SAE Aerospace
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AEROSPACE RECOMMENDED PRACTICE

SAE ARP1493 REV. A

Issued 1979-07
Revised 1992-08
Reaffirmed 2007-07

Wheel and Brake Design and Test Requirements for Military Aircraft

RATIONALE

This document has been reaffirmed to comply with the SAE 5-Year Review policy.

1. SCOPE:

This document covers military aircraft wheel and brake equipment.

1.1 Purpose:

This document provides recommended practices for the design and testing of wheels and brakes for new design military aircraft. It is intended for use by airframe and military personnel in formulating detail design and performance specifications. It is not intended to be used as a procurement document.

2. REFERENCES:

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AS586 Wheel and Brake (Sand and Permanent Mold) Castings - Minimum Requirements for Aircraft Applications
AS666 Cavity Design and O-ring Selection for Static Seal Use in Aircraft Tubeless Tire Wheels

2.2 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-A-8625
MIL-A-87221
MIL-A-8860
MIL-A-8862
MIL-A-8863

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2.2 (Continued):

MIL-C-25427
MIL-C-83231
MIL-G-5514
MIL-G-83016
MIL-H-5440
MIL-I-6868
MIL-P-23377
MIL-P-25732
MIL-S-8698

MIL-STD-105
MIL-STD-470
MIL-STD-785
MIL-STD-838

MIL-HDBK-275

MS27436
MS27611
MS28775
MS33649

2.3 Definitions:

2.3.1 DESIGN DRAWINGS: The terms "specification control drawing" or "applicable design drawing" referred to in this document will be interpreted as meaning the design drawing prepared by and available from the procuring activity.

2.3.2 NORMAL OPERATING PRESSURE: Normal operating pressure will be interpreted as meaning that pressure or force required to produce an aircraft deceleration in accordance with the procurement document, as determined by an average of pressure measurements in landplane landing design gross weight tests specified in 4.2.7.

2.3.3 NORMAL PARKING PRESSURE: Normal parking pressure will be interpreted as meaning that pressure or force required to lock the wheel at a load equal to the rated static load specified for the wheel at a torque in accordance with that derived in 3.5.6.

2.3.4 MAXIMUM OPERATING PRESSURE: Maximum operating pressure(s) will be interpreted as meaning the maximum pressure(s) which the aircraft system can supply to the brake under design conditions.

2.3.5 WEIGHTS AND SPEEDS: As a minimum, the weight conditions specified in Table 3 and related speeds are defined in the MIL-A-8860 series, MIL-S-8698, or MIL-A-87221 as applicable. For speeds use the following:

TABLE 1

Condition	Brakes On Speed	Aircraft Weight
Normal landing	0.9 V_a	LPLGW
Maximum landing	0.9 V_a	MLGW
Rejected takeoff	1.0 MWLO	MTOGW
Worn brake RTO	0.9 MWLO	MTOGW
Rapid turnaround (if required)		
Landing	0.9 V_a	LPLGW
Taxi In	(1)	LPLGW
Taxi Out	(1)	MTOGW
RTO	0.9 MWLO	MTOGW

where:

V_a = Standard day approach speed for related weight
LPLGW = Landplane landing gross weight
MLGW = Maximum landing gross weight
MWLO = Rational main wheel lift off speed at sea level standard day
MTOGW = Maximum takeoff gross weight
(1) = Brake energy is a function of amount of braking required to oppose the idle thrust and the number of anticipated stops during the taxi phase

In the event more severe design conditions exist, the more severe conditions shall be used.

2.3.6 LOADS: For the purpose of load testing, the following definitions will apply:

a. Limit Load: The maximum load anticipated in all normal conditions of operation as determined by the procuring activity. It should be not less than the load determined by utilizing MIL-A-8860 series specifications, MIL-A-87221, or as defined in the aircraft detail specification.

b. Yield Load: 1.15 times the limit load.

c. Design Ultimate Load: 1.5 times the limit load.

d. Design landing loads will be as determined by the procuring activity in accordance with the load conditions of MIL-A-8862 and MIL-A-8863.

3. REQUIREMENTS:

3.1 Drawings:

3.1.1 Design Proposal Drawings: Design proposal drawings prepared by the wheel and brake manufacturer should include the following:

a. Reference to the applicable specification.

b. Two-view and cross-sectional drawing including definition of the rim flange, brake and wheel mounting, hydraulic installation data, and envelope definition.

c. Material, principal manufacturing process, and finish definition for all major components.

d. Wheel static and dynamic loading conditions, brake energy definitions, separate and combined maximum weights for the wheel and brake assemblies.

e. Brake design parameters including:

(1) Heat sink mass and definition of heat sink components
(2) New and worn
(3) Swept area
(4) Mean radius
(5) Piston area

f. Brake performance predictions including:

(1) Pressure-volume curve defining the pressure to begin brake piston movement
(2) Pressure to cause disk contact
(3) Brake release pressure
(4) Maximum system pressure at full flow to allow for rudder, spoilers, speed brakes, etc.

g. Other technical information required to communicate the design.

3.1.2 Interface Drawing: Component or assembly interface drawings suitable for alternate source procurement shall be the subject of separate contract by specific request.

3.2 Materials:

Unless otherwise specified in the procurement specification, the following materials are commonly used for the major components:

a. Aluminum components: Forged aluminum 2014-T6 or 2014-T61 are suitable alloys for wheel halves and brake housings

3.3 Protective Treatment:

Unless otherwise specified in the procurement specification, aluminum alloy should be anodized in accordance with MIL-A-8625, Type II or III, all over after cold working.

In addition, all exterior surfaces should be painted with one coat of MIL-P-23377 primer and two coats of MIL-C-83231 urethane top coating.

3.4 Detail Design Requirements:

3.4.1 Wheel Design Requirements:

3.4.1.1 Tie Bolts: Wheel tie bolts, where used, should be of the through-type with nuts; no inserts shall be permitted. If chamfered washers are used, they should be chamfered on both sides. Appropriate MS head form bolts should be used. Appropriate thread lubricant and torque values should be specified with appropriate substantiation.

3.4.1.2 Demountable Flange: Demountable flange wheel configuration should be designed in a manner which will prevent the flange and its retaining device from leaving the wheel in case a flat tire occurs while the wheel is rolling. Design consideration should be given to protection against corrosion and fretting.

3.4.1.3 Wheel Fatigue: It is recommended that a system for tracking accumulated wheel usage in service be established. Accordingly, wheels will incorporate time change counters or an alternative concept consistent with the aircraft maintenance philosophy.

