DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Aviation Rulemaking Advisory Committee; Transport Airplane and Engine Issue Area—Phase 2 of Low Speed Alerting Task

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of new task assignment for the Aviation Rulemaking Advisory Committee (ARAC).

SUMMARY: The FAA assigned the Aviation Rulemaking Advisory Committee (ARAC) a new task to identify and develop recommendations on additional requirements for low speed alerting. Phase 1 of the task addresses new standards for transport category airplanes. Phase 2 of the task addresses possible retrofit standards for existing transport category airplanes. This notice is to inform the public that the ARAC working group has completed activity for Phase 1 of the task and will begin activity for Phase 2.

FOR FURTHER INFORMATION CONTACT: Joe Jacobsen, Airplane & Flight Crew Interface Branch, ANM–111, Transport Airplane Directorate, Federal Aviation Administration, 1601 Lind Ave, SW., Renton, Washington 98057; telephone (425) 227–2011, facsimile (425) 227–1149; e-mail *joe.jacobsen@faa.gov.*

SUPPLEMENTARY INFORMATION:

Background

The FAA established ARAC to provide advice and recommendations to the FAA Administrator on the FAA's rulemaking activities with respect to aviation-related issues. With respect to low speed alerting, the FAA previously revised regulations in the area of flight guidance (autopilot) and performance and handling qualities in icing conditions to improve transport airplane standards for low speed protection (in the case of icing, stall warning standards were enhanced). However, as a result of several recent loss-of-control accidents and incidents, the FAA has identified a need for additional low speed safeguards, in addition to the regulatory actions that have already been taken. The committee addressed the Phase 1 task—new part 25 standards under the existing Avionics System Harmonization Working Group within the Transport Airplane and Engine Issues Group. (The FAA published a notice of Phase 1 task assignment in the **Federal Register** (75 FR 16902) on April 2, 2010.) The committee will also address the Phase 2 task—parts 25/121/129 retrofit standards under the existing Avionics Systems Harmonization Working Group within the Transport Airplane and Engine Issues Group.

The Task

ARAC was initially tasked with providing information that will be used to develop standards and guidance material for low speed alerting systems. This information may result in standards that complement existing stall warning requirements. The working group provided a report that addressed several low speed alerting technical questions, relative to new aircraft designs (Phase 1 task—new part 25 standards), and provided the rationale for their responses.

Since the Phase 1 task is complete, ARAC is now tasked with providing information that will be used to develop possible retrofit standards and guidance material for low speed alerting systems. This information may result in standards that complement existing stall warning requirements. The working group will also be expected to provide a report that addresses the following low speed alerting technical questions, relative to existing aircraft designs (Phase 2 task—part 25/121/129 retrofit standards), and provide the rationale for their responses. If the recommendation for retrofit is the same as for new designs, the working group should state the rationale and not repeat the information previously reported. If there is disagreement within the working group, those items should be documented, including the rationale from each party and the reasons for the disagreement.

- How timely is the airplane in alerting the crew of flight below the intended operating speed?
- How timely relative to stall warning?
- Is alerting instantly recognizable, clear, and unambiguous to the flightcrew?
- How are nuisance alerts minimized?
- Does the alerting operate under all operating conditions, configurations, and phases of flight, including icing conditions?
- Does the alerting operate during manual and autoflight?
- After reviewing airworthiness, safety, cost, benefit, and other relevant factors, including recent certification and fleet experience, are there any additional considerations that should be taken into account?
- Is coordination necessary with other harmonization working groups (e.g., Human Factors, Flight Test)? (If yes, coordinate and report on that coordination.)
- If improvements are needed for low speed alerting in the existing fleet, should the FAA adopt a design approval holder (part 26) requirement to mandate development of design changes, or would an operational rule be sufficient? In responding, the working group should address the factors set forth in "FAA Policy Statement: Safety—A Shared Responsibility—New Direction for Addressing Airworthiness Issues for Transport Airplanes" (70 FR 40166, July 12, 2005). The ARAC working group should provide information that could lead to standards for low speed alerting that can be satisfied with practical design approaches.

Schedule

The required completion date for Phase 2 of the task is 15 months after the FAA publishes this notice in the **Federal Register**.

ARAC Acceptance of Task

ARAC accepted the task and assigned it to the existing Avionics Systems Harmonization Working Group in the Transport Airplane and Engine Issue Area. The working group serves as support to ARAC and assists in the analysis of assigned tasks. ARAC must review and approve the working group's recommendations. If ARAC accepts the working group's recommendations, it will forward them to the FAA.

Working Group Activity

The Avionics Systems Harmonization Working Group must comply with the procedures adopted by ARAC. As part of the procedures, the working group must:

1. Prepare a work plan on how to complete the task, including the rationale for this plan. Present the plan for consideration to the Transport Airplane and Engine Issues Group following publication of this notice.
2. Give a detailed conceptual presentation of the proposed recommendations prior to proceeding with the work stated in item 3 below.
3. Draft the appropriate documents and required analyses and/or any other related materials or documents.
4. Provide a status report at each meeting of the ARAC held to consider Transport Airplane and Engine Issues.

Participation in the Working Group

The Avionics Systems Harmonization Working Group is composed of technical experts having an interest in the assigned task. We recommend the existing working group be expanded to include individuals involved in current fleet operations so there is appropriate representation for the Phase 2 task. A

working group member need not be a representative or a member of the full committee.

If you have expertise in the subject matter and wish to become a member of the working group, write to the person listed under the caption **FOR FURTHER INFORMATION CONTACT** expressing that desire. Describe your interest in the task and state the expertise you would bring to the working group. We must receive all requests by March 17, 2011 for the meeting scheduled to start from March 15 to 17, 2011, located at the Cessna Conference Center, 6711 West 31st Street South, Wichita, Kansas 67215. The assistant chair, the assistant executive director, and the working group co-chairs will review the requests and advise you whether or not your request is approved.

If you are chosen for membership on the working group, you must represent your aviation community segment and actively participate in the working group by attending all meetings and providing written comments when requested to do so. You must devote the resources necessary to support the working group in meeting any assigned deadlines. You must keep your management chain and those you may represent advised of working group activities and decisions to ensure that the proposed technical solutions do not conflict with your sponsoring organization's position when the subject being negotiated is presented to ARAC for approval. Once the working group has begun deliberations, members will not be added or substituted without the approval of the assistant chair, the assistant executive director, and the working group co-chairs.

The Secretary of Transportation determined that the formation and use of the ARAC is necessary and in the public interest in connection with the performance of duties imposed on the FAA by law. Meetings of the ARAC are open to the public. Meetings of the Avionics Systems Harmonization Working Group will not be open to the public, except to the extent individuals with an interest and expertise are selected to participate. The FAA will make no public announcement of working group meetings.

Issued in Washington, DC, on February 28, 2011.

Pamela Hamilton-Powell,

Executive Director, Aviation Rulemaking Advisory Committee.

[FR Doc. 2011–4761 Filed 3–2–11; 8:45 am]

BILLING CODE 4910–13–P

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

[Docket No. FAA–2011–0146]

Notice of Intent To Review Structure of the Aviation Rulemaking Advisory Committee

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice and request for public comment.

SUMMARY: The FAA is considering restructuring the Aviation Rulemaking Advisory Committee (ARAC). This notice is to inform the public of FAA's intent and invites the public to provide any ideas or thoughts it may have on this matter.

DATES: Send your comments on or before April 4, 2011.

ADDRESSES: You may send comments identified by Docket Number FAA–2011–0146 using any of the following methods:

- *Government-wide rulemaking Web site:* Go to *http://www.regulations.gov* and follow the instructions for sending your comments electronically.
- *Mail:* Send comments to the Docket Management Facility; U.S. Department of Transportation, 1200 New Jersey Avenue, SE., West Building Ground Floor, Room W12–140, Washington, DC 20590.
- *Fax:* Fax comments to the Docket Management Facility at 202–493–2251.
- *Hand Delivery:* Bring comments to the Docket Management Facility in Room W12–140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

Privacy: We will post all comments we receive, without change, to *http://www.regulations.gov,* including any personal information you provide. Using the search function of our docket Web site, anyone can find and read the comments received into any of our dockets, including the name of the individual sending the comment (or signing the comment for an association, business, labor union, etc.). You may review DOT's complete Privacy Act Statement in the **Federal Register** published on April 11, 2000 (65 FR 19477–78).

Docket: To read background documents or comments received, go to *http://www.regulations.gov* at any time or to the Docket Management Facility in Room W12–140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

SUPPLEMENTARY INFORMATION:

Background

The Aviation Rulemaking Advisory Committee (ARAC) was established in February 1991 to provide FAA's Administrator with industry and public input in the form of information, advice, and recommendations to be considered in the full range of FAA rulemaking activities. These factors are consistent with the dictates of the Administrative Procedures Act (APA). The exchange of ideas that occurs through the ARAC process affords the FAA additional opportunities to obtain firsthand information and insight from those parties who are most affected by existing and proposed regulations.

ARAC consists of approximately 55 member organizations selected by the FAA as most representative of the various viewpoints of those impacted by FAA regulations. The organizations provide a membership fairly balanced in terms of points of view of those represented and the functions to be performed by the committee. The committee is composed of organizations representing air carriers, airports, flight attendants, manufacturers, pilots, public interest and advocacy groups, repair stations, and consumer groups. Members serve in a representative capacity. In addition, an Executive Committee (ExCom) was formed to provide overall administrative oversight for committee activities. The ExCom consists of the ARAC Chair and Vice Chair, who serve as chairperson and vice chairperson, respectively for ExCom; assistant chairpersons representing aeronautical technical subject areas (presently, air carrier operations, maintenance, occupant safety, general aviation certification and operations, noise, aircraft certification, airport certification, transport airplane and engine, rotorcraft, and training and qualifications) with active projects only in transport airplane and engine, and air carrier operations.

The goal of ARAC is to assemble the strongest expertise possible to address particular issues facing the aviation industry and traveling public. The committee conducts its business in open deliberations in the form of public meetings (working groups are exempted). As an advisory body, ARAC has consistently exercised its independence and freedom to provide the FAA recommendations that are not influenced or predetermined by the government. Since 1998, ARAC has submitted more than 110 documented recommendations or products to the

March 11, 2013

Federal Aviation Administration
800 Independence Avenue, SW
Washington, D.C. 20591

Attention: Lirio Liu, Director, Office of Rulemaking
Subject: ARAC Recommendation, Avionics System Harmonization Working Group (ASHWG)
Reference: Tasking Notice 77 FR 11844 (March 3, 2011)

Dear Lirio,

On behalf of the Aviation Rulemaking Advisory Committee, I am pleased to submit the attached report and presentations as an ARAC recommendation. This report addresses the Phase 2 – Low Airspeed Alerting (Retrofit Applications) and presents the following key findings and recommendations:

(1) A detailed examination of low airspeed/low energy events (accidents and incidents over a 20 year period), including all contributing factors, not just the lack of a low airspeed alert.
(2) Examination of operational and safety data to help determine whether a low airspeed alert would have operational benefit.
(3) Sufficient quantification of the effectiveness of a low airspeed alert (future JSIT report pending).
(4) A cost-benefit analysis to determine how the system can be "practically" implemented for existing aircraft.

The ASHWG formally requests that when this data is gathered, the FAA task the ARAC to reconvene and review that data for further recommendations.

If a low airspeed alert is required in the future, the ASHWG recommends that the information from this report be used to develop the rules and associated guidance. There must be an integrated approach that incorporates design changes with flight crew procedures and pilot training. There may be multiple mitigations to improve low airspeed awareness.

To facilitate FAA/EASA harmonization and implementation, any associated rulemaking should be reviewed by the ASHWG to ensure that it is aligned with the findings in this report.

The ARAC approved the report for transmittal to the FAA during its March 5th, 2013 meeting.
I want to thank all the members of the RPWG for their hard work on both phases of this report.

Sincerely,

Dan Elwell
ARAC Chairman

Copy: Renee Butner – FAA Office of Rulemaking
ARAC members
Loran Haworth – FAA Representative
Joe Jacobsen – FAA, Transport Airplane Directorate

Contents

1 Background

At the agency's request, the Aviation Rulemaking and Advisory Committee (ARAC) provide advice and recommendations to the Federal Aviation Administration (FAA) on aviation-related rulemaking activities.

As a result of several loss-of-control accidents and incidents, the FAA and EASA identified a need for additional low airspeed safeguards, therefore, the agencies issued Amendment 14 CFR Part 25-121, issued Oct 9, 2007 and CS 25 Amendment 3, effective Sept 19, 2007, *Performance and Handling Qualities in Icing Conditions* to address handling and low speed protection requirements in icing conditions. In addition:

(1) In June 2007 the FAA revised Advisory Circular AC 25-11A and EASA introduced CS-25 amendment 11, AMC 25-11, which includes guidance for low airspeed *awareness*.
(2) In November 2010 the FAA revised 14 CFR § 25.1322 and EASA issued CS-25 amendment 11 for flightcrew *alerting*.
(3) Information from AC 25.1329-1B (and the associated AMC) provides information which may be helpful in determining how to address low airspeed conditions. These were released in 2006.

To augment the regulatory actions taken, the Transport Airplane and Engine Issues Group (TAEIG) assigned the Avionics Systems Harmonization Working Group (ASHWG) to provide information for developing standards and guidance on low airspeed alerting systems (LAS), which could complement existing stall warning requirements. The ASHWG activity was broken into two tasks.

1.1 The First Task

The ASHWG addressed the following ten (10) technical questions relative to new aircraft designs in its first report provided to the ARAC and FAA in April 2011:

(1) How much time is needed to alert the crew in order to avoid stall warning or excessive deviation below the intended operating speed?
(2) What would make the alerting instantly recognizable, clear, and unambiguous to the flight crew?
(3) How could nuisance alerts be minimized?
(4) Could the alerting operate under all operating conditions, configurations, and phases of flight, including icing conditions?
(5) Could the alerting operate during manual and auto flight?
(6) Could the system reliability be made consistent with existing regulations and guidance for stall warning systems?
(7) Are there any regulations or guidance material that might conflict with new standards?
(8) What recommended guidance material is needed?
(9) After reviewing airworthiness, safety, cost, benefit, and other relevant factors, including recent certification and fleet experience, are there any additional considerations that should be taken into account?
(10) Is coordination necessary with other harmonization working groups (e.g., Human Factors, Flight Test)? (If yes, coordinate and report on that coordination.)

