MIL-P-26366A
15 NOVEMBER 1962
Superseding
MIL-P-26366 (USAF)
4 December 1958
(See section 6)

MILITARY SPECIFICATION

PROPELLER SYSTEMS, AIRCRAFT, GENERAL SPECIFICATION FOR

This specification has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force.

1. SCOPE

1.1 Scope. This specification covers standard requirements and tests for aircraft propeller systems.

1.2 Classification. The model designation will be assigned by the propeller system manufacturer in accordance with a system acceptable to the procuring activity and shall be specified in the model specification.

2. APPLICABLE DOCUMENTS

2.1 The applicable documents referenced in this specification and listed in the following publication, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein:

PUBLICATION

AIR FORCE-NAVY AERONAUTICAL BULLETIN

No. 343 Specifications and Standards Applicable to Aircraft Engines and Propellers, Use of

(Copies of documents required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Model specification. An aircraft propeller system model specification conforming to Specification MIL-P-26567 shall be submitted by the contractor for approval.

3.1.1 *Propeller system.* A propeller system shall consist of a propeller and propeller accessories. The components which make up the propeller, and the propeller accessories, shall be listed in the model specification (see 6.6.1.5).

3.2 Qualification and acceptance. The qualification and acceptance of any propeller system shall be in accordance with the provisions of section 4 of this specification.

3.3 Mockup. A full-scale mockup shall be prepared for examination as soon as the contractor has established the installation features of the propeller. After the propeller mockup has been approved, the propeller installation drawing shall be forwarded to the procuring activity for approval. Any changes required by the procuring activity shall be subject to negotiation as provided in the contract.

3.3.1 *Engine alterations.* Prior to the mockup, the installation and operation of the propeller shall not be predicated on subsequent alterations of the engine nose or output gearbox.

3.3.2 *Installation changes.* Changes to the propeller features requiring changes in the engine-aircraft installation made after approval of the mockup shall be submitted to the procuring activity for approval. The mockup shall be kept current with approved changes, at least through the first production contract.

3.4 Performance characteristics. The propeller system performance characteristics shall be specified in the model specification. These performance characteristics shall be determined using the specified electrical supply; the grade and quantity of lubricants and fluids, if applicable, together with the engine, engine control and aircraft system specified in the model specification.

3.4.1 *Lubrication.* The lubricants shall be selected from military specifications and shall be specified in the model specification. No change in lubricants shall be required for operation throughout the complete ground and air temperature range.

3.4.2 *Ratings*. The aerodynamic performance ratings shall be specified in the model specification.

3.4.3 *Estimates*. The estimated performance shall be specified in the model specification (see 6.4).

3.4.4 *Altitude-temperature limits for unfeathering and operation*. The unfeathering and operating limits shall be defined in the model specification.

3.4.5 *Flight conditions*. The propeller system shall function satisfactorily under the following flight conditions:

(a) Level posistion (horizontal) with the propeller inclined 20 degrees to either side.
(b) Level position (horizontal) with the propeller inclined 45 degrees to either side for a period of 30 seconds.
(c) Zero to 45 degrees below horizontal with up to 10 degrees inclination on either side.
(d) 90-degree below horizontal for a period of 30 seconds.
(e) Zero to 105 degrees above horizontal with up to 10 degrees inclination on either side.
(f) Flight operation under negative 1 "g" flight conditions for 60 seconds.
(g) Flight operation under zero "g" flight conditions for 30 seconds.

3.4.6 *Ambient temperature conditions*. The propeller system shall perform satisfactorily when supplied with the specified electrical power and the specified lubricants and fluids, if applicable, under the following conditions:

(a) Cold start: The propeller system shall be capable of rotation, after soaking in a static condition at sea level and -65° F for 8 hours, without damage to an-y part of the propeller system and shall function satisfactorily.
(b) Static unfeather: The propeller system shall be capable of unfeathering for air starting in 45 seconds after 8 hours of continuous soaking in a static condition at sea level and -65°F.
(c) High temperature: The propeller system shall be capable of rotation, after soaking in a static condition at sea level and + 160° F for 8 hours, without damage to any part of the propeller system and shall function satisfactorily.

3.4.6.1 *Airspeed and altitude*. The propeller system shall operate satisfactorily within the ambient temperature ranges shown in figure 1 throughout the airspeed and altitude operating limits specified in the model specification.

3.4.7 *Reverse thrust*. The propeller system shall operate satisfactorily in the reverse thrust condition up to the limits specified in the model specification.

3.4.8 *Static thrust*. The static thrust (pounds) generated by the propeller shall be specified in the model specification.

3.4.9 *Power transients*. During all permissible power transients and times of accomplishment of such. transients established for the engine, the propeller response shall be compatible with the transient engine performance requirements stated in the engine general specification. Characteristics of the propeller system which define response under transient conditions shall be specified in the model specification.

3.4.10 *Rotational speed*. The rotational speed of the propeller shall be specified in the model specification for the following conditions, as applicable:

Ground idle
Flight idle
Takeoff
Normal
Cruise

3.4.11 *Range and rates of pitch-change*. The pitch-changing mechanism shall adequately control the blades throughout all regimes of flight and ground operation. The maximum rate and range of pitch-change shall be specified in the model specification. The range of pitch-change shall be sufficient that zero rotation of the propeller can be obtained in the feathered condition in all engine out cruise regimes, and full power absorbed in reverse pitch at zero forward speed. The rate of pitch-change shall

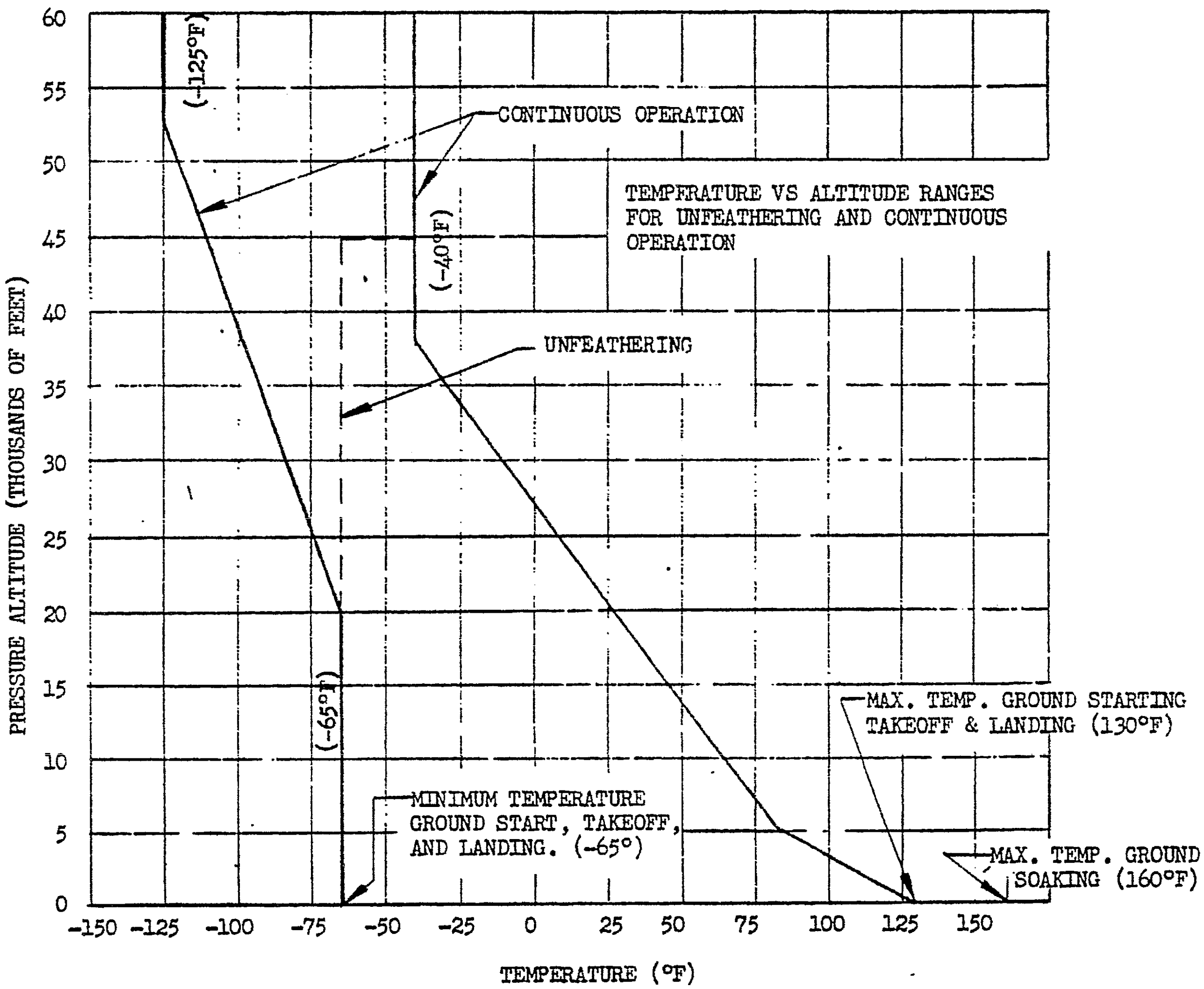


FIGURE 1. *Temperature range vs. altitude.*

be that necessary to limit transients in engine speeds to acceptable amounts.

3.4.12 *Maximum diameter*. The maximum diameter of the propreller(s) shall be specified in the model specification.

3.4.13 *Position*. The type of installation of the mounted propeller shall be specified in the model specification.

3.4.14 *Rotation*. The direction of propeller rotation as viewed from the rear of the aircraft, whether the drive is single or dual rotation, shall be specified in the model specificaiton.

3.4.15. *Number of blades*. The number of blades of the propeller, whether the construction is of fixed or removable blade configuration, shall be specified in the model specification.

3.4.16 *Design Aq*. The propeller shall be free of stress in excess of appropriate material endurance limits for the maximum design "Aq" condition anticipated for the aircraft, and the design "Aq" shall be specified in the model specification.

3.4.17 *Blade activity factor*. The blade activity factor shall be specified in the model specification.

3.4.18 *Polar moment of inertia*. The polar moment of inertia shall be specified in the model specification.

3.4.19. *Sound pressure fields*. The propeller manufacturer shall furnish the procuring activity the estimated around pressure field generated by the propeller throughout the range of operating conditions.

3.5 Materials and processes. Materials and processes used in the manufacture of aircraft propeller systems shall be suitable for the purpose, and shall conform to the applicable specifications in accordance with ANA Bulletin No. 343, When contractors specifications are used for materials and processes, such specifications shall be subject to approval by the Government. The use of nongovernmental specifications shall not constitute waiver of Government inspection.

3.5.1 *Dissimilar metals*. Unless protected against electrolytic corrosion, dissimilar metals shall not be used in contact with each other. Dissimilar metals are defined in Standard MS33586.

3.6 Standards.

3.6.1 *Standard parts*. AN or MS standard parts shall be used, where applicable, and shall be identified by their standard part numbers.

3.6.2 *Design standards*. MS and AND design standards shall be used wherever applicable.

3.7 Drawings and diagrams. The contractor shall furnish the following preliminary drawings and diagrams to the using service with the submission of the model specification and in addition shall incorporate reduced size copies of the same drawings and diagrams in the body of the model specification:

(a) Propeller installation including clearances for maintenance checking, adjustment, and removal of accessories and components subject to separate removal.

(b) Propeller accessory and component installation drawings (for units not mounted on the propeller).

(c) Electrical installation connection diagram showing the circuits internal and external to the propeller required for installation.

(d) Hydraulic installation interconnecting diagram showing interconnection between component units internal and external to the propeller required for installation.

3.8 Design and construction.

3.8.1 Structural and functional. The propeller shall be constructed with sufficient margin of structural reliability to preclude failure during its service life in its specified application. It shall function satisfactorily throughout the design envelope of the specified engine-aircraft combination.

3.8.2 *Propeller system design and construction changes*.

3.8.2.1 *Changes in design*. No changes shall be made in the design or materials of parts listed in approved propeller system parts list(s), except when such changes are approved in accordance with the provisions of ANA Bulletin No. 391.

3.8.2.2 *Approval of changes*. Approval of changes shall not relieve the contractor of full responsibility for the results of such changes on any propeller system characteristic.

3.8.3 *Changes in vendors*. For each specific propeller system model the contractor shall prepare a list of those processes, parts, components, and subassemblies which require substantiation test approved in the event of a change in the fabrication source, and shall include the specific substantiation testing required for each item. This list will be subject to the scrutiny of the local Government. inspector and the procuring activity to insure the completeness and the adequacy of the substantiation tests. However, the prime responsibility for effective control of all fabrication sources and changes in these sources shall rest with the contractor. No change shall be made in vendors or fabrication sources for the parts listed except when such changes are approved by the procuring activity.

3.8.4 *Parts list(s)*. The parts list(s) for the propeller system that successfully completes the qualification test shall constitute the approved parts list (s) for any subsequent propeller system of the same model to be delivered to the procuring activity. Changes to the approved propeller system parts list(s) shall be governed by the requirements specified in 3.8.2.

3.9 Reversibility. Wherever practicable, items and parts shall be designed to prevent reverse assembly or installation where such assembly or installation would cause a propeller malfunction.

3.10 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. The drawing number requirements of Specification MIL-D-70327 shall govern changes in the manufacturer's part numbers.

3.11 Accessibility. Insofar as practicable, parts of the propeller system requiring routine service checking, adjustment, or replacement shall be readily accessible for servicing without teardown of the propeller or removal of any major parts. The times required for all routine inspection, maintenance, and replacement actions shall be specified in the model specification.

3.12 Electrical systems.

3.12.1 *Electrical power*. Any limitation of the propeller system caused by loss of electrical power shall be specified in the model specification.

3.12.1.1 *External electrical power*. When power is required from the aircraft electrical system, the following shall apply:

(a) The electrical power requirements (of the propeller system) such as voltage, current, phase, and frequency shall be specified in the model specification.

(b) Propeller system electrical equipment shall operate satisfactorily under the applicable long term and transient voltage variations set forth in Standard MIL-STD-704.

3.12.2 *Radio interference*. All electrical and electronic components shall not cause radio interference beyond the limits specified in Specification MIL-I-26600.

3.12.3 *Ignition-proof*. All electrical components located in a potentially explosive environment that are not heretically sealed shall be ignition-proof in order not to ignite any explosive mixture surrounding the equipment.

3.12.4 *Connectors and cable*. It shall be possible to connector disconnect electrical connectors and to flex electrical conductors as necessary for routine maintenance, at a temperature of –65° F, without damage to these items.

3.12.5 *Grounding*. All electrical circuits shall be designed to preclude grounding or ground return through bearings.

3.13 Hydraulic systems.

3.13.1 *Hydraulic power*. Any limitation of the propeller system caused by loss of hydraulic power shall be specified in the model specification.

3.13.1.1 *Self-contained hydraulic system*. The capacity of the self-contained hydraulic system shall be specified in the model specification.

3.13.1.2 *External hydraulic power*. When externally supplied hydraulic power is required for the propeller system, the pressure, flow, and quantity requirements shall be specified in the model specification.

3.13.1.3 *Fluids*. The operating fluid shall be specified in the model specification. The fluid shall be selected from military specifications, and no change in fluid shall be required for operation throughout the complete ground and air temperature range.

3.13.1.3.1 *Fluid contamination*. Filter capacity shall be such as to allow operation between the filter inspection periods specified by the propeller manufacturer.

(a) Self-contained hydraulic systems: The propeller manufacturer shall specify the filtration requirements of fluid being installed in the systems.

(b) Non-self-contained hydraulic systems: The propeller shall operate on the fluid being supplied.

3.13.1.4 *Fluid lines and fittings*. It shall be possible to connect or disconnect fluid line fittings and to flex fluid lines as necessary for routine maintenance, at a temperature of –65° F without damage to these items.

3.14 Dry weight of propeller system. The dry weight of the propeller system shall not exceed that specified in the model specification. The weights of components which are included in the dry weight of the propeller system, and which are airframe or engine mounted, shall be listed.

3.14.1 *Weight of residual fluids*. The estimated weight of residual fluids remaining in the propeller after operation and drainage, while the propeller is in its normal attitude, shall be specified in the model specification.

3.15 Overall dimensions. The maximum overall dimensions of the propeller shall be shown on the installation drawing.

3.16 Flight maneuver forces. The propeller shall withstand without permanent deformation or failure the conditions specified in figure 2.

3.17 Ground support attachments. Mounting provisions shall be provided on the propeller for support. of the propeller on ground equipment. The location and dimensions shall be shown on the installation drawing.

3.18 Rotating parts.

3.18.1 *Vibration*. The propeller shall be free of destructive vibration at the rated propeller conditions including steady-state and tran-

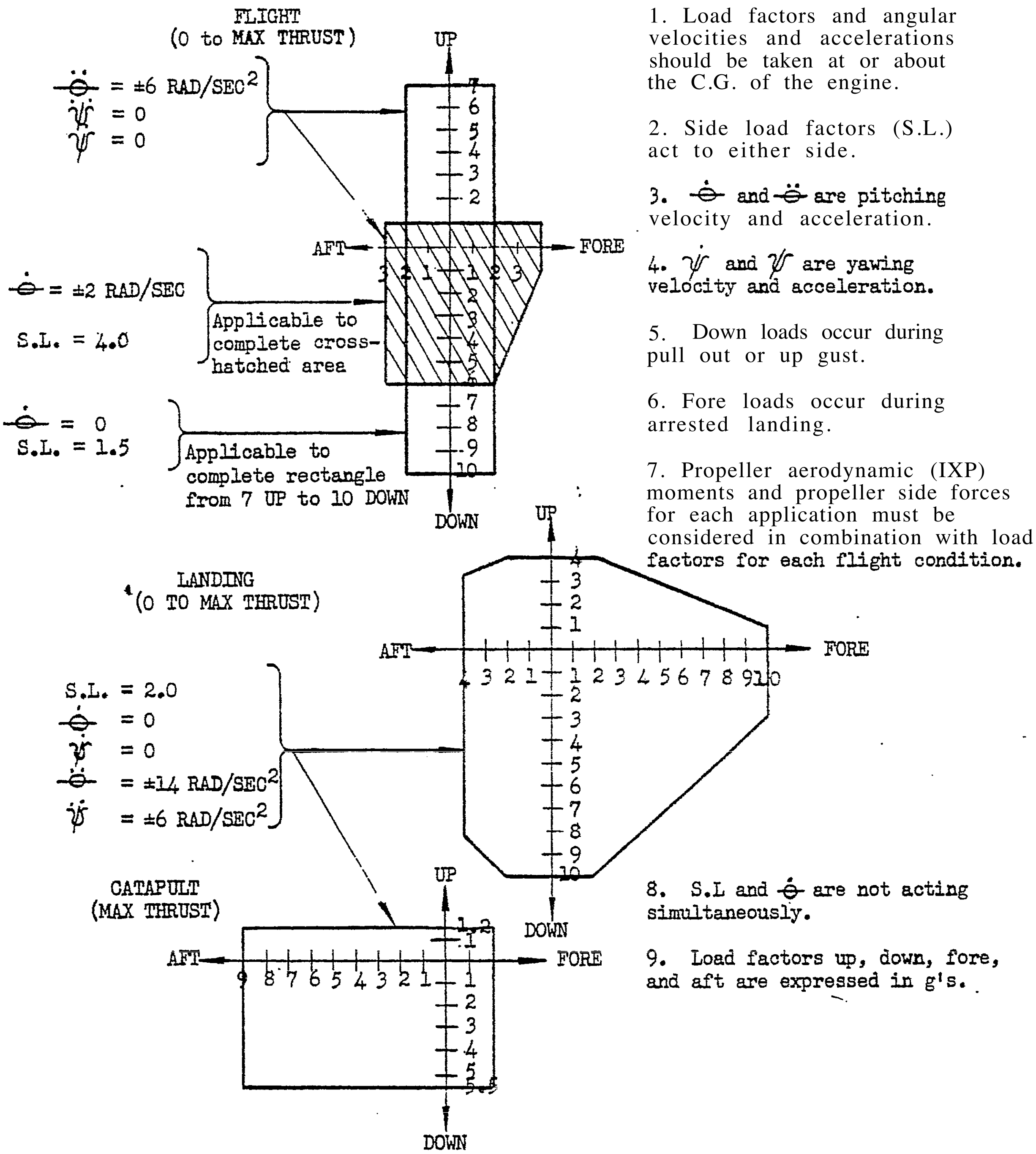


Figure 2. Flight maneuver load diagrams.

sient conditions of normal engine operation and within the Aq level specified in the model specification. Restrictions in propeller operating conditions determined by vibration surveys shall be listed in the model specification.

3.19 Propeller accessory limiting temperatures. Engine and engine compartment mounted propeller accessories shall be capable of continuous operation under normal operating conditions and under the maximum temperature conditions anticipated in their environment. Airframe mounted propeller accessories other than the above shall be designed to meet the ambient temperature limitations of Specification MIL-E-5272. Maximum temperatures of the environment and the accessories, heat rejection rates, maximum endurance times and maximum temperatures after shutdown, as applicable, shall be specified in the model specification.

