CAA MAJ-14

AC 29.45. § 29.45 (Amendment 29-24) PERFORMANCE - GENERAL.

a. Explanation.

* * * * *

b. Procedures.

(1) Winds For Testing.

(i) Allowable wind conditions will vary with the type of test and will also be different for different types and gross weight rotorcraft. For example, higher winds can usually be tolerated for takeoff and landing distance tests than for hover performance. Likewise higher winds can sometimes be tolerated during hover performance testing on large, heavy rotorcraft with high rotor downwash velocities than for smaller rotorcraft with rotor downwash velocities. Generally, unless the effects of wind on hover performance tests can be determined and/or accounted for, hover performance testing should be conducted in winds of 3 knots or less.

(ii) Past experience has shown that a steady wind of 0 to 10 knots will result in acceptable takeoff and landing performance if distances are corrected for the winds measured during these tests. This is not the case for vertical takeoffs and landings. To obtain consistent and repeatable vertical performance data, the same general wind criteria used to obtain hover performance; i.e., up to 3 knots, should be adhered to for vertical performance determination. In actuality, a rotorcraft may exhibit reduced IGE hover performance in winds from 3 to 15 knots due to partial immersion of the main rotor in its own vortex. Since the height-speed envelope determination is affected by wind just as vertical takeoff and landing performance are, the same allowable winds for testing should be adhered to for HV testing; i.e., 0 to 5 knots. For Category A testing, the effects of crosswind and/or tailwind should also be considered up to the maximum for which Category A certification is requested.

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CAA MAJ-11

AC 29.59A (AC's 29.60, 29.61, & 29.62) §§ 29.59 (29.60, 29.61 and 29.62) (Amendment 29-39) TAKEOFF PATH, DISTANCE AND REJECTED TAKEOFF; GROUND LEVEL AND ELEVATED HELIPORT: CATEGORY A

(For § 29.59 prior to Amendment 39, see paragraph AC 29.59.)

* * * * *

b. Procedures.

* * * * *

(7) Power. Power used for demonstrating performance should be limited to minimum specification values on the operating engine(s). This may be accomplished by adjustment of the engine topping to minimum specification values including consideration of temperature effects on engine power. If topping results in unrepresentative engine power management, the validity of the Cat A procedure must also be established with representative in-service characteristics. The method used for simulating engine failure must be representative of the power decay characteristics that will occur during a real, sudden engine failure and acceleration of the remaining engine(s). In order to cushion a rejected take-off it is acceptable for the engine/transmission transient range to be entered in order to droop the rotor provided performance credit is not taken for this additional power above the maximum permitted rating and it can be shown that the engine(s) will limit in all conditions requested by the applicant. Any excursion beyond established transient limits in this flight phase should be substantiated to the extent that it does not constitute an immediate hazard to the rotorcraft.

(8) Turbine engine power does not vary directly with density altitude (H_D). At a given H_D, turbine engine power available varies with ambient temperature. Turbine engines typically produce less horsepower as ambient temperature is increased (pressure altitude decreases) at a given density altitude, although some engines produce less horsepower at extremely cold temperatures. In either event, if one test sequence is to be utilized for a given H_D, it would be appropriate to restrict test power to the lowest value attainable from a minimum specification engine through the approved ambient temperature range at the density altitude of the test. To attain maximum weights for varying ambient conditions, the applicant may utilize a parametric mapping of power available, pressure altitude, and temperature effects. For this case, engine topping may be adjusted throughout a range appropriate to the test H_D.

(9) Aircraft Loading. Both forward and aft CG extremes should be spot checked to determine the critical loading for takeoff distances. Forward center of gravity is usually critical for continued takeoff distance tests while aft CG may be critical for the rejected takeoff due to forward/downward field of view. A minimum of two weights

CAA MAJ-11 (continued)

should be flown at each altitude if the manufacturer elects to schedule field length variation as a function of gross weight. One weight should be the maximum weight for prevailing conditions and the other weight(s) should be low enough to attain a sufficient spread to verify weight accountability.

(10) Extrapolation. Takeoff and landing data may be extrapolated up to 4000 feet along an established W/σ line, to the maximum gross weight of the rotorcraft. However, extrapolation will not be considered valid if unacceptable or marginally acceptable landing gear loads are experienced during testing at weights below the W/σ limit. See paragraph AC 29.77b(5) for further discussion of landing gear loads.

(11) Ambient Conditions. Appropriate test limits for ambient conditions such as wind and temperature are contained in paragraph AC 29.45. Test data should be corrected for existing wind conditions during takeoff distance testing. Credit for headwind conditions may be given during flight manual data expansion. Refer to paragraph AC 29.1587(a)(3)(iii) under "Wind Accountability" for allowable wind credit. Care should be applied in considering headwind credit for vertical operations as previous experience has resulted in difficulty collecting meaningful, repeatable data.

