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MILITARY SPECIFICATION

HELICOPTER FLYING AND GROUND HANDLING QUALITIES; GENERAL REQUIREMENTS 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 This specification covers the design requirements for flying and ground handling qualities of U.S. military helicopters.

2. APPLICABLE DOCUMENTS

There are no applicable documents.

3. REQUIREMENTS

3.1 General.

3.1.1 With the exception of 3.6, section 3 contains the requirements for the flying qualities, and for certain relevant ground-handling characteristics, of all helicopters procured by the Department of the Army, the Department of the Navy, and the Department of the Air Force, that are required to operate under visual flight conditions. Paragraph 3.6 applies to helicopters required to operate under instrument flight conditions. The required characteristics are those which are considered, on the basis of present knowledge, as tending to insure satisfactory handling qualities and are subject to modification as indicated by new information. Every effort shall be made by designers to provide additional desirable characteristics which have been omitted as specific requirements.

3.1.2 Unless otherwise specified, the requirements of section 3 shall apply at all normal service loadings over the operating rotor speed range and all operational altitudes and temperatures. For the purposes of section 3, normal service loadings shall include all combinations of gross weight and center of gravity locations that could ordinarily be encountered in normal service operations.

3.2 Longitudinal characteristics.

3.2.1 It shall be possible to obtain steady, smooth flight over a speed range from at least 30 knots rearward to maximum forward speed as limited either by power available or by roughness due to blade aerodynamic limitations, but not by control power. This speed range shall be construed to include hovering and any other steady state flight condition, including steady climbs and steady descents. Throughout the specified speed range a sufficient margin of control power, and at least adequate control to produce 10 percent of the maximum attainable pitching moment in hovering shall be available at each end to control the effects of longitudinal disturbances. This requirement shall apply not only to powered flight, but also to autorotative flight at forward speeds between zero and the maximum forward speed for autorotation. Within the limits of speed specified in 3.2.1 and during the transitions between hovering and the specified extremes, the controls and the helicopter itself shall be free from objectionable shake, vibration, or roughness, as specified in 3.7.1.

3.2.2 The helicopter shall be reasonably steady while hovering in still air (winds up to 3 knots), requiring a minimum movement of the cyclic controls to keep the machine over a given spot on the ground, for all terrain clearances up to the disappearance of ground effect. In any case, it shall be possible to accomplish this with less than ±1.0-inch movement of the cyclic controls.

3.2.3 For all conditions and speeds specified in 3.2.1, it shall be possible in steady-state flight to trim steady, longitudinal control forces to zero. At these trim conditions, the controls shall exhibit positive self-centering characteristics. Stick "jump" when trim is actuated is undesirable.

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TABLE I. *Power and speed conditions*

Initial trim and power condition	Speed range of interest
Hovering	0 to 30 knots.
Level flight at 35 knots	15 to 60 knots.
Level flight at 80 percent V_{max}	60 percent $V_{max} - V_{max}$.
Level flight at V_{max}	80 percent $V_{max} - V_{limit}$.
Climb at best rate of climb	V_{max} R/C ± 15 knots.
Partial power descent at 300 to 500 fpm	15 to 60 knots.
Autorotation with trim as in "Level flight at 80 percent V_{max}" above	60 percent $V_{max} - V_{max}$ for autorotation.
Autorotation at speed for minimum rate of descent	15 knots—(trim speed +20 knots).

3.2.4 At all trim conditions and speeds specified in 3.2.1, the longitudinal force gradient for the first inch of travel from trim shall be no less than 0.5 pound per inch and no more than 2.0 pounds per inch. In addition, however, the force produced for a 1-inch travel from trim by the gradient chosen shall not be less than the breakout force (including friction) exhibited in flight. There shall be no undesirable discontinuities in the force gradient, and the slope of the curve of stick force versus displacement shall be positive at all times with the slope for the first inch of travel from trim greater than or equal to the slope for the remaining stick travel.

3.2.5 With the helicopter trimmed in steady, level, horizontal flight at maximum forward speed, it shall be possible readily and safely to bring the machine to a quick stop and hover. With the helicopter trimmed in hovering flight, it shall be possible to accelerate rapidly to maximum forward speed, maintaining approximately constant altitude.

3.2.6 Without retrimming, the longitudinal control forces required to change from any trim and power condition to any other trim and power condition as specified in table I, or for performance of the maneuvers discussed in 3.2.5 and 3.5.4 or any other normal helicopter maneuvers, shall not exceed the values given in table II.

3.2.7 With the control trimmed for zero force, breakout forces, including friction in the longitudinal control system, shall conform with the values given in table II when measured in flight.

3.2.8 The controls shall be free from objectional transient forces in any direction following rapid longitudinal stick deflections. During and following rapid longitudinal displacement of the control stick from trim, the force acting in a direction to resist the displacement shall not at any time fall to zero. Longitudinal control displacement shall not produce lateral control forces in excess of 20 percent or pedal forces in excess of 75 percent of the associated longitudinal force. For helicopters employing power-boosted or power-operated controls, there shall be no lateral or directional control forces developed.

