



AEROSPACE INFORMATION REPORT

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Superseding AIR6168

(R) Landing Gear Structural Health Monitoring

RATIONALE

This report provides engineering reference data, historical information, and educational material useful to the technical community regarding Structural Health Monitoring (SHM) systems for landing gear. The report is being updated to ensure the latest information on SHM technology is available to the technical community. This document will require periodic review in order to stay up to date with latest developments in SHM technologies.

AIR6168A has been reaffirmed to comply with the SAE Five-Year Review policy.

A reaffirmed status is given to technical reports that have been reviewed by the technical committee and deemed to be current with no need for immediate revision. No changes have been made to this document as a result of this review.

INTRODUCTION

The landing gear of an aircraft is a unique assembly. It must bear extreme and varying loads when an aircraft maneuvers on the ground and while taking off or landing, yet it must be lightweight and compact. The landing gear is both a structure and machine. In its simplest form, it is a structure with energy absorption capability. However, in its modern incarnation, it is a complex machine with controlled articulation, means for steering and braking, multiple axes of energy absorption, and the sole structure supporting the aircraft on the ground.

In most applications, landing gears have no structural redundancy. This reality, coupled with the conflicting design requirements of high load carrying capacity versus minimum weight and size, results in a landing gear being predominantly manufactured from very high strength (but relatively low toughness) steel, aluminum, and titanium alloys. This is in contrast to most airframes and other aircraft structures, which are typically made from ductile alloys that can withstand relatively long cracks that grow over time.

The significant difference between the aircraft structure and landing gear is also reflected in the fact that aircraft design and approval methodologies are quite different. For example, many airframe designs use "damage tolerant" design methodologies, which assume the presence of cracks in structural members and ensure that, should cracking develop, a safe period of operation is available before the cracks are detected and rectified. In contrast, due to the design constraints identified above, most landing gears currently use "safe life" design methods that do not permit or consider cracks. (NOTE: Exceptions include the United States Navy carrier-based aircraft landing gear that use damage tolerance design methodology in addition to safe life techniques and require more than one lifetime for crack growth from initiation to critical length.) Therefore, many of the SHM technologies potentially applicable to damage tolerant structure that are based on non-catastrophic crack growth in the airframe are not applicable to landing gear structures. The landing gear also has movable elements that form part of the overall assembly. These components must be considered when taking into account monitoring of the entire landing gear structure.

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The differences between landing gear systems and other aircraft systems mean that an alternative approach must often be taken with landing gear SHM solutions. Historically, landing gears have only been fitted with the minimum number of sensors required to indicate the position of the structure, state of articulation, weight on wheels, and wheel speed indication. It is difficult to achieve high levels of sensor reliability in the harsh environment of the landing gear. As aircraft system complexity increases and the reliability of sensor systems increases, it is interesting to evaluate the benefit offered by more measurements compared to the reliability decrease inherent in adding more components to a system.

The original AIR was based on the article *Landing Gear*, published in the Encyclopedia of Structural Health Monitoring [1], and has been updated with newer reference material that has become available since publication.

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1. SCOPE

This SAE Aerospace Information Report (AIR) discusses past and present approaches for monitoring the landing gear structure and shock absorber (servicing), opportunities for corrosion detection, methods for transient overload detection, techniques for measuring the forces seen by the landing gear structure, and methods for determining the fatigue state of the landing gear structure. Landing gear tire condition and tire pressure monitoring are detailed in ARP6225, AIR4830, and ARP6137, respectively. Aircraft Brake Temperature Monitoring Systems (BTMS) are detailed in AS1145.

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 +1 724-776-4970 (outside USA), www.sae.org.

AIR4830	Aircraft Tire Pressure Monitoring Systems
AIR5938	Information on Hard Landings
AIR6258	Fiber Optic Sensors for Aerospace Applications
ARP4462	Barkhausen Noise Inspection for Detecting Grinding Burns in High Strength Steel Parts
ARP5908	Landing Gear Servicing
ARP6137	Tire Pressure Monitoring Systems (TPMS) for Aircraft
ARP6225	Aircraft Tire Inspection - In-Service Removal Criteria
ARP6366	Fiber Optic Sensor Specification Guidelines for Aerospace Applications
ARP6461	Guidelines for Implementation of Structural Health Monitoring on Fixed Wing Aircraft
AS1145	Aircraft Brake Temperature Monitoring Systems (BTMS)

2.2 Quoted References

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