CS-29 AMENDMENT 6 — CHANGE INFORMATION

EASA publishes amendments to certification specifications as consolidated documents. These documents are used for establishing the certification basis for applications made after the date of entry into force of the amendment.

Consequently, except for a note '[Amdt No: 29/6]' under the amended paragraph, the consolidated text of CS-29 does not allow readers to see the detailed changes introduced by the new amendment. To allow readers to also see these detailed changes, this document has been created. The same format as for the publication of notices of proposed amendments (NPAs) has been used to show the changes:

(a) deleted text is ~~struck through~~;

(b) new or amended text is highlighted in blue;

(c) an ellipsis '(…)' indicates that the remaining text is unchanged.

BOOK 2

CS-29 BOOK 2 — ACCEPTABLE MEANS OF COMPLIANCE

AMC 29 General is amended as follows:

AMC 29 General

(a) The AMC to CS-29 consists of FAA AC 29-2C — ~~Change 4, dated 1 May 2014~~ Change 7, dated 4 February 2016, with the changes/additions given in this Book 2 of CS-29.

(b) The primary reference for each of these AMCs is the CS-29 paragraph. Where there is an appropriate paragraph in FAA AC 29-2C — ~~Change 4, dated 1 May 2014~~ Change 7, dated 4 February 2016, this is added as a secondary reference.

AMC 29.865 is amended as follows:

AMC 29.865 External Loads

This AMC provides further guidance and acceptable means of compliance to supplement FAA AC 29-2C Change 4 7 AC 29.865B § 29.865 (Amendment 29-43) EXTERNAL LOADS to meet EASA's interpretation of CS 29.865. As such, it should be used in conjunction with the FAA AC but should take precedence over it, where stipulated, in the showing of compliance.

AMC No 1 below addresses the specificities of complex personnel-carrying device systems for human external cargo applications.

AMC No 2 below contains a recognised approach to the approval of simple PCDSs if required by the applicable operating rule or if an applicant elects to include simple PCDSs within the scope of type certification.

AMC No 1 to CS 29.865 EXTERNAL LOADS

a. Explanation

(1) This ~~advisory material~~ AMC contains guidance for the certification of helicopter external-load attaching means and load-carrying systems to be used in conjunction with operating rules such as Regulation (EU) No 965/2012 on Air Operations[1]. ~~The four RLC classes are summarised in Figure AMC 29.865-1 and discussed in paragraph d. Under the operating rules, RLC Classes A, B, and C are eligible, under specific restrictions, for both human external cargo (HEC) and non-human external cargo (NHEC) operations.~~ Paragraph ~~AC 29.25 (ref.:~~CS 29.25~~)~~ also concerns, in part, jettisonable external cargo.

(2) CS 29.865 provides a minimum level of safety for large category rotorcraft designs to be used with operating rules, such as Regulation (EU) No 965/2012 on Air Operations. Certain aspects of operations, such as microwave tower and high-line wire work, may also be regulated separately by other agencies or entities. For applications that could come under the regulations of more than one agency or entity, special certification emphasis will be required by both the applicant and the approving authority to assure all relevant

[1] Commission Regulation (EU) No 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council (OJ L 296, 25.10.2012, p. 1).

safety requirements are identified and met. Potential additional requirements, where thought to exist, are noted herein.

(3) The CS provisions for external loads (29.865) do not discern the difference between a crew member and a compensating passenger when either is carried external to the rotorcraft. Both are considered to be HEC.

b. Definitions

~~(1) Applicable cargo type: the cargo type (i.e. non-human external cargo (NHEC), human external cargo (HEC), or both) that each RLC class is eligible to use by regulation.~~

(1~~2~~) Backup quick-release subsystem (BQRS): the secondary or 'second choice' subsystem used to perform a normal or emergency jettison of external cargo.

(2~~3~~) Cargo: the part of any rotorcraft-load combination that is removable, changeable, and is attached to the rotorcraft by an approved means. For certification purposes, 'cargo' applies to HEC and non-human external cargo (NHEC).

(3~~4~~) Cargo hook: a hook that can be rated for both HEC and NHEC. It is typically used by being fixed directly to a designated hard point on the rotorcraft.

(4~~5~~) Dual actuation device (DAD): this is a sequential control that requires two distinct actions in series for actuation. One example is the removal of a lock pin followed by the activation of a 'then free' switch or lever for load release to occur (in this scenario, a load release switch protected only by an uncovered switch guard is not acceptable). For jettisonable HEC applications, a simple, covered switch does not qualify as a DAD. Familiarity with covered switches allows the pilot to both open and activate the switch in one motion. This has led to inadvertent load release.

(5~~6~~) Emergency jettison (or complete load release): the intentional, instantaneous release of NHEC or HEC in a preset sequence by the quick-release system (QRS) that is normally performed to achieve safer aircraft operation in an emergency.

(6~~7~~) External fixture: a structure external to and in addition to the basic airframe that does not have true jettison capability and has no significant payload capability in addition to its own weight. An example is an agricultural spray boom. These configurations are not approvable as 'External Loads' under CS 29.865.

(7) External Load System. The entire installation related to the carriage of external loads to include not only the hoist or hook, but also the structural provisions and release systems. A complex PCDS is also considered to be part of the external load system.

(8) Hoist: a hoist is a device that exerts a vertical pull, usually through a cable and drum system (i.e. a pull that does not typically exceed a 30-degree cone measured around the z-rotorcraft axis).

(9) Hoist demonstration cycle (or 'one cycle'): the complete extension and retraction of at least 95 % of the actual cable length, or 100 per cent of the cable length capable of being used in service (i.e. that would activate any extension or retraction limiting devices), whichever is greater.

(10) Hoist load-speed combinations: some hoists are designed so that the extension and retraction speed slows as the load increases or nears the end of a cable extension. Other hoist designs maintain a constant speed as the load is varied. In the latter designs, the load-speed combination simply means the variation in load at the constant design speed of the hoist.

(11) Human external cargo (HEC): a person (or persons) who, at some point in the operation, is (are) carried external to the rotorcraft. ~~See non-human external cargo (NHEC).~~

(12) Non-human external cargo (NHEC): any external cargo operation that does not at any time involve a person (or persons) carried external to the rotorcraft.

(13) Normal jettison (or selective load release): the intentional release, normally at optimum jettison conditions, of NHEC.

(14) Personnel-carrying device system (PCDS) is a device that has the structural capability and features needed to transport occupants external to the helicopter during HEC or helicopter hoist operations. A PCDS includes but is not limited to life safety harnesses (including, if applicable, a quick-release and strop with a connector ring), rigid baskets and cages that are either attached to a hoist or cargo hook or mounted to the rotorcraft airframe.

(15) Primary quick-release subsystem (PQRS): the primary or 'first choice' subsystem used to perform a normal or emergency jettison of external cargo.

(16) Quick-release system (QRS): the entire release system for jettisonable external cargo (i.e. the sum total of both the primary and backup quick-release subsystem). The QRS consists of all the components including the controls, the release devices, and everything in between.

(17) Rescue hook (or hook): a hook that can be rated for both HEC and NHEC. It is typically used in conjunction with a hoist or equivalent system.

(18) Rotorcraft-load combination (RLC): the combination of a rotorcraft and an external load, including the external-load attaching means. ~~RLCs are designated as Class A, Class B, Class C, and Class D as follows:~~

~~(i) Class A RLC means one in which the external load cannot move freely, cannot be jettisoned, and does not extend below the landing gear.~~

~~(ii) Class B RLC means one in which the external load is jettisonable and is lifted free of land or water during the rotorcraft operation.~~

~~(iii) Class C RLC means one in which the external load is jettisonable and remains in contact with land or water during the rotorcraft operation.~~

(iv) ~~Class D RLC means one in which the external load is other than a Class A, B or C and has been specifically approved by the relevant authority for that operation (i.e. HEC operations for which the operator is receiving remuneration from the person being transported).~~

(19) Spider: a spider is a system of attaching a lowering cable or rope or a harness to an NHEC (or HEC) RLC to eliminate undesirable flight dynamics during operations. A spider usually

has four or more legs (or load paths) that connect to various points of a PCDS to equalise loading and prevent spinning, twisting, or other undesirable flight dynamics.

(20) True jettison capability: the ability to safely release an external load using an approved QRS in 30 seconds or less.

NOTE: In all cases, a PQRS should release the external load in less than 5 seconds. Many PQRSs will release the external load in milliseconds, once the activation device is triggered. However, a manual BQRS, such as a set of cable cutters, could take as much as 30 seconds to release the external load. The 30 seconds would be measured starting from the time the release command was given and ending when the external load was cut loose.

(21) True payload capability: the ability of an external device or tank to carry a significant payload in addition to its own weight. If little or no payload can be carried, the external device or tank is an external fixture (see definition above).

(22) Winch: a winch is a device that can employ a cable and drum or other means to exert a horizontal (i.e. x-rotorcraft axis) pull. However, in designs that utilise a winch to perform a hoist function by use of a 90-degree cable direction change device (such as a pulley or pulley system), the winch system is considered to be a hoist. ~~However, since a winch can be used to perform a hoist function by use of a 90-degree cable direction change device (such as a pulley or pulley system), a winch system may be considered to be a hoist.~~

c. <u>Procedures</u>

The following certification procedures are provided in the most general form. Where there are significant differences between the cargo types, the differences are highlighted.

(1) General Compliance Procedures for CS 29.865: The applicant should clearly identify both the RLC and the applicable cargo types (NHEC or HEC) for which an application is being made. The structural loads and operating envelopes for each ~~RLC class and~~ applicable cargo type should be determined and used to formulate the flight manual supplement and basic loads report. The applicant should show by analysis, test, or both, that the rotorcraft structure, the external-load attaching means, and the complex PCDS, if applicable, meet the specific requirements of CS 29.865 and any other relevant requirements of CS-29 for the proposed operating envelope.

NOTE: the approved maximum internal gross weight should never be exceeded for any approved HEC configuration (or simultaneous NHEC and HEC configuration). ~~It is possible, if approved, to carry both HEC and NHEC externally, simultaneously as two separate external loads. However, in no case is it intended that the approved maximum internal gross weight should be exceeded for any approved HEC configuration (or combined NHEC and HEC configuration) in normal operations.~~

(2) Reliability of the external load system, including the QRS.

(i) The hoist, QRS, and rescue hook system should be reliable for all phases of flight and the applicable configurations for those phases (i.e. operating, stowed, or unstowed) for which approval is sought. The hoist should be disabled (or an overriding, fail-safe mechanical safety device such as either a flagged removable shear pin or a load-lowering brake should be utilised) to prevent inadvertent load unspooling or release during any extended flight phases in which hoist operation is not intended. Loss of hoist operational control should also be considered.

(ii) A failure of the external load system~~,~~ (including QRS, hook, ~~the~~ complex PCDS where applicable, and ~~its~~ attachments to the rotorcraft) should be shown to be extremely improbable (i.e. 1×10^{-9} failures per flight) for all failure modes that could cause a catastrophic failure, serious injury or a fatality anywhere in the total airborne system. Uncontrolled high-speed descent of the hoist cable would fall into this category. All significant failure modes of lesser consequence should be evaluated and shown to be at least improbable (i.e. 1×10^{-5} failures per flight). ~~An acceptable method of achieving this goal is to submit the following for subsequent approval:~~

(iii) The reliability of the system should be demonstrated by completion and approval of the following:

(A~~i~~) A functional hazard assessment (FHA) to determine the hazard severity of failures associated with the external load system. The effect of the flailing cable after a load release should be considered. ~~A failure modes and effects analysis (FMEA) showing that all potential failure modes of the airborne system that may result in catastrophic failures, serious injuries or fatalities are extremely improbable and any less significant failures are improbable.~~

(B) A fault tree analysis (FTA) or equivalent to verify that the hazard classification of the FHA has been met.

