AEROSPACE STANDARD

AS707	REV. C

Issued 1967-10
Reaffirmed 2012-05
Revised 2013-11

Superseding AS707B

(R) Thermal Sensitive Inflation Pressure Release Devices for Tubeless Aircraft Wheels

RATIONALE

This revision to AS707 adds references, and provides grammatical corrections and clarification of the design, interface, and test requirements. It changes terminology from “thermal release devices” to “fuse plugs,” consistent with FAA and government documents.

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1. SCOPE

The focus of this SAE Aerospace Standard (AS) is the integration of thermally actuated pressure release devices, hereafter referred to as fuse plugs, with the wheel and brake assembly. It does not address the manufacturing, quality or acceptance test requirements pertaining to the production of these fuse plugs. It establishes minimum design, installation, qualification, and operational requirements for fuse plugs which are used only in tubeless tire type aircraft braked wheels. Fuse plugs are designed to completely release the contained inflation pressure from a tubeless tire and wheel assembly when brake generated heat causes the tire or wheel to exceed a safe temperature level. The objective is to prevent tire or wheel rupture due to brake generated heat that could cause an unsafe condition for personnel or the aircraft. (Reference: U.S. Department of Transportation FAA Advisory Circular No. 23-17C; Title 14, Code of Federal Regulations (14 CFR) Part 25.735 (j); U.S. Department of Transportation FAA Advisory Circular No. 25.735-1 and U.S. Department of Transportation FAA Advisory Circular No. 25-7C.)

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

ARP597 Wheels and Brakes, Supplementary Criteria for Design Endurance Civil Transport Aircraft

ARP1493 Wheel and Hydraulically Actuated Brake Design and Test Requirements for Military Aircraft

ARP1619 Replacement and Modified Brakes and Wheels

2.1.2 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

Technical Standard Order TSO-C26d Aircraft Wheels, Brakes and Wheel/Brake Assemblies for Parts 23, 27 and 29 Aircraft

Technical Standard Order TSO-C135a Transport Airplane Wheels and Wheel and Brake Assemblies Title 14, Code of Federal Regulations (14 CFR) Part 25.731 (d) - Airworthiness Standards: Transport Category Airplanes, Wheels

Title 14, Code of Federal Regulations (14 CFR) Part 25.735 (j) - Airworthiness Standards: Transport Category Airplanes, Brakes and Braking Systems

U.S. Department of Transportation FAA Advisory Circular No. 23-17C - Systems and Equipment Guide for Certification of Part 23 airplanes and Airships

U.S. Department of Transportation FAA Advisory Circular No. 25.735-1 - Brakes and Braking Systems Certification Tests and Analysis

U.S. Department of Transportation FAA Advisory Circular No. 25-7C - Fight Test Guide for Certification of Transport Category Airplanes

2.1.3 U.S. Government Publications

Available from DLA Document Services, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6396, http://quicksearch.dla.mil/.

MIL-W-5013L Wheel and Brake Assemblies Aircraft, General Specification For

3. DESIGN

Fuse plug location and melting point temperature shall be selected so that release of tire inflation pressure occurs before a tire or wheel rim temperature contrary to safe operation of the wheel and tire assembly is reached but not so low that inadvertent release occurs during normal operations including quick turnaround operation. Also, there shall be no premature release during the accelerate-stop or most severe landing conditions. (Reference: U.S. Department of Transportation FAA Advisory Circular No. 23-17C and U.S. Department of Transportation FAA Advisory Circular No. 25-7C.)

3.1 Actuation Temperature

The fuse plug actuation temperature shall be selected to be consistent with permissible temperature levels for the wheel and tire, respectively, for a given aircraft application.

