Safety Enhancement SE 223 Cargo – Hazardous Material Fires – Prevention and Mitigation	
Safety Enhancement Action:	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.
Implementers: (Select all that apply)	☒ Air Carrier ☐ Industry Association ☐ Commercial Aviation Safety Team (CAST) ☐ Joint Implementation Measurement and Data Analysis Team (JIMDAT) ☐ Research Organization ☐ Labor Organization ☐ Manufacturer ☒ Regulator ☒ Other (specify) Industry Standards Committee
Statement of Work:	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*
Total Financial Resources:	**Total: $44.3M** Output 1: $5.7M Output 2: $2.7M Output 3: $13.5M Output 4: $0.4M Output 5: $22.0M

Relation to Current Aviation Community Initiatives:

- CAST Safety Enhancement (SE) 127, Remaining Risk – Cargo – Cargo Fire Management.
- SAE International (SAE) AGE–2A Committee – standards development for fire-resistant containers (FRC).
- Federal Aviation Administration (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 research and development (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 material fires.

Performance Goal Indicators:

Output (OP) Implementation:

Date	Implementation in U.S. Cargo Operations					
	OP1: Li batteries identified	OP2: Li batteries packaging usage	OP3: Use of FCC/FRC in ops	OP4/5: Risk assessment	Event Risk Reduction Estimate	Fatality Risk Reduction Estimate
1/1/2017	0%	0%	8%	25%	14.6%	11.4%
1/1/2020	25%	0%	15%	50%	30.3%	23.8%
1/1/2022	40%	50%	30%	80%	47.9%	38.4%
1/1/2027	55%	60%	40%	80%	51.3%	42.5%
1/1/2032	70%	70%	60%	80%	57.4%	49.5%

Key Milestones:

	Flow time (months)	Start Date	End Date
Output 1	30	1/1/2017	6/30/2019
Output 2	60	1/1/2017	12/31/2021
Output 3	78	1/1/2017	6/30/2023
Output 4	24	1/1/2017	12/31/2018
Output 5	24	1/1/2017	12/31/2018

Potential Obstacles:	Section II lithium batteries may be extremely difficult for air carriers to reliably identify with current requirements in place. Complicating factors include— • 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.
Detailed Implementation Plan Notes:	
CICTT Code:	F–NI

Output 1:	
Description:	Air carriers 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.
Lead Organization:	National Air Carrier Association (NACA)
Supporting Organizations:	Airlines for America (A4A) Regional Airline Association (RAA)
Other Affected Organizations:	

Organization	**How affected**
FAA Flight Standards Service (AFS)	Approve air carriers' revised policies, procedures, and training.
Air Line Pilots Association International (ALPA)	Possible coordination activities
Indirect air carriers and other third party shippers	Revise procedures and training on packaging shipments for air transport.
FAA Hazardous Materials Safety Program (ADG)	Possible coordination activities
International Air Transport Association (IATA)	Possible coordination activities

Implementers: (Select all that apply)	☒ Air Carrier ☐ Industry Association ☐ Commercial Aviation Safety Team (CAST) ☐ Joint Implementation Measurement and Data Analysis Team (JIMDAT)	☐ Research Organization ☐ Labor Organization ☐ Manufacturer ☐ Regulator ☐ Other (specify) _____

