Request for deviation from applicable airworthiness code
Consultation Paper

Equipment model: Main wheel for Large Transport aircraft

Airworthiness code involved: European Technical Standard Order ETSO-C135
Transport aeroplane wheels and wheels and brake assemblies.

Date: 20.04.2007

1. Introductory note

The hereby presented Deviation request shall be subject to public consultation, in accordance with EASA Management Board Decision n°7-2004[1] products certification procedure dated 30 March 2004, Article 3 (2.) of which states:

"2. Deviations from the applicable airworthiness codes, environmental protection certification specifications and/or acceptable means of compliance with Part 21, as well important special conditions and equivalent safety findings, shall be submitted to the panel of experts and be subject to a public consultation of at least 3 weeks, except if they have been previously agreed and published in the Official Publication of the Agency. The final decision shall be published in the Official Publication of the Agency."

2. Background

2.1 Identification of issue

The main wheel for a large transport aircraft meets the minimum performance standard prescribed by ETSO-C135 except for the requirement hereunder.

ETSO-C135 § 3.2.2.2 Combined Yield Load (wheels tests) requires: "There must be no interference in any critical areas between the wheel and brake assembly, or between the most critical deflected tyre and brake (with fittings) up to limit load conditions..."

During ETSO-C135 qualification testing, interference occurred between brake and tyre before the combined limit loads were reached. Indeed the tyre selected by the aircraft manufacturer came in contact with the brake structure (Brake Actuator carrier torque take-out) at a combined load value of 72% of limit radial load and 90% of limit side load.

The wheel manufacturer is submitting to EASA this deviation request against ETSO-C135 for the main wheel for this aircraft type.

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[1] cf. EASA Web: http://www.easa.europa.eu/doc/About_EASA/Manag_Board/2004/mb_decision_0704.pdf

2.2 Arguments supporting the deviation request

The wheel manufacturer claims that deviations concerning similar cases has been substantiated and approved previously and proposes EASA accept the relevant deviation as is, according to the following arguments.

Tests results have been submitted by the wheel manufacturer to the aircraft manufacturer. According to the aircraft manufacturer a side load is not predicted to exceed 90% of limit load for this condition more often than once in 10,000 flights.

The aircraft manufacturer stated that in case of interference only 2 positions (8 wheels per aircraft) would be affected, and that in case of a 2 tyres failure, this failure would be considered as minor, for airplane safety.
Moreover, when conditions for this aircraft are compared with a similar aircraft model from the same manufacturer (same wheel rim diameter), similar combined load vectors and lateral tyre stiffness are found.
Also, the lateral distance (clearance) between tyre and brake are similar for this aircraft and a similar model from the same manufacturer. With the fleet of this similar model accumulating more than 38,000 landings to date, no such interference has been identified.

Annex 1 includes a 7-page document issued by the aircraft manufacturer to substantiate more precisely those statements.

The wheel manufacturer recalls that a similar request for deviation has already been granted by a subcontracted National Aviation Authority on behalf of EASA for another of its main wheels.

Taking into account the facts presented above, the wheel manufacturer considers that this main wheel complies with the ETSO-C135 requirements, providing an equivalent level of safety.

The wheel manufacturer agrees that the information contained in this document is not proprietary.

ANNEX 1 (7 pages): Aircraft manufacturer analysis on Brake tire interference at limit side load (ETSO / TSO-C135 compliance)

2.3 EASA Position

EASA agrees that all aspects of the ETSO minimum performance standard have been met by this wheel, with the exception of paragraph 3.2.2.2, which requires that there shall be no interference between wheel brake and tyre at combined limit radial and side load conditions.