(C) A system safety assessment (SSA) to demonstrate compliance with the applicable certification requirements.

(D) An analysis of the non-redundant external load system components that constitute the <u>primary load path</u> (e.g. beam, cable, hook), to demonstrate compliance with the applicable structural requirements.

(E~~ii~~) A repetitive test of all functional devices that cycles these devices under critical structural conditions, operational conditions, or a combination of both at least 10 times each for NHEC and 30 times for HEC. This is applicable to both primary and backup subsystems. It is assumed that only one hoist cycle will typically occur per flight. This rationale has been used to determine the 10 demonstration cycles for NHEC applications and 30 demonstration cycles for HEC applications. However, if a particular application requires more than one hoist cycle per flight, then the number of demonstration cycles should be increased accordingly by multiplying the test cycles by the intended higher cycle number per flight. These repetitive tests may be conducted on the rotorcraft or by using a bench simulation that accurately replicates the rotorcraft installation. ~~a repetitive test of all the functional devices that cycles these devices at least 30 times under critical structural conditions, operational conditions, or a combination of both.~~

(Fiii) An environmental qualification for the proposed operating environment. This review includes consideration of low and high temperatures (typically – 40 °C (– 40 °F) to + 65.6 °C (+ 150 °F), altitudes to 12 000 feet, humidity, salt spray, sand and dust, vibration, shock, rain, fungus, and acceleration. The appropriate rotorcraft sections of RTCA Document DO-160/ EUROCAE ED-14 for high and low temperature and vibration are considered to be acceptable for environmental qualification. The environmental qualification will address icing for those external load systems installed on rotorcraft approved for flight into icing conditions. an environmental qualification review covering the proposed operating environment.

(G) Qualification of the hoist itself to the appropriate electromagnetic interference (EMI) and lightning threat levels specified for NHEC or HEC, as applicable. This qualification can occur separately or as part of the entire on-board QRS.

Figure AMC 29.865B-1

Rotorcraft-Load Combination Versus Applicable Cargo Type Data And Definition Summary

Possible RLCs and Cargo Types	Category 'A' rating and one-engine-inoperative (OEI) hover capability	Notes	Direct two-way voice communications required See paragraph d(10)
HEC RLC A	No	Note 2	No
NHEC RLC A	No		N/A
HEC RLC B	No	Note 2	No
NHEC RLC B	No		N/A
HEC RLC C	No	Note 2	No
NHEC RLC C	No		N/A
HEC RLC D	Yes, see paragraph d(12) Yes, See Paragraph	Note 1, 3, 4 Note 1,	Yes

NOTES:

1. A person (or persons) being carried or transported for remuneration outside the rotorcraft can only be carried as a Class D RLC.

2. A person (or persons) who is (are) not being carried or transported for remuneration is (are) knowledgeable of the risks involved, and at some point is (are) required to be outside the

~~rotorcraft in order to fulfil the mission. This (these) person (persons) is (are) considered to be RLC Class A, B, or C HEC as appropriate to the operation.~~

~~3. The rotorcraft is approved to the Category A engine isolation requirements of Part 29 and has a one-engine-inoperative/out-of-ground effect (OEI/OGE) hover performance capability, for the requested operating and weight envelopes, to be eligible for certification to the Class D RLC (ref.: paragraph c(12)).~~

~~4. A Class D RLC operation may be conducted with an external cargo design having a physical configuration that meets the definitions of § 1.1 for RLC Class A, B, or C.~~

(3) Testing.

(i) Hoist system load-speed combination ground tests. The load versus-speed combinations of the hoist should be demonstrated on the ground (either using an accurate engineering mock-up or a rotorcraft) by showing repeatability of the no load-speed combination, the 50 per cent load-speed combination, the 75 per cent load-speed combination, and the 100 per cent (i.e. system rated limit) load-speed combination. If more than one operational speed range exists, the preceding tests should be performed at the most critical speed.

(A) At least 1/10 of the hoist demonstration cycles (see definition) should include the maximum aft angular displacement of the load from the vertical, applied for under CS 29.865(a).

(B) A minimum of six consecutive, complete operation cycles should be conducted at the system's 100 per cent (i.e. system limit rated) load-speed combination.

(C) In addition, the demonstration should cover all normal and emergency modes of intended operation and should include operation of all control devices such as limit switches, braking devices, and overload sensors in the system.

(D) All quick disconnect devices and cable cutters should be demonstrated at 0 per cent, 25 per cent, 50 per cent, 75 per cent, and 100 per cent of system limit load or at the most critical percentage of limit load.

Note: some hoist designs have built-in cable tensioning devices that function at the no load-speed combination, as well as at other load-speed combinations. This device should work during the no load-speed and other load-speed cable-cutting combinations.

(E) Any devices or methods used to increase the mechanical advantage of the hoist should also be demonstrated.

(F) During a portion of each demonstration cycle, the hoist should be operated from each station from which it can be controlled.

(ii) Hoist and rescue hook systems or cargo hook systems flight test: an in-flight demonstration test of the hoist system should be conducted for helicopters designed to carry NHEC or HEC. The rotorcraft should be flown to the extremes of the applicable manoeuvre flight envelope and to all conditions that are critical to strength, manoeuvrability, stability, and control, or any other factor affecting airworthiness. Unless a lesser load is determined to be more critical for either dynamic stability or other reasons, the maximum hoist system rated load or, if less, the maximum load requested for approval (and the associated limit load data placards) should be used for these tests. The minimum hoist system load (or zero load) should also be demonstrated in these tests.

(iii) CS 29.865(d) Flight test Verification Work: flight test verification work that thoroughly examines the operational envelope should be conducted with the external cargo carriage device for which approval is requested (especially those that involve HEC). The flight test programme should show that all aspects of the operations applied for are safe, uncomplicated, and can be conducted by a qualified flight crew under the most critical service environment and, in the case of HEC, under emergency condition. Flight tests should be conducted for the simulated representative NHEC and HEC loads to demonstrate their in-flight handling and separation characteristics. Each placard, marking, and flight manual supplement should be validated during flight testing.

(A) General: flight testing or an equivalent combination of analysis, ground tests, and flight tests should be conducted under the critical combinations of configurations and operating conditions for which basic type certification approval is sought. The critical load condition of the intended cargo (e.g. rocks, lumber, radio towers, HEC) may be defined by a heavy weight and low area cargo or a low weight and high area cargo. The effects of these load conditions should be evaluated throughout the operational aspects of cargo loading, take-off, cruise up to maximum allowable speed with cargo, jettison, and landing. The helicopter handling with different cable conditions should include lateral transitions and quick stops up to the helicopter approved low airspeed limitations. Additional combinations of external load and operating conditions may be subsequently approved under relevant operational requirements as long as the structural limits and reliability considerations of the basic certification approval are not exceeded (i.e. equivalent safety is maintained). The qualification flight test of this subparagraph is intended to be accomplished primarily by analysis or bench testing. However, at least one in-flight, limit load drop test should be conducted for the critical load case. If one critical load case cannot be clearly identified, then more than one drop test might be necessary. Also, in-flight tests for the minimum load case (i.e. typically the cable hook itself) with the load trailing both in the minimum and maximum cable length configurations should be conducted. Any safety-of-flight limitations should be documented and placed in the RFM or RFMS. In certain low-gross weight, jettisonable HEC configurations, the complex PCDS may act as a trailing aerofoil that could result in entangling the complex PCDS with the rotorcraft. These configurations should be assessed on a case-by-case basis by analysis or flight test to ensure that any safety-of-flight limitations are clearly identified and placed in the RFM or RFMS (also see PCDS).

(B) Separation characteristics of jettisonable external loads. For all jettisonable RLCs of any applicable cargo type, satisfactory post-jettison separation characteristics of all loads should meet the minimum criteria that follow:

(1) Separate functioning of the PQRS and BQRS resulting in a complete, immediate release of the external load without interference by the rotorcraft or external load system.

(2) No damage to the helicopter during or following actuation of the QRS and load jettisoning.

(3) A jettison trajectory that is clear of the helicopter.

(4) No inherent instability of the jettisonable (or just jettisoned) HEC or NHEC while in proximity to the helicopter.

(5) No adverse or uncontrollable helicopter reactions at the time of jettison.

(6) Stability and control characteristics after jettison that are within the originally approved limits.

(7) No adverse degradation on helicopter performance characteristics after jettison.

(C) Jettison requirements for jettisonable external loads: for representative cargo types (low, medium, and high density loads on long and short lines), emergency and normal jettison procedures should be demonstrated (by a combination of analysis, ground tests, and flight tests) in sufficient combinations of flight conditions to establish a jettison envelope that should be placed in the flight manual.

(D) QRS demonstration. Repetitive jettison demonstrations that use the PQRS, which may be accomplished during ground or flight tests, should be conducted. The BQRS should be utilised at least once.

(E) QRS reliability (i.e. failure modes) affecting flight performance. The FHA of the QRS (see paragraph c.(2) above) should show that any single system failure will not result in unsatisfactory flight characteristics, including any QRS failures resulting in asymmetric loading conditions.

(F) Flight test weight and CG locations: all flight tests should be conducted at the extreme or critical combinations of weight and longitudinal and lateral CG conditions within the applied for flight envelope. Typically the two load conditions would be a heavy weight and low area cargo, and a low weight and high area cargo. The rotorcraft should remain within approved weight and CG limits, both with the external load applied, and after jettison of the load.

(G) Jettison Envelopes. Emergency and normal jettison demonstrations should be performed at sufficient airspeeds and descent rates to establish any restrictions for satisfactory separation characteristics. Both the maximum and minimum airspeed limits and the maximum descent rate for safe separation should be determined. The sideslip envelope as a function of airspeed should be determined.

(H) Altitude. Emergency and normal jettison demonstrations should be performed at altitudes that are consistent with the approvable operational envelope and with the manoeuvres necessary to overcome any adverse effects of the jettison.

(I) Attitude. Emergency and normal jettison demonstrations should be performed from all attitudes that are appropriate to normal and emergency operational usage. Where the attitudes of HEC or NHEC with respect to the helicopter may be varied, the most critical attitude should be demonstrated. This demonstration would normally be accomplished by bench testing.

(4) Rotorcraft Flight Manual (RFM) and Rotorcraft Flight Manual Supplement (RFMS):

(i) General.

(A) Present appropriate flight manual procedures and limitations for all HEC operations.

(1) The approval of an external loads equipment design in accordance with CS 29.865 does not provide an approval to conduct external loads operations. Therefore, the following should be included as a limitation in the RFM or RFMS:

- *The external load equipment certification approval does <u>not</u> constitute an operational approval; an operational approval for external load operations must be granted by the competent authority.*

(2) The RFM or RFMS that will be approved through the certification activity should not contain any references to the previously used RLC classes.

(B) For non-HEC designs, the following limitation should be included within the RFM or RFMS:

- *The external load system does not comply with the CS-29 certification provisions for Human External Cargo (HEC).*

(C) The RFM or RFMS may contain suitable text to clarify whether the external load system meets the applicable certification provisions for lifting an external load free of land or water and whether the load is jettisonable.

