Safety Enhancement SE 210.4 ASA – Research – Flight Crew Performance Data	
Safety Enhancement Action:	Aviation community (government, industry, and academia) performs research to enhance tools and methods for collecting and analyzing flight crew performance data in situations associated with loss of energy and/or attitude state awareness, suitable for use in the design process.
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)
Statement of Work:	A CAST study showed that flight crew performance limitations were involved in half of the18 loss-of-control events. The aviation community (government, industry, and academia) should conduct research and development to enhance tools and methods for analyzing flight crew performance for use in design practices and processes. The research should focus on flight crew responses to situations associated with loss of energy and/or attitude state awareness, and should encompass the following: 1. Develop a database of historical flight crew performance response situations associated with loss of energy and/or attitude state awareness. 2. Enhance methods and guidelines used in the design process to assess flight crew performance in these situations. 3. Develop and validate prototype technologies for detection and mitigation of attention issues for use in design evaluation.
Total Financial Resources:	**Total: $11.0M** Output 1: $3.0M Output 2: $4.0M Output 3: $4.0M
Relation to Current Aviation Community Initiatives:	• National Aeronautics and Space Administration (NASA) Aviation Safety Program • Title 14, Code of Federal Regulations (14 CFR) 25.771 (a) and (c), *Pilot compartment* • 14 CFR 25.1301, *Function and installation – intended function of installed systems* • 14 CFR 25.1302, *Installed systems and equipment for use by the flightcrew* • 14 CFR 25.1309 (a) and (c), *Equipment, systems and installations*, amendment 25–123 • 14 CFR 25.1322, *Flightcrew alerting*, amendment 25–131 • 14 CFR 25.1329, *Flight guidance system – Autopilot, flight director and autothrust*

Performance Goal Indicators:	Provide cost-effective tools and methods that more effectively collect and analyze flight crew performance in situations associated with loss of energy and/or attitude state awareness, for use in the design process. All technologies should be developed with consideration for their potential acceptability under applicable current 14 CFR part 25 design standards.
Key Milestones:	<table><tr><th></th><th>Flow time (mo)</th><th>Start Date</th><th>End Date</th></tr><tr><td>Output 1:</td><td>52</td><td>12/31/2013</td><td>4/30/2018</td></tr><tr><td>Output 2:</td><td>57</td><td>12/31/2013</td><td>9/30/2018</td></tr><tr><td>Output 3:</td><td>60</td><td>12/31/2013</td><td>12/31/2018</td></tr><tr><td>Completion:</td><td>60</td><td>12/31/2013</td><td>12/31/2018</td></tr></table>
Potential Obstacles:	• Data on flight crew performance in situations is sparse and difficult to generalize across applied pilot-in-the-loop experimentation. • Access to Aviation Safety Information Analysis and Sharing (ASIAS) data (and additional data) may be needed.
Detailed Implementation Plan Notes:	Supporting CAST Intervention Strategies IS 1221—Industry should research and develop automatic systems to assist flight crews with error prevention, error trapping, and error recovery (e.g. expert systems to recognize, confirm and alert crews to potentially hazardous conditions and errors of commission/omission). IS 49–R—Industry should perform research and development of methods to evaluate and improve the reliability and failure tolerance of flight systems (including hardware, software and human performance). IS 1248—To enable failure analyses that are based upon realistic levels of flight crew reliability, researchers should develop and validate models of human error suitable for use in certification analyses and by aviation standards organizations (SAE International, Radio Technical Commission for Aeronautics (RTCA), etc.) for developing standards. IS 356—Research should be done to develop an effective tactical decision-making model for flight crews in time critical situations.
CICTT Code:	Loss of Control–Inflight (LOC–I)

Output 1:		
Description:	Develop a historical database of flight crew performance in situations associated with loss of energy and/or attitude state awareness, for use in the design process.	
Lead Organization:	Federal Aviation Administration (FAA)	
Supporting Organizations:	Airbus Bombardier, Inc. Embraer National Aeronautics and Space Administration (NASA) The Boeing Company	
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. NASA will coordinate with the FAA and manufacturer research organizations to acquire available flight crew performance data that captures flight crew actions and responses in situations associated with loss of energy and/or attitude state awareness, including but not limited to— a) Flight deck cautions and warnings; b) Collision or terrain avoidance; c) Recovery from externally induced upsets, including wake vortex and windshear; d) Aircraft malfunction detection, diagnosis, and control; and e) Go-around performance. 2. Research organizations will review results with industry and FAA to ensure consensus regarding acceptability and confidence of the database and methods for its application. 3. JIMDAT will track research results against the risk reduction performance of airplane state awareness (ASA) safety enhancements (SE) and make recommendations to CAST for future technology implementations.	
Financial Resources:	Total: $3.0M (12.0 Full Time Equivalent (FTE))	
Itemized Resources:	R&D Org: 12.0 FTE to perform study NOTES: • For labor, 1 FTE was assumed to = $250K.	

