MIL-S-19557D(AS)
29 January 1988
SUPERSEDING
MIL-S-19557C(AS)
11 September 1972

MILITARY SPECIFICATION

STARTERS;
AIRCRAFT ENGINE, AIR TURBINE,
GENERAL SPECIFICATION FOR

This specification is approved for use within the Naval Air Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE.

1.1 Scope. This specification establishes the performance, design, qualification, and quality conformance inspection requirements for air turbine starters for aircraft gas turbine engines.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commanding Officer, Naval Air Engineering Center, Systems Engineering and Standardization Department (SESD) Code 53, Lakehurst, NJ 08733-5100, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 2995

SPECIFICATIONS

FEDERAL

A-A-884	-	Tape, Pressure-sensitive Adhesive, Box Closure
QQ-A-250/1	-	Aluminum 1100, Plate and Sheet
PPP-B-636	-	Boxes, Shipping, Fiberboard
PPP-C-850	-	Cushioning Material, Polystrene Expanded, Resilient
PPP-S-760	-	Strapping, Nonmetallic (and Connectors)

MILITARY

MIL-P-116	-	Preservation, Methods of
MIL-B-121	-	Barrier Material, Grease-proofed, Water-proofed, Flexible
DOD-D-1000	-	Drawings, Engineering and Associated Lists
MIL-D-3464	-	Desiccants, Activated, Bagged, Packaging Use and Static Dehumidification
MIL-C-5501	-	Caps and Plugs, Protective, Dust and Moisture Seal
MIL-P-7105	-	Pipe Threads, Taper, Aeronautical National Form, Symbol ANPT, General Requirements for
MIL-S-7742	-	Screw Threads, Standard, Optimum Selected Series; General Specification for
MIL-L-7808	-	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number 0-148
MIL-S-8879	-	Screw Threads, Controlled Radius Root with Increased Minor Diameter; General Specification for
MIL-R-20092	-	Rubber or Plastic Sheets and Assembled and Molded Shapes, Synthetic, Foam or Sponge Open Cell (Framed Latex)
MIL-L-23699	-	Lubricating Oil, Aircraft Turbine Engines, Synthetic Base
MIL-P-26514	-	Polyurethane Foam, Rigid or Flexible, for Packaging
MIL-C-26861	-	Cushioning Material, Resilient type, General

(See Supplement 1 for a list of specification sheets.)

STANDARDS

MILITARY

DOD-STD-100	-	Engineering Drawing Practices
MIL-STD-129	-	Marking of Shipments and Storage
MIL-STD-130	-	Identification Marking of U.S. Military Property

MIL-STD-143	-	Standards and Specifications, Order of Precedence for the Selection of
MIL-STD-147	-	Palletized Unit Loads
MIL-STD-202	-	Test Methods for Electronic and Electrical Component Parts
MIL-STD-461	-	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-462	-	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-794	-	Parts and Equipment, Procedures for Packaging of
MIL-STD-810	-	Environmental Test Methods and Engineering Guidelines
MIL-STD-838	-	Lubrication of Military Equipment
MIL-STD-882	-	System Safety Program Requirements
MIL-STD-889	-	Dissimilar Metals
MIL-STD-1523	-	Age Control of Age-Sensitive Elastomeric Materiel (For Aerospace Application)
MIL-STD-2164	-	Environmental Stress Screening Process for Electronic Equipment
MS33537	-	Insert, Screw Thread, Helical Coil, Coarse and Fine Thread, Standard Dimensions for
MS33540	-	Safety Wiring and Cotter Pinning, General Practices for
MS33666	-	Packing, Preformed, Aeronautical Elastomeric, Range of Sizes
MS33668	-	Packing, Preformed, Elastomeric, Tube Fitting, Range of Sizes

(Copies of specifications and standards required by the manufacturers in connection with a specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.1.1 Model specification. If required, a model specification shall be prepared in the format of this specification after integrating the requirements from the applicable specification sheet. The first page shall contain the approval date, Navy model number, the manufacturer's name and address, and a manufacturer designated model specification number. The model specification number and approval date shall appear on each page. The envelope figure specified on the specification sheet and the drawings of 3.5.5

shall be included in the model specification in reduced form.

3.2 Qualification. Starters furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list (QPL) at the time set for opening bids (see 4.5 and 6.3).

3.3 Characteristics.

3.3.1 Performance ratings. The starter shall be capable of producing rated torque and output drive speed, as specified on the specification sheet, when supplied with air at the rated inlet conditions, and when operating with the specified remote air control valve. The control value charateristics shall be as specified of the specification sheet. The manufacturer shall furnish performance data in the model specification on each model starter proposed. The data shall be in the form shown on figures 1 through 5, and may be estimated or calculated until the starter has been tested. After that time, performance data shall be based on test results (see 4.4.4.1, 4.5.2 and 4.5.4).

3.3.2 Functional requirements. The starter shall be designed and constructed to satisfy the functional requirements below and other requirements as specified on the specification sheet.

3.3.2.1 Cutout speed. The starter cutout speed shall be as specified on the specification sheet (see 4.4.4.1 and 4.5.2).

3.3.2.2 Cutout switch. The starter shall be equipped with a cutout switch that will open a normally closed electrical circuit when the starter output drive attains the cutout speed of 3.3.2.1. The switch shall be designed to withstand a surge current of 2.5 amperes at 28 volts when the ambient temperature is at -65°F. The switch shall not be polarity sensitive. The drive speed shall be measured at the location specified on the specification sheet (see 4.4.4.1, 4.4.5.1, 4.4.6.1 and 4.5.2).

3.3.2.3 Overrunning. When a spline drive and overrunning clutch-type mechanism is used, the starter shall not be damaged as a result of overrunning for the time specified on the specification sheet. The overrunning shall be accomplished at the maximum misalignment specified for the engine accessory drive and without lubrication from the engine. The drag in the overrunning clutch shall be minimized to prevent rotation of starter components (see 4.4.4.2 and 4.5.3).

3.3.2.4 Engagement. Engagement of the starter drive to the engine accessory drive shall be by means of a jaw, overrunning clutch, or other device. The engagement shall be automatic upon initiation of the airflow and shall be accomplished with a minimum of shock and without damage to the starter or engine. The starter drive shall not be dependent on the engine accessory drive for alignment. Disengagement shall be rapid and complete at the end of a starting cycle. There shall be a minimum of ratcheting with jaw-type drives. Reengagement shall be accomplished rapidly and without damage to starter or engine when the starter or the engine drives or both are rotating from zero to the cutout speed of 3.3.2.1 (see 4.4.4.3).

3.3.2.5 Torque limiting device. The starter shall incorporate slip clutch or shear section to prevent damage to both the starter (except for shear section failure) and the engine in the event of excessive starter torque. The output drive shall be designed so that if it fails the resulting parts will be retained within the starter and engine accessory drive.

3.3.2.5.1 Shear section. The shear section shall be replaceable without disassembly of the starter. A starter output drive shear section shall incorporate a means of limiting axial movement of the output drive. The maximum permissible static shear torque to be transmitted to the engine by the starter output drive under all operating conditions, including engagement and reengagement, shall not exceed the value specified on the specification sheet (see 4.4.4.4.1).

3.3.2.5.2 Slip clutch. When a slip clutch is provided in lieu of a shear section, it shall prevent torque transmission in excess of the breakaway torque specified on the specification sheet (see 4.4.4.4.2).

3.3.2.6 No load operation. The starter shall be capable of operating without damage with the cutout switch inoperative and no load on the output drive shaft for at least the time and the speed specified on the specification sheet (see 4.4.4.5).

3.3.2.7 Consecutive cycles. The starter shall be capable of operating without damage for the number of consecutive endurance test cycles specified on the specification sheet (see 4.4.4.6).

3.3.2.8 Sustained motoring. The starter shall be capable of providing and maintaining rated torque and speed, at rated inlet conditions, for the time specified on the specification sheet (see 4.4.4.7).

3.3.2.9 Direction of rotation. The direction of rotation (as viewed from the anti-drive pad) shall be as specified on the specification sheet and shall be consistent with the direction of rotation stamped on the nameplate.

3.3.2.10 Lubrication. The starter shall be self-lubricating, including internal splines, when using any of the approved oils or greases allowed by MIL-STD-838. The starter shall be designed and constructed to prevent the entrance of engine oil into the starter and the leakage of lubricants from the starter, except as noted below. The starter shall be capable of completing the endurance test of 4.4.6.1 and the overrunning test of 4.4.4.2 without changing or adding any lubricant.

3.3.2.10.1 Oil system. The oil reservoir shall have two oil fill ports, one on each side, and one oil drain port. The oil fill ports shall be used to indicate oil quantity level. Oil quantity shall be at the proper level when the starter is filled to overflow at the fill port, with the starter in the normal attitude. In the normal attitude, it shall be possible to completely drain the reservoir using the drain connection provided without the use of an external pressurant. Optimum port location(s) with respect to starter servicing shall be determined during the aircraft mockup of 4.4.3. Oil loss shall be no greater than 15 percent of the reservoir capacity at the completion of the overrunning test of 4.4.4.2. Starter operation with MIL-L-23699 oil shall not be required when the oil temperature is below that

corresponding to a kinematic viscosity of 13,000 centistokes. If MIL-L-23699 oil is used, the starter shall also be compatible with MIL-L-7808 oil. No liquid lubricant shall issue from any lubrications system vent(s) during any mode of operation.

3.3.3 Environmental conditions. Starter performance shall not be adversely affected during or after exposure to the following environmental conditions.

3.3.3.1 Temperature range. The starter shall operate satisfactorily, without impairment of function or change in adjustment, throughout the ambient temperature range specified on the specification sheet. The starter shall not be damaged when exposured to the temperature range specified on the specification sheet while not operating, and shall operate satisfactorily when returned to the ambient temperature range (see 4.4.5.1).

3.3.3.2 External surface temperature. The maximum external surface or skin temperature shall not exceed the value specified on the specification sheet during or following any starter operation. External covering or insulating blankets may be used to satisfy this requirement (see 4.4.5.1).

