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SUPERSEDING
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29 May 1963

MILITARY SPECIFICATION

BRAKE SYSTEMS, WHEEL, AIRCRAFT, DESIGN OF

This specification is mandatory for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the brake system design requirements for aircraft equipped with wheel-type landing gear.

* 1.2 Classification. The brake systems shall be either hydraulic or pneumatic; manually operated, power operated, manual-power operated; and shall be of the following types:

Type I - Manual pressure generating: The control unit generates pressure by manual actuation.

Type II - Power pressure generating: The control unit meters pressure from a power generating system.

Type III - Manual power pressure generating: Pressure is manually generated in a slave control unit which in turn operates the main control unit which meters fluid from a pressure generating system.

Type IV - Power-boosted manual pressure generating: The control unit generates pressure by manual actuation and, in addition, the manually generated pressure is boosted by pressure from a power generating system.

Type V - Power brake valve with emergency master cylinder: One part of the control unit meters pressure from a power generating system, and another part of the control unit serves as a standby manual pressure generating unit when the power system is inoperative.

2. APPLICABLE DOCUMENTS

* 2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of this specifcation to the extent specified herein:

SPECIFICATIONS

Military

MIL-T-781	Terminal; Wire Rope, Swaging
MIL-W-5013	Wheel and Brake Assemblies: Aircraft
MIL-W-5424	Wire Rope, Steel, (Corrosion Resisting) Flexible, Preformed (For Aeronautical Use)
MIL-H-5440	Hydraulic Systems, Aircraft, Types I and II, Design, Installation, and Data Requirements for
MIL-P-5518	Pneumatic Systems, Aircraft; Design, Installation, and Data Requirements for
MIL-V-5525	Valves, Aircraft Power Brake
MIL-C-6026	Control Unit, Pressure Generating, Manually Operated, Aircraft Hydraulic Brake System
MIL-P-7034	Pulleys, Groove, Antifriction-Bearing, Grease-Lubricated, Aircraft
MIL-S-7742	Screw Threads, Standard, Optimum Selected Series: General Specification for
MIL-C-7979	Cylinders; Hydraulic Brake, Master, Power Assisted
MIL-B-8075	Brake Control Systems, Antiskid, Aircraft Wheels: Instructions for Preparation of Specifications for
MIL-H-8775	Hydraulic System Components, Aircraft and Missiles, General Specification for
MIL-H-8794	Hose, Rubber, Hydraulic, Fuel and Oil Resistant
MIL-H-8891	Hydraulic Systems, Manned Flight Vehicles, Type III, Design, Installation, and Data Requirements for
MIL-F-9490	Flight Control Systems - Design, Installation and Test of, Piloted Aircraft, General Specification for
MIL-F-18372	Flight Control Systems, Design, Installation and Test of, Aircraft (General Specification for)
MIL-C-25427	Coupling Assembly, Hydraulic, Self-Sealing, Quick Disconnect

STANDARDS

Military

MIL-STD-203	Aircrew Station Controls and Displays for Fixed Wing Aircraft

MIL-STD-250	Aircrew Station Controls and Displays for Rotary Wing Aircraft
MS33540	Safety Wiring and Cotter Pinning, General Practices for

Air Force-Navy Aeronautical

AN6204	Valve, Hydraulic Bleeder

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer).

3. REQUIREMENTS

* 3.1 General requirements. The brake systems covered by this specification shall be operable under all conditions of weather and compatible with the type (temperature range) and class (pressure limits) of hydraulic or pneumatic systems as specified in MIL-H-5440, MIL-P-5518, or MIL-H-8891, whichever is applicable.

3.2 Selection of materials. Specifications and standards for all materials, parts, and Government certification and approval of processes and equipment, which are not specifically designated herein and which are necessary for the execution of this specification, shall be selected in accordance with procedures established by the procuring activity, except as provided in the following paragraph.

* 3.2.1 Standard parts. Standard parts (MS or AN) shall be used wherever they are suitable for the purpose and shall be identified on the drawing by their part numbers. In the event there is no suitable corresponding standard part in effect on date of invitation for bids, commercial parts may be used provided they conform to all requirements of this specification and more than one source is available for replacement.