1.2 The Second Task

This report provides answers to the following low speed alerting technical questions relative to *existing* aircraft designs), including a recommendation as to whether retrofit requirements should be the same as new designs.

(1) How timely is the airplane in alerting the crew of flight below the intended operating speed?
(2) How timely relative to stall warning?
(3) Is alerting instantly recognizable, clear, and unambiguous to the flightcrew?
(4) How are nuisance alerts minimized?
(5) Does the alerting operate under all operating conditions, configurations, and phases of flight, including icing conditions?
(6) Does the alerting operate during manual and autoflight?
(7) After reviewing airworthiness, safety, cost, benefit, and other relevant factors, including recent certification and fleet experience, are there any additional considerations that should be taken into account?
(8) Is coordination necessary with other harmonization working groups (e.g., Human Factors, Flight Test)? (If yes, coordinate and report on that coordination.)
(9) If improvements are needed for low speed alerting in the existing fleet, should the FAA and EASA adopt a design approval holder (part 26) requirement to mandate development of design changes, or would an operational rule be sufficient?

Note that the terms “low airspeed” and “low energy” are both used in this report. A low airspeed alert is intended to provide awareness to the flight crew that the aircraft’s airspeed is reaching a point where the energy level of the aircraft is being compromised.

1.3 Definitions, Acronyms, and Abbreviations

The following are key definitions for this report:

- Alphafloor – The point automated low energy protection will engage.
- Low Airspeed Alert – Provides visual, aural or tactile awareness that the aircraft’s airspeed is reaching a point where the decrease exceeds a pre-determined threshold.
- Low Energy Alert – Provides awareness that the Angle of Attack exceeds a pre-determined low energy threshold.

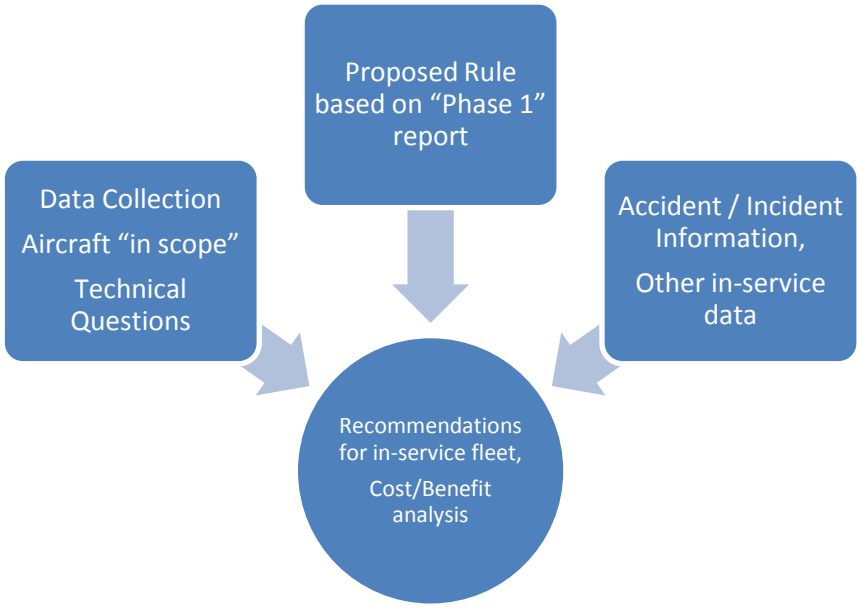
The following are acronyms and abbreviations used in this report:

- AC/AMC – Advisory Circular/Acceptable Means of Compliance
- AoA – Angle of Attack
- ARAC – Aviation Rulemaking Advisory Committee
- ASHWG – Avionics Systems Harmonization Working Group
- EASA – European Aviation Safety Agency
- EICAS – Engine Instrument and Crew Alerting System
- FAA – Federal Aviation Administration

- FBW – Fly-by-Wire
- JSIT – Joint Safety Implementation Team
- LAS – Low Airspeed Alerting System
- PFD – Primary Flight Display
- TAEIG - Transport Airplane and Engine Issues Group
- TAWS – Terrain Awareness and Warning System

2 Process Followed

In order to perform this task, the ASHWG prepared a work plan, and presented a summary of that plan to the TAEIG.



Following approval of the work plan, information was collected from aircraft manufacturers to identify existing designs' capability to provide low airspeed awareness and alert functionality.

The ASHWG were provided with a review of relevant accident information to understand whether a low airspeed alerting function could have played a role in reducing loss of control. Specifically, a briefing was provided of a summary of six events occurring from 1999 – 2009, where failure to maintain proper airspeed resulted in a loss of control.

Three key factors were discussed in creating the findings for this report:

(1) Distractions in the flight deck.
(2) The effectiveness of the alerting in aircraft; and
(3) Lack of flight crew system knowledge resulting from current training.

As a result of this data collection and group discussion, the ASHWG were able to generate this report.

3 Scope

Aircraft certificated under 14CFR/CS 25 and operated under 14CFR/CS 121, 129 and 135 (and the international equivalent) manufactured in the Americas and Europe. Representing the global air transport fleet of approximately 24,000; approximately 85% of the total current air transport fleet of 28,000.

All of the aircraft in this analysis were certificated prior the update 14CFR/CS 25.1322, 25.1329, and their associated advisory material. The flight deck capability of the aircraft was categorized into major groups:

(1) Representing 21% of the fleet studied, aircraft with no low airspeed alert before stick shaker, no PFD (i.e., glass display), and minimal alerting (i.e., no crew alerting "system" or EICAS.
(2) Aircraft with no low airspeed alert before stick shaker, but with PFD and centralized alert capability (but no low airspeed alert); approximately 15% of aircraft studied.
(3) Aircraft with PFD and visual low airspeed alert; approximately 10% of the aircraft studied.
(4) Aircraft with PFD and both visual and aural low airspeed alert. Boeing and Airbus aircraft representing approximately 45% of the fleet.

NOTE: Approximately 8-9 % of the 24,000 aircraft covered by this report did not have manufacturer data available, so are excluded from the analysis.

Appendix A and B provide the survey used to help generate this information and the survey results.

4 Key Findings and Recommendations

Imposing a rule on existing aircraft to incorporate a practical method for implementing low airspeed alerts can only be substantiated by:

(1) A detailed examination of low airspeed/low energy events (accidents and incidents over a 20 year period), including all contributing factors, not just the lack of a low airspeed alert.
(2) Examination of operational and safety data to help determine whether a low airspeed alert would have operational benefit.
(3) Sufficient quantification of the effectiveness of a low airspeed alert (future JSIT report pending).
(4) A cost-benefit analysis to determine how the system can be "practically" implemented for existing aircraft.

The ASHWG formally requests that when this data is gathered, the FAA task the ARAC to reconvene and review that data for further recommendations.

If a low airspeed alert is required in the future, the ASHWG recommends that the information from this report be used to develop the rules and associated guidance. There must be an integrated approach that incorporates design changes with flight crew procedures and pilot training. There may be multiple mitigations to improve low airspeed awareness.

To facilitate FAA/EASA harmonization and implementation, any associated rulemaking should be reviewed by the ASHWG to ensure that it is aligned with the findings in this report.

5 Technical Questions

The answers to technical questions 5.1 through 5.6 are limited to aircraft designs that incorporate a low airspeed alert system; i.e., approximately 45% of the in-service aircraft.

The terms “low airspeed” and “low energy” are used in this report; both are intended to provide awareness that airspeed is reaching a point where the aircraft may be compromised.

(1) Example of Low Airspeed Alert: The alert is primarily a function of airspeed, configuration and minimum maneuver speed. It is set when the airspeed decreases 30 percent into the lower amber band. It is reset when airspeed increases above the amber band.

(2) Example of Low Energy Alert: The alert is a function of configuration, deceleration rate and flight path angle; it is presented when the AoA exceeds an alpha low energy threshold; The AoA corresponds to when it is impossible to recover a long term positive flight path by only increasing lift. The crew’s attention is drawn to the speed scale and indicates the need to adjust thrust.

5.1 How timely is the airplane in alerting the crew of flight below the intended operating speed?

The aircraft alerts the crew to airspeed that may result in negative operational situations. Manufacturers provide different protections based upon other alerting capabilities. Both design approval holders that have low airspeed alerting systems complied with the standard established by the authorities.

Existing designs with low airspeed alerting systems are dependent on stall warning information or to other implemented protections.

The designs are not intended to alert for a deviation from the intended operating speed. Rather there are alerts that a stall warning is approaching or of a low energy situation. Both systems are timely in that they indicate a potentially adverse airspeed situation.

5.2 How timely relative to stall warning (alphafloor)?

Design approval holders ensured no spurious activation of the alert occurred over a variety of flight conditions and airplane configurations. Evaluations were also performed to ensure that the alert reset properly. These testing and analyses established compliance with the standards established by the authorities.

The alert was tested in wings level and in turn at different slat/flap configurations, different acceleration rates, and with & without airbrakes. Operational scenarios (for example approach, cruise, and climb) were evaluated to validate minimal nuisance alerts and subjectively validate acceptable alerting prior to stick shaker. One of the worst-case scenarios for evaluating nuisance alerting was during go-around, with one engine inoperative.

The setting of the low energy alert aims at providing enough time to the pilot to manually recover an adequate level of energy through thrust adjustment, before engagement of any protection mechanism if applicable, for low deceleration rates. The approach cases were considered the most significant, so a one second response time was considered to evaluate the effectiveness of a timely thrust increase before stick shaker was activated.

For nominal deceleration rates (1-2 kts per second), the low airspeed alert is intended to provide the pilot sufficient time to increase thrust and minimize the possibility of decelerating to stick shaker activation.

5.3 Is alerting instantly recognizable, clear, and unambiguous to the flightcrew?

The low airspeed alert systems which provide two senses of attention-getting characteristics are considered to be instantly recognizable by the FAA/EASA, however exceptions have been previously approved (for example, an aural "SPEED SPEED SPEED" voice with a visual indication on the display, coincident with an amber/red band directly on the speed tape, with no written messages. In each case the specific content of the alert makes it clear and unambiguous.

Alerts which provide a visual only sense may not be instantly recognizable under all operating conditions; these represent a small subset of the population.

5.4 How are nuisance alerts minimized?

Existing designs input filtering and large margins from normal operating speeds as techniques to minimize nuisance alerts. Some designs filter airspeed inputs while other designs filter Angle of Attack (AoA). Designs also reduce the likelihood where there are large and sudden fluctuations in airspeed or AoA (e.g., in turbulence).

Nuisance alerts have also been minimized by other conditions such as a fixed number excursion below a pre-determined low airspeed value or accounting for failure of a suitable speed protection mechanism (e.g. autopilot/autothrottle).

A reset of the low airspeed alert (from on to off) typically occurs after the aircraft has recovered to a point when the actual airspeed rises by a fixed value (e.g. 5 kts) above the top of the amber low speed band.

5.5 Does the alerting operate under all operating conditions, configurations, and phases of flight, including icing conditions?

Low airspeed alerting operates in most (but not all) operating conditions; there are phases of flight where low airspeed alerting may not be warranted; for example, during take-off, prior to flap retraction, or above 2500 feet. While the alert is helpful in approach and landing conditions when low energy situation is more likely to occur; there may be other protections from airspeed deviations for take-off, climb, in cruise and en-route. There are also certain abnormal system conditions (e.g., air data failure, alpha data failure) where the alert will be inoperative. The designs include operations during icing conditions.

With respect to configuration, in certain FBW aircraft load factor is used in setting the alert parameter, whereas all alert systems account for the effects of normal weight and center of gravity variations.

5.6 Does the alerting operate during manual and autoflight?

Yes.

5.7 After reviewing airworthiness, safety, cost, benefit, and other relevant factors, including recent certification and fleet experience, are there any additional considerations that should be taken into account?

(1) Aircraft with a history of low airspeed awareness issues be clearly identified.

(a) Any relevant accident/incident information and the specific reasons why low airspeed contributed to those events.

(b) Detailed information on the effectiveness of any installed low airspeed alert must be clearly identified.

(c) Precursor information from operational databases by aircraft type for low airspeed conditions that did not result in a reportable incident/accident. from:

- Line Operations Safety Audit (LOSA)
- Flight Operations Quality Assurance (FOQA)
- Aviation Safety Action Program (ASAP)
- Aviation Safety Reporting System (ASRS)

(2) A comprehensive solution to address the need for low-airspeed alerting in existing fleets should be considered, based on the recommendations contained within section 5.10 of this report.

The range of necessary changes to implement low airspeed alert system is variable; the cost and benefit are also variable. This report provides representative examples of a potential integrated and functional solution. One or more technical solutions may be the most practical to incorporate in existing aircraft types. Several example “functional solutions” are described in Appendix C.

Any change will require updated flight crew procedures and pilot training to ensure proper management of the aircraft energy state when presented with a low airspeed alert.

(3) If a low airspeed alert system retrofit is mandated, a cost-benefit analysis must be performed to establish whether the implementation would be economically feasible.

The analysis must be done on a certification-basis. Aircraft variability is vital to understanding the feasibility of implementing the alert system vs. its expected effectiveness. Focus on those aircraft with known concerns of low-airspeed control, as opposed to a broad analysis, to support a specific aircraft safety finding. Expected longevity of the aircraft type being analyzed must be taken into account. For example, there may be plans to make a specific aircraft type obsolete (retire) as a result of future airspace requirements.

