TAS-15-01 Models for Advanced Flight Simulators For Advanced Maneuvers

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| **Title of Research Requirement** | **Develop Models that Enhance the Ability to use Advanced Flight Simulators for Advanced Maneuvers**  |
| TCRG | TAS |
| Fiscal Year | 2015 |
| TCRG Tech Priority | 01 |
| Date | 7/31/2012 |
| TCRG Lead | Jeff Schroeder |
| OPI Reference | AFS-400 |
| Sponsor/Point of Contact | Jeffery Schroeder |
| Endorsement of Sponsoring Office's Manager | Yes |
| Office Manager's Approval | Robert Ruiz, 8/22/12 |
| Description of the Requirement | Problem/need: Loss-of-control is the number-one cause of fatalities in the worldwide commercial jet fleet. Flight simulator improvements are needed to mitigate this number-one cause through better awareness, recognition, avoidance, as well as teaching appropriate recovery techniques if loss-of-control occurs. |
|  | R&D Gap: Presently, flight simulators are used to train pilots in approach-to-stall maneuvers and not for full stalls or significant upset situations. This is primarily because the aircraft models in flight simulation lack accuracy in the pitch, roll, and yaw axes at the high angles-of-attack where stall occurs. In fact, the simulator is usually easier to fly than the aircraft in these environments. Some data exist to improve the models to make them more representative of the aircraft; however, the possible improvements have received limited evaluation and better alternatives may exist. |
|  | Requirement: Develop and validate improvements to flight simulator mathematical models to make their dynamic response representative of the aircraft in full aerodynamic stalls. |
| Sponsor Outcome & Implementation Plan | Outcome: Reduced accident rate due to loss of control, as well as reduced incident rate of stall warnings and unintended upset attitudes. |
|  | Implementation plan: Specifications for satisfactory simulation responses will be added to 14 CFR Part 60 for future simulator qualification. Notice of proposed rulemaking for Part 60 revision is December 2013. Enactment of upset recovery training rule is August 2014. |
| NextGen Connection | No |
| NextGen Linkage Info. | N/A |
| Metrics, Milestones, and Project Phases | Metrics: Simulator versus flight time histories of pitch, roll, and yaw responses to pilot input at stall; aircraft buffet response at stall; autoflight characteristics at stall. |
|  | Milestones: A. -- Determine data requirements to improve models (Jan. 2014)B. -- Develop modeling techniques that result in changes to the math model structure to allow matching of flight data (July 2014)C -- Change and verify math model changes to the FAA's 737-800 simulator (Nov. 2015)D -- Validate flight simulator stall response with type-rated test pilots (Feb. 2016). |
|  | Project phases -- |
|  | Phase 1: Data requirements; |
|  | Exit criteria: Damping values and control effectiveness in the roll and yaw axis match the in-flight values to within 20%. |
|  | Phase 2: Math model modification; |
|  | Exit criteria: Model incorporates variables determined from Phase 1 and can be implemented in real-time without increasing the frame rate. |
|  | Phase 3: Software changes and verification in flight simulator; |
|  | Exit criteria: Flight simulator results overlay analysis results. |
|  | Phase 4: Model validation with test pilots |
|  | Exit criteria: Subjective evaluation from six or more test pilots reveals that simulator characteristics near stall are representative of the aircraft.  |
| Background | P.L. 111-216 requires the FAA to "conduct a rulemaking proceeding to require part 121 air carriers to provide flight crewmembers with ground training and flight training or flight simulator training -- (A) to recognize and avoid a stall of an aircraft or, if not avoided, to recover from the stall; and (B) to recognize and avoid an upset of an aircraft or, if not avoided, to execute such techniques as available data indicate are appropriate to recover from the upset in a given make, model, and series of aircraft." |