(D) The RFM or RFMS should contain emergency procedures detailing the steps to be taken by the flight crew during emergencies such as an engine failure, hoist failure, flight director or autopilot failure, etc.

(E) The RFM or RFMS normal procedures should explain the required procedures to conduct a safe external load operation. Such information may include the methods for attachment and normal release of the external load.

(ii) HEC installations.

(A) For HEC installations, the following additional information/limitation should be included in the RFM or RFMS:

(1) That the external load system meets the CS-29 certification specifications for Human External Cargo (HEC).

(2) Operation of the external load equipment with HEC requires the use of an approved Personnel Carrying Device Systems (PCDS).

NOTE: for a simple PCDS, also refer to AMC No. 2 to 29.865

(B) Crew member communications.

(1) The flight manual should clearly define the method of communication between the flight crew and the HEC. These instructions and manuals should be validated during flight testing.

(2) If the external load system does not include equipment to allow direct intercommunication among required crew members and external occupants, the following limitation may be included within the limitations section of the RFM or RFMS:

- *This external load system does not include equipment to allow direct intercommunication among required crew members and external occupants. Operating this external load equipment with HEC is not authorised unless appropriate equipment to allow direct intercommunication between required crew members and external occupants has an airworthiness approval.*

(iii) Additional RFM or RFMS requirements are contained within each applicable paragraph of this AMC.

(5) Continued airworthiness.

(i) Instructions for Continued Airworthiness: maintenance manuals (and RFM supplements) developed by applicants for external load applications should be presented for approval and should include all appropriate inspection and maintenance procedures. The applicant should provide sufficient data and other information to establish the frequency, extent, and methods of inspection of critical structure, systems, and components. CS 29.1529 and Appendix A to CS-29 requires this information to be included in the maintenance manual. For example, maintenance requirements for sensitive QRS squibs should be carefully determined, documented, approved during certification, and included as specific mandatory scheduled maintenance requirements that may require either ‘daily’ or ‘pre-flight’ checks (especially for HEC applications).

(ii) Hoist system continued airworthiness. The design life of the hoist system and any limited life components should be clearly identified, and the Airworthiness Limitations Section of the maintenance manual should include these requirements. For STCs, a maintenance manual supplement should be provided that includes these requirements.

Note: the design life of a hoist and cable system is typically between 5 000 and 8 000 cycles. Some hoist systems have usage time meters installed. Others may have cycle counters installed. Cycle counters should be considered for HEC operations and high-load or other operations that may cause low-cycle fatigue failures.

(6~~2~~) –CS 29.865(a) Static Structural Substantiation and CS 29.865(f) Fatigue Substantiation Procedures: The following static structural substantiation methods and fatigue substantiation should be used:

(i) Critical Basic Load Determination. The critical basic loads and corresponding flight envelope are determined by statically substantiating the gross weight range limits, the corresponding vertical limit load factors (N_{ZW}) and the safety factors applicable for the type of external load for which the application is being made.

NOTE: ~~I~~in cases where NHEC or HEC can have more than one shape, centre of gravity, centre of lift, or be carried at more than one distance in-flight from the rotorcraft attachment, a critical configuration for certification purposes may not be determinable. If such a critical configuration can be determined, it may be examined for approval as a ‘worst case’ to satisfy a particular certification criterion or several criteria, as appropriate. If such a critical configuration cannot be determined, the extreme points of the operational external load configuration envelope should be examined, with consideration given to any other points within the envelope that experience or any other rationale indicates as points that need to be investigated.

(ii) Vertical Limit and Ultimate Load Factors. The basic N_{ZW} is converted to the ultimate load by multiplying the maximum vertical limit load by the appropriate safety factor (for restricted category approvals, see the guidance in paragraph AC 29 MG 5 of FAA AC 29-2C Change 7). This ultimate load is used to substantiate all the existing structure affected by, and all the added structure associated with, the load-carrying device, its attachments and its cargo. Casting factors, fitting factors, and other dynamic load factors should be applied where appropriate.

(A) NHEC applications. In most cases, it is acceptable to perform a standard static analysis to show compliance. A vertical limit load factor (N_{ZW}) of 2.5 g is typical for heavy gross weight NHEC hauling configurations (ref.: CS 29.337). This vertical load factor should be applied to the maximum external load for which the application is being made, together with a minimum safety factor of 1.5.

(B) HEC applications.

(1) If a safety factor of 3.0 or more is used, it is acceptable to perform a standard static analysis to show compliance. The safety factor should

be applied to the yield strength of the weakest component in the system (QRS, complex PCDS, and attachment load path). If a safety factor of less than 3.0 is used, both an analysis and a full-scale ultimate load test of the relevant parts of the system should be performed.

(2) Since HEC applications typically involve lower gross weight configurations, a higher vertical limit load factor is required to assure that the limit load is not exceeded in service. The applicant should use either the conservative value of 3.5 g or an analytically derived maximum vertical limit load factor for the requested operating envelope. Linear interpolation between the vertical load factors of the maximum and minimum design weights may be used. However, in no case may the vertical limit load factor be less than 2.5 g for any ~~RLC~~ HEC application ~~for HEC~~.

(3) For the purpose of structural analysis or test, applicants should assume a 101.2-kg (223-pound) man as the minimum weight of each occupant carried as HEC.

NOTE: ~~I~~if the HEC is engaged in work tasks that employ devices of significant added weight (e.g. heavy backpacks, tools, fire extinguishers, etc.), the total weight of the 101.2-kg (223-pound) man and their equipment should be assumed in the structural analysis or test.

(iii) Critical Structural Case. For applications involving more than one RLC class or cargo type, the structural substantiation is required only for the most critical case. The most critical case should be determined by rational analysis.

(iv) Jettisonable Loads. For the substantiating analyses or tests of all jettisonable ~~RLC~~ external loads, including HEC, the maximum external load should be applied at the maximum angle that can be achieved in service, but not less than 30 degrees. The angle should be measured from the sling-load-line to the rotorcraft vertical axis (z axis) and may be in any direction that can be achieved in service. The 30-degree angle may be reduced in some or all directions if it is impossible to obtain due to physical constraints or operating limitations. The maximum allowable cable angle should be determined and approved. The angle approved should be based on structural requirements, mechanical interference limits, and flight-handling characteristics over the most critical conditions and combinations of conditions in the approved flight envelope.

(v) Hoist System Limit Load.

NOTE: ~~I~~if a hoist cable or a long-line cable is utilised, a new dynamic system is established. The characteristics of the system should be evaluated to assure that either no hazardous failure modes exist or that they are acceptably minimised. For example, the hoist cable or long-line cable may exhibit a natural frequency that could be excited by sources internal to the overall structural system (i.e. the rotorcraft) or by sources external to the system. Another example is the loading effect of the cable acting as a spring between the rotorcraft and the suspended external load.

(A) Determine the basic loads that would result in the failure or unspooling of the hoist or its installation, respectively.

NOTE: ~~T~~this determination should be based on static strength and any significant dynamic load magnification factors.

(B) Select the lower of the two values as the ultimate load of the hoist system installation.

(C) Divide the selected ultimate load by 1.5 to determine the true structural limit load of the system.

(D) Determine the manufacturer's approved 'limit design safety factor' (or that which the applicant has applied for). Divide this factor into the true structural limit load (from (C) above) to determine the hoist system's working (or placarded) limit load.

(E) Compare the system's derived limit load to the applied for one 'g' payload multiplied by the maximum downward vertical load factor (N_{ZWMAX}) to determine the critical payload's limit value.

(F) The critical payload limit should be equal to or less than the system's derived limit load for the installation to be approvable.

(vi) Fatigue Substantiation Procedures

NOTE: the term 'hazard to the rotorcraft' is defined to include all hazards to either the rotorcraft, to the occupants thereof, or both.

(A) Fatigue evaluation of NHEC applications. Any critical components of the suspended system and their attachments (e.g. the cargo hook, or bolted or pinned truss attachments), the failure of which could result in a hazard to the rotorcraft, should be included in an acceptable fatigue analysis.

(B) Fatigue evaluation of HEC applications. The entire external load system, including the complex PCDS, should be reviewed on a component-by-component basis to determine which, if any, components are fatigue critical. These components should be analysed or tested to ensure that their fatigue life limits are properly determined, and the limits should then be placed in the limited life section of the maintenance manual.

(7~~3~~) CS 29.865(b) and CS 29.865(c) Procedures for Quick-Release Systems and Cargo Hooks: for jettisonable RLCs of any applicable cargo type, both a primary quick-release system (PQRS) and a backup quick-release system (BQRS) are required. Features that should be considered are:

(i) The PQRS, BQRS and their load-release devices and subsystems (such as electronically actuated guillotines) should be separate (i.e. physically, systematically, and functionally redundant).

(ii) The controls for the PQRS should be installed on one of the pilot's primary controls, or in an equivalently accessible location. The use of an 'equivalent accessible location' should be reviewed on a case-by-case basis and utilised only where equivalent safety is clearly maintained.

(iii) The controls for the BQRS may be less sophisticated than those of the PQRS. For instance, manual cable cutters are acceptable provided they are listed in the flight manual as a required device and have a dedicated, placarded storage location.

(iv) The PQRS should release the external load in less than 5 seconds. The BQRS should release the external load in less than 30 seconds. This time interval begins the moment an emergency is declared and ends when the load is released.

(v) Each quick-release device should be designed and located to allow the pilot or a crew member to accomplish external cargo release without hazardously limiting the ability to control the rotorcraft during emergency situations. The flight manual should reflect the requirement for a crew member and their related functions.

(vi) CS 29.865(c)(1) QRS Requirements for Jettisonable HEC Operations.

(A) For jettisonable HEC operations, both the PQRS and BQRS are required to have a dual activation device (DAD) for external cargo release. The DAD should be designed to require two actions with a definite change of direction of movement, such as opening a switch or pushbutton cover followed by a definite change of direction in order to activate the release switch or pushbutton. Any possibility of opening the switch cover and inadvertently releasing the load with a single motion is not acceptable. An additional level of safety may also be provided through the use of Advisory and Caution messages. For example, an advisory 'ON' message might be illuminated when the pilot energises (but not arms) the system with a master switch. A cautionary 'ARMED' message would then illuminate when the pilot opens the switch guard. In this case, a possible unwanted flip of the switch guard would be immediately recognised by the crew. The switch design should be evaluated by ground or flight test. The RFM or RFMS should contain a clear description of the DAD functionality that includes the associated safety features, normal and emergency procedures, and applicable advisory and caution messages.

(B) The DAD is intended for emergency use during the phases of flight in which the HEC is carried or retrieved. The DAD can be used for both NHEC and HEC operations. However, because it can be used for HEC, the instructions for continued airworthiness should be carefully reviewed and documented. The DAD can be operated by the pilot from a primary control or, after a command is given by the pilot, by a crew member from a remote location. Additional safety precautions (such as a lock wire) should be considered for remote hoist console in the cabin. Any emergency release function provided by a remote hoist console should also be designed to protect against inadvertent activation during the hoist operation. If the backup DAD is a cable cutter, it should be properly secured, placarded and readily accessible to the crew member who is intended to use it.

(vii) CS 29.865(b)(3)(ii) Electromagnetic Interference. Protection of the QRS against potential internal and external sources of EMI and lightning is required. This is necessary to prevent an inadvertent load release from sources such as lightning strikes, stray electromagnetic signals, and static electricity.