(a) Costs should consider:

- The proposed rule and advisory information for existing aircraft
- The proposed technical solution
- An estimate to develop and certificate the proposed technical solution (non-recurring per aircraft type)

- An estimate to retrofit the proposed technical solution (recurring per aircraft type)
- Operational manual changes
- Training

(b) Benefits should consider the following:

- Current accident/incident rate by aircraft type that would be prevented by implementation of a low airspeed alert
- Average cost per accident/incident

5.8 Is coordination necessary with other harmonization working groups (e.g. Human Factors, Flight Test)? (If yes, coordinate and report on that coordination)

Yes, coordination with other harmonization working groups has already occurred.

An advisory circular developed by the FAA-Industry Stall/Stickpusher Working Group in 2010 was published by the FAA in August 2012 (reference: AC 120-109, Stall and Stick Pusher Training) and provided training procedures for stall and stick pusher recovery. The preventions in this AC should be updated to include low airspeed alerting awareness and recovery procedures.

An aviation rulemaking committee (208ARC) addressing stall and loss of control avoidance and recovery training used the information from this AC and additional inputs from industry on Loss of Control to address the pilot training aspects in their final report submitted to the FAA in December 2012. AFS-210 should be made aware of the contents of our report to ensure that low airspeed alerting awareness and recovery procedures are included in the subsequent Upset Recovery and Loss of Control NPRM that should be published for comment in late Spring, 2013.

Coordination is required with the Airplane State Awareness Joint Safety Implementation Team (JSIT), who will be generating a cost-benefit analysis. Reports from JSIT will provide the detailed data required to substantiate the effectiveness of low-airspeed alerting into existing aircraft. The report is to provide other means of mitigation that could help reduce loss of control, for those aircraft which were examined (those with specifically known loss of control accidents/incidents).

5.9 *If improvements are needed for low speed alerting in the existing fleet, should the FAA/EASA adopt a design approval holder (part 26) requirement to mandate* development of design changes, or would an operational rule be sufficient?

A Part 26 requirement is not necessary. If a broad requirement is deemed necessary an operational rule (e.g., part 121) would be sufficient. The operational rule would have to be specific to low airspeed alerting, regardless of the existing aircraft systems on board, and would be based on the information provided in this report.

5.10 In responding, the working group should address the factors set forth in "FAA Policy Statement: Safety—A Shared Responsibility—New Direction for Addressing Airworthiness Issues for Transport Airplanes" (70 FR 40166, July 12, 2005). The

ARAC working group should provide information that could lead to standards for low speed alerting that can be satisfied with practical design approaches.

If the FAA can justify that a rule is deemed necessary, the ASHWG recommends rulemaking and guidance that existing fleets may be able to utilize based on the information already contained within AC 25.1329-1B and AC 25.1322-1. This does not directly reference AC 25.1329-1B (and EASA Amendment CS-25/4) but instead incorporates the appropriate wording from this AC. AC 25.1329-1B was written for flight guidance systems for forward fit applications.

The following material from the referenced guidance information may be helpful in understanding the aspects of existing material relevant to low airspeed alerting:

Low Airspeed Alerting should be developed in accordance with AC 25.1322-1. A low airspeed alert should be considered as a caution level alert which precedes a warning condition (such as a stall warning), to provide immediate flight crew awareness and subsequent flight crew response.

Caution alerts should be developed in accordance with AC/AMC 25.1322-1, Paragraph 6.d:

> d. Caution Alerts.
>
> (1) The alert elements used for caution are typically identical to those used for warnings, as both require immediate flightcrew awareness.
>
> (2) Some caution alerts are related to conditions that are precursors to potential time-critical warning conditions. In these cases, the alerting system elements associated with the caution should be consistent with the elements for related time-critical warnings (described in paragraph 6b of this AC). For example, reactive windshear warnings, ground-proximity warnings, and caution alerts can develop into time-critical warning alerts.

Two senses for attention getting should be provided. The low airspeed alert should be sufficiently specific to direct the attention of the flight crew as to the energy state of the airplane.

Under conditions where multiple alerts are occurring, or during certain failure conditions, the flight crew's workload may be significantly challenged, and any one specific alert may be missed.

Certain failure conditions may reduce the confidence of the flight crew to believe that one or more alerts are valid. For example, if the airspeed information presented to the flight crew were unreliable, the crew may not believe that the logic to set the low airspeed alert is working correctly.

Note that these considerations are not necessarily specific to low airspeed alerting - that is, alerts from legacy aircraft designs which are not in compliance with the recently updated 14 CFR/CS §25.1322, and specifically those where a suitable attention-getting means is necessary, may exhibit similar behaviors.

It is also important to note that none of the aircraft for which low airspeed "incidents" were evaluated by the JSAT had a low airspeed alerting function which would be in compliance.

Prioritization of low airspeed alerts should be developed in accordance with AC/AMC 25.1322-1, paragraph 8.a:

> a. Rules and General Guidelines.
>
> (1) All flight deck alerts must be prioritized into warning, caution, and advisory categories (§ 25.1322(b)).
>
> (2) To meet their intended function(s), alerts must be prioritized based upon urgency of flightcrew awareness and urgency of flightcrew response (§ 25.1301(a)). Normally, this means time-critical warnings are first, other warnings are second, cautions are third, and advisories are last (§ 25.1322(b)).
>
> (3) Depending on the phase of flight, there may be a need to re-categorize certain alerts from a lower urgency level to a higher urgency level. Furthermore, prioritization within alert categories may be necessary. For example, when near threatening terrain, time-critical aural warnings must be prioritized before other warnings within the warning-alert category
>
> (25.1322(c)(1)). AC 25-23, Airworthiness Criteria for the Installation Approval of a Terrain Awareness and Warning System (TAWS) for Part 25 Airplanes, also identifies situations where prioritization within alert categories is necessary.
>
> (4) The prioritization scheme within each alert category, as well as the rationale, should be documented and evaluated, by following the guidance in paragraph 13, *Showing Compliance for Approval of a Flightcrew-Alerting System*, of this AC.
>
> (5) Documentation should include the results of analyses and tests that show that any delayed or inhibited alerts do not adversely impact safety.

The intended function of the low airspeed alert should be documented, and the alert design should be incorporated according to its intended function.

A low airspeed alert may still be needed for systems that provide a speed protection function. Factors which should be considered include the reliability of the speed protection, the availability of the speed protection function in other than normal flight control laws and in particular flight phases, and speed protection failure conditions where a low airspeed alert may still be needed. Alternatively, aircraft fitted with a high incidence protection system that can demonstrate the loss of AOA protection is improbable (remote) may constitute an Equivalent Level of Safety (Ref 14 CFR §25.1309(b)(2); CS 25.1309(b)(3)).

Standard stall warning and high-speed alerts are not always timely enough for the flight crew to intervene to prevent unacceptable speed excursions. Low Airspeed Alerting should be shown to be appropriate and timely to ensure flightcrew awareness and enable the pilot to keep the airplane within an acceptable margin from the low speed range of the normal flight envelope.

Data regarding crew recognition and response from the Human Engineering Compendium by Boff/Lincoln may be helpful to develop a more "complete" timeline, from condition to expected recovery.

For practical reasons, on existing airplanes where integration of new alerts into the flight deck would be very challenging, incorporating low airspeed alerts into existing designs should consider the guidance contained in AC/AMC 25.1322-1, paragraph 14:

> 14. Integrating Flightcrew-Alerting System Elements into the Existing Fleet.
>
> a. General.
>
> (1) This material provides recommendations to applicants on how to retrofit existing airplanes so they comply with § 25.1322 without major modifications to the current flightcrew alerting system.
>
> (2) System upgrades to existing airplanes should be compatible with the original airplane's flightcrew-alerting philosophy. The existing alerting system might not be able to facilitate the integration of additional systems and associated alerts due to limitations in the system inputs, incompatible technologies between the airplane and the system being added, or economic considerations.
>
> (a) We discourage incorporating a new additional master visual function into the flightcrew-alerting system. If it is not feasible to include additional systems and associated alerts in the existing master visual function, an additional master visual function may be installed, provided that it does not delay the flightcrew's response time for recognizing and responding to an alert.
>
> (b) Where possible, new alerts should be integrated into the existing flightcrew alerting system. If these alerts cannot be integrated, individual annunciators or an additional alerting display system may be added.
>
> (c) Not all alerts associated with failure flags need to be integrated into the central alerting system. However, for those alerts requiring immediate flightcrew awareness, the alert needs to meet the attention-getting requirements of § 25.1322(c)(2) as well as the other requirements in § 25.1322. Thus, a master visual or master aural alert may not be initiated, but an attention-getting aural or tactile indication must still accompany an attention-getting visual failure flag to meet the attention-getting requirement of § 25.1322(a)(1), which requires attention-getting cues through at least two different senses for warning and caution alerts.
>
> b. Visual Alerts. Following the guidance in paragraphs 5 and 6 of this AC, determine whether or not the added system features will require activation of an airplane master visual alert.
>
> c. Aural Alerts.

(1) Using the guidance in this AC, determine if an added system will require activating an aural alert.

(2) The new aural alert should be integrated into the existing aural alerting system and functions. If this is not possible, a separate aural alerting system may be installed, provided that a prioritization scheme between existing aural alerts and the new aural alerts is developed so that each alert is recognized and can be acted upon in the time frame appropriate for the alerting situation. This may require a demonstration of any likely combination of simultaneous alerts.

After the new and existing alerts have been merged, follow the guidance in this AC for determining how to prioritize the alerts.

d. Tactile Alerts.

(1) Using the guidance in this AC, determine if an added system will require activating a tactile alert.

(2) If possible, incorporate the new tactile alert into the existing aural alerting system. If this is not possible, a separate tactile alerting system may be installed, provided that the following elements are included:

(a) A prioritization scheme between existing tactile alerts and the new tactile alerts should be developed so that each alert is recognized and can be acted upon in the time frame appropriate for the alerting situation. After the new and existing alerts have been merged, follow the guidance in this AC for determining how to prioritize the alerts.

(b) A means to ensure that an individual alert can be understood and acted upon. This may require a demonstration of any likely combination of simultaneous alerts.

In addition to design, appropriate flight crew procedures and training for proper reaction in response to the alert must be provided.

Flight crew procedures to facilitate corrective action from the low airspeed condition:

(1) The need to continue flying the airplane
(2) The recognition of the low airspeed condition
(3) An assessment of the aircraft's energy state, and other conditions which may be a factor in determining appropriate corrective action
(4) Roles and responsibilities between flight crew members
(5) The corrective action necessary to avoid a stall condition, and recover to safe flight

Pilots need to be trained in crew procedures, CRM measures, stall recovery and airspeed management to provide the knowledge and skills to avoid negative aircraft situations that result from low airspeed, and to respond correctly and consistently to the alerts.

Appendix A – Aircraft Survey

The following survey was administered to aircraft manufacturers, and the attached data in Appendix B was collected through the survey to identify where and how low airspeed alerting has been implemented in existing fleets.

Survey - Low Airspeed Indications, Alerting & Protection/Limiting

As a result of several recent accidents and incidents, the FAA has identified a possible need for additional low airspeed safeguards and tasked the Aviation Rulemaking Advisory Committee (ARAC) to answer technical questions on this subject. The ARAC assigned this task to the Avionics Systems Harmonization Working Group (ASHWG). To accomplish this task, the ASHWG is collecting information on the low airspeed indications, alerting and protection/limit functions available on current commercial airplanes. The ASHWG will provide information to help develop recommendations on whether there should be regulatory requirements and guidance material for retrofit of low airspeed alerting on existing aircraft.

Any rulemaking that the FAA might undertake based on the ARAC recommendations would be subject to a cost-benefit analysis. Detailed information for the FAA tasking to ARAC can be found at 76 FR 11844. The survey requests information on low airspeed flight deck indications, alerting and protection/limiting functions as well as technical information on input parameters to these functions. The following are brief definitions of terms to help in understanding the survey.

- “Indications” for low airspeed conditions - information presented full time on a display or indicator.

- “Alerting” for low airspeed conditions - additional information presented to the flight crew (visual and/or aural) only under specific predefined conditions.

- “Protection/limiting” for low airspeed or approach to stall conditions - functions that automatically provide assistance to the flight crew (e.g., throttle advance, increase in stick forces), but only under specific predefined conditions.

The ASHWG strictly adheres to ethical standards, public law, and federal policies for safeguarding the confidentiality of all participants in this survey. Completion of this survey is voluntary and all responses to the survey that are released will not contain survey participant information.

The survey should take approximately 20-30 minutes to complete per airplane model. Please complete the survey within 30 days of receipt. It is recommended that you review the attached survey file and gather all the necessary information before completing the online survey.

Thank you for participating in this survey.