3.4.1.4 Lubricant and Lubricant Retainers: Suitable retainers should be provided to prevent lubricant from reaching the braking surface and to prevent foreign material from entering the bearings. The retainers should be removable to allow for cleaning and lubrication of the bearings. Where possible, the wheel bearings should be sealed on a stationary surface. Wheel bearing seals should not be designed to rub on the stationary or permanent portion of the brake housing or strut. Rubbing surface should be on an individual part that is inexpensive to replace so that any wear will not cause condemnation of the brake or strut. Applicable requirements of MIL-STD-838 and MIL-HDBK-275 should be observed. A suitable lubricant shall be specified.

3.4.1.5 Lubrication Fittings: Wheels should not be fitted with pressure type lubrication fittings excepting amphibian and beaching gear applications.

3.4.1.6 Wheel Valve and Boss: Tubeless tire valves should conform to MS27436. The boss which accommodates the valve should be in accordance with MS33649.

3.4.1.7 Overinflation Protection Devices: Overinflation protection devices should be provided unless deleted by the procurement specification. Valve boss should be in accordance with MS33649.

3.4.1.8 Tire Pressure Gages: If used, tire pressure gage should conform to MIL-G-83016. The gage boss should be in accordance with MS33649.

3.4.1.9 Valve Cores: Valve core assemblies should be selected from Tire & Rim Association standards currently in use with the military services.

3.4.1.10 Wheel Mating Seals and Grooves: Seals and grooves should be in accordance with AS666. Standard MIL-P-25732 seal compounds should be used unless the temperature environment exceeds the compound capability.

3.4.1.11 Static Balance: Wheel halves should be statically balanced with asymmetrical or nonsymmetrical components installed or simulated within the limits specified in Figure 1 to the nearest whole ounce-inch. Assembly of the two wheel halves of a split-type wheel assembly in alternate position or assembly of halves of different wheels should not result in unbalance beyond the specified limits. Static balance operations for wheels may be omitted, provided the manufacturer shows by an adequate sampling plan that the unbalance requirement is never exceeded.

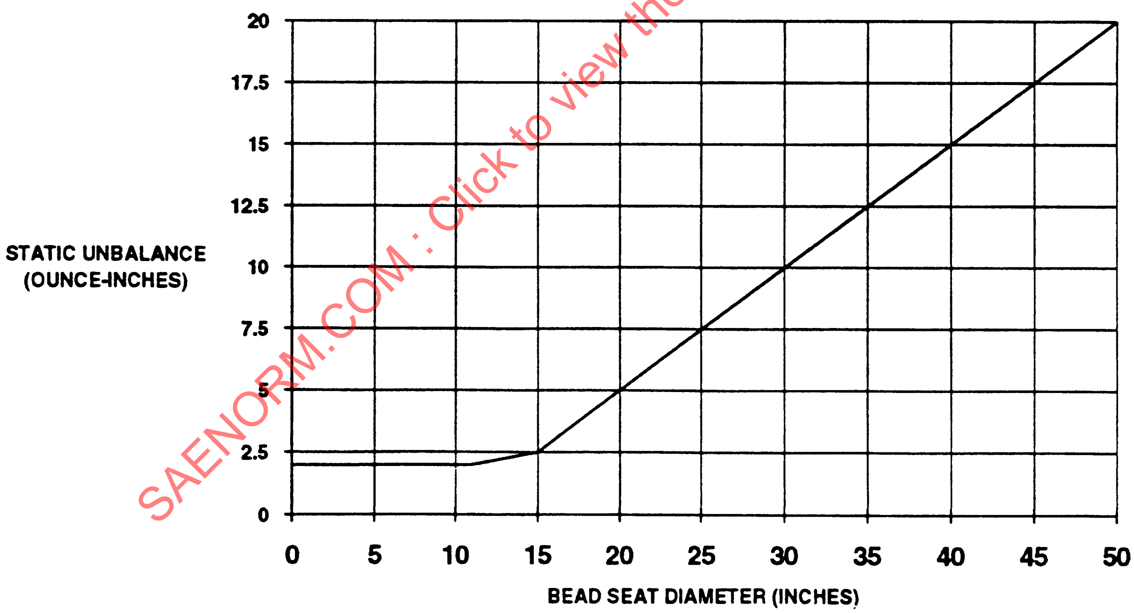

FIGURE 1 - Allowable Static Unbalance

3.4.1.12 Braked Wheel Thermal Sensitive Pressure Release Devices (Fuse Plugs): A minimum of three fuse plugs should be provided and located in the wheel tubewell area approximately equally spaced about the wheel. They should be designed so that tire pressure will be released prior to tire or wheel failure resulting from temperature induced structural degradation. The wheel bead ledge temperature should not be permitted to exceed 400 °F (204 °C) without fuse plug actuation. The fuse plugs should not actuate during tests at maximum landing weight (3 stop, Table 3) (Reference AS707).

3.4.1.13 Wheel Burst Factor: The following wheel burst load factors apply to wheel tests:

TABLE 2

Type Aircraft	Factor Times Rated Inflation Pressure
Land based aircraft	3.5
Carrier based aircraft	4.5
Helicopter	3.0

3.4.1.14 Wheel Safety: Nitrogen inflation is required for safety reasons.

3.4.2 Brake Design Requirements:

3.4.2.1 Seals and Glands: Piston cylinder design should be in accordance with MIL-G-5514 where feasible. MS28775 seals should be used unless the temperature environment exceeds the compound capability, in which case, appropriate seals should be selected. Other configuration seals may be used with prior approval.

3.4.2.2 Wear Indicators: The brake assembly should have wear indicators visible when performing a walkaround inspection with readily identifiable "go-no go" limits without requiring measurement.

3.4.2.3 Automatic Adjusters: Automatic adjusters should be provided to compensate for brake lining wear where needed. Brake assemblies should be designed for the most practical protection of the brake adjusters.

3.4.2.4 Cylinder Liners: Brake cylinder liners should be furnished and should be designed to be replaceable. If aluminum pistons or cylinder liners are used, the surface wiped by dynamic seals should be anodized in accordance with MIL-A-8625, Type III. Helicopters are frequently excepted from this requirement.

3.4.2.5 Inlet and Bleeder Fittings: Brake inlet fittings, threads, and bosses should be in accordance with MIL-H-5440. Brake bleeder valves should conform dimensionally to MS27611 and installed in a boss, inlet fitting, or attaching bolt machined in accordance with MS33649. A threaded steel insert should be provided for inlet bosses in nonferrous brake housings. All fittings should be safetied or suitably locked. Self-sealing couplings, if required by the procurement specification, should conform to MIL-C-25427. As an option, self-sealing, quick-disconnect assemblies may be provided to enable brake assemblies to be bled in the shop rather than on the aircraft, if appropriate to the aircraft maintenance philosophy.