(A) Jettisonable NHEC systems should not be adversely affected when exposed to the electrical field of a minimum of 20 volts per metre (i.e. CAT U or equivalent) radio-frequency (RF) field strength per RTCA Document DO-160/ EUROCAE ED-14.

(B) Jettisonable HEC systems should not be adversely affected when exposed to the electrical field of a minimum of 200 volts per metre (i.e. CAT Y) RF field strength per RTCA Document DO-160/ EUROCAE ED-14.

(1) These RF field threat levels may need to be increased for certain special applications such as microwave tower and high voltage high line repairs. Separate criteria for special applications under multi-agency regulation (such as IEEE or OSHA standards) should also be addressed, as applicable, during certification. When necessary, the Special Condition process can be used to establish a practicable level of safety for specific high voltage or other special application conditions. The helicopter High-intensity Radiated Fields (HIRF) safety assessment should consider the effects on helicopter flight safety due to a HIRF-induced failure or malfunction of external load systems, such as an uncommanded hoist winch activation without the ability to jettison, or an uncommanded load jettison. The appropriate failure effect classification should be assigned based on this assessment, and compliance should be demonstrated with CS 29.1317 and the guidance in AMC 20-158. This should not be limited to the cable cutter devices or load jettison subsystems only. In some designs, an uncommanded load release or a hoist winch activation could also result from a failure of the command and control circuits of the system.

(2) An approved standard rotorcraft test, which includes the full HIRF frequency and amplitude external and internal environments, on the QRS and any applicable complex PCDS, or the entire rotorcraft including the QRS and any applicable complex PCDS, could be substituted for the jettisonable NHEC and HEC systems tests as long as the RF field strengths directly on the QRS and PCDS are shown to equal or exceed those defined by paragraphs c.(7)(vii)(A) and c.(7)(vii)(B) above for NHEC and HEC respectively.

(3) The EMI levels specified in paragraphs c.(7)(vii)(A) and c.(7)(vii)(B) above are total EMI levels to be applied to the QRS (and affected QRS

component) boundary. The total EMI level applied should include the effects of both external EMI sources and internal EMI sources. All aspects of internally generated EMI should be carefully considered including peaks that could occur from time-to-time due to any combination of on-board systems being operated. For example, special attention should be given to EMI from hoist operations that involve the switching of very high currents. Those currents can generate significant voltages in closely spaced wiring that, if allowed to reach some squib designs, could activate the device. Shielding, bonding, and grounding of wiring associated with operation of the hoist and the quick-release mechanism should be clearly and adequately evaluated in design and certification. When recognised good practices for such installation are applied, an analysis may be sufficient to highlight that the maximum possible pulse generated into the squib circuit will have an energy content orders of magnitude below the squib no-fire energy. If insufficient data is available for the installation and/or the squib no fire energy, this evaluation may require testing. One acceptable test method to demonstrate the adequacy of QRS shielding, bonding, and grounding would be to actuate the hoist under maximum load, together with likely critical combinations of other aircraft electrical loads, and demonstrate that the test squibs (which are more EMI sensitive than the squibs specified for use in the QRS) do not inadvertently operate during the test.

~~(vi) Other Load Release Types. In some current configurations, such as those used for high line operations, a load release may be present that is not on the rotorcraft but is on the complex PCDS itself. Examples are a tension release device that lets out line under an operationally induced load or a personal rope cutter. These devices are acceptable if:~~

~~(A) The off-rotorcraft release is considered to be a 'third release'. This type of release is not a substitute for a required release (i.e. PQRS or BQRS);~~

~~(B) The release meets all other relevant requirements of CS 29.865 and the methods of this AMC or equivalent methods; and~~

~~(C) The release has no operational or failure modes that would affect continued safe flight and landing under any operations, critical failure modes, conditions, or combination of either.~~

(8~~vii~~) Cargo Hooks or Equivalent Devices and their Related Systems. All cargo hooks or equivalent devices should be approved to acceptable aircraft industry standards. The applicant should present these standards, and any related manufacturer's certificates of production or qualification, as part of the approval package.

(i~~A~~) General. Cargo hook systems should have the same reliability goals and should be functionally demonstrated under the critical loads for NHEC and HEC, as appropriate. All engagement and release modes should be demonstrated. If the hook is used as a quick-release device, then the release of critical loads should be demonstrated under conditions that simulate the maximum allowable bank angles and speeds and any other critical operating conditions. Demonstration of any re-latching features and any safety or warning devices should also be conducted. Demonstration of actual in-flight emergency quick-release capability may not be necessary if the quick-release capability can be acceptably simulated by other means.

NOTE ~~1~~: Cargo hook manufacturers specify particular shapes, sizes, and cross sections for lifting eyes to assure compatibility with their hook design (e.g. Breeze Eastern Service Bulletin CAB-100-41). Experience has shown that, under certain conditions, a load may inadvertently hang up because of improper geometry at the hook-to-eye interface that will not allow the eye to slide off an open hook as intended.

~~NOTE 2:~~ For both NHEC and HEC designs, the phenomenon of hook dynamic roll-out (inadvertent opening of the hook latch and subsequent release of the load) should be considered to assure that QRS reliability goals are not compromised. This is of particular concern for HEC applications. Hook dynamic roll-out occurs during certain ground-handling and flight conditions that may allow the lifting eye to work its way out of the hook.

Hook dynamic roll-out typically occurs when either the RLC's sling or harness is not properly attached to the hook, is blown by down draft, is dragged along the ground or through water, or is otherwise placed into a dangerous hook-to-eye configuration.

The potential for hook dynamic roll-out can be minimised in design by specifying particular hook-and-eye shape and cross-section combinations. For non-jettisonable RLCs, a pin can be used to lock the hook-keeper in place during operations.

~~NOTE:~~ Some cargo hook systems may employ two or more cargo hooks for safety. These systems are approvable. However, a loss of any load by a single hook should be shown to not result in a loss of control of the rotorcraft. In a dual hook system, if the hook itself is the quick-release device (i.e. if a single release point does not exist in the load path between the rotorcraft and the dual hooks), the pilot should have a dual PQRS that includes selectable, co-located individual quick releases that are independent for each hook used. A BQRS should also be present for each hook. For cargo hook systems with more than two hooks, either a single release point should be present in the load path between the rotorcraft and the multiple hook system, or multiple PQRSs and BQRSs should be present.

(ii~~B~~) Jettisonable Cargo Hook Systems. For jettisonable applications, each cargo hook:

(A~~1~~) should have a sufficient amount of slack in the control cable to permit cargo hook movement without tripping the hook release.

(B~~2~~) should be shown to be reliable.

(C~~3~~) For HEC systems, unless the cargo hook is to be the primary quick-release device, each cargo hook should be designed so that operationally induced loads cannot inadvertently release the load. For example, a simple cargo hook should have a one-way, spring-loaded gate (i.e. 'snap hook') that allows load attachment going into the gate but does not allow the gate to open (and subsequently lose the HEC) when an operationally induced load is applied in the opposite direction. For HEC applications, cargo hooks that also serve as quick-release devices should be carefully reviewed to assure they are reliable.

(iii) Other Load Release Types. In some current configurations, such as those used for high-line operations, a load release may be present that is not on the rotorcraft but is on the PCDS itself. Examples are a tension-release device that lets out line under an operationally induced load, or a personal rope cutter. For long-line/sling operations, a load release may also be present that is not on the rotorcraft but is a remote release system. The long-line remote release allows the pilot to not release the line itself during repetitive loading operations. The release of the load by a dedicated switch at the pilot controls, through the secondary hook on a long line, presents additional risks due to the possibility of the long line impacting the tail or the main rotor after a release, due to its elasticity. These devices are acceptable if:

(A) The off-rotorcraft release is considered to be a 'third release' means. This type of release is not a substitute for a required release (i.e. PQRS or BQRS);

(B) The cargo hook release, and the long line remote release are placed on the primary controls in a way that avoids confusion during operation. One example of compliance would be to place the cargo hook release on the cyclic, and the long line remote release on the collective, to avoid any possible confusion in the operation;

(C) The RFM or RFMS includes a description of the new control in the cockpit, and its function and an RFM or RFMS note to the pilot is included, indicating that the helicopter hook emergency release procedures are fully applicable;

(D) The release meets all the other relevant requirements of CS 29.865 and the methods of this AMC or equivalent methods; and

(E) The release has no operational or failure modes that would affect continued safe flight and landing under any operations, critical failure modes, conditions, or combinations of these.

For long-line remote release, the following points should be considered:

(1) The long line should not be of an elastic material that allows spring up/rebound when unloaded or elevated dynamics when loaded.

(2) The long line should have a residual weight that allows its release from the helicopter hook when the long line is unloaded.

(3) The RFM or RFMS should include all operating procedures to ensure that the long line does not impact the rotors after cargo release or during unloaded flight phases.

(4) The hook should be designed to minimise inadvertent activation. An example may be a protective device (cage) around the locking mechanism of the long line hook.

(5) A means should be provided to prevent any fouling of cables in the event of a rotation of the external load. An example may be the inclusion of a swivel or slip ring.

(6) Installation of a long line that is provided with electrical wiring to control the hook will generally represent a new electromagnetic coupling path from the external area to the internal systems that may not have been considered for type certification. As such, the impact of this installation on the coupling to helicopter systems, due to direct connection or cross talk to wiring, should be addressed as part of compliance with CS 29.610, 29.1316 and 29.1317.

(9) Cable

(i) Cable attachment. Either the cable should be positively attached to the hoist drum and this attachment should have ultimate load capability or an equivalent means should be provided to minimise the possibility of inadvertent, complete cable unspooling.

(ii) Cable length and marking. A length of cable closest to the cable's attachment to the hoist drum should be visually marked to indicate to the operator that the cable is near full extension. The length of the cable to be marked is a function of the maximum extension speed of the system and the operator's reaction time needed to prevent cable run out. It should be determined during certification demonstration tests. In no case should the length be less than 3.5 drum circumferences.

(iii) Cable stops. Means should be present to automatically stop cable movement quickly when the system's extension and retraction operational limits are reached.

~~(4) CS 29.865(b)(3) Reliability Determination for QRSs and Devices: QRSs are required to be reliable. The primary electrical and mechanical failure modes that should be identified and minimised are: (1) load release by any means, and (2) loss of continued safe flight and landing capability due to a QRS failure. However, any failure that could result in catastrophic failure modes, serious injuries or fatalities should also be identified and shown to be extremely improbable. All other failure modes should be shown to be improbable. The reliability of each QRS system should be demonstrated by completion and approval of all of the following:~~

~~(i) An FMEA showing that all potential failure modes of the QRS which may result in catastrophic failures, serious injuries or fatalities are extremely improbable and any less-significant failures are improbable.~~

(ii) A repetitive test of all functioning devices that affect or comprise the QRS, which tests all the critical conditions or combinations of critical conditions at least 10 times each for NHEC and 30 times each for HEC, using both the primary and backup quick-release subsystems.

(iii) An environmental qualification programme that includes consideration of high and low temperatures (typically – 40 °C (– 40 °F) to + 65.6 °C (+ 150 °F)), altitudes up to 12 000 feet, humidity, salt spray, sand and dust, vibration, shock, rain, fungus, and acceleration. Testing should be conducted in accordance with RTCA/DO-160 or MIL-STD-810 for high- and low-temperature tests and for vibrations.

(iv) Using the methods of compliance in other relevant paragraphs of AC 29-2C including where supplemented and amended by CS-29 Book 2 or equivalent methods.

