European Aviation Safety Agency

Terms of Reference

for rulemaking task RMT.0586

Tyre pressure monitoring system

ISSUE 1

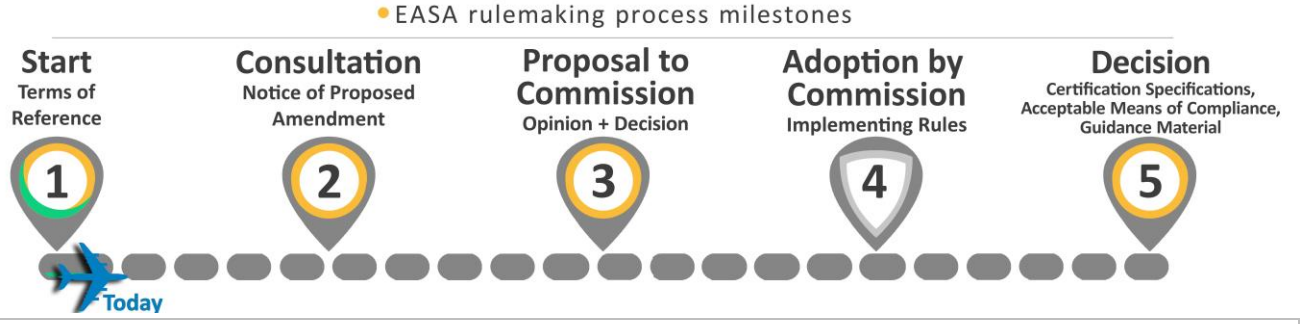
Issue/rationale

Improper tyre pressure, in particular underinflation, remains a major contributing factor to tyre- and wheel-failure-related accidents or incidents. These kinds of occurrences continue to occur regularly despite a number of regulatory changes established over the last 40 years.

It is widely recognised that ensuring correct aircraft tyre inflation pressure is the most important factor for safe tyre operations.

The specific objective of this rulemaking task is to propose a regulatory change to ensure that the tyres' inflation pressures of large aeroplanes remain within the pressure specifications defined by the aircraft manufacturer.

Action area:	Design and maintenance improvements		
Affected rules:	CS-25; Part-26; CS-26; Part-M; AMC & GM to Part-M		
Affected stakeholders:	Design organisations manufacturing large aeroplanes and their suppliers; operators of large aeroplanes; maintenance organisations		
Driver:	Safety	**Rulemaking group:**	Yes
Impact assessment:	Full	**Rulemaking Procedure:**	Standard



30.5.2017	2018/Q3	2019/Q3 (Part-26, Part-M) (CS-25)	2020/Q3 (Part-26, Part-M)	2020/Q3 (CS-26, AMC & GM to Part-M)

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

1.1. General

Improper tyre pressure, in particular underinflation, remains a major contributing factor to tyre- and wheel-failure-related accidents or incidents. These kinds of occurrences continue to occur regularly despite a number of regulatory changes established over the last 40 years.

It is widely recognised that ensuring correct aircraft tyre inflation pressure is the most important factor for safe tyre operations. Operation with underinflated tyres is damaging to aircraft tyres and causes tyre break-up either directly or indirectly; on a multi-wheel assembly, an underinflated tyre increases the risk of failure of the companion tyre(s).

In general, aircraft tyre/wheel assemblies have several possible leak paths (in the order of 10). It is also acknowledged that an aircraft tyre can normally lose up to 5 % of its pressure within 24 hours.

Underinflation of a single tyre (even a gross underinflation) on a multi-wheel assembly is nearly impossible to detect by visual check (e.g. during pilot preflight check), because the correctly inflated tyre would carry the load and would therefore prevent the abnormal flattening of the underinflated tyre.

Tyre overinflation, although occurring less frequently, is known to cause wheel fatigue issues with associated threats from wheel failure.

1.2. SAE International review

In 2007, an SAE group, the A-5 Aerospace Landing Gear Systems Committee, conducted a review of the damaging effects of tyre and wheel failures, and they issued Aerospace Information Report (AIR) 5699 (issued November 2007, reaffirmed on 25.10.2013)[1].

The report provides an in-service operational data analysis based on databases from the US National Transportation Safety Board (NTSB) and from major aircraft manufacturers, over approximately 40 years (up to 2005). It is confirmed that tyre-pressure-related events are preponderant, representing about 65 % of all data events.