(12) Vertical Takeoffs.

* * * * *

(13) Night Operations.

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CAA MAJ-14

AC 29.59A (AC's 29.60, 29.61, & 29.62) §§ 29.59 (29.60, 29.61 and 29.62) (Amendment 29-39) TAKEOFF PATH, DISTANCE AND REJECTED TAKEOFF; GROUND LEVEL AND ELEVATED HELIPORT: CATEGORY A

(For § 29.59 prior to Amendment 39, see paragraph AC 29.59.)

a. Explanation. * * * * *

b. Procedures.

* * * * *

(11) Vertical Takeoffs.

(i) * * * * *

(ii) * * * * *

(iii) * * * * *

(iv) * * * * *

(A) * * * * *

(B) * * * * *

(C) When used, the back-up technique usually requires the pilot to keep sufficient portions of the helipad in view and involves a rearward movement from the takeoff point to the TDP. In such cases the rearward horizontal distance required should be established as the distance from the rearmost point of the rotorcraft at the initiation of takeoff to the rearmost part of the rotorcraft at TDP. As stated in AC 29.45, crosswinds and/or tailwinds should be considered if requested by the applicant. Typically, this will require flight-testing to evaluate performance, pilot workload, view, and visual cueing.

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CAA MAJ-13

AC 29.59A (AC's 29.60, 29.61, & 29.62) §§ 29.59 (29.60, 29.61 and 29.62) (Amendment 29-39) TAKEOFF PATH, DISTANCE AND REJECTED TAKEOFF; GROUND LEVEL AND ELEVATED HELIPORT: CATEGORY A

(For § 29.59 prior to Amendment 39, see paragraph AC 29.59.)

a. Explanation. * * * * *

b. Procedures.

* * * * *

(12) Night Operations.

(i) A minimum of three normal takeoffs (and landings) should be conducted to ensure that aircraft lighting (internal and external) is adequate to allow normal Category A operations at night.

(ii) Engine failures should be simulated from points along the requested takeoff and landing profiles. Night OEI rejected takeoffs and continued takeoffs from the TDP and OEI landings from the LDP should be conducted at the requested WAT limiting conditions to ensure adequate night field of view, suitability of aircraft external lighting, and realization of Category A profiles.

(iii) If special airfield marking/lighting is used as a reference or to define the TDP/LDP, the aircraft external lighting should be evaluated to ensure the airfield marking/lighting is adequately visible for night operations.

CAA MAJ-13

AC 29.75A. (AC's 29.77, 29.79, 29.81, & 29.83) §§ 29.75, 29.77, 29.79, 29.81, and 29.83 (Amendment 29-39) LANDING.

(For § 29.77 and § 29.79 prior to Amendment 39, see paragraphs AC 29.77 and AC 29.79 respectively.)

a. Explanation.

* * * * *

b. Procedures - Category A Requirements.

(1) Explanation. The Category A certification concept limits landing weight to a value that will allow the rotorcraft, following an engine failure at the landing decision point (LDP), to land within the available area or to execute a balked landing descending no lower than 15 feet (or higher depending on rotorcraft geometry and performance characteristics) above the landing surface. For elevated heliports the rotorcraft may descend below the landing surface, but all parts of the rotorcraft must clear the heliport and other obstacles by not less than 15 feet. These minimum heights should be demonstrated with variations in piloting techniques and with pilot recognition and reaction times for engine failures occurring before/after LDP. See figure AC 29.75A-1. For additional information addressing the OEI landing case at night, refer to AC29.59A.b(12).

(i) * * * * *

(ii) * * * * *

(iii) * * * * *

(2) Procedures.

(i) * * * * *

(ii) * * * * *

(iii) Power. Power used for demonstrating performance should be limited to minimum specification values on the operating engine(s). This may be accomplished by adjustment of the engine topping to minimum specification values including consideration of temperature effects on engine power. If topping

CAA MAJ-13 (continued)

results in unrepresentative engine power management, the validity of the Cat A procedure must also be established with representative in-service characteristics. The method used for simulating engine failure must be representative of the power decay characteristics that will occur during a real, sudden engine failure and acceleration of the remaining

engine(s). In order to cushion the OEI landing, it is acceptable for the engine/transmission transient range to be entered in order to droop the rotor, provided performance credit is not taken for this additional power above the maximum permitted rating and it can be shown that the engine(s) will limit in all conditions requested by the applicant. Any excursion beyond established transient limits in this flight phase should be substantiated to the extent that it does not constitute an immediate hazard to the rotorcraft.

iv. * * * * *

CAA MIN-02

AC 29.337. § 29.337 (Amendment 29-30) LIMIT MANEUVERING LOAD FACTOR.

a. Explanation. The rotorcraft must be designed and substantiated to load factors as specified to provide a minimum level of structural integrity of the rotorcraft airframe and rotors.