(5) Functional Reliability and Durability Compliance Procedures for Hoist Systems under CS 29.865(b)(3)(i) and (c)(2): hoist systems and their installations in the rotorcraft should be designed, approved, and demonstrated as follows:

(i) Reserved

(ii) Reserved

(iii) It is assumed that only one hoist cycle will typically occur per flight. This rationale has been used to determine the requirement for 10 demonstration cycles for NHEC applications and 30 demonstration cycles for HEC applications. However, if a particular application requires more than one hoist cycle per flight, then the number of demonstration cycles should be increased accordingly.

(iv) The hoist or rescue hook system should be reliable for the phases of flight in which it is operable, unstowed, partially unstowed, or in which cargo is carried. The hoist should be disabled (or an overriding, fail-safe mechanical safety device such as either a flagged removable shear pin or a load-lowering brake should be utilised) to prevent inadvertent load unspooling or release during any extended flight phases in which hoist operation is not intended. Loss of hoist operational control should also be considered. The reliability of the system should be demonstrated by completion and approval of all of the following:

(A) An FMEA showing that all potential failure modes of the hoist or rescue hook system which may result in catastrophic failures, serious injuries or fatalities are extremely improbable and any less-significant failures are improbable.

(B) Unless a more rational test method is presented and approved, at least 10 repetitive tests of all functional devices, which exercise the entire system's functional parameters, should be conducted. These

~~repetitive tests may be conducted on the rotorcraft, or by using a bench simulation that accurately replicates the rotorcraft installation.~~

~~(C) A hoist unit environmental qualification programme that includes consideration of high and low temperatures (typically – 40 °C (– 40 °F) to + 65.6 °C (+ 150 °F)), altitudes up to 12 000 feet, humidity, salt spray, sand and dust, vibration, shock, rain, fungus, and acceleration. Testing in accordance with RTCA/DO-160 or MIL-STD-810 for high- and low-temperature tests and for vibrations. Hoist manufacturers should submit a test plan and follow-on test reports to the applicant and the authority following the completion of the qualification. It is intended that the hoist itself either be prequalified to the EMI and lightning threat levels specified for NHEC or HEC, as applicable for the requested operation, or that it be qualified as part of the entire on-board QRS to these threat levels.~~

~~(D) All instructions and documents necessary for continued airworthiness, normal operations, and emergency operations.~~

~~(v) Cable Attachment. Either the cable should be positively attached to the hoist drum and the attachment should have ultimate load capability, or equivalent means should be provided to minimise the possibility of inadvertent, complete cable unspooling.~~

~~(vi) Cable Length and Marking. A length of the cable nearest to the cable's attachment to the hoist drum should be visually marked to indicate to the operator that the cable is near to its full extension. The length of cable to be marked is a function of the maximum extension speed of the system and the operator's reaction time needed to prevent cable run-out. It should be determined during certification demonstration tests. In no case should the length be less than 3.5 drum circumferences.~~

~~(vii) Cable Stops. Means should be present to automatically stop cable movement quickly when the system's extension and retraction operational limits are reached.~~

~~(viii) Hoist System Load-Speed Combination Ground Tests. The load versus speed combinations of the hoist should be demonstrated on the ground (either using an accurate engineering mock-up or a rotorcraft) by showing the repeatability of the no load-speed combination, the 50 per cent load-speed combination, the 75 per cent load-speed combination and the 100 per cent (i.e. system rated limit) load-speed combination. If more than one operational speed range exists, the preceding tests should be performed at either all speeds or at the most critical speed.~~

~~(A) At least 1/10 of the demonstration cycles (see definition) should include the maximum aft angular displacement of the load from the drum, applied for under § 29.865(a).~~

(B) A minimum of 6 consecutive, complete operation cycles should be conducted at the system's 100 per cent (i.e. system limit rated) load-speed combination.

(C) In addition, the demonstration should cover all normal and emergency modes of intended operation and should include operation of all control devices such as limit switches, braking devices, and overload sensors in the system.

(D) All quick-release devices and cable cutters should be demonstrated at 0, 25, 50, 75 and 100 per cent of the system limit load or at the most critical percentage value.

NOTE: Some hoist designs have built-in cable-tensioning devices that function at the no load-speed combination, as well as at other load-speed combinations. These devices should be shown to work during the no load-speed and other load-speed cable-cutting demonstrations.

(E) All electrical and mechanical systems and load-release devices for any jettisonable NHEC or HEC RLC should be shown to be reliable by both analysis and testing.

(F) Any devices or methods used to increase the mechanical advantage of the hoist should also be demonstrated.

(G) During a portion of each demonstration cycle, the hoist should be operated from each station from which it can be controlled.

NOTE: A reasonable amount of starting and stopping during demonstration cycles is acceptable.

(ix) Hoist System Continued Airworthiness. The design life of the hoist system and any life limited components should be clearly identified, and the Airworthiness Limitations Section of the maintenance manual should include these requirements. For STCs, a maintenance manual supplement should be provided that includes these requirements.

NOTE: Design lives of hoist and cable systems are typically between 5 000 and 8 000 cycles. Some hoist systems have usage time meters installed. Others may have cycle counters installed. Cycle counters should be considered for HEC operations and high-load or other operations that may cause low-cycle fatigue failures.

(x) Hoist System Flight Tests. An in-flight demonstration test of the hoist system should be conducted for helicopters designed to carry NHEC or HEC. The rotorcraft should be flown to the extremes of the applicable manoeuvre flight envelope and to all conditions that are critical to strength, manoeuvrability, stability, and control, or any other factor affecting airworthiness. Unless a lesser load is determined to be more critical for either dynamic stability or other reasons, the maximum hoist system rated load or, if less, the maximum load requested for approval (and the associated limit load data placards) should be used for these tests. The minimum hoist system load (or zero load) should also be demonstrated in these tests.

(6) CS 29.865(b)(3)(ii) Electromagnetic Interference: protection of the QRS against potential internal and external sources of electromagnetic interference (EMI) and lightning is required. This is necessary to prevent inadvertent load releases from sources such as lightning strikes, stray electromagnetic signals, and static electricity.

(i) Jettisonable NHEC systems should be able to absorb a minimum of 20 volts per metre (i.e. CAT U) radio frequency (RF) field strength per RTCA/DO-160.

(ii) Jettisonable HEC systems should be able to absorb a minimum of 200 volts per metre (i.e. CAT Y) RF field strength per RTCA/DO-160.

NOTE 1: These RF field threat levels may need to be increased for certain special applications such as microwave tower and high-voltage high line repairs. Separate criteria for special applications under the regulations of more than one agency or entity (such as the Institute of Electrical and Electronics Engineers (IEEE) or Occupational Safety and Health Administration (OSHA) standards) should also be addressed, as applicable, during certification. When necessary, the issue paper process can be used to establish a practicable level of safety for specific high-voltage or other special application conditions. For any devices or means added to meet the regulations of more than one agency or entity, their failure modes should not have an adverse effect on flight safety. Other certification authorities may require higher RF field threat levels than those required by CS 29.865 (e.g. CS-29 Appendix E).

NOTE 2: An approved standard rotorcraft test that includes the full HIRF frequency and amplitude external and internal environments on the QRS and complex PCDS (or the entire rotorcraft including the QRS and complex PCDS) could be substituted for the jettisonable NHEC and HEC systems tests defined by c(6)(i) and c(6)(ii) respectively, as long as the RF field strengths directly on the QRS and complex PCDS are shown to equal or exceed those of c(6)(i) and c(6)(ii).

NOTE 3: The EMI levels specified in c(6)(i) and c(6)(ii) are total EMI levels to be applied to the QRS (and affected QRS component) boundary. The total EMI level applied should include the effects of both external and internal EMI sources. All aspects of internally generated EMI should be carefully considered including peaks that could occur from time to time due to any combination of on-board systems being operated. For example, special attention should be given to EMI from hoist operations that involve the switching of very high currents. Those currents can generate significant voltages in closely spaced wiring that, if allowed to reach some squib designs, could activate the device. Shielding, bonding and grounding of wiring associated with the operation of the hoist and the quick-release mechanism should be clearly and adequately evaluated in design and certification. This evaluation may require testing. One acceptable test method to demonstrate the

~~adequacy of QRS shielding, bonding and grounding would be to actuate the hoist under maximum load together with likely critical combinations of other aircraft electrical loads and demonstrate that the test squibs (which are more EMI sensitive than the squibs specified for use in the QRS) do not inadvertently operate during the test.~~

~~(7) CS 29.865(c)(1) QRS Requirements for Jettisonable HEC Operations: For jettisonable HEC operations, both the PQRS and BQRS are required to have a dual actuation device (DAD) for external cargo release. Two distinct actions are required to minimise inadvertent jettison of HEC. The DAD is intended for emergency use during the phases of flight that the HEC is carried or retrieved. The DAD can be used for both NHEC and HEC operations. However, because it can be used for HEC, the Instructions for Continued Airworthiness should be carefully reviewed and documented. The DAD can be operated by the pilot from a primary control or, after a command is given by the pilot, by a crew member from a remote location. If the backup DAD is a cable cutter, it should be properly secured, placarded and readily accessible to the crew member intended to use it.~~

(10~~8~~) CS 29.865(c)(2) PCDS: for all HEC applications that use complex PCDSs, an approval is required. The complex PCDS may be either previously approved or is required to be approved during certification. In either case, its installation should be approved~~. The complex PCDS is required to be reliable. The failure of the complex PCDS, and its attachments to the rotorcraft, should be shown to be extremely improbable (i.e.~~ ~~1×10^{-9}~~ ~~failures per flight) for all failure modes that could cause a catastrophic failure, serious injury or fatality. All significant failure modes of lesser consequence should be shown to be improbable (i.e.~~ ~~1×10^{-5}~~ ~~failures per flight). An acceptable method of achieving this goal is to apply for and be granted approval for:~~

~~(i) a failure modes and effects analysis (FMEA) showing that all the potential failure modes of the complex PCDS that may result in catastrophic failures, serious injuries or fatality, are extremely improbable and any less significant failures are improbable.~~

~~(ii) a repetitive test of all functional devices that cycles these devices at least 30 times under critical structural conditions, operational conditions, or a combination.~~

~~(iii) an environmental qualification review of the proposed operating environment.~~

NOTE: Complex PCDS designs can include relatively complex devices such as multiple occupant cages or gondolas. The purpose of the PCDS is to provide a minimum acceptable level of safety for personnel being transported outside the rotorcraft. The personnel being transported may be healthy or injured, conscious or unconscious.

(i~~v~~) Regulation (EU) No 965/2012 on Air Operations contains the minimum performance specifications and standards for simple PCDSs, such as HEC body harnesses.

(ii~~v~~) Static Strength. The complex PCDS should be substantiated for the allowable ultimate load and loading conditions as determined under paragraph c(6~~2~~) above.

(iii~~vi~~) Fatigue. ~~CS 29.865(f) requires the metallic components of t~~The complex PCDSs ~~to~~ should be substantiated for fatigue ~~in accordance with CS 29.571 (ref.: c(14))~~ as determined under paragraph c(6) above.

(iv~~ii~~) Personnel Safety. For each complex PCDS design, the applicant should submit a design evaluation that assures the necessary level of personnel safety is provided. As a minimum, the following should be evaluated.

(A) The complex PCDS should be easily and readily entered or exited.

(B) It should be placarded with its proper capacity, the internal arrangement and location of occupants, and ingress and egress instructions.

(C) For door latch fail-safety, more than one fastener or closure device should be used. The latch device design should provide direct visual inspectability to assure it is fastened and secured.