3.4.2.6 Brake Operating Pressure and Release: The brake should be compatible with the full range of operating pressures provided by the aircraft. The brake return mechanism should fully release to the design travel at a pressure not less than 110% of the maximum steady state back pressure as felt by the brake.

3.4.2.7 Operating Media: The brakes should be compatible with the operating media as defined in the procurement specification for the applicable aircraft.

3.4.2.8 Piston Stops: Piston stops should be provided which limit piston travel to prevent venting of hydraulic fluid upon heat sink failure or operation beyond the normal removal condition. The piston stops should allow sufficient piston travel to permit a maximum design gross weight rejected takeoff at the 100% worn brake condition with the maximum operating hydraulic pressure applied. The stops shall be designed for 1.5 times maximum operating pressure without the brake discs installed.

3.4.3 Detail Design Requirements - General: The configuration should be compatible with the total aircraft performance, maintenance, and operational environment. Wheel-brake assembly design should be such as to tolerate external loads and braking action which may be associated with proper performance during brake application while aircraft is steered through a turn. Wheel and brake assemblies should be capable of use on any mounting position on the aircraft. Brake heat sink removal should not be required for wheel removal. Standard fasteners should be used where practical on wheel and brake assemblies.

3.4.3.1 Wheels and brakes should be designed so that they cannot be improperly assembled or improperly installed on the aircraft where practical.

3.4.3.2 Sufficient rework material should be provided to allow rework and repair of base material in areas historically troublesome; i.e., bearing bores, wheel tie bolt bosses, and brake attachment bushings.

3.4.3.3 Special Tools: Special or unusual tools and equipment should not be required for installation, removal, or normal maintenance and inspection of the wheels and brakes unless authorized by the procuring activity.

3.4.3.4 Maintainability: MIL-STD-470 should be used as a design guide.

3.4.3.5 Identification of Product: All markings should be legible and easily read.

3.4.3.5.1 Wheel Marking: Wheels should carry the following information. Integral lettering should be required; nameplates should be used only when specifically approved.

a. Size

b. Serial number on both wheel halves, on demountable flange and wheel body, or, in the case of other designs, on similar major wheel parts

c. Manufacturer's name and/or code and part number

d. Date of manufacture (month and year, which may be combined with the serial number)

3.4.3.5.1 (Continued):

e. All tie-bolt type wheels should carry a warning note to require deflation of the tire before loosening of the tie bolts

f. Tie-bolt type wheels should carry a suitable note to clearly describe the lubrication method and torque values used in tightening the tie bolts

3.4.3.5.2 Brake Marking: Brakes should carry the following information. Stamping or integral lettering is preferred. If nameplates are required, details should be submitted with the drawings of 3.1.1.

a. Manufacturer's name and part number

b. Date of manufacture (month and year, which may be combined with the serial number)

c. Serial number

d. Fluid type

3.4.3.5.3 Location of Marking: When practicable, the part number should be so located as to be readable after assembly of the part in the complete unit.

3.4.3.5.4 Part and Subassembly Marking: Each part and subassembly, except the following, should be marked with the appropriate part or subassembly part numbers:

a. Those which are permanently assembled by welding, brazing, soldering, or riveting. These should carry the subassembly part number.

b. Those which do not have suitable or sufficient surface for the part number.

c. Those upon which marking would impair the function or structural integrity.

3.4.3.5.5 Type of Marking: Marking should be such that they will not be obliterated or effaced as a result of service usage where practical.

3.4.4 Interface Definition for Wheel and Brake Detail Design: The wheel and brake detail specification provided by the procuring activity should define the following interface information together with a statement of the basis for the information, whether analytical, test, or estimated.

3.4.4.1 Tires: The following tire data should be provided, when available:

a. Size designation

b. Tire construction (type)

c. Ply rating

d. Speed rating

e. Load rating

f. Dynamic load - N.W.

g. Rated inflation pressure

h. Load deflection curves (rated deflection)

i. Weight (nominal and maximum)

j. Tire dimensions:

(1) Section width (maximum and minimum)
(2) Outside diameter (maximum and minimum)
(3) Shoulder width (maximum)
(4) Shoulder diameter (maximum)

k. Static loaded radius

l. Flat tire radius

m. Aspect ratio

n. Polar moment of inertia

o. Vertical, lateral, and fore and aft spring rates through bottomed conditions

p. Approximate bottoming load

q. Tread skid depth

r. Wheel dimensions:

(1) Bead ledge width (minimum)
(2) Wheel rim size
(3) Width between flanges
(4) Bead ledge diameter
(5) Flange height

3.4.4.2 Strut-Axle: The following related strut-axle information should be provided:

a. Dimensions

b. Material

c. Finish

d. Load distribution in the axle attachment

e. Deflection with load

f. Fore and aft spring rates

g. Damping

h. Temperature limitations

i. Axle centerline attitude relative to ground line

j. Strength limits

k. Torsional spring rate

3.4.4.3 Hydraulics: The aircraft hydraulic information should be provided as follows:

a. Hydraulic fluid description and temperature limitations

b. Normal and maximum steady state back pressure

c. Hydraulic fitting callout

d. Definition of anti-spin requirements, if used

e. Maximum fluid displacement

f. Maximum pressure rate of application

g. Spike surge definition

h. Parking brake pressure (maximum and minimum)

3.4.4.4 Skid Control System: The following information should be provided, when available:

a. Wheel speed transducer

b. Envelope and mounting information

c. Temperature limitations

3.4.4.4 (Continued):

d. Dynamic pressure ramp rates

e. Concentricity of drive mechanism

f. Wheel speed transducer drive interface requirements

3.4.4.5 Aircraft General: The following general information should be provided:

a. Wheel well temperature profile

b. Orientation on aircraft gear up and gear down

c. Critical g loads during all phases of the operational environment

d. Maximum allowable dimensional envelope

3.5 Capability Requirements:

3.5.1 Performance: The wheels and brakes should satisfy the test requirements specified in Section 4.

3.5.2 Reliability: Satisfactory completion of all applicable tests in Section 4 should constitute demonstration of compliance with MIL-STD-785.

3.5.3 Maintainability: MIL-STD-470 should be used as a design guide. The requirements must be consistent with the system program requirements. Quantitative task allotments should be identified.

3.5.4 Braking Capacity: The brake energy absorption capacity of the installed wheel and brake assembly should be defined in the detailed specification and should consider all aspects of the aircraft detail specification and anticipated realistic operational requirements. It is recommended that the design service life and the design usage be based on the mission requirements with due consideration of the following factors:

a. Total number of flights

b. Total number and type of landings

c. Total service years

d. Mission mix or number of flights of each mission

e. Any other special requirements, such as functional check flights, ground maintenance operational checks, etc.

f. Special operations, such as quick turnaround

Unless otherwise specified, the brake should be designed to provide the number of dynamometer stops defined in Tables 3 and 4. Separate heat sinks are used for Table 3 and Table 4 testing.

