

Safety Enhancement SE 205.4
ASA – Design – Features for Out-of-Production Airplane Designs

Safety Enhancement Action:	Manufacturers study the feasibility of incorporating, into applicable existing out-of-production transport category airplane (TCA) type designs, design features to address the risks identified by the airplane state awareness (ASA) Joint Safety Analysis Team (JSAT) and Joint Safety Implementation Team (JSIT).										
Implementers: (Select all that apply)	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none;"><input type="checkbox"/> Air Carrier</td> <td style="width: 50%; border: none;"><input type="checkbox"/> Research Organization</td> </tr> <tr> <td style="border: none;"><input checked="" type="checkbox"/> Industry Association</td> <td style="border: none;"><input type="checkbox"/> Labor Organization</td> </tr> <tr> <td style="border: none;"><input type="checkbox"/> Commercial Aviation Safety Team (CAST)</td> <td style="border: none;"><input checked="" type="checkbox"/> Manufacturer</td> </tr> <tr> <td style="border: none;"><input checked="" type="checkbox"/> Joint Implementation Measurement and Data Analysis Team (JIMDAT)</td> <td style="border: none;"><input type="checkbox"/> Regulator</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none;"><input type="checkbox"/> Other (specify) _____</td> </tr> </table>	<input type="checkbox"/> Air Carrier	<input type="checkbox"/> Research Organization	<input checked="" type="checkbox"/> Industry Association	<input type="checkbox"/> Labor Organization	<input type="checkbox"/> Commercial Aviation Safety Team (CAST)	<input checked="" type="checkbox"/> Manufacturer	<input checked="" type="checkbox"/> Joint Implementation Measurement and Data Analysis Team (JIMDAT)	<input type="checkbox"/> Regulator		<input type="checkbox"/> Other (specify) _____
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Statement of Work:	<p>A CAST study of 18 loss-of-control accidents and incidents resulting from flight crew loss of ASA determined that several design features, working separately or in conjunction, could have significantly reduced the likelihood of these accidents or incidents occurring. Manufacturers should study the potential to implement design features into existing out-of-production TCA type designs. Candidate features for study include:</p> <ol style="list-style-type: none"> 1. Low airspeed caution alerting; 2. Bank angle alerting and recovery guidance display systems; 3. Virtual day-visual meteorological conditions (VMC) display systems, such as synthetic vision or equivalent systems, which permit flight crews to operate in a day-VMC-like environment, regardless of external visibility; and 4. Energy state cues, such as flight path, acceleration, and speed deviation, in a manner similar to modern head-up displays for two scenarios: <ol style="list-style-type: none"> a) As part of a virtual-VMC display, and b) As a standalone implementation on the primary flight displays (PFD). <p>The JIMDAT will review the results of the studies with manufacturers and operators and propose follow-on CAST safety enhancements (SE) for development and implementation of forward-fit production line changes and retrofit service bulletins for those combinations of models and features determined by the studies to be feasible.</p> <p>Note: The start of studies in Outputs 3 and 4 will await the results of the studies performed in SE 204. Upon completion each output in SE 204, CAST will review the results to determine if these features should go forward for further feasibility assessment in out-of-production airplanes. If no feasible implementation options exist for these features in current production airplanes, CAST will close these outputs in SE 205</p>										