1) Select your airplane model:

・ □Airbus A300-600 or A310 All

- □Airbus A318/319/320/321/330/340/380 All
- □ATR ATR42 All
- □ATR ATR72 All
- □BaE J31 All
- □BaE J41 All
- □Boeing 717 All
- □Boeing 727 All
- □Boeing 737 -300, -400, -500 Conv
- □Boeing 737 -300, -400, -500 EADI F/S
- □Boeing 737 -300, -400, -500 EADI Spd Tape
- □Boeing 737 -600, -700, -800, -900
- □Boeing 747 -200
- □Boeing 747 -400
- □Boeing 757 -200 EADI F/S
- □Boeing 757 -200, -300 EADI Spd Tape
- □Boeing 767 -200, -300 EADI F/S
- □Boeing 767 -200, -300 EADI Spd Tape
- □Boeing 767 -400
- □Boeing 777 All
- □Boeing DC9 All
- □Boeing MD 80 All
- □Boeing MD 90 All
- □Boeing MD10 All
- □Boeing MD11 All
- □Bombardier CRJ -100, -200, -400, -440
- □Bombardier CRJ -700, -701, -702
- □Bombardier CRJ -705, -900
- □Bombardier DHC8 -100, -200, -300
- □Bombardier DHC8 -400
- □Embraer 120 All
- □Embraer 135 All
- □Embraer 140 All
- □Embraer 145 All
- □Embraer 170 All
- □Embraer 175 All
- □Embraer 190 All
- □Saab 340 All

Section 1 - General System Capabilities

2) 1-1. What general system capabilities does the airplane have to support new flight deck indications and alerting? (Check all that apply)

- □Primary Flight Display (with speed tape)
- □Alert message system (visual message list)
- □Master caution/warning light
- □Aural tone and/or voice capability
- □Enhanced Ground Proximity Warning System
- □Angle of attack data
- □Flap data
- □Anti-ice active data
- □Other (please specify)

If you selected other, please specify

_____

Section 2 - INDICATIONS for Low Airspeed Awareness

3) 2-1.What low airspeed awareness indications or cues (other than alerts) are presented on the airspeed indicator or airspeed tape? (Check all that apply)

[Reference AC 25-11A Appendix 1, Paragraph 2.3 provides information for low airspeed awareness]

- □Colored bands
- □Trend vectors
- □Speed bugs
- □Other (please specify)

If you selected other, please specify

_____

4) 2-2. What other indications exist that support low airspeed awareness, although it may not be the primary function? (Check all that apply)

- □Pitch limit indicator
- □Angle of attack indicator
- □Other (please specify)

If you selected other, please specify

_____

Section 3 - ALERTING Functionality for Low Airspeed Conditions (prior to stall warning)

5) 3-1. What additional visual indications are presented to the flight crew for a low airspeed alert, prior to stall warning? (Check all that apply)

[CFR 14 Part 25.1322, Paragraph (c) (2) provides requirements for alerting indications]

- □Discrete indicator (lamp)
- □Master caution light
- □Indicator on Crew Alerting display
- □Indicator on Primary Flight Display
- □Change in display of current airspeed (i.e., flash, color change, etc)
- □Change in display of angle of attack or angle of attack threshold (i.e., flash, color change, etc)
- □Other (please specify)

If you selected other, please specify

_____

6) 3-2. What aural indications are presented to the flight crew for a low airspeed alert, prior to stall warning? (Check all that apply, and specify in Comments)

[CFR 14 Part 25.1322, Paragraph (c) (2) provides requirements for alerting indications]

- □Voice (please specify)
- □Tone (please specify)
- □Other (please specify)

Additional comments

_____

7) 3-3. What input parameters are used in the logic for the low airspeed alert? (Check all that apply)

- □Airspeed
- □Airspeed rate of change
- □Angle of attack
- □Barometric altitude
- □Radio altitude
- □Minimum maneuver speed
- □Stick shaker speed
- □Manual or automatic flight state
- □Thrust/power parameters
- □Time
- □Other (please specify)

If you selected other, please specify

_____

8) 3-4. Is the low airspeed alert adjusted for the following conditions/configurations? (Check all that apply)

- □Flaps setting
- □Speedbrake extension
- □Weight
- □CG

- □Load factor/g-loading
- □Icing conditions
- □Other (please specify)

If you selected other, please specify

_____

9) 3-5. What trip point is used to activate the low airspeed alert? (Check all that apply)

- □X kts or X% in the low speed amber band
- □X% above stall speed
- □X degrees angle of attack
- □Low airspeed alert is same as stall warning
- □Other (please specify)

If you selected other, please specify

_____

10) 3-6. How do you minimize nuisance alerts? (Check all that apply)

- □Hysteresis (e.g. delay in reset)
- □Filtering
- □Large margins from normal operating speed
- □Special combinations of input parameters
- □Manual inhibit
- □Automatic inhibit
- □Other (please specify)

If you selected other, please specify

_____

11) 3-7. What circumstances or conditions are used to inhibit the low airspeed alert? (Check all that apply)

- □Baro Altitude
- □Radio Altitude
- □Priorities with other alerts
- □Phase of flight (e.g., takeoff, approach)
- □Non-normal configurations
- □Other (please specify)

If you selected other, please specify

_____

12) 3-8. Is there a design requirement or goal for a minimum time margin between the low airspeed alert activation and stall warning activation? (assuming these are two independent points)

- □Yes (please specify below)
- □No

Additional comments

_____

13) 3-9. Can you provide a description or illustration or logic diagram or equation that describes how the low airspeed alert is activated?

- □Yes (If so, email to the point of contact identified in the introduction)
- □No

14) 3-10. How did you determine that the Low Airspeed Alert is timely (i.e., provides the pilot sufficient time to avoid stall warning, or some other identified point)? (Check all that apply)

- □Analysis
- □In-service history
- □Flight test
- □Flight simulator or lab testing
- □Other (please specify)

If you selected other, please specify

_____

15) 3-11. Is the alerting functionality you have described above implemented on all airplanes or only some through a customer option, STC or later add-on?

- □All
- □Some through option, STC or later add-on

16) 3-12. If you selected some through option, STC or later add-on, please specify the number of airplanes modified versus the number in the fleet:

Number of airplanes modified _____

Number airplanes in the fleet _____

Section 4 - PROTECTION/LIMITING functionality (automated assistance) for low airspeed or approach to stall conditions?

17) 4-1. What protection/limiting functionality is available to automatically assist the pilot for low airspeed conditions, prior to stall warning? (Check all that apply)

- □Autothrottle "wakeup"/automatic thrust activation
- □Stick pusher
- □Automatic pitch control
- □Increased column/stick forces
- □Angle of attack protection
- □Auto-slat extension
- □Angle of attack limit
- □Other (please specify)

If you selected other, please specify

_____

18) 4-2. What protection/limiting functionality is available to automatically assist the pilot for approach to stall conditions, at/after stall warning? (Check all that apply)

- □Stick pusher
- □Automatic pitch control
- □Increased column/stick forces
- □Angle of attack protection
- □Auto-slat extension
- □Angle of attack limit
- □Other (please specify)

If you selected other, please specify

_____

Appendix B – Survey Results

Appendix B contains the data which was collected through the survey questions in Appendix A, to identify where and how low airspeed alerting has been implemented in existing fleets.

		1-1. What general system capabilites does the airplane have to support new flight deck indications and alerting?									
Model Capabilities (Reference survey question in parentheses)	Airplane model (number in fleet at the time of data collection)	Primary Flight Display (with speedtape)	Alert message system (visual message list)	Master caution/warning light	Aural tone and/or voice capability	Enhanced Ground Proximity Warning System	Angle of attack data	Flap data	Anti-ice active data	Other	OtherText
Round dial No SW cptr	Boeing DC9 All (433)	No	No	Yes	Yes	Yes	Yes	Yes	No	No	EGPWS is available as an STC
	Boeing 727 All (826)	No	No	No	Yes	Yes	Yes	Yes	No	No	
	Boeing 747-200 (202)	No	No	No	Yes	Yes	Yes	Yes	No	No	
Round dial Have SW cptr to support	Embraer 120 All (126)	No	No	Yes	Yes	No	Yes	Yes	Yes	No	
	Boeing 737 -300, -400, -500 Conv (1550)	No	No	Yes	Yes	Yes	Yes	Yes	No	No	EGPWS is available as an STC
	Boeing MD 80 All (1016)	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No	
	Boeing MD 90 All (108)	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No	
	Saab 340 All (197)	No	No	Yes	Yes	Yes	No	No	No	No	
Have EFIS & alert capability. (1-1)	Boeing 737 -300, -400, -500 EADI F/S (190)	No	No	Yes	Yes	Yes	Yes	Yes	No	No	
	Boeing 757-200 EADI F/S (971)	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No	
	Boeing 767-200, -300 EADI F/S (880)	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No	
	Boeing 737 -300, -400, -500 EADI Spd Tape (58)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	
	Boeing 757-200, -300 EADI Spd Tape (37 -300 only)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	
	Boeing 767 -200, -300 EADI Spd Tape (46)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	
	Bombardier CRJ-100, -200, -400, -440 (718)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
	Bombardier CRJ -700, -701, -702 (215)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Ice Detector detected ice
	Bombardier CRJ -705, -900 (105 -900)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
PFD with visual low airspeed alert indication only. (3-1)	Embraer 135 All (137)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	
	Embraer 140 All (74)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	
	Embraer 145 All (503)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	
	Embraer 170 All (76)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	
	Embraer 175 All (54)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	
	Embraer 190 All (51)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	
	Boeing 717 All (155)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	
	Boeing MD10/11 All (257)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	
	Airbus A300-600 or A310 All (A300-158; A310-70)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	
Visual & aural low airspeed alert indication. (3-1, 3-2)	Boeing 737 -600, -700, -800, -900 (3908)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	
	Boeing 747-400 (675)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	
	Boeing 767-400 (38)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	
	Boeing 777 All (981)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	
	Airbus A318/319/320/321/330/340/380 All (767) (318-321--724; 330-380--43)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	

Model Capabilities (reference survey question in parenthesis)	Airplane model (number in fleet at the time of data collection)	Q 1 When low airspeed awareness indications or cues (other than stall) are presented on the airspeed indicator or airspeed tape: Colored bands	Trend vector	Speed flags	Other	Other Text
Round dial No SW cpb	Boeing DC-9 All (433)	No	No	No	No	
	Boeing 727 All (826)	No	No	No	No	
	Boeing 747-200 (202)	No	No	No	No	
Round dial Have SW cpb or support	Embraer 120 All (126)	No	No	No	Yes	Trend/Flow indicator
	Boeing 737 -300, -400, -500 Classic (1550)	No	No	No	No	
	Boeing MD 90 All (101)	No	No	No	No	
	Boeing MD 90 All (100)	No	No	No	No	
	Saab 340 All (107)	No	No	Yes	No	
Have FFIS & alert capability (1-3)	Boeing 737 -300, -400, -500 EADI F/S (190)	No	No	No	Yes	Trend/Flow indicator
	Boeing 757-200 EADI F/S (371)	No	No	No	Yes	
	Boeing 767-200, -300 EADI F/S (680)	No	No	No	Yes	
	Boeing 737 -300, -400, -500 EADI Spd Tape (58)	Yes	Yes	Yes	No	
	Boeing 757-200, -300 EADI Spd Tape (37 -300 only)	Yes	Yes	Yes	No	
	Boeing 767 -200, -300 EADI Spd Tape (46)	Yes	Yes	Yes	No	
	Bombardier CRJ-100, -200, -400, -440 (718)	Yes	Yes	Yes	No	
	Bombardier CRJ -700, -701, -702 (215)	Yes	Yes	Yes	No	
	Bombardier CRJ -705, -900 (105 -900)	Yes	Yes	Yes	No	
PFD with visual low airspeed alert indication only (3-1)	Embraer 135 All (137)	Yes	Yes	No	No	When airspeed trend vector reaches the red band, accompanied often with a second cue
	Embraer 140 All (78)	Yes	Yes	No	No	
	Embraer 145 All (593)	Yes	Yes	No	No	
	Embraer 170 All (76)	Yes	Yes	No	No	
	Embraer 175 All (54)	Yes	Yes	No	No	
	Embraer 190 All (51)	Yes	Yes	No	No	
	Boeing 717 All (155)	Yes	Yes	Yes	No	
	Boeing MD10/11 All (257)	Yes	Yes	Yes	No	
	Airbus A300-600 or A310 All (A300 150; A310 70)	Yes	Yes	Yes	No	
Visual & aural low airspeed alert indication (3-1, 3-2)	Boeing 737 -600, -700, -800, -900 (3900)	Yes	Yes	Yes	No	
	Boeing 747-400 (675)	Yes	Yes	Yes	No	
	Boeing 767-400 (35)	Yes	Yes	Yes	No	
	Boeing 777 All (981)	Yes	Yes	Yes	No	
	Airbus A318/319/320/321/330/340/350 All (767) (318-321 -724; 330-340 -43)	Yes	Yes	Yes	No	

Model Capabilities (Reference survey question # / conditional)	Airplane model (numbers in fleet at the time of data collection)	7.7 What other indications exist that support low airspeed awareness - although it may not be the primary function?			
		Pitch limit indicator	Angle of attack indicator	Other	Other Text
Round dial No SW opt	Boeing DC9 All (113)	No	No	No	
	Boeing 727 All (826)	No	No	No	
	Boeing 747-200 (202)	No	No	No	
Round dial Have SW opt to support	Embraer 120 All (126)	No	No	No	
	Boeing 717, 300, 400, 500 Classic (1558)	No	No	No	
	Boeing MD 80 All (1015)	Yes	No	No	
	Boeing MD 90 All (100)	Yes	No	No	
	Saab 340 All (197)	No	No	No	
Have LLTS & alert capability. (1.1)	Boeing 737 300, 400, 500 EADI F/S (150)	No	No	No	
	Boeing 757-200 EADI F/S (971)	Yes	No	No	
	Boeing 767-200, -300 EADI F/S (880)	Yes	No	No	
	Boeing 737 300, 400, 500 EADI Spd Tape (98)	Yes	No	No	
	Boeing 757-200, -300 EADI Spd Tape (37 -300 only)	Yes	No	No	
	Boeing 767 -200, -300 EADI Spd Tape (46)	Yes	No	No	
	Bombardier CRJ-100, -200, -400, -440 (718)	No	No	No	
	Bombardier CRJ -700, -701, -702 (215)	No	No	No	
	Bombardier CRJ -705, -900 (105 -900)	No	No	No	
PFD with visual low airspeed alert indication only. (1.1)	Embraer 135 All (137)	Yes	No	No	
	Embraer 140 All (74)	Yes	No	No	
	Embraer 145 All (503)	Yes	No	No	
	Embraer 170 All (76)	Yes	No	No	
	Embraer 175 All (54)	Yes	No	No	
	Embraer 190 All (51)	Yes	No	No	
	Boeing 717 All (155)	Yes	No	No	
	Boeing MD10/11 All (25)	Yes	No	No	
	Airbus A300-600 or A310 All (A300-155; A310-70)	Yes	No	No	
Visual & aural low airspeed alert indication. (3.1, 3-2)	Boeing 737 -600, -700, -800, -900 (3908)	Yes	Yes	Yes	The Angle of attack indicator is an available option the "other" is the pilot selectable flight path vector
	Boeing 747-400 (675)	Yes	No	Yes	There is a pilot-selectable flight path vector
	Boeing 767-400 (36)	Yes	Yes	Yes	Pilot-selectable flight path vector
	Boeing 777 All (281)	Yes	Yes	Yes	The Angle of attack indicator is an available option the "other" is the pilot selectable flight path vector
	Airbus A318/319/320/321/330/340/380 All (767) (318-321 -724, 330-380 -43)	Yes	No	No	

Model Capabilities (reference survey question #)	Airplane model (number in fleet at the time of data collection)	3.1. What additional visual indications are presented to the flight crew for a low airspeed alert, prior to stall warning? Discrete indicator (lamp)	Master caution light	Indication on Crew Alerting Display	Indication on Primary Flight Display	Change in display of current airspeed (e.g. flash, color change, etc.)	Change in display of AOA, or with threshold (e.g. flash, color change, etc.)	Other	Other Text
Round dial No SW cpb	Boeing DC9 All (433)	No	No	No	No	No	No	No	
	Boeing 727 All (826)	No	No	No	No	No	No	No	
	Boeing 747-200 (202)	No	No	No	No	No	No	No	
Round dial Have SW cpb to support	Embraer 120 All (126)	No	No	No	No	No	No	Yes	[illegible]
	Boeing 737-300, -400, -500 Conv (1590)	No	No	No	No	No	No	No	
	Boeing MD-80 All (1076)	No	No	No	No	No	No	No	
	Boeing MD-90 All (109)	No	No	No	No	No	No	No	
	Saab 340 All (197)	No	No	No	No	No	No	No	
Have EFIS & alert capability. (1-1)	Boeing 737-300, -400, -500 EADI F/S (180)	No	No	No	Yes	No	No	No	10 kts below target speed
	Boeing 757-200 EADI F/S (971)	No	No	No	Yes	No	No	No	
	Boeing 767-200, -300 EADI F/S (880)	No	No	No	Yes	No	No	No	
	Boeing 737-300, -400, -500 EADI Spd Tape (58)	No	No	No	No	No	No	No	
	Boeing 757-200, -300 EADI Spd Tape (37 -300 only)	No	No	No	No	No	No	No	
	Boeing 767-200, -300 EADI Spd Tape (46)	No	No	No	No	No	No	No	
	Bombardier CRJ 100, -200, -400, -440 (718)	No	No	No	No	No	No	Yes	
	Bombardier CRJ 700, 701, 702 (215)	No	No	No	No	No	No	Yes	Engine Cont Ignition light and message
	Bombardier CRJ 705, 900 (105 900)	No	No	No	No	No	No	Yes	
PFD with visual low airspeed alert indication only (1-1)	Embraer 135 All (177)	No	No	No	Yes	Yes	No	No	
	Embraer 140 All (74)	No	No	No	Yes	Yes	No	No	
	Embraer 145 All (961)	No	No	No	Yes	Yes	No	No	
	Embraer 170 All (80)	No	No	No	Yes	Yes	No	No	
	Embraer 175 All (34)	No	No	No	Yes	Yes	No	No	
	Embraer 190 All (31)	No	No	No	Yes	Yes	No	No	
	Boeing 717 All (155)	No	No	No	Yes	Yes	No	No	
	Boeing MD10/11 All (137)	No	No	No	Yes	Yes	No	No	
	Airbus A300-600 or A310 All (A300-758, A310-70)	No	Yes	No	Yes	No	No	Yes	Tailored compliance: 1) dynamic red speedtape on PFD, 2) AP disconnect at VLS-10 associated to master caution [illegible] 3) signature [illegible] of [illegible] by autoconnection of ATHR "THR [illegible]" [illegible] on FMA PFD
Visual & aural low airspeed alert indication. (2-1, 2-2)	Boeing 737-600, -700, -800, -900 (2900)	No	No	No	Yes	Yes	No	No	
	Boeing 747-400 (675)	No	Yes	Yes	Yes	Yes	No	No	
	Boeing 767-400 (38)	No	Yes	Yes	Yes	Yes	No	No	
	Boeing 777 All (801)	No	Yes	Yes	Yes	Yes	No	No	
	Airbus A318/319/320/321/330/340/380 All (707) (318-321-724, 330-340-43)	No	Yes	Yes	Yes	No	Yes	No	[illegible] considered: 1) dynamic amber & red speedtape on PFD, 2) [illegible] amber flashing in EDAM & PFD 3) AP disconnect at alphaprot + [illegible]

		3-1. What aural indications are presented to the flight crew for a low airspeed alert, prior to stall warning?			
Model Capabilities (Reference survey question in parentheses)	Airplane model (number in fleet at the time of data collection)	Voice (please specify)	Tone (please specify)	Other (please specify)	Comment/Text
Round dial No SW cpb	Boeing DC9 All (433)	No	No	No	
	Boeing 727 All (826)	No	No	No	
	Boeing 747-200 (202)	No	No	No	
Round dial Have SW cpb to support	Embraer 120 All (126)	No	No	Yes	The aural [illegible] shaker motor is loud enough to be perceived by pilots
	Boeing 737 -300, -400, -500 Classic (1550)	No	No	No	
	Boeing MD 90 All (1016)	No	No	No	
	Boeing MD 90 All (108)	No	No	No	
	Saab 340 All (197)	No	No	No	
Have FFIS & alert capability. (1-1)	Boeing 737 -300, -400, -500 EADI F/S (190)	No	No	No	
	Boeing 757-200 EADI F/S (571)	No	No	No	
	Boeing 767-200, -300 EADI F/S (680)	No	No	No	
	Boeing 737 -300, -400, -500 EADI Spd Tape (58)	No	No	No	
	Boeing 757-200, -300 EADI Spd Tape (37 -300 only)	No	No	No	
	Boeing 767 -200, -300 EADI Spd Tape (46)	No	No	No	
	Bombardier CRJ-100, -200, -400, -440 (718)	No	No	No	
	Bombardier CRJ -700, 701, 702 (215)	No	No	No	
	Bombardier CRJ -705, 900 (105 -900)	No	No	No	
PFD with visual low airspeed alert indication only. (1-1)	Embraer 135 All (137)	No	No	Yes	The aural [illegible] shaker motor is loud enough to be perceived by pilots
	Embraer 140 All (74)	No	No	Yes	
	Embraer 145 All (503)	No	No	Yes	
	Embraer 170 All (76)	No	No	Yes	
	Embraer 175 All (54)	No	No	Yes	
	Embraer 190 All (51)	No	No	Yes	
	Boeing 717 All (155)	No	No	No	
	Boeing MD10/11 All (257)	No	No	No	
	Airbus A300 600 or A310 All (A300-158; A310-70)	No	No	Yes	"cavalry charge" when AP disconnect & autothrottle
Visual & aural low airspeed alert indication. (3-1, 3-2)	Boeing 737 -600, -700, -800, -900 (3908)	Yes	No	No	Service Bulletin available to enable voice - "AIRSPEED LOW AIRSPEED LOW"
	Boeing 747-400 (675)	No	Yes	No	Standard EICAS caution tone
	Boeing 767-400 (38)	No	Yes	No	
	Boeing 777 All (981)	No	Yes	No	
	Airbus A318/319/320/321/330/340/380 All (767) (318 321 -724; 330 380 -43)	Yes	No	No	"Speed-Speed-Speed" below 2500ft

		1-2. What input parameters are used in the logic for the low airspeed alert?											
Model Capabilities (Reference letter/ number in parentheses)	Airplane model (number in fleet at the time of data collection)	Airspeed	Airspeed rate of change	Angle of attack	Barometric altitude	Radio altitude	Minimum maneuver speed	Stick shaker speed	Manual or automatic flight state	Thrust or power parameters	Time	Other	Other Text
Round dial. No SW opt.	Boeing DC9 All (433)	No	No	No	No	Yes	No	No	No	No	No	No	
	Boeing 727 All (576)	No	No	No	No	No	No	No	No	No	No	No	
	Boeing 747-200 (282)	No	No	No	No	No	No	No	No	No	No	No	
Round dial. Have SW opt. in system	Embraer 120 All (120)	No	No	Yes	No	No	No	Yes	No	No	No	No	
	Boeing 737 -300, -400, -500 Classy (1550)	No	No	No	No	No	No	No	No	No	No	No	
	Boeing MD-80 All (1010)	No	No	No	No	No	No	No	No	No	No	No	
	Boeing MD-90 All (108)	No	No	No	No	No	No	No	No	No	No	No	
	Saab 340 All (197)	No	No	No	No	No	No	No	No	No	No	No	
Have EFIS & alert capability. (1-1)	Boeing 737 -300, -400, -500 EADI F/S (190)	Yes	No	No	No	No	No	No	No	No	No	No	
	Boeing 757-200 EADI F/S (971)	Yes	No	No	No	No	No	No	No	No	No	No	
	Boeing 767-200, -300 EADI F/S (880)	Yes	No	No	No	No	No	No	No	No	No	No	
	Boeing 737 -300, -400, -500 EADI Spd Tape (56)	No	No	No	No	No	No	No	No	No	No	No	
	Boeing 757-200, -300 EADI Spd Tape (37 -300 only)	No	No	No	No	No	No	No	No	No	No	No	
	Boeing 767 -200, -300 EADI Spd Tape (46)	No	No	No	No	No	No	No	No	No	No	No	
	Bombardier CRJ-100, -200, -400, -440 (718)	No	No	Yes	No	No	No	No	No	No	No	Yes	
	Bombardier CRJ-700, -701, -702 (215)	No	No	Yes	No	No	No	No	No	No	No	Yes	Mach & AoA rate
	Bombardier CRJ-705, -900 (105 -900)	No	No	Yes	No	No	No	No	No	No	No	Yes	
EFIS with visual low airspeed alert indicator only (1-4)	Embraer 135 All (11)	No	No	Yes	No	No	Yes	Yes	No	No	No	No	
	Embraer 140 All (14)	No	No	Yes	No	No	No	Yes	No	No	No	No	
	Embraer 145 All (30)	No	No	Yes	No	No	No	Yes	No	No	No	No	
	Embraer 170 All (1)	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No	No	
	Embraer 175 All (56)	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No	No	
	Embraer 190 All (51)	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No	No	
	Boeing 717 All (159)	Yes	No	No	No	No	Yes	Yes	No	No	No	No	
	Boeing MD10/11 All (25)	Yes	No	No	No	No	Yes	Yes	No	No	No	No	
	Airbus A300-600 w/ A310 All (A300-15; A310-70)	Yes	Yes	Yes	No	No	No	No	No	No	No	No	
Visual & aural low airspeed alert indication (1-1, 1-2)	Boeing 737 -600, -700, -800, -900 (3668)	Yes	No	No	No	No	Yes	Yes	No	No	No	No	
	Boeing 747-400 (975)	Yes	No	No	No	No	Yes	Yes	No	No	No	No	
	Boeing 767-400 (38)	Yes	No	No	No	No	Yes	Yes	No	No	No	No	
	Boeing 777 All (981)	Yes	No	No	No	No	Yes	Yes	No	No	No	No	
	Airbus A318/319/320/321/330/340/380 All (767) (318-321-724; 330-380 -43)	Yes	Yes	Yes	No	Yes	No	No	No	No	No	Yes	Mach (for alpha-floor/ protection)

		Is the low airspeed alert adjusted for the following conditions/configurations?							
Model Capabilities (Reference number in parentheses)	Airplane model (number in fleet at the time of data collection)	Flaps setting	Speedbrake extension	Weight	CG	Load factor/g-loading	Icing conditions	Other	OtherText
Round dial No SW cpb	Boeing DC9 All (423)	No	No	No	No	No	No	No	
	Boeing 727 All (526)	No	No	No	No	No	No	No	
	Boeing 747-200 (202)	No	No	No	No	No	No	No	
Round dial Have SW cpb to support	Embraer 120 All (120)	Yes	No	No	No	No	Yes	No	
	Boeing 737 -300, -400, -500 Classic (1550)	No	No	No	No	No	No	No	
	Boeing MD-80 All (1015)	No	No	No	No	No	No	No	
	Boeing MD-90 All (108)	No	No	No	No	No	No	No	
	Saab 340 All (197)	No	No	No	No	No	No	No	
Have EFIS & alert capability. (1.1)	Boeing 737 -300, -400, -500 EADI F/S (190)	No	No	No	No	No	No	No	
	Boeing 757-200 EADI F/S (971)	No	No	No	No	No	No	No	
	Boeing 767-200, -300 EADI F/S (880)	No	No	No	No	No	No	No	
	Boeing 737 -300, -400, -500 EADI Spd Tape (56)	No	No	No	No	No	No	No	
	Boeing 757-200, -300 EADI Spd Tape (37 -300 only)	No	No	No	No	No	No	No	
	Boeing 767 -200, -300 EADI Spd Tape (46)	No	No	No	No	No	No	No	
	Bombardier CRJ-100, -200, -400, -440 (718)	Yes	No	No	No	No	No	Yes	Uses
	Bombardier CRJ-700, -701, -702 (215)	Yes	No	No	No	No	No	Yes	
	Bombardier CRJ -705, -900 (105 -900)	Yes	No	No	No	No	No	Yes	
PFD with visual low airspeed alert indication only. (1.4)	Embraer 135 All (137)	Yes	No	No	No	No	Yes	No	
	Embraer 140 All (74)	Yes	No	No	No	No	Yes	No	
	Embraer 145 All (503)	Yes	No	No	No	No	Yes	No	
	Embraer 170 All (74)	Yes	No	No	No	No	Yes	No	
	Embraer 175 All (54)	Yes	No	No	No	No	Yes	No	
	Embraer 190 All (51)	Yes	No	No	No	No	Yes	No	
	Boeing 717 All (155)	Yes	No	Yes	Yes	Yes	Yes	No	
	Boeing MD-10/11 All (25)	Yes	No	Yes	Yes	Yes	Yes	No	
	Airbus A300-600 w A310 All (A300-156; A310-70)	Yes	Yes	Yes	No	Yes	No	No	
Visual & aural low airspeed alert indication (3.1, 3.2)	Boeing 737 -600, -700, -800, -900 (3966)	Yes	No	Yes	Yes	Yes	Yes	No	The adjustments are made to the amber bar/barber pole, which directly affects alerting calc
	Boeing 747-400 (975)	Yes	No	Yes	Yes	Yes	Yes	No	
	Boeing 767-400 (38)	Yes	No	Yes	Yes	Yes	Yes	No	
	Boeing 777 All (981)	Yes	No	Yes	Yes	Yes	Yes	No	
	Airbus A318/319/320/321/330/340/350 All (767) (318,321,-724; 330,350 -43)	Yes	Yes	Yes	No	Yes	No	No	

		2.5 What trig point is used to activate the low airspeed alert?					
Model Capabilities (Reference survey question in parentheses)	Airplane model (number in fleet at the time of data collection)	X kts or X% of the low speed amber band	X% aboveStall speed	X degrees angle of attack	Low airspeed alert is same as stall warning	Other	Other Text
Round dial No SW cpbl	Boeing DC9 All (433)	No	No	No	No	No	
	Boeing 727 All (626)	No	No	No	No	No	
	Boeing 747-200 (202)	No	No	No	No	No	
Round dial have SW cpbl in engine	Embraer 120 All (125)	No	No	Yes	Yes	No	
	Boeing 737 -300, -400, -500 Classic (1500)	No	No	No	No	No	
	Boeing MD-80 All (1016)	No	No	No	No	No	
	Boeing MD 90 All (108)	No	No	No	No	No	
	Saab 340 All (197)	No	No	No	No	No	
Have EFIS & alert capability. (1-3)	Boeing 737 -300, -400, -500 EADI EFS (190)	No	No	No	No	Yes	Difference from target airspeed (10 kts)
	Boeing 757-200 EADI EFS (971)	No	No	No	No	Yes	Difference from target airspeed
	Boeing 767-200, -300 EADI EFS (880)	No	No	No	No	Yes	Difference from target airspeed
	Boeing 737 -300, -400, -500 EADI Spd Tape (58)	No	No	No	No	No	
	Boeing 757-200, -300 EADI Spd Tape (37 -300 only)	No	No	No	No	No	
	Boeing 767 -200, -300 EADI Spd Tape (46)	No	No	No	No	No	
	Bombardier CRJ 100, -200, -400, -440 (718)	No	No	Yes	No	No	
	Bombardier CRJ -700, -701, -702 (215)	No	No	Yes	Yes	No	
	Bombardier CRJ -705, -900 (105 -900)	No	No	Yes	No	No	
EFD with visual low airspeed alert indication only. (1-3)	Embraer 135 All (137)	No	No	Yes	Yes	No	
	Embraer 140 All (74)	No	No	Yes	Yes	No	
	Embraer 145 All (301)	No	No	Yes	Yes	No	
	Embraer 170 All (76)	Yes	No	Yes	Yes	No	
	Embraer 175 All (54)	Yes	No	Yes	Yes	No	
	Embraer 190 All (51)	Yes	No	Yes	Yes	No	
	Boeing 717 All (155)	Yes	No	No	No	No	
	Boeing MD10/11 All (257)	Yes	No	No	No	No	
	Airbus A300-600 and A310 All (A300-B2, -B4, A310-200)	Yes	Yes	Yes	No	No	
Visual & aural low airspeed alert indication. (3-4, 3-5)	Boeing 737 -600, -700, -800, -900 (3588)	Yes	No	No	No	No	10%
	Boeing 747-400 (675)	Yes	No	No	No	No	
	Boeing 767-400 (58)	Yes	No	No	No	No	
	Boeing 777 All (891)	Yes	No	No	No	No	
	Airbus A318/319/320/321/330/340/350 All (767) (318-321--724; 330-380--43)	No	No	Yes	No	No	

		1-6: How do you minimize nuisance alerts?							
Model / type/Other (Reference survey question in parentheses)	Airplane model (number in fleet at the time of data collection)	Hysteresis (e.g. delay in reset)	Filtering	Large margins from normal operating speed	Special combinations of input parameters	Manual Inhibit	Automatic Inhibit	Other	Other Text
Round dial No SW cpb	Boeing DC9 All (433)	No	No	No	No	No	No	No	
	Boeing 727 All (626)	No	No	No	No	No	No	No	
	Boeing 747-200 (292)	No	No	No	No	No	No	No	
Round dial Have SW cpb to perform	Embraer 120 All (129)	No	No	Yes	No	No	No	No	
	Boeing 737-300, -400, -500 Conv (559)	No	No	No	No	No	No	No	
	Boeing MD-80 All (1010)	No	No	No	No	No	No	No	
	Boeing MD-90 All (198)	No	No	No	No	No	Yes	No	
	Saab 340 All (592)	No	No	No	No	No	No	No	
Have FFIS & alert capability (1-1)	Boeing 737-300, -400, -500 EADI F/S (190)	No	No	No	No	No	No	No	
	Boeing 757-200 EADI F/S (971)	No	No	No	No	No	No	No	
	Boeing 767-200, -300 EADI F/S (880)	No	No	No	No	No	No	No	
	Boeing 737-300, -400, -500 EADI Spd Tape (58)	No	No	No	No	No	No	No	
	Boeing 757-200, -300 EADI Spd Tape (37 -300 only)	No	No	No	No	No	No	No	
	Boeing 767-200, -300 EADI Spd Tape (46)	No	No	No	No	No	No	No	
	Bombardier CRJ 100, -200, -400, -440 (716)	No	Yes	Yes	No	No	No	No	
	Bombardier CRJ-700, -701, -702 (219)	No	Yes	Yes	No	No	No	No	
	Bombardier CRJ-705, -900 (105 900)	No	Yes	Yes	No	No	No	No	
PFD with visual low airspeed alert indication only (2-1)	Embraer 135 All (137)	No	Yes	Yes	No	No	No	No	
	Embraer 140 All (74)	No	Yes	Yes	No	No	No	No	
	Embraer 145 All (503)	No	Yes	Yes	No	No	No	No	
	Embraer 170 All (76)	Yes	Yes	Yes	No	No	No	No	
	Embraer 175 All (54)	Yes	Yes	Yes	No	No	No	No	
	Embraer 190 All (51)	Yes	Yes	Yes	No	No	No	No	
	Boeing 717 All (155)	No	No	No	No	No	No	No	
	Boeing MD10/11 All (75)	No	No	No	No	No	No	No	
	Airbus A300-600 or A310 All (A300-156, A310-70)	No	Yes	Yes	No	No	Yes	No	
Visual & aural low airspeed alert indication (3-1, 3-2)	Boeing 737-600, -700, -800, -900 (3900)	Yes	Yes	Yes	No	No	No	No	The alert is triggered when current airspeed has decreased so as to "use up" 40% of the minimum maneuver speed margin in autothrottle. The alert is removed when airspeed is greater than minimum maneuver speed.
	Boeing 747-400 (675)	Yes	Yes	Yes	No	No	No	No	
	Boeing 767-400 (38)	Yes	Yes	Yes	No	No	No	No	
	Boeing 777 All (981)	Yes	Yes	Yes	No	No	No	No	
	Airbus A318/319/320/321/330/340/380 All (767) (318-321-724; 330-340-43)	No	Yes	Yes	No	No	Yes	No	

Model Capabilities (reference survey question in parentheses)	Airplane model (number in fleet at the time of data collection)	3-1 "Which parameters or conditions are used to enable the low airspeed alert?" Baro Altitude	Radio Altitude	Priorities with other alerts	Phase of flight (e.g., takeoff, approach)	Non-normal configurations	Other	Other Text
Round dial No SW cpbl	Boeing DC-9 All (413)	No	No	No	No	No	No	
	Boeing 727 All (525)	No	No	No	No	No	No	
	Boeing 747-200 (262)	No	No	No	No	No	No	
Tunnel dial Have SW cpbl to support	Embraer 120 All (126)	No	No	No	No	No	Yes	Weight On Wheels input to ground mode Law
	Boeing 737 -300, -400, -500 Classic (1550)	No	No	No	No	No	No	
	Boeing MD-90 All (104E)	No	No	No	No	No	No	
	Boeing MD-90 All (100)	No	No	No	No	No	No	
	Saab 340 All (197)	No	No	No	No	No	No	
Have EFIS & alert capability (1-1)	Boeing 737 -300, -400, -500 EADI FIS (190)	No	No	No	No	No	No	
	Boeing 757-200 EADI EFIS (971)	No	No	No	No	No	No	
	Boeing 767-200, -300 EADI FIS (880)	No	No	No	No	No	No	
	Boeing 737 -300, -400, -500 EADI Spd Tape (58)	No	No	No	No	No	No	
	Boeing 757-200, -300 EADI Spd Tape (37 -300 only)	No	No	No	No	No	No	
	Boeing 767 -200, -300 EADI Spd Tape (46)	No	No	No	No	No	No	
	Bombardier CRJ 100, -200, -400, -440 (718)	No	No	No	No	No	No	
	Bombardier CRJ -700, -701, -702 (215)	No	No	No	No	No	No	
	Bombardier CRJ -705, -900 (105 -900)	No	No	No	No	No	No	
PFD with visual low airspeed alert indication only (2-1)	Embraer 135 All (137)	No	No	No	No	No	Yes	Weight On Wheels input to ground mode Law
	Embraer 140 All (74)	No	No	No	No	No	Yes	
	Embraer 145 All (503)	No	No	No	No	No	Yes	
	Embraer 170 All (76)	No	No	No	No	No	Yes	
	Embraer 175 All (54)	No	No	No	No	No	Yes	
	Embraer 190 All (91)	No	No	No	No	No	Yes	
	Boeing 717 All (155)	No	No	No	No	No	No	
	Boeing MD-10/11 All (257)	No	No	No	No	No	No	
	Airbus A300-600 or A310 All (A300-158; A310-70)	No	Yes	No	No	No	No	
Visual & aural low airspeed alert indication (3-1, 3-2)	Boeing 737 -600, -700, -800, -900 (3982)	No	No	No	Yes	No	Yes	The low speed alert is inhibited until first flap retraction after takeoff. This logic detects that the flaps have changed after takeoff
	Boeing 747-400 (675)	No	No	No	Yes	No	Yes	
	Boeing 767-400 (38)	No	No	No	Yes	No	Yes	
	Boeing 777 All (581)	No	No	No	Yes	No	Yes	
	Airbus A318/319/320/321/330/340/380 All (767) (318-321-224, 330-380-43)	No	Yes	No	No	No	Yes	clal/flap conf for "Speed Speed-Speed" alert

		3.8. Is there a design requirement or goal for a minimum time margin between the low airspeed alert activation and stall warning activation?		3.9. Can you provide a description or illustration or logic diagram or equation that describes how the low airspeed alert is activated?
Model Capabilities (Reference survey question in parentheses)	Airplane model (number in fleet at the time of data collection)	Yes or No	Comment text	Yes or No
Round dial No SW opt	Boeing DC9 All (433)			
	Boeing 727 All (826)			
	Boeing 747-200 (202)			
(round dial) Have SW opt to answer	Embraer 120 All (176)			
	Boeing 737 -300, -400, -500 Classic (1550)			
	Boeing MD 90 All (1016)			
	Boeing MD 90 All (108)			
	Saab 340 All (197)			
Have EFIS & alert capability (1-1)	Boeing 737 -300, -400, -500 EADI EFIS (190)	No		No
	Boeing 757-200 EADI EFIS (571)	No		No
	Boeing 767-200, -300 EADI EFIS (880)	No		No
	Boeing 737 -300, -400, -500 EADI Spd Tape (58)			
	Boeing 757-200, -300 EADI Spd Tape (37 -300 only)			
	Boeing 767 -200, -300 EADI Spd Tape (46)			
	Bombardier CRJ 100, -200, -400, -440 (710)	No		Yes
	Bombardier CRJ -700, -701, -702 (215)	No		Yes
	Bombardier CRJ -705, -900 (105 -900)	No		Yes
Yes with visual low airspeed alert indication only (1-1)	Embraer 135 All (137)	No		Yes
	Embraer 140 All (74)	No	Low Speed alert is the same as Stall	Yes
	Embraer 145 All (503)	No	Low Speed alert is the same as Stall	Yes
	Embraer 170 All (76)	No	Low Speed alert is the same as Stall	Yes
	Embraer 175 All (54)	No	Low Speed alert is the same as Stall	Yes
	Embraer 190 All (51)	No	Low Speed alert is the same as Stall	Yes
	Boeing 717 All (155)	No		No
	Boeing MD10/11 All (257)	No		No
	Airbus A300-600 or A310 All (A300-158; A310-70)	No	Single time margin value cannot address all dynamic conditions	Yes
Visual & aural low airspeed alert indication (3-1, 3-2)	Boeing 737 -600, -700, -800, -900 (3908)	No		Yes
	Boeing 747-400 (675)	No		Yes
	Boeing 767-400 (38)	No		Yes
	Boeing 777 All (981)	No		Yes
	Airbus A318/319/320/321/330/340/380 All (767) (318 321 -724; 330 380 -43)	No	single time margin value cannot address all dynamic conditions	Yes