(1) A range of design positive load factors from +3.5 to +2.0 may be used.

(2) A range of design negative load factors from -1.0 to -0.5 may be used.

(3) Load factors inside the range of +3.5 to -1.0 may be used provided the probability of exceeding the design load factors is shown by analysis and flight tests to be extremely remote, and the selected load factors are appropriate to each weight condition between design maximum and minimum weights.

(4) Load factors exceeding these “minimums” may be used.

b. Procedures.

(1) The applicant may elect to substantiate the rotorcraft for a design maneuvering load factor less than +3.5 and more than -1.0. Whenever this option is used, an analytical study and flight demonstration are required. Maximum available rotor lift with both power on and power off must be considered when substantiating maneuver load factors less than the specified values.

* * * * *

FAA-MAJ-06

AC 29.631. § 29.631 (Amendment 29-40) BIRD STRIKE.

a. Explanation. Amendment 40 adds requirements for continued safe flight and landing after a bird strike. Compliance with § 29.631 should be shown for a 2.2 lb (1.0 kg) bird at a relative velocity equal to the lesser of V_{NE} or V_H at altitudes up to 8,000 feet. For Category A certification, the rotorcraft should be capable of continued safe flight and landing after the described bird strike. For Category B certification, the rotorcraft should be capable of a safe landing after the bird strike.

b. Procedures. For compliance with FAR 29.631, it should be demonstrated by test or analysis supported by test evidence that,

(1) The windshields will withstand, without penetration, and,

(2) The rotorcraft is capable of continued safe flight and landing following impact with a 2.2-lb (1.0 kg) bird at V_{NE} or V_H (whichever is the lesser) at altitudes up to 8,000 feet. Areas of impact that are of particular interest include flight control surfaces and exposed flight control system components.

EURO-MIN-03

AC 29.672. § 29.672 (Amendment 29-24) STABILITY AUGMENTATION, AUTOMATIC, AND POWER-OPERATED SYSTEMS.

a. Explanation.

(1) This rule requires that the pilot be made aware of stability augmentation, automatic, or power-operated system failures which could lead to an unsafe condition. It should be understood that this requirement applies to stability augmentation and supplementary controls and not the primary flight control system, which is dealt with under § 27.695 and associated advisory material. Examples of clearly distinguishable warnings include, but are not limited to, an obvious aircraft attitude change following the failure or an audio warning tone. A visual indication itself may not be adequate since detection of a visual warning would normally require special pilot attention. The use of devices such as stick pushers or shakers is not acceptable as a warning means. However, this rule is not intended to eliminate the use of such devices for other purposes. Examples of automatic control systems other than a stability augmentation system would be a pitch axis actuator used for the purpose of demonstrating compliance with longitudinal static stability requirements or a fly-by-wire elevator. The design of such systems must not interfere with completion of the control checks described in § 29.671(c). Further, for control systems where a series actuator malfunction could degrade control authority, a means should be provided to the pilot to determine actuator alignment (see § 29.1329(b)).

(2) * * * * *

CAA MIN-01

AC 29.672. § 29.672 (Amendment 29-24) STABILITY AUGMENTATION, AUTOMATIC, AND POWER-OPERATED SYSTEMS.

a. Explanation.

(1) This rule requires that the pilot be made aware of stability augmentation, automatic, or power-operated system failures which could lead to an unsafe condition. Examples of clearly distinguishable warnings include, but are not limited to, an obvious aircraft attitude change following the failure or an audio warning tone. A visual indication itself may not be adequate since detection of a visual warning would normally require special pilot attention. The use of devices such as stick pushers or shakers is not acceptable as a warning means. However, this rule is not intended to eliminate the use of such devices for other purposes. Examples of automatic control systems other than a stability augmentation system would be a pitch axis actuator used for the purpose of demonstrating compliance with longitudinal static stability requirements or a fly-by-wire elevator. The design of such systems must not interfere with completion of the control checks described in § 29.671(c). Further, for control systems where a series actuator malfunction could degrade control authority, a means should be provided to the pilot to determine actuator alignment (see § 29.1329(b)).