3.2.9 There shall be no objectionable or

TABLE II. *Limit control force values (pounds) (when measured in flight with adjustable friction off)*

Control	Limit control force	Limit control forces for breakout, including friction forces	
		Minimum	Maximum
Longitudinal cyclic	8.0	0.5	1.5
Lateral cyclic	7.0	0.5	1.5
Collective	7.0	[1] 1.0	3.0
Directional	15.0	[1] 3.0	7.0

[1] *May be measured with adjustable friction set.*

excessive delay in the development of angular velocity in response to control displacement. The angular acceleration shall be in the proper direction within 0.2 second after longitudinal control displacement. This requirement shall apply for the speed range specified in 3.2.1.

3.2.10 The helicopter shall, at all forward speeds and at all trim and power conditions specified in table I, except as noted below, possess positive, static longitudinal control force, and control position stability with respect to speed. This stability shall be apparent in that at constant throttle and collective pitch-control settings a rearward displacement of and pull force on the longitudinal-control stick shall be required to hold a decreased value of steady, forward speed, and a forward displacement and push force be required to hold an increased value of speed. In the speed range between 15 and 50 knots forward, and 10 to 30 knots rearward, the same characteristics are desired, but a moderate degree of instability may be permitted. However, the magnitude of the change in the unstable direction shall not exceed 0.5 inch for stick position or 1.0 pound for stick force.

3.2.10.1 The stability requirements of 3.2.10 are intended to cover all steady flight conditions in which the helicopter might be operated for more than a short time interval. As a guide for the conditions to be investigated, the tabulation of pertinent conditions in table I may be utilized, all referred to the most critical center of gravity position.

3.2.10.2 The helicopter shall not exhibit excessive longitudinal trim changes with variations of rate of climb or descent at constant airspeed. Specifically, when starting from trim, at any combination of power and airspeed within the flight envelope, it shall be possible to maintain longitudinal trim with a longitudinal control displacement of no more than 3 inches from the initial trim position as the engine power or collective pitch, or both, are varied throughout the available range. Generally, the airspeeds needing the most specific investigation of the above characteristics include V_{max} and the speeds between zero and one-half the speed for minimum power.

3.2.11 The helicopter shall exhibit satisfactory dynamic stability characteristics following longitudinal disturbances in forward flight. Specifically, the stability characteristics shall be unacceptable if the following are not met for a single disturbance in smooth air:

(a) Any oscillation having a period of less than 5 seconds shall damp to one-half amplitude in not more than 2 cycles, and there shall be no tendency for undamped small amplitude oscillations to persist.

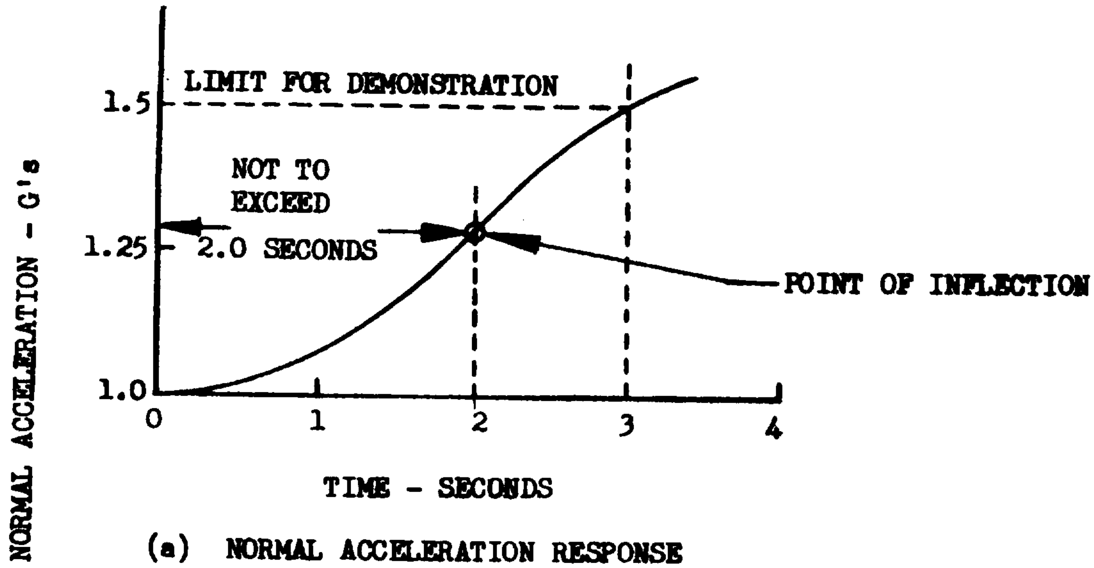
(b) Any oscillation having a period greater than 5 seconds but less than 10 seconds shall be at least lightly damped.

