SAE Aerospace
An SAE International Group

AEROSPACE RECOMMENDED PRACTICE

SAE ARP813 REV. C

Issued 1966-12
Reaffirmed 2010-06
Revised 2012-04

Superseding ARP813B

(R) Maintainability Recommendations for Aircraft Wheel and Hydraulically Actuated Brake Design

RATIONALE

This document defines the aircraft industry recommended practice for maintainability features for aircraft wheel and hydraulically actuated brake design.

1. SCOPE

This SAE Aerospace Recommended Practice (ARP) recommends the maintainability features which should be considered in the design of aircraft wheels and brakes. The effect on other factors, such as, cost, weight, reliability, and compatibility with other systems should be weighed before the incorporation of any of these maintainability features into the design.

1.1 Purpose

The purpose of this ARP is to identify design features for aircraft wheels and hydraulically actuated brakes which would enhance their maintainability.

2. 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.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/ARP813C

2.1 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.

AIR4403A Selection, Testing, Lubrication, and Sealing of Single Row Tapered Roller Bearings for Aerospace Wheel Applications

AIR5490 Carbon Brake Contamination

AIR5567 Test Method for Catalytic Carbon Brake Disk Oxidation

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

2.2 FAA Publications

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

TSO-C135a Transport Airplane Wheels and Wheel and Brake Assemblies

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

2.3 Other Publications

2.3.1 Tire and Rim Association Publications

Available from The Tire and Rim Association, 175 Montrose West Avenue, Suite 150, Copley, OH 44321, Tel: 330-666-8121, www.us-tra.org.

