SE 201

CAST Safety Enhancement (SE)

Design – Bank Angle Alerting and Recovery Guidance Systems

Study Topic
ASA
Airplane State Awareness

CICTT Risk Areas
LOC–I

Section I: SE Overview

Study Topic Overview Summary

CAST chartered the Airplane State Awareness (ASA) Joint Safety Analysis Team (JSAT) in August 2010 and the ASA Joint Safety Implementation Team (JSIT) in 2012 as a follow-on activity to the previous Loss of Control (LOC) JSAT in 2000. Historically, Loss of Control-Inflight (LOC–I) has been, and continues to be, one of the largest categories of commercial aviation fatal accidents. Loss of ASA is a subset of LOC–I accidents and incidents, defined as events in which the flightcrew lost awareness of the airplane's attitude or energy state. Between 2001 and 2010, half of all LOC–I accidents involved loss of ASA. The ASA JSIT recommended, and CAST adopted, 19 ASA SEs, 7 of which focus on airplane design.

The ASA JSAT's study of 18 LOC accidents and incidents determined that excessive bank, resulting from flightcrew loss of ASA, played a role in 6 accidents.

SE Objective

CAST recommends manufacturers implement bank angle alerting and recovery guidance display systems in accordance with Title 14, Code of Federal Regulations (14 CFR) § 25.1322, amendment 25–131, on applicable new transport category aircraft (TCA) programs launched after January 1, 2015. Applicable new TCA programs include:

- New type certificate programs.
- Major derivative, amended type certificate programs involving redesign of flight deck avionics.

Primary Risks Mitigated

Loss of Control-Inflight (LOC–I)

Action	Organization(s)	Strategy	Description	Due Date
Action 1	Aircraft Manufacturers	Equipment	Agree to implement bank angle alerting and recovery guidance display systems.	08/31/2014
	Comments: CAST closed this action based on aircraft manufacturer response to CAST communication.			
Action 2	Aircraft Manufacturers	Equipment	Implement bank angle alerting and recovery guidance display systems.	12/31/2020
	Comments: CAST closed this action based on manufacturers having already addressed the intent of the SE on new type designs.			

See section II of this SE for detailed action descriptions.

References: The detailed analysis in the ASA JSAT Final Report (June 5, 2015) and the ASA JSIT Final Report (December 31, 2014) is available through CAST.

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SECTION II: DETAILED ACTION INFORMATION

Action 1: Agree to implement bank angle alerting and recovery guidance displays

Primary Implementer	**Aircraft Manufacturers**
Action Objective	CAST-represented manufacturers should agree to implement bank angle alerting and recovery guidance display systems on applicable new transport category aircraft (TCA) type designs launched after January 1, 2015.
Action Timeline	Flow Time: 12 months o 6 months for Aerospace Industries Association (AIA) to send request letters o 12 months for manufacturers to respond to letters Due Date: 08/31/2014
Timeline/Flow for Future Adopters	N/A
CAST Lead	AIA

#	Organization(s)	Detailed Steps
1a	AIA	Communicate with CAST-represented manufacturers that are currently producing, or are expected to produce, TCAs for use in Title 14, Code of Federal Regulations (14 CFR) part 121 operations, explaining the ASA analysis and the role of spatial disorientation in ASA accidents.
	Complete.	
1b	Aircraft Manufacturers	Review the CAST ASA study and recommendations, and respond to AIA by indicating intention to incorporate bank angle alerting and recovery guidance into all applicable new TCA type designs launched after January 1, 2015.
	Complete based on aircraft manufacturer response to CAST communication.	
1c	AIA	Track implementation and report progress to JIMDAT and CAST.
	Reported to JIMDAT and CAST in August 2015.	

Notes	All CAST-represented manufacturers of TCAs should receive and respond to the CAST communication.

Note: See Section III for detailed costs and resources.

SECTION II: DETAILED ACTION INFORMATION

Action 2: Implement bank angle alerting and recovery guidance displays

Primary Implementer	**Aircraft Manufacturers**
Action Objective	Aircraft manufacturers should implement bank angle alerting and recovery guidance display systems on applicable new transport category aircraft (TCA) programs launched after January 1, 2015.
Action Timeline	Flow Time: 72 months after January 1, 2015 Due Date: 12/31/2020
Timeline/Flow for Future Adopters	TBD when CAST closes this action.
CAST Lead	Aerospace Industries Association (AIA)

#	Organization(s)	Detailed Steps
2a	Aircraft Manufacturers	Implement bank angle alerting and recovery guidance on applicable new TCA program launched after January 1, 2015.
	Complete.	
2b	AIA	Track implementation and report progress to CAST.
	Complete based on manufacturers having already addressed the intent of the SE on new type designs.	