	with no further action required.																																		
Total Financial Resources:	Total:	\$3.9M																																	
	Output 1:	\$0.1M																																	
	Output 2:	\$1.1M																																	
	Output 3:	\$1.1M																																	
	Output 4:	\$1.6M																																	
Relation to Current Aviation Community Initiatives:	<ul style="list-style-type: none"> • Radio Technical Commission for Aeronautics (RTCA) Standards Committee (SC)–213 “Enhanced Flight Vision Systems and Synthetic Vision Systems” • 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” • Federal Aviation Administration (FAA) Title 14 of the Code of Federal Regulations (14 CFR) § 25.1322, Amendment 25–131, <i>Flight Crew Alerting</i> • FAA Advisory Circular (AC) 25.1322–1, <i>Flight Crew Alerting</i> • Aviation Rulemaking Advisory Committee (ARAC) Avionics Systems Harmonization Working Group Report, <i>Low Speed Alerting Recommendations Report – Phase II</i>, published March 11, 2013 • CAST SE 192, <i>ASA – Design – Low Airspeed Alerting</i> • CAST SE 200, <i>ASA – Design – Virtual Day-VMC Displays</i> • CAST SE 201, <i>ASA – Design – Bank Angle Alerting and Recovery Guidance Systems</i> • CAST SE 204, <i>ASA – Design – Features for Existing non-Fly-by-Wire Airplane Designs</i> 																																		
Performance Goal Indicators:	<p><u>Risk Reduction Potential</u> The ASA JSIT performed a general assessment of the potential risk reduction that could be attained by the year 2025 through implementation of the recommended features in out-of-production airplanes.</p> <table border="1"> <thead> <tr> <th>Feature <i>Out-of-production airplanes</i></th> <th>Change Type†</th> <th>Airplanes Modified</th> <th>%2025 Fleet Modified</th> <th>2025 Event Risk Reduction</th> </tr> </thead> <tbody> <tr> <td>Multisensory Low Airspeed Caution Alert (Output 2)</td> <td>R</td> <td>~2,000</td> <td>19%</td> <td>4.4%</td> </tr> <tr> <td>Bank Angle Alerting & Recovery Guidance (Output 3)</td> <td>R</td> <td>~2,000</td> <td>19%</td> <td>3.9%</td> </tr> <tr> <td>Energy State Cues on PFD (Output 4)</td> <td>R</td> <td>~2,000</td> <td>19%</td> <td>4.5%</td> </tr> <tr> <td>Virtual day-VMC displays with energy state cues (Output 4)</td> <td>R</td> <td>~2,000</td> <td>19%</td> <td>10.1%</td> </tr> <tr> <td>All features combined</td> <td>R</td> <td>~2,000</td> <td>19%</td> <td>21.3%</td> </tr> </tbody> </table>					Feature <i>Out-of-production airplanes</i>	Change Type†	Airplanes Modified	%2025 Fleet Modified	2025 Event Risk Reduction	Multisensory Low Airspeed Caution Alert (Output 2)	R	~2,000	19%	4.4%	Bank Angle Alerting & Recovery Guidance (Output 3)	R	~2,000	19%	3.9%	Energy State Cues on PFD (Output 4)	R	~2,000	19%	4.5%	Virtual day-VMC displays with energy state cues (Output 4)	R	~2,000	19%	10.1%	All features combined	R	~2,000	19%	21.3%
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	<p style="text-align: center;">† P = production change only; R = retrofit change only ; P+R = production & retrofit change</p> <p><u>Implementation</u> SE Implementation will be tracked by JIMDAT through periodic reports from the manufacturers through their JIMDAT member representatives.</p> <p><u>Effectiveness</u> Effectiveness of implemented features will be assessed by monitoring the following metrics:</p> <ul style="list-style-type: none"> • Flight Operational Quality Assurance (FOQA) metrics show a reduction in incidents of high-risk overbanks (bank angle greater than 45 degrees associated with subthreshold roll rates at load factor less than 1.2 g's and loss of vertical speed greater than 1,000 feet per minute). • FOQA metrics show a reduction in incidents of stall warnings associated with speed decay. 																								
<p>Key Milestones:</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th style="text-align: center;"><u>Flow time (mo)</u></th> <th style="text-align: center;"><u>Start Date</u></th> <th style="text-align: center;"><u>Target Completion Date</u></th> </tr> </thead> <tbody> <tr> <td>Output 1:</td> <td style="text-align: center;">6</td> <td style="text-align: center;">12/31/13</td> <td style="text-align: center;">6/30/14</td> </tr> <tr> <td>Output 2:</td> <td style="text-align: center;">48</td> <td style="text-align: center;">6/30/14</td> <td style="text-align: center;">6/30/18</td> </tr> <tr> <td>Output 3:</td> <td style="text-align: center;">24</td> <td style="text-align: center;">6/30/16</td> <td style="text-align: center;">6/30/18</td> </tr> <tr> <td>Output 4:</td> <td style="text-align: center;">24</td> <td style="text-align: center;">6/30/19</td> <td style="text-align: center;">6/30/21</td> </tr> <tr> <td>Completion:</td> <td style="text-align: center;">90</td> <td style="text-align: center;">12/31/13</td> <td style="text-align: center;">6/30/21</td> </tr> </tbody> </table>		<u>Flow time (mo)</u>	<u>Start Date</u>	<u>Target Completion Date</u>	Output 1:	6	12/31/13	6/30/14	Output 2:	48	6/30/14	6/30/18	Output 3:	24	6/30/16	6/30/18	Output 4:	24	6/30/19	6/30/21	Completion:	90	12/31/13	6/30/21
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<p>Potential Obstacles:</p>	<ul style="list-style-type: none"> • Expense and complexity of design changes for existing type designs • Variation of existing fleet hardware • Flight crew training on new features • Availability of resources to conduct feasibility studies within each company 																								
<p>Detailed Implementation Plan Notes:</p>	<p><u>Supporting CAST Intervention Strategies</u></p> <p><i>Low Airspeed Caution Alerting</i></p> <p>In order to improve early flight crew awareness of a decreasing energy state, manufacturers should develop and implement multisensory low airspeed alerting at the caution level (see 14 CFR 25.1322, amdt 25-131) in existing and in-development airplanes, as practical and feasible. The focus of this SE is on low cost, low technology solutions with ease of retrofit and production incorporation. For example, when airspeed decreases below the minimum maneuver speed by a specified margin (but is still above the stall warning speed), an aural alert (e.g., "Airspeed Low") would sound accompanied by an amber visual cue on the</p>																								

airspeed indicator.

Bank Angle Alerting and Recovery Guidance

In order to provide explicit control guidance and mitigate risks resulting from excessive bank angle, manufacturers should develop additional cues on the PFD to indicate direction for appropriate action to recover from unusual roll attitude. For example, at an excessive right bank angle, a bank angle aural alert would sound accompanied by an amber visual cue on the attitude indicator. If the bank angle continued to increase in the direction of the upset, the alert could transition to a warning. The aural could change to “bank angle, roll left,” and the display could provide a red arrow cue to indicate the direction to roll towards wings-level. Such guidance should be integrated with either aural or tactile alerting schemes.

Virtual Day-VMC Displays and Energy State Cues

Manufacturers should develop and implement virtual day-VMC display systems, such as synthetic vision or equivalent systems, which permit flight crews to operate in a day-VMC-like environment, regardless of external visibility. For the purpose of this SE, “virtual day-VMC displays” describe systems with the following elements:

- Presented full time in the primary field-of-view;
- Presented to both flight crew members; and
- Include display of energy state cues, including flightpath, acceleration, and speed deviation, in a manner similar to modern head-up displays.

Depending on each manufacturer’s implementation plan, implementation of virtual day-VMC displays may benefit from completion of associated research as described in ASA SE 200. While not a requirement for implementation, subsequent definition of these minimum system requirements in a published standards document (e.g., RTCA DO–315) may reduce implementation and certification risk for some future programs.

Applicability

The ASA JSIT recommends manufacturers study these features on the following models:

Low Airspeed Caution Alerting¹ <i>Output 2</i>	Bank Angle Alerting w/Recovery Guidance¹ <i>Output 3</i>	Energy State Cues on the PFD <i>Output 4</i>	Virtual Day-VMC Display Systems <i>Output 4</i>
<u>Airbus</u> A300-600 A310	<u>Airbus</u> A300-600 A310	<u>Airbus</u> A300-600 A310	<u>Airbus</u> A300-600 A310
<u>Boeing</u> 717-200 737-300/400/500 747-400 757-200/300 MD-11 MD88/90	<u>Boeing</u> 717-200 737-300/400/500 747-400 757-200/300 MD-11 MD88/90	<u>Boeing</u> 717-200 737-300/400/500 747-400 757-200/300 MD-11 MD88/90	<u>Boeing</u> 717-200 737-300/400/500 747-400 757-200/300 MD-11 MD88/90
<u>Bombardier</u> CRJ 200	<u>Bombardier</u> CRJ 200	<u>Bombardier</u> CRJ 200	<u>Bombardier</u> CRJ 200
<u>Embraer</u> EMB 120 ERJ 135/195	<u>Embraer</u> EMB 120 ERJ 135/195	<u>Embraer</u> EMB 120 ERJ 135/195	<u>Embraer</u> EMB 120 ERJ 135/195

¹ On programs where addition of visual elements on the PFD may not be cost-beneficial, the JSIT recommends manufacturers consider adding only the aural component of these alerts.

Feasibility Study Guidelines

Unless otherwise noted, each feature’s feasibility study should consider the following elements:

1. Existing production change and service bulletin information. If the feature has already been incorporated in the production line of an existing type design, the manufacturer need only consider development of a service bulletin for retrofit. If a retrofit service bulletin also exists for a given model, no further study of the feature on that model is necessary. The manufacturer should identify existing service bulletin information in its response to CAST.
2. Market analysis. This analysis should include an estimate, based on the manufacturer’s marketing projection, of the following as applicable for each model:

	<ul style="list-style-type: none"> a) The year in which a retrofit package could be offered; and b) The minimum number of airplanes for the model the manufacturer determines would need to be modified in order to justify the cost, based on the benefits accrued by reduced risk contributed by that model in the overall fleet. <p>NOTE: For out-of-production airplanes, this market analysis may be used to determine if a feature has enough potential market penetration to justify further study. If the manufacturer predicts that too few airplanes of a particular model will be able to implement the feature to justify the development cost, a summary of the market analysis results would be sufficient to complete the study for that model.</p> <ul style="list-style-type: none"> 3. Rough Order of Magnitude (ROM) cost estimates. Cost estimates should be given from initial development to entry into service, broken out by airplane type, and should include at least the following: <ul style="list-style-type: none"> a) An estimate, in hours, of the engineering, pilot, and administrative labor required to develop design changes that would introduce these features into the production line and as a retrofit package into delivered airplanes. This estimate should include supplier labor hours as well as hours estimated for certification, both by the manufacturer and the regulatory authorities. b) An estimate, in hours, of the pilot-in-the-loop simulator hours required to develop and certify the change. c) An estimate, in hours, of flight test time required to develop and certify the system. d) An estimate, in dollars, of hardware or parts required per airplane to support the change. 4. Technical feasibility assessment. This assessment should cover installation of the technologies on the production line as well as development of service bulletins to be made available for retrofitting the technology to delivered airplanes. 5. Certification risks. Any certification barriers, such as insufficient guidance for means of compliance, inconsistency with current FAA certification policy, or impact on other certified systems or Airplane Flight Manual procedures should be identified. 6. Impact to operators. An estimate, in hours, of additional flight crew training time for new systems and of airplane downtime to install service bulletins for retrofit scenarios. If the change can be implemented in parallel to other maintenance activities, only the incremental time or cost of the installation need be considered.
CICTT Code:	Loss of Control–Inflight (LOC–I)
Output 1:	
Description:	Manufacturers’ agreement to perform feasibility studies for implementing recommended features in existing out-of-production transport category airplane (TCA) type designs, pending results of safety enhancement (SE) 204 as applicable.

Lead Organization:	Aerospace Industries Association (AIA)	
Supporting Organizations:	Airbus Bombardier, Inc. Embraer The Boeing Company	
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 type="checkbox"/> Research Organization <input type="checkbox"/> Labor Organization <input checked="" type="checkbox"/> Manufacturer <input type="checkbox"/> Regulator <input type="checkbox"/> Other (specify) _____
Actions:	<ol style="list-style-type: none"> 1. AIA will communicate with CAST-represented airplane manufacturers that provide continuing operational safety support for TCAs currently in use in U.S. 14 CFR part 121 operations, explaining the ASA analysis and encouraging them to study the feasibility of implementing the following design features into applicable existing out-of-production TCA type designs: <ol style="list-style-type: none"> a. Low airspeed caution alerting; b. Bank angle alerting and recovery guidance display systems; c. Virtual day-visual meteorological conditions (VMC) display systems, such as synthetic vision or equivalent systems, which permit flight crews to operate in a day-VMC-like environment, regardless of external visibility; and d. Energy state cues, such as flightpath, acceleration, and speed deviation, in a manner similar to modern head-up displays for two scenarios: <ol style="list-style-type: none"> i. As part of a virtual-VMC display, and ii. As a standalone implementation on the primary flight displays (PFD). 2. CAST-represented airplane manufacturers review the communication and its applicability to existing out-of-production type designs. Manufacturers should then respond as follows: <ol style="list-style-type: none"> a. If service bulletin information to incorporate any of the features currently exists for a model, the manufacturer should identify the service bulletin information in its response. b. If the feature is currently expected to be incorporated on an existing out-of-production TCA type design, the manufacturer should note this in their response and provide an estimate as to when the feature is expected to enter into service, including availability of service bulletins for retrofit. c. For other models, manufacturers should respond with their agreement to conduct the requested feasibility studies (with agreement to conduct assessments for Outputs 3 and 4 studies pending the completion of associated study in CAST SE 204), and provide a point of contact for JIMDAT and AIA and estimated completion date for each study element. 	

	3. AIA will track implementation and report progress to JIMDAT and CAST.	
Financial Resources:	Total: \$0.1M (0.4 Full Time Equivalent (FTE))	
Itemized Resources:	Manufacturers: 0.3 FTE (~0.08 FTE per manufacturer, for communication and scoping of study) AIA: 0.1 FTE, for communication and tracking	
	Notes: <ul style="list-style-type: none"> For labor, 1 FTE = \$250K 	
Output Notes:	<u>Applicability</u> All CAST-represented manufacturers of transport category airplanes currently operating under U.S. part 121 should receive and respond to the CAST communication.	
Time Line:	<ul style="list-style-type: none"> 3 months after CAST initiates SE for AIA to send request letters 6 months after CAST initiates SE for manufacturers and suppliers to respond to letter 	
Target Completion Date:	6/30/14. Completed 12/4/14.	
Output 2:		
Description:	Manufacturers perform feasibility studies for implementing low airspeed alerting in existing out-of-production non-fly-by-wire (non-FBW) transport category airplane (TCA) type designs.	
Lead Organization:	Aerospace Industries Association (AIA)	
Supporting Organizations:	Airbus Bombardier, Inc. Embraer JIMDAT The Boeing Company	
Implementers: (Select all that apply)	<input type="checkbox"/> Air Carrier <input checked="" type="checkbox"/> Industry Association <input type="checkbox"/> Commercial Aviation Safety Team (CAST) <input checked="" type="checkbox"/> Joint Implementation Measurement and Data Analysis Team (JIMDAT)	<input type="checkbox"/> Research Organization <input type="checkbox"/> Labor Organization <input checked="" type="checkbox"/> Manufacturer <input type="checkbox"/> Regulator <input type="checkbox"/> Other (specify) _____
Actions:	<ol style="list-style-type: none"> CAST-represented airplane manufacturers will perform an internal feasibility study on implementation of low airspeed caution alerting in existing out-of-production non-FBW TCA type designs, as described in the safety enhancement (SE) Detailed Implementation Plan Notes section. Upon completion of the feasibility studies, the manufacturers will respond to AIA with their findings. Manufacturers will consult with AIA and the JIMDAT to estimate incremental values of expected risk resulting from implementation of the feature in their specific fleets. Fleet-specific 	