The wheel manufacturer requests a deviation to ETSO-C135 for paragraph 3.2.2.2, which states,

> *"There must be no interference in any critical areas between the wheel and brake assembly, or between the most critical deflected tyre and brake (with fittings) up to limit load conditions, taking into account the axle flexibility. Lack of interference can be established by analyses and/or tests."*

The justification of this deviation request is made with the following arguments,

a) Acceptable aircraft level risk

The aircraft manufacturer has analysed the aircraft level hazards associated with the potential tyre failure which could be caused by this interference. It has been determined that the likely failure mode, the loss of up to two tyres on a single gear, has consequences no worse than major for the aircraft. This classification has been accepted by the aircraft certifying authority.

b) Unlikely to reach this loading condition in service

The aircraft manufacturer quotes a statistical examination of side load factors collected from large transport aircraft in service. This shows that the case giving rise to this loading condition is conservative for commercial airliners and becomes more conservative with increasing aircraft size.
EASA only partially accept this report in support of this deviation, since it is understood that the data in the report quoted is "clipped" data - i.e. the data was edited at source before use by the authors of the report. The report is useful, however, for showing typical, rather than extreme, operational loads and for the showing of trends. The report does show, however, that larger aircraft tend to experience lower lateral loads than smaller aircraft. The report also shows that high lateral loads are not typical of service experience which does contribute to this particular case.

c) Comparison to existing approved design in service

The aircraft manufacturer compares the tyre clearances for the subject wheel and brake assembly with those of a similar large transport aircraft already in service. They claim that the dimensions are similar as are the loads and the tyre stiffnesses, and so the service record (of no identified interferences) for the comparison aircraft can be used as supporting evidence that tyre/brake interferences are not likely.
EASA consider this comparison valid, but it is made against a single type with some, but not extensive, service history and also having a different configuration of landing gear.

EASA has reviewed this requested deviation and agrees that the above arguments are acceptable compensating factors providing an equivalent level of safety for the intent of ETSO C135 requirements. Therefore, EASA envisages granting the requested deviation to ETSO with limitations stated on the ETSO Authorisation.

Note: If this deviation is accepted, it would than be published in the Official Publication of the Agency. It would then be usable by other applicants, if they could substantiate their specific case with relevant data and when supported by the applicable aircraft manufacturer.

To: [redacted])

From: [redacted] Engineer for [redacted] Wheels/Tires/Brakes)
[redacted] Engineer for [redacted] Landing Gear Structures)

Subject: [redacted] Brake Tire Interference at Limit Side Load (TSO-C135 Compliance)

Date: January 8, 2007

Reference: FAA TSO-C135, Transport Airplane Wheels and Wheel and Brake Assemblies, dated May 2, 2002

[redacted] has informed [redacted] that the [redacted] main tire touches the [redacted] brake actuator housing at a combined load condition of 72% of limit radial load and 90% of limit side load during TSO-C135 testing. A side load is not predicted to exceed 90% of limit load for this condition more often than once in 10,000 flights. This letter is to inform [redacted] that this condition is acceptable.

The applicable Federal Aviation Regulation which generates this load condition is §25.495, see attachments 1 and 2. Assuming tires 1 and 2 on the L/H Gear have brake/tire interference, the next highest side load would be tires 1 and 2 on the R/H Gear. These tires have loads that are approximately 33% of the maximum limit loads. Since brake/tire interference occurs at 72% of limit radial load and 90% of limit side load, we can conclude that only two of the eight MLG tires on the [redacted] would have brake/tire interference under limit load conditions. Further, even if two tires were to fail as a result of contact, the [redacted] brake system functional hazard assessment does not classify failure of two tires as a major hazard effect on the airplane (loss of more than 50% of tires on a single gear is defined as a major hazard effect on the airplane). Thus, failure of two tires is considered minor in its effect on airplane safety. (See attachment 3.)

DOT/FAA/AR-02/129, "Side Load Factor Statistics from Commercial Aircraft Ground Operations, January 2003", presents analyses and statistical summaries of landing and ground operations data gathered to provide the FAA with a technical basis for assessing the suitability of the 0.5-g lateral acceleration criteria for turning. As noted in the report, for ground turning operations measured, lateral load factors are decidedly a function of airplane size. It is also recognized that the 0.5g lateral load factor is an arbitrary value specified for the maximum required ground turning load condition and that for larger/heavier transport jets such as the [redacted] the lateral loads experienced during ground turns are substantially less.

