



**Joint Authorities for Rulemaking of Unmanned Systems
WG-3 Airworthiness**

**Certification Specification for
Light Unmanned Rotorcraft Systems
(CS-LURS)**

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BOOK 1:

AIRWORTHINESS CODE

Book 1, Subpart A – General

CS-LURS.1 Applicability

(See AMC CS-LURS.1)

This airworthiness code is applicable to Light Unmanned Rotorcraft Systems with Light Unmanned Rotorcraft maximum certified take-off weights not exceeding 750 kg.

For the purposes of CS-LURS the Light Unmanned Rotorcraft is a conventional helicopter.

In operational terms, applicability of this airworthiness code is limited to all DAY/NIGHT VFR Visual Line Of Sight Operations and excludes all human transport, flight into known icing conditions, and aerobatics.

Book 1 Subpart B – Flight

General

CS-LURS.21 Proof of compliance

Each requirement of this subpart must be met at each appropriate combination of weight and center of gravity within the range of loading conditions for which

- (a) By tests upon a rotorcraft of the type for which certification is requested, or by calculations based on, and equal in accuracy to, the results of testing; and
- (b) By systematic investigation of each required combination of weight and centre of gravity, if compliance cannot be reasonably inferred from combinations investigated.

CS-LURS. 23 Approved Operational Envelope

(See AMC CS-LURS.23)

The applicant must determine the boundaries of the approved operational envelope within which safe flight, under normal and emergency conditions, and emergency recovery capabilities will be demonstrated.

In determining this envelope, the applicant must consider environmental conditions such as wind speed, light conditions etc.

CS-LURS.25 Weight limits

- (a) *Maximum weight.* The maximum weight is the highest weight at which compliance with each applicable requirement of this CS-LURS is shown. The maximum weight must be established so that it is-
 - (1) Not more than-
 - (i) The highest weight selected by the applicant;
 - (ii) The design maximum weight, which is the highest weight at which compliance with each applicable structural loading condition of this CS-LURS is shown; or
 - (iii) The highest weight at which compliance with each applicable flight requirement of this CS-LURS is shown.
 - (2) Not less than the higher value resulting from the sum of:
 - (i) The empty weight determined under CS-LURS.29, the weight of the fuel corresponding to maximum fuel capacity, the weight of full oil capacity, and the weight of removable ballast.
- (b) *Minimum weight.* The minimum weight (the lowest weight at which compliance with each applicable requirement of this CS-LURS is shown) must be established so that it is

- (1) Not more than the empty weight determined under CS-LURS.29;
- (2) Not less than the design minimum weight at which compliance with each applicable structural loading condition and each applicable flight requirement of this CS-LURS is shown

CS-LURS.27 Centre of gravity limits

The extreme forward and aft centers of gravity and, where critical, the extreme lateral centers of gravity must be established for each weight established in CS-LURS.25. Such an extreme may not lie beyond-

- (a) The extremes selected by the applicant;
- (b) The extremes within which the structure is proven; or
- (c) The extremes within which compliance with the applicable flight requirements is shown.

CS-LURS.29 Empty weight and corresponding centre of gravity

(see AMC CS-LURS.29)

- (a) The empty weight and corresponding centre of gravity must be determined by weighing the rotorcraft without payload, unless it is part of the type design, but with-
 - (1) Fixed ballast;
 - (2) Unusable fuel determined under CS-LURS.959; and
 - (3) Full operating fluids, including-
 - (i) Oil;
 - (ii) Other fluids required for normal operation of rotorcraft systems.
- (b) The condition of the rotorcraft at the time of determining empty weight must be one that is well defined and can be easily repeated, particularly with respect to the weights of fuel, oil, coolant, and installed equipment.

CS-LURS.31 Removable ballast

Removable ballast may be used in showing compliance with the flight requirements of this Subpart.

CS-LURS.33 Main rotor speed and pitch limits

(a) Main rotor speed limits. A range of main rotor speeds must be established that-

- (1) With power-on, provides adequate margin to accommodate the variations in rotor speed occurring in any appropriate maneuver, and is consistent with the kind of governor or synchronizer used; and
- (2) With power-off, allows each appropriate auto-rotative maneuver to be performed throughout the ranges of airspeed and weight for which certification is requested.

(b) Normal main rotor high pitch limits (power on). For rotorcraft, except helicopters required to have a main rotor low speed warning under sub-paragraph (e), it must be shown, with power-on and without exceeding approved engine maximum limitations, that main rotor speeds substantially less than the minimum approved main rotor speed will not occur under any sustained flight condition. This must be met by-

- (1) Appropriate setting of the main rotor high pitch stop;
- (2) Inherent rotorcraft characteristics that make unsafe low main rotor speeds unlikely; or
- (3) Adequate means to warn the UA Pilot of unsafe main rotor speeds.

(c) Normal main rotor low pitch limits (power-off). It must be shown, with power-off, that-

- (1) The normal main rotor low pitch limit provides sufficient rotor speed, in any auto-rotative condition, under the most critical combinations of weight and airspeed; and
- (2) It is possible to prevent overspeeding of the rotor without exceptional UA Piloting skill.

(d) Emergency high pitch. If the main rotor high pitch stop is set to meet sub-paragraph (b)(1), and if that stop cannot be exceeded inadvertently, additional pitch may be made available for emergency use.

(e) Main rotor low speed warning for helicopters.

There must be a main rotor low speed warning which meets the following requirements:

- (1) The warning must be furnished to the UA Pilot in all flight conditions, including power-on and power-off flights, when the speed of a main rotor approaches a value that can jeopardize safe flight.
- (2) The warning shall be furnished by a device.
- (3) The warning must be clear and distinct under all conditions, and must be clearly distinguishable from other warnings. A visual device that requires the attention of the UA Pilot is not acceptable by itself.
- (4) The warning device must automatically deactivate and reset when the low-speed condition is corrected. If the device has an audible warning, it must also be equipped with a means for the UA Pilot to manually silence the audible warning before the low-speed condition is corrected.

PERFORMANCE

CS-LURS.45 General

- (a) Unless otherwise prescribed, the performance requirements of this Subpart must be met for still air and a standard atmosphere (at sea-level).
- (b) The performance must correspond to the engine power available under the particular ambient atmospheric conditions, based on a relative humidity of 80% and considering the particular flight condition.
- (c) The available power must correspond to engine power, not exceeding the approved power less installation losses on power absorbed by accessories.

CS-LURS.51 Take-off

- (a) The take-off, with take-off power and rpm, and at the most critical centre of gravity-
 - (1) May not require exceptional UA piloting skill or exceptionally favorable conditions; and
 - (2) Must be made in such a manner that a landing or emergency recovery procedure in accordance with CS-LURS.1412 can be made safely at any point along the flight path if any engine or motor fails.
- (b) Sub-paragraph (a) must be met throughout the ranges of altitude and weight, and the maximum take-off distance away from the UA pilot, for which certification is requested.

CS-LURS.65 Climb

The steady rate of climb must be determined at maximum continuous power:

- (a) At a speed for which certification is requested;
- (b) From sea level up to an altitude for which certification is requested;
- (c) At weights and temperatures for which certification is requested.

CS-LURS.71 Glide performance

If autorotation capability is implemented to fulfill the requirements of CS-LURS.1412, the minimum rate of descent airspeed and the best angle-of-glide airspeed must be determined in autorotation at-

- (a) Maximum weight; and
- (b) Rotor speed(s) selected by the applicant.

CS-LURS.73 Performance at minimum operating speed

- (a) The hovering ceiling must be determined, over the ranges of weight, altitude and temperature for which certification is requested, with -
 - (1) Take-off power;
 - (2) The helicopter in ground effect at a height consistent with normal take-off procedures; and
- (b) The hovering ceiling determined under subparagraph (a) must be at least 915m (3000 ft) at maximum weight with a standard atmosphere.

CS-LURS.75 Landing

- (a) The rotorcraft must be able to be landed safely with no excessive vertical acceleration, no tendency to bounce, nose over, ground loop, porpoise, or water loop, and without exceptional UA Piloting skill or exceptionally favorable conditions, with
 - 1) Approach or glide speeds appropriate to the type of rotorcraft and selected by the applicant;
 - 2) With one engine inoperative
- (b) Sub-paragraph (a) must be met at the maximum landing distance away from the UA pilot for which certification is requested.

CS-LURS.79 Limiting height-speed envelope

- (a) If there is any combination of height and forward speed (including hover) under which a safe landing or flight termination cannot be made under applicable power failure condition in sub-paragraph (b), a limiting height-speed envelope must be established (including all pertinent information) for that condition, throughout the ranges of-
 - (1) Altitude, from standard sea level conditions to the maximum altitude capability of the rotorcraft, or 2134m (7000 ft), whichever is less; and
 - (2) Weight, from the maximum weight (at sea-level) to the lesser weight selected by the applicant for each altitude covered by sub-paragraph (a)(1). The weight at

altitudes above sea-level may not be less than the maximum weight or the highest weight allowing hovering out of ground effect whichever is lower.

(b) The applicable power failure conditions are:

- (1) For single-engine helicopters, full autorotation;
- (2) For multiengine helicopters, one engine inoperative (where engine isolation features ensure continued operation of the remaining engines); and the remaining engines at the greatest power for which certification is requested; and
- (3) For other rotorcraft, conditions appropriate to the type.

FLIGHT CHARACTERISTICS

CS-LURS.141 General

The rotorcraft must -

(a) Except as specifically required in the applicable paragraph, meet the flight characteristics requirements of this Subpart-

- (1) At the altitudes and temperatures expected in operation;
- (2) Under any critical loading condition within the range of weights and centers of gravity for which certification is requested;
- (3) For power-on operations, under any condition of speed and rotor rpm for which certification is requested; and
- (4) For power-off operations, under any condition of speed and rotor rpm for which certification is requested that is attainable with the controls rigged in accordance with the approved rigging instructions and tolerances.

(b) Be able to maintain any required flight condition and make a smooth transition from any flight condition to any other flight condition without exceptional UA Piloting skill, alertness, or strength, and without danger of exceeding the limit load factor under any operating condition probable for the type, including sudden complete power failure.

CS-LURS.143 Controllability and maneuverability

(see AMC CS-LURS.143 controllability and maneuverability)

(a) The rotorcraft must be safely controllable and maneuverable-

- (1) During steady flight; and
- (2) During any maneuver appropriate to the type, including-
 - (i) Take-off;
 - (ii) Climb;
 - (iii) Level flight;

- (iv) Turning flight;
- (v) Glide;
- (vi) Landing (power-on),; and
- (vii) Recovery to power-on flight from a balked auto-rotative approach, and
- (viii) Landing (one engine power off),.

(b) The Flight Control System (FCS) must allow satisfactory roll and pitch control at V_{NE} with-

- (1) Critical weight;
- (2) Critical centre of gravity;
- (3) Critical rotor rpm; and
- (4) One engine Power off and power-on.

(c) A wind velocity of not less than 31 km/h (17 kts) must be established in which the rotorcraft can be operated without loss of control on or near the ground in any maneuver appropriate to the type (such as crosswind take-offs, sideward flight, and rearward flight) with-

- (1) Critical weight;
- (2) Critical centre of gravity;
- (3) Critical rotor rpm
- (4) Altitude from standard sea level conditions to the maximum altitude for which landing and takeoff certification is sought.

(d) Unless the total loss of all engines required for the controllability of the RPAS is shown to be extremely improbable in accordance with AMC CS-LURS.1309, the rotorcraft, , must be controllable over the range of speeds and altitudes for which certification is requested when such power failure occurs with maximum continuous power and critical weight. No corrective action time delay for any condition following power failure may be less than-

- (1) For the cruise condition, one second, or normal pilot reaction time (whichever is greater); and
- (2) For any other condition, normal pilot reaction time.

CS-LURS.171 Stability

(see AMC CS-LURS.171 Stability)

The rotorcraft must be able to be flown, without undue UA Pilot fatigue or strain, in any normal manoeuvre for a period of time as long as that expected in normal operation. At least three landings and take-offs must be made during this demonstration.

(a) The UAV in all its operating modes, both augmented by the Flight Control System (FCS) and in manual direct piloting conditions (where applicable), including the effects of sensor and computational errors and delays, must be longitudinally, directionally and laterally stable in any condition normally encountered in service, at any combination of weight and centre of gravity for which certification is requested.

- (b) Transient response in all axes during transition between different flight conditions and FCS flight modes must be smooth, convergent, and exhibit damping characteristics with minimal overshoot of the intended flight path.
- (c) In addition to data obtained by computation or modeling, stability analysis must be supported by the results of relevant flight tests.
- (d) Stability also must be assessed in manual direct piloting conditions (where applicable), taking due account of data-link latencies.
- (e) Pilot induced oscillation (PIO) tendencies must be safe, with particular consideration to manual direct piloting conditions flight characteristics (where applicable).

GROUND AND WATER HANDLING CHARACTERISTICS

CS-LURS.231 General

The rotorcraft must have satisfactory ground and water handling characteristics, including freedom from uncontrollable tendencies in any condition expected in operation.

CS-LURS.239 Spray characteristics

If certification for water operation is requested, no spray characteristics during taxiing, take-off, or landing may obscure the vision of the UA Pilot or damage the rotors, propellers, or other parts of the rotorcraft.

CS-LURS.241 Ground resonance

The rotorcraft may have no dangerous tendency to oscillate on the ground with the rotor turning.

BOOK 1 SUBPART C - STRENGTH REQUIREMENTS
GENERAL
<p>CS-LURS.301 Loads</p> <p>(a) Strength requirements are specified in terms of limit loads (the maximum loads to be expected in service) and ultimate loads (limit loads multiplied by prescribed factors of safety). Unless otherwise provided, prescribed loads are limit loads.</p> <p>(b) Unless otherwise provided, the specified air, ground, and water loads must be placed in equilibrium with inertia forces, considering each item of mass in the rotorcraft. These loads must be distributed to closely approximate or conservatively represent actual conditions.</p> <p>(c) If deflection under load would significantly change the distribution of external or internal loads, this redistribution must be taken into account.</p>
<p>CS-LURS.302 Interaction of systems and structures (see Appendix C)</p> <p>For rotorcraft equipped with systems that affect structural performance, either directly or as a consequence of a failure or malfunction, the influence of these systems and their failure conditions must be taken into account when showing compliance with the requirements of Subparts C and D. Appendix C of CS-LURS must be used to evaluate the structural performance of rotorcraft equipped with these systems.</p>
<p>CS-LURS.303 Factor of safety</p> <p>Unless otherwise provided, a factor of safety of 1.5 must be used. This factor applies to external and inertia loads unless its application to the resulting internal stresses is more conservative.</p>
<p>CS-LURS.305 Strength and deformation</p> <p>(a) The structure must be able to support limit loads without detrimental permanent deformation. At any load up to limit loads, the deformation may not interfere with safe operation.</p> <p>(b) The structure must be able to support ultimate loads without failure. This must be shown by-</p> <p style="padding-left: 20px;">(1) Applying ultimate loads to the structure in a static test for at least 3 seconds; or</p>

(2) Dynamic tests simulating actual load application.