NTSB data (events recorded with some level of aircraft damage) showed that tyre and wheel failure events resulted in 11 fatal accidents, 8 hull losses with no fatalities, 11 events with debris entered in fuel tank or engine, 36 events with airframe damage, and 7 decompressions.

Furthermore, the SAE International A-5 Aerospace Landing Gear Systems Committee assessed how regulation changes or industry practice could mitigate any of the events. The outcome was that the most promising future action (apart from the implementation of tyre servicing with nitrogen) is the implementation of a tyre pressure monitoring system (TPMS). This could, in view of the SAE International A-5 Aerospace Landing Gear Systems Committee review, potentially mitigate 38 % of all the events reviewed.

[1] SAE Aerospace Information Report (AIR) 5699 ('A Guide for the Damaging Effects of Tire and Wheel Failures') available on the SAE International website at: http://standards.sae.org/air5699/.

The SAE International A-5c Aircraft Tires Committee then also prepared and published Aerospace Recommended Practice (ARP) 6137 (dated 10.6.2010, reaffirmed on 10.8.2015)[2]. This SAE International ARP establishes the overall component and system function guidelines and minimum performance levels for a TPMS.

1.3. Occurrences and safety recommendations related to the issue

Boeing 757-300, registration 4X-BAU, accident in London Gatwick during landing, on 3 October 2000

Tyre debris created various damages to the underside of the right wing (flap, slat, flap track fairings, fuselage/wing fairing), to the No 2 engine nacelle and pylon, right main landing gear (MLG) doors and components of the right MLG. In addition, damage was apparent to the hydraulic flexible hoses installed on the right MLG, with two of the six hoses leaking (No 3 wheel brake line and a bogie tilt actuator line). The forward flexible conduit carrying electrical cables had been struck by tyre debris but no cable damage was evident.

Evidence showed that both right MLG aft tyres (tyres 7 and 8) failed within a few seconds of each other shortly after aircraft touchdown. It was concluded that the accident had probably been caused by operating with either tyre 7 or tyre 8 underinflated. It was possible that either or both of the tyres had previously been damaged by an earlier episode of operating while underinflated or with an underinflated partner tyre.

No injuries resulted from this accident.

In July 2010, the UK Air Accidents Investigation Branch (AAIB) forwarded Safety Recommendation (SR) UNKG-2002-014 to the European Aviation Safety Agency (EASA):

SR UNKG-2002-014: '*It is recommended that Airworthiness Authorities such as the JAA and FAA consider implementing the measures outlined in AAIB Safety Recommendations 99-11 and 99-12 concerning requirements for tyre pressure monitoring and warning systems*.'

In the course of a previous accident investigation (*BAC 1-11 registration G-AWYR at Birmingham Airport, UK, on 21 November 1997, AAIB Bulletin 4-99, related to a tyre burst during take-off caused by underinflation*), the following AAIB SRs were made:

SR 99-11: '*The CAA consider a requirement for the installation, on the wheels of UK registered aircraft where a potentially hazardous level of tyre underinflation can be undetectable by external visual inspection, of a device to provide ready indication of such a condition during routine pre-flight external inspection*.'

SR 99-12: '*The CAA consider requiring the fitment on future aircraft types on the UK Register of a system to provide continuous flight deck indication of tyre pressures and/or warning of abnormal pressures*.'

Mc Donnell Douglas MD 88, serious incident in Vienna Schwechat Airport, on 31 July 2008

The investigation showed that an unsecured valve stem on the rim of tyre 2 worked loose and the O-ring underneath was torn apart, which had the effect of deflating the tyre. As a result, during the take-off run and past the point of decision, the tread of the tyre broke away, breaking off part of the water

[2] SAE International Aerospace Recommended Practice (ARP) 6137 ('Tire Pressure Monitoring Systems (TPMS) for Aircraft') available on the SAE International website at: http://standards.sae.org/arp6137/.

deflector attached to the left engine. The landing gear well was damaged, and then parts of the tread were thrown into the left engine, which caused loss of power and vibration, after which the engine was shut down. From the landing gear well damage, no locking indication of the left-hand landing gear could be observed, and as a precaution the subsequent landing was performed in accordance with the 'Landing with unsafe landing gear and possible evacuation of the aircraft' checklist. There was no person injured during this incident. In December 2013, the Austrian investigators provided several SRs to EASA/Federal Aviation Administration; the following ones are related to the present RMT:

SR AUST-2013-008: '*EASA, FAA: SE/SUB/ZLF/8/2013: Supplement to Certification Specifications 25 (CS-25), pressure displays of landing gear tyres: Insufficient pressure in landing gear tyres can, as happened in this serious incident, cause massive damage to the aircraft and result in flight situations with increased risk. On this topic also see, for example, the accident report issued by the US National Transportation Safety Board (NTSB): Runway Overrun During Rejected Takeoff, Global Exec Aviation, Bombardier Learjet 60, N999LJ, Columbia, South Carolina, September 19, 2008, http://www.ntsb.gov/doclib/reports/2010/aar1002.pdf. CS-25 should be revised to specify installation of pressure indicators for all landing gear tyres in the cockpit of commercial aircraft*.'

