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APPENDIX: 4

BULLETIN TYPE: Joint Flight Standards Information Bulletin for Air Transportation (FSAT) and General Aviation (FSGA)

BULLETIN NUMBER: FSAT 00-16A and FSGA 00-09A

BULLETIN TITLE: AD 2000-22-02, B737 Uncommanded Rudder

EFFECTIVE DATE: 12/08/00

AMENDED DATE: 12/11/00

TRACKING NUMBER: A-99-25

APPLICABILITY: This bulletin is applicable to all Flight Standards District Offices (FSDO), Certificate Management Offices (CMO), and Principal Operations Inspectors (POI) overseeing operators who operate Boeing B737-100, -200, -300, -400, -500, -600, -700, -800, and -900 series airplanes.

NOTE: THIS BULLETIN REQUIRES PTRS INPUT, SEE PARAGRAPH #(5).

NOTE: FSAT 98-03, Recognition of and Recovery from Unusual Attitudes and Upsets Caused by Reverse Rudder Response Involving Boeing 737's, is canceled as of the effective date of this bulletin.

1. PURPOSE. This bulletin has the following purposes:

A. To respond to the National Transportation Safety Board (NTSB) recommendation A-99-25;

B. To announce the issuance of Airworthiness Directive AD 2000-22-02, superseding AD 96-26-07;

C. To cancel and supersede FSAT 98-03; and

D. To provide guidance to Flight Standards District Offices (FSDO), Certificate Management Offices (CMO), and Principal Operations Inspectors (POI) overseeing operators of

Boeing 737 airplanes regarding appropriate response by those operators to the new AD 2000-22-02.

2. BACKGROUND. A series of accidents and incidents involving Boeing 737 airplanes brought the airplane's rudder system under the scrutiny of the NTSB and other organizations involved in aviation safety.

A. NTSB Recommendations. Among the NTSB recommendations relating to the B737 accident at Aliquippa, Pennsylvania, were the following:

(1) A-99-21. Convene an engineering test and evaluation board to conduct a failure analysis to identify potential failure modes, a component and subsystem test to isolate particular failure modes found during the failure analysis, and a full-scale integrated systems test of the Boeing 737 rudder actuation and control system to identify potential latent failures and validate operation of the system without regard to minimum certification standards and requirements in Title 14 of the Code of Federal Regulations (14 CFR) part 25. Participants in the engineering test and evaluation board should include the Federal Aviation Administration (FAA); National Transportation Safety Board technical advisors; the Boeing Company; other appropriate manufacturers; and experts from other government agencies, the aviation industry, and academia. A test plan should be prepared that includes installation of original and redesigned Boeing 737 main rudder power control units and related equipment and exercises all potential factors that could initiate anomalous behavior (such as thermal effects, fluid contamination, maintenance errors, mechanical failure, system compliance, and structural flexure). The engineering board's work should be completed by March 31, 2000, and published by the FAA.

(2) A-99-25. Require all 14 CFR part 121 air carrier operators of the Boeing 737 to provide their flight crews with initial and recurrent flight simulator training in the "Uncommanded Yaw or Roll" and "Jammed or Restricted Rudder" procedures in Boeing's 737 Operations Manual. The training should demonstrate the inability to control the airplane at some speeds and configurations by using the roll controls (the crossover airspeed phenomenon) and include performance of both procedures in their entirety.

B. FAA Response. In May of 1999, the FAA responded

to A-99-21 by forming the B737 Flight Controls Engineering Test and Evaluation Board (ETEB). The failure analysis was completed without regard either to the minimum certification standards, or to the probability of occurrence of any of the identified failure modes. The resulting findings and recommendations of the ETEB apply to all models of the Boeing 737, and are posted at the following public Internet Website:

<http://www.faa.gov/newsroom.htm>

3. DISCUSSION. As part of the evaluation process, the ETEB assembled ten airline flightcrews (captains and first officers) from four airlines to participate in the simulations of several rudder system failure scenarios. Each crew was fully qualified and current, with varying levels of experience. The simulated flights were conducted in a high-fidelity engineering aircraft simulator configured as a B737-300. The ETEB's findings and recommendations regarding Procedures and Training are covered in more detail in an appendix to this bulletin.

4. ACTION. FSDO's, CMO's, and POI's overseeing operators who operate B737 airplanes shall ensure:

A. That each assigned operator of B737-100, -200, -300, -400, -500, -600, -700, -800, and -900 series airplanes is aware of the requirements of AD 2000-22-02 and is in compliance with those requirements regarding revisions to the airplane flight manual (AFM) and compliance by the December 13, 2000, deadline.