(D) Any fabric used should be durable and should be at least flame-resistant.

(E) Reserved

(F) Occupant retention devices and the related design safety features should be used as necessary. In simple designs, rounded corners and edges with adequate strapping (or other means of HEC retention relative to the complex PCDS) and head supports or pads may be all the safety features that are necessary. Complex PCDS designs may require safety features such as seat belts, handholds, shoulder harnesses, placards, or other personnel safety standards.

(v~~iii~~) EMI and Lightning Protection. All essential, affected components of the complex PCDS, such as intercommunication equipment, should be protected against RF field strengths to a minimum of RTCA Document~~/~~DO-160/ EUROCAE ED-14 CAT Y.

(vi~~ix~~) Instructions for Continued Airworthiness. All instructions and documents necessary for continued airworthiness, normal operations and emergency operations should be completed, reviewed and approved during the certification process. There should be clear instructions to describe when the complex PCDS is no longer serviceable and should be replaced in part or as a whole due to wear, impact damage, fraying of fibres, or other forms of degradation. In addition, any life limitations resulting from compliance with paragraphs c.(10)(ii) and (iii) should be provided.

(vii~~x~~) Flotation Devices. Complex PCDSs that are intended to have a dual role as flotation devices or life preservers should meet the relevant requirements for 'Life Preservers'. Also, any complex PCDS design to be used in the water should have a flotation kit. The flotation kit should support the weight of the maximum number of occupants and the complex PCDS in the water and minimise the possibility of the occupants floating face down.

(viii~~xi~~) ~~Aerodynamic~~ Considerations for flight testing. It should be shown by flight tests that the device is safely controllable and manoeuvrable during all requested flight regimes without requiring exceptional piloting skill. The flight tests should entail the complex PCDS weighted to the most critical weight. Some complex PCDS designs may spin, twist or otherwise respond unacceptably in flight. Each of these designs should be structurally restrained with a device such as a spider, a harness, or an equivalent device to minimise undesirable flight dynamics.

(ix~~xii~~) Medical Design Considerations. Complex PCDSs should be designed to the maximum practicable extent and placarded to maximise the HEC's protection from medical considerations such as blocked air passages induced by improper body configurations and excessive losses of body heat during operations. Injured or water-soaked persons may be exposed to high body heat losses from sources such as rotor washes and airstreams. The safety of occupants of complex PCDSs from transit-induced medical considerations can be greatly increased by proper design.

(x) Hoist operator safety device. When hoisting operations require the presence of a hoist operator on board, appropriate provisions should be provided to allow the hoist operator to perform their task safely. These provisions shall include an appropriate hoist operator restraint system. This safety device is typically composed of a safety harness and a strap attached to the cabin used to adequately restrain the hoist operator inside the cabin while operating the hoist. For certification approval, the hoist operator safety device should comply with CS 29.561(b)(3) for personnel safety. The applicant should submit a design evaluation that assures the necessary level of personnel safety is provided. As a minimum, the following should be evaluated:

(A) The strap attaching point on the body harness should be appropriately located in order to minimise as far as is practicable the likelihood of injury to the wearer in the case of a fall or crash.

(B) The safety device should be designed to be adjustable so that the strap is tightened behind the hoist operator.

(C) The strap should allow the hoist operator to detach themselves quickly from the cabin in emergency conditions (e.g. crash, ditching). For that purpose, it should include a QRS including a DAD.

(D) The safety device should be easily and readily donned or doffed.

(E) It should be placarded with its proper capacity and lifetime limitation.

(F) Any fabric used should be durable and should be at least flame resistant.

~~(9) CS 29.865(c)(3) QRS Design, Installation and Placarding: for jettisonable HEC applications, the QRS design, installation and associated placarding should be given special consideration to assure the proper level of occupant safety.~~

(11~~0~~) CS 29.865(c)(4) Intercom Systems for HEC Operations: for all HEC operations, the rotorcraft is required to be equipped for, or otherwise allow, direct intercommunication under any operational conditions among crew members and the HEC. An intercommunications system may also be approved as part of the external load system, or alternatively, a limitation may be placed in the RFM or RFMS as described under paragraph c.(4)(ii)(B)(2) of this AMC. ~~For some systems, voice or hand signals to PCDS~~

~~occupants may be acceptable. For other systems and for RCL Class D operations, more sophisticated devices such as two-way radios or intercoms should be employed.~~

~~(11) CS 29.865(c)(5) Flight Manual Procedures: appropriate flight manual procedures and limitations for all HEC operations should be presented. All limitations are required to be approved for all RLCs of Class A, B, or C that employ HEC. The flight manual should clearly define the method of communication between the flight crew and the HEC. These instructions and manuals should be validated during flight testing.~~

(12) CS 29.865(c)(6) Limitations for HEC Operations: for jettisonable HEC operations, a rotorcraft may be required by operations requirements to meet the Category A engine isolation requirements of CS-29 and to have one-engine-inoperative/out-of-ground effect (OEI/OGE) hover performance capability in its approved, jettisonable HEC weight, altitude, and temperature envelope.

(i) In determining OEI hover performance, dynamic engine failures should be considered. Each hover verification test should begin from a stabilised hover at the maximum OEI hover weight, at the requested in-ground-effect (IGE) or OGE skid or wheel height, and with all engines operating. At this point, the critical engine should be failed and the aircraft should remain in a stabilised hover condition without exceeding any rotor limits or engine limits for the operating engine(s). As with all performance testing, engine power should be limited to the minimum specification power. ~~Engine failures may be simulated by rapidly moving the throttle to idle provided a 'needle split' is obtained between the rotor and engine RPM.~~

(ii) Normal pilot reaction time should be used, following the engine failure, to maintain the stabilised hover flight condition. When hovering OGE or IGE at the maximum OEI hover weight, an engine failure should not result in an altitude loss of more than 10 per cent or 4 feet, whichever is greater, of the altitude established at the time of engine failure. In either case, a sufficient power margin should be available from the operating engine(s) to regain the altitude lost during the dynamic engine failure and to transition to forward flight.

(iii) Consideration should also be given to the time required to recover (winch up and bring aboard) the ~~Class D~~ human external ~~load~~ cargo and to transition to forward flight. This time increment may limit the use of short-duration OEI power ratings. For example, for a helicopter that sustains an engine failure at a height of 40 feet, the time required to re-stabilise in a hover, recover the external load (given the hoist speed limitations), and then transition to forward flight (with minimal altitude loss) would likely preclude the use of the 30-second engine ratings and may encroach upon the 2 ½-minute ratings. Such an encroachment into the 2 ½-minute ratings is not acceptable.

~~(iv) For helicopters that incorporate engine-driven generators, the hoist should remain operational following an engine or generator failure. A hoist should not be powered from a bus that is automatically shed following the loss of an engine or generator. Maximum two-engine generator loads should be established so that~~

~~when one engine or generator fails, the remaining generator can assume the entire rotorcraft electrical load (including the maximum hoist electrical load) without exceeding the approved limitations.~~

(iv) The rotorcraft flight manual (RFM) should contain information that describes the expected altitude loss, any special recovery techniques, and the time increment used for recovery of the external load when establishing maximum weights and wheel or skid heights. The OEI hover chart should be placed in the performance section of the RFM or RFM supplement. The allowable altitude extrapolation for the hover data should not exceed 2 000 feet.

(13) For helicopters that incorporate engine-driven generators, the hoist should remain operational following an engine or generator failure. A hoist should not be powered from a bus that is automatically shed following the loss of an engine or generator. Maximum two-engine generator loads should be established so that when one engine or generator fails, the remaining generator can assume the entire rotorcraft electrical load (including the maximum hoist electrical load) without exceeding the approved limitations.

~~(13) CS 29.865(d) Flight Test Verification Work: flight test verification work (or an equivalent combination of analysis and ground testing, either in conjunction with or in addition to operating rules such as Regulation (EU) No 965/2012 on Air Operations) that thoroughly examines the operational envelope should be conducted with the external cargo carriage device for which approval is requested (especially those that involve HEC). The flight test programme should show that all aspects of the operations applied for are safe, uncomplicated, and can be conducted by a qualified flight crew under the most critical service environment and, in the case of HEC, under emergency conditions. Flight tests should be conducted for the simulated representative NHEC and HEC loads to demonstrate their in-flight handling and separation characteristics. Each placard, marking and flight manual supplement should be validated during flight testing.~~

~~(i) General. Flight testing (or an equivalent combination of analysis and testing) should be conducted under the critical combinations of configurations and operating conditions for which basic type certification approval is sought. Additional combinations of external loads and operating conditions may be subsequently approved under the relevant operational requirements as long as the structural limits and reliability considerations of the basic certification approval are not exceeded (i.e. equivalent safety is maintained). The qualification flight test work of this subparagraph is intended to be accomplished primarily by analysis or bench testing. However, at least one in-flight limit load drop test should be conducted for the critical load case. If one critical load case cannot be clearly identified, then more than one drop test might be necessary. Also, in-flight tests for the minimum load case (i.e. typically the cable hook itself) with the load trailing both in the minimum and maximum cable length configurations should be conducted. Any safety-of-flight limitations should be documented and placed in the rotorcraft flight manual (RFM). In certain low gross weight, jettisonable HEC configurations, the complex PCDS may act as a trailing aerofoil that could result in entangling the complex PCDS and the rotorcraft. These configurations should be~~

~~assessed on a case-by-case basis by analysis or flight test to assure that any safety-of-flight limitations are clearly identified and placed in the RFM.~~

~~(ii) Separation Characteristics of Jettisonable External Loads. For all jettisonable RLCs of any applicable cargo type, the satisfactory post-jettison separation characteristics of all loads should meet the following minimum criteria:~~

~~(A) Immediate 'clean' operation of the QRS, including 'clean' separate functioning of the PQRS and BQRS.~~

~~(B) No damage to the helicopter during or following actuation of the QRS and load jettisoning.~~

~~(C) A jettison trajectory clear of the helicopter.~~

~~(D) No inherent instability of the jettisonable (or just jettisoned) HEC or NHEC while in proximity to the helicopter.~~

~~(E) No adverse or uncontrollable helicopter reactions at the time of jettison.~~

~~(F) Stability and control characteristics after jettison should be within the originally approved limits.~~

~~(G) No unacceptable degradation of the helicopter performance characteristics after jettison.~~

~~(iii) Jettison Requirements for Jettisonable External Loads. For representative cargo types (low-, medium- and high-density loads on long and short lines), emergency and normal jettison procedures should be demonstrated (by a combination of analysis, ground tests, and flight tests) at sufficient combinations of flight conditions to establish a jettison envelope that should be placed in the RFM.~~

~~(iv) QRS Demonstration. Repetitive jettison demonstrations should be conducted that use the PQRS. The BQRS should be utilised at least once.~~

~~(v) QRS Reliability (i.e. failure modes) Affecting Flight Performance. The FMEA of the QRS (ref.: c(4)) should show that no single system failure will result in unsatisfactory flight characteristics, including any QRS failures that result in asymmetric loading conditions.~~

~~(vi) Flight Test Weight and CG Locations. All flight tests should be conducted at the extreme or critical combinations of weight and longitudinal and lateral CG conditions within the flight envelope that is applied for. The rotorcraft should remain within the approved weight and CG limits both with the external load applied and after jettison of the load.~~

