SE 213

CAST Safety Enhancement (SE)

SAFE OPERATING AND DESIGN PRACTICES FOR STARS AND RNAV DEPARTURES

STUDY TOPIC
RNAV
AREA NAVIGATION

CICTT RISK AREAS
MAC

SECTION I: SE OVERVIEW

SECTION I

Study Topic Overview Summary	FAA and industry stakeholders asked the ASIAS program to proactively conduct studies in 2010 and 2012 to identify new or increased risks associated with area navigation (RNAV) departure procedures and optimized descent profile Standard Terminal Arrival Route (STAR) procedures before the potential risks result in an accident. ASIAS forwarded the study results to CAST in 2012, and CAST chartered the RNAV/STAR Joint Safety Analysis and Implementation Team (JSAIT) to examine the findings and develop risk mitigations. The RNAV JSAIT found most pilot reports indicate lateral deviations on RNAV departure procedures before the first fix as a result of not having the flight management system programmed correctly for the departure runway, and altitude deviations (missed crossing restrictions) on STARs, particularly on optimized descent profile procedures.
SE Objective	CAST recommends the regulator, FAA Air Traffic Organization (ATO), and industry develop and implement safe operating and design practices to mitigate errors on STAR and RNAV departures.
Primary Risks Mitigated	Airprox/Traffic Alert and Collision Avoidance System (TCAS) Alert/Loss of Separation/Near Midair Collisions/Midair Collisions (MAC)

Action	Organization(s)	Strategy	Description	Due Date
Action 1	FAA AFS, FAA ATO	Policy, Guidance	Develop guidance to align training for flightcrews, training for controllers, and procedure and chart design.	12/31/2016
	Comments: CAST closed this action based on the publication of FAA Orders 8260.58A and 8260.3C, and Advisory Circular (AC) 90–105A.			
Action 2	FAA AFS, Air Carriers	Policy, Training	FAA AFS develops commonly accepted safe operating practices to mitigate errors on STARs and RNAV departures. Air carrier training organizations develop, review, and amend training syllabi to emphasize policies relating to STARs and RNAV departures.	05/31/2020[1]
	Comments: CAST closed this action based on industry members reporting safety issues previously identified in the RNAV JSAIT and SE 213 Working Group have been addressed through improved standards, procedures, and training.			
Action 3	FAA ATO	Policy, Training	Develop commonly accepted safe operating practices for air traffic control of STARs and RNAV departures, and training syllabi to incorporate these practices and emphasize related policies and procedures.	12/31/2017
	Comments: CAST closed this action based on the publication of FAA ATO training materials and FAA Order JO 7110.65X.			

[1] CAST is leaving Action 2 open beyond the original due date to gather stakeholder implementation feedback. CAST expects implementers completed this action on the original schedule, so the due date and flow time remains unchanged.

Action 4	FAA ATO	Policy	Develop and implement guidance for improved procedure design and charting to mitigate operational errors on STARs and RNAV departures.	12/31/2017
	Comments: CAST closed this action based on the publication of FAA Orders 8260.3C and 8260.58A.			

See section II of this SE for detailed action descriptions.

References: The detailed analysis in the RNAV Departures and STAR Operations Joint Safety Analysis and Implementation Team (RNAV/STAR JSAIT) Final Report (February 12, 2015) is available through CAST.

TABLE OF CONTENTS

SECTION II: DETAILED ACTION INFORMATION

Action 1: Develop guidance to align training with procedure/chart design and implementation

Primary Implementer	**FAA Air Traffic Organization (ATO); FAA Flight Standards Service, Safety Standards (AFS)**
Action Objective	The FAA, in collaboration with industry, should develop guidance to align training for flightcrews, training for controllers, and procedure and chart design and implementation.
Action Timeline	Flow Time: 34 months Due Date: 12/31/2016
Timeline/Flow for Future Adopters	N/A
CAST Lead	FAA ATO, FAA AFS