(c) Any oscillation having a period greater than 10 seconds but less than 20 seconds shall not achieve double amplitude in less than 10 seconds.

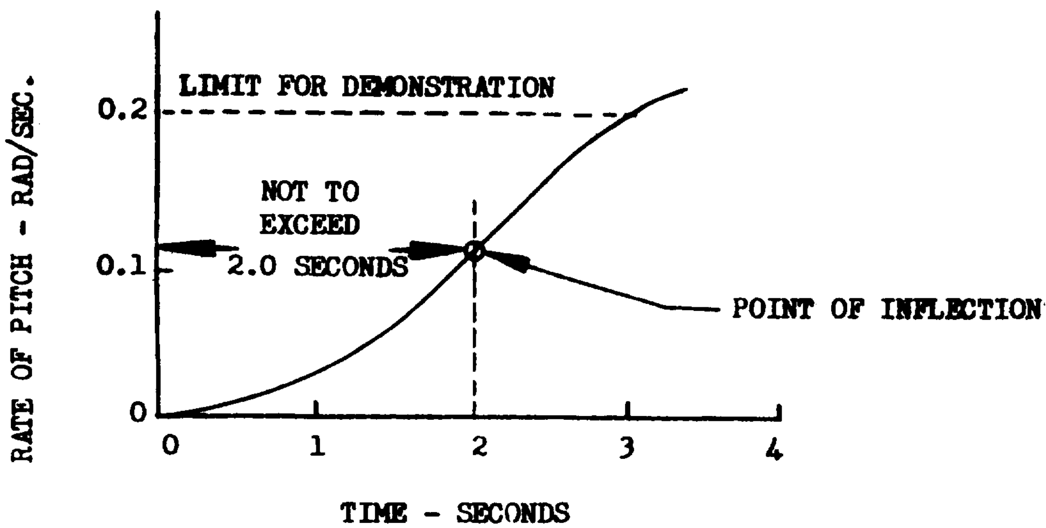
3.2.11.1 The following is intended to insure acceptable maneuver stability characteristics. The normal acceleration stipulations are intended to cover all speeds above that for minimum power required; the angular velocity stipulations shall apply at all forward speeds, including hovering.

(a) After the longitudinal control stick is suddenly displaced rearward from trim a sufficient distance to generate a 0.2 radian/sec. pitching rate within 2 seconds, or a sufficient distance to develop a normal acceleration of 1.5 g within 3 seconds, or 1 inch, whichever is less, and then held fixed, the time-history of normal acceleration shall become concave downward within 2 seconds following the start of the maneuver, and remain concave downward until the attainment of maximum acceleration. Preferably, the time-history of normal acceleration shall be concave downward throughout the period between the start of the manuever and the attainment of maximum acceleration. Figure 1(a) is illustrative of the normal acceleration response considered acceptable.

(b) During this maneuver, the time-history of angular velocity shall become concave downward within 2.0 seconds following the start of the



(a) NORMAL ACCELERATION RESPONSE



(b) ANGULAR VELOCITY RESPONSE

FIGURE 1. *Typical normal acceleration and pitch rate response. (In this sample the control input was limited by normal acceleration.)*

maneuver, and remain concave downward until the attainment of maximum angular velocity; with the exception that for this purpose, a faired curve may be drawn through any oscillations in angular velocity not in themselves objectionable to the pilot. Preferably, the time-history of angular velocity should be distinctly concave downward throughout the period between 0.2 second after the start of the maneuver and the attainment of maximum angular velocity. Figure 1(b) is illustrative of the angular velocity response considered acceptable.

3.2.11.2 To insure that a pilot has reasonable time for corrective action following moderate deviations from trim attitude (as, for example, owing to a gust), the effect of an artificial disturbance shall be determined. When the longitudinal control stick is suddenly displaced rearward from the trim, the distance determined in 3.2.11.1 above, and held for at least 0.5 second, and then returned to and held at the initial trim position, the normal acceleration shall not increase by more than 0.25 g within 10 seconds from the start of the disturbance, except 0.25 g may be exceeded during the period of control application. Further, during the subsequent nosedown motion (with the controls still fixed at trim) any acceleration drop below the trim value shall not exceed 0.25 g within 10 seconds after passing through the initial trim value.

3.2.12 The response of the helicopter to motion of the longitudinal control shall be such that in the maneuver described in 3.2.11.1, the resulting normal acceleration always increases with time until the maximum acceleration is approached, except that a decrease not perceptible to the pilot may be permitted.