* 3.3 Design. The design and installation of aircraft braking systems shall be in accordance with the applicable requirements of MIL-H-5440, MIL-P-5518, MIL-H-8775, MIL-H-8891, or MIL-F-18372 and MIL-F-9490 and shall employ to the fullest possible extent the standard components listed therein. Type IV brake systems shall be used on all carrier-based aircraft for which the type I system would be inadequate to hold the aircraft on a 10° slope at maximum design gross weight. A type II brake system may be used for carrier-based aircraft which have an antiskid control system. Where type I or type IV manual systems alone will not meet the 10° slope requirements, a type II, III, or V system shall be used, but special provisions shall be incorporated to hold the aircraft on the 10° slope without the use of normal power-generating systems. All detachable

components and parts shall be safetied in accordance with MS33540 or secured by an approved method that will prevent loosening.

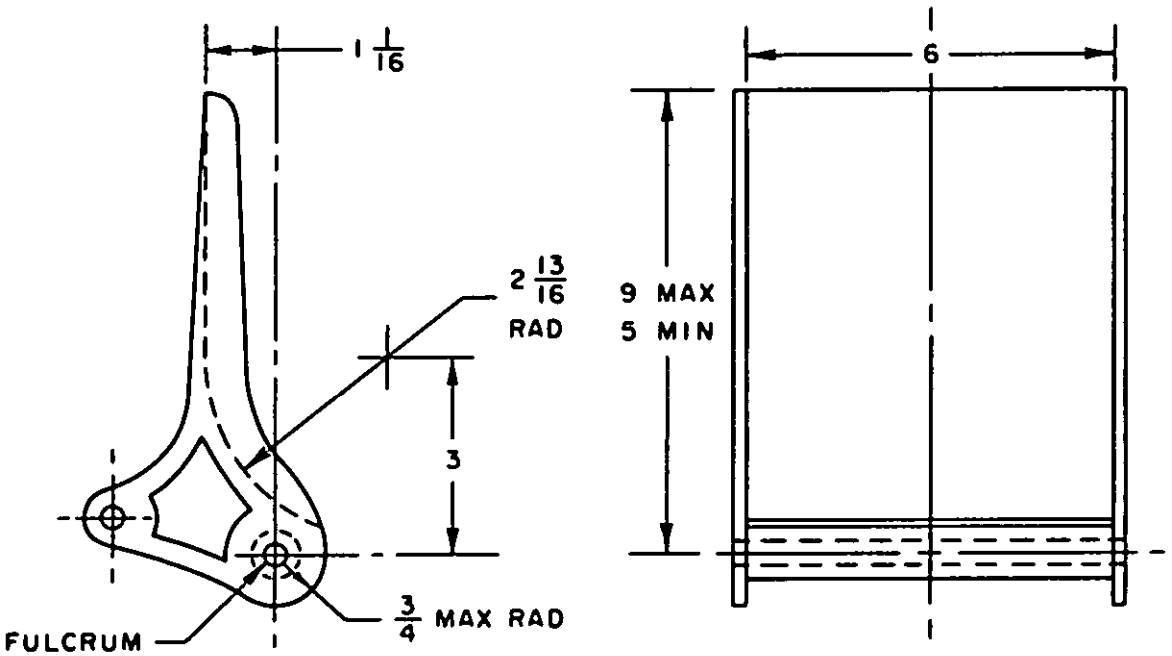
3.3.1 Wheels and brakes. Wheel and brake assemblies shall conform to the requirements of MIL-W-5013 and the applicable standards.

* 3.3.2 Normal brake controls. Right and left brakes shall be separately actuated and shall be so designed that they can be applied by toe force on brake pedals on the rudder controls except for bicycle gear or quadricycle gear, where other suitable brake controls may be used subject to approval of the procuring activity. Pedal location shall conform to the requirements of MIL-STD-203 or MIL-STD-250, as applicable. The brake pedal linkages shall be so designed that a comfortable angle of approximately 90° between the pilot's foot and his lower leg is maintained throughout the full range of movement of the rudder pedals and seat. Strength shall be provided in the brake pedal and associated linkage to withstand 300 pounds applied at the tip of the pedal with no yielding. The desired shape and travel of the brake pedals and the brake control device shall be as free as possible of friction and lost motion (see figures 1 and 2). Means shall be provided to positively return the brake pedals to the off position when toe force is removed from the pedals. No pumping shall be allowed in order to meet the deceleration and parking requirements.