B. That each such operator provides the new UNCOMMANDED RUDDER procedure specified in AD 2000-22-02 to its flight crewmembers, stressing that AD 2000-22-02 supersedes the JAMMED or RESTRICTED RUDDER procedure contained in AD 96-26-07. All other procedures contained in AD 96-26-07 remain unchanged.

C. That each such operator includes the UNCOMMANDED RUDDER procedure specified in AD 2000-22-02 in the manuals and approved training program of its B737 flight crewmembers, stressing that this procedure supersedes the JAMMED or RESTRICTED RUDDER procedure contained in AD 96-26-07. (Refer to HBAT 99-07)

D. That each such operator includes the existing UNCOMMANDED YAW or ROLL procedure and the new UNCOMMANDED RUDDER procedure contained in the approved AFM in initial and recurrent ground training of its B737 flight crewmembers.

E. That each such operator takes advantage of simulator flight training in a qualified flight simulator when practical,

respecting the limitations of the simulator, to address UNCOMMANDED YAW or ROLL and UNCOMMANDED RUDDER procedures. The training should demonstrate the inability to control the airplane at some speeds and configurations by using the roll controls (the crossover airspeed phenomenon) and should include performance of both procedures in their entirety.

NOTE: A copy of AD 2000-22-02, as revised by amendment 39-11948, may be obtained through the Aircraft Certification Service Website at: <http://av-info.faa.gov/ad/boeing00.htm>

5. PROGRAM TRACKING AND REPORTING SUBSYSTEM (PTRS).

A. PTRS Entry. Each operations inspector affected by this bulletin shall make a PTRS entry to record the ACTIONS accomplished in accordance with paragraph 4 above. Entries in the "Activity Code" field and the "National Use" field should be made to signify that the operator knows of the existence and availability of AD 2000-22-02. The PTRS entry for distribution of this bulletin to the operator shall be listed as activity code 1381, and the "National Use" field shall be **FSAT0016**. The "Comment Section" of the PTRS shall be used to record interaction and response of the operator (see B below).

B. Specific PTRS Comment Section Entries. Because of the intense scrutiny of the issues relating to the B737 rudder, the quality of the PTRS entries is especially important. The PTRS will remain in an open (O) status until items 5B (1) and (2) are completed. The following specific entries for the PTRS comment section are required.

(1) Airplane Flight Manual revised per AD 2000-22-02 on (DATE);

(2) UNCOMMANDED YAW or ROLL and UNCOMMANDED RUDDER procedures included in training program and manuals used by B737 flightcrews on (DATE).

6. INQUIRIES. The Air Transportation Division, AFS-200, developed this bulletin with input from the Seattle Aircraft Evaluation Group. Any inquiry from operators may be directed to the POI having oversight responsibility at the Certificate Holding District Office (CHDO) or CMO. Principal operations inspectors and any region staff may direct their inquiries concerning this bulletin to either Hop Potter at (202) 267-3723 or Will Swank at (202) 493-4602.

7. EXPIRATION. This bulletin will remain in effect until superceded or canceled.

/s/
L. Nicholas Lacey
Director, Flight Standards Service

Reference Only

APPENDIX

1. As part of the evaluation process, the ETEB assembled ten airline flight crews (captains and first officers) from four airlines to participate in the simulations of several rudder system failure scenarios. Each crew was fully qualified and current, with varying levels of experience. The simulated flights were conducted in a high-fidelity engineering aircraft simulator configured as a B737-300. The following findings and recommendations were derived from data and comments collected during flight simulation sessions, during flight crew debriefings, and during surveys of selected crew training facilities.

2. Findings. The following ETEB findings relate to procedures and training.

A. The flightcrews found the existing *Jammed or Restricted Rudder* Emergency Procedure, the procedure specified in AD 96-26-07, to be confusing and difficult to use.

B. The flightcrews appeared to have inadequate training in the use of the *Jammed or Restricted Rudder* Emergency Procedure.

C. The flightcrews had inadequate knowledge of the rudder system.

D. Some flightcrews and maintenance personnel may not be aware that rudder pedal kicks are an indication of a potentially serious flight control problem.

E. The flightcrews did not always determine whether the airplane was in a configuration suitable for landing.

F. The rudder pedal position was not always a reliable indication of the actual rudder position.

G. The flightcrews were not trained in how rudder pedals feel at rudder blowdown limit.

H. The flightcrews did not recover consistently from large roll and yaw upsets at low altitude.

I. Training simulators examined by the ETEB do not adequately simulate rudder malfunctions.

3. Recommendations. The following ETEB recommendations were among those relating to procedures and training. ETEB recommendations are shown in **bold underlined text**; FAA comments are in plain text, as follows:

A. Operating Procedure. Develop a new, simplified "Jammed or Restricted Rudder Emergency Procedure," which includes a controllability check.