As further discussion of the likelihood of actual contact between the tire and brake actuator housing, service data has been analyzed in conjunction with qualification data. A similar wheel rim size is used on the [redacted] MLG (52x21.0R22) and the [redacted] MLG (50x20.0R22). The combined load vectors are similar for the [redacted] and [redacted]. The lateral tire stiffness values are similar for the [redacted] and [redacted]. The lateral distance from the tire to the brake is similar for the [redacted] and the [redacted] No such interference has been identified in the life of the [redacted] fleet (estimated at 38,296 landings). (See attachments 4 and 5.)

Best Regards,

[redacted]
Wheels/Tires/Brakes Engineering

[redacted]
Landing Gear Structures Engineering

Attachments 1 - 6

Attachment 1

[redacted] Main Wheel Limit Loads

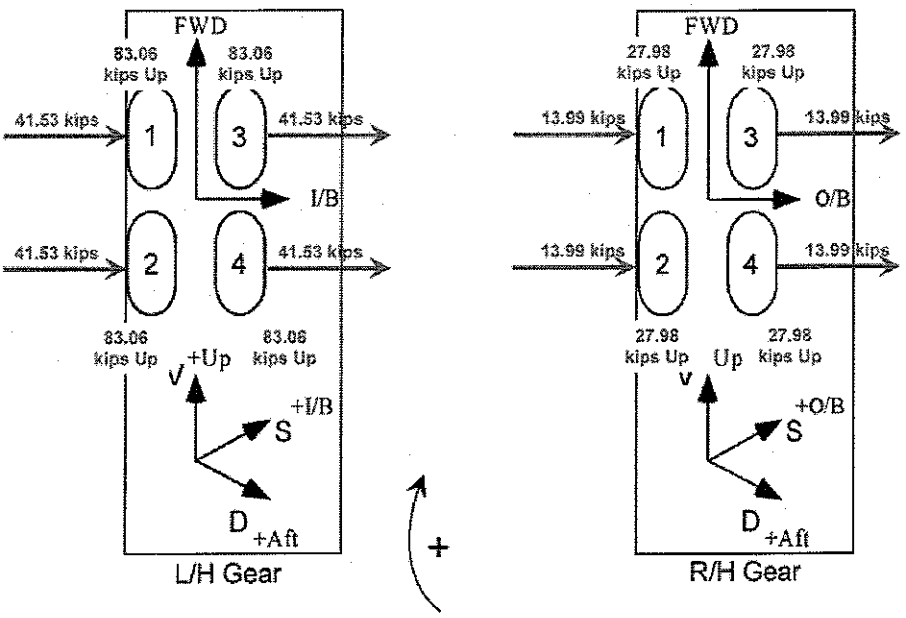
The critical wheel reactions for the [redacted] main landing gear are calculated to the requirements of 14CFR 25.495, which states:

> In the static position, the airplane is assumed to execute a steady turn by nose gear steering, or by application of sufficient differential power, so that the limit load factors applied at the center of gravity are 1.0 vertically and 0.5 laterally. The side ground reaction of each wheel must be 0.5 of the vertical reaction.

The reactions are calculated assuming the airplane is at its maximum taxi weight and critical center of gravity.

Attachment 2

[redacted] Main Wheel Loods (§25.495)
Ground Turn Right, 50/50 Tire
Distribution (Limit)



Attachment 3

Data Supporting "Equivalent Level of Safety"

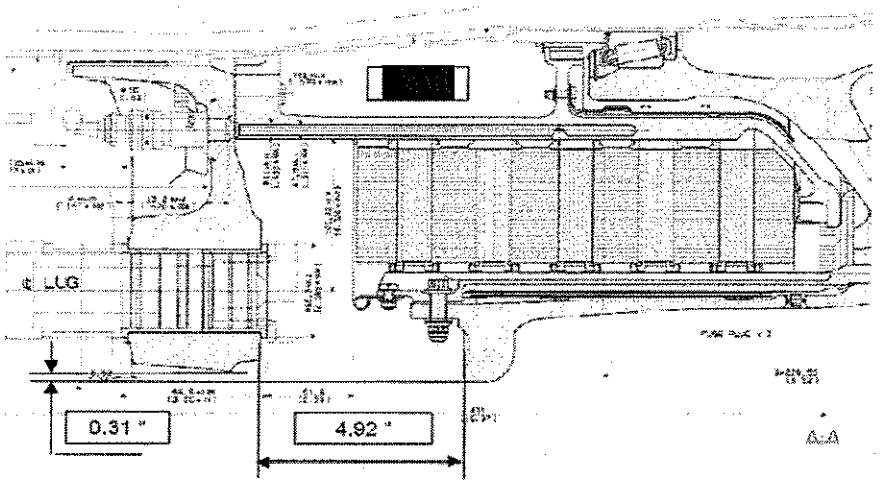
The following table is from the [redacted] brake system functional hazard assessment.