|  | Both NASA Langley and Bihrle Applied Research have been evaluating promising approaches toward improving simulator models near stall. Coordination with their efforts will occur through quarterly phonecons with individuals at both organizations. The sponsor has developed professional contacts with both organizations via the International Committee for Aviation Training in Extended Envelopes. |
| Regulatory Link | 14 CFR Part 60  |
| Output | Specific criteria for qualifying flight simulators at or near the stall condition. AVS would use this output to revise 14 CFR Part 60. The final rulemaking for the enactment of P.L. 111-216 is Aug. 2014; however, it is expected that the rulemaking can refer to the specific outcomes of this requirement. |
| Notes |   |
| 1) Criteria-Potential to Prevent or Mitigate Safety Risks\* | 1=Essential  |
| Evidence Justification | Evidence: High. The Boeing's Statistical Summary of Commercial Jet Airplane Accidents lists loss-of-control in-flight as the number-one cause of fatalities in the worldwide commercial jet fleet. |
|  | Impact: High. Flight simulators are the principal way air carriers are trained, and the belief is that better training will reduce the associated accident and incident rate, as required by P.L. 111-216. |
| 1b) Feedback |   |
| 2) Criteria-Identify and Analyze Emerging Threats | 9=None  |
| 2a) Rationale for Ranking | This research is developing solutions for a known risk, namely loss-of-control in-flight. |
| 2b) Feedback |   |
| 3) Criteria-Enhance Existing Safety Regulations and Standards | 1=Essential  |
| 3a) Rationale for Ranking | Evidence: High. Existing requirements in 14 CFR Part 60 do not satisfactorily address mathematical model behavior past the approach-to-stall flight regime. This was also confirmed by an industry survey developed by the stall/stick-pusher working group. |
|  | Impact: High. The outputs of this research will specify the 14 CFR Part 60 modeling requirements. |
| 3b) Feedback |   |
| 4) Criteria-Prepare for New Technologies, etc. | 1=Essential  |
| 4a) Rationale for Ranking | Evidence: High. The evaluation of the new stall models will develop and improve our understanding of the new model technologies that are required to enable stall training. |
|  | Impact: High. The evaluations will have a timely impact on the development of the new stall modeling regulations. |
| 4b) Feedback |   |
| 5) Criteria-Answer Internal and External Drivers | 1=Essential  |
| 5a) Rationale for Ranking | Evidence: High. P.L. 111-216, NTSB A-97-47 (Status: Closed, unnacceptable response), and NTSB A-07-003 (Status: Open, acceptable response) all state that the existing regulations and standards need to be enhanced for stall and upset recovery training. The outputs of this project address these enhancements directly. |
|  | Impact: High. The output of having specific stall model response criteria addresses the issues raised by external organizations. |
| 5b) Feedback |   |
| 6) Additional Justification (if none, add "None" to block. | None |
| Proposed Project Manager | Andrew Cheng, (609) 485-4904  |
| Total Prioritized Funding Level FY2012 ($K) | $561  |
| Total Prioritized Funding Level FY2013 ($K) | $750  |
| Total Prioritized Funding Level FY2014 ($K) | $725  |
| Previous FY | [Develop Models that Enhance the Ability to use Advanced Flight Simulators for Advanced Maneuvers](https://avssp.faa.gov/avs/aviationsafetyresearch/_layouts/listform.aspx?PageType=4&ListId=%7bEA672CC6-BB7A-4B07-A2B7-62392F41D077%7d&ID=527&RootFolder=*)  |
| Old Requirement Number | None  |
| Attached List of Task(s) | Yes  |
| BnYd | No  |
| Attachments  | [TAS 15-01 FY15 ANG-E272 Cost Estimate.xlsx](https://avssp.faa.gov/avs/aviationsafetyresearch/Lists/RED%20Requirements/Attachments/1254/TAS%2015-01%20FY15%20ANG-E272%20Cost%20Estimate.xlsx) |
|  | [Task Description TAS-15-01.xls](https://avssp.faa.gov/avs/aviationsafetyresearch/Lists/RED%20Requirements/Attachments/1254/Task%20Description%20TAS-15-01.xls) |