The Tire & Rim Association (TRA) Aircraft Tire & Rim Year Book

3. RECOMMENDED DESIGN FEATURES

3.1 Wheels

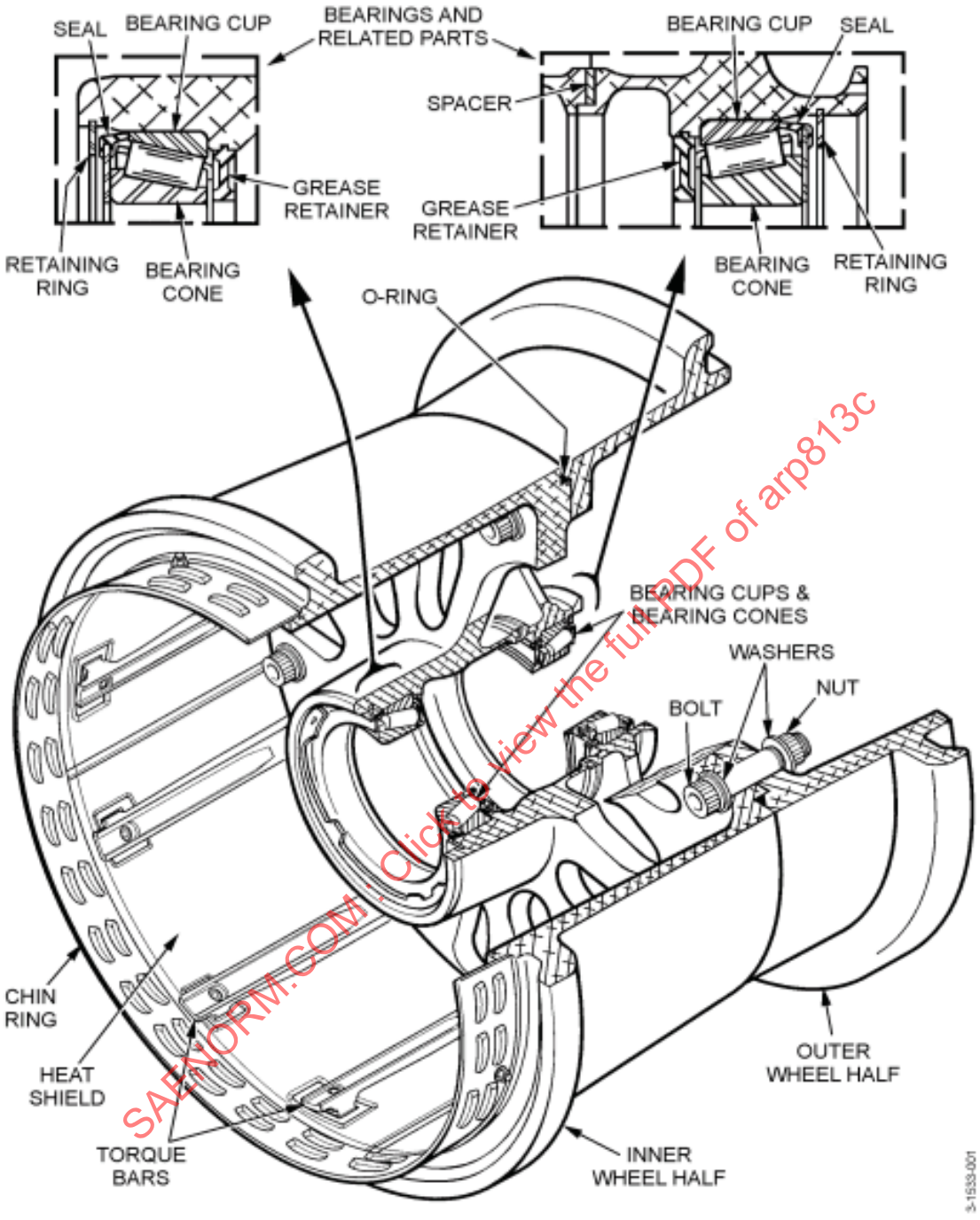

FIGURE 1 - AIRCRAFT BOLTED WHEEL NOMENCLATURE

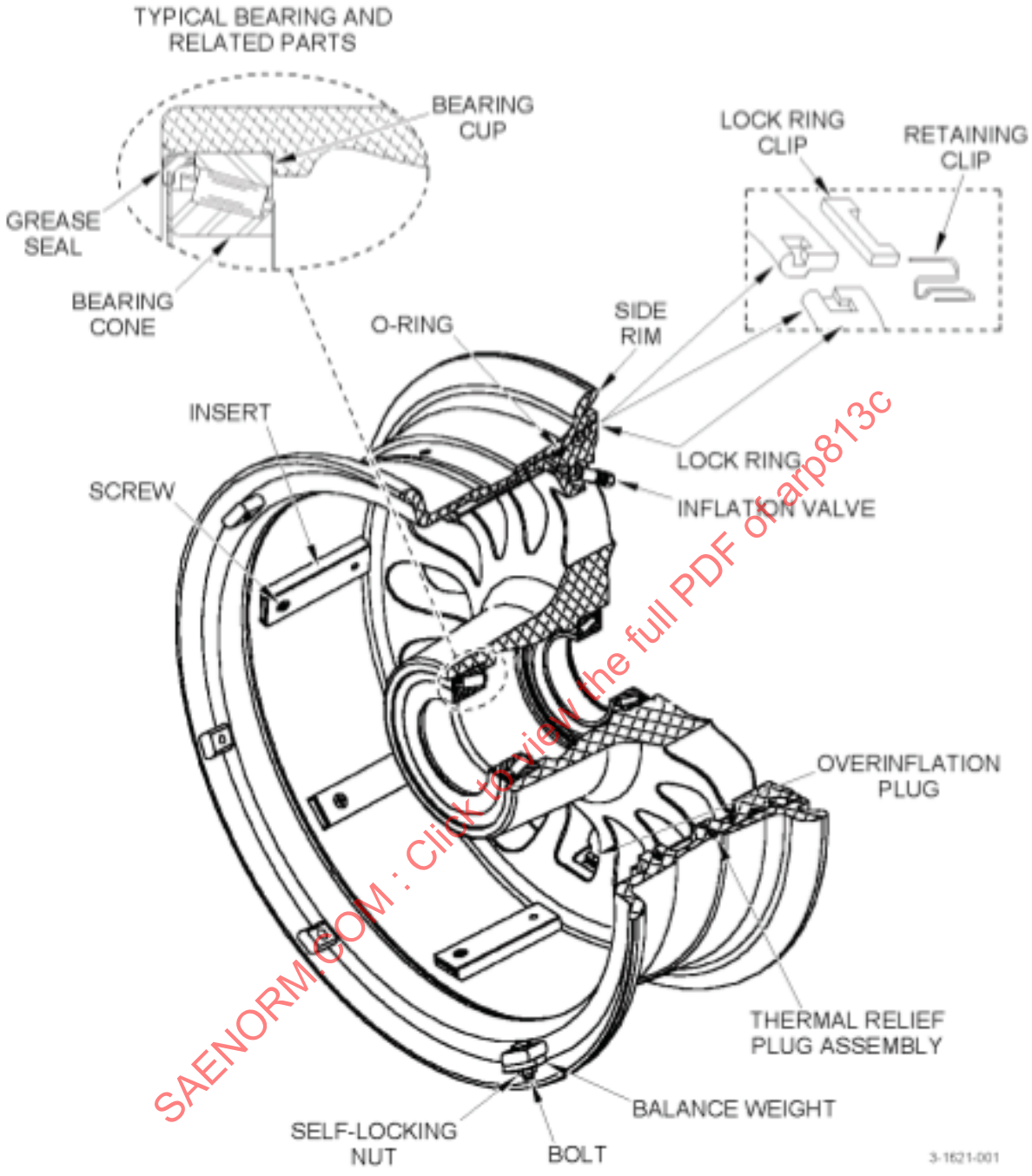

FIGURE 2 - AIRCRAFT LOCK-RING WHEEL NOMENCLATURE

3.1.1 It is desirable that heat shields, if used, and not of the continuous type, should be readily removable without the removal of brake rotor drive keys so wheel inspection procedures are not prevented or hindered. Heat shield design should prevent destructive abrasion between the shield and basic wheel material by supporting the sides of the heat shield in slots in the drive keys/bars or equivalent retainer attached to the drive keys/bars. Heat shields should be designed to preclude damage, material breakout, excessive wear or looseness in attachment areas. The wheel heat shields should also be designed to minimize direct contamination of brake friction components by deicing and cleaning fluids. Heat shields should be processed to eliminate sharp edges and surfaces that could injure maintenance personnel. Heat shields should not protrude beyond the wheel contour (drive keys/bars). It is desirable that heat shields be non-hygroscopic (i.e., does not readily absorb or retain moisture). If multi-layer heat shields are used they should have drains that tolerate heat shield immersion and not contain absorbent materials capable of retaining cleaning solvents.

3.1.2 Wheel bearing seal rubbing surfaces should rotate with the wheel, be readily replaceable, and have adequate abrasion resistance to prolong service life of the sealing surface. The design should provide for ease of replacement and/or repair of the rubbing surface(s).

3.1.3 Grease seals should be elastomeric (reinforced) and provided on both sides of the inboard and outboard wheel bearings. Wheel grease dams, which are an integral part of the forging/casting, should be avoided. If metallic grease dams are used they should be of sufficient strength to be used as a bearing surface in removing bearing cups. Grease dams that are elastomeric should be suitably secured/reinforced so they are not dislodged during wheel installation.

3.1.4 The wheel and/or brake should be designed so that the wheel assembly rotor drive keys/bars cannot be improperly aligned with the brake assembly rotors during wheel installation. If a device is mounted on the wheel to prevent improper alignment of the wheel with the brake rotors, the device should be readily replaceable, sturdy and positively fastened.