3.20 Ice control system. The propeller shall incorporate an ice control system for the blades, cuffs, and spinner. Either electrical, fluid, gas, compound, or mechanical ice control systems or combinations of two or more of such systems may be used when approved by the procuring activity. The ice control system(s) shall be specified in the model specification. The propeller shall operate satisfactorily under the meteorological conditions included in table I.

TABLE I. Ice control design conditions

Attribute	Condition I	Condition II
Liquid water content	1 gram/cubic meter.	2 grams/ cubic meter.
Atmospheric air temperature.	−4° F	+23° F.
Flight velocity	Static	Static.
Altitude	Sea level	Sea level.
Mean effective drop diameter.	15 microns	25 microns.

3.20.1 *Type of ice control.* The type of ice control may be continuous, cyclic, or a combination of both as specified in the model specification. Unless continuous ice control is provided, operation of the ice control system shall be accomplished either automatically or manually as specked in the model specification. Continuous operation of the ice control system in flight shall not damage the propeller system. Requirements for indication of the operation of the ice control system shall be specified in the model specification.

3.20.2 *Electrical ice control system.*

3.20.2.1 *Electrical contact surface.* All aluminum-oxide films, lacquers, or similar nonconducting coatings shall be removed from the actual contact area of all surfaces required to act as a path for electrical power and from the local areas under screws, nuts, or the like used for assembly or mounting purposes to provide an electrical connection in accordance with the requirements of Specification MIL-W-5088.

3.20.22 *Electrical ice control circuits.* All electrical circuits pertaining to ice control systems shall be so physically and electrically isolated that no interference with the propeller operation or control will result. The leads used to conduct electrical power to the heating elements shall withstand the aerodynamic centrifugal and vibratory loading to which they will be subjected during propeller operation.

3.20.2.3 *Bonding materials.* Cements, adhesives, or brazing used to bond blade, spinner, or cuff electrical heating elements shall be specified in the model specification. Bonding processes which cause a reduction in physical properties of the item to which the element is bonded shall be specified in the model specification.

3.20.2.4 *Cover surfaces.* Surfaces exposed to the air blast shall consist only of materials designed to resist abrasion and corrosion. External surfaces of installed heating elements shall be aerodynamically smooth. Externally mounted rubber or plastic surfaced elements shall be inherently of sufficient flexibility and elasticity to allow installation in service areas without special dies, stretching equipment., etc.

3.20.2.5 *Blade heating area.* The heating elements shall heat the inboard section of the exposed blade length to the propeller radius approved by the procuring activity. The width of the blade heated on both the thrust and camber frees shall extend from the leading edge back to a distance at no point less than 17 percent of the blade chord.

3.20.2.6 *Cuff heating area*. The heating elements shall heat the leading edge of the cuff for its entire length and at least 20 percent of both cuff face areas emanating from the leading edge.

3.20.2.7 *Blade heating elements*. Heating elements for propeller blades not equipped with cuffs shall be continuous throughout their length. The heated area shall approach as near as practicable the juncture between the blade and spinner or hub. Heating elements for propeller blades equipped with cuffs may. be of two pieces with the cuff element and blade element separate, but compatible and designed for a single electrical supply circuit. The non-heated length between cuff and blade elements shall not exceed 2 inches. The external heating element installation shall result. in no distortion of the propeller airfoil contour.

3.20.2.8 *Spinner heating area*. The heating elements shall heat the entire area of the rotating spinner surface.

3.20.23 *Power requirements*. The power requirements of the ice control system depend on the mission, performance and design of the specific aircraft application and shall be specified in the model specification. Heating element wattage shall be calculated after reducing the voltage by an amount equal to the voltage drop in the complete circuit to each heating element. The type of phase loading, overload and open circuit sensing devices shall be described in the model specification.

3.20.2.10 *Cyclic heating controls*. A cyclic control unit shall be provided as a component part of the system. The schedule of the cyclic control shall be specified in the model specification.

3.20.3 *Fluid ice control system*.

3.20.3.1 *Fluid flow pattern*. The system shall accomplish a flow pattern of the fluid on the propeller blades, cuffs, and spinner, as necessary, to provide satisfactory ice control under the conditions of table I.

3.20.3.2 *Fluid*. The fluid, flow rate, and pressure shall be specified in the model specification.

3.20.3.3 *Connecting lines and fittings*.

3.20.33.1 Fittings. Straight thread fittings shall be in accordance with Specification MIL-F-5509.

3.20.4 *Compound ice control system*.

3.20.4.1 *Compounds*. The compound used shall produce a surface which will prevent ice adhesion when applied to the spinner, cuff, or blade surface as applicable. No damage to the protected surface shall occur from the solution resulting when the compound comes into contact with water. The kind of compound used shall be specified in the model specification.

3.20.4.2 *Protected blade area*. The blade area to be protected by the compound shall not be less than 75 percent of the blade length on inboard section and transversely from the leading edge to include approximately 25 percent of the chord.

320.4.3 *Protected cuff area*. The cuff area to be protected by the compound shall be at least 20 percent of the cuff area on both cuff faces along the entire leading edge.

3.20.4.4 *Protected spinner area*. The entire spinner surface shall be protected by the compound.

3.20.5 *Gas ice control system*. Gas ice control system shall produce sufficient heat to melt the layer of ice adhering to the surface of the blade, cuff, and spinner, as applicable, which will permit ice removal by action of centrifugal force or produce sufficient heat to prevent ice formation on the blade, cuff, and spinner, as applicable, and shall not affect the functional operation of the propeller or produce any undesirable structural or aerodynamic effects.

3.20.5.1 *Ice control pattern*. The system shall accomplish a pattern of heat on the propeller blades, cuffs, and spinners as necessary to provide satisfactory ice control under the conditions of table I.

3.20.5.2 *Heat requirements*. A complete definition of the heat source and heat requirements of the system shall be specified in the model specification.

3.20.5.3 *Controls*. Protective devices supplied as part of the propeller system shall be specified in the model specification.

3.21 Connection identification. The propeller shall be permanently marked for instrumentation and electrical and hydraulic connections. Similar fluid and electrical connections required in the propeller model shall be made physically non-interchangeable. All fluid lines shall be suitably identified,

3.22 Support. The propeller shall be of a mounting type conforming to and compatible with the engine or gear box design and shall be specified in the model specification. Where applicable, the propeller drive(s) used shall conform to the applicable standards listed on Standard AND10152.

3.23 Blade. Prime attention in the selection of materials find methods of construction of the blades shall be given to such factors as abrasion, moisture, corrosion, and other deteriorating operational factors that tend to adversely affect the structural integrity and safety.

3.23.1 *Blade pitch*. The propeller shall either be so constructed that when the blades are assembled in the hub, the difference between their mean aerodynamic angles shall not exceed 0.2 degree throughout the entire operating range as well as against the limiting pitch stops, or the propeller shall incorporate means of adjusting the individual blade angle in increments of 0.2 degree or less.

3.23.2 *Blade track*. Corresponding points adjacent to the tips of the blades of the propeller shall be in the same plane perpendicular to the axis of rotation within the tolerance specified in the model specification.

3.23.2 *Blade vent hole*. When vent holes are required they shall be specified in the model specification.

3.23.4 *Marking of blade*. A stripe of yellow enamel, 1/8 inch by 2 inches, conforming to Specification MIL-E-5556, color No. 33538 of Federal Standard No. 595, shall be applied on the thrust face of each blade. The stripe shall be along the chord of the referenced station used for blade indexing. The stripe shall be centered on the referenced chord within ±1/16 inch longitudinally and within ±½ inch laterally.

3.23.5 *Standard blade shank ends*. Ground adjustable blade shank ends shall be specified in the model specification.

3.23.6 *Finishing wood blades*. The external surface of wood blades shall be specified in the model specification. After finishing, the tip of each blade shall be painted for an inboard distance of 4 inches with enamel conforming to Specification MIL-E-5556, color No. 33538 of Federal Standard No. 595.

3.24 Hub. The hub shall withstand all loads imposed during all operating regimes of the propeller. Where applicable, the hub mounting shall conform to Standards AND10152, AS-127, and ARP502.

3.24.1 *Cone and cone seats*. Front and rear cones shall be in accordance with Standard MS-5007 and MS5008, as applicable. Cone seats of hubs having splined bores conforming to one of the specified standards in 3.24 shall be free from plating and capable of providing an evenly distributed bearing area contact and interchangeability of mating cones.

3.24.2 *Retaining nuts and map rings*. All retaining nuts and snap rings used on non-controllable hubs shall be in accordance with Standards MS5011 and MS5009, respectively,

3.25 Spinner. A spinner which provides an airflow compatible with airframe and engine requirements shall be specified in the model specification. Spinner designs shall provide access for inspection and servicing of the propeller pitchchange mechanisms, propeller brush block and slip ring assembly, oil filler opening, lubrication fittings and such other items as may be applicable to the installation. It shall accurately maintain its form in the installed position when rotating under operating conditions as well as when subjected to normal handling during maintenance or overhaul.

3.25.1 *Symmetry*. Dimensional symmetry shall be maintained throughout the entire axial length of the spinner.

3.25.2 *Balance provisions*. Provisions for correcting static or dynamic unbalance condition shall be specified in the model specification.

3.25.3 *Spinner-blade seals*. The seals shall be replaceable parts and mounted without restriction to movement between the blade and hub and capable of withstanding rotational forces without loss or impairment.

3.25.4 *Quick detachment*. Quick detachment features shall be incorporated in the spinner. External fasteners or other attaching means shall be designed and installed to pre-

668732 O -63 - 2

vent their separation from the spinner in the unlocked condition.

3.25.5 *Installation*. The spinner shall be such that when installed it shall in no way impair the strength of the propeller and shall not interfere with the functioning of the propeller or propeller controls. Mounting provisions for accurately centering the spinner on the hub shall be capable of withstanding frequent installation or removal of the spinner without damage.

3.26 Blade cuff. The type of blade cuff shall be specified in the model specification. The attaching means shall be such that injury will not result to the blade from chafing and maximum corrosion protection will be afforded.

3.27 Pitch-changing systems.

3.27.1 *Pitch-changing*. The pitch-changing system shall function satisfactorily throughout all regimes of flight and ground operation and shall be described in the model specification.

3.27.1.1 *Hydraulic operation*. When the pitch-changing system is hydraulically actuated, in whole or in part and the source of hydraulic power or fluid is self-contained, the system shall be independent of the engine lubricating system and the aircraft hydraulic system. If the engine lubricating oil is used, the propeller manufacturer shall utilize the oil passages provided by the applicable engine or external lines if passages are not provided.

3.27.1.2 *Electric operation*. When the pitch-changing system is electrically operated, in whole or in part, the voltage and frequency of the current for which the pitch-changing system is designed shall be compatible with the aircraft electrical system. In cases where the propeller manufacturer provides the source of power that is independent of the aircraft electrical system, the electrical source shall be contained within the propeller.

3.27.1.3 *Mechanical operation*. When the pitch-changing system is entirely mechanically operated, the pitch change operating force shall be available at all propeller speeds. Provisions for unfeathering of the propeller shall be provided.

3.28 Control system.

3.28.1 *Performance*. The control system shall control propeller operation to attain the steady-state and transient propeller performances specified in the model specification.

3.28.2 *Provisions*. The propeller control system shall include all necessary provisions required for proper and complete automatic, manual, or emergency control of the propeller. These provisions shall be specified in the model specification. These provisions depend upon the requirements for a given application and will include one or more of the following:

(a) All elements of self-contained type propeller control systems required for speed governing in normal or reverse pitch, for control in the beta regime, and for emergency features shall be contained within the propeller and shall function independently of the synchronizer. The only elements that may be mounted remotely are the synchronizers of the governor trimming type, the elements that must be incorporated in the pilot's or flight engineer's power control unit, sources of emergency signals such as negative torque signals (NTS) and items of secondary importance (i.e., tachometer generator). In other type systems, emergency features not self-contained within the propeller shall be specified in the model specification.

(b) The primary features of self-contained type propeller control systems shall function independently of the engine oil system or the aircraft electrical system insofar as flight safety features are concerned. Other functions such as back-up protection or those that do not involve flight safety of the aircraft such as speed synchronization, phase synchronizing, or feathering near zero rpm may utilize electrical power from the aircraft electrical system. In other type control systems, functions dependent upon the engine oil system or the aircraft electrical system, shall be listed in the model specification.

(c) The propeller control system shall incorporate the following emergency features:

(1) A mechanical low pitch stop.

(2) A feathering system operable under all flight conditions including windmilling dives. An emergency means of initiating feathering shall be incorporated which is independent of the normal means for such operations.

(3) A control linkage which when connected with the engine NTS output mechanism shall provide protection against catastrophic drag.

(4) An adequate mechanical pitch look that shall engage in the event of overspending or loss of hydraulic pressure or similar failure. The pitch lock shall act, when engaged, to prevent motion of the blades toward low pitch in the normal governing range but shall permit motion of the blades toward high pitch. Pitch lock settings shall be specified in the mode? specification.

(d) Phase synchronization that shall maintain the blade phase angle relationship of all propellers to one another within ± 15 degrees under all normal steady-state flight conditions in smooth air.

(e) Reverse operation to a fixed negative blade angle compatible with the engine. Overspeed during propeller reversal shall be compatible with engine overspeed limits. Maximum time to reverse from the low pitch stop shall be as specified in the model specification.

(f) The propeller response shall be sufficiently rapid that it will not permit overspeeds in excess of those specified in the engine model specification. Transient limitations may be a function of the engine overspeed mechanism on installations where applicable. The system exclusive of the synchronizer shall prevent speed oscillations in excess of ±0.5 percent under stabilizer flight conditions.

3.28.3 *Speed synchronization*. Synchronization of propellers for multi-engine aircraft shall be provided as a secondary speed control and shall be specified in the model specification, The control shall act to maintain the rotational speed of the slave propeller(s) to that of the master propeller within ±2 rpm in the propeller normal governing range.

3.28.4 *Governing*. Normal and reverse governing shall be specified in the model specification. Selective constant speed governing at any selected speed within the range necessary for. optimum performance of the applicable engine shall be incorporated in the propeller,

3.28.4.1 *Governors*. Where the propeller is controlled by a governor which is not an integral part of the propeller assembly, the governor shall be constructed to conform to the mounting specified by the applicable engine model specification. The governor shall regulate the propeller speed between the limits specified in the model specification.

3.28.5 *Input mechanism at the propeller*. A single input (pitch actuating) mechanism shall be provided for the propeller to modulate blade pitch throughout the operating range.

3.28.5.1 *Input mechanism travel*. The total travel and position of this mechanism shall be compatible with the aircraft system. In the governing and beta regimes, the relationship between the motion of the propeller input mechanism and resulting changes in governor setting and propeller pitch shall be essentially linear.

3.28.5.2 *Reversing input mechanism*. If reversing features are provided as part of the propeller system, a reverse thrust condition shall be reached by movement of an appropriate input. mechanism. The total travel and position shall be compatible with the aircraft system.

3.28.5.3 *Input mechanism torque*. The torque required to operate the input mechanism through its range of travel shall not exceed 25 pound-inches and torque variation shall not exceed 10 pound-inches. With the propeller operating, the absence of external torque shall not result in input mechanism creep within the operating range. The estimated input mechanism torque shall be specified in the model specification.

3.28.6 *Control system adjustment*. External adjustment to the control shall be limited to adjustments which can be made correctly with the propeller assembled. These adjustments shall be clearly marked and accessible with the propeller installed. All other adjustments shall be protected to avoid tampering. The external adjustments shall be specified in the model specification.

3.28.6.1 *Adjustments*. When adjustments of limiting values of the controlled propeller variables are required, positive features shall be provided so that it shall not be possible to preset the adjustments to the extent that will result in catastrophic consequences to the aircraft.

3.28.7 *Ground handling control*. Adequate provisions shall be provided for situations in which it is desired to change pitch while the propeller rotational speed is at zero.

3.28.8 *Maintainability*. The propeller and control assemblies shall provide for simple adjustment, ready accessibility, and adequate field cleaning procedures.

3.28.9 *Reliability*. The propeller control system shall be designed for inherent reliability. The system shall be designed to prevent propeller overspeeds beyond limits specified in the model specification. Either manual or automatic safety features may be provided to insure the foregoing reliability.

3.28.10 *Failure analysis*. A failure analysis shall be submitted to the procuring activity for review prior to initiation of the qualification test.

3.28.11 *Stress analysis*. A stress analysis of all important propeller components, with particular emphasis given to vital components as indicated by the failure analysis shall be submitted to the procuring activity for review in conjunction with the failure analysis. The stress analysis shall include prediction of the magnitude of steady stresses (or loads) and prediction of the magnitude and frequency of the vibratory stresses (or loads).

3.29 Component mounting. Components mounted on the nose of a reciprocating engine shall be specified in the model specification, and these mountings shall conform to the applicable standards listed on Standard AND10152. Components mounted on the nose of other types of engines or gear boxes shall be located to provide the necessary installation clearances as specified in 3.7. Those components mounted at other locations on the engine shall conform to the provisions provided on the engine.

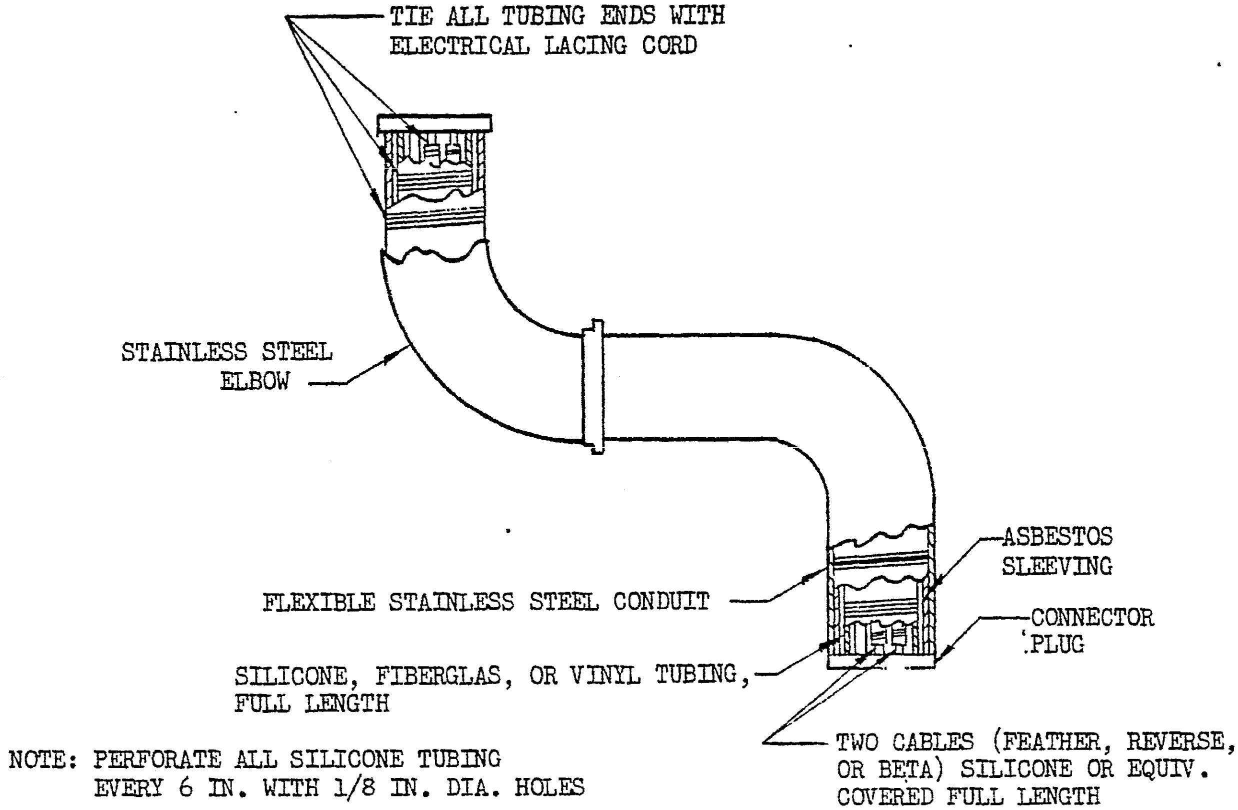
3.29.1 *Attaching parts*. Attaching parts utilized for either installation of a propeller or components and provided by the propeller contractor shall be listed in the model specification.

3.30 Electrical harnesses. Electrical harnesses furnished by the propeller contractor as components for the propeller control or ice control systems shall be so constructed as to withstand the environmental conditions to which they will be exposed, including vibration, temperature, abrasion, moisture and fire. An acceptable harness construction is shown in figure 3. Harnesses shall be specified in the model specification.

