified several events where better communication would have enhanced the evacuation. Another example is related to better information or briefings to passengers.

A full list of the NTSB Recommendations reviewed and considered by the ARC is in Appendix 4.

FAA-requested review

In addition to the issues that emerged from its review of in-service information, the ARC considered factors identified by FAA as being raised in other forums as potentially having an influence on evacuation. These are listed below:

	Other issues	Disposition after discussion
1	Service or emotional support animals	No recommendation drafted
2	Passenger load factors	No recommendation drafted
3	Seat spacing	Currently being evaluated by CAMI
4	Passenger anthropometry	Currently being evaluated by CAMI
5	Quantity of carry-on baggage	Recommendation drafted
6	Family groups being separated	No recommendation drafted
7	Electronic device/entertainment distractions	No recommendation drafted
8	Passenger age and disabilities	No recommendation drafted
9	Unoccupied exit seating	No recommendation drafted Currently being evaluated by another FAA group
10	Lack of systematic data collection on evacuation events	Recommendation drafted

Table 1

Two of these items were also identified in the review of in-service events. Namely, that passengers frequently take carry-on baggage in an evacuation (item 5), and that there is no systematic collection of data for evacuation events (item 10.) These items are discussed in section IV.

Of the remainder of the items, the ARC is not currently recommending any action regarding items 1, 6, 7, 8, and 9. Although these items could foreseeably impact evacuation, there were no reports of them doing so in the events assessed by the ARC. These issues would lend themselves to better data collection in a more systematic review of evacuation events as identified in item 10. Although there was no recommendation made on item 9, this topic is the subject of a separate FAA-established Exit Seats Working Group. The findings of that working group are still pending but their work and the linkage to this ARC are discussed further in Appendix 7.

Regarding item 2, the ARC was not able to find information on the passenger load factor for each of the events. However, the ARC was able to assess the airplanes making up most of the fleet in terms of the passengers on board versus the type-certificated maximum number of passengers permitted to be on board. This is shown in Table 2.

Airplane model	Number of Events	Approximate % of max seating capacity
1. 737	66	77%
2. 777	10	54%
3. MD-80/90	20	72%
4. A320/319	49	79%
5. A321	9	
6. A330/340	8	63%
7. E190/195	13	74%
Total:	175	

Table 2

This shows single-aisle airplanes tend to be closer to their maximum capacity than twin-aisle airplanes. However, due to the limited amount of available data, this should not be considered absolute.

The ARC expressed concern that passenger load factors were increasing, so the success of emergency evacuations in years past might not be relevant if more people had to evacuate from the same airplanes. The Bureau of Transportation Statistics (BTS) maintains data on passenger load factors over time. The previous ten years of BTS load factor data is shown in Figure 2.

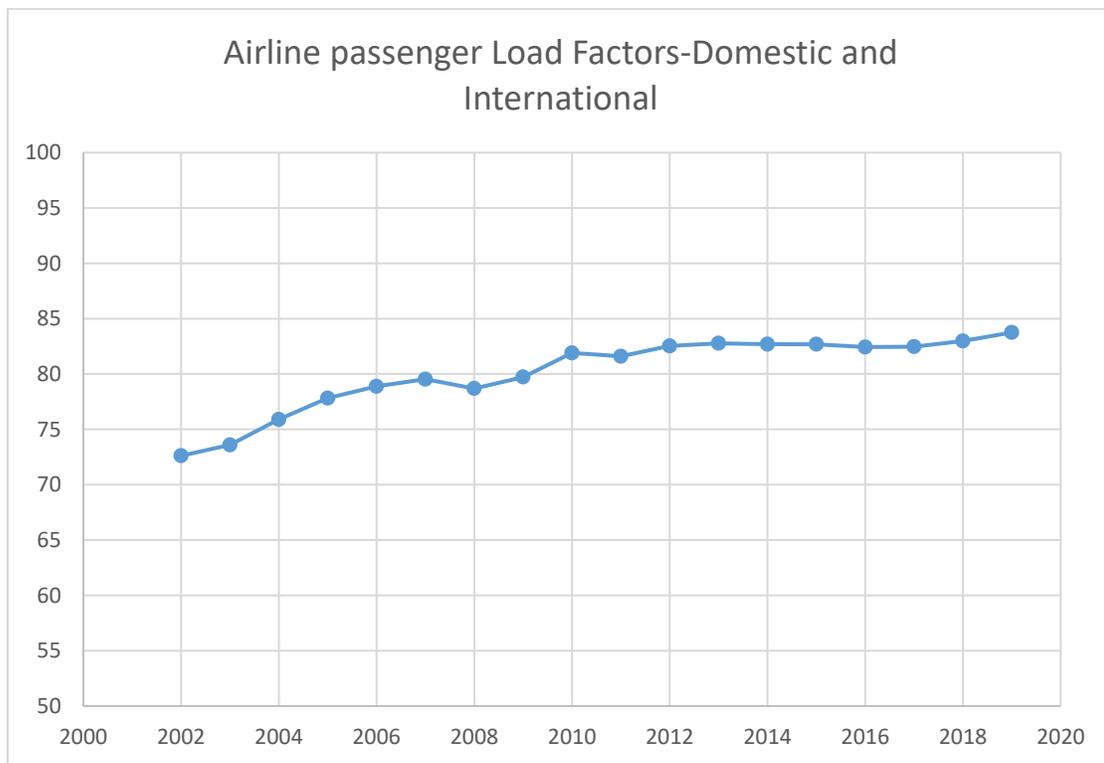


Figure 2⁴

⁴ <https://www.transtats.bts.gov/DataElements.aspx?Data=5>

This data shows there was a noticeable increase in load factor between 2002 and 2010, but the load factor has remained constant since 2010, which corresponds to the period of events reviewed by the ARC. These numbers are higher than those in Table 2 from the event review, because most airplanes operate with fewer than the maximum number of passenger seats permitted.

For items 3 and 4, CAMI is currently analyzing data for an extensive study of the impact of seat spacing on egress. The study includes a thorough assessment of participant anthropometry as compared with the national averages. The study is summarized below.

CAMI Experimental Research Project - Preliminary Finding:

The research project was designed as a factorial study of the effect of seat spacing (pitch) and width on evacuation from an airplane using a ramp. The intent of using this type of design was to isolate the factors of interest (seat pitch and width) to determine what influence they may have on the outcome of interest (evacuation times) while minimizing the impact of any additional variables that may be present during an evacuation by other factors within the “real world” (e.g., evacuation slides, baggage, animals, children, etc.). Using this methodology, the goal of this research project was to understand specifically how seat pitch and width affect an airplane evacuation and if their effect is great enough to be considered a significant safety factor for airplane passengers in the event of an evacuation. In addition to the factorial research question, this project was used to collect a large amount of anthropometric data from the participants for comparison of the research population to the population as a whole, as well as use of the anthropometrics for logical analysis of airplane ergonomic factors both within this project and in the future.

Data collection was completed in January 2020, and data reduction and analysis are currently ongoing (as of the conclusion of the ARC’s activities). A published report for this research project is planned for the fall of 2020.

C. Cost/Benefit Analysis

Paragraph 4.f. of the ARC charter directs the ARC to estimate the costs and benefits of each recommended change to regulations. The ARC has made numerous recommendations involving regulations, some of which are simply to reassess a regulation to determine if it should be changed. However, there are also recommendations for specific changes. Due to the time constraints for the ARC’s review, it was not possible to provide an estimate of costs and benefits for each of those recommendations. The ARC could pursue development of cost and benefits assessments but estimates several additional months would be required.

III. Findings and Observations

As noted previously, Appendix 6 contains the entire list of ARC findings/observations. Some of the ARC findings resulted in no recommended action. Findings/observations that have recommendations are contained in section IV.

Some of the observations and findings are addressed by more than one recommendation, whereas multiple findings may be addressed in a single recommendation. Thus, the recommendations in section IV do not correspond one for one with the findings in Appendix 6. In addition, to document significant discussion within the ARC, Appendix 7 contains certain significant observations where ultimately no recommendation was identified.

IV. Recommendations

The Emergency Evacuation Standards ARC (ARC) drafted 27 recommendations based on the findings and observations discussed above. Some of these recommendations are for improving regulation clarity, proposing a review of perceived incorrect or obsoleted regulations, and harmonization with other countries' regulatory standards. Other recommendations are for regulatory (or guidance) changes that resulted from the review of the in-service events discussed below.

A. List of Recommendations

EES-1. The ARC recommends the FAA establish a working group to document cause(s) for smoke/fume issues and develop corrective actions that will prevent or minimize smoke/fume events and consider effects on passengers as well (to the extent that it affects evacuation).

EES-2. The ARC recommends the FAA, in coordination with other Aviation Authorities, consider the introduction of changes to the requirements currently included in § 25.810 with the scope to allow easier identification of the evacuation path by the evacuees and their faster and safer transition from the wing to the ground.

EES-3. The ARC recommends the FAA revise AC 25-17A to include the following guidance for determining airplane attitudes and measuring sill heights corresponding to the loss of one or more legs of landing gear.

EES-4A. The ARC recommends the FAA review §§25.1362, 25.1423, and 121.319 to ensure current regulations adequately cover all aspects of the survivability and use of crew interphone and public address systems. The ARC also recommends in the long-term, the FAA should set standards for communication system handsets function and markings to be standardized for all aircraft types.

EES-4B. The ARC recommends the FAA collect, catalogue, and review these and similar recent evacuation incidents involving crew to passenger and crew to crew communications that are facilitated by onboard communications equipment.

EES-5. The ARC recommends the FAA amend AC 150/5210-17C, §1.3.6 “Training Curriculum (Application of Extinguishing Agents).”

EES-6. The ARC recommends the FAA review the Continuous Analysis and Surveillance System data and other data sources and determine if the fire detection system failure rate warrants a corrective action plan.

EES-7. The ARC recommends the FAA revise §25.810(d) to make the requirements for off-wing assist means (escape slides) consistent with those in §25.810(a) applying to assist means used at non-over-wing exits.

EES-8. The ARC recommends the FAA revise existing requirements applicable to emergency lighting systems of large airplanes to mandate higher illumination levels consistent with current state-of-the-art lighting systems.

EES-9. The ARC recommends the FAA replace the current text of 14 CFR §25.813(c)(3)(iii) with the text of CS 25.813(c)(6) and harmonize all of 14 CFR §25.813 with CS-25.813, in particular with respect to passageway width requirements of 14 CFR §25.813(c)(1)(i) and CS 25.813(2)(i).

EES-10. The ARC recommends the FAA ensure flight attendants who conduct an evacuation demonstration for an original equipment manufacturer (OEM) use emergency evacuation procedures valid for foreseeable evacuation scenarios.

EES-11. The ARC recommends the FAA conduct research to reevaluate the design requirements related to single and dual flight attendant jumpseats to ensure occupants of a single or dual flight attendant jumpseat are afforded the opportunity to properly utilize their respective seat belt and shoulder restraints. The ARC additionally recommends the FAA conduct research related to a dual flight attendant jumpseat when occupied by two males of larger size versus the assumption a dual jumpseat would be occupied by one 95th percentile male and one female. The ARC also recommends the FAA reevaluate the applicability of the design criteria that will be identified as appropriate for the geometry of flight attendant seat to design changes to the interiors of an in-service airplane or newly manufactured airplane of an existing model. Finally, the ARC recommends the FAA conduct research to ensure injurious body-to-body contact does not occur between the occupants in an emergency landing.

EES-12. The ARC recommends the FAA evaluate the staffing requirements of §121.391 to determine if any updates are needed, including whether to amend §121.391(a).

EES-12. Dissent of Regional Airline Association (RAA).

The ARC was tasked with reviewing available data from the past ten years of accidents and incidents in which passengers evacuated transport category aircraft used in air transportation. To accomplish this, a list of 290 accidents and incident reports were identified and subsequently examined. There was no data gathered from the reports that were examined, that suggested that the number of flight attendants on board the aircraft

had any material effect on the outcome of the evacuations. As a result of the findings, there are no arguments to be made that supports any recommendation.

EES-13. The ARC recommends the FAA revise AC 121-242D Appendix 1(6)(a)2.--Exit Seating.

EES-14. The ARC recommends the FAA establish a universal designated emergency radio frequency (such as 121.500) at all airports certified under 14 CFR Part 139 and amend AC 150/5210-7D (or current revision) to ensure flight crew, ARFF personnel, and air traffic control personnel are aware of its designation.

EES-15. The ARC recommends the FAA:

1. Research and promote the essential actions for flight crewmember to perform during an actual or potential emergency evacuation scenario.
2. Direct aircraft manufacturers to –
 - Review and revise, as necessary the Emergency Evacuation Checklist to ensure the actions are logical, necessary, and appropriately ordered.
3. Direct aircraft operators to –
 - Revise the applicable Emergency Evacuation Checklist to align with manufacturer guidance;
 - Revise their procedures to align with industry best-practices and FAA research (as described above);
 - Update their emergency procedures to remove ambiguity concerning the flight crew decision to initiate, continue, or stop an emergency evacuation;
 - Ensure flight crewmembers complete realistic, simulator-based emergency evacuation initial and recurrent training related to decision-making and timeliness on an annual basis.

EES-16. The ARC recommends the FAA, in coordination with other state aviation authorities and aircraft accident investigative agencies, collect, catalogue, and analyze “non-urgent” evacuations (also known as “rapid disembarkations”) to better understand the decision-making processes that lead to these events. The ARC further recommends the FAA and its regulatory partners use this information to determine whether a decision to initiate a “non-urgent evacuation” is ever appropriate in certain limited circumstances.

EES-17. The ARC recommends the FAA revise AC 121-29B to include a new subparagraph suggesting the need for pre-flight safety announcements and pre-landing safety announcement to include verbiage that all carry-on baggage should be left behind on the aircraft if an emergency is encountered in either takeoff or landing. Additionally, the ARC recommends FAA air carrier inspectors conduct a review of the air carriers they oversee to evaluate if the air

carrier's announcements reference the need to leave carry-on baggage behind in the event of an emergency.

EES-18. The ARC recommends the FAA, in coordination with other state aviation authorities, collect, catalogue, and analyze evacuation incidents in which less than 50% of exits are utilized.

EES-19. The ARC recommends the FAA collect, catalogue, and review these and similar recent evacuation incidents involving crew-to-passenger and crew-to-crew communications facilitated by onboard communications equipment.

EES-20. The ARC recommends the FAA revise §25.810(a)(1)(iv) to require the 25-knot wind requirement be combined with the effects of an engine(s) running at ground idle for an escape slide in close proximity to the engine inlet.

EES-21. The ARC recommends the FAA implement a process for periodic review of evacuation-related standards based on demographics and anthropometry, such that as those characteristics evolve, the need for changes to the requirements can be anticipated and updated when necessary.

EES-22. The ARC recommends the FAA adopt the sub-team 4 (Equipage) recommendations in the TACDWG report to the FAA, dated September 20, 2018, pertaining to the above items and the recommendation pertaining to the emergency equipment and its associated guidance material.

EES-23. The ARC recommends the FAA amend §139.317 to require a mobile stair truck vehicle with sufficient reach to aircraft cabin doors to allow safe and organized deplaning of passengers and crew and/or to allow rapid entry to aircraft by fire suppression and rescue personnel at all §139.315 Index B, C, D and E airports.

EES-24. The ARC recommends the FAA act on the recommendations contained in the ARFFRWG and ARFFWG reports and NFPA Standard 403.

EES-25. The ARC recommends the FAA modernize ARFF services at U.S. airports by amending and updating §139.315 - Aircraft rescue and firefighting: Index determination, §139.317 - Aircraft rescue and firefighting: Equipment and agents, and §139.319 - Aircraft rescue and firefighting: Operational requirements. The ARC also recommends the FAA review the ARFFRWG final report submitted to FAA in March 2004 and incorporate relevant NFPA Standards (see below) as they pertain to ARFF services.

EES-26. The ARC recommends the FAA consider including cargo operations as part of the overall airport response to an aircraft accident as applicable to 14 CFR Part 139 to ensure one level of safety for all occupants onboard cargo operations.

EES-27. The ARC recommends all organizations, companies, and individuals working to improve occupant safety collect the information suggested in the two sources above to provide a complete picture of survival factors in aviation accidents and incidents.

B. Recommendation Discussion with Supporting Material

EES-1. Subject

Airplane Condition/Design Recommendation - Issue 8 - To address evacuation events caused by smoke/fumes that were suspected/confirmed to be sourced to the air supply system.

Applicable Regulations and Guidance

14 CFR §§25.831(a) and (b), 25.1309(c), 121.703(a)(5) and (c)

Finding

There are many sources of smoke/fumes onboard aircraft, even in the absence of fire. Outside the cabin, smoke/fumes may be sourced to other vehicles or to damaged aircraft engines, auxiliary power unit (APU), landing gear, and tires. Inside the cabin, sources of smoke/fumes include electrical faults, failed fans, blown/clogged ducting, and overheated batteries. In addition, the aircraft ventilation system (environmental control system), which is fed with unfiltered bleed air from the engines/APU, can supply smoke/fumes to the cabin/flight deck via the ventilation ducting. This happens when the bleed air is contaminated with engine oil, hydraulic fluid, exhaust, or deicing fluid fumes. Filtering the bleed air for these contaminants would reduce the number of smoke/fume-initiated evacuations.

The ARC reviewed a group of 290 airline emergency evacuation events of which 56 involved smoke/fumes but no fire and were either suspected or confirmed to be sourced to cabin air supply. Specifically, the conditions documented in those reports were consistent with supply air contamination and did not refer to any other confirmed fault such as electrical failure, smoldering cargo, damaged landing gear, or smoking engines. Most of these evacuations took place using escape slides and, in many, passengers and crew were injured, sometimes seriously. Preventing exposure to air supply system-sourced smoke/fumes would have prevented these evacuations and, thus, would improve flight safety.

The need to clean airborne contaminants from the bleed air supplied to the cabin and flight deck has been recognized for decades. For example, in 1955, engineers at North American Aviation proposed to either design aircraft with bleed air cleaning equipment or install a separate cabin compressor independent of the engines to compress ventilation air, all intended to prevent the supply of oil fumes to the cabin and flight deck.⁵ Unfortunately, the company did not act on its own recommendation. More recently, in 2002, a congressionally-mandated National Research Council committee recommended that the FAA “investigate and publicly

⁵ Reddall, HA. “Elimination of engine bleed air contamination” Paper presented by North American Aviation engineer at the SAE Golden Anniversary Aeronautic Meeting, Los Angeles, CA, 11-15 Oct. 1955.

report on the need for and feasibility of installing air cleaning equipment...to prevent or minimize the introduction of contaminants into the passenger cabin.”⁶ However, no meaningful action was taken.

In the 2012 FAA Reauthorization Act (Section 517), Congress mandated that the FAA “implement a research program for the identification or development of appropriate and effective air cleaning technology...for the engine and auxiliary power unit bleed air supplied to the passenger cabin and flight deck of a pressurized aircraft...The technology...shall have the capacity, at a minimum to remove oil-based contaminants from the bleed air supplied to the passenger cabin and flight deck...”

However, instead of implementing an air cleaning research program, the FAA notified Congress that fume events are too rare to justify the cost. Specifically, the FAA claimed that US airlines had only reported an average of two oil fume events (and zero hydraulic fluid events) per year for 10 years (2002-11). However, a search of just one of those FAA databases,⁷ citing the same search terms and time period, produced the following US airline reports: 1,336 oil fume events; 1,799 bleed-sourced events that were most likely to be either oil or hydraulic fluid; 1,019 undefined air supply system fumes that were primarily related to air conditioning pack contamination; 1,193 fume events for which too little information was provided to ascertain the source; and 168 hydraulic fluid events. Even these data are an underestimate of the actual number of fume events during that time period because the FAA does not require airlines to report fume events that either occur on the ground or for which a mechanical defect/failure was not identified. Also, there is evidence that airlines underreport fume events to the FAA⁸⁻⁹. Notably, FAA-funded researchers published a paper in 2015 which described their search of FAA fume event databases. They concluded that US airlines reported one oil/hydraulic fluid fume event to the FAA for every 5,000 flights during a six-year period,¹⁰ which is three orders of magnitude more than what the FAA reported to Congress in 2013. Most recently, on March 1, 2020, Airlines for America published ATA Spec 126, which is intended to “*provide recommended practices for operators to mitigate and reduce the risk to passengers and crew in the event of odors, fumes, and visible haze/smoke not suspected to be related to fire in the cabin atmosphere.*”¹¹

⁶ NRC. The Airliner Cabin Environment and The Health of Passengers and Crew (Summary), US National Research Council, ISBN 0-309-08289-7, National Academy Press, Washington, DC, 2002.

⁷ US airline reports to the Service Difficulty Reporting database from 1/1/2002-12.31.2011 that included one or more of the search terms: fume, odor, smell, smoke, bleed air. Airline reporting is required per 21CFR121.703. FOIA requests submitted 3/4/2014 and 3/20/2015; data received 9/15/2015.

⁸ Murawski, JTL (2012) “Case study: Analysis of reported contaminated air events at one major US airline in 2009-10,” American Institute of Aeronautics and Astronautics, published online 16 Nov 2012: <https://doi.org/10.2514/6.2011-5089>; Presented at the 41st International Conference on Environmental Systems, July 19, 2011, Portland, Oregon.

⁹ FAA (2006) “Guidance for smoke/fumes in the cockpit/cabin: Order 8300.10,” Flight Standards Information Bulletin for Airworthiness 06-05A, US Federal Aviation Administration, Washington, DC.

¹⁰ Shehadi, M; Jones, B; and Hosni, M. (2016) “Characterization of the frequency and nature of bleed air contamination events in commercial aircraft,” *Indoor Air*, 26(3): 478-88. doi: 10.1111/ina.12211. Epub 2015 Apr 25.

¹¹ A4A (2020) “ATA Spec 126: Recommended practices for addressing cabin air quality events,” Airlines for America, Washington, DC (March 1, 2020).

EES-1 Recommendation

The ARC recommends the FAA establish a working group to document cause(s) for smoke/fume issues and develop corrective actions that will prevent or minimize smoke/fume events and consider effects on passengers as well (to the extent that it affects evacuation). Based on the findings of the working group, the FAA require that effective measures be developed and implemented in order to ensure that the ventilation air supplied to the flight deck and cabin in operation is free from smoke/fumes because those conditions have been shown to sometimes necessitate emergency evacuations.

Rationale

Most of these evacuations took place using escape slides and, in many, passengers and crew were injured, sometimes seriously. Preventing exposure to air supply system-sourced smoke/fumes would have prevented these evacuations and, thus, would improve flight safety.

EES-2. Subject

Airplane Condition/Design Recommendation: Issues 10 and 11 and Part 25 Type Certification Recommendation: Issue 12 - Evacuation from over-wing exits: escape path marking and evacuee comprehension, 6-ft requirement for assist means.

Applicable Regulations and Guidance

14 CFR §§25.810(c), 25.813(c)(3)(ii), and 25.810(d)

Finding

Based on a review of the evacuation events through over-wing exits (see Appendix 9), some evacuees do not understand where/how to egress from a wing when no escape slide is provided. A review of the applicable regulations and guidance reveals potential for improvement, because although the escape route is introduced as such, there is not enough emphasis that evacuees shall be guided effectively to the point where they are to leave the wing.

Section 25.810(c) addresses the creation of the escape route on the wing with respect to width and contrast ratio. Section 25.813(c)(3)(ii) addresses instructions on how to open the exit, but no guidance is provided to indicate where an evacuee should go after the exit is opened.

Section 25.810(d) mandates the installation of an assist means if the place on the wing at which the escape route required by 25.810(c) terminates is more than 6 feet from the ground with the airplane on the ground and the landing gear extended.

EES-2 Recommendation

The ARC recommends the FAA, in coordination with other Aviation Authorities, consider the introduction of changes to the requirements currently included in §25.810 with the scope to allow easier identification of the evacuation path by the evacuees and their faster and safer transition from the wing to the ground.

The ARC recommends the regulatory changes involve one or more of the following options:

1. The FAA amend 25.813(c)(3)(ii) as follows:

3) *For each Type III exit, regardless of the passenger capacity of the airplane in which it is installed, there must be placards that-*

(i)...

(ii) Accurately state or illustrate the proper method of opening the exit, including the use of handholds; if the exit is over a wing, and the airplane design does not include an off-wing assist means per Sec 25.810(d), the placards must also indicate the direction of the evacuation route on the wing.

2. The FAA review over-wing evacuation path marking requirements and consider options for improving marking visibility/design to facilitate better recognition by passengers evacuating through over-wing exits of proper direction to exit from wing.

3. The FAA reassess the requirement under 25.810 to define conditions that would require an escape slide. Other factors may drive different recommendations for over-wing exits (25.810(d)) versus non-over-wing exits¹² governed by 25.810(a).

Rationale

Of the 290 airplane evacuation events entered into the ARC data matrix, approximately 16% involved evacuations using Type III over-wing exits. A number of these evacuations occurred on airplane models that are not required to provide assist means to enable evacuees to reach the ground as per § 25.810(d). In some of these evacuations on airplane models that are not equipped with off-wing escape slides, it was observed that evacuees did not follow the marked escape route on the wing, but instead used other, less safe, routes to reach the ground. This led to injuries in some cases and delayed the evacuation to the ground. See Appendix 9 for a detailed review of the events that involved airplanes with emergency exits not equipped with an emergency egress assist means (ref. 14 CFR §§ 25.810(a) and (d)).

The above-proposed amendments will improve passenger awareness of the direction of the escape route required by 25.810(c) and facilitate their safe transition from the wing to the ground. In particular, the installation of an escape slide may significantly reduce the risk that evacuees do not recognize the evacuation path on the wing and may at the same time ensure faster evacuation of the passenger cabin. The ARC recognizes for airplanes with a maximum passenger seating capacity not exceeding 19 (as indicated in the airplane TCDS), the exposure to the risk of injuries when evacuating from an emergency exit not equipped with assist means is more tolerable considering the low occupancy of the cabin.

¹² Although the specific finding relates to exits over the wing, the ARC recommends that any assessment of the criteria used to determine when a means to assist to the ground is required (e.g., an escape slide) be addressed to other exits as well.

EES-3. Subject

Airplane Condition/Design Recommendation: Issue 13 - Guidance for analyzing airplane adverse attitudes and exit sill heights corresponding to the loss of one or more legs of landing gear.

Applicable Regulations and Guidance

14 CFR §§25.803(a), 25.809(a), 25.809(b)(1), 25.810(a)(1)(iii), and 25.810(d)(2)

Finding

Of the 290 airplane evacuation events entered into the ARC data matrix, approximately 25% involved an airplane at a non-normal attitude due to the loss of one or more legs of landing gear. After reviewing the pertinent regulations and guidance, the ARC determined the condition seems to be addressed by the regulations:

- **§ 25.803(a):** Requires “*each crew and passenger area must have emergency means to allow rapid evacuation in crash landings, with the landing gear extended as well as with the landing gear retracted...*”
- **§ 25.809(a):** Requires the likely areas of evacuee ground contact “*be viewable ... with the landing gear extended as well as in all conditions of landing gear collapse.*”
- **§ 25.809(b)(1):** Requires the ability to open each emergency exit ... “*with the airplane in the normal ground attitude and in each of the attitudes corresponding to collapse of one or more legs of the landing gear.*”
- **§ 25.810(a)(1)(iii):** Requires the assist means provided for non-over-wing exits to “*be of such length after full deployment that the lower end is self-supporting on the ground and provides safe evacuation of occupants to the ground after collapse of one or more legs of the landing gear.*”
- **§ 25.810(d)(2):** Requires off-wing assist means to “*usable and self-supporting with one or more legs collapsed.*”

However, the ARC also discovered a lack of guidance on how airframe manufacturers should establish the airplane adverse attitudes and exit sill heights corresponding to the loss of one or more legs of landing gear. Through its discussions, the ARC discovered, due to the lack of FAA guidance, there are minor differences in the assumptions airframe manufacturers use to establish the airplane adverse attitudes and exit sill heights.

There is FAA guidance in AC 25-17A on how the wing trailing edge height is determined, which involves a similar analysis method.

EES-3 Recommendation

The ARC recommends the FAA revise AC 25-17A to include the following guidance for determining airplane attitudes and measuring sill heights corresponding to the loss of one or more legs of landing gear:

For §§25.803(a), 25.809(a), 25.809(b)(1), 25.810(a)(1)(iii), and 25.810(d)(2), the airplane attitude and exit sill heights corresponding to the loss of one or more legs of landing gear may be established as follows:

- (i) All combinations of landing gear collapse must be considered.
- (ii) Conditions analyzed will typically involve three ground contact points (e.g., nose gear, main gear, forward fuselage, wing box, aft fuselage, engine, wing).
- (iii) The gross weight and center of gravity (CG) location should be considered for typical takeoff and landing configurations.
- (iv) Conditions where the airplane CG is not within the triangle formed by the three contact points (in the plan view) may be excluded, since the airplane would not be in a stable condition.
- (v) The landing gear oleo setting, tire pressure, and any other rigging-dependent tolerances should be the average.
- (vi) The landing gear strut and tire compression should be based on the gross weight and CG location used in paragraph (iii) above.
- (vii) The landing gear ground contact points may be considered the intersection of the landing gear post centerline with the static ground plane or the planar centroid of the centers of each tire contact area on the static ground plane, whichever is more appropriate for the landing gear design.
- (viii) For passenger exits, the sill height is measured from the centerline of the door sill. For the flight crew exits, the measurement is taken from the lowest point of the exit opening in whichever condition is being analyzed. For over-wing emergency exits requiring an assist means as per §25.810(d), the wing height shall be established and measured at a representative point considering the escape route on the wing and the design and integration of the associated assist means.
- (ix) The deflections and/or deformations associated with the static ground contact forces may be considered. This includes adjustments to landing gear strut and tire compression due to any changes in the landing gear post loads, nacelle crush, and engine strut deflections.

The dynamic effects of a crash event do not need to be considered (e.g., fuselage crush beyond what would be expected in a static condition, loss of engine(s)).

- (x) Airplane pitch and roll angles are measured relative to the ground plane.
- (xi) For adverse attitude conditions where the height of the forward fuselage has increased compared to the normal attitude condition, it may be assumed that the nose gear remains attached but is off the ground.

Rationale

The above-proposed new guidance for AC 25-17A will drive consistency in how the airplane attitudes and exit sill heights are determined and ensure the intent of the applicable regulations addressing the loss of one or more legs of landing gear is achieved.

EES-4. Subject

Airplane Condition/Design Recommendation: Issue 18 - In the events where communications issues were reported, crew members were sometimes unable to communicate with each other using the interphone system or provide announcements to the passengers using the public address system. The communications issues were a result of both aircraft and procedural issues.

Applicable Regulations and Guidance

14 CFR §§25.1362, 25.1423, and 121.319.

Finding

Due to the lack of information on survival aspects in some of the events the ARC reviewed, it is not clear how many cases of poor communications resulted from either a failure of the communication or public address systems or difficulty in the use of communications handsets. The ARC did learn there were some cases of the communication system and public address systems being inoperative due to aircraft damage. In at least one accident cabin crew members found difficulty in using the communication handsets due to unfamiliarity.

Some aircraft in the same airline fleet have different handset designs and, as a result, in the case of an accident, when cabin crew are under severe pressure, their unfamiliarity with the different handsets compromised their ability to use the interphone system.

