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(See Section 6.)

MILITARY SPECIFICATION

STRUCTURAL DESIGN REQUIREMENTS, HELICOPTERS

This specification has been approved by the Department of the Air Force and by the Navy Bureau of Aeronautics.

1. SCOPE

1.1 Scope.- This specification covers the static and dynamic structural design criteria for helicopters. It defines the minimum requirements for flight, ground, and pilot loads, the load distribution, and the accompanying stress of all components.

1.2 Application.- The requirements of this specification are applicable to all helicopters unless specific deviations are authorized by the procuring activity.

1.3 Classification.- For purposes of this specification, helicopters shall be divided into the following classes:

Class I - Those helicopters whose primary mission falls under one of the following general headings: Rescue, evacuation, assault (cargo and troop), liaison, reconnaissance, artillery spotting, utility, training, or antisubmarine warfare

Class II - Those helicopters whose mission falls under the general heading of cargo and are designed for a cargo loading of 5,000 pounds or less.

Class III - Those helicopters whose mission falls under the general heading of cargo and are designed for a cargo loading in excess of 5,000 pounds.

2. APPLICABLE DOCUMENTS

2.1 The following specifications and publications, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein:

SPECIFICATIONS

Military

MIL-D-7579	Data, Development Airplane Engineering
MIL-C-7514	Cloth, Coated, Synthetic and Fibrous Glass
MIL-H-8501	Helicopter Flying Qualities, Requirements for

MIL-P-6264	Plastic Sheet; Vinyl Copolymer, Thin
MIL-S-5659	Soundproofing and Insulating Materials
MIL-S-6144	Soundproofing for Aircraft; General Specification for Installation of
MIL-T-8679	Test Requirements, Ground, Helicopter

Bureau of Aeronautics

SR-6	Contract Design Data Requirements for Aircraft and Aircraft Parts
SR-134	The Requirements of Power Plant Vibration Isolator Installations for Naval Airplanes

PUBLICATIONS

Air Force-Navy-Civil Bulletins

ANC-2	Ground Loads
ANC-5	Strength of Metal Aircraft Elements
ANC-12	Vibration and Flutter Prevention Handbook

Air Research and Development Command

ARDC Manual 80-1	Handbook of Instructions for Aircraft Designers

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

2.2 Other publications.- The following documents form a part of this specification. Unless otherwise indicated, the issue in effect on date of invitation for bids, shall apply.

National Advisory Committee for Aeronautics

NACA Technical Note 1604	Standard Symbols for Helicopters
NACA Report 474	Nomenclature for Aeronautics
NACA RM L9H08	An Empirical Method for Estimating Trailing Edge Loads at Transonic Speeds

(Application for copies should be addressed to the National Advisory Committee for Aeronautics, 1512 H Street, N. W., Washington, D. C.)

3. REQUIREMENTS

3.1 General.-

3.1.1 Strength.- The entire helicopter structure, including beaching units and hoisting sling, where applicable, shall be capable of supporting without failure the ultimate loads resulting from the loading conditions and ultimate factor of safety specified in Section 3, and shall be capable of withstanding without failure the repeated load and endurance tests of Specification MIL-T-8679. Allowable stress values to be used in the stress analyses shall be those taken from approved Government publications, such as Bulletin ANC-5, or various NACA or Bureau of Standards reports, whenever possible.

3.1.1.1 For Air Force helicopters, allowable stresses based on test data unreduced by a material variation factor may be used if sufficient number of tests have been conducted. The supporting data shall be submitted to the procuring activity for approval. If the data are considered to be inadequate, the allowable values will be disapproved and the values of Bulletin ANC-5 shall govern. Tests of material samples only are not regarded as sufficient evidence in most cases. Generally, the test program should include panels and fabricated parts of the actual structure.

3.1.1.2 For Navy helicopters, the Bureau of Aeronautics requires correction of test data for material variation factors.

3.1.2 Factors of safety.-

3.1.2.1 Yield.- The minimum yield factor of safety for Naval aircraft shall be 1.15, and for Air Force aircraft shall be 1.0.

3.1.2.2 Ultimate.- The minimum ultimate factor of safety shall be 1.5.

3.1.3 Deformations.-

3.1.3.1 Interactions.- The magnitude and distributions of the limit, yield, and ultimate loads that result from the loading conditions and factors of safety specified in Section 3 shall include in their determination the effects of deformations of the structure which result from the corresponding loads.

3.1.3.2 Permanent deformations.- The structure shall be capable of supporting the yield and limit loads that result from the loading conditions and the yield factor of safety specified in Section 3, without permanent deformation that would affect adversely the aerodynamic characteristics or the mechanical operation of any part of the helicopter, or that would be noticeable upon inspection.

3.1.3.3 Doors, cowling, locks, and fasteners.- Doors, cowling, locks, and fasteners, including landing gear up and down locks and cowling fasteners, shall not deflect from their intended positions in such manner as to permit unwanted opening, closing, or release of coverings, or unlocking or unfastening of mechanisms at all loads up to ultimate.

3.1.3.4 Loads from thermal deformations.- The magnitudes and distributions of internal loads that result from the loading conditions specified in Section 3 shall include in their determination the effects of thermal deformation. Deformations resulting from operation under all ambient temperatures in the range from -65°F to +160°F shall be considered.

3.1.4 Reactions.- The loads that result from the design conditions specified in Section 3 shall be balanced rationally by translational and rotational inertia or by a conservative method acceptable to the procuring activity.

3.1.5 Gross weight.- The gross weights for the design criteria outlined in this specification shall be the gross weights of paragraphs 3.1.5.1 and 3.1.5.2 and any lesser gross weights that are practical for flight, where such lesser weights are critical.

3.1.5.1 Basic design gross weight.- The basic design gross weight for the loads and loading conditions of Section 3 shall be the takeoff gross weight of the helicopter with full internal and external load items required for it to perform the primary mission defined in the detail specification. The basic design gross weight shall apply for flight, landing, takeoff, and ground handling conditions, where applicable.

3.1.5.2 Design alternate gross weight.- The design alternate gross weight for the loads and loading conditions of the symmetrical flight conditions of Section 3 shall be that gross weight as defined in the detail specification. The load factors shall be those specified for the basic design gross weight multiplied by the ratio of the basic design gross weight divided by the design alternate gross weight. These load factors shall be not less than 2.0. This alternate gross weight shall also be used for landing conditions and for ground handling conditions, as specified.