3.1.5 Possible fretting between wheel halves at mating surfaces, such as the inner and outer registers, tie bolt boss areas, lock-ring groove and demountable flange interfaces (lock ring retained wheels) should be minimized by the use of adequate bearing area, tie bolts of sufficient number, size and preload, and judicious selection of spacer materials. For lock-ring retained wheels, any rotation of the demountable flange or lock-ring should not cause premature removal of the wheel from service or damage to the mating surfaces. Lock-ring retained wheels should be designed with a suitable retaining device (i.e., snap ring or stop) to keep the demountable flange from proceeding too far inboard and becoming lodged during tire demounting.

3.1.6 Consideration should be given to maintenance inspection procedures during the selection of wheel processes, finishes, and coatings used to protect the wheel from corrosion. Paint finishes if used should be high gloss to promote easy cleaning and in a paint color to minimize on-aircraft cleaning (military).

3.1.7 Inboard and outboard wheel halves (or wheel base and demountable flange) should be clearly identified by part and serial number and be readable when the wheel is installed on the aircraft. Impression stamping, etching, or embossing should be located only in noncritical areas. Raised pads are preferred. Space should be provided to mark tire changes or inspection events. In addition, mounting provisions should be provided on both wheel halves (or wheel base and demountable flange) for the attachment of 2D bar code plates or direct marked 2D bar codes which are visible from the outside of the assembled wheel.

3.1.8 Whenever possible, balance weights should be avoided for braked wheels. Instead balance requirements should be specified and met solely by wheel manufacturing. Reusable balance weight attachment provisions when required, for statically balancing the wheel half assemblies, should be considered. Spin balancing of nose wheels is recommended over static (bubble) balancing.

3.1.9 Materials used for the impregnation of cast wheels should be resistant to paint stripping solutions and hydraulic fluids.

3.1.10 Aircraft quality wheel bearings of a standard size should be used whenever practical. When selecting aircraft wheel bearings, consideration should be given to designs that prevent installation of otherwise matching parts with different load ratings, especially for different wheels (nose and main) used on the same aircraft. Differences in bearing components, materials, finishes, and/or geometric tolerances can adversely affect bearing fatigue performance. Changes in bearing geometry can have pronounced effects on bearing performance. In light of this, and knowing that cones are not paired with cups at any point in the distribution chain, changes affecting interface features, and unapproved intermix of bearing parts of different manufacturers are definitely not recommended (Reference AIR4403A Paragraph .3.2.8).

3.1.11 Sufficient material should be provided in the structure of the wheel to allow for the rework and installation of cup bushings (0.060 in (1.52 mm) minimum wall thickness) or oversize bearing cups. Adequate material should be provided in the nose wheel rim (flange) to allow rework/removal of possible tow bar or arresting cable damage. Adequate material should be allowed in the bead seat and tubewell area to compensate for some allowable corrosion and fretting damage. Recommended tolerances on nominal wheel diameters are specified within the Aircraft Tire & Rim Year Book.

3.1.12 Sealing features of split and lock-ring retained flange tubeless wheels should be designed for protection from handling damage.

3.1.13 Aircraft standard hardware should be used wherever possible, unless aircraft standard hardware will not accommodate design requirements and unique aircraft quality hardware must be used.

3.1.14 Thermal sensitive pressure release devices (fuse plugs) should be located so that they are accessible for removal when the tire is installed on the wheel assembly for commercial applications. Access for military (and some commercial) applications requires tire removal. Fuse plug design should be capable of operation in a fuse plug boss that has been oversized for corrosion removal without requiring an oversize fuse plug. Threaded fuse plugs should be avoided.

3.1.15 Provision should be made for removal of all parts from the basic wheel halves, such as inserts, bearing cups and bushings, to accommodate necessary overhaul operations without damage to the wheel areas around these parts.

3.1.16 As an anticorrosion measure, provision should be made for adequate drainage of the installed wheel so that fluids will not be trapped or held in pockets. Adequate material should be provided to permit rework of areas, which commonly encounter corrosion. The design should include provisions to inhibit galvanic corrosion.