EES-4A Recommendation-Design

The ARC recommends the FAA review §§25.1362, 25.1423, and 121.319 to ensure current regulations adequately cover all aspects of the survivability and use of crew interphone and public address systems.

The ARC also recommends in the long-term, the FAA should set standards for communication system handsets function and markings to be standardized for all aircraft types.

EES-4B Recommendation-Procedures

The ARC recommends the FAA collect, catalogue, and review these and similar recent evacuation incidents involving crew to passenger and crew to crew communications that are facilitated by onboard communications equipment. This data should be used to inform the development of robust guidance for operators in developing procedures, checklists, and scenario-based training for use of aircraft public address and interphone systems. Procedures and checklists and back-up equipment must account for any foreseeable malfunctions of one or more system elements. All hands-on training must be conducted using training equipment that at minimum replicates abnormal and emergency operation as necessary to meet the training objective.

Rationale

Communications issues were present in at least 58 of events reviewed. The above-proposed recommendations will improve crewmember to crewmember and crewmember to passenger communications in the event of emergency evacuations.

EES-5. Subject

Airplane Condition/Design Recommendation: Issue 19 and External Environment: Issue 5 - Influence of a wet surface on the safe usage of escape slides.

Applicable Regulations and Guidance

TSO-C69c §4.21.1

AC 150/5210-17C

Finding

During event reviews, the ARC observed some injuries occurred when escape slides were used in wet conditions. The ARC also reviewed one event during which a cabin crew member fell exiting an escape slide to which ARFF had applied firefighting foam. The injured cabin crew member stated the slide was slippery. Specifically, of the 148 events where escape slides were used, 14 events (approximately 9%) were identified where rain was noted during the evacuation. In looking at these evacuations, the ARC discovered only one event where the aircraft was on all gear and there were serious injuries (2) that may have occurred during use of the slide (though the cause of the injuries is not defined). The remaining events either had no/minor injuries or there were other crash circumstances, such as an adverse attitude, that would have contributed to the injuries.

Under TSO-C69c §4.21.1, escape slides must be tested in a simulated rain of 1 inch per hour and demonstrate they are safe to use. This test is done at an aircraft door sill height condition that represents the aircraft on all its gear. All the escape slides deployed during the 14 events where rain was involved would have been qualified as meeting the TSO-C69c requirement even though some were qualified to a previous TSO revision which still included the requirement.

Only one event cited the application of firefighting foam on the slide as a contributing factor to an evacuee injury. There were many events involving an ARFF response. Approximately 20% of the 148 events where slides were used involved some fire outside the aircraft. However, in these events, there was no indication the use of firefighting foam had any adverse effect on evacuation.

EES-5 Recommendation

Based on a review of the events investigated and the low injury rate in wet conditions, the ARC does not recommend a revision to the TSO-C69c requirement or recommend changes to the escape slide design for such conditions.

However, regarding ARFF firefighting foam and its effect on escape slide performance, the ARC recommends the FAA amend AC 150/5210-17C, §1.3.6 “Training Curriculum (Application of Extinguishing Agents)” to include the following information from National Fire Protection Association (NFPA) 402 “*Guide for Aircraft Rescue and Fire-Fighting Operations*” Chapter 9 - Section 9.3.3:

“Aircraft evacuation slides are coated with gray aluminized paint to protect them from nearby fires for up to 90 seconds; however, they remain susceptible to heat and fire exposure. They are combustible, and when exposed to radiant heat they may melt and deflate, rendering them unusable. ARFF personnel should protect evacuation slides from heat and flame to the best of their abilities but should be extremely careful not to apply foam to the operational area of the slide. Foam on the slide may increase the descent speed of evacuees, potentially causing injuries.”

The ARC also recommends the FAA disseminate this information to all ARFF services via a “CertAlert” for Part 139 Certificated Airports to reiterate the importance of this topic.

Rationale

Understanding the possible effects of “wet conditions” on escape slide performance is useful for ARFF training.

EES-6. Subject

Airplane Condition/Design Recommendation: Issue 20 - In-flight fire warnings leading to evacuation.

Applicable Regulations and Guidance

14 CFR §§25.1309 and 25.1322.

Finding

Many evacuations are the result of false cargo fire detector signals. A June 2000 FAA study reported a rate of 100 false indications to 1 accurate indication.¹³

EES-6 Recommendation

The ARC recommends the FAA review the Continuous Analysis and Surveillance System data and other data sources and determine if the fire detection system failure rate warrants a corrective action plan, e.g. the introduction of retroactive requirements. The smoke detection systems installed on recently certified large airplane models already guarantee a significant reduction of false positives and are typically based on the elaboration of signals (obscuration, temperature, humidity) given by multiple sensors.

Rationale

Many false warnings result in a diversion and some of those diversions lead to evacuations. In some of those evacuations, there were serious injuries. FAA report DOT/FAA/TC-16/49 “Research Into Fire, Smoke or Fumes Occurrences on Transport Airplanes” looked at inflight smoke/fire/fume events from 2002 to 2011¹⁴. During that time there were 24 evacuations following a false fire warning, 15 of which were due to cargo fire detection. The ARC observed 12 evacuation events resulting from false warnings in the 290 events reviewed for this report. The installation of the multi-sensor detectors will result in the decrease of the number of emergency evacuations resulting from in-flight fire false positive warnings.

EES-7. Subject

Part 25 Type Certification Recommendation: Issue 9 - Alignment of §25.810 requirements for means to assist airplane occupants to the ground from non-over-wing and over-wing exits.

Applicable Regulations and Guidance

14 CFR §§25.810(a)(1) and 25.810(d)

Finding

In the airplane evacuation events reviewed, the overall performance of the escape slides was good, and there are no specific recommendations to make regulatory changes to drive improved performance. However, when reviewing the pertinent regulations and guidance, it was determined that there are inconsistencies in the requirements for escape slides that are provided for non-over-wing and over-wing exits.

- **§ 25.810(a)(1):** Identifies the requirements for escape slides installed at non-over-wing emergency exits in the passenger cabin.

¹³ *Aircraft Cargo Compartment Smoke Detector Alarm Incidents on U.S.-Registered Aircraft, 1974-1999*, DOT/FAA/AR-TN00/29 (June 2000).

¹⁴ The database supporting the report was later extended to events through 2014 and is available at: <https://www.fire.tc.faa.gov/zip/MasterModelVersion3DDeliverable.zip>

- **§ 25.810(d):** Identifies the requirements for off-wing escape slides provided for over-wing exits.

Through its discussions, the ARC determined while there are inconsistencies in the requirements, airframe manufacturers and escape slide suppliers consistently demonstrate compliance for non-over-wing and over-wing escape slides. The guidance provided in AC-25-17A also suggests there should be consistency in the means of compliance for §§ 25.810(a)(1) and 25.810(d).

EES-7 Recommendation

The ARC recommends the FAA revise §25.810(d) to make the requirements for off-wing assist means (escape slides) consistent with those in §25.810(a) applying to assist means used at non-over-wing exits. The ARC does not propose any changes to §25.810(a).

Rationale

The above recommendation would clarify the intent of §25.810(d) and eliminate the inconsistencies in the regulations that apply to escape slides provided to assist occupants in descending to the ground from non-over-wing exits and off-wing escape routes. Since current means of compliance used by airframe and escape slide manufactures are consistent for non-over-wing and off-wing escape slides, it would ensure at least the current level-of-safety provided is maintained in the future with no appreciable added costs.

EES-8. Subject

Part 25 Type Certification Recommendation: Issue 11- Currency of Emergency Lighting Standards.

Applicable Regulations and Guidance

14 CFR §25.812

Finding

The requirements for emergency lighting were introduced in 1967 in amendment 25-15. The requirement for illumination level for the exit signs and for the cabin emergency lighting has not changed since this amendment.

The illumination technologies used 40 years ago (incandescent lighting) were very different from the technologies used today (LEDs). The industry has evolved, without any regulation change, and all aircraft delivered today have an emergency lighting system and illuminated exit signs with a performance well above the minimum requirements (in many cases an order of magnitude brighter). The same is true for the evacuation slide lighting.

For example, the requirement is that at a height of 40 inches, the average illumination should be no less than 0.05 foot-candles or 0.5 lux, which is 10 times below the level of performance

of recently-certified systems. Regarding the evacuation assist means, the regulation mandates 0.03 foot-candles (0.3 lux) whereas the latest slides provide an illumination above 1 lux.

It would be reasonable to improve the minimum illumination levels required in the rule to reduce the gap with the level of performance of state-of-the-art emergency lighting systems recently certified for installation on large airplanes. This would not create any burden to the industry as these systems would still be considered compliant, and it would prevent an applicant for a new aircraft type from designing an emergency lighting system with a questionable performance level.

In terms of dispatch relief, this would not create any burden as the idea is not to go beyond what exists today, nor to mandate a retrofit.

EES-8 Recommendation

The ARC recommends the FAA revise existing requirements applicable to emergency lighting systems of large airplanes to mandate higher illumination levels consistent with current state-of-the-art lighting systems.

Rationale

The new requirements may be written in the same prescriptive form as current ones or they could be fixed performance objectives such as:

- Passengers should be able to identify the location of any emergency exit in a smoke-filled cabin, with the sole illumination of the emergency lighting system and the exit signs.
- The emergency lighting system should allow the passengers, in a smoke-filled cabin, to orient themselves in order to find the emergency exits.

Regardless of which option is selected, the FAA should develop any new requirements and associated guidance material using the following references:

- Evidence coming from research:
- The existing regulations for buildings accessible to the public. For example, the European standard mandates a minimum illumination of 5 lux for the emergency lighting system. This level is deemed to be the minimum needed for people to orient themselves in the building to find the emergency exits.

EES-9. Subject

Part 25 Type Certification Recommendation: Issue 12 - Emergency Exit Access – harmonize hatch disposal requirement with EASA.

Applicable Regulations and Guidance

14 CFR §25.813

Finding

Of the 290 airplane evacuation events entered into the ARC data matrix, approximately 16% involved evacuations using Type III over-wing exits. The ARC observed when the Type III exit defined in 14 CFR §25.807(a)(3) is a removable hatch, the disposal of the hatch out of the egress path of evacuees was not applied in a consistent manner, although §25.813(c)(iii) requires placards to indicate an appropriate location to place the hatch after removal. Placing the hatch in the Type III exit area—either on seats adjacent to the exit, in the passageway leading to the exit, or on the wing—holds the potential to make egress through the Type III exit more difficult or introduce an obstacle in the escape route on the wing required by §25.810(c). This may delay the evacuation.

With Certification Specification (CS) 25.813 (CS-25.813) Amendment 9, EASA introduced the concept of the Automatically Disposable Hatch (ADH). When this hatch is fully opened, it must automatically go to a position that will not reduce the size of the exit opening or the passageway(s) leading to the exit below their minimum required dimensions, nor obstruct egress from the exit via the escape route specified in CS-25.810.

14 CFR §25.813(c)(3)(iii) requires, “...if the exit is a removable hatch, state the weight of the hatch and indicate an appropriate location to place the hatch after removal.”

CS-25.813(c)(6) reads, “...each Type III exit must be designed such that when operated to the fully open position, the hatch/door is automatically disposed so that it can neither reduce the size of the exit opening, the passageway(s) leading to the exit, nor the unobstructed space specified in sub-paragraph I(2)(ii) of this paragraph, to below the required minimum dimensions. In the fully open position it must also not obstruct egress from the exit via the escape route specified in CS 25.810I”.

EES-9 Recommendation

The ARC recommends the FAA replace the current text of 14 CFR §25.813(c)(3)(iii) with the text of CS 25.813(c)(6), as follows:

“Each Type III exit must be designed such that when operated to the fully open position, the hatch/door is automatically disposed so that it can neither reduce the size of the exit opening, the passageway(s) leading to the exit, nor the unobstructed space specified in sub-paragraph I(1)(ii) of this paragraph, to below the required minimum dimensions. In the fully open position it must also not obstruct egress from the exit via the escape route specified in Sec. 25.810I.”

Furthermore, the ARC recommends the FAA harmonize all of 14 CFR §25.813 with CS-25.813, in particular with respect to passageway width requirements of 14 CFR §25.813(c)(1)(i) and CS 25.813(2)(i), which is consistent with FAA practice upon an equivalent level of safety finding.

Rationale

The above-proposed recommendation provides harmonization between FAA and EASA regulation and will, by introducing the concept of an automatic disposable hatch, reduce the

risk of obscuring the Type III exit by a hatch that is not appropriately placed after exit opening during an emergency evacuation. Full harmonization of §25.813 between FAA and EASA will ensure consistent application of the rule.

EES-10. Subject

Part 121 Type Certification Recommendation: Issue 1 – Clarifying flight attendant procedures during Emergency Evacuation Demonstration.

Applicable Regulations and Guidance

14 CFR §§121.291, and 121.397

14 CFR Part 121, Appendix D

FAA FSIMS 8900.1 CHG 310, paragraph 3-3513, 4/30/14

Finding

The ARC discussed procedures used by flight attendants in emergency evacuation demonstrations. 14 CFR Part 121, Appendix D, paragraph (a)(19) states:

“The certificate holder’s approved procedures and all of the emergency equipment that is normally available, including slides, ropes, lights, and megaphones, must be fully utilized during the demonstration.”

In addition, 14 CFR §121.397 states:

“(a) Each certificate holder shall, for each type and model of airplane, assigned to each category of required crewmember, as appropriate, [provide] the necessary functions to be performed in an emergency or a situation requiring emergency evacuation. The certificate holder shall show those functions are realistic, can be practically accomplished, and will meet any reasonably anticipated emergency including the possible incapacitation of individual crewmembers or their inability to reach the passenger cabin because of shifting cargo in combination cargo-passenger airplanes.

(b) The certificate holder shall describe in its manual the functions of each category of required crewmembers under paragraph (a) of this section.”

In order to verify the procedures of certificate holders for emergency evacuation, an ARC member representing the Association of Flight Attendants-CWA asked flight attendant safety committee members at several airlines to review their approved training procedures for emergency evacuations. The ARC member determined flight attendants are not trained to direct passengers to go forward or aft of a usable exit.

14 CFR Part 121, Appendix D, requires the certificate holder to use its approved procedures in the conduct of an emergency evacuation demonstration, and sets regulatory limits on what procedures may be approved. The capability to handle emergency situations, in general, and emergency evacuation, in particular, is based on the complement of required flight attendants. The duties assigned to the required complement of flight attendants must be realistic, capable

of being practically accomplished, and take into account the possible incapacitation of an individual crewmember.¹⁵ Having flight attendants direct passengers to proceed past a usable exit to one forward or aft of that exit may not be able to be accomplished in all emergency evacuation scenarios.

EES-10 Recommendation

The ARC recommends the FAA ensure flight attendants who conduct an evacuation demonstration for an original equipment manufacturer (OEM) use emergency evacuation procedures valid for foreseeable evacuation scenarios.

Rationale

In any emergency evacuation scenario, while it is always realistic and appropriate for flight attendants to call for passengers to “Come this way!” to a usable exit, or to block an unusable exit; in some common evacuation scenarios, including those involving smoke and/or fire, it may be unsafe for flight attendants to direct passengers past a usable exit to another exit fore or aft of the usable exit. Having flight attendants speak, or more accurately, yell commands telling passengers to pass a usable exit and travel to another exit up to 60 feet fore or aft of that usable exit will not work in many actual emergency evacuations, and is therefore not trained by most operators. In actual evacuations, when smoke and/or fire are present, a flight attendant may not be able to see whether an exit up to 60 feet fore or aft of a usable exit is blocked.

Furthermore, in an actual emergency evacuation, it would be difficult to split the flow of passengers, some to the usable exit and some past it, because, unlike the test subjects in a typical evacuation demonstration, a real evacuation has family members and close friends trying to evacuate together. Any attempt by flight attendants to command individuals within these groups to go past a usable exit would likely disrupt the flow of evacuees wanting to go out the nearest exit with their family or friend(s), as explained in the attached letter on “exit bypass.” This is not to say in an evacuation demonstration, flight attendants are to prevent passengers from bypassing a usable exit on their own, only that they should not command them to do so in order to rebalance the flow to another cabin zone and exit.

In conclusion, since emergency evacuation demonstrations are required to have flight attendants use their certificate holder’s approved emergency evacuation procedures, the FAA should ensure the flight attendant crew in a full-scale evacuation demonstration is not provided additional evacuation information, instructions, procedures, or training beyond the certificate holder’s evacuation training and procedures. The evacuation times and rates in a successful demonstration are used in evacuation certification of types and models of airplanes proposed by OEMs as similar to previously tested airplanes. Those numeric values from previous tests should be achieved using actual line evacuation procedures of the operator for which its flight attendants must be properly trained.

¹⁵ FAA, Order 8900.1 CHG 310, 3-3513 *DUTY ASSIGNMENT OF REQUIRED AND NONREQUIRED F/As*. April 30, 2014. http://fsims.faa.gov/PICDetail.aspx?docId=8900.1,Vol.3,Ch33,Sec4_SAS See also 14 CFR §121.397.

EES-11. Subject

Part 121 Type Certification Recommendation: Issue 4 - Anthropometric suitability of flight attendant seats.

Applicable Regulations and Guidance

14 CFR §§25.562(a), 25.785(h), and 121.311(i)

Finding

The ARC suggests the FAA reevaluate requirements applicable to the design of flight attendant jumpseats configured to be utilized by two occupants, versus a single-occupant jumpseat, to ensure the occupants of such jumpseats may make proper use of the seating system and of the available restraint system, so they may not suffer serious injury in an emergency landing.

While the ARC's review of the accidents did not specifically point to the concern related to the adequacy of dual flight attendant jumpseats to protect occupants from suffering injuries, the ARC expressed interest in additional research on this topic as an overall design change that could enhance aviation safety. Passenger egress in an incident or accident is influenced by many factors, including airframe crashworthiness requirements that allow passengers the ability to move to an exit without obstructions blocking their egress path. Other factors that can influence survivability is the use of seats, safety belts and shoulder harnesses by all occupants. Seat designs can influence proper use of safety belts and shoulder harnesses for all occupants but especially related to some of the current flight attendant jumpseat designs installed on some aircraft.

Advisory Circular 25.785-1B, *Flight Attendant Seat and Torso Restraint System Installations*, provides information and guidance related to compliance with portions of 14 CFR 25.785 and 121.311 where they pertain to flight attendant seats. Although AC 25.785-1B is dated 2010, it appears very few design or installation changes have been made in relation to flight attendant jumpseats requirements since AC 25.785-1 was drafted in 1981.

The AC notes a single flight attendant jumpseat should provide at least 17.25 inches of shoulder clearance. A dual flight attendant jumpseat should provide at least 34.5 inches of shoulder clearance. "The recommended seat width of 34.5 inches is based on two 50th percentile males (17.7 inches wide at the shoulder, minus .25-inch soft tissue compression on each side, equals 17.2 inches times 2 equals 34.4 inches.)" [AC 25.785-1A and 1B]

However, the AC specifies the above minimum dimensions should be met "where design conditions permit."

Later the FAA revised the AC to incorporate guidance related to compliance with flight attendant direct view requirements. Direct view requirements and the promulgation of a requirement for testing of flight attendant jumpseats for emergency landing dynamic conditions reaching a minimum of 16g are the significant changes (Amendment 25-5, effective March 6, 1980).

In both dated versions of the AC there is reference to a 1985 FAA Public Technical Conference on Emergency Evacuation of Transport Airplanes that recommended the AC be revised to address the close proximity of flight attendant jumpseats with respect to passenger seats; and, recommendations pertaining to the width of single and double flight attendant jumpseats. However, the minimum dimensions for flight attendant jumpseats listed in the 1994 and 2010 versions of the AC have not changed.

Advisory Circulars by their nature are guidance and provide one means for showing compliance with a regulation. According to the AC, design changes to interiors of an in-service airplane or newly manufactured airplane of an existing model can be introduced as long as they do not result in flight attendant seats being narrower than the seats presently approved as part of the airplane type design.

The body characteristics for both women and men have changed since the first rules were promulgated for occupant protection. Weight and height measurements have been collected in the United States since the late 1950s. These early body characteristics were also used to design and test some of the seat restraints in current aircraft. A 2018 National Health Statistics Report references weight and height averages from 1960-1962, specifically noting the average range of men during those years went from the average weight of a 5-foot, 2 inch male at 146 pounds, to a 6-foot, 1-inch tall man at 190 pounds. The report notes the average height from 1960 to 2002 only increased by one inch, however the weight of an average American male increased from around 166 pounds to 191 pounds during that same time span.¹⁶

Testing of both passenger and crew seats always assumes the occupant is making proper use of the seats, seat belts, and shoulder harnesses (§25.562). However, concerns have been voiced that the width of some of the current dual flight attendant jumpseats may not be adequate to allow two larger male occupants to properly use their seat belts or shoulder harnesses due to either one, or both, occupants not being able to properly align their bodies on the jumpseat in relation to the seat belts and shoulder harness. This is because the combined lower body width of both occupants is wider than the width of the dual flight attendant jumpseat. This alignment issue is generally not seen in the single flight attendant jumpseat because a single occupant has the ability to align their body to be centered on the jumpseat to assist with the proper use of the seat belts and shoulder harnesses.

§ 25.562 Emergency landing dynamic conditions.

(a) The seat and restraint system in the airplane must be designed as prescribed in this section to protect each occupant during an emergency landing condition when—

(1) Proper use is made of seats, safety belts, and shoulder harnesses provided for in the design; and . . .

¹⁶ Fryar CD, Kruszon-Moran D, Gu Q, Ogden CL. Mean Body Weight, Height, Waist Circumference, and Body Mass Index Among Adults: United States, 1999–2000 Through 2015–2016. National Health Statistics Reports; No. 122. Hyattsville, Md.: National Center for Health Statistics. 2018

§ 25.785 Seats, berths, safety belts, and harnesses.

(a) A seat (or berth for a nonambulant person) must be provided for each occupant who has reached his or her second birthday.

(b) Each seat, berth, safety belt, harness, and adjacent part of the airplane at each station designated as occupiable during takeoff and landing must be designed so that a person making proper use of these facilities will not suffer serious injury in an emergency landing as a result of the inertia forces specified in §§25.561 and 25.562.

(c) Each seat or berth must be approved.

(d) Each occupant of a seat that makes more than an 18-degree angle with the vertical plane containing the airplane centerline must be protected from head injury by a safety belt and an energy absorbing rest that will support the arms, shoulders, head, and spine, or by a safety belt and shoulder harness that will prevent the head from contacting any injurious object. Each occupant of any other seat must be protected from head injury by a safety belt and, as appropriate to the type, location, and angle of facing of each seat, by one or more of the following:

- (1) A shoulder harness that will prevent the head from contacting any injurious object.
- (2) The elimination of any injurious object within striking radius of the head.
- (3) An energy absorbing rest that will support the arms, shoulders, head, and spine.

AC 25.785-1B – Flight Attendant Seat and Torso Restraint Systems Installations

...

7. FLIGHT ATTENDANT SEAT GEOMETRY AND TORSO RESTRAINT INSTALLATION.

a. Design changes to interiors of an in-service airplane or newly manufactured airplane of an existing model should not result in flight attendant seats being narrower than the seats presently approved as part of the airplane type design when those seats do not meet the minimum dimensions in this AC. Where design conditions permit, the minimum width of a single occupant flight attendant seat should be increased to provide at least 17.25 inches of shoulder clearance, and the width of a double occupant flight attendant seat should be increased to provide at least 34.5 inches of shoulder clearance. These seat widths apply for both forward and aft-facing seats.

- (1) This increase in width is desirable in order to accommodate the larger size of male flight attendants who have been employed since the designs of most flight attendant seats were established. The recommended seat width of 34.5 inches is based on two 50th percentile males (17.7 inches wide at the shoulder, minus .25-inch soft tissue compression on each side, equals 17.2 inches times 2 equals 34.4 inches.)
- (2) As an illustration, the remaining space on a 34.5-inch wide double seat occupied by a 95th percentile male (19.2 inches shoulder width minus .50-inch soft tissue compression equals 18.7 inches) is 15.8 inches remaining. This 15.8 inch seat width, plus .50-inch soft tissue compression, means that a female that is 16.3 inches wide at the shoulder could occupy the seat together with a 95th percentile male. This shoulder width is slightly larger than a 50th percentile female (16.0 inches).

During ARC recommendation reviews the issue of maintenance repairs to in-service flight attendant jumpseats was brought up as a concern. One member reported that they had received information that during maintenance when new restraints were installed, the specific lengths of

the restraints appeared to be shorter than the original installation. When the FAA reviews the AC it is suggested that a section be added that addresses information for service providers.

EES-11 Recommendation

Similar to the recommendations made in 1985 FAA Public Technical Conference on Emergency Evacuation of Transport Airplanes, the ARC recommends the FAA conduct research to reevaluate the design requirements related to single and dual flight attendant jumpseats to ensure occupants of a single or dual flight attendant jumpseat are afforded the opportunity to properly utilize their respective seat belt and shoulder restraints.

The ARC additionally recommends the FAA conduct research related to a dual flight attendant jumpseat when occupied by two males of larger size versus the assumption a dual jumpseat would be occupied by one 95th percentile male and one female. This reevaluation of design is especially important when the flight attendant jumpseats could be required to accommodate two male occupants.

The ARC also recommends the FAA reevaluate the applicability of the design criteria that will be identified as appropriate for the geometry of flight attendant seat to design changes to the interiors of an in-service airplane or newly manufactured airplane of an existing model.

Finally, recognizing concerns still exist related to the spacing between flight attendant jumpseats and passenger occupants, the ARC recommends the FAA conduct research to ensure injurious body-to-body contact does not occur between the occupants in an emergency landing.

Rationale

The current published material related to the design dimensions of flight attendant jumpseats has not been updated in several decades to take into consideration the changes of body characteristics in today's population. The failure to address these changes in body characteristics could result in hazards or injuries if the regulation and guidance for flight attendant jumpseats are not updated.

EES-12. Subject

Part 121 Type Certification Recommendation: Issue 5 and Procedures and Training: Issue 18 – Are flight attendant requirements adequate to ensure safe emergency evacuations?

Applicable Regulations and Guidance

14 CFR §§121.291, 121.391, 121.397, and 121.417
FAA FSIMS 8900.1 CHG 310, paragraph 3-3513, 4/30/14

Finding

While the ARC's review of the accidents did not specifically point to a concern related to the adequacy of flight attendant staffing, the ARC supported FAA evaluation of this topic that could enhance aviation safety.

The FAA promulgated 14 CFR §121.391, which establishes the “one flight attendant per 50 passenger seating capacity” rule (one per 50 rule), in March 1965. §121.391(a) sets a minimum of one flight attendant crewmember per 50 passenger seating capacity, and §121.391(b) may increase that minimum if a greater number of flight attendants are used in the emergency evacuation demonstration than that required in paragraph (a). In addition, 14 CFR §121.397(a) requires necessary functions be assigned in an emergency or a situation requiring emergency evacuation and the certificate holder shall show those functions are realistic, can be practically accomplished, and will meet any reasonably anticipated emergency including the possible incapacitation of individual crewmembers.

Another aspect of §121.391 in 1965, and for many years thereafter, was that airline rates and routes were regulated by the Civil Aeronautics Board. Because of this, operators were able to provide point-to-point service and flights to smaller communities with load factors lower than those of recent years. When the rule was being developed and promulgated, average passenger load factor was 55%.¹⁷ The most recent annual average load factor of 84%, Table 2 supra, means today, flight attendants will on average be responsible for evacuating almost 30% more occupants in a given emergency than they were when this rule was promulgated. In addition, while one may argue one flight attendant per 50 passenger seats is sufficient to meet the 90-second evacuation demonstration requirement, the variety of hazardous emergency conditions flight attendants face in real evacuations, including more difficult combinations of exit availability, smoke, fire, airplane, and equipment damage, further supports the need to consider whether one flight attendant per 50 passenger seats is sufficient to accomplish their procedures and ensure safe emergency evacuations.

In 1994, Cranfield University conducted a study commissioned by the U.K. Civil Aviation Authority and the FAA on the influence of cabin crew members on passenger evacuations during an emergency.¹⁸ Participants were tasked with performing four emergency evacuations in a cabin simulator. Incentive payments were used to motivate the participants and reproducing the urgency which can occur in an emergency. A total of 1,307 participants took part in the evacuation tests. The results showed that the performance and number of cabin crew significantly influenced participant behavior and evacuation rates.

One of the conditions not present at the time the FAA promulgated the one per 50 rule is the current wide-scale presence of large overhead bins on airplanes operated under 14 CFR Part 121. In many evacuations reviewed by the ARC, passengers took time to retrieve carry-on bags and carry them down the aisle and through exits. In addition to briefing passengers to leave carry-on bags behind in the event of an emergency evacuation, the presence of a uniformed flight attendant at each floor level exit would allow for proper management of the evacuation through increased crew presence and the ability to command passengers with bags to “just leave that behind” or “throw that bag into an empty seat row.”

¹⁷ FAA Statistical Handbook of Aviation, Federal Aviation Agency, p. 153, 1966 Edition.

¹⁸ H.C. Muir and A.M. Cobbett; *Influence of Cabin Crew During Emergency Evacuation at Floor Level Exits*; CAA Paper 95006:Part A; FAA No. DOT/FAA/AR-95/52 (London Civil Aviation Authority, 1996).

And on top of all this, on August 2, 2005, in the Air France Flight 358 accident in which the aircraft overran the runway and caught fire with 297 passengers and 12 crewmembers on board, the regulations called for one cabin crewmember for every 50 passenger seats, so this flight required only 6 cabin crew. But there were 3 supplemental cabin crew on board who contributed to the success of the evacuation with no fatalities in a little over two minutes. In its analysis of survivability, Canada's Transportation Safety Board reported:

“The availability of three supplemental cabin crew members on AFR358 undoubtedly contributed to the success of the evacuation, as evidenced by the roles they played during the evacuation. Two were in command of passenger evacuations at emergency exits and the third played a pivotal role in opening an emergency exit and subsequently assisted passengers at the foot of the R4 slide.”¹⁹

EES-12 Recommendation

The ARC recommends the FAA evaluate the staffing requirements of §121.391 to determine if any updates are needed, including whether to amend regulation §121.391(a).

Rationale

14 CFR Part 121 does not require or have provisions for extra or non-required flight attendants. The capability to handle emergency situations in general, and emergency evacuations in particular, is based on the complement of required flight attendants, whose duties “must be realistic, capable of being practically accomplished, and take into account the possible incapacitation of an individual crewmember.”²⁰ Increasing the number of flight attendants on some airplanes will mitigate risks inherent to having only a single flight attendant to perform emergency evacuation duties that may require at least two flight attendants. An individual flight attendant at each floor level exit on airplanes with over 100 passenger seats could help to anticipate the possible incapacitation of a flight attendant crewmember and ensures, during emergency evacuations, each floor-level exit door is properly operated and passenger flows are managed so risks involved with unsupervised floor-level exits that may become unusable are eliminated or reduced, and airplane occupant injuries are minimized.

Dissent of Regional Airline Association (RAA)

The Tasks of the Emergency Standards Evacuation ARC Charter dated 4/24/2019 are as follows:

- a. Review and become familiar with current evacuation system rules and advisory material and previous recommendation reports on this subject submitted to the FAA by the ARAC.
- b. Review available data from the past ten years of accidents and incidents in which passengers evacuated transport category aircraft used in air transportation.