	• Rough Order of Magnitude (ROM) estimates provided for CAST prioritization and assessment—actual resources to be informed by historical research and development (R&D) cost data from similar programs through each organization's normal research planning process • "R&D Org" resources indicate general labor support required to perform the research. Specific organization support will be determined through normal organizational R&D planning efforts using guidance from a CAST R&D forum to discuss development of and execution of R&D plans by member organizations.
Output Notes:	This is a research detailed implementation plan (DIP). The initial output would be a database focused on conditions associated with loss of energy and/or attitude state awareness.
Time Line:	• 6 months from CAST approval for NASA to convene a CAST R&D forum to discuss development of and execution of R&D plans by member organizations • 42 months after R&D forum for research organizations to complete initial database • Population and maintenance of database to continue beyond R&D, with management of database to be determined
Target Completion Date:	4/30/2018 (extended from 12/31/2017). Closed 06/07/2018 based on completion of R&D work.
Output 2:	
Description:	Enhance methods and guidelines used in the design process to assess flight crew performance in situations associated with loss of energy and/or attitude state awareness.
Lead Organization:	National Aeronautics and Space Administration (NASA)
Supporting Organizations:	Airbus Bombardier, Inc. Embraer Federal Aviation Administration (FAA) Aircraft Certification Service (AIR) Department of Defense (DoD) The Boeing Company
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. NASA will coordinate with the FAA and manufacturer research organizations to develop enhanced tools and methods for use in the design process to represent flight crew responses in situations associated with loss of energy and/or attitude state awareness. These methods will incorporate information from the flight crew performance database developed in Output 1 to enhance or

	expand beyond current design methodologies, such as qualitative pilot-in-the-loop simulation evaluations. 2. Research organizations will work with industry and FAA to achieve consensus regarding the acceptability and applicability of these methods and guidelines for use in the design process. 3. Research organizations should publish findings in publicly available reports. 4. JIMDAT will track research results against the risk reduction performance of airplane state awareness (ASA) safety enhancements (SE) and make recommendations to CAST for future technology implementations.
Financial Resources:	Total: $4.0M (16.0 Full Time Equivalent (FTE))
Itemized Resources:	R&D Org: 16.0 FTE to perform study NOTES: • For labor, 1 FTE was assumed to = $250K. • Rough Order of Magnitude (ROM) estimates provided for CAST prioritization and assessment—actual resources to be informed by historical research and development (R&D) cost data from similar programs through each organization's normal research planning process • "R&D Org" resources indicate general labor support required to perform the research. Specific organization support will be determined through normal organizational R&D planning efforts using guidance from a CAST R&D forum to discuss development of and execution of R&D plans by member organizations.
Output Notes:	This is a research detailed implementation plan (DIP).
Time Line:	• 6 months from CAST approval for NASA to convene a CAST R&D forum to discuss development of and execution of R&D plans by member organizations • 42 months after R&D forum for research organizations to complete R&D studies
Target Completion Date:	9/30/2018 (extended from 3/31/2018). Completed and closed 10/04/2018 based on completed NASA research. JIMDAT will review reports and recommend appropriate follow-on actions.
Output 3	
Description:	Develop and validate prototype technologies for detection and mitigation of attention issues associated with loss of energy and/or attitude state awareness, for use in design evaluation.
Lead Organization:	National Aeronautics and Space Administration (NASA)
Supporting Organizations:	Airbus Bombardier, Inc. Embraer Federal Aviation Administration (FAA) Aircraft Certification Service (AIR)

	The Boeing Company	
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. NASA will coordinate with FAA AIR and manufacturer research organizations to further develop prototype technologies for detection and mitigation of attention issues for use in design evaluation. Technologies should include eye tracking, functional Near infrared Spectroscopy (fNIRS), heart rate variarbility (HRV), or other physiological measures. 2. Research organizations will evaluate prototype technologies with the FAA and the design/evaluation community, and publish findings in publicly available reports. 3. JIMDAT will track research results against the risk reduction performance of airplane state awareness (ASA) safety enhancements (SE) and make recommendations to CAST for future technology implementations.	
Financial Resources:	Total: $4.0M (16.0 Full Time Equivalent (FTE))	
Itemized Resources:	R&D Org: 16.0 FTE to perform study NOTES: • For labor, 1 FTE was assumed to = $250K. • Rough Order of Magnitude (ROM) estimates provided for CAST prioritization and assessment—actual resources to be informed by historical research and development (R&D) cost data from similar programs through each organization's normal research planning process • "R&D Org" resources indicate general labor support required to perform the research. Specific organization support will be determined through normal organizational R&D planning efforts using guidance from a CAST R&D forum to discuss development of and execution of R&D plans by member organizations.	
Output Notes:	This is a research detailed implementation plan (DIP). NOTE: This output may be combined with output 2 of SE 211, pending review during the CAST R&D forum.	
Time Line:	• 6 months from CAST approval for NASA to convene a CAST R&D forum to discuss development of and execution of R&D plans by member organizations • 54 months after R&D forum for research organizations to complete R&D studies	

Target Completion Date:	12/31/2018. Completed and closed 10/04/2018 based on completed NASA research. JIMDAT will review reports and recommend appropriate follow-on actions.
Reference Material	
Supporting CAST Intervention Strategies	NOTE: *This section lists applicable CAST Intervention Strategies (IS) used to develop the actions in this detailed implementation plan (DIP). These ISs are listed to provide traceability and supporting rationale for the recommended actions. IS recommendations may be wholly or only partly represented in the DIP, based on a final determination of feasible actions during DIP development.* IS 1221—Industry should research and develop automatic systems to assist flight crews with error prevention, error trapping, and error recovery (e.g. expert systems to recognize, confirm and alert crews to potentially hazardous conditions and errors of commission/omission). IS 49–R—Industry should perform research and development of methods to evaluate and improve the reliability and failure tolerance of flight systems (including hardware, software and human performance). IS 1248—To enable failure analyses that are based upon realistic levels of flight crew reliability, researchers should develop and validate models of human error suitable for use in certification analyses and by aviation standards organizations (SAE International, Radio Technical Commission for Aeronautics (RTCA), etc.) for developing standards. IS 356—Research should be done to develop an effective tactical decision-making model for flight crews in time-critical situations.