Actions:	1. Airline industry associations communicate with their air carrier members, explaining the analysis undertaken by CAST regarding hazardous material fires in aircraft cargo compartments. 2. Air carriers modify their 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. 3. Air carriers modify initial and recurrent training to communicate the procedural changes to appropriate personnel, including— a. Flightcrew members, b. Cargo acceptance agents, c. Dispatchers, d. Ramp agents, and e. Quality assurance inspectors. 4. Air carrier actions are considered complete when— a. The air carrier has revised its policies and procedures as noted for the carriage of lithium batteries as cargo, and b. All affected air carrier personnel have received training on the new policies and procedures. 5. Airline industry associations track implementation at their member carriers and report progress to JIMDAT and CAST.
Financial Resources:	$5.7M (21.75 Full Time Equivalents (FTE) and $250K overhead)
Itemized Resources:	• 5 Largest Cargo Operators: 2 FTEs/operator, $50K overhead. • 47 other "will-carry" (WC) part 121 operators: 0.25 FTE, min. overhead. *Note: Non-recurring cost. There are 52 part 121 WC operators as of 12/1/2016.* • Assume no new operational costs given current system for identification and pilot notification.
Output Notes:	Section I lithium batteries must be identified per the regulations; therefore, the Implementation Value in the timeline applies to Section II lithium batteries.
Timeline:	30 months after CAST approval. • 6 months for airline associations to contact air carrier members. • 12 months for air carriers to modify procedures. • 12 months for air carriers to perform initial training.
Target Completion Date:	Output 1a: 6/30/2017 to contact air carrier members. Output 1b: 6/30/2018 to modify procedures. Output 1c: 6/30/2019 to perform initial training.

Output 2:	
Description:	Develop performance-based fire mitigation standards for hazardous materials packaging.
Lead Organization:	FAA Aircraft Certification Service (AIR)
Supporting Organizations:	FAA Technical Center Standards Organization(s) (as tasked by AIR)
Other Affected Organizations:	**Organization** / **How affected** Airline pilot labor organizations — Member outreach on new/revised standards Airlines for America (A4A) — Member outreach on new/revised standards National Air Carrier Association (NACA) — Member outreach on new/revised standards Packaging manufacturers — Implementing new/revised standards into packaging designs
Implementers: (Select all that apply)	☐ Air Carrier ☐ Industry Association ☐ Commercial Aviation Safety Team (CAST) ☐ Joint Implementation Measurement and Data Analysis Team (JIMDAT) ☐ Research Organization ☐ Labor Organization ☐ Manufacturer ☒ Regulator ☒ Other (specify) Industry Standards Committees
Actions:	1. FAA AIR establishes the scope of the performance-based fire mitigation standards for hazardous materials packaging (internal fire, external fire, etc.). 2. FAA AIR formally tasks the appropriate industry standards activity (such as SAE; RTCA, Inc.; the International Organization for Standardization (ISO); or ASTM International) to develop packaging standards consistent with the scope of the tasking. 3. FAA Technical Center participates in and supports the development and validation of the packaging standards by providing technical expertise and conducting tests or validation efforts. 4. FAA AIR reviews the standards, when complete, and publishes appropriate guidance material, as applicable. 5. FAA AIR coordinates the publication of a reference to the standard by FAA and/or Pipeline and Hazardous Materials Safety Administration (PHMSA). 6. FAA AIR tracks implementation and report progress to JIMDAT and CAST.
Financial Resources:	$2.7M (7.5 FTEs and $800K)
Itemized Resources:	• Industry/FAA Standards Committee: 4.5 FTEs, $400K (travel + misc.). • FAA Technical Center R&D: 3 FTEs and $400K non-recurring costs.

Output Notes:	This cost does not include the development of packaging to meet the standard.
Timeline:	60 months from CAST approval. • 12 months for AIR to establish scope of standards and task standards committee. • 36 months for standards committee to complete work and publish report. • 12 months for FAA to publish guidance based on standards committee work.
Target Completion Date:	12/31/2017 for FAA AIR to establish scope of standards and task standards committee. 12/31/2020 for standards committee to complete work and publish report. 12/31/2021 for FAA AIR to publish guidance based on standards committee work.