¹⁹ TSB Canada; *AVIATION INVESTIGATION REPORT A05H0002, RUNWAY OVERRUN AND FIRE, AIR FRANCE AIRBUS A340-313 F-GLZQ, TORONTO/LESTER B. PEARSON INTERNATIONAL AIRPORT, ONTARIO, 02 AUGUST 2005*; p. 111. <https://www.tsb.gc.ca/eng/rappports-reports/aviation/2005/a05h0002/a05h0002.pdf> See also the following video, especially the segment from -29:30 to -25:30: <https://www.facebook.com/watch/?v=119752428629314>

²⁰ FAA, Order 8900.1 CHG 310, 3-3513 *DUTY ASSIGNMENT OF REQUIRED AND NONREQUIRED F/As*. April 30, 2014. http://fsims.faa.gov/PICDetail.aspx?docId=8900.1,Vol.3,Ch33,Sec4_SAS

- c. Review the considerations listed in sections 337 and 323 of the FAA Reauthorization Act of 2018 with the exception of ditching and passenger seat dimensions.
- d. Identify any safety issues to be addressed based on available accident and incident data.
- e. Develop recommendations in the following categories:
 - Evacuation system design and testing.
 - Evacuation procedures, including exit row seating.
- f. For each recommendation to change regulations, include:
 - Estimates of cost to implement the change, including both safety and monetary costs.
 - Estimates of benefits to the public, including both safety and monetary benefits.

Recommendation EES-12: The current recommendation in the ARC report is as follows:

The ARC Recommends the FAA evaluate the staffing requirements of §121.391 to determine if any updates are needed, including whether to amend §121.391(a). This recommendation is not supported by either the tasks required by the ARC charter as shown above, or by the supporting information gathered from the review of the accidents and incidents selected from the past 10 years. In fact, the ARC report as currently written did not argue that the number of flight attendants was in any way inadequate and currently states the following in the finding:

“While the ARC’s review of the accidents did not specifically point to a concern related to the adequacy of flight attendant staffing....” Accordingly there is no rationale for including this recommendation in the ARC report.

Alternate Finding

The ARC was tasked with reviewing available data from the past ten years of accidents and incidents in which passengers evacuated transport category aircraft used in air transportation. To accomplish this, a list of 290 accidents and incident reports were identified and subsequently examined. There was no data gathered from the reports that were examined, that suggested that the number of flight attendants on board the aircraft had any material effect on the outcome of the evacuations. As a result of the findings, there are no arguments to be made that support any recommendation.

EES-13. Subject

Part 121 Type Certification Recommendation: Issues 12 and 13 and Procedures & Training: Issue 14 and 19 – Some evacuees do not understand where/how to egress from a wing when no escape slide is provided. As a result, passenger briefing in exit rows should be improved.

Applicable Regulations and Guidance

14 CFR § 121.585(d)
AC 121-24D

Finding

Enhanced communication is needed between flight attendants and passengers seated in exit rows to let them know the proper way to safely exit off the wing once they go through the over-wing exit door/hatch.

14 CFR §121.585(d) states each certificate holder shall include on passenger information cards presented in the language in which briefings and oral commands are given by the crew, at each exit seat affected by this section, information that, in the event of an emergency in which a crewmember is not available to assist, a passenger occupying an exit seat may use if called upon to perform the following functions:

(10) Assess, select, and follow a safe path away from the emergency exit.²¹

AC 121-24D (6)(a)(2)-Exit Seating states: “Refer each passenger to any unique characteristics of the exit included on the safety information briefing card and/or operating instruction placard (e.g., Boeing 737-800 over-wing exits are hinged at the top and open outward, or Airbus A320 over-wing exits have manual inflation handles in the upper inner corners). Passengers may be seated in exit seating that is also assigned to a flight attendant. These passengers are encouraged to watch the flight attendant arm the evacuation slide and assess outside conditions at the exit. Passengers should review pictures of the emergency exit operation sequence, including the location of the backup inflation lanyard. The F/A should ask passengers to review the safety information briefing card for the location, retrieval, and use of lifelines when installed at a window exit.”

Based on a review of this AC, the ARC recommends the FAA require air carriers to add information to the exit row briefing to focus attention on the evacuation path once the passenger leaves the aircraft through an over-wing exit.

EES-13 Recommendation

The ARC recommends the FAA revise AC 121-24D Appendix 1 (6)(a)2.--Exit Seating to include the following new language:

Individual briefings provide passengers in exit rows the opportunity to ask questions about the exit operation and emergency egress procedures. Depending on the aircraft type, model, series, configuration, and seat location, exit seating consists of staffed and unstaffed emergency exits. An example of a staffed emergency exit is one where an emergency exit has a trained and qualified crewmember positioned at a jump seat in close proximity to the emergency exit. This staffed exit may or may not have a passenger occupying each exit seat location. A second type of exit seat is an unstaffed emergency exit where a crewmember is assigned to two exits a primary exit and a secondary exit assignment.

An individual Exit Briefing should be given to each passenger seated in the exit row. Each passenger that occupies a staffed or an unstaffed exit seat should be directed to pay special attention to any unique characteristics of the exit and egress path illustrated

²¹ Emphasis added.

on the safety information briefing card, operating instruction placard and directional arrows on the wing or emergency slide. Exit seat passengers in close proximity to staffed emergency exits are encouraged to observe the flight attendant arm the evacuation slide and assess outside conditions at the exit. Crew members should emphasize the importance of carefully assessing conditions prior to opening an “unstaffed” emergency exit, how to operate the handle, secure or stow the exit and following directional arrows on the wing surface to egress using the trailing edge of the wing.

Rationale

ARC review of relevant events (see Appendix 9) revealed some evacuees do not understand where or how to egress from a wing when no escape slide is provided. Event 119 illustrated the issue when evacuees exited from the wing to the ground by climbing over and down an engine cowling.

EES-14. Subject

Procedures & Training: Issue 2 - Effective direct communications between ARFF Personnel, Flight Crew, and Air Traffic Control personnel can reduce emergency evacuations (and related injuries). Additionally, direct communication creates a link between these three groups during an aircraft emergency that will better coordinate efforts, knowledge, and resources.

Applicable Regulations and Guidance

AC 150/5210-7D

The United States of America Aeronautical Information Publication (AIP), published by the authority of the Federal Aviation Administration. - GEN 3.7 Aircraft Rescue and Fire Fighting Communications

Finding

Based on data evaluated from our case studies it was apparent in some cases, communication between the flight crew and ARFF should have occurred or been timelier.

EES-14 Recommendation

The ARC recommends the FAA establish a universal designated emergency radio frequency (such as 121.500) at all airports certified under 14 CFR Part 139 and amend AC 150/5210-7D (or current revision) to ensure flight crew, ARFF personnel, and air traffic control personnel are aware of its designation.

Rationale

While statistical studies of this topic could not be established, anecdotal information suggests this universal communication capability between flight crew and ARFF personnel may reduce the number of unneeded aircraft evacuations, preventing unnecessary injuries to passengers and crew, and may provide a higher level of safety to ARFF personnel by avoiding hazards to themselves, to prevent damage to aircraft systems and equipment; and prevent the unnecessary application of fire extinguishing agents.

The frequency 121.500 is considered the universal frequency for aircraft emergencies and provides a frequency every airman knows can be used in an emergency without having to look up or ask for a specific frequency during high stress emergencies. It should be noted the current FAA AC for Aircraft Rescue and Fire Fighting Communications (150/52107D) states the following:

“On airports without an Airport Traffic Control Tower (ATCT) or when the ATCT is closed, the Emergency Aircraft should contact the ARFF IC on the CTAF published for the airport or the civil emergency frequency (121.5 MHz).”

Regardless of whether it is 121.500 or another frequency, there is a definite need to have a universal frequency flight crew can use at any airport in an emergency.

EES-15. Subject

Procedures & Training: Issue 3 and 4 - Flight deck and cabin crew member procedures and training related to emergency evacuation decision-making and execution need to be enhanced.

Applicable Regulations and Guidance

14 CFR §121.417

Finding

Within the accident set reviewed, the ARC observed at least two common negative trends related to the flight crew operation before or during the initiation of the emergency evacuation:

- The complexity of the applicable Non-Normal Checklist(s) and the Emergency Evacuation Checklist led to delays in rendering the aircraft safe for the initiation and/or completion of the emergency evacuation.
- The physical execution of an emergency evacuation (exiting the airplane) is challenging, even when the flight and/or cabin crewmembers are committed to doing so (i.e.- putting the plan into motion).

In summary, the ARC determined many of the evacuations studied could have been conducted more efficiently and expeditiously if the crewmembers had additional training related to emergency evacuation scenarios.

EES-15 Recommendation

The ARC recommends the FAA:

1. Research and promote the essential actions for flight crewmember to perform during an actual or potential emergency evacuation scenario. These directives should include –
 - An industry-standard time delay for cabin crewmembers to initiate the evacuation in absence of direction from the flight crew;

- Best practices regarding methods of communication between the flight deck and cabin crewmembers in a potential or actual emergency evacuation scenario, including face-to-face verbal communication and evacuation alerting systems;
 - Best practices regarding assertiveness and clarity of communication from the flight deck – to all cabin crewmembers – the need to either prepare for or initiate an emergency evacuation;
 - Training related to the identification of a potential or actual emergency evacuation scenario and the decision-making skills required to conduct a timely initiation of the evacuation, if required; and
 - Training related to the identification and execution of other methods to expeditiously vacate the aircraft without the need or ability to conduct a full-scale evacuation.
2. Direct aircraft manufacturers to –
- Review and revise, as necessary the Emergency Evacuation Checklist to ensure the actions are logical, necessary, and appropriately ordered. The revisions should minimize procedural items (such as informing Air Traffic Control) before the aircraft is configured appropriately for the evacuation.
 - Whenever practical and necessary, the ‘Flap Extension’ item of the checklist should occur at the beginning of the checklist procedure.
 - Whenever practical, the ‘Engine Shutdown’ item of the checklist should occur immediately after the ‘Flap Extension’ item, or, if ‘Flap Extension’ is not required, the ‘Engine Shutdown’ item of the checklist should occur at the beginning of the checklist procedure.
3. Direct aircraft operators to –
- Revise the applicable Emergency Evacuation Checklist to align with manufacturer guidance;
 - Revise their procedures to align with industry best-practices and FAA research (as described above);
 - Update their emergency procedures to remove ambiguity concerning the flight crew decision to initiate, continue, or stop an emergency evacuation;
 - Ensure flight crewmembers complete realistic, simulator-based emergency evacuation initial and recurrent training related to decision-making and timeliness on an annual basis.

Rationale

The proposed enhancements to emergency evacuation training will provide flight crewmembers the decision-making skills they need to develop an appropriate and timely response to a potential or actual emergency evacuation scenario.

EES-16. Subject

Procedures and Training: Issue 5 - Not all evacuations are carried out in a time-critical manner.

Applicable Regulations and Guidance

14 CFR §§25.803, 121.291, and 121.397

FSIMS AT JTA 1.3.8 (OP) and Order 8110.4C

Finding

The selected incidents listed in appendix 5 involve “non-urgent” evacuations, often labeled as “rapid disembarkations.” This form of evacuation may be intended to minimize the number of injuries that may arise from the use of slides during events that present, in the judgment of the crew, a less than imminent threat to the health and safety of the aircraft’s occupants, or there may be other reasons. Unfortunately, the reports of these incidents, which are generally superficial since these “evacuations” rarely lead to full investigations, lack sufficient detail of underlying factors. Currently, no specific regulations, procedures, checklists, or training govern (to the best of the ARC members’ knowledge) these “evacuations”, which generally occur away from the gate and do not involve the full and aggressive use of crewmember commands and emergency egress equipment. This category of event occurs much more frequently than anticipated, indicating the need to better understand the circumstances and decision-making involved, and, in the best interests of aviation safety, to either eliminate the category, or develop standard procedures, checklists, and training to specify when a “non-urgent evacuation” may or may not be initiated. See appendix 4 for brief synopses of identified events.

EES-16 Recommendation

The ARC recommends the FAA, in coordination with other state aviation authorities and aircraft accident investigative agencies, collect, catalogue, and analyze “non-urgent” evacuations (also known as “rapid disembarkations”) to better understand the decision-making processes that lead to these events. The ARC further recommends the FAA and its regulatory partners use this information to determine whether a decision to initiate a “non-urgent evacuation” is ever appropriate in certain limited circumstances. If this is the case, the FAA and its partners should develop consistent guidance to operators for development of effective procedures, checklists, and training for “non-urgent” evacuations.

Rationale

The above-proposed recommendations are needed to address so-called “non-urgent” evacuations, which occur far more often than anticipated but are essentially conducted in an *ad hoc* manner. This recommendation is intended to develop guidance that will either prohibit or discourage the practice, or, in the event a clear safety benefit is apparent, define the processes to initiate “non-urgent” evacuations with development of appropriate procedures, checklists, and training necessary to ensure safe implementation.

EES-17. Subject

Procedures and Training: Issue 6 - Passengers retrieving and taking carry-on baggage during an evacuation may delay the evacuation or encourage other passengers to also take their carry-on baggage. Short of imposing fines upon passengers for non-compliance with flight attendant instructions, one possible solution was to increase the information and instructions relayed to passengers during safety briefings conducted onboard the flight.

Applicable Regulations and Guidance

14 CFR §§121.571 and 121.589

AC 121-29B

FAA Safety Assurance System (SAS)

Finding

In its June 2000 safety study, “Emergency Evacuation of Commercial Airplanes”, the NTSB stated passengers attempting to take their carry-on baggage with them in an evacuation interrupted the flow of the evacuation by stopping to retrieve the bags from overhead bins. The report also stated flight attendants reported attempts to take carry-on bags from passengers before exiting the aircraft during an emergency. Subsequent accident investigations by the NTSB have also referenced concerns with passengers taking carry-on baggage with them during an emergency evacuation. The ARC’s review of 290 evacuation events noted some examples of concerns over carry-on baggage during the evacuation. However, many of the accidents reviewed were lacking in substantial details, carry-on baggage comments being one of them.

The ARC discussed the previous and current concerns around passengers retrieving and taking carry-on baggage with them during an emergency evacuation. The ARC could not find any clear examples in the accidents reviewed that would point to a measured delay in the evacuation time due to passengers retrieving carry-on bags and taking them with them during the evacuation. With that information, the ARC discussed other options to enhance safety. One of the suggestions was providing better instructions to passengers prior to departure and prior to landing, or some type of education campaign.

Briefing passengers before takeoff is required by 14 CFR §121.571. Reading the regulation exactly as written, briefing passengers on carry-on baggage is not specifically required. However, 14 CFR §121.589 requires an air carrier to have an approved carry-on baggage program; AC 121-29B provides guidance on how to comply with the regulation.

- **§121.571:** Requires an oral briefing before takeoff on smoking, location of exits, use of safety belts, location and the use of flotation means.
- **§121.589:** Requires each certificate holder to have a carry-on baggage program in the certificate holder’s operation specifications which would include information related to size and amounts of carry-on baggage allowed for their operations, the appropriate methods of stowage for both regular and passenger assistive devices.

- **AC 121-29B:** Provides the certificate holder with additional information on complying with some of the requirements in §121.589. Specifically, §121.589.4.k. notes that training should be provided to crewmembers related to “... *how to handle carry-on baggage during an emergency.*”

Some air carrier’s pre-flight safety briefings currently contain statements reminding passengers in the event of an emergency all carry-on baggage should be left behind. It is assumed air carriers make this statement as part of their carry-on baggage program to help ensure carry-on baggage does not hinder an emergency evacuation. Air carriers conduct training on how to handle carry-on baggage during an emergency, generally with flight attendants’ voice commands reflecting statements during the evacuation to “leave everything.” During ARC discussions, members also noted some carriers may not make any reference to the need to leave carry-on baggage in an emergency during the pre-flight safety briefing. This inconsistency in the delivery of the safety information pertaining to carry-on baggage in an emergency led the ARC to support the recommendation that announcements pertaining to the concerns of retrieving and taking carry-on baggage during an emergency should be enhanced via guidance and/or oversight by the FAA.

The FAA implemented the Safety Assurance System (SAS), to assist FAA Aviation Safety Inspectors (ASIs) provide oversight and surveillance plans after a possible hazard has been identified. Most times the hazard could be identified at the certificate-holder level, but in this situation the ARC has identified the continued issue of passengers taking carry-on baggage during an emergency evacuation could warrant the ASIs re-assessing the pre-flight safety announcements to ensure during the pre-flight safety demonstration passengers are reminded that should an emergency occur that they should leave all carry-on baggage behind during an evacuation. The ASI’s review could also incorporate a similar survey to ensure the video language is also reflected in any live safety demonstration verbiage.

Recognizing an unplanned emergency evacuation can happen either on takeoff or landing, it is also recommended that air carriers adopt some additional verbiage in their pre-landing announcements. Currently many carriers as part of their pre-landing announcement already ask passengers to bring seatbacks forward, put tray tables upright in a locked position, and turn off large electronic devices, just to name a few. In addition, passengers are also reminded to stow their carry-on baggage. It is suggested that during that pre-landing cabin preparation announcement that air carriers add a short reminder message that all carry-on baggage should be left behind in the event of an emergency.

EES-17 Recommendation

The ARC recommends the FAA revise AC 121-29B to include a new subparagraph suggesting the need for pre-flight safety announcements and pre-landing safety announcement to include

verbiage that all carry-on baggage should be left behind on the aircraft if an emergency is encountered in either takeoff or landing.

Additionally, the ARC recommends FAA air carrier inspectors conduct a review of the air carriers they oversee to evaluate if the air carrier's announcements reference the need to leave carry-on baggage behind in the event of an emergency.

Rationale

From the events reviewed by the ARC, passengers continue to retrieve and take carry-on baggage down escape slides during some emergency evacuations. This has the potential to delay evacuations and injure passengers and flight crew during evacuations. Improvements in announcements prior to the flight and prior to landing has minimal impact to operator costs and may have a significant impact on speed and safety of aircraft evacuations.

EES-18. Subject

Procedures and Training: Issue 7 - Use of less than 50% of the exits is not uncommon.

Applicable Regulations and Guidance

14 CFR §§25.803, 121.291, 121.397, and Part 25, Appendix J

Finding

Of the 71 events where the information was documented, 18 events (more than 25%) involved the use of less than 50% of the incident aircraft's emergency exits. The reasons for egressing from less than 50% of the available exits vary by the event, and may have resulted from one or more of the following factors (note this is not an exhaustive list): adverse attitude of the aircraft; fire on one side of the aircraft; door or slide malfunction; blockage of one or more exits within the cabin; or blockage external to one or more doors or other environmental conditions preventing safe deployment of the slide. The applicable design and operating regulations require demonstration of compliance with the following performance metric: evacuation of the maximum certificated passenger capacity within 90 seconds, when using only one exit from each exit pair. Although use of less than 50% of the exits is not unusual, the ARC observed none of these evacuations resulted in loss of life.

EES-18 Recommendation

The ARC recommends the FAA, in coordination with other state aviation authorities, collect, catalogue, and analyze evacuation incidents in which less than 50% of exits are utilized. This will support a detailed understanding of the specific factors that lead to underutilization of aircraft exits. If the data suggests some of these factors include deficiencies in design, maintenance, or crew procedures or decision-making, the ARC recommends the FAA work with the airlines and airframe manufacturers to develop consistent guidance for design, maintenance, procedures, and training. If the data also suggests possible regulatory deficiencies, the ARC recommends the FAA work with other state aviation authorities to update and harmonize regulations as appropriate.

Rationale

The above-proposed recommendations will mitigate the potential for unacceptable risks to occupant safety from the use of fewer than all available exits in emergency evacuations.

EES-19. Subject

Procedures and Training: Issue 15 - Communication issues during evacuations.

Applicable Regulations and Guidance

14 CFR §§25.1423, 121.318, and 121.319

FSIMS AT JTA 1.3.8 (OP), Policy Letter PL-009 and Order 8900.1, Volume 3, Chapter 23, §§5 and 7

Finding

The following incidents include situations in which crew announcements to each other and/or passengers were inhibited by equipment malfunctions, garbled, misunderstood, or ignored and led to unintended results.

- Mar 23rd 2018, [Accident: Smartwings B738 at Budapest, smoke from tug prompts evacuation](#), A Smartwings Boeing 737-800 on behalf of Israir Airlines, registration OK-TVP performing flight 6H-716 (scheduled dep Mar 22nd) from Budapest (Hungary) to Tel Aviv (Israel)... The airline reported the smoke came from a nearby vehicle, not the aircraft itself, and entered the aircraft cabin via the engines and air conditioning system causing commotion on board despite the captain's repeated announcements that the smoke was coming from the outside of the aircraft and everything was okay on board of the aircraft. These announcements however did not prevent the emergency slides being deployed unnecessarily.
- Sep 3rd 2014, [Incident: Jet2 B733 at East Midlands on Sep 3rd 2014, electrical problems resulting in smoke in cabin](#), A Jet2.com Boeing 737-300, registration G-GDFT performing flight LS-644 from Ibiza, SP (Spain) to East Midlands, EN (UK)... Passengers reported the aircraft went around just prior to touch down and landed on its second round, it appeared however the (public) audio system had failed during the second approach.
- Jun 16th 2012, [Accident: Blue Islands AT42 at Jersey on Jun 16th 2012, gear collapse](#), A Blue Islands Avion de Transport Regional ATR-42-300, registration G-DRFC performing flight SI-308 from Guernsey, CI to Jersey, CI (UK)... passengers, concerned about a burning smell, started to move to exit the aircraft, the flight attendant realized it would be difficult to contact the flight deck while trying to control the passengers and decided to initiate an evacuation... The captain, after both engines had been shut down, assessed the situation following the obvious failure the exact nature was not known to the crew and decided to order an evacuation. When he wanted to

make the announcement, he already saw the passenger leaving the aircraft and did not make the announcement.

- Mar 25th 2008, [Report: Air Atlanta Icelandic B743 at Dhaka on Mar 25th 2008, engine and wing on fire, smoke in cabin](#), An Air Atlanta Icelandic Boeing 747-300 on behalf of Saudi Arabian Airlines, registration TF-ARS performing flight SV-810 from Madinah (Saudi Arabia) to Dhaka (Bangladesh). The reason for not opening doors at location L3, L4 and L5 initially was most likely due to the fact that the commander ordered the cabin crew to remain seated prior to the emergency evacuation. The cabin crew members at locations L3 to L5 most likely did not hear the emergency evacuation command from the senior cabin crew member as he was only using a megaphone.

EES-19 Recommendation

The ARC recommends the FAA collect, catalogue, and review these and similar recent evacuation incidents involving crew-to-passenger and crew-to-crew communications facilitated by onboard communications equipment. This data should be used to inform the development of robust guidance for operators in developing procedures, checklists, and scenario-based training for use of aircraft public address and interphone systems. Procedures and checklists and back-up equipment must account for any foreseeable malfunctions of one or more system elements. All hands-on training must be conducted using training equipment that at minimum replicates abnormal and emergency operation as necessary to meet the training objective.

Rationale

The above-proposed recommendations will improve crewmember-to-crewmember and crewmember-to-passenger communications in the event of emergency evacuations.

EES-20. Subject

External Environment Recommendation: Issue 9 and Part 25 Type Certification
Recommendation: Issue 9 - Escape slide function with an engine(s) running.

Applicable Regulations and Guidance

14 CFR §25.810(a)(1)(iv)

Finding

Of the airplane evacuation events entered into the ARC data matrix, 6-8 of them occurred or began with at least one engine running. During its discussion, the ARC discovered the FAA and EASA have long considered engines running during an emergency evacuation to be a foreseeable event, and various Means of Compliance (MOC) issue papers and certification review items have been issued to ensure it is addressed as part of the certification of escape slides positioned in close proximity to an engine inlet. The MOC issue papers and certification review items require airframe and escape slide manufacturers to demonstrate the escape slide provides for safe evacuation in a 25-knot wind combined with the effects of the engine running at ground idle. The ARC also discovered EASA recently adopted a similar requirement and associated guidance in CS 25.810, Amendment 18.

EES-20 Recommendation

The ARC recommends the FAA revise §25.810(a)(1)(iv) to require the 25-knot wind requirement be combined with the effects of an engine(s) running at ground idle for an escape slide in close proximity to the engine inlet.

Current Regulations - §25.810(a)(1)(iv)

(a)(1) The assisting means for each passenger emergency exit must be a self-supporting slide or equivalent; and, in the case of Type A or Type B exits, it must be capable of carrying simultaneously two parallel lines of evacuees. In addition, the assisting means must be designed to meet the following requirements--

...

(iv) It must have the capability, in 25-knot winds directed from the most critical angle, to deploy and, with the assistance of only one person, to remain usable after full deployment to evacuate occupants safely to the ground.

Proposed Regulations - §25.810(a)(1)(iv)

(a)(1) The assisting means for each passenger emergency exit must be a self-supporting slide or equivalent; and, in the case of Type A or Type B exits, it must be capable of carrying simultaneously two parallel lines of evacuees. In addition, the assisting means must be designed to meet the following requirements--

...

(iv) It must have the capability, in 25-knot winds directed from the most critical angle, to deploy and, with the assistance of only one person, to remain usable after full deployment to evacuate occupants safely to the ground. For escape slides positioned forward of an engine(s), the effects of the engine(s) running at ground idle must be included.

AC 25-17A

The ARC does not recommend any changes to the AC.

Rationale

The above proposal would codify current standard practice and ensure at least the current level of safety is maintained for future designs. The ARC does not recommend pure harmonization with CS 25.810(a)(1)(iv), because the CS does not distinguish between escape slides positioned forward and aft of the engine. It was later clarified in CS Part 25 Acceptable Means of Compliance (AMC) guidance that *“the applicability of the combined effect of a 46 km/hr (25-knot) wind and the engine(s) running at ground idle should be only to escape slides positioned forward of the engine(s) and in such proximity to the engine air intake(s) that the deployment of the escape slide could be influenced.”* The ARC recommends the FAA make the regulation as clear as possible and avoid the need for clarifying guidance.

The ARC discussed the possibility of also applying the combined condition to escape slides positioned aft of the exit, but concluded it is not feasible for the following reasons:

- 1) The engine exhaust velocity alone, which can be well above 100 knots where it could impinge on an escape slide, is too high for the state of the art of inflatable escape slide technology.

- 2) The risks associated with engine exhaust are less severe than they are with the engine inlet (i.e., getting blown over by the engine exhaust is less severe than getting sucked into the engine).

Since the above-proposed regulation change is consistent with the current MOC used by airframe and escape slide manufacturers, it would ensure at least the current level-of-safety provided is maintained in the future with no appreciable added costs.

EES-21. Subject

FAA Request Review Recommendations: Issue 3 and 4 - Regulatory standards that are prescriptive in defining dimensional requirements, based on anthropometry and scenario.

Applicable Regulations and Guidance

14 CFR §§25.807, 25.813, 25.815, and 25.817

Finding

As discussed earlier, many of the evacuation requirements are intended to address scenarios for which a straightforward performance standard is not readily available. In those cases, the requirements tend to specify dimensions meant to address both the anthropometry of the flying public, as well as situations too hazardous to test with human subjects. Examples are aisle width, passageway dimensions, and exit opening sizes. These requirements are intended to provide adequate provisions for egress, considering a range of occupant sizes, under varying conditions where rapid egress is essential, e.g., when there is a fire and the airplane may not be on all its landing gear. These requirements have not been transformed into performance standards using the dimensions guidance because of the difficulty in maintaining standardization.

EES-21 Recommendation

The ARC recommends the FAA implement a process for periodic review of evacuation-related standards based on demographics and anthropometry, such that as those characteristics evolve, the need for changes to the requirements can be anticipated and updated when necessary. The FAA should link this process to research on evacuation, and what the ramifications of changing demographics and anthropometry may mean relative to the existing standards. This should include an effort to baseline the anthropometric factors that could influence the existing requirements.

Rationale:

Most of these dimensional requirements have been in place for several decades. In that time the population has changed and will likely continue to change. For example, the average height of a US male over the age of 19, in a study from 1988-1994, was 69.13 inches. The average weight was 180.7 pounds. By 2018, these values had changed to 68.7 inches and 195.1 pounds, respectively. In fact, the average height of a US male had decreased from 2014 by a fraction of an inch, although weight has continued to increase. Regardless, these changes indicate one set of dimensional requirements might not be suitable in perpetuity.

Although the ARC did not identify cases where the regulatory dimensions were inadequate, the fact they are fixed, while the population changes, could eventually lead to issues if nothing is done.

EES-22. Subject

Adoption of cabin safety recommendations made by the Transport Aircraft Crashworthiness and Ditching Working Group (TACDWG).

Applicable Regulations and Guidance

14 CFR §§25.809(a), 25.810(a)(1)(ii), 25.811(g), 25.812(b)(1) and (2), and 25.1411(g)

Finding

One request of the ARC was to review recommendations related to airplane evacuation from the NTSB and other pertinent organizations. As part of this review ARC members were provided a copy of the Transport Aircraft Crashworthiness and Ditching Working Group (TACDWG) report to the FAA, dated September 20, 2018. The recommendations related to crashworthiness and ditching in this report are considered out of scope of this ARC. However, there are several recommendations directly related to airplane evacuation, and they pertain to 14 CFR Part 25 regulations this committee was tasked with assessing.

The pertinent TACDWG recommendations address:

- Means for assessing outside conditions prior to an emergency exit being opened - §25.809(a)
- Allowable time to open an exit and deploy the assist means - §25.810(a)(1)(ii)
- Exit signs and markings (symbols) - §§25.811(g), 25.812(b)(1) and (2)

The evacuation event reports reviewed by this ARC did not specifically address the above issues. The TACDWG was able to achieve full consensus in favor of the recommendations pertaining to the above items as well as another recommendation pertaining to the emergency equipment and its associated guidance material (see the Sub-Team 4 section of the TACDWG report for the complete list of safety equipment recommendations).

EES-22 Recommendation

The ARC recommends the FAA adopt the sub-team 4 (Equipage) recommendations in the TACDWG report to the FAA, dated September 20, 2018, pertaining to the above items and the recommendation pertaining to the emergency equipment and its associated guidance material.

Rationale:

As noted above, the TACDWG was able to achieve full consensus in favor of these recommendations. The cost vs. benefit assessment of the recommended changes is addressed in the TACDWG report.

EES-23. Subject

ARFF Mobile Stair Vehicles.

Applicable Regulations and Guidance

14 CFR §139.317

AC 150/5220-10E

Finding

Based on data evaluated from case studies it was apparent there were (and will continue to be) a large number of evacuations where emergency slides were unnecessarily used to get passengers and crew off aircraft, even if the emergency was not life threatening, with several people injured during this evacuation process.

In addition to the benefits of evacuating an aircraft in a non-life-threatening situation, time is of the essence when rescue personnel are boarding an aircraft involved in a crash or fire that has occupants aboard who are unable to self-evacuate. For aircraft that do not have boarding stairs, a rapid entry is dependent upon having air stairs or an Interior Access Vehicle (IAV) as part of the ARFF response.

Following the Asiana Airlines accident in San Francisco and in response to NTSB recommendation A-14-60, the Aircraft Rescue and Firefighters Working Group (ARFFWG) created a Task Group that conducted an applied research project to examine theories, knowledge, methods, and techniques concerning the creation of a minimum staffing level. The project consisted of a comprehensive literature review of all relevant documents and publications, as well as a research exercise which was conducted at Atlantic City International Airport (ACY).