3.1.6 Distribution of mass items.- The distributions of mass items for the loads and loading conditions of Section 3 shall be all those that are practicable for operation of the helicopter at any gross weight up to the greater of the basic design or design alternate gross weight, including all critical combinations of useful-load and fixed-equipment items (or ballast used to represent these items) for which provision is required.

3.1.7 Center of gravity positions.- The center of gravity (cg) positions to be employed with the loads and loading conditions of paragraph 3.2 shall be the maximum forward and maximum aft positions, and any cg position within this range which produces a critical loading. These positions shall be obtained for all gross weights and their distributions that are practicable for flight operation. For the loads and loading conditions of paragraph 3.4, the cg positions within the foregoing range that are critical for each landing gear unit shall be employed.

3.1.8 Load distribution.- The distributions of airloads, inertia loads, and dynamic loads used in the structural design shall be determined by applicable wind-tunnel tests, flight tests, or acceptable analytical methods and by the use of aerodynamic data which are demonstrated to be applicable. The airload distributions shall include the significant effects of compressibility and stall.

3.1.9 Fatigue.- The magnitude of stress reversals shall be minimized, and materials and design details shall be used that minimize the possibility of fatigue failure.

3.1.10 Load factors.- Unless otherwise stated, load factors outlined herein are limit load factors at the helicopter's cg. The following load factors shall be used for helicopter design:

Class I	-	+3.5, -0.5
Class II	-	+3.0, -0.5
Class III	-	+2.5, -0.5

3.2 Flight and takeoff loading conditions.-

3.2.1 Flight load parameters.-

3.2.1.1 Airspeeds.- The airspeeds shall be those specified for the flight loading conditions of Section 3, and any lower or intermediate airspeeds that result in critical loads on any part of the helicopter. For those cases involving compressibility or blade stall effects, the design speeds shall be as approved by the procuring activity.

3.2.1.2 Altitudes.- The altitudes for the loading conditions specified in Section 3 shall be the altitude at which the equivalent airspeed corresponding to V_H is a maximum, the altitude at which the maximum Mach number at the rotor blade tip is attained, and any intermediate altitude that results in limitations (critical loads, excessive vibration, etc) arising from variations of the aerodynamic characteristics of rotor blade stall.

3.2.1.3 Control motions.- The following time intervals shall be used for the control forces and displacements specified in paragraph 3.2:

Class I	-	0.2 second
Class II	-	0.3 second
Class III	-	0.4 second

When required, special provisions shall be made in the control system such that control displacements shall not be possible in less than the time specified.

3.2.2 Symmetrical flight.-

3.2.2.1 Maximum speed.- The airspeeds shall be V_D in forward, rearward, and sideward flight. The normal load factor shall be unity. The rotor speed shall be as follows:

(a) The limit rotor speed, power on; and:
(b) The design minimum rotor speed, power on.

3.2.2.2 Design fatigue loading.- The design fatigue loading shall be in accordance with an approved, fatigue design loading schedule. The helicopter and its components, except those covered by applicable specifications, shall be designed for a minimum fatigue life of 1,000 hours.

3.2.2.3 Symmetrical dive and pullout.- The forward airspeed shall be V_D and 0.6 V_H. The normal load factors shall be as specified in paragraph 3.1.10 for each specified airspeed. The rotor speed shall be as follows:

(a) The limit rotor speed, power on; and:
(b) The design minimum rotor speed, power on.

The pitching accelerations shall be those developed by a linear displacement of the controls in not more than the time specified in paragraph 3.2.1.3 to that displacement which results in the specified load factor followed, after attainment of the specified load factor, by linear return of the controls in not more than the time specified in paragraph 3.2.1.3 to that displacement required for level flight.

3.2.2.4 Vertical takeoff.- The helicopter shall be on the ground. The collective pitch control shall be displaced to change the main rotor blade pitch from the minimum to the maximum angle in not more than the time specified in paragraph 3.2.1.3. The resultant normal load factor shall be as specified in paragraph 3.1.10. The rotor speed shall be the limit rotor speed, power on.

3.2.3 Unsymmetrical flight.-

3.2.3.1 Rolling pullout with maximum control displacement.- The forward airspeed shall be V_D and any lower speed that results in critical loads. The rotor speed shall be as follows:

(a) The limit rotor speed, power on; and:
(b) The design minimum rotor speed, power on.

The rate of roll shall be the maximum attainable with a 100-pound lateral control force, or full lateral displacement, applied in not more than the time specified in paragraph 3.2.1.3. The normal load factors shall be 0.8 times the positive load factor specified in paragraph 3.1.10, and also shall be zero. The maximum rate of roll and the load factor shall occur simultaneously. The directional control shall be as follows:

(a) Maintained fixed in its neutral position.
(b) Displaced in the direction of recovery to the maximum available displacement in not more than the time specified in paragraph 3.2.1.3.

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3.2.3.2 Yawing.- The airspeeds shall be V_D and any lesser speed which produces critical side loads in forward flight and sideward flight. The cockpit directional control shall be displaced to the maximum displacement as limited by stops (or the maximum displacement attainable with a directional control force of 300 pounds steadily applied) in not more than the time specified in paragraph 3.2.1.3. The control displacement shall be maintained until the maximum angle of sideslip is developed, and shall then be returned to neutral at the same rate of displacement. The rotor speed shall be the limit rotor speed, power on.

3.2.4 Autorotational flight.-

3.2.4.1 Symmetrical dive and pullout.- The forward airspeeds shall be that for minimum rate of descent and V_D. The rotor speed shall be the limit rotor speed, power off, and the design minimum rotor speed, power off. The load factor to be attained in a symmetrical pullout at each specified airspeed shall be as specified in paragraph 3.1.10. The pitching acceleration shall be that developed by a linear displacement of the collective and cyclic controls in not more than the time specified in paragraph 3.2.1.3 to that displacement which results in the specified load factor followed, after attainment of specified load factor, by linear return of the controls in not more than the time specified in paragraph 3.2.1.3 to that displacement required for level flight.

3.2.4.2 Yawing.- The forward airspeeds shall be V_D in power off flight and the forward speed for minimum rate of descent, power off, or any intermediate speed which produces critical side loads. The cockpit directional control shall be displaced to the maximum displacement as limited by stops (or the maximum displacement attainable with a directional control force of 300 pounds steadily applied) in the time specified in paragraph 3.2.1.3. The control displacement shall be maintained until the maximum angle of slideslip is developed, and shall then be abruptly returned to neutral at the same rate of displacement. The rotor speed shall be the limit rotor speed, power off.