		3-10. How did you determine that the Low Airspeed Alert is timely (i.e., provides the pilot sufficient time to avoid stall warning, some other identified point)?					
Model Capabilities Questionnaire survey question in parentheses)	Airplane model (number in fleet at the time of data collection)	Analysis	In-service history	Flight test	Flight simulator or lab testing	Other	Other Text
Round dial No SW cpbl	Boeing DC9 All (433)	No	No	No	No	No	
	Boeing 727 All (674)	No	No	No	No	No	
	Boeing 747-200 (202)	No	No	No	No	No	
Round dial Have SW cpbl to support	Embraer 120 All (126)	No	No	Yes	No	Yes	The values used for stick shaker activation follow the certification requirements (25.207) and are confirmed via flight test
	Boeing 737 -300, -400, -500 Exec (1550)	No	No	No	No	No	
	Boeing MD 80 All (1015)	No	No	Yes	No	No	
	Boeing MD 90 All (108)	No	No	No	No	No	
	Saab 340 All (197)	No	No	No	No	No	
Have FFIS & alert capability. (1.1)	Boeing 737 -300, -400, -500 EADI FFS (190)	No	No	No	No	No	
	Boeing 757-200 EADI FFS (971)	No	No	No	No	No	
	Boeing 767-200, -300 EADI FFS (880)	No	No	No	No	No	
	Boeing 737 -300, -400, -500 EADI Spd Tape (58)	No	No	No	No	No	
	Boeing 757-200, -300 EADI Spd Tape (37 -300 only)	No	No	No	No	No	
	Boeing 767 -200, -300 EADI Spd Tape (46)	No	No	No	No	No	
	Bombardier CRJ-100, -200, -400, -440 (718)	No	No	No	No	Yes	Has not been verified
	Bombardier CRJ-700, -701, -702 (215)	No	No	No	No	Yes	
	Bombardier CRJ-705, -900 (105-900)	No	No	No	No	Yes	
FFU with visual low airspeed alert indication only (1.1)	Embraer 135 All (139)	No	No	Yes	No	Yes	The values used for stick shaker activation follow the certification requirements (25.207) and are confirmed via flight test
	Embraer 140 All (74)	No	No	Yes	No	Yes	
	Embraer 145 All (345)	No	No	Yes	No	Yes	
	Embraer 170 All (75)	No	No	Yes	No	Yes	
	Embraer 175 All (54)	No	No	Yes	No	Yes	
	Embraer 190 All (51)	No	No	Yes	No	Yes	
	Boeing 717 All (155)	No	No	No	No	No	
	Boeing MD10/11 All (257)	No	No	No	No	No	
	Airbus A300-600 or A310 All (A300-158, A310-70)	Yes	Yes	Yes	Yes	No	
Visual & aural low airspeed alert indication. (1.1, 1.2)	Boeing 737 -600, -700, -800, -900 (2908)	Yes	Yes	Yes	Yes	No	
	Boeing 747-400 (675)	Yes	Yes	Yes	Yes	No	
	Boeing 767-400 (38)	Yes	Yes	Yes	Yes	No	
	Boeing 777 All (381)	Yes	Yes	Yes	Yes	No	
	Airbus A318/319/320/321/330/340/380 All (757) (318-321-724; 330-380-43)	Yes	Yes	Yes	Yes	No	

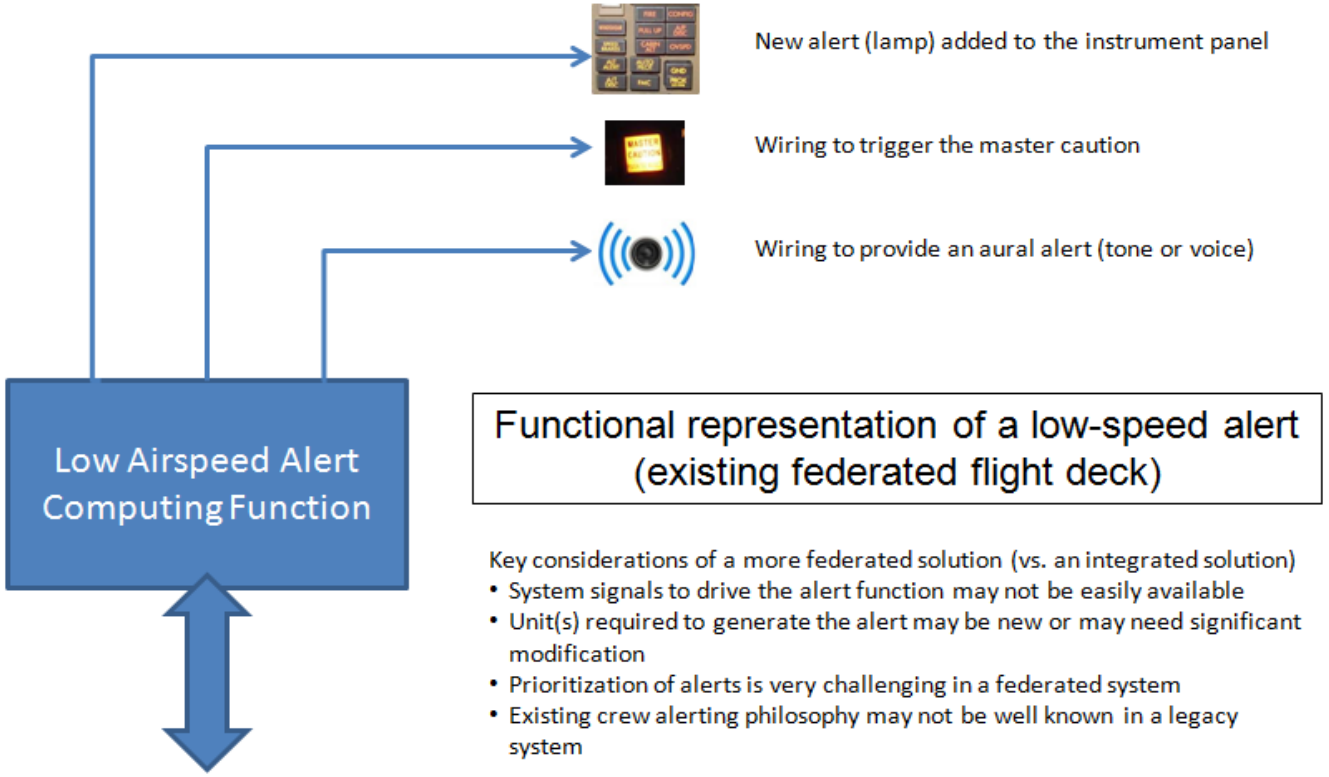
		3-11. Is the alerting functionality you have described above implemented on all airplanes or only some through a customer option, STC or later add-on?		3-12. If you selected some through option, STC or later add-on, please specify the number of airplanes modified versus the number in the fleet:	
Model Capabilities (Reference survey question in parentheses)	Airplane model (number in fleet at the time of data collection)	All	Some through option, STC or later add-on	Number of airplanes modified	Number airplanes in the fleet
Round dial No SW cptr	Boeing DC9 All (433)	No	No		
	Boeing 727 All (826)	No	No		
	Boeing 747-200 (202)	No	No		
Round dial Have SW cptr to support	Embraer 120 All (126)	Yes	No		
	Boeing 737 -300, -400, -500 Conv (1550)	No	No		
	Boeing MD 80 All (1016)	No	No		
	Boeing MD 90 All (108)	No	No		
	Saab 340 All (197)	No	No		
Have EFIS & alert capability. (1-1)	Boeing 737 -300, -400, -500 EADI F/S (190)	Yes	No		
	Boeing 757-200 EADI F/S (971)	Yes	No		
	Boeing 767-200, -300 EADI F/S (880)	Yes	No		
	Boeing 737 -300, -400, -500 EADI Spd Tape (58)	No	No		
	Boeing 757-200, -300 EADI Spd Tape (37 -300 only)	No	No		
	Boeing 767 -200, -300 EADI Spd Tape (46)	No	No		
	Bombardier CRJ-100, -200, -400, -440 (718)	Yes	No		
	Bombardier CRJ -700, -701, -702 (215)	Yes	No		
	Bombardier CRJ -705, -900 (105 -900)	Yes	No		
PFD with visual low airspeed alert indication only. (3-1)	Embraer 135 All (137)	Yes	No		
	Embraer 140 All (74)	Yes	No		
	Embraer 145 All (503)	Yes	No		
	Embraer 170 All (76)	Yes	No		
	Embraer 175 All (54)	Yes	No		
	Embraer 190 All (51)	Yes	No		
	Boeing 717 All (155)	Yes	No		
	Boeing MD10/11 All (257)	Yes	No		
	Airbus A300-600 or A310 All (A300-158; A310-70)	Yes	No		
Visual & aural low airspeed alert indication. (3-1, 3-2)	Boeing 737 -600, -700, -800, -900 (3908)	No	Yes	400	3700
	Boeing 747-400 (675)	No	Yes	350	680
	Boeing 767-400 (38)	Yes	No		
	Boeing 777 All (981)	Yes	No		
	Airbus A318/319/320/321/330/340/380 All (767) (318-321--724; 330-380--43)	Yes	No		

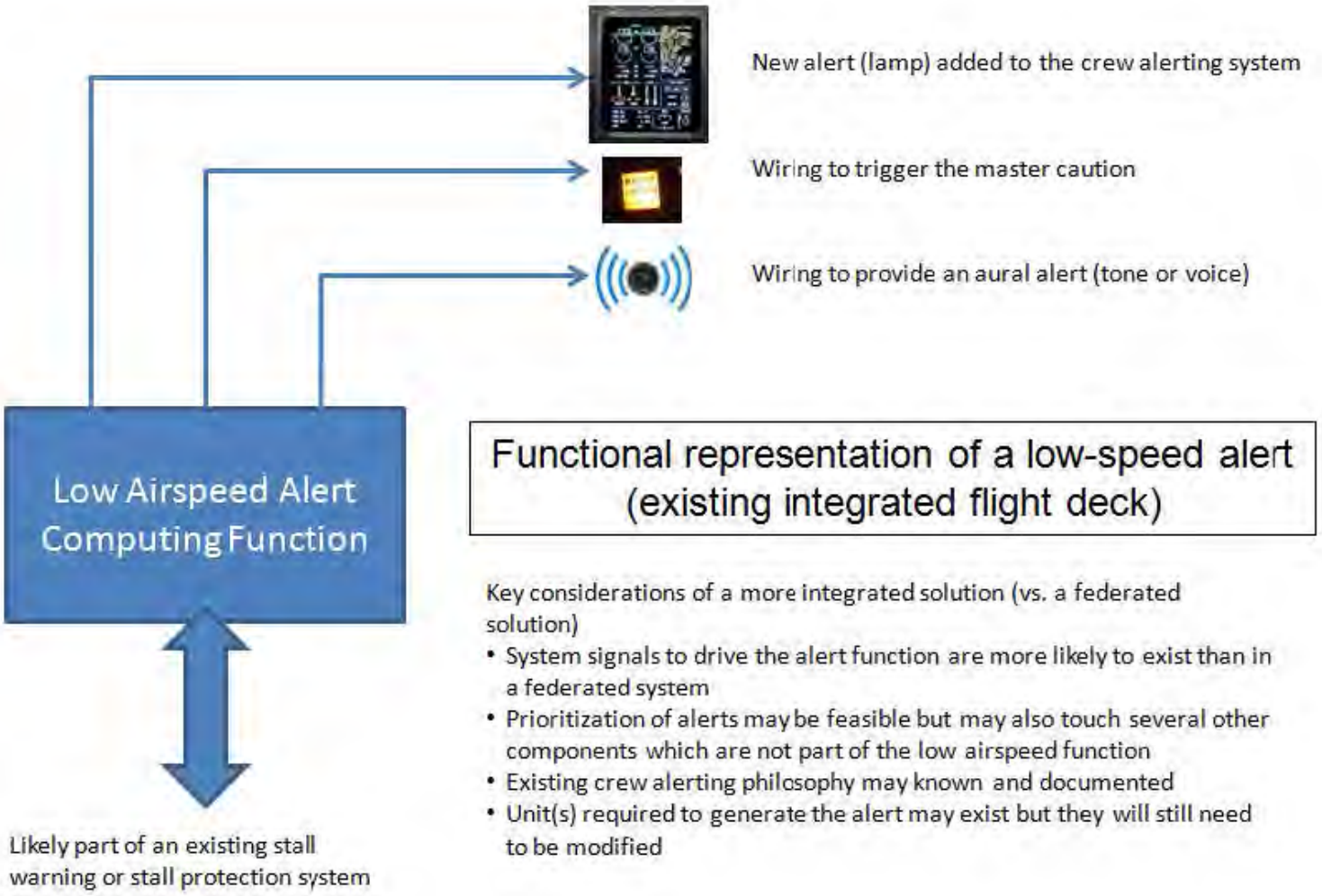
		4.1 What protection/limiting functionality is available to automatically assist the pilot for low airspeed conditions, prior to stall warning?								
Model Capabilities (Reference survey questions in parentheses)	Airplane model (number in fleet at the time of data collection)	Autothrottle "wakeup" (or automatic thrust activation)	Stick pusher	Automatic pitch control	Increased column/stick forces	Angle of attack protection	Auto slat extension	Angle of attack limit	Other	Other Text
Round dial No SW type	Boeing DC9 All (433)	No	No	No	No	No	No	No	No	
	Boeing 727 All (826)	No	No	No	No	No	No	No	No	
	Boeing 747-200 (282)	No	No	No	No	No	No	No	No	
Round dial Have SW type to support	Embraer 120 All (120)	No	No	No	No	No	No	No	Yes	Stick Shaker
	Boeing 737-300, -400, -500 Conv (1556)	No	No	No	No	No	Yes	No	No	
	Boeing MD 80 All (1016)	No	No	No	No	No	Yes	No	No	
	Boeing MD 90 All (109)	No	No	No	No	No	Yes	No	No	
	Saab 340 All (197)	No	No	No	No	No	No	No	No	
Have EFIS & alert capability. (4.1)	Boeing 737 -300, -400, -500 EADI F/S (190)	No	No	No	No	No	Yes	No	No	
	Boeing 757-200 EADI F/S (971)	No	No	No	No	No	Yes	No	No	
	Boeing 767-200, -300 EADI F/S (880)	No	No	No	No	No	Yes	No	No	
	Boeing 737 -300, -400, -500 EADI Spd Tape (58)	No	No	No	No	No	Yes	No	No	
	Boeing 757-200, -300 EADI Spd Tape (37 -300 only)	No	No	No	No	No	Yes	No	No	
	Boeing 767 -200, -300 EADI Spd Tape (46)	No	No	No	No	No	Yes	No	No	
	Bombardier CRJ-100, -200, -400, -440 (718)	No	No	No	No	No	No	No	No	
	Bombardier CRJ -700, -701, -702 (215)	No	No	No	No	No	No	No	No	
	Bombardier CRJ -705, -900 (105 -900)	No	No	No	No	No	No	No	No	
PFD with visual low airspeed alert indication only. (3.1)	Embraer 135 All (137)	No	No	No	No	No	No	No	Yes	Stick Shaker
	Embraer 140 All (74)	No	No	No	No	No	No	No	Yes	
	Embraer 145 All (303)	No	No	No	No	No	No	No	Yes	
	Embraer 170 All (76)	No	No	No	No	No	No	Yes	No	
	Embraer 175 All (54)	No	No	No	No	No	No	Yes	No	
	Embraer 190 All (51)	No	No	No	No	No	No	Yes	No	
	Boeing 717 All (155)	Yes	No	No	No	No	No	No	No	
	Boeing MD10/11 All (257)	Yes	No	No	No	No	Yes	No	No	
	Airbus A300-600 or A310 All (A300 156; A310 [illegible])	Yes	No	Yes	Yes	No	No	No	Yes	alpha-floor function - [illegible] (conf1 to conf0) with "blue" [illegible]
Visual & aural low airspeed alert indication. (3.1; 3.2)	Boeing 737 -600, -700, -800, -900 (3900)	Yes	No	No	No	No	Yes	No	No	
	Boeing 747-400 (575)	Yes	No	No	No	No	No	No	No	
	Boeing 767-400 (38)	No	No	No	No	No	Yes	No	No	
	Boeing 777 All (981)	Yes	No	No	Yes	No	Yes	No	No	
	Airbus A318/319/320/321/330/340/380 All (767) (318-321 -224; 330-340 -43)	Yes	No	Yes	No	Yes	Yes	No	Yes	alpha-floor function - [illegible] to go from conf1 to conf clean