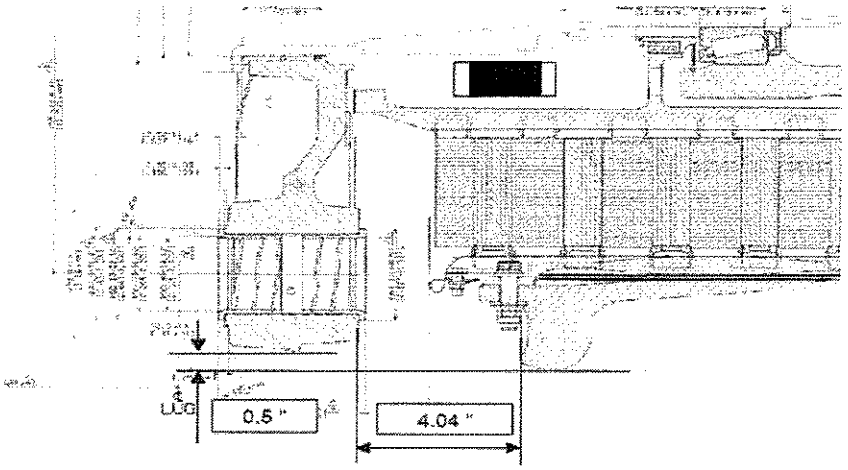
Functional Hazard Assessment					
ID	Function	Hazard Description	Phase	Hazard Effect Classification	Remarks
MSB70	Wheels / Tires / Brakes	Loss of more than 50% of tires (failed or deflated) on a single gear fail to provide adequate braking force when needed.	L1, L2, T1	Major	Loss of more than 50% of tires on one gear can overload remaining tires and cause loss of all tires on a gear resulting in longer stopping distances.

L1 – Landing 60 knots and below (Low speed).
L2 – Landing 60 knots and above (High speed).
T1 – Takeoff Roll Prior to V1.

Attachment 4

Tire / Brake Interference Comparison: [redacted] vs. [redacted]





Attachment 5

Data Supporting Rationale to Establish [redacted] Successful Service Experience as Validating [redacted] Successful Service Experience

Background

Background: [redacted] (52x21.0R22) has similar MLG wheel rim size as [redacted] (50x20.0R22). [redacted] Maximum Limit Side Load Condition: 83,060 lb (radial), 41,530 lb (side) - combined load vector = 92,864 lb.

[redacted] Maximum Limit Side Load Condition: 110,000 lb (radial), 82,000 lb (side) – combined load vector = 137,200 lb.

Comparable Tire Side Stiffness

Tire Side Stiffness Factor:

[redacted] Main Landing Gear tire is size 50x20.0R22 34PR 235 mph (tested tire size during TSO qualification).

[redacted] Main Landing Gear tire is minimum size 52x21.0R22 36PR 235 mph (tested tire size during TSO qualification).

The [redacted] tire has similar lateral stiffness to the [redacted] tire (see attachment 6 tire qualification chart – Static Lateral Deflection Test).

Tire to Brake Lateral Distance

The lateral distance from the tire to the brake is shown in attachment 4. The [redacted] lateral distance (4.92 inches) is similar to the [redacted] lateral distance (4.04 inches).

Comparison with [redacted] Tire Service History

Based on the lower combined loads of the [redacted] and the similarity shown above with tire lateral stiffness and tire to brake lateral distance, the [redacted] brake/tire can use the service experience of the [redacted]. There have been 38,296 landings for the [redacted] fleet as of November 30, 2006. There have been no recorded instances of the [redacted] tires touching the brake in [redacted] fleet history.

Attachment 6