

Safety Enhancement SE 225 (R&D)
Cargo – Hazardous Material Fires – Containment and Suppression

Safety Enhancement Action:	Air carriers, aircraft manufacturers, lithium battery manufacturers, shippers of hazardous materials, manufacturers of unit load devices (ULD), and manufacturers of packaging for hazardous materials conduct research and develop systems for mitigating the effects of a fire involving hazardous materials through improved containment and/or suppression.
Implementers: (Select all that apply)	<input type="checkbox"/> Air Carrier <input type="checkbox"/> Industry Association <input type="checkbox"/> Commercial Aviation Safety Team (CAST) <input type="checkbox"/> Joint Implementation Measurement and Data Analysis Team (JIMDAT) <input checked="" type="checkbox"/> Research Organization <input type="checkbox"/> Labor Organization <input type="checkbox"/> Manufacturer <input checked="" type="checkbox"/> Regulator <input type="checkbox"/> Other (specify) _____
Statement of Work:	The aviation community should conduct research and develop standards for containment and/or suppression solutions that mitigate hazardous material fires (including but not limited to lithium batteries) for at least 6 hours. These systems could be aircraft-based, or installed within the cargo container, or in the hazardous material’s packaging.
Total Financial Resources:	Total: \$38.0M Output 1: \$6.1M Output 2: \$16.5M Output 3: \$2.7M Output 4: \$12.7M FAA: \$7.0M Industry: \$31.0M
Relation to Current Aviation Community Initiatives:	<ul style="list-style-type: none"> • Industry is researching hazardous materials packaging. • Industry is researching ULDs capable of safely transporting hazardous materials.
Performance Goal Indicators:	

Key Milestones:	Flow time (months)		Start Date	End Date
	Output 1	84	1/1/2017	12/31/2023
Output 2	168	1/1/2017	12/31/2030	
Output 3	36	1/1/2017	12/31/2019	
Output 4	54	1/1/2017	6/30/2021	
Completion	168	1/1/2017	12/31/2030	
Potential Obstacles:	Regulators not providing standards.			
Detailed Implementation Plan Notes:	Given the limited state of effectiveness of today's containment and suppression systems and the variables surrounding the risk with lithium battery fires, this safety enhancement involves a progressive solution starting with current state-of-the-art containment/suppression technology and evolving through research and development (R&D) to higher performance.			
CICTT Code:	F-NI			

Output 1:			
Description:	Standards and R&D results for containment and/or suppression solutions that are integrated into cargo containers and capable of mitigating hazardous material fires (including but not limited to those involving lithium batteries) for at least 6 hours.		
Lead Organization:	FAA Aircraft Certification Service (AIR)		
Supporting Organizations:	FAA Technical Center Aerospace Industries Association (AIA) Cargo container manufacturers Air carriers		
Other Affected Organizations:			
Implementers: (Select all that apply)	<table border="0" style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> <input type="checkbox"/> Air Carrier <input type="checkbox"/> Industry Association <input type="checkbox"/> Commercial Aviation Safety Team (CAST) <input type="checkbox"/> Joint Implementation Measurement and Data Analysis Team (JIMDAT) </td> <td style="width: 50%; vertical-align: top;"> <input checked="" type="checkbox"/> Research Organization <input type="checkbox"/> Labor Organization <input type="checkbox"/> Manufacturer <input checked="" type="checkbox"/> Regulator <input type="checkbox"/> Other (specify) _____ </td> </tr> </table>	<input type="checkbox"/> Air Carrier <input type="checkbox"/> Industry Association <input type="checkbox"/> Commercial Aviation Safety Team (CAST) <input type="checkbox"/> Joint Implementation Measurement and Data Analysis Team (JIMDAT)	<input checked="" type="checkbox"/> Research Organization <input type="checkbox"/> Labor Organization <input type="checkbox"/> Manufacturer <input checked="" type="checkbox"/> Regulator <input type="checkbox"/> Other (specify) _____
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Actions:	<ol style="list-style-type: none"> 1. FAA AIR, in conjunction with other stakeholders including the FAA Technical Center, industry associations, air carriers, and cargo container manufacturers, establishes requirements and test standards to be used in cargo container development, based on industry regulation and air carrier risk profiles in conjunction with the fire hazard characterization being developed. 2. FAA AIR tasks appropriate standards committee to develop standards specific to the known risks associated with lithium batteries, including— <ol style="list-style-type: none"> a. Temperature and time limits; b. Management of explosive, flammable gases and the associated pressure pulse of an explosion; and c. Impact resistance of materials when at a high temperature. 3. Air carriers and cargo container manufacturers, in conjunction with the FAA Technical Center, develop and test prototype cargo containers that can contain and/or suppress in accordance with the test standards identified in action 1, for at least a 6-hour duration. 4. FAA AIR reports progress on research to JIMDAT and CAST. 		
Financial Resources:	\$6.1M (\$2.1M FAA, \$4M industry)		