3.1.17 Adequate space should be provided around the bolt heads and nuts to accommodate standard socket wrenches without damaging the finish of adjacent structure due to contact. Adequate material should be provided to allow for corrosion and mechanical damage removal around bolt holes and hole faces and for the installation of bushings for suitable repair. An even number of tie bolts should be considered to allow interface with the most commonly used twin spindle torquing machines.

3.1.18 The wheel should be designed so it can be maintained with commercially available tools, especially tire bead breakers.

3.1.19 The wheel should be of the divided type retained by tie bolt or lock-ring retention to permit tire mounting/dismounting with relative ease. Lock ring retained demountable flange wheels should be considered over tie bolt retained wheels in order to reduce part count and minimize non-destructive inspection requirements/risks.

3.1.20 Large bore inflation valves are desirable. The inflation valve should be located in an accessible location for tire servicing, and adequate clearance for valve extension should be provided to permit the use of standard inflation servicing chucks. Location of the tubeless valve should be such as to permit valve removal without wheel disassembly. Space should be provided for possible installation of a tire pressure gage/fill valve assembly. Over-inflation valves should have a unique sized inlet from the inflation valve inlet to prevent incorrect installation. Inflation valves, pressure gauges, over-inflation valves, etc. (protruding items) should be mounted so they are recessed in the bowl of the wheel half and thus protected from damage during handling of the wheel.

3.1.21 Thread inserts should be provided in tapped holes, or adequate material should be provided to accommodate inserts/slimserts for repair.

3.1.22 The wheel and its components should be designed to prevent the improper assembly of parts. Double countersunk washers should be utilized to prevent improper installation.

3.1.23 Wheel Rotor Drives

3.1.23.1 If wheel drive inserts (drive keys or drive caps) are used, they should be wear resistant coated (Tungsten Carbide Cobalt (WC-Co) or equivalent) and easy to remove. Blind holes should be avoided when attaching drive inserts (keys/caps) to the wheel structure.

3.1.23.2 Wheel drive bars (commonly referred to as beam keys or torque bars) are preferred over drive keys/caps (envelope permitting). Drive bars should be attached to the wheel by aircraft standard fasteners on one end, and the other end should interface with the wheel via a through hole, thus providing for a replaceable repair bushing (with oversize capability). All drive designs should be wear resistant coated (WC-Co or equivalent) and suited for high temperatures.

3.1.24 Provisions should be considered for the installation of a tire pressure indicator. This indicator should be visible after wheel installation and should have sufficient accuracy to indicate whether the tire pressure is within safe operating limits.

3.1.25 The disassembly warning information (i.e., WARNING DEFLATE TIRE BEFORE DISASSEMBLY) presented on the wheel should be easily visible regardless of the orientation of the wheel.

3.1.26 Inboard and outboard wheel halves should be designed to consider machined surfaces in critical areas which can accommodate (automated) ultrasonic/eddy current NDI.

3.1.27 Wheel hubcap attachment should allow for easy removal/installation during wheel/tire change. V-band clamps are a preferred design over threaded fastener attachment.

3.1.28 The wheel, grease seals, and wheel bearings should be designed in such a way that the wheel bearings and grease seals will remain with the wheel assembly upon installation and removal from the aircraft. This will prevent possible bearing and seal contamination.

3.1.29 Synthetic hydrocarbon/lithium complex (non-hygroscopic) wheel bearing grease is preferred over petroleum/clay hygroscopic wheel bearing grease.

3.1.30 If fastener torque values are subject to change they should not be permanently marked on the wheels. In these cases the maintenance manual is the only place torque values should be referenced.

3.1.31 Seals used in the wheel design should be compatible with fluids listed in the maintenance manuals.

3.2 Brakes

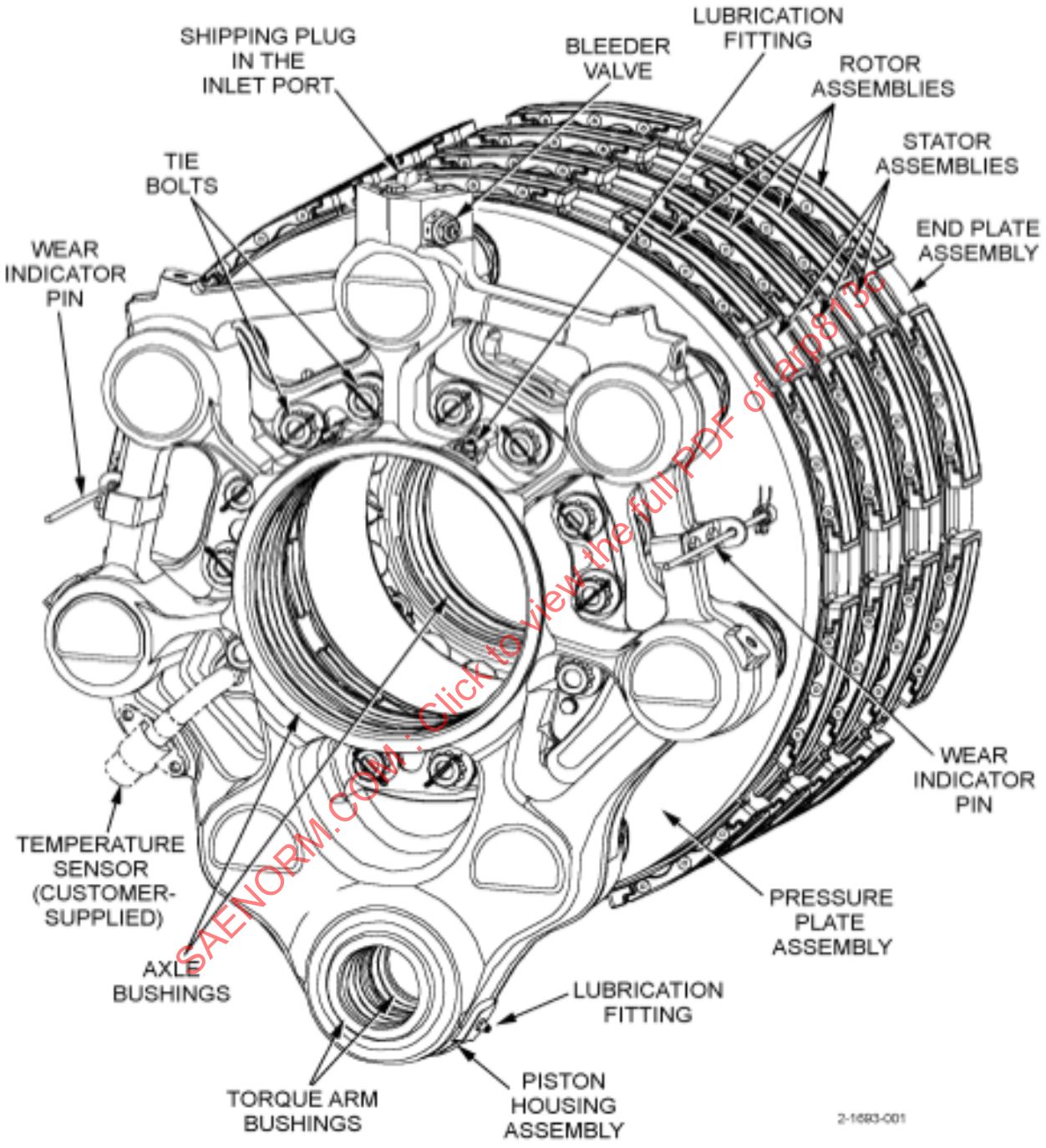

FIGURE 3 - AIRCRAFT HYDRAULICALLY ACTUATED BRAKE NOMENCLATURE