CS-LURS.307 Proof of structure

(See AMC CS-LURS.307)

- (a) Compliance with the strength and deformation requirements of this Subpart must be shown for each critical loading condition accounting for the environment to which the structure will be exposed in operation. Structural analysis (static or fatigue) may be used only if the structure conforms to those structures for which experience has shown this method to be reliable. In other cases, substantiating load tests must be made. (See AMC LURS 307(a))
- (b) Proof of compliance with the strength requirements of this Subpart must include -
- (1) Dynamic and endurance tests of rotors, rotor drives, and rotor controls;
 - (2) Limit load tests of the control system, including control surfaces;
 - (3) Operation tests of control system;
 - (4) Flight stress measurement tests; and
 - (5) Any additional tests required for new or unusual design features.

CS-LURS.309 Design limitations

The following values and limitations must be established to show compliance with the structural requirements of this Subpart:

- (a) The design maximum weight.
- (b) The main rotor rpm ranges power-on and power-off.
- (c) The maximum forward speeds for each main rotor rpm within the ranges determined in sub-paragraph (b).
- (d) The maximum rearward and sideward flight speeds.
- (e) The centre of gravity limits corresponding to the limitations determined in sub-paragraphs (b), (c), and (d).

- (f) The rotational speed ratios between powerplant and each connected rotating component.
- (g) The positive and negative limit manoeuvring load factors.

FLIGHT LOADS

CS-LURS.321 General

- (a) The flight load factor must be assumed to act normal to the longitudinal axis of the rotorcraft, and to be equal in magnitude and opposite in direction to the rotorcraft inertia load factor at the centre of gravity.
- (b) Compliance with the flight load requirements of this Subpart must be shown-
 - (1) At each weight from the design minimum weight to the design maximum weight; and
 - (2) With any practical distribution of disposable load within the operating limitations in the Flight Manual.

CS-LURS.337 Limit manoeuvring load factor

The rotorcraft must be designed for-

- (a) A limit manoeuvring load factor ranging from a positive limit of 3.5 to a negative limit of -1.0; or
- (b) Any positive limit manoeuvring load factor not less than 2.0 and any negative limit manoeuvring load factor of not less than -0.5 for which-
 - (1) The probability of being exceeded is shown by analysis and flight tests to be extremely remote; and
 - (2) The selected values are appropriate to each weight condition between the design maximum and design minimum weights.

CS-LURS.339 Resultant limit manoeuvring loads

The loads resulting from the application of limit manoeuvring load factors are assumed to act at the centre of each rotor hub and each auxiliary lifting surface, and to act in directions, and with distributions of load among the rotors and auxiliary lifting surfaces, so as to represent each critical manoeuvring condition, including power-on and power-off flight with the maximum design rotor tip speed ratio. The rotor tip speed ratio is the ratio of the rotorcraft flight velocity component in the plane of the rotor disc to the rotational tip speed of the rotor blades, and is expressed as follows:

$$\mu = \frac{V \cos \alpha}{\Omega R}$$

where-

V = The airspeed along the flight path (m/s);

a = The angle between the projection, in the plane of symmetry, of the axis of no feathering and a line perpendicular to the flight path (radians, positive when the axis is pointing aft);

Ω = The angular velocity of the rotor (radians per second); and

R = The rotor radius (m).

CS-LURS.341 Gust loads

(see FAA AC-27-1B)

The rotorcraft must be designed to withstand, at each critical airspeed including hovering, the loads resulting from a vertical gust of 9.1 m/s (30 ft/s).

CS-LURS.351 Yawing conditions

(a) Each rotorcraft must be designed for the loads resulting from the manoeuvres specified in subparagraphs (b) and (c) with-

- (1) Unbalanced aerodynamic moments about the centre of gravity which the aircraft reacts to in a rational or conservative manner considering the principal masses furnishing the reacting inertia forces; and
- (2) Maximum main rotor speed.

(b) To produce the load required in sub-paragraph (a), in unaccelerated flight with zero yaw, at forward speed from zero up to $0.6 V_{NE}$ -

- (1) Displace the directional control suddenly to the maximum deflection limited by the control stop or by the actuator force specified in CS-LURS.395(a);
- (2) Attain a resulting sideslip angle or 90° , whichever is less; and
- (3) Return the directional control suddenly to neutral.

(c) To produce the load required in sub-paragraph (a), in unaccelerated flight with zero yaw, at forward speeds from $0.6 V_{NE}$ up to V_{NE} or V_H , whichever is less-

- (1) Displace the directional control suddenly to the maximum deflection limited by the control stops or by the actuator force specified in CS-LURS.395 (a);
- (2) Attain a resulting sideslip angle or 15° , whichever is less, at the lesser speed of V_{NE} or V_H .
- (3) Vary the sideslip angles of sub-paragraphs (b)(2) and (c)(2) directly with speed; and
- (4) Return the directional control suddenly to neutral.

CS-LURS.361 Engine torque

(see AMC CS-LURS.361)

- (a) The limit torque may not be less than -
- (1) For four- stroke engines- the mean torque for maximum continuous power multiplied by
 - (i) 1.33, for engines with five or more cylinders; and
 - (ii) 2, 3, 4 or 8, for engines with four, three, two or one cylinder, respectively.
 - (2) For two- stroke engines- the mean torque for maximum continuous power multiplied by
 - (i) 2 for engines with three or more cylinders,
 - (ii) 3, or 6, for engines with two or one cylinder, respectively.
 - (3) For rotary engines- the mean torque for maximum continuous power multiplied by:
 - (i) 1.33 for engines with three or more discs
 - (ii) 2, or 4, for engines with two or one disc, respectively
 - (4) For turbine engines: the mean torque for maximum continuous power multiplied by 1.25
 - (5) For electrical engines: the maximum peak torque to be expected in the complete engine speed range.

CONTROL SURFACE AND SYSTEM LOADS

CS-LURS.391 General

Each auxiliary rotor, each fixed or movable stabilizing or control surface, and each system operating any flight control must meet the requirements of CS-LURS.395, -411, and -427.

CS-LURS.395 Control system

- (a) The part of each control system from the actuator to the control stops must be designed to withstand forces resulting from maximum loads and torques generated by the actuating system.
- (b) Each primary control system, including its supporting structure, must be designed as follows:
- (1) to withstand forces resulting from maximum loads and torques generated by the actuating system;
 - (2) (Reserved);
 - (3) If the system design or the normal operating loads are such that a part of the system cannot react to the limit forces prescribed in (b)of this subpart, that part of the system must be designed to withstand the maximum loads that can be obtained in normal operation. The minimum design loads must, in any case, provide a rugged system for service use, including consideration of fatigue, jamming, ground gusts, control inertia and friction loads. In the absence of rational analysis, the design loads resulting from 0.60 of the specified forces in (b)of this subpart are acceptable minimum design loads.

(4) If operational loads may be exceeded through jamming, ground gusts, control inertia, or friction, the control system must withstand these loads, without yielding.

CS-LURS.411 Ground clearance: anti- torque device guard

(a) It must be impossible for the anti-torque device to contact the landing surface during a normal landing.

(b) If a guard is required to show compliance with sub-paragraph (a) -

(1) Suitable design loads must be established for the guard; and

(2) The guard and its supporting structure must be designed to withstand those loads.

CS-LURS.427 Unsymmetrical loads

(a) Horizontal tail surfaces and their supporting structure must be designed for unsymmetrical loads arising from yawing and rotor wake effects in combination with the prescribed flight conditions.

(b) To meet the design criteria of sub-paragraph (a), in the absence of more rational data, both of the following must be met:

(1) 100 % of the maximum loading from the symmetrical flight conditions acts on the surface on one side of the plane of symmetry and no loading acts on the other side.

(2) 50 % of the maximum loading from the symmetrical flight conditions acts on the surface on each side of the plane of symmetry but in opposite directions.

(c) For empennage arrangements where the horizontal tail surfaces are supported by the vertical tail surfaces, the vertical tail surfaces and supporting structure must be designed for the combined vertical horizontal surface loads resulting from each prescribed flight condition, considered separately. The flight conditions must be selected so the maximum design loads are obtained on each surface. In the absence of more rational data, the unsymmetrical horizontal tail surface loading distributions described in this paragraph must be assumed.

CS-LURS.471 General

(a) *Loads and equilibrium.* For limits ground loads-

(1) The limit ground loads obtained in the landing conditions in this Subpart must be considered to be external loads that would occur in the rotorcraft structure if it were acting as a rigid body; and

(2) In each specified landing condition, the external loads must be placed in equilibrium with linear and angular inertia loads in a rational or conservative manner.

(c) *Critical centers of gravity.* The critical centers of gravity within the range for which certification is requested must be selected so that the maximum design loads are obtained in each landing gear element.

CS-LURS.473 Ground loading conditions and assumptions

- (a) For specified landing conditions, a design maximum weight must be used that is not less than the maximum weight. Rotor lift may be assumed to act through the centre of gravity throughout the landing impact. This lift may not exceed two-thirds of the design maximum weight.
- (b) Unless otherwise prescribed, for each specified landing condition, the rotorcraft must be designed for a limit load factor of not less than the limit inertia load factor substantiated under CS-LURS.725.

CS-LURS.475 Shock absorbers

Unless otherwise prescribed, for each specified landing condition, the shock absorbers must be assumed to be in their most critical position.

CS-LURS.501 Ground loading conditions: landing gear with skids

- (a) *General.* Rotorcraft with landing gear with skids must be designed for the loading conditions specified in this paragraph. In showing compliance with this paragraph, the following apply:
- (1) The design maximum weight, centre of gravity, and load factor must be determined in CS-LURS.471 to 475.
 - (2) Structural yielding of elastic spring members under limit loads is acceptable.
 - (3) Design ultimate loads for elastic spring members need not exceed those obtained in a drop test of the gear with-
 - (i) A drop height of 1.5 times that specified in CS-LURS.725; and
 - (ii) An assumed rotor lift of not more than 1.5 times that used in the limit drop tests prescribed in CS-LURS.725.
 - (4) Compliance with sub-paragraphs (b) to (e) must be shown with-
 - (i) The gear in its most critically deflected position for the landing condition being considered; and
 - (ii) The ground reactions rationally distributed along the bottom of the skid tube.
- (b) *Vertical reactions in the level landing attitude.* In the level attitude, and with the rotorcraft contacting the ground along the bottom of both skids, the vertical reactions must be applied as prescribed in sub-paragraph (a).
- (c) *Drag reactions in the level landing attitude.* In the level attitude, and with the rotorcraft contacting the ground along the bottom of both skids, the following apply:
- (1) The vertical reactions must be combined with horizontal drag reactions of 50 % of the vertical reaction applied at the ground
 - (2) The resultant ground loads must equal the vertical load specified in sub-paragraph (b).
- (d) *Side loads in level landing attitude.* In the level attitude, and with the rotorcraft contacting the ground along the bottom of both skids, the following apply:

- (1) The vertical ground reaction must be-
 - (i) Equal to the vertical loads obtained in the condition specified in sub-paragraph (b); and
 - (ii) Divided equally among the skids.
- (2) The vertical ground reactions must be combined with a horizontal side load of 25 % of their value.
- (3) The total side load must be applied equally between the skids and along the length of the skids.
- (4) The unbalanced moments are assumed to be resisted by angular inertia.
- (5) The skid gear must be investigated for-
 - (i) Inward acting side-loads; and
 - (ii) Outward acting side-loads.

(e) *One-skid landing loads in the level attitude.* In the level attitude, and with the rotorcraft contacting the ground along the bottom of one skid only, the following apply:

- (1) The vertical load on the ground contact side must be the same as that obtained on that side in the condition specified in sub-paragraph (b).
- (2) The unbalanced moments are assumed to be resisted by angular inertia.

(f) *Special conditions.* In addition to the conditions specified in sub-paragraphs (b) and (c), the rotorcraft must be designed for the following ground reactions:

- (1) A ground reaction load acting up and aft at an angle of 45° to the longitudinal axis of the rotorcraft. This load must be-
 - (i) Equal to 1.33 times the maximum weight;
 - (ii) Distributed symmetrically among the skids;
 - (iii) Concentrated at the forward end of the straight part of the skid tube; and
 - (iv) Applied only to the forward end of the skid tube and its attachment to the rotorcraft.
- (2) With the rotorcraft in the level landing attitude, a vertical ground reaction load equal to one-half of the vertical load determined in sub-paragraph (b). This load must be-
 - (i) Applied only to the skid tube and its attachment to rotorcraft; and
 - (ii) Distributed equally over 33.3 % of the length between the skid tube attachments and centrally located midway between the skid tube attachments.

CS-LURS.505 Ski landing conditions

If certification for ski operation is requested, the rotorcraft, with skis, must be designed to withstand the following loading conditions (where P, is the maximum static load in N on each ski with the rotorcraft at design maximum weight, and n, is the limit load factor determined under CS-LURS.473 (b)).

(a) Up-load conditions in which-

- (1) A vertical load of P_n , and a horizontal load of $P_n/4$ are simultaneously applied at the pedestal bearings; and
- (2) A vertical load of 1.33 P is applied at the pedestal bearings.

- (b) A side-load condition in which a side load of $0.35 P_n$ is applied at the pedestal bearings in a horizontal plane perpendicular to the centerline of the rotorcraft.
- (c) A torque-load condition in which a torque load of $1.33 P$ in Nm is applied to the ski about the vertical axis through the centerline of the pedestal bearings.

WATER LOADS

CS-LURS.521 Float landing conditions

If certification for float operation is requested, the rotorcraft, with floats, must be designed to withstand the following loading conditions (where the limit load factor is determined under CS-LURS.473(b)):

- (a) Up-load conditions in which-
 - (1) A load is applied so that, with the rotorcraft in the static level attitude, the resultant water reaction passes vertically through the centre of gravity; and
 - (2) The vertical load prescribed in subparagraph (a)(1) is applied simultaneously with an aft component of 0.25 times the vertical component.
- (b) A side-load condition in which-
 - (1) A vertical load of 0.75 times the total vertical load specified in sub-paragraph (a)(1) is divided equally among the floats; and
 - (2) For each float, the load share determined in sub-paragraph (b)(1), combined with a total side load of 0.25 times the total vertical load specified in sub-paragraph (b)(1), is applied to the float only.

MAIN COMPONENT REQUIREMENTS

CS-LURS.547 Main rotor structure

- (a) Each main rotor assembly (including rotor hubs and blades) must be designed as prescribed in this paragraph. (See AMC LURS.547(a))
- (b) (Reserved)
- (c) The main rotor structure must be designed to withstand the following loads prescribed in CS-LURS.337 to -341:
 - (1) Critical flight loads.
 - (2) Limit loads occurring under normal conditions of autorotation. For this condition, the rotor rpm must be selected to include the effects of altitude.
- (d) The main rotor structure must be designed to withstand loads simulating-
 - (1) For the rotor blades, hubs, and flapping hinges, the impact force of each blade against its stop during ground operation; and
 - (2) Any other critical condition expected in normal operation.
- (e) The main rotor structure must be designed to withstand the limit torque at any rotational speed including zero. In addition-

- (1) The limit torque need not be greater than the torque defined by a torque limiting device (where provided), and may not be less than the greater of-
 - (i) The maximum torque likely to be transmitted to the rotor structure in either direction; and
 - (ii) The limit engine torque specified in CS-LURS.361.
- (2) The limit torque must be distributed to the rotor blades in a rational manner.