TABLE 3 - Wheel Brake Capacity Requirements

Type of Aircraft	No. of Dynamometer Stops	Average Rate of Deceleration /1/ (ft/s/s)	Aircraft Weight Condition	Energy Credit /2/ Reversed Propeller or Engine Thrust	Energy Credit /2/ Drag Parachute
1. Rotary wing	20 1	6 8.8	Basic design gross Maximum landing gross	Not applicable No	Not applicable No
2. Research and other types not listed	As specified by the procuring activity	As specified by the procuring activity	As specified by the procuring activity	As specified by the procuring activity	As specified by the procuring activity
3. Land and carrier based:					
Fixed wing	30 /3/	10	Landplane landing design gross	Yes /4/	Yes /4/
	3 /3/	10	Maximum landing gross	No	Yes /4/
	1 /6/	10	Maximum landing gross or takeoff gross	No	No
			Maximum (RTO) /5/	No	Yes

/1/ Aircraft deceleration and dynamometer deceleration should be consistent with the approved brake energy analysis.
/2/ The amount of energy credit should be approved by the procuring activity in each instance.
/3/ The 30-3 dynamic torque sequence shall be conducted with 3 sequences of 10 landplane landing design gross weight (normal energy) stops followed by one maximum landing gross weight (overload energy) stop.
/4/ If used in standard landing procedure.
/5/ Test to whichever condition is the more critical.
/6/ A new heat sink should be used for the RTO stop. For steel and carbon brake designs, the brake may be conditioned prior to the RTO demonstration by three 50% landplane landing design energy break-in stops (30 stop).

7. The calculations for Table 3 capacity requirements should represent the worst situation as they affect overall sizing of the brakes.
8. Maximum operating pressure will be applied to the brake assembly and released prior to each of the 30-3-1 stop demonstrations.
9. Success criteria:
    a. 30-3 Sequence:
        (1) KE absorption
        (2) Torque pressure relationship
        (3) No failed parts permitted
        (4) No malfunctions
        (5) No lining fusing
        (6) Fuse plugs must not activate
        (7) Thermal limits applicable
        (8) Stop distance
    b. RTO Test:
        (1) KE absorption
        (2) Stop distance
        (3) Brake torque pressure relationship
        (4) No malfunctioning
        (5) Fuse plug activation, if temperature limits are exceeded
        (6) Thermal limits as applicable

TABLE 4 - Wheel Brake Field Service Life Spectrum

Applicable to all land and carrier based type aircraft listed on Line 3 of Table 3. All conditions are to represent average expected operational aircraft in service.

Brake Stop Description	Typical Field Service Landing	Short Field Landing	Overweight Landing /3/	Aborted Mission
Kinetic energy (ft-lb)				
Deceleration (ft/s/s)				
Tire load (lb)				
Brake on velocity (kts)				
Flywheel inertia equivalent (lb)				
Taxi distance at 30 knots (ft)	7500 before and after stop	3000 before and after stop	7500 before and after stop	3000 before stop
Number of 30 knot stops during taxi (one of which is to be at maximum effort)	2 before and after stop	2 before and after stop	2 before and after stop	2 before stop
Number of stops and sequence of stops at each condition (read left to right and top to bottom)	5 5 20 60 5 /1/ 5	- 1 1 - - -	1 - - 3 1 -	- - - - - 1 /2/
TOTAL	100	2	5	1

/1/ Using wear data obtained, calculate the safe removal point in aircraft service. At this point, rework the stack of heat sink members and/or linings such that the minimum thickness remains for the final 12-stop demonstration.

/2/ The worn brake RTO stop is conducted to determine the aborted mission KE capacity of a worn brake and to demonstrate the ability of the brake to complete an aborted mission stop to reasonable conditions. See Note 4.

/3/ Maximum energy landing.

4. For Table 4, the analysis is to be based on realistic average conditions expected to be experienced in service usage of the aircraft.
5. The brake drag and energy absorbed during taxi should be consistent with the operational environment defined for the specific aircraft. Cooling air of 30 knots may be used during all taxis. Taxi snubs during rolling may be specified if applicable to the aircraft system.
6. Extrapolate wear data achieved as testing proceeds to judge the conformity of performance to the design goal.
7. Maximum operating pressure will be applied to the brake assembly and released prior to each of the 108 stop demonstrations.
8. Success criteria:
   a. Wear within limits
   b. No detrimental brake drag
   c. No detrimental component distortion
   d. Torque pressure relationship specified
   e. Thermal limits if applicable
   f. No failed parts
   g. No binding
   h. No malfunctioning
   i. Stop distance achieved

3.5.4 (Continued):

Testing to Table 3 is intended to cover capacity requirements, principally for sizing and performance limits, including safety of flight. Table 4 is intended to represent durability requirements under realistic average operating conditions in actual service.

3.5.4.1 Landing and Takeoff Brake Capacity Analysis: The design brake energy should be the result of a rational aircraft and aircraft operational analysis and should be approved by the procuring activity. For the analysis, the following criteria should apply unless stated otherwise: On the landplane landing, maximum landing and rejected takeoff conditions, the brakes should be applied to a torque level associated with the effectively available dry concrete tire-friction level. The ground velocity of brake application should be as defined in 5.3.5. The service energy condition will be defined from the average service landing weight, landing rollout, and braking techniques anticipated for the aircraft. The landplane landing, maximum landing, and maximum takeoff weights should be as defined in MIL-A-8860 or MIL-A-87221.

3.5.4.2 Operational Energy Analysis: An aircraft operational energy analysis should be performed which considers the total operational environment required of the aircraft. The results of the analysis should be approved by the procuring activity and reflected in the brake test program.

3.5.4.2.1 Turnaround Capacity: In the event a mission turnaround requirement is placed upon the total aircraft system, a special brake dynamic torque test sequence should be conducted demonstrating the required capability. The test sequence should be subject to the approval of the government procuring activity.

3.5.4.3 Additional Testing: Consideration should be given to conducting special tests during the development program to evaluate the following to establish operating limits:

a. Hot brake parking - kinetic energy limit

b. Structural functional integrity or metal creep after heat exposure and parking

c. Fuse plug actuation and energy limits

d. Dynamic compatibility with support structure

e. Dynamic compatibility with antiskid control system

3.5.5 Wheel Capacity: The load capacity of each landing wheel on an aircraft should be equal to or greater than the maximum load that the wheel will be subject to at maximum towing or taxiing design gross weight of the aircraft. Additionally, nose wheels should carry a dynamic rating equivalent to the actual maximum dynamic load for the condition of load shifting onto the nose gear during braking. In cases where auxiliary wheels do not normally support static loads (as in wingtip protection wheels), the wheel capacity will be determined by the procuring activity, based on appropriate dynamic loading calculations. A complete static and dynamic analysis of the main and auxiliary wheel loads should be made by the aircraft manufacturer. From this analysis a loading spectrum should be prepared.

3.5.6 Compatibility Requirements: Wheel and brake assemblies should be subjected to laboratory tests for the purpose of proving compatibility of the wheel and brake assembly with the airplane brake system. Dynamometer stops should be performed at normal braking energy levels with the brakes actuated by a system simulating a pilot's commands through the airplane's braking system, including any skid control provisions. Additionally, a torque requirement analysis should be performed which considers wet and dry brake static and dynamic torque requirements of the brake assembly during the expected operational aircraft environment. The results of the analysis should produce the brake pressure torque requirements definition in the procurement specification and should be demonstrated during qualification testing.

These compatibility tests should be designed to accumulate evidence that:

a. The overall brake system has characteristics that permit the pilot to safely control the airplane's velocity during ground operations.

b. The individual system components function as required to achieve overall system performance.

c. The durability or structural integrity on any individual brake system component is not impaired by operating under simulated braking conditions and that the system components fit together and function as required, including laboratory test axles which simulate the structural deflection characteristics of the aircraft axle.

3.5.7 Environment: The wheel and brake equipment should be compatible with the intended air vehicle environmental requirements.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Product Verification:

Product verification of design and performance requirements may be made by analysis, demonstration, similarity, or by tests.

4.1.1 Stress Analysis: The manufacturer should prepare a stress analysis covering the wheel and brake assembly. All static and fatigue loads should be analyzed and margins of safety noted for critical parts.

4.2 Test Methods:

4.2.1 Radial Load Test: This test should be performed by applying the radial load to the wheel through a tire of proper size and fit inflated to an initial pressure equal to the rated inflation pressure (or as specified in the procuring document for shipboard operations). Either air or water inflation may be used. If the tire is filled with water, the water should be bled off during loading to approximate the same tire deflection that would result if air inflation were used, and the inflation pressure should not exceed the pressure at maximum tire deflection. The load should be applied to the wheel and perpendicular to the axle centerline by means of an axle passing through the hub. The tire should be loaded directly against a flat, nondeflecting surface. Deflection and permanent set readings should be taken at suitable points on the wheel to indicate deflections of the wheel rim at the bead seat, hubs, and other critical areas. Wheels intended for tubeless tire mounting should be so tested with said mountings unless otherwise specified. If the radial load component of the combined load test exceeds the radial load test requirement, then the radial load test may be omitted. The required radial load tests are specified below.

4.2.1.1 Yield Radial Load Test: The wheel should support the yield radial load for 10 s when applied consecutively at 90°, 180°, and 270°, followed by three more load applications at the 0° position with brake assembly or a suitable simulation installed. The 0° position should be the most critical load contact point which should normally include the valve hole. The 90° increments may be altered when structural conditions indicate. The successive loadings at the 0° position should not cause radial permanent set increments of increasing magnitude. The permanent set increment caused by the last loading (at the 0° position) should not exceed 5% (or .005 in (.127 mm) whichever is greater) of the total deflection caused by the last loading. There should be no yielding of the wheel such as would result in loose bearing cups, air leakage, or interference in any critical clearance areas. The bearing cups and cones and rollers should be used for this test.

4.2.1.2 Ultimate Radial Load Test: The ultimate load should be applied at the 0° position of the same wheel on which the yield radial loads were applied. The wheel should support the ultimate load for 10 s after which there should be no cracks in any areas. The bearing cones may be replaced with conical bushings, but the cups should be used. If desired, a tubeless tire may be replaced with tire and tube.

4.2.2 Design Landing Radial Load Test: The load should be applied in the same manner as described in 4.2.1. The load should be supported for not less than 10 s, and the resulting permanent set should not produce loose bearing cups, air leakage, interference in critical running areas, or make the wheel unsuitable for further service. The tire inflation pressure should be the maximum design operating pressure for the condition being simulated. For Navy aircraft intended for shipboard use, the wheel should be loaded for this test condition through 1-3/8 in (35 mm) diameter cable or steel bar that simulates statically the wheel design landing load plus the load imposed rolling over or landing on a 1-3/8 in (35 mm) diameter cable. If a cable is used, the specimen should be at least 3 ft (914 mm) long with ends secured to prevent looseness. Unless otherwise specified by the procuring activity, the wheel should be loaded perpendicular to the axle centerline.

4.2.3 Combined Load Test: The combined load test should be performed by applying the load to the wheel through a tire inflated to an initial pressure equal to the rated inflation pressure or the carrier design operating pressure. Air or water inflation pressure may be used. If the tire is filled with water, the water should be bled off during loading to approximate the same tire deflection that would result if air inflation were used, and inflation should not exceed the pressure at maximum tire deflection. Yield loads should be applied in both inboard and outboard directions on the same wheel and at the ground angle and magnitude determined by the airframe manufacturer in accordance with applicable specifications. The wheel and tire assembly should be mounted on an axle passing through the hub. The tire should be loaded directly against a flat, nondeflecting surface so that the combined load is as ascertained above. The loads should be applied simultaneously, either continuously or in increments of approximately 10% of the specified values. Readings should be taken at suitable points on the wheel to indicate deflections and permanent sets. The required combined load tests are specified below.

For the yield and ultimate combined load tests, it is permissible to limit the tire deflection to that deflection achieved under limit load conditions of vertical and lateral loads by use of load transfer blocks (saddle type) which bear directly on wheel rim structure. Another alternative, where justifiable, is the use of tire inflation exceeding the aforementioned values.

4.2.3.1 Yield Combined Load Test: The wheel should support the components of the yield combined load applied consecutively at 90°, 180°, and 270°, followed by three more load applications at the 0° position with brake assembly or a suitable simulation installed. Each load application should be sustained for a minimum of 10 s. The 0° position should be the most critical load contact point which should normally include the valve hole. The 90° increments may be altered when structural conditions dictate. The successive loadings at the 0° position should not cause permanent set increments of increasing magnitude. There should be no yielding of the wheel such as would result in loose bearing cups, air leakage through the wheel or past the wheel seal, or interference in any critical clearance areas. The bearing cups and cones and rollers should be used for this test. A conventional tire and tube may be used when testing a tubeless wheel only when it has been demonstrated that pressure will be lost due to the inability of the tire bead to remain properly positioned when under load.

4.2.3.2 Wheel-Brake Interference: For wheel assemblies used in conjunction with brakes, the yield load test of 4.2.1.1, 4.2.2, and 4.2.3.1 must be run with the brake assembly or a suitable simulation installed, and it should be determined that no interference exists.

4.2.3.3 Ultimate Combined Load Test: The ultimate combined load should be applied at the 0° position of the same wheel on which the respective yield combined load tests were performed. The ultimate load should be sustained for a minimum of 10 s after which there should be no cracks in any area. The wheel should be loaded in the most critical direction. The bearing cones may be replaced with conical bushings, but the cups should be used. Tubeless tire mountings may be replaced with a tire and tube.

4.2.4 Burst Test: The burst test load should be applied to the wheel by means of hydrostatic pressure in the tire. A tire and tube may be used when testing a tubeless tire wheel by adding the necessary valve hole to the test article. Wheels of land-based aircraft should be tested to a burst pressure of 3.5 times the rated tire pressure, at the rated static load of the wheel or the burst strength of the tire, whichever is least. Wheels of carrier-based aircraft should be tested to 4.5 times the rated tire pressure or to the burst strength of the tire, whichever is least. Helicopter wheels should be tested to a burst pressure producing not less than 3.0 times the axial load which results from the tire pressure required for the static wheel load at the taxi gross weight. Alternate specifications may be specified by the procuring activity. Overinflation devices may be removed or isolated.

4.2.5 Roll Test: The roll test should consist of a series of landings or a continuous roll of the wheel assembly against a rotating road wheel. Roll tests should be performed with tires having the same size and ply rating and construction (bias or radial) as will be installed for aircraft usage. Tubeless tires should be used when testing tubeless wheels. Roll test tire inflation pressure should be the flat-surface inflation, as specified by the procuring activity, applicable to the loading condition imposed. For each loading condition, the roll test tire inflation pressure should be constant. All tire test pressures, road wheel sizes, and mileage should be reported in the qualification test report. Roll tests should be performed in accordance with the following procedures and conditions and should not result in cracks or other evidence of failure. Final inspection should be made with all hardware removed from the structural components.

a. Thermal Conditioning: Prior to roll testing, all wheels utilizing shot peening, roll burnishing, or other cold-working processes should have been subjected to thermal conditioning equivalent to the cumulative temperature-time history resulting from brake heat dissipation experienced during the dynamic torque tests of 4.2.7 except for the rejected takeoff condition. Thermal conditioning may be accomplished by performing dynamic torque testing, by simulation of the thermal distribution in the wheel utilizing a simulated brake heat sink to produce the same temperatures encountered during the dynamic torque testing, or by a suitable oven heat soak.

b. Stress Measurement: The stresses in the bead seat or other areas affected by the tire should be measured for each loading condition and for each test inflation pressure which is utilized. The stress measurements shall be reported in the qualification test report. Any change in the tire supplier, construction, or ply rating should require retest of wheel or generation of a suitable comparative stress analysis.

4.2.5 (Continued):

c. Minimum Roll Distance: The applied loading conditions and roll distances will be supplied by the procuring activity. The minimum requirement should be 3000 miles (4800 km) at loads encountered on the aircraft at maximum taxi gross weight.

(1) A suitable portion of the roll test should be conducted at the static rated capacity. A minimum combined load roll of 75 miles (121 km) in each direction should be conducted with combined radial and side loads corresponding to those produced by a .20 g turn at maximum design gross weight.

(2) Helicopter wheels are not subject to the loading conditions in (1) above unless specified in the detail specification. Instead, helicopter wheels should be rolled 250 miles (400 km) minimum with an applied radial load not less than the static wheel reaction based on helicopter maximum taxi gross weight.

(3) Wheels for carrier-based aircraft should be subjected to a roll test which simulates catapult takeoff loads. The conditions for this test should be proposed by the aircraft manufacturer and approved by the Naval Air Systems Command.

(4) Fifth percent of the straight roll portion of the roll test for carrier-based aircraft wheels should be conducted with the tire inflated to the pressure required for shipboard operation.

(5) As part of the roll test, conduct a 50-mile straight roll test at rated load with 90% recommended tie-bolt torque.

d. Extended Roll Test: Upon completion of the minimum roll requirement, the roll test conditions should be repeated until wheel failure occurs. Tie bolt or bearing failure after the minimum portion of the test has been completed will not be construed as wheel failure. The roll to failure portion of this test may be concluded prior to failure provided a total roll test distance of 6000 miles has been obtained on the test wheel. The qualification test report should be amended to include these data.

e. Alternate Tests: When specified by the procurement document, alternate test arrangements representing combined loads or spectrum tests may be required.

4.2.6 Tubeless Wheel Pressure Test:

4.2.6.1 Dynamic Pressure Test: The tubeless tire, whose growth has stabilized and wheel assembly should be rolled under the load specified by the straight roll test (4.2.5) for 25 miles (40 km) with no pressure drop greater than 5% or 5 psi, whichever is less. Mileage accumulated during this test may be used in computing the total mileage in the roll test.

4.2.7 Dynamic Torque Test: The dynamic torque tests should be in accordance with the conditions outlined on the applicable specification drawing or in the procurement specification. Unless otherwise specified, the number of stops should be as specified in Section 3. The wheel and brake should successfully complete the test sequence defined in Tables 3 and 4. Table 3 testing is fundamentally for the purpose of establishing braking capacity and performance capability. Table 4 testing is a demonstration of field service life. Success criteria listed on Tables 3 and 4 apply.

a. Break Wear Characterization: Brake wear data from each of the significant test conditions is to be extrapolated and a curve plotted relating brake life for the various energy conditions represented. Tubeless tires shall be used where applicable.

During these tests, the brake assembly may be disassembled to enhance learning during development-qualification testing. Parts may not be changed or removed except as noted at the beginning of taxiing per Table 4. The brake may have the lining dust removed by the use of an air hose or equivalent with the wheel removed. When the wheel assembly is reinstalled, the brake rotating disk must be placed in the same position and in relationship with the other disks and wheel disk drive keys as they were when the wheel was removed. After completion of the test, all parts should be cleaned and inspected for defects. No parts should have cracked during these tests to the extent of compromising the structural integrity during the 20 or 30-3 stop condition of Table 3, or the first 102 stop conditions of Table 4. If cracks or defects are present, an analysis should be performed to determine the origin and cause of the defect and the potential effect of continued service. Tubeless tires should be used when testing tubeless wheels. The tire should be the same size and ply rating and construction type as the aircraft installed tire. The dynamic torque tests should be in accordance with the following procedure:

a. Test to design requirements as furnished by the airframe manufacturer.

b. A flywheel weight should be selected which provides an inertia equivalent approximately equal to, but not less than, the effective mass of aircraft per brake based on the rational analysis of 3.5.4.1. The inertia equivalent should not exceed the desired mass by more than 10% or 100 lb, whichever is greater. Energy and drag forces caused by auxiliary braking means such as aerodynamic drag, reversed thrust, and drag chutes may be accommodated by adjusting the inertia downward from the actual aircraft mass. In any cases where residual engine thrust exceeds these auxiliary braking forces, added inertia is to be used. For testing in accordance with Table 3, the energy credit is disallowed in certain cases. The inertia adjustments mentioned above do not apply in such cases.

c. The flywheel speed at application of the brake should be determined as that peripheral speed which, under the chosen flywheel weight, will give the required kinetic energy. Brake application speed shall be the actual speed when using electrical simulation dynamometer.