#	Organization(s)	Detailed Steps
1a	FAA, Industry	Review relevant information including recent or proposed revisions to FAA Order 7110.113D and FAA Order 7110.65 and the problems identified in the Joint Safety Analysis and Implementation Team (JSAIT) final report on STARs and RNAV departures.
	Complete.	
1b	FAA, Industry	Develop guidance for each of three communities (flightcrews, air traffic service providers, and procedure/chart designers) to address common problems with a coordinated approach. This guidance will contain a statement of problems to be addressed and an outline of commonly accepted safe operating practices relating to each of the three communities.
	FAA Orders 8260.58A and 8260.3C published March 14, 2016. Advisory Circular 90–105A published March 7, 2016.	

Notes	Milestone: Completion of coordinated guidance for flightcrews, air traffic service providers, and procedure/chart designers addressing RNAV departure and STAR arrival problems.

Note: See Section III for detailed costs and resources.

Action 2: Develop flightcrew safe operating practices and training for STARs and RNAV departures

Primary Implementer	**FAA Flight Standards Service, Safety Standards (AFS)**
Action Objective	The FAA AFS, in collaboration with industry, should develop commonly accepted safe operating practices for flightcrews to mitigate errors on STARs and RNAV departures. Air carrier training organizations should develop, review, and amend training syllabi to emphasize each air carrier's policies relating to STARs and RNAV departures.
Action Timeline	Flow Time: 24 months o AFS to complete development of commonly accepted safe operating practices 12 months after completion of overall guidance from Action 1 (assuming coordination starts in parallel with collaboration meetings in Action 1). o Air carriers to complete revisions to policies/procedures and training curricula within 12 months after AFS issues commonly accepted safe operating practices. Due Date: 05/31/2020
Timeline/Flow for Future Adopters	TBD
CAST Lead	FAA AFS

#	Organization(s)	Detailed Steps
2a	FAA AFS	In collaboration with industry, updates advisory circulars (AC) containing details of commonly accepted safe operating practices for flightcrews to mitigate errors on STAR and RNAV departures.
	Complete.	
2b	Air Carrier Training Organizations	Develop, review and amend training syllabi as well as air carrier policies and procedures to be consistent with the guidance in the ACs for conducting STARs and RNAV departures.
	Complete.	

Notes

- CAST is leaving this action open beyond the original due date to gather stakeholder implementation feedback. CAST expects implementers completed this action on the original schedule, so the due date and flow time remains unchanged.
- For RNAV departures, the following items are to be reviewed and updated as appropriate in the guidance materials:
  - The importance of maintaining an accurate mental model of the desired direction of flight; this provides a crosscheck to trap programming errors.
  - The importance of initial Flight Management System (FMS) entries and management of changes, including changes that occur before departure, during taxi out, and in-flight.
  - The importance of entering, checking, changing and monitoring for:
    - Filed flight plan,
    - System initialization,
    - Waypoint loading,
    - Flight plan check,
    - Initial taxi clearance, and

SECTION II

Note: See Section III for detailed costs and resources.

- Changes in weight and balance, performance, runway or Standard Instrument Departure.
- The need to review standard operating procedures and other applicable flight documents.
- The appropriate use of autopilot and its importance in achieving the precision required for executing RNAV departure procedures.
- The roles of both pilot flying and pilot monitoring.

- For STARs, the following items are to be considered for the guidance materials:
  - Pilot vigilance, planning, and management of workload and distractions by conducting early, detailed briefings of STAR procedures.
  - Pilot knowledge of automation systems operations.
  - Management of automation systems in cases of altitude, speed, and course amendments, especially when the STAR is resumed.
  - STAR phraseology, specifically “descend via,” speed amendment, and runway change phraseology.

Note: See Section III for detailed costs and resources.