CS-LURS.549 Fuselage, landing gear, rotor pylon and engine structures

(see AMC LURS 549(b)(1))

- (a) Each fuselage, landing gear, rotor pylon and engine structure must be designed as prescribed in this paragraph. Resultant rotor forces may be represented as a single force applied at the rotor hub attachment point.
- (b) Each structure must be designed to withstand-
 - (1) The critical loads prescribed in CS-LURS.337 to -341; (see AMC LURS 549(b)(1))
 - (2) The applicable ground loads prescribed in CS-LURS.471, -473, -501, -505, and -521; and
 - (3) The loads prescribed in CS-LURS.547(d) and (e).
- (c) Auxiliary rotor thrust, and the balancing air and inertia loads occurring under accelerated flight conditions, must be considered.
- (d) The engine mount and adjacent fuselage structure must be designed to withstand the loads occurring under accelerated flight and landing conditions, including engine torque.

CS-LURS.561 Crashworthiness

(see AMC to CS-LURS.561(b) and (c))

- (a) Performance data shall be provided to allow the operator to establish the appropriate predefined and unpopulated forced landing areas, unless the RPAS is fitted with a FTS as prescribed in CS-LURS.1412(a)(1).
- (b) When a forced landing area identified under CS-LURS.1412(a)(2) is chosen for compliance with CS-LURS.1412, the rotorcraft, although it may be damaged in emergency landing conditions, must be designed as prescribed in subparagraphs (c) of this paragraph to protect third parties on ground under those conditions.
- (c) The rotorcraft must include self-containment features as much as practical and must be designed so that –
 - (1) projection of parts (items of mass to be considered include, but are not limited to, rotors, transmissions, engines and payloads) that may constitute a potential injury to third parties, outside the forced landing area, is unlikely,
 - (2) the rotorcraft does not constitute a source of ignition or leak of flammable fluids in hazardous quantities in case of an emergency forced landing, and,
 - (3) any explosion after the forced landing must not constitute a hazard for third parties outside the forced landing area

FATIGUE EVALUATION

CS-LURS.571 Fatigue evaluation of flight structure

(see AMC to CS-LURS.571)

- (a) General. Each portion of the flight structure (the flight structure includes rotors, rotor drive systems between the engines and the rotor hubs, controls, fuselage, landing gear and their related primary attachments) the failure of which could be catastrophic, must be identified and must be evaluated in subparagraph (b), (c). The following apply to each fatigue evaluation:
- (1) The procedure for the evaluation must be approved.
 - (2) The locations of probable failure must be determined.
 - (3) In-flight measurement must be included in determining the following:
 - (i) Loads or stresses in all critical conditions throughout the range of limitations in CS-LURS.309, except that manoeuvring load factors need not exceed the maximum values expected in operation.
 - (ii) The effect of altitude upon these loads or stresses.
 - (4) The loading spectra must be as severe as those expected in operation including ground-air-ground cycles. The loading spectra must be based on loads or stresses determined in sub-paragraph (a)(3).
- (b) Fatigue tolerance evaluation. It must be shown that the fatigue tolerance of the structure ensure that the probability of catastrophic fatigue failure is extremely remote without establishing replacement times, inspection intervals or other procedures in paragraph A.LURS.4 of Appendix A.
- (c) *Replacement time evaluation.* It must be shown that the probability of catastrophic fatigue failure is extremely remote within a replacement time furnished in paragraph A.LURS.4 of Appendix A.

BOOK 1 SUBPART D - DESIGN AND CONSTRUCTION

GENERAL

CS-LURS.601 Design

- (a) The rotorcraft may have no design features or details that experience has shown to be hazardous or unreliable.
- (b) The suitability of each questionable design detail and part must be established by tests.

CS-LURS.602 Critical parts

(See AMC CS-LURS.602)

- (a) A critical part is a part, the failure of which could have a catastrophic effect upon the rotorcraft, and for which critical characteristics have been identified which must be

controlled to ensure the required level of integrity.

- (b) If the type design includes critical parts, a critical parts list shall be established. Procedures shall be established to define the critical design characteristics, identify processes that affect those characteristics, and identify the design change and process change controls necessary for showing compliance with the quality assurance requirements of Part-21. (See AMC CS-LURS.602)

CS-LURS.603 Materials

The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must -

- (a) Be established on the basis of experience or tests;
- (b) Meet approved specifications that ensure their having the strength and other properties assumed in the design data; and
- (c) Take into account the effects of environmental conditions, such as temperature and humidity, expected in service.

CS-LURS.605 Fabrication methods

- (a) The methods of fabrication used must produce consistently sound structures. If a fabrication process, such as gluing, spot welding, or heat-treating, requires close control to reach this objective, the process must be performed according to an approved process specification.
- (b) Each new aircraft fabrication method must be substantiated by a test program.

CS-LURS.607 Fasteners

- (a) Each removable bolt, screw, nut, pin, or other fastener whose loss could jeopardize the safe operation of the rotorcraft must incorporate two separate locking devices. The fastener and its locking devices may not be adversely affected by the environmental conditions associated with the particular installation.
- (b) No self-locking nut may be used on any bolt subject to rotation in operation unless a non-friction locking device is used in addition to the self-locking device.

CS-LURS.609 Protection of structure

Each part of the structure must-

- (a) Be suitably protected against deterioration or loss of strength in service due to any cause, including-
 - (1) Weathering;
 - (2) Corrosion; and

(3) Abrasion; and

(b) Have provisions for ventilation and drainage where necessary to prevent the accumulation of corrosive, flammable, or noxious fluids.

CS-LURS.611 Inspection provisions

There must be means to allow the close examination of each part that requires-

- (a) Recurring inspection;
- (b) Adjustment for proper alignment and functioning;
- (c) Lubrication. or
- (d) Rigging and de-rigging.

CS-LURS.613 Material strength properties and design values

(See AMC CS-LURS.613)

- (a) Material strength properties must be based on enough tests of material meeting specifications to establish design values on a statistical basis.
- (b) The design values must be chosen so that the probability of any structure being under-strength because of material variations is extremely remote. (See AMC CS-LURS.613(b).)
- (c) Where the temperature attained in an essential component or structure in normal operating conditions has a significant effect on strength, that effect must be taken into account. (See AMC CS-LURS.613(c).)

CS-LURS.615 Design properties

(See AMC CS-LURS.615)

- (a) Design properties may be used subject to the following conditions:
 - (1) Where applied loads are eventually distributed through a single member within an assembly, the failure of which would result in the loss of the structural integrity of the component involved, the guaranteed minimum design mechanical properties ("A" values) must be met.
 - (2) Redundant structures, in which the failure of the individual elements would result in applied loads being safely distributed to other load carrying members, may be designed on the basis of the 90 % probability ("B" values).
 - (3) "A" and "B" values are defined as follows:
 - (i) An "A" value is a value above which at least 99 % of the population of values is expected to fall with a confidence of 95 %.
 - (ii) A "B" value is a value above which at least 90 % of the population of values is expected to fall with a confidence of 95 %.
- (b) Design values greater than the guaranteed minimums required by sub-paragraph (a) may be used if a "premium selection" of the material is made in which a specimen of

each individual item is tested before use to determine that the actual strength properties of that particular item will equal or exceed those used in design.

(c) Material correction factors for structural items such as sheets, sheet-stringer combinations, and riveted joints, may be omitted if sufficient test data are obtained to allow a probability analysis showing that 90 % or more of the elements will equal or exceed allowable selected design values. (See AMC CS-LURS 615.)

CS-LURS.619 Special factors

The factor of safety prescribed in CS-LURS.303 must be multiplied by the highest pertinent special factors prescribed in CS-LURS.621 to -625 for each part of the structure whose strength is -

- (a) Uncertain;
- (b) Likely to deteriorate in service before normal replacement; or
- (c) Subject to appreciable variability because of uncertainties in manufacturing processes or inspection methods. For composite structures, a special test factor which takes into account material variability and the effects of temperature and absorption of moisture shall be used.

CS-LURS.621 Casting factors

For castings, the strength of which is substantiated by at least one static test and which are inspected by visual methods, a casting factor of 2.0 must be applied. This factor may be reduced to 1.25 providing the reduction is substantiated by tests on not less than three sample castings and all production castings are subjected to an approved visual and radiographic inspection or an approved equivalent nondestructive inspection methods.

CS-LURS.623 Bearing factors

- (a) Except as provided in sub-paragraph (b), each part that has clearance (free fit), and that is subject to pounding or vibration, must have a bearing factor large enough to provide for the effects of normal relative motion.
- (b) No bearing factor need be used on a part for which any larger special factor is prescribed.

CS-LURS.625 Fitting factors

For each fitting (part or terminal used to join one structural member to another) the following apply:

- (a) For each fitting whose strength is not proven by limit and ultimate load tests in which actual stress conditions are simulated in the fitting and surrounding structures, a fitting factor of at least 1.15 must be applied to each part of-
 - (1) The fitting;

- (2) The means of attachment; and
- (3) The bearing on the joined members.

(b) No fitting factor need be used for joint designs based on comprehensive test data (such as continuous joints in metal plating, welded joints, and scarf joints in wood).

(c) For each integral fitting, the part must be treated as a fitting up to the point at which the paragraph properties become typical of the member.

CS-LURS.629 Flutter

(See AMC CS-LURS.629)

Each aerodynamic surface of the rotorcraft must be free from flutter under each appropriate speed and power condition.

ROTORS

CS-LURS.653 Pressure venting and drainage of rotor blades

(a) For each rotor blade-

- (1) There must be means for venting the internal pressure of the blade;
- (2) Drainage holes must be provided for the blade; and
- (3) The blade must be designed to prevent water from becoming trapped in it.

(b) Sub-paragraphs (a)(1) and (a)(2) do not apply to sealed rotor blades capable of withstanding the maximum pressure differentials expected in service.

CS-LURS.659 Mass balance

(a) The rotors and blades must be mass balanced as necessary to-

- (1) Prevent excessive vibration; and
- (2) Prevent flutter at any speed up to the maximum forward speed.

(b) The structural integrity of the mass balance installation must be substantiated.

CS-LURS.661 Rotor blade clearance

There must be enough clearance between the rotor blades and other parts of the structure to prevent the blades from striking any part of the structure during any operating

condition.
<p>CS-LURS.663 Ground resonance prevention means</p> <p>(a) The reliability of the means for preventing ground resonance must be shown either by analysis and tests, or reliable service experience, or by showing through analysis or tests that malfunction or failure of a single means will not cause ground resonance.</p> <p>(b) The probable range of variations, during service, of the damping action of the ground resonance prevention means must be established and must be investigated during the test required by CS-LURS.241.</p>
CONTROL SYSTEMS
<p>CS-LURS.671 General</p> <p>(a) Each control and control system must operate with the ease, smoothness, and positiveness appropriate to its function.</p> <p>(b) Each element of each flight control system must be designed, or distinctively and permanently marked, to minimize the probability of any incorrect assembly that could result in the malfunction of the system.</p>
<p>CS-LURS.673 Primary flight control</p> <p>Primary flight controls are those used for immediate control of pitch, roll, yaw, and vertical motion of the rotorcraft.</p>
<p>CS-LURS.674 Interconnected controls</p> <p>Each primary flight control system must provide for safe flight and landing and operate independently after a malfunction, failure, or jam of any auxiliary interconnected control.</p>
<p>CS-LURS.675 Stops</p> <p>(a) Each control system must have stops that positively limit the range of motion of the controls.</p> <p>(b) Each stop must be located in the system so that the range of travel of its control is not appreciably affected by-</p> <ol style="list-style-type: none"> (1) Wear; (2) Slackness; or (3) Take-up adjustment.

(c) Each stop must be able to withstand the loads corresponding to the design conditions for the system.

(d) For each main rotor blade-

- (1) Stops that are appropriate to the blade design must be provided to limit travel of the blade about its hinge points; and
- (2) There must be means to keep the blade from hitting the droop stops during any operation other than starting and stopping the rotor.

CS-LURS.679 Control system locks

If there is a device to lock the control system with the rotorcraft on the ground or water, there must be means to-

- (a) Give unmistakable warning to the UA Pilot when the lock is engaged; and
- (b) Prevent the lock from engaging in flight.

CS-LURS.681 Limit load static tests

(a) Compliance with the limit load requirements of this CS-LURS must be shown by tests in which-

- (1) The direction of the test loads produces the most severe loading in the control system; and
- (2) Each fitting, pulley, and bracket used in attaching the system to the main structure is included.

(b) Compliance must be shown (by analyses or individual load tests) with the special factor requirements for control system joints subject to angular motion.

CS-LURS.683 Operation tests

It must be shown by operation tests that, when the controls are operated with the control system loaded to correspond with loads specified for the system, the system is free from-

- (a) Jamming;
- (b) Excessive friction; and
- (c) Excessive deflection.

CS-LURS.685 Control system details

(a) Each detail of each control system must be designed to prevent jamming, chafing, and interference from cargo, payload, loose objects or the freezing of moisture.

- (b) There must be means to prevent the entry of foreign objects into places where they would jam the system.
- (c) There must be means to prevent the slapping of cables or tubes against other parts.
- (d) Cable systems must be designed as follows:
 - (1) Cables, cable fittings, turnbuckles, splices and pulleys must be of an acceptable kind.
 - (2) The design of the cable systems must prevent any hazardous change in cable tension throughout the range of travel under any operating conditions and temperature variations.
 - (3) No cable smaller than 2.38 mm (three thirty-seconds of an inch) diameter may be used in any primary control system.
 - (4) Pulley kinds and sizes must correspond to the cables with which they are used. (See AMC CS-LURS.685(d)(4)).
 - (5) Pulleys must have close fitting guards to prevent the cables from being displaced or fouled.
 - (6) Pulleys must lie close enough to the plane passing through the cable to prevent the cable from rubbing against the pulley flange.
 - (7) No fairlead may cause a change in cable direction of more than 3°.
 - (8) No clevis pin subject to load or motion and retained only by cotter pins may be used in the control system.
 - (9) Turnbuckles attached to parts having angular motion must be installed to prevent binding throughout the range of travel.
 - (10) There must be means for visual inspection at each fairlead, pulley, terminal and turnbuckle.
- (e) Control system joints subject to angular motion must incorporate the following special factors with respect to the ultimate bearing strength of the softest material used as a bearing:
 - (1) 3.33 for push-pull system other than ball and roller bearing systems.
 - (2) 2.0 for cable systems.
- (f) For control system joints, the manufacturer's static, non-Brinell rating of ball and roller bearings must not be exceeded.

CS-LURS.687 Spring devices

- (a) Each control system spring device where failure could cause flutter or other unsafe characteristics must be reliable.
- (b) Compliance with sub-paragraph (a) must be shown by test simulating service conditions.

