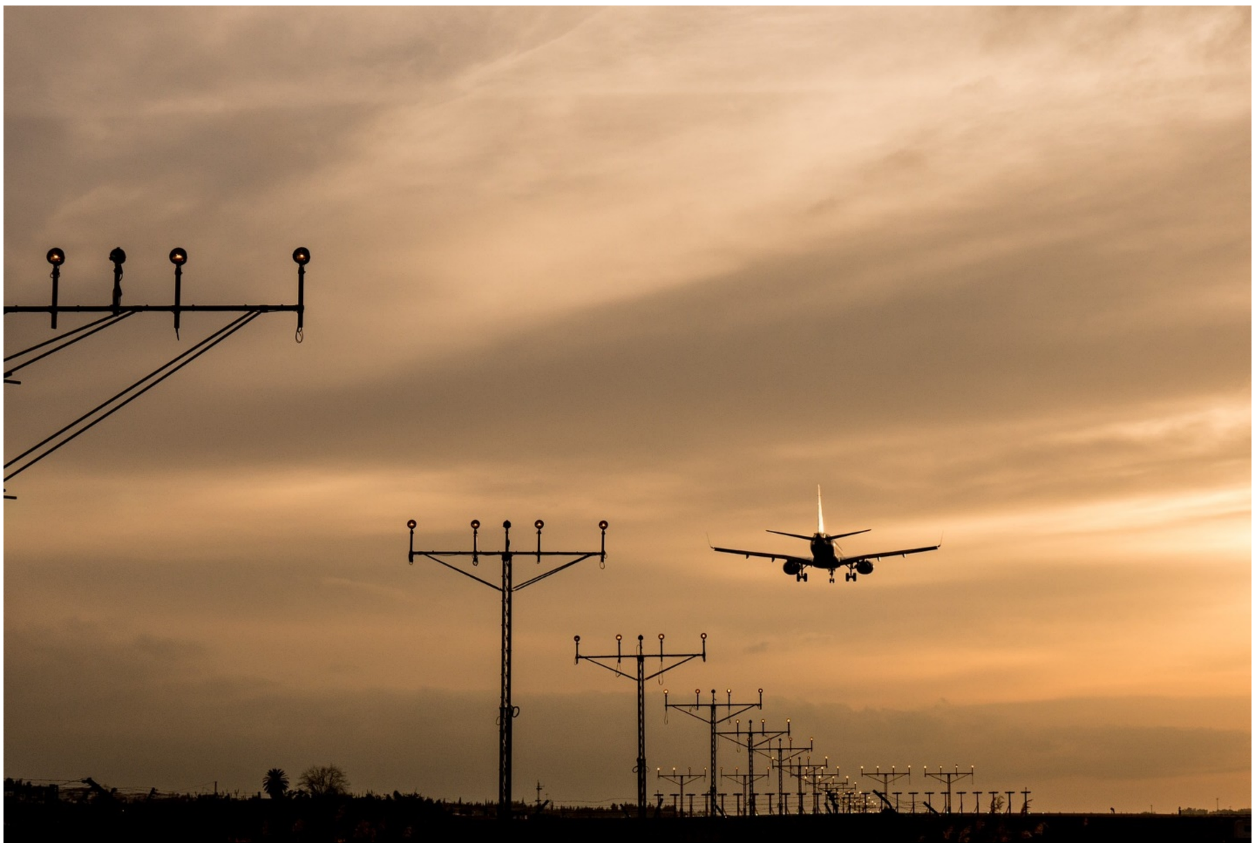
Approach and Landing Misalignment
Joint Safety Analysis and Implementation Team



Final Report

Analysis and Recommendations

December 02, 2021

Approach and Landing Misalignment Joint Safety Analysis and Implementation Team Final Report

Provided to the Commercial Aviation Safety Team

from

The Approach and Landing Misalignment Joint Safety Analysis and Implementation Team

December 02, 2021

ACKNOWLEDGEMENTS

The Approach and Landing Misalignment Joint Safety Analysis and Implementation Team would like to express appreciation to the organizations that provided support to the team in the form of team members and meeting support:

- American Association of Airport Executives
- Airports Council International-North America
- Air Canada
- Air Line Pilots Association, International
- Airbus
- Airlines for America
- Allied Pilots Association
- Collins Aerospace
- Delta Air Lines
- Federal Aviation Administration
- FedEx Corporation
- Flight Safety Foundation
- Honeywell
- National Air Traffic Controllers Association
- PAI Consulting
- PSA Airlines
- Regional Airline Association
- Republic Airways
- SkyWest Airlines
- Southwest Airlines
- Spirit Airlines
- The Boeing Company
- The MITRE Corporation
- United Airlines
- United Parcel Service

OVERVIEW

The risk for approach and landing misalignment (ALM) has been identified throughout the National Airspace System (NAS). This risk includes aircraft approaching or landing on a surface other than what they were cleared for. These other surfaces include the wrong runway, taxiway, or airport. While these events have typically been corrected in time to prevent an adverse outcome, there have been high-profile events, including an event involving an air carrier approach to a taxiway instead of the assigned runway (Air Canada flight 759 (ACA759), July 7, 2017, San Francisco, California).[1] The Commercial Aviation Safety Team (CAST) and the Aviation Safety Information Analysis and Sharing (ASIAS) Executive Board (AEB) formed the ALM Joint Safety Analysis and Implementation Team (JSAIT) to advance the understanding of factors influencing misaligned approaches and landings and recommend mitigations as appropriate.