3.31 Balance.

3.31.1 *Blade*. Prior to painting, all blades shall be balanced against a master balance which has ben approved by the procuring activity. The blade shall balance horizontally and vertically at any two blade angles 90 degrees apart. The rotation of the blade caused by horizontal out-of-balance shall be stopped or reversed by an opposite moment determined as the weight of the blade times an eccentricity of 0.002 inch except that a moment of 0.10 pound-inch minimum shall be used. The rotation of the blade caused by vertical out-of-balance shall be stopped or reversed by an opposite moment determined as the weight of the blade times an eccentricity of 0.004 inch except that a moment of 0.20 pound-inch minimum shall be used. It is permissible to use equipment of equivalent accuracy in which the unbalance is determined with the blade centerline located in either a horizontal or vertical position, Where balancing equipment other than knife edges is used, the unbalanced moment specified above may be applied as scale rending deviations from the specified master moments.

3.31.1.1 *Ground adjustable*. For correction of horizontal balance in ground adjustable blades a concentric hole shall be bored in the



HARNESS DATA TYPICAL FOR ALL PROPELLER INSTALLATIONS

1. ALL HARNESS ASSEMBLIES WILL BE FABRICATED OF FLEXIBLE STAINLESS STEEL PER SPECIFICATION MIL-T-7880, TYPE II, GRADE A.
2. ALL CABLES WILL BE HIGH TEMPERATURE WIRE IN ACCORDANCE WITH SPECIFICATION MIL-W-25038.
3. ASBESTOS SLEEVING (PREFERABLY IMPREGNATED WITH PLASTIC ON EXTERIOR) WILL BE PLACED OVER THE ENTIRE CABLE BUNDLE AND SECURELY TIED AT BOTH ENDS.
4. SILICONE, FIBERGLAS, OR VINYL TUBING WILL BE PLACED OVER THE FEATHER, REVERSE, OR BETA INDIVIDUAL CABLES FOR FULL CABLE LENGTH.
5. CABLE BUNDLES WILL BE COVERED WITH THE TUBING THE ENTIRE LENGTH WHEN THE HARNESS REQUIRES SHARP BENDS.
6. ELECTRICAL LACING CORD PER SPECIFICATION MIL-T-713, TYPE P, CLASS I, SHALL BE USED TO TIE ALL SLEEVING AND TUBING ENDS.
7. CONNECTORS SHALL BE FIREPROOF, MOISTURE-PROOF, AND DESIGNED TO WITHSTAND HIGH VIBRATION REQUIREMENTS. CONNECTOR TERMINALS SHALL BE CRIMP TYPE AND SCINTILLA FIREPROOF CONNECTORS ARE THE ONLY APPROVED SOURCE TO DATE (NO SUBSTITUTES).
8. FERRULES - STAINLESS STEEL BRAZED TO FLEXIBLE STAINLESS STEEL CONDUIT.

FIGURE 3. *Typical harness section.*

shank end of the blade in such a manner that it will not be detrimental to the strength of the blade. The balancing material placed within the hole shall be adequately secured.

3.31.1.2 *Wood*. Final balance of wood blades shall be attained by the removal of material not to exceed the minimum allowable tolerances specified in the model specification. Other means shall be subject to approval by the procuring activity, as shown in figure 4.

3.31.2 *Hub*. The rotation of the hub caused by out-of-balance shall be stopped or reversed by an opposite moment determined as the weight of the hub times an eccentricity of 0.0005

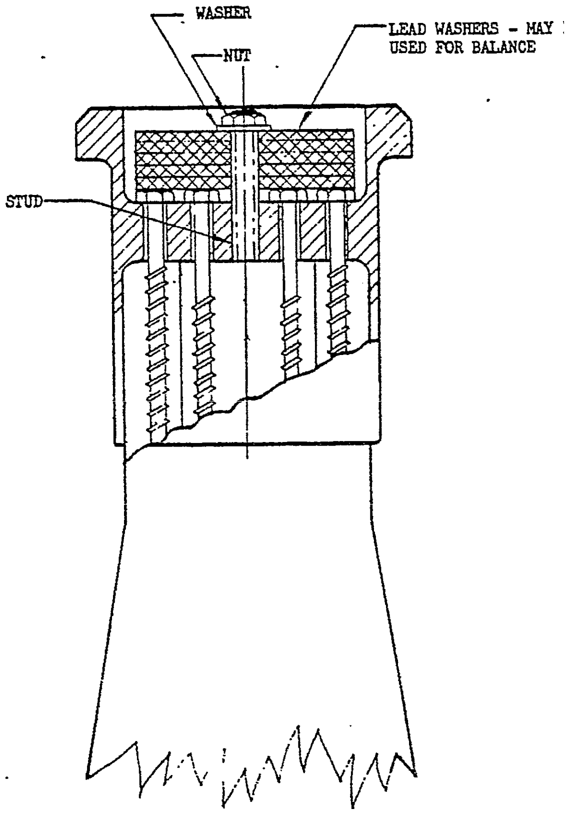


FIGURE 4. Balancing blade.

inch applied in such a manner that no force other than the mass of the applied balancing or reversing weight is the indicating feature. When equipment other than knife edges is used the same tolerance shall be applied in an equivalent manner.

3.31.2.1 *Ground adjustable*. The hubs Shall be balanced without the clamp rings being in place. In order to attain final balance of the finished hub about the axis of the shaft, metal may be removed as shown on the manufacturers drawing.

3.31.2.2 *Controllable pitch*. In the case of hubs which have been provided with means of correcting the unbalance of the completely assembled propeller, the balancing of the hub assembly shall be accomplished with this balancing means adjusted to its neutral or mean position so as to retain its maximum effectiveness for correcting any unbalance of the completely assembled propeller. Other means shall be used to correct any unbalance of the hub assembly.

3.31.2.3 *Fixed pitch*. Final balance of the finished hub about the axis of the shaft shall be attained without the addition of weights. Metal may be removed as specified on the manufacturers drafting to meet the final balance requirement.

3.31.3 *Spinner*. The means used to support. the spinner for balancing shall provide the same degree of accuracy of centering and aligning the spinner as will be obtained when the spinner is installed on the propeller.

3.31.3.1 *Static*. The assembled spinner with all parts attached shall be balanced on knife edges so that the rotation of the spinner caused by out-of-balance shall be stopped or reversed by an opposite moment. The opposite moment shall be determined as the weight of the spinner times an eccentricity of 0.0005 inch, applied in such manner that no force other than the mass of the applied balancing or reversing weight is the indicating factor. Other equipment of equivalent accuracy may be used in which case the unbalance may be applied as a scale reading.

3.31.3.2 *Dynamic*. The assembled spinner with all parts attached shall be balanced at 550 ±50 rpm on a machine having an accuracy of correction for balance in terms of displacement of 0.000025 inch, to secure an unbalance of not more than 2.0 ounce-inches in each of two planes.

3.31.4 *Propeller*.

331.4.1 *Provisions*. Provisions shall be made for attaching balance weights in each of two balancing planes located as far apart axially as practicable, fore and aft of the plane of the blades. Points of attachment must be readily accessible with the propeller mounted on the aircraft.

3.31.4.2 *Static*. The rotation of the propeller caused by out-of-balance shall be stopped or reversed by an opposite moment. The opposite moment shall be determined as the weight of the propeller times an eccentricity of 0.0005 inch applied in such manner that no force other than the mass of the applied balancing or reversing weight is the indicating factor. The balance requirement shall be met with any blade in a vertical and horizontal position. It is permissible to use equipment giving equivalent accuracy which balances the propeller in a horizontal plane, in which case the unbalance may be applied as a scale reading.

3.31.4.2.1 *Ground adjustable*. Horizontal balance shall be accomplished as specified in 3.31.4.2 without additional provisions.

3.31.4.2.2 *One-piece wood*. One-piece wood propellers shall be balanced with a hub bolted securely onto the propeller. Balance may be secured by the application of liquid finish to the lighter blades for horizontal balance, or by securing a brass plate to the wood portion of the hub for vertical balance.

3.32 Propeller reverse or beta tel-lights. When required, signal provisions shall be provided in the propeller for reverse tel-lights or beta tel-lights and shall be specified in the model specification.

3.33 Fail-safe provisions. With the exception of primary structural components, fail-safe provisions shall be provided. This shall be accomplished by use of designs requiring double failures or otherwise providing adequate protection against the consequences of such failures.

3.34 Environmental conditions. The propeller shall satisfy the applicable requirements when subjected to the following tests:

(a) Hot soak -------------------------- (4.6.2.3)
(b) Cold soak ------------------------- (4.6.2.4)
(c) Humidity ------------------------ (4.6.2.6)
(d) High altitude ----------------------- (4.6.2.5)
(e) Salt spray ------------------------ (4.6.2.9)
(f) Vibration endurance ------------ (4.6.4.4)
(g) Fungus --------------------------- (4.6.2.8)
(h) Sand and dust ------------------ (4.6.2.7)
(i) Explosion-proof ------------------ (4.6.2.10)

3.35 Flutter. The propeller shall be free from flutter under static conditions up to 120 percent rated engine speed and at powers up to the standard day takeoff power rating of the engine, or up to the ram power rating of the engine, whichever is specified in the model specification.

3.36 Mechanical shock. The propeller shall function satisfactorily under all conditions of shock to which it will be exposed during all flight regimes of the aircraft operation. Those parts requiring special attention, because of the shock environment, together with the magnitude and frequency of the shock application shall be specified in the model specification.

3.37 External mechanical power. When external mechanical drives for mounting and driving propeller components are utilized, they shall be specified in the model specification. These drives shall conform to the applicable standards listed on standard AND10230.

3.38 Cover plates. Cover plates for covering all drive openings when the component is not mounted for propeller shipment, shall be supplied with each propeller. Suitable provisions for covering or plugging all other connection openings shall be made.

3.39 Pressure connections. Connection bosses on the propeller for transmitting fluids from the engine to the propeller shall conform to Standard AND10050.

3.40 Screw threads.

3.40.1 *Straight screw threads*. All conventional straight screw threads shall conform to the requirements of Specification MIL-S-8879. If allowance is required for elevated temperature, corrosive atmosphere, or other conditions which may cause thread seizure this allowance shall be obtained by increasing the diameters of the internal threads.

3.40.2 *Tapered pipe threads*. Tapered pipe threads may be employed only for permanently plugging drilled or cored openings and shall conform to the requirements of Specification MIL-P-7105.

3.41 Protective treatment and coatings. With the exception of the areas listed below, all parts not in constant contact with oil shall be corrosion-resistmt or suitably protected:

(a) Working surfaces
(b) Threads
(c) Drive pad faces

3.42 Identification of product. Equipment, assemblies, and parts shall be uniformly and legibly marked for identification. Marking shall be in accordance with Standard MIL-STD-130 and the minimum information on the identification plate Standard MS24123, except for the specific components as follows:

(a) Propeller: Propellers shall be marked with the following information:
(1) Model designation
(2) Serial number
(3) Manufacturer's identification

Fixed-pitch propellers with integral spinners shall be stamped on the upstream or front face, in a location that is visible from the front of the propeller when installed on the aircraft. Marking shall be confined to an area not exceeding 1 inch from the spinner. Two-blade propellers without spinner shall be marked on the side of the boss, Blade Number 1 shall be identified by the stamp "1" just outside the hub.

(b) Hub: The following information shall be stamped or etched in a location such as to be readily visible when installed on an engine (in an aircraft nacelle) but not in a location to produce critical stress concentrations:

(1) Model designation (propeller)
(2) Serial number
(3) Part number

(c) Blades:

(1) Each blade shall have the following information stamped or etched on the base or ferrule, as applicable, in such a manner as not to affect the balance or strength of the blade:

a. Model designation
b. Serial number
c. Part number
d. Ferrule model designation

(2) The following information shall be enameled, labeled, or painted on the blade parallel to the longitudinal axis of the blade, and on the canbered face. This marking shall be given one coat of clear varnish or lacquer.

a. Model designation
b. Serial number
c. Part number
d. Manufacturer's identification

(d) Spinner: The following spinner markings shall be placed on the inside of the spinner shell or bulkhead at an appropriate and accessible location to insure that this information will not be obliterated if outside surfaces of the spinner are painted:

(1) Part number
(2) Serial number
(3) Manufacturer's identification

(e) Reusable blade cuff: The following information shall be painted with enamel or labeled on the cambered face of the reusable cuff parallel to the axis of the blade and approximately in the center of the cuff area:

(1) Part number

(f) Ice control heating elements: The following information shall be painted or labeled on the exposed surface of electrical ice control heating elements:

Element; Heating, Propeller Blade (cuff) (spinner)
Electrical ice control
Operating voltage______ Resistance ______
Ohms max Ohms min ______
Serial No.______ Weight ______

(g) Ice control timer: The following information shall be stamped or painted on the electrical ice control timer:

Timer; Propeller, Electrical ice control
Operating voltage______ Timer on ______
Timer off ______
Serial No. ______ Weight ______

3.42.1 *Age control for synthetic rubber parts*. Age control for all synthetic rubber parts, except for fluorocarbon materials, shall be in accordance with ANA Bulletin No. 438.

3.43 Reports—propeller system.

3.43.1 *Test reports*. Following completion of each separate propeller system or component test, or consecutive group of tests conducted on any single test assembly or components a report shall be submitted. These reports, certified by a Government representative as to proper conduct of the tests, will constitute the basis for approval of the individual tests. Each report shall contain essentially the following items:

(a) Cover (title of report, number of the report, source of report, date, name(s) of the author (s), and contract number).

(b) Title page (title of report, number of report, source of the report, date, name(s) of the author(s), and contract number).

(c) Abstract (a brief statement of the contents of the report, inducting the objective).

(d) Table of contents.

(e) List of illustrations (provide figure numbers and captions of all illustrations). Photographs, charts, and graphs should be treated as illustrations and given figure numbers. When used in a separate series, tables should be given Roman numerals. (Examples: figure 1, figure 2, etc.; table I, table II, etc.).

(f) Summary (a brief resume of the test conducted, including objective, procedure, results, conclusions, and recommendations).

(g) Body of the report:

(1) Brief general description of the propeller or of the component(s) and a detailed description of all features which differ from the previous model, if applicable.

(2) If approval is being requested, without test, based on similarity to a component or assembly for which previous test approval was obtained, any physical or functional dissimilarities or differences in testing requirements with respect to the tested component and reference to the approved component test report shall be included.

(3) Method of test (general description of test facility, equipment, and methods used in conducting the test).

(4) Record of test (chronological history of all events in connection with all of the testing).

(5) Analysis of results (a complete discussion of all phases of the test, such as probable reason for failure and unusual wear, comparison in performance with previous models, and analysis of general operation).

(6) Calibration data including acceptante limits. (Data in corrected form shall be shown by suitable curves.)

(7) Tabulated data of all pertinent instrument readings and all required instrument readings taken during the test. Extraneous readings which the propeller manufacturer may desire to take during the test need not be reported.

(8) Description of the condition of the propeller or components at disassembly inspection.

(9) Conclusions and recommendations, with respect to approval of the propeller or components tests, supplemented by such discussion as is necessary for their justification.

3.43.2 *Summary report.* Following completion of all the tests specified herein, a final report shall be prepared which will constitute a record of all information pertaining to the tests. This report will normally be used as a basis for qualification approval of the complete propeller. This report shall contain essentially the following items:

(a) Cover (title of report, number of the report, source of report, date, security markings).

(b) Title page (title of report, number of report, source of report, date, name of author(s), contract number).

(c) Abstract (a brief statement of the contents of the report, including the objective).

(d) Table of contents.

(e) Summary (a brief resume and summary of each of the tests conducted, giving the title of each test, test report number, the item tested, dates of testing, and a general statement of the results).

(f) Conclusions and recommendations.

3.43.3 *Number and distribution of copies.* When the qualification tests are conducted at the contractor's plant for approval of a new type or model, the number of copies and distribution shall be as specified in the contractor order.

4. QUALITY ASSURANCE PROVISIONS

4.1 Inspection responsibility. The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order. 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.

4.2 Classification of tests. The inspection and testing of aircraft. propeller systems shall be classified as follows:

(a) Qualification tests (4.4 through 4.7).
(b) Acceptance tests (4,8).

4.3 Test conditions (see 6.6.1.4).

4.3.1 *Accuracy of data*. Reported data shall be accurate within the tolerances shown below. All instruments and equipment shall be calibrated at intervals acceptable to the Government representative to insure that the required degree of accuracy is maintained:

Item of data	*Tolerances*
Rotational speed	±0.5 percent of the value obtained at maximum rating
Reserve thrust	±1.0 percent of the value being measured
Static thrust	±1.0 percent of the value being measured
Rates of pitch change	±1.0 percent of the value obtained at maximum rating
Propeller weight	±2 percent
All other data	±3.0 percent of the value obtained at maximum rating

43.2 *Propeller weight*. The dry weight of the complete propeller shall be measured. If the weight is measured after the propeller has been serviced with fluid, when applicable, the dry Weight maybe calculated by subtracting the weight of residual fluids, in accordance with 3.14.1 of the contractor's model specification from the measured propeller weight.

4.3.3 *Corrections:* Readings of thrust and horsepower absorption at various rotational speeds and blade angle settings, rpm, fuel flow rate, specific fuel consumption, gas pressures, and gas temperatures shall be corrected to NACA standard sea level atmospheric conditions as defined in NACA TN 1235. Approval of the procuring activity shall be required for location of the barometric pressure and ambient temperature measuring devices. In order to determine conformance with the propeller performance ratings, the corrected thrust and horsepower absorption shall be determined by a method mutually agreed upon by the contractor find the procuring activity prior to initiation of the qualification tests.

4.3.4 *Barometer correction for temperature*. The barometer shall be corrected for temperature.

4.3.5 *Barometer reading*. The barometer shall be read and recorded at intervals not exceeding 3 hours.

4.3.6 *Vapor pressure data*. Wet and dry bulb air temperature readings shall be taken at intervals not exceeding 3 hours.

4.3.7 *Certification of operators*. All operators performing fusion welding shall be certified in accordance with Specification MIL-T-5021. Fluorescent penetrant and magnetic particle inspectors shall be certified in accordance with Standard MIL-STD-410.

4.3.8 *Test propellers*. Propellers having identical parts lists shall be used for all the tests herein specified and applicable to the particular propeller model undergoing tests. All components essential to the proper functioning and safety of the propeller shall, without change of components, go through all those tests in which the cumulative effects of the tests may affect the qualification or acceptance of the propeller.

4.3.9 *Temperature*. Unless otherwise specified herein, the following tolerances shall be maintained where the applicable temperatures are specified:

Applicable temperature	*Tolerance*
−65° F	+0 −5° F
+70° F	±5° F
+130° F	±5° F
+160° F	+5 −0° F

4.3.10 *Accreditable test time*. Test time shall not be credited by increments shorter than 15 minutes, except when shorter periods are a test requirement.

4.4 Qualification tests. Qualification of any complete propeller of the model defined in the contractor's model specification shall be predicated on the satisfactory completion of qualification tests specified herein and approval of the test report by the procuring activity. Qualification tests shall consist of:

(a) Preliminary flight release tests (PFRT) (4.5)

(b) Accreditation tests (4.6)

(c) Aircraft test (4.7)

4.4.1 *Qualifiafion test procedures*. The details and procedures of the qualification tests for the propeller shrill be established by the contractor, subject to review and coordination with the testing activity and the approval of the procuring activity. The testing activity designated by the contractor shall be subject to approval of the Government. The tests, as applicable, shall consist. of sequential simulated flight cycles and functional operation of the propeller controls.

4.4.2 *Hydraulic systems*.

4.4.2.1 *Fluid pressure*. The fluid pressure. adjustments, if applicable, shall be made at the beginning of the test to the value(s) specified in the model specification. No further adjustments that may affect. the loading, functioning, or operation of the components or the propeller shall be permitted during the test.

4.4.2.2 *Fluid servicing*. The fluid system shall be drained and filled with new fluid at the start of the specific propeller test. When externally supplied hydraulic power is a requirement only new makeup fluid shall be introduced into the system Subsequent to initial servicing. No fluid shall be drained from or added to the system during the test unless authorized by the Government representative. The system shall further be maintained in accordance with the requirements of the contractor as approved by the procuring activity.

4.4.3 *Qualification test log data*. The contractor shall include copies of the original qualification test log data as an appendix to the applicable report required by 8.43. The qualification test log data format, except as required herein, shall be as provided by the contractor.

4.4.3.1 *Miscellaneous data*. The date, operating schedule, propeller model designation, and serial number shall be recorded on each log sheet.

4.4.3.2. *Test notes*. Notes shall be placed on the log sheets of all incidents of the run, such as leaks, vibration, and other irregular functioning of the propeller or the test apparatus, and the corrective measures taken.

4.5 Preliminary flight release tests (PFRT). A complete preproduction propeller shall be subjected to the following PFRT to insure that the propeller has sufficient durability and reliability prior to release for flight testing under controlled conditions.

4.5.1 *Whirl stand tests*.

4.5.1.1 *Test conditions*.

4.5.1.1.1 *Test apparatus*. The whirl stand tests of the propeller shall be conducted on test apparatus capable of developing horsepower and variations of speed, without forward velocity, in excess of that specified in the contractor's model specification.