	<p>values of risk reduction will be based on the estimated proportion of the fleet affected and the airplane state awareness (ASA) Joint Safety Implementation Team (JSIT) risk reduction estimates for the feature against the event set.</p> <p>3. AIA will track completion of the feasibility studies and report progress to JIMDAT and CAST.</p>
Financial Resources:	Total: \$1.1M (4.4 Full Time Equivalent (FTE))
Itemized Resources:	<p>Manufacturers: 4.0 FTE (1.0 FTE per manufacturer, for 4 manufacturers), to perform studies</p> <p>AIA: 0.2 FTE, for communication, tracking, and consultation</p> <p>JIMDAT: 0.2 FTE, for communication, tracking, and consultation</p> <p>Notes:</p> <ul style="list-style-type: none"> For labor, 1 FTE = \$250K
Output Notes:	<p><u>Option for Reduced Effectiveness Features</u></p> <p>The effectiveness of low airspeed alerting, as envisioned by the ASA Joint Safety Analysis Team (JSAT) and JSIT, assumes a multisensory alerting function generally incorporating a visual amber indication on a graphical primary flight display combined with an aural alert (e.g., a tone or a verbal such as “Airspeed Low”). The JSIT recognizes that not all out-of-production airplanes have the capability to support this function on their primary flight display (PFD) without significant modification and certification costs. In these cases it would be reasonable for the manufacturers to consider implementation options that include only an aural component of the low airspeed caution.</p> <p>Output extended from 6/30/16 to 6/30/17.</p>
Time Line:	<ul style="list-style-type: none"> 18 months after completion of Output 1 for manufacturers to complete studies 24 months after completion of Output 1 for manufacturers to consult AIA and JIMDAT to determine feasibility
Target Completion Date:	6/30/18 (extended in April 2017 from original date of 6/30/17 to give aircraft manufacturers sufficient time to complete feasibility studies for out-of-production airplanes). Completed and closed 10/04/2018 based on manufacturers reporting incorporating low airspeed alerting is not feasible in out-of-production fleets. SE 192 being revised to recommend after-market implementation of low airspeed alerting on targeted fleets.
Output 3:	
Description:	Pending the outcome of Safety Enhancement (SE) 204, manufacturers study the feasibility and cost of implementing bank angle alerting and recovery guidance display systems in existing out-of-production transport category airplane (TCA) type designs that have graphical primary flight displays (PFD).
Lead Organization:	Aerospace Industries Association (AIA)

Supporting Organizations:	Airbus Bombardier, Inc. Embraer JIMDAT The Boeing Company	
Implementers: (Select all that apply)	<input type="checkbox"/> Air Carrier <input checked="" type="checkbox"/> Industry Association <input type="checkbox"/> Commercial Aviation Safety Team (CAST) <input checked="" type="checkbox"/> Joint Implementation Measurement and Data Analysis Team (JIMDAT)	<input type="checkbox"/> Research Organization <input type="checkbox"/> Labor Organization <input checked="" type="checkbox"/> Manufacturer <input type="checkbox"/> Regulator <input type="checkbox"/> Other (specify) _____
Actions:	<ol style="list-style-type: none"> 1. JIMDAT will review the results of SE 204, Output 3, and make recommendations to CAST on continued assessment of this feature in out-of-production airplanes. 2. Pending CAST approval of further study from action 1, CAST-represented airplane manufacturers will perform an internal feasibility study on implementation of bank angle alerting and recovery guidance in existing out-of-production TCA type designs that have graphical PFD, as described in the SE Detailed Implementation Plan Notes section. 3. Upon completion of the feasibility studies, the manufacturers will respond to AIA with their findings. Manufacturers will consult with AIA and the JIMDAT to estimate incremental values of expected risk resulting from implementation of the feature in their specific fleets. Fleet-specific values of risk reduction will be based on the estimated proportion of the fleet affected and the airplane state awareness (ASA) Joint Safety Implementation Team (JSIT) risk reduction estimates for the feature against the event set. 4. AIA will track completion of the feasibility studies and report progress to JIMDAT and CAST. 	
Financial Resources:	Total: \$1.1M (4.4 Full Time Equivalent (FTE))	
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Output Notes:		
Time Line:	<ul style="list-style-type: none"> • 6 months after completion of CAST SE 204 Output 3 (Estimated Completion Date 6/30/16) for JIMDAT to review results and make recommendations to CAST, and for CAST approval to perform SE 205 Output 3 	