The final report submitted to the FAA identified many issues in addition to minimum staffing levels, including a study on the use of mobile stairs/Interior Access Vehicles (IAV) which lead to a recommendation to the FAA that is specific to this ARCs' recommendation; *“The recommendation of this Task Group is that all Index B, C, D, and E airports be required to have an interior access vehicle that has sufficient reach to gain rapid entry to all aircraft with scheduled service at the airport. The minimum staffing for this vehicle is one person, whose initial job is to respond to the scene, position the vehicle, and, when appropriate, raise the stairs to the designated door. This person can then assume other duties, including interior fire attack or rescue.”*

The FAA currently allows airports to use federal funding for the purchase of these units, providing they follow AC 150/5220-10E.

As for personnel assigned to operate these units, it should be understood their operation will more than likely be conducted in a hazardous environment around the aircraft, also known as a “hot zone.” Operating in the “hot zone” calls for personnel in proper protective gear who have been trained in ARFF operations. Therefore, when these units are put into service at an

emergency scene, ARFF personnel should be utilized rather than airport operations, airline, or maintenance personnel.

EES-23 Recommendation

The ARC recommends the FAA amend §139.317 to require a mobile stair truck vehicle with sufficient reach to aircraft cabin doors to allow safe and organized deplaning of passengers and crew and/or to allow rapid entry to aircraft by fire suppression and rescue personnel at all §139.315 Index B, C, D and E airports.

Rationale

As identified in the “Findings” section of this recommendation, the ARC noted a large number of evacuations where emergency slides were used to get passengers and crew off aircraft, even if the emergency was not life threatening, with several people being injured during the evacuation process. In many of these evacuations, a mobile stair truck brought by responding ARFF personnel could have been used in lieu of the emergency chutes/slides, therefore preventing these injuries. Mobile stair vehicles, when correctly deployed, provide a safe and stable platform for enplaning rescue personnel or deplaning passengers and crew.

Other issues that can be alleviated with the use of a Mobile Stair truck/IAV include but should not be limited to:

- Allowing use of exits closed due to equipment malfunctions (no slides/chutes) during emergency evacuations.
- Providing ARFF personnel with a quicker and safer means of gaining access to the cabin interior to conduct search and rescue as well as fire suppression operations.
- Allowing access to the cabin by emergency personnel called to provide medical assistance to a victim on an aircraft when that aircraft does not have access to a terminal or jet bridge.
- Aiding in the removal of victims who require immobilization due to injury, illness or other forms of incapacitation.
- Providing rapid entry for Law Enforcement Officers needed on an aircraft that does not have access to a terminal or jet bridge.

Additional information on recommendations from previous advisory committees on these subjects is in Appendix 10.

EES-24. Subject

Minimum Manning Standards for ARFF Personnel.

Applicable Regulations and Guidance

14 CFR Part 139, Subpart D and §§139.315, 139.317, and 139.319

Finding

In the events reviewed by the ARC, there were no reported cases of inadequate ARFF response. However, information garnered during ARC studies, including, but not limited to, previous aviation accident reports not included in this group's case studies, previous NTSB recommendations, and previous studies addressing this subject, have identified there were (and continue to be) a large number of 14 CFR §139.315 airports operating with an inadequate number of ARFF personnel, preventing them from safely accomplishing their mission of initiating access to aircraft cabin for search and rescue operations as well as beginning interior aircraft rescue and firefighting operations.

There are documented incidents where ARFF personnel were instrumental in making entry into an aircraft to conduct interior search and rescue as well as fire suppression operations that have resulted in the rescue of both passengers and crew. There have also been documented incidents where a lack of ARFF personnel has contributed to a loss of lives due to no interior search and rescue being conducted. NTSB recommendations have been submitted to the FAA that address minimum manning standards. The topic of minimum manning standards at US airports has been specifically addressed in at least two NTSB accident reports:

- 1. Runway Overrun During Landing American Airlines Flight 1420 McDonnell Douglas MD-82, N215AA Little Rock, Arkansas June 1, 1999 – Amend 14 Code of Federal Regulations 139.319(j) to require a minimum Aircraft Rescue and Fire Fighting staffing level that would allow exterior firefighting and rapid entry into an airplane to perform interior firefighting and rescue of passengers and crewmembers. (A-01-65)*
- 2. Descent Below Visual Glidepath and Impact With Seawall Asiana Airlines Flight 214 Boeing 777-200ER, HL7742 San Francisco, California July 6, 2013 – Once the minimum staffing level has been developed by the Aircraft Rescue and Firefighting (ARFF) Working Group, as requested in Safety Recommendation A-14-60, amend 14 Code of Federal Regulations 139.319(j) to require a minimum ARFF staffing level that would allow exterior firefighting and rapid entry into an airplane to perform interior firefighting and rescue of passengers and crewmembers. (A-14-48)*

After the Little Rock accident on June 1, 1999 the FAA announced the assignment of a new task to ARAC. Additional information on recommendations from previous advisory committees on these subjects is in Appendix 10.

EES-24 Recommendation

The ARC recommends the FAA act on the following recommendations contained in the following reports and standard:

1. The ARFF Requirements Working Group (ARFFRWG) Notice of Proposed Rulemaking FINAL RECOMMENDATION to the ARAC Airport Certification Issues Group 14 CFR Part 139 Subpart D, March 2004.
2. Aircraft Rescue Fire Fighting Working Group (ARFFWG) Response to the National Transportation Safety Board A-14-60 Recommendation, May 20, 2018.
3. National Fire Protection Association (NFPA) Standard 403 – Aircraft Rescue and Firefighting Services at Airports.

Rationale

ARFF personnel are responsible for assisting with and ensuring all passengers and crew are off an aircraft being evacuated. While the FAA considers it the responsibility of the flight and/or cabin crew to evacuate an aircraft, common sense dictates this cannot always be the case. The impact forces of an aircraft incident may render crewmembers incapacitated and unable to perform their duties thereby not being in a position to evacuate themselves let alone other passengers and crew. It is no longer accepted that the only job of ARFF is to arrive at the scene of an aircraft crash and just maintain a “rescue path” allowing aircraft occupants a safe path from the fuselage away from fire. ARFF services should be working to get into the aircraft to begin interior fire suppression and rescue operations. There are currently no legislative mandates that identify a minimum number of ARFF personnel assigned at 14 CFR §139.315 certificated airports. This lack of regulation allows airports to operate ARFF services without the minimum number of ARFF personnel required to conduct interior fire search, rescue, and extinguishment within a reasonable timeframe after an aircraft crash.

As identified earlier in this document, two working groups have conducted applied research projects to examine theories, knowledge, methods, and techniques concerning the creation of a minimum staffing level and submitted reports to the FAA (ARFFRWG in 2004 and ARFFWG in 2018). In addition, NFPA has published multiple standards pertaining to ARFF advocating scientifically-based consensus codes and standards, research, and education for fire and related safety issues, including NFPA Standard 403 – “*Aircraft Rescue and Firefighting Services at Airports,*” which sets a minimum manning standard for ARFF services, and NFPA Standard 1003 – “*Standard for Airport Firefighter Professional Qualifications,*” which identifies the minimum job performance requirements for ARFF personnel, including requirements for the extrication and rescue of occupants remaining in a fuselage immediately after the “self-evacuation” phase of an incident. Additionally, the FAA has directed ARFF services to follow NFPA standards in several ARFF-related ACs, including:

- 150/5210-17C – Programs for Training of Aircraft Rescue and Firefighting Personnel
- 150/5230-4B – Aircraft Fuel Storage, Handling, Training, and Dispensing on Airports
- 150/5220-10E – Guide Specification for Aircraft Rescue and Fire Fighting (ARFF) Vehicles

- 150/5210-23 – ARFF Vehicle and High Reach Extendable Turret (HRET) Operation, Training and Qualifications
- 150/5220-17B – Aircraft Rescue and Fire Fighting (ARFF) Training Facilities
- 150/5210-13C – Airport Water Rescue Plans and Equipment
- 150/5210-5D – Painting, Marking, and Lighting of Vehicles Used on an Airport
- 150/5210-14B – Aircraft Rescue Fire Fighting Equipment, Tools and Clothing
- 150/5210-15A – Aircraft Rescue and Firefighting Station Building Design
- 150/5210-7D – Aircraft Rescue and Fire Fighting Communications
- 150/5210-6D – Aircraft Fire Extinguishing Agents

Additional information on recommendations from previous advisory committees on these subjects is in Appendix 10.

EES-25. Subject

Updating 14 CFR §139.315 - Aircraft Rescue and Firefighting (ARFF): Index determination, 14 CFR §139.317 - Aircraft rescue and firefighting: Equipment and agents and 14 CFR §139.319 - Aircraft rescue and firefighting: Operational requirements.

Applicable Regulations and Guidance

14 CFR Part 139, Subpart D and §§139.315, 139.317, and 139.319

Finding

ARFF services can have a major influence on lives saved versus lives lost and the number and severity of injuries occurring during an emergency evacuation of passengers and crew from an aircraft. The amount of firefighting agent and vehicles, the number of trained personnel involved in an evacuation, and how long it takes for those personnel to arrive on the scene of an accident are critical factors in the outcome of an emergency evacuation.

ARFF operations and personnel are governed by 14 CFR Part 139, subpart D, specifically 14 CFR §139.315 - Aircraft rescue and firefighting: Index determination, 14 CFR §139.317 - Aircraft rescue and firefighting: Equipment and Agents, and 14 CFR §139.319 - Aircraft Rescue and Firefighting: Operational requirements. During its review, the ARC noted these regulations have not been revised or had any major update since approximately 1995. With changes in civilian aviation occurring through time, including the size of aircraft, the amount of fuel carried, where the fuel is carried, materials used in aircraft construction, and passenger loads, among other changes, there is a strong need to amend and update these regulations.

EES-25 Recommendation

The ARC recommends the FAA modernize ARFF services at U.S. airports by amending and updating §139.315 - Aircraft rescue and firefighting: Index determination, §139.317 - Aircraft rescue and firefighting: Equipment and agents, and §139.319 - Aircraft rescue and firefighting: Operational requirements.

The ARC also recommends the FAA review the ARFFRWG final report submitted to FAA in March 2004 and incorporate relevant NFPA Standards (see below) as they pertain to ARFF services.

Rationale

From an ARFF standpoint, a number of issues dictate the success of an aircraft evacuation during an emergency. This includes manpower to complete specific tasks necessary for passenger and crew survival such as fire suppression and rescue, the amount of fire suppression agents (foam and water, clean agents such as Halon and Halotron and other specialty agents such as PPK and Metal-X) carried to the scene, the time it takes to reach the scene, the presence of equipment and vehicles such as mobile stair trucks to assist passengers and crew from an aircraft without the need to evacuate down slides/chutes, and means to have clear and concise communications between ARFF personnel, flight crews, and ATCT personnel.

The Preamble for the original printing of 14 CFR Part 139, Certification and Operations: Land Airports Serving CAB - Certificated Scheduled Air Carrier Operating Large Aircraft (Other than Helicopters), published at 37 Fed. Reg. 12278 (June 21, 1972), provides insight into the evolution and current form of 14 CFR Part 139 Subpart D., There have been many amendments to 14 CFR Part 139 through 1995. There have been no major updates with regard to ARFF since 1995.

After an accident in Little Rock Arkansas in 1999, the NTSB issued Safety Recommendation A-01-65 which asked the FAA to review the existing aircraft rescue and firefighting (ARFF) requirements contained in 14 CFR Part 139, subpart D and identify ARFF requirements that should be added, modified, or deleted. This review was to include the current rule and any other documents the agency may have issued regarding Part 139, Subpart D, and any ARFF standards issued by other organizations. Additional information on recommendations from previous advisory committees on these subjects is in Appendix 10.

NFPA Standards

The National Fire Protection Association (NFPA) publishes more than 300 consensus codes and standards intended to minimize the possibility and effects of fire and other risks. NFPA codes and standards, administered by more than 250 Technical Committees comprising approximately 8,000 volunteers, are adopted and used throughout the world. NFPA Standards that focus on aircraft rescue and firefighting services are:

- NFPA 402 Guide for Aircraft Rescue and Fire-Fighting Operations
- NFPA 403 Standard for Aircraft Rescue and Fire-Fighting Services at Airports
- NFPA 405 Standard for the Recurring Proficiency of Airport Fire Fighters
- NFPA 407 Standard for Aircraft Fuel Servicing
- NFPA 408 Standard for Aircraft Hand Portable Fire Extinguishers
- NFPA 412 Standard for Evaluating Aircraft Rescue and Fire-Fighting Foam Equipment
- NFPA 414 Standard for Aircraft Rescue and Fire-Fighting Vehicles
- NFPA 422 Guide for Aircraft Accident/Incident Response Assessment
- NFPA 424 Guide for Airport/Community Emergency Planning

- NFPA 1003 Standard for Airport Fire Fighter Professional Qualifications
- NFPA 1971 Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting

The FAA has included NFPA Standards for ARFF services in several of its ARFF-related ACs, including:

- 150/5210-17C - Programs for Training of Aircraft Rescue and Firefighting Personnel
- 150/5230-4B - Aircraft Fuel Storage, Handling, Training, and Dispensing on Airports
- 150/5220-10E - Guide Specification for Aircraft Rescue and Fire Fighting (ARFF) Vehicles
- 150/5210-23 - ARFF Vehicle and High Reach Extendable Turret (HRET) Operation, Training and Qualifications
- 150/5220-17B - Aircraft Rescue and Fire Fighting (ARFF) Training Facilities
- 150/5210-13C - Airport Water Rescue Plans and Equipment
- 150/5210-5D - Painting, Marking, and Lighting of Vehicles Used on an Airport
- 150/5210-14B - Aircraft Rescue Fire Fighting Equipment, Tools and Clothing
- 150/5210-15A - Aircraft Rescue and Firefighting Station Building Design
- 150/5210-7D - Aircraft Rescue and Fire Fighting Communications
- 150/5210-6D - Aircraft Fire Extinguishing Agents

EES-26. Subject

Applicability of 14 CFR Part 139 to scheduled cargo air transportation.

Applicable Regulations and Guidance

14 CFR Part 139

Finding

The ARC focused on the issue of emergency evacuation to address passenger issues. However, during its review, the ARC discussed the issue of airport requirements covering response to cargo aircraft accidents. Although review of cargo operation accidents and airport response to cargo accidents was considered out of scope of this ARC, it became evident to the ARC that previous work had been undertaken but not yet completed in relation to this topic.

Past research by other working groups estimated cargo operations account for slightly less than 15% of the total Part 121 aircraft in use and/or registered. Cargo operations include both wide- and narrow-body aircraft but a larger percentage of wide-body aircraft registered in the U.S. are dedicated to cargo operations. That means these wide-body cargo aircraft may fly into airports that may not have enough fire protection capability because the airport is not required to account for these larger aircraft when determining the required fire protection quantities and/or response. This percentage will shift slightly over time given the changes in operator and commercial needs, however cargo ratios related to wide- and narrow-body aircraft tend to be relatively static. The FAA has the ability to gather more specific details on aircraft

distribution counts by passenger/all-cargo operations and wide-/narrow-body aircraft to support further work on this recommendation.

Despite being a small percentage of flights landing at an airport, cargo flights have the potential for fire, may shut down airport operations as a result of an emergency, and may result in death to the occupants. Given that cargo aircraft may carry multiple occupants including flight crew, supernumeraries, and jumpseaters varying in age, size, strength, height, and weight, it could be difficult for all occupants to evacuate out of the cargo aircraft after an accident. Some older cargo aircraft configurations may have traditional passenger exits with evacuation slides, but some exits may not be accessible due to cargo loading. Newer-designed cargo aircraft may be equipped with only one side door at L1, which is used for entry and exit to the aircraft. This L1 door is not normally equipped with an emergency evacuation slide. The primary method of evacuation is via the inertial reels/diapers.

Injuries or incapacitation can occur to cargo occupants during an emergency event, which would reduce the speed or ability to egress the aircraft via inertial reels/diapers. Cargo occupants—human lives—can benefit from the lifesaving aspects of an airport’s emergency response.

EES-26 Recommendation

The ARC recommends the FAA consider including cargo operations as part of the overall airport response to an aircraft accident as applicable to 14 CFR Part 139 to ensure one level of safety for all occupants onboard cargo operations.

Rationale

The recommendation would eliminate inconsistencies in the regulations that provide different levels of airport emergency response for cargo operations as compared to passenger operations.

EES-27. Subject

Systematic collection of data for evacuation events.

Finding:

The ARC found it difficult to obtain specific details for many of the events due to a lack of information. In many cases the events were only referenced in news sources and official investigative reports were unavailable. It was unclear if this was because the relevant authority had not completed its investigation or had not initiated an investigation. If the event did not rise to the level of an accident there was typically less data available. Safety studies such as the one conducted by this ARC, which have the goal of preventing accidents and incidents and improving the survivability of occupants, often rely on review and analysis of detailed information from investigative reports.

Better documentation would have benefitted this report and provided more information for analysis of actual or potential safety deficiencies. This would also support future initiatives that may investigate occupant safety on aircraft. There are multiple resources to help support

uniform collection of information both in the United States and internationally to enhance safety.

The International Civil Aviation Organization (ICAO) Annex 13 – Aircraft Accident and Incident Investigation supports the uniform reporting of incidents and collection of information and writing of reports. In addition, in 2017 ICAO developed the Manual on the Investigation of Cabin Safety Aspects in Accidents and Incidents (Doc 10062) to encourage the uniform application of the Standards and Recommended Practices (SARPs) contained in Annex 13, particularly in relation to survival aspects. Similarly, the US NTSB encourages uniform collection of information and investigations to improve transportation safety. NTSB also provides a suggested template for collecting information related to survival factors.

Both ICAO and NTSB suggest collecting details related to evacuation paths, documenting interior damage, equipment use, and crew and passenger interviews, to name a few specifics.

EES 27 Recommendation

The ARC recommends all organizations, companies, and individuals working to improve occupant safety collect the information suggested in the two sources above to provide a complete picture of survival factors in aviation accidents and incidents.

Rationale

The recommendation supports more systematic collection of evacuation event data which is imperative for continued analysis and the development of safety improvements.

V. Conclusion

The ARC found overall safety in evacuations is very high, considering evacuation events are extremely infrequent when compared to the total number of flights, numbering around 2.5 per month worldwide (based on available data). Nonetheless, there are areas for improvement both in terms of requirements and data gathering to assess requirements.



Appendix 1

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Aviation Rulemaking Committee Charter

Effective Date:
4/24/2019
Amended: 2/18/2020

SUBJECT: Emergency Evacuation Standards Aviation Rulemaking Committee

1. **PURPOSE.** Effective April 24, 2019, this charter established the Emergency Evacuation Standards Aviation Rulemaking Committee (ARC), according to the Administrator's authority under Title 49 of the United States Code (49 U.S.C. § 106(p)(5)). The charter is hereby amended to allow the Emergency Evacuation Standards ARC to address passenger demographics on evacuation capabilities.

The sponsor of the ARC is the Associate Administrator for Aviation Safety. This charter outlines the ARC's organization, responsibilities, and tasks.

2. **BACKGROUND.** The FAA Reauthorization Act of 2018 (Pub. L. 115-254), section 337, Aircraft Cabin Evaluation Procedures, requires the following:

(a) *REVIEW.—The Administrator of the Federal Aviation Administration shall review—*

(1) *evacuation certification of transport-category aircraft used in air transportation, with regard to—*

(A) *emergency conditions, including impacts into water;*

(B) *crew procedures used for evacuations under actual emergency conditions;*

(C) *any relevant changes to passenger demographics and legal requirements, including the Americans with Disabilities Act of 1990 (42 U.S.C. 12101 et seq.), that affect emergency evacuations; and*

(D) *any relevant changes to passenger seating configurations, including changes to seat width, padding, reclining, size, pitch, leg room, and aisle width; and*

(2) *recent accidents and incidents in which passengers evacuated such aircraft.*

(b) *CONSULTATION: REVIEW OF DATA.—In conducting the review under subsection (a), the Administrator shall—*

(1) *consult with the National Transportation Safety Board, transport-category aircraft manufacturers, air carriers, and other relevant experts and Federal agencies, including groups representing passengers, airline crew members, maintenance employees, and emergency responders; and*

(2) *review relevant data with respect to evacuation certification of transport-category aircraft.*

(c) *REPORT TO CONGRESS.—Not later than 1 year after the date of enactment of this Act, the Administrator shall submit to the appropriate committees of Congress a report on the results of the review under subsection (a) and related recommendations, if any, including recommendations for revisions to the assumptions and methods used for assessing evacuation certification of transport-category aircraft.*

A related provision in the FAA Reauthorization Act of 2018, section 323, Exit Rows, requires:

- (a) *REVIEW.*—The Administrator shall conduct a review of current safety procedures regarding unoccupied exit rows on a covered aircraft in passenger air transportation during all stages of flight.
- (b) *CONSULTATION.*—In carrying out the review, the Administrator shall consult with air carriers, aviation manufacturers, and labor stakeholders.
- (c) *REPORT.*—Not later than 1 year after the date of enactment of this Act, the Administrator shall submit to the appropriate committees of Congress a report on the results of the review.
- (d) *COVERED AIRCRAFT DEFINED.*—In this section, the term “covered aircraft” means an aircraft operating under part 121 of title 14, Code of Federal Regulations.

This review of exit row procedures will be a subtask of the Emergency Evacuation Standards ARC.

The Emergency Evacuation Standards ARC will not address impacts into water (ditching) because that topic has already been evaluated. The FAA previously tasked the Aviation Rulemaking Advisory Committee (ARAC) to examine the FAA’s requirements for impacts into water (ditching) and make recommendations for changes to FAA rules and guidance in that regard (80 FR 31946, June 4, 2015). The ARAC submitted the recommendations to the FAA on October 22, 2018.

The Emergency Evacuation Standards ARC will also not address the impact of seat dimensions on evacuation capabilities, because that topic is already under evaluation. The FAA Civil Aerospace Medical Institute (CAMI) is currently evaluating the effect of seat dimensions on evacuation capability.

- 3. **OBJECTIVES OF THE ARC.** The ARC will provide a forum for affected parties to discuss and provide recommendations to the FAA on certification of emergency evacuation systems, designs, and procedures. For any recommendation to change regulatory requirements, the ARC will provide cost and benefit estimates.
- 4. **TASKS OF THE ARC.** The tasks of the ARC are:
 - a. Review and become familiar with current evacuation system rules and advisory material and previous recommendation reports on this subject submitted to the FAA by the ARAC.
 - b. Review available data from the past ten years of accidents and incidents in which passengers evacuated transport category aircraft used in air transportation.
 - c. Review the considerations listed in sections 337 and 323 of the FAA Reauthorization Act of 2018 with the exception of ditching and passenger seat dimensions.
 - d. Identify any safety issues to be addressed based on available accident and incident data.
 - e. Develop recommendations in the following categories:

- i. Evacuation system design and testing.
 - ii. Evacuation procedures, including exit row seating.
- f. For each recommendation to change regulations, include:
 - i. Estimates of cost to implement the change, including both safety and monetary costs.
 - ii. Estimates of benefits to the public, including both safety and monetary benefits.

Within 5 months from the first meeting after the effective date of the charter, submit a recommendation report to the FAA Co-Chair and the Director of the Office of Rulemaking.

5. ARC PROCEDURES.

- a. The ARC acts solely in an advisory capacity by advising and providing written recommendations to the FAA Co-Chair.
- b. The ARC may propose related follow-on tasks outside the stated scope of the ARC to the FAA Co-Chair.
- c. The ARC may reconvene following the submission of the recommendation report for the purposes of providing advice and assistance to the FAA, at the discretion of the FAA Co-Chair, provided the charter is still in effect.

- 6. ARC ORGANIZATION, MEMBERSHIP, AND ADMINISTRATION.** The FAA will set up a committee of members from the aviation community. Members will be selected based on their familiarity and experience with evacuation system design and evacuation procedures. Membership will be balanced in viewpoints, interests, and knowledge of the committee's objectives and scope.

The provisions of the August 13, 2014, Office of Management and Budget (OMB) guidance, "Revised Guidance on Appointment of Lobbyists to Federal Advisory Committees, Boards, and Commissions" (79 FR 47482), continues the ban on registered lobbyists participating on Agency Boards and Commissions if participating in their "individual capacity." The revised guidance allows registered lobbyists to participate on Agency Boards and Commissions in a "representative capacity" for the "express purpose of providing a committee with the views of a nongovernmental entity, a recognizable group of persons or nongovernmental entities (an industry, sector, labor unions, or environmental groups, etc.) or state or local government." For further information, refer to the OMB Guidance at 79 FR 47482.

Membership is limited to promote discussion. Attendance, active participation, and commitment by members is essential for achieving the objectives and tasks. When necessary, the ARC may set up specialized and temporary working groups that include at least one ARC member and invited subject matter experts from industry and government.

The ARC membership will consist of airplane manufacturers, airplane seat manufacturers, aviation escape system manufacturers, part 121 air carriers, the National Transportation Safety Board, and organizations representing flight attendants, airline maintenance employees, airline passengers and airport emergency responders. The FAA will also invite foreign aviation regulatory authorities to participate as observers. FAA and other Agency subject matter experts may be requested to participate as Observers and to provide technical support to the ARC members.

- a. At the request of the Sponsor, Aircraft Certification Service will function as the FAA Co-Chair and will:
 - 1) Select and appoint industry and the FAA participants as members,
 - 2) Select the Industry Co-Chair from the membership of the ARC,
 - 3) Ensure FAA participation and support from all affected lines-of-business,
 - 4) Provide notification to the members of the time and place for each meeting, and
 - 5) Receive any status report and the recommendations report.
 - b. Once appointed, the Industry Co-Chair will:
 - 1) Coordinate required ARC meetings in order to meet the objectives and timelines,
 - 2) Establish and distribute meeting agendas in a timely manner,
 - 3) Keep meeting notes, if deemed necessary,
 - 4) Perform other responsibilities as required to ensure the objectives are met,
 - 5) Provide status reports, as requested, in writing to the FAA Co-Chair, and
 - 6) Submit the recommendation report to the FAA Co-Chair and the Director of the Office of Rulemaking.
7. **PUBLIC PARTICIPATION.** Meetings are not open to the public. Persons or organizations outside the ARC who wish to attend a meeting must get approval in advance of the meeting from the Industry Co-Chair and the FAA Co-Chair.
8. **AVAILABILITY OF RECORDS.** Consistent with the Freedom of Information Act, Title 5, U.S.C., § 552, records, reports, agendas, working papers, and other documents that are made available to or prepared for or by the ARC will be available for public inspection and copying at the Office of Rulemaking, FAA Headquarters, 800 Independence Ave. SW, Washington, D.C. 20591. Fees will be charged for information furnished to the public according to the fee schedule published in Title 49 of the Code of Federal Regulations, part 7.

You can find this charter on the FAA Committee Database website at:

http://www.faa.gov/regulations_policies/rulemaking/committees/documents/.

9. **DISTRIBUTION.** This charter is distributed to the Office of the Associate Administrator for Aviation Safety, the Office of the Chief Counsel, and the Office of Rulemaking.

10. EFFECTIVE DATE AND DURATION. The ARC is effective upon issuance of this charter and will remain in existence for a maximum of 24 months, unless the charter is sooner suspended, terminated, or extended by the Administrator.

Issued in Washington, D.C. on Tuesday, February 18, 2020.

A handwritten signature in black ink that reads "Steve Dickson". The signature is written in a cursive style with a large, stylized "S" and "D".

Steve Dickson
Administrator

AIRCRAFT CABIN EVACUATION PROCEDURES ARC

Proposed Member Organizations

FAA Co-Chair: Aircraft Certification Service

Industry Co-Chair: Air Cruisers (Safran) or Rockwell Collins (B/E Aerospace)

Members from Industry:

Airbus
Air Cruisers (Safran)
Airlines for America (A4A)
Association of Flight Attendants (AFA)
Boeing
Bombardier
Embraer
Frontier Airlines
National Transportation Safety Board (NTSB)
Collins (B/E Aerospace)
Spirit Airlines
Flyers Rights
International Association of Machinists
Aircraft Rescue and Fire Fighting Working Group

Observers:

Agência Nacional de Aviação Civil (ANAC)
European Aviation Safety Agency (EASA)
Transport Canada Civil Aviation (TCCA)

Appendix 2

Evacuation-Related Regulatory Requirements and Advisory Material

Type Certification:

§25.561 General(c)(1)(iii), (d).

Amdt 25-91: Large masses in the passenger compartment must be positioned so that if they break loose, they will be unlikely to cause injury or damage escape means. Seats and items of mass must not deform under emergency landing loads in any manner that would impede rapid evacuation.

§25.562(c)(8) Emergency landing dynamic conditions.

Amdt 25-64: Seats must not yield under dynamic loading conditions to the extent they would impede rapid evacuation of the airplane occupants.

Guidance: AC 25.562-1B

§25.735(g) Brakes and braking systems.

Amdt 25-108: It must be demonstrated that for at least 5 minutes from application of the parking brake, no condition occurs (or has occurred during the stop), including fire associated with the tire or wheel and brake assembly, that could prejudice the safe and complete evacuation of the airplane.

§25.793 Floor surfaces.

Amdt 25-51: The floor surface of all areas, which are likely to become wet in service, must have slip resistant properties.

§25.801 Ditching.

Amdt 25-72: Design measures must be taken to minimize the probability that, in an emergency landing on water, the behavior of the airplane would cause immediate injury to the occupants or would make it impossible for them to escape. It must also be shown that the flotation time and trim of the airplane will allow the occupants to leave the airplane and enter the life rafts.

§25.803 Emergency evacuation.

Amdt 25-72: Each crew and passenger area must have emergency means to allow rapid evacuation in crash landings, with the landing gear extended as well as with the landing gear retracted, considering the possibility of the airplane being on fire. For airplanes having a seating capacity of more than 44 passengers, it must be shown that the maximum seating capacity, including the number of crewmembers required by the operating rules for which certification is requested, can be evacuated from the airplane to the ground under simulated emergency conditions within 90 seconds.

Guidance: AC 25.803-1A

Appendix J to Part 25—Emergency Evacuation

Amdt 25-114: Describes the test criteria and procedures to be used for showing compliance with §25.803

§25.807 Emergency exits.

Amdt 25-114: Emergency exit Types I, II, III, IV, A, B, and C as well as ventral and tailcone are as defined. Flightcrew emergency exit requirements are also defined. The maximum number of passenger seats permitted for each exit of a specific type installed in each side of the fuselage is as prescribed.

Guidance: AC 25.807-1

§25.809 Emergency exit arrangement.

Amdt 25-116: Each emergency exit, including each flightcrew emergency exit, must be a movable door or hatch in the external walls of the fuselage, allowing an unobstructed opening to the outside. In addition, each emergency exit must have means to permit viewing of the conditions outside the exit when the exit is closed.

§25.810 Emergency egress assist means and escape routes.

Amdt 25-114: Each non over-wing Type A, Type B or Type C exit, and any other non-over-wing landplane emergency exit more than 6 feet from the ground with the airplane on the ground and the landing gear extended, must have an approved means to assist the occupants in descending to the ground. The assisting means for each passenger emergency exit must be a self-supporting slide or equivalent. The assisting means for flightcrew emergency exits may be a rope or any other means demonstrated to be suitable for the purpose. An escape route must be established from each over-wing emergency exit.