Output 3:	
Description:	Air carriers implement one or more of the following state-of-the-art containment or suppression systems as best fits their operational needs, as feasible: 1. Fire containment covers (FCC), 2. Fire-resistant containers (FRC), 3. A container-based fire suppression system, or 4. Aircraft-based systems that deliver a suppression agent into unit load devices (ULD).
Lead Organization:	National Air Carrier Association (NACA)
Supporting Organizations:	Airlines for America (A4A)
Other Affected Organizations:	**Organization** / **How affected** FAA Aircraft Certification Service (AIR) — Approval of newly installed or modified containment or suppression systems FAA Flight Standards Service (AFS) — Approval of training programs related to newly installed or modified containment or suppression systems
Implementers: (Select all that apply)	☒ Air Carrier ☐ Industry Association ☐ Commercial Aviation Safety Team (CAST) ☐ Joint Implementation Measurement and Data Analysis Team (JIMDAT) ☐ Research Organization ☐ Labor Organization ☐ Manufacturer ☐ Regulator ☐ Other (specify) _____

Actions:	1. Airline industry associations contact their member carriers and communicate the recommendations of the CAST Cargo HazMat Fire study, recommending they should implement one of more of the following to mitigate hazardous material fires in their operations: a. FCCs, b. FRCs, c. A container-based fire suppression system, or d. Aircraft-based systems that deliver a suppression agent into ULDs. 2. Air carriers determine the performance objectives for any mitigations needed, based on their given operation. 3. Air carriers evaluate each available option for its effectiveness at meeting the performance objective as compared to the feasibility of implementing the option. 4. Air carriers implement chosen option(s), as feasible. 5. Airline industry associations track implementation and report progress to JIMDAT and CAST.
Financial Resources:	$13.5M (labor for evaluation) + cost of equipment (varies widely)
Itemized Resources:	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 following cost estimates are provided for informational purposes: • New FCC: $1K-$2K each. • FRC: o New: $5K-$9K each. o Retrofit: $3K-$7K each. • Container-based fire suppression systems: o New: $7K-$11K each. o Retrofit: $5K-9K each. o $50 maintenance per container per year. • Aircraft-based system: $300K per aircraft (parts and labor for installation; does not include engineering/certification costs). Minimal maintenance. • 1 FTE per operator x 52 WC operators = 52 FTEs. • 1 FAA FTE for standards development. • Fuel burn cost dependent on operator mitigation strategy.

Output Notes:	1. The FRC portion of this output ties to research and specifications currently being developed in SE 127, Cargo Fire Management, which is already funded. 2. 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).
Timeline:	78 months from CAST approval. • 18 months for air carriers to define performance objectives and perform feasibility studies. • 60 months from feasibility studies completion for air carrier to implement chosen option.
Target Completion Date:	6/30/2018 for air carriers to define performance objectives and perform feasibility studies. 6/30/2023 for air carriers to implement chosen option.

Output 4:	
Description:	FAA publishes 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.
Lead Organization:	FAA Aircraft Certification Service (AIR)
Supporting Organizations:	FAA Flight Standards Service (AFS) FAA Hazardous Materials Safety Office (ADG) Aircraft manufacturers Air carriers
Other Affected Organizations:	**Organization** / **How affected** Airlines for America (A4A) / National Air Carrier Association (NACA): Solicit member air carrier input on draft guidance and distribute final material to members. European Aviation Safety Agency (EASA): Review published guidance and determine if relevant to distribute to its regulated air carriers.
Implementers: (Select all that apply)	☐ Air Carrier ☐ Industry Association ☐ Commercial Aviation Safety Team (CAST) ☐ Joint Implementation Measurement and Data Analysis Team (JIMDAT) ☐ Research Organization ☐ Labor Organization ☐ Manufacturer ☒ Regulator ☐ Other (specify) _____

Actions:	1. FAA AIR/FAA ADG coordinates with FAA 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 FCCs over palletized cargo. d. Fire protection resulting from FRCs. 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 Output 2 (when available). 2. FAA publishes the appropriate risk assessment guidance material. 3. FAA AFS tracks implementation and report progress to CAST.
Financial Resources:	$0.375M (1.5 FTEs)
Itemized Resources:	1.5 FAA FTEs to develop guidance.
Output Notes:	The type and format of the guidance material are left to the FAA's discretion.
Timeline:	24 months
Target Completion Date:	12/31/2018