Model Capabilities (Reference survey question in parentheses)	Airplane model (number in fleet at the time of data collection)	4.2. What protection/limiting functionality is available to automatically assist the pilot for approach to stall conditions, after stall warning? Stick pusher	Automatic pitch control	Increased column/stick force	Angle of attack protection	Auto slat extension	Angle of attack limit	Other	Other Text
Round dial No SW cpty	Boeing DC9 All (433)	No	No	No	No	No	No	No	
	Boeing 727 All (626)	No	No	No	No	No	No	No	
	Boeing 747-200 (202)	No	No	No	No	No	No	No	
Round dial Have SW cpty to support	Embraer 120 All (120)	Yes	No	No	No	No	No	No	
	Boeing 737 -300, -400, -500 Conv (1556)	No	No	No	No	No	No	No	
	Boeing MD 80 All (1016)	Yes	No	No	No	No	No	No	
	Boeing MD 90 All (108)	Yes	No	No	No	No	No	Yes	Flying flap/slat/aileron airplane nose down capability at full column forward
	Saab 340 All (197)	Yes	No	No	No	No	No	No	
Have EFIS & alert capability. (1.1)	Boeing 737 -300, -400, -500 EADI F/S (190)	No	No	No	No	No	No	No	
	Boeing 757-200 EADI F/S (971)	No	No	Yes	No	No	No	No	
	Boeing 767-200, -300 EADI F/S (888)	No	No	Yes	No	No	No	No	
	Boeing 737 -300, -400, -500 EADI Spd Tape (58)	No	No	No	No	No	No	No	
	Boeing 757-200, -300 EADI Spd Tape (37 -300 only)	No	No	Yes	No	No	No	No	
	Boeing 767 -200, -300 EADI Spd Tape (46)	No	No	Yes	No	No	No	No	
	Bombardier CRJ-100, -200, -400, -440 (718)	Yes	No	No	No	No	No	Yes	AP disconnect at shaker/stall warning
	Bombardier CRJ -700, -701, -702 (215)	Yes	No	No	No	No	No	Yes	
	Bombardier CRJ -705, -900 (105 -900)	Yes	No	No	No	No	No	Yes	
PFD with visual low airspeed alert indication only. (3.1)	Embraer 135 All (137)	Yes	No	No	No	No	No	No	Pitch limit protection
	Embraer 140 All (74)	Yes	No	No	No	No	No	No	
	Embraer 145 All (503)	Yes	No	No	No	No	No	No	
	Embraer 170 All (26)	No	No	No	No	No	Yes	No	
	Embraer 175 All (34)	No	No	No	No	No	Yes	No	
	Embraer 190 All (51)	No	No	No	No	No	Yes	No	
	Boeing 717 All (155)	Yes	No	No	No	No	No	No	
	Boeing MD10/11 All (297)	No	No	No	No	No	No	No	
	Airbus A300-600 or A310 All (A300-150; A310-70)	No	No	No	No	No	No	No	
Visual & aural low airspeed alert indication. (3.1, 3.2)	Boeing 737 -600, -700, -800, -900 (2900)	No	No	Yes	No	No	No	No	
	Boeing 747-400 (575)	No	No	No	No	No	No	No	
	Boeing 767-400 (38)	No	No	Yes	No	No	No	No	
	Boeing 777 All (981)	No	No	Yes	No	No	No	No	
	Airbus A318/319/320/321/330/340/380 All (767) (318-321 -724; 330-380 -43)	No	No	No	No	No	No	No	

Appendix C– Example Implementations

This appendix illustrates two possible functional implementations – one for a federated configuration and one for an integrated configuration. These are representative functional examples and will vary between aircraft types.





Functional representation of a low-speed alert (existing integrated flight deck)

Key considerations of a more integrated solution (vs. a federated solution)

- System signals to drive the alert function are more likely to exist than in a federated system
- Prioritization of alerts may be feasible but may also touch several other components which are not part of the low airspeed function
- Existing crew alerting philosophy may known and documented
- Unit(s) required to generate the alert may exist but they will still need to be modified

U.S. Department
of Transportation
**Federal Aviation
Administration**

800 Independence Ave., SW.
Washington, DC 20591

Mr. Dan Elwell
Chair, Aviation Rulemaking
Advisory Committee
Airlines for America
1301 Pennsylvania Ave, NW, Suite 1100
Washington, DC 20004

AUG 11 2014

Dear Mr. Elwell:

The FAA received the Low Airspeed Alerting Phase 2 Task Report from ARAC in March 2013. This report was developed by the Avionics Systems Harmonization Working Group (ASHWG) in response to a 2011 tasking from the FAA, which asked for industry information to support a potential requirement of low airspeed alerting in all airplanes operating under 14 CFR parts 121 and 129. The Phase II Final Report does not contain an assessment of the potential cost and benefits of implementation of such systems, as the ASHWG was awaiting completion of other studies on this subject. Those studies are now complete and their results should be available to the ASHWG soon.

Since receipt of the report, the FAA has internally evaluated several potential options for proposed alerting systems, based on our estimates of their cost and predicted effectiveness at preventing future loss-of-control accidents resulting from unobserved airspeed loss and stall. Per the FAA Office of Rulemaking Committee Manual, Part 3, section 2.4, the FAA may seek additional clarification from an ARAC working group on work related to a completed tasking through the ARAC Chair.

The FAA is requesting ARAC to reconvene the ASHWG to review the FAA's evaluation of the systems and the additional information now available from other concluded studies on this subject. Specifically, we propose to meet with available members of the ASHWG, present the options we have evaluated, and gather additional information as to their suitability for addressing the hazard of unobserved airspeed decay. The ASHWG should provide recommendations based on its review and plan to discuss the recommendations during the September 2014 ARAC meeting. The FAA would like to note that it has not initiated rulemaking on this matter; therefore, this discussion should be considered a continuation of the FAA's previous tasking on this topic.

Sincerely,

Lirio Liu

Designated Federal Officer

The Boeing Company
P.O. Box 3707, MC 09-76
Seattle, WA 98124-2207

April 6, 2015
B-H020-REG-15-TLM-25

Ms. Lirio Liu
Director, Office of Rulemaking, ARM-1
Federal Aviation Administration
800 Independence Avenue, SW.
Washington, D.C. 20591

Lirio.liu@faa.gov

Subject: Avionics System Harmonization Working Group – Phase 2 Low Airspeed Alerting (response to request for clarification)

Reference: Federal Register Tasking Notice (76 FR 11844, March 3, 2011) and ARAC Low Speed Alerting Phase 2 Task Report, March 2013

Dear Ms. Liu,

On behalf of the Aviation Rulemaking Advisory Committee (ARAC), I am pleased to submit the attached letter from the Avionics Systems Harmonization Working Group (ASHWG). On August 11, 2014, the FAA requested that ARAC reconvene the ASHWG to review "the FAA's evaluation of the systems and additional information now available from other concluded studies on this subject." The FAA's request was described as an extension of the prior tasking which resulted in the March 2013 submittal of the Low Speed Alerting Phase 2 Task Report from ARAC.

The ARAC reviewed the response from ASHWG and approved the information for transmittal to the FAA during its March 19, 2015, meeting. I want to thank all the members of the ASHWG for supporting the request from FAA and their quick response.

Sincerely,

Todd Sigler
ARAC Chair

Enclosure

Mr. Craig R. Bolt
Assistant Chair, Aviation Rulemaking Advisory Committee (ARAC)
Pratt & Whitney
400 Main Street, Mail Stop 165-30
East Hartford, CT 06108

23 February, 2015

Dear Mr. Bolt,

The Avionics Systems Harmonization Working Group (ASHWG) has reviewed the report provided by Mr. Wilborn and Mr. Jacobsen from the FAA, titled "Part 121/129 Low Airspeed Alerting Analysis, Review of Design Mitigations."

Many thanks to Mr. Wilborn and Mr. Jacobsen for providing the ASHWG with the opportunity to review and comment.

The report included two low speed alerting design mitigation options:

- Option 1: Add low airspeed aural caution – Implement an aural alert to trigger at an airspeed above the stall warning speed by an appropriate margin
- Option 2: Ensure compliance with latest §25.1329(h) requirements on low speed awareness (must protect against, or alert to, low airspeed)

ASHWG Feedback on the Options:
It is not completely clear what the difference is between the two design mitigation options. Both would seem to require at least an aural low speed alert. What would the rest of the Option 1 requirements be if they are not the same as the CFR 14 25.1329(h) requirements?

The analysis should consider a third design mitigation, to demonstrate that existing aircraft are compliant with the latest 25.1329(h) using the latest Acceptable Means of Compliance.

There was no additional ASHWG feedback on the methodology described in the report. However, there is some feedback on the technical challenges the manufactures may face in implementing a feasible (let alone compliant) solution:

- An interface to the various Stall Warning Computers may be needed for a particular aircraft type, in order to obtain a "Maneuvering Speed" value which is basically an Angle of Attack before that for Stick Shaker. That will likely turn many of the "Software Only" change fields in the report to "Software+Hardware" change and increase complexity. For example, on one particular aircraft a Maneuvering Angle of Attack (AOA) equivalent to Maneuvering Speed was

needed, and that had to come from a Stall Margin/Yaw Damper computer to provide that signal.

> *NOTE: The ASHWG members will provide any updates for specific aircraft that should change from a "Software Only" to a "Software + Hardware" update. This will be provided no later than 13 March, 2015*.

- As an alternative, Maneuvering AOA could be probably calculated from raw AOA but would need to be corrected for Flap position and for some aircraft types, thrust. That would still likely require aircraft wiring changes.

Regarding the cost data in the report:

1. Cost – The costs appear to be off by nearly an order of magnitude.
    a. Need to consider
        i. OEM design/cert non-recurring. This may include development costs to determine a suitable 'maneuvering speed' or 'maneuvering AOA' if that data does not exist. This may require simulator or aircraft testing.
        ii. Supplier design/cert non-recurring, and
        iii. Updating training simulators for 3 different simulator suppliers.
    b. Each of the three is easily $200-500K, with the supplier cost easily approaching $1M many times.
    c. The cost of certification for the OEM and supplier is significant.
    d. Recommend that a minimum cost of $600k be used in the analysis for the SW only changes, $1M for SW+HW (minor) and $2.5M for SW+HW(major).
2. Some applications may incur additional costs:
    a. May have more than one LRU
        i. One for the visual effect (PFD), and
        ii. One for the aural effect (EGPWS or warning/alerting system) of the alert.
        iii. OEM design costs also must consider airframe wiring when multiple LRUs are involved.

iv. Recommend that for a complex change (more than one LRU) the total cost be doubled for the analysis.

The cost / benefit analysis may consider a different set of benefits for freighter fleets, as well as account for any regional or global differences in the cost per fatal accident. The level of safety should be equivalent, however, regardless of the flight operations. For example, the expected cost per fatality in the EU is estimated around € 2 M rather than $ 9.1 M - this will have an effect on the cost-benefit ratio.

In addition to the report, a follow up file titled “LAA Fleet Projection for Cost Benefit” was provided to the ASHWG, providing additional detail for the fleet projection used in the cost-benefit calculations for the low airspeed alert analysis.

Regarding the fleet data/sizing, the FAA report should clarify the scope and intent of the Part 121/129 rules and how might they read. For example, what are the target fleets for retroactive implementation of the low speed alert? Certain fleets were considered to be excluded for various reasons when the ASHWG survey was developed. A Part 121 rule applies to all models unless stated otherwise.

Additional feedback regarding the fleet data/sizing

1) The graph plotted on the far right of the table shows the gray area as “Flt Env Prot”. Many airplanes included in there do not have Flight Envelope Protection that would meet any requirement, so the gray area should also state that it includes airplanes that already have a low airspeed alert.

2) The B747-800 in the FBW section should be moved to Non-FBW and listed as B747-8.

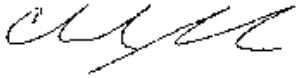
3) The B777-300 shows only 2 airplanes. There are closer to 500. The search should include the 777-300ER.

4) The 767-400 has the Boeing standard low airspeed alert as a basic feature. Change from SW Only to None.

5) The 747-400 has the Boeing standard low airspeed alert as an option and most have it. Change from SW Only to None.

6) The 757-200, 767-200, and 767-300 should be changed from SW Only to HW & SW. Most will require a HW change to a SW loadable EICAS computer.

Best regards,



Clark Badie,

Avionics Systems Harmonization Working Group