SECTION II: DETAILED ACTION INFORMATION

Action 3: Develop ATC safe operating practices and training for STARs and RNAV departures

Primary Implementer	**FAA Air Traffic Organization (ATO)**
Action Objective	FAA ATO, with air carrier input, should develop commonly accepted safe operating practices for air traffic control of STARs and RNAV departures. FAA ATO should develop, review, and amend ATO training syllabi to incorporate these practices and emphasize policies and procedures relating to STARs and RNAV departures.
Action Timeline	Flow Time: 28 months o Initiate activity after guidance is completed in Action 1, which is expected to occur 18 months after CAST approval. o 12 months for FAA ATO to complete development of commonly accepted safe operating practices. o Additional 12 months for FAA ATO to complete revisions to policies / procedures and training curricula. Due Date: 12/31/2017
Timeline/Flow for Future Adopters	N/A
CAST Lead	FAA ATO

#	Organization(s)	Detailed Steps
3a	FAA ATO	With air carrier input, develop commonly accepted safe operating practices for air traffic control of STARs and RNAV departures.
	Revisions to RNAV procedure guidance in FAA Order JO 7110.65X published September 12, 2017.	
3b	FAA ATO	Develop, review, and amend ATO training syllabi to incorporate these practices and emphasize policies and procedures relating to STARs and RNAV departures.
	Complete based on the publication of FAA ATO training materials on the FAA's Electronic Learning Management System (eLMS).	

Notes

- Air Traffic Service providers consider the following activities when developing commonly accepted safe operating practices, including training:
  - Compiling, evaluating and disseminating improved safe operating practices for air traffic control (ATC) to manage changes that affect flightcrews on STARs and RNAV departures.
  - Developing a systematic approach to manage individual changes to assigned runways, STARs, and RNAV departure Standard Instrument Departures (SID)/route of flight.
  - Enhancing air traffic controller awareness of the impact on the flightcrew of runway or departure procedure changes after pushback.
  - Enhancing air traffic controller awareness of the impact on the flightcrew of a change to the runway, route of flight, altitudes or speeds after the aircraft has been established on an arrival.
  - Enhancing air traffic controller awareness of changes to charted speed and altitude constraints in flight, and rejoins on STARs and RNAV departures.
  - Standardizing phraseology for RNAV departures and STARs and implement uniformly, and assuring controllers receive training regarding any changes.

SECTION II

Note: See Section III for detailed costs and resources.

- Developing a systematic approach to make wholesale changes when necessary to runway, STAR or RNAV departure procedure assignments and provide timely notification to flightcrews.
- Increasing the use and availability of Flight Deck Training (FDT) flights for controllers, to the extent practical.
- Evaluating new procedures using facility simulators to identify workload issues and to provide focus for training, to the extent practical.
- Ensuring that new procedures and airspace implementations are accompanied by training, including reinforcement of controller-controller communications when handing off aircraft, on the new operations and requirements.
- Investigating opportunities for reducing the need to alternate between an initial RNAV departure clearance and an initial clearance of a heading on takeoff.

- Developers of commonly accepted safe operating practices consider including guidance for the following pilot-controller interactions:
  - Initial clearance,
  - Runway, SID, STAR, or en route changes,
  - Departure and arrival routing rejoin procedures,
  - Alternating between vectors and RNAV, and
  - Improved clearance specificity with regard to restrictions (speed, altitude).

Note: See Section III for detailed costs and resources.

Action 4: Develop guidance/training for improved procedures and charting for STARs/RNAV departures

Primary Implementer	**FAA Air Traffic Organization (ATO)**
Action Objective	FAA ATO, in collaboration with air carriers and industry aeronautical chart providers, should develop and implement guidance for improved procedure design and charting to mitigate operational errors on STARs and RNAV departures.
Action Timeline	Flow Time: 28 months o Initiate activity after guidance is completed in Action 1, which is expected to occur 18 months after CAST approval. o 12 months for FAA ATO to complete development of commonly accepted safe operating practices. o Additional 12 months for FAA ATO to complete revisions to policies / procedures and training curricula. Due Date: 12/31/2017
Timeline/Flow for Future Adopters	TBD
CAST Lead	FAA ATO