Notes	This action assumes completion in conjunction with a new aircraft development effort and, therefore, specific completion timelines are dependent upon new aircraft development program schedules. Programs launched after December 31, 2020, may still incorporate the design feature, but their entry in service is not likely to significantly contribute to the current CAST risk reduction target for 2025; therefore, this SE tracks implementation only until this date.

Note: See Section III for detailed costs and resources.

SECTION III: SUPPLEMENTAL INFORMATION

Source Study	ASA Joint Safety Analysis Team (JSAT) Final Report (June 5, 2014) ASA Joint Safety Implementation Team (JSIT) Final Report (December 31, 2014)
Related Initiatives	• National Aeronautics and Space Administration (NASA) Aviation Safety Program – Loss of Control and Recovery Research, Spatial Disorientation/Loss of Energy State Awareness (SD/LESA) Study • FAA 14 CFR § 25.1322, Amendment 25–131 • FAA Advisory Circular 25.1322–1, Flight Crew Alerting

Total Cost	**$100,000**	*Note: For labor, 1 Full Time Equivalent (FTE) = $250,000*
Action 1	$100,000	0.3 FTE
Action 2	See below	

	Organization	Resources Needed
Direct Resource Overview – Government	N/A	N/A

	Organization	Resources Needed
Direct Resource Overview – Industry	AIA	• Action 1: 0.1 FTE for communication and tracking.
	Aircraft Manufacturers	• Action 1: 0.2 FTE (~60 hours per manufacturer for communication). *Note: Four manufacturers of part 25 aircraft operated in Title 14, Code of Federal Regulations (14 CFR) part 121 operations are represented at CAST:* o *Airbus (CAST member),* o *Boeing (CAST member),* o *Bombardier (represented by Aerospace Industries Association (AIA)), and* o *Embraer (represented by AIA).*

Action 2 Resource Overview

Many costs associated with implementing this feature would occur as part of any new airplane program; therefore only incremental development costs should be considered. These incremental costs depend on many factors and the total cost to provide this functionality in the future airplane fleet depends upon the number of airplane programs that implement it, with initial development costs being higher on the first program to incorporate the feature and significantly reduced development costs for implementation in follow on programs. Taken together, the variations of possible scenarios make it impractical to estimate a single, total cost for this action. The manufacturers on the ASA JSIT instead developed a range of potential development costs which are provided here for reference.

Estimated incremental development costs per program:

Incremental program (per manufacturer) cost estimates for additional engineering work expected to implement this feature in a new airplane program.

- Manufacturer engineering and pilot hours: 5000–25,000.
- Avionics supplier engineering hours: 2,000–10,000.
- Simulator time: 100–300 hours, dedicated.
- Flight test time: 1–5 hours, dedicated.
- Parts: none (software only, will use same displays).

SECTION III

Based on these estimates, the JSIT anticipates that development costs of this feature (for the initial program) may run in the range of $1 million to $5 million. Follow-on programs would have reduced costs. These estimates account for the following elements:

1. Design – airplane manufacturers:
   a) Definition of avionics requirements (e.g., graphics/throughput) to support functionality.
   b) Integration of system into manufacturer's flight deck and do initial functional validation.
2. Install/Build – avionics suppliers.
   a) Code creation.
   b) Line replaceable unit (LRU) assembly.
   c) Software delivery.
3. Test – airplane manufacturers and avionics supplies:
   a) Software qualification.
   b) Functional verification.
   c) Integration.
   d) Ground and flight tests.
   e) Fault testing.
4. Certification – airplane manufacturers and regulators:
   a) Application and project planning.
   b) Certification plan and basis (requirements definition), identify means of compliance.
   c) Component compliance findings.
   d) Conformity and test observation.
   e) Review data and final compliance finding.
5. Training/Flight Operations – airplane manufacturers:
   a) Engineering course/procedures development.
   b) Update manuals.
   c) Develop training materials.
   d) Update simulators.

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
N/A	N/A

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
1.1	12/05/2019	Action 2 closed based on manufacturers having already addressed the intent of the SE on new type designs.
1.0	09/17/2018	New SE format. Content reorganized and terminology updated. No substantive changes. Action 1 closed at August 2015 CAST meeting.
Original	08/01/2013	CAST adopted SE 201.