3.2.13 Longitudinal control power shall be such that when the helicopter is hovering in still air at the maximum overload gross weight or at the rated power, a rapid 1.0-inch step displacement from trim of the longitudinal control shall produce an angular displacement at the end of 1.0 second which is at least $\frac{45}{3\sqrt[3]{W+1000}}$ degrees. When maximum available displacement from trim of the longitudinal control is rapidly applied, the angular displacement at the end of 1.0 second shall be at least $\frac{180}{3\sqrt[3]{W+1000}}$ degrees. In both expressions W represents the maximum overload gross weight of the helicopter in pounds.

3.2.14 To insure satisfactory initial response characteristics following a longitudinal control input and to minimize the effects of external disturbances, the helicopter in hovering shall exhibit pitch angular velocity damping (that is, a moment tending to oppose the angular motion and proportional in magnitude to the angular velocity) of at least 8 $(I_y)^{0.7}$ ft-lb/rad/sec, where I_y is the moment of inertia about the pitch axis expressed in slug-ft^2.

3.3 Directional and lateral characteristics.

3.3.1 Directional control shall be sufficiently powerful, in order that its use in conjunction with the other normal controls will permit easy execution of all normal taxiing maneuvers with wheel gear on land and float gear in water using normal rotor speeds. In particular, the following ground handling conditions shall be met:

(a) It shall be possible, without the use of brakes, to maintain a straight path in any direction in a wind of 35 knots.

(b) It shall be possible to make a complete turn in either direction by pivoting on one wheel in a wind of 35 knots.

3.3.2 From the hovering condition, it shall be possible to obtain steady, level, translational flight at a sidewise velocity of 35 knots to both the right and the left. At the specified sidewise velocity and during the transition from hovering, the controls and the helicopter itself shall be free from objectionable shake, vibration, or roughness as specified in 3.7.1.

3.3.3 The requirements of 3.2.2 shall be applicable to lateral as well as to longitudinal control motions. It shall be possible to meet this requirement with less than ±1-inch movement of the directional control.

3.3.4 In all normal service loading conditions, including those resulting in asymmetrical lateral center of gravity locations and steady flight under the conditions specified in 3.2.1 (including autorotation) and 3.3.2, a sufficient margin of control effectiveness, and at least adequate control to produce 10 percent of the maximum attainable hovering rolling moment shall remain at each end.

3.3.5 Directional control power shall be such that when the helicopter is hovering in still air at the maximum overload gross weight or at rated takeoff power, a rapid 1.0-inch step displacement from trim of the directional control shall produce a yaw displacement at the end of 1.0 second which is at least $\frac{110}{3\sqrt[3]{W+1000}}$

degrees. When maximum available displacement from trim of the directional control is rapidly applied at the conditions specified above, the yaw angular displacement at the end of 1.0 second shall be at least $\frac{330}{3\sqrt{W+1000}}$ degrees. In both equations W represents the maximum overload gross weight of the helicopter in pounds.

3.3.6 It shall be possible to execute a complete turn in each direction while hovering over a given spot at the maximum overload gross weight or at takeoff power (in and out of ground effect), in a wind of at least 35 knots. To insure adequate margin of control during these maneuvers, sufficient control shall remain at the most critical azimuth angle relative to the wind, in order that, when starting at zero yawing velocity at this angle, the rapid application of full directional control in the critical direction results in a corresponding yaw displacement of at least $\frac{110}{3\sqrt{W+1000}}$ degrees in the first second, where W represents the maximum overload gross weight of the helicopter in pounds.

3.3.7 The response of the helicopter to directional-control deflection, as indicated by the maximum rate of yaw per inch of sudden pedal displacement from trim while hovering shall not be so high as to cause a tendency for the pilot to overcontrol unintentionally. In any case, the sensitivity shall be considered excessive if the yaw displacement is greater than 50 degrees in the first second following a sudden pedal displacement of 1 inch from trim while hovering at the lightest normal service loading.

3.3.8 It shall be possible to make coordinated turns in each direction while in autorotation, at all autorotation speeds.

3.3.9 The helicopter shall possess positive, control fixed, directional stability, and effective dihedral in both powered and autorotative flight at all forward speeds above 50 knots, 0.5 V_{max}, or the speed for maximum rate of climb, whichever is the lowest. At these flight conditions with zero yawing and rolling velocity, the variations of pedal displacement and lateral control displacement with steady sideslip angle shall be stable (left pedal and right stick displacement for right sideslip) up to full pedal displacement in both directions, but not necessarily beyond a sideslip angle of 15 degrees at V_{max}, 45 degrees at the low speed determined above, or beyond a sideslip angle determined by a linear variation with speed between these two angles. Between sideslip angles of ±15 degrees, the curve of pedal displacement and lateral control displacement plotted against sideslip angle shall be approximately linear. In all flight conditions specified above, a 10 percent margin of both lateral and longitudinal control effectiveness (as defined in 3.2.4 and 3.3.4) shall remain.

3.3.9.1 At the conditions specified in 3.3.9, it shall be possible to make complete turns in each direction with pedals fixed, by use of cyclic control stick alone. At all speeds specified in 3.3.9, no reversal of rolling velocity (i.e., return through zero) shall occur after a small lateral step displacement of the control stick is made with pedals fixed. The stick deflection chosen shall be such that the maximum angle of bank reached during 6 seconds is approximately 30 degrees. This requirement is intended to apply to angular velocity type controls.

3.3.9.2 During pedal fixed rolling maneuvers, there shall be no objectionable adverse yaw.

3.3.10 For all conditions and speeds specified in 3.2.1 and 3.3.2, it shall be possible in steady flight to trim steady lateral and directional control forces to zero. At these trim conditions, the controls shall exhibit positive self centering characteristics. Stick "jump" when trim control is actuated is undesirable.

3.3.11 At all trim conditions and speeds specified in 3.3.10, the lateral force gradient for the first inch of travel from trim shall be no less than 0.5 pound per inch and no more than 2.0 pounds per inch. In addition, however, the force produced for a 1-inch travel from trim by the gradient chosen shall not be less than the breakout force (including friction) exhibited in flight. The slope of the curve of stick force versus displacement shall be positive at all times and the slope for the first inch of travel from trim shall always be greater than or equal to the slope for the remaining stick travel. The directional control shall have a limit force of 15 pounds at maximum deflection with a linear force gradient from trim position. There shall be no undesirable discontinuities in either the lateral or directional force gradients.

3.3.12 From trimmed initial conditions, the lateral and directional control forces required for the performance of the maneuvers discussed in 3.2.6, 3.3.1, 3.3.2, 3.3.4, 3.3.5, 3.3.6, 3.3.8, and 3.3.9.1, shall conform with the values given in table II.

3.3.13 With the controls trimmed for zero force, the breakout forces including friction in the lateral and directional control systems shall conform with the values given in table II when measured in flight.

3.3.14 The controls shall be free from objectionable transient forces in any direction following rapid lateral stick or pedal deflections. During and following a rapid lateral displacement of the control stick from trim or a rapid pedal displacement from trim, the force acting in a direction to resist the displacement shall not at any time fall to zero. Lateral control displacement shall not produce longitudinal control forces in excess of 40 percent or pedal forces in excess of 100 percent of the associated lateral force. Pedal displacement shall not produce longitudinal control forces in excess of 8 percent or lateral control forces in excess of 6 percent of the associated pedal force. For helicopters employing power-boosted or power-operated controls, there shall be no longitudinal control forces developed in conjunction with lateral or directional control displacement.

3.3.15 The response of the helicopter to lateral-control deflection, as indicated by the maximum rate of roll per inch of sudden control deflection from the trim setting, shall not be so high as to cause a tendency for the pilot to overcontrol unintentionally. In any case, at all level flight speeds, including hovering, the control effectiveness shall be considered excessive if the maximum rate of roll per inch of stick displacement is greater than 20 degrees per second.

3.3.16 There shall be no objectionable or excessive delay in the development of angular velocity in response to lateral or directional control displacement. The angular acceleration shall be in the proper direction within 0.2 second after control displacement. This requirement shall apply for all flight conditions specified in 3.2.1, including vertical autorotation.

3.3.17 The helicopter shall not exhibit excessive lateral trim changes with changes in power or collective pitch, or both. Specifically, when starting from trim at any combination of power and airspeed within the flight envelope of the helicopter, it shall be possible to maintain lateral trim with a control displacement amounting to no more than 2 inches from the initial trim position as the engine power or collective pitch, or both, are varied either slowly or rapidly in either direction throughout the available range.

3.3.18 Lateral control power shall be such that when the helicopter is hovering in still air at the maximum overload gross weight or at the rated power, a rapid 1-inch step displacement from trim of the lateral control shall produce an angular displacement at the end of one-half second of at least $\frac{27}{\sqrt[3]{W+1000}}$ degrees. When maximum available displacement from trim of the lateral control is rapidly applied at the conditions specified above, the resulting angular displacement at the end of one-half second shall be at least $\frac{81}{\sqrt[3]{W+1000}}$ degrees. In both expressions W represents the maximum overload gross weight of the helicopter in pounds.

3.3.19 To insure satisfactory initial response characteristics following either a lateral or directional control input and to minimize the effect of external disturbances, the helicopter, in hovering, shall exhibit roll angular velocity damping (that is, a moment tending to oppose the angular motion and proportional in magnitude to the rolling angular velocity) of at least $18(I_x)^{0.7}$ ft-lb/rad/sec., where I_x is the moment of inertia about the roll axis expressed in slug-ft^2. The yaw angular velocity damping should preferably be at least $27(I_z)^{0.7}$ ft-lb/rad/sec., where I_z is the moment of inertia about the yaw axis expressed in slug-ft^2.

3.4 Vertical characteristics.

3.4.1 It shall be possible to maintain positive control of altitude within ±1.0 foot by use of the collective-pitch control while hovering at constant rotor rpm under the conditions of

3.2.2. This shall be accomplished with a minimum amount of collective stick motion required, and in any case it shall be possible to accomplish this with less than ±½ inch movement of the collective stick. When a governor is employed, there shall be no objectional vertical oscillation resulting from lag in governor response.

3.4.2 The collective-pitch control shall remain fixed at all times unless moved by the pilot and shall not tend to creep, whether or not cyclic or directional controls are moved. The maximum effort required for the collective control shall not exceed the values specified in table II. The breakout force (including friction) shall be within the acceptable limits as specified in table II.

3.4.3 Movement of the collective-pitch control shall not produce objectionable forces in the cyclic control; in no case shall these forces exceed 1 pound. In helicopters where power-operated or power-boosted controls are utilized, there shall be no control force coupling.

3.5 Autorotation, rotor characteristics, and miscellaneous requirements.

3.5.1 It shall be possible while on the ground to start and stop the rotor blades in winds up to at least 45 knots. For helicopters with a gross weight of less than 1,000 pounds, this requirement shall be at least 35 knots. For all ship-based helicopters, this requirement shall be at least 60 knots while headed into the wind.

3.5.2 It shall be possible without the use of wheel chocks to maintain a fixed position on a level paved surface with takeoff rotor speed while power is being increased to takeoff power in winds as specified in 3.5.4.1.

3.5.3 It shall be possible to perform all required maneuvers, including taxiing and pivoting, without damage to rotor coning stops and without contact between the blades and any part of the structure.

3.5.4 The helicopter shall be capable of making satisfactory landings and takeoffs. Specifically, the following conditions shall be met.

3.5.4.1 It shall be possible to make satisfactory, safe vertical takeoffs and landings in steady winds up to 45 knots and winds with gusts up to 45 knots. This shall apply to all helicopters, except those with a gross weight less than 1,000 pounds, which shall be capable of the foregoing in winds and gusts up to 35 knots.

3.5.4.2 From a level paved surface, it shall be possible to make satisfactory, safe running takeoffs with wheel-type gear, up to ground speeds of at least 35 knots.

3.5.4.3 For both power-on and autorotative conditions, it shall be possible to make satisfactory, safe landings on a level paved surface, with wheel and skid gear, up to ground speeds of at least 35 knots. This shall be construed to cover landings with 3 knots ground speed in any direction and up to a side drift of at least 6 knots when landing with a ground speed of 35 knots.

3.5.4.4 In autorotation at a touchdown ground speed of 35 knots on a level paved surface, with wheel and skid gear, it shall be possible to bring the helicopter to a stop within 200 feet.

3.5.4.5 For all helicopters equipped with emergency flotation gear in both power-on and autorotative conditions, it shall be possible to make satisfactory, safe landings, on smooth water up to at least 15 knots surface speed. This shall be construed to cover landings with 3 knots surface speed in any direction and up to a side drift of at least 5 knots when landing with a surface speed of 15 knots.

3.5.5 The helicopter shall be capable of entering into power-off autorotation at all speeds from hover to maximum forward speed. The transition from powered flight to autorotative flight shall be established smoothly, with adequate controllability and with a minimum loss of altitude. It shall be possible to make this transition safely when initiation of the necessary manual collective-pitch control motion has been delayed for at least 2 seconds following loss of power. At no time during this maneuver shall the rotor speed fall below a safe minimum transient autorotative value (as distinct from power-on or steady-state autorotative values). This shall be construed to cover both single and multiengine helicopters.

3.5.5.1 Sudden power reduction, power application, or loss of power with collective control fixed, shall not produce pitch, roll, or yaw attitude changes in excess of 10 degrees in 2 seconds, except that, at speeds below that for best climb, a 20-degree yaw in 2 seconds will be accepted.

3.5.6 The control forces during the transition to autorotative flight under the conditions of 3.5.5 shall never exceed the values specified in table II.

3.5.7 It shall be possible, in still air at sea level, at the end of stabilized autorotative descents, to make repeatedly safe, power-off autorotative landings at speeds of 15 knots or less. Reduction of this autorotative landing speed to zero is highly desirable. This shall be construed to cover both single and multiengine helicopters.

3.5.8 For helicopters equipped with power-boosted or power-operated controls, the following conditions shall be met:

(a) In trimmed level flight at any speed, out-of-trim conditions resulting from abrupt power-operated control system failure shall be such that:

(1) With controls free for at least 3 seconds, the resulting rates of yaw, roll, and pitch shall not exceed 10 degrees per second, and the change in normal acceleration shall not exceed ±½ g.

(2) It shall be possible to continue level flight with zero sideslip with forces to operate the controls not exceeding 80 pounds for the directional control, 25 pounds for the collective and longitudinal controls, and 15 pounds for the lateral control.

(b) With power-operated control system off, it shall be possible to trim steady longitudinal, lateral, and directional control forces to zero under all the conditions and speeds specified in 3.2.1 and 3.3.2.

(c) With power-operated control system off, the collective-pitch control shall not tend to creep, whether or not cyclic or directional controls are moved.

(d) With the helicopter trimmed in steady level flight at 40 knots under power-operated control system failure conditions, it shall be possible without retrimming to make a normal landing approach and landing with control forces not exceeding the limits given in 3.5.8(a)(2).

(e) Engine failure or electrical system failure, or both, shall not result in primary power-operated control system failure.

(f) Power-operated control system failure shall not result in failure of the trim systems.

(g) For helicopters having two or more completely independent power-operated control systems, the requirements of 3.5.8(a) shall be met upon failure of one of the complete systems during the period of transfer from one system to another. With the remaining system or systems, 3.5.8(b) shall apply and the rates of control motion attainable shall be such that safe operation of the helicopter is in no way compromised, and shall in no case be less than 50 percent of the normal rates. In such operations, including the approach and landing specified in 3.5.8(d), the control forces stated in 3.5.8(a)(2) shall be considered an absolute maximum, and it is desired that these forces be considerably lower.

3.5.9 Automatic stabilization and control or stability augmentation equipment, or both, may be employed to meet all of the above requirements of section 3, provided that suitable separate requirements for system reliability are met. If such equipment is employed, the following conditions shall be met:

(a) With the automatic stabilization and control or stability augmentation equipment or both engaged, and from steady level flight for a period greater than 30 seconds, out-of-trim conditions resulting from abrupt complete disengagement or from abrupt complete failure of the equipment shall be such that with controls free for 3 seconds following the disengagement or failure, the resulting rates of yaw, roll, and pitch shall not exceed 10 degrees per second and the change in normal acceleration shall not exceed ± ½ g. When engaging the automatic stabilization and control or stability augmentation equipment, there shall be no apparent switching transients.

(b) For helicopters employing completely independent dual automatic stabilization and control or dual stability augmentation equipment, or a completely independent combination of both, the requirements of 3.5.9(a) shall be met upon the failure of one complete system during the period of transfer from one system to another, but need not be met for a simultaneous failure of both.

(c) It shall be possible on the ground, with the automatic stabilization and control or stability augmentation equipment or both operating and engaged to move the controls manually to all limits without exceeding the forces of table II. For helicopters with power-operated controls, this requirement shall apply also with rotor stopped.

(d) Helicopters employing automatic stabilization and control or stability augmentation equipment or both shall possess a sufficient degree of stability and control with all the equipment disengaged to allow continuation of normal level flight and the manuevering necessary to permit a safe landing under visual flight conditions.

(e) In cases where automatic stabilization and control or stability augmentation devices, or both, are used to compensate for divergent tendencies of the basic airframe, a considerable margin of control power beyond that needed to overcome airframe instability under simple flight conditions shall be provided. For this purpose, sufficient control margin over the amount required to perform maneuvers and to accomplish stability augmentation shall be provided. Specifically for pitch, roll, and yaw control, the augmentation system in combination with pilot controlled inputs shall not utilize more than 50 percent of the available control moment in the unstable direction from the trim position for straight level flight at a given speed when performing the following maneuvers:

(1) Steady level-flight turn at cruise speed to maximum load factor attainable in actual operation, or the design or placard load factor, whichever occurs first.

(2) Steady sideslips in both powered and autorotative flight at the combinations of speed and sideslip angle set forth in 3.3.9.

3.5.10 For all operating conditions, there shall be no dead spots in any of the control systems which permit more than ±0.2-inch motion of the cockpit control without corresponding motion of the rotor blades, control surfaces, etc.

3.5.11 For all operating conditions, longitudinal, lateral, directional, or vertical control motions shall not produce adverse response of the helicopter due to mechanical coupling in the control system.

3.5.11.1 If mechanical intermixing of longitudinal, lateral, directional, or vertical control motions is required to achieve the above requirements of section 3, no adverse limitations in control power shall exist with any possible combination of control inputs throughout the entire range of each of the control motions.

3.6 Instrument flight characteristics.

3.6.1 For any helicopter required to operate under instrument flight conditions, the more stringent supplementary flying qualities requirements of 3.6 shall apply, in addition to the foregoing requirements of section 3. It shall be possible, without demanding undue pilot effort, to fly on instruments at all speeds, from hover to design cruise speed; for this purpose automatic stabilization and control or stability augmentation equipment, or both, may be employed, in addition to any required for compliance with visual flight criteria. The failure or disengagement of the equipment that provides the instrument flight characteristics shall not result in a degeneration of the stability and control characteristics of the helicopter below any of those specified in this specification for helicopters required to operate under visual flight conditions.