#	Organization(s)	Detailed Steps
4a	FAA ATO	Develop commonly accepted practices for safe procedure design and charting to align with the guidance developed in Action 1.
	FAA Orders 8260.58A and 8260.3C published March 14, 2016.	
4b	FAA ATO	Modify procedure design, charting, and implementation processes as needed to incorporate these practices.
	Complete.	
4c	FAA ATO	Modify training materials that reflect commonly accepted safe operating practices for procedure design and charting.
	Complete.	
4d	FAA ATO	Conduct training on a recurring basis to increase awareness of the commonly accepted safe operating practices for procedure design and charting.
	Complete.	

Notes

- Developers of the guidance review existing directives and standards, and update as appropriate, with respect to the following:
  - Minimizing procedure complexity and restrictions where practical
  - Minimizing route conflicts
  - Minimizing overlapping departure/arrival routes
  - Minimizing chart clutter to improve information retrieval
  - Presenting missed crossing restriction (MCR) hotspots as annotations on the STAR charts similar to the Runway Incursion hotspots shown on airport diagrams.

SECTION II

Note: See Section III for detailed costs and resources.

- Including all airspeed and altitude restrictions in the plan view on the chart (making them available for being programmed in the Flight Management System (FMS) rather than only in the notes.
- Taking steps to ensure that criteria, guidance, and lessons learned are incorporated into the procedure design and charting processes.
- Ensuring that STAR and RNAV departure procedures are designed to minimize controller interventions due to other flows, including common visual flight rules (VFR) flows, to the maximum extent possible.
- Designing additional T routes for general aviation (GA) traffic, as necessary, to avoid Standard Instrument Departure (SID) and STAR flows.
- Modeling flight tracks and TCAS resolution advisories (RA) on new and revised procedures to proactively identify areas of potential RA hotspots. Analysis will focus on areas adjacent to Class B airspace limits, heavily used Special Use Airspace (SUA), or other conflicting VFR or instrument flight rules (IFR) traffic flows. Airspace and procedure designers will also consider adjustments to procedures to address areas with a high incidence of missed crossing restrictions (for example, adjust altitudes on procedures to increase vertical separation, adjust lateral path, or adding routes to separate satellite airport traffic).
- Ensuring that procedure designs align with either existing airspace boundaries, letters of agreement (LOA) between facilities, and air traffic control (ATC) standard operating procedures (SOP), or that new/revised airspace boundaries, LOAs and SOPs are in place and trained before implementing new or revised procedures.
- Leveraging the FAA Knowledge Repository, Performance-Based Navigation (PBN) Lessons Learned, as a tracking mechanism to resolve existing issues and capture new issues and using PBN Lessons Learned to track resolution of issues.
- Ensuring application of PBN Lessons Learned by requiring documentation of any variance from the guidance as part of the formal procedure design process. Tracking overall application of PBN Lessons Learned to guide changes to training and systems.
- Providing PBN Lessons Learned training for procedure designers.
- Consider documented safety occurrences as identified by ATO, leveraging ASIAS results, in the prioritization of procedure revisions.
- Considering chart design during the procedure design process or before publication, with focus on how a procedure will be visually presented to the pilot or controller with regard to human factors, in both paper and electronic formats. Consider a review of chart format by line pilots (not technical pilots or procedure designers) before publication.

Note: See Section III for detailed costs and resources.