(2) The corrective flight control input following a system failure should be in the logical direction. For example, a malfunction resulting in a nosedown pitch of the aircraft should require a corrective cyclic control input in the aft direction. The system deactivating means does not have to be located on the primary flight control grips; however, it should be easily accessible to the pilot. Consideration should be given to the consequences of inadvertent de-selection of the automatic stabilization system, especially if the deactivation control is mounted on a primary control grip. Malfunctions and subsequent recoveries must be shown throughout the operating envelope of the aircraft. In a case where control authority is decreased following a malfunction, a reasonable flight envelope must be defined wherein compliance with controllability and maneuverability requirements can be demonstrated. This reduced flight envelope must be presented in the flight manual. Compliance with trim and stability characteristics is not required following a malfunction; however, a pilot workload assessment should be made to show that a mission can be safely continued to completion following the worst-case single failure.

b. * * * * *

FAA-MIN-01

AC 29.683. § 29.683 OPERATION TESTS.

a. Explanation. The rule requires that the control system be free from jamming, excessive friction, and excessive deflection. An operational test is required in which specified loads are applied at the pilot controls and carried through an operating control system.

b. Procedures.

(1) Compliance with the requirements of this rule is obtained by use of a test setup similar to that used for the limit load tests of § 29.681, except the load reactions at the blades (or surfaces) must allow for movement of the blades (or surfaces) as the system is operated through its operating range.

(2) Fixtures are normally affixed to the surfaces (or replace the surfaces) to allow pulley arrangements which provide for movement under load. These fixtures should be evaluated to assure that system loads up to limit will be applied during the full range of operations of each system.

(3) Each flight control system should be operated through its entire range under a light load and under limit load. As the controls are being operated, the system should be checked for jamming, excessive friction, and excessive deflection. Excessive deflection includes deflection sufficient to contact other systems or structure. Also, if under these limit load conditions the components deflect, the deflection would be considered excessive if there is permanent deformation of any component or supporting structure. Also any deflection that results in an uncorrected condition when the load is released, e.g., if a bellcrank is forced off-center or over-center during load and does not return to the normal position after load release is excessive deflection. Floor panels, wall panels, and other access panels may have to be removed to permit visual checks of the entire control system. However, care should be taken when removing panels so that airframe structure is not weakened enough to deflect from its normal position when test loads are applied to the control system.

CAA MAJ-09

AC 29.777. § 29.777 COCKPIT CONTROLS.

a. Explanation. This section defines the general cockpit control requirements. Cockpit control location and arrangement, with respect to the pilot's seat, must be designed to accommodate pilots from 5'2" to 6'0" in height. Pilots within this range should be able to reach all required controls and have sufficient clearance with the structure, panels, etc.

b. * * * * *.

EURO-MAJ-01

AC 29.955A. § 29.955 (Amendment 29-26) FUEL FLOW.

a. Explanation. * * * * *

b. Procedures.

* * * * *

(8) Fuel transfer system. In some multiengine rotorcraft, a fuel asymmetry may exist between the fuel systems of each engine so that the pilot may need to transfer fuel from one system to another under normal flight operations. In that case, the fuel transfer is not required to be an automated function if it can be shown that it does not impose an excessive workload on the flight crew.

CAA MAJ-06

AC 29.1305B. 29.1305 (Amendment 29-34) POWERPLANT INSTRUMENTS.

a. Explanation. Amendment 29-34 added §§ 29.1305(a)(24) and 29.1305(a)(25) to provide for 30-second/2-minute OEI power ratings.

(1) Section 29.1305(a)(24) adds the requirement that a device or means be provided to alert the crew of the use of the 30-second and 2-minute OEI power level. The crew should be alerted when the 30-second or 2-minute interval begins and when the time interval ends. The amount of time spent at the 30-second or 2-minute OEI power levels is at the crew's discretion, unlike the other limits for 30-second OEI that are set by an automatic control required by § 29.1143. The purpose for providing the time interval alerts and automatically controlling the 30-second OEI limits is to free the crew from monitoring the engine instruments during critical phases of flight caused by the loss of an engine. Additional considerations regarding display of usage may be necessary to accommodate partial use of 30-second power interval in combination with longer use of the 2-minute power interval for a total usage of 2-minute 30-second, as allowed by AC 29.1521B.

(2) * * * * *

b. * * * * *

(1) * * * * *

(2) To meet the requirements of Section 29.1305(a)(25), a device should be installed on the engine or the airframe to record the time and each usage of 30-second and 2-minute OEI power levels. The information on the time and usage of 30-second and 2-minute OEI power should be recoverable from the recording device by ground personnel. The device should not be capable of being reset in flight and should only be capable of being reset by ground personnel. Prior to each flight this device should be capable of being checked for proper operation and to determine if 30-second or 2-minute OEI power levels were used during the previous flight.

c. Integrated Display Systems. This advisory material is to provide guidance for compliance to Part 27 and Part 29 regulations as they apply to integrated display systems. The integration aspects of these systems require some additional issues to be addressed during certification. The term "must" in this advisory material is used in the sense of ensuring the applicability of these particular methods of compliance when the acceptable means of compliance described herein is used. This advisory material establishes an acceptable means, but not the only means of certifying an integrated display system.