3.6.1.1. For any helicopter required to operate under instrument or all-weather conditions, the following control power and angular velocity damping requirements shall apply in hovering:

	Angular displacement at end of 1 sec. for a rapid 1-inch control displacement-degrees	Angular velocity damping ft-lbs/rad/sec.
Longitudinal	$\frac{73}{\sqrt[3]{W+1000}}$	15 $(I_y)^{0.7}$
Directional	$\frac{110}{\sqrt[3]{W+1000}}$	27 $(I_z)^{0.7}$
Lateral	(1)	25 $(I_x)^{0.7}$

(1) [illegible] lateral requirement is based on the angular displace[illegible]t at the end of one-half second following a control displ[illegible]nent and for a 1-inch control displacement shall be [illegible] $\frac{32}{\sqrt[3]{W+1000}}$ degrees displacement in the first on[illegible] second. For full available displacement of the [illegible]s from trim, the values of angular displacement [illegible]d above shall be multiplied by 4 for longitudinal [illegible] for lateral and for directional values.

[illegible].6.1.2 Longitudinal- and lateral-directional [illegible]cillations with controls fixed following a single [illegible]isturbance in smooth air shall exhibit the fol[illegible]owing characteristics:

(a) Any oscillation having a period of less than 5 seconds shall damp to one-half amplitude in not more than one cycle. There shall be no tendency for undamped small amplitude oscillations to persist.

(b) Any oscillation having a period of less than 10 seconds shall damp to one-half amplitude in not more than two cycles. There shall be no tendency for undamped small oscillations to persist.

(c) Any oscillation having a period greater than 10 seconds but less than 20 seconds shall be at least lightly damped.

(d) Any oscillation having a period greater than 20 seconds shall not achieve double amplitude in less than 20 seconds.

3.6.2 The requirements specified in 3.3.9 shall be extended to include control force stability, and the variations of pedal force and lateral control force with sideslip shall conform to the requirements specified in 3.3.9 for the corresponding control displacements. In addition, the requirements specified in 3.3.9.1 shall apply with pedals free.

3.6.3 The helicopter shall, at all forward speeds and at all trim and power conditions specified in table I, possess positive, static longitudinal control force, and control position stability with respect to speed.

3.7 Vibration characteristics.

3.7.1 In general, throughout the design flight envelope, the helicopter shall be free of objectionable shake, vibration, or roughness. Specifically, the following vibration requirements shall be met:

(a) Vibration accelerations at all controls in any direction shall not exceed 0.4 g for frequencies up to 32 cps and a double amplitude of 0.008 inch for frequencies above 32 cps; this requirement shall apply to all steady speeds within the helicopter design flight envelope and in slow and rapid transitions from one speed to another and during transitions from one steady acceleration to another.

(b) Vibration accelerations at the pilot, crew, passenger, and litter stations at all steady speeds between 30 knots rearward and V_{cruise} shall not exceed 0.15 g for frequencies up to 32 cps and a double amplitude of 0.003 inch for frequencies greater than 32 cps. From V_{cruise} to V_{limit} the maximum vibratory acceleration shall not exceed 0.2 g up to 36 cps, and a double amplitude of 0.003 inch for frequencies greater than 36 cps. At all frequencies above 50 cps a constant velocity vibration of 0.039 fps shall not be exceeded.

(c) Vibration characteristics at the pilot, crew, passenger, and litter stations shall not exceed 0.3 g up to 44 cps and a double amplitude of 0.003 inch at frequencies greater than 44 cps during slow and rapid linear acceleration or deceleration from any speed to any other speed within the design flight envelope.

3.7.2 The magnitude of the vibratory force at the controls in any direction during rapid longitudinal or lateral stick deflections shall not exceed 2 pounds. Perferably, these vibratory forces shall be zero.

3.7.3 The helicopter shall be free from mechanical instability, including ground resonance, and from rotor weaving and flutter that influence helicopter handling qualities, during all operating conditions, such as landing, takeoff, and flight.

4. QUALITY ASSURANCE PROVISIONS

Not applicable.

5. PREPARATION FOR DELIVERY

Not applicable.

6. NOTES

6.1 Intended use. This specification establishes the design requirements for flying and ground handling qualities of military helicopters.

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

Preparing activity:
Air Force—AFSC

SPECIFICATION ANALYSIS SHEET			Form Approved Budget Bureau No. 119-R004
INSTRUCTIONS This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity *(as indicated on reverse hereof)*.			
SPECIFICATION			
ORGANIZATION *(Of submitter)*		CITY AND STATE	
CONTRACT NO.	QUANTITY OF ITEMS PROCURED	DOLLAR AMOUNT $	
MATERIAL PROCURED UNDER A ☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT			
1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE? A. GIVE PARAGRAPH NUMBER AND WORDING.			
B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.			
2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID			
3. IS THE SPECIFICATION RESTRICTIVE? ☐ YES ☐ NO IF "YES", IN WHAT WAY?			
4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*			
SUBMITTED BY *(Printed or typed name and activity)*		DATE	

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