* 3.3.2.1 Manually operated systems, type I. Manual hydraulic braking control systems shall incorporate a brake control unit or units which shall conform to MIL-C-6026. The total displacement of the control unit shall be at least 25 percent greater than the maximum displacement, including line expansion required to hold the wheels locked against a 33° slope for aircraft at maximum design gross weight and a 20° slope for helicopters at design alternate gross weight. The control unit shall preferably be connected directly to the brake pedal lever. The compressible medium of the temperature compensating device in the control unit shall be designed with a minimum preload of 50 percent and a minimum bottoming load of 125 percent of the parking pressure required to hold aircraft on an 18° slope at maximum design gross weight and to hold helicopters on a 10° slope at design alternate gross weight. This device shall have fluid displacement equivalent to the change in volume of the fluid in the brake system, neglecting the reservoir, under a temperature change of 44.4°C (112°F). Manual braking control systems shall be such that:

(a) A foot force of between 15 and 20 pounds at the tip of the pedal shall be required to cause initial movement of the brake pedal.

* (b) A foot force of between 75 and 125 pounds at the tip of the pedal shall develop the torque required on the landplane landing design gross weight or at design alternate gross weight brake stop conditions of the table entitled



DIMENSIONS IN INCHES

FIGURE 1. Brake Pedal Shape

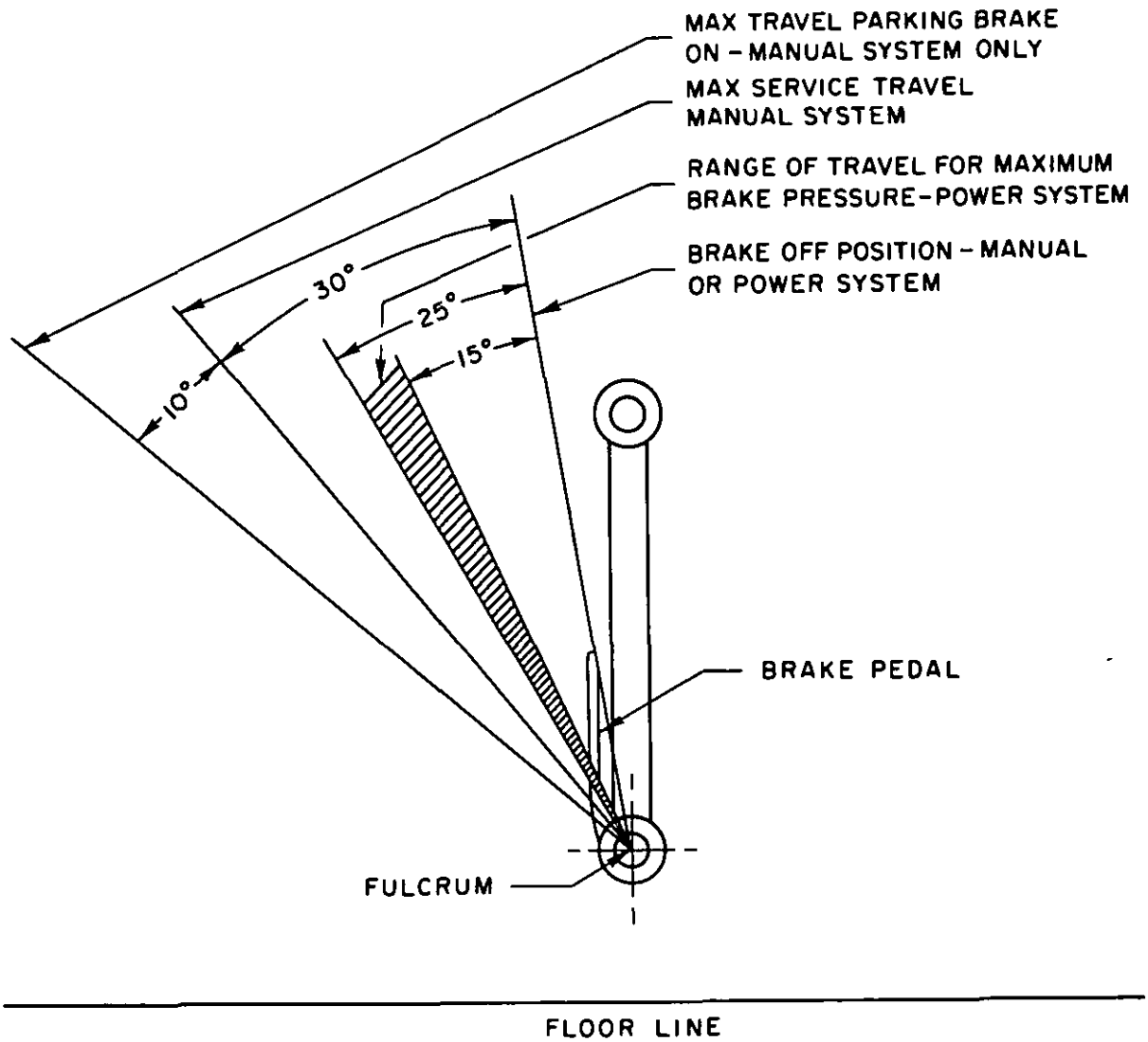


FIGURE 2. Brake Pedal Travel

"Wheel Brake Capacity Requirements" of MIL-W-5013. The brake pressure thus obtained shall be consistent with the average of the repeated dynamometer tests of the brake in the landplane landing design gross weight condition or at design alternate gross weight.

(c) The travel of the pedal for full brake application shall be as indicated on figure 2. It shall not exceed 30° while meeting the requirements of subparagraph (b) above.

* (d) In all positions of the brake pedal or the rudder linkage and the seat, it shall be possible for the pilot to apply sufficient static brake torque to hold the wheels locked against a 33° slope for aircraft at maximum design gross weight and a 20° slope for helicopters at design alternate gross weight. It shall be possible to meet this requirement with the brakes at a temperature of 21°C (70°F).