ANALYSIS AND INTERVENTION PROCESS

The ALM JSAIT members consisted of air carrier pilots, safety analysts, and original equipment manufacturers (OEM), as well as Federal Aviation Administration (FAA) air traffic controllers and analysts. The ALM JSAIT used an initial dataset of reports from mandatory and voluntary safety programs from an ASIAS database that contains reports from Title 14 Code of Federal Regulations (14 CFR) part 121 air carriers and general aviation (GA) operators participating in ASIAS. Some 14 CFR part 129 air carrier reports were in the dataset because the deidentified nature of some of the data prevented filtering them out. The data sources contained reports from July 2015 through October 2017. Voluntary reports, such as ASAP and ATSAP reports, have limitations including the varying reporting culture of an operator or region. The rate of these types of ALM reports is dependent on the total number of reports received through ASIAS and is not necessarily reflective of the actual rate of ALM events. The ALM JSAIT also performed a gap analysis of more recent mandatory reports from November 2017 through February 2019, but the differences in the contributing factors between the two sets did not warrant expanding the full analysis of ASAP and ATSAP into the gap analysis range.

The ALM JSAIT developed a hierarchical taxonomy tailored to the nuances of misalignment events to categorize the reports and identify contributing factors. This taxonomy also served as the team's Standard Problem Statements (SPS). The ALM JSAIT then developed intervention strategies (IS) and scored them using standard CAST processes. The team packaged viable interventions into four traditional safety enhancements (SE) and one research and development (R&D) SE.

[1] Taxiway Overflight Air Canada Flight 759
https://www.ntsb.gov/investigations/AccidentReports/Reports/AIR1801.pdf

FINDINGS

The majority of reported misalignment events were wrong runway approaches. While being reported significantly more frequently than other types of misalignments, they tended to be less severe. Wrong runway landings and wrong airport approaches were the other top categories of events.

The ALM JSAIT found approximately 80 percent of reports had pilot error and pilot human factors flagged as contributing factors. Some of the most common pilot errors included flight management computer (FMC) programming errors and failure to monitor/cross-check.

The ALM JSAIT's general findings found some common attributes of misalignments are when—

- Flightcrew members execute changes in the Flight Management System (FMS) without coordinating with the other flightcrew members,
- A runway is changed by air traffic control (ATC) after initial assignment,
- The runway assigned is different from what is expected by the flightcrew during the approach briefing, and
- Operations are conducted under visual meteorological conditions (VMC).

One theme throughout the study, though not specifically tracked, is the effect of parallel runways on ALM risk. The presence of multiple parallel surfaces combined with other contributing factors—such as expectation bias of the assigned runway at airports with multiple parallel runways—contributed to the occurrence of misalignments. Another hazard is approaching multiple parallel runways. It is difficult to detect the misalignment early because the flight path difference approaching the correct and incorrect runway is relatively narrow compared to approaching non-parallel runways where approach paths are from different directions and may be separated by miles.

The ALM JSAIT identified specific findings from the dataset. The top three findings for each category of contributing factors are—

- Pilot Error—
  - FMC programming error,
  - Failure to monitor/cross-check, and
  - Pilot deviation.
- Pilot Human Factors—
  - Expectation bias,
  - Task saturation, and
  - Distraction.

- Controller Error—
  - Readback/hearback,
  - Incorrect clearance, and
  - Other.
- Weather—
  - Natural lighting,
  - Clouds/low visibility, and
  - High head/tailwinds.
- Airport Layout—
  - Airport lighting issue,
  - Visual similarity to another surface, and
  - Visual similarity to nearby airport.

Following the standard CAST process, the ALM JSAIT determined Importance (P1) and Applicability (A) scores for each SPS through team discussion.

INTERVENTION STRATEGIES

The ALM JSAIT identified a list of ISs. The team then followed CAST processes and scored the ISs to determine Intervention Effectiveness (IE) based on Overall Effectiveness (OE) and Feasibility (F).