CS-LURS.691 Autorotation control mechanism

If autorotation capability is implemented to fulfill the requirements out of CS-LURS.1412, each main rotor blade pitch control mechanism must allow rapid entry into autorotation after power failure.

LANDING GEAR

CS-LURS.723 Shock absorption tests

The landing inertia load factor and the reserve energy absorption capacity of the landing gear must be substantiated by the tests prescribed in CS-LURS.725 and 727, respectively or by analysis. These tests must be conducted on the complete rotorcraft or on undercarriage units in their proper relation.

CS-LURS.725 Limit drop test

(See AMC CS-LURS.725)

The limit drop test must be conducted as follows:

- (a) The drop height must be-
 - (1) 330 mm (13 inches) from the lowest point of the landing gear to the ground; or
 - (2) Any lesser height, not less than 203 mm (8 inches), resulting in a drop contact velocity equal to the greatest probable sinking speed likely to occur at ground contact in normal power-off landings.
- (b) If considered, the rotor lift specified in CS LURS.473(a) must be introduced into the drop test by appropriate energy absorbing devices or by the use of an effective mass.
- (c) Each landing gear unit must be tested in the attitude simulating the landing condition that is most critical from the standpoint of the energy absorbed by it.
- (d) When an effective mass is used in showing compliance with sub-paragraph (b), the following formula may be used instead of more rational computations:

$$W_e = W [h+(1-L)^d]/[h+d]$$

$$N = n_j [W_e/W] + L$$

W_e = the effective weight to be used in the drop test (kg)

W = (kg), equal to the static reaction on the undercarriage unit with the rotorcraft in the most critical attitude. A rational method may be used in computing the reaction, taking into consideration the moment arm between the undercarriage reaction and the rotorcraft centre of gravity.

h = specified free drop height (mm).

L = ratio of assumed rotor lift to the rotorcraft weight.

d = the vertical component of the landing gear travel (mm) relative to the drop mass.

n = limit inertia load factor.

n_j = the load factor developed, during impact, on the mass used in the drop test (i.e., the acceleration dv/dt in g recorded in the drop test plus 1.0).

CS-LURS.727 Reserve energy absorption drop test

The reserve energy absorption drop test must be conducted as follows:

- (a) The drop height must be 1.5 times that specified in CS-LURS.725(a).
- (b) Rotor lift, where considered in a manner similar to that prescribed in CS-LURS.725(b), may not exceed 1.5 times the lift allowed under that sub-paragraph.
- (c) The landing gear must withstand this test without collapsing. Collapse of the landing gear occurs when a member of the nose, tail, or main gear will not support the rotorcraft in the proper attitude or allows the rotorcraft structure, other than the landing gear and external accessories, to impact the landing surface.

CS-LURS.737 Skis

The maximum limit load rating of each ski must equal or exceed the maximum limit load determined under the applicable ground load requirements of this CS-LURS.

FLOATS AND HULLS

CS-LURS.751 Main float buoyancy

- (a) For main floats, the buoyancy necessary to support the maximum weight of the rotorcraft in fresh water must be exceeded by-
 - (1) 50 %, for single floats; and
 - (2) 60 %, for multiple floats.
- (b) Each main float must have enough watertight compartments so that, with any single main float compartment flooded, the main floats will provide a margin of positive stability great enough to minimize the probability of capsizing.

CS-LURS.753 Main float design

- (a) *Bag floats*. Each bag float must be designed to withstand-
 - (1) The maximum pressure differential that might be developed at the maximum altitude for which certification with that float is requested; and
 - (2) The vertical loads prescribed in CS-LURS.521(a), distributed along the length of the bag over three-quarters of its projected area.
- (b) *Rigid floats*. Each rigid float must be able to withstand the vertical, horizontal, and side loads prescribed in CS-LURS.521. These loads may be distributed along the length of the float.

CARGO ACCOMMODATIONS

CS-LURS.787 Cargo and payload compartments

(a) Each cargo and payload compartment must be designed for its placarded maximum weight of contents and for the critical load distributions at the appropriate maximum load factors corresponding to specified flight and ground load conditions, except the emergency landing conditions of CS-LURS.561.

FIRE PROTECTION

CS-LURS.855 Cargo compartments

- (a) Each cargo compartment must be constructed of, or lined with, materials that are at least Fire Resistant.
- (b) No compartment may contain any controls, wiring, lines, equipment, or accessories whose damage or failure would affect safe operation, unless those items are protected so that-
 - (a) They cannot be damaged by the movement of cargo in the compartment; and
 - (b) Their breakage or failure will not create a fire hazard.

CS-LURS.859 Temperature control systems

- (a) *General.* Any temperature control system required by the flight control and other critical systems must be able to maintain the temperatures of those critical systems within the limits established for those systems under critical operating conditions.
- (b) Any temperature control systems required by the flight control or other critical systems must not fail in such a way that will interfere with the function of those critical systems.

CS-LURS.861 Fire protection of flight controls and flight structure

Each part of the structure, controls, rotor mechanism, and other parts essential to a controlled landing that would be affected by powerplant fires must be fireproof or protected so they can perform their essential functions for at least 5 minutes under any foreseeable powerplant fire conditions.

CS-LURS.863 Flammable fluid fire protection

In each area where flammable fluids or vapours might escape by leakage of a fluid system, there must be means in the form of adequate segregation, ventilation and drainage, to minimize the probability of ignition of the fluids and vapours, and the resultant hazards if ignition does occur.

ELECTRICAL BONDING AND LIGHTNING PROTECTION
<p>CS-LURS.867 Electrical bonding and protection against lightning and static electricity (See AMC CS-LURS.867)</p> <p>(a) The UAS must be protected against Catastrophic effects from lightning and static electricity. A lightning analysis assessment has to be carried out and agreed with the Certifying Authority.</p> <p>(b) For metallic components, compliance with sub-paragraph (a) may be shown by</p> <ol style="list-style-type: none"> (1) Bonding the components and grounding them properly to the airframe; or (2) Designing the components so that a strike will not result in a Catastrophic event. <p>(c) For non-metallic components, compliance with sub-paragraph (a) may be shown by</p> <ol style="list-style-type: none"> (1) Designing the components to minimize the effect of a strike; or (2) Incorporating acceptable means of diverting the resulting electrical current so as not to result in a Catastrophic event <p>(d) There must be provisions for electrically bonding the rotorcraft to the ground fuelling equipment</p>
MISCELLANEOUS
<p>CS-LURS.871 Leveling marks</p> <p>There must be reference marks for leveling the rotorcraft on the ground.</p>
<p>CS-LURS.873 Ballast provisions</p> <p>Ballast provisions must be designed and constructed to prevent inadvertent shifting of ballast in flight.</p>
BOOK 1 SUBPART E- POWERPLANT
GENERAL
<p>CS-LURS.901 Installation</p> <p>(a) For the purpose of this part, the powerplant installation includes each part of the rotorcraft (other than the main and auxiliary rotor structures) that -</p> <ol style="list-style-type: none"> (1) Is necessary for propulsion; (2) Affects the control of the major propulsive units; or (3) Affects the safety of the major propulsive units between normal inspections or overhauls.

- (b) For each powerplant and its installation -
 - (1) Each component of each powerplant and its installation must be constructed, arranged, and installed to ensure its continued safe operation between normal inspections or overhauls for the range of temperature and altitude for which approval is requested;
 - (2) Accessibility must be provided to allow any inspection and maintenance necessary for continued airworthiness;
 - (3) Electrical interconnections must be provided to prevent differences of potential between major components of the installation and the rest of the rotorcraft;
 - (4) Design precautions must be taken to minimize the possibility of incorrect assembly of components and equipment essential to safe operation of the rotorcraft, except where operation with the incorrect assembly can be shown to be extremely improbable.
(See AMC CS-LURS.901.)
- (c) The installation must comply with -
 - (1) The instructions for installing the engine required in the relevant code defined under CS-LURS.903(a); and
 - (2) The applicable provisions of this Subpart.
(See AMC CS-LURS 901(c).)

CS-LURS.903 Engines

The engines must meet the specifications of Appendix B. (See AMC CS-LURS.903(a).)

- (a) The engines must be type certified under:
 - 1. The specifications of Appendix B to this CS-LURS.
 - 2. For combustion engines the specifications of Appendix B to CS-VLR can be applied
- (b) *Engine or drive system cooling fan blade protection.*
 - (1) If an engine or rotor drive system cooling fan is installed, there must be a means to protect the rotorcraft and allow a safe landing if a fan blade fails. This must be shown by showing that –
 - (i) The fan blades are contained in case of failure;
 - (ii) Each fan is located so that a failure will not jeopardize safety; or
 - (iii) Each fan blade can withstand an ultimate load of 1.5 times the centrifugal force resulting from operation limited by the following:
 - (A) For fans driven directly by the engine--
 - (1) The terminal engine r.p.m. under uncontrolled conditions; or
 - (2) An over-speed limiting device.
 - (B) For fans driven by the rotor drive system, the maximum rotor drive system rotational speed to be expected in service, including transients.
 - (2) Unless a fatigue evaluation under CS-LURS.571 is conducted, it must be shown that cooling fan blades are not operating at resonant conditions within the operating limits of the rotorcraft.
 - (3) Turbine engine installation. For turbine engine installations, the powerplant systems associated with engine control devices, systems, and instrumentation must be designed to give reasonable assurance that those engine operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service.

CS-LURS.907 Engine vibration

- (a) Each engine must be installed to prevent the harmful vibration of any part of the engine or rotorcraft.
- (b) The addition of the rotor and the rotor drive system to the engines must not subject the principal rotating parts of the engine to excessive vibrations or vibration stresses (see AMC CS-LURS 907).
- (c) No part of the rotor drive system may be subjected to excessive vibration stresses.

ROTOR DRIVE SYSTEM

CS-LURS.917 Design

- (a) Each rotor drive system must incorporate a unit to automatically disengage any engine from the main and auxiliary rotors if that engine fails.
- (b) Each rotor drive system must be arranged so that each rotor necessary for control in autorotation will continue to be driven by the main rotors after disengagement of the engine(s) from the main and auxiliary rotors.
- (c) If a torque limiting device is used in the rotor drive system, it must be located so as to allow continued control of the rotorcraft when the device is operating.
- (d) The rotor drive system includes any part necessary to transmit power from the engines to the rotor hubs. This includes gear boxes, shafting, universal joints, couplings, rotor brake assemblies, clutches, supporting bearings for shafting, any attendant accessory pads or drives, and any cooling fans that are a part of, attached to, or mounted on the rotor drive system.

CS-LURS.921 Rotor brake

If there is a means to control the rotation of the rotor drive system independently of the engine, any limitations on the use of that means must be specified, and the control for that means must be guarded to prevent inadvertent operation.

CS-LURS.923 Rotor drive system and control mechanism tests

- (a) Each part tested as prescribed in this paragraph must be in a serviceable condition at the end of the tests. No intervening disassembly which might affect test results may be conducted.
- (b) Each rotor drive system and control mechanism must be tested for not less than 50 hours or the specified time to the first overhaul of the engine, rotor drive system or control mechanism, whichever is less. The test must be conducted on the rotorcraft, and the torque must be absorbed by the rotors to be installed, except that other ground or flight test facilities with other appropriate methods of torque absorption may be used if the conditions of support and vibration closely simulate the conditions that would exist during a test on the rotorcraft.
- (c) A 60% part of the test prescribed in subparagraph (b) must be run at not less than maximum continuous torque and the maximum speed for use with maximum continuous torque. In this test, the main rotor controls must be set in the position that will give maximum longitudinal cyclic pitch change to simulate forward flight. The auxiliary rotor controls must be in the position for normal operation under the conditions of the test.
- (d) A 30% of the test prescribed in subparagraph (b) must be run at not less than 75% of maximum continuous torque and the minimum speed for use with 75% of maximum continuous torque. The main and auxiliary rotor controls must be in the position for normal operation under the conditions of the test.
- (e) A 10% part of the test prescribed in subparagraph (b) must be run at not less than take-off torque and the maximum speed for use with take-off torque. The main and

auxiliary rotor controls must be in the normal position for vertical ascent.

- (f) The parts of the test prescribed in subparagraphs (c) and (d) must be conducted in intervals of not less than 30 minutes and may be accomplished either on the ground or in flight. The part of the test prescribed in sub-paragraph (e) must be conducted in intervals of not less than 5 minutes.
- (g) At intervals of not more than two hours during the tests prescribed in sub-paragraphs (c), (d) and (e), the engine must be stopped rapidly enough to allow the engine and rotor drive to be automatically disengaged from the rotors.
- (h) Under the operating conditions specified in subparagraph (c), 250 complete cycles of lateral control, 250 complete cycles of longitudinal control of the main rotors, and 250 complete cycles of control of each auxiliary rotor must be accomplished. A "complete cycle" involves movement of the controls from the neutral position, through both extreme positions, and back to the neutral position, except that control movements need not produce loads or flapping motions exceeding the maximum loads or motions encountered in flight. The cycling may be accomplished during the testing prescribed in sub-paragraph (c).
- (i) At least 100 start-up clutch engagements must be accomplished-
 - (1) So that the shaft on the driven side of the clutch is accelerated; and
 - (2) Using a speed and method selected by the applicant.

CS-LURS.927 Additional tests

- (a) Any additional dynamic, endurance, and operational tests, and vibratory investigations necessary to determine that the rotor drive mechanism is safe, must be performed.
- (b) If turbine engine torque output to the transmission can exceed the highest engine or transmission torque rating limit, and that output is not directly controlled by the LURS UA Pilot under normal operating conditions (such as where the primary engine power control is accomplished through the flight control), the following test must be made:
 - (1) Under conditions associated with all engines operating, make 200 applications, for 10 seconds each, of torque that is at least equal to the lesser of:
 - (i) The maximum torque used in meeting CS 27.923 plus 10%; or
 - (ii) The maximum attainable torque output of the engines, assuming that torque limiting devices, if any, function properly.
 - (2) For multi-engine rotorcraft under conditions associated with each engine in turn becoming inoperative, apply to the remaining transmission torque inputs, the maximum torque attainable under probable operating conditions, assuming that torque limiting devices, if any, function properly. Each transmission input must be tested at this maximum torque for at least 15 minutes.
 - (3) The tests prescribed in this paragraph must be conducted on the rotorcraft at the maximum rotational speed intended for the power condition of the test and the torque must be absorbed by the rotors to be installed, except that other ground or flight test facilities with other appropriate methods of torque absorption may be used if the conditions of support and vibration closely simulate the conditions that would exist during a test on the rotorcraft.
- (c) It must be shown by tests that the rotor drive system is capable of operating under auto-rotative conditions for 15 minutes after the loss of pressure in the rotor drive primary oil system.

CS-LURS.931 Shafting critical speed

- (a) The critical speeds of any shafting must be determined by demonstration, except that analytical methods may be used if reliable methods of analysis are available for the particular design.
- (b) If any critical speed lies within, or close to, the operating ranges for idling, power-on, and auto-rotative conditions, the stresses occurring at that speed must be within safe limits. This must be shown by tests.
- (c) If analytical methods are used and show that no critical speed lies within the permissible operating ranges, the margins between the calculated critical speeds and the limits of the allowable operating ranges must be adequate to allow for possible variations between the computed and actual values.