	<ul style="list-style-type: none"> • 12 months after CAST approval for manufacturers to complete studies • 18 months after CAST approval for manufacturers to consult AIA and JIMDAT to determine feasibility 										
Target Completion Date:	6/30/18. Completed and closed 10/04/2018 based on manufacturers reporting bank angle alerting and recovery guidance system implementation is not feasible in out-of-production fleets.										
Output 4:											
Description:	Pending the outcome of Safety Enhancement (SE) 204, manufacturers study the feasibility and cost of implementing virtual day-visual meteorological conditions (VMC) displays, such as synthetic vision or equivalent systems, and the full-time presentation of energy state cues (flightpath, acceleration, and speed deviation) in a manner similar to modern head-up displays, in existing out-of-production transport category aircraft (TCA) type designs that have graphical primary flight displays (PFD).										
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<input type="checkbox"/> Joint Implementation Measurement and Data Analysis Team (JIMDAT)	<input type="checkbox"/> Regulator										
	<input type="checkbox"/> Other (specify) _____										
Actions:	<ol style="list-style-type: none"> 1. JIMDAT will review the results of SE 204, Output 4, and make recommendations to CAST on continued assessment of this feature in out-of-production airplanes. 2. Pending CAST approval of further study from action 1, CAST-represented airplane manufacturers will perform an internal feasibility study on implementation of virtual day-VMC displays, such as synthetic vision or equivalent systems, and the full-time presentation of energy state cues (flightpath, acceleration, and speed deviation) in a manner similar to modern head-up displays, in existing out-of-production TCA type designs that have graphical PFDs, as described in the SE Detailed Implementation Plan Notes section. The study should consider two options: <ol style="list-style-type: none"> a) Virtual day-VMC displays that incorporate energy state cues as part of the display. b) Energy state cues presented on the PFDs without virtual day-VMC displays. 3. Upon completion of the feasibility studies, the manufacturers will respond to AIA with their findings. Manufacturers will consult with AIA and the JIMDAT to estimate incremental values of 										

	<p>expected risk resulting from implementation of the feature in their specific fleets. Fleet-specific values of risk reduction will be based on the estimated proportion of the fleet affected and the airplane state awareness (ASA) Joint Safety Implementation Team (JSIT) risk reduction estimates for the feature against the event set.</p> <p>4. AIA will track completion of the feasibility studies and report progress to JIMDAT and CAST.</p>
Financial Resources:	Total: \$1.6M (6.4 Full Time Equivalent (FTE))
Itemized Resources:	<p>Manufacturers: 6.0 FTE (1.5 FTE per manufacturer, for 4 manufacturers), to perform studies</p> <p>AIA: 0.2 FTE, for communication, tracking, and consultation</p> <p>JIMDAT: 0.2 FTE, for communication, tracking, and consultation</p> <p>Notes:</p> <ul style="list-style-type: none"> For labor, 1 FTE = \$250K
Output Notes:	
Time Line:	<ul style="list-style-type: none"> 6 months after completion of CAST SE 204 Output 4 (Estimated Completion Date (ECD) 12/31/18) for JIMDAT to review results and make recommendations to CAST, and for CAST approval to perform SE 205 Output 4 18 months after CAST approval for manufacturers to complete studies 24 months after CAST approval for manufacturers to consult AIA and JIMDAT and determine feasibility
Target Completion Date:	6/30/2021. Completed and closed 10/04/2018 based on manufacturers reporting virtual day-VMC display implementation on out-of-production fleets is not feasible.

Reference Material	
<p>Supporting CAST Intervention Strategies</p>	<p>NOTE: <i>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.</i></p> <p>IS 1233—To improve flight crew awareness of low airspeed, manufacturers should develop and regulators should ensure implementation of systems that alert flight crews when the airplane reaches its minimum maneuvering speed (i.e., “top of amber band”) on airplanes with no (or with overrideable) flight envelope protection, in accordance with 14 CFR 25.1322 at amdt 25–131.</p> <p>IS 1002—To prevent unusual attitudes and enhance recovery from them, manufacturers should design and implement attitude alerting systems that provide caution and warning level alerts, including multisensory flight crew guidance, as appropriate and in accordance with 25.1322 at Amendment level 25–131 (e.g., “roll left” combined with arrows to indicate direction for recovery).</p> <p>IS 1003 in accordance with To prevent the occurrence of spatial disorientation, manufacturers should develop and regulators should ensure implementation of synthetic vision systems on the PFD in accordance with using standardized formats - to support continuous attitude, altitude and terrain awareness.</p> <p>IS 1039 in accordance with To improve flight crew awareness of energy state, manufacturers should provide flightpath marker, acceleration, speed deviation, and runway symbol on the PFD and/or Heads-up Display (HUD).</p> <p>IS 1010 in accordance with To prevent the occurrence of spatial disorientation, the aviation industry should conduct research to establish minimum requirements (e.g., field of view, field of regard, display minification, display elements) necessary for a synthetic vision system to prevent spatial disorientation.</p>