~~(vii) Jettison Envelopes. Emergency and normal jettison demonstrations should be performed at sufficient airspeeds and decent rates to establish any restrictions for satisfactory separation characteristics. Both the maximum and minimum airspeed limits and the maximum descent rate for safe separation should be determined. The sideslip envelope as a function of airspeed should be determined.~~

~~(viii) Altitude. Emergency and normal jettison demonstrations should be performed at altitudes consistent with the approvable operational envelope and with the manoeuvring requirements necessary to overcome any adverse effects of the jettison.~~

~~(ix) Attitude. Emergency and normal jettison demonstrations should be performed from all attitudes appropriate to normal and emergency operational usage. Where the attitudes of HEC or NHEC with respect to the helicopter may vary, the most critical attitude should be demonstrated. This demonstration would normally be accomplished by bench testing.~~

~~(x) Hoist and Rescue Hook Systems or Cargo Hook Systems. An in-flight demonstration test of the hoist system should be conducted for helicopters designed to carry NHEC or HEC. The rotorcraft should be flown to the extremes of the applicable manoeuvre flight envelope and to all conditions that are critical to strength, manoeuvrability, stability, and control, or any other factor affecting its airworthiness. Unless a lesser load is determined to be more critical for either dynamic stability or other reasons, the maximum hoist system rated load or, if less, the maximum load requested for approval (and the associated limit load data placards) should be used for these tests. The minimum hoist system load (or zero load) should also be demonstrated in these tests.~~

(14) CS 29.865(e) External Loads Placards and Markings: placards and markings should be installed next to the external-load attaching means, in a clearly noticeable location, that state the primary operational limitations — specifically including the maximum authorised external load. Not all operational limitations need be stated on the placard (or equivalent markings); only those that are clearly necessary for immediate reference in operations. Other more detailed operational limitations of lesser immediate importance should be stated either directly in the RFM or in an RFM supplement.

~~(15) CS 29.865(f) Fatigue Substantiation: the fatigue evaluation of CS 29.571 should be applied as follows:~~

~~NOTE: The term 'hazard to the rotorcraft' is defined to include all hazards to either the rotorcraft, to the occupants thereof, or both.~~

~~(i) Fatigue Evaluation of NHEC Applications. Any critical components of the suspended system and their attachments (such as the cargo hook or bolted or pinned truss attachments), the failure of which could result in a hazard to the rotorcraft, should undergo an acceptable fatigue analysis in accordance with AC 29 MG 11, paragraph e.~~

~~(ii) Fatigue Evaluation of HEC Applications. The entire complex PCDS and its attachments should be reviewed on a component-by-component basis to determine which components, if any, are fatigue critical or damage intolerant. These components should be analysed or tested (per AC 27 MG 11, AC 29 MG 11, or other equivalent methods) to assure their fatigue life limits are properly determined and placed in the limited life section of the maintenance manual.~~

(15~~6~~) Other Considerations

(i) Agricultural Installations (AIs): AIs can be approved for either jettisonable or non-jettisonable NHEC or HEC operations as long as they meet relevant certification and operations requirements and follow appropriate compliance methods. However, most current AI designs are external fixtures (see definition), not external loads. External fixtures are not approvable as jettisonable external cargo because they do not have a true payload (see definition), true jettison capability (see definition), or a complete QRS. Many AI designs can dump their solid or liquid chemical loads by use of a 'purge port' release over a relatively long time period (i.e. greater than 30 seconds). This is not considered to be a true jettison capability (see definition) since the external load is not released by a QRS and since the release time span is typically greater than 30 seconds (ref.: b(20) and c(7)). Thus, these types of AIs should be approved as non-jettisonable external loads. However, other designs that have the entire AI (or significant portions thereof) attached to the rotorcraft, that have short time frame jettison (or release) capabilities provided by QRSs that meet the definitions herein and that have no post-jettison characteristics that would endanger continued safe flight and landing may be approved as jettisonable external loads. For example, if all the relevant criteria are properly met, a jettisonable fluid load can be approved as an NHEC external cargo. FAA AC 29-2C Change 7 AC 29 MG 5 discusses other AI certification methodologies.

(ii) External Tanks: external tank configurations that have true payload (see definition) and true jettison capabilities (see definition) should be approved as jettisonable NHEC. External tank configurations that have true payload capabilities but do not have true jettison capabilities should be approved as non-jettisonable NHEC. An external tank that has neither a true payload capability nor true jettison capability is an external fixture; it should not be approved as an external load under CS 29.865. If an external tank is to be jettisoned in flight, it should have a QRS that is approved for the maximum jettisonable external tank payload and is either inoperable or is otherwise rendered reliable to minimise inadvertent jettisons above the maximum jettisonable external tank payload.

(iii) Logging Operations: These operations are very susceptible to low-cycle fatigue because of the large loads and relatively high load cycles that are common to this industry. It is recommended that load-measuring devices (such as load cells) be used to assure that no unrecorded overloads occur and to assure that cycles producing high fatigue damage are properly considered. Cycle counters are recommended to assure that acceptable cumulative fatigue damage levels are identifiable and are not exceeded. As either a supplementary method or an alternate method, maintenance instructions should be considered to assure proper cycle counting and load recording during operations.

~~(17) Reserved~~

~~(18) Instructions for Continued Airworthiness. Maintenance manuals (and RFM supplements) developed by applicants for external load applications should be presented for approval and should include all appropriate inspection and maintenance procedures. The applicant~~

~~should provide sufficient data and other information to establish the frequency, extent, and methods of inspection of critical structures, systems and components. This information is required by CS 29.1529 to be included in the maintenance manual. For example, maintenance requirements for sensitive QRS squibs should be carefully determined, documented, approved during certification, and included as specific mandatory scheduled maintenance requirements that may require either 'daily' or 'pre-flight' checks (especially for HEC applications).~~

AMC No 2 to CS 29.865 EXTERNAL LOADS OPERATIONS USING SIMPLE PERSONNEL-CARRYING DEVICE SYSTEMS

[…]

Approval of Simple PCDSs

[…]

(b)

[…]

Note 5: The assembly of the different components should also consider the intended use. For example, the attachment of the tethering strap to the harness of a hoist operator should be of a DAD quick-release type to allow quick detachment from the aircraft following a ditching or emergency landing. The tethering strap should also be adjustable to take up slack and avoid shock loads being transmitted to other components.

New AMC 29.1303 is created as follows:

AMC 29.1303 Flight and navigation instruments

This AMC provides further guidance and acceptable means of compliance to supplement FAA AC 29-2C Change 7 AC 29.1303. § 29.1303 which is the EASA acceptable means of compliance, as provided for in AMC 29 General. However, some aspects of the FAA AC are deemed by EASA to be at variance with EASA's interpretation or its regulatory system. EASA's interpretation of these aspects is described below. Paragraphs of FAA AC 29.1303. § 29.1303 that are not amended below are considered to be EASA acceptable means of compliance.

a. Explanation

[...]

(2) For rotorcraft, loss of or misleading primary flight information (attitude, altitude, and airspeed) is considered to be a catastrophic failure condition in instrument meteorological conditions. For an attitude instrument to be usable, it should be capable of providing the pilot with reliable references to pitch and roll attitudes throughout the possible rotorcraft angular position and rotational operating ranges so that a pilot can correctly recognise the extent of the unusual or extreme attitude and initiate an appropriate recovery manoeuvre. As indicated previously in paragraph a., an ETSO approval does not ensure compliance with the CS-29 installation requirements, including those requirements in CS 29.1303(g)(1).

(i) The minimum usability requirements for the aircraft attitude systems are defined in CS 29.1303(g)(1). The phrase in CS 29.1303(g)(1) '…is usable through +/-80 degrees of pitch and +/-120 degrees of roll' means that the pilot should be able to quickly and accurately determine the aircraft's pitch attitudes up to 80 degrees nose up and 80 degrees nose down. The ADI should also allow the pilot to quickly and accurately determine the aircraft's roll attitude to 120 degrees of left and right roll.

(ii) The minimum usability requirement for the aircraft attitude system defined in CS 29.1303(g)(1) applies to all attitude systems installed in the aircraft. Attitude systems that do not meet the minimum usability requirements can provide misleading information to the pilot.

[…]

New AMC MG 1 is created as follows:

AMC MG 1 Certification procedure for rotorcraft avionics equipment

This AMC provides further guidance and acceptable means of compliance to supplement FAA AC 29-2C Change 7 MG 1, which is the EASA acceptable means of compliance, as provided for in AMC 29 General. Specifically, this AMC addresses aspects where the FAA AC has been deemed by EASA to be at variance with EASA's interpretation or its regulatory system. These aspects are as follows and the remaining paragraphs of FAA AC 29-2C Change 7 MG 1 that are not amended below are considered to be EASA acceptable means of compliance.

a. Pre-test Requirements

[…]

(4)

(i) Environment. An appropriate means for environmental testing is set forth in Radio Technical Commission for Aeronautics (RTCA) Document DO-160. Applicants should submit test reports showing that the laboratory-tested categories, such as temperature, vibration, altitude, etc., are compatible with the environmental demands placed on the rotorcraft. This can be achieved by determining the specific local environmental conditions in which the equipment will be installed and establishing the compatibility with the required DO-160 environmental condition.

[…]

b. Test Procedures.

[…]

(4)

[…]

(v) Localiser performance should be checked for rotor modulation in approach while varying the rotor RPM throughout its normal range.

(A) Localiser intercept. In the approach configuration and a distance of at least 10 NM from the localiser facility, fly toward the localiser front course, inbound, at an angle of at least 50 degrees. Perform this manoeuvre from both left and right of the localiser beam. No flags should appear during the period of time in which the deviation indicator moves from full deflection to on course. If the total antenna pattern has not been shown to be adequate by ground checks or by VOR flight evaluation, additional intercepts should be made. The low limits of interception should be determined.

(B) Localiser tracking. While flying the localiser inbound and not more than 5 miles before reaching the outer marker, change the heading of the rotorcraft to obtain full needle deflection. Then fly the rotorcraft to establish localiser on course operation. The localiser deviation indicators should direct the rotorcraft to the localiser on course. Perform this manoeuvre with both a left and a right needle deflection. Continue tracking the localiser until over the transmitter. Conduct at least three acceptable front, and if applicable, back course flights to 200 feet or less above the threshold.

(5)

[...]

(ii) Glideslope Intercept. The glideslope should be intercepted at both short and long distances in order to ensure correct functioning. Observe the glideslope deviation indicator for proper crossover as the aircraft flies through the glide path. No flags should appear between the times when the needle leaves the full-scale fly-up position and when it reaches the full-scale fly-down position.

[...]

(v) Glideslope performance should be sampled for rotor modulation during the approach, while varying the rotor RPM throughout its normal range.

(6)

[...]

(iii) Technical. Approach the markers at a reasonable ground speed and at an altitude of 1 000 feet above ground level. While passing over the outer and middle markers with the localiser deviation indicator centred, the annunciators should illuminate for an appropriate duration. Check that the intensity of the indicator lights is acceptable in bright sunlight and at night. For slower rotorcraft, the duration should be proportionately longer.

[...]

(12) Inertial Navigation. AC 20-138 (current version) contains the basic criteria for the engineering evaluation of an inertial navigation system (INS). Further tailoring and refinement of the guidance contained within AC 20-138 may be required by the applicant in order to make it fully applicable to the rotorcraft domain.

[...]

(18)

[...]

(iv) Flight Test.

[...]

(B) The suitable glide path angles at low speed (< 70 kt KIAS) should be evaluated for IFR certificated aircraft.