CS-LURS.935 Shafting joints

Each universal joint, slip joint, and other shafting joints whose lubrication is necessary for operation must have provision for lubrication.

CS-LURS.939 Turbine engine operating characteristics

- (a) Turbine engine operating characteristics must be investigated in flight to determine that no adverse characteristics (such as stall, surge, or flameout) are present, to a hazardous degree, during normal and emergency operation within the range of operating limitations of the rotorcraft and of the engine.
- (b) The turbine engine air inlet system may not, as a result of airflow distortion during normal operation, cause vibration harmful to the engine.
- (c) For governor-controlled engines, it must be shown that there exists no hazardous torsional instability of the drive system associated with critical combinations of power, rotational speed, and control displacement.

FUEL SYSTEM

CS-LURS.951 General

- (a) Each fuel system must be constructed and arranged to ensure a flow of fuel at a rate and pressure established for proper engine functioning under any normal operating condition and must be arranged to minimize the occurrence of vapour lock and to prevent introducing air into the system.
- (b) The fuel system must be arranged so that no fuel pump can draw fuel from more than one tank at a time. Gravity feed systems must not supply fuel to the engine from more than one tank at a time, unless the airspaces are interconnected in a manner to ensure that all interconnected tanks feed equally.
- (c) Each fuel system for a compression ignition engine must be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 27°C (80°F) and having 0.198 cc of free water per liter (0.75 cc per US gallon, 0.899 cc per Imperial gallon) added and cooled to the most critical condition for icing likely to be encountered in operation.
- (d) Fuel system is to be interpreted as the electrical power subsystem for electrical engine applications

CS-LURS.954 Fuel system lightning protection (New)

The fuel system must be designed and arranged to prevent the ignition of fuel vapor within the system by--

- a) Direct lightning strikes to areas having a high probability of stroke attachment;
- b) Swept lightning strokes to areas where swept strokes are highly probable; or
- c) Corona and streamering at fuel vent outlets

CS-LURS.955 Fuel flow

- (a) *General.* The ability of the fuel system to provide fuel at the rates specified in this paragraph and at a pressure sufficient for proper carburetor or fuel injector operation must be shown in the attitude that is most critical with respect to fuel feed and quantity of unusable fuel. These conditions may be simulated in a suitable mock-up. In addition:-
 - (1) The quantity of fuel in the tank may not exceed the amount established as the unusable fuel supply for that tank under CS-LURS.959 plus that necessary to show compliance with this paragraph; and
 - (2) If there is a fuel flow meter, it must be blocked during the flow test and the fuel must flow through the meter bypass.
 - (3) The fuel filter required by CS-LURS. 977 must be blocked to other degree necessary to provide the highest foreseeable pressure across the filter.
- (b) *Gravity Systems.* The fuel flow rate for gravity systems (main and reserve supply) must be 150% of the take-off fuel consumption of the engine(s) it supplies with fuel..
- (c) *Pump Systems.* The fuel flow rate for each pump system (main and reserve supply) must be 125%of the take-off fuel consumption of the of the engine(s) it supplies with fuel at the maximum power established for take-off. This flow rate is required for each primary engine-driven pump and each emergency pump, and must be available when the pump is running as it would during take-off.
- (d) *Multiple fuel tanks.* If any engine can be supplied with fuel from more than one tank, it must be possible, in level flight, to regain full power and fuel pressure to that engine in not more than 10 seconds after switching to any full tank after engine malfunctioning due to fuel depletion becomes apparent while the engine was being supplied from any other tank.

CS-LURS.959 Unusable fuel supply

The unusable supply for each tank must be established as not less than the quantity at which the first evidence of malfunction occurs under the most adverse fuel feed condition occurring under any intended operations and flight maneuvers involving that tank.

CS-LURS.961 Fuel system hot weather operation

Each suction lift fuel system and other fuel systems with features conducive to vapor formation must be shown by test to operate satisfactorily (within certification limits) when using fuel at a temperature of 43°C (110° F) .

CS-LURS.963 Fuel tanks: general

(See AMC LURS.963)

- (a) Each fuel tank must be able to withstand, without failure, the vibration, inertia, fluid, and structural loads that it may be subjected to in operation.
- (b) Each flexible fuel tank liner must be of an acceptable kind.
- (c) Each integral fuel tank must have adequate facilities for interior inspection and repair.
- (d) The maximum exposed surface temperature of any component in the fuel tank must be less, by a safe margin, than the lowest expected auto-ignition temperature of the fuel or fuel vapour in the tank. Compliance with this requirement must be shown under all operating and all failure or malfunction conditions of all components inside the tank.
- (e) Means shall be provided to prevent fuel tanks and their contents being heated above the maximum temperature used to demonstrate compliance with CS-LURS.65(b). (See AMC LURS.963(e))

CS-LURS.965 Fuel tank tests

Each fuel tank must be able to withstand the following pressure without failure or leakage:

- (a) For each conventional metal tank and non metallic tank with walls not supported by the rotorcraft structure, a pressure of 24 kPa.
- (b) For each integral tank, the pressure developed during the maximum limit acceleration of the rotorcraft with a full tank, with simultaneous application of the critical limit structural loads.
- (c) For each non metallic tank with walls supported by the rotorcraft structure and constructed in an acceptable manner using acceptable basic tank material, and with actual or simulated support conditions, a pressure of 14 kPa, for the first tank of a specific design. The supporting structure must be designed for the critical loads occurring in the flight or landing strength conditions combined with the fuel pressure loads resulting from the corresponding accelerations.

CS-LURS.967 Fuel tank installation

- (a) Each fuel tank must be supported so that tank loads are not concentrated. In addition-
 - (1) There must be pads, if necessary, to prevent chafing between each tank and its supports;
 - (2) Padding must be non-absorbent or treated to prevent the absorption of fuel;
 - (3) If flexible tank liner is used, it must be supported so that it is not required to withstand fluid loads;
 - (4) Interior surfaces adjacent to the liner must be smooth and free from projection that could cause wear, unless
 - (i) Provisions are made for protection of the liner at those points; or
 - (ii) The construction of the liner itself provides such protection.
 - (5) A positive pressure must be maintained within the vapour space of each bladder cell under all conditions of operation except for a particular condition for which it is shown that a zero or negative pressure will not cause the bladder cell to collapse; and
 - (6) Siphoning of fuel (other than minor spillage) or collapse of bladder fuel cells may not result from improper securing or loss of the fuel filler cap.

- (b) Each tank compartment must be ventilated and drained to prevent the accumulation of flammable fluids or vapours. Each compartment adjacent to a tank that is an integral part of the rotorcraft structure must also be ventilated and drained.
- (c) No fuel tank may be on the engine side of the firewall. There must be at least 13 mm of clearance between the fuel tank and the firewall. No part of the engine nacelle skin that lies immediately behind a major air opening from the engine compartment may act as the wall of an integral tank.
- (d) Fuel tanks, fuel tank components and fuel system components must be designed, located, and installed so as to retain fuel under the inertia forces prescribed for the emergency landing conditions in CS-LURS.561.

CS-LURS.969 Fuel tank expansion space

Each fuel tank must have an expansion space of not less than 2 % of the tank capacity, unless the tank vent discharges clear of the rotorcraft (in which case no expansion space is required). It must be impossible to fill the expansion space inadvertently with the rotorcraft in the normal ground attitude.

CS-LURS.971 Fuel tank sump

- (a) Each fuel tank must have a sump with an effective capacity, in the normal ground and flight attitudes, of 0.10 % of the tank capacity or 120 cm³, whichever is greater, unless-
 - (1) The fuel system has a sediment bowl or chamber that is accessible for drainage and has a capacity of 25 cm³
 - (2) Each fuel tank outlet is located so that in the normal ground attitude, water will drain from all parts of the tank to the sediment bowl or chamber.
- (b) Each sump, sediment bowl, and sediment chamber drain required by sub-paragraph (a) must comply with the drain provisions of CS-LURS.999(b)(1), (2) and (3).

CS-LURS.973 Fuel tank filler connection

- (a) Fuel spilled during fuelling must be prevented from entering the fuel tank compartment or any part of the rotorcraft other than the tank itself.
- (b) Each filler cap must provide a fuel-tight seal for the main filler opening. However, there may be small openings in the fuel tank cap for venting purposes or for the purpose of allowing passage of a fuel gauge through the cap

CS-LURS.975 Fuel tank vents and carburetor vapour vents

- (a) Each fuel tank must be vented from the top part of the expansion space so that venting is effective under all normal flight conditions. Each vent must minimize the probability of stoppage by dirt or ice.

(b) The venting system must be designed to minimize spillage of fuel through vents to an ignition source in the event of a rollover during landing or ground operation.

CS-LURS.977 Fuel strainer and filter

- (a) There must be a fuel filter between the tank outlet and the carburetor inlet or fuel injector. This fuel filter must -
 - (1) Have the capacity (with respect to operating limitations established for the engine) to ensure that engine fuel system functioning is not impaired, with the fuel contaminated to a degree (with respect to particle size and quantity) that is greater than that established for the engine approval; and
 - (2) Be easily accessible for draining and cleaning.
 - (3) Have a sediment trap and drain except that it need not have a drain if the strainer or filter is easily removable for drain purposes.
- (b) There must be a strainer at the outlet of each fuel tank. This strainer must-
 - (1) Have 3 to 6 meshes per centimeter;
 - (2) Have a length of at least twice the diameter of the fuel tank outlet;
 - (3) Have a diameter of at least that of the fuel tank outlet; and
 - (4) Be accessible for inspection and cleaning.

ELECTRICAL POWER SUBSYSTEM FOR PROPULSION

CS-LURS.981 Energy Storage, Performance and Indication

- (a) The battery must be able to provide the necessary voltage and current required by the engine and electrical equipment throughout the complete operational envelope.
- (b) The battery pack charger must be considered part of the UAV system. The charger must have indicators for fault and charging status.

CS-LURS.983 Energy Storage, Safety

- (a) Safe cell temperatures and pressures must be maintained during any probable charging or discharging condition, or during any failure of the charging or battery monitoring system not shown to be extremely remote. The battery installation must be designed to preclude Hazardous effect due to explosion in the event of those failures..
- (b) Design of the batteries must consider the occurrence of self-sustaining, uncontrolled increases in temperature or pressure. Associated protection means shall be implemented as per (a).
- (c) No explosive or toxic gasses emitted by any battery in normal operation or as the result of any failure of the battery charging or monitoring system, or battery installation not shown to be extremely remote, may accumulate in hazardous quantities within the aircraft.
- (d) Battery installations must meet the requirements of CS LURS.863

- (e) No corrosive fluids or gasses that may escape from any battery may damage surrounding structure or any adjacent systems, equipment or electrical wiring, of the airplane in such a way as to cause a failure condition that is not compliant with CS LURS.1309 (b).
- (f) Each battery installation must have provisions to prevent any hazardous effect on structure or essential systems that may be caused by the maximum amount of heat the battery can generate during a short circuit of the battery or of its individual cells.
- (g) Battery control and monitoring system must have an automatic function to control the charging rate of the battery so as to prevent battery overheating or overcharging, and,
 - (1) A battery temperature sensing and over-temperature warning system with a means for automatically disconnecting the battery from its charging source in the event of an over-temperature condition or,
 - (2) A battery failure sensing and warning system with a means for automatically disconnecting the battery from its charging source in the event of battery failure.
- (h) Any battery installation whose function is required for safe operation of the aircraft, must incorporate a monitoring and warning feature that will provide an indication to the appropriate flight crewmembers, whenever the state of charge (SOC) of the batteries have fallen below levels considered acceptable for dispatch of the aircraft.
- (i) The Instructions for Continued Airworthiness required by CS LURS.1529 must contain maintenance requirements for measurements of battery capacity at appropriate intervals to ensure that batteries whose function is required for safe operation of the aircraft will perform their intended function as long as the batteries are installed in the aircraft. The Instructions for Continued Airworthiness must also contain maintenance procedures for batteries in spares storage to prevent the replacement of batteries whose function is required for safe operation of the aircraft, with batteries that have experienced degraded charge retention ability or other damage due to prolonged storage at low SOC

CS-LURS.985 Energy Storage, Installation

- (a) The battery installation must be able to withstand the applicable inertial loads.
- (b) The installation provisions, the environment and the intended usage of all batteries must meet all performance, operating and safety requirements established by the battery manufacturer.
- (c) There must be means to minimize the risk of battery overheating/explosion (e.g. cooling, temperature sensor, active battery management system).
- (d) Information concerning battery storage, operation, handling, maintenance, safety limitations and battery health conditions must be provided in the applicable manuals per subpart G.

FUEL SYSTEM COMPONENTS

CS-LURS.991 Fuel pumps

- (a) Compliance with CS-LURS.955 may not be jeopardized by failure of-
 - (1) Any one pump except pumps that are approved and installed as parts of a type certificated engine; or
 - (2) Any component required for pump operation except, for engine driven pumps, the engine served by that pump.
 - (3) Operation of any fuel pump may not affect engine operation so as to create hazard, regardless of the engine power or functional status of any other fuel

pump.

CS-LURS.993 Fuel system lines and fittings

- (a) Each fuel line must be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and accelerated flight conditions.
- (b) Each fuel line connected to components of the rotorcraft between which relative motion could exist must have provisions for flexibility.
- (c) Each flexible connection in fuel lines that may be under pressure and subjected to axial loading must use flexible hose assemblies.
- (d) Each flexible hose must be approved or must be shown to be suitable for the particular application.
- (e) Each shutoff valve and its control must be designed, located, and protected to function properly under any condition likely to result from an engine fire.

CS-LURS.995 Fuel valves

- (a) There must be a positive, quick-acting valve to shut-off fuel to the engine.
- (b) Where there is more than one source of fuel supply there must be means for independent feeding from each source.
- (c) No shut-off valve may be on the engine side of any firewall.

CS-LURS.999 Fuel system drains

- (a) There must be at least one accessible drain at the lowest point in each fuel system to completely drain the system with the rotorcraft in any ground attitude to be expected in service.
- (b) Each drain required by sub-paragraph (a) must-
 - (1) Discharge clear of all parts of the rotorcraft;
 - (2) Have manual or automatic means to assure positive closure in the off position; and
 - (3) Have a drain valve that is readily accessible and which can be easily opened and closed.

OIL SYSTEM

CS-LURS.1011 Engine: General

- (a) If an engine is provided with an independent oil system it must be capable of supplying the engine with an appropriate quantity of oil at a temperature not exceeding the maximum established as safe for continuous operation.
- (b) Each oil system must have a usable capacity adequate for the endurance of the rotorcraft.
- (c) If an engine depends upon a fuel/oil mixture for lubrication, then a reliable means of providing it with the appropriate mixture must be established. (See AMC CS-

LURS.1011(c.)