SECTION III: SUPPLEMENTAL INFORMATION

Source Study	RNAV Departures and STAR Operations Joint Safety Analysis and Implementation Team (RNAV/STAR JSAIT) Final Report (February 12, 2015)
Related Initiatives	• Performance-Based Aviation Rulemaking Committee (PARC) Operational Use of Flight Path Management Systems • PARC Vertical Navigation (VNAV) Action Team • PARC Performance-Based Navigation (PBN) Naming and Charting Action Team • Obstacles to PBN Implementation

Total Cost	**$2,770,000**	*Note: For labor, 1 Full Time Equivalent (FTE) = $250,000*
Action 1[2]	$900,000	
Action 2	$690,000	
Action 3	$120,000	
Action 4	$1,060,000	

	Organization	Resources Needed
Direct Resource Overview – Government	FAA AFS	• Action 1: 2.0 FTE for document development, review and approval. • Action 2: 2.0 FTE to review and update advisory circulars. • Action 3: 2.0 FTE for coordination and training implementation.
	FAA AIR	• Action 4: 0.25 FTE for coordination.
	FAA AJV	• Action 4: 2.0 FTE to develop guidance material.
	FAA ATO	• Action 3: 0.5 FTE (assumes 0.25 FTE to develop training materials + 0.25 FTE to implement)

	Organization	Resources Needed
Direct Resource Overview – Industry	Air Carrier Industry Assns.	• Action 2: 0.25 FTE (assumes ~0.05 – 0.1 FTE at each association for coordination/collaboration). *Note: 55 air carriers are represented by three CAST-member air carrier industry associations:* o *Airlines for America (A4A),* o *Regional Airline Association (RAA), and* o *National Air Carrier Association (NACA).*
	Labor Organizations	• Action 2: 0.5 FTE (assumes 0.25 FTE at each organization for support and communication). *Note: Two pilot labor organizations are represented at CAST:* o *Air Line Pilots Association (ALPA), and* o *Coalition of Air Line Pilots Associations (CAPA).*

[2] Action 1 collaboration meetings:
- 1.2 FTE: 20 team members, 3 face-to-face meetings, 0.02 FTE (40 hours) per member per meeting; assume team is composed of 3 FAA AFS, 3 FAA ATO, 5 air carrier, 3 association, 3 manufacturer and 3 labor representatives.
- $90,000 for travel (20 team members, 3 face-to-face meetings).
- $7,000 administrative cost (meeting support, logistics).

Indirect Resource Overview

The organizations identified in this section are not expected to incur direct costs associated with implementing this SE, but they may incur indirect costs within their normal line of work.

Organization	Description
Air Carriers	Action 2: No additional costs expected for air carriers to review guidance material and recommended safe operating practices, and incorporate them into the operator's training program. o Assumes air carrier changes to policies/procedures and training curriculum occur routinely, and no additional costs would be associated with changes to align with guidance for STARs and RNAV departures. This assumes amended training does not add time to current flightcrew training footprint; rather, current training is revised and improved. o Assumes revised concepts will be included in initial and recurrent training.

SECTION IV: REVISION LOG

Major revisions (whole numbers) represent CAST-approved changes to SE language. Minor revisions (decimals) represent minor changes to target dates or completion notes that do not affect implementer actions.

Revision	Date	Description
1.7	06/04/2020	Action 2 closed.
1.6	05/07/2020	Administrative revision to Action 2 due date; flow time not affected.
1.5	08/15/2019	Administrative revision to Action 2 due date; flow time not affected.
1.4	06/06/2019	Action 2 due date extended.
1.3	02/06/2019	Action 2 due date extended.
1.2	12/06/2018	Action 2 due date extended.
1.1	10/04/2018	Action 2 due date extended.
1.0	09/17/2018	New SE format. Content reorganized and terminology updated. No substantive changes.
0.5	06/07/2018	Action 2 due date extended.
0.4	12/07/2017	Action 2 due date extended from 12/31/2017 to 04/30/2018. Action 3 closed. Action 4 closed.
0.3	08/03/2017	Actions 2–4 due dates extended from 08/31/2017 to 12/31/2017.
0.2	12/01/2016	Action 1 closed.
0.1	08/04/2016	Action 1 due date extended from 08/31/2016 to 12/31/2016.
Original	02/06/2014	CAST adopted SE 213.