CAA MAJ-10

AC 29.1321. § 29.1321 (Amendment 29-21) ARRANGEMENT AND VISIBILITY.

a. Background. This section is the first in a series that concerns the installation of instruments. Specific requirements for individual instruments are addressed in other paragraphs. The instruments should be arranged in a manner such that the pilot may avail himself of the information displayed by the instruments without undue distraction. Additionally, for instrument flight, the rule requires that the attitude, altitude, airspeed, and compass indicators be grouped in the so-called standard "T. Instrument location and arrangement, with respect to the pilot's seat, should be designed to accommodate pilots from 5'2" to 6'0" in height. Pilots within this range should be able to see and, where necessary, reach and operate all of the displays.

b. * * * * *.

CAA MAJ-02

AC 29.1333. § 29.1333 (Amendment 29-24) INSTRUMENT SYSTEMS.

a. Explanation. Prior to Amendment 29-24, this requirement was titled "Duplicate Instrument Systems," and its provisions were intended to be applied when duplicate flight instruments were required by any operating rule. It is the intent of this rule to prevent degrading of the first pilot's instrument system, or the only pilot's instrument system in a single-pilot-approved rotorcraft, by not permitting peripheral systems to be connected to it. However, with the introduction of integrated avionic systems, it may be possible to accept that additional systems be connected to the first pilot's instrument system if provision has been made to ensure that the integrity of essential flight information. In addition, equipment must not be connected to operating systems for the second pilot's required instruments unless it is extremely improbable that failure of such additional equipment would affect that operating system. Similar provisions are also included in Appendix B to Part 29, Airworthiness Criteria for Helicopter Instrument Flight.

b. Procedures.

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CAA MIN-03

AC 29.1351. § 29.1351 (Amendment 29-40) ELECTRICAL SYSTEMS AND EQUIPMENT -GENERAL.

a. Explanation. * * * * *
b. Procedures. * * * * *

c. * * * * *

(3) Category A rotorcraft (See FAR 29.1351(d)(2) Amendment 29-40).

(i) FAR 29.1351(d)(2) is applicable to Category A rotorcraft and requires that provision be made to ensure adequate electrical supplies to those systems which are necessary for continued safe flight and landing in the event of a failure of all normal generated electrical power. All components and wiring of the alternate supplies should be physically and electrically segregated from the normal system and should be such that no single failure, including the effects of fire, the cutting of a cable bundle, or the loss of a junction box.

(ii) * * * * *

(iii) The systems required by FAR 29.1351(d)(2) may differ between rotorcraft types and roles and should be agreed with the Authority. They should normally include: or control panel will affect both normal and alternate supplies.

(A) Attitude information;

(B) Radio communication and flight crew intercommunication;

(C) Navigation;

(D) Cockpit and instrument lighting;

(E) Heading, airspeed and altitude information, including appropriate pitot head and static vent heating;

Note: Where the aircraft is to be approved for IFR, pitot head and, where appropriate, static vent heating specified in paragraph (E) above (relating to required air data for airspeed information while operating in an emergency configuration) should be provided for the complete duration (at least 30 minutes) while operating on emergency power. A 5-minute "landing" time for the landing light operation specified in paragraph (I) above should be provided.

* * * * *

CAA MAJ-06

AC 29.1521B. § 29.1521 (Amendment 29-34) POWERPLANT LIMITATIONS.

a. Explanation. Amendment 29-34 adds §§ 29.1521(i) and (j). The new §§ 29.1521(i) and (j) introduce the 30-second and 2-minute OEI power rating limitations, respectively. These paragraphs define the limitations on the use of the 30-second and 2-minute power ratings using terminology similar to that developed for the 2 ½-minute and 30-minute power ratings. Additionally, these paragraphs require the ability to detect any damage that occurs due to the use of either 30-second or 2-minute OEI limits and requires that the procedures to inspect for such damage be provided in the instructions for continued airworthiness for either the engine and/or the airframe.

b. Procedures. All of the policy material pertaining to this section remains in effect. Additionally, the following procedures should be considered:

Sections 29.1521(i) and (j) require limitations for 30-second/2-minute OEI operation for multi-turbine engine powered rotorcraft. The same parameters required for the takeoff and continuous ratings should be established as limitations for each approved OEI rating (i.e., maximum rotational speed, time, gas temperature, and torque). These new ratings can only be approved as a rating in conjunction with the other. That is, a rotorcraft with a 30-second OEI rating must also have a 2-minute OEI rating and vice-versa. The 30-second and 2-minute OEI ratings are also limited to use for continued operation of the remaining engine(s) upon failure or precautionary shutdown of an engine. Upon the use of 30-second or 2-minute OEI, an inspection for damage to the airframe and/or engine should be conducted. The inspection should be accomplished per the procedures furnished by the airframe and engine manufacturers, and any damage occurring due to the use of these new ratings should be detected using these inspection procedures. Section 29.923 includes requirements for qualification of the rotor drive system for 30-second and 2-minute OEI powers. Section 29.1501(a) requires that information necessary for safe operation should be established as limitations. The limitation information provided in this paragraph should be provided in the flight manual. This includes the requirement for an inspection prior to further flight after the use of either 30-second or 2-minute OEI.