3.3.3.3 Altitude. The starter shall be capable of operating at rated torque and speed when supplied with air at the rated inlet conditions from sea level to the maximum rated altitude specified on the specification sheet. In addition, the starter shall operate satisfactorily in the overrunning mode from sea level to the maximum overrunning altitude specified on the specification sheet (see 4.4.5.2).

3.3.3.4 External loads. The starter shall operate satisfactorily during and after exposure to any of the external loads shown on figure 6 without permanent deformation. The starter shall also remain attached to the engine after exposure to 1.5 times the figure 6 loads, but need not operate satisfactorily thereafter (see 4.4.5.3).

3.3.3.5 Attitude. The starter shall be capable of producing rated torque and speed when operating in any of the attitudes shown in the clear area of figure 7. The starter shall also be capable of operate in the overrunning mode in any of the attitudes shown in the clear and shaded areas of figure 7, and for at least 60 seconds at negative "g" and 30 seconds at zero "g" conditions throughout the envelope (see 4.4.5.4).

3.3.3.6 Humidity. The starter shall be resistant to malfunctions and deterioration when subject to 95 percent or higher humidity conditions for extended periods (see 4.4.5.5).

3.3.3.7 Rain. The starter shall be capable of operating during and after exposure to blowing rain (see 4.4.5.6).

3.3.3.8 Fungus. All materials used in the construction of the starter shall be resistant to fungus and the effects of the chemicals produced by the fungus (see 4.4.5.7).

3.3.3.9 Salt fog. Starter performance shall not be degraded after exposure to salt-laden air (see 4.4.5.8).

3.3.3.10 Sand and dust. The starter shall be capable of performing 50 start cycles with the compressed air supply contaminated with dust, and after the exterior has been exposed to sand (see 4.4.5.9).

3.3.3.11 Nonoperational vibration. The starter shall be capable of providing rated torque and speed after exposure to a vibrational environment (see 4.4.5.10).

3.3.3.12 Explosion-proof. Electrical components shall not ignite an explosive mixture surrounding the starter (see 4.4.5.11).

3.3.4 Reliability. The starter shall be capable of performing the number of starts specified on the specification sheet and, shall be designed to have a mean-time-between-failures (MTBF), as specified, when installed and operated in accordance with prescribed procedures (see 4.4.6.1).

3.3.5 Maintainability. The starter design shall permit easy assembly, disassembly, location of trouble sources, routine service checking, adjustment and maintenance by service personnel with a minimum of training; when using tools and equipment normally available commercially. The starter shall be capable of operating for the number of overrunning hours specified in 3.3.2.3 and the number of cycles specified in 4.4.6.1 with no scheduled or unscheduled maintenance. The modular concept of assembly shall be utilized whenever possible in order to increase maintainability and reduce overhaul and maintenance costs. The design goal shall be such that any subassembly of the starter can be replaced without disassembly of the complete starter or removal of other components (see 4.4.6.2).

3.3.6 Structural performance.

3.3.6.1 Containment. When specified on the specification sheet, the starter shall be designed to contain a maximum energy burst of the turbine wheel at no less than the maximum cutout speed of 3.3.2.1. In addition, the starter shall be designed to either prevent or contain any failure which would occur as a result of operating without a load on the output drive shaft (see 4.4.7.1.1 and 4.4.7.1.2).

3.3.6.1.1 Housing integrity. When containment is required, all rotating components and the starter housing shall remain attached to the engine accessory drive pad.

3.3.6.1.2 Automatic shutoff valve. If an automatic shutoff valve is used to prevent failure of rotating components during a no load operation, the leakage past the valve shall not cause any rotating components to fail for a period of 2.5 hours.

3.3.6.2 Vibration. The starter shall be free of destructive vibration at all output shaft rotational speeds and operational conditions (see 4.3.3).

3.3.6.3 Proof spin. All high speed parts of the starter shall be capable of withstanding the equivalent room temperature proof spin speed for ten seconds. The proof spin speed shall be specified and shall be above the maximum operating speed but below the minimum yield speed (see 4.4.7.2 and

4.5.5).

3.3.6.4 Proof pressure. The starter shall withstand the pressure specified on the specification sheet without structural deformation or the loss of the capability to produce rated torque and speed (see 4.4.7.3 and 4.5.6).

3.3.7 Electrical requirements.

3.3.7.1 Electromagnetic emissions and susceptibility. All electrical parts shall comply with MIL-STD-461 class Alg equipment (see 4.4.8.1).

3.3.7.2 Dielectric strength. All electrical parts shall be subjected to a dielectric strength test in accordance with MIL-STD-202 Method 301 (see 4.4.8.2 and 4.5.7).

3.3.7.3 Insulation resistance. All electrical parts shall be subjected to an insulation test in accordance with MIL-STD-202 Method 302 (see 4.4.8.3 and 4.5.8).

3.3.8 Survivability.

3.3.8.1 Nuclear, biological and chemical (NBC) protection. If specified on the specification sheet, the starter shall be capable of being operated and maintained in a radiological, biological and chemical environment. External and internal surfaces shall be resistant to chemical reaction and the adherence or absorption of contaminants. The starter shall be configured to promote post-mission decontamination through the use of gaseous or liquid (aqueous or organic) agents or a brief exposure to elevated surface temperature or both agents and temperature. Decontamination techniques shall not cause deterioration or corrosion of the starter (see 4.4.9).

3.4 Installation.

3.4.1 Size and dimensions. The size of the starter shall be within the envelope configuration specified on the specification sheet. The starter installation configuration shall be approved by the Navy. The manufacturer shall coordinate the installation with the Navy prior to fabrication of the qualification units. The manufacturer's Navy-approved installation drawing will form a part of the model specification.

3.4.2 Mounting. The starter shall be designed to mount on the engine accessory drive of 3.4.2.2 within the specified tolerances without measurement or adjustment of the engine or starter drives prior to installation. Mounting shall not require special tools and there shall be no loose or separable parts when the starter is removed. No separable parts shall be attached to the engine other than the quick-attach-detach adapter and the engine jaw when jaw-type engagement is used. The output drive member of the starter shall be compatible and mate with the specified engine accessory drive. Starters designed with a jaw-type drive must contain both jaw drives with the starter. The jaw design and method of attachment shall be approved by the Navy.

3.4.2.1 Quick attach detach (QAD) mounting. An approved QAD mounting shall be provided. Any adapter required to modify the engine accessory drive

in order to mount the starter shall be furnished with the starter, but it shall be considered as attached to the engine after initial installation. The starter shall be indexed to the adapter so that it can be installed only in the proper position. The QAD clamp shall incorporate a self-locking feature.

3.4.2.2 Engine accessory drive. The starter shall be designed for mounting on the engine accessory drive specified on the specification sheet. The forces generated by the starter during starter operation shall not exceed the design requirements of the respective engine accessory drive pad (see 4.4.10).

3.4.3 Air inlet and exhaust connections. The starter air inlet and exhaust shall be as described on the envelope configuration of 3.4.1.

3.4.3.1 Mechanical loads and moments. The starter air inlet and exhaust flanges shall be capable of withstanding 50 lbf in shear, 100 lbf axially and a 300 lbf-in moment resulting from thermal expansion, deflection, and vibration.

3.4.4 Overhung moment. The total overhung moment of the starter, including lubricant, QAD mounting adapter and related clamp, engine jaw adapter drive, etc., shall not exceed the value specified on the specification sheet.

3.4.5 Weight. The total weight of the starter, including lubricant, QAD mounting adapter and related clamp, engine jaw adapter drive, etc., shall not exceed the values specified on the specification sheet.

3.5 Designs and Construction.

3.5.1 Materials, processes and parts.

3.5.1.1 Materials and processes. Specifications and standards for all materials and processes which are not specifically designated in this specification and are necessary for the execution of this specification, shall be selected from groups II and IV of MIL-STD-143. When manufacturer's documents are used for materials and processes, such documents shall be subjected to review by the Navy and unless specifically disapproved, will be considered released upon qualification of the starter. The documents shall be submitted in accordance with 3.5.5g. The use of non-government specifications shall not constitute waiver of Government inspection. The Government reserves the right to inspect any and all processes of the manufacturer.

3.5.1.1.1 Materials. The use of magnesium and magnesium alloys shall be prohibited. Copper and cadmium shall not be used in parts which are in direct contact with oil during starter operation. Dissimilar metals as defined in MIL-STD-889 shall not be used in direct contact with each other.

3.5.1.1.2 Corrosion protection. The corrosion protection treatments shall be of the highest order of effectiveness in accordance with Appendix A of MIL-STD-889. The materials, coatings and processes used in the design and manufacture of the starter shall be corrosion resistant. Fabrication processes which might affect the basic grain structure or surface condition, so as to provide a starting point for corrosion, shall be avoided.

3.5.1.2 Parts.

3.5.1.2.1 Packings. All packings used in the design of the starter shall conform to the applicable dimensions and tolerances shown on MS33666 and MS33668. Age controls for elastomeric materials shall comply with MIL-STD-1523.

3.5.1.2.2 Screw threads. All screw threads shall conform to the requirements of MIL-S-8879, Class 3A or 3B only. The use of MIL-S-7742 is optional for threads used for: (a) electrical connections, (b) screw threads 0.138 inch diameter and smaller, and (c) interference fits and other application where MIL-S-7742 threads are suitable for the intended purposes such as installation end of studs or external threads of inserts and their mating tapped holes. Duplicate parts differing only in thread form are not permitted.

3.5.1.2.3 Tapered pipe threads. Tapered pipe threads shall be in accordance with MIL-P-7105 and shall be used only for permanently plugging drilled or cored openings.

3.5.1.2.4 Helical coil installation. The dimensions and tolerances of the parent material threads intended for use with helical coil inserts shall comply with MS33537.

3.5.1.2.5 Safetying. Provisions shall be made to prevent all screws and screw parts from accidental loosening. Such parts shall be safety wired or fitted with safety stop nuts, where applicable. All other connections liable to be loosened by vibration shall be safetied in a similar manner. If safetying is accomplished by wiring, it shall be in accordance with MS33540. The use of lock nuts which incorporate nonmetallic inserts as a locking feature shall be avoided.

3.5.2 Component parts. The starter shall consist of a turbine rotor, reduction gearing, automatically operated engaging and disengaging mechanism for coupling with the engine drive, quick-attach-detach (QAD) mounting, torque overload protection device, and an automatically operated cutout switch.