Learjet 60, registration N999LJ, accident on 19 September 2008

The aircraft crashed during a rejected take-off at the Columbia Metropolitan Airport, South Carolina (USA). The accident resulted in four fatalities including two passengers and both crew members. Two additional passengers were seriously injured.

The NTSB investigation revealed that the accident aircraft's tyre pressure had not been checked for approximately 3 weeks. The tyres of this aircraft experienced approximately 2 % loss of pressure per day. The NTSB determined that the tyre pressure at the time of the accident was approximately 140 psi. The recommended tyre pressure is 219 psi.

The underinflation of the four MLG tyres resulted in the failure of all four MLG tyres. The NTSB found fragments of the failed tyres that revealed folded rubber and melted nylon used to produce the tyres. In addition, hydraulic fluid was found on some tyre fragments, confirming that the tyre failure also compromised some elements of the aircraft's hydraulic system.

Finally, the NTSB's investigation identified that there is a significant inconsistency in the operating community about the pilot's role in ensuring correct tyre pressure prior to take-off. Visual inspection of high-pressure tyres, such as those of the accident aircraft, will not help detect an improperly inflated tyre. By the time a tyre shows visual signs of poor inflation, the tyre manufacturer will require that the underinflated tyre and the axle-mate (the other tyre on the same landing gear) be replaced.

The NTSB issued several **safety recommendations to the FAA**, including the following ones:

> '*Require that all 14 Code of Federal Regulations Part 121, 135, and 91 subpart K operators perform tire pressure checks at a frequency that will ensure that the tires remain inflated to within aircraft maintenance manual-specified inflation pressures*.' (A-10-47)
>
> '*Require that aircraft maintenance manuals specify, in a readily identifiable and standardized location, required maintenance intervals for tire pressure checks (as applicable to each aircraft)*.' (A-10-48)
>
> '*Require tire pressure monitoring systems for all transport-category airplanes*.' (A-10-50)

1.4. FAA/EASA Safety Alert for Operators (SAFO)

On 6 January 2011, the FAA issued a SAFO[3] stressing the importance of ensuring that aircraft tyres are properly inflated and detailing the potential consequences that improper tyre pressure can have on aircraft performance during taxiing, take-off and landing. SAFO 11001 was then endorsed by EASA through Safety Information Bulletin (SIB) No 2013-10[4].

SAFO 11001 also refers to the 1991 accident that involved a Douglas DC-8-61 (registration C-GMXQ) which crashed shortly after take-off from Jeddah, Saudi Arabia, killing all 261 people on board. The probable cause of the crash was underinflated tyres, which in turn caused an overheated tyre to explode during taxiing, which then caused other tyres to catch on fire during the take-off role. The fire continued as the wheels were retracted into the wheel well, eventually causing a loss of hydraulic control and finally an in-flight break-up which destroyed the aircraft. This accident also revealed numerous human factor issues that contributed to the underinflated tyre.

1.5. Current regulatory framework

Tyre pressure checking

In the EASA regulatory system:

— there is no rule specifically mandating tyre pressure checks at a frequency that will ensure that the tyres remain inflated within the inflation pressures specified in the aircraft maintenance manual (AMM); there is also no guidance material (GM) on tyre pressure checks;

— there is no regulation in the field of certification or maintenance standards for equipment (like inflators) used by operators or maintenance companies to check and establish aircraft tyre inflation pressure.

In the USA: FAA Advisory Circular (AC) 20-97B (*Aircraft Tire Maintenance and Operational Practices*, dated 18 April 2005)[5] recommends that all aircraft have 'daily' tyre pressure checks.

Note: Some aeroplane manufacturers also published service information letters recommending that tyre pressures be checked daily (or sometime specified as every 24 hours).