In some circumstances, the highest power used during an OEI event might be lower than the 30-second OEI power band but still inside the certified power band of the 2-minute OEI power rating. In this case, it is permissible to extend the use of the 2-minute OEI power rating to a total duration of 2.5 minutes. However, that additional 30-second period will be considered as a de-rated 30-second OEI power rating when considering the required mandatory maintenance actions.

CAA MAJ-08

AC 29.1585. § 29.1585 (Amendment 29-24) OPERATING PROCEDURES.

a. * * * * *

b. Procedures. Procedural information should be presented in substantial accord with the categories described below:

(1) Normal Procedures. Normal procedures are concerned with peculiarities of the rotorcraft design and operating features encountered in connection with routine operations, including malfunction cases not considered in the other procedures section (i.e., not considered to degrade safety). Material conforming to the above should be presented for each phase of flight, following in sequence from preflight through engine shutdown, and should include, but not be limited to, systems operation (including fuel system information prescribed in § 29.1585(b)), missed approaches, etc.

(2) Abnormal Procedures (Optional). Abnormal procedures are concerned with foreseeable situations, usually entailing a failure condition, in which the use of special systems, and/or the alternate use of regular systems, may be expected to maintain an acceptable level of airworthiness. Typical examples of events considered to entail abnormal procedures are minor engine malfunctions and associated conditions for safe flight, stopping and restarting engines in flight, extending landing gear or flaps by alternate means, approach with inoperative engine(s), etc.

(3) Emergency Procedures. Emergency procedures are concerned with foreseeable but unusual situations in which immediate and precise action by the crew, as detailed in the recommended procedures, may be expected to reduce substantially the risk of disaster. Typical examples of incidents considered to be emergencies are fire, ditching, loss of tail rotor thrust or control, etc. It is expected that, in the case of tail rotor failure, the emergency procedures will have been validated by analysis, simulation or any relevant service experience. The analysis or simulation of the tail rotor control failure procedures may be validated where practical by limited flight test.

(4) * * * * *

CAA MIN-11

CHAPTER 3
AIRWORTHINESS STANDARDS
TRANSPORT CATEGORY AIRCRAFT

MICELLANEOUS GUIDANCE (MG)

AC 29 MG 19 USE OF FADEC CONTROLLED ENGINE POWER ABOVE CERTIFICATED LIMITS (Limit Override Function)

a. Background. The advent of digital electronic engine control systems, commonly known as FADEC, has allowed engine and airframe manufacturers to control engine thermal, mechanical and torque limits very precisely such that it is now possible to prevent 'red line limits' being exceeded automatically without pilot action being required.

In the past, with hydro-mechanical engine control systems (HMU) limits (e.g. gas generator speed or fuel flow) would be set so as to ensure availability of the rated power even with a deteriorated engine. This meant that a pilot might be able to access extra power in an emergency situation, with a possible beneficial effect on the flight path. Considering One Engine Inoperative (OEI) flight on a multi-engine helicopter, the additional power would be relatively small and not guaranteed but for All Engines Operating (AEO), use of the OEI ratings above the normal AEO Take Off Rating could provide significant amounts of additional power and this has traditionally been available, although not permitted for use by the Flight Manual.

The Limit Override concept would allow either manually or automatically triggered access to OEI or AEO power above the ratings for use in emergency situations only. This would allow continuation of the existing situation with HMU controlled engines, which has proven acceptable for certification in the past.

Because FADEC technology allows precise control at limiting parameters, it becomes a conscious decision to incorporate a design feature that is intended to allow limits to be exceeded. This guidance is provided to ensure that any such design feature does not degrade the safety standard achieved historically using HMU controlled engines.

b. Requirements. Requirements that are relevant to the provision of a Limit Override function are 29.143, 29.303, 29.361, 29.927(a), 29.1143(f), 30 second ratings, 29.1301(a) and (d), and 29.1581(a)(2).

c. General Considerations.

(1) The intent of a Limit Override function would be to provide the possibility but not the guarantee of additional power in an emergency situation. It should function satisfactorily when activated in any probable operating situation and not cause a hazard

CAA MIN-11 (continued)

the aircraft.

(2) One probable operational situation when a pilot would perceive the need for additional power in an emergency would be if the Rotor RPM (Nr) was drooping, either All Engines Operating (AEO) or One Engine Inoperative (OEI). This could represent a worst case for activation of Limit Override as the FADEC would attempt to accelerate the engine at the maximum rate and it should be shown that no adverse engine operating characteristics, e.g. surge, flame out or failure occur in this situation.

(3) Activation of a Limit Override function should not be capable of making any given situation worse, i.e. the power available should not be reduced from that available with the engine(s) running at the limit that has been overridden. This could be the situation if adverse engine operating characteristics were encountered as above.

(4) The rotorcraft must of course continue to meet all the requirements of Part 29 when the Limit Override function is not in use.

d. Engine Considerations.

(1) Continued Availability of Engine Power. A primary concern for exceeding limits to access possibly available engine power is to maintain "some" level of confidence in engine integrity for a "limited" time following use. Discussions between industry and authorities, and considering the inadvertent limit exceedence historically possible with HMU controlled engines, indicate that "land as soon as possible" would be acceptable (implying continued use of the engine for some time) but "land immediately" would not be appropriate. The reasoning for this is that the use of Limit Override should "not create a hazardous condition". This implies that engine(s) should remain under FADEC control operating for a time and at temperature, speed and torque settings acceptable to the engine and airframe manufacturers and authorities to ensure continued safe flight and landing. Maintenance action may be required after landing.

(2) Operation above OEI Thermal Limits. Because FADEC have allowed more precise control of engines closer to physical limits and with the advent of 30 second ratings, the amount of additional power that can be realized above the rated OEI limits can be very small. A recent study and practical example indicated as little as one percent. This amount of additional power has been shown in simulation studies to have a negligible effect on flight path in OEI flight, but taking greater amounts of power above the thermal limits could seriously degrade the ability of the engine to sustain continued safe flight. OEI Limit Override of the thermal limits gives very limited flight path benefit, reduces engine integrity and leads to the possibility of excessive pilot expectations of the performance benefit, which could result in less safe normal helicopter operation. These factors indicate that OEI limit override above the thermal limits, particularly the 30-second rating limits do not have a clear safety benefit and the value in pursing this

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concept is limited. Any proposal to exceed the 30 second rating limits would require development of a special condition as FAR/JAR 29.1143 (e) and (f) require that a means must be provided to prevent any engine from exceeding the installed engine limits.

(3) OEI Torque Limits Larger power reserves are potentially available at lower temperatures and altitudes when engines are constrained by a torque (rather than thermal) limit. This would offer additional power, which could be beneficial in avoiding main rotor droop below the normal operating range, minimizing the “snowball” effect caused by torque limiters. In such events holding torque steady while allowing the rotor speed to decrease, results in the engine output power also decreasing (Engine Power α Torque / Rotor Speed).

It is usual to declare a Maximum Torque on the engine Type Certificate Data Sheet based on the highest torque encountered during a test block within the engine type test (see FAR/JAR-E 820). However it is rare to deliberately set this test in order to demonstrate high torque. If required by a helicopter constructor, a separate test could be run to establish a higher torque, offering a power increase at low temperatures, and in a way that engine integrity could be ensured. This additional test can be carried out within the framework of the existing rules and additional advisory material in JAR-E as this would result in a situation that would not involve overriding engine limits.

(4) All Engines Operating. The ability to exceed the takeoff power limits when operating AEO has been available for emergency situations in the past with most HMU controlled engines and this has been accepted using current guidance for propulsion systems. There is no requirement to provide takeoff power limiting devices but these have been implemented successfully on some rotorcraft equipped with FADEC, also incorporating automatic or manual means to access OEI engine power for emergency use. Simulation studies have shown that significant benefit to the rotorcraft flight path can be gained in emergency situations by the use of power above the AEO takeoff rating but within the OEI rating limits. Retention of AEO access to some level of OEI power is considered to be a safety benefit. The maximum ratings to be considered should be the 2 minute / 2½ minute ratings because present certification control requirements limit 30 second ratings to OEI conditions only. A Special Condition would be necessary to allow 30 second OEI power during AEO operations.

e. Airframe Considerations.

(1) Rotor Drive System As a Limit Override function is intended for emergency use only with no formal performance or other credit being taken for it, it is not intended that additional regulatory or certification stringency be applied to the design of the rotor drive system. In many operational cases, any additional engine power obtained by use of Limit Override would be within existing approved drive system limits. It is possible, however, that torque greater that those normally approved (e.g.

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29.927(b)(1)) not considering Limit Override could be proposed. In this case, it should be established that the rotor drive system is safe for the proposed torque. This is

required by 29.927(a) and 29.1301(a), but consideration of the maximum torque possible using a Limit Override function need only be adequate to allow for a one off application of the Limit Override torque in service. The applicant should propose the means to establish rotor drive system safety in the Limit Override case.