3.3.2.2 Power-operated systems, types II and III. Power-operated brake control systems shall exhibit no objectionable time lag between pedal movement and brake response. Such systems shall develop "feel" at the pedals, in proportion to the amount of energizing force applied to the brake. Hydraulic power brake valves shall conform to MIL-V-5525. The normal brake system, including accumulators if used, shall be designed to prevent depletion of brake pressure supply due to pilot operation during normal landing run or ground handling of the aircraft. Consideration should be given to appropriate hydraulic pump operating speeds.

3.3.2.2.1 Power braking systems shall be such that:

(a) A foot force of between 15 and 20 pounds at the tip of the pedal shall be required to cause initial metering through the power brake valve.

* (b) A foot force of between 65 to 85 pounds at the tip of the pedal shall develop the torque required on the landplane landing design gross weight or at design alternate gross weight brake stop conditions of the table entitled "Wheel Brake Capacity Requirements" of MIL-W-5013. The brake pressure thus obtained shall be consistent with the average of the repeated dynamometer tests of the brake in the landplane landing design gross weight condition or at design alternate gross weight.

* (c) Brake pressure sufficient to hold the wheels locked shall be available at the upper ranges of travel of the brake pedal or rudder linkage and the seat to hold against a 33° slope for aircraft at maximum design gross weight and a 20° slope for helicopters at design alternate gross weight. It shall be possible to meet this condition with the brakes at a temperature of 21°C (70°F).

(d) The travel of the pedals shall be as shown on figure 2. It shall be between 15° and 25° to produce the maximum available brake pressure.

* 3.3.2.3 Controls of carrier-based aircraft, types II, IV, and V systems. On those carrier-based aircraft where power brake systems are required, the brake control shall conform to MIL-C-7979, as applicable. With the power system operative, the brakes shall meet the requirement for power-operated systems. With the power system inoperative, the system shall meet the requirements for manually operated systems, except the deceleration capability at 175 pounds maximum foot force shall be consistent with the aircraft operational requirements as approved by the procuring activity. For helicopters, 175 pounds maximum foot force shall produce a 5 foot per second per second deceleration at basic design gross weight. The braking capability must be adequate for a minimum aircraft braking coefficient of friction of 0.2.

* 3.3.3 Emergency brake control system. All aircraft using types II and III brake systems shall be provided with an emergency brake system capable of decelerating the aircraft under the conditions specified in 3.3.2.2.1(b). If an emergency hydraulic system is used, metered differential brake control shall be provided. The emergency system shall be completely independent of the normal system up to the shuttle valve or equivalent unit at the brake. A system wherein a failure of one-half of the normal system still allows the specified decelerations with differential control is considered equivalent to a separate emergency system. When accumulators or air bottles are used for the emergency braking, they shall have sufficient capacity to provide at least 10 full brake applications, assuming brakes are adjusted to recommended clearances, and of which the last shall provide a coefficient of 0.18 minimum between tire and runway recommended clearances. The volume of hydraulic fluid required should be based on pressures and displacements required to meet the specified deceleration applications considering three of the applications are with cold brakes and seven are with hot brakes. If air bottles are used for the emergency system, the lines between the air bottle control valve and the shuttle valve shall be automatically vented to the atmosphere when not in use. Whenever feasible, emergency brake systems shall function by continued pressure on the brake pedal. Emergency systems shall be designed to facilitate operational checks. The emergency brake system shall be designed to preclude entrapment of the normal system fluid within any of the components which could prevent the brake system from going into an emergency mode.

3.3.4 General design requirements

* 3.3.4.1 Brake systems on all aircraft shall be provided with a parking brake control located and actuated in accordance with MIL-STD-203 and MIL-STD-250, as applicable, except that the parking lock may be omitted from jet-powered

interceptors, jet-powered fighters, and carrier-based aircraft. The parking mechanism shall provide sufficient pressure in the brake system to develop a torque to hold on an 18° slope for aircraft at maximum design gross weight and a 10° slope for helicopters at a design alternate gross weight. The parking lock system shall include means to compensate for predicted leakage and temperature variation so that at least 75 percent of the parking brake torque defined above is maintained over a minimum period of 1 hour with engines off and a 40°F drop in temperature. A 40° increase above the initial parking temperature shall not result in excessive pressure in the brake system.

3.3.4.2 Operating media. Brakes shall be designed for use with the operating medium mutually determined by the procuring activities and the aircraft manufacturer for the particular application (hydraulic, pneumatic, mechanical).

* 3.3.4.3 Brake lines. Brake lines shall be routed to facilitate proper bleeding. Traps or bends in hydraulic lines which might cause air pockets shall be avoided. Wherever practicable, the lines shall have a continuous drop from the brake valve or control unit to the brakes. If traps or bends cannot be avoided, then a separate AN6204, or equivalent, bleeder valve shall be installed to accomplish proper bleeding in accordance with MIL-H-5440.

3.3.4.4 Provisions for removal of brakes. Brakes which must be removed before wheels are removed shall be connected with flexible hose conforming to MIL-H-8794, as determined by the brake operating pressure and volumetric expansion requirements. Self-sealing couplings conforming to MIL-C-25427 shall be used on all brakes which must be removed before the wheel can be removed.

3.3.4.5 Control cables. Brake control cables shall conform to MIL-W-5424. Swaged terminals conforming to MIL-T-781 shall be used on the ends of brake control cables. Pulleys conforming to MIL-P-7034 shall be used wherever brake control cables change direction more than 5°

3.3.4.6 Accessibility. Sufficient clearance or openings shall be provided in order that brake adjustments and bleeding of hydraulic brakes may be easily accomplished. Reservoirs, brake actuators, valves, or cylinders shall be located outside the cockpit or cabin enclosure.

3.3.4.7 Filler plug. The brake control unit or external reservoir, as applicable, shall be provided with a readily accessible filler plug. Space and means shall be provided for easily checking the fluid level in the unit. The thread shall be selected from MIL-S-7742 with the maximum pitch practicable.

* 3.3.5 Antiskid control requirements. Unless otherwise specified in the aircraft detail specification, an antiskid system shall be provided on all aircraft, except helicopters, equipped with type II, III, or V brake systems. Antiskid control devices shall be in accordance with MIL-B-8075.

* 3.3.5.1 Hydraulic response time. Hydraulic brake systems with an integrated antiskid control system shall be designed to produce the minimum hydraulic response time within practical limits for improved antiskid control performance. Minimum response time shall be achieved by minimization of major response contributors such as brake displacement, line expansion, line length, and flow restrictions.

* 3.3.6 Brake system flow. It shall be shown by analysis of the hydraulic flow transferred to and from the brakes during the most adverse conditions, in addition to the nonbrake flow through valves and modulators, that adequate capacity is provided to prevent any degradation of the brake system performance.

