European Aviation Safety Agency

Terms of Reference

for rulemaking task RMT.0397

Unintended or inappropriate rudder usage — rudder reversals

ISSUE 1

Issue/rationale

— Service experience and occurence investigations show that, regardless of training, some pilots make inadvertent and erroneous rudder inputs. Some pilots might also have a wrong understanding of what the design maneuvering speed (V_A) is and the extent of structural protection that exists when an aeroplane is operated at speeds below its V_A.

— Applying inappropriate rudder inputs like rudder reversals may exceed the aeroplane structural limit loads or even ultimate loads. The worst-case scenario is the failure of primary structure and/or flight controls which can lead to a catastrophic loss of control of the aircraft, similar to what happened to the American Airlines A300-600 in November 2001.

Action area:	Loss of control in flight		
Affected rules:	CS-25		
Affected stakeholders:	Design Approval Holders (DAH), manufacturers of large aeroplanes		
Driver:	Safety	**Rulemaking group:**	No
Impact assessment:	Light	**Rulemaking Procedure:**	Standard

1. Why we need to change the rules — issue/rationale

1.1 Rudder reversals

Related safety issues

Service experience and occurence investigations show that, regardless of training, some pilots make inadvertent and inappropriate rudder pedal inputs. Accident and incident data show aeroplanes that, as a result of rudder deflections driven by pedal reversals, have experienced vertical tail load levels surpassing the aeroplane's structural limit load and sometimes ultimate load capability.

The following occurrences illustrate this issue:

— On 12 November 2001, an Airbus A300–600 crashed at Belle Harbor (New York, USA) on climb-out resulting in 265 fatalities and an aeroplane hull loss. The National Transportation Safety Board (NTSB) found 'that the probable cause of this accident was the in-flight separation of the vertical stabilizer as a result of the loads beyond ultimate design that were created by the first officer's unnecessary and excessive rudder pedal inputs. Contributing to these rudder pedal inputs were characteristics of the Airbus A300–600 rudder system design and elements of the American Airlines Advanced Aircraft Manoeuvring Program.' In August 2010, the NTSB issued the following safety recommendation (EASA ref. UNST-2010-119):

  'The National Transportation Safety Board recommends that the European Aviation Safety Agency modify European Aviation Safety Agency Certification Specifications for Large Aeroplanes CS-25 to ensure safe handling qualities in the yaw axis throughout the flight envelope, including limits for rudder pedal sensitivity. (A-10-119).'

— In two other events, commonly known as the Miami Flight 903 event, and the Interflug event, the pilot commanded pedal reversals caused loads on the A300–600/A310 fins exceeding their ultimate load level. Both aeroplanes were designed with greater structural strength than required by the current certification standards, and, therefore, there were no catastrophic consequences.

— On 27 May 2005, a de Havilland DHC–8–100 (Dash 8) aeroplane (registration C–GZKH, serial number 117) departed from St. John's to Deer Lake, Newfoundland, with 36 passengers and 3 crewmembers on board. During the climb-out from St. John's, the indicated airspeed gradually decreased to the point that the aeroplane entered an aerodynamic stall. The aeroplane descended rapidly, out of control, losing 4 200 feet before the aircraft was recovered approximately 40 seconds later. The incident occurred in instrument meteorological conditions during daylight hours. There were no injuries and the aeroplane was not damaged. During this event, the pilot commanded a pedal reversal.

— In January 2008, an Airbus A319 encountered a wake vortex. The pilot responded with several pedal reversals. Analyses show that this caused a fin load exceeding limit load by approximately 29 %. The pilot eventually stabilised the aeroplane and landed safely.

The current yaw manoeuvre specifications in CS-25 (i.e. CS 25.351) address large rudder pedal inputs at airspeeds up to the design dive airspeed (V_D). This ensures safe structural aeroplane characteristics throughout the flight envelope from single full rudder pedal inputs. However, the standard does not address the loads imposed by rudder pedal reversals. Additionally, other CS-25 specifications (CS 25.671) require that controls operate with ease, smoothness, and positiveness appropriate to their function. However, these specifications do not address specific control system parameters such as inceptor travel, breakout force, or force gradient.