§25.811 Emergency exit marking.

Amdt 25-88: Each passenger emergency exit, its means of access, and its means of opening must be conspicuously marked. The identity and location of each passenger emergency exit must be recognizable from a distance equal to the width of the cabin. Each emergency exit that is required to be openable from the outside, and its means of opening, must be marked on the outside of the airplane.

§25.812 Emergency lighting.

Amdt 25-128: An emergency lighting system, independent of the main lighting system, must be installed and include illuminated emergency exit marking and locating signs; sources of general cabin illumination; interior lighting in emergency exit areas; floor proximity escape path marking; and exterior emergency lighting. Floor proximity emergency escape path marking must provide emergency evacuation guidance for passengers when all sources of illumination more than 4 feet above the cabin aisle floor are totally obscured.

Guidance: AC 25.812-1A, AC 25.812-2

§25.813 Emergency exit access.

Amdt 25-128: Each required emergency exit must be accessible to the passengers and located where it will afford an effective means of evacuation. Emergency exit distribution must be as uniform as practical, taking passenger distribution into account. No door may be installed

between any passenger seat that is occupiable for takeoff and landing and any passenger emergency exit, such that the door crosses any egress path.

§25.815 Width of aisle.

Amdt 25-38: The passenger aisle width at any point between seats must equal or exceed the prescribed values.

§25.817 Maximum number of seats abreast.

Amdt 25-15: On airplanes having only one passenger aisle, no more than 3 seats abreast may be placed on each side of the aisle in any one row.

§25.851(b)(2) Fire extinguishers

Amdt 25-142: The capacity of each required built-in fire extinguishing system must be adequate to extinguish/suppress the fire for the duration required to land and evacuate the airplane.

Operations:

§121.291 Demonstration of emergency evacuation procedures.

Amdt 121-307: Each certificate holder must conduct an actual demonstration of emergency evacuation procedures to show that each type and model of airplane with a seating capacity of more than 44 passengers to be used in its passenger-carrying operations allows the evacuation of the full capacity, including crewmembers, in 90 seconds or less.

Appendix D to Part 121—Criteria for Demonstration of Emergency Evacuation Procedures Under §121.291

Amdt 121-233: Describes the criteria to be used for conducting emergency evacuation demonstrations in accordance with §121.291

§121.309 Emergency equipment.

§121.310 Additional emergency equipment.

§121.311(i) Seats, safety belts, and shoulder harnesses.

§121.319 Crewmember interphone system.

§121.391 Flight attendants.

§121.393 Crewmember requirements at stops where passengers remain on board.

§121.394 Flight attendant requirements during passenger boarding and deplaning.

§121.397 Emergency and emergency evacuation duties.

§121.417 Crewmember emergency training.

§121.421 Flight attendants: Initial and transition ground training.

§121.570 Airplane evacuation capability.

§121.571 Briefing passengers before takeoff.

§121.585 Exit Seating.

Advisory Circulars (AC):

AC 25-17A	Transport Airplane Cabin Interiors Crashworthiness Handbook
AC 25.562-1B	Dynamic Evaluation of Seat Restraint Systems and Occupant Protection on Transport Airplanes
AC 25.785-1B	Flight Attendant Seat and Torso Restraint System Installations
AC 25.803-1B	Emergency Evacuation Demonstrations
AC 25.807-1	Uniform Distribution of Exits
AC 25.812-1	Floor Proximity Emergency Escape Path Marking
AC 25.812-2	Floor Proximity Emergency Escape Path Marking Systems Incorporating Photoluminescent Elements
AC 120-47	Survival Equipment for use in Overwater Operations
AC 120-48A	Communication and Coordination Between Flightcrew Members and Flight Attendants
AC 121-24D	Passenger Safety Information Briefing and Briefing Cards
AC 121-29B	Carry-On Baggage

Full-Scale Evacuation Demonstration History

The requirements for emergency evacuation demonstrations were first established in 14 CFR part 121 (§ 121.291) by Amendment 121-2, effective March 3, 1965. Operators were required to conduct full-scale evacuation demonstrations within a time limit of two minutes using 50 percent of the exits. The purpose of the demonstration was to validate the crewmembers' abilities to execute the established emergency evacuation procedures and to ensure realistic assignment of functions to the crew. A full-scale demonstration was required upon: (1) initial introduction of a type and model of airplane into passenger-carrying operation, (2) an increase in passenger seating capacity of five percent or greater, or (3) a major change in the cabin interior that would affect emergency evacuation.

The requirement for the airplane manufacturer to conduct an evacuation demonstration for airplanes having a seating capacity of more than 44 passengers was established in § 25.803 by Amendment 25-15, effective October 24, 1967. The time limit for the manufacturer's demonstration was established at 90 seconds, and the part 121 time limit was reduced to 90 seconds. It was considered that the manufacturer's demonstration would show the basic capability of a new airplane and, as before, the part 121 demonstration was intended to account for crew training and adequate crew procedures. Therefore, the demonstration conditions were somewhat different.

With the addition of the requirement for a full-scale demonstration in part 25, § 25.803(d) allowed for analysis in lieu of demonstration under certain conditions. Section 25.803(d) stated that the demonstration need not be repeated for a change in the interior arrangement or a passenger capacity change of not more than five percent, or both, if it could be substantiated by analysis that the passengers could be evacuated in 90 seconds. At that time, analysis was used

for decreases in passenger capacity when an airplane was reduced in size. Generally, the analysis was based on a full-scale demonstration for the larger airplane. Analyses were also used for increases of less than five percent.

By Amendments 25-46 and 121-149, effective December 1, 1978, § 25.803 was revised to allow a means other than actual demonstration to substantiate the evacuation capability of the airplane and to replace the existing part 25 demonstration conditions with conditions that would satisfy both part 25 and part 121 so one demonstration could serve both requirements. Part 25 was changed to match the conditions in part 121.

Amendment 25-46 removed the five percent limitation on analysis from § 25.803(d). It was proposed in Notice 75-26, that analysis or a combination of analysis and tests be used to show evacuation capability. Amendment 25-46 dropped the provision which allowed analysis alone and required a combination of analysis and tests to assure approvals would be based on sufficient test data. The possibility was considered that sufficient data may not be available in the case of a completely new airplane model or a model which had major changes or a considerably larger passenger capacity than a previously approved model. Thus, the requirement that the Administrator find the data used in the analysis acceptable was intended to preclude approvals that might be based on insufficient test data to support the proposed analysis.

Subsequent changes to the requirement were intended to reduce the risk of injury to participants and make demonstrations more consistent, such that the results of one demonstration could be more directly compared with another.

Appendix 3

List of Evacuation Events Reviewed

1. Dec 9th 2019, [Incident: PSA CRJ2 at Washington, fumes in cabin, .](#)
2. Nov 21st 2019, [Accident: THY B738 at Odessa, runway excursion and nose gear collapse on landing,](#)
3. Nov 13th 2019, [Incident: Binter AT72 near Las Palmas, engine fire indication,](#)
4. Nov 11th 2019, [Accident: Envoy E145 at Chicago, runway excursion on landing](#)
5. Nov 8th 2019, [Incident: India A321 at Bhubaneswar, fire seen from engine](#)
6. Nov 4th 2019, [Incident: PSA CRJ9 near Greenville, smoke on board.](#)
7. Sep 25th 2019, [Accident: Azur B763 at Barnaul, gear fire on landing prompts evacuation,](#)
8. Sep 13th 2019, [Vueling A20N at Barcelona, smoke in cabin](#)
9. Sep 11th 2019, [Incident: Jetblue A321 near Nassau, cargo smoke indication, then engine fire warning,](#)
10. Sep 8th 2019, [Cayman B733 near Orlando, cargo smoke indication](#)
11. Aug 27th 2019, [Accident: Air China A333 at Beijing, aircraft on fire at the gate.](#)
12. August 22, 2019, [Accident: Hawaiian A21N near Honolulu, fumes and smoke on board prompt evacuation,](#) Aug 15th 2019, [Omni International B763 at Shannon, rejected takeoff due to open cockpit window, subsequent brakes fire and evacuation,](#)
13. Aug 15th 2019, [Accident: Ural A321 at Moscow, bird strike into both engines forces landing in corn field,.](#)
14. Aug 5th 2019, [Accident: British Airways A321 at Valencia on Aug 5th 2019, smoke on board,](#)
15. Jul 19th 2019, [Nordwind B738 at Moscow, rejected takeoff due to smoke on board](#)
16. Jun 29th 2019, [United A319 at New York and Newark, hydraulic issues](#)
17. May 12th 2019, [Myanmar E190 at Mandalay, nose gear failed to extend](#)
18. May 10th 2019, [Jazz DH8C at Toronto, fuel truck ran into aircraft.](#)
19. May 5th 2019, [Accident: Aeroflot SU95 at Moscow on May 5th 2019, aircraft bursts into flames during rollout and burns down](#)
20. May 3rd 2019, [Miami B738 at Jacksonville, runway overrun on landing, aircraft ends up in river,](#)
21. Mar 10th 2019, [United B739 near Houston, engine problem results in evacuation.](#)
22. Mar 9th 2019, [Transat B738 near Newark, cargo smoke indication.](#)
23. Mar 5th 2019, [China Southern B738 at Zhuhai, rejected takeoff due to engine and APU fire indications](#)
24. Mar 4th 2019, [Incident: Air China B773 near Anadyr on Mar 4th 2019, cargo smoke indication,.](#)
25. Mar 1st 2019, [Skywest CRJ9 at Detroit, rejected takeoff due to smoke on board.](#)

26. Mar 1st 2019, [Laudamotion A320 at London, rejected takeoff after loud bang, evacuation.](#)
27. Feb 28th 2019, [Flybe E195 at Exeter, haze on board prompts evacuation before departure.](#)
28. Feb 10th 2019, [Qantas B738 near Cairns, burning odour in the flight deck.](#)
29. Jan 30th 2019, [Norra AT72 at Tallinn, overheating relay in cockpit.](#)
30. Dec 10th 2018, [Indigo A20N at Kolkata, smoke on board.](#)
31. Nov 29th 2018, [Vietjet A21N at Banmethuot, both nose wheels separated on landing.](#)
32. Nov 9th 2018, [Accident: Fly Jamaica B752 at Georgetown on Nov 9th 2018, hydraulic failure causes runway excursion on landing.](#)
33. Oct 10th 2018, [Yakutia SU95 at Yakutsk, overran runway on landing](#)
34. Sep 28th 2018, [Niugini B738 at Chuuk, touched down in sea short of runway.](#)
35. Sep 26th 2018, [US-Bangla B738 at Chittagong, landed without nose gear.](#)
36. Sep 1st 2018, [Accident: UTAir B738 at Sochi on Sep 1st 2018, overran runway on landing](#)
37. Aug 28th 2018, [Capital Beijing A320 at Macau, dropped nose wheels on hard touchdown \(3.406G\).](#)
38. Aug 16th 2018, [Accident: Xiamen B738 at Manila on Aug 16th 2018, runway excursion on landing.](#)
39. Aug 3rd 2018, [Jet Airways B738 at Riyadh, rejected takeoff from taxiway results in taxiway excursion.](#)
40. Aug 2nd 2018, [Incident: Jazeera A320 at Hyderabad, engine fire after touch down.](#)
41. July 31, 2018, Durango airport Mexico: Aeromexico Connect, Embraer 190; 99 passengers, 6 crew; takeoff, postcrash fire.
42. May 21st 2018, [Onur A332 at Jeddah, landed without nose gear.](#)
43. May 8, 2018, [Accident: Delta MD90 at Denver on May 8th 2018, smoke in cabin during taxi.](#)
44. Apr 29th 2018, [Accident: Lion B738 at Gorontalo, runway excursion on landing.](#)
45. Apr 27, 2018, [Incident: Envoy E140 near Raleigh Durham on Apr 27th 2018, smoke "declared" in cabin.](#)
46. Apr 20th 2018, [Accident: World Atlantic MD83 at Alexandria, right main gear collapsed during rollout.](#)
47. Mar 27th 2018, [Incident: Globus B738 at Moscow, rejected takeoff due to smoke in cabin.](#)
48. Mar 23rd 2018, [Accident: Smartwings B738 at Budapest, smoke from tug prompts evacuation.](#)
49. Mar 11, 2018, [Accident: Southwest B738 near Albuquerque on Mar 11th 2018, smell smoke in cabin](#)
50. Feb 20th 2018, [Dana MD83 at Port Harcourt, overran runway by 300 meters.](#)
51. Feb 13th 2018, [Delta A332 at Lagos, engine fire.](#)
52. Dec 3rd 2017, [Nordic Regional E190 near Turku, smell of smoke in cabin.](#)

53. Nov 24th 2017, [Spicejet DH8D near Nagpur, smoke in cabin and cockpit.](#)
54. Nov 13th 2017, [Accident: China Southern B738 near Changsa on Nov 13th 2017, cargo smoke indication.](#)
55. Nov 10th 2017, [Accident: Flybe DH8D at Belfast, gear problem, landed without nose gear.](#)
56. Nov 2nd 2017, [Lingus A320 near Cork, smoke in cockpit.](#)
57. Oct 13th 2017, [Accident: Cebu Pacific A320 at Iloilo on Oct 13th 2017, runway excursion.](#)
58. Sep 9th 2017, [Accident: Bhutan A319 at Kolkata on Sep 9th 2017, smoke from APU prompts evacuation.](#)
59. Jul 19th 2017, [Accident: Thomas Cook B753 at Hurgada on Jul 19th 2017, loud bang followed by smoke on board prompts evacuation onto runway before departure.](#)
60. Jul 16th 2017, [Incident: Aeromexico B738 at Mexico City on Jul 16th 2017, rejected takeoff due to tyre damage, evacuation.](#)
61. Jul 2nd 2017, [Accident: Skywest CRJ7 at Denver, engine fire on landing.](#)
62. Jun 30th 2017, [Incident: Indigo A320 at Patna on Jun 30th 2017, rejected takeoff due to engine stall prompts evacuation.](#)
63. Jun 21st 2017, [Accident: PSA CRJ7 near Montgomery on Jun 21st 2017, smoke in cockpit.](#)
64. Jun 9th 2017, [India A320 at Jammu, overran runway on landing.](#)
65. Jun 8th 2017, [Incident: Jazz DH8D at Seattle on Jun 8th 2017, smoke in cabin.](#)
66. May 31st 2017, [Accident: Sriwijaya B733 at Manokwari on May 31st 2017, overran runway on landing, nose gear collapsed.](#)
67. May 23, 2017, [Accident: United B752 at Newark on May 23rd 2017, evacuation onto taxiway following reported engine fire.](#)
68. March 28, 2017, [Accident: Peruvian B733 at Jauja on Mar 28th 2017, hard landing, runway excursion, all gear collapsed, aircraft caught fire.](#)
69. Mar 27th 2017, [Accident: Taban B734 at Ardabil on Mar 27th 2017, right main gear collapse on landing.](#)
70. Mar 8th 2017, [Ameristar MD83 at Detroit, overran runway after rejected takeoff due to elevator malfunction.](#)
71. Feb 23rd 2017, [Accident: Flybe DH8D at Amsterdam, right main gear collapse on landing.](#)
72. Feb 22nd 2017, [Incident: Virgin Australia AT72 near Williamtown on Feb 22nd 2017, smoke in cockpit.](#)
73. Feb 7th 2017, [Accident: Western Air SF34 at Grand Bahamas on Feb 7th 2017, electrical problems, left main gear collapse on landing back.](#)
74. Feb 1st 2017, [Incident: Garuda B738 at Yogyakarta, runway excursion on landing](#)
75. Jan 3rd 2017,.
76. Dec 27th 2016, [Jet Airways B738 at Goa, runway excursion during rejected takeoff.](#)

77. Dec 25th 2016, [Accident: Wings AT72 at Semarang, runway excursion, main gear collapse.](#)
78. Dec 11th 2016, [Incident: Copa E190 at Santa Clara on Dec 11th 2016, rejected takeoff due to engine failure and smoke in cabin.](#)
79. Dec 10th 2016, [Jordan B734 at Kabul, soft landing causes right main gear collapse.](#)
80. Nov 1st 2016, [Incident: VivaColombia A320 at Bogota on Nov 1st 2016, overheated brakes lead to evacuation.](#)
81. Oct. 28, 2016, [Accident: American B763 at Chicago on Oct 28th 2016, rejected takeoff, fire at right hand wing due to uncontained engine failure.](#)
82. Sep 27th 2016, [Incident: Nelson DH8C at Nelson on Sep 27th 2016, hydraulic smoke prompts evacuation.](#)
83. Sep 26th 2016, [Accident: Cebu AT72 at Cebu on Sep 26th 2016, rejected takeoff due to engine oil fluctuation.](#)
84. Sep 24, 2016, [Accident: Commutair DH8B at Washington on Sep 24th 2016, landed without nose gear](#)
85. Sep 23rd 2016, [Accident: Network Australia F100 at Perth on Sep 23rd 2016, hydraulic problem, fumes on board.](#)
86. Aug 24th 2016, [Incident: Regent B737 at Dhaka on Aug 24th 2016, rejected takeoff due to gear fire, evacuation.](#)
87. Aug 9th 2016, [Incident: Wisconsin CRJ2 at Indianapolis on Aug 9th 2016, smoking brakes.](#)
88. Aug 3rd 2016, [Accident: Emirates B773 at Dubai, long landing, go around without thrust results in runway impact, aircraft on fire.](#)
89. Jul 31st 2016, [Incident: Air China B738 at Beijing on Jul 31st 2016, rejected takeoff due to engine failure.](#)
90. Jul 30th 2016, [Incident: Trans States E145 at Toronto on Jul 30th 2016, smoke in cabin.](#)
91. Jul 21st 2016, [Accident: American A320 at West Palm Beach on Jul 21st 2016, fuel leak.](#)
92. Jul 5th 2016, [Incident: Envoy E145 near Mason City on Jul 5th 2016, smoke in cockpit.](#)
93. Jun 27th 2016, [Accident: Singapore B773 enroute on Jun 27th 2016, engine fuel leak into engine oil system.](#)
94. Jun 15th 2016, [Accident: Jet Airways AT72 at Bangalore on Jun 15th 2016, engine fire, smoke in cabin.](#)
95. May 27th 2016, [Accident: Korean B773 at Tokyo, rejected takeoff due to engine fire.](#)
96. Apr. 28, 2016, [Accident: TAME E190 at Cuenca on Apr 28th 2016, overran runway.](#)
97. Apr 4th 2016, [Accident: Batik B738 and Transnusa AT42 at Jakarta on Apr 4th 2016, collision on runway, both aircraft on fire, takeoff clearance with towed aircraft on runway.](#)
98. Mar 28th 2016, [Incident: India A319 at Mumbai on Mar 28th 2016, tower reports smoke from landing gear.](#)

99. Mar 20th 2016, [Incident: Peruvian B735 at Cusco on Mar 20th 2016, runway excursion during rejected takeoff due to blown tyre](#)
100. Mar 17th 2016, [Incident: Arabia A320 near Riyadh, cargo smoke indication, delayed emergency services prompt evacuation.](#)
101. Mar 15th 2016, [Accident: India A320 at Mumbai on Mar 15th 2016, burst tyres on landing.](#)
102. Mar 12th 2016, [Incident: Peace B735 at Port Harcourt on Mar 12th 2016, false smoke detector indication.](#)
103. Feb. 23, 2016, Sapporo, Japan: Japan Airlines Boeing 737-800, smoke in cabin on taxi.
104. Feb 10th 2016, [Incident: Orenair B772 at Punta Cana on Feb 10th 2016, engine shut down in flight, burst tyre and smoke on landing.](#)
105. Dec 15th 2015, [Incident: Horizon DH8D at Spokane on Dec 15th 2015, smoke in cockpit and cabin.](#)
106. Dec 15th 2015, [Accident: Southwest B733 at Nashville on Dec 15th 2015, went off taxiway.](#)
107. Nov 6th 2015, [Accident: Batik B739 at Yogyakarta on Nov 6th 2015, overran runway.](#)
108. Nov 3rd 2015, [Accident: Shaheen B734 at Lahore, runway excursion, both main gear collapsed.](#)
109. Oct. 29, 2015, [Accident: Dynamic B762 at Fort Lauderdale on Oct 29th 2015, fuel leak results in engine fire.](#)
110. Oct 12th 2015, [Incident: Delta B738 at Montego Bay on Oct 12th 2015, cargo fire indication.](#)
111. Sep 30th 2015, [Accident: Luxair DH8D at Saarbruecken on Sep 30th 2015, takeoff ending on belly, smoke in cabin.](#)
112. Sept. 8, 2015, [Accident: British Airways B772 at Las Vegas on Sep 8th 2015, rejected takeoff due to engine fire, engine failure uncontained.](#)
113. Sep 7th 2015, [Incident: Air India A320 at Delhi on Sep 7th 2015, hydraulic failure, smoke from landing gear and evacuation.](#)
114. Aug 20th 2015, [Accident: China Southern A321 near Shenyang on Aug 20th 2015, cargo fire indication.](#)
115. Aug 2nd 2015, [Incident: Citilink A320 at Padang on Aug 2nd 2015, runway excursion on landing.](#)
116. Jul 30th 2015, [Accident: American MD82 at Dallas on Jul 30th 2015, smoke in cabin at gate.](#)
117. Jul 26th 2015, [Accident: Shenzhen A320 near Guangzhou on Jul 26th 2015, passenger attempts to set aircraft alight.](#)
118. Jul 8th 2015, [Accident: Hainan B738 near Hefei on Jul 8th 2015, cargo smoke indication.](#)
119. Jul 3rd 2015, [Accident: China Southern B738 near Sanya on Jul 3rd 2015, engine shut down in flight.](#)
120. Jul 2nd 2015, [Accident: Maldivian DHC6 at Kuredu, hard emergency landing, aircraft sunk.](#)
121. Jun 29th 2015, [Accident: Westjet B737 near Winnipeg on Jun 29th 2015, bomb hoax causes injuries during evacuation.](#)

122. Jun 8th 2015, [Accident: Allegiant MD83 at Saint Petersburg on Jun 8th 2015, odour of electrical burning smoke.](#)
123. Jun 7th 2015, [Incident: LAN A319 at Cajamarca on Jun 7th 2015, both engines on fire during departure preparation.](#)
124. Jun 5th 2015, [Incident: Commutair DH8B near Hartford on Jun 5th 2015, fire in cockpit.](#)
125. May 10th 2015, [Accident: Joy MA60 at Fuzhou, runway excursion on 6G landing.](#)
126. May 1st 2015, [Accident: Hawaiian B763 at Kahului on May 1st 2015, odour in cabin.](#)
127. Apr 25th 2015, [Accident: THY A320 at Istanbul on Apr 25th 2015, hard landing, go-around, engine problem, gear problem, gear collapse, runway excursion.](#)
128. Apr 14th 2015, [Accident: Asiana A320 at Hiroshima on Apr 14th 2015, touched down short of runway.](#)
129. Mar 29th 2015, [Accident: Air Canada A320 at Halifax on Mar 29th 2015, touched down short of runway.](#)
130. Mar 8th 2015, [Accident: Spicejet DH8D at Hubli on Mar 8th 2015, runway excursion on landing.](#)
131. Mar 5th 2015, [Accident: Delta MD88 at New York on Mar 5th 2015, runway excursion on landing.](#)
132. March 4, 2015, Denver International Airport: American Airlines Airbus A321-211 (single-aisle), smoke filled the airplane after landing.
133. Mar 4th 2015, [Accident: THY A333 at Kathmandu on Mar 4th 2015, runway excursion and nose gear collapse.](#)
134. Feb 9th 2015, [Accident: US Airways E190 at Houston on Feb 9th 2015, nose gear up landing.](#)
135. Feb 3rd 2015, [Accident: Garuda AT72 at Praya on Feb 3rd 2015, runway excursion, nose gear collapse.](#)
136. Dec 16th 2014, [Accident: Flybe DH8D near Belfast on Dec 16th 2014, engine fire.](#)
137. Nov 6th 2014, [Accident: Jazz DH8D at Edmonton on Nov 6th 2014, right main gear collapse on landing, runway excursion, propeller blade\(s\) impacted fuselage.](#)
138. Oct 28th 2014, [Accident: Starbow B462 at Accra on Oct 28th 2014, hydraulic failure.](#)
139. Oct 4th 2014, [Accident: Emirates A332 at Karachi on Oct 4th 2014, protective breathing equipment catches fire.](#)
140. Sep 25th 2014, [Incident: Sun Country B738 near Boise on Sep 25th 2014, wheel well fire indication.](#)
141. Sep 23rd 2014, [Incident: Southwest B735 at Austin on Sep 23rd 2014, odour in cabin.](#)
142. Sep 18th 2014, [Incident: Jetblue A320 at Long Beach on Sep 18th 2014, engine fire.](#)
143. Sep 16th 2014, [Incident: Tindi DHC7 at Hope Bay, engine fire indication,.](#)
144. Sep 3rd 2014, [Incident: Jet2 B733 at East Midlands on Sep 3rd 2014, electrical problems resulting in smoke in cabin.](#)
145. Aug 20th 2014, [Accident: Indigo A320 at Delhi on Aug 20th 2014, smoke from gear after landing causes evacuation.](#)

146. Aug 13th 2014, [Incident: Vueling A319 at Florence on Aug 13th 2014, gear fire after landing.](#)
147. Aug 13th 2014, [Incident: Jazz DH8D near Ottawa on Aug 13th 2014, cargo smoke indication.](#)
148. Aug 9th 2014, [Accident: Jetblue A321 at San Juan on Aug 9th 2014, rejected takeoff.](#)
149. Jun 23rd 2014, [Accident: Ryanair B738 enroute on Jun 23rd 2014, turbulence injures 5 occupants.](#)
150. Jun 6th 2014, [Incident: Jet2 B733 at Blackpool on Jun 6th 2014, smoke from right hand side after landing.](#)
151. May 10th 2014, [Accident: Iran Aseman F100 at Zahedan, left main gear did not extend.](#)
152. Apr 11th 2014, [Accident: Kenya Airways E190 at Dar es Salaam on Apr 11th 2014, runway excursion on landing.](#)
153. Mar 28th 2014, [Incident: Aeromar AT42 at Lazaro Cardenas on Mar 28th 2014, smoking brakes during line up.](#)
154. Mar 27th 2014, [Accident: Swiss RJ1H at London on Mar 27th 2014, rejected takeoff.](#)
155. Mar 13th 2014, [Accident: US Airways A320 at Philadelphia on Mar 13th 2014, rejected takeoff.](#)
156. Jan 29th 2014, [Accident: Greenland DH8B at Ilulissat, runway excursion on landing, Denmark's Havarikommissionen \(HCL\) have released their preliminary report \(\[http://www.hcl.dk/da/~media/Files/Havarikommissionen/Havarirapporter/Luftfart%202014/HCLJ510_2014_258%20%20Foreloebig%20redegoerelse.ashx\]\(http://www.hcl.dk/da/~media/Files/Havarikommissionen/Havarirapporter/Luftfart%202014/HCLJ510_2014_258%20%20Foreloebig%20redegoerelse.ashx\)\).](#)
157. Jan 14th 2014, [Incident: SAS CRJ9 at Copenhagen on Jan 14th 2014, rejected takeoff.](#)
158. Jan 6th 2014, [Incident: Singapore A388 near Baku, loss of cabin pressure.](#)
159. Jan 5th 2014, [Accident: Saudia B763 at Madinah on Jan 5th 2014, right main gear up landing.](#)
160. Nov 4th 2013, [Accident: Royal Air Maroc B763 at Montreal on Nov 4th 2013, cargo belt loader caught fire.](#)
161. Sep 8th 2013, [Accident: Thai A333 at Bangkok on Sep 8th 2013, runway excursion on landing.](#)
162. Aug 25th 2013, [Accident: Shenzhen B738 at Shenzhen on Aug 25th 2013, APU fire during taxi.](#)
163. Aug 21st 2013, [Accident: Xiamen B737 at Fuzhou on Aug 21st 2013, evacuation after landing gear fire indication.](#)
164. Aug 19th 2013, [Accident: Buffalo DC3 at Yellowknife on Aug 19th 2013, engine fire..](#)
165. Aug 18th 2013, [Incident: Jetblue E190 near Philadelphia, smell of smoke.](#)
166. Jul 28th 2013, [Accident: Air France B773 at Paris on Jul 28th 2013, evacuation while boarding due to fumes.](#)
167. Jul 22nd 2013, [Accident: Southwest B737 at New York on Jul 22nd 2013, nose gear collapse on landing.](#)
168. Jul 6th 2013, [Accident: Asiana B772 at San Francisco on Jul 6th 2013, touched down short of the runway, broke up and burst into flames.](#)
169. Jun 13th 2013, [Accident: SkyBahamas SF34 at Marsh Harbour on Jun 13th 2013, runway excursion/](#)

170. Jun 8th 2013, [Accident: Wizz A320 at Rome on Jun 8th 2013, left main gear did not extend.](#)
171. Jun 8th 2013, [Accident: US Airways B752 at Kona on Jun 8th 2013, evacuation during push back causes 4 injuries.](#)
172. Jun 2nd 2013, [Accident: Cebu Pacific A320 at Davao on Jun 2nd 2013, runway excursion.](#)
173. May 24th 2013, [Accident: British Airways A319 near London on May 24th 2013, unlatched doors on both engines separated, fuel leak, engine on fire shut down.](#)
174. May 24th 2013, [Accident: VIA A320 at Varna on May 24th 2013, runway excursion.](#)
175. May 15th 2013, [Accident: Shenzhen A320 near Guilin on May 15th 2013, bomb hoax.](#)
176. May 8th 2013, [Incident: Delta B763 at Honolulu on May 8th 2013, rejected takeoff, blew all main gear tyres.](#)
177. Apr 17th 2013, [Incident: PSA CRJ2 near Philadelphia on Apr 17th 2013, smoke on board, evacuation.](#)
178. Apr 13th 2013, [Accident: Lionair B738 at Denpasar on Apr 13th 2013, landed short of runway and came to stop in sea.](#)
179. Feb 2nd 2013, [Accident: Carpatair AT72 at Rome on Feb 2nd 2013, runway excursion on landing, main and nose gear collapsed.](#)
180. Jan 12th 2013, [Incident: Tahiti AT72 at Papeete on Jan 12th 2013, engine fire.](#)
181. Jan 16th 2013, [Accident: ANA B788 near Takamatsu on Jan 16th 2013, battery problem and burning smell on board \(including JAL Boston, Ethiopian London and JAL Tokyo events\).](#)
182. Dec 25th 2012, [Accident: Bagan F100 near Heho, landed on road outside airport.](#)
183. Dec 22nd 2012, [Accident: Perimeter SW4 at Sanikiluaq on Dec 22nd 2012, runway overrun on second approach.](#)
184. Oct 16th 2012, [Accident: Britair CRJ7 at Lorient on Oct 16th 2012, overran runway on landing.](#)
185. Oct 19th 2012, [Accident: jet2 B738 at Glasgow on Oct 19th 2012, rejected takeoff.](#)
186. Oct 14th 2012, [Accident: Corendon B738 at Antalya on Oct 14th 2012, cockpit fire.](#)
187. Oct 11th 2012, [Report: Thomas Cook B752 at Glasgow and near Manchester on Oct 11th 2012 and Oct 12th 2012, smoke/fumes on board.](#)
188. Sep 3rd 2012, [Accident: XL Airways B738 at Cologne on Sep 3rd 2012, injuries after malfunction of air conditioning system.](#)
189. Jul 18th 2012, [Accident: American Eagle CRJ7 at Peoria on Jul 18th 2012, smoke in cabin.](#)
190. Jun 18th 2012, [Accident: Mahan B743 at Jeddah on Jun 18th 2012, uncontained engine failure.](#)
191. Jun 16th 2012, [Accident: Blue Islands AT42 at Jersey on Jun 16th 2012, gear collapse.](#)
192. May 28th 2012, [Accident: Carpatair SB20 at Florence on May 28th 2012, engine fire indication.](#)
193. May 17th 2012, [Accident: Dolomiti AT72 at Munich on May 17th 2012, smoke in cockpit, engine problem, runway excursion on landing.](#)
194. May 17th 2012, [Incident: OLT Express A320 near Sofia on May 17th 2012, loss of cabin pressure, fire in cabin.](#)

195. Mar 29th 2012, [Accident: Feeder F50 at Wau on Mar 29th 2012, runway excursion.](#)
196. Mar 6th 2012, [Accident: Silkair A319 at Solo on Mar 6th 2012, reported gear fire on landing](#)
197. Apr 16th 2012, [Accident: Virgin Atlantic A333 near London on Apr 16th 2012, cargo fire indication.](#)
198. Feb 13th 2012, [Accident: Carpatair SB20 at Craiova, runway excursion during takeoff](#)
199. Feb 5th 2012, [Incident: SAS MD82 at Copenhagen on Feb 5th 2012, rejected takeoff and evacuation.](#)
200. Jan 23rd 2012, [Incident: Expressjet E145 at Washington on Jan 23rd 2012, unsafe gear](#)
201. Dec 20th 2011, [Accident: Sriwijaya B733 at Yogyakarta on Dec 20th 2011, runway excursion.](#)
202. Dec 9th 2011, [Accident: Cathay B744 at Shanghai on Dec 9th 2011, smoke in cabin during taxi.](#)
203. Nov 30th 2011, [Incident: Windrose E190 near Kiev, emergency exit open indication.](#)
204. Nov 10th 2011, [Accident: SA Airlink RJ85 at Johannesburg on Nov 10th 2011, landed without nosegear.](#)
205. Nov 1st 2011, [Accident: LOT B763 at Warsaw on Nov 1st 2011, forced gear up landing.](#)
206. Sep 14th 2011, [Accident: United Airlines B752 at Washington on Sep 14th 2011, reported engine fire.](#)
207. Sep 4th 2011, [Accident: Trans States E145 at Ottawa on Sep 4th 2011, runway excursion, main gear collapse.](#)
208. Aug 29th 2011, [Accident: Gulf Air A320 at Kochi on Aug 29th 2011, runway excursion.](#)
209. Aug 5th 2011, [Incident: American B763 at Chicago on Aug 5th 2011, brake fire.](#)
210. Jul 30th 2011, [Accident: Caribbean B738 at Georgetown, overran runway](#)
211. Jul 29th 2011, [Accident: Egyptair B772 at Cairo on Jul 29th 2011, cockpit fire.](#)
212. Jul 24th 2011, [Accident: Uni Airways MD90 at Taipei on Jul 24th 2011, rejected takeoff](#)
213. Jul 21st 2011, [Incident: Flybe DH8D near Edinburgh on Jul 21st 2011, cargo smoke indication](#)
214. Jul 17th 2011, [Accident: Arann AT72 at Shannon, nose gear collapse.](#)
215. Jun 21st 2011, [Accident: Delta B752 at Atlanta on Jun 21st 2011, engine fire.](#)
216. Jun 11th 2011, [Incident: Rossiya A319 at Rostov, overran runway.](#)
217. May 16th 2011, [Incident: Cathay Pacific A333 near Singapore, engine shut down in flight, engine fire.](#)
218. Apr 4th 2011, [Accident: United Airlines A320 at New Orleans on Apr 4th 2011, smoke in cockpit, complete electronic failure, runway excursion, evacuation.](#)
219. Mar 19th 2011, [Incident: Comair CRJ7 near Grand Rapids on Mar 19th 2011, smoke in cockpit.](#)
220. Mar 2nd 2011, [Accident: North Flying SW4 at Oslo, runway excursion on landing.](#)
221. Jan 6th 2011, [Report: Easyjet A319 at Belfast on Jan 6th 2011, taxiway de-icing prompts evacuation.](#)
222. Jan 1st 2011, [Accident: Kolavia T154 at Surgut on Jan 1st 2011, aircraft burned down](#)

223. Dec 30th 2010, [Accident: Delta B753 near Colorado Springs on Dec 30th 2010, engine shut down in flight.](#)
224. Dec 23rd 2010, [Accident: TAM A320 near Salvador on Dec 23rd 2010, cabin pressure problems then galley fire.](#)
225. Dec 21st 2010,
226. Dec 4th 2010, [Accident: THY B773 at Istanbul on Dec 4th 2010, cargo fire indication.](#)
227. Nov 18th 2010, [Incident: Continental B752 at Newark, smoke in cockpit.](#)
228. Nov 10th 2010, [Accident: Kuwait A306 near Kuwait on Nov 10th 2010, smoke in cabin.](#)
229. Nov 4th 2010, [Accident: Qantas A388 near Singapore on Nov 4th 2010, uncontained engine failure.](#)
230. Oct 31st 2010, [Accident: 1Time MD82 at Johannesburg on Oct 31st 2010, rejected takeoff.](#)
231. Oct 24th 2010, [Accident: Aero Contractors B735 at Lagos on Oct 24th 2010, mist in cabin.](#)
232. Sep 24th 2010, [Accident: Windjet A319 at Palermo on Sep 24th 2010, touched down short of runway.](#)
233. Sep 24th 2010, [Accident: Southern Air B742 at Frankfurt on Sep 24th 2010, rejected takeoff due to uncontained engine failure.](#)
234. Sep 4th 2010, [Incident: AirExplore B734 at Kos on Sep 4th 2010, engine fire at the apron.](#)
235. Aug 27th 2010, [Accident: Jet Airways B738 at Mumbai on Aug 27th 2010, evacuation during taxi leads to injuries.](#)
236. Aug 26th 2010, [Incident: Chautauqua E135 at Milwaukee on Aug 26th 2010, smoke from brakes, evacuation,.](#)
237. Aug 26th 2010, [Accident: Jetblue A320 at Sacramento on Aug 26th 2010, brake fire on landing.](#)
238. Aug 21st 2010, [Incident: Aero Contractor B735 at Jos, runway excursion on landing.](#)
239. Aug 19th 2010, [Incident: Flybe DH8D at Manchester on Aug 19th 2010, dense smoke in cabin.](#)
240. Aug 16th 2010, [Accident: Aires B737 at San Andres Island on landed short of runway and broke up.](#)
241. Aug 4th 2010, [Accident: United Airlines B763 at Chicago on Aug 4th 2010, brakes fire on landing.](#)
242. Jul 25th 2010, [Accident: Allegiant MD83 near Flagstaff on Jul 25th 2010, engine fire indication.](#)
243. Jul 16th 2010, [Accident: SA Express DH8C at Kimberly, aardvark strike.](#)
244. Jun 16th 2010, [Accident: Trans States E145 at Ottawa on Jun 16th 2010, runway overrun.](#)
245. May 30th 2010, [Accident: Spirit Airlines A319 at Ft. Lauderdale on May 30th 2010, smoke in cabin.](#)
246. May 5th 2010, [Accident: Satena E145 at Mitu, overran runway.](#)
247. Apr 13th 2010, [Accident: Cathay A333 at Hong Kong on Apr 13th 2010, engine stuck at high thrust.](#)

248. Apr 2nd 2010, [Accident: Norwegian B738 near Alicante on Apr 2nd 2010, wheel well fire indication.](#)
249. Mar 23rd 2010, [Accident: Air Canada A320 at Toronto on Mar 23rd 2010, steering problem and smell of smoke.](#)
250. Feb 11th 2010, [Accident: Trigana AT42 at Bone on Feb 11th 2010, forced landing on a field, both engines not operating.](#)
251. Feb 4th 2010, [Accident: Yakutia AN24 at Yakutsk, early gear retraction causes rejected takeoff.](#)
252. Jan 10th 2010, [Accident: United Airlines A319 at Newark on Jan 10th 2010, right main gear did not deploy.](#)
253. Dec 22nd 2009, [Accident: American B738 at Kingston on Dec 22nd 2009, overran runway on landing.](#)
254. Dec 16th 2009, [Incident: Flybe DH8D near Manchester on Dec 16th 2009, smoke in cockpit.](#)
255. Dec 3rd 2009, [Accident: Batavia B734 at Bali on Dec 3rd 2009, smoke from engine, passengers evacuate on their own.](#)
256. Dec 2nd 2009, [Accident: Merpati F100 at Kupang on Dec 2nd 2009, landed without left main gear..](#)
257. Nov 18th 2009, [Accident: Allegiant MD87 at Wichita on Nov 18th 2009, engine failure.](#)
258. Nov 18th 2009, [Accident: Iran Air F100 at Isfahan, gear problem on takeoff, gear collapse on landing.](#)
259. Nov 12th 2009, [Accident: Jetlink Air CRJ1 at Kigali, throttle jam, impacted terminal after return.](#)
260. Oct 4th 2009, [Accident: Airtran B712 at Orlando on Oct 4th 2009, engine fire indication.](#)
261. Sep 14th 2009, [Accident: Contact F100 at Stuttgart on Sep 14th 2009, landing without main gear.](#)
262. Sep 4th 2009, [Accident: Air India B744 at Mumbai on Sep 4th 2009, engine fire during taxi out.](#)
263. Sep 3rd 2009, [Accident: Jetblue E190 near Nassau on Sep 3rd 2009, engine fire on approach.](#)
264. Aug 21st 2009, [Accident: SATA Acores ATP at Porto Santo, rejected takeoff.](#)
265. Aug 7th 2009, [Incident: Vietnam Airlines A320 at Ho Chi Minh City, hydraulics problems.](#)
266. Aug 5th 2009, [Accident: Vueling A320 at Paris on Aug 5th 2009, engine smoking during push back.](#)
267. Aug 2nd 2009, [Incident: British Airways B752 near Barcelona on Aug 2nd 2009, smoke in cabin.](#)
268. Jul 24th 2009, [Incident: Aeroflot B763 at Moscow on Jul 24th 2009, wheel fire.](#)
269. Jul 10th 2009, [Accident: British Airways B744 at Phoenix on Jul 10th 2009, smoke prompts evacuation after push back.](#)
270. Jul 4th 2009, [Incident: Olympic Airlines A343 over Atlantic on Jul 4th 2009, bomb hoax.](#)

271. Jun 22nd 2009, [Incident: Falcon Air Express MD83 at Aruba on Jun 22nd 2009, APU smoke in cabin.](#)
272. Jun 14th 2009, [Accident: Express Air D328 at Tanahmerah, veered off runway.](#)
273. Jun 11th 2009, [Accident: Atlantic Southeast CRJ2 at Atlanta on Jun 11th 2009, left main gear did not deploy.](#)
274. May 20th 2009, [Incident: Austral MD83 at Buenos Aires, smoke in cabin prompts evacuation.](#)
275. May 12th 2009, [Incident: Southwest B733 at Houston on May 12th 2009, tire fire.](#)
276. Mar 25th 2009, [Incident: Aerolineas Argentinas MD88 at Trelew, smoke in cabin prompts evacuation.](#)
277. Feb 23rd 2009, [Accident: Lion Air MD90 at Batam on Feb 23rd 2009, nose gear failure.](#)
278. Feb 13th 2009, [Accident: BA Cityflyer RJ1H at London on Feb 13th 2009, collapsed nose gear.](#)
279. Feb 4th 2009, [Incident: Uni Airways DH8C at Makung, rejected takeoff.](#)
280. Jan 15th 2009, [Accident: US Airways A320 at New York, ditched in Hudson River.](#)
281. Dec 20th 2008, [Accident: Continental B735 at Denver on Dec 20th 2008, veered off departure runway and burst into flames.](#)
282. Dec 11th 2008, [Incident: Delta Airlines MD88 near Greenville on Dec 11th 2008, smoke in cockpit.](#)
283. Oct 18th 2008, [Accident: XL Airways B738 near Belgrade on Oct 18th 2008, smoke from engine after diversion.](#)
284. Aug 27th 2008, [Accident: Sriwijaya Air B732 at Jambi on Aug 27th 2008, runway overrun.](#)
285. Aug 24th 2008, [Accident: Air Dolomiti AT72 at Munich on Aug 24th 2008, brakes fire taxiing out.](#)
286. Aug 1st 2008, [Accident: Flybe E195 near Isle of Man on Aug 1st 2008, smell of smoke in cockpit, evacuation.](#)
287. Mar 25th 2008, [Report: Air Atlanta Icelandic B743 at Dhaka on Mar 25th 2008, engine and wing on fire, smoke in cabin.](#)
288. Mar 19th 2008, [Report: Cirrus D328 at Mannheim on Mar 19th 2008, overran runway, gear collapse.](#)
289. China Airlines (Taiwan), Boeing 737-800, B18616, Okinawa, August 20, 2007
290. Aug 2nd 2005, [Crash: Air France A340 at Toronto on Aug 2nd 2005, overshoots runway and bursts in flames.](#)

Appendix 4

Evacuation-Related NTSB Recommendations

The following NTSB Recommendations were reviewed by the ARC for action if necessary.

Recommendation	Actions Taken
A-10-080/A-10-094: Require quick-release girts and handholds on all evacuation slides and ramp/slide combinations.	Current draft SAE Standard AS8994 would include this provision, and would be the basis for an FAA Technical Standard Order
A-09-026: Require that operators provide pilots with guidance requiring that pilots and flight attendants actively monitor exit availability and configure the airplane and cabin for an evacuation when the airplane is stopped away from the gate after a significant event to help expedite an emergency evacuation if one becomes necessary.-- the November 12, 2013, final rule does not contain the relevant provisions that were included in the SNPRM.	Related to issues identified with communication as well as the non-emergency evacuations
A-06-069: Require that any cabin personnel on board 14 Code of Federal Regulations Part 135 flights who could be perceived by passengers as equivalent to a qualified flight attendant receive basic FAA-approved safety training in at least the following areas: preflight briefing and safety checks; emergency exit operation; and emergency equipment usage. This training should be documented and recorded by the Part 135 certificate holder.	Not addressed by ARC review
A-00-072/A-00-073: Require all newly certificated commercial airplanes to meet the evacuation demonstration requirements prescribed in Title 14 Code of Federal Regulations Part 25, regardless of the number of passenger seats on the airplane. {and for partial demonstrations }	Not addressed by ARC review
A-00-076: Require Type III over-wing exits on newly manufactured aircraft to be easy and intuitive to open and have automatic hatch stowage out of the egress path.	Pending harmonization activity re automatic disposal. Reiterated in this ARC report.
A-00-077: Require air carriers to provide all passengers seated in exit rows in which a qualified crewmember is not seated a preflight	ARC recommendation

personal briefing on what to do in the event the exit may be needed.	
A-00-085: Require air carriers to conduct periodic joint evacuation exercises involving flight crews and flight attendants.	ARC recommendation
A-00-086: Conduct research and explore creative and effective methods that use state-of-the-art technology to convey safety information to passengers. The presented information should include a demonstration of all emergency evacuation procedures, such as how to open the emergency exits and exit the aircraft, including how to use the slides.	Related to ARC recommendation
A-00-087: Require minimum comprehension testing for safety briefing cards.	Related to ARC recommendation
A-00-090/A-98-022: Require all newly manufactured transport-category airplanes operating under Title 14 Code of Federal Regulations Part 121 to be equipped with independently powered evacuation alarm systems operable from each crewmember station, and establish procedures and provide training to flight crews and flight attendants regarding the use of such systems.	Not addressed by ARC review
A-92-074: Amend 14 CFR Part 121-417 to require an evacuation and/or wet ditching drill group exercise during recurrent training. Ensure that all reasonable attempts are made to conduct joint flightcrew/flight attendant drills, especially for crewmembers operating on airplanes with two-person cockpit crews.	Not addressed by ARC review
A-76-073: Require modification of continental air lines' flightcrew emergency evacuation training program to insure that adequate emphasis is placed on the aspects of crew coordination, team effort, and awareness of individual crewmember's responsibilities as leaders of an evacuation.	Airline specific, but related to ARC recommendation
Although not in the 'unacceptable' category, this recent recommendation is relevant to the ARC: A-18-09. Conduct research to (1) measure and evaluate the effects of carry-on baggage on passenger deplaning times and safety during an emergency evacuation and (2) identify effective countermeasures to reduce any determined risks and implement the countermeasures.	FAA research activity pending

Appendix 5

Events with “Rapid Disembarkation”

- 11. Aug 27th 2019, [Accident: Air China A333 at Beijing, aircraft on fire at the gate](#), An Air China Airbus A330-300, registration B-5958 performing flight CA-183 from Beijing (China) to Tokyo Haneda (Japan), was boarding for departure, when smoke emanated from the aircraft prompting a rapid disembarkation of the people on board, cabin and flight crew vacated the aircraft via the jet bridge after all passengers. Emergency services responded and extinguished a fire in the forward cargo hold. There were no injuries, the aircraft received substantial damage.
- 30. Dec 10th 2018, [Indigo A20N at Kolkata, smoke on board](#), smoke developed in cabin and cockpit of the aircraft prompting the crew to declare emergency. The aircraft continued to Kolkata for a safe landing on runway 01R and taxied to a remote stand on the apron. A number of passengers opened the aft exits and slid down the evacuation slides, most of the passengers disembarked normally via stairs.
- 53. Nov 24th 2017, [Spicejet DH8D near Nagpur, smoke in cabin and cockpit](#), No. 3 Bearing Carbon Seal failed in service resulting in oil leak into the gas path causing oil fumes getting into the aircraft cabin through the Bleed Off Valves. Safe landing on Nagpur's runway 32, taxied to the stand where the crew shut the engines down and instructed the cabin crew to evacuate the aircraft through the left door.
- 56 .Nov 2nd 2017, [Lingus A320 near Cork, smoke in cockpit](#), crew taxied the aircraft to the stand, set the park brake, assessed the situation again and found there were still fumes in the cockpit, the captain thus decided to perform a rapid disembarkation. While most of the passengers and crew disembarked via the front and aft steps, the passengers in the emergency exit rows opened the emergency exit doors, about 32 passengers stepped onto the wings, half of them used the emergency slides. The other half returned to the cabin and disembarked via the stairs. There were no injuries, however, one person felt unwell and was taken to a local hospital.
- 87. Aug 9th 2016, [Incident: Wisconsin CRJ2 at Indianapolis on Aug 9th 2016, smoking brakes](#), An Air Wisconsin Canadair CRJ-200 on behalf of American Airlines, registration N455AW performing flight ZW-3786/AA-3786 from Philadelphia, PA to Indianapolis, IN (USA) with 32 people on board, landed on Indianapolis' runway 23L and rolled out safely. Upon vacating the runway the crew reported they had a brakes problem, possibly a dragging brake, and requested emergency services to attend the aircraft for hot brakes. The crew shut the aircraft down, a rapid disembarkation onto the taxiway commenced.
- 93. Jun 27th 2016, [Accident: Singapore B773 enroute on Jun 27th 2016, engine fuel leak into engine oil system](#), A Singapore Airlines Boeing 777-300, registration 9V-SWB performing flight SQ-368 from Singapore (Singapore) to Milan Malpensa (Italy) with 222 passengers and 19 crew, was enroute at FL300 over the Andaman Sea about 2 hours into the flight when the crew decided to descend the aircraft to FL170 and return to Singapore due to an oil leak at the right hand engine (GE90). The aircraft landed safely on Singapore's runway 20C about 2:20 hours later and slowed down. While passengers broke into clapping and cheering and the

aircraft turned off the runway, a spark was seen at the right hand side causing the right hand engine and wing to catch fire, the aircraft stopped on the taxiway, emergency services sprung into action and extinguished the fire, the crew kept the passengers on board while firefighters doused the fire. The passengers subsequently disembarked via stairs. There were no injuries, the aircraft sustained substantial damage to right engine and right wing.

- 172 .Jun 2nd 2013, [Accident: Cebu Pacific A320 at Davao on Jun 2nd 2013, runway excursion](#), A Cebu Pacific Airbus A320-200, registration RP-C3266 performing flight 5J-971 from Manila to Davao (Philippines) with 165 passengers and 6 crew, veered right of the runway at 19:05L (11:05Z) while landing on Davao's runway 23 in heavy rain and came to a stop with the nose gear collapsed, both engines received substantial damage due to ground contact following the nose gear collapse...On Jun 4th the airline added, that the aircraft was evacuated 15 minutes after coming to a stop. Both engines had made ground contact following the nose gear collapse however, both engines were severely damaged, likely beyond repair, and emitted smoke. The crew however quickly established that the engines were not on fire. Due to the tilted position of the aircraft the crew anticipated that an emergency evacuation would cause injuries, assessed the situation and then decided to perform a precautionary disembarkation via the left hand front door and evacuation slide.
- 187 .Oct 11th 2012, [Report: Thomas Cook B752 at Glasgow and near Manchester on Oct 11th 2012 and Oct 12th 2012, smoke/fumes on board](#), A Thomas Cook Boeing 757-200, registration G-FCLA performing flight MT-3549 from Dalaman (Turkey) to Glasgow, SC (UK) with 231 passengers and 8 crew, had safely landed and had reached the gate, passengers were disembarking via the jetway attached to the L2 door. While approaching the gate the crew had activated the APU, the APU started normally without any anomaly and without smells, the crew subsequently focused on post flight activities when some time during disembarkation the captain became aware of a strong smell and some blue haze in the cockpit. The captain (57, ATPL, 16,000 hours total, 12,000 hours on type) left the cockpit, discovered thick smoke in the cabin, the front section of the cabin was already empty however there were still passengers in the rear section of the cabin, the commander therefore went to the next interphone and ordered the immediate evacuation of the aircraft. The doors L4 and R4 were re-armed then opened, the slides deployed and passengers evacuated onto the apron, the door R3 was also re-armed and opened with passengers using that exit, the door L3 remained closed due to obstacles outside, doors L1/R1 were not used because the front section of the cabin was already empty. One of about 60 passengers using the slides received a very minor injury in the evacuation.
- 188. Sep 3rd 2012, [Accident: XL Airways B738 at Cologne on Sep 3rd 2012, injuries after malfunction of air conditioning system](#), An XL Airways Germany Boeing 737-800, registration D-AXLF performing flight G1-110 from Hanover to Cologne/Bonn (Germany) with 186 passengers, 10 infants and 6 crew, had safely landed on Cologne's runway 24 and was taxiing towards the terminal, when smoke appeared in the cabin seemingly originating from the air conditioning vents. The occupants rapidly deplaned via stairs... The disembarkation of passengers however was disorderly, cabin crew perceived the passengers as highly emotional and aggressive. 11 passengers were taken to hospital but were able to continue to Gaziantep the following day.

- 217. May 16th 2011, [Incident: Cathay Pacific A333 near Singapore, engine shut down in flight, engine fire](#), Singapore's Ministry of Transport (MOT) released their final report (<http://www.mot.gov.sg/news/20140822%20CX%20330%20Engine%20Fire%2016%20May%2011-%20Final%20Report.pdf>), CX-715 landed on runway 02C and vacated the runway onto taxiway E-5, emergency services noticed the right hand engine was on fire and began fighting the fire. In the meantime the commander (40, ATPL, 8,534 hours total, 3,632 hours on type), pilot flying, had instructed cabin crew to remain on standby for an evacuation and attempted to establish contact with the fire chief to inquire about the status of the engine but was unable to establish contact. About 3 minutes after the first attempt to talk to the fire chief the first officer (41, ATPL, 7,385 hours total, 3,238 hours on type), pilot monitoring, opened the cockpit window and talked to the fire chief directly. The fire chief informed the first officer that the fire in the #2 engine had been put out and equipment was being arranged for the disembarkation of passengers.
- 229. Nov 4th 2010, [Accident: Qantas A388 near Singapore on Nov 4th 2010, uncontained engine failure](#), A Qantas Airbus A380-842, registration VH-OQA performing flight QF-32 from Singapore (Singapore) to Sydney, NS (Australia) with 440 passengers and 26 crew, was climbing out of Singapore overhead the Indonesian Island of Batam about 20nm south of Singapore about 6 minutes into the flight when the #2 engine (Trent 972, inboard left hand) emitted a loud bang suffering from an uncontained failure...After assessing the checklists the crew decided the safest course of action would be to disembark the passengers through the right hand doors via stairs. A single door was elected so that the passengers could be counted and the other doors remained available should a rapid evacuation via slides become necessary...The first passenger disembarked through the #2 main deck forward door 55 minutes after landing, the last passenger disembarked about 1 hour later...No injuries occurred on board of the aircraft. Two persons received minor injuries on the ground at the Island of Batam.
- 238. Aug 21st 2010, [Incident: Aero Contractor B735 at Jos, runway excursion on landing](#), Nigeria's Accident Investigation Board (AIB) released their final report (<http://aib.gov.ng/download.php?filename=REPORT%20ON%20THE%20ACCIDENT%20INVOLVING%20205N-BLE.pdf>) The AIB analysed: "The captain was busy calling Lagos, and the emergency evacuation was not accomplished as required by the Emergency Operation Check List and Company's Ops Manual see section 1.17.1.4 above. He later requested for step to disembark the passengers as he could not taxi the aircraft off the runway. Passengers were disembarked without injuries or further incident. The investigation revealed that due to the nature of the incident there was a risk of fire outbreak. The crew did not follow the approved emergency and company procedures to mitigate this possibility."
- 241. Aug 4th 2010, [Accident: United Airlines B763 at Chicago on Aug 4th 2010, brakes fire on landing](#), A United Airlines Boeing 767-300, registration N644UA performing flight UA-949 from London Heathrow, EN (UK) to Chicago O'Hare, IL (USA) with 178 passengers and 12 crew, had landed on O'Hare's runway 27L and was just about to turn off onto runway 22R when the tower ordered the crew to stop right there and hold position after a small brake fire was detected on the left hand main gear. The airplane stopped, an evacuation via the right hand slides was initiated while emergency services responded and quickly put the fire out. The evacuation was aborted, around 100 people had already come down the slides with others still

on board. 3 passengers were taken to a local hospital, 3 more were treated at the airport. Emergency services reported, that at least one brakes assembly caught fire. The right hand slides were deployed away from the fire. Emergency services treated a number of passengers who exited via the slides for minor injuries. 2 passengers were taken to hospitals with minor ankle injuries, another passenger was taken to hospital with chest pain, 3 other passengers were treated at the airport for scratches and bruises. The NTSB reported on Dec 24th 2010 in their [preliminary report](#) that the left main gear brake piston housing had ruptured. The right aft passenger slide did not inflate. The brakes assembly and the slide were removed from the aircraft and are undergoing examination. 6 minor injuries occurred during the evacuation.

- 243. Jul 16th 2010, [Accident: SA Express DH8C at Kimberly, aardvark strike](#), South Africa's Civil Aviation Authority released their final report (<http://www.caa.co.za/resource%20center/accidents%20&%20incid/reports/2010/8805.pdf>), A South African Express Airways de Havilland Dash 8-300, registration ZS-NLY performing flight XZ-1107/SA-1107 from Johannesburg to Kimberly (South Africa) with 40 passengers and 4 crew, had just touched down with its main gear on Kimberly's runway 20, the nose gear about to touch down, when the nose gear struck an aardvark on the runway and bent backwards. The crew managed to stop the aircraft on the runway centerline, no injuries occurred...After the airplane came to a standstill 1838 meters down the runway the first officer assessed the situation with regards to a possible fire, after it was clear there was no fire the first officer helped the passenger disembarking the aircraft via the main access door onto the runway. The captain completed working the shutdown in ground emergency checklist and subsequently assisted with the evacuation. Arriving emergency services also assisted with the evacuation of the aircraft.
- 257. Nov 18th 2009, [Accident: Allegiant MD87 at Wichita on Nov 18th 2009, engine failure](#), An Allegiant Air McDonnell Douglas MD-87, registration N952MA performing flight G4-5813 from Wichita, KS to Bulkhead City, AZ (USA) with 125 passengers and 5 crew, was climbing through 1500 feet out of runway 19R, when the left hand engine emitted a loud bang, the crew received an engine fire indication followed by an ATC transmission indicating, that flames from the left engine were visible on the ground. The crew levelled at 4000 feet and returned to Wichita, where the airplane landed safely on runway 19R about 8 minutes later. The airplane was initially evacuated via slides, a number of passengers went down the slides, most of the passengers disembarked via stairs brought to the airplane...Allegiant Air reported, that one passenger received minor injuries in the evacuation...The FAA reported, that two persons reported minor injuries after using the slides.
- 264. Aug 21st 2009, [Accident: SATA Acores ATP at Porto Santo, rejected takeoff](#), The Portugese Gabinete de Prevencao e Investigacao de Acidentes com Aeronaves (GPIAA) released their final report in Portugese (<http://www.gpiaa.gov.pt/tempfiles/20101022100837moptc.pdf>), A SATA Air Acores BAe ATP, registration CS-TFJ performing flight SP-1691 from Porto Santo to Funchal (Portugal) with 14 passengers and 4 crew, rejected takeoff due to the failure of the right hand engine. The airplane slowed safely, the passengers were rapidly deplaned onto the runway, one passenger received a minor injury while stepping down onto the runway and was treated at the airport.

Attending fire fighters quickly put out a resulting fire in the right hand engine...The aircraft was accelerating for takeoff when the crew recognized the failure of the right hand engine at speed less than 80 knots (low speed). The engine temperature reached 1200 degrees C, an orange glow was seen in the cabin and the engine emitted a lot of smoke. The crew rejected takeoff and discharged the engine fire bottle. The airplane stopped on the runway, the crew shut all systems down and ordered the evacuation of the aircraft through the left hand rear door. The two cabin crew instructed the passengers to use the slide at the left hand rear door, however, it became apparent that the slide had not inflated. One passenger jumped down nonetheless and received a minor foot injury, 11 more followed the example without injuries. The remaining 2 passengers and 4 crew evacuated via the left hand forward door and slide.

- 265. Aug 7th 2009, [Incident: Vietnam Airlines A320 at Ho Chi Minh City, hydraulics problems](#), A Vietnam Airlines Airbus A320-200, registration VN-A302 performing flight VN-453 from Nha Trang to Ho Chi Minh City (Vietnam) with 164 passengers, was on approach to Ho Chi Minh City, when the crew noticed an abnormal level of hydraulics fluid in one of the hydraulics systems affecting the aircraft brakes and declared emergency. The aircraft blew two main gear tyres during the subsequent landing on runway 25L (3800 meters/12500 feet concrete) and veered off the runway to the right stopping with all three gear struts on soft ground. The passengers were evacuated using the slides. Initial Vietnamese reports including pictorial evidence (showing the airplane with all but rear doors closed and stairs at the rear exit, no slides visible, see top picture) had suggested, that the airplane had come to a stop on the runway and passengers deplaned via stairs.
- 287. Mar 25th 2008, [Report: Air Atlanta Icelandic B743 at Dhaka on Mar 25th 2008, engine and wing on fire, smoke in cabin](#), An Air Atlanta Icelandic Boeing 747-300 on behalf of Saudi Arabian Airlines, registration TF-ARS performing flight SV-810 from Madinah (Saudi Arabia) to Dhaka (Bangladesh) with 307 passengers and 18 crew, had just touched down on Dhaka's runway 14 when the tower controller alerted the crew to seeing a fire on the right hand wing. Almost at the same time the crew received a fire indication for the #3 engine (JT9D). The crew discharged one bottle, after 20 seconds the second bottle of fire extinguisher without being able to extinguish the fire. The aircraft was evacuated through the L1 and L2 doors. 15 passengers and 2 crew received minor injuries in the evacuation, the aircraft received substantial damage beyond economical repair...Two out of six suitable emergency exits on the left side were used (L1 and L2) to evacuate most of the passengers during the emergency evacuation. The reason for not opening doors at location L3, L4 and L5 initially was most likely due to the fact that the commander ordered the cabin crew to remain seated prior to the emergency evacuation. The cabin crew members at locations L3 to L5 most likely did not hear the emergency evacuation command from the senior cabin crew member as he was only using a megaphone. Furthermore these exits were not opened later since the passengers moved aggressively to the opened exits, L1 and L2. The reason for not opening emergency exit UDL at the upper deck was evaluated by the crew to be too risky for the passengers.

Appendix 6

Summary List of Findings and Observations and Topics to be Assessed

Category	No	Finding/Observation/Topic	Recommendation Number
Airplane Condition/Design	1	Occupants using provided restraints seem to be well protected from impact injuries.	None
	2	Exits seem to be accessible	None
	3	Occupants seem to have enough time to get out of the airplane	None
	4	Use of less than 50% of the exits is foreseeable	None
	5	Passengers retrieving bags during an evacuation is common.	None
	6	Exits with escape slides seem to provide adequate evacuation rate capability	None
	7	Many evacuees suffer minor injuries and some serious injuries using the escape slides.	None
	8	Many evacuations were the result of smoke and/or fume events.	EES-1
	9	Is the space provided for flight attendants at an exit adequate to facilitate a rapid evacuation?	None
	10	Is the 6-ft requirement for assist means too high for over-wing exits? Or non-over-wing exits?	EES-2
	11	Some evacuees do not understand where/how to egress from a wing when no escape slide is provided.	EES-2
	12	Some slides malfunctioned during the emergency evacuation (deployment reliability).	None
	13	Adverse attitudes corresponding to the loss of one or more legs of landing gear are relatively common.	EES-3
	14	Many evacuations are the result of brake/landing gear area or engine fires.	None

	15	More events were at landing, or due to an inflight event that results in a landing.	None
	16	Relatively few exits are not used due inability to open them.	None
	17	Assist means that are deployed into a usable condition tend to remain usable for the duration of the evacuation.	None
	18	Communication impeded due to PA/Interphone problems.	EES-4A & 4B
	19	Slide performance in wet conditions.	EES-5
	20	Many evacuations are the result of false cargo fire detector signals.	EES-6
Procedures & Training	1	In some cases, communication between FC and CC could have been timelier.	None
	2	In some cases, communication between FC and ARFF should have occurred or been timelier.	EES-14
	3	The time to complete the checklist appears to have caused delays in getting engines shut down and emergency evacuation initiated, in some cases.	EES-15
	4	In some of the time critical conditions, the initiation of the evacuation could have been timelier.	EES-15
	5	Not all evacuations are carried out in a time-critical manner.	EES-16
	6	Passengers retrieving bags during an evacuation is common.	EES-17
	7	Use of less than 50% of the exits is foreseeable.	EES-18
	8	Initiation of evacuation seems to be a challenge, even when the crew are committed to doing it.	EES-15
	9	Should there be any changes related to footwear or clothing?	None
	10	ARFF direct involvement in the actual emergency evacuation is more common than previously thought.	EES-14
	11	Many evacuations are the result of fires in engines and landing gear area.	None
	12	Adverse attitudes corresponding to the loss of one or more legs of landing gear are relatively common.	None
	13	More events were at landing, or due to an inflight event that results in a landing.	None

	14	Passenger operated exits have been opened prematurely.	None
	15	Communication issues during evacuations.	EES-19
	16	Evacuation procedures when CC are incapacitated.	None
	17	Passenger management on the ground does not seem to be very consistent.	None
	18	Is the requirement for 1 CC per 50 passenger seats appropriate?	None
	19	Some evacuees do not understand where/how to egress from a wing when no escape slide is provided.	None
External Environment	1	High winds.	None
	2	Extreme temperature.	None
	3	Rain/snow.	None
	4	Ambient light.	None
	5	Exposure to firefighting foam.	None
	6	Terrain – Regular (runway, taxiway).	None
	7	Terrain – Irregular (off runway, soft ground uneven terrain).	None
	8	Body of water.	None
	9	Engines running.	EES-20
	10	Presence of emergency response vehicles can (equipment and/or personnel) impeded evacuation.	None
	11	Application of deicing fluid.	None
Maintenance	1	Use of less than 50% of the exits is foreseeable.	None
	2	Emergency equipment including PA and interphone systems / loss of these systems.	None
Part 25 Type Certification	1	14 CFR §25.561(c)(1)(iii), (d)—Items of mass.	None
	2	14 CFR §25.562(c)(8) —Emergency landing dynamic conditions.	None
	3	14 CFR §25.735(g) —Brakes and braking systems.	None
	4	14 CFR §25.793—Floor surfaces.	None

	5	14 CFR §25.801—Ditching.	None	
	6	14 CFR §25.803—Emergency Evacuation.	None	
	7	14 CFR §25.807—Emergency Exits.	None	
	8	14 CFR §25.809—Emergency Exit Arrangements.	None	
	9	14 CFR §25.810—Emergency Egress Assist Means and Escape Routes.	EES-7 EES-20	
	10	14 CFR §25.811—Emergency Exit Markings.	None	
	11	14 CFR §25.812—Emergency Lighting.	EES-8	
	12	14 CFR §25.813—Emergency Exit Access.	EES-2 EES-9	
	13	14 CFR §25.815—Width of aisle.	None	
	14	14 CFR §25.817—Maximum number of seats abreast.	None	
	15	14 CFR §25.851(b)(2) —Fire extinguishers.	None	
	16	14 CFR § 25 Appendix J	None	
	Part 121 Operational Approval	1	14 CFR §121.291—Demonstration of emergency evacuation procedures.	EES-10
		2	14 CFR §121.309—Emergency equipment.	None
		3	14 CFR §121.310—Additional emergency equipment.	None
		4	14 CFR §121.311(i) —Seats, safety belts, and shoulder harnesses	EES-11
5		14 CFR §121.391—Flight attendants.	EES-12	
6		14 CFR §121.393—Crewmember requirements at stops where passengers remain on board.	None	
7		14 CFR §121.394—Flight attendant requirements during passenger boarding and deplaning.	None	
8		14 CFR §121.397—Emergency and emergency evacuation duties.	None	
9		14 CFR §121.417—Crewmember emergency training.	None	
10		14 CFR §121.421—Flight attendants: Initial and transition ground training.	None	

	11	14 CFR §121.570—Airplane evacuation capability.	None
	12	14 CFR §121.571—Briefing passengers before takeoff.	EES-13
	13	14 CFR §121.585—Exit seating.	EES-13
FAA- Requested Review (refer to section II)	3/4	Regulatory standards that are prescriptive in defining dimensional requirements, based on anthropometry and scenario.	EES-21
Other Recommendations	N/A	Adoption of cabin safety recommendations made by the Transport Aircraft Crashworthiness and Ditching Working Group (TACDWG)	EES-22
	N/A	Mobile Stair Vehicles/Air Stairs and ARFF	EES-23
	N/A	Minimum Manning Standards for ARFF Personnel	EES-24
	N/A	Updating 14 CFR §139.315 – Aircraft Rescue and Firefighting (ARFF): Index determination, 14 CFR §139.317 – Aircraft rescue and firefighting: Equipment and agents, and 14 CFR §139.315 – Aircraft rescue and firefighting: Operational requirements.	EES-25
	N/A	Applicability of 14 CFR Part 139 to scheduled cargo air transportation	EES-26
	N/A	Systemic collection of data for evacuation events	EES-27

Appendix 7

Findings Assessed in Depth Resulting in No Recommendations

1. Subject – No recommendation suggested by ARC

Brakes and braking systems: risk of fire linked to brake condition after high kinetic energy dynamometer stop(s).

Applicable Regulation(s)

14 CFR §25.735(g)

Finding

In a significant amount of the airplane evacuation events entered into ARC data matrix, the time interval between the aircraft stop and the start of the emergency evacuation of the cabin exceeded five minutes.

14 CFR §25.735(g) requires that during the dynamometer testing for brakes, the parking brake pressure is promptly and fully applied for at least 3 minutes; in addition, it must be demonstrated that for at least 5 minutes after application of the parking brake pressure, no condition occurs that could prejudice the safe and complete evacuation of the airplane (a similar requirement is also included in TSO-C135a paragraph 3.3.4.5). Applicable advisory material is included in AC 25.735-1.

In 1988, the FAA, in cooperation with the Joint Aviation Authority (JAA) and other organizations representing the American and European aerospace industries, began a process to harmonize the airworthiness requirements of the United States and the airworthiness requirements of Europe, especially in the areas of Flight Test and Structures. Starting in 1992, the FAA harmonization effort for various systems related airworthiness requirements was undertaken by the ARAC. An ARAC working group of industry and government braking systems specialists of Europe, the United States, and Canada was chartered and named as the Braking System Harmonization Working Group (HWG) by notice in the Federal Register (59 FR 30080, June 10, 1994).

The outcome was Notice of Proposed Rulemaking (NPRM) No. 99-16, which was published in the Federal Register on August 10, 1999 (64 FR 43570) and Supplemental Notice of Proposed Rulemaking (SNPRM) No. 99-16A, which was published in the Federal Register on December 18, 2000 (65 FR 79298).

Among other requirements, the NPRM introduced 14 CFR 25.735(g).

Both the 3- and 5-minute timeframes, according to the NPRM, are brake test requirements related to a safe evacuation of the airplane. As clarified by the FAA in the Preamble to the final rule, the criteria are based on regulations for 90-second cabin evacuation; pilot recognition

time; time to deploy slides; and time for fire trucks to arrive at the scene of the fire, as well as previous certification tests experience.

The parking brake must be applied following the high kinetic energy dynamometer stop demonstration for a minimum of three minutes, which is considered to be the minimum period of time required to cover the brake's ability to maintain the airplane in a stationary condition to allow a safe evacuation.

On the basis that an evacuation may be determined as prudent or necessary, and that such an evacuation must be capable of completion, irrespective of the timely response of the emergency services, five minutes appeared to be a reasonable period of time for the associated brake systems and equipment to remain free from conditions that might prejudice or jeopardize the evacuation. The five minutes period starts at the time of initial application of the parking brake, this being a time during which the possible need for evacuation and airport emergency services occurs following an accelerate-stop.

Conclusion

It is proposed that the Evacuation ARC does not recommend any change to the requirements of 25.735(g).

Rationale

A design that meets the requirements of 14 CFR §25.735(g) normally does it with an appreciable margin. If a sustained fire does not develop within the five minutes timeframe specified in the rule, it is unlikely that it may develop after the five minutes limit. An increase of the duration of the evaluation period will not drive any change to the design of brakes, braking systems, or airplanes designed to meet the current standard.

2. Subject – No recommendation suggested by ARC

Some escape slides malfunctioned or were not usable during emergency evacuations. Most airplane evacuations are equipped with emergency evacuation escape slides while other aircraft exits that have a sill height below 6 feet are not required to have escape slides. This recommendation evaluated and reviewed all evacuations during the past ten (10) years and evaluated if there are any deficiencies in escape slide system reliability during emergency evacuations.

Applicable Regulation

14 CFR §25.810

Finding

Of the evacuation events entered into the ARC data matrix, 65 percent involved the use of escape slides. The balance were events with aircraft without slides (e.g. ATR 42, Embraer 145, CRJ 200) or aircraft with slides installed that decided to evacuate the aircraft without using these slides (e.g. rapid disembarkation using stairs or aircraft ended up in water where a

land evacuation was not possible). There were 15 events (which is about 10 percent) where there was a deployment or usability issue with one or more slides.

In three of these 15 events, there were extenuating circumstances that impacted the escape slides performance. In Event 170, the aircraft struck a seawall during landing causing the aircraft to break apart and causing the slides to experience g-loads in excess of their design limits. Some slides became dislodged from their aircraft doors and some deployed in the cabin. These noted slide deployment issues were not caused by a problem with the slides designs, it was an unforeseen loading conditions that drove the slide deployment and usability issues on this aircraft.

In Event 212, the Aft right-hand slide was deployed in an area where debris outside the Aft RH door punctured the slide rendering it unusable. External debris whether from the aircraft itself or from the aircraft surrounding environment can damage the inflatable slide. The inflatable fabric is designed to meet certain TSO-C69c strength/tear requirements but sometimes the crash environment includes sharp objects that far exceed what would be considered reasonable requirements for an inflatable material.

In Event 65, two slides collapsed during an evacuation. Post-test examination of the escape slides involved in this accident found they were 17 and 18 years old. The slides had exceeded the manufacturer's recommended 15-year service life.

There is also a question regarding Event 286 which involved a 737-200 built in 1985. The slides are hanging from the R1 and R2 doors but were not inflated. The slides on the originally certified 737-200 were manually inflated slides and they switched to automatic deployment in later years. It could be that these slides were designed to be manually inflated and due to the condition of the aircraft (on its belly), the flight attendants decided not to deploy the slides. The slide part numbers were not provided in the report so this could not be verified. This event has been reported as having a slide deployment or usability issue as a conservative assumption.

If the 3 events above (170, 212, 65) are set aside for the reasons mentioned, 12 events remain where there was a slide deployment or usability issue. Based on the success rate for 148 events evaluated would be around 92%.

Conclusion

Based on the data evaluated from the 148 evacuations where slides were used and the relatively high success rate for evacuation events without escape slide reliability issues, there is no recommendation to improve escape slide reliability.

Rationale:

Based on this investigation of 10+ years of evacuation events where slides were used, it is expected that 9 out 10 evacuation events will have no slide deployment or usability issues.

3. Subject – No recommendation suggested by ARC

Many evacuees suffer minor injuries and some serious injuries evacuating an aircraft during emergency evacuations. Most airplane evacuations are equipped with emergency evacuation escape slides while other aircraft exits that have a sill height below 6 feet are not required to have escape slides. This recommendation evaluated and reviewed all serious and fatal injuries during the past ten (10) years and evaluated if there are any correlations or deficiencies in the use of evacuation escape slide systems during emergency evacuations.

Applicable Regulations

14 CFR §25.810

Finding

Of the airplane evacuation events entered into the Emergency Evacuation Standards ARC data matrix, 65 percent involved the use of escape slides. The balance were events with aircraft without slides (e.g. ATR 42, Embraer 145, CRJ 200) or aircraft with slides installed, that were evacuated without using these slides (e.g. rapid disembarkation using stairs or aircraft ended up in water where a land evacuation was not possible). There were a total of 23,552 passengers/crew that were involved in the 148 aircraft evacuation events involving slides. Of the 148 evacuation events where slides were used, there were 39 events where passengers/crew sustained either serious or fatal injuries.

Serious Injuries

Of those 39 events, 169 passengers/crew suffered serious injuries out of more than 23552 total passengers/crew, which is less than 1% of the total passengers/crew on board these aircrafts.

It is worth noting that of the 169 serious injuries, almost half (i.e. 77) occurred in just two (2) events;

- Asiana 777 in SFO, Flight #214 (event 170) with 44 serious injuries
- Kolavia Tu-154 in Surgut, Russia, Flight #KGL248 (event 224) with 33 serious injuries.

The remaining 100 serious injuries were from the remaining 37 evacuation events.

It is also worth noting that many of the serious injuries were caused by reasons unrelated to the escape slide (e.g. crash impact). Of the 169 passengers that were seriously injured, only 105 can be directly tied to the evacuation and, of those, only 11 were tied directly to the use of escape slides. Assuming all 105 passengers were injured using escape slides (worst case assumption) provides an injury rate of 4.5E-3 or approximately 5 serious injuries per 1000 evacuees that use the slide.

Fatal Injuries

Of those 39 evacuations, 50 passengers/crew suffered fatal injuries out of the 23552 total passengers/crew, for just under 0.2% of the total passengers/crew on board. This would be an injury rate of approximately $2.1E-3$ or about 2 fatal injuries per 1000 evacuees.

It is worth noting that of the 50 fatalities, 82% (i.e. 41) occurred in a single event;

Aeroflot Superjet 100 in Moscow, Flight #SU-1492 (event 20), 41 fatalities. Of those fatalities, most were succumbed to smoke and/or fire related injuries, and not due to inadequate evacuation slides. The lack of egress from the rear of the aircraft was due to the initial impact, fire and/or smoke and no reports of door exits or evacuation slide issues. If this event is excluded from the fatal injuries, the total percentage of fatalities per passenger is less than 0.04% or an injury rate of $3.8E-4$ or 4 fatal injuries per 10000 evacuees.

As with the serious injuries, it is worth noting that the fatalities were almost entirely caused by reasons unrelated to the escape slide (e.g. crash impact, fire, etc.). Of the 50 passenger fatalities, there was only one possible slide related fatality. This happened during Event 128 when an 86- year-old female was struck in head during the crash/evacuation. She ended up with a skull fracture and died six days later. Assuming this fatal injury was linked to using the escape slide, this would result in a fatal injury rate of less than $1E-4$ or 1 fatal injury per 10000 evacuees.

Conclusion

Based on the data evaluated from the 148 evacuations where slides were used and the relatively low serious and fatal injury rates, there is no clear indication that any recommendation to improve the evacuation slide systems is warranted.

Rationale

The above conclusion is based on the evidence that the injury rate is approximately 5 serious injuries per 1000 evacuees and 1 fatal injury per 10000 evacuees.

4. Subject – No recommendation suggested by ARC

Intent of the airplane evacuation requirement in 14 CFR §25.803(c) and the test criteria and procedures specified in 14 CFR part 25 appendix J.

Applicable Regulation(s)

14 CFR §25.803(c) and 4 CFR part 25 appendix J

Finding

In many of the evacuation events reviewed, the time to evacuate the airplane exceeded 90 seconds and/or the number and distribution of the usable emergency exits were not consistent with the specified in § 25.803(c) and Appendix J. There were committee discussions on the subject and the following was prepared to clarify the intent of the airplane evacuation requirement in § 25.803(c) and the test criteria and procedures in Appendix J:

Compliance with the requirements of 14 CFR §§25.807 through 25.815 is a prerequisite to show compliance with §25.803. In type certification projects, the proposed aircraft design is extensively evaluated to determine if the intent of §§25.807 through 25.815 is met. This involves reviewing the design of:

- Passenger emergency exits;
- Associated access provisions, including aisles, cross-aisles, and passageways;
- Emergency egress assisting means and escape routes;
- Emergency exit marking; and
- Emergency lighting system.

Furthermore, the determination of the rated capacities of the provided exit types, and the evaluation of the geometric distribution of the exits in the cabin, result in limitations to the maximum passenger seating capacity of the airplane to the passenger seating densities of the various cabin zones.

Finally, the full-scale demonstration required by §25.803 is conducted to assess the evacuation capability of the airplane and, when compliance with § 121.291 is requested, to also demonstrate the effectiveness of crew training and emergency procedures. Appendix J to Part 25 specifies acceptable conditions to perform the evacuation demonstration.

The use of analysis is allowed by § 25.803(c) to substantiate that the airplane can be evacuated within 90 seconds under the conditions specified in Appendix J without actually conducting the demonstration. The use of analysis can eliminate the need to conduct a full-scale demonstration where adequate knowledge is already available from previous full-scale demonstrations or other tests. The use of analysis is allowed to achieve a reduction of the number of full-scale demonstrations and consequently of the number of participants exposed to the risk of injuries.

As clarified in FAA AC 25.803-1A (Emergency Evacuation Demonstrations; dated 3/12/12), the requirements for emergency evacuation demonstrations were first established in 14 CFR Part 121 (§ 121.291) by Amendment 121-2 in 1965. Operators were required to conduct full-scale evacuation demonstrations within a time limit of two minutes using 50 percent of the exits. The purpose of the demonstration was to validate the crew members' abilities to execute the established emergency evacuation procedures and to ensure realistic assignment of functions to the crew.

The requirement to conduct an evacuation demonstration for airplanes having a seating capacity of more than 44 passengers was established in § 25.803 by Amendment 25-15 in 1967. The time limit for the design certification was established at 90 seconds, and the time limit in § 121.291 was reduced to 90 seconds. It was considered that the demonstration required by § 25.803 would show the basic capability of a new airplane and, as before, the § 121.291 demonstration would account for crew training and adequacy of crew procedures. Therefore, the demonstration conditions were somewhat different.

By Amendments 25-46 and 121-149, effective in 1978, §25.803 was revised to allow a means other than actual demonstration to substantiate the evacuation capability of the airplane and to replace the existing Part 25 demonstration conditions with conditions that would satisfy both Part 25 and Part 121. Part 25 was changed to match the conditions in Part 121.

Finally, Amendment 121-176, effective in 1982, allowed a Part 121 certificate holder to use the results of a Part 25 demonstration or the Part 121 demonstration of another operator to show compliance with §121.291.

The test conditions specified in Appendix J have been revised several times to reduce the potential for injuries to the participants: the age/gender mix to be used when conducting an emergency evacuation demonstration has been subject to less stringent acceptance criteria, it has been allowed the use of stands or ramps for descending from over-wing exits (only when the airplane is not equipped with an off-wing descent means) and the use of pre-deployed escape slides, a low level of ambient lighting in the test facility, and briefing of test passengers on the safety precautions taken for the demonstration.

The intent of §25.803 and of Appendix J is therefore to provide a standard test method to perform a comprehensive evaluation of the evacuation capability of the aircraft. The related test conditions and pass/fail criteria (e.g. the 90 s limit to the evacuation time) are not supposed to directly cover any envelope of realistic emergency evacuation scenarios but rather to generate the evidence that the aircraft design has a minimum level of performance in terms of evacuation capability. Considering the objective to guarantee and preserve the safety of the participants, it is difficult to identify any significant change to the current content of § 25.803 and Appendix J.

One aspect of the standard that is frequently criticised is the practice that foresees that one exit from each pair should be used in the demonstration. For example, it could be allowed to select the 50% of usable exits without any constraint (e.g. in an airplane with four pair of exits, only the two most forward emergency exits pairs could be used). However, a similar change would certainly trigger the re-evaluation of the appropriateness of the 90 second limit to the evacuation time. The likely outcome might be an increase of that limit with consequent negligible impact on the level of safety.

Conclusion

The ARC does not recommend any changes §25.803 or the test criteria and procedures specified in and Appendix J.

Rationale

The airplane evacuation requirement in § 25.803(c) and the test criteria and procedures in Appendix J are not intended to directly cover or envelope actual emergency evacuation scenarios that may occur in service, but rather they provide a standard method for assessing the evacuation capability of the airplane and to demonstrate the effectiveness of crew emergency procedures and training when compliance with § 121.291 is requested per paragraph g) of Appendix J.

5. Subject – No recommendation suggested by ARC

FAA Request Review Recommendations: Issue 9 - Reauthorization Bill Section 323: EES
ARC Subtask Exit Row Seating

Applicable Regulation and Guidance

14 CFR §121.585

Finding

The ARC was tasked to review the current safety procedures regarding exit rows on transport category aircraft in air transportation. In carrying out the subtask review the FAA consulted with members from the EES ARC which included representatives from transport category aircraft manufacturers.

The ARC reviewed approximately 290 events. The spreadsheet categories identified are captured in Appendix 7. Of these categories, two questions were identified to capture whether over-wing exit seats were occupied or not and whether this had any influence on the evacuation.

Evacuation ARC Category Workbook Questions
Question: HF13 states: Were all exit rows occupied by one or more passengers?
Summary: 18 of 20 events where there were responses recorded indicated that exit rows were occupied by one or more passengers. Event 35 was the only event where it was reported that there were no passengers seated in the over-wing exit seats. Event 254 was unique in that even though there were no passengers in the exit rows, a dead-heading flight attendant was positioned in the exit row for the planned “gear-up” landing.
Question: HF13.1 asks: If not, which exit rows were not occupied by passengers? What was the consequence (delayed exit opening, exit not opened, no adverse effect, etc.)?
Summary: 20 out of 20 events had no reported adverse effect due to the quick thinking, risk mitigation and risk based decision making by the cabin crewmember.
<u>Unoccupied exit seating</u> Event 35 ²² : #Niugini – F/A crew moved to over-wing exits to direct passengers and launch life raft, 28 passengers + 2 CC from left over-wing exit, 2 pilots/ 2CC and engineer from 1L, 6 passengers 4CC and the Load Master from right aft over-wing exit
<u>Deadheading crewmember (passenger) reseated to unoccupied exit seat</u>

²² <http://avherald.com/h?article=4be42f25/0000&opt=0>

Event 254²³: #UALA A319 with unoccupied exit seats 48 passengers 6 crew. The cabin was prepared for a gear up landing, cabin crew identified a dead heading flight attendant of another airline amongst the passengers and positioned him to assist opening the over-wing exits

Of the 290 airplane evacuation events entered into the Emergency Evacuation Standards (EES) Aviation Rulemaking Committee (ARC) data matrix, there were 2 events (about 0.68%) where information was available regarding the unoccupied exit seating making the events noteworthy. In both of these reported events, a trained and qualified flight attendant assisted or redirected passengers to the unoccupied emergency exit row.

In addition, the FAA separately established an Exit Seat Working Group (ESWG) to participate in the review. This consultant group was formed by invitation to the three aviation trade groups (Airlines for America, the Regional Airline Association, and the National Air Carrier Association) and two labor organizations, the Association of Flight Attendants-CWA and the Association of Professional Flight Attendants. The deliberations of the ESWG form the basis of a separate report to Congress. At the time of this writing, that report is under coordination within the FAA.

Knowing the ESWG had previously assessed the issue, the ARC constrained its review to the actual events noted above. Although suggesting procedures to require crewmembers to ask passengers seated near an unoccupied exit seat to pay special attention to the general safety information briefing and safety information cards that show the operation of the exit would seemingly add value, the ARC did not fully assess the subject based on the limited information available from actual events.

Conclusion

Based on the limited information review, and the more comprehensive report pending from the ESWG, the EES-ARC has no recommendation for changing regulations related to exit seating.

²³ <https://avherald.com/h?article=42591700/0000&opt=0>

Appendix 8

ARC Data Collection Tool--Categories

Question Number	Question
K1	<i>Aircraft Model (e.g. B777-200, A320-200, ERJ190-300, etc.)?</i>
K2	<i>Aircraft Type (Regional, Single aisle, Cargo, Combi, Dual aisle, or Double Deck)?</i>
K3	<i>Did a fire occur?</i>
K4	<i>Was the airplane on all of its gear?</i>
K5	<i>Were emergency exits and assist means used?</i>
D1	<i>Certified maximum allowable number of passenger seats for the Model?</i>
D2	<i>Certification basis of aircraft (principle Amendment level)?</i>
D21	<i>If escape slides were used, what TSO were the qualified to (e.g., TSO-C69a, -C69b, -C69c, None)?</i>
D28	<i>16g or 9g seat designs?</i>
D3	<i>Airplane Date of Manufacture (DOM)?</i>
D3.1	<i>Date of Delivery?</i>
D4	<i>Were any Dispatch Relief (e.g., Minimum Equipment List (MEL)) conditions present that could affect evacuation?</i>
D4.1	<i>If yes, what was the MEL item? How did it affect, or how could have it affected the evacuation?</i>
D5	<i>Did the flight crew deliberately burn off or dump fuel prior to the event?</i>
D6	<i>Cabin exit arrangement (Type, distribution, and total # of exits)?</i>
D22	<i>Total number of passenger seats?</i>
D23	<i>Total number of passengers?</i>
D24	<i>Passenger load factor (percentage of passenger seats occupied)?</i>
OT1	<i>Ratio of number of actual passengers to certified passenger limit?</i>
D25	<i>Predominate seat pitch(es)?</i>
D26	<i>Number of passengers in each cabin zone (between Doors 1 and 2, Doors 2 and 3, etc.)? Refer to Figure (if available).</i>
D27	<i>Number and seat locations of cabin crew? Refer to Figure (if available).</i>

D7	<i>How many exits were opened? (Note type of exits.)</i>
D8	<i>Ratio of exits opened to total number of exits?</i>
D11	<i>Ratio of exits used during the evacuation?</i>
HF2	<i>Number of passengers that used each exit?</i>
HF2.1	<i>Which exits did flight and cabin crew use to evacuate?</i>
D9	<i>Were any exits not opened?</i>
D9.1	<i>If yes, which exit(s) was not opened and why?</i>
HF14	<i>Did the cabin crew open all cabin exits?</i>
HF14.1	<i>If no, who opened each exit (cabin crew, flight crew, passenger)?</i>
HF3	<i>Number of cabin crew that played an active role in the evacuation?</i>
HF3.1	<i>How many cabin crew assisted at an active exit during evacuation?</i>
HF3.2	<i>List any other passengers that acted to support evacuation.</i>
HF4	<i>Did some cabin crew assist with the evacuation at a location away from an active exit?</i>
HF4.4	<i>If yes, where were they positioned and what duty did they perform?</i>
HF5	<i>Did any cabin crew not take an active role in managing the evacuation?</i>
HF5.1	<i>If yes, why?</i>
HF6	<i>Did any crew provide assistance on the ground during the evacuation?</i>
HF6.1	<i>If yes, which crew member(s)? When did they leave the airplane?</i>
D10	<i>Were all opened exits used during the evacuation?</i>
D10.1	<i>If not, which opened exits were not used and during the evacuation and why?</i>
HF7	<i>Did the flight crew take an active role in facilitating a rapid evacuation of the passengers?</i>
HF7.1	<i>If yes, what duty did they perform?</i>
D12	<i>Did the status of any exit change during the evacuation?</i>
D12.1	<i>If yes, what caused the status change?</i>
D13	<i>Was the opening of any exit delayed due to mechanical issues or other reason not related to external hazards (e.g., mechanical issue not crash-related)?</i>

D13.1	<i>If yes, which exit(s) had a delayed opening that was not crash-related, what caused the delay, and how long was the delay?</i>
D14	<i>Was the opening of any of emergency exit delayed due to the crash environment (fire, smoke, deformation, or other hazard resulting from the accident)?</i>
D14.1	<i>If yes, which exit(s) had a delayed opening, what caused the delay, and how long was the delay?</i>
D15	<i>Were flight crew exits used?</i>
D15.1	<i>If yes, who used the flight crew exits?</i>
D16	<i>What assist means were provided (slide, stairs, rope, wing flap, none) on the airplane?</i>
D17	<i>What assist means were used?</i>
D18	<i>Were there any deployment issues associated with an assist means (i.e., did any assist means not deploy into a usable condition)?</i>
D18.1	<i>If yes, which assist means did not properly deploy and why?</i>
D19	<i>Did any deployed assist means become unusable due to a malfunction or loss of function during the evacuation (e.g., did an escape slide lose pressure to the extent it became unusable during the evacuation)?</i>
D19.1	<i>If yes, which assist means had issues, what was the issue, and when did it occur?</i>
D20	<i>Ratio of opened exits with functioning assist means to number of opened exits with assist means.</i>
D20.1	<i>Ratio of exits with functioning assist means to total exits.</i>
D29	<i>Were airbags deployed (seat belt or monument installed)?</i>
D29.1	<i>If yes, were there any identified issues or concerns with the airbags?</i>
D29.2	<i>Were there any passenger seats with upper torso restraints (e.g., shoulder harness, 3-pt restraints? Refer to Figure (if available).</i>
D30	<i>Were any notable issues raised with respect to First/Business Class seat or suite features that limit visibility and/or access between main aisles?</i>
D31	<i>Was the width of the main aisle raised as a potential issue?</i>
D32	<i>Any unusual interior configuration designs (non-standard monuments, galleys, suites)?</i>
D33	<i>Any aircraft system issues that could have adversely affected egress (e.g. engines, emergency lighting, PA, egress means)?</i>