CS-LURS.1013 Oil tanks

- (a) Each oil tank must be supported so that tank loads are not concentrated. In addition-
 - (1) There must be pads, if necessary, to prevent chafing between each tank and its supports;
 - (2) Padding must be non-absorbent or treated to prevent the absorption of oil;
 - (3) If flexible tank liner is used, it must be supported so that it is not required to withstand fluid loads;
 - (4) Interior surfaces adjacent to the liner must be smooth and free from projection that could cause wear, unless-
 - (i) Provisions are made for protection of the liner at those points; or
 - (ii) The construction of the liner itself provides such protection.
 - (5) A positive pressure must be maintained within the vapour space of each bladder cell under all conditions of operation except for a particular condition for which it is shown that a zero or negative pressure will not cause the bladder cell to collapse; and
 - (6) Siphoning of oil (other than minor spillage) or collapse of bladder oil cells may not result from improper securing or loss of the oil filler cap.
 - (7) Withstand any vibration, inertia and fluid loads expected in operation
- (b) Each tank compartment must be ventilated and drained to prevent the accumulation of flammable fluids or vapours. Each compartment adjacent to a tank that is an integral part of the rotorcraft structure must also be ventilated and drained.
- (c) The oil level must be easy to check without having to remove any cowling parts (with the exception of oil tank access covers) or having to use any tools.
- (d) If the oil tank is installed in the engine compartment it must be made of fireproof material except that, if the total oil capacity of the system including tanks, lines and sumps is less than 5 liters, it may be made of fire resistant material.

CS-LURS.1015 Oil tank tests

Each oil tank must be able to withstand the following pressure without leakage :

- (a) For each conventional metal tank and non metallic tank with walls not supported by the rotorcraft structure, a pressure of 35 kPa.
- (b) For each integral tank, the pressure developed during the maximum limit acceleration of the rotorcraft with a full tank, with simultaneous application of the critical limit structural loads.
- (c) For each non metallic tank with walls supported by the rotorcraft structure and constructed in an acceptable manner using acceptable basic tank material, and with actual or simulated support conditions, a pressure of 14 kPa, for the first tank of a specific design. The supporting structure must be designed for the critical loads occurring in the flight or landing strength conditions combined with the oil pressure loads resulting from the corresponding accelerations.

CS-LURS.1017 Oil lines and fittings

- (a) Oil lines must comply with the fuel system requirements of CS-LURS. 993.
- (b) *Breather lines.* Breather lines must be arranged so that-
 - (1) Condensed water vapour or oil that might freeze and obstruct the line cannot accumulate at any point;
 - (2) The breather discharge will not constitute a fire hazard if foaming occurs;
 - (3) The breather does not discharge into the engine air induction system;
 - (4) The breather outlet is protected against blockage by ice or foreign matter.

CS-LURS.1019 Oil strainer or filter

Each oil strainer or filter in the powerplant installation must be constructed and installed so that oil will flow at the normal rate through the rest of the system with the strainer or filter element completely blocked.

CS-LURS.1021 Oil system drains

A drain (or drains) must be provided to allow safe drainage of the oil system. Each drain must –

- (a) Be accessible; and
- (b) Have manual or automatic means for positive locking in the closed position.

CS-LURS.1027 Transmissions and gearboxes: general

- (a) Pressure lubrication systems for transmissions and gearboxes must comply with the engine oil system requirements of CS-LURS.1013, -1015, -1017, -1021 and –1337(d).
- (b) Each pressure lubrication system must have an oil strainer or filter through which all of the lubricant flows and must -
 - (1) Be designed to remove from the lubricant any contaminant which may damage transmission and drive system components or impede the flow of lubricant to a hazardous degree;
 - (2) Be equipped with a means to indicate collection of contaminations of the filter or strainer at or before opening of the bypass required by subparagraph (b)(3); and
 - (3) Be equipped with a bypass constructed and installed so that-
 - (i) The lubricant will flow at the normal rate through the rest of the system with the strainer or filter completely blocked; and
 - (ii) The release of collected contaminants is minimized by appropriate location of the bypass to ensure that collected contaminants are not in the bypass flow path.
- (c) For each lubricant tank or sump outlet supplying lubrication to rotor drive system and rotor drive system components, a screen must be provided to prevent entrance

into the lubrication system of any object that might obstruct the flow of lubricant from the outlet to the filter required by sub-paragraph (b). The requirements of sub-paragraph (b) do not apply to screens installed at lubricant tank or sump outlets.

(d) Splash-type lubrication systems for rotor drive system gearboxes must comply with CS-LURS.1021 and .1337(d).

(e)

COOLING

CS-LURS.1041 General

(a) Each powerplant cooling system must be able to maintain the temperatures of powerplant components within the limits established for these components under critical operating conditions for which certification is required and after normal shutdown. Powerplant components to be considered include but may not be limited to engines, rotor drive system components, and the cooling or lubricating fluids used with these components.

(b) Compliance with sub-paragraph (a) must be shown in tests conducted under the conditions prescribed in that paragraph.

CS-LURS.1043 Cooling tests

(a) *General.* For the tests prescribed in CS-LURS.1041(b), the following apply:

- (1) If the tests are conducted under conditions deviating from the maximum ambient atmospheric temperature specified in sub-paragraph (b), the recorded powerplant temperatures must be corrected under sub-paragraphs (c) and (d) unless a more rational correction method is applicable.
- (2) No corrected temperature determined under sub-paragraph (a)(1) may exceed established limits.
- (3) The fuel used during the cooling tests must be of the minimum grade approved for the engines, and the mixture settings must be those normally used in the flight stages for which the cooling tests are conducted.
- (4) The test procedures must be as prescribed in CS-LURS.1045.

(b) *Maximum ambient atmospheric temperature.* A maximum ambient atmospheric temperature corresponding to sea-level conditions of at least 38°C (100°F) must be established. The assumed temperature lapse rate is 1.98°C (3.6°F) per 305m (1000ft) of altitude above sea-level until a temperature of -56.5°C (-69.7°F) is reached, above which altitude the temperature is considered constant at -56.5°C (-69.7°F). However, for winterization installations, the applicant may select a maximum ambient atmospheric temperature corresponding to sea level conditions of less than 38°C (100°F).

(c) *Correction factor (except cylinder barrels).* Unless a more rational correction applies, temperature of engine fluids and powerplant components (except cylinder barrels) for which temperature limits are established, must be corrected by adding to them the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum component or fluid temperature recorded during the cooling test.

(d) *Correction factor for cylinder barrel temperature.* Cylinder barrel temperatures must be corrected by adding to them 0.7 times the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum cylinder barrel temperature recorded during the cooling test.

CS-LURS.1045 Cooling test procedures

- (a) *General.* For each stage of flight, the cooling tests must be conducted with the rotorcraft-
 - (1) In the configuration most critical for cooling; and
 - (2) Under the conditions most critical for cooling.

- (b) *Temperature stabilization.* For the purpose of the cooling tests, a temperature is "stabilized" when its rate of change is less than 1°C (1.8°F) per minute. The following component and engine fluid temperature stabilization rules apply:
 - (1) For each rotorcraft, and for each stage of flight -
 - (i) The temperatures must be stabilized under the conditions from which entry is made into the stage of flight being investigated; or
 - (ii) If the entry normally does not allow temperature to stabilize, operation through the full entry condition must be conducted before entry into the stage of flight being investigated in order to allow the temperatures to attain their natural levels at the time of entry.
 - (2) For each rotorcraft during the take-off stage of flight, the climb at take-off power must be preceded by a period of hover during which the temperatures are stabilized.

- (c) *Duration of test.* For each stage of flight the tests must be continued until-
 - (1) The temperatures stabilize or 5 minutes after the occurrence of the highest temperature recorded, as appropriate to the test condition;
 - (2) That stage of flight is completed; or
 - (3) An operating limitation is reached.

LIQUID COOLING

CS-LURS.1061 Installation

- (a) *General.* Each liquid-cooled engine must have an independent cooling system (including coolant tank) installed so that -
 - (1) Each coolant tank is supported so that tank loads are distributed over a large part of the tank surface;
 - (2) There are pads between the tank and its supports to prevent chafing. Padding must be non-absorbent or must be treated to prevent the absorption of flammable fluids; and
 - (3) No air or vapour can be trapped in any part of the system, except the expansion tank, during filling or during operation.

- (b) *Coolant tank*
 - (1) Each coolant tank must be able to withstand the vibration, inertia, and fluids loads to which it may be subjected in operation.
 - (2) Each coolant tank must have an expansion space of at least 10% of the total cooling system in the normal ground attitude.
 - (3) It must be impossible to fill the expansion space inadvertently with the rotorcraft in the normal ground attitude.

- (c) *Filler connection.* Each coolant tank filler connection must be marked as specified in CS-LURS. 1557 (c). In addition -

- (1) Spilled coolant must be prevented from entering the coolant tank compartment or any part of the rotorcraft other than the tank itself; and
 - (2) Each recessed coolant filler connection must have a drain that discharges clear of the rotorcraft.
- (d) *Lines and fitting.* Each coolant system line and fitting must comply with the fuel system line requirements of CS-LURS. 993, except that the inside diameter of the engine coolant inlet and outlet lines may not be less than the diameter of the corresponding engine inlet and outlet connections.
- (e) *Radiators.* Each coolant radiator must be able to withstand any vibration, inertia, and coolant pressure load to which it may normally be subjected. In addition –
- (1) Each radiator must be supported to allow expansion due to operating temperatures and prevent the transmittal of harmful vibration to the radiator; and
 - (2) If flammable coolant is used, the air intake duct to the coolant radiator must be located so that (in case of fire) flames from the nacelle cannot strike the radiator.
- (f) *Drains.* There must be an accessible drain that –
- (1) Drains the entire cooling system (including the coolant tank, radiator, and the engine) when the rotorcraft is in the normal ground attitude;
 - (2) Discharges clear of the entire rotorcraft; and
 - (3) Has means to positively lock it closed.

CS-LURS.1063 Coolant tank test

Each coolant tank must comply with the fuel tank test requirements of CS-LURS. 965, except that the test required by CS-LURS. 965 (a) must be replaced with a similar test using the sum of the pressure developed during the maximum ultimate acceleration with a full tank or a pressure of 24 kPa, whichever is greater, plus the maximum working pressure of the system.

INDUCTION SYSTEM

CS-LURS.1091 Air induction

- (a) The air induction system for each engine must supply the air required by the engine under the operating conditions and manoeuvres for which certification is requested.
- (b) Each cold air induction system opening must be outside the cowling if backfire flames can emerge.
- (c) If fuel can accumulate in any air induction system, that system must have drains that discharge fuel-
 - (1) Clear of the rotorcraft; and
 - (2) Out of the path of exhaust flames.

CS-LURS.1093 Induction system icing protection

- (a) *Reciprocating and rotary engine.* The engine air induction system must have means to prevent and eliminate icing. Unless this is done by other means, it must be shown that, in air free of visible moisture at a temperature of -1°C (30°F) and with the engine at 75 % of maximum continuous power-
- (1) Each rotorcraft with a sea-level engine using conventional venturi carburetors has a preheater that can provide a heat rise of 50°C (90 °F);
 - (2) Each rotorcraft with a sea-level engine using carburetors tending to prevent icing has a sheltered alternate source of air, and that the preheat supplied to the alternate air intake is not less than that provided by the engine cooling air downstream of the cylinders;
 - (3) Each rotorcraft with an altitude engine using conventional venturi carburetors has a preheater capable of providing a heat rise of 67 °C (120 °F); and
 - (4) Each rotorcraft with an altitude engine using carburetors tending to prevent icing has a preheater that can provide a heat rise of-
 - (i) 56 °C (100 °F); or
 - (ii) If a fluid de-icing system is used, at least 22 °C (40 °F).
- (b) *Supercharged reciprocating and rotary engine.* For an engine having a supercharger to pressurize the air before it enters the carburetor, the heat rise in the air caused by that supercharging at any altitude may be utilized in determining compliance with sub-paragraph (a) if the heat rise utilized is that which will be available, automatically, for the applicable altitude and operating condition because of supercharging.
- (c) *Turbine engines*
- (1) Each turbine engine and its air inlet system must operate throughout the flight power range of the engine (including idling), without the accumulation of ice on engine or inlet system components that would adversely affect engine operation or cause a serious loss of power or thrust –
 - (i) Under the icing conditions specified in EASA CS-Definitions; and
 - (ii) In snow, both falling and blowing, within the limitations established for the aircraft for such operation.
 - (2) Each turbine engine must idle for 30 minutes on the ground, with the air bleed available for engine icing protection at its critical condition, without adverse effect, in an atmosphere that is at a temperature between -9° and -1°C (between 15° and 30°F) and has a liquid water content not less than 0.3 grams per cubic meter in the form of drops having a mean effective diameter not less than 20 microns, followed by momentary operation at take-off power or thrust. During the 30 minutes of idle operation, the engine may be run up periodically to a moderate power or thrust setting in a manner acceptable to the Agency.

EXHAUST SYSTEM

CS-LURS.1121 General

For each exhaust system –

- (a) There must be means for thermal expansion of manifolds and pipes;
- (b) There must be means to prevent local hot spots;
- (c) Exhaust gases must discharge clear of the engine air intake, fuel system components, and drains;
- (d) Each exhaust system part with a surface hot enough to ignite flammable fluids or vapours must be located or shielded so that leakage from any system carrying flammable fluids or vapours will not result in a fire caused by impingement of the fluids or vapours on any part of the exhaust system including shields for the exhaust system.
- (e) Each exhaust heat exchanger must incorporate means to prevent blockage of the exhaust port after any internal heat exchanger failure.

CS-LURS.1123 Exhaust piping

- (a) Exhaust piping must be heat and corrosion resistant, and must have provisions to prevent failure due to expansion by operating temperatures.
- (b) Exhaust piping must be supported to withstand any vibration and inertia loads to which it would be subjected in operations.
- (c) Exhaust piping connected to components between which relative motion could exist must have provisions for flexibility.

POWERPLANT ACCESSORIES

CS-LURS.1163 Powerplant accessories

- (a) Each engine-driven accessory must-
 - (1) Be satisfactory for mounting on the engine concerned;
 - (2) Use the provisions on the engine for mounting; and
 - (3) Be sealed to prevent contamination of the engine oil system and the accessory system.
- (b) Electrical equipment subject to arcing or sparking must be installed in such a way to minimize the probability of contact with any flammable fluids or vapours that might be present in a free state.
- (c) Unless other means are provided, torque limiting means must be provided for accessory drives located on any component of the transmission and rotor drive system to prevent damage to these components from excessive accessory load.

CS-LURS.1165 Engine ignition systems

- (a) Each battery ignition system must be supplemented by a generator that is automatically available as an alternate source of electrical energy to allow continued engine operation if any battery becomes depleted.
- (b) The capacity of batteries and generators must be large enough to meet the simultaneous demands of the engine ignition system and the greatest demands of any electrical system components that draw from the same source.
- (c) The design of the engine ignition system must account for : -
 - (1) The condition of an inoperative generator ;
 - (2) The condition of a completely depleted battery with the generator running at its normal operating speed; and
 - (3) The condition of a completely depleted battery with the generator operating at idling speed if there is only one battery.
 - (4) There must be means to warn the UA Pilot if malfunctioning of any part of the electrical system is causing the continuous discharge of any battery used for engine ignition.

POWERPLANT FIRE PROTECTION

CS-LURS.1183 Lines, fittings, and components

- (a) Except as provided in sub-paragraph (b), each component, line, and fitting carrying flammable fluid in any area subject to engine fire conditions must be at least fire resistant, except that flammable fluid tanks and supports which are part of and attached to the engine must be fireproof or be enclosed by a fireproof shield unless damage by fire to any non-fireproof part will not cause leakage or spillage of flammable fluid. Components must be shielded or located so as to safeguard against the ignition of leaking flammable fluid. An integral oil sump of less than 23.7 liters (5.2 Imperial gallons/25-US quart) capacity on an engine need not be fireproof nor be enclosed by a fireproof shield.
- (b) Sub paragraph (a) does not apply to-
 - (1) Lines, fittings, and components which are already approved as part of a type certificated engine; and
 - (2) Vent and drain lines, and their fittings whose failure will not result in, or add to, a fire hazard.
- (c) Each flammable fluid drain and vent must discharge clear of the induction system air inlet.

CS-LURS.1185 Flammable fluids

- (a) Each fuel tank must be isolated from the engines by a firewall or shroud.
- (b) Each tank or reservoir, other than a fuel tank, that is part of a system containing flammable fluids or gases must be isolated from the engine by a firewall or shroud, unless the design of the system, the materials used in the tank and its supports, the shutoff means, and the connections, lines and controls provide a degree of safety equal to that which would exist if the tank or reservoir were isolated from the engine.
- (c) There must be at least 13mm of clear airspace between each tank and each firewall or shroud isolating that tank, unless equivalent means are used to prevent heat transfer from each engine compartment to the flammable fluid.

CS-LURS.1187 Ventilation

Each compartment containing any part of the powerplant installation must have provision for ventilation.

CS-LURS.1191 Firewalls

- (a) The engine must be isolated by a firewall, shroud, or equivalent means, from the payload compartment, structures, controls, rotor mechanisms, and other parts that are-
 - (1) Essential to a controlled landing; and
 - (2) Not protected under CS-LURS 861;

- (b) Reserved.
- (c) In meeting sub-paragraph (a), account must be taken of the probable path of a fire as affected by the airflow in normal flight and in autorotation.
- (d) Each firewall and shroud must be constructed so that no hazardous quantity of air, fluids, or flame can pass from any engine compartment to other parts of the rotorcraft.
- (e) Each opening in the firewall or shroud must be sealed with close-fitting, fireproof grommets, bushings, or firewall fittings.
- (f) Each firewall and shroud must be fireproof and protected against corrosion.

CS-LURS.1193 Cowling and engine compartment covering

- (a) Each cowling must be constructed and supported so that it can resist any vibration, inertia, and air loads to which it may be subjected in operation.
- (b) There must be means for rapid and complete drainage of each part of the cowling in the normal ground and flight attitudes. No drain may discharge where it will cause a fire hazard.
- (c) Cowling must be at least fire resistant.
- (d) Each part behind an opening in the engine compartment cowling must be at least fire resistant for a distance of at least 60 cm aft of the opening.
- (e) Each part of the cowling subjected to high temperatures due to its nearness to exhaust system ports or exhaust gas impingement, must be fireproof.

CS-LURS.1194 Other Surfaces

All surfaces aft of, and near, powerplant compartments, other than tail surfaces not subject to heat, flames, or sparks emanating from a powerplant compartment, must be at least fire resistant.

SUBPART F – EQUIPMENT

GENERAL

CS-LURS.1301 Function and installation

- (a) Each item of installed LURS equipment and systems must –
 - (1) Be of a kind and design appropriate to its intended function;
 - (2) Be labeled as to its identification, function, or operating limitations, or any applicable combination of these factors;
 - (3) Be installed according to limitations specified for that equipment; and
- (b) The LURS equipment and systems must be designed and installed so that:
 - (1) Those required for type certification or by operating rules, or whose improper functioning would reduce safety, perform as intended under the aircraft operating and environmental conditions.
 - (2) Other equipment and systems are not a source of danger in themselves and do not adversely affect the proper functioning of those covered by sub-paragraph (b)(1) of this paragraph.

CS LURS.1303 Flight and navigation instruments

The LURS equipment should provide the data for the required flight and navigation instruments as defined in CS LURS.1709

CS-LURS.1305 Powerplant instruments

The LURS equipment should provide the data for the required powerplant instruments as defined in CS LURS.1711

CS-LURS.1307 Miscellaneous equipment

The following is the required miscellaneous equipment:

- (a) An adequate source of electrical energy, where electrical energy is necessary for operation of the rotorcraft.
- (b) Electrical protective devices.

CS-LURS.1309 Equipment, systems, and installations

-(Refer to separate document AMC RPAS.1309)

The requirements of this section, except as identified in paragraphs (a) through (d), are applicable, in addition to specific design requirements of CS-LURS, to any equipment or system as part of the UAS.

- a) The UAS equipment and systems must be designed and installed so that:
 - 1) Those required for type certification or by operating rules perform as intended under the UAS operating and environmental conditions including radio frequency energy and the effects (both direct and indirect) of lightning strikes.
 - 2) Any equipment and system does not adversely affect the safety of the UAS, the UAS crew, third parties or the proper functioning of those covered by paragraph (a)(1) of this section.
- b) The UAS systems and associated components considered separately and in relation to other systems, must be designed and installed so that:
 - 1) Each catastrophic failure condition is extremely improbable and does not result from a single failure;
 - 2) Each hazardous failure condition is extremely remote; and
 - 3) Each major failure condition is remote.

(c) Information concerning an unsafe system operating condition must be provided in a timely manner to the crew to enable them to take appropriate corrective action. An appropriate alert must be provided if immediate pilot awareness and immediate or subsequent corrective action is required. Systems and controls, including indications and annunciations, must be designed to minimize crew errors which could create additional hazards

CS-LURS.1310 Power source capacity and distribution

- (a) Each installation whose functioning is required for type certification or by operating rules and that requires a power supply is an "essential load" on the power supply. The power sources and the system must be able to supply the following power loads in probable operating combinations and for probable durations:
- (1) Loads connected to the system with the system functioning normally.
 - (2) Essential loads, after failure of any one prime mover, power converter, or energy storage device.
 - (3) Essential loads for which an alternate source of power is required, after any failure or malfunction in any one power supply system, distribution system, or other utilization system.
- (b) In determining compliance with subparagraph (a)(2) of this paragraph, the power loads may be assumed to be reduced under a monitoring procedure consistent with safety in the kinds of operation authorized.

CS-LURS.1316 Electrical and electronic system lightning protection

See AMC CS-LURS.1316

- a) Each electrical and electronic system that performs a function, for which failure would prevent the continued safe flight and landing of the rotorcraft, must be designed and installed so that--
- (1) The function is not adversely affected during and after the time the rotorcraft is exposed to lightning; and
 - (2) The system automatically recovers normal operation of that function in a timely manner after the rotorcraft is exposed to lightning.
- For rotorcraft approved for instrument flight rules operation, each electrical and electronic system that performs a function, for which failure would reduce the capability of the rotorcraft or the ability of the flightcrew to respond to an adverse operating condition, must be designed and installed so that the function recovers normal operation in a timely manner after the rotorcraft is exposed to lightning.

CS-LURS.1317 High-Intensity Radiated Fields (HIRF) Protection

See Appendix D

- a) Except as provided in paragraph (d) of this section, each electrical and electronic system that performs a function whose failure would prevent the continued safe flight and landing of the rotorcraft must be designed and installed so that--
- (1) The function is not adversely affected during and after the time the rotorcraft is exposed to HIRF environment I, as described in appendix D to this part;
 - (2) The system automatically recovers normal operation of that function, in a timely manner, after the rotorcraft is exposed to HIRF environment I, as described in appendix D to this part, unless this conflicts with other operational or functional requirements of that system;
 - (3) The system is not adversely affected during and after the time the rotorcraft is exposed to HIRF environment II, as described in appendix D to this part; and
 - (4) Each function required during operation under visual flight rules is not adversely affected during and after the time the rotorcraft is exposed to HIRF environment III, as described in appendix D to this part.
- b) (b) Each electrical and electronic system that performs a function whose failure would significantly reduce the capability of the rotorcraft or the ability of the flightcrew to respond to an adverse operating condition must be designed and installed so the system is not adversely affected when the equipment providing these

functions is exposed to equipment HIRF test level 1 or 2, as described in appendix D to this part.

(c) Each electrical and electronic system that performs a function whose failure would reduce the capability of the rotorcraft or the ability of the flightcrew to respond to an adverse operating condition, must be designed and installed so the system is not adversely affected when the equipment providing these functions is exposed to equipment HIRF test level 3, as described in appendix D to this part.

INSTRUMENTS: INSTALLATION

CS-LURS.1323 Airspeed indicating system

If an airspeed indicating system is required per CS LURS.1709:

- (a) Each airspeed indicating system must be calibrated to indicate true airspeed (at sea-level with a standard atmosphere) with a minimum practicable system calibration error.
- (b) The airspeed indicating system must be calibrated in flight at forward speeds of 37 km/h (20 kts) and over.

CS LURS.1325 Static pressure system

If a static pressure system is required per CS LURS.1709:

- (a) Each sensor with static air case connections must be vented so that the influence of rotorcraft speed, the opening and closing of panels, external loads, airflow variation and moisture or other foreign matter, does not seriously affect its accuracy.

The design and installation of a static pressure system must be such that-

- (1) Positive drainage of moisture is provided;
- (2) Chafing of the tubing, and excessive distortion or restriction at bends in the tubing, is avoided; and
- (3) The materials used are durable, suitable for the purpose intended, and protected against corrosion

CS LURS.1327 Magnetic direction sensor

If a Magnetic Direction Indicator is required per CS LURS.1709, then the magnetic direction sensor must be installed so that its accuracy is not excessively affected by the rotorcraft's vibration or magnetic fields.

CS-LURS.1329 Flight control system

(see AMC CS-LURS.1329)

The system must be designed and adjusted so that, within the range of adjustment available to the pilot, it cannot produce hazardous loads on the rotorcraft or create hazardous deviations in the flight path under any flight condition appropriate to its use, either during normal operation or in the event of a malfunction, assuming that corrective actions begins within a reasonable period of time.

CS-LURS.1331 Instruments using a power supply

For each rotorcraft-

- a) Each indicating sensor required by CS LURS.1709 must derive its energy from power sources adequate to maintain its required accuracy at any speed above the best rate-of-climb speed;
- b) Each indicating sensor required by CS LURS.1709 must be installed so as to prevent malfunction due to rain, oil and other detrimental elements

CS LURS.1337 Powerplant instruments

(a) Instruments and instrument lines

(1) Each powerplant instrument line must meet the requirements of CS LURS.961 and 993 .

(2) Each line carrying flammable fluids under pressure must -

- (i) Have restricting orifices or other safety devices at the source of pressure to prevent the escape of excessive fluid if the line fails; and
- (ii) Be installed and located so that the escape of fluids would not create a hazard.

(3) Each powerplant instrument sensing device that utilises flammable fluids must be installed and located so that the escape of fluid would not create a hazard.

(b) *Fuel flow meter system.* If a fuel flow meter system is installed, each metering component must have a means for bypassing the fuel supply if malfunction of that component severely restricts fuel flow.

(c) *Oil quantity indicator.* There must be means to indicate the quantity of oil in each tank on the ground (including during the filling of each tank).

(d) Rotor drive system transmissions and gearboxes utilizing ferromagnetic materials must be equipped with chip detectors designed to indicate or reveal the presence of ferromagnetic particles resulting from damage or excessive wear. Chip detectors must be removable for inspection of the magnetic poles for metallic chips

ELECTRICAL SYSTEMS AND EQUIPMENT

CS-LURS.1351 General

- (a) Electrical system capacity. Electrical equipment must be adequate for its intended use. In addition-
 - (1) Electric power sources, their transmission cables, and their associated control and protective devices must be able to furnish the required power at the proper voltage to each load circuit essential for safe operation; and
 - (2) Compliance with sub-paragraph (a)(1) must be shown by an electrical load analysis, or by electrical measurements that take into account the electrical loads applied to the electrical system in probable combinations and for probable durations.

- (b) Function. For each electrical system, the following apply:
 - (1) Each system when installed, must be -
 - (i) Free from hazards in itself, in its method of operation, and in its effects on other parts of the rotorcraft; and
 - (ii) Protected from fuel, oil, water other detrimental substances, and mechanical damage.
 - (2) Electric power sources must function properly when connected in combination or independently, except that alternators may depend on a battery for initial excitation or for stabilization.
 - (3) No failure or malfunction of any source may impair the ability of any remaining source to supply load circuits essential for safe operation, except that the operation of an alternator that depends on a battery for initial excitation or for stabilization may be stopped by failure of that battery
 - (4) Each electric power source control must allow the independent operation of each source, except that controls associated with alternators that depend on a battery for initial excitation or for stabilization need not break connection between the alternator and its battery.

- (c) Generating system, if installed. There must be at least one generator if the system supplies power to load circuits essential for safe operation. In addition-
 - (1) Each generator must be able to deliver its continuous rated power;
 - (2) Generator voltage control equipment must be able to dependably regulate each generator output within rated limits;
 - (3) Each generator must have a reverse current cutout designed to disconnect the generator from the battery and from the other generators when enough reverse current exists to damage that generator.
 - (4) Each generator must have an overvoltage control designed and installed to prevent damage to the electrical system, or to equipment supplied by the electrical system, that could result if that generator were to develop an overvoltage condition; and
 - (5) There must be a means to give immediate warning to the UA Pilot of a failure of any generator.

- (d) NA

- (e) Fire resistance. Electrical equipment must be so designed and installed that in the event of a fire in the engine compartment, during which the surface of the firewall adjacent to the fire is heated to 1100°C for 5 minutes or to a lesser temperature substantiated by the applicant, the equipment essential to continued safe operation and located behind the firewall will function satisfactorily and will not create an additional fire hazard. This may be shown by test or analysis.

- (f) External power. If provisions are made for connecting external power to the rotorcraft, and that external power can be electrically connected to equipment other than that used for engine starting, means must be provided to ensure that no external power supply having a reverse polarity, or reverse phase sequence, can supply power to the rotorcraft's electrical system.