Fuse plugs shall be designed to release consistently within ±10 °F (±6 °C) of their melting point temperature or rating at any tire inflation pressure from low to rated pressure with the rated pressure adjusted for temperature rise. This melting point and tolerance includes the effects of heat and variations in rates of temperature change. It also accounts for acceptable variations in eutectic alloy chemistry including foreign materials and impurities. When the installed fuse plugs reach the selected temperature level as a result of absorbed heat, they shall completely release the contained inflation pressure of the tire. The installation shall be such that the fuse plugs function properly and consistently prior to the wheel bead seat exceeding critical rim or tire temperatures. Upon reaching the melting point temperature, fuse plugs shall melt cleanly, at all pressures. There shall be no partial melts, or pin hole leaks. (Reference: U.S. Department of Transportation FAA Advisory Circular No. 23-17C, U.S. Department of Transportation FAA Advisory Circular No. 25.735-1 and U.S. Department of Transportation FAA Advisory Circular No. 25-7C.)

3.2 Orifice

The orifice in each fuse plug shall be sufficiently large to assure decreasing tire pressure under all conditions, in particular, during the time that the wheel is being overheated. (Reference U.S. Department of Transportation FAA Advisory Circular No. 23-17C, U.S. Department of Transportation FAA Advisory Circular No. 25.735-1 and U.S. Department of Transportation FAA Advisory Circular No. 25-7C.) The size of each orifice shall be such as to permit the tire inflation pressure to decrease to 50% of its initial value in not more than 2 minutes when only one fuse plug releases.

The location, number of fuse plugs and orifice size shall release tire pressure prior to tire or wheel failure resulting from temperature induced structural degradation following the maximum energy condition(s), typically accelerate-stop and/or most severe landing stop.

3.3 Wheel Interface

Although the number of fuse plugs shall be minimized to achieve maximum installation reliability, a minimum of three shall be used with consideration for as equal a circumferential spacing as possible and appropriately located to reduce the tire pressure to a safe level before any part of the wheel becomes unacceptably hot, irrespective of the wheel orientation.

Consideration shall be given to the installation of the fuse plugs in the wheel at a location that minimizes the effect on fatigue life of the wheel structure.

3.4 Wheel Deflection

The installation and fit between the wheel and the fuse plugs shall be such as to allow for wheel deflections under all static and dynamic operating conditions while simultaneously exposed to the entire range of ambient and brake induced temperatures. The clearance and strength of the fuse plugs shall be sufficient to allow cyclic deflections of the wheel without failure, impaired function, or leakage of the fuse plugs or their associated seals at all wheel temperatures below the melting point temperature of the fuse plugs.

3.5 Materials and Finish

Materials and finishes shall be of aircraft quality, and shall be electrolytically and thermally compatible with the wheel material. If fusible materials are used, it is desirable that they be of the eutectic type, preferably cadmium free.

3.6 Environment

The fuse plugs shall be capable of withstanding the same environmental conditions as are imposed on the wheel.

4. INSTALLATION

Details of installation of the fuse plugs shall receive approval of the procuring agency.

4.1 Identification

Each fuse plug shall be identified with regard to rated temperature either by part number, code number, color code, or other permanent type marking as established by the manufacturer. Although not practical for some applications, it is desirable that this marking be visible for inspection with the tire installed on the wheel including under adverse environmental conditions.

4.2 Location

The design and location of the fuse plugs shall be such as to permit inspection without removal of the tire from the wheel where practical. This preference for inspection without removal of the tire shall not take precedence over the need to correctly position the fuse plugs for efficient gas release per 3.3. Changing the fuse plugs with or without removal of the tire shall be a procuring agency option.

The fuse plugs shall be designed and located so that once activated their continued operation is not impaired by the releasing gas. Restrictions around the pressure release orifice shall not cause deflation times to exceed the time required to ensure wheel integrity.

If the fuse plugs expel material when they release pressure, they shall be located to assure that any expelled material will not strike personnel in the vicinity of the aircraft or any vulnerable equipment on the aircraft or the wheel and brake assemblies.

The fuse plugs shall be located in such a manner that damage from normal handling does not occur.