Tyre explosion and burst prevention — large aeroplanes

In 1993, FAR Part 25 Amendment 25-78 introduced a requirement § 25.733(e) for tyres to be inflated with an inert gas (e.g. nitrogen). The same requirement was added to JAR-25 and is now in CS-25 (Certification Specifications for Large Aeroplanes).

CS 25.733 'Tyres', paragraph (e) reads: 'For an aeroplane with a maximum certificated take-off weight of more than 34019 kg (75 000 pounds), tyres mounted on braked wheels must be inflated with dry nitrogen or other gases shown to be inert so that the gas mixture in the tyre does not contain oxygen in excess of 5% by volume, unless it can be shown that the tyre liner material will not produce a volatile

[3] SAFO 11001 dated 1.6.2011, entitled 'The Importance of Properly Inflated Aircraft Tires', available at: https://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/safo/all_safos/media/2011/SAFO11001.pdf.

[4] EASA Safety Information Bulletin No 2013-10, dated 10.7.2013, entitled 'Properly Inflated Aircraft Tyres', available at: http://ad.easa.europa.eu/ad/2013-10.

[5] https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/22044

gas when heated, or that means are provided to prevent tyre temperatures from reaching unsafe levels.'

In 2002, FAR Part 25 Amendment 25-107 amended § 25.731 'Wheels' and § 25.735 'Brakes for overpressure and over temperature protection of wheels'. Similar specifications are part of CS-25 since its original issue, which originates from JAR-25 Amdt 16 dated 1 May 2003.

CS 25.731 'Wheels', paragraph (d) reads: 'Overpressure burst prevention. Means must be provided in each wheel to prevent wheel failure and tyre burst that may result from excessive pressurisation of the wheel and tyre assembly.'

CS 25.735 'Brakes and braking systems', paragraph (j) reads: 'Over-temperature burst prevention. Means must be provided in each braked wheel to prevent a wheel failure, a tyre burst, or both, that may result from elevated brake temperatures. Additionally, all wheels must meet the requirements of CS 25.731(d).'

None of the above rules specifically address avoiding operations with underinflated tyres.

Although the industry has developed and introduced into service TPMSs, there is currently no regulation requiring the installation of such systems.

Protection against consequences of tyre and wheel failures — large aeroplanes

CS-25 contains certification specifications for the protection of large aeroplanes against tyre and wheel failure (debris and burst effects). In December 2013, EASA issued Amendment 14 of CS-25 which upgraded these specifications and the associated acceptable means of compliance.

CS 25.734 'Protection against wheel and tyre failures' requires the following:

> 'The safe operation of the aeroplane must be preserved in case of damaging effects on systems or structures from:
>
> - tyre debris;
> - tyre burst pressure;
> - flailing tyre strip; and
> - wheel flange debris.'

AMC 25.734 provides a set of models defining the threats.

CS 25.963 'Fuel tank: general' requires the following:

> '(e) Fuel tanks must comply with the following criteria in order to avoid hazardous fuel leak:
>
> (1) Fuel tanks located in an area where experience or analysis indicates a strike is likely, must be shown by analysis supported by test, or by test, to address penetration and deformation by tyre and wheel fragments, small debris from uncontained engine failure or APU failure, or other likely debris (such as runway debris).'

AMC 25.963(e) provides guidance and acceptable means of compliance for the evaluation of fuel tanks designs, and it also refers to AMC 25.734 for wheel and tyre failure threat models.

AMC 25.1309 also identifies tyre burst as an item to be considered for Particular Risk Analysis.

These specifications address the consequence of a wheel or tyre failure, but not the means to prevent such a failure in the first place.

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 RMT will contribute to the achievement of the overall objectives by addressing the issues outlined in Chapter 1.

Aircraft tyre incorrect inflation pressure has the potential to create catastrophic consequences. This has been demonstrated by at least two fatal and hull loss accidents in the past 10 years. In addition, there has been a number of events where the outcome was not catastrophic but had the potential to be.

The specific objective of this proposal is to propose a regulatory change to better ensure that the inflation pressures of tyres of large aeroplanes remain within the pressure specifications defined by the aircraft manufacturer.

3. How we want to achieve it

The proposal should consider better enforcing the operator's responsibility to ensure regular tyre pressure checks, and also the obligation for large aeroplane manufacturers to define the tyre pressure checks procedures and intervals in the Instructions for Continuing Airworthiness (ICA); as different practices exist in terms of content and presentation of the information in the AMM, it should be considered whether this ICA item can be better standardised among manufacturers and aircraft.