(2) Structure. As for the rotor drive system, it is not intended that additional regulatory or certification stringency be applied to the design of rotorcraft structure. In many operational cases, any additional engine power obtained by use of Limit Override would be within existing torque used in accordance with 29.361for structural substantiation. If higher torque is proposed, it should at least be established that no structural failure would occur as a result of application of Limit Override torque. As use of a Limit Override function would be restricted to extreme emergency situations only, the resulting loads would not be considered representative of the normal maximum loads to be expected in service and the factor of safety as specified in 29.303 need not be applied. The applicant should propose the means to establish structural safety in the Limit Override case.

(3) Controllability and Maneuverability. It is not intended that additional regulatory or certification stringency be applied to the flight characteristics or flight test of rotorcraft embodying a Limit Override feature. Any OEI Limit Override additional power is most likely to be within the power approved for AEO use and there are unlikely to be any controllability issues associated with such additional power. Considering the AEO case, existing designs using HMU control of engine power, have generally had no physical constraints on access to OEI power levels, with the exception of some designs incorporating a drive system torque limiting system which could in some situations limit access to OEI power. Although it is predictable that loss of control, most probably in yaw, would occur in some flight conditions with the higher torque and possibly low Nr that could be generated by use of a Limit Override function, this situation would not be considered to be a maneuver typical of the type and therefore not covered by the controllability and maneuverability requirements of 29.143

f. Access to Limit Override. There is no requirement to provide physical limiting devices against access to power levels above the 'red line' limits. It is permissible to rely on the pilot to observe limits, as has been the case for HMU designs. FADEC designs typically do however provide such physical limits by controlling parameters at

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the red line limits. Limit Override can be achieved by either automatic or manual means and both have been approved previously. Automatic activation of Limit Override has typically been based on Nr values but other innovative means of assessing extreme emergency situations are not precluded. Automatic activation should be tested in flight and shown to function correctly without hazarding the rotorcraft. Manual activation would typically consist of a button or other control mounted on the primary flying controls to provide easy access for the pilot. Care should be taken in the design of a manual control to achieve an acceptable compromise between ease of access and inadvertent operation. Manual activation of the Limit Override function should be flight tested in representative flight conditions not precluded by RFM advice, but including Nr reduced below the normal power on governed range, and shown to function correctly without hazard to the rotorcraft.

g. Recording of Limit Override Events. A means should be provided to record automatically any use of the Limit Override function. As the rotorcraft would be rendered unserviceable by Limit Override use, a cockpit indication of use should be provided that would prevent a further flight being carried out without the knowledge of the crew.

h. Rotorcraft Flight Manual. The RFM should contain sufficient information to ensure safe operation of a Limit Override function (29.1581(a)(2) refers). This could include, but is not limited to the following suggestions:

(1) Description of the method of activation and what resulting indications the crew is likely to see.

(2) If the function is automatically activated, there should be a description of the parameters that will cause activation.

(3) If the function is manually activated, the RFM should prohibit selection of Limit Override unless the rotorcraft is in a dangerous emergency situation that could be alleviated by the possibility of additional power.

There should be a statement that following use of the Limit Override function, the rotorcraft should be placed unserviceable for rectification action before being flown again.

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(AC 29-2C, Appendix A, A29.3(b)(2), Instructions for Continued Airworthiness)

REQUIREMENTS
(Continued)

13. WORK RECOMMENDED

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14. APPLICABLE WEAR TOLERANCES

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15. TROUBLESHOOTING

Troubleshooting information describing:

a. Probable malfunctions.

b. How to recognize those malfunctions. (Probable Cause). *Some malfunctions could be identified on the basis of a baseline vibration signature provided as follows in the maintenance manual:*

> *The baseline vibration characteristics of the basic aircraft configuration to be used for maintenance or trouble shooting purposes should be provided as the vibratory aircraft reference in the maintenance manual. These characteristics should be given for specified loading and flight conditions (speed, altitude) with vibration pickups at specified airframe locations decided by the manufacturer. The characteristics should be given as a typical range of vibration levels at these locations and for the most representative frequencies and directions for the rotorcraft concerned (N omega main rotor and n omega tail rotor...). The manufacturers and operators should keep the basic vibration data updated from field/service experience if mutually agreed.*

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AC 29 APPENDIX B. AIRWORTHINESS GUIDANCE FOR ROTORCRAFT INSTRUMENT FLIGHT

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b. Procedures.

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(8) Cockpit Arrangement.

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(v) Typically the integrity of essential flight information presented to the first pilot must be ensured by not permitting peripheral systems to be connected to that instrument system. However, with the introduction of integrated avionic systems, it may be possible to accept that additional systems be connected to the first pilot's instrument system if provision has been made to ensure that the integrity of essential flight information is preserved. In addition, equipment must not be connected to operating systems for the second pilot's required instruments unless it is extremely improbable that failure of such additional equipment would affect that operating system. Similar provisions are also included in AC 29.1333.

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