(1) Evaluate:

[...]

(ix) If the glide path angle for IFR aircraft has not been evaluated, then a limitation should be included in the rotorcraft flight manual or rotorcraft flight manual supplement. This limitation should limit IFR coupled RNAV approach operations to an appropriate and justifiably conservative glide path angle and the minimum approach airspeed that meet flight manual limitations. This is necessary until evaluations are accomplished and the determination is made that the autopilot-GPS integration supports steep-angle, low speed operations.

AMC MG 6 is amended as follows:

AMC MG 6 Emergency Medical Service (EMS) systems installations, including interior arrangements, equipment, Helicopter Terrain Awareness and Warning System (HTAWS), radio altimeter, and Flight Data Monitoring System (FDMS)

This AMC provides further guidance and acceptable means of compliance to supplement ~~the~~ FAA AC 29-2C Change ~~4~~ 7 MG 6, which is the EASA acceptable means of compliance, as provided for in AMC 29 General. ~~Specifically, this AMC addresses aspects where the FAA AC has~~ However, some aspects of the FAA AC are ~~been~~ deemed by EASA ~~as being~~ to be at variance with ~~the~~ EASA's interpretation or its regulatory system. EASA's interpretation of ~~T~~these aspects is described below. ~~are as follows and the remaining p~~Paragraphs of FAA AC 29-2C Change 7 MG 6 that are not ~~referenced~~ amended below are considered to be EASA acceptable means of compliance:

[...]

New AMC MG 16 is created as follows:

AMC MG 16 Certification guidance for rotorcraft Night Vision Imaging System (NVIS) aircraft lighting systems

This AMC provides further guidance and acceptable means of compliance to supplement FAA AC 29-2C Change 7 MG 16, which is the EASA acceptable means of compliance, as provided for in AMC 29 General. However, some aspects of the FAA AC are deemed by EASA to be at variance with EASA's interpretation or its regulatory system. EASA's interpretation of these aspects is described below. Paragraphs of FAA AC 29-2C Change 7 MG 16 that are not amended below are considered to be EASA acceptable means of compliance.

[...]

d. References (use the current versions of the following references).

(1) Regulatory (CS-29 paragraphs).

21.93	29.1321	29.1401
29.1	29.1322	29.1413
29.21	29.1331(a)(3)	29.1501
29.141(c)	29.1333	29.1523
29.561	29.1351	29.1525
29.771	29.1355	29.1529
29.773	29.1357	29.1541
29.777	29.1359	29.1543
29.779	29.1381	29.1545
29.785	29.1383	29.1549
29.803	29.1385	29.1553
29.811	29.1387	29.1555
29.812	29.1389	29.1557
29.853	29.1391	29.1559
29.1301	29.1393	29.1561
29.1303	29.1395	29.1581
29.1305	29.1397	29.1583
29.1307	29.1399	29.1585
29.1309		

(2) Other references.

Document	**Title**
FAA AC 25-11B	Electronic Flight Displays
FAA AC 20-74	Aircraft Position and Anticollision Light Measurements
FAA AC 20-88A	Guidelines on the Marking of Aircraft Powerplant Instruments (Displays)
FAA AC 20-152	RTCA, Inc., Document RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware
RTCA DO-268	Concept of Operations, Night Vision Imaging System for Civil Operators
RTCA DO-275	Minimum Operational Performance Standards for Integrated Night Vision Imaging System Equipment

SAE ARP 4754A	Certification considerations for highly-integrated or complex aircraft systems

Document	Title
SAE ARP 4761	Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment
SAE ARP 5825A	Design Requirements and Test Procedures for Dual Mode Exterior Lights
ETSO-C4c	Bank and Pitch Instruments
ETSO-C8e	Vertical Velocity Instrument (Rate-of-Climb)
ETSO-C87a	Airborne Low-Range Radio Altimeter
ETSO-C164	Night Vision Goggles (NVG)

[...]

e. Background.

[...]

(7) Night vision goggles (NVGs) enhance a pilot's night vision by amplifying certain energy frequencies. The NVGs for civil use are based on performance criteria in ETSO-C164 and RTCA Document DO-275. These NVGs are known as 'Class B NVG' because they have filters applied to the objective lenses that block energy below the wavelength of 665 nanometres (nm). The Class B objective lens filter allows more use of colour in the cockpit, with truer reds and ambers. The ETSO specifies Class B NVGs for civil use. Because NVGs will amplify energy that is not within the range of the filter, it is important that the NVIS lighting system keeps those incompatible frequencies out of the cockpit. However, there are NVGs in civil use that do not conform to the ETSO-C164 standard because they have Class A filters on their objective lenses. Class A filters block energy below the wavelength of 625 nm. As a result, Class A NVGs amplify more wavelengths of visible light, so they require special care in the use of colour in the cockpit. Applicants are advised that Class A NVGs are deemed to be not acceptable for certification by EASA.

[...]

(9) Point 21.A.91 of Annex I to Regulation (EU) No 748/2012 contains the criteria for the classification of changes to a type certificate. For NVIS approved rotorcraft, experience has shown that some changes, which are classified as being minor according to the AMC to 21.A.91 for unaided flight, may have an appreciable effect on the cockpit/cabin lighting characteristics, and thus on crew vision through the NVGs. Therefore, the classification of design changes of NVIS approved rotorcraft should take into account the effects on cockpit/cabin lighting characteristics and the NVIS.

[...]

f. Procedures.

[...]

(6) Required equipment, instrument arrangement and visibility.

(i) In addition to the instruments and equipment required for flight at night, the following additional instruments and equipment will typically be necessary for NVG operations (to be defined for each helicopter). The applicable operational regulations that specify aircraft equipment required for night and NVG operations should be reviewed.

(A) NVIS lighting.

(B) A helmet with suitable NVG mount for each pilot and crew member required to use NVGs.

(C) NVGs for each pilot and crew members required to use NVGs.

(D) Point SPA.NVIS.110(b) of Annex V (Part-SPA) to Regulation (EU) 965/2012 on air operations, and the associated AMC and GM, requires a radio altimeter with analogue representation. It is recommended that an applicant carries out a careful evaluation of the radio altimeter human-machine interface (including the presentation of height and the possibility of selecting the DH) to establish that it is able to provide the crew with the necessary information.

(E) A slip/skid indicator.

(F) A gyroscopic attitude indicator.

(G) A gyroscopic direction indicator or equivalent.

(H) Vertical speed indicator or its equivalent.

(I) Communications and navigation equipment necessary for the successful completion of an inadvertent IMC procedure in the intended area of operations.

(J) Any other aircraft or personal equipment required for the operation (e.g., curtains, NVG stowage, extra batteries for NVGs).

New AMC MG 17 is created as follows:

AMC MG 17 Guidance on analysing an Advanced Flight Controls (AdFC) System

The guidance contained within FAA AC 29-2C Change 7 MG 17 has been deemed by EASA to be at variance with EASA's interpretation or its regulatory system and therefore should not be considered to be EASA acceptable means of compliance.

New AMC MG 21 is created as follows:

AMC MG 21 Guidance on creating a system level Functional Hazard Assessment (FHA)

The guidance contained within FAA AC 29-2C Change 7 MG 21 has been deemed by EASA to be at variance with EASA's interpretation or its regulatory system and therefore should not be considered to be EASA acceptable means of compliance.

New AMC MG 23 is created as follows:

AMC MG 23 Automatic Flight Guidance and Control Systems (AFGCS) installation in CS-29 Rotorcraft

This AMC provides further guidance and acceptable means of compliance to supplement FAA AC 29-2C Change 7 MG 23, which is the EASA acceptable means of compliance, as provided for in AMC 29 General. However, some aspects of the FAA AC are deemed by EASA to be at variance with EASA's interpretation or its regulatory system. EASA's interpretation of these aspects is described below. Paragraphs of FAA AC 29-2C Change 7 MG 23 that are not amended below are considered to be EASA acceptable means of compliance.

a. Purpose.

(1) The following Radio Technical Commission for Aeronautics (RTCA) documents are considered to be guidance for showing compliance with the relevant certification specifications for the installation of automatic flight control guidance and control systems (AFGCS).

(i) RTCA Document DO-325, *Minimum Operational Performance Standards (MOPS) for Automatic Flight Guidance and Control Systems and Equipment*, issued 8 December 2010.

(ii) RTCA Document DO-336, *Guidance for Certification of Installed Automatic Flight Guidance and Control Systems (AFGCS) for Part 27/29 Rotorcraft*, issued 21 March 2012.

(2) RTCA Document DO-325 contains the minimum operational performance standards (MOPS) for AFGCS equipment. DO-336 provides guidance on obtaining installation approval of AFGCS in rotorcraft. It invokes parts of DO-325 as the performance standards that are applicable for the installation of AFGCS equipment in rotorcraft. It provides guidance on conducting a safety assessment. Lastly, DO-336 provides lists of the regulations that can be applicable to an AFGCS installation and potential methods of compliance with those regulations.

(3) The guidance contained in DO-336 and DO-325 is not mandatory and provides guidance for showing compliance with the applicable provisions of CS-29.

Note: following this guidance alone does not guarantee acceptance by EASA. EASA may require additional substantiation or design changes as a basis for finding compliance.

b. Guidance for the use of RTCA Documents DO-325 and DO-336.

RTCA Document DO-336 has two primary focus items: to highlight the requirements for a proper safety assessment (Chapter 8) and the compliance demonstration (Chapter 9).

Note: each of these should be discussed with EASA very early in the certification programme, and included in the certification plan.

c. References.

(1) CS-29 provisions

Paragraph	Title
29.671	General. (Control Systems)
29.672	Stability augmentation, automatic, and power-operated systems.
29.1309	Equipment, systems, and installations.
29.1329	Automatic pilot system.
29.1335	Flight director systems.
Appendix B to CS-29	Airworthiness Criteria for Helicopter Instrument flight

(2) AMC/ACs (available at http://rgl.faa.gov/) or https://www.easa.europa.eu/document-library/certification-specifications/group/amc-20-general-acceptable-means-of-compliance-for-airworthiness-of-products-parts-and-appliances#group-table)

AMC/AC	Title
20-115D	Airborne Software Development Assurance Using EUROCAE ED-12 and RTCA DO-178
20-138	Airworthiness Approval of Positioning and Navigation Systems
20-152	RTCA, Inc., Document RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware.
21-50	Installation of TSOA Articles and LODA Appliances
29-2C, Section 29.671	Control Systems - General.
29-2C, Section 29.672	Stability Augmentation, Automatic, and Power-Operated Systems.
29-2C, Section 29.1309	Equipment, Systems, and Installations.
29-2C, Section 29.1329	Automatic Pilot System.
29-2C, Section 29.1335	Flight Director Systems.

(3) Industry standards (RTCA documents are available at www.rtca.org and SAE international documents are available at www.sae.org):

Document	Title
RTCA/ DO-178	Software Considerations in Airborne Systems and Equipment Certification
RTCA/ DO-254	Design Assurance Guidance for Airborne Electronic Hardware
RTCA/ DO-325	Minimum Operational Performance Standards (MOPS) for Automatic Flight Guidance and Control Systems and Equipment, issued December 8, 2010.
RTCA/ DO-336	Guidance for Certification of Installed Automatic Flight Guidance and Control Systems (AFGCS) for Part 27/29 Rotorcraft, issued March 21, 2012.
SAE, International ARP 4754A	Guidelines for Development of Civil Aircraft and Systems
SAE, International ARP 4761	Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment