Runway Safety Alerting Subgroup

Investigative Technologies Aviation Rulemaking Committee

Recommendation Report

[August 8, 2024]

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I. Executive Summary

The Runway Safety Alerting Subgroup of the Investigative Technologies Aviation Rulemaking Committee (ARC) provides the following recommendations:

Certified Existing Avionics

Certified Existing Avionics for Newly Manufactured Aircraft

- The FAA should require runway safety capabilities for newly manufactured large airplanes in Part 121 air carrier operations after date TBD. The capabilities should include those technologies that provide runway and airport situational awareness information to crews that notify or alert the flight crew when the aircraft is aligned to a surface that is not a runway, when it is aligned with the incorrect surface, or when the runway is too short. These capabilities would not necessarily need to meet the definition of alerts contained in 14 CFR 25.1322.

Certified Existing Avionics for Existing Aircraft

- The FAA should work with industry to determine a minimum capability for runway and airport situational awareness information to crews that notify or alert the flight crew when the aircraft is aligned to a surface that is not a runway, when it is aligned with the incorrect surface, or when the runway is too short that would fulfill the intent of regulation for aircraft retrofits. Operators should make every effort to install this technology on existing fleets that are capable. While recognizing that the National Transportation Safety Board (NTSB)[1] and certain members of the subgroup support a mandate, the members of the subgroup were unable to reach a consensus on a retrofit mandate for the existing fleet of aircraft operating in the US (parts 121 & 129).

Future Certified Avionics Capabilities

Certification of Collision Alerting Capabilities

- The FAA should pursue the necessary resources to expedite the certification of collision alerting capabilities, including associated regulatory guidance.

FAA Action to Foster Adoption of Collision Alerting Capabilities

- Once the standards (e.g., RTCA MOPS, FAA TSO) and regulatory guidance (e.g., Advisory Circulars) have been developed for the certification of ADS-B-based collision alerting capability (e.g., SURF-A/IA), the FAA should:
  - Require ADS-B-based collision alerting capabilities for newly manufactured aircraft after date TBD;
  - Install supporting ground infrastructure, where appropriate and as necessary, to provide the position accuracy required to provide ADS-B-based collision alerting capability via both 1090ES and Universal Access Transceiver (UAT) broadcasts; and

[1] NTSB recommendations A-18-025, A-18-026

- Provide a means for Part 121 air carriers and other appropriate operators of existing aircraft to obtain operational approval of the use of such capability.
- The FAA should encourage Part 121 air carriers and other appropriate operators to purchase collision alerting capabilities for existing aircraft.

Portable Electronic Flight Bags

FAA Continue Permitting Use of EFBs

- The FAA should continue allowing the use of portable Electronic Flight Bags (EFBs) by Part 121 air carriers and other appropriate operators, for runway situational awareness applications.

Airports

FAA Engagement With Airport Operators to Promote Innovative Technologies

- The FAA should engage with airports as it works with both internal and external stakeholders to mitigate runway incursion and excursion risks with innovative technologies. These technologies include ADS-B equipage for airside ground vehicles; sensing and alerting technologies that are integrated into air traffic operations; new and enhanced surface surveillance capabilities; and changes to physical airfield infrastructure, including runways, taxiways, and associated lighting and marking systems.

Expansion of Ground Vehicle ADS-B Transponder Equipage

- The FAA should work with stakeholders, including airport operators, aircraft operators, and ground service entities to expand the ADS-B transponder[2] equipage by ground vehicles that are authorized to operate in the movement area. This is an important part of overall runway surface safety initiatives. Methods could include policies, or other appropriate mechanisms (e.g. educational materials, Advisory Circulars, etc.) and expanded federal assistance for these safety items.

FAA Surface Safety Initiatives

Deployment of Approach Runway Verification

- The FAA should expeditiously deploy the Approach Runway Verification (ARV) capability at all appropriate facilities.

Deployment of Surface Awareness Initiative

- The FAA should deploy Surface Awareness Initiative (SAI) expeditiously at all 230 potential sites. Deployments should be based on a prioritization using a Safety Risk

[2] 150/5220-26 (Consolidated to include Changes 1-3)

Assessment to address the highest potential for runway safety events. SAI also serves as an important baseline to expand on this foundational capability to enhance safety.

Expansion of Runway Status Lights

- The FAA should develop a modernized, more cost-effective method to provide Runway Status Lights (RWSL) at additional airports and enhancements at existing locations.

FAA Councils/Committees and Coordination Efforts

- The FAA should identify one office/organization to coordinate the various agency councils/committees and associated efforts.

International Harmonization of Collision Avoidance Technologies

- The FAA should work with International Civil Aviation Organization (ICAO) and international regulatory authorities to harmonize the airborne and ground-based collision avoidance technologies.

II. Chairs' Comments

The subgroup[3] began meeting in January 2024 with the goal of developing recommendations by June 2024. Due to this constrained time frame, the subgroup has concentrated on issues related to air carrier operations and larger aircraft as well as airports served by certificated scheduled air carriers. While some of the recommendations may be applicable to other airports and flight operations, the FAA should consider establishing another group to cover these operators and airports. Specifically, a group targeting general aviation may be appropriate.

III. Current Regulatory Landscape

The FAA has various means to address the use of runway safety capabilities. For example, avionics follow an FAA Technical Standards Order (TSO)[4] and type certification to support meeting the regulatory certification requirements of parts 21, 23, and 25. [5] The air carrier and commercial operator regulatory requirements of parts 91K, 121, 129, and 135[6] have relevant requirements for the operational use of avionics by pilots as well as requirements for operating safely. In addition, while not a standard for certification, Advisory Circulars are also an important resource that FAA uses to guide industry use of runway safety capabilities such as EFBs.

[3] See Appendix for a listing of subgroup members.
[4] 14 C.F.R. Part 21 ("FAA Technical Standards Order").
[5] *Id*.; 14 C.F.R. Part 23 ("Airworthiness Standards: Normal Category Airplanes"); 14 C.F.R. Part 25 ("Airworthiness Standards: Transport Category Airplanes").
[6] 14 C.F.R. Parts 91K, 121, 129, 135 (concerning air carrier and operator certification).

For airports, the FAA has established a regulatory framework for safety under Part 139[7] for certificated airports, including those that serve scheduled air carrier operations. In addition, there are a number of Advisory Circulars that instruct airport operators on means to address runway safety.

IV. Industry & Government Overview

A. Background on Surface Safety

A diverse array of stakeholders, both public and private, have taken action on surface safety and are continuing their efforts. This includes the FAA, international safety and regulatory authorities, NTSB, airports, Congress, original equipment manufacturers (OEMs), avionics suppliers, air carriers, and general aviation operators.

The NTSB has issued numerous safety recommendations to the FAA to prevent runway incursions and other airport surface incidents. It currently has a series of open safety recommendations issued to the FAA, covering the following:

- Require airplanes landing at primary airports within Class B and Class C airspace to be equipped with a system that alerts pilots when an airplane is not aligned with a runway surface (A-18-25).
- Work with aircraft and avionics manufacturers to develop the technology for a cockpit system that alerts pilots when an airplane is not aligned with the intended runway surface and require the system on airplanes landing at certain airports (A-18-26).
- Research how to make a closed runway more conspicuous to pilots when at least one parallel runway is in use, and how to more effectively signal a runway closure to pilots during ground and flight operations at night (A-18-28).
- Collaborate with aircraft and avionics manufacturers and software designers to develop the technology for a flight deck system that would provide visual and aural alerts to flight crews of traffic on a runway or taxiway and traffic on approach to land. (A-24-4; Open—Unacceptable Response)
- Require that the technology developed in response to Safety Recommendation A-24-4 be installed in all newly certificated transport-category airplanes. (A-24-5; Open—Unacceptable Response)
- Require that existing transport-category airplanes be retrofitted with the technology developed in response to Safety Recommendation A-24-4. (A-24-6; Open—Unacceptable Response)

[7] 14 C.F.R. Part 139 ("Certification of Airports").

A recently closed recommendation (A-18-27) to the FAA dealt with modification of airport surface detection equipment systems to detect potential taxiway landings and alert air traffic controllers about potential collision risks.

International authorities including the European Aviation Safety Authority (EASA) and ICAO have taken multiple surface safety actions as part of an increased emphasis on airport surface safety. The Flight Safety Foundation has launched the Global Action Plan for Prevention of Runway Incursions (GAPPRI), which brings together states and regulators, aircraft manufacturers and operators, pilots, air navigation service providers (ANSPs), airport operators, and R&D to develop synchronized, consensus-based recommendations. Many of the GAPPRI recommendations are consistent with the areas being addressed by this subgroup report.

At a number of airports and air traffic control facilities, a range of incursion prevention technologies such as runway entrance and takeoff hold lights, "stop bars," guard lights, and enhanced markings are in place. The FAA has installed systems at 44 airports[8] that enhance situational awareness for controllers, including technologies providing surveillance of aircraft and ground vehicles on the airport surface movement area and approach and departure routes; display the position, movement, and relative location of these vehicles; and provide alerts of potential runway collision situations.

The FAA is also developing capabilities for alerting when an aircraft on approach is misaligned, either to the runway itself or to a taxiway instead of the assigned runway. The FAA's Runway Incursion Mitigation (RIM) Program regularly conducts a data-driven nationwide assessment of airports with the greatest risk for runway incursions, triggering a joint FAA/industry effort to mitigate incursion risks for listed airports, with a focus on capital improvements to the airport itself. Airport operators and other stakeholders also participate in local runway safety action teams (RSATs) which discuss surface movement issues and concerns at FAA and federal contract towered airports and formulate a Runway Safety Action Plan (RSAP) to address these concerns.

Congress has conducted hearings, passed legislation, and provided funding and support for efforts to prevent runway incursions and other airport surface incidents – and continues to do so.

Current and near future avionics technologies addressing runway safety generally fall into the following areas: takeoff, approach and landing, and collisions on runways. Incidents tend to stem from factors including use of erroneous parameters for takeoff computation, erroneous flight management system data input, incorrectly configured aircraft, and/or incorrectly positioned aircraft. Some avionics manufacturers have developed related technologies, which can be both retrofitted on a number of existing aircraft and added to newly manufactured

[8] ASDE-X and ASSC information available at: https://www.faa.gov/newsroom/runway-safety-fact-sheet#:~:text=The%20Surface%20Safety%20Risk%20Index%20is%20the%20methodology%20developed%20by,damage%2C%20injuries%2C%20and%20fatalities.

aircraft. These technologies use aural and visual display alerts to provide pilots with added situational awareness that can lead a pilot to take appropriate action during takeoff as well as approach and landing. Another avionics technology currently in use predicts and provides warnings regarding potential runway overruns. A technology expected to debut in the near future will make use of Automatic Dependent Surveillance-Broadcast (ADS-B)[9] surveillance to provide visual and aural alerts to reduce the risk of runway traffic collisions.

Air carriers have implemented training provisions that seek to prevent surface safety incidents and invested in flight deck capabilities for pilots. Some operators, including general aviation operators, also make use of applications available on tablet computers or other portable electronic devices which help avoid incidents by improving pilot situational awareness. Air carriers and general aviation aircraft operators have deployed a variety of equipment with different associated capabilities. Thus, there is not a defined baseline of aircraft-based technologies for surface safety.

B. FAA Surface Safety Initiatives

A top priority for FAA is to reduce runway safety risk by employing surface safety tools, programs, and best practices. Highlights include the following:

Safety Data—Metrics and Risk Identification

- *Surface Safety Metric (SSM) and Surface Safety Risk Index:* Helps identify the greatest risks in the runway environment and assesses the severity of these risks.
- *Risk-Based Safety Management (RBSM):* Proactively identifies and addresses potential risks to prevent escalation of hazardous situations.
- *Aviation Risk Identification Assessment (ARIA):* Automated tool using surveillance data at surface surveillance equipped airports to identify and categorize potential risk of collision based on vertical, lateral, and speed components to support better decisions about safety.

Operationally Focused Activities Addressing Current Issues at Airports

- *Runway Safety Council (RSC):* Brings together the FAA and certain aviation industry segments to improve runway safety using risk-based, data-driven, integrated system solutions.
- *Runway Safety Action Teams (RSAT):* Brings local airport stakeholders together at least annually to identify surface safety concerns and develop plans to mitigate or eliminate risk. (Special Focus RSAT meetings are held at high-risk airports.)
- *Runway Safety Action Plan (RSAP)*: Outlines RSAT meeting discussions and agreed upon Action Items among stakeholders intended to address and track local surface safety concerns.

[9] *Automatic Dependent Surveillance–Broadcast (ADS-B)* provides real-time aircraft position data.

- *Surface Safety Events and Symposiums:* Focuses on general and commercial aviation as well as vehicle operations, emphasizing operator awareness and education to reduce the risk of surface events.

Multimedia and Charting for Airport Users

- *Pilot Outreach:* Active promotion of pilot safety products, including over 125 safety videos and a Runway Safety Pilot Simulator library offering interactive practice scenarios for pilots and Pilot Handbooks encompassing valuable preflight planning resources for pilots at over 40 airports.
- *Arrival Alert Notices (AANs):* Provides photo-based approaches to over 40 airports with a history of misalignment risk, as well as providing language describing the misalignment risk.
- *Automated Closure/Restriction Notice Diagrams:* Offer users at almost 200 towered facilities a visual depiction of runway & taxiway closures as well as operational restrictions lasting over 24 hours at airports using the NOTAM Manager system.
- *Hot Spot Standardization:* Aims to reduce the potential for runway confusion by standardizing hot spot symbology and associated verbiage.

Runway safety technologies[10] and progressions include:

- *Runway Status Light (RWSL)* systems (at 20 airports with ASDE-X) increase situational awareness for aircrews and airport vehicle drivers by adding traffic information from surface and approach surveillance systems and illuminating red in-pavement airport lights to signal a potentially unsafe situation.
- *Airport Surface Detection Equipment Model X (ASDE-X)* (at 35 airports) provides a surveillance system allowing air traffic controllers to track surface movement on runways and taxiways to help reduce critical Category A and B runway incursions while also alerting controllers of potential runway conflicts.
- *Airport Surface Surveillance Capability (ASSC)* (at 9 airports) allows controllers to see aircraft and ground vehicles on the airport surface and on approach and departure paths within a few miles of the airport to help prevent runway collisions and reduce surface delays in all weather.
- A*SDE-X Taxiway Arrival Prediction (ATAP)* system (at 43 airports) integrates data from diverse sources, providing air traffic controllers with an alert when an aircraft is lining up to land on a taxiway by mistake.
- *Runway Incursion Mitigation (RIM)* program identifies and addresses nonstandard geometry factors at runway/taxiway intersections that have experienced a high number of runway incursions.

[10] See https://www.faa.gov/surface-safety-portfolio for more information about FAA runway safety technology initiatives.

- *Runway Safety Action Team (RSAT) Web Tool* uses a photo-based map to record historic, site-specific surface events on airports to quickly identify airfield risk locations for improved awareness and to promote effective risk reductions.

Future technologies in development include the following:

- *Approach Runway Verification (ARV)*[11] provides ATC both visual and audible alerts if an aircraft on arrival is lined up with the wrong runway, a closed runway, a taxiway, or even the wrong airport. Each airport environment can be uniquely adapted such that these alerts trigger based on the uniqueness of their surface configuration and airport arrival routes.
- The *Surface Awareness Initiative (SAI)* was created to equip airports lacking surface surveillance capabilities with innovative and cost-effective technological solutions using ADS-B, thereby expanding the ATC's situational awareness. The SAI will integrate ADS-B technology, displaying aircraft and vehicles with this capability on an airport surface map which may include runways, taxiways, hold ramps, and other movement areas, ensuring that the airport surface is visible to controllers regardless of weather conditions. FAA is planning installation at four sites (Austin, TX (AUS); Dallas, TX Love Field (DAL); Indianapolis, IN (IND); and Nashville, TN (BNA)) in June 2024.
- The Runway Incursion Device (RID) is a capability used by Air Traffic Control to provide additional situational awareness of occupied and closed runways. The RID provides an audible and visual alert to controllers when a runway is not available for departing or landing aircraft. RID devices will be installed at five airports for an operational evaluation by November 2024, with deployments to 74 airports beginning in 2025.
- The *Runway Incursion Reduction (RIR) Program* conducts research on hazard-detection technologies to enhance runway safety, focusing on alerts for corrective actions. The *Runway Incursion Prevention through Situational Awareness (RIPSA)* project, within this program, tests affordable technologies at smaller airports without advanced ground surveillance systems, emphasizing surface surveillance and operator annunciation concepts.

C. Aircraft-Based Technologies

Some aircraft and avionics technologies are currently available; others are in various stages of development. The following provides an overview and introduction for those covering aircraft-related capabilities.

Airport Situational Awareness

[11] See https://www.faa.gov/newsroom/faa-rolls-out-new-technology-controllers-improve-surface-safety-nations-airports for more information about the FAA's use of ARV.

- Provides general crew situational awareness by indicating the aircraft's current position on an electronic airport map. Can be integrated into the flight deck avionics or be implemented on an Electronic Flight Bag.

Runway Alignment & Incursion Alerting

- Provides a crew awareness when the taxiing aircraft approaches runway on the ground or on final approach, e.g.:
    - "Approaching 34L."
- Provides a crew awareness when the aircraft lines up with a runway on the ground, e.g.:
    - "On Runway 34L."

Runway Excursion

- Runway Overrun Awareness and Alerting System (ROAAS) provides crew awareness when the system predicts the aircraft cannot stop on the runway, e.g.:
    - "Go Around" in air.
    - "Max Brakes – Max Reverse" on ground.
    - EASA Part-26 at 26.205 currently mandates ROAAS for new large airplanes used in commercial air transport entering into service after January 1, 2025. It should be noted that EASA has proposed extending the mandate compliance date by 18 months to July 1, 2026, to provide sufficient time to develop and update aircraft and obtain certification to meet the new mandate.
- Provides flight crew awareness when the aircraft begins a takeoff with insufficient runway remaining (including a takeoff from a short runway and intersection takeoff on a long runway) or approaching to a runway with insufficient length, e.g.:
    - "Caution Short Runway," "Runway Too Short."
- Provides flight crew awareness by providing the distance remaining on the runway during landing roll or rejected takeoff, e.g.:
    - "3000 Remaining", "2000."
- Provides crew awareness when the aircraft hasn't touched down within the touchdown zone, e.g.:
    - "Long Landing."

Wrong Surface

- Provides crew awareness when the aircraft begins a takeoff on a surface other than a runway, e.g.:
    - "Caution On Taxiway."
- Provides crew awareness when the aircraft lines up on a surface other than a runway on short final, e.g.:
    - "Caution Taxiway," "Not A Runway."
- Provides crew awareness if an aircraft is not lined up on the programmed takeoff runway, e.g.:

- "Runway Disagree."

Future Technologies

Runway Incursion Alerting

- SURF-A/SURF-IA provides a crew awareness when the system predicts a conflict with other traffic on a runway during takeoff and landing, e.g.:
  - "Traffic On Runway," "Traffic On Final."

Electronic Flight Bag (EFB) Capabilities

Portable EFB provides a unique platform that contributes to runway safety by providing important information to pilots. EFBs are typically not integrated with aircraft systems, but host databases and applications that are valuable for runway safety. The use of EFBs is authorized via air carrier operational approval rather than through airworthiness certification.

V. ARC Charter – Tasks and Objectives

The FAA created the Investigative Technologies Aviation Rulemaking Committee on June 7, 2023. On September 21, 2023, it added the following task:

Provide recommendations on how to require cockpit (flight deck) alerting technologies designed to reduce runway safety events.

These technologies alert the flight crew to take corrective actions:
- When the aircraft is aligned to a surface that is not a runway.
- When the aircraft is aligned with the incorrect runway.
- When a runway is too short.

Subsequent communication between the ARC leadership and the FAA clarified the tasking, providing important parameters for the work of the subgroup.

Provide recommendations on technologies designed to reduce runway safety events. These technologies **may include alerting the flight crew** to take corrective actions:

i. when the aircraft is aligned to a surface that is not a runway,
ii. when the aircraft is aligned with the incorrect surface, or
iii. when a runway is too short.

As the subgroup began its work, it also became apparent that it needed to include the alerting for a potential collision with another aircraft (or ADS-B equipped ground vehicle) on the airport runway. Therefore, it has included conflict alerting in the recommendations. Likewise, the subgroup identified ADS-B equipage for ground vehicles as an important issue to support expanding use of aircraft based and FAA ATC equipment that is reliant on ADS-B surveillance.

VI. ARC Activities and Outputs

A. Runway Safety Alerting Subgroup

Initial work included identifying various Subject Matter Expert (SME) representatives to provide level setting and informational briefings to the subgroup. These SMEs included representatives from aircraft and avionics manufacturers, airports, FAA offices engaged in airport safety, the National Transportation Safety Board (NTSB), air carriers, Airline Pilots Association, Allied Pilots Association, and the Flight Safety Foundation.

To address the tasking, the subgroup identified a list of areas to develop recommendations for action. This included a discussion of how the capabilities being recommended correlate to address recent events and address those contained in the tasking. The subgroup used an "Evaluation Checklist" that guided discussions. Because of the various types of issues examined, the relevance of each criterion varied depending on the topic area. The criteria used were:

- Capabilities – availability, timing – forward fit/retrofit, limitations and associated issues/requirements, future and associated issues.
- Assessment of effectiveness – against the tasking using a "good/better/best" solution evaluation.
    - Technologies (capabilities) may include alerting the flight crew to take corrective actions:
        - When the aircraft is aligned to a surface that is not a runway.
        - When the aircraft is aligned with the incorrect surface.
        - When a runway is too short.
        - For conflict alerting purposes.
- Vulnerabilities of each technology/capability.
- Human factors considerations.
- Identifying gaps – how do recommendations address events?
- Operations outside of the United States.
- Define follow-on efforts.
- Roles and responsibilities of FAA, industry, airport and aircraft operators, standards organizations, etc.

The subgroup determined that following the clarification to the tasking made via the parent Investigative Technologies ARC, the recommendations would go beyond flight deck-based technology. However, the subgroup did not attempt to provide a comprehensive evaluation of all airport surface initiatives.

The subgroup identified human factors as a critical consideration when developing and implementing a runway awareness and collision avoidance alerting function and determining how it relates to other safety systems on the aircraft (e.g. TAWS, TCAS). Experience from operators and pilots indicates that certain human factors issues must be considered, including relevancy of information and the potential for redundant information or for correct interpretation of aural alerts or information in the flight deck at critical times to avoid nuisance

information and alerts. OEMs and avionics manufacturers apply human factors principles when developing a baseline feature set during certification. In addition, operators should have the ability to configure alerting to better support their particular operating environment and aircraft.

As the industry has implemented awareness and alerting technologies, there is a clear need to address issues such as volume control and timing of alerts, along with the appropriateness of "wording" (ICAO vs US phraseology) and application in the operating environment. Verification, salience, automation, missed or false alerts, and suppression of alerts are all issues that must be considered. Likewise, the industry must support flight deck technologies with training, crew procedures, operating manuals, etc.

Thus, human factors are a foundational consideration as the FAA and industry move forward with airport safety alerting capabilities.

VII. ARC Recommendations – Intent, Rationale, and Approach

RS1 – *Certified Existing Avionics (Part 25, Part 121)*

RS1A – Certified Existing Avionics for Newly Manufactured Aircraft

RS1A	The FAA should require runway safety capabilities for newly manufactured large airplanes in Part 121 air carrier operations after date TBD. The capabilities should include those technologies that provide runway and airport situational awareness information to crews that notify or alert the flight crew when the aircraft is aligned to a surface that is not a runway, when it is aligned with the incorrect surface, or when the runway is too short. These capabilities would not necessarily need to meet the definition of alerts contained in 14 CFR 25.1322.

INTENT: To improve safety by requiring newly manufactured commercial carrier aircraft to equip and use capabilities that alert the flight crew in particular circumstances that may lead to runway safety events.

RATIONALE: There are a variety of avionics addressing runway safety alerting currently available for equipping from the OEM. Because runway safety alerting is available to all aircraft in production, it can be ordered by the customer.

Making broader use of existing alerting capabilities in forward fit aircraft is an important step in advancing runway safety. Likewise, similar to how the ICAO standard for Annex 6 Part I and EASA's ROAAS equipage mandate for new production will foster the equipage of new and "in-production" large airplanes, proactive FAA action to encourage equipage will promote harmonization and provide more clarity to commercial carriers.

APPROACH: FAA should take action for future fit of newly manufactured aircraft after a date to be determined.

In the interim before a regulatory requirement for installation of this equipment, FAA should provide guidance for the industry and consider a policy statement that would strongly encourage aircraft equipping and use.

RS1B – Certified Existing Avionics for Existing Aircraft

RS1B	The FAA should work with industry to determine a minimum capability for runway and airport situational awareness information to crews that notify or alert the flight crew when the aircraft is aligned to a surface that is not a runway, when it is aligned with the incorrect surface, or when the runway is too short that would fulfill the intent of regulation for aircraft retrofits. Operators should make every effort to install this technology on existing fleets that are capable. While recognizing that the NTSB[12] and certain members of the subgroup support a mandate, the members of the subgroup were unable to reach a consensus on a retrofit mandate for the existing fleet of aircraft operating in the US (parts 121 & 129).

INTENT: Safety would be improved by ensuring that, to the extent feasible, existing commercial carrier aircraft equip and use capabilities that alert the flight crew in particular circumstances that may lead to runway safety events.

RATIONALE: There are a variety of avionics addressing runway safety alerting currently available for equipping for retrofit on aircraft in the existing fleet. Making broader use of existing alerting capabilities in existing aircraft is an important step in advancing runway safety.

NTSB has had a long-standing recommendation for direct pilot warnings for airport safety hazards as an efficient means to warn the flight crew in a position to take immediate action. A minimum level of capability improves safety to mitigate surface safety issues.

APPROACH: The members of the subgroup were unable to reach a consensus on a mandate for retrofit of the technology on aircraft in the existing fleet. However, there was agreement that safety is improved when aircraft are equipped with, or are activated with if they are already installed but not enabled, capabilities providing alerts to the flight crew for the following:

1. When the aircraft is aligned to a surface that is not a runway,
2. When the aircraft is aligned with the incorrect surface, or
3. When a runway is too short.

It must be recognized that there may not be one avionics device that meets all three of these areas, but instead a combination of functionalities to achieve the safety goal. Aircraft operators

[12] NTSB recommendations A-18-025, A-18-026

are encouraged to retrofit systems or combinations of systems that most closely meet the intent of the NTSB/FAA recommendations.

The FAA should also partner with industry to develop a better assessment of aircraft equipage with runway safety alerting capabilities, the barriers that may need to be addressed, and the path for increasing equipage in the existing fleet. This effort could also include an assessment by MITRE of the causal factors and how the associated technology would address them, correlating with how it would apply to the current fleet.

When encouraging equipage with these capabilities, it must be recognized that some aircraft in the existing fleet may have a suite of avionics that are outdated, and the remaining service life of the aircraft may make it financially untenable for a retrofit to occur.

Other Certified Existing Avionics areas for consideration and awareness

- Runway safety alerting capabilities are highly dependent on GPS. The FAA must recognize the vulnerability of that technology/capability. There is a need for resilience and awareness if the GPS is somehow compromised, leading to inaccurate information and alerting.
- The aircraft-based capabilities rely on databases, and it is critical to maintain the currency of this information.
- Human factors are a critical element to successful implementation of flight deck-based alerting capabilities.

RS2 – *Future Certified Avionics Capabilities (Part 25, Part 121)*

RS2A – Certification of Collision Alerting Capabilities

RS2A	The FAA should pursue the necessary resources to expedite the certification of collision alerting capabilities, including associated regulatory guidance.

INTENT: To facilitate development and adoption of an aircraft-based collision alerting capability. This would include the hiring of staff and associated agency resources as well as creation of a guidance/standard (e.g. FAA TSO, RTCA MOPS), provided it does not delay the certification, approval, and availability of the technology for early adoption.

RATIONALE: During the subgroup's evaluation of technology, review of FAA air traffic control runway safety technologies, and discussion of addressing recent runway safety events, there was a strong consensus on the importance of collision alerting capabilities. While air traffic controllers and pilots were able to respond and prevent an accident in several recent events, it is crucial that pilots have an aircraft-based capability to "see and receive alerting" of a potential collision.

Existing avionics provide capabilities that are currently available either for new aircraft or as retrofit for existing aircraft to alert the flight crew when the aircraft is aligned to a surface that is not a runway, when it is aligned with the incorrect surface, or when the runway is too short. Collision avoidance alerting would provide an important safety enhancement by expanding alerting technology to take the location of other aircraft or ground vehicles into account.

Certification and standardization of this technology would spur more widespread manufacturing and adoption. An important consideration is the absence of an industry consensus standard for collision alerting. Avionics could be certified without a standard, and the subgroup had concerns that waiting could delay availability of equipment.

APPROACH: Based on technical briefings from avionics manufacturers and OEMs, collision alerting capabilities are in the process of final development and certification. These capabilities depend on the use of ADS-B, specifically the use of ADS-B In, which relies on other aircraft (or ground vehicles) to be equipped with ADS-B Out capability for the alerting capability to detect another aircraft or vehicle. The FAA should dedicate the necessary resources to certify collision alerting capabilities.

RS2B – FAA Action to Foster Adoption of Collision Alerting Capabilities

RS2B	Once the standards (e.g., RTCA MOPS) and regulatory guidance (e.g., Advisory Circulars) have been developed for the certification of ADS-B-based collision alerting capability (e.g., SURF-A/IA), the FAA should: • Require ADS-B-based collision alerting capabilities for newly manufactured aircraft after date TBD. • Install supporting ground infrastructure, where appropriate and as necessary, to provide the position accuracy required to provide ADS-B-based collision alerting capability via both 1090ES and Universal Access Transceiver (UAT) broadcasts. • Provide a means for Part 121 air carriers and other appropriate operators of existing aircraft to obtain operational approval of the use of such capability. • Encourage Part 121 air carriers and other appropriate operators to purchase collision alerting capabilities for existing aircraft.

INTENT: To foster widespread adoption of aircraft-based collision alerting capabilities.

RATIONALE: Widespread adoption of this technology among carriers would provide an important tool for enhancing pilot ability to avoid runway collisions. It also would help address the latency between a controller alerting system, notification to the pilot, and the subsequent reaction.

APPROACH: The FAA should encourage carriers to purchase this capability for future aircraft deliveries. For carriers, the various safety, efficiency, and capacity benefits of ADS-B In help

support the business case for its procurement. A tangible form of encouragement would be for the FAA to implement the necessary ATC infrastructure upgrades that are required before the deployment of several ADS-B In airborne applications so that improved operational benefits in addition to safety can be fully realized (e.g., Interval Management). Currently, many carriers are deferring investment in ADS-B In due to the perception that the FAA is not committed to making the necessary upgrades to the ATC system in a timely manner and the impact that belief has on the business case.

Commercial carriers should also consider, and the FAA should encourage, installing runway safety collision alerting capability in the existing fleet when an aircraft is being retrofitted for ADS-B In.

In support of position accuracy required for ADS-B based collision alerting, the FAA should continue to investigate the infrastructure that may be needed for surface surveillance.

Other Future Certified Avionics areas for consideration and awareness

- This approach would also assume that OEMs would accept the installation of certified avionics that was not done according to an industry standard. Avionics manufacturers may proceed while a standard is in development.
- The collision avoidance capability is also based on both aircraft (and/or ground vehicles) being ADS-B transponder equipped.
- Human factors are a critical element to successful implementation of flight deck-based alerting capabilities.
    - Industry is taking various approaches for displaying the airport information in a pilot's forward field of view including aircraft installed display, Heads up Display, or "helmets."
    - Pilot perception of accepting/responding to alerts – important to avoid nuisance.

RS3 – *Portable Electronic Flight Bags*

RS3 - FAA Continue Permitting Use of EFBs

RS3	The FAA should continue allowing the use of portable Electronic Flight Bags (EFBs) by Part 121 air carriers and other appropriate operators, for runway situational awareness applications.

INTENT: Making use of EFB contributes to runway safety by providing a range of information about traffic and airport surface depictions and maps to pilots. This continues to offer a valuable way to efficiently make runway safety information available.

RATIONALE: The air carrier operator community makes extensive use of EFB capabilities, including those related to airport safety awareness. In addition, the providers of the technologies make regular updates and develop new features. This occurs with a higher rate of

frequency than that of installed, certified, and integrated avionics. Therefore, these capabilities should continue to comprise part of the spectrum of runway safety tools available to pilots and carriers, while keeping their limitations in mind.

APPROACH: Previous subgroup discussion highlighted that portable EFBs are not an appropriate solution for the long term as they are not in the primary field of view, do not have alerting capabilities, and have challenges with integration with existing procedures and other alerting equipment on the airplane. Although there are limits because an EFB is not certified, the use offers helpful awareness and other information to pilots that requires appropriate discipline in its use. While the limitations of EFBs make them inappropriate as an alerting function, they are acceptable when used judiciously for situational awareness and enhancing "notifications."

EFBs are currently available with a low barrier of entry, fast update cycle, and ability to expand available applications. Comfort with the use of electronic devices has also facilitated pilot use of this technology.

It must be recognized that an EFB should only be used for awareness and is dependent on non-certified GPS availability to alert the flight crew when the aircraft is aligned to a surface that is not a runway, when it is aligned with the incorrect surface, and when the runway is too short.

Other Electronic Flight Bag areas for consideration and awareness

- There are vulnerabilities associated with EFB including the reliance on WiFi – Cell connection for Part 121, and the need for procedures to address an information disagreement between the EFB and aircraft technology.
- Need to maintain the currency of the database and the absence of an industry consensus standard to maintain database currency.
- Power source, battery life, and safety/stability of batteries are a consideration.
- Human factors are a critical element of successful implementation of flight deck-based alerting capabilities.

RS4 – *Airports*

RS4A – FAA Engagement With Airport Operators to Promote Innovative Technologies

RS4A	The FAA should engage with airports as it works with both internal and external stakeholders to mitigate runway incursion and excursion risks with innovative technologies. These technologies include ADS-B equipage for airside ground vehicles; sensing and alerting technologies that are integrated into air traffic operations; new and enhanced surface surveillance capabilities; and changes to physical airfield infrastructure, including runways, taxiways, and associated lighting and marking systems.

INTENT: To ensure that the FAA engages with airport operators as stakeholders as new innovative runway incursion and excursion prevention technologies are developed and deployed to enhance airport safety.

RATIONALE: Since airport operators play a vital role in safety, their engagement and awareness in the development and implementation of systems—especially those that necessitate infrastructure modifications—is essential.

APPROACH: The FAA should engage individual airports in discussions of innovative incursion and excursion prevention technologies via existing safety forums. As airport operators are the party responsible for airfield infrastructure investments (e.g., runways, taxiways, associated lighting and marking systems), their engagement is essential in addressing runway incursion and excursion risks. Airport operators also often have a role in facilitating deployment of FAA incursion and excursion prevention technologies and/or providing supporting infrastructure (e.g., power supply, data conduits) for them.

The FAA should also make use of collaborative efforts such as local runway safety action teams (RSATs)—inclusive of airport operators—identifying runway incursion hotspots located at their facility that need to be clearly communicated to pilots and assessing appropriate safety mitigations for these hotspots. At the national level, this engagement can take place via the Runway Safety Council (RSC).

Assessments of innovative technologies and emerging FAA programs, guidance, or requirements associated with them should include considerations of supporting infrastructure requirements; anticipated effects of the technologies on existing airport operations and infrastructure; and airport operator roles and responsibilities for system acquisition, operation, training, and equipage (e.g., airside ground vehicle ADS-B transponders).

RS4B – Expansion of Ground Vehicle ADS-B Transponder Equipage

RS4B	The FAA should work with stakeholders, including airport operators, aircraft operators, and ground service entities to expand the ADS-B transponder[13] equipage by ground vehicles that are authorized to operate in the movement area. This is an important part of overall runway surface safety initiatives. Methods could include policies, or other appropriate mechanisms (e.g. educational materials, Advisory Circulars, etc.) and expanded federal assistance for these safety items.

INTENT: To expand the equipage of ADS-B transponders on ground service vehicles.

RATIONALE: ADS-B is a "passive" surveillance system that requires the installation of transponders for the aircraft or ground vehicle to be depicted on a flight deck or SAI control tower display.

[13] 150/5220-26 (Consolidated to include Changes 1-3)

APPROACH: To make effective use of ADS-B based aircraft or control tower technologies, the FAA should:

- Review Airport Improvement Plan eligibility for ground vehicle transponders.
- Work with the Federal Communications Commission (FCC) to determine safe limits on the number of ground vehicle transponders for an airport.
- Update its policy on the use of ADS-B for ground vehicles that expands the use of this important capability.

RS5 – *FAA Surface Safety Initiatives*

RS5A – Deployment of Approach Runway Verification

RS5A	The FAA should expeditiously deploy the Approach Runway Verification (ARV) capability at all appropriate facilities.

INTENT: To build on the FAA's long history of implementing technologies designed to provide airport safety capabilities to air traffic controllers to prevent runway incursions, and potential collisions between aircraft and ground vehicles.

RATIONALE: To improve on the current state of FAA technology for use by air traffic controllers, the FAA should field the new ARV capability that confirms the accuracy of approach procedures and produces terminal alerts of wrong runway, closed runway, and wrong airport aircraft alignments to prevent wrong surface landings.

APPROACH: The portfolio of ground-based tools for air traffic controllers supports airport surface safety operations. Likewise, at 20 airports, the FAA has fielded RWSL that alert pilots of an aircraft on a runway at certain locations on the airport. ARV is an important technology for airports served by air carriers. Its implementation would complement these technologies and provide the tools necessary for controllers as part of the FAA's integrated suite of runway safety alerting technologies.

RS5B – Deployment of Surface Awareness Initiative

RS5B	The FAA should deploy Surface Awareness Initiative (SAI) expeditiously at all 230 potential sites. Deployments should be based on a prioritization using a Safety Risk Assessment to address the highest potential for runway safety events. SAI also serves as an important baseline to expand on this foundational capability to enhance safety.

INTENT: To provide air traffic controllers with the display of surface traffic at airports that do not currently have a surface surveillance system (ASDE-X or ASSC) collision alerting capabilities.

RATIONALE: SAI gives controllers information on ADS-B equipped aircraft and ground vehicles that can support safety by avoiding a potential collision between aircraft and/or ground vehicles.

APPROACH: The FAA currently has 4 sites identified for SAI deployment, with a total of 230 potential sites. The FAA should stay on course with this expeditious implementation schedule for SAI and should use a prioritization based on addressing the risk for runway safety events that a surface awareness tool would help mitigate.

RS5C – Expansion of Runway Status Lights

RS5C	The FAA should develop a modernized, more cost-effective method to provide Runway Status Lights (RWSL) at additional airports and enhancements at existing locations.

INTENT: To expand airport access to real-time surface alerting.

RATIONALE: Expanding the FAA's runway safety portfolio with a real-time surface alerting system is crucial. The current deployment of RWSL at 20 airports provides important safety benefits. The alert to pilots related to the occupancy of a runway is valuable and has contributed to runway safety by avoiding potential collisions. It supports both aircraft and ground vehicle operations.

APPROACH: To improve on the current state, the FAA should either reactivate its RWSL program or identify a more cost-effective approach that would provide a similar capability at additional airports.

RS6 – *FAA Councils/Committees and Coordination Efforts*

RS6	The FAA should identify one office/organization to coordinate the various agency councils/committees and associated efforts.

INTENT: To ensure that the FAA takes actions to prevent potential stovepipes that might develop over time regarding its numerous initiatives to address runway safety.

RATIONALE: A centralized approach to integrating runway safety activities will more efficiently leverage FAA and industry resources such as technology investments, coordination efforts, and safety/operational assessments.

APPROACH: The FAA should establish a focal point within the agency with visibility into the various activities, which could prevent redundancies or incongruent efforts and investments. This focal point can include the means to facilitate and coordinate activities by entities including the Air Traffic Organization, Office of Airports, Office of Aviation Safety, FAA field offices, and industry partners such as pilots, airports, aircraft operators, air traffic controllers, and air carriers.

RS7 – *International Harmonization of Collision Avoidance Technologies*

RS7	The FAA should work with ICAO and international regulatory authorities to harmonize the airborne and ground-based collision avoidance technologies.

INTENT: To ensure that the solutions adopted by the FAA, airports and aircraft operators, OEMs, avionics manufacturers, and others in the aviation industry are consistent and compatible with solutions adopted by civil aviation authorities outside of the United States.

RATIONALE: Improvements in aviation safety have global implications, and the harmonization of efforts to improve airport surface safety supports certification of aircraft technologies. This harmonization would also support a consistency of ground-based technologies and associated capabilities.

APPROACH: The FAA should work with ICAO to harmonize airborne and ground-based collision avoidance technologies.

VIII. Appendix: ARC Participants in Runway Safety Alerting Subgroup

Adler	Richard	FAA	Aircraft Certification
Arnold	Josh	JetBlue	Dir Operational Safety and SMS
Ausley	Mike	UPS	Flt Ops Tech and Safety Manager
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Deleeuw	John	American	MD Safety & Efficiency
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Hahn	Ed	ALPA	Sr Engineer ATM & Technology
Herman	Jason	ALPA	Airport & Ground Safety Environment Chair, Delta MEC
Hildebrandt	Craig	Airbus	Sr Dir Safety & Flight Ops Tech Affairs
Ishihara	Yasuo	Honeywell	Sr. Technical Fellow
Johnson	Lisa	American	Sr Mgr. of Assurance and Efficiency
Langridge	Matt	Gulfstream	
McCormick	Aimee	FAA	ASO Runway Safety Program Office
McDowell	Mike	Collins Aerospace	Director, Avionics Strategy – CNS/ATM
O'Brien	Jason	Delta	Tech Pilot (Capt.)
Oswald	Chris	ACI	SVP Safety & Reg Affairs
Paul	George	NACA	
Prater	Jon	FAA	Training & Simulation Grp (AFS-280)
Quackenbush	Kyle	MITRE	
Renk	Ron	United	Chief Technical Pilot
Schell	Ethan	Boeing	Engineer - Subject Matter Expert
Stiefel	Kurt	FAA	Tech & Procedures Div (AFS-400)
Thompson	Mark	Horizon Air	Dir, Reg Compliance & Flight Standards
Townsend	Brian	CAPA	Capt. American Airlines
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