* 3.3.7 Brake system maximum pressure. The maximum metered brake pressure may be any value up to the maximum hydraulic pressure available at the inlet of the pressure metering control unit. The strength of the brake subsystem components shall be based on the factors of safety specified by the procuring activity.

* 3.3.8 Pressure metering control unit. The ports and internal fluid passages shall be sized to permit adequate flow to and from the antiskid control valve. Considerations shall include the desired initial brake response from the fully released position against residual pressure to the brake applied position in addition to subsequent cyclic application of pressure by the antiskid control valve.

* 3.3.9 Hydraulic lines

* 3.3.9.1 Sizes. Hydraulic lines for supply and return shall be selected to provide minimum pressure drops compatible with flow requirements of the pressure metering control units, antiskid control valves, and brake assemblies under installed environmental conditions.

* 3.3.9.2 Flex hose. The utilization of flex hoses between the control unit and the wheel shall be held to a minimum to minimize accumulation effect during pressure changes.

* 3.3.10 Antiskid control valve. The valves shall be located as close as practicable to the brake assemblies to improve hydraulic coupling.

* 3.3.11 Parking requirements. System parking requirements shall recognize internal leakage of the antiskid control valve. Shutoff valves may be used to block quiescent flow to system return. A skid control valve shall be designed to be suitable for the pressures generated with the shutoff valve actuated.

* 3.3.12 System reverse bleeding. Reverse bleeding of the brake system shall be limited to those installations which provide adequate internal or external means to prevent entry of contaminants into hydraulic components. Some antiskid control valves, for example, can be rendered inoperative if contaminants reach valve spools and orifices. Self-contained inlet filters in these control valves are not effective during reverse bleeding.

* 3.3.13 Contamination level of hydraulic fluids. Filtration shall be provided as required to ensure satisfactory antiskid control valve performance. The filter shall retain all particles which can adversely affect valve operation. Capacity shall be consistent with established overhaul periods. If the antiskid control valve has a self-contained inlet filter, the absolute particle size rating of the upstream filter shall be not larger than the nominal particle size rating of the self-contained filter.

* 3.3.14 Brake design requirements

* 3.3.14.1 Response. Unless otherwise specified, minimum brake release response time shall be a design goal. The need for specific requirements shall be determined by the airframe contractor.

* 3.3.14.2 Fluid displacement. Hydraulic fluid volume change shall be a minimum from residual pressure to maximum operating pressure for both new and fully worn brake conditions. A relatively high brake structural spring rate and self-adjusters shall be considered to accomplish this.

* 3.3.14.3 Ports and passages. Ports and internal fluid passages shall be designed to assure minimum air entrapment and minimum flow restrictions and to minimize asymmetric actuating force changes around the brake periphery.

* 3.3.15 Design analysis. A hydraulic analysis shall be performed to assure that the components of the brake system and the antiskid control valve are capable of achieving the required brake application and antiskid control response. The characteristics and the effects of the following items during aircraft braking shall also be considered in the analysis:

(a) Fluid supply to the brake system

(b) Fluid return to the hydraulic system reservoir including fluid entering the return line from the operation or leakage of hydraulic components other than those in the brake or antiskid control systems

(c) Minimum ambient and fluid temperatures which will be encountered.

3.4 Workmanship. Workmanship shall be of the quality necessary to produce brake systems free from defects which affect proper functioning in service.

4. QUALITY ASSURANCE PROVISIONS

4.1 This section is not applicable to this specification.

5. PREPARATION FOR DELIVERY

5.1 This section is not applicable to this specification.

6. NOTES

6.1 Intended use. The design requirements specified herein are intended for use in the design of brake systems used on aircraft equipped with wheel-type landing gear.

6.2 The margins of this specification are marked with an asterisk to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only, and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:
Army - AV
Navy - AS
Air Force - 11

Review activities:
Army - AV
Navy - AS
Air Force - 70

Preparing activity:
Air Force - 11

Project No. 1630-0040

SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 22-R255

INSTRUCTIONS: This sheet is to be filled out by personnel, either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments and suggestions submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or serve to amend contractual requirements.

SPECIFICATION

ORGANIZATION

CITY AND STATE

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO *(If "yes", in what way?)*

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity - Optional)*

DATE

DD FORM 1 JAN 84 1426

REPLACES EDITION OF 1 OCT 64 WHICH MAY BE USED.

AFLC-WPAFB-OCT 67 2M