4.5.1.1.2 *Test propeller*. The same test propeller shall be used for all the whirl stand tests defined herein and shall consist of the aerodynamic configuration specified in the model specification with the blades assembled in the hub and properly restrained to insure a fixed angle setting for test under the following conditions:

> When capable of being separated from the propeller assembly, the spinner or ice control equipment may be removed from the test propeller for the calibration and vibratory stress survey as approved by the procuring activity. The components not included on the propeller for the calibration and vibratory stress survey shall be tested in accordance with 4.5.1.8.

4.5.1.1.3 *Test data*. During the whirl stand tests the following data shall be recorded, where applicable, in multiple increments of 50 or 100 rpm, as may be required, throughout the total rpm range of the test run:

Time of day.
Total test time.
Oscillograph stress traces.
Propeller speed, rpm.
Blade angle, degrees.
Corrected horsepower.
Corrected thrust, lbs.
Torque, ft-lbs.
Barometer, inches.

Ambient temperature, °F.*
Established formula for determining corrected horsepower, thrust, and torque.
Data for reading oscillograph recordings of stress traces.

**Note*. Ambient temperature shall be recorded at intervals not greater than 60 minutes.

4.5.1.2 Teardown inspection. The propeller submitted for test shall be completely disassembled to allow a detailed inspection of all vital working parts. Those components which are permanently joined together will be excepted. Individual parts or components shall be examined for evidence of suitable quality of materials based on physical inspections and process control data and may be supplemented by physical and chemical tests to determine the extent of conformance to contractor's specifications and drawings. The condition of the individual parts or components shall be recorded. Periodic inspection during tests will be approved by the procuring activity.

4.5.1.3 *Instrumentation*. The instrumentation and techniques used for recording the vibratory stress survey of the whirl stand tests, the number of strain gages and types of each used, their distribution, the range of operating conditions over which vibratory stress data will be recorded, the type of recording equipment used and the intervals at which recordings will be made, and the propeller components to be subjected to the vibratory stress survey shall be subject to review and approval by the procuring activity. Additional or revised instrumentation similar in nature is permitted. The instrumentation shall be sufficient to record stress traces, propeller rpm, and blade angle. The following is provided as a guide for the survey. Strain gages shall be installed on one blade of the propeller substantially in accordance with figure 5 for measurement of blade shank longitudinal bending and transverse stresses. A limited number of strain gages shall be installed on adjacent or opposite or both adjacent and opposite propeller blades, as required. Instrumentation data format for strain, gage installation on the propeller blade and their respective connection to the recording oscillograph used f or making the vibratory stress data shall be prepared substantially in accordance with figures 6 and 7.

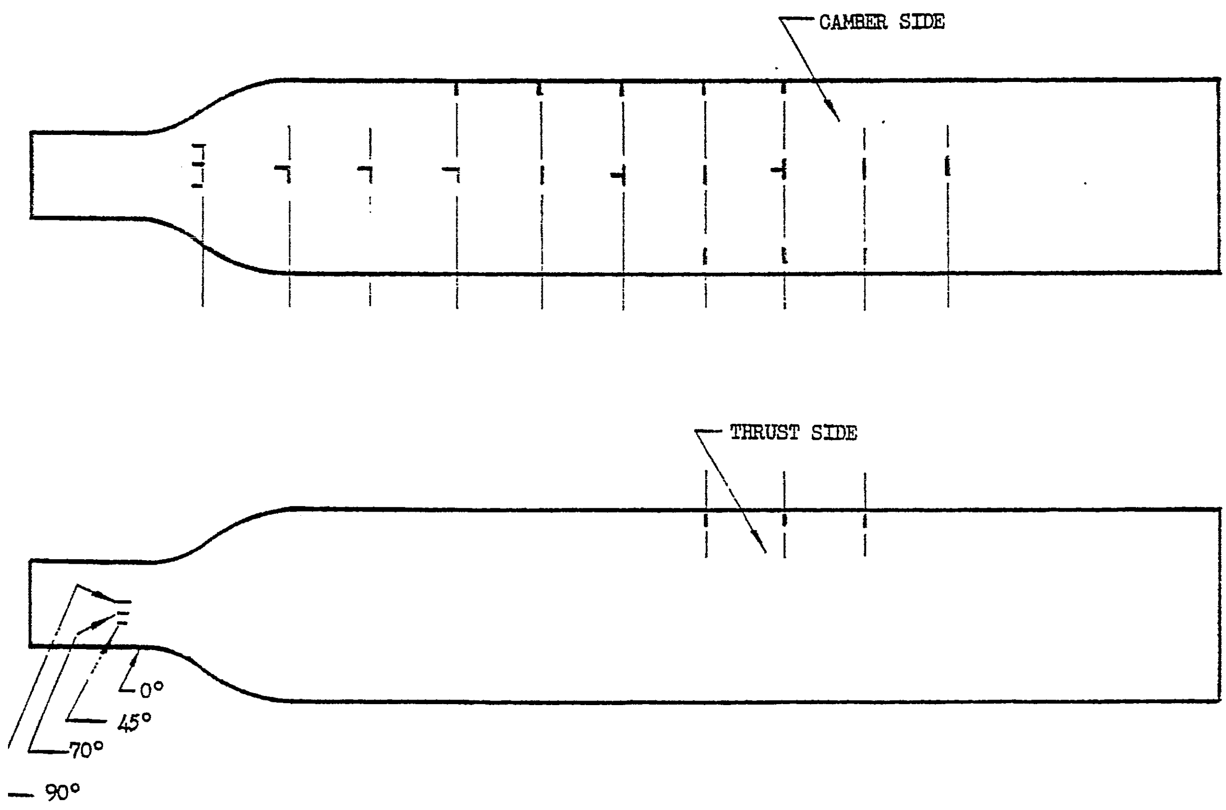


FIGURE 5. *Typical strain gage layout.*

CONTRACT NR.				DATE	
VIBRATION TEST NO.		TASK NO.		GAGE TYPE	GAGE FACTOR
HUB MFR		HUB DWG NO.	HUB SER NO.		
BLADE MFR		BLADE DWG NO.			
NO. OF BLADES	DIAMETER	ENGINE	STAND OR PLANE		

1					2					3					4				
SERIAL NO.					SERIAL NO.					SERIAL NO.					SERIAL NO.				
GAGE NO.	STATION OR % R ORIEN-TATION	IN FROM TIP	IN FROM T.E.	GAGE TYPE	GAGE NO.	STATION OR % R ORIEN-TATION	IN FROM TIP	IN FROM T.E.	GAGE TYPE	GAGE NO.	STATION OR % R ORIEN-TATION	IN FROM TIP	IN FROM T.E.	GAGE TYPE	GAGE NO.	STATION OR % R ORIEN-TATION	IN FROM TIP	IN FROM T.E.	GAGE TYPE
											NOTE: IDENTIFY 0° SHANK POSITION AND DIRECTION OF INCREASE ANGLE.								
											SHEAR BRIDGES AS REQUIRED								

C-L CAMBER FACE LONGITUDINAL   C-T CAMBER FACE TRANSVERSE   T-I THRUST FACE LONGITUDINAL   T-T THRUST FACE TRANSVERSE   SB SHEAR BRIDGE

FIGURE 6. *Strain gage installation data.*

PROPELLER: ______________________ V.I. NR: ______________________

ENGINE: ______________________ PROJ. NR: ______________________

TEST LOCATION: ______________________ DATE: ______________________

CONTRACT NR.

	CHANNEL NR	1	2	3	4	5	6	7	8	9	10	11	12
CONN 1	GAGE NR												
	BLADE NR												
CONN 2	GAGE NR												
	BLADE NR												
CONN 3	GAGE NR												
	BLADE NR												
CONN 4	GAGE NR												
	BLADE NR												
CONN 5	GAGE NR												
	BLADE NR												
CONN 6	GAGE NR												
	BLADE NR												

REMARKS:

FIGURE 7. *Propeller vibration connection sheet.*

4.5.1.4 *Propeller reassembly*. After instrumentation, the propeller shall be reasembled in accordance with the test provisions required in 4.5.1.1.2.

4.5.1.5 *Vibratory stress survey*. A vibratory stress survey of the propeller shall be conducted on a whirl stand to determine the stress characteristics of the hub find blade and the flutter characteristics of the blade, The data obtained by this survey shall be used in determining the test operational limitations for subsequent testing of the propeller on the whirl rig. Blade angle settings for the test shall be selected so that, if flutter is present, a flutter boundary curve can be determined for the propeller. This vibratory stress survey may be conducted simultaneously with the calibration test of 4.5.l.6 Stress limits shall be supplied to the approved testing activity prior to structural proof testing as specified in 4.5.1.7. The data shall be prepared substantially in accordance with figures 8 and 9.

4.5.1.6 *Calibration test*. The procedure during the propeller calibration shall be such as to establish the sea level static performance characteristics of the complete propeller. The propeller shall be calibrated at various rotational speeds up to 120 percent of the maximum rated speed of the propeller as specified in the model specification, in increments of not more than 5-degree settings of the blade angle over the range specified in the test program. Data shall be recorded for each angle at increments of rpm as specified in 4.5.1.1.3. The blade angle absorbing minimum power shall be determined and recorded. Blade deflect ion data shun be recorded during the calibration runs. The increments of rpm at which data are recorded shall be reduced to obtain more detailed information in the suspected high stress conditions. Curves shall be drawn showing corrected horsepower and thrust at various speeds for each blade angle from log data obtained during the test. The estimated blocking factor attributable to the test rig shall be noted on the curves. Figures 10 and 11 are typical curves. The whirl stand calibration test observed log data format shall be prepared substantially in accordance with figures 12 and 13, as applicable.

4.5.1.7 *Structuural proof tests*.

4.5.1.7.1 *Endurance run*. A 20-hour endurance run shall be conducted on the propeller including spinner, cuffs, and ice control equipment. During the run the blade angle shall be set at that angle at which the propeller absorbs normal rated actual static sea level horsepower at normal rated rpm. The propeller shall be run at 150 percent of the maximum rated horsepower of the propeller.

4.5.1.7.2 *Overspeed run*. A l-hour overspeed run shall be conducted on the propeller including spinner, cuffs, and ice control equipment. During the run, the blade angle shall be set at that angle at which the propeller absorbs at least normal rated nctual static sea level horsepower at 120 percent of the maximum rated propeller rpm.

4.5.1.7.2.1 *Test condition*. If not previously approved, the provisions of 4.5.1.1.2 shall apply only in the event that the vibratory stress instrumentation required for monitoring the stress conditions of the propeller during the overspeed run is susceptible to damage by those assembly components specified.

4.5.1.8 *Alternate test*. When either of the conditions of 4.5.1.1.2 or 4.5.1.7.2.1 are approved for component alternate testing, a l-hour run shall be conducted on those specified components mounted on a propeller assembly with stub blades at 120 percent. of maximum rated propeller rpm.

4.5.1.9 *Teardown inspection*. After completion of the testing specified in 4.5.1.5, 4.5.1.6, 4.5.1.7, and 4.5.1.8, the propeller and components shall be completely disassembled for examination of all parts and measured as necessary to disclose excessively worn, distorted, or weakened parts. These measurements shall be compared with the data recorded in 4.5.1.2 and the contractor's drawing dimensions and tolerances, Photographic records shall be made of failures, wear, and other unusual conditions. At the option of the procuring activity, periodic teardown inspection during specific, test will be accomplished.

4.5.1.10 *Propeller reassembly*. After satisfactory completion of all the previous tests and inspections, the propeller shall be reassembled to include all necessary control subassemblies for conducting an overspeed feather test.

TEST OPERATORS ______________________________

PINEAPPLE NO. ____________ BLADE ANGLE ________ DATE ________

V.T.NO. | W.T.NO.

CON. NO. | RUN NO.

ENDURANCE TIME (HOURS)

TIME OF DAY

ATTENUATOR SETTING: 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1

P.V.

TORQUE PR.

COND. NO OR R.P.M.

FILM NO.

CHANNEL NO. | GAGE NO. | BLADE NO.

PROPELLER { HUB MFG. ____________ DWG NO. ________ / BLADE MFG. ____________ DWG NO. ________ } { MFR. ________ / TYPE ________ / SERIAL NO. ________ }

PROJECT NO. ____________ LOCATION ____________

FIGURE 8. *Propeller vibration test data sheet.*

OPERATOR

PAGE

DATE

V.T. NO.

CONDITION RECORD NO.	TIME OF DAY	TOTAL TIME	RPM	P.V.	CHANNELS											
					1	2	3	4	5	6	7	8	9	10	11	12

FIGURE 9. *Oscilloscope data sheet.*

668732 O - 63 - 4

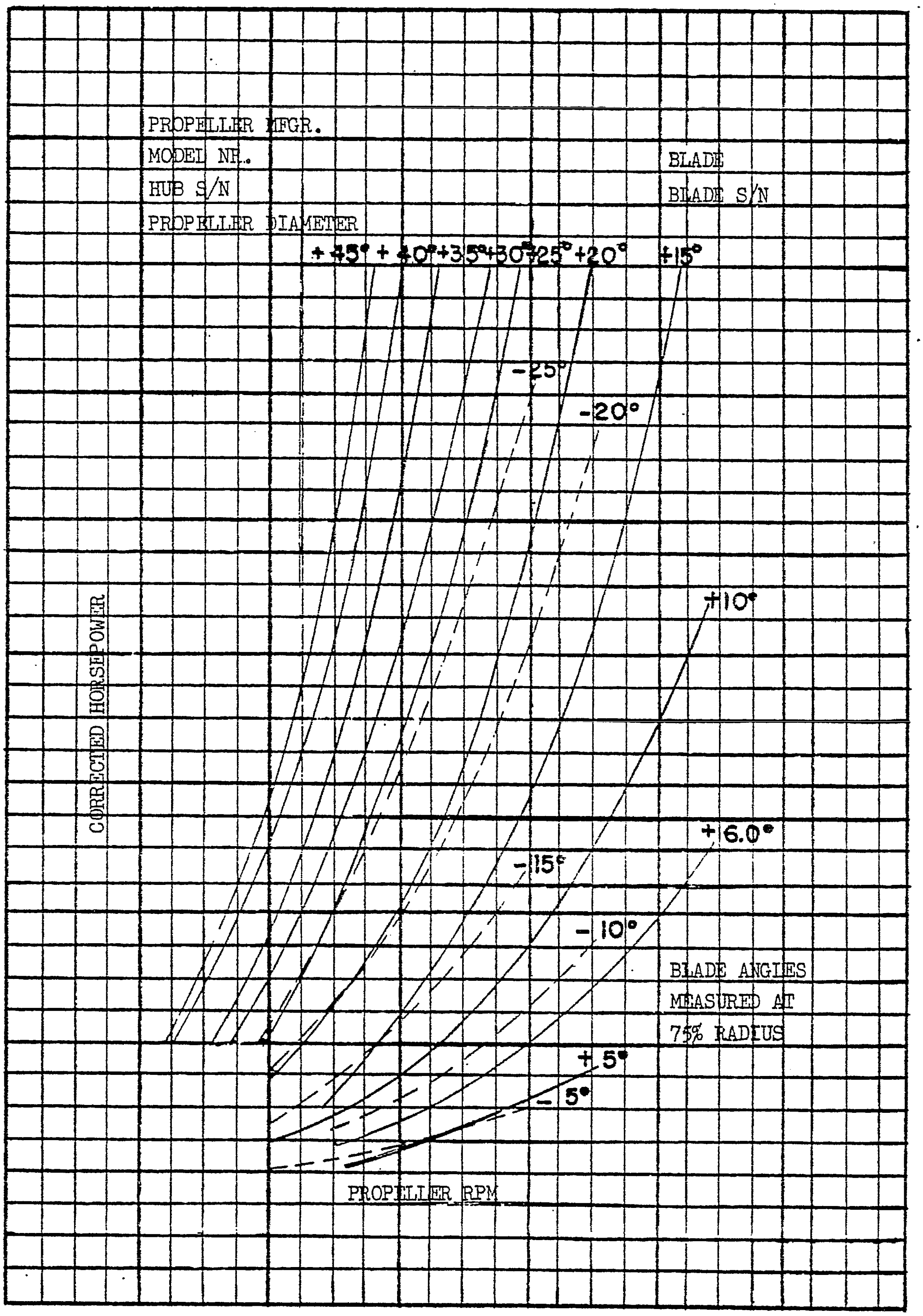


FIGURE 10. *Typical calibration curves.*

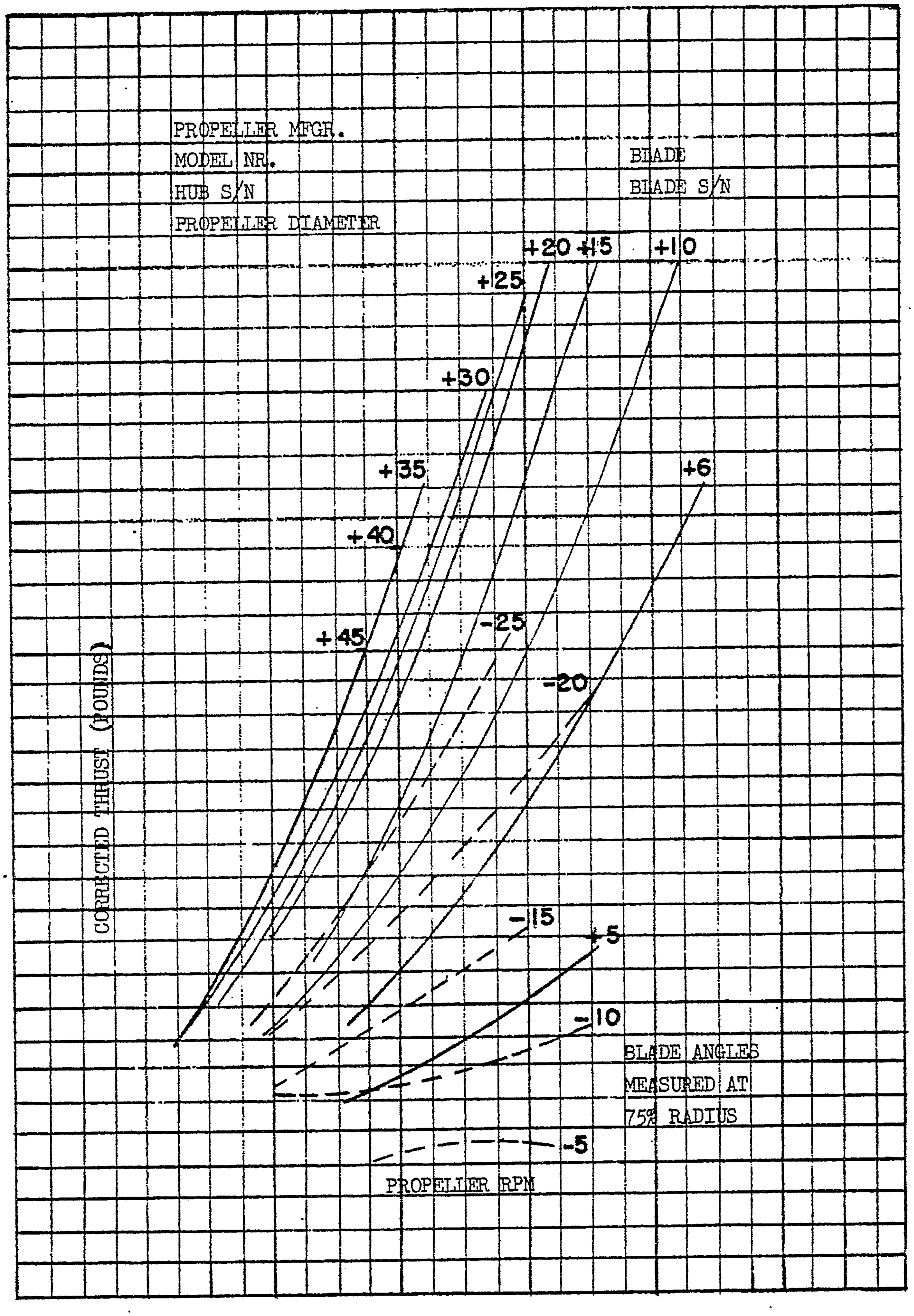


FIGURE 11. *Typical calibration curves.*

DATE			MFR	MOTOR ☐ HIGH ☐ LOW	ENGINEER
TASK NO.			HUB DWG	SHAFT ☐ HIGH ☐ LOW	CREW CHIEF
BAROMETER	TEMPERATURE	AIR FACTOR	HUB SERIAL	GEAR RATIO	CONTROLS OPR.
TORQUE-MULTIPLIER			BLADE DWG	BRUSH TIME	TORQUE OPR.
ROTATION			BLADE SERIAL	RIG TIME	RIG THRUST OPR.
ADAPTER					DUAL THRUST OPR.
TABLE	ANGLE				BALCONY OPR.