(1) New Procedure. The recommendation to develop a new, simplified JAMMED or RESTRICTED RUDDER emergency procedure, improving upon that contained in AD 96-26-07, was addressed by representatives from industry, including Boeing, and the FAA. They developed an UNCOMMANDED RUDDER procedure to replace the existing JAMMED or RESTRICTED RUDDER emergency procedure. That UNCOMMANDED RUDDER emergency procedure, validated by industry and the FAA, was found to streamline and simplify the existing emergency procedure. That UNCOMMANDED RUDDER emergency procedure was published in the Federal Register on November 16, 2000, as part of AD 2000-22-02, as revised by amendment 39-11948, effective November 13, 2000, may be obtained through the Aircraft Certification Service Website at:

<http://av-info.faa.gov/ad/boeing00.htm>

(2) Modifications to the Procedure. AD 2000-22-02, as revised and published, explicitly requires that the UNCOMMANDED RUDDER procedure, the memory items and the sequence of checklist items may not be amended in respect to procedural sequence, memory items, and/or associated text, except by submitting a request for an alternative method of compliance as specified later in the rule. However, format of the procedure may be amended to have the look and feel of the operator's current checklist.

B. Training Recommendations.

(1) **Include the operation of the rudder control system and potential rudder control system malfunctions in pilot initial ground school and recurrent training.**

(2) **Make flightcrews and maintenance personnel aware of the seriousness of rudder pedal "kicking."**

(3) **Add the capability to simulate rudder malfunctions to training simulators.**

(a) Ground and Simulator Training. Several subjects were identified by the ETEB as significant elements to be included in ground training, and, to the extent possible, to be included in flight training using simulators. All B737 simulators in the United States have now been upgraded with data packages specifically developed for that flight training.

(b) Specific Training Subjects. The ETEB recommended the following specific subjects to promote better understanding by flightcrews in respect to the rudder system and to increase their ability to recover from an uncommanded rudder movement:

(i) The mechanical and hydraulic redundancy, including hydraulic power supply of the rudder control system.

(ii) Rudder blowdown and its effect on pedal limiting.

(iii) The adverse effects of aft-column on upset recovery.

(iv) The concept of crossover speed, and its critical effect on safe recovery from a rudder hardover.

(v) In the presence of some malfunctions, pedal position may not be a reliable indication of rudder position.

(vi) Rudder pedal "kicking" may be an indication of a malfunction that could become hazardous if other malfunctions should occur.

(4) Increase emphasis during simulator training on upset recovery, especially at low altitude. Also increase emphasis on the adverse effect of "up elevator" during the roll to "wings-level."

(a) Better Understanding. Pilots would benefit from a better understanding of the dynamics involved in unusual attitude recovery. A key topic is the desirable effect of unloading the airplane (decreasing the angle-of-attack) to increase the aileron and spoiler authority relative to the rudder, while achieving better acceleration until adequate recovery airspeed is achieved. Such training is effectively addressed in ground training.

(b) Training in Flight Simulators. While respecting the limitations inherent in each simulator, training providers should increase emphasis during simulator training on upset

prevention, recognition, and recovery, especially at low altitude.

(c) Upset Recovery Training -- FAA Guidance Regarding Upset Recovery Training. The importance of airplane upset recovery training has been variously addressed in HBAT 95-10, Select Event Training, in FSAT 98-03 (superseded by this FSAT), and in FSAT 99-12 (FSGA 99-08), Maneuvering Speeds for Boeing 727-100/200/300/400/500 Series Airplanes. The "Airplane Upset Recovery Training Aid" developed in a collaboration including industry and the FAA continues to be recommended as a valuable reference for operators in developing upset recovery training.

(d) ETEB Makes Specific Recommendations. The ETEB made several specific recommendations in respect to upset recovery training, including the following:

(i) The UNCOMMANDED RUDDER emergency procedure is intended to be a memory item type procedure. It must be taught and trained that way.

(ii) Initial training syllabus should include information on adverse effects of pulling back on the yoke, increasing angle of attack, and increased load factor on roll rate during upset recovery.

(iii) Recurrent simulator training should include demonstration of unloading the airplane versus pulling back during the roll to "wings-level."

(iv) Training should emphasize using all available roll and yaw control during recovery, and make the pilot aware of the natural tendency to use less than maximum.