ICAO and third countries references relevant to the content of this RMT

Like CS-25, FAR Part-25 and ICAO Annex 8 do not have provisions addressing the whole safety issue described above, i.e. protection against inappropriate multiple rudder pedal inputs.

FAA is addressing, in part, this condition for new designs by requiring under Part-25, §25.601[1] that applicants for new type certificates show that their design is capable of continued safe flight and landing after experiencing rudder pedal reversals. For fly-by-wire architectures, the applicants have been able to show compliance with this requirement by appropriate rudder control laws. These control laws have been incorporated through software and, therefore, add no weight or maintenance cost to the aeroplanes. However, depending on the design, such control laws might only be capable of a limited number of pedal reversals prior to exceeding airframe ultimate loads.

On 28 March 2011, the FAA published a notice of new task assignment for the Aviation Rulemaking Advisory Committee (ARAC) to consider whether changes to Part-25 are necessary to address rudder pedal sensitivity and rudder reversals[2]. The task has been conducted by the Flight Controls Harmonization Working Group (FCHWG).

EASA participated in the FCHWG group. The ARAC report was finalised in November 2013, and approved by the ARAC on 19 December 2013[3].

The FCHWG made three recommendations:

1) Enhanced Flight Crew Training Recommendation.

2) Proposed new regulation 25.353 ('Rudder control reversal conditions'), which would apply to new transport aeroplanes.

3) For existing transport aeroplanes, the FCHWG believes that retrofit should be considered on a case-by-case basis and that if any potentially unsafe conditions are found they should be addressed using airworthiness directives. (Note: FCHWG reviewed several aeroplanes as part of the FCHWG deliberations. None were found to have an unsafe condition.)

NOTE: For recommendation 2, there are dissenting opinions, which are discussed in the ARAC report.

Based on this ARAC report the FAA is preparing a notice of proposed rulemaking (NPRM) which should be published in 2017.

EASA Special Condition

In December 2015, EASA consulted on a proposed Special Condition (SC) on 'Rudder Control Reversal Load Conditions'[4]. The SC, applicable to large aeroplanes, was prepared based on the ARAC recommendations and aims at ensuring that aeroplanes are design tolerant to two rudder pedal

[1] Part-25, § 25.601 General (identical to CS 25.601): '*The aeroplane may not have design features or details that experience has shown to be hazardous or unreliable. The suitability of each questionable design detail and part must be established by tests.*'

[2] The ARAC notice is available on the FAA Website using the following link: http://www.gpo.gov/fdsys/pkg/FR-2011-03-28/pdf/2011-7180.pdf

[3] The ARAC report is available on the FAA Website using the following link: https://www.faa.gov/regulations_policies/rulemaking/committees/documents/media/TAEfch-rpsrr-3282011.pdf

[4] The EASA Special Condition is available on the EASA Website using the following link: https://www.easa.europa.eu/documents/public-consultations/proposed-special-condition-c-xx

doublets. In addition to the SC consultation, EASA also provided new acceptable means of compliance (AMC) for information of stakeholders.

1.2 Manoeuvering speed limitation statement in the Aeroplane Flight Manual (AFM)

The NTSB investigation of the accident to the Airbus A300–600 in Belle Harbor on 12 November 2001, concluded that pilots might have a wrong understanding of what the design maneuvering speed (V_A) is and the extent of structural protection that exists when an aeroplane is operated at speeds below its V_A.

V_A is a structural design airspeed used in determining the strength requirements for the aeroplane and its control surfaces. The structural design requirements do not cover multiple control inputs in one axis or control inputs in more than one axis at a time at any speed, even below V_A.