D33.1	<i>If yes, which system(s) issues? How did it, or how could have it adversely affected egress?</i>
D34	<i>Was the airplane equipped with an Evacuation Alarm?</i>
D34.1	<i>If yes, was it activated?</i>
D34.2	<i>If yes or no, were there any issues?</i>
E1	<i>Day or night conditions?</i>
E2	<i>Was weather considered a possible adverse factor in the evacuation?</i>
E2.1	<i>If yes, what was the weather condition(s) that may have factored into event?</i>
E3	<i>Event Location (on taxi way, runway, off runway, or off airport)?</i>
E4	<i>Phase of flight (e.g., taxi, takeoff, landing)?</i>
E5	<i>Were there external hazards present that were not related to the airplane accident (e.g., water, structures, trees)?</i>
E5.1	<i>If yes, were there any hazards that affected evacuation?</i>
E6	<i>Aircraft on all gear or in an adverse attitude?</i>
E7	<i>Were there any breaks in the fuselage?</i>
E7.1	<i>If yes, were they used to escape the airplane, and if so, by how many evacuees?</i>
E8	<i>Was there smoke or fire inside the cabin during the evacuation?</i>
E8.1	<i>If yes, what was the source of the smoke or fire?</i>
E9	<i>Was there smoke or fire outside of the cabin during the evacuation?</i>
E9.1	<i>If yes, what was the source of the smoke or fire?</i>
E10	<i>Was there internal structural deformation or damage that could impede evacuation or access to an emergency exit(s)?</i>
E10.1	<i>If yes, what was the deformation or damage and which exit(s) did it impede access to?</i>
E11	<i>Were there other internal impediments to evacuation (e.g., aircraft panels or other debris in aisles or passageways)?</i>
E11.1	<i>If yes, what was the impediment and which exit(s) did it impede access to?</i>
E12	<i>Were engines running during the evacuation?</i>
E12.1	<i>If yes, what was the duration of engine run time after aircraft stop?</i>

E12.2	<i>If yes, what was the duration of engine run time after evacuation start?</i>
PC4	<i>What was the time from airplane stop to when the evacuation command was given?</i>
PC11	<i>When did the first communication between flight crew to cabin crew actually occur as measured from when aircraft came to a stop?</i>
PC7	<i>What was the time when communication from crew to passengers occurred measured from aircraft stop?</i>
PC4.1	<i>What is the time from airplane stop to when first aircraft exit is opened</i>
HF1	<i>Time from evacuation command to when the last person not requiring assistance from rescue crew evacuated?</i>
HF1.1	<i>Time from evacuation command to when last person evacuated?</i>
HF8	<i>Were there injuries or fatalities?</i>
HF8.1	<i>If yes, how many injuries? How many fatalities?</i>
HF8.2	<i>Suspected cause of serious injuries or fatalities?</i>
HF9	<i>Were carry-on bags retrieved during evacuation?</i>
HF9.1	<i>If yes, describe.</i>
HF9.2	<i>If yes, was there any reported adverse effect on evacuation?</i>
HF10	<i>Did the cabin crew follow procedures during evacuation?</i>
HF10.1	<i>If not, which procedures were not followed?</i>
HF12	<i>Was flight crew procedural design inadequate/ineffective/incorrect for evacuation?</i>
HF12.1	<i>If yes, explain how.</i>
HF12.2	<i>Was flight crew procedural execution inadequate/ineffective/incorrect for evacuation?</i>
HF12.3	<i>If yes, explain how.</i>
HF13	<i>Were all exit rows occupied by one or more passengers?</i>
HF13.1	<i>If not, which exit rows were not occupied by passengers? What was the consequence (delayed exit opening, exit not opened, no adverse effect, etc.)?</i>
HF15	<i>Were there any passengers who required assistance during evacuation?</i>

HF15.1	<i>If yes, where were they seated and who provided them assistance during the evacuation?</i>
HF16	<i>Were there any infants (lap babies)?</i>
HF16.1	<i>If yes, how many infants?</i>
HF16.2	<i>Were any of the infants injured?</i>
HF17	<i>Was there anything unique about the occupant demographics (e.g., generally older, younger, military, experienced flyers, etc.)?</i>
HF18	<i>Were seat belts used by all passengers?</i>
HF18.1	<i>If no, were there any adverse consequences for the passengers who did not wear seat belts or those around them?</i>
HF19	<i>Were Personal Electronic Devices (PEDs) (phones, headphones, laptops, etc.) used by passengers during the evacuation?</i>
HF19.1	<i>If yes, did the use of PEDs impede the evacuation? If so, how did it impede?</i>
HF20	<i>Were any animals involved (service animals, emotional support animals, pets)?</i>
HF20.1	<i>If yes, did they impede the evacuation? If so, how?</i>
HF22	<i>Did passengers climb over seat backs?</i>
HF23	<i>Were there any footwear-related issues (shoes worn or not and type)?</i>
HF25	<i>How long had the passengers been on the airplane prior to the event occurring?</i>
HF26	<i>Did all passengers follow instructions prior to evacuation? If not, describe issue.</i>
HF27	<i>Did all passengers follow instructions during the evacuation? If not, describe issue.</i>
HF28	<i>Were there any other issues that impacted passenger evacuation? If yes, describe issue.</i>
PC1	<i>Was the evacuation Planned or Unplanned?</i>
PC2	<i>Who initiated the evacuation?</i>
PC3	<i>What is the operator's procedure for who initiates an emergency evacuation?</i>
PC5	<i>Was there crew to passenger communication pre-evacuation?</i>
PC6	<i>Was there any issue affecting crew to passenger communication during evacuation?</i>

PC6.1	<i>If yes, what was the issue affecting crew to passenger communication (e.g., interphone issues, language issues, hard to hear, etc.)?</i>
PC8	<i>Was there flight crew to passenger communication during evacuation?</i>
PC10	<i>Considering the severity of the situation, was there timely and effective communication between flight crew and cabin crew?</i>
PC10.1	<i>If no, was the communication, or lack of communication, between flight crew and cabin crew identified as a potential issue or concern?</i>
PC10.2	<i>Who initiated the communication between the flight crew and cabin crew?</i>
PC10.3	<i>What was the communication response time from the flight crew to cabin crew or vice versa?</i>
PC10.4	<i>Was there an unsuccessful attempt to communicate between flight crew and cabin crew?</i>
PC10.5	<i>If yes, why was the communication unsuccessful?</i>
PC12	<i>Aside from the egress assist means, was any other emergency equipment used (e.g., PBE, fire extinguishers, megaphone, flashlight)?</i>
PC13	<i>Was crew training identified as an issue (e.g., flight crew, cabin crew, joint crew training)?</i>
PC13.1	<i>If so, what was the identified concern with crew training?</i>
PC14	<i>Was a dedicated exit row passenger briefing provided?</i>
PC15	<i>Was assisted removal of a passenger(s) required for evacuation?</i>
PC15.1	<i>If so, why was assistance needed and who provided the assistance?</i>
PC16	<i>Was flight crew evacuation checklist completed up to evacuation command before evacuation was initiated?</i>
PC16.1	<i>If no, which steps were skipped?</i>
PC17	<i>What was the format of the pre-flight safety briefing (e.g., video, safety demo, verbal, etc.)?</i>
PC18	<i>Were there any comments reported on pre-flight safety briefing?</i>
PC18.1	<i>If yes, describe.</i>

PC19	<i>Did the crew take steps to manage the evacuees on the ground after evacuation?</i>
PC19.1	<i>If yes, did they follow standard procedures?</i>
ER1	<i>Was there an emergency response from ground personnel?</i>
ER1.1	<i>If so, was it by Aircraft Rescue Firefighters (ARFF) or other service (e.g., police, structure firefighters)?</i>
ER2	<i>Did the response make a difference to evacuation?</i>
ER2.1	<i>If yes, how did it make a difference? If no, why not?</i>
ER4	<i>What type of equipment was used?</i>
ER5	<i>Number of emergency personnel responding?</i>
ER6	<i>What level of emergency response was available at event site?</i>

Appendix 9

Events Involving Aircraft with Emergency Exits not Required to be Equipped with an Emergency Egress Assist Means

Of the airplane evacuation events entered into the Emergency Evacuation Standards ARC data matrix, 31% reported an evacuation event that included egress from an over-wing exit (48 events) or a non-over-wing exit (44 events) without assist means. There were 98 serious injuries and 5 fatalities. Of the 48 events that included egress from an over-wing exit without assist means, 14 events reported serious/fatal injuries that were a result of the evacuation. There were 48 serious injuries and no fatalities.

- **Event #37, September 1, 2018, UT Air 737-800, flight UT-579 from Moscow to Sochi (Russia):** 170 crew and passengers, 10 minor injuries, and 8 serious injuries. The injuries occurred during the evacuation.
- **Event #119, July 8, 2015, Hainan Airlines B737-800, flight HU-7244 from Hefei to Guangzhou (China):** 171 crew and passengers, 5 minor injuries, and 3 serious injuries. The 3 serious injuries involved fractured legs and a fractured elbow. Serious injuries were due to sliding off engine cowl (versus wing flap). There is visual evidence showing passengers sliding off the engine cowl.
- **Event #120, July 3, 2015, China Southern Airlines B737-800, flight CZ-3081 from Guangzhou (China) to Bangkok (Thailand):** 139 crew and passengers, 11 minor injuries, and 2 serious injuries. The 2 serious injuries were ankle fractures due to evacuation.
- **Event #123, June 8, 2015, Allegiant MD83, flight G4-864 from Saint Petersburg FL to Hagerstown MD:** 147 crew and passengers, 6 minor injuries, and 1 serious injury. The serious injury was a fractured wrist. It is unknown as to when the injury occurred.
- **Event #153, April 11, 2014, Kenya Airways ERJ-190, flight KQ-482 from Nairobi (Kenya) to Dar es Salaam (Tanzania):** 55 crew and passengers, 6 minor injuries, and 1 serious injury. The injuries occurred during the evacuation.
- **Event #188, October 14, 2012, Corendon Airlines B737-800, flight 7H-773 from Antalya (Turkey) to Trondheim (Norway):** 196 crew and passengers, 25 minor injuries, and 2 serious injuries. The 2 serious injuries were a fractured leg and a fractured arm. It is reported that the passengers jumped from the over-wing exit presumably from the wing to the ground. There is no supporting visual evidence. It is worth noting that this event occurred during aircraft push back. As a result, it is likely that the flaps were not yet set to the take-off position, which means that if passengers exited off the trailing edge, the height of the wing/flap trailing edge off the ground could have been higher than 6 feet.
- **Event #191, July 18, 2012, American Eagle CRJ-700, flight MQ-3773 from Denver CO to Chicago O'Hare IL:** 57 crew and passengers, unknown minor injuries, and 1

serious injury. The serious injury was a broken ankle during the evacuation through an over-wing exit.

- **Event #194, May 28, 2012, Varpatair SB20, flight V3-444 from Florence (Italy) to Timisoara (Romania):** 49 crew and passengers, 5 minor injuries, and 1 serious injury. The serious injury was a fractured lower limb. It was reported that several passengers fell down onto the apron and received injuries.
- **Event #212, July 30, 2011, Caribbean Airlines B737-800, flight BW-523 from Port of Spain (Trinidad and Tobago) to Georgetown (Guyana):** 163 crew and passengers, unknown minor injuries, and 1 serious injury. The serious injury was a broken leg during evacuation, which led to amputation.
- **Event #237, August 27, 2010, Jet Airways B737-800, flight 9W-2302 from Mumbai (India) to Chennai (India):** 153 crew and passengers, 21 minor injuries, and 4 serious injuries. Serious injuries were fractures from exiting an over-wing exit and jumping down to the ground.
- **Event #255, December 22, 2009, American Airlines B737-800, flight AA-331 from Miami FL to Kingston (Jamaica):** 154 passengers, unknown minor injuries, and 14 serious injuries. Some passengers may have been injured by falling overhead bins and passenger service units; however, it is unknown when all the injuries occurred.
- **Event #257, December 3, 2009, Batavia B737-400, flight 7P-701 from Surabaya (Indonesia) to Kupang (Indonesia):** 151 crew and passengers, 3 minor injuries, and 3 serious injuries. It is unknown when the injuries occurred; however, it was reported passengers panicked and forced opened a door and jumped off the plane.
- **Event #283, December 20, 2008, Continental B737-500, flight CO-1404 from Denver CO to Houston TX:** 115 crew and passengers, 41 minor injuries, and 6 serious injuries. It is unknown when all injuries occurred; however, it was reported most injuries were spinal injuries that occurred during landing.
- **Event #288, August 1, 2008, Flybe E195, flight BE-7016 from Manchester (England) to Belfast City (United Kingdom):** 95 crew and passengers, 4 minor injuries, and 1 serious injury. It is unknown when all injuries occurred; however, it was reported passengers found the evacuation slide very steep and lacking a round out delivering passengers onto the runway at a high speed. This and the attempts by passengers to slow their slide were the prime reason for injuries in the evacuation.

Of the 44 events that included egress from a non-over-wing exit without assist means, 3 events reported serious/fatal injuries that were a result of the evacuation. There were 3 serious injuries and no fatalities.

- **Event #197, March 29, 2012, Feeder F50, flight FDD-360 from Juba to Wau (South Sudan):** 55 crew and passengers, 4 minor injuries, and 1 serious injury. A flight attendant broke her leg during evacuation.

- **Event #252, February 11, 2010, Trigana AT42, flight TGN-168 from Berau to Samarinda (Indonesia):** 52 crew and passengers, no minor injuries, and 1 serious injury. It is unknown when the injury (a fracture) occurred.
- **Event #287, August 24, 2008, Air Dolomiti AT72, flight EN-3990 from Munich (Germany) to Bologna (Italy):** 63 crew and passengers, 1 minor injury and 1 serious injury. The serious injury was a broken forearm during evacuation.

Observations

1. The percentage of injuries from the 6-ft requirement for assist means for over-wing exits or non-over-wing exits is in general low.
2. The 92 of evacuation events that included egress from an over-wing exit or a non-over-wing exit without assist means included a total of 7746 crew and passengers. Of those, 98 (1.3%) sustained a serious injury and there were 5 (0.06%) fatalities. For the 48 events that involved an over-wing exit without assist means, there were 5627 crew and passengers with 90 (1.6%) serious injuries and 4 (0.07%) fatalities. For the 44 events that involved non-over-wing exits without assist means, there were 2119 crew and passengers with 8 (0.38%) serious injuries and 1 (.05%) fatality. It should be noted that none of the fatalities from the 92 events were evacuation related.
3. There were only three events identified on regional jet aircraft without slides where injuries did occur during evacuation out the aircraft door.
4. Of the 14 over-wing injury cases, only two could be related to the proper use of the over-wing exit. In event 119, evacuees went off the wing at the engine cowling and not the wing/flap trailing edge as intended. In event 188, assuming evacuees went down the trailing edge of the wing/flap as intended, the position of the flap was likely not in the take-off position providing the proper height for evacuation off the trailing edge.

Appendix 10

Aircraft Rescue and Firefighting (ARFF) Advisory Committee Activity

Aircraft Rescue Fire Fighting Working Group Response to the National Transportation Safety Board A-14-60 Recommendation by the Aircraft Rescue Fire Fighting Working Group A-14-60 Task Group FINAL REPORT from May 20, 2018.

Following the Asiana Airlines accident in San Francisco and in response to NTSB recommendation A-14-60, the Aircraft Rescue and Firefighters Working Group (ARFFWG) created a Task Group that conducted an applied research project to examine theories, knowledge, methods and techniques concerning the creation of a minimum staffing level as well as other issues regarding aircraft emergency evacuations.

The following information was gathered from the above-identified report:

4.5.2.1 Discussion of Aircraft Interior Access Vehicles

The Federal Aviation Administration (FAA) Aircraft Rescue & Fire Fighting (ARFF) Research Program conducted a study regarding the feasibility and demand of a new concept vehicle designated an Interior Access Vehicle (IAV) for rapid access to aircraft doorways for the ARFF industry. The primary function of this new concept, i.e., IAV, was to aid firefighters in making a safe and rapid entry into an aircraft fuselage, as well as assist in the egress of passengers, while adding a firefighting capability.

This study was conducted based upon an NTSB investigation into 46 emergency aircraft investigations that occurred between 1997 and 1999. Using the FAA's Civil Aerospace Medical Institute evacuation simulation programs, the ARFF Research Program studied how making closed exits available again by using an IAV could improve evacuation times, once emergency passenger evacuation had begun. Results showed that, during a total evacuation, an IAV could significantly impact evacuation times, especially in double aisle aircraft.

After those studies, NFPA 414, Standards for Aircraft Rescue and Firefighting Vehicle, developed a standard for an Interior Aircraft Access Vehicle (IAV) (NFPA 414-2017 (Chapter 5). The IAV reference also resides in FAA AC 150/5220-10E, "Guide Specifications for Aircraft Rescue and Firefighting (ARFF) Vehicles" Appendix A.4.

NFPA 414 Chapter Five: Interior Access Vehicle.

A.4. 1 ADDITION: Chapter 5. An Interior Access Vehicle (IAV) must meet at least the agent requirements of CFR Part 139.317(a)

A.4.2 AMENDMENT: 5.1.3

The vehicle must provide access to sill heights of between 7 feet (2.3 meters) and up to at least the lower sills of the largest aircraft operating at the airport. This sill height is sufficiently low enough to allow access to the lowest sill height aircraft currently in operation (e.g. DC9) that does not have its own integral stairs.

A.4.3 ADDITION: 5.4

While on a 15 degree tilt the platform and stairs must be able to be leveled as a unit to within 5 degrees of horizontal for operational use.

A.4.4 AMENDMENT: 5.4.2

The vehicle must pass a 15-degree tilt test with stairs fully extended without stabilizing equipment. However, the platform is not required to be fully loaded to the design weight capacity. Side wheel chocks may be used to prevent the vehicle from sliding on the table surface, but their height is not to exceed 5% of the tire diameter.

NOTE: The FAA will allow side wheel chocks to prevent an IAV from sliding on a tilt table surface with a low coefficient of friction. The FAA has accomplished some IAV testing using a tilt table which allows chocking not to exceed 5% of the vehicle's tire diameter.

The ARC includes the information on IAVs to show the value of having air stairs available for ARFF is not a new concept. The FAA recognizes the benefit of IAVs (mobile air stairs) both for gaining access to aircraft and assisting passengers in evacuation. NFPA 414 Addition A.4-1 (see paragraph above) requires an IAV carry at least the agent quantities described in 14 CFR §139.317a. Typically, this is 500 lbs. of dry chemical. By adding this requirement, presumably the vehicle could “count as” a portion of the required ARFF response. For airports, the most difficult hurdle in adding an IAV to the response fleet is the staffing required to drive another vehicle.

The FAA sought development of “a Notice of Proposed Rulemaking (NPRM) to implement any modifications, deletions, or additions identified in the review of 14 13 CFR Part 139, Subpart D.” In response to this tasking, the ARAC created the Aircraft Rescue and Firefighters Working Group (ARFFRWG). The ARFFRWG submitted its report to the FAA in 2004. The report contained the following paragraph:

“The ARFFRWG considers the current regulation concerning ARFF personnel inadequate, although there is debate among the members as to what should be required. There was general consensus among the group that interior aircraft fire fighting and rescue should be a mandatory role for ARFF personnel. The current regulatory role for ARFF personnel to merely provide an exit path for self-evacuating aircraft occupants is not acceptable to the ARFFRWG. The number of occupants and available fuel load in a commercial aircraft far exceeds that which is present in most ground vehicle accidents and structure fires. However, the current Part 139 requires significantly less personnel to respond to a commercial aircraft accident/incident than a municipal fire and rescue department would dispatch to a vehicle accident or structure fire. The current FAR Part 139 can be interpreted to require only one person per required ARFF vehicle. Under this interpretation, an Index C airport with two ARFF vehicles meeting the index requirement is only required to have two persons available during periods of air carrier operations.”

As part of its findings and recommendation, the ARFFRWG produced a chart containing the recommended number of ARFF personnel at an airport based on its 14 CFR Part 139.315 Index.

Following the Asiana Airlines accident in San Francisco and in response to NTSB recommendation A-14-60, the ARFFWG created a Task Group that conducted an applied research project to examine theories, knowledge, methods and techniques concerning the creation of a minimum staffing level. The project consisted of a comprehensive literature review of all relevant documents and publications, as well as a research exercise which was conducted at Atlantic City International Airport (ACY). The purpose of these timed trials was to collect data sets measuring time requirements for the individual steps necessary to: 1. Gain rapid access into the airplane 2. Perform interior firefighting 3. Perform rescue of passengers and crewmembers. Their report, submitted to the FAA, documents the findings derived from the literature review and provides the description of all timed trials and the results of those trials. The final portion of this paper addresses critical factors that must be considered in the determination of the minimum firefighting staff required in any given scenario, as well as the conclusions and recommendations derived from this research project by the Task Group.

Both reports have been submitted to the FAA and as of the time this recommendation was written, there have been no regulatory actions implemented to address minimum manning standards as brought forth in the above reports and their recommendations. There continue to be FAA-certificated airport ARFF services operating with just one firefighter per truck.

Topics identified in reports submitted to FAA from the 2018 ARFFWG and the 2004 ARFFRWG:

Aircraft Rescue Fire Fighting Working Group Response to the National Transportation Safety Board A-14-60 Recommendation, May 20, 2018

- ***EXECUTIVE SUMMARY***

- This paper explored the third of four recommendations directed to the Aircraft Rescue Fire Fighting Working Group (ARFFWG) as part of the National Transportation Safety Board's (NTSB) letter, dated July 16, 2014 [1]. The letter contained specific recommendations from the accident involving a Boeing 777-200ER, Korean registration HL7742, operating as Asiana Airlines flight 214, that occurred on July 6, 2013, at San Francisco International Airport, San Francisco, California. The third recommendation (A14-60) from the NTSB was aimed at the development of "a minimum aircraft rescue and firefighting staffing level that would allow exterior firefighting and rapid entry into an airplane to perform interior firefighting and rescue of passengers and crewmembers"*

- *The following list and table summarize the primary responses of the Task Group relative to A-14-60.*

- *For Index A airports, increase the agent quantities and number of ARFF vehicles to align with Category 5 (NFPA and ICAO). That would require a minimum of two vehicles and 2,760 gallons of water for foam production, i.e., an increase of 1,420 gallons of water. This would improve the airports' ability to perform exterior firefighting by providing the opportunity to re-service a vehicle with agent if a vehicle runs out of agent before an event is terminated, while at least one vehicle remains staffed to continue exterior firefighting. This*

would also provide water for interior firefighting and a minimum of two firefighters to attack an interior fire and make rescue.

- For all Index B, C, D and E airports, require an interior access vehicle, staffed by a minimum of one firefighter, that has sufficient reach to gain rapid entry to all aircraft with scheduled service at the airports.
- For Index B airports, in addition to dedicated drivers / operators for each ARFF vehicle, and an interior access vehicle staffed with a minimum of one firefighter, require additional staffing of two to perform initial search and rescue, and two to perform interior firefighting.
- For Index C airports, in addition to dedicated drivers / operators for each ARFF vehicle, and an interior access vehicle staffed with a minimum of one firefighter, require additional staffing of two to perform initial search and rescue, and two to perform interior firefighting.
- For Index D airports, in addition to dedicated drivers / operators for each ARFF vehicle, and an interior access vehicle staffed with a minimum of one firefighter, require additional staffing of four to perform initial search and rescue, and four to perform interior firefighting (two per aircraft aisle per task).
- For Index E airports, in addition to dedicated drivers / operators for each ARFF vehicle, and an interior access vehicle staffed with a minimum of one firefighter, require additional staffing of four to perform initial search and rescue, and four to perform interior firefighting (two per aircraft aisle per task).
- Create Index F for all airports operating multi-deck passenger aircraft or aircraft exceeding 250 feet in length to carry sufficient quantities of water. In addition to dedicated drivers / operators for each ARFF vehicle, and an interior access vehicle staffed with a minimum of one firefighter, require additional staffing of four to perform initial search and rescue, and four to perform interior firefighting (two per aircraft aisle per task).

2004 ARFFRWG Study/Report

- The FAA established the Aviation Rulemaking Advisory Committee (ARAC) to provide advice and recommendations to the FAA Administrator on the its rulemaking activities with respect to aviation-related issues. On March 22, 2001, the FAA announced the assignment of a new task to ARAC. Specifically, the FAA sought development of “a Notice of Proposed Rulemaking (NPRM) to implement any modifications, deletions, or additions identified in the review of 14 13 CFR Part 139, Subpart D.” In response to this tasking, ARAC created the ARFFRWG.
- The ARAC tasked the ARFFRWG as follows:
 1. Review the existing aircraft rescue and firefighting (ARFF) requirements contained in 14 CFR Part 139, Subpart D and identify ARFF requirements that should be added, modified, or deleted. This review should include the current rule and any other documents the agency may have issued regarding Part 139, Subpart D, and any ARFF standards issued by other organizations.

2. Develop an NPRM to incorporate the modifications, deletions, and additions identified in the preceding reviews. The NPRM should include the preamble and rule language along with any supporting legal analysis.

3. ARAC may be asked to recommend the disposition of any substantive comments the agency received in response to the NPRM.

- As part of this project, ARAC specifically asked the ARFFRWG to address the following ARFF issues:
 - a. The number of trucks and amount of agent;
 - b. Vehicle response times;
 - c. Personnel requirement; and
 - d. Airport ARFF Index
- *Sec. 139.303(a) ARFF Personnel*

The ARFFRWG considers the current regulation concerning ARFF personnel inadequate, although there is debate among the members as to what should be required. There was general consensus among the group that interior aircraft fire fighting and rescue should be a mandatory role for ARFF personnel. The current regulatory role for ARFF personnel to merely provide an exit path for self-evacuating aircraft occupants is not acceptable to the ARFFRWG. The number of occupants and available fuel load in a commercial aircraft far exceeds that which is present in most ground vehicle accidents and structure fires. However, the current Part 139 requires significantly less personnel to respond to a commercial aircraft accident/incident than a municipal fire and rescue department would dispatch to a vehicle accident or structure fire. The current FAR Part 139 can be interpreted to require only one person per required ARFF vehicle. Under this interpretation, an Index C airport with two ARFF vehicles meeting the index requirement is only required to have two persons available during periods of air carrier operations.
- *The Proposed Amendments*

OPTION 1 – MINIMUM ARFF STAFFING & STAFFING TASK ANALYSIS

(a) ARFF personnel shall be readily available during air carrier operations to staff required ARFF and other emergency vehicles and to perform ARFF operations. The minimum number of trained ARFF personnel capable of arriving at the furthest end of the farthest runway within the 34 times specified in 139.319(h)(2) shall not be less than that outlined in Table 1.

Table 1, Minimum ARFF Personnel per ARFF Category

<i>Airport Category</i>	<i>ARFF Personnel</i>
<i>1</i>	<i>*</i>
<i>2</i>	<i>*</i>
<i>3</i>	<i>*</i>
<i>4</i>	<i>3</i>
<i>5</i>	<i>6</i>
<i>6</i>	<i>9</i>
<i>7</i>	<i>12</i>
<i>8</i>	<i>12</i>
<i>9</i>	<i>12</i>
<i>10</i>	<i>15</i>

Note: Categories 1-3 fall outside the applicability of this Part.

(b) Additionally, a staffing task analysis shall be performed by experienced ARFF personnel and the certificate holder, to determine additional staffing requirements. The staffing task analysis shall evaluate ARFF response to a worst case, aircraft/incident accident scenario at the certificated airport. The analysis shall be supported by a risk assessment which examines the risks to aircraft occupants.

OPTION 2 – STAFFING TASK ANALYSIS

(a) ARFF personnel shall be readily available during air carrier operations to staff required ARFF and other emergency vehicles and to perform ARFF operations.

(b) A staffing task analysis shall be performed by experienced ARFF personnel and the certificate holder to determine staffing requirements. The staffing task analysis shall evaluate ARFF response to a worst case, aircraft accident/incident scenario at the certificated airport. The analysis shall be supported by a risk assessment which examines the risks to aircraft occupants.

The NTSB issued Safety Recommendation A-01-65 which asked the FAA to review the existing ARFF requirements contained in 14 CFR Part 139, subpart D and identify ARFF requirements that should be added, modified, or deleted. As part of its response, the FAA asked ARAC to address Airport ARFF Index.

Over the course of 24 months, the ARFFRWG met twelve times to research the issue and develop recommendations for the ARAC. The Working Group began by establishing terms of reference to guide their internal deliberations, determining they would generate recommendations in the following manner:

1. Proposed changes to Part 139, Subpart D.
2. Proposed changes to other FAR Parts as appropriate.
3. Proposed new FAA Advisory Circulars and Orders, or changes to existing ACs and Orders, as necessary to support revised procedures or requirements not deemed appropriate for inclusion in Part 139, Subpart D.

The Working Group developed both a majority and minority position on each issue where it found itself irreconcilably divided. Some individual Working Group members also provided comments on issues when their respective organizations differed from the position taken by the ARAC Working Group. For the issues that the Group was unable to reach full consensus, the members agreed to submit the majority opinion and their recommended language for use in the document. The member(s) with an opposing opinion, the minority, submitted their position and justification to accompany the majority opinion in the document.

The document submitted by this ARAC group proposed to revise the current airport certification regulation with respect to aircraft rescue and firefighting (ARFF) requirements for airports serving scheduled air carrier operations in aircraft designed for more than 9 seats, addressing four primary issues: (1) the amount of aircraft rescue and firefighting equipment and agent that should be required at certificated U.S. airports; (2) airport ARFF index determination; (3) personnel requirements, and (4) the time and location on the airport that should be prescribed for ARFF response, both for airport certification and annual evaluation purposes. A section of an air carrier operation regulation, as well as a section of a transport category aircraft certification regulation, also would need to be amended to conform with proposed changes to airport certification requirements documented in the recommendation report.

Appendix 11

Emergency Evacuation Standards (EES) Aviation Rulemaking Committee (ARC) Members

Regulatory Representatives

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FAA- Civil Aerospace Medical Institute (CAMI)
European Aviation Safety Agency (EASA)
Agência Nacional de Aviação Civil (ANAC)
National Transportation Safety Board (NTSB)
Boeing
Airbus
Embraer
Safran/Air Cruisers
Safran/Zodiac
Collins/Goodrich
Collins/BE Aerospace
Flyers Rights
Airline Pilots Association (ALPA)
Association of Flight Attendants (AFA)
Regional Airline Association (RAA)
Airlines for America (A4A)
Simulation – Alpine Metal Tech
National Air Carrier Association (NACA)
University of Greenwich, UK