4.2.7 (Continued):

d. The following should be accomplished: Bring the flywheel to the proper velocity, land the test wheel, apply the prescribed load, apply brake pressure, and bring the test unit to a complete stop. The design specification will identify the required stop time and/or stop distance. The average stop time or distance for any five consecutive landplane landing weight stops should be equal to the correct stop time or distance for the test condition. All stops which fail to meet the minimum required performance must be compensated by a comparable increase in deceleration within the next five stops. Alternately, added testing, which satisfactorily demonstrates the capability of the brake to produce the deceleration required, may be accomplished.

e. During the dynamic torque test, the brake pressures required to develop static torque suitable to comply with the torque compatibility analysis (3.5.6) should be determined under the following conditions:

(1) With brake at room temperature, approximately 70 °F (21 °C)

(2) With brake heated by a landplane landing design gross weight energy stop and with static torque test applied as soon as possible after completion of that stop consistent with safety precautions that must be taken

(3) At less than 10%, at 50% approximately, and again after 90% of the number of stops required by Table 4, or as otherwise specified by the procuring activity. (This test may be conducted by applying a tangential force at the static radius of the tire.)

(4) If carbon composite or other water absorbing material is used as brake lining material and aircraft is designated for shipboard operation, the following additional test should be performed:

0.5 gal (1892 ml) of water should be sprayed into heat sink cavity of the brake. The brake should be able to produce a static torque equivalent to parking a maximum gross weight airplane in any orientation on a 10° slope without movement. The hydraulic pressure for this test should contribute to establishing the emergency braking pressure for the airplane.

f. During the dynamic torque test, the following data should be recorded:

(1) Weight and description of wheel, brake, and tire used

(2) Flywheel diameter, inertia equivalent, speeds, and kinetic energies

4.2.7 (Continued):

(3) The test facility should obtain time-temperature relationships of the following components for the conditions noted and present the data in the formal qualification test report:

(a) Hydraulic fluid

(b) Wheel adjacent to the fuse plug (if incorporated)

(c) Bead ledge above each brake

(d) Other critical components

(e) Axle

(f) Brake heat sink

Temperature recordings should continue until the hottest portion has cooled to 300 °F (149 °C). Temperature limits of the bead ledge should not be in excess of 350 °F (177 °C) for maximum landing condition of Table 3 unless otherwise defined in the applicable specification document. A minimum of three design landing stops, and the critical one stop test should be conducted without accelerated cooling after conclusion of the stop. Park the brake with parking pressure, if applicable, and record temperatures of the bead seat, disks, and fluid until temperature peaks are reached without cooling air after a typical field service landing and an overweight landing of Table 4. Accelerated air cooling on other stops may be employed after the above-noted components have attained their peak temperature. Cooling air may be used to simulate taxi conditions. Three additional landing stops should be monitored with accelerated cooling, if used. Accelerated cooling procedures should be described. When cooling fans are used, the time of cooling, ambient temperature, and velocity at the test brake should be noted in the test report.

(4) Wheel load

(5) Brake operating pressure (or force) for each stop, based on distance

(6) Average dynamic torque for each stop, based on distance

(7) Stopping time and distance for each stop

(8) Static torque information

(9) Fluid displacement for new brake and brake worn to maximum allowable clearance at room temperature for each wear condition

(10) Tangential force at circumference of tire required to rotate wheel, with brake pressure released to back pressure after completion of every fifth stop of Table 4.

4.2.7 (Continued):

(11) Time required for wheel, brake, and tire assembly, landed against flywheel, to stop flywheel from an initial landing speed of 30 mph. This observation should be made after every fifth stop of Table 4 with back pressure applied except that it may be omitted when no noticeable brake drag is present.

(12) Brake operating clearance prior to test and at least four times during the test of Table 4.

(13) The thickness of the lining of each of lined disks and the thickness of each unlined disk at the beginning and at the end of the normal energy stops (including "3" stop or overload conditions where applicable)

(14) The number of missions to wear out a brake should be estimated by measuring the average wear from Table 4 testing and prorating this wear to the fully worn condition using data from the disk and/or lining with the least usable friction material remaining at the time of the measurement. This wear position will be consistent with the wear pin indicator setting and should be such that the aborted mission stop capability remains in the brake.

(15) Time after stop to fuse plug release and energy level of stop

(16) Ability of tubeless tire wheels to retain pressure satisfactorily under braking conditions.

(17) Any other information that will be of assistance to ultimate users of the wheel and brake assembly

g. Real time data traces should be made during the dynamic torque test, recording the following for each run for submission with the test report:

(1) Flywheel velocity

(2) Test wheel velocity

(3) Brake torque

(4) Brake pressure at the brake port

4.2.7.1 Safe Brake Service Removal Point: Unless otherwise specified, the brake assembly should have a useful service life on the aircraft until the wear indicator device has a 100% worn indication. The 100% worn point should be such that an aborted mission stop per Table 4 can be performed by the brake assembly as demonstrated by a suitable laboratory test. The laboratory test specimen should be worn to the 100% worn indicator point by aircraft, laboratory, by machining or combinations thereof as approved by the procuring activity prior to demonstrating the worn brake stop of Table 4.

4.2.8 Lining Fusion Test: A dynamic test should be conducted to show that no lining fusion or welding will occur over the full operational range of the brake up to and including the three-stop condition. The test procedure should be subject to approval of the procuring activity. (Not applicable to brakes having carbon-carbon heat sink materials.)

4.2.9 Turnaround Dynamic Torque Test: Unless otherwise specified, the wheel-brake-tire assembly turnaround capacity should be sufficient to provide the aircraft with a typical service landing, a 30 knot 2 mile (3.2 km) taxi-in, a 15 min hold, a 2 mile (3.2 km) taxi out, and abort capability to the maximum landing design energy condition. Thirty knot cooling air may be utilized for the landing stop, taxi, and abort portions of the turnaround demonstration. The turnaround capability should be laboratory demonstrated on a 90 to 100% worn brake assembly.