3.2.5 Gusts.- The airspeed shall be V_H in forward flight. A gust of $50\ \sigma^{-0.5}$ feet per second shall be encountered. The gust alleviation factor shall be determined from figure 1. The rotor speeds shall be all speeds up to the limit rotor speed, power on.

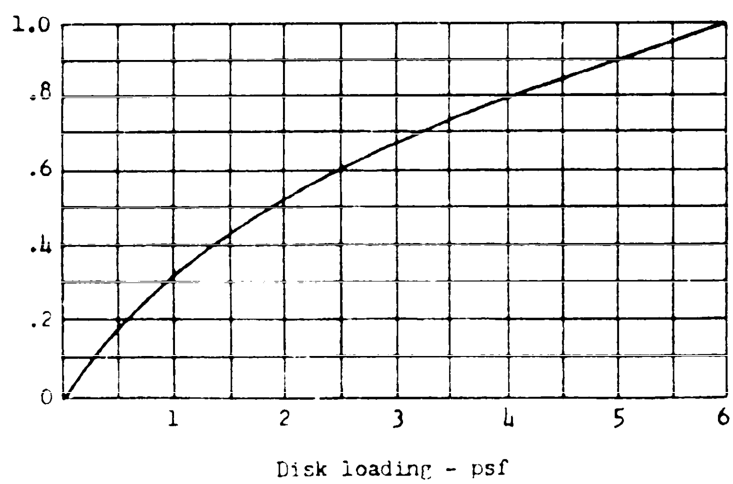

FIGURE 1. Gust alleviation factor

3.3 Miscellaneous loading conditions.-

3.3.1 Rotor acceleration.- The rotor acceleration loads shall be those developed by application of 1.5 times the torque developed at the military-power rating of the powerplant(s), or by application of 1.5 times the maximum torque transmissible to any single rotor by the transmission system, whichever is the greater, in not more than 0.1 second. Except for flight conditions, these loads (including the inertia loads resulting from the rotor blade(s) striking the stops) shall be distributed between any 2 blades of a 3-bladed articulated rotor, or any 3 blades of a 4- or 5-bladed articulated rotor. For rotors not embodying drag hinges, these loads shall be equally distributed to all blades of that rotor.

3.3.2 Rotor braking loads.- The loads that can be imposed by application of 2.0 times the maximum braking torque transmitted by the rotor brake shall be equally distributed to all blades of the rotor(s).

3.3.3 Blade trailing edge loads at transonic speeds.- Trailing edge loads over the aft 30 percent of airfoil sections at transonic speeds shall be determined by acceptable methods, or shall be based upon the data of NACA RM L9H08 or, alternatively, in accordance with this paragraph. In addition to the airloads determined by use of acceptable analytical methods for incompressible flow, the net airload intensity over at least the aft 30 percent of the airfoil section shall be increased by a uniformly distributed "compressibility increment" equal in magnitude to the following empirical value:

$$0.35\left[\frac{M}{M_{cr}} - 1\right]^{0.5} \cdot \rho \frac{V^2}{2}$$

in which M_{cr} is the free stream Mach number at which the speed of sound is first reached locally at the section being considered when the section angle of attack is that for the design condition being considered. This increment of net airload intensity is not applicable for Mach numbers less than 0.6. For values of M/M_{cr} greater than 2.0, the value of the trailing edge compressibility increments need not exceed 0.35q. The addition of this empirical load increment to the basic airloads for those portions of the rotor blade or control surface to which the condition is applicable need not be considered to increase the net total airload on any blade or rotor, nor to require any change in attitude to effect aerodynamic balance of the aircraft or rotor blade.

3.4 Ground loading conditions.-

3.4.1 Structure affected.- The landing loads specified in paragraph 3.4 shall be used in the design of the complete helicopter. For crash landing, the conditions shall be as specified in paragraph 3.4.7. Consideration shall be given to inertia loads imposed on the supports and carry-through structures for all items of equipment and disposable loads for which provision is required. Tires and oleos shall be assumed to have been serviced to the pressures and static extensions that are recommended by the contractor for operation at the more critical of basic design and design alternate gross weights.

3.4.1.1 Chapter 1 and Chapter 7 of Bulletin ANC-2 shall apply.

3.4.2 Landing parameters.- The limit sinking speed shall be 8 feet per second in combination with 2W/3-rotor lift at the basic design gross weight and, alternately, shall be 6 feet per second in combination with 2W/3-rotor lift at the design alternate gross weight. The maximum allowable ground reaction shall be specified by the procuring activity.

3.4.3 Yield strength for landing: (Applicable to Navy, Bureau of Aeronautics, only).- The yield load factor shall not be exceeded in a landing with sinking speeds equal to that specified in paragraph 3.4.2 times the square root of 1.15. The yield load factor shall not be exceeded in a landing with the sinking speeds specified in paragraph 3.4.2 at a gross weight of 1.15 times the appropriate design gross weight. The yield load factor shall not exceed 4.5 in the landings specified in paragraph 3.4.

3.4.4 Reserve energy requirement.- Failure of the structure shall not occur in a drop with a sinking speed equal to the limit value of sinking speed associated with the landing weights as specified in paragraph 3.4.2 times the square root of 1.5.

3.4.5 Landing.- The landing load conditions of Chapters 2 and 3 of Bulletin ANC-2 shall apply. In lieu of the speeds V_{S_L} and 1.2 V_{S_L} of Bulletin ANC-2, the touchdown speed shall be the maximum forward speed corresponding to an autorotative landing with a sinking speed defined in paragraph 3.4.2 during the flare out following the approach.

3.4.5.1 Main gear obstruction loads.- In lieu of Drift landing for the Nose wheel type and the Tail wheel type, specified in Chapter 2 of Bulletin ANC-2, the following shall apply: The main landing gear shall contact the ground simultaneously, with the auxiliary landing gear just clear of the ground. The forward velocity shall be zero. The vertical components of the ground reactions shall be those which would result from contacts with the specified sinking speed and rotor lift. A load equal to one-half of the maximum vertical reaction at each wheel, but not greater than 1.0 W, shall be applied in a forward, aft, inboard, and outboard direction, each in combination with the vertical load, considering each wheel independently. The transverse loads on the other wheels shall be zero. Swiveled wheels shall be so swiveled as to trail with respect to the transverse loads. For Navy helicopters, the swiveled wheels also shall be centered and locked.

