SE 223 CAST Safety Enhancement (SE)

HAZARDOUS MATERIALS FIRES – PREVENTION AND MITIGATION

STUDY TOPIC
RR-CARGO
REMAINING RISK – CARGO FIRES

CICTT RISK AREAS
F–NI

SECTION I: SE OVERVIEW

SECTION I

Study Topic Overview Summary

CAST chartered the Remaining Risk (RR) Joint Safety Analysis Team (JSAT) and Joint Safety Implementation Team (JSIT) in 2003 to study and mitigate risks outside of the largest aviation fatality risks outside of what CAST had studied between 1997 and 2002. The RR JSAT/JSIT identified several risk areas and mitigations related to cargo; cargo fires continue to pose a significant risk. In 2006, CAST adopted two SEs regarding cargo fires—SE 126 (R&D) and SE 127—as recommended by the RR JSIT.

CAST adopted SE 126 (R&D) and SE 127 as recommended by the RR JSIT. SE 126 recommended R&D to mitigate risks of hazardous materials fires that would otherwise overwhelm containment systems designed for Class A fires. CAST adopted four additional SEs (223 through 226) as a result of the research in 2016.

SE Objective

CAST recommends air carriers, aircraft manufacturers, lithium battery manufacturers, and shippers of hazardous materials develop and implement means to prevent fires involving hazardous materials from occurring on board aircraft, or to prevent any fires that do occur from endangering the aircraft or its occupants.

Specifically, to reduce the occurrence of accidents and incidents due to cargo fires involving hazardous materials, including lithium batteries, the aviation community (government, industry, and academia) should develop and implement the following:

1. A procedural method to identify and provide information to the flightcrew about the presence of lithium batteries, including those categorized under International Civil Aviation Organization (ICAO) Dangerous Goods Section II*, tendered for transport by aircraft. Note: Most hazardous materials with a comparable fire risk (especially hazardous materials that can both ignite and fuel a fire) are already required to be declared to the operator and made known to the flightcrew.
2. Systematic, performance-based fire mitigation standards for hazardous materials at the packaging level.
3. Systematic, performance-based fire mitigation standards for hazardous materials at the cargo container level.
4. Procedures that prevent the cumulative hazard of multiple dangerous goods shipments on the aircraft to exceed the capability of aircraft fire protection systems and operator equipment.

*Section II covers non-declared shipment of lithium cells/batteries, up to either eight cells < 20 Watt-hours or up to two batteries < 100 Watt-hours

Primary Risks Mitigated

Fire/Smoke (Non-Impact) (F–NI)

Action	Organization(s)	Strategy	Description	Due Date
Action 1	Air Carriers	Procedures	Develop policies and procedures requiring all lithium batteries tendered as cargo to be identified to the operator and shipment information provided to the flightcrew.	06/30/2019
	Comments: CAST closed this action based on implementer feedback received to date.			
Action 2	FAA AIR	Policy	Develop performance-based fire mitigation standards for hazardous materials packaging.	08/31/2023

SECTION I: SE OVERVIEW

Action	Organization(s)	Strategy	Description	Due Date
Action 3	Air Carriers	Equipment	Implement one or more CAST-identified state-of-the-art containment or suppression systems.	06/30/2023
Action 4	FAA AIR	Guidance	Publish guidance material for a hazardous materials risk assessment process for air carriers.	12/31/2021
	Comments: CAST closed this action based on the publication of FAA AC 120–121, Safety Risk Management Involving Items in Aircraft Cargo Compartments.			
Action 5	Air Carriers	Procedures	Develop policies and procedures for conducting hazardous materials risk assessments, and policy limiting hazardous materials.	12/31/2022
	Comments: CAST closed this action based on air carrier completion of risk assessments using the guidance contained in AC 120–121.			
	See section II of this SE for detailed action descriptions.			

References: The detailed analysis in the RR JSAT/JSIT Final Report and SE 126, Mitigations for Hazardous Material Fires, is available through CAST.

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SECTION II: DETAILED ACTION INFORMATION

Action 1: Develop lithium battery policies and procedures

Primary Implementer	**Air Carriers**
Action Objective	Air carriers should develop policies and procedures requiring all lithium batteries tendered as cargo to be identified to the operator and information on the shipment provided to the flightcrew.
Action Timeline	Flow Time: 30 months o 6 months for air carrier industry associations to contact air carrier members. o 12 months for air carriers to modify procedures. o 12 months for air carriers to perform initial training. Due Date: 06/30/2019 o 06/30/2017 for air carrier industry associations to contact air carrier members. o 06/30/2018 for air carriers to modify procedures. o 06/30/2019 for air carriers to perform initial training.
Timeline/Flow for Future Adopters	TBD when CAST closes this action.
CAST Lead	National Air Carrier Association (NACA)

#	Organization(s)	Detailed Steps
1a	Air Carrier Industry Assns.	Communicate with air carrier members, explaining the analysis undertaken by CAST regarding hazardous materials fires in aircraft cargo compartments.
	Complete.	
1b	Air Carriers	Modify policies and procedures to— a. Require the identification of excepted lithium batteries offered as cargo for transportation by aircraft. b. Present information on excepted lithium batteries tendered as cargo to the flightcrew.
	Complete.	
1c	Air Carriers	Modify initial and recurrent training to communicate the procedural changes to appropriate personnel, including flightcrew members, cargo acceptance agents, dispatchers, ramp agents, and quality assurance inspectors.
	Complete.	
1d	Air Carriers	Air carrier actions are considered complete when the air carrier has revised its policies and procedures as noted for the carriage of lithium batteries as cargo, and all affected air carrier personnel have received training on the new policies and procedures.
	Complete.	
1e	Air Carrier Industry Assns.	Track implementation at member carriers and report progress to JIMDAT and CAST.
	Complete.	

Notes

- Section I lithium batteries must be identified per the regulations; therefore, the Implementation Value in the timeline applies to Section II lithium batteries.
- Section II lithium batteries may be extremely difficult for air carriers to reliably identify with current requirements in place. Complicating factors include—

Note: See section III for detailed costs and resources.

- The relatively small size of such batteries,
- The large quantity of such batteries transported by air,
- The widespread usage of such batteries, and
- Multiple transition points of such batteries from manufacturer to end consumer.

Note: See section III for detailed costs and resources.

Action 2: Develop performance-based fire mitigation standards

Primary Implementer	**FAA Aircraft Certification Service (AIR)**
Action Objective	FAA AIR should develop performance-based fire mitigation standards for hazardous materials packaging.
Action Timeline	Flow Time: 69 months o 12 months for FAA AIR to establish scope of standards and task standards committee. o 36 months for standards committee to complete work and publish report. o 21 months for FAA AIR to publish guidance based on standards committee work. Due Date: 08/31/2023 o 12/31/2017 for FAA AIR to establish scope of standards and task standards committee. o 12/31/2020 for standards committee to complete work and publish report. o 08/31/2023 for FAA AIR to publish guidance based on standards committee work.
Timeline/Flow for Future Adopters	TBD when CAST closes this action.
CAST Lead	FAA AIR

#	Organization(s)	Detailed Steps
2a	FAA AIR	Establish the scope of the performance-based fire mitigation standards for hazardous materials packaging (internal fire, external fire, etc.).
2b	FAA AIR	Formally task the appropriate industry standards activity (such as SAE International; RTCA, Inc.; the International Organization for Standardization (ISO); or ASTM International) to develop packaging standards consistent with the scope of the tasking.
2c	FAA Technical Center	Participate in and support the development and validation of the packaging standards by providing technical expertise and conducting tests or validation efforts.
2d	FAA AIR	Review the standards, when complete, and publish appropriate guidance material, as applicable.
2e	FAA AIR	Coordinate the publication of a reference to the standard by FAA and/or Pipeline and Hazardous Materials Safety Administration (PHMSA).
2f	FAA AIR	Track implementation and report progress to JIMDAT and CAST.

Notes

Note: See section III for detailed costs and resources.

Action 3: Implement containment or suppression systems

Primary Implementer	**Air Carriers**
Action Objective	Air carriers should implement one or more state-of-the-art containment or suppression systems, as feasible.
Action Timeline	Flow Time: 78 months o 18 months for air carriers to define performance objectives and perform feasibility studies. o 60 months from feasibility studies completion for air carriers to implement chosen option. Due Date: 06/30/2023 o 6/30/2018 for air carriers to define performance objectives and perform feasibility studies. o 6/30/2023 for air carriers to implement chosen option.
Timeline/Flow for Future Adopters	TBD when CAST closes this action.
CAST Lead	National Air Carrier Association (NACA)

#	Organization(s)	Detailed Steps
3a	Air Carrier Industry Assns.	Contact member air carriers and communicate the recommendations of the CAST Cargo HazMat Fire study, recommending they implement one of more of the following to mitigate hazardous materials fires in their operations: a. Fire containment covers (FCC), b. Fire-resistant containers (FRC), c. A container-based fire suppression system, or d. Aircraft-based systems that deliver a suppression agent into unit load devices (ULD).
3b	Air Carriers	Determine the performance objectives for any mitigations needed, based on the air carrier's given operation.
3c	Air Carriers	Evaluate each available option for its effectiveness at meeting the performance objective as compared to the feasibility of implementing the option.
3d	Air Carriers	Implement chosen option(s), as feasible.
3e	Air Carrier Industry Assns.	Track implementation and report progress to JIMDAT and CAST.

Notes

- The FRC portion of this action ties to research and specifications currently being developed in SE 127, Cargo Fire Management, which is already funded.
- Current state-of-the-art technologies have not proven to be effective in containing/suppressing fires involving certain chemistries, quantities, or sizes of bulk shipments of lithium batteries (not packed with or contained in equipment).

Note: See section III for detailed costs and resources.

Action 4: Publish guidance for hazardous materials risk assessment

Primary Implementer	**FAA Aircraft Certification Service (AIR)**
Action Objective	FAA should publish guidance material for a risk assessment process that enables air carriers to determine the amount and type of hazardous materials that, if carried on an aircraft and involved in a fire, results in a fire that can be managed by the air carrier's fire protection methodologies.
Action Timeline	Flow Time: 45 months Due Date: 12/31/2021
Timeline/Flow for Future Adopters	TBD
CAST Lead	FAA AIR

#	Organization(s)	Detailed Steps
4a	FAA AIR/ FAA Security and Hazardous Materials Safety (ASH)	Coordinate with FAA Flight Standards Service, Safety Standards (AFS), aircraft manufacturers, air carriers, and other stakeholders to develop guidance for a risk assessment process that enables air carriers to determine the amount and type of hazardous materials, that, if carried on an aircraft and involved in a fire that can be managed by the air carrier's fire protection methodologies, including one or more of the following: a. The aircraft's fire suppression system certified as part of the aircraft's type design. b. Additional fire suppression capability that has been added to the aircraft in service. c. Fire protection resulting from fire containment covers (FCC) over palletized cargo. d. Fire protection resulting from fire-resistant containers (FRC). e. Fire protection resulting from containers that include an internal fire suppression system. f. Fire protection resulting from use of packaging that meets the standards in Action 2 (when available).
	Complete.	
4b	FAA	Publish the appropriate risk assessment guidance material.
	Complete.	
4c	FAA AFS	Track implementation and report progress to CAST.
	Complete based on the publication of FAA AC 120–121, Safety Risk Management Involving Items in Aircraft Cargo Compartments.	

Notes	The type and format of the guidance material are left to the FAA's discretion.

Note: See section III for detailed costs and resources.

SECTION II: DETAILED ACTION INFORMATION

Action 5: Develop procedures for hazardous materials risk assessments

Primary Implementer	**Air Carriers**
Action Objective	Air carriers should develop policies and procedures for conducting risk assessments for the hazardous materials allowed on their aircraft, and accompanying policy to limit the amount and type of hazardous materials that are within the capability of the fire protection method(s) used.
Action Timeline	Flow Time: 36 months (upon completion of Action 4) Due Date: 12/31/2022
Timeline/Flow for Future Adopters	TBD
CAST Lead	National Air Carrier Association (NACA)

#	Organization(s)	Detailed Steps
5a	Air Carrier Industry Assns.	Notify member air carriers of the guidance material in Action 4, once it is published.
	Complete.	
5b	Air Carriers	Gather data on the capabilities of the fire protection system(s) used.
	Complete.	
5c	Air Carriers	Gather data on the types and quantity of cargo carried and their contribution to a fire (for example, their flammability, gas generation, or explosion risk).
	Complete.	
5d	Air Carriers	Use the published risk assessment guidance material to limit the types and quantities of hazardous materials to those that can be safely carried.
	Complete.	
5e	Air Carrier Industry Assns.	Track implementation and report progress to JIMDAT and CAST.
	Complete based on air carrier completion of risk assessments using the guidance contained in AC 120–121.	

Notes	Air carriers could conduct the risk assessment on the information gathered before the FAA guidance material is published.

SECTION II

Note: See section III for detailed costs and resources.

SECTION III: SUPPLEMENTAL INFORMATION

Source Study	Cargo Hazardous Material Fires (SE 126) Working Group
Related Initiatives	• CAST SE 127, Remaining Risk – Cargo – Cargo Fire Management. • SAE AGE–2A Committee – standards development for FRCs. • FAA Technical Standard Order TSO–C203, Fire Containment Covers. • Industry development and testing of FRCs. • Industry development and certification of supplemental fire suppression system used in main deck Class "E" cargo compartments. • Industry research into new fire suppressing agents. • Industry R&D into hazardous materials packaging (including packaging for lithium batteries). • Government research in the area of lithium battery risk. *Note: The above-referenced initiatives are not necessarily specific to hazardous materials fires.*

Total Cost	**$44,275,000**	*Note: For labor, 1 Full Time Equivalent (FTE) = $250,000*	
Action 1	$5,700,000	21.75 FTE	Plus $250,000 overhead.
Action 2	$2,700,000	7.5 FTE	Plus $800,000 in R&D, travel, and overhead.
Action 3	$13,500,000	52 FTE	Plus cost of equipment (varies widely).
Action 4	$375,000	1.5 FTE	
Action 5	$22,000,000		(~$19.5M in air carrier labor costs, $2.5M in overhead)

	Organization	Resources Needed
Direct Resource Overview – Government	FAA AIR	• Action 2: 4.5 FTE, $400,000 (travel + misc.) for industry/FAA standards committee. • Action 4: 1.5 FAA FTEs to develop guidance.
	FAA Technical Center	• Action 2: 3 FTE and $400,000 non-recurring costs for R&D. *Note: This cost does not include the development of packaging to meet the standard.*
	FAA	• Action 3: 1 FAA FTE for standards development.

SECTION III

	Organization	Resources Needed
Direct Resource Overview – Industry	Air Carriers	• Action 3: o New FCC: $1,000–$2,000 each. o FRC: ▪ New: $5,000–$9,000 each. ▪ Retrofit: $3,000–$7,000 each. o Container-based fire suppression systems: ▪ New: $7,000–$11,000 each. ▪ Retrofit: $5,000–9,000 each. ▪ $50 maintenance per container per year. o Aircraft-based system: $300,000 per aircraft (parts and labor for installation; does not include engineering/certification costs). Minimal maintenance. o 1 FTE per operator x 52 will-carry (WC) operators = 52 FTEs. o Fuel burn cost dependent on operator mitigation strategy. *Note: Implementation costs will vary widely based on each air carrier's evaluation and implementation of options. Analysis assumes air carriers will perform their own cost-benefit assessments when making a determination. The cost estimates above are provided for informational purposes only.* • Action 5 (non-recurring costs): o Largest 5 cargo operators: ▪ 8 FTEs per operator for evaluation program support. ▪ $500,000 per operator in other overhead costs. o Other 47 part 121 WC operators: 0.75 FTE per operator for evaluation program support. *Notes: Lost revenue will vary by operator and the details of their risk assessment mitigations.* *Recurring expenses for operators will vary.*

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
1.9	02/02/2023	Action 2 due date extended from 02/28/2023 to 08/31/2023. Action 5 closed.
1.8	10/06/2022	Action 2 due date extended from 09/30/2022 to 02/28/2023.
1.7	04/07/2022	Action 1 closed.
1.6	10/07/2021	Action 2 due date extended from 12/31/2021 to 09/30/2022. Action 4 completed and closed. Action 5 due date extended from 12/31/2021 to 12/31/2022.
1.5	04/07/2021	Action 4 due date extended from 06/30/2021 to 12/31/2021.
1.4	11/02/2020	Action 4 due date extended from 12/31/2020 to 06/30/2021.
1.3	10/07/2020	Action 4 due date extended from 09/30/2020 to 12/31/2020.
1.2	07/01/2020	Action 4 due date extended from 12/31/2019 to 09/30/2020.
1.1	12/06/2018	Action 4 due date extended from 12/31/2018 to 12/31/2019. Action 5 due date extended from 12/31/2018 to 12/31/2021.
1.0	09/17/2018	New SE format. Content reorganized and terminology updated. No substantive changes.
Original	12/01/2016	CAST adopted SE 223.