The NTSB found that many pilots of transport category aeroplanes mistakenly believe that, as long as the aeroplane's speed is below V_A, they can make any control input they desire without risking structural damage to the aeroplane. As a result, the NTSB recommended[5] that the FAA amends all relevant regulatory and advisory material to clarify that operating at or below maneuvering speed does not provide structural protection against multiple full control inputs in one axis or full control inputs in more than one axis at the same time.

The FAA agreed with the safety recommendation and amended FAR Part-25, §25.1583(a)(3) in August 2010[6]. The final rule adopted clarifying changes to certain statements that must be furnished in each AFM identifying the types of control inputs to avoid because they may result in structural failure. It also removed an inconsistency concerning the reference to 'maneuvering speed V_A' in §25.1583(a)(3). Sections 1.2 and 25.335(c) define 'V_A' as the 'design maneuvering speed,' not the 'maneuvering speed.'

On the EASA side, CS 25.1583(a)(3) has not been amended and is consistent with the previous FAR Part-25, §25.1583(a)(3).

2. What we want to achieve — objective

- The overall objectives of the EASA system are defined in Article 2 of Regulation (EC) No 216/2008. This project will contribute to the achievement of the overall objectives by addressing the issues outlined in Chapter 1.
- The specific objective of this proposal is to mitigate the safety risk created by unintended or inappropriate rudder pedal usage by pilots of large aroplanes, in particular multiple rudder pedal reversals, which can lead to overstress and failure of primary structure and/or flight controls, and, consequently, loss of control of the aeroplane.

3. How we want to achieve it

- The ARAC analysed the issue described in Chapter 1 and made several recommendations. The FCHWG, with participation of EASA, conducted the task.
- In the frame of this RMT, EASA will propose an amendment of CS-25 applicable to new certification projects for large aeroplanes based on the second recommendation of the FCHWG,

5 See NTSB safety recommendation A–04–060, which can be found here: https://www.ntsb.gov/about/employment/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=A-04-060

6 See Federal Register /Vol. 75, No. 157 /Monday, August 16, 2010, page 49815: Amendment No. 25-130 – Maneuvering Speed Limitation Statement https://www.gpo.gov/fdsys/pkg/FR-2010-08-16/pdf/2010-20195.pdf

i.e. 'Proposed new regulation 25.353, which would apply to new transport aeroplanes'. This proposal would create a new load condition protecting the aeroplane against inappropriate rudder pedal usage. For new certification projects, the applicability of CS 25.353 will be in accordance with the certification requirements/processes, which includes Part 21.A.101 changed product rule.

— Cooperation with the FAA will be ensured in order to reach harmonisation of the new CS-25 and Part-25 specifications, as well as acceptable means of compliance.

— Furthermore, it is proposed to amend CS 25.1583(a)(3) on manoeuvring speed limitation statement in the AFM in harmonisation with FAR Part-25, amendment 25-130.

4. What are the deliverables

— A Notice of Proposed Amendment (NPA) proposing an amendment to CS-25,

— An Executive Director (ED) Decision amending CS-25, including a comment-response document (CRD).

5. Reference documents

5.1. Related decisions

— ED Decision 2003/002/RM of 17 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for large aeroplanes (« CS-25 »).

5.2. Reference documents

— FAA Aviation Rulemaking Advisory Committee (ARAC) — Flight Controls Harmonization Working Group (FCHWG) 'Rudder Pedal Sensitivity/Rudder Reversal Recommendation' Report dated 7 November 2013: https://www.faa.gov/regulations_policies/rulemaking/committees/documents/media/TAEfch-rpsrr-3282011.pdf

— EASA Special Condition (SC) on 'Rudder Control Reversal Load Conditions': https://www.easa.europa.eu/documents/public-consultations/proposed-special-condition-c-xx

— Federal Register /Vol. 75, No. 157 /Monday, August 16, 2010, page 49815: Amendment No. 25-130 – Maneuvering Speed Limitation Statement: https://www.gpo.gov/fdsys/pkg/FR-2010-08-16/pdf/2010-20195.pdf