Output 5:	
Description:	Air carriers 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.
Lead Organization:	National Air Carrier Association (NACA)
Supporting Organizations:	Airlines for America (A4A) Air carriers
Other Affected Organizations:	
Implementers: (Select all that apply)	☒ Air Carrier ☐ Industry Association ☐ Commercial Aviation Safety Team (CAST) ☐ Joint Implementation Measurement and Data Analysis Team (JIMDAT) ☐ Research Organization ☐ Labor Organization ☐ Manufacturer ☐ Regulator ☐ Other (specify) _____
Actions:	1. Airline associations notify their members carriers of the guidance material in Output 4, once it is published. 2. Air carriers gather data on the capabilities of the fire protection system(s) used. 3. 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). 4. 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. 5. Airline industry associations track implementation and report progress to JIMDAT and CAST.
Financial Resources:	$22M (~$19.5M in air carrier labor costs, $2.5M in overhead)

Itemized Resources:	<u>Operator Procedures (Non-recurring):</u>
	• Largest 5 cargo operators:
	  o 8 FTEs per operator for evaluation program support.
	  o $500K per operator in other overhead costs.
	• Other 47 part 121 WC operators: 0.75 FTE per operator for evaluation program support.
	
	Lost revenue will vary by operator and the details of their risk assessment mitigations.
	
	Recurring expenses for operators will vary.

Output Notes:	Air carriers could conduct the risk assessment on the information gathered before the FAA guidance material is published.
Timeline:	24 months
Target Completion Date:	12/31/2018

Reference Material	
Supporting CAST Intervention Strategies	<u>Packaging</u> IS1506a: Packaging and/or battery manufacturers should develop and HazMat shippers should utilize packaging that can contain a fire involving the hazardous material it contains for no less than 6 hours, if no external ignition source is necessary to initiate a fire. IS1506b: Manufacturers should develop and HazMat shippers should utilize packaging that will not lead to or continue propagation from an external/internal fire source. <u>Regulatory/Industry Standards and/or Operator Procedures</u> IS1570: Regulators should require systematic, performance-based fire mitigation standards for Hazardous Materials at the packaging and/or container level. IS1598a: Regulators should create regulations that do not allow the cumulative hazard of dangerous goods shipments on the aircraft to exceed the capability of aircraft fire protection systems and operator equipment. IS1529: Regulators should develop and require a new smoke penetration test procedure to account for the unique hazards (e.g., pressure and temp.) of lithium-battery fires. IS1598b: Operators carrying air-shipments of dangerous goods should develop procedures that do not allow the cumulative hazard of dangerous goods shipments on the aircraft to exceed the capability of aircraft fire protection systems and operator equipment. IS1513b: To minimize lithium battery-related accidents, operators and shipping companies should implement a reliable system to identify all lithium batteries onboard aircraft, regardless of regulatory exceptions and to provide such information to the operator and the flight crew. IS1513: To minimize hazmat-related accidents, operators and shipping companies should implement a reliable system to identify all hazardous materials capable of causing a fire onboard aircraft, regardless of regulatory exceptions and to provide such information to the flight crew. See IS843.

Supporting CAST Intervention Strategies	<u>Containers</u> IS1572: Container manufacturers should develop, operators should utilize fire resistant containers (including fire containment covers) that can prevent the spread of flames and heat from HMFs getting outside the container and protect the contents from the effects of an external fire for no less than 6 hours. IS1503a: Container manufacturers should develop and operators should utilize container-based suppression systems utilized within suitable containers that can suppress lithium-ion battery fires for no less than 6 hours. IS1503b: Container manufacturers should develop and operators should utilize container-based suppression systems utilized within suitable containers that can suppress lithium-metal battery fires for no less than 6 hours. IS1504a: Containers manufacturers should develop and operators should utilize fire resistant containers (including fire containment covers) that can prevent the spread of flames and heat from [hazardous material fires including] lithium-ion battery fires outside the container for no less than 6 hours. IS1504b: Containers manufacturers should develop and operators should utilize fire resistant containers (including fire containment covers) that can prevent the spread of flames and heat from [hazardous material fires including] lithium-metal battery fires outside the container for no less than 6 hours.