3.4.5.2 Auxiliary gear obstruction loads.- The auxiliary landing gear shall contact the ground simultaneously, with the main wheels just clear of the ground. The forward velocity shall be zero. The vertical components of the ground reactions shall be those which would result from contacts with the specified sinking speed and rotor lift. A load equal to seven-tenths of the maximum vertical reaction at each wheel, but not greater than 1.0 W, shall be applied in a forward, aft, inboard, and outboard direction, each in combination with the vertical load, considering each wheel independently. The transverse loads on the other wheels shall be zero. Swiveled wheels shall be so swiveled as to trail with respect to the transverse loads. For Navy helicopters, the swiveled wheels also shall be centered and locked.

3.4.5.3 Nose down landing.- The helicopter shall contact the ground on the forward landing gear with the aft landing gear just clear of the ground. The forward velocity shall be zero. The vertical components of the ground reactions shall be those which would result from contacts at the specified sinking speed and rotor lift.

3.4.5.4 Tail down landing.- The helicopter shall contact the ground on the aft landing gear with the forward landing gear just clear of the ground. The forward velocity shall be zero. The vertical components of the ground reactions shall be those which would result from contacts at the specified sinking speed and rotor lift.

3.4.6 Taxiing and ground handling.- Chapters 3 and 4 of Bulletin ANC-2 shall apply. The weights to be used with the Bulletin ANC-2 requirements shall be the greater of paragraphs 3.1.5.1 or 3.1.5.2.

3.4.6.1 Securing.- (This applies to ship-based helicopters only; land-based helicopters shall be designed to the mooring requirements of Bulletin ANC-2.) For the following conditions, the rotor blades shall be secured to the fuselage or to the ground or deck:

(a) The helicopter shall be secured to the level ground or deck. The loads shall be the weight of the helicopter and those resulting from a 100-knot wind from any horizontal direction. The balancing forces shall be distributed among the securing points in a rational and conservative manner.

(b) The helicopter shall be secured to the deck of a ship rolled 45 degrees to the horizontal. The side load parallel to the deck and acting through the helicopter cg shall be 1.0 W. The load normal to the deck and acting through the helicopter cg shall be 1.0 W and 0.4 W. The balancing forces shall be distributed among the securing points and the landing gear in a rational or conservative manner.

3.4.6.2 Wind loads.- The helicopter shall be on the level ground or deck with the rotors turning at the critical rotor speed for ground flapping. The aerodynamic loads shall be those resulting from a 60-knot wind from any horizontal direction for ship-based helicopters, and 40-knot wind for land-based helicopters. Inertia loads resulting from the flapping of the rotor blades shall be combined with the aerodynamic loads.

3.4.6.3 Handling.- The jacking loads shall be those of Bulletin ANC-2. The hoisting loads shall be those of Bulletin ANC-2, except that the load factor shall be 2.0. For the hoisting condition, the rotors shall be in both the extended and folded positions. All jury struts shall be in place when rotors are folded.

3.4.7 Crash landing.- Sufficient strength shall be provided in the seat installation and attachments of engines, transmissions, equipment, and useful load items (including fuel tanks one-half full) and their carry-through structure to prevent failure of such attachments which would result in injury to personnel. The ultimate inertia-load factors shall be those specified by the procuring activity.

3.5 Control system loads.- The control system between the point of application of the pilot-applied loads and the swashplate(s), rotor-blade pitch-control-surface arm or control-surface horn, and any irreversible mechanism shall be subjected to the loads resulting from the (limit) pilot-applied loads of this paragraph, or the loads imposed by the rotor blades, whichever are greater. These loads shall be considered to apply with the pertinent cockpit control in any position within its limits of travel. The steady and oscillatory loads between the swashplate(s) or any irreversible mechanism and the rotor-blade pitch-control horn shall be as determined by a conservative or rational analysis. Reactions to the loads shall be provided as follows:

(a) By the control system stops only.
(b) By the control system locks only.
(c) By the irreversible mechanism only, with the irreversible mechanism locked with the control surface in any position within its limit of motion.

(d) By the attachments of the control system to the rotor-blade pitch-control horn only, with the control horn position within its limit of motion.

(e) By the attachments of the control system to the surface-control horn, with the control in any position within its limit of motion.

3.5.1 Stick or control column.- A force of 200 pounds shall be applied to the top of the pilot's handgrip in a fore-and-aft direction at any angle within 30 degrees above or below the horizontal. For lateral stick movement, a force of 100 pounds shall be applied to the top of the pilot's handgrip. For wheel controls, two 100-pound forces shall be applied in a fore-and-aft direction at 2 points diametrically opposite each other on the rim of the wheel. A single 80-pound force in the fore-and-aft direction shall be applied at any point on the circumference of the wheel. A couple in the plane of the wheel, consisting of 2 equal and opposite 80-pound forces, at points diametrically opposite each other, shall be applied.

3.5.2 Foot-operated directional controls.- A force of 300 pounds shall be applied to the point of contact of foot with pedal.

3.5.3 Handcrank or handwheel controls.- A tangential force which varies linearly with radius from 150 pounds for radii of 8 inches, or greater, to 50 pounds for radii of 2 inches, or less, shall be applied from any direction within 30 degrees of the plane of rotation of the control.

3.5.4 Twist controls.- For controls requiring operation by a twist of the hand, a torque equal to 50 R inch-pounds shall be applied to the control (R being the radius of the control knob or handle in inches).

3.5.5 Collective-pitch controls.- A force of 150 pounds shall be applied to the handle of the control in either direction of motion of the control ±30 degrees to the plane of movement of the control.

3.5.6 Distribution of loads within system.- Where the reaction to the pilot-applied loads is provided by 2 branches of a control system, each branch shall be considered, alternatively, to provide 100 percent of the total reaction in either direction.

3.5.7 Duplicate system.- When duplicate control systems are employed, the control-system loads shall be applied to each system separately, with the other system disconnected.

3.5.8 Dual-control system.- For helicopters which are provided with dual-control systems, 75 percent of the pilot-applied loads shall be applied simultaneously at each of the control stations.

3.5.9 Power-control system.- For helicopters which are provided with power-control systems, the control system will be designed to withstand the loads which can be applied by the power source combined with the pilot-applied loads where the design of the system permits them to be combined.

3.6 Mechanical instability, flutter, and vibration.-

3.6.1 Vibration comfort levels.- The helicopter shall be so designed that the main rotor-induced fuselage and control-stick vibration levels do not exceed the limits specified in Specification MIL-H-8501.

3.6.2 Flutter.- The criteria contained in Bulletin ANC-12 shall be applied with reference to prevention of flutter of such components as wings, fins, stabilizers, and control surfaces not attached to the rotors. The helicopter shall be free of flutter and divergence at speeds up to 1.15 times the design-limit speed. The rotor blades and attached control surfaces, if applicable, shall be free of flutter and divergence at rotor speeds up to 1.25 times the design-limit rotor speed with and without power.

3.6.3 Mechanical instability.- The helicopter shall be designed to be free of mechanical instability at all rotor speeds and operating conditions (landing, takeoff, taxiing, and flight) when equipped with each type of landing gear to be used on the helicopter, under the entire range of gross weight conditions, and throughout the extreme temperature range specified by the contract.

3.6.3.1 Method of analysis.- Any rational method of analysis may be used which results in a calculation of the instability ranges and the damping necessary to eliminate those ranges which could be excited in the obtainable rotor-speed range.

3.6.3.2 Rigid blades.- The calculations of the mechanical instability analysis shall demonstrate that the lower limit of the instability speed range is above the maximum speed for the main rotors.

3.6.3.3 Hinged blades.- If the blades are attached to the main rotor hub by means of drag hinges, dampers shall be utilized and shall be of sufficient damping capacity, as determined by the analysis of paragraph 3.6.3.1, to preclude mechanical instability.

3.6.3.3.1 Blade dampers.- Dampers, except friction-type dampers, shall provide forces or torques that are at least proportional to the linear and angular velocities, respectively. If relief valves are provided, they shall not affect the forces or torque applied by the damper during any portion of the specified ground rev-up test. If friction dampers alone are used, the hub effective damping in any mode of motion critical from the point of view of mechanical instability shall be at least 30 percent of critical damping.

3.6.4 Engine, shaft, and rotor vibration.- There shall be no significant resonances (critical speeds or flywheel-type resonance) of the mounted engine-drive-shaft rotor system in the operating range of the helicopter. There shall be no flywheel-type resonance involving rigid body modes of the helicopter from idle rotor speed to maximum rotor speed.

3.6.5 Antivibration provisions.-

3.6.5.1 General.- Suitable antivibration provisions shall be used in order to achieve the levels of vibration specified in the paragraph titled Vibration characteristics, of Specification MIL-H-8501.

3.6.5.2 Vibration-isolating and absorbing systems.- For reciprocating engine installations, a suitable vibration-isolating system shall be provided. When the design of the helicopter is such that the rotor-powerplant system is mounted as a unit, the natural frequencies of the mounted rotor-powerplant system, when installed in the helicopter, shall not exceed 70 percent of the minimum flight operating rotor speed. For conventional reciprocating engine installations, the natural frequencies of the mounted engine installed in the helicopter shall not exceed 35 percent of the minimum flight operating engine speed in the rotational mode of motion about the crankshaft axis, nor exceed 70 percent of the minimum operating engine speed in all other modes of vibration. In either of the above types of installation, no resonance of the mounted rotor-powerplant system or the mounted powerplant shall occur within ±10 percent of rotor or engine idling speed, as applicable.

3.6.5.2.1 Turbojet engine installations.- Adequate space shall be reserved on all prototype helicopters for the inclusion of vibration-isolating or vibration-absorbing systems and for motions of the powerplant caused by their functioning. If the requirements of Specification MIL-H-8501 can be met without such systems, they will be considered unnecessary. If such systems are used, their characteristics shall be approved by the procuring activity.

3.6.5.2.2 Contractor's responsibility.- The design or selection and installation of vibration-isolating systems and their proper functioning shall be the responsibility of the aircraft contractor.

3.6.5.2.3 Strength and durability requirements.- Requirements for strength, weight, durability, and prevention of deterioration shall be those contained in ARDC Manual 80-1 (for Air Force contracts), or Specification SR-134 (for Navy contracts).

3.6.5.2.4 Miscellaneous design requirements.-

3.6.5.2.4.1 Vibration-isolating systems shall be provided with motion limiting stops, or brakes which will prevent excessive displacements of the powerplant or rotor, and which will limit the relative motion of the powerplant and rotor to a magnitude corresponding to the allowances made in powerplant and rotor controls and other connections between the powerplant, rotor, and the helicopter structure.

3.6.5.2.4.2 Means shall be provided to prevent the complete separation of the powerplant or rotor from the helicopter in case of failure of the isolator elastic material or its bonding. In case of such failure, the displacement of the powerplant shall not be sufficient to break fuel or oil lines, or result in rotor blades striking any part of the helicopter.

3.6.5.2.4.3 Design criteria for electrical bonding, and required clearances in vibration-isolating systems, shall be those contained in ARDC Manual 80-1, or Specification SR-134, as applicable.

3.6.5.3 Rotor blade clearance.- The design of the rotor system(s) shall be such that, upon installation on the helicopter, there shall be sufficient clearance of the blades to the ground, to each other, and to other parts of the helicopter. In general, because of blade length, flexibility, and articulation, the clearance during operation will be different than the static clearance. During operation in all flight regimes, the clearance between main rotor blades and other parts of the helicopter shall be not less than 9 inches, and preferably 12 inches. In the coaxial, synchropter, tandem, and laterally disposed multirotor configurations, the clearance between main rotor blades of adjacent rotors shall be not less than 6 inches during operation. The clearance between auxiliary rotor blades and other parts of the helicopter shall be not less than 6 inches, and between blades of adjacent auxiliary rotors, not less than 4 inches under all operating conditions. The design of the rotors shall be such as to preclude the possibility of the blades striking each other or any part of the helicopter. Sufficient clearance shall be provided, with the rotors in operation, in order that crew members will not be in the plane of rotation and can safely enter and leave the aircraft.

3.6.6 Noise levels.- Whenever compatible with the required performance characteristics of the helicopter, it shall be so designed that the noise levels at the head level of all crew and passenger positions do not exceed the "Desired level" specified in table I when the helicopter is in level flight at a pressure altitude of 1,000 feet, the heating or ventilating system full on, and the powerplants developing normal rated power, thrust, or speed. In no case, however, shall the noise levels exceed the "Maximum level" of table I.

TABLE I

Noise level tolerances

Frequency band, cps	Maximum level	Desired level
Over-all	123 db	113 db
75-150	120 db	108 db
150-300	115 db	102 db
300-600	113 db	98 db
600-1,200	110 db	95 db
1,200-2,400	103 db	85 db
2,400-4,800	95 db	75 db

3.6.6.1 If necessary, soundproofing blankets conforming to Specification MIL-S-5659 shall be installed in accordance with Specification MIL-S-6144 to effect the specified levels of table I. Blankets in areas of fuel and oil sloppage, etc, shall be covered with a nonporous trim cloth in accordance with Specification MIL-C-7514 and with a backing film conforming to Specification MIL-P-6264 to prevent absorption of flammable fluids. The contractor shall furnish a report thereon, as specified in Index No. 17.2 of paragraph 3.7.3.3. This report shall include:

(a) Sketches and tables which give the unit weight, area, construction, and location of each soundproofing blanket installed.
(b) For compartments which inclose powerplants and personnel, sketches and tables which give the unit weight, area, material, and location of windows, fuselage skin panels firewalls, and floors.

3.7 Data requirements.-

3.7.1 General.- Static and dynamic structural design data and stress analysis shall be prepared and submitted in accordance with paragraph 3.7.

3.7.1.1 Data submittal.- The data required in paragraph 3.7 shall be submitted to the procuring activity in accordance with Specification SR-6 or Specification MIL-D-7579 (whichever is applicable), or in accordance with the terms of the contract.

3.7.1.2 Sequence of data submittal.- Unless otherwise specified by the contract, the sequence of submittal of the data required in paragraph 3.7 shall be as follows:

(a) The list of report titles specified in paragraph 3.7.3.4 shall be submitted no later than 3 months after date of receipt of letter of intent or other such notice of award of contract.

(b) Within 4 months after the date of receipt of letter of intent or other such notice of award of contract, or within 2 months after date of mockup review, whichever is later, the contractor shall submit under Index No. 1.1 of paragraph 3.7.3.3 at least the maximum and minimum weight and the limits of cg travel proposed for flight, takeoff, alighting, and handling design conditions with bases for their selection.

(c) Within 4 months after the date of receipt of letter of intent or other such notice of award of contract, the contractor shall submit under Index No. 3.1 of paragraph 3.7.3.3 at least the sources of aerodynamic data and a description of methods and assumptions to be used in determining the magnitudes and distributions of all aerodynamic loads.

(d) All structural design data shall be submitted as soon as practical and, when specified, not later than 30 days prior to delivery of the ground test articles. All calculations of loads shall be submitted at least 30 days prior to the request for release for the first flight or, when specified, not later than 30 days prior to delivery of the ground test article. All structural design data, except the data of item 18, paragraph 3.7.3.3, shall be submitted at least 30 days prior to request for release for other than normal flying.

(e) Where applicable, the flutter, mechanical instability, powerplant and main rotor vibration isolation analyses, and soundproofing report (Index No. 17, 17.1, 9.1.2, and 17.2, respectively, paragraph 3.7.3.3) shall be submitted at least 30 days prior to release for related ground vibration tests.

3.7.2 Form and content of reports.- Reports prepared to satisfy the data requirements of paragraph 3.7 shall conform to the form and contents as specified in this paragraph.

3.7.2.1 Report form.- Reports shall consist of the parts specified in this paragraph in the order presented.

3.7.2.1.1 Cover.- Stiff-backed report covers of light colors shall be used and shall contain the following information:

(a) Contractor's identification or report by title and number.
(b) Aircraft model number and contract number.
(c) Date of issue.

3.7.2.1.2 Title page.- In addition to the same information required for the cover, the title page shall include signatures of responsible witnesses and provisions for indexing revisions.

3.7.2.1.3 Table of contents.- A complete, detailed table of contents, arranged in order of sequence, shall be included. The table may be omitted from reports of 15 pages or less.

3.7.2.1.4 References.- The table of references shall include the report, drawing numbers, and titles. Adequate reference shall be contained for all items in the report, the origin of which is not obvious. Reference reports shall be submitted to the procuring activity unless already on file with the procuring activity.

3.7.2.1.5 Symbols.- Symbols, abbreviations, and units, if not defined when they first appear in the text material, or if they do not appear in standard lists of aircraft nomenclature, shall be defined in the table of symbols.

3.7.2.1.6 Summary.- The summary shall list the principal results discussed by the report.

3.7.2.1.7 Introduction.- The introduction shall include the purpose and authorization for the report.

3.7.2.1.8 Discussion.- The discussion shall include a description of the item investigated, loading conditions involved, and methods of analysis. Description of the structure, supplemented by sketches showing important features shall be included for the purposes of clarity.

3.7.2.1.9 Analysis.- All steps in calculations or derivations necessary for clarity shall be included. Lengthy derivations of formulas shall be placed in an appendix. Tabular methods shall be used to summarize results.

3.7.2.1.10 Conclusions.-

3.7.2.2 Report content.- The detail contents of each report shall be in accordance with the applicable number of the indexing system of paragraph 3.7.3.3. In addition, the contents of each report shall satisfy the requirements of this paragraph, where applicable.

3.7.2.2.1 Page numbering.- Each page shall include page number, report number, model designation, date, and the names of the computer and checker. Revised pages shall show the revision date.

3.7.2.2.2 Loads.- Loads shall always be identified as limit, yield, or ultimate loads. Where special factors are required, such as bearing factors, they shall not be included until computation of the margin of safety.

3.7.2.2.3 Stress computations.- The stress analysis computations shall be presented as clearly and concisely as possible. Unorthodox method of stress analysis shall be substantiated for accuracy and application. The derivation of unusual stress analysis formulas shall be shown.

3.7.2.2.4 Sketches.- Adequate sketches shall be provided throughout the report to eliminate the necessity of referring to drawings of the aircraft. Assembly or installation drawings where suitable for specific illustration purposes may, when reduced to the size of the report, be included therein. The following information shall be included on the sketches:

(a) Each sketch shall be titled and numbered.
(b) The station centerlines, skin mold lines, and adjoining structures shall be shown in each sketch in order to locate the structure in the aircraft.
(c) Part numbers of the numbers analyzed shall be shown on each sketch.
(d) Sections through the structure which are analyzed shall be indicated on the sketches.

3.7.3 Structural design data.- For purposes of preparing the structural design data, the structural analyses shall be divided into two major portions: (a) The external loads section, and (b) the stress analysis section.

3.7.3.1 External load section.- The section for determination of external loads shall show the origin and computation of all the external loads which the aircraft structure must sustain, as required by this specification.

3.7.3.2 Stress analysis section.- The stress analysis section shall contain all the analytical computations proving the strength of the structural members of the aircraft. New or revised analyses shall be required to cover structural revisions in the aircraft subsequent at the first stress analysis. For all models, the structure at all times shall be fully justified by stress analysis. For each aircraft model subsequent to the first experimental model, a table listing all the stress analyses covering that particular model shall be submitted with the stress analyses.

3.7.3.3 Index.- For purposes of identification, the structural design data shall be divided to conform to the following indexing system:

Index No.	Contents of report
1.	Inertia loads, shears, and moments for unit acceleration.
1.1	Structural weight analysis and distribution of inertia loads, shears, and moments for unit linear accelerations.
1.2	Moments of inertia and distribution of inertia loads, shears, and moments for unit angular accelerations.
1.3	Structural description report. This report shall contain, as a minimum, a complete description of the basic structure, controls, rotor system, landing gear installation, engine and transmission installation, and shall include the following structural design information pertinent to the skin stringers, longerons and frames incorporated in the fuselage, rotor blades, and tail surfaces: (a) Location. (b) Skin panel sizes. (c) Materials and material conditions. (d) Material gages. (e) Dimensional cross sections of structural members.
2.	Air force and moment coefficients, and distributions and centroids of unit airloads on helicopter.
2.1	Spanwise distributions and centroids of unit airload coefficients on rotor blades for flight loadings.
2.2	Chordwise distributions and centroids of unit airload coefficients on rotor blades for flight loadings.
2.3	Spanwise and chordwise distributions and centroids of unit airload coefficients on stabilizing surfaces for flight loadings.
2.4	Critical air force and moment coefficients and distributions of airloads over fuselage.
2.4.1	Critical pressure distribution over cockpit enclosures.
2.5	Air force and moment coefficients for complete helicopter for flight loadings.
3.	General structural design criteria and resulting design loads on complete helicopters.

Index No.	Contents of report
3.1	Free flight loading conditions.
3.2	Ground loading conditions.
3.2.1	Takeoff and alighting.
3.2.2	Miscellaneous ground handling, tie down, hoisting, etc.
4.	Structural analysis of stabilizing surfaces.
4.1	Resulting loads, shears, bending moments and torsional moments for applicable conditions under index No. 3 for:
4.1.1	Horizontal surfaces.
4.1.2	Vertical surfaces.
4.2	Stress analysis, member sizes, and margins of safety (including effects of redistribution of airloads due to deflections) for:
4.2.1	Horizontal surfaces.
4.2.2	Vertical surfaces.
4.2.3	Fittings.
5.	Structural analysis of land-type landing gear installation.
5.1	Land-type landing gear analysis: Complete stress analysis, member sizes, and margins of safety for applicable conditions under Index No. 3 for:
5.1.1	Main gear.
5.1.2	Auxiliary gear.
5.1.3	Tail bumper.
6.	Float-type landing gear installation.
6.1	Floats, float bracing or supporting structure-member loads, sizes, and margins of safety for applicable conditions under Index No. 3.
6.2	Stress analysis of miscellaneous float gear fittings.
7.	Structural analysis of rotor group.
7.1	Rotor analysis: Resulting loads, shears, bending moments, and torsional moments for applicable design conditions under Index No. 3 for:
7.1.1	Blades.
7.1.2	Hub.
7.1.3	Fittings, hinges, damper, damper bracket, etc.

Index No.	Contents of report
7.2	Rotor analysis: Stress analysis, member sizes, and margins of safety (including effects of redistribution of airloads caused by deflections) for:
7.2.1	Blades.
7.2.2	Hub.
7.2.3	Fittings, hinges, damper, damper brackets, etc.
8.	Structural analysis of fuselage.
8.1	Fuselage analysis: Resulting loads, shears, bending moments, and torsional moments for applicable conditions under Index No. 3.
8.2	Fuselage analysis: Stress analysis, member sizes, and margins of safety for:
8.2.1	Fuselage, including pylon.
8.2.2	Cockpit enclosures.
8.2.3	Supporting structures and fittings for fixed equipment and useful load items.
9.	Structural analysis of powerplant supporting structure and transmissions.
9.1	Resulting loads, shears, and moments for applicable conditions under Index No. 3.
9.1.1	Mount: Complete stress analysis, member sizes, and margins of safety.
9.1.2	Vibration isolators: Strength and vibration isolating characteristics (if not included in Index No. 9.1.1).
9.1.3	Transmission: Complete stress analysis, member sizes, and margins of safety, except where the strength of components are substantiated by test.
10.	Structural analysis of flight controls: Loads, shears, moments, member sizes, and margins of safety for air loadings and pilot-control loading conditions for:
10.1	Longitudinal, lateral, directional, and vertical controls.
11.	Structural analysis of armament installations: Loads, stress analysis, member sizes, and margins of safety.
12.	Structural analysis of external load items: Loads, stress analysis, member sizes, and margins of safety for:
12.1	External fuel tanks.
12.2	Rescue equipment.

Index No.	Contents of report
13.	Structural analysis of beaching gear and controls: Loads, stress analysis, member sizes, and margins of safety.
14.	Structural analysis of hoisting sling and hoisting fitting: Loads, stress analysis, member sizes, and margins of safety.
15.	Structural analysis of towing gear (if helicopter is towed as a glider): Loads, stress analysis, member sizes, and margins of safety.
16.	Structural analysis of miscellaneous interconnecting fittings and joints.
17.	Aeroelastic stability calculations: Determination of critical speeds of flutter and airfoil divergence for complete helicopter.
17.1	Preliminary mechanical instability analysis.
17.2	Soundproofing and soundproofing installation report (where applicable).
18.	Strength summary and operating restrictions for all flight and ground conditions and for all structural assemblies and components.

3.7.3.4 Data preparation requirements.- The contractor shall submit for acceptance reports of all applicable structural calculations listed in the indexing system of paragraph 3.7.3.3. A list of titles of all structural calculation reports to be submitted and an estimated date of submittal of each shall be forwarded to the procuring activity in accordance with paragraph 3.7.1.2. The list of structural calculations shall be in report form, which shall contain provisions for lists of other structural reports and drawings that shall be submitted subsequent to transmittal of the list of structural calculations. The list of structural calculations shall be revised as necessary during the course of the design by inclusions of additional or revised pages. Data referred to in a report shall be forwarded to the procuring activity for information prior to or concurrently with submittal of the report, unless such data are known to be available to the procuring activity.

3.7.3.5 Applicable structural reports.- Previously accepted reports submitted for prototype aircraft or for similar structural assemblies need not be resubmitted. However, the applicability of these data shall be substantiated, and revised title pages submitted.

3.7.3.6 Structural drawings.- Drawings submitted shall be layouts, or the first drawings normally prepared which show the required information. A list of structural drawings and the estimated dates of submittal of each shall be forwarded prior to or concurrently with the first drawing submitted. Submittal of drawings for release shall begin soon after receipt of the letter of intent, or other such notice of award, and shall continue with the development of the design. The contractor shall indicate all authorized deviations from the detail or other applicable specifications, in order to facilitate review of the drawings. These deviations should be marked in colored crayon, the color of which is in sharp contrast to the color of the print. Release of drawings under this paragraph does not constitute official release of unauthorized deviations from detail or design specification requirements. Drawings shall show the major structural design features, including skin-stiffening systems, important fitting attachments, carry-through structures, joints, splices, cutouts, and other such discontinuities, typical sections through load-carrying members, materials employed, and heat treatment, types of riveting, types of welding, and other methods of attachment of important parts.

4. QUALITY ASSURANCE PROVISIONS

4.1 This section is not applicable to this specification.

5. PREPARATION FOR DELIVERY

5.1 General.- The design data described by this specification shall be prepared for delivery in accordance with the applicable contract design data requirements.

6. NOTES

6.1 Intended use.- The design criteria specified herein are intended to define structural design requirements and structural data requirements applicable to military helicopters.

6.2 Superseding data.- This specification supersedes Section 2, paragraphs 7 through 7.4 of Section 7, and Section 8 of Bureau of Aeronautics Specification SR-189.

6.3 Definitions and symbols.- The definitions of the symbols and expressions used in this specification are given below. Definitions of symbols and expressions not included should conform with the definitions listed in NACA Report No. 474, and in NACA Technical Note No. 1604.

6.3.1 Airspeed, equivalent V_e - The product of the true airspeed and the square root of the relative density.

6.3.2 Airspeed, true, V - The speed of the helicopter, along its flight path, with respect to the body of air through which it is moving.

6.3.3 Area, rotor-disk, A - The area enclosed by the projection of the arc swept by the rotor blade tips. The area of the overlapped portions of multirotored helicopters should not be included in the disk area.

6.3.4 Autorotation - The ability of the helicopter to maintain a condition of flight corresponding to the gliding flight of fixed-wing aircraft by maintaining the rotor's angular velocity without engine power, the rotating force being provided by the forward component of the lift forces acting on the rotor blades.

6.3.5 Conditions, critical - The design conditions which impose the most severe loadings on the helicopter structure.

6.3.6 Density, relative, σ - The ratio of air density to the air density at sea level, $\sigma = \rho/\rho_0$.

6.3.7 Dive - A maneuver executed for the purpose of increasing forward, sideward, or rearward speed while simultaneously decreasing altitude.

6.3.8 External stores - The term external stores should be interpreted to mean any item mounted externally on the aircraft.

6.3.9 Factor, gust alleviating, K - A factor by which the specified gust velocity is multiplied to obtain an equivalent sharp-edge gust.

6.3.10 Factor of safety, ultimate - The factor of safety specified for the determination of ultimate loads.

6.3.11 Factor of safety, yield - The factor of safety specified for the determination of design-yield loads.

6.3.12 Limit.- The term limit used throughout this specification in such phrases as "limit load factor" is intended to refer to the design limit as specified in the applicable design specifications.

6.3.13 Load factor, n - The ratio of a given mean, steady-state load to an arbitrary reference load. The arbitrary reference load will be indicated by the context and is usually the weight of the helicopter or the magnitude of the load when the helicopter is in static equilibrium. When employed, the subscript indicates the direction of the given load.

6.3.14 Load factor, limit - A load factor which establishes a strength level for design of the helicopter and helicopter components. The limit load factor is the maximum value which occurs or is measured at the cg of the helicopter and should not include the oscillatory increment of load factor.

6.3.15 Load, design yield - A limit load multiplied by the specified yield factor of safety.

6.3.16 Load, failing - The load at which failure of a structure occurs.

6.3.17 Load, fatigue - A load which will be experienced during normal service operation such that it will determine the fatigue safety of components of the helicopter.

6.3.18 Load, limit - A load which can be sustained without structural yielding, the magnitude of which is sufficiently large that the probability of being exceeded corresponds to a minimum acceptable level of operational safety.

6.3.19 Load, proof - Any load which will not cause permanent deformation of the structure to which it is applied.

6.3.20 Load, ultimate - A limit load multiplied by the specified ultimate factor of safety.

6.3.21 Load, yield-strength - The load at which the test data or observations, or both, demonstrate that the structure has sustained significant permanent deformation that will affect adversely the aerodynamic characteristics or the mechanical operation of any part of the helicopter, or that will be noticeable upon inspection.

6.3.22 Maximum aft (or forward) center of gravity - The term maximum aft or maximum forward cg positions used in this specification should be interpreted to mean the maximum positions used for the design in accordance with paragraph 3.1.7.

6.3.23 Maximum safe - An adjective which, in combination with a parameter such as speed, loud factor, altitude, etc, denotes the limit for which limit strength of airworthiness is available.

6.3.24 Normal flying - Normal flying for helicopters should be interpreted to consist of the following:

(a) Takeoff, hovering, and landing.
(b) Flying in a normal attitude with the following limitations:

(1) The speed at any altitude should not exceed the maximum speed attainable in sustained level flight at that altitude, using normal-rated power.

(2) The accelerations should not exceed 1.5g.
(3) The angle of bank should not exceed 30 degrees.
(4) The flight controls should not be moved abruptly.

6.3.25 Rotor speed, design minimum, power on - The minimum practical rotor speed attainable in power on flight at the basic design gross weight.

6.3.26 Rotor speed, design maximum, power on - The rotor speed attainable, using military-rated power or thrust.

6.3.27 Rotor speed, limit, power on - The design maximum rotor speed, power on, multiplied by the factor 1.25.

6.3.28 Rotor speed, design minimum, power off - The minimum practical rotor speed attainable in autorotative flight at the basic design gross weight.

6.3.29 Rotor speed, design maximum, power off - The maximum rotor speed attainable in forward flight at an airspeed of V_D with engine(s) delivering zero power or thrust.

6.3.30 Rotor speed, limit, power off - The design maximum rotor speed, power off, multiplied by the factor 1.25.

6.3.31 Speed - Speeds specified herein are equivalent airspeed in knots defined as $V\sqrt{\sigma}$.

6.3.32 Speed, design maximum level flight, V_H - The design maximum level flight speed in forward, rearward, and sideward flight should be defined as the maximum speed attainable at the basic design gross weight in level flight, using military-rated power or thrust, or as may be limited by blade stall or compressibility effects.

6.3.33 Speed, limit dive, V_D - The speed V_H multiplied by the factor 1.20 for class I helicopters, and a factor of 1.15 for classes II and III helicopters.

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