TIME	MOTOR RPM	SHAFT RPM		TORQUE		HORSEPOWER			THRUST			CORRECTED DATA		
		IND	X	IND	FT-LBS	TOTAL	LOSS	NET	RIG	DUAL	TOTAL	RPM	HP	THRUST

FIGURE 12. *Propeller electric motor whirl test.*

DATE	RIG	HUB DWG NO.	ENGINEER	TEMP
MFR	ADAPTER	HUB SERIAL NO.	CREW CHIEF	BAROMETER
PROJ NO.	BAFFLES	BLADE DWG NO.	TEST CREW	AIR FACTOR
WHIRL TEST NO.		BLADE SERIAL NO.		RIG FACTOR
SHEET NO.				TH FACTOR

ANGLE												
RPM												
COR HP												
COR TH												
ARM VOLTS												
MULTIPLIER												
ARM AMPS												
MULTIPLIER												
ARM WATTS												
CU LOSS												
FWI LOSS												
GEAR LOSS												
TOTAL HP												
TOTAL LOSS												
NET HP												
TH SCALE												
BAL THRUST												
ACTUAL TH												
START												
STOP												
TEST TIME												
START												
STOP												
RIG TIME												
REMARKS												

FIGURE 13. *Propeller whirl test data sheet.*

4.5.1.11 *Overspeed feather test*. The propeller shall be subjected. to an overspeed feather test consisting of 25 cycles of operation of the control mechanism. The propeller shall be as-resembled with counterweighted blades and the test cycles shall consist of the following:

Initiation of feathering action shall be accomplished at 141 percent of maximum rated rpm from the low pitch stop blade angle. The rpm shall be reduced at a linear rate from 141 percent at the low-pitch stop blade angle to 120 percent at 45-degree blade angle. The rpm shall be maintained at 120 percent for the remainder of the feathering cycle.

The propeller shall demonstrate that feathering can be accomplished at the above conditions to overcome the encountered maximum centrifugal twisting moment in normal and emergency operation.

4.5.2 *50-hour engine test*.

4.5.2.1 *Test conditions*.

4.5.2.1.1 *Test apparatus* The following test apparatus shall apply for all 50-hour engine tests, as applicable.

4.5.2.1.1.1 *Engine test stand*. The 50-hour engine test of the propeller shall be conducted on the model of the engine specified in the contractor's model specification, in an engine test stand, unless otherwise approved by the procuring activity. The stand shall include provisions to mount the engine and accurately control engine temperatures, pressures, speed, and fuel rates, so that desired power conditions may be maintained during propeller testing.

4.5.2.1.1.2 *Automatic recording equipment*. Automatic recording equipment shall be used to record data during the execution of that part of the 50-hour engine test requiring the evaluation of time versus propeller and engine variables. Other recording apparatus, if used, shall be capable of synchronization with the automatic recording equipment.

4.5.2.1.2 *Test propeller*. The same test propeller shall be used for the entire 50-hour test.

4.5.2.1.3 *Test data*. During the 50-hour engine test, the following data shall be recorded, where applicable, at intervals not greater than 60 minutes:

Time of day.
Time of starts and stops, and total time accumulated.
Total test time.
Engine speed, rpm.
Engine actual shaft horsepower.*
Torque, ft-lbs.
Engine case or gearbox vibration at points shown on installation drawing, mils.
Fuel flow, lbs/hr.*
Specific fuel consumption.
Fuel inlet pressure, psi.
Main or manifold pressure, psi or inches - mercury.
Primary pump pressure, psi.
Transient recovery time.*
Engine bleed opening point.*
Secondary pump pressure, psi.
Oil inlet pressure, psi.
Engine or gearbox oil outlet pressure, psi.
Engine or gearbox main oil pressure, psi.
Engine case vent pressure, psi.
Compressor inlet and discharge pressure, psi.
0il inlet temperature, °F.
Engine or gearbox oil outlet temperature, °F.
Torque bearing temperature, °F.
Turbine inlet temperature, °F.*
Compressor inlet and discharge temperature, °F.
Condition or power lever positions, degrees.
Synchronizer operation.
Barometer, inches.
Synchrophaser operation.
Negative torque signal operation.
Ambient temperature, °F.
Measured recording-oscillograph stress traces.
Propeller pitch pressure, psi.
Propeller speed, rpm.*
Propeller operating fluid temperature, °F.
Blade angle, degrees.*

*Note: For steady-state and transient calibrations, items marked with an asterisk, as applicable, need be recorded and such other data as may be pertinent to the installation.

4.5.2.2 *Instrumentation*. The instrumentation and techniques used for the required vibratory stress survey of the 50-hour engine test shall be as specified in 4.5.1.3. Instrumentation necessary for the propeller operating conditions required by all other tests specified herein shall be incorporated.

4.5.2.3 *Calibiations, checks, and adjustments*. Engine and propeller performances shall independently meet the requirements specified in their respective model specifications prior to the 50-hour engine test.

4.5.2.4 *Test propeller assembly*. The test propeller shall be assembled to the configuration specified in the model specification.

4.5.2.5 *Installation static functional check*. The engine propeller test installation shall be checked in the static condition to determine the functional characteristics of the control linkages, voltages, continuity of control circuitry, and typical preflight checks. The relationship between the power lever, coordinator lever, propeller lever, blade angle and condition lever shall be established as applicable for the complete range of power and condition lever travel, for increasing and decreasing power condition. Any adjustments required shall be made using only external means to obtain the limits required.

4.5.2.6 *Vibratory stress survey*. A vibratory stress survey of the propeller covering all appropriate conditions of engine operation shall be conducted in the engine test stand to determine the stress characteristics of the propeller when operated in the stand environment. Applicable vibratory stress survey attenuator settings, and data shall be prepared substantially in accordance with figures 8, 9, and 14.

4.5.2.7 *Control response test*. The control response test may be conducted concurrently with the vibratory stress survey specified in 4.5.2.6 and shall include the response of the engine-propeller to power and speed changes throughout the range of operation of the engine under normal ground and simulated fright. conditions of the aircraft.

4.53.7.1 *Steady-state check*. The procedure for the steady-state check shall be such as to establish that the static sea level performance characteristics of the complete engine-propeller combination satisfactorily meets the required values of the contractors' model specifications. External adjustments shall be made to obtain the required operational performance. Further propeller adjustments shall not be permitted without. Government approval. After all adjustments have been made, a calibration shall be conducted to obtain steady-state. data as specified in 1.5.2.1.3 for a series of power lever settings. When applicable, the settings for these steady-state checks shall be made when in governing and are as follows:

Full reverse.
Ground idle.
Flight idle.
60 percent normal rating.
80 percent normal rating.
Normal rated.
Military (takeoff).
Military ram.
Military wet.

The steady-state operation at each of the various power lever settings specified above shall be recorded by automatic equipment.

4.5.2.7.2 *Transient check*. After completion of the steady-state check specified in 4.5.2.7.1, the engine-propeller control system shall undergo a transient check to determine the stability of the control system, rate of pitch change, and response of the engine-propeller combination. The procedure during the transient check shall be conducted in the order given unless otherwise approved by the procuring activity. For all power lever and input mechanism movements, if applicable, the lever shall be advanced or retarded in 1 second or less. Transient checks shall be conducted in accordance with the schedule shown in table II, and automatic equipment recordings shall be made at each transient throughout the specified power lever movement. Calibration shall be conducted to obtain data as specified in 4.5.2.1.3.

4.5.2.7.3 *Miscellaneous checks*. Individual miscellaneous system operation checks, as applicable, shall be conducted on the propeller. The propeller shall be subjected to operating loads simulating as nearly as practicable those encountered during emergency operation. Sufficient instrumentation shall be provided to indicate the performance of each applicable component and to indicate that the functional relationships of components acting together are maintained as required by the applicable test schedule. Functional checks shall be performed

TEST TITLE ______ CONTR. NR. ______

CONDITION	R.P.M.	MANIFOLD PRES.	TORQUE NOSE	SHP	I.A.S.	ALTITUDE	MANEUVER	ACCEL. "G's"	°C.	% POWER	
1						GND.	GND. OPER.	1.0		F.I.	
2							HEADWIND OPERATION			40% NRP	
3										60% NRP	
4										80% NRP	
5										100% NRP	
6										MRP	
7						GND.	GND. OPER.	1.0		F.I.	
8							CROSSWIND OPERATION			40% NRP	
9										60% NRP	
10										80% NRP	
11										100% NRP	
12										MRP	

NOTES:
1. PERFORM CONDITION 1 THRU 6 WITH AIRCRAFT FACING INTO WIND OF 10 MPH OR LESS.
2. PERFORM CONDITION 7 THRU 12 WITH AIRCRAFT POSITIONED IN CROSSWIND (90°) OF 20 MPH OR MORE WITH TEST PROPELLER ON LEE SIDE.
3. OBTAIN ONE BRIEF RECORD AT EACH TEST CONDITION POINT.
4. DURING CONDITIONS 1 THRU 12 FOR AIRCRAFT GROUND TESTING, ONLY TEST ENGINE NEED BE OPERATED.
5. MRP = MILITARY RATED POWER   NRP = NORMAL RATED POWER   F.I. = FLIGHT IDLE

FIGURE 14. *Condition sheet.*

TABLE II. *Tent schedule*

Normal transients	I.A.S. (knots) [1]	Altitude [1]
Flight idle to 60% normal to flight idle	0,150,250,350, and normal operating speed.	Sea level to max in 10,000 ft. increments.
Flight idle to 80% normal to flight idle		
Flight idle to 100% normal to flight idle		
Flight idle to takeoff normal to flight idle		
Flight idle to takeoff normal to ground idle	0 and max landing speed	Sea level
Flight idle to takeoff normal to max reverse		
Flight idle to max reverse	0	
Ground idle to flight idle		
Takeoff to 60% normal to takeoff	0,150,250,350 V_{no}	Sea level to max in 10,000 ft. increments.
Takeoff to 80% normal to takeoff		
Takeoff to ground idle to takeoff	0 and max landing speed	Sea level
Takeoff to max reverse to takeoff		
Special transients		
Flight idle to 60% normal to flight idle		
Flight idle to 80% normal to flight idle		
Ground idle to flight idle to takeoff to ground idle [2]		
Ground idle to flight idle to takeoff to max reverse [3]		
Flight idle to max reverse to takeoff		

Power lever movement is 1 second or less for all transients. Sufficient time shall be allowed at each new power setting for stabilization of all normal transients. A pause of 3 seconds is permitted at the middle power setting for the special transients before moving to the final power setting.

If the engine installation incorporates bleed, all the transients shall be repeated with maximum bleed.

Takeoff power transients shall be checked with "dry" and "wet" if the engine has a wet rating.

[1] Applicable only when transients are conducted as part of 4.5.3.5.

[2] A maximum of 5 seconds shall be expended in going from ground idle through flight idle to takeoff holding full takeoff power for 3 seconds before moving to next power setting.

to indicate that no calibrated component has changed its calibrations beyond allowble service limits and that the function of uncalibrated components is unimpared. When applicable, the miscellaneous systems operations checks shall be as follows:

(*a*) Normal feather shutdown.

(*b*) Emergency feather shutdown with simultaneous manual fuel shutoff.

(*c*) Manual feather and unfeather after shutdown.

(*d*) Emergency negative torque signal by means of a monentary fuel interruption.

(*e*) Effects of changes in electrical voltage and power supply within the limits specified in Standard MIL-STD-704.

(*f*) Effects of ac power failures.

(*g*) Overspeed mechanical pitch lock.

(*h*) Mechanical low pitch stop.

A continuous recording shall be made at each of the above miscellaneous checks throughout the contractor's procedures as approved by the procuring activity.

4.5.2.8 *Cycle test*. Following the control response tests, the propeller shall be subjected to the cyclic test consisting of 50 successive 1-hour cycles of operation. A continuous recording shall be made of the transistory and steady-state conditions specified in 4.5.2.7.1 and 4.5.2.7.2 prior to and after the cyclic test. Visual inspections shall be accomplished as a precautionary measure for direction of parts failure and other irregular functioning of the propeller. These inspections shall be accomplished after the first, third, sixth, and every tenth hour interval thereafter, unless test conditions warrant more frequent intervals. Each cycle shall consist of the following runs:

Time at setting (minutes)	*Type of running or power lever position*
5	Ground idle
5	Taxi cycles:* Ground idle to maximum reverse; Maximum reverse to flight idle; Flight idle to ground idle
5	Takeoff
5	Military
10	Normal rating
10	90 percent rating
10	75 percent rating
4	Flight idle
1	Maximum reverse
5	Repeat of taxi cycles

*Note: Repeat approximately 10 times with alternate slow and rapid power lever motion.

The engine test observed data shall be prepared substantially in accordance with figure 15.

4.5.2.9 *Teardown inspection*. After completion of the 50-hour engine test, the propeller and components shall be completely disassembled for examination in accordance with the provisions of 4.5.1.9.

4.5.2.10 *Deviation from normal operation*. Whenever there is evidence that the propeller is deviating from normal operation or is not meeting the contractor's model specification requirements during the testing specified in 4.5.2.8, the discrepancy shall be immediately reported to the Government representative, If any of the following discrepancies are detected after starting of the cyclic test, the number of creditable hours of testing shall be disallowed:

(a) Linkages pertaining to the propeller require adjustment.

(b) Propeller speed setting exceeds the established schedule by ± 0.5 percent.

(c) Failure of any component adversely affecting propeller control performance.

(d) Failure of any component adversely affecting propeller integrity.

(e) Detection of any failure of any component directly or indirectly affecting control performance during teardown inspection.

(f) Detection of excessive wear of any part or component during teardown inspection.

(g) Necessity to add operating fluid, if applicable.

In the event. of a discrepancy of a propeller component, a. suitable retest penalty maybe imposed at the discretion of the procuring activity.

4.5.3 *Preliminary aircraft test*.

4.5.3.1 *Test conditions*.

4.5.3.1.1 *Test apparatus*. The following test apparatuses shall apply for all preliminary aircraft tests, as applicable.

4.5.3.1.1.1 *Aircraft test bed*. The preliminary aircraft test of the propeller shall be conducted on an aircraft test bed or a suitable aircraft having a nacelle configuration similar to the proposed application.

4.5.3.1.2 *Test propeller*. The same test propeller shall be used for all the preliminary aircraft tests and shall be in accordance with the contractor's model specification.

4.5.3.1.3 *Test data*. During the preliminary aircraft test, all pertinent test data provisions of 4.5.2.1.3 shall be applicable. In addition, recordings shall be made of the pertinent aircraft performance parameters.

4.5.3.2 *Instrumentation*. The instrumentation and techniques used for monitoring the required vibratory stress survey of the preliminary aircraft test shall be as specified in 4.5.1.3. In addition, the following instrumentation is provided as a guide. The instrumentation shall be sufficient to provide a continuous record of power lever position, pitch angle in degrees, yaw angle in degrees, and a coordinating signal from the photo panel frame counter. Visual indicating instruments shall be provided to the pilot for yaw angle in degrees. The wiring to the nacelle and cabin shall consist of a pair of shielded wires (No. 22 AWG or larger) with adequate insulating jacket over each shield. All wires and shields shall be insulated from the aircraft's ground and from each other. The power batteries for the recording equipment. shall be of sufficient capacity to stand the current draw of the maximum circuitry without jeopardy to data recording. When utilized, the strain gage batteries shall be of sufficient capacity to withstand the maximum steady drain without jeop-

DATE							PAGE NO.
PROJECT NO.		W.T. NO.	E.T. NO.	H.P.	RPM	TEST STAND NO.	
PROJECT TITLE				ENGINEER		EXTENSION	
HUB SERIAL NO.		BLADE SERIAL NO.			ENGINE MODEL		
HOURS FORWARDED	ENDURANCE	TAKE-OFF	CYCLES	TEST TIME	ENGINE MFR. NO.		

HOURS COMPLETED				
TIME STARTED				
TIME STOPPED				
ENG RPM				
ENG %				
TORQUE				
ACTUAL H.P.				
VIBRATION (MILS)	NO.		SERIAL NO.	
		COMP HOR		
		COMP VERT		
		TURB HOR		
		TURB VERT		
		G.B. HOR		
		G.B. VERT		
FUEL FLOW				
FUEL FLOW LB/HP/HR				
FUEL SPECIFIC				
FUEL INLET PRESSURE				
MAIN OR MANIFOLD PRESSURE				
PRIMARY PUMP PRESSURE				
SECONDARY PUMP PRESSURE				
OIL INLET PRESSURE				
OIL OUTLET PRESSURE - ENG				
OIL OUTLET PRESSURE - G.B.				
MAIN OIL PRESSURE - ENG				
MAIN OIL PRESSURE - G.G.				
REAR OIL PRESSURE PSI				
NOSE OIL PRESSURE PSI				
CASE VENT PRESSURE - ENG				
CRANKCASE PRESSURE PSI				
COMP INLET PRESSURE - HG				
COMP DISCHG PRESSURE - HG				
OIL IN TEMP				
OIL OUT TEMP - G. B.				
OIL OUT TEMP - ENG				
TORQUE BEARING TEMP				
TURB INLET TEMP				
COMP DISCHG TEMP				
COMP INLET TEMP				
CARB. AIR TEMP. °F.				
CONDITION LEVER POSITION				
ABS. DRY MAN. PRESS.				
AIR STACK PRESS. IN. HG.				
NOZZLE PRESS. PSI				
COOLING AIR PRESS. H_2O				
BAROMETER	DRY BULB TEMPERATURE			
	WET BULB TEMPERATURE			
	TRUE BAROMETER IN HG			
	VAPOR PRESSURE			
	CORRECTED BAROMETER HG			
RECORDED BY				

CREW (ENGINE) 1	2	3	4
CREW (VIBRATION) 1	2	3	4

FIGURE 15. *Propeller engine test log.*

ardy or compromise to the data being recorded. The batteries shall be free of leakage to the case or aircraft ground or both case and aircraft ground. The pitch and yaw head transmitter shall be mounted on the wing tip. The wiring from the wing tip to the cabin instrumentation shall consist of wires (No. 18 AWG or larger) insulated from the aircraft ground from from each other. The pitch and yaw transmitter heads shall be compatible with 2,000-ohm potentiometers. All necessary propeller vibratory stress instrumentation shall be installed prior to complete assembly. Instrumentation necessary for monitoring the propeller control operation required by all other tests specified herein shall be incorporated.

4.5.3.3 *Installation static functional check*. The installation static functional check shall be conducted in the static condition to determine the engine-propeller combination functional characteristics specified in 4.5.2.5.

4.5.3.4 *Steady-state check*. The steady-state check shall be conducted in accordance with the provisions of 4.5.2.7.1.

4.5.3.5 *Transcient check*. The transient check shall be conducted in accordance with the provisions of 4.5.2.7.2.

4.5.3.6 *Vibratory stress survey*.

4.5.3.6.1 *Ground survey*. A ground vibration stress survey of the propeller shall be conducted on all nacelles of the aircraft to determine the stress characteristics of the propeller when operated in the aircraft environment. Figure 14 is provided as a guide for the survey.

4.5.3.6.2 *Flight survey*. A flight vibratory stress survey of the propeller shall be conducted on all nacelles of the aircraft to determine the stress characteristics of the propeller when operated in the aircraft environment. The following is provided as a guide. The survey shall consist of obtaining all necessary stress measurements from the various strain gage groups as specified on figures 16, 17, and 18. The survey shall be conducted at the two extremes of gross weights, at the maximum permissible gross weight, and at the minimum gross weight possible with the test configuration of the aircraft. During takeoff, a continuous recording shall be obtained, starting when the power lever(s) are advanced, and continuing until the aircraft is in a stabilized climb. A 5-second record of all climb conditions shall be obtained. A continuous recording shall be made of each turn maneuver, including the point of maximum "g" loading. The negative braking condition shall be continuously recorded throughout from positive thrust operation to the maximum reverse thrust condition. All other conditions shall be briefly recorded. Applicable vibratory stress survey attenuator settings, oscillograph reduction and condition log data formats shall be prepared substantially in accordance with figures 16, 17, and 18.

4.5.3.7 *Miscellaneous checks*. The individual miscellaneous system operation checks listed in 4.5.2.7.3, as applicable, shall be conducted on the test propeller. During these checks the propeller shall function satisfactorily in all emergency conditions within the specified performance. of the engine-propeller combination. Sufficient instrumentation shall be provided to indicate the performance of each applicable component and to indicate that the fuctional relationships of components acting together are maintained as required by the applicable test schedule. Functional checks shall be performed to indicate that no calibrated component has changed its calibration beyond allowable service limits and that the function of uncalibrated components is unimpaired.

4.6 Accreditation tests. A complete preproduction propeller shall be subjected to the following accreditation tests to insure that the propeller has sufficient durability and reliability to insure a margin of safety in excess of normal service requirements, for all flight regimes of the specified production aircraft.

4.6.1 *150-hour engine test*. A 150-hour engine test shall be conducted on the propeller. The cyclic test shall be continued for 150 successive 1-hour cycles of operation as specified in 4.5.2.8. In addition, the ice control system shall be operated continuously during the cyclic test in accordance with the contractor's model specification. Applicable ice control data shall be recorded in conjunction with other data. Prior to operation during the cyclic test, the ice control system (s) shall be initially checked to establish proper functioning.

TEST TITLE ________ CONTR. NR. ________

CONDITION	R.P.M.	MANIFOLD PRES.	TORQUE NOSE	SHP	I.A.S.	ALTITUDE	MANEUVER	ACCEL. "G's"	°C.	% POWER	
13					SEE NOTE 4		T.O.	1.0		MRP	
14						1000 OR LESS	CLIMB			MRP	NORMAL CLIMB MANEUVER
15										MRP	CLIMB AT MINIMUM CLIMB IAS AT MRP
16										100% NRP	CLIMB AT MINIMUM CLIMB IAS AT 100% NRP
17										MRP	CLIMB AT MAXIMUM CLIMB IAS AT MRP
18										100% NRP	CLIMB AT MAXIMUM CLIMB IAS AT 100% NRP
19						10000'	LEVEL FLT.			MRP	
20										100% NRP	
21										80% NRP	
22										60% NRP	
23										40% NRP	
24										F.I.	

NOTES:
1. DURING PERFORMANCE OF ALL FLIGHT CONDITIONS MAINTAIN SPECIFIED POWER VALUES ON ALL ENGINES.
2. FOR CONDITIONS 14 THRU 24 FLAPS SHALL BE IN FAIRED POSITION.
3. CONDITIONS 13 THRU 24 SHALL BE SCHEDULED FOR FIRST DATA FLIGHT, ALSO INCLUDE CONDITIONS 53 & 54.
4. VARIOUS IAS SHALL BE USED FROM MINIMUM TO MAXIMUM.

FIGURE 16. *Condition sheet.*

TEST TITLE ______ CONTR. NR. ______

CONDITION	R.P.M.	MANIFOLD PRES.	TORQUE NOSE	SHP	I.A.S.	ALTITUDE	MANEUVER	ACCEL. "G's"	°C.	% POWER	
25						15000'	CLIMB	1.0		MRP	
26						20000'	LEVEL FLT.			MRP	
27										100% NRP	
28										80% NRP	
29										60% NRP	
30							SHALLOW DIVE			40% NRP	
31							SHALLOW DIVE			F.I.	
32						25000'	CLIMB	1.0		MRP	
33						30000'	LEVEL FLT.			MRP	
34										100% NRP	
35										80% NRP	
36							SHALLOW DIVE			60% NRP	
37										40% NRP	
38										F.I.	

NOTES: 1. ALTITUDE SHALL INCLUDE MAXIMUM FOR AIRCRAFT.

2. IAS SHALL INCLUDE MINIMUM AND MAXIMUM FOR AIRCRAFT.

FIGURE 17. *Condition sheet.*

TEST TITLE ______________ CONTR. NR. ______________

CONDITION	RPM	MANIFOLD PRESS.	TORQUE NOSE	SHP	IAS	ALTITUDE	MANEUVER	ACCEL. "G's"	°C	% POWER	YAW ANGLE	
39						10000'	YAW TRIM	1.0			0°	
40					SAME SPEED		LEFT YAW				9°	CONTINUOUS, SMOOTH YAW FROM 0° TO 9° MAXIMUM
41							RIGHT YAW				9°	CONTINUOUS, SMOOTH YAW FROM 0° TO 9° MAXIMUM
42							YAW TRIM				0°	
43					SAME SPEED		LEFT YAW				5°	CONTINUOUS, SMOOTH YAW FROM 0° TO 5° MAXIMUM
44							RIGHT YAW				5°	CONTINUOUS, SMOOTH YAW FROM 0° to 5° MAXIMUM
45							YAW TRIM			MRP	0°	
46					SAME SPEED		LEFT YAW			MRP	4°	CONTINUOUS, SMOOTH YAW FROM 0° TO 4° MAXIMUM
47							RIGHT YAW			MRP	4°	CONTINUOUS, SMOOTH YAW FROM 0° TO 4° MAXIMUM
48							LEFT TURN	1.5		MRP		CLIMBING TURN TO LEFT. HOLDING MRP
49					SAME SPEED		RIGHT TURN	1.5		MRP		CLIMBING TURN TO RIGHT. HOLDING MRP
50							LEFT TURN	2.0		MRP		CLIMBING TURN TO LEFT. HOLDING MRP
51							RIGHT TURN	2.0		MRP		CLIMBING TURN TO RIGHT. HOLDING MRP
52					START 250	START 12000'	SHALLOW DIVE	1.0		MRP		DIVE FROM 12000' AND 250 KN TO 8000' AND 300KN (VNE)
53							APPROACH					(REPRESENTATIVE SPEEDS) NORMAL LANDING APPROACH
54					APPROX. 100	0	GND. TAXI					PROPELLER REVERSE BRAKING USE MAX. PERMISSIBLE POWER

NOTES: 1. MAINTAIN SAME POWER VALUES ON ALL FOUR ENGINES DURING CONDITIONS 39 THRU 47.

2. IAS SHALL INCLUDE MINIMUM AND MAXIMUM FOR AIRCRAFT.

FIGURE 18. *Condition sheet.*

4.6.2 *Environmental tests (see 6.6).*
4.6.2.1 *Test conditions.*

4.6.2.1.1 *Test apparatus.* The environmental test of the propeller shall be conducted on apparatus which is capable of meeting the specific test conditions. Where applicable, the test apparatus shall be such that the test propeller shall not exceed 50 percent of the internal volume of the test chamber, and the heat source shall be so located that radiant heat shall not fall directly on the propeller assembly under test. Normal day atmospheric conditions for the propeller operational checks are satisfactory.

4.6.2.1.2 *Test propeller.* The propeller(s) used for the environmental tests shall be in accordance with the contractor's model specification, unless otherwise specified herein. The propeller shall be completely connected electrically, mechanically, or hydraulically, whichever be the case, to permit operation of the pitch change mechanism throughout its complete range.

4.6.2.1.3 *Test data.* Prior to conducting any of the tests. specified herein, the propeller shall be operated under normal day atmospheric conditions and a record made of all data necessary to determine compliance with the contractor's model specification. These data shall provide the criteria for checking satisfactory performance of the test propeller undergoing environmental tests. Variation from normal day atmospheric condition performance shall be within limits acceptable to the procuring activity. All necesary test data, if not established herein, to be recorded and the recording intervals shall be acceptable to the Government representative.

4.6.2.2 *Instrumentation.* The instrumentation and techniques used for monitoring the environmental test data shall be sufficient to provide all necessary data for evaluation of the test propeller requirements.

4.6.2.3 *Hot soak.* The test propeller shall be exposed initially to an 8-hour soak at 160°F. sea level pressure. The propeller shall then simulate a start with 130° F convection cooling air and be brought up to takeoff rpm. Fifty cycles of pitch change operation shall be conducted at the rate of one cycle per minute. The above test shall be conducted five separate times, with a teardown inspection after each test sufficient to determine that the propeller, including the ice-control system, has not been damaged.

4.6.2.4 *Cold soak.* The propeller assembly shall be subjected to a static unfeather test and a cold start test.

4.6.2.4.1 *Static unfeather and cold start test.* The assembly shall be rotated at the takeoff rpm specified in the model specification at an ambient temperature of 70°F for 15 minutes, during which time pitch changes shall be made in sequence of increase-decrease feather, unfeather, and reverse. The pitch change sequence shall be repeated as often as practicable within the time limit of 15 minutes. The rotational speed shall be reduced to zero, during which time the test assembly shall be placed in the full-feather position such that a feather shut down is accomplished as the rotation reaches zero. The ambient temperature shall be reduced to -65° F as rapidly as practicable and held at this point for an 8-hour soak. The test assembly shall then be unfeathered for a minimum of 20 degrees from the full-feather position while static, by means of the unfeather system in 45 seconds without damage to the unfeather system or related mechanism. Immediately after which, rotation of the propeller shall be started and increased 275 ±5 rpm and run at this speed for a period of 5 minutes. At ambient temperatures of 70° F and -65° F, the following data shall be recorded: Feather motor voltage, feather motor current, ambient temperature time to move blades a minimum of 20 degrees from full-feather position, temperature of feather motor prior and after unfeather, and blade angle. The above test shall be completed five separate times with a teardowm inspection after each test sufficient to determine that no part of the assembly has been damaged.

4.6.2.5 *High altitude.* The assembly shall be rotated at the takeoff rpm specified in the model specification at an ambient temperature of +70°F for 15 minutes, during which time, pitch changes shall be made in sequences of increase, decrease, feather, unfeather, and reverse. The pitch change sequence shall be repeated as often as practicable within the time limit of 15 minutes. The rotational speed shall be reduced to zero, during which time the propeller shall be placed in the air start position by the time the rotation reaches zero. The ambient temperature shall be reduced to –65°F at the specified altitude as rapidly as practicable. As soon as this temperature and altitude condition has been reached, rotation of the propeller shaft shall be started and increased to takeoff rpm. The pitch change sequence noted above shall be followed once every 80 minutes during an 8-hour continuous run at the specified altitude and ambient temperature. After each sequence of pitch change, the rate of pitch change at 25 propeller rpm overspeed and underspend at the high and low beta angle limits shall be determined. The ice control system shall be subjected to operation at the specified altitude without current flow. A determination of the effect of current flow shall also be performed, The wear rate of the brushes and rings shall be such as to indicate a total wear life compatible with the desired propeller overhaul period of 1,500 hours. The following data shall be recorded at sea level and altitude conditions, as applicable:

Altitude
Ambient temperature
Rotational speed of propeller
Feather motor temperature
Reference motor temperature
Governor temperature
Sump oil temperature
Power unit temperature
Feather motor current. and voltage
Blade angle movement during pitch change
Sump pressure
Degree of oil aeration
Beta high and low angle
Mechanical reference on-speed
Electrical reference on-speed
Rate of pitch change at 25 rpm underspeed
Rate of pitch change at 25 rpm overspeed
Centrifugal switch operating rpm

This test shall be accomplished five separate times.

4.6.2.6 *Humidity*. The propeller, including the ice control system, shall be subjected to an atmosphere of clear water vapor under cycle conditions specified as follows for a period of 15 days. After 12 hours, the propeller shall be checked through 5 pitch change cycle-s for proper operation. Upon completion of the 15-day test, the propeller shall be dried without forced convection for 12 hours in air at less than 70° F with not less than 15 percent relative humidity. At the conclusion of this period, four over-voltage power supply transients in accordance with Standard MIL-STD-704 shall be applied. Operation of the propeller shall be checked at normal input voltages, for normal operation. The propeller shall be disassembled and inspected. No corrosion or other defects shall be present that affect the function or structural strength of the propeller.

Humidity condition test cycling

Time period (in hours)	Relative humidity (percent)	Ambient temp. (°F)
8	95±5	130
4	Holding chamber moisture content constant.	130—gradually decrease temperature down to 70
8	Holding chamber moisture content constant.	70.
4	95±5 holding chamber moisture content constant or adding vapor.	70 uniformly up to 130

4.6.2.7 *Sand and dust*. The propeller shall be installed in a test chamber so that the air stream will strike the forward face of the assemlly at a velocity of 100 feet per minute. The air shall carry sand and dust at a concentration of 1.5±0.4 grams per cubic foot. The sand and dust used shall consist of more than 90 percent Sio_2, shall be angular in structure, and shall screen as follows:

100-mesh screen US Standard Sieve Series passes 100 percent.
140-mesh screen US Standard Sieve Series passes 98±2 percent.
200-mesh screen US Standard Sieve Series passes 90±2 percent.
325-mesh screen US Standard Sieve Series passes 75±2 percent.

The temperature of the circulating air shall be controlled as follows:

Time	*Air temperature °F*
First 6 hours	75±10
Second 6 hours	150±10
Third 6 hours	75±10

At the end of the 18-hour exposure and before cleaning any portion of the propeller, the electrical components shall be subjected to four over-voltgage power supply transient voltage variations specified in paragraph titled "D-c power system characteristics" of Standard MIL-STD-7O4. The propeller shall be functionally checked and then completely disassembled and inspected for indication of sand and dust contamination. Type and quantity of sand or dust found within the assembly shall be such as not to shorten the life or to affect function of the propeller in any way. The ice control system shall be subjected to the above test at the specified speeds without current flow. The type and quantity of sand and dust found and the brush wear experienced in 18 hours of operation shall indicate a brush wear life of 500 hours.

4.6.2.8 *Fungus*. The propeller, including the ice control system, shall be placed in a suitable chamber and inoculated with a mixture of fungus spores containing at least those types listed below:

Group I	Chaetomium globosum USDA 1042.4 or Myrothecium verrucaria USDA 1334.2
Group II	Aspergillus niger USDA Tc215–4247
Group III	Aspergillus terreus PQMD 82J
Group IV	Penicillium citrinum ATCC 9849
Group V	Fusarium moniliforme USDA 1004.1

Stock culture designation and source:

Symbols	*Source*
USDA	U.S. Department of Agriculture, Beltsville, Maryland
ATCC	American Type Culture Collection, 2112 M Street, NW., Washington 6, D.C.
PQMD	Philadelphia Q.M. Depot, 2800 20th Street, Philadelphia, Pa.

The chamber ambient atmosphere shall then be maintained at a temperature of 85°±5° F and a relative humidity of 95±5 percent for a 28-day period. The propeller shall function satisfactorily after completing this test. The propeller shall be completely disassembled and inspected for effects of fungus which would affect the life or function of the propeller. Evidence that all materials used do not support fungus growth shall constitute grounds for waiver of this test.

4.6.2.9 *Salt spray*. The propeller, including the ice control system, shall be placed in an exposure chamber and subjected to a salt spray test in accordance with Method 811 of Federal Test Method Standard No. 151. The salt spray test shall be operated for 50 hours. The propeller shall operate satisfactorily after completing the test. The salt deposits resulting from the test conditions may be removed prior to operation. A visual inspection shall be performed to insure that the propeller is free from deterioration and corrosion of any internal or external components that could in any manner prevent the propeller from meeting operational requirements during service life.

4.6.2.10 *Explosion-proof*. Accessories and components located in a potentially explosive environment shall be tested in accordance with Procedure IV of Specification MIL-E-5272.

4.6.2.11 *Radio interference check*. A radio interference check shall be conducted on the test propeller in accordance with Specification MIL-I-26600.

4.6.3 *Endurance test (500-hour rig)*.

4.6.3.1 *Test rig*. The test of the propeller shall be conducted on a test rig which shall be capable of developing variations of speed in excess of that specified in the model specification. Provisions shall be incorporated for controlling and monitoring the propeller through all simulated ground and fright operation.

4.6.3.1.1 *Instrumentation*. Instrumentation necessary for monitoring the propeller operation required by the endurance test shall be incorporate.

4.6.3.1.2 *Test propeller assembly*. The propeller for the test shall be assembled with counterweighted stub blades. When capable of being individually separated from the propeller assembly the spinner and ice control equipment may be eliminated as components of the test propeller, as approved by the procuring activity.

4.6.3.1.3 *Test duration*. The test shall consist of 500 l-hour cycles. The cycles shall be as specified in 4.5.2.8. The propeller operation shall be recorded before, during, and after the test.

4.6.3.1.4 *Deviation from normal operation*. Whenever there is evidence that the propeller is deviating from normal operation during the endurance test, the deviations shall be reported to the Government. representatives. If any of the following discrepancies are detected after starting the test, the number of creditable hours of testing shall be disallowed.

- *(a)* Linkages pertaining to the propeller requiring adjustment.
- *(b)* Failure of any component. adversely affecting propeller control performance.
- *(c)* Failure of any component adversely affecting propeller integrity;
- *(d)* Detection of any failure of any component directly or indirectly affecting control performance during teardown inspection.
- *(e)* Detection of excessive wear on any part or component during teardown inspection.
- *(f)* Necessity to add operating fluid, if applicable.

In the event of a discrepancy of a propeller component, a suitable retest penalty maybe imposed at the discretion of the procuring activity.

4.6.4 *Components and accessories tests.*

4.6.4.1 *Conditions*. Test apparatuses necessary for conducting the tests, method and procedures of tests, and data obtained during the tests shall be determined by the contractor and approved by the procuring activity. The components and accessories subject to tests shall be identical to those specified in the contractor's model specifiation.

4.6.4.2 *Structural*. All major structural components shall be subjected to fatigue and, where necessary, ultimate strength tests to aid in assessment of their durability under service applied loads. These tests will include 1xP testing on the gyroscopic rig at Wright-Patterson Air Force Base. The components subject to test, the methods and procedure of test, and data to be obtained during the test shall be determined by the contractor and approved by the procuring activity.

4.6.4.3 *Mechanical shook*. Propeller components and accessories not designed to mount on the engine or not mounted on the engine during the engine test phase shall undergo a mechanical shock test in accordance with Specification MIL-E-5272 and operate satisfactorily after completion of the test.

4.6.4.4 *Vibration endurance*. Propeller components and accessoris not designed to mount on the engine or not mounted on the engine during the engine test phase shall undergo a vibration endurance test in accordance with the applicable procedures of Specification MIL-E-5272 and shall operate satisfactorily after completion of the test.

4.6.4.5 *Temperate limitations*. Propeller components and accessories not designed to mount on the engine or not mounted on the engine during the engine test phase shall be tested in accordance with Specification MIL-E-5272, high temperature test Procedure II, and low temperature test Procedure I, and shall operate satisfactorily after completion of the tests,

4.6.4.6 *Durability*. Prior to installation of the propeller on the prototype or first production aircraft, the components of the propeller designed to perform certain functions shall be subjected to applicable tests to establish the capability of the component to perform their respective functions for at least the period of 1,500 hours between overhaul. The tests shall be of a "cycle" type for the specified time duration or number of cycles and shall be conducted on those control or emergency system components which are not limited to the following:

- *(a)* Control unit—(e.g., complete, unitary-housed control assembly which attaches to the hub for general control and pitch change power): Test duration shall be for a minimum of 500 hours.
- *(b)* Pitch change mechanism: Test duration shall be for a minimum of 500 hours.
- *(c)* Low pitch stop: Exposure shall be of the maximum magnitude which the component will encounter in service. Test duration shall be for a minimum of 100 cycles.
- *(d)* Mechanical pitch lock: Exposure shall be at various rates of actuation. Test duration shall be for a minimum of 1,500 cycles.

(e) Feathering and unfeathering: Exposure shall be under various conditions of speed and power. Test duration shall be for a minimum of 500 cycles of which no less than 100 cycles shall be accomplished at maximum condition of propeller operation.

(f) Negative torque signal: Exposure shall be under those conditions normally expected to be encountered in service. The test shall be for a minimum of 1,000 cycles.

(g) Ice control system: The propeller electrical ice control system components, including brushes and rings, shall be subjected to a 500-hour durability test at the temperature-altitude conditions specified in the model specification.

4.6.4.7 *Teardown inspection*. After completion of the tests, the propeller components which underwent test shall be completely disassembled and inspected in accordance with 4.5.1.9.

4.7 Aircraft test.

4.7.1 *Test conditions*.

4.7.1.1 *Test apparatus*. The following test apparatus shall apply for all aircraft tests as applicable.

4.7.1.1.1 *Automatic recording equipment*. Automatic recording equipment shall be used as specified in 4.5.2.1.1.2.

4.7.1.1.2 *Aircraft*. The aircraft test of the propeller shall be conducted on the prototype or first production aircraft which shall provide suitable means for testing the propeller. In the case of a multiengined aircraft application, the test shall be conducted on all nacelles.

4.7.1.2 *Test propeller*. The propeller(s) used for all the aircraft tests shall be in accordance with the model specification except for modification required for instrumentation. For multiengined aircraft all nacelles shall incorporate identical models of the propeller.

4.7.1.3 *Test data*. During the aircraft test all pertinent test data provisions of 4.5.2.1.3 shall be applicable. In addition, recordings shall be made of the indicated air speed in knots, altitude in feet, and the rate of climb in feet per minute.

4.7.2 *Instrumentation*. The instrumentation and techniques used for monitoring the required vibratory stress survey of the aircraft test shall be as specified in 2.5.3.2.

4.7.3. *Vibratory stress survey*.

4.7.3.1 *Ground survey*. A ground vibration stress survey of the propeller shall be conducted on all nacelles of the aircraft to determine the stress characteristics of the propeller when operated in the aircraft environment: The following is provided as a guide. For four-engine aircraft, the propeller shall be initially installed at the number three nacelle position and shall remain at this position until all specified testing conditions have been completed. The same procedure shall apply for two-engine aircraft with initial installation at the number two nacelle position. The ground survey shall be conducted utilizing four strain gage groups. A survey shall be made of ground operation which shall consist of obtaining all necessary stress measurements from three designated strain gage groups during the performance of conditions 1 through 12 and 66 through 71 as specified on figures 19a, 19b, and 20. After completion of the above specified ground survey with the three designated strain gage groups, the propeller shall be resurveyed utilizing the fourth strain gage group, which shall be a composite grouping determined by the analysis of the three designated strain gage groups, to obtain stress measurements at the same conditions when installed at the number two, one, and four nacelle positions, in that order. An additional survey shall be accomplished, if the above representative conditions indicate a requirement. Applicable vibratory stress survey attenuator settings, oscillograph reduction and condition log data formats shall be prepared substantially in accordance with figures 8, 9, and 21 through 25.

4.7.3.2 *Flight survey*. A flight vibratory stress survey of the propeller shall be conducted on all nacelles of the aircraft to determine the stress characteristics of the propeller when operated in the aircraft environment. The following is provided as a guide. For four-engine aircraft, the propeller shall be initially installed at the number three nacelle position and shall remain at this position until all specified testing conditions have been completed. The same procedure shall apply for two-engine aircraft with initial installation at the number two nacelle position. The flight survey shall be conducted utilizing four strain gage groups. A survey shall be made of flight operation which shall consist of obtaining all necessary stress measurements from three designated strain gage groups during the performance of conditions 13 through 24, 25 through 38, 39 through 47, 48 through 54, 55 through 65, and 72 through 73, as specified on figures 19a and 19b. The survey shall be conducted at three gross weights; maximum permissible gross weight, medium gross weight, and minimum gross weight for the specified aircraft. While conducting the following flight conditions, as applicable, a continuous oscillograph recording shall be taken:

(*a*) During takeoff, starting when the power lever (s) is advanced, and continuing until the aircraft is in a stabilized climb.

(*b*) During climb, starting with a stabilized level flight and proceeding through the climb range until the airspeed is reduced to the minimum permissible (or safe) indicated airspeed.

(*c*) During each turn maneuver including the point of maximum "g" loading.

(*d*) During the two times the pull of gravity pull-up maneuver.

(*e*) During yaws from yaw trim through the desired angle and recovery.

(*f*) During low speed to maximum indicated airspeed, holding maximum allowable power on shallow dive with 100 percent flaps.

(*g*) During high speed dives.

(*h*) During negative braking condition, from positive thrust operation to the maximum reverse thrust condition.

Condition No.	*Attitude*	*Altitude*	*Gross weight*	*Nacelles* 3	2	1
				Strain gage group		
1–6	Grd. headwind-------	------	-----------------	1–2–3	4	4
7–12	Grd. crosswind-------	------	-----------------	1–2–3	4	4
13	Takeoff-------------	------	High--------------	1–2–3	4	4
1	Takeoff-------------	------	Medium-----------	1	4	
13	Takeoff-------------	------	Low--------------	1	4	
14–18	Climbs (no flaps)-----	10,000 or less.	High--------------	1–2–3	See cond. 72 and	
14–18	Climbs (no flaps)-----		Medium-----------	1	See cond. 72 and	
			Low --------------	1	See cond. 72 and	
19–24	Level flight----------	10,000	High--------------	1–2–3	4	4
19–24	Level flight----------	10,000	Medium-----------	1	4	
19–24	Level flight----------	10,000	Low--------------	1	4	
25	Climb---------------	15,000	High (max. gr. wt. for altitude).	1	4	
26–29	Level Flight---------	20,000	High--------------	1	4	
26–29	Level Flight---------	20,000	Low--------------	1	4	
30 and 31	Shallow dive---------	20,000	Low--------------	1		
32	Climb---------------	25,000	High (max. gr. wt. for altitude).	1	4	
33–35	Level flight----------	30,000	High--------------	1	4	
33–35	Level flight----------	30,000	Low--------------	1		
36–38	Shallow dive---------	30,000	Low--------------	1		
39–41	Yaws---------------	10,000	-----------------	1	4	4
42–44	Yaws---------------	10,000	-----------------	1	4	4
45–47	Yaws---------------	10,000	-----------------	1	4	4
48–51	Climbing turns-------	10,000	High--------------	1	4	4
48–51	Climbing turns-------	10,000	Low--------------	1		
52	Shallow dive---------	12,000	Low--------------	1	4	

FIGURE 19a. *Summary of test requirements*

Condition No.	*Attitude*	*Altitude*	*Gross weight*	*Nacelles* 3	2	1	4
				Strain gage group			
53	Approach	------	High	1-2-3	4	4	4
53	Approach	------	Medium	1			
53	Approach	------	Low	1			
54	Reverse braking	------	High	1-2-3	4	4	4
54	Reverse braking	------	Medium	1			
54	Reverse braking	------	Low	1			
55	2G Pull-up	10, 000	High	1	4	4	
55	2G Pull-up	10, 000	Low	1			
56	Air delivery	10, 000	High	1			
57	Shallow dive	10, 000	Low	1	4		
58-60	Yaw	10, 000		1	4	4	4
61-65	Climbs (with flaps)	10, 000	High	1	4	4	4
61-65	Climbs (with flaps)	or	Medium		4		
61-65	Climbs (with flaps)	less	Low	1	4		
66-0 deg. through 71-0 deg. Grd. headwind				1	4		
66-30 deg. through 71-30 deg. Grd. (Aircraft 30 deg. CCW)[1]				1	4		
66-60 deg. through 71-60 deg. Grd. (Aircraft 60 deg. CCW)				1	4		
66-90 deg. through 71-90 deg. Grd. (Aircraft 90 deg. CCW)				1	4		
66-120 deg. through 71-120 deg. Grd. (Aircraft 120 deg. CCW)				1	4		
66-150 deg. through 71-150 deg. Grd. (Aircraft 150 deg. CCW)				1	4		
66-210 deg. through 71-210 deg. Grd. (Aircraft 210 deg. CCW)				1	4		
66-240 deg. through 71-240 deg. Grd. (Aircraft 240 deg. CCW)				1	4		
66-270 deg. through 71-270 deg. Grd. (Aircraft 270 deg. CCW)				1	4		
66-300 deg. through 71-300 deg. Grd. (Aircraft 300 deg. CCW)				1	4		
66-330 deg. through 71-330 deg. Grd. (Aircraft 330 deg. CCW)				1	4		
Airplane shall be positioned in wind to obtain maximum response, which will be determined from nacelles 2 and 3 data, (Conditions 66-0 degrees through 71-0 degrees)						4	4
72	Continuous climb	10, 000	High		4	4	4
72	Continuous climb	10, 000	Medium		4		
72	Continuous climb	10, 000	Low		4		
73	Continuous climb	10, 000	High		4	4	4
73	Continuous climb	10, 000	Medium		4		
73	Continuous climb	10, 000	Low		4		

[1] CCW—Counterclockwise

FIGURE 19b. *Summary of test requirements.*

FIGURE 20. *Wind stress measurements.*

A 5-second recording shall be taken on all climb conditions with exception of those specified above. The simulated air delivery drop, if applicable, for the stabilized condition shall be recorded. All other conditions shall be briefly recorded. After completion of the above specified fright, survey with the three designated strain gage groups, the test propeller shall be resurveyed utilizing the fourth strain gage group, which shall be a composite grouping determined by the analysis of the three designated strain gage groups, to obtain stress measurements at the same conditions when installed at the number two, one, and four nacelle positions, in that order. An additional survey shall be accomplished if the above representative conditions indicate a requirement. Applicable vibratory stress survey attenuator settings, oscillograph reduction, and condition log data formats shall be prepared substantially in accordance with figures 8,9, and 26 through 31.

4.7.3.3 *Control response test.* A control response test shall be conducted. The test shall include the response of the engine propeller to power and speed changes throughout the range of operation of the engine under all flight conditions of the aircraft and shall include all cheeks and tests as specified in 4.5.2.7. The control response test may be conducted concurrently with the flight survey specified in 4.7.3.2.

4.7.3.4 *Temperature survey.* A temperature survey shall be conducted on the propeller during ground and flight operation to demonstrate propeller cooling within specified temperature limits.

TEST TITLE ______________ CONTR. NR. ______________

CONDITION	R.P.M.	MANIFOLD PRES.	TORQUE NOSE	SHP	I.A.S.	ALTITUDE	MANEUVER	ACCEL. "G's"	°C.	% POWER		
1					0	GND.	GND. OPER.	1.0		FI		HEADWIND OPERATION
2										40% NRP		(PERFORM WITH AIRPLANE FACING INTO WIND OF 10 MPH OR LESS)
3										60% NRP		
4										80% NRP		
5										100% NRP		
6										MRP		
7					0	GND.	GND. OPER.	1.0		FI		CROSSWIND OPERATION
8										40% NRP		(PERFORM WITH AIRPLANE POSITIONED IN CROSSWIND (90°) OF 20 MPH OR MORE WITH TEST PROP ON LEE SIDE)
9										60% NRP		
10										80% NRP		
11										100% NRP		
12										MRP		

NOTE: OBTAIN APPROX. 5 SECOND RECORDING AT EACH TEST POINT.

FIGURE 21. *Condition sheet.*

TEST TITLE ______________ CONTR. NR. ______________

CONDITION	RPM	MANIFOLD PRESS.	TORQUE NOSE	SHP	IAS	ALTITUDE	MANEUVER	ACCEL. "G's"	°C	% POWER	
GROUND OPERATION - CONDITIONS 66 THRU 71 - THESE CONDITIONS ARE TO BE PREFORMED IN A WIND OF 20 MPH OR GREATER AND REPEATED AT EACH OF ELEVEN AIRPLANE POSITIONS PROCEDURE AS FOLLOWS: STARTING WITH HEADWIND CONDITION, PERFORM TESTING AS SPECIFIED AND REPEAT WITH AIRPLANE REPOSITIONED IN 30° INCREMENTS (CCW) UNTIL EACH OF ELEVEN POSITIONS HAVE BEEN RECORDED, OMITTING THE 180° OR TAILWIND POSITION.											
66-0°					0	GND	GND OPER	1.0		FI	PERFORM CONDITIONS 66-0° THRU 71-0° IN WIND OF 20 MPH OR MORE WITH AIRPLANE POSITIONED IN ACCORD WITH ATTACHED SKETCH.
67-0°					↓	↓	↓	↓		40% NRP	↓
68-0°					↓	↓	↓	↓		60% NRP	↓
69-0°					↓	↓	↓	↓		80% NRP	↓
70-0°					↓	↓	↓	↓		100% NRP	↓
71-0°					↓	↓	↓	↓		MRP	↓
66-30°					0	GND	GND OPER	1.0		FI	PERFORM CONDITIONS 66-30° THRU 71-30° IN WIND OF 20 MPH OR MORE WITH AIRPLANE POSITIONED IN ACCORD WITH ATTACHED SKETCH.
67-30°					↓	↓	↓	↓		40% NRP	↓
68-30°					↓	↓	↓	↓		60% NRP	↓
69-30°					↓	↓	↓	↓		80% NRP	↓
70-30°					↓	↓	↓	↓		100% NRP	↓
71-30°					↓	↓	↓	↓		MRP	↓

FIGURE 22. *Condition sheet.*

TEST TITLE ____________ CONTR. NR. ____________

CONDITION	RPM	MANIFOLD PRESS.	TORQUE NOSE	SHP	IAS	ALTITUDE	MANEUVER	ACCEL. "G's"	°C	% POWER	
66-60°					0	GND	GND OPER	1.0		FI	PERFORM CONDITIONS 66-60° THRU 71-60° IN WIND OF 20 MPH OR MORE
67-60°										40% NRP	WITH AIRPLANE POSITIONED IN ACCORD WITH ATTACHED SKETCH.
68-60°										60% NRP	
69-60°										80% NRP	
70-60°										100% NRP	
71-60°										MRP	
66-90°					0	GND	GND OPER	1.0		FI	PERFORM CONDITIONS 65-90° THRU 71-90° IN WIND OF 20 MPH OR MORE
67-90°										40% NRP	WITH AIRPLANE POSITIONED IN ACCORD WITH ATTACHED SKETCH.
68-90°										60% NRP	
69-90°										80% NRP	
70-90°										100% NRP	
71-90°										MRP	
66-120°					0	GND	GND OPER	1.0		FI	PERFORM CONDITIONS 66-120° THRU 71-120° IN WIND OF 20 MPH OR MORE
67-120°										40% NRP	WITH AIRPLANCE POSITIONED IN ACCORD WITH ATTACHED SKETCH.
68-120°										60% NRP	
69-120°										80% NRP	
70-120°										100% NRP	
71-120°										MRP	

FIGURE 23. *Condition sheet.*

TEST TITLE ______________ CONTR. NR. ______________

CONDITION	RPM	MANIFOLD PRESS.	TORQUE NOSE	SHP	IAS	ALTITUDE	MANEUVER	ACCEL. "G's"	C°	% POWER	
66-150°					0	GND	GND OPER	1.0		FI	PERFORM CONDITIONS 66-150° THRU 71-60° IN WIND OF 20 MPH OR MORE WITH AIRPLANE POSITIONED IN ACCORD WITH ATTACHED SKETCH.
67-150°										40% NRP	
68-150°										60% NRP	
69-150°										80% NRP	
70-150°										100% NRP	
71-150°										MRP	
66-210°					0	GND	GND OPER	1.0		FI	PERFORM CONDITIONS 66-210° THRU 71-90° IN WIND OF 20 MPH OR MORE WITH AIRPLANE POSITIONED IN ACCORD WITH ATTACHED SKETCH.
67-210°										40% NRP	
68-210°										60% NRP	
69-210°										80% NRP	
70-210°										100% NRP	
71-210°										MRP	
66-240°					0	GND	GND OPER	1.0		FI	PERFORM CONDITIONS 66-240° THRU 71-120° IN WIND OF 20 MPH OR MORE WITH AIRPLANE POSITIONED IN ACCORD WITH ATTACHED SKETCH.
67-240°										40% NRP	
68-240°										60% NRP	
69-240°										80% NRP	
70-240°										100% NRP	
71-240°										MRP	

FIGURE 24. *Condition sheet.*

						TEST TITLE ______				CONTR. NR. ______		
CONDI-TION	RPM	MANIFOLD PRESS.	TORQUE NOSE	SHP	I.A.S.	ALTI-TUDE	MANEUVER	ACCEL. "G's"	°C.	% POWER		
66–270°					0	GND.	GND. OPER.	1.0		FI		PERFORM CONDITIONS 66–270° THRU 71–270° IN WIND OF 20 MPH OR MORE WITH AIRPLANE POSITIONED IN ACCORD WITH ATTACHED SKETCH.
67–270°										40% NRP		
68–270°										60% NRP		
69–270°										80% NRP		
70–270°										100% NRP		
71–270°										MRP		
66–300°					0	GND.	GND. OPER.	1.0		FI		PERFORM CONDITIONS 66–300° THRU 71–300° IN WIND OF 20 MPH OR MORE WITH AIRPLANE POSITIONED IN ACCORD WITH ATTACHED SKETCH.
67–300°										40% NRP		
68–300°										60% NRP		
69–300°										80% NRP		
70–300°										100% NRP		
71–300°										MRP		
66–330°					0	GND.	GND. OPER.	1.0		FI		PERFORM CONDITIONS 66–330° THRU 71–330° IN WIND OF 20 MPH OR MORE WITH AIRPLANE POSITIONED IN ACCORD WITH ATTACHED SKETCH.
67–330°										40% NRP		
68–330°										60% NRP		
69–330°										80% NRP		
70–330°										100% NRP		
71–330°										MRP		

FIGURE 25. *Condition sheet.*

TEST TITLE ______________ CONTR. NR. ________

CONDITION	RPM	MANIFOLD PRESS.	TORQUE NOSE	SHP	I.A.S.	ALTITUDE	MANEUVER	ACCEL. "G's"	°C.	% POWER		
13							TAKE-OFF	1.0		MRP		OBTAIN CONTINUOUS RECORDING OF TAKE-OFF AND CLIMB-OUT
14						10000 OR LES	CLIMB	1.0		MRP	FLAPS	NORMAL CLIMB MANEUVER
15										MRP	RETRACTED	CLIMB AT MINIMUM CLIMB IAS HOLDING MRP
16										100% NRP		CLIMB AT MINIMUM CLIMB IAS HOLDING 100% NRP
17										MRP		CLIMB AT INTERMEDIATE CLIMB IAS HOLDING MRP
18										100% NRP		CLIMB AT INTERMEDIATE CLIMB IAS HOLDING 100% NRP
19						10000	LEVEL FLIGHT	1.0		MRP		OBTAIN BRIEF RECORDING AT EACH CONDITION WHEN STABILIZED
20										100% NRP		
21										80% NRP		
22										60% NRP		
23										40% NRP		
24										FI		

NOTE: 1. DURING PERFORMANCE OF ALL FLIGHT CONDITIONS MAINTAIN SPECIFIED POWER VALUES ON ALL ENGINES.

FIGURE 26. *Condition sheet.*

TEST TITLE ____________ CONTR. NR. ____________

CONDITION	RPM	MANIFOLD PRESS.	TORQUE NOSE	SHP	IAS	ALTITUDE	MANEUVER	ACCEL. "G's"	°C	% POWER	
25						15000	CLIMB	1.0		MRP	OBTAIN BRIEF RECORDING OF NORMAL STABILIZED CLIMB
26						20000	LEVEL FLIGHT	1.0		MRP	OBTAIN BRIEF RECORDING AT EACH CONDITION WHEN STABILIZED
27										100% NRP	
28										80% NRP	
29										60% NRP	
30							SHALLOW DIVE			40% NRP	
31										FI	
32						25000	CLIMB	1.0		MRP	OBTAIN BRIEF RECORDING OF NORMAL STABILIZED CLIMB
33						30000	LEVEL FLIGHT	1.0		MRP	OBTAIN BRIEF RECORDING AT EACH CONDITION WHEN STABILIZED
34										100% NRP	
35										80% NRP	
36							SHALLOW DIVE			60% NRP	
37										40% NRP	
38										FI	

NOTE: 1. MAINTAIN SPECIFIED POWER VALUES ON ALL ENGINES.

FIGURE 27. *Condition sheet.*

TEST TITLE ____________ CONTR. NR. ____________

CONDITION	RPM	MANIFOLD PRESS.	TORQUE NOSE	SHP	IAS	ALTITUDE	MANEUVER	ACCEL. "G's"	°C	% POWER	YAW ANGLE	
39						10000	TRIM	1.0			0°	BRIEF RECORDING
40						↓	LEFT YAW	↓			9°	OBTAIN CONTINUOUS RECORDING 0° TRIM TO 9° MAX. LEFT YAW
41						↓	RIGHT YAW	↓			9°	OBTAIN CONTINUOUS RECORDING 0° TRIM TO 9° MAX. RIGHT YAW
42						↓	TRIM	1.0			0°	BRIEF RECORDING
43						↓	LEFT YAW	↓			5°	OBTAIN CONTINUOUS RECORDING 0° TRIM TO 5° MAX. LEFT YAW
44						↓	RIGHT YAW	↓			5°	OBTAIN CONTINUOUS RECORDING 0° TRIM TO 5° MAX. RIGHT YAW
45					MAX. ALLOWABLE	10000	TRIM	1.0			0°	BRIEF RECORDING
46					LEVEL FLIGHT	↓	LEFT YAW	↓			4°	OBTAIN CONTINUOUS RECORDING 0° TRIM TO 4° MAX. LEFT YAW
						↓	RIGHT YAW	↓			4°	OBTAIN CONTINUOUS RECORDING 0° TRIM TO 4° MAX. RIGHT YAW

NOTE: 1. IF IAS GREATER THAN 275 KNOTS. IAS ADJUST ALLOWABLE YAW ACCORDINGLY.

2. MAINTAIN SAME POWER SETTINGS ON ALL ENGINES.

FIGURE 28. *Condition sheet.*

TEST TITLE ______________ CONTR. NR. ______

CONDITION	RPM	MANIFOLD PRESS.	TORQUE NOSE	SHP	IAS	ALTITUDE	MANEUVER	ACCEL. "G's"	°C	% POWER		
48					200	10000	LEFT TURN	1.5		MRP		OBTAIN CONTINUOUS RECORDING OF 1.5 G CLIMBING LEFT TURN
49					200	↓	RIGHT TURN	1.5		MRP		OBTAIN CONTINUOUS RECORDING OF 15G CLIMBING RIGHT TURN
50					200	10000	LEFT TURN	2.0		MRP		OBTAIN CONTINUOUS RECORDING OF 2G CLIMBING LEFT TURN
51					200	↓	RIGHT TURN	2.0		MRP		OBTAIN CONTINUOUS RECORDING OF 2G CLIMBING RIGHT TURN
52					START 250	START 12000	DIVE	1.0		NOTE		OBTAIN CONTINUOUS RECORDING OF DIVE MANEUVER FROM 12000 FT., 250K. IAS THRU PULL-OUT AFTER REACHING VNE
					↓	↓	↓	↓				
					END VNE	AS REQ'D	PULL OUT	AS REQ'D				
53					NOTE	NOTE	NORMAL APPROACH			NOTE		OBTAIN CONTINUOUS RECORDING OF NORMAL LANDING APPROACH, THRU TOUCH-DOWN AND REVERSE BRAKING (USING MAX. PERMISSIBLE POWER)
AND												
54							REVERSE BREAKING					

FIGURE 29. *Condition sheet.*

								TEST TITLE				CONTR. NR.
CONDITION	RPM	MANF. PRESS.	TORQUE NOSE	SHP	IAS	ALTITUDE	MANEUVER	ACCEL. "G's"	°C	% POWER		
55					200	10000	PULL-UP	2.0		MRP		OBTAIN CONTINUOUS RECORDING OF 2G PULL-UP, HOLDING MRP
56					NOTE	10000	ADS	1.0		NOTE	NOTE FLAPS	APPROACH STALL CONDITION AS NECESSARY TO SIMULATE AN AIR DELIVERY DROP, FLAPS AND POWER AS REQUIRED. OBTAIN BRIEF RECORDING WHEN STABILIZED.
57					NOTE	APPROX. 10000	SHALLOW DIVE	1.0		NOTE	100% FLAPS	SHALLOW DIVE WITH 100% FLAPS. OBTAIN CONTINUOUS RECORDING FROM LOW AIRSPEED TO MAXIMUM ALLOWABLE IAS, HOLDING POWER AS REQUIRED.
58					250	10000	TRIM	1.0	0°	NOTE		BRIEF RECORDING.
59						↓	LEFT YAW	↓	5°			OBTAIN CONTINUOUS RECORDING. 0° TRIM TO 5° MAX LEFT YAW.
60						↓	RIGHT YAW	↓	5°			OBTAIN CONTINUOUS RECORDING 0° TRIM TO 5° MAX RIGHT YAW.
61					NOTE	10000 OR LESS	CLIMB	1.0		MRP	NOTE FLAPS	NORMAL CLIMB MANEUVER USING MAX ALLOWABLE FLAPS.
62						↓	↓	↓		MRP	↓	CLIMB AT MINIMUM CLIMB IAS, HOLD MRP, USE MAX ALLOWABLE FLAPS.
63						↓	↓	↓		100% MRP	↓	CLIMB AT MINIMUM CLIMB IAS, HOLD 100% NRP, USE MAS ALLOW. FLAPS.
64						↓	↓	↓		MRP	↓	CLIMB INTERMEDIATE CLIMB IAS, HOLD MRP, USE MAX ALLOW. FLAPS.
65						↓	↓	↓		100% NRP	↓	CLIMB AT INTERMEDIATE CLIMB IAS, HOLD 100% NRP, USE MAX.ALLOW.FLAPS

FIGURE 30. *Condition sheet.*

TEST TITLE ________________ CONTR. NR. ________

CONDI-TION	RPM	MANF. PRES.	TORQUE NOSE	SHP	IAS	ALTI-TUDE	MANEUVER	ACCEL. "G's"	°C	% POWER		
72						10000	CLIMB	1.0		NOTE		PERFORM CLIMB MANEUVER AS SPECI-FIED WITH FLAPS RETRACTED

NOTE: AT MILITARY RATED POWER, STABILIZE AT MAXIMUM LEVEL FLIGHT AIRSPEED. HOLDING MRP THROUGHOUT, ENTER THE CLIMB REGIME. SLOWLY AND CONTINUOUSLY INCREASING THE ANGLE-OF-CLIMB. (APPROACHING A STALL CONDITION) UNTIL AIRSPEED FALLS OFF. TO MINIMUM PERMISSIBLE (OR SAFE) IAS. OBTAIN A CONTINUOUS RECORDING OF THE ENTIRE MANEUVER.

CONDI-TION	RPM	MANF. PRES.	TORQUE NOSE	SHP	IAS	ALTI-TUDE	MANEUVER	ACCEL. "G's"	°C	% POWER		
73						10000	CLIMB	1.0		NOTE		PERFORM CLIMB MANEUVER AS SPECI-FIED WITH FLAPS RETRACTED.

NOTE: AT 100% NORMAL RATED POWER, STABLIZE AT MAXIMUM ATTAINABLE LEVEL FLIGHT AIRSPEED. HOLDING 100 NRP THROUGHOUT, ENTER THE CLIMB REGIME, SLOWLY AND CONTINUOUSLY INCREASING THE ANGLE-OF-CLIMB. (APPROACHING A STALL CONDITION) UNTIL AIRSPEED FALLS OFF TO MINIMUM PERMISSIBLE (OR SAFE) IAS. OBTAIN A CONTINUOUS RECORDING OF THE ENTIRE MANEUVER.

FIGURE 31. *Condition sheet.*

4.7.3.5 *Fluid tank test*. If an airframe mounted fluid tank is furnished as a part of the propeller system, the tank shall withstand without failure the vibration and slosh tests as specified by approved test procedures submitted by contractor.

4.8 Acceptance tests. Acceptance tests shall consist of the following tests:

(a) Individual tests (4.8.1).
(b) Sampling tests (4.8.2).

4.8.1 *Individual tests*. Each propeller shall be subjected to the following tests:

(a) Examination of product (4.8.1.1).
(b) Functional tests (48.1.2).

4.8.1.1 *Examination of product*. Individual parts and subassemblies shall be examined for workmanship and suitability of materials based on physical inspection and process control data. The examination may be supplemented by physical and chemical tests to determine the extent of conformance to the contractors' specifications and drawings, These shall include the following tests.

4.8.1.1.1 *Magnetic inspection*. Magnetic particle inspection shall be performed on all highly stressed parts made of magnetic materials in accordance with Specification MIL-I-6868 or AMS2640.

4.8.1.1.2 *Fluorescent penetrant inspection*. Fluorescent penetrant inspection shall be performed on all highly stressed nonmagnetic metallic parts in accordance with Specification MIL-I-6866 or AMS2645.

4.8.1.1.3 *Radiographic or ultrasonic inspection*. Radiographic or ultrasonic inspection shall be performed as required. Radiographic inspection shall be in accordance with Specification MIL-I-6865. Laboratories performing radiographic inspection shall be certified in accordance with Specification MIL-X-6141.

4.8.1.1.4 *Material test*. Samples of all materials used in the propeller shall be selected in the manner and quantity specified in the appropriate material specification and subjected to the required tests.

4.8.1.1.5 *Conformance to drawings*. Individual parts and subassembly shall be inspected for conformance to the applicable drawings and specifications.

4.8.1.1.6 *Component parts inspection*. Component parts shall be inspected using sampling procedures specified in Standard MIL-STD–105 or other valid sampling plans. Contractor-prepared classification of defects shall be submitted to the procuring activity for approval.

4.8.1.2 *Functional tests*. Propeller subassemblies shall be subjected to functional tests consisting of the following provisions and schedule.

4.8.1.2.1 *Subassemblies, inspection of*. Subassemblies that require mechanical adjustment only shall be inspected and tested 100 percent. All subassemblies, such as governors and synchronizers, shall be functionally tested 100 percent and all major subassemblies, such as complete assemblies and unitary-housed control assemblies that make up the propeller assembly shall be tested 100 percent as specified in the appropriate contractor engineering standard inspection specification approved by the procuring activity,

4.8.2 *Sampling tests*. Propeller assemblies shall be subjected to the following tests which shall be conducted in the sequence given.

4,8.2.1 *Sampling procedure*. All production propellers shall be subjected to acceptance test in accordance with DOD Handbook H106 (Multilevel Continuous Sampling Procedures and Tables for Inspection by Attributes) assuring an average outgoing quality limit of 5 percent.

4.8.2.1.1 *Test methods*. Details of the test for the propellers shall be established by the contractor and set forth in appropriate specifications subject to review and approval by the procuring activity. The test shall consist of sequential cycles and functional operation of the propeller controls.

4.8.2.1.1.1 *Test rig*. The test rig shall be capable of testing a propeller throughout its specified rpm range under the following conditions:

(a) Blade loads shall be simulated with counterweights.
(b) Maximum allowable continuous operating temperature shall be achieved during operation.

(c) One-hour cycles, including emergency negative torque signal operation and feathering, as applicable, shall be used.

4.8.2.1.1.2 *Test duration.* The propellers shall be subjected to a test rig run of 10 hours trouble-free operation in accordance with test provisions required in 4.8.2.1.1.

4.8.2.1.2 *Inspection and acceptance after rig run.* Propellers that complete the rig run shall be disassembled sufficiently to allow a limited inspection for defects of vital working parts to an extent as established in an appropriate contractor's specification subject to the approval of the Government. Control major subassemblies and hub major subassemblies shall be reassemble{ after inspection and retested in accordance with appropriate contractor functional test specifications. Upon successful completion of the inspection and retest as appropriate, the propeller shall be processed for final Government acceptance.

4.8.2.1.3 *Determination of defects.* Any discrepancy discovered during the testing and inspection specified in 4.8.2 shall be reported to the Government representative. A defect shall be defined as any condition which indicates unsatisfactory performance of the 10-hour test or at disassembly and examination of the propeller upon completion of the 10-hour test, also any component defect which experience indicates could result in failure or which could materially reduce usability of the propeller for its intended purpose.

4.8.2.1.4 *Rejection and retest.* If the propeller shows a defect during test, it shall hereinafter be rejected and removed from the sampling plan schedule and shall be considered and handled as a separate item. After correction of the condition responsible for rejection, the propeller shall be subjected to both the functional test in 4.8.1.2 and the 10-hour test in 4.8.2. Prior to retest, full details concerning the defect and the corrective action taken shall be furnished the Government representative. Any propeller defective after retest shall not be resubmitted without the specific approval of the Government representative.

4.8.3 *Stoppages.* Stoppage from any cause shall require a repetition of the particular period during which the stoppage occurred, at the option of the Government representative. External oil leakage will be considered as stoppage. If, on close inspection at the completion of the rig run, external oil leaks beyond acceptable limits are discovered, a check run or a complete rerun after sealing the leak shall be made at the discretion of the Government representative.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, and packing. The propeller and components shall be prepared for shipment and storage in accordance with Specification MIL-P-6074. The contractor shall furnish a packing list with each propeller. All parts, components and tools which are not installed on the propeller, but which are shipped with the propeller, shall be included on the packing list.

5.2 Marking for shipment. In addition to those marking requirements specified in Specification MIL-P-6074, interior packages and exterior shipping containers shall be marked in accordance with Standard MIL-STD-129.

6. NOTES

6.1 Intended use. The aircraft propellers covered by this specification are intended for aircraft propulsion.

6.2 Ordering data. Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) Propeller model designation (see 3.1).
(c) Levels of preservation, packaging and packing (see 5.1).

6.3 Previously qualified components and accessories. Similarity of propeller components and accessories with past propeller corn-ponents find accessories may form the basis for the deletion of specific tests or portions thereof.

6.4 Guarantees. All items in the propeller model specification are guaranteed unless specified as "estimates."

6.5 Design and installation criteria. In consideration of acceptable design criteria and recommended practices, for the guidance of design, construction, and installation of military aircraft propellers, reference should be made to Bulletin ANC-9.

6.6 Symbols and definitions. The applicable symbols and definitions used in the propeller model specification will be as specified in Bulletin ANC-9, and will be in addition to those as specified hereafter.

6.6.1 *Definitions*.

6.6.1.1 *Government*. The term "Government" as used in this specification should be interpreted to mean the procuring activity.

6.6.1.2 *Procuring activity*. The procuring activity is the service which negotiates the propeller contract.

6.6.1.3 *Estimates*. An estimate is a value for a characteristic which has been predicted by the contractor from available knowledge.

6.6.1.4 *Standard conditions*. Standard conditions are the values of air temperature and pressure given in NACA TN 1235. The standard humidity, for the purpose of this specification, is zero vapor pressure at all altitudes.

6.6.1.5 *Propeller*. A propeller consists of those components necessary for primary propeller operation, such as hub, blades, spinner, control, etc., and including only the items listed as propeller components in the model specification.

6.6.1.6 *Propeller accessories*. Propeller accessories are those assemblies listed in the model specification required for secondary propeller operation, such as synchronizers, deicing timers, etc.

6.6.1.7 *Propeller components*. Propeller components are items of equipment, rotating or nonrotating, furnished as parts of the propeller required for propeller operation.

6.6.1.8 *Pitch-changing systems*. The pitch-changing systems are those systems comprised of all the components required to translate the pitch-changing power into angular blade movement.

6.6.1.9 *Beta regime*. The beta regime is the regime during which the blade angle is controlled directly by movement of a cockpit lever, rather than by the constant speed mechanism.

6.6.1.10 *Design Aq*. Aq is a one times propeller speed (IXP) excitation factor, where A is the angularity of airflow into the propeller disc in degrees and q is the airplane dynamic pressure in pounds per square foot.

6.7 Superseding data. This specification supersedes the following propeller specifications:

MIL-H-5443----------Dated 14 December 1949
MIL-P-5444----------Dated 14 December 1949
MIL-P-5446A---------Dated 24 August 1954
MIL-P-5447A(ASG)--Dated 30 November 1953
MIL-P-5448----------Dated 14 December 1949
MIL-P-5449----------Dated 14 December 1949
MIL-P-5450----------Dated 14 December 1949
MIL-P-5451----------Dated 14 December 1949
MIL-P-5452A---------Dated 25 June 1952
MIL-P-5641----------Dated 20 February 1950
MIL-D-6727----------Dated 13 July 1953
MIL-P-7715----------Dated 14 June 1951

Notice: When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Custodians:
Army—TC
Navy—Wep
Air Force—AFSC
Preparing activity:
Air Force—AFSC

INDEX

Paragraph title	Page
Acceptance tests	59
Accessibility	5
Accuracy of data	18
Accreditable test time	18
Accreditation tests	36
Adjustments	12
Age controls for synthetic rubber parts	16
Aircraft	44
Aircraft test	44
Aircraft test bed	34
Airspeed and altitude	2
Alternate test	23
Altitude-temperature limits for unfeathering and operation	2
Ambient temperature conditions	2
Applicable docments	1
Approval of changes	4
Attaching parts	12
Automatic recording equipment	30, 44
Balance	12
Balance provisions	9
Barometer correction for temperature	18
Barometer reading	18
Beta regime	61
Blade	9, 12
Blade activity factor	3
Blade cuff	10
Blade heating area	7
Blade heating elements	8
Blade pitch	9
Blade track	9
Blade vent hole	9
Bonding materials	7
Calibrations, checks, and adjustments	31
Calibration test	23
Certification of operators	18
Changes in design	4
Changes in vendors	4
Classification	1
Classification of tests	18
Cold soak	40
Component mounting	12
Component parts inspection	59
Components and accessories tests	43
Compound ice control system	8
Compounds	8
Conditions	43
Cone and cone seats	9
Conformance to drawings	59
Connecting line and fittings	8
Connection identification	8
Connector and cable	5
Controllable pitch	14
Control response test	31, 47
Controls	8
Control system	10
Control system adjustment	12
Corrections	18
Cover plates	15
Cover surfaces	7
Cuff heating area	8
Cyclic heating controls	8
Cyclic test	33
Definitions	61
Design and construction	4
Design and installation criteria	60
Design Aq-	3, 61
Design standards	4
Determination of defects	60
Deviation from normal operation	34, 42
Dissimilar metals	4
Drawings and diagrams	4
Dry weight of propeller system	5
Durability	43
Dynamic	14
Electrical contact surface	7
Electrical harnesses	12
Electrical ice control circuits	7
Electrical ice control system	7
Electrical power	5
Electrical systems	5
Electric operation	10
Enduance run	23
Endurance test (500-hour rig)	42
Engine alterations	1
Engine test stand	30
Environmental conditions	15
Environmental tests (see 6.6)	40
Estimates	2, 61
Examination of product	59
Explosion-proof	42
External electrical power	5
External hydraulic power	5
External mechanical power	15

Paragraph title	*Page*
Fail-safe provisions	15
Failure analysis	12
50-hour engine test	30
Finishing wood blades	9
Fittings	8
Fixed pitch	14
Flight condition	2
Flight maneuver forces	6
Flightsurvey	36, 44
Fluid	8
Fluid contamination	5
Fluid flow pattern	8
Fluid ice control system	8
Fluid lines and fittings	5
Fluid pressure	19
Fluid servicing	19
Fluid tank	59
Fluids	5
Fluorescent penetrant inspection	59
Flutter	15
Functional tests	59
Fungus	42
Governing	11
Government	61
Governors	11
Ground adjustable	14, 15
Groundhandling control	12
Ground support attachments	6
Ground survey	36, 44
Grounding	5
Guarantees	60
Heat requirements	8
High altitude	40
Hot soak	40
Hub	9, 13
Humidity	41
Hydraulic operation	10
Hydraulic power	15
Hydraulic systems	5, 19
Ice control pattern	8
Ice control system	7
Identification of product	15
Ignition-proof	5
Individual tests	59
Input mechanism torque	11
Input mechanism travel	11
Inspection and acceptance after rig run	60
Inspection responsibility	17
Instalation	10
Installation changes	1
Installation static functional check	31,36
Instrumentation	20, 30, 34, 40, 42, 44
Intended use	60
Interchangeability	4
Lubrication	1
Magetic inspection	59
Maintakability	12
Marking for shipment	60
Marking of blade	9
Materials and processes	3
Material test	59
Maximum diameter	3
Mechanical operation	10
Mechanical shock	15, 43
Micellaneous checks	31, 36
Miscellaneous data	19
Mockup	1
Model specification	1
Notes	60
Number and distribution of copies	17
Number of blades	3
150-hour engine test	36
One-piece wood (propeller)	15
Ordering data	60
Overall dimensions	6
Overspeed feather test	30
Overspeed run	23
Parts list(s)	4
Performance	10
Performance characteristics	1
Pitch-changing	10
Pitch-changing systems	10, 61
Polar moment of inertia	3
Position	3
Power requirements	8
Power transients	2
Preliminary aircraft test	34
Preliminary flight release tests (PFRT)	19
Preparations for delivery	60
Preservation, packaging, and packing	60
Pressure connections	15
Previously qualified components and accessories	60
Procuring actitity	61
Propeller	14, 61
Propeller accessories	61
propeller accessory limiting temperatures	7
Propeller components	61
Propeller reassembly	23

Paragraph title	*Page*
Propeller reverse or beta tel-lights	15
Propeller system	1
Propeller system design and construction changes	4
Propeller weight	18
Protected blade area	8
Protected cuff area	8
Protected spinner area	8
Protective treatment and coatings	15
Provisions	10, 14
Qualification and acceptance	1
Qualification test log data	19
Qualification test procedure	19
Qualification tests	18
Quality assurance provisions	17
Quick detachment	9
Radiographic or ultrasonic inspection	59
Radio interference	5
Radio interference check	42
Range and rates of pitch-change	2
Ratings	2
Rejection and retest	60
Reliability	12
Reports-propeller system	16
Requirements	1
Retaining nuts and snap rings	9
Reversibility	4
Reversing input mechanism	11
Reverse thrust	2
Rotating parts	6
Rotation	3
Rotational speed	2
Salt spray	42
Sampling procedure	59
Sampling tests	59
Sand and dust	41
Scope	1
Screw threads	15
Self-contained hydraulic system	5
Sound pressure fields	3
Speed synchronization	11
Spinner	9, 14
Spinner—blade seals	9
Spinner heating area	8
Standard blade shank ends	9
Standard conditions	61
Standard	4
Standards	4
	14
	40

Paragraph title	*Page*
Static thrust	2
Steady-state check	31, 36
Stoppages	60
Straight screw threads	15
Stress analysis	12
Structural	43
Structural and functional	4
Structural proof tests	23
Subassemblies, inspection of	59
Summary report	17
Superseding data	61
Support	9
Symbols and definitions	61
Symmetry	9
Tapered pipe threads	15
Teardown inspection	20, 23, 34, 44
Temperature	18
Temperature limitations	43
Temperature survey	47
Test apparatus	19, 30, 34, 40, 44
Test-conditions	18, 19, 23, 30, 34, 40, 44
Test data	19, 30, 34, 40, 44
Test duration	42, 60
Test methods	59
Test notes	19
Test propeller	19, 30, 34, 40, 44
Test propeller assembly	31, 42
Test propellers	18
Test reports	16
Test rig	42, 59
Transient check	31, 36
Type of ice control	7
Vapor pressure data	18
Vibration	6
Vibration endurance	43
Vibratory stress survey	23, 31, 36, 44
Weight of residual fluids	5
Whirl stand tests	19
Wood (blade)	13

FIGURES

Figure title	
Balancing blade, Figure 4	14
Condition sheet: Figure 14	32
Figure 16	37
Figure 17	38
Figure 18	39
Figure 21	48
Figure 22	49
Figure 23	50

Figure title — *Page*

Condition sheet-Continued
Figure 24- - - - - - - - - - - 51
Figure 25- - - - - - - - - - - 52
Figure 26- - - - - - - - - - 53
Figure 27- - - - - - - - - - - 54
Figure 28- - - - - - - - - - 55
Figure 29- - - - - - - - - - - 56
Figure 30- - - - - - - - - - 57
Figure 31- - - - - - - - - - 58

Flight maneuver load diagrams, Figure 2 - 6
Oscilloscope data sheet, Figure 9- - - - - - - 25
Propeller electric motor whirl test, Figure 12- 28
Propeller engine test log, Figure 15- - - - - 35
Propeller vibration connection sheet, Figure 7- 22
Propeller vibration test data sheet Figure 8 - 24

Figure title — *Page*

Propeller whirl test data sheet, Figure 13 - 29
Strain gage installation data, Figure 6- - 21
Summary of test requirements:
Figure 19a- 45
Figure lab- 46
Temperature range vs. altitude, Figure 1- 3
Typical calibration curves:
Figure 10- 26
Figure 11- 27
Typical harness section, Figure 3- - - - - - 13
Typical strain gage layout, Figure 5- - - - 20
Wind stress measurements, Figure 20- - - 47

TABLES

Table title

Ice control design conditions, Table I- - 7
Transient schedule, Table II- - - - - - - - - - 33