4.2.10 Compatibility Tests: Suitable compatibility tests should be conducted reflecting the results of the analysis and the requirements of 3.5.6 herein and which are reflected in the detailed specification.

4.2.11 Structural Torque Test: The brake should be actuated at the maximum operating pressure. Tangential load should then be applied at the static radius of the tire until the applied tangential load equals 1.2 times (1.0 for helicopters) the maximum rated static load of the wheel. The friction surfaces of the brake may be bolted or clamped together or otherwise restrained to withstand the required tangential load of 1.2 times (1.0 for helicopters) the maximum rated static load of the wheel. The wheel and brake should withstand the structural torque test without failure for 3 s. In the case of a structural carbon brake, the structural torque test will be conducted on a 100% worn brake as defined in 4.2.7.1.

This configuration may be achieved by machining the test specimen to the worn dimensions. Data will be obtained using 1.5 maximum operating pressure to a torque level resulting in slippage or failure, whichever comes first. In the event the tangential load does not achieve 1.2 times the maximum static rating of the wheel, the carbon heat sink members may be restrained and the test reconducted to achieve 1.2 times the static wheel load tangential load.

4.2.11.1 Co-rotating Wheels: Co-rotating wheels should also be tested to verify the structural integrity of the co-rotating feature. They should be subjected to a tangential load of 1.2 times maximum rated load of the wheel applied at the static radius of the tire. There should be no evidence of failure as a result of this test.

4.2.12 Overpressure Test: For structural evaluation the brake should be parked for a period of 5 min with an applied operating pressure equal to twice the maximum operating pressure. The test should be conducted with linings and heat sink having thickness comparable to the maximum permissible wear. There should be no leakage or failure during this test.

4.2.13 Endurance: The hydraulic brake should be subjected to 100 000 cycles (50 000 for helicopters) of application and release of pressure equal to normal operating pressure or parking pressure, whichever is greater, and 5000 cycles (2500 for helicopters) at a pressure equivalent to the maximum operating pressure. This test should be conducted using a minimum clearance equivalent to the minimum clearance allowable between adjustments. The first portion of the test may be divided into four parts so that 25 000 cycles (12 500 for helicopters) may be applied at each of four positions of brake piston travel conforming to 25%, 50%, 75%, and 100% travel, respectively. The rate of cycling should be no greater than 30 cpm. During and at conclusion of the test, the leakage rate should be limited as specified in 4.3.3.1.2, and there should be no evidence of other malfunction. Alternate endurance tests may be used upon written authorization of the procuring activity.

4.2.13.1 Brake Return Pressure: Tests should be conducted before and after the endurance tests (4.2.13) to determine the minimum hydraulic pressure to bring the braking surfaces into contact. Tests should likewise be conducted to determine the minimum pressure or force at which the braking surfaces disengage on release of pressure. The tests should be conducted with the brake mounted on a horizontal axle with the wheel assembled. The braking surfaces should disengage on release of pressure at all pressures below that specified on the applicable design drawing.

4.2.13.2 Impulse Cycling: The brake housing should be subjected to 200 000 cycles from 0.35 to 1.35 times the maximum operating pressure at a maximum cycling rate consistent with achieving the required pressure levels. The test should be performed with the piston travel at the most critical setting. There should be no evidence of failure in the housing as a result of this test.

4.2.14 Extreme Temperature Test:

4.2.14.1 Aging and Heat Test: The brake, filled with operating fluid, should be subjected for 7 days to a temperature of 225 °F (107 °C) for MS seals or better, or higher temperature as required by the particular application other than 3-stop maximum landing conditions. With the brake and operating fluid being maintained at this temperature, the brake should be cycled 1000 times at normal operating pressure followed immediately by 25 cycles at maximum operating pressure. Leakage rate should be limited as specified in 4.3.3.1.2. Where warranted, deviation from the aging temperature and the time specified above may be granted upon presentation of substantiating data to the activity responsible for approval.

4.2.14.2 Cold Test: Upon completion of the aging heat test (4.2.14.1), the brake, filled with operating fluid under atmospheric pressure, should be subjected to a temperature of -65 °F (-54 °C) for a period of 72 h. There should be no leakage during this period. With the brake and operating fluid being maintained at this temperature, the brake should be cycled 25 times at normal operating pressure followed immediately by five cycles at maximum operating pressure. The brake clearance should be checked between each cycle at maximum operating pressure to insure that the brake releases completely. The time required for the brake to release completely should be noted. Leakage rate should not exceed one drop for 3 in of seal. Upon completion of the cold test, the brake should satisfactorily pass the static and dynamic leakage test as specified in 4.3.3.1.1 and 4.3.3.1.2.

4.2.15 Special Test Requirements: Special design and test requirements as specified by the procuring activity may supersede the above. The inclusion of any auxiliary feature in the wheel or brake design, such as a tire pressure control system or a safety overpressurization prevention relief valve, should require a formal demonstration, and the procedure and results must be approved in writing by the responsible government procuring activity.

4.2.16 Service Test: The right is reserved to require suitable service tests of wheels, brakes, or wheel-brake assemblies prior to granting of approval. This test will consist of a series of flight tests or taxi tests with the equipment installed on the aircraft for which it was designed.

4.2.17 Safety of Flight Tests: The following level of successful testing should be completed before the wheel or brake equipment or the wheel-brake assembly is considered safe to release for flight test:

a. Wheels:

(1) All static load tests (4.2.1 and 4.2.3)

(2) Burst test (4.2.4)

(3) 30% of the required roll test (4.2.5)

b. Brakes:

(1) Satisfactory completion of the testing defined in Table 3, plus 60% of the endurance test, 90% of structural torque test, and full completion of the static pressure test.

4.3 Quality Conformance Tests:

4.3.1 Tests of Materials and Parts: Materials and parts used in the manufacture of wheels and brakes should be subjected to the following tests when required or specified:

a. Examination of Product: A suitable examination of products should be generated during the qualification program. The parts used for qualification tests are to be representative of production parts.

b. Materials Test:

(1) X-ray Control: Aluminum and magnesium alloy castings should have X-ray control in accordance with AS586.

(2) Penetrant Inspection: Unless otherwise authorized by the procuring activity, penetrant inspection should be in accordance with MIL-I-6866.

(3) Magnetic Inspection: All magnetizable highly stressed parts of wheels and brake assemblies should be subjected to magnetic inspection in accordance with MIL-I-6868.

(4) Forging Inspection: Inspection should be in accordance with the applicable material specification.