Since a legal obligation on tyre pressure check would not always guarantee that the tyres are correctly inflated (e.g. air leakage in the tyre/wheel assembly, maintenance error or negligence, failure/inaccuracy of the inflation equipment, operator not correctly performing the regular checks, etc.), the proposal should also consider requiring the installation of a TPMS which alerts the pilots when a tyre pressure is abnormal or out of tolerance.

Therefore, the following elements should be considered by the rulemaking group:

(a) Create new CS-25 specifications for the installation of a TPMS on new large aeroplane designs. The possibility to dispatch with this system inoperative should also be considered (MMEL item).

(b) Introduce a new retroactive rule (Part-26/CS-26) mandating the installation of a TPMS on already certified large aeroplanes (consider production cut-in and retrofit options).

(c) Require from large aeroplane type certificate holders (TCH) that ICA documents specify, in a readily identifiable and standardised location, the required maintenance procedures and intervals for tyre pressure checks (as applicable to each aircraft). New CS-25 and Part-26/CS-26 provisions could be considered to enforce this obligation on new designs, and potentially on in-service/in-production large aeroplanes.

(d) Review Part-M and the related AMC/GM and potentially propose new provisions to enforce the obligation of operators of large aeroplanes to ensure tyre pressure checks at a frequency that will ensure that the tyres remain inflated within the inflation pressures specified in ICA.

A regulatory impact assessment (RIA) should be performed to analyse the different possible options.

4. What are the deliverables

— A notice of proposed amendment (NPA) proposing regulatory changes. Depending on the outcome of the RIA, the proposal may include:

- a draft decision amending CS-25,
- a draft opinion amending Part-26,
- a draft decision amending CS-26,
- a draft opinion amending Part-M, and
- a draft decision amending AMC/GM to Part-M.

— A comment-response document (CRD) addressing the comments received during the NPA public consultation.

— Depending on the outcome of the NPA public consultation, one or more of the following items:

- a decision amending CS-25,
- an opinion amending Part-26,
- a decision amending CS-26,
- an opinion amending Part-M, and
- a decision amending AMC/GM to Part-M.

5. Profile and contribution of the rulemaking group

This RMT shall be supported by a rulemaking group. The following skills should be provided by the members of the group:

— expertise in large aeroplane hydromechanical systems design and certification, including proven experience in design/installation and certification of tyre pressure monitoring systems;

— good knowledge of large aeroplane ICAs related to maintenance procedures and intervals for tyre pressure checks;

— good knowledge of maintenance regulations applicable to operators of large aeroplanes in the field of tyre pressure checks (in particular Part-M and related AMC/GM).

For the sake of harmonisation, participation of the FAA and TCCA in this rulemaking group is encouraged.

6. Reference documents

6.1. Affected regulations

— Commission Regulation (EU) 2015/640 of 23 April 2015 on additional airworthiness specifications for a given type of operations and amending Regulation (EU) No 965/2012 (OJ L 106, 24.4.2015, p. 18)

— Commission Regulation (EU) No 1321/2014 of 26 November 2014 on the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organisations and personnel involved in these tasks (OJ L 362, 17.12.2014, p. 1)

6.2. Affected 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 »)

— ED Decision 2015/013/R of 8 May 2015 adopting Certification Specifications for additional airworthiness specifications for operations (« CS-26 »)

— ED Decision 2015/029/R of 17 December 2015 issuing acceptable means of compliance and guidance material to Part-M, Part-145, Part-66, and Part-147 of Regulation (EU) No 1321/2014 and repealing Decision 2003/19/RM of the Executive Director of the Agency of 28 November 2003

6.3. Reference documents

— SAE International AIR5699 (‘A Guide for the Damaging Effects of Tire and Wheel Failures’) available on the SAE International website at: http://standards.sae.org/air5699/

— SAE International ARP6137 (‘Tire Pressure Monitoring Systems (TPMS) for Aircraft’) available on the SAE International website at: http://standards.sae.org/arp6137/

— SAFO 11001 dated 1.6.2011, entitled ‘The Importance of Properly Inflated Aircraft Tires’, available at: https://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/safo/all_safos/media/2011/SAFO11001.pdf

— EASA Safety Information Bulletin No 2013-10, dated 10.7.2013, entitled ‘Properly Inflated Aircraft Tyres’, available at: http://ad.easa.europa.eu/ad/2013-10

— FAA Advisory Circular (AC) 20-97B, ‘Aircraft Tire Maintenance and Operational Practices’, dated 18 April 2005