Itemized Resources:	<p>FAA costs for generating information for standard and standards development:</p> <ul style="list-style-type: none"> • \$1.5M labor (3 Full Time Equivalents (FTE) per year for 2 years). • \$0.6M overhead/testing. <p>Industry (air carrier, OEM, suppliers) costs for development of system(s):</p> <ul style="list-style-type: none"> • \$2.5M labor (2 FTEs per year for 5 years). • \$1.5M overhead/testing. <p><i>Note: 1 FTE = \$250K.</i></p>
Output Notes:	<ol style="list-style-type: none"> 1. Development of system does not include cost or time for aircraft certification. 2. Duration for system development is based on technology and economic feasibility.
Timeline:	<p>84 months from CAST approval.</p> <ul style="list-style-type: none"> • 24 months to develop standards. • 60 months to research systems and publish results.
Target Completion Date:	<ul style="list-style-type: none"> • Output 1a: 12/31/2018 to develop standards. • Output 1b: 12/31/2023 to research systems and publish results.

Output 2:

Description:	Standards and R&D results for containment and/or suppression systems that are integrated into the aircraft and capable of mitigating hazardous material fires (including but not limited to those involving lithium batteries) for at least 6 hours.	
Lead Organization:	FAA Aircraft Certification Service (AIR)	
Supporting Organizations:	FAA Technical Center Aerospace Industries Association (AIA) Cargo container manufacturers Aircraft manufacturers Air carriers	
Other Affected Organizations:		
Implementers: (Select all that apply)	<input type="checkbox"/> Air Carrier <input type="checkbox"/> Industry Association <input type="checkbox"/> Commercial Aviation Safety Team (CAST) <input type="checkbox"/> Joint Implementation Measurement and Data Analysis Team (JIMDAT)	<input checked="" type="checkbox"/> Research Organization <input type="checkbox"/> Labor Organization <input type="checkbox"/> Manufacturer <input checked="" type="checkbox"/> Regulator <input type="checkbox"/> Other (specify) _____
Actions:	<ol style="list-style-type: none"> 1. FAA AIR, in conjunction with other stakeholders including the FAA Technical Center, industry associations, air carriers, and aircraft manufacturers, establishes requirements and test standards to be used in aircraft-based fire suppression system development, based on industry regulation and air carrier risk profiles in conjunction with the fire hazard characterization being developed. 2. FAA AIR tasks appropriate standards committee to develop standards specific to the known risks associated with lithium batteries, including— <ol style="list-style-type: none"> a. Temperature and time limits; b. Management of explosive, flammable gases and the associated pressure pulse of an explosion; and c. Impact resistance of materials when at a high temperature. 3. Air carriers and aircraft manufacturers, in conjunction with the FAA Technical Center, develop and test prototype systems that can contain and/or suppress in accordance with the test standards for at least a 6-hour duration. 4. FAA AIR tracks progress and reports to JIMDAT and CAST. 	
Financial Resources:	\$16.5M (\$3.5M FAA, \$13M industry)	

Itemized Resources:	<p>FAA costs for standards development:</p> <ul style="list-style-type: none"> • \$2.5M labor (2.5 FTEs per year for 4 years). • \$1M overhead/testing. <p>Industry (air carrier, OEMs supplier) costs for development of prototype system(s):</p> <ul style="list-style-type: none"> • \$10M labor (4 FTEs per year for 10 years). • \$3M overhead/testing. <p><i>Note: 1 FTE = \$250K.</i></p>
Output Notes:	<ol style="list-style-type: none"> 1. Containment and/or suppression may be performed with the introduction of a suppressing agent into a container from the aircraft-based system. 2. Duration for system development is based on technology and economic feasibility. 3. Development of system does not include cost or time for aircraft certification.
Timeline:	<p>168 months (14 years) from CAST approval.</p> <ul style="list-style-type: none"> • 48 months (4 years) to develop standards. • 120 months (10 years) to complete and publish research on systems.
Target Completion Date:	<ul style="list-style-type: none"> • Output 2a: 12/31/2020 to develop standards. • Output 2b: 12/31/2030 to complete and publish research on systems.

Output 3:

Description:	Standards and R&D results for containment and/or suppression solutions that are integrated into hazardous material packaging and capable of mitigating hazardous material fires (including but not limited to those involving lithium batteries) for at least 6 hours. Implement performance-based fire mitigation standards for hazardous materials packaging.	
Lead Organization:	FAA Aircraft Certification Service (AIR)	
Supporting Organizations:	FAA Technical Center Packaging manufacturers Air carriers	
Implementers: (Select all that apply)	<input type="checkbox"/> Air Carrier <input type="checkbox"/> Industry Association <input type="checkbox"/> Commercial Aviation Safety Team (CAST) <input type="checkbox"/> Joint Implementation Measurement and Data Analysis Team (JIMDAT)	<input checked="" type="checkbox"/> Research Organization <input type="checkbox"/> Labor Organization <input type="checkbox"/> Manufacturer <input checked="" type="checkbox"/> Regulator <input type="checkbox"/> Other (specify)
Actions:	<ol style="list-style-type: none"> 1. FAA AIR, in conjunction with other stakeholders including the FAA Technical Center, industry associations, air carriers, and packaging manufacturers, establishes requirements and test standards to be used in performance-based fire mitigation standard for hazardous materials packaging (internal fire, external fire, etc.). 2. FAA AIR tasks appropriate standards committee to develop standards specific to the known risks associated with lithium batteries, including— <ol style="list-style-type: none"> a. Temperature and time limits; b. Management of explosive, flammable gases and the associated pressure pulse of an explosion; and c. Impact resistance of materials when at a high temperature. 3. Air carriers and hazardous material shippers, in conjunction with the FAA Technical Center, develop and test prototype packaging that can contain and/or suppress in accordance with the test standards for at least a 6-hour duration. 4. FAA AIR tracks progress and reports results to JIMDAT and CAST. 	
Financial Resources:	\$2.65M (\$1.15M FAA, \$1.5M industry)	

Itemized Resources:	FAA costs for standards development: <ul style="list-style-type: none"> • \$0.75M labor. • \$0.4M overhead. Industry (air carriers, OEMs, suppliers) costs for development of packaging prototypes: <ul style="list-style-type: none"> • \$1M labor. • \$0.5M overhead. <i>Note: 1 FTE = \$250K.</i>
Output Notes:	<ol style="list-style-type: none"> 1. Extensive R&D has already occurred. 2. Development will be an ongoing process due to the new battery types and chemistries continually being introduced.
Timeline:	36 months from CAST approval. <ul style="list-style-type: none"> • 12 months to develop standards. • 24 months to develop packaging.
Target Completion Date:	Output 3a: 12/31/2017 to develop standards. Output 3b: 12/31/2019 to develop packaging.

Output 4:

Description:	Standards for the exclusion of smoke in the cockpit when the smoke is produced from hazardous materials (including but not limited to those involving lithium batteries). Research and develop results on barriers and/or smoke removal systems with specific regards to smoke, pressure, temperature, and flammable vapors.	
Lead Organization:	FAA Aircraft Certification Service (AIR)	
Supporting Organizations:	FAA Technical Center Aircraft manufacturers Air carriers	
Other Affected Organizations:		
Implementers: (Select all that apply)	<input type="checkbox"/> Air Carrier <input type="checkbox"/> Industry Association <input type="checkbox"/> Commercial Aviation Safety Team (CAST) <input type="checkbox"/> Joint Implementation Measurement and Data Analysis Team (JIMDAT)	<input checked="" type="checkbox"/> Research Organization <input type="checkbox"/> Labor Organization <input type="checkbox"/> Manufacturer <input checked="" type="checkbox"/> Regulator <input type="checkbox"/> Other (specify) _____
Actions:	<ol style="list-style-type: none"> 1. FAA AIR sponsors research to characterize the effects of increased smoke, pressure, temperature, and flammable vapors associated with fires involving lithium batteries. The research should also— <ol style="list-style-type: none"> a. Include a survey of technology in development to understand emerging energy storage technologies and the hazards that technology may present when involved in fire on board aircraft. b. Explore considerations of these effects (such as removal of smoke, pressure, temperature, and flammable vapors) at the aircraft level. 2. FAA Technical Center, in conjunction with FAA AIR, aircraft manufacturers, and air carriers, conducts the research and document results in publicly available reports. 3. FAA AIR reports research status and completion to JIMDAT and CAST. 	
Financial Resources:	\$12.7M (\$1.3M FAA, \$11.4M industry)	

Itemized Resources:	FAA costs for standards development: <ul style="list-style-type: none"> • \$1M labor (2.5 FTEs for 1.5 years). • \$0.3M overhead. Industry (air carrier, OEM, supplier) costs for development of system(s): <ul style="list-style-type: none"> • \$9M labor (3 FTEs per year for 3 years, for 4 OEMs). • \$2.4M overhead. <i>Note: 1 FTE = \$250K.</i>
Output Notes:	<ol style="list-style-type: none"> 1. Development of systems based on new type design, excludes current production and retrofit. 2. FAA Technical Center has performed a few smoke characterization tests.
Timeline:	54 months from CAST approval. <ul style="list-style-type: none"> • 18 months to develop standards. • 36 months to develop systems.
Target Completion Date:	Output 4a: 6/30/2018 to develop standards. Output 4b: 6/30/2021 to develop systems.

Reference Material

Supporting CAST Intervention Strategies

IS1572: Container manufacturers should develop and 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 materials 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 materials including] lithium-metal battery fires outside the container for no less than 6 hours.

IS1504d: Manufacturers/Regulators should develop and operators should utilize compartments that can contain the effects of a lithium-metal battery fire for no less than 6 hours.

IS1505a: Manufacturers should develop and operators should implement aircraft-based systems which introduce extinguishing agent into a container(s) to suppress [hazardous materials fires including] lithium-ion battery fires for no less than 6 hours.

IS1530: Regulators should require, manufacturers should develop, and operators should implement a means for removing/mitigating smoke, pressure, and flammable vapors produced by lithium batteries (ion and metal) from the aircraft.

IS1505b: Manufacturers should develop and operators should implement aircraft-based systems which introduce extinguishing agent into a container(s) to suppress [hazardous materials fires including] lithium-metal battery fires for no less than 6 hours.

IS1504c: Manufacturers/Regulators should develop and operators should utilize compartments that can contain the effects of a lithium-ion battery fire for no less than 6 hours.

IS842: To minimize the risk of cargo-related fires, regulators should require and manufacturers and

	<p>operators should install full fire suppression systems in all cargo compartments of all airplanes, including retrofit of existing airplanes.</p> <p>IS1504e: Manufacturers should develop and regulators should require aircraft systems be designed so that HMFs will not prevent the continued safe flight or landing of the aircraft.</p> <p>IS1540: Manufacturers should develop and operators should utilize compartments that can contain the effects of lithium battery and highly flammable fluid fires for no less than 6 hours.</p> <p>IS1528: Manufacturers should develop and regulators should require a secondary smoke barrier encapsulating the cockpit, providing as much protection as possible from HMF-related smoke/fire/heat hazards.</p> <p>IS1527: Manufacturers should develop and regulators should require an alternative system for removing smoke from the flight deck.</p>
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