- Technologies—Airplane manufacturers and avionics suppliers have developed, and continue to develop, new onboard technologies for the flightdeck to improve flightcrew situational awareness of ALMs. Rather than reviewing individual technologies for mitigation, the technologies category was condensed to focus on three specialties: situational awareness, advisory, and alerting.
  - Situational Awareness Technologies—Technologies that provide additional situational awareness to the flightcrew on approach (recommended to move forward into an SE).
  - Advisory Technologies—Technologies that provide audio advisories informing the flightcrew to which runway the aircraft is aligned (recommended to move forward into an SE).
  - Alerting Technologies—Technologies that provide alerts including corrective action to the flightcrew when the aircraft is aligned to a surface that is not a runway, when the aircraft is aligned with the incorrect runway, or when a runway is too short (recommended to move forward into an SE).
- Airport Environment—While each airport has its own environment, and all terminal areas could benefit from location-specific mitigations to reduce the risk of ALM events, the

ALM JSAIT focused on general interventions that could be applied to airports across the NAS regardless of their number of operations, runway layout, or other attributes.

- Communication of runway construction.
- Lighting on runway numbers.
- Safety Alert for Operations (SAFO) on lighting (runway lighting intensity) adjustments at tower.
- Visual clarity between surfaces.
- Similar airport callouts on airport maps.
- Hotspots for wrong surface operations.

- Procedures and Policies—Many air carriers would benefit from additional training or adjustments to standard operating procedures (SOP) to bring situational awareness of ALM risk to their pilots. The discussion with the ALM JSAIT members focused on possible mitigations to be used across the industry that could be extracted from any specific, available air carrier training.
    - Runway assignment plan similar to what is used at Salt Lake City International Airport (SLC), Salt Lake City, Utah. This plan provides flightcrews advanced notification of the likely primary and backup landing runways in use at the time of arrival (recommended to move forward into an SE).
    - 1,000-foot call-out for runway assignment on approach (recommended to move forward into an SE).
    - SAFO to inform pilots to say "unable" when it is too difficult to accommodate an approach. An example of such material may include SAFO 21005, Risk Associated with Visual Approaches.
    - Training on visual approach (recommended to move forward into an SE).
    - Recommending backing-up visual approaches with an available instrument approach procedure (IAP) instrument (recommended to move forward into an SE).
    - Instrument approaches over visual approaches as practical (recommended to move forward into an SE).
- ATC—Some ATC technologies and information outreach can be used as mitigations and to develop greater awareness of ALM events.
    - Tower technology enhancements, including Airport Surface Detection Equipment—Model X (ASDE–X), ASDE–X and Airport Surface Surveillance Capability (ASSC) Taxiway Arrival Prediction (ATAP), Standard Terminal Automation Replacement System (STARS), and Approach Runway Verification (ARV) for runway misalignment (recommended to move forward into an SE).
    - ALM JSAIT study—Information outreach to ATC facilities by providing ALM JSAIT study results to ATC facilities (recommended to move forward into an SE).

SEs

The ALM JSAIT bundled the ISes into SEs based on OE, F, and IE. Those IS scores were analyzed and the ALM JSAIT identified those with the highest scores to be used to develop five SEs, as summarized below.

SE	OBJECTIVE
SE 231 Aircraft-based Technologies	• OEMs should evaluate their current production fleet and/or avionics suites and new type design aircraft, as well as incorporate these technologies as appropriate. • Aircraft operators should evaluate available technology against their fleets and decide what technology they will incorporate into their fleet.
SE 232 Ground-based Technologies	• Establish a comprehensive list of existing and developing technologies for prevention of misalignments. • Establish a periodic review of ALM data to prioritize air traffic facilities that would benefit from technology that would mitigate ALM risk.
SE 233 Air Carrier Procedures and Training	• FAA Flight Standards Service (AFX) should publish guidance on flightcrew best practices to prevent a misalignment. CAST should communicate findings of the ALM JSAIT to air carriers. • Air carriers should evaluate existing approach and landing procedures against recommended misalignment prevention best practices. • Air carriers should assess and revise air carrier policies and procedures based on the results from the evaluation described in the bullet point above.
SE 234 Air Traffic Control Policies and Procedures	• Establish a working group for testing the expansion of the runway assignment plan. • Use operable runway alignment equipment.
SE 235 (R&D) Aircraft-based Technologies	• Manufacturers should develop and make available, on new transport category aircraft, enhanced aircraft design features as feasible, that increase flightcrew awareness of runway/taxiway/aerodrome ALMs.

CONCLUSION AND RECOMMENDATIONS

The ALM JSAIT recommended, and CAST adopted, SEs to reduce the risk of misaligned approaches and landings. The SEs address misalignment risk from the perspectives of aircraft, air carriers, ground (airport), and ATC. CAST recommends the implementation of four SEs:

- SE 231, Aircraft-based Technologies,
- SE 232, Ground-based Technologies,
- SE 233, Air Carrier Procedures and Training, and
- SE 234, Air Traffic Control Policies and Procedures