5. QUALIFICATION TESTING

5.1 General

The fuse plugs, when installed in the wheel assembly, shall be capable of satisfying the tests specified below. These tests shall be conducted and the requirements met for the purpose of demonstrating satisfactory performance of the fuse plugs. In all such tests, the fuse plugs shall function per the intended design allowing deflation at the rate described in 3.2. In addition, the fuse plugs shall be subjected to the entire wheel and brake qualification tests or equivalent tests based on the original qualification test results. (Reference: U.S. Department of Transportation FAA Advisory Circular No. 23-17C and U.S. Department of Transportation FAA Advisory Circular No. 25-7C.) All tests shall meet the applicable requirements of Section 3.

With satisfactory performance of the fuse plugs during wheel and brake qualification, and simulated field operation tests, verification by similarity to existing designs may be claimed for the performance tests of 5.2 through 5.7. When claiming similarity, due consideration shall be given to actuation temperature, wheel and brake design, fuse plug design and location, and tire inflation pressure and volume. (Reference: ARP1619.)

5.2 Release Temperature Test

The wheel manufacturer shall demonstrate the effectiveness of the fuse plugs in preventing hazardous tire blowout or wheel failure. It shall be demonstrated that the fuse plugs release tire contained gas following any brake usage condition for which the wheel temperature at the bead seat reaches a maximum temperature level agreed upon for the component capabilities with the contracted suppliers. (Reference ARP1493.) The fuse plugs shall release consistently within ±10 °F (±6 ˚C) of their melting point temperature or rating at any tire inflation pressure from low to the rated pressure adjusted for the contained inflation gas temperature. This may be demonstrated during qualification and flight testing of the brake assemblies, typically the accelerate-stop and most severe landing stop conditions. It shall also be demonstrated that the fuse plugs will not release the tire pressure prematurely during takeoff and landing, including during quick turnaround operations. Refer to 5.8.

5.3 Low Pressure Test

A fuse plug shall be installed in a fixture that dimensionally duplicates the wheel fit specified for production. A pressure of 50 psi (345 kPa) shall be applied and temperature increased at a rate no greater than 10 °F/minute (6 °C/minute) until the pressure releases. The fuse plug shall function per the intended design.

5.4 Rate of Flow Test

A tire shall be mounted and the wheel assembled in the normal manner. After the tire has been inflated to the rated inflation pressure, one fuse plug shall be thermally actuated. The inflation pressure shall decrease at the rate specified in 3.2.

5.5 Static Leakage Test

When subjected to 1.5 times its rated operation pressure, there shall be no evidence of leakage from any fuse plug as evidenced by a string of bubbles, or bubbles that continually form and release individually, when immersed in water for 10 minutes.

5.6 Extreme Temperature Leakage Test

A fuse plug shall be installed in a fixture which dimensionally duplicates the wheel fit specified for production. The fit shall be near the extreme end of the tolerance, that is, largest diameter hole with the smallest diameter fuse plug.

A constant pressure equal to the pressure rating of the tire shall be applied while the fixture and installed fuse plug are cycled five times between an elevated temperature 20 °F (11 °C) below the rated temperature of the fuse plug and the low temperature specified for the application. The rate of temperature change shall not be greater than 10 °F/minute (6 °C/minute). The test fixture and fuse plug shall then be heated to the upper test limit and the pressure adjusted to 1.5 times the rated pressure of the fuse plug or 1.5 times its application pressure, whichever is greater. The temperature shall be maintained for 72 hours.

Upon completion of the elevated temperature leakage check, the fixture and fuse plug shall again be subjected to the low temperature extreme. The pressure shall be adjusted to 1.5 times the rated pressure of the fuse plug or 1.5 times its application pressure, whichever is greater and the temperature maintained for a period of 24 hours.

There shall be no leakage at or through the fuse plug during all portions of these tests.

An alternate test procedure using a wheel and tire may be used, provided that prior approval is obtained from the procuring agency. Appropriate allowance shall be made for the diffusion rate through the tire when establishing the amount of leakage permissible for this alternate procedure.