3.5.3 Nameplate and product marking.

3.5.3.1 Nameplate. Each starter shall be clearly and permanently marked with an irreversible nameplate conforming to MIL-STD-130, securely attached to a part of the starter which will not ordinarily be renewed during normal service life. The following information shall be on the nameplate:

STARTER; AIRCRAFT ENGINE, AIR TURBINE, NAVY MODEL _____
SPECIFICATION: MIL-S-19557/___ (Insert specification sheet number)
*ROTATION: (Indicate by an arrow)
FILL WITH _____ FL. OZ., MIL-L-23699 or MIL-L-7808
MANUFACTURER'S PART NUMBER _____ **LESS ISSUE _____
MANUFACTURER'S SERIAL NUMBER _____
GOVERNMENT ORDER OR CONTRACT NUMBER _____
NATIONAL STOCK NUMBER _____

NOTE: * The arrow showing the direction of rotation may be included on a single nameplate with other specified data or, at the option of the manufacturer, it may be stamped on a separate plate attached immediately adjacent to the main nameplate.
** For use by Naval Air Rework Facilities

3.5.3.1.1 Marking of product. The Navy model designation shall not be used on a starter until notification has been received in writing from the Navy that the starter has been approved for use on Naval aircraft.

3.5.3.2 Marking of parts. Each part and assembly shall be marked with its part number and drawing revision symbol where applicable. The part number shall be the same as the drawing number, except for those parts which: (a) do not have a suitable or sufficient surface for a part number or (b) are permanently assembled by welding, brazing, soldering, or riveting. The later parts shall carry the assembly part number.

3.5.3.2.1 Part number. The part number shall, when practicable, be located to permit its being read after assembly of the complete unit. The marking shall be such that it will not be obliterated as a result of service usage during the life of the part. The part number shall be limited to a maximum of 15 digits or characters and shall not be coded to describe part characteristics. All parts shall be marked with the latest drawing revision letter or number to which the part was made. Unless otherwise specified on the parts list, all parts shall be marked with the vendor or fabrication source of that particular part. Part number changes shall be in accordance with the requirements of DOD-STD-100.

3.5.4 Design control.

3.5.4.1 Standardization. Standardization principles, standard parts, materials, processes, tools, subsystems, and components shall be used to the maximum extent possible without compromise in design or performance of the starter. All parts, materials, and processes, whether or not identified as a Government, industry or manufacturer standard shall be qualified for the intended use as a part of the verification specified herein. Items already in the Government inventory shall be used to the maximum extent possible where suitable for the intended purpose. Variation in similar components or parts shall be held to the absolute minimum. Proprietary designs shall be kept to a minimum. Under conditions wherein economics of production conflict with standardization objectives, the latter group will govern, or the Navy shall be requested to select the component desired for use.

3.5.4.1.1 Design standards. MS and AND design standards shall be used unless they are determined by the manufacturer to be unsuitable for the

purpose.

3.5.4.1.2 Standard parts. The military standard parts developed specifically for use in aircraft engines shall take precedence over any other military standard. Where general purpose standards, as defined by envelope dimensions or Qualified Product List (QPL), are used in critical or high strength application, such parts shall be identified by the manufacturer's part number. Parts derived from general purpose standards solely on an inspection or selection basis shall be identified by the manufacturer's part number and all previous identification marks shall be removed.

3.5.4.2 Parts list. The parts list for the starter which is granted qualification approval based on (a) the satisfactory completion of the qualification tests and (b) the approval of the qualification test detail inspection and test report by the qualifying activity, shall constitute the approved parts list for any subsequent starter of the same model to be delivered to the Government. The manufacturer shall assign an item configuration control number to the starter configured by the approved parts list. This number, together with the approved parts list, shall be continuously updated to reflect incorporation of approved engineering changes. The item configuration control number shall be used to identify the starters to be delivered. The approved parts list shall be prepared in accordance with DOD-STD-100 and shall show the latest drawing revision letter or number used to manufacture the parts incorporated in the starter at the time of acceptance. The use of the so-called "clip system" of attaching engineering change forms to the applicable drawing in lieu of showing the change(s) in the body of the drawing shall not be permitted.

3.5.5 Drawings. The manufacturer shall furnish the following drawings and diagrams to the qualifying activity with the submission of the qualification test samples. The drawings shall be in accordance with DOD-D-1000 Level 3.

a. Starter installation drawing shall show the starter center of gravity, all connecting fittings, clearance required for installation and removal, filter locations and cleaning instructions if applicable.

b. Electrical diagram shall show all electrical circuits up to the connecting points of the aircraft electrical system.

c. Cutaway or cross sectional drawing of the starter and all components shall show all parts in their normal assembled position and shall specify part numbers of all parts or components subassemblies.

d. Assembly drawing shall show:

(1) All dimensions, clearances, and fits,

(2) Materials, treatment and finishes (identify each by specification number),

(3) Construction and

(4) Characteristics and ratings.

e. A complete set of manufacturing drawings.

f. Packing requirements and packing drawings for the starter.

g. All manufacturer specifications listed in the manufacturing drawings.

3.5.6 Design and construction changes.

3.5.6.1 Changes in design. No changes shall be made in the design or materials of a starter that has been qualified in accordance with this specification, except when the changes are approved by the qualifying activity.

3.5.6.2 Changes in vendors. Changes in a vendor or fabrication source of those parts used in the qualification tests shall be in accordance with the following procedure:

The manufacturer shall prepare and submit to the qualifying activity a list of tests to qualify an alternative vendor source. The specific tests required to substantiate their capability to qualify as a starter part shall be defined. The fabrication source of selected vendor components will be included in this list. The list shall be subjected to approval by the qualifying activity. The manufacturer thereafter shall be responsible for insuring that all parts, components, and assemblies on the substantiation list comply with the qualified fabrication source, and that any changes to those sources are effectively controlled. The manufacturer shall be responsible for performance of substantiation tests to establish satisfactory alternate vendors or fabrication sources. A fabrication source is defined as the prime physical source producing the part, component, or assembly. Changes of fabrication location, such as to another plant of an individual vendor, shall be construed as a change of fabrication source.

3.5.6.3 Responsibility for changes. Approval by the qualifying activity of changes from the qualification test starter does not relieve the manufacturer of full responsibility for the results of such changes on any starter characteristic.

3.5.7 Interchangeability. All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable with each other with respect to installation and performance, except that matched parts or selective fits will be permitted where required.

3.5.8 Safety. Impingement of exhaust gases on surrounding equipment shall not present a safety hazard. A system safety program shall be implemented in accordance with Task 100 of MIL-STD-882.

3.6 Workmanship. The workmanship and finish shall be of sufficiently high grade to insure satisfactory operation, reliability, and durability consistent with the application and storage life requirements of the starter.

4. QUALITY ASSURANCE PROVISION.

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the manufacturer may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the manufacturer's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the manufacturer of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective materials.

4.2 Classification of inspections. The inspections specified herein are classified as follows:

a. Qualification inspection (see 4.4 and table I).

b. Quality conformance inspection (see 4.5 and table II).

4.3 Manner of inspection.

4.3.1 Inspection conditions.

4.3.1.1 Ambient conditions. Unless otherwise specified, all tests shall be conducted within an ambient temperature range from 50 to 120°F and with exhaust conditions at the prevailing ambient pressure.

4.3.1.2 Pressure rate increase. The pressure rise shall be limited to the maximum opening rate specified in 3.3.1, and the pressure rise shall be smooth and at a positive rate. Zero time shall correspond to the first indication of pressure rise measured at the starter inlet flange.

4.3.2 Burn-in. All electrical and electronic parts of the starter shall be subjected to the burn-in check of 4.5.9 prior to starter assembly and submittal for qualification inspection or quality conformance inspection.

4.3.3 Vibration monitoring. A vibration transducer shall be attached to the starter and the vibration level monitored during all operational tests for qualification inspection and quality conformance inspection. Vibration above a mutually agreed upon limit shall be cause for rejection.

4.3.4 Data. The following data shall be recorded:

a. Drive speed (rpm).

b. Drive torque (lbf-ft).

c. Airflow rate (lbm/min).

d. Inlet air total pressure (psia).

e. Inlet air total temperature (^{o}F).

f. Vibration (in/sec).

g. Outlet air total pressure (psia)*.

h. Outlet air total temperature (^{o}F)*.

i. Outlet air static pressure (psia)*.

j. Lubricant temperature (^{o}F)*.

*These parameters may not be needed unless specifically required to determine acceptance performance.

4.3.4.1 Accuracy of data. The reported data for all starter calibrations and tests shall have a steady-state accuracy within the limits shown below. All instruments and equipment shall be acceptable to the Government and shall be calibrated as necessary to ensure that the required degree of accuracy is maintained.

a.	Torque	±1.0 percent of the rated output torque.
b.	Speed	±0.2 percent of the rated output drive speed.
c.	Airflow	±1.5 percent of the value being measured.
d.	Temperature	±2.0^{o}F up to 400^{o}F, ±5.0^{o}F above 400^{o}F, ±7.0^{o}F above 750^{o}F.
e.	Vibration velocity	±5.0 percent of the specified limit.
f.	Pressure	±1.0 percent of the maximum value.

4.4 Qualification inspection. Tests shall be conducted in the order deemed most desirable by the qualifying agency, except for the environmental tests which shall be run in the order shown. The starter shall be cycled at the conclusion of each operational test to verify that the starter can produce rated torque and speed. Failure to produce rated torque and speed, or to meet any other specified pass/fail criteria, shall be cause for rejection (see 4.4.11). The qualifying agency reserves the right to disassemble the starters partially or completely before, during and after qualification inspection.

4.4.1 Qualification sample. The qualification sample shall consist of two starters of each manufacturer's part number upon which qualification is desired. One additional shaft coupling shall be supplied with each starter. The starters and shaft couplings shall be accompanied by the model specification per 3.1.1, parts list per 3.5.4.2 and one complete set of drawings per 3.5.5. Each starter shall be identified by a securely attached tag that is clearly and durably marked with the following information:

SAMPLE FOR QUALIFICATION
SUBMITTED BY (manufacturer's name) ON (date) FOR QUALIFICATION IN ACCORDANCE WITH THE REQUIREMENTS OF MIL-S-19557/(insert specification sheet number and date) UNDER AUTHORIZATION OF (reference Navy letter authorizing tests)
STARTERS; AIRCRAFT ENGINE, AIR TURBINE
MANUFACTURER'S PART NUMBER:
NAVY WORK UNIT NUMBER:

The starters, QAD couplings, model specification, parts list and drawings shall be forwarded to the Naval Air Propulsion Center, 1440 Parkway Avenue, Gate 1, Trenton, NJ 08628. Authorization shall be obtained from the Naval Air Propulsion Center (ATTN: PE22), P. O. Box 7176, Trenton, NJ 08628-0176 prior to the submittal of the qualification samples.

4.4.2 Examination of product. Each starter shall be subjected to a careful inspection to insure proper assembly, configuration, workmanship, materials, finishes, processing, weight, identification and compliance with applicable specifications.

4.4.3 Mock-up. The manufacturer shall conduct a mock-up or trial installation to verify form and fit of the starter as required by this specification and to demonstrate compatibility with the applicable aircraft. Optimum port locations shall be determined in accordance with 3.3.2.10.1. Prior to the submittal of the starters to the qualifying activity, the manufacturer should arrange, with the Naval Air Systems Command (AIR-53631), Washington, DC 20361-5360, a mock-up or trial installation of the starter that is offered for qualification. Any costs incident to the actual mock-up or trial installation on the aircraft shall be borne by the manufacturer.

4.4.4 Operational tests. One starter submitted for qualification shall be supplied with air at the rated inlet conditions and shall be subjected to the following tests.

4.4.4.1 Initial calibration. The initial calibration shall consist of starter operation at six equally spaced increments from zero to the cutout speed and shall include the rated speed specified in 3.3.1. The data required by 4.3.2 shall be recorded at each condition. Stabilized speeds shall be obtained by loading the starter output shaft by means of a suitable loading device. The starter airflow and output drive torque versus output drive speed shall be within the limits specified in 3.3.1. External cooling may be used during this calibration if excessive lubricant temperatures will result from prolonged operation required to obtain stabilized data.

4.4.4.2 Overrunning test. This test applies to starters employing overrunning clutches. The test shall be accomplished at the maximum misalignment specified for the starter drive and there shall be no scheduled or unscheduled maintenance. The test shall consist of rotating the starter drive in accordance with the conditions specified on the specification sheet. No damage or excessive wear shall result from this test. If the starter is lubricated with oil, the oil loss shall be no greater than the requirement specified in 3.3.2.10.1.

4.4.4.3 Engagement test. A disengagement and reengagement test shall be conducted on the starter to demonstrate compliance with 3.3.2.4. The starter shall be disengaged and reengaged at speeds ranging from zero to cutout speed in equal increments selected to provide a minimum of ten engagements. No damage to the starter shall result from this test.

4.4.4.4 Torque limiting device test.

4.4.4.4.1 Shear section strength. After completion of all tests, both shear shafts of the two qualification starters shall be sheared and the shearing section torque recorded. The shear value shall not exceed the value specified in 3.3.2.5.1.

4.4.4.4.2 Slip clutch torque. The starter shall be locked to the engine accessory drive end of the torquemeter and air at the rated inlet conditions shall be supplied through the control valve specified in 3.3.1. Response rate of the instrumentation used shall have a flat frequency response to 1,000 Hz. The maximum torque measured shall not exceed the value specified in 3.3.2.5.2. If this torque is a function of initial starter drive position (e.g., as might occur with a jaw or ratchet and pawl-type drive), the starter drive shall be positioned initially so as to result in the highest torque being developed.

4.4.4.5 No load test. With the cutout switch inoperative, the starter shall be operated at the stabilized no load speed and for the period of time specified in 3.3.2.6, and shutdown. The no load speed obtained during this test shall not be less than that specified. There shall be no evidence of damage or failure.

4.4.4.6 Consecutive cycle test. The starter shall be operated without damage for the number of consecutive endurance test cycles specified in 3.3.2.7. Time between rundown to zero speed and initiation of the next cycle shall not exceed 15 seconds. External cooling shall not be permitted during this test.

4.4.4.7 Sustained motoring test. While coupled to a loading device, the starter shall be operated at rated speed and rated torque for the time specified in 3.3.2.8. No damage to the starter shall result from this test. External cooling shall not be permitted during this test.

4.4.5 Environmental tests.

4.4.5.1 Extreme temperature operation test. Thermocouples shall be located on the surface of the starter and inside the starter where the temperature is last to stabilize. The starter shall be placed in a test chamber and the temperature reduced to the minimum exposure temperature of

3.3.3.1. The internal temperature shall be stabilized for four hours and then increased to the minimum ambient temperature for one hour. The cutout switch shall be supplied with electrical power in accordance with 3.3.2.2 and shall function within the limits specified. If the starter is equipped with a slip clutch, the maximum torque shall be measured in accordance with 4.4.4.4.2 and shall not exceed the maximum breakaway torque specified in 3.3.2.5.2. The starter shall be subjected to three consecutive endurance start cycles of 4.4.6.1 when supplied with air as specified on the specification sheet. The temperature shall be increased to the maximum exposure temperature in not more than one hour. The internal temperature shall then be stabilized at the maximum exposure temperature for four hours. The temperature shall be reduced to the maximum ambient temperature for one hour. The starter shall again be supplied with air as specified on the specification sheet and subjected to three consecutive endurance start cycles. The surface temperature during the start cycles shall not exceed the value specified in 3.3.3.2.

4.4.5.2 Altitude test. The starter shall be installed in an altitude chamber and supplied with air at the rated inlet conditions. At least five altitudes between sea level and the maximum rated altitude of 3.3.3.3 shall be selected. The starter shall demonstrate rated torque and speed at each altitude and at the maximum rated altitude. The altitude shall then be changed to the maximum overrunning altitude of 3.3.3.3 and maintained for at least five hours. If the starter is equipped with an overrunning clutch, it shall be operated in accordance with 4.5.3 during this period. The altitude shall be returned to sea level and the starter shall demonstrate rated torque.

4.4.5.3 External load test. The starter shall be mounted in a static rig to demonstrate its capability to withstand the maximum external loads of 3.3.3.4. The acceleration loads, gyroscopic moments and reaction loads shall be applied separate and then in combination. Stress and deflection data shall be obtained at critical locations. The starter shall then be supplied with air at the rated inlet conditions and the starter shall produce rated torque and speed. The loads shall be increased to 1.5 times the figure 6 loads and the starter shall remain attached, but need not operate.

4.4.5.4 Attitude test. The starter shall demonstrate rated torque and speed at each of the test points around the clear area of figure 7. The starter shall also be operated in the overrunning mode for 30 minutes at each of the test points shown.

4.4.5.5 Humidity test. The starter shall be subjected to a humidity test in accordance with Procedure III, Method 507 of MIL-STD-810.

4.4.5.6 Rain test. The starter shall be subjected to a blowing rain test in accordance with Procedure I, Method 506 of MIL-STD-810. The starter shall be operated for two start cycles during the test.

4.4.5.7 Fungus test. The starter shall be subjected to a fungus test in accordance with Method 508 of MIL-STD-810.

4.4.5.8 Salt fog test. The starter shall be subjected to a salt fog test in accordance with Method 509 of MIL-STD-810.

4.4.5.9 Sand and dust test. The starter shall be subjected to an operating dust test and a nonoperating sand test in accordance with Method 510 of MIL-STD-810. The compressed air supply shall be contaminated with dust in accordance with the composition, size and concentration of I-3.2d and e. The starter shall be started twice with the contaminated air. The starter exterior shall then be exposed to blowing sand in accordance with Procedure II for 90 minutes per face (minimum: top, bottom, each side and the end furthest from the engine) while the starter is not operating. Following the blowing sand, the starter shall be operated for 50 start cycles with the contaminated compressed air supply. The starter shall be disassembled and there shall be no evidence of impending failure.

4.4.5.10 Nonoperational vibration test. The starter shall be subjected to vibrational test in accordance with Category 4, Procedure I, Method 514 of MIL-STD-810.

4.4.5.11 Explosion-proof test. All electrical components, including electrical connectors, not hermetically sealed shall be subjected to an explosion-proof test in accordance with Procedure I, Method 511 of MIL-STD-810. The starter shall be tested to the maximum external surface temperature of 3.3.3.2 and the maximum overrunning altitude of 3.3.3.3.

4.4.6 Reliability and maintainability tests.

4.4.6.1 Endurance test. The starter shall be subjected to an endurance test to demonstrate the mean-time-between-failures (MTBF) specified in 3.3.4, and the maintenance requirements of 3.3.5. The starter shall complete the endurance test specified on the specification sheet without damage to, adjustment of, or replacement of any of the component parts. The cutout switch shall be supplied with electrical power in accordance with 3.3.2.2 and shall function within the limits specified. After half of the endurance cycles have been completed, the wires to the cutout switch shall be reversed to demonstrate the polarity requirement. External cooling is permitted to expedite tests. If the starter is equipped with a slip clutch, it shall be subjected to a slip clutch torque test in accordance with 4.4.4.4.2 prior to completion of the endurance test. The torque test shall be conducted at prevailing ambient conditions.

4.4.6.1.1 Post-endurance calibration. The starter shall be subjected to a post-endurance test calibration at the same inlet air conditions and speeds as the initial calibration of 4.4.4.1.

4.4.6.1.2 Test completion. The endurance test will be considered satisfactorily completed when the following conditions have been satisfied:

a. The torque is not less than the minimum specified.

b. The airflow is not greater than the maximum specified.

c. There are no component failures or impending failures.

4.4.6.2 Maintainability/maintenance (M/M) demonstration. A M/M demonstration shall be performed to demonstrate the requirements of 3.3.5. The demonstration shall cover the complete disassembly and reassembly of the

starter, including a demonstration of the length of time and procedures used to remove and replace starter parts that are removed separately. During the demonstration the extent to which standard tools can be used for disassembly and reassembly shall be demonstrated. The maintenance inspection provisions shall be demonstrated to determine suitable location and access for inspection. The checking procedures and range of tolerances shall be demonstrated after the starter has been reassembled. The starter shall be mounted on a drive pad and all of its interface connections installed and removed at least 100 times. At the completion of the demonstration, the starter shall be installed in a test rig and supplied with air at the rated inlet conditions. The starter shall demonstrate its capability to produce rated torque and speed.

4.4.7 Structural tests.

4.4.7.1 Containment tests. A witness shield, constructed from 0.032-inch thick aluminum and cylindrical in shape, shall be used to serve as an energy level indicator for any particles ejected from the starter during this test. The shield shall be placed around the starter and displaced from the starter housing three inches. It shall extend from the starter mounting flange to three inches beyond the anti-drive end of the starter. The aluminum shall conform to QQ-A-250/1.

4.4.7.1.1 Hub containment test. Following teardown inspection of the starter which has completed the endurance testing, it shall be reassembled with the turbine wheel slotted to induce a three-equal-segment hub burst at a speed not less than the maximum cutout speed. The starter shall be operated with the output speed switch inoperative, and at the inlet conditions specified on the specification sheet. All components shall be contained within the starter housing, the starter housing shall remain attached to the mounting pad of the engine accessory drive, and the witness shield shall not be penetrated by any parts.

4.4.7.1.2 No load failure test. With the cutout speed switch inoperative and air at the inlet conditions specified on the specification sheet, the starter shall be operated until failure occurs and rotation ceases. All components shall be contained within the starter housing, the starter shall remain attached to the mounting pad of the engine accessory drive, and the witness shield shall not be penetrated. If the starter incorporates any device designed to prevent failure when subjected to the specified inlet conditions, then the starter be subjected to these conditions for 2.5 hours without failure of any component parts.

4.4.7.2 Proof spin test. Prior to any operational starter tests, all high speed parts shall be proof spun for ten seconds at the equivalent room temperature proof speed to verify the requirements of 3.3.6.3. Following the test all parts shall be within allowable limits and there is no evidence of imminent failure.

4.4.7.3 Proof pressure test. A proof pressure test shall be conducted to verify the requirements of 3.3.6.4. The specified pressures shall be maintained for two minutes. At the completion of the test there shall be no evidence of damage, distortion or external leakage. The starter shall be operated to verify that it can produce rated torque and speed.

4.4.8 Electrical tests.

4.4.8.1 Electromagnetic emissions and susceptibility test. All electrical parts of the starter shall be subjected to tests below in accordance with MIL-STD-462 to verify the requirements of 3.3.7.1.

4.4.8.2 Dielectric strength test. The electrical components of the starter shall be subjected to a dielectric strength test in accordance with Method 301 of MIL-STD-202. The magnitude of the test voltage shall be 1,050 volts direct current and shall be maintained for at least one minute between all mutually insulated circuits.

4.4.8.3 Insulation resistance test. The electrical components of the starter shall be subjected to an insulation resistance test in accordance with Method 302 of MIL-STD-202. Test condition B shall be used for a minimum of two minutes between all mutually insulated circuits and between all circuits tied together and the starter case or chassis.

4.4.9 Nuclear, biological and chemical (NBC) protection test. The NBC protection requirements of 3.3.8.1 shall be verified by the test delineated on the specification sheet.

4.4.10 Engine starting test. The starter shall be installed on an engine for which it was designed and subjected to the number of start cycles as specified on the specification sheet. The test shall be conducted at prevailing ambient conditions. At the end of the test the engine and starter pad dimensions shall be checked. All dimensions shall be within tolerances and there shall be no evidence of damage or imminent failure. Failure to start the engine shall be cause for rejection.

4.4.11 Teardown inspection. A teardown inspection consisting of complete disassembly of the starter shall be made at the completion of the qualification test. Dimensional inspection shall be made of all wearing parts. Rotating parts shall be subjected to Magnaflux or Zyglo inspection, except that assembled anti-friction bearings shall not be subjected to Magnaflux inspection. Rotating parts subjected to centrifugal stresses shall be measured on dimensions likely to show growth. Where practicable, seal clearances shall be determined. Failure of or any abnormal wear or damage to any part, sufficient to impair continued use of the starter, shall be sufficient cause for rejection of the starter.

4.4.12 Rejection and retest. Any starter failing to meet the requirements of the qualification tests shall be rejected and returned at the manufacturer's expense. Starters which have been rejected may be replaced or repaired to correct the defects and resubmitted for all specified tests. Before resubmitting, full particulars concerning previous rejection and the action taken to correct the original defects shall be furnished. Starters rejected after retest shall not be resubmitted without the specific approval of the qualifying activity.

4.4.13 Retention of qualification. Starters shall be retained on the qualified products list (QPL) by certification by a responsible management official. The official shall certify that the starter is still available, can

be produced under the same conditions as originally qualified and that the starter meets the requirements of the current issue of the specification. Certification shall be conducted at intervals not to exceed two years.

4.5 Quality conformance inspection. Each starter delivered under the production contract shall be subjected to the following examinations, calibration and checks.

4.5.1 Examination of product. Each starter shall be inspected thoroughly to insure proper assembly, configuration, workmanship, materials, finishes, processing, weight, identification and compliance with applicable specifications.

4.5.2 Rated torque calibration. When supplied with the rated inlet conditions of 3.3.1, the starter shall produce rated torque and speed, and the airflow shall not exceed the maximum specified. The starter shall be accelerated to the cutout speed of 3.3.2.1 and the starter shall disengage.

4.5.3 Overrunning check. This check applies to starters employing overrunning clutches. The check shall consist of rotating the starter drive to the maximum shaft speed for five minutes. The starter shall be disassembled sufficiently to insure that there is no damage or excessive wear as a result of this check.

4.5.4 Measured stall airflow check. The starter airflow at the stall condition shall be measured. The starter output drive speed shall not exceed 200 rpm during this check.

4.5.5 Proof spin check. Prior to any operational starter checks all high speed parts, such as the turbine wheel, shall be proof spun for ten seconds at the equivalent room temperature proof speed. Following the test all parts shall be within allowable limits and there shall be no evidence of imminent failure.

4.5.6 Proof pressure check. A proof pressure check shall be conducted to verify the requirements of 3.3.6.4. The specified pressures shall be maintained for two minutes. At the completion of the test there shall be no evidence of damage, distortion or external leakage. The starter shall be operated to verify that it can produce rated torque and speed.

4.5.7 Dielectric strength check. The electrical components of the starter shall be subjected to a dielectric strength test in accordance with Method 301 of MIL-STD-202. The magnitude of the test voltage shall be 1,050 volts direct current and shall be maintained for at least one minute between all mutually insulated circuits.

4.5.8 Insulation resistance check. The electrical components of the starter shall be subjected to an insulation resistance test in accordance with Method 302 of MIL-STD-202. Test condition B shall be used for a minimum of two minutes between all mutually insulated circuits and between all circuits tied together and the starter case or chassis.

4.5.9 Burn-in check. All electrical and electronic parts shall be subjected to an environmental stress screening (ESS) process in accordance

with category 4 or 5, as applicable, of MIL-STD-2164. The high and low temperature extremes of the chamber shall be the same as the exposure temperature range of 3.3.3.1, except when the external surface temperature limit of 3.3.3.2 is greater than the high extreme.

5. PACKAGING

5.1 Preservation.

5.1.1 Parts. All parts shall be sealed by closures conforming to MIL-C-5501 prior to initiation of the preservation procedure.

5.1.2 Cleaning. The surface of the starter shall be cleaned in accordance with MIL-P-116 Process C-1.

5.1.3 Drying. Drying shall be in accordance with MIL-P-116.

5.1.4 Preservation application. Preservation application shall be in accordance with MIL-P-116 Type P-3 or P-6.

5.1.5 Unit packs. The starter shall be wrapped or bagged in a grease proof paper conforming to MIL-B-121 Type I, Grade A, Class 1 and sealed with tape in accordance with A-A-884.

5.2 Packing. Packing shall be level A or C as specified (see 6.2.1).

5.2.1 Level A. The starter shall be individually packed in a premolded cushioning material conforming to PPP-C-850, MIL-R-20092, MIL-P-26514 or MIL-C-26861. Space shall be provided in the cushioning material, adjacent to the starter, for the desiccant. The volume to be provided for the desiccant shall be in accordance with MIL-P-116. The desiccant shall comply with MIL-D-3464 Type II. The starter shall then be packaged in a box conforming to PPP-B-636, Type CF, Domestic Class, Double Wall Variety, Grade 200.

5.2.2 Level C. Level C packing shall conform to MIL-STD-794 requirements for this level.

5.2.3 Unitized loads. When the gross weight exceeds 200 pounds or a volume of 40 cubic feet for shipment to one destination, the load shall be unitized in accordance with MIL-STD-147, Load Type Ia, Bonding Means and K with PPP-S-760 Type II strapping.

5.3 Marking. The exterior of each package shall be marked in accordance with MIL-STD-129 and shall include the following information:

NATIONAL STOCK NUMBER -
MANUFACTURER'S MODEL DESIGNATIONS -
ITEM DESCRIPTION - STARTERS; AIRCRAFT ENGINE, AIR TURBINE
SPECIFICATION - MIL-S-19557/__(AS) MODEL _____
QUANTITY AND UNIT OF ISSUE -
CONTRACT NUMBER -
DATE OF MANUFACTURE -
LEVEL OF PROTECTION AND DATE -

6. NOTES

6.1 Intended use. The air turbine starters described in this specification are intended to start the gas turbine engine onboard the aircraft specified on the specification sheet. The starters operate from compressed air supplied by ground support equipment, engine bleed air or other airborne supply.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number and date of this specification, and the applicable specification sheet number and title.

b. See applicable specification sheet (see 3.1).

c. Levels of preservation, packaging and packing (see 5.1).

6.2.2 Data requirements. When this specification is used in an acquisition and data which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL incorporated into the contract. When the provisions of DOD FAR Supplement, Part 27, Sub-Part 27.410-6 (DD Form 1423) are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the manufacturer in accordance with the contract or purchase order requirements. Deliverable data required by this specification is cited in the following paragraphs.

Paragraph no.	Data requirement title	Applicable DID no.	Option
3.1.1	Contractor Developed Specifications	DI-A-5026	--
3.5.4.2	Engineering Drawings and Associated Lists	DI-E-7031	--
3.5.5a	Engineering Drawings and Associated Lists	DI-E-7031	--
3.5.5b	Engineering Drawings and Associated Lists	DI-E-7031	--
3.5.5c	Engineering Drawings and Associated Lists	DI-E-7031	--
3.5.5d	Engineering Drawings and Associated Lists	DI-E-7031	--
3.5.5e	Engineering Drawings and Associated Lists	DI-E-7031	--
3.5.5f	Packing Requirements and Packing Drawings	DI-L-5475	--
3.5.5g	Contractor Design/Development Documents	DI-E-30136	--
3.5.6.2	Technical Report	UDI-S-23272	--

(Data item descriptions related to this specification, and identified in section 6 will be approved and listed as such in DOD 5010.12-L, AMSDL. Copies of data item descriptions required by the manufacturer in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion in Qualified Products List (QPL-19557) whether or not such products have actually been so listed by that date. The attention of the manufacturers is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Air Systems Command (AIR-53631), Washington, DC 20361-5360; however, information pertaining to qualification of the starter may be obtained from the Naval Air Propulsion Center (ATTN: PE22), P. O. Box 7176, Trenton, NJ 08628-0176.

6.4 Subject term (key word) listing.

Starters
Aircraft engine
Gas turbine

6.5 Changes from previous issue. Asterisks (*) are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

TABLE I. Requirements for qualification.

REF. - 4.2

4.4.1	Qualification sample
4.4.2	Examination of product
4.4.3	Mock-up
4.4.4	Operational tests (heading)
4.4.4.1	Initial calibration
4.4.4.2	Overrunning test
4.4.4.3	Engagement test
4.4.4.4	Torque limiting device test (heading)
4.4.4.4.1	Shear section strength
4.4.4.4.2	Slip clutch torque
4.4.4.5	No load test
4.4.4.6	Consecutive cycle test
4.4.4.7	Sustained motoring test
4.4.5	Environmental tests (heading)
4.4.5.1	Extreme temperature operation test
4.4.5.2	Altitude test
4.4.5.3	External load test
4.4.5.4	Attitude test
4.4.5.5	Humidity test
4.4.5.6	Rain test
4.4.5.7	Fungus test
4.4.5.8	Salt fog test
4.4.5.9	Sand and dust test
4.4.5.10	Nonoperational vibration test
4.4.5.11	Explosion-proof test
4.4.6	Reliability and maintainability tests (heading)
4.4.6.1	Endurance test
4.4.6.1.1	Post endurance calibration
4.4.6.1.2	Test completion
4.4.6.2	Maintainability/maintenance demonstration
4.4.7	Structural tests (heading)
4.4.7.1	Containment tests (heading)
4.4.7.1.1	Hub containment test
4.4.7.1.2	No load failure test
4.4.7.2	Proof spin test
4.4.7.3	Proof pressure test
4.4.8	Electrical tests (heading)
4.4.8.1	Electromagnetic emissions and susceptibility test
4.4.8.2	Dielectric strength test
4.4.8.3	Insulation resistance test
4.4.9	NBC protection test
4.4.10	Engine starting test
4.4.11	Teardown inspection
4.4.12	Rejection and retest
4.4.13	Retention of qualification

TABLE II. Requirements for quality conformance.

REF. - 4.2

4.5.1	Examination of product
4.5.2	Rated torque calibration
4.5.3	Overrunning check
4.5.4	Measured stall airflow check
4.5.5	Proof spin check
4.5.6	Proof pressure check
4.5.7	Dielectric strength check
4.5.8	Insulation resistance check
4.5.9	Burn-in check

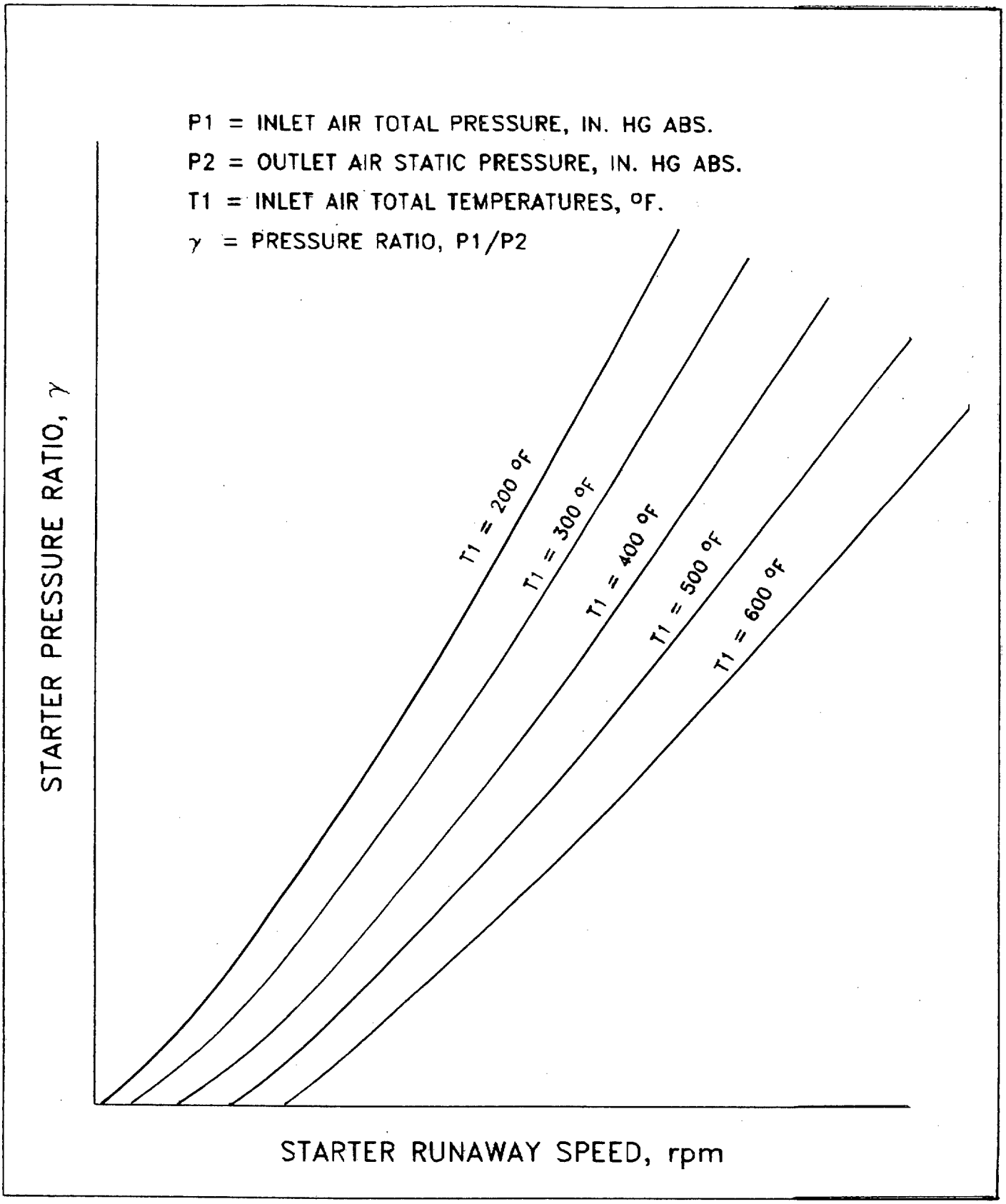


FIGURE 1. Starter no load speed.

REF. - 3.3.1

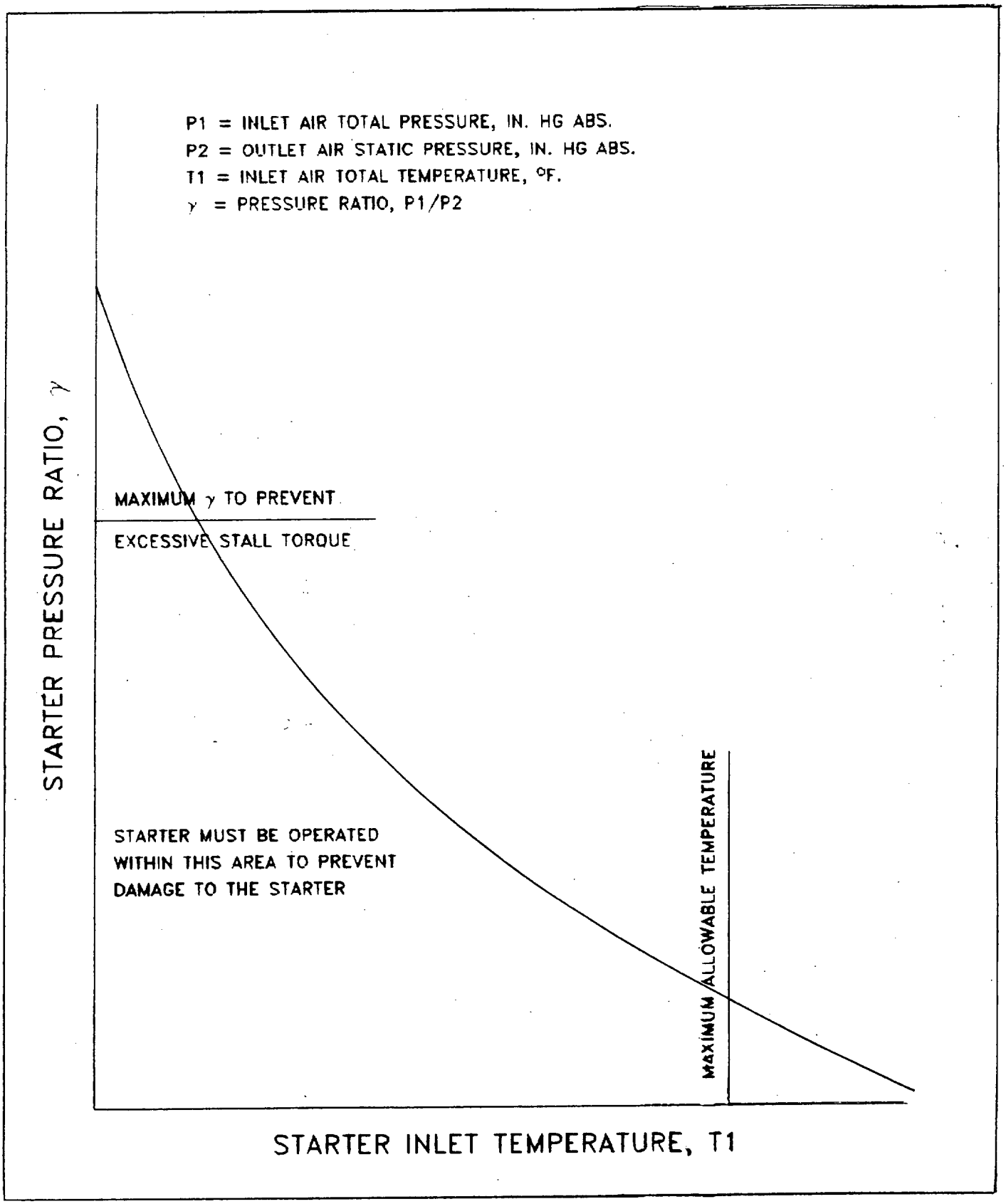


FIGURE 2. Pressure ratio limit to prevent starter overspeed.

REF. - 3.3.1

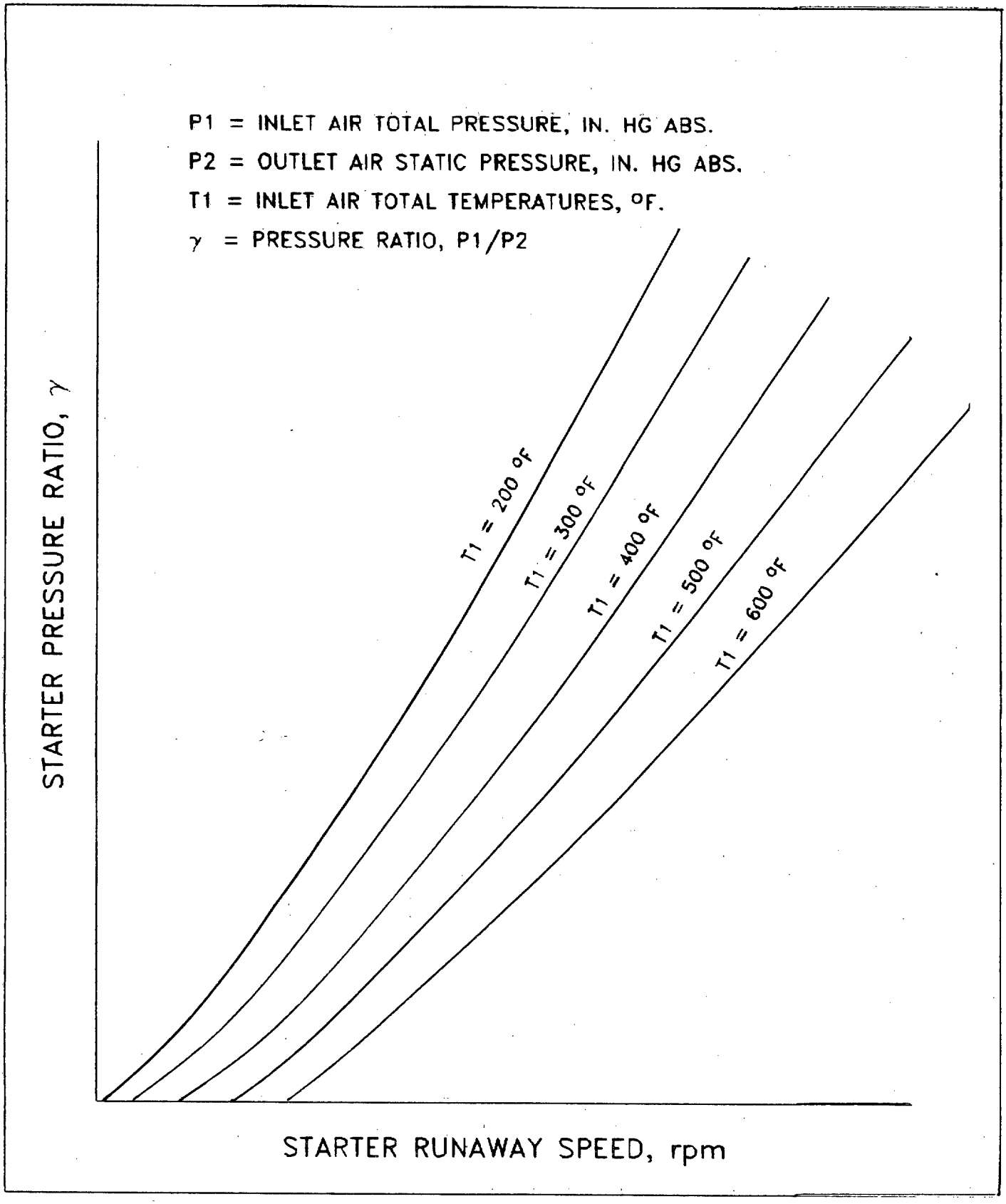


FIGURE 3. Starter performance under rated inlet conditions.

REF. - 3.3.1

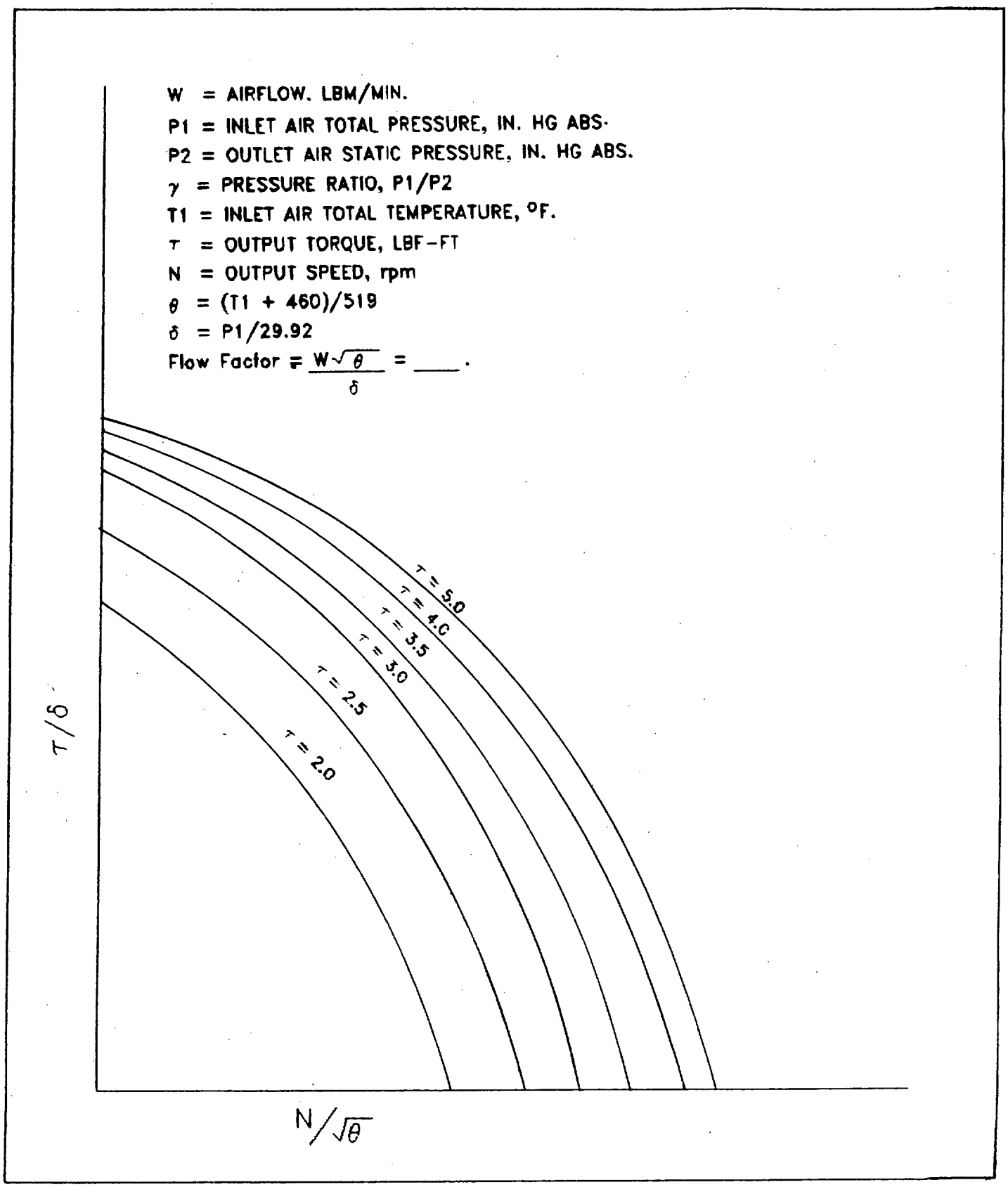


FIGURE 4. Starter performance under range of inlet conditions.

REF. - 3.3.1

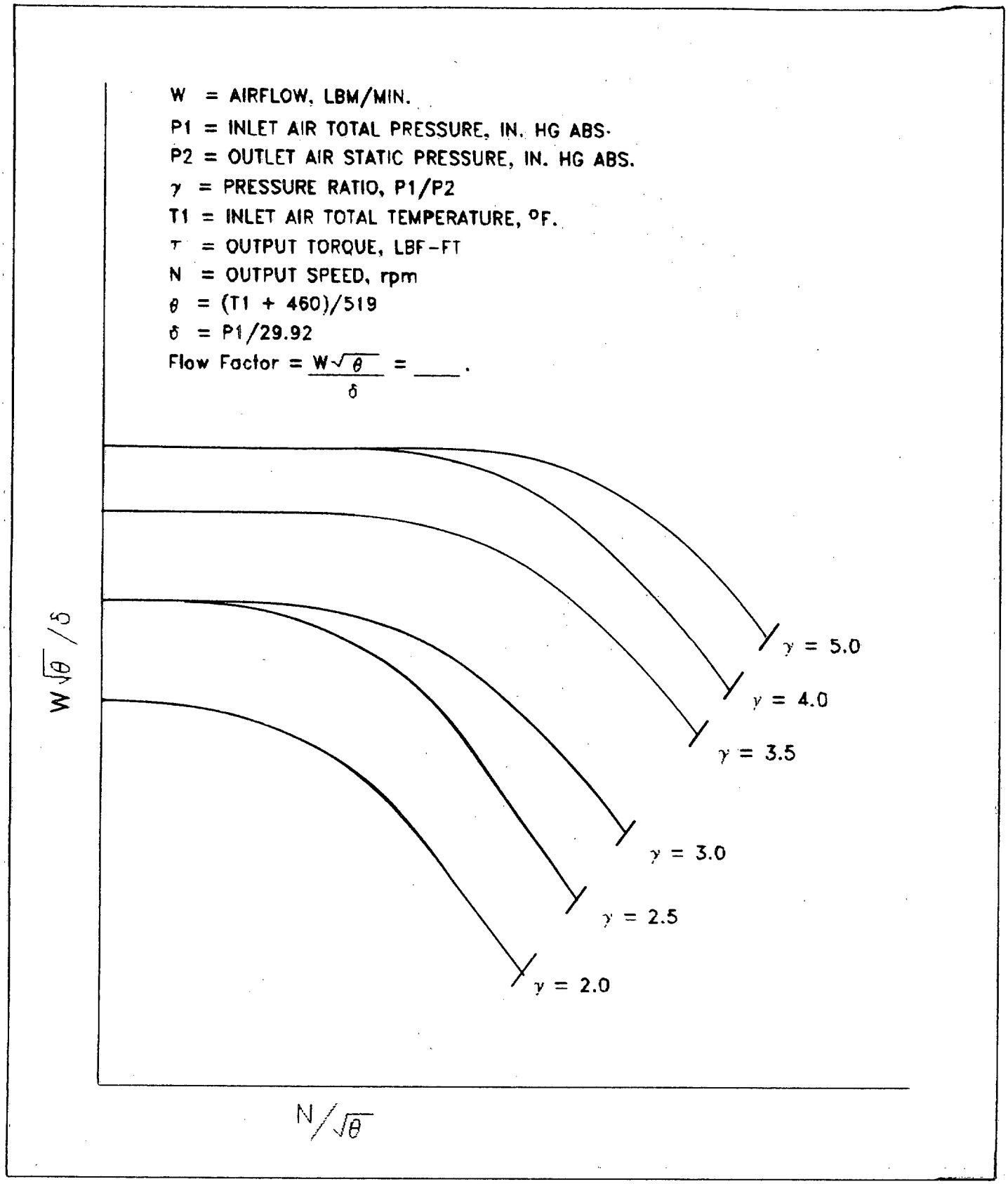


FIGURE 5. Starter performance under range of inlet conditions.

REF. - 3.3.1

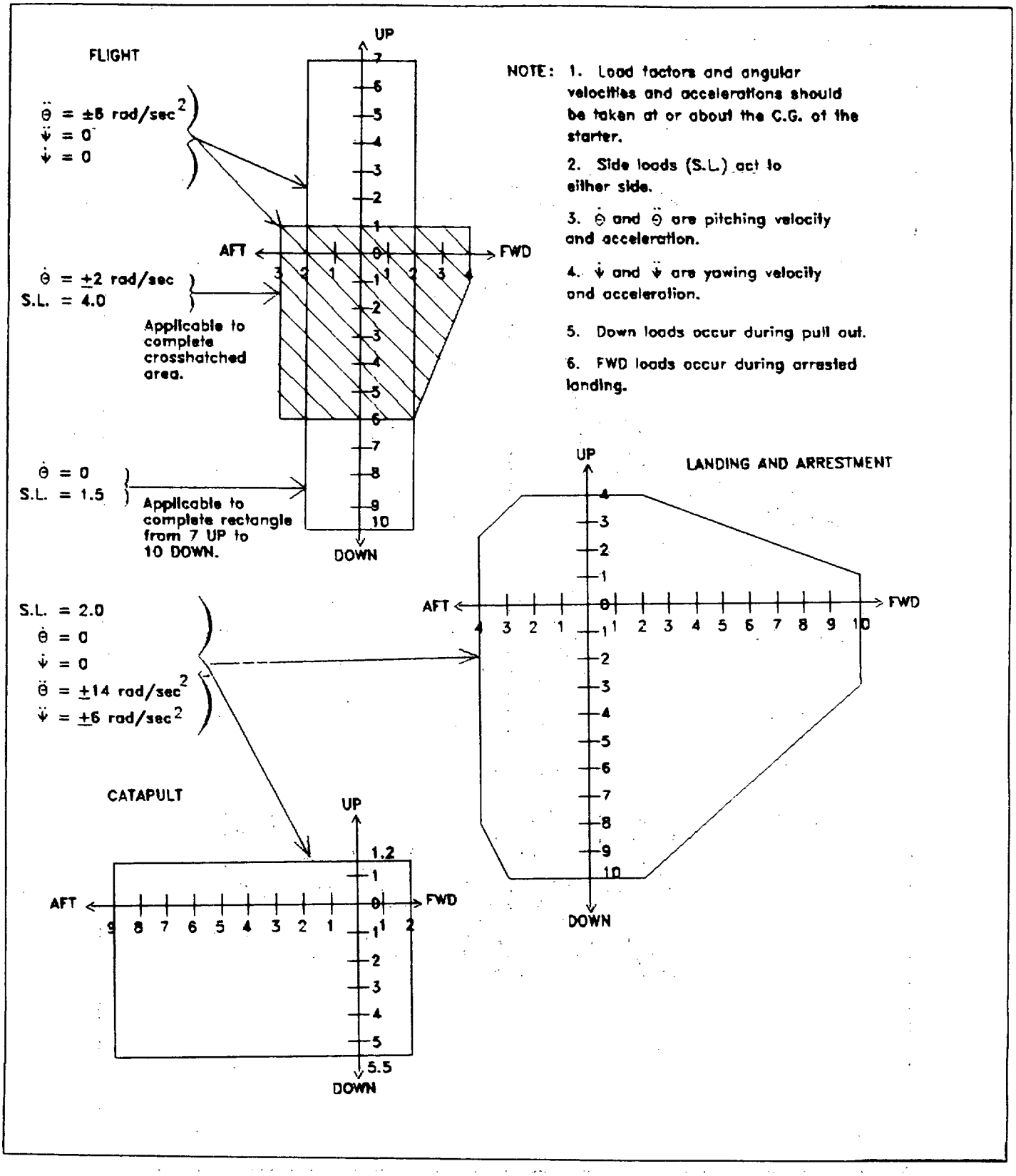
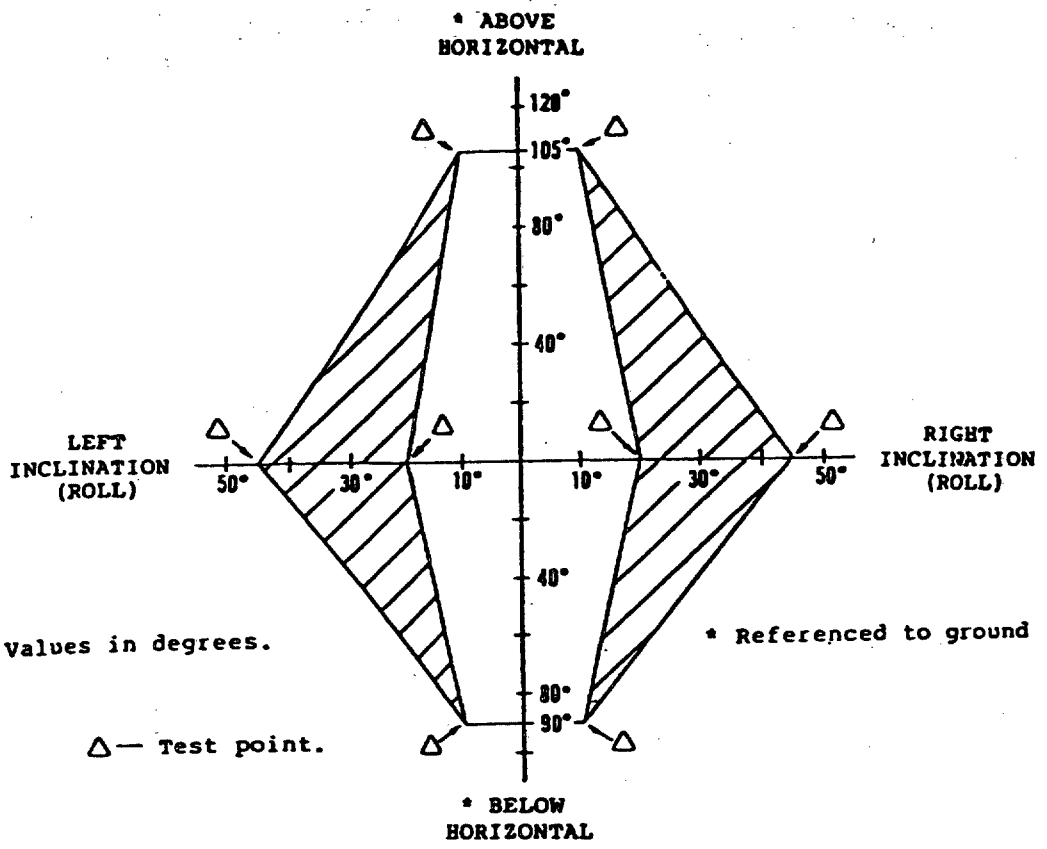


FIGURE 6. External loads.

REF. - 3.3.3.4



NOTE: 1. This figure defines the attitude limits under static ground test stand (gravity) conditions. The forces generated during maneuvering flight may have a combined or resultant effect that permits pitch and roll attitudes that exceed the limits of this figure without encountering a starter limiting condition.
2. The starter centerline is perpendicular to the plane of the page and looking forward from the rear of the starter.

FIGURE 7. Operating attitude.

REF. - 3.3.3.5, 4.4.5.4

ALPHABETICAL INDEX

TABLES AND FIGURES

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(Project 2995-N059)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ VENDOR ☐ USER ☐ MANUFACTURER ☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

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