- (g) It must be shown by analysis, tests or both, that the UAS (UAV + Ground Station) can be operated safely in the approved operational envelope according CS-LURS.23, for a period required to perform the emergency recovery procedure according CS-LURS.1412 in case of normal (main) electrical power inoperative

CS-LURS.1353 Storage battery design and installation

- (a) Each storage battery must be designed and installed as prescribed in this paragraph.
- (b) Safe cell temperatures and pressures must be maintained during any probable charging and discharging condition. No uncontrolled increase in cell temperature may result when the battery is recharged (after previous complete discharge) -
 - (1) At maximum regulated voltage or power;
 - (2) During a flight of maximum duration; and
 - (3) Under the most adverse cooling condition likely to occur in service.
- (c) Compliance with sub-paragraph (b) must be shown by test or experience with similar batteries and installations.
- (d) No explosive or toxic gases emitted by any battery in normal operation, or as the result of any probable malfunction in the charging system or battery installation, may accumulate in hazardous quantities within the rotorcraft.
- (e) No corrosive fluids or gases that may escape from the battery may damage surrounding structures or adjacent essential equipment.
- (f) Each battery installation capable of being used to start an engine or auxiliary power unit must have provisions to prevent any hazardous effect on structure of essential systems that may be caused by the maximum amount of heat the battery can generate during a short circuit of the battery or its individual cells.
- (g) Battery installations capable of being used to start an engine or auxiliary power unit must have -
 - (1) A system to control the charging rate of the battery automatically so as to prevent battery overheating;
 - (2) A battery temperature sensing and over temperature warning system with means for disconnecting the battery from its charging source in the event of an over-temperature condition; or
 - (3) A battery failure sensing and warning system with a means for disconnecting the battery from its charging source in the event of battery failure.

CS-LURS.1357 Circuit protective devices

- (a) Protective devices, such as circuit breakers, must be installed in each electrical circuit other than-
 - (1) The main circuits of starter motors; and
 - (2) Circuits in which no hazard is presented by their omission.
- (b) A protective device for a circuit essential to flight safety may not be used to protect any other circuit.
- (c) Where installed, each remotely resettable circuit protective device (“trip free” device in which the tripping mechanism cannot be over-ridden by the operating control) must be designed so that
 - (1) A remote operation to be done by the UAV crew is required to restore service after tripping; and

- (2) If an overload or circuit fault exists, the device will open the circuit regardless of the position of the operating control.
- (3) Where automatic resettable circuit protection devices are used they must be designed so they comply with (c) (2) and restore circuit integrity on removal of fault condition.

(d) If the ability to reset a circuit breaker is essential to safety in flight, that circuit must be located and identified so that it can be readily remotely reset in flight.

CS-LURS.1359 Electrical system fire protection

- (a) Components of the electrical system must meet the applicable fire protection requirements of CS-LURS.861 and CS-LURS.1183.
- (b) Electrical cables, terminals and equipment in designated fire zones, that are used during emergency procedures, must be at least fire-resistant.
- (c) Insulation on electrical wire and cable must be self-extinguishing when tested at an angle of 60° in accordance with approved methods. The average burn length must not exceed 76 mm (3 in) and the average flame time after removal of the flame source must not exceed 30 seconds. Drippings from the test specimen must not continue to flame for more than an average of 3 seconds after falling.

CS-LURS.1361 UA Electrical Load Shedding

- (a) There must be an easily discernible and accessible means to allow ready shedding of electrical loads on the UA.
- (b) Load shedding must be achieved by disconnection of all electric power sources on the UA from the power distribution systems except load circuits that are required for continued safe flight and landing
- (c) The point of disconnection must be adjacent to the power sources controlled.

CS-LURS.1365 Electric cables

- (a) Each electric connecting cable must be of adequate capacity and correctly routed, attached and connected so as to minimize the probability of short circuits and fire hazards.
- (b) Each cable and associated equipment that would overheat in the event of circuit overload or fault must be at least flame resistant and may not emit dangerous quantities of toxic fumes.

CS-LURS.1367 Switches

Each switch must be

- (a) Able to carry its rated current;

- (b) Constructed with enough distance or insulating material between current carrying parts and the housing so that vibration in flight will not cause shorting;
- (c) Accessible to appropriate maintenance staff ; and
- (d) Labeled as to operation and the circuit controlled

LIGHTS

CS-LURS.1384 External lights

- a) If external lights are installed for see & avoid purpose, then they must comply with paragraphs 27.1385 to 27.1401 of CS-27 as appropriate.
- b) For RPA where a) is impractical, a special condition applies.

SAFETY EQUIPMENT

CS-LURS.1412 Emergency recovery capability

(see AMC CS-LURS.1412)

- (a) The UAS must integrate an emergency recovery capability to prevent third party risk that consists of :
 - (1) a flight termination system, procedure or function that aims to immediately end the flight, or,
 - (2) an emergency recovery procedure that is implemented through UA crew command or by the onboard systems. This may include automatic pre-programmed course of action to reach a predefined and unpopulated forced landing area, or,
 - (3) any combination of CS-LURS.1412 (a) (1) and CS-LURS.1412 (a) (2).
- (b) The emergency recovery capability must be achievable in the whole flight envelope under the most adverse combination of environmental and operating conditions
- (c) The emergency recovery capability must be safeguarded from interference leading to inadvertent or unauthorized operation.
- (d) The emergency recovery capability must receives its electrical power, if needed, from the bus that provides the maximum reliability for operation..
- (e) The emergency recovery capability must be achievable after loss of the primary electrical system.
- (f) Use of explosives to perform in-flight destruction of the air vehicle is not an acceptable means of compliance to this requirement

CS-LURS.1413 Contingency procedures

See AMC CS-LURS.1413

- a) To ensure, the unmanned aircraft does not present a danger to people and properties on ground and does not present a risk for mid-air collision following a control link degradation, each UAV shall specify in the Flight Manual or other approved Manual the contingency procedures for the degraded status according CS-LURS.1425:
 - i. Degraded message error rate (DMER)
 - ii. Critical message error rate (CMER)

iii. Automatic message error rate (AMER)

b) The Contingency procedures must be safeguarded from interference leading to inadvertent operation.

COMMAND AND CONTROL DATALINK

CS-LURS.1421 General

See AMC CS-LURS.1421

(a) The UAS communication system consists of the following subsystems:

- (1) the command and control data link subsystem,
- (2) the ATC communication subsystem,
- (3) the payload data link subsystem.

(b) The present part on Command and Control Datalink only covers the command and control data link subsystem. ATC communication and payload data link are regulated by Operation materials.

(c) A UAS must include a command and control data link for control of the UAS with the following functions:

- (1) Transmittal of UAS crew commands from the CONTROL STATION to the UAS (uplink), and
- (2) Transmittal of UAS status data from the UAS to the CONTROL STATION (downlink). This status data must include the appropriate data as defined in CS LURS.1709
- (3) The status of the datalink uplink and downlink needs to be indicated to the remote pilot.

CS-LURS.1423 Command and control data link loss

See AMC CS-LURS.1423

a) The unmanned aircraft shall not present a danger to people and properties on ground following the complete loss of the data link.

b) The unmanned aircraft shall not present a danger for a mid-air collision following the complete loss of the control data link.

c) There must be an alert for the UAS crew, via a clear and distinct aural and visual signal, for any loss of the command and control data link.

d) A command and control data link loss strategy must be established, approved and presented in the UAS Flight Manual taking into account the emergency recovery capability as defined in CS-LURS.1412

e) The command and control data link loss strategy shall include an reacquisition process in order to try to re-establish in a reasonable short time the command and control data link.

CS-LURS.1425 Command and control data link modes

See AMC CS-LURS.1425

- a) Due to possible fluctuation of the command and control datalink, each UAV shall specify in the Flight Manual or other approved Manual the:
- (1) Normal transmission mode
 - (2) Degraded message error rate (DMER) mode
 - (3) Critical message error rate (CMER) mode
 - (4) Automatic message error rate (AMER) mode

CS-LURS.1427 Required C2 Communication Performance (C2-RCP)

See AMC CS-LURS.1427

- a) Each UAV shall specify in the Flight Manual or other approved Manual the Required C2 Communication Performance (C2-RCP) in terms of:
- Throughput
 - Communication transaction time
 - Continuity
 - Availability
 - Integrity
- With regard to the command and control data link degradation according CS-LURS.1425
- b) A message error rate (MER) above the CMER for a period longer than the “Minimum Time Before link Recovery” (MTBR) shall initiate the contingency procedure according CS-LURS.1413 for AMER.

CS-LURS.1429 Required Command and control data priorities

See AMC CS-LURS.1429

- a) Each UAV shall specify in the Flight Manual or other approved Manual the priority of the Required Command and Control Data required for CS-LURS.1709 with regard to the command and control data link degradation DMER, CMER and AMER according CS-LURS.1425
- b) A datalink performance which does not allow the transmission of the Required Command and control data at the CMER for a period longer than the “minimum time before link recovery” (MTBR) shall initiate the Emergency recovery procedure according CS-LURS.1412.

MISCELLANEOUS EQUIPMENT

CS-LURS.1431 Electronic equipment

Electronic equipment and installations must be free from hazards in themselves, in their method of operation, and in their effects on other components.

CS-LURS.1461 Equipment containing high energy rotors

- (a) Equipment containing high-energy rotors must meet sub-paragraphs (b), (c), or (d).
- (b) High-energy rotors contained in equipment must be able to withstand damage caused by malfunctions, vibration, abnormal speeds, and abnormal temperatures. In addition -
 - (1) Auxiliary rotor cases must be able to contain damage caused by the failure of high energy rotor blades; and
 - (2) Equipment control devices, systems, and instrumentation must reasonably ensure that no operating limitations affecting the integrity off high-energy rotors will be exceeded in service.
- (c) It must be shown by test that equipment containing high-energy rotors can contain any failure of a high energy rotor that occurs at the highest speed obtainable with the normal speed control devices inoperative.
- (d) Equipment containing high-energy rotors must be located where rotor failure will not adversely affect continued safe flight.

CS-LURS.1481 Payload

- a) A payload is a device or equipment carried by the RPA, which performs the mission assigned. The payload comprises all elements of the air vehicle that are not necessary for flight but are carried for the purpose of fulfilling specific mission objectives. It is assumed that a RPA System Type Certification Basis may be released for several payload configurations.
- b) Where a RPA System is designed to carry payloads, the integration and operation of those payloads must not adversely affect the safe flight and control of the RPA;

BOOK 1 - SUBPART G - OPERATING LIMITATIONS AND INFORMATION

GENERAL

CS-LURS.1501 General

- (a) Each operating limitation specified in CS-LURS. 1503 to 1525 and other limitations and information necessary for safe operation must be established.
- (b) The operating limitations and other information necessary for safe operation must be made available to the crew members as prescribed in CS-LURS.1541 to 1589.

OPERATING LIMITATIONS

CS-LURS.1503 Airspeed limitations: general

- (a) An operating speed range must be established.
- (b) When airspeed limitations are a function of weight, weight distribution, altitude, rotor speed, power, or other factors, airspeed limitations corresponding with the critical combinations of these factors must be established.

CS-LURS.1505 Never-exceed speed

- (a) The never-exceed speed, V_{NE} , must be established so that it is-
 - (1) Reserved
 - (2) Not more than the lesser of-
 - (i) 0.9 times the maximum forward speeds established under CS-LURS.309;
 - (ii) 0.9 times the maximum speed shown under CS-LURS.251 and 629; or
 - (iii) 0.9 times the maximum speed substantiated for advancing blade tip mach number effects.
- (b) V_{NE} may vary with altitude, rpm, temperature, and weight, if
 - (1) No more than two of these variables (or no more than two instruments integrating more than one of these variables) are used at one time, and
 - (2) The range of these variables (or of the indications on instruments integrating more than one of these variables) are large enough to allow an operationally practical and safe variation of V_{NE} .
- (c) A stabilized power-off V_{NE} denoted as V_{NE} (power-off) may be established at a speed less than V_{NE} established pursuant to subparagraph (a), if the following conditions are met:
 - (1) V_{NE} (power-off) is not less than a speed midway between the power-on V and the speed used in meeting the requirements of CS-LURS.65(b).
 - (2) V_{NE} (power-off) is-
 - (i) A constant airspeed;
 - (ii) A constant amount less than power-on V_{NE}
 - (iii) A constant airspeed for a portion of the altitude range for which certification is requested, and a constant amount less than power on V_{NE} for the remainder of the altitude range.

CS-LURS.1509 Rotor speed

- (a) *Maximum power-off (autorotation)*. The maximum power-off rotor speed must be established so that it does not exceed 95 % of the lesser of -
 - (1) The maximum design rpm determined under CS-LURS.309(b) ; and
 - (2) The maximum rpm shown during the type tests.
- (b) *Minimum power-off*. The minimum power-off rotor speed must be established so that it is not less that 105 % of the greater of -
 - (1) The minimum shown during the type tests; and
 - (2) The minimum determined by design substantiation.
- (c) *Minimum power-on*. The minimum power-on rotor speed must be established so that it is-

(1) Not less than the greater of-

- (i) The minimum shown during the type tests; and
- (ii) The minimum determined by design substantiation; and

(d) Not more than a value determined under CS-LURS.33 (a)(1) and (b)(1).

CS-LURS.1519 Weight and centre of gravity

The weight and centre of gravity limitations determined under CS-LURS.25 and 27, respectively, must be established as operating limitations.

CS-LURS.1521 Powerplant limitations

- (a) *General.* The powerplant limitations prescribed in this paragraph must be established so that they do not exceed the corresponding limits established for the engine.
- (b) *Take-off operation.* The powerplant take-off operation must be limited by -
 - (1) The maximum rotational speed, which may not be greater than -
 - (i) The maximum value determined by the rotor design; or
 - (ii) The maximum value shown during the type tests;
 - (2) The maximum allowable value of the critical engine parameters;
 - (3) The time limit for the use of the power corresponding to the limitations established in subparagraph (b)(1) and (2);
- (c) *Continuous operation.* The continuous operation must be limited by-
 - (1) The maximum rotational speed which may not be greater than-
 - (i) The maximum value determined by the rotor design; or
 - (ii) The maximum value shown during the type tests;
 - (2) The minimum rotational speed shown under the rotor speed requirements in CS-LURS. 1509(c).
- (d) *Fuel grade or designation.* The minimum fuel grade must be established so that is not less than that required for the operation of the engine within the limitations in sub-paragraph (b) and (c).

CS-LURS.1523 Minimum Flight Crew

The minimum flight crew must be established so that it is sufficient for safe operation considering:

- (a) The workload on individual crew members
- (b) Each crew member workload and role must be determined considering the following:
 - (1) Flight path control

- (2) Separation and collision avoidance with ground obstacle or air traffic
- (3) Navigation
- (4) Communications
- (5) Operation and monitoring of all UAS systems required for continued safe flight and landing
- (6) Tasks not related to piloting (e.g. payload operation)
- (7) Command decisions and
- (8) The accessibility and ease of operation of necessary controls by the appropriate crew member during all normal and emergency operations when at the crew member flight station.

(c) The kinds of operation authorized under CS-LURS.1525.

CS-LURS.1525 Kinds of operation

The kinds of operation to which the rotorcraft is limited are established as part of the certification and by the installed equipment.

CS-LURS.1527 Maximum operating altitude

The maximum altitude up to which operation is allowed, as limited by flight, structural, powerplant, functional, or equipment characteristics, must be established.

CS-LURS.1529 Instructions for Continued Airworthiness

(See Appendix A)

Instructions for Continued Airworthiness in accordance with Appendix A must be prepared.

MARKINGS AND PLACARDS

CS-LURS.1541 General

(a) The LURS must contain-

- (1) The markings and placards specified in CS-LURS.1557, CS-LURS.1565 and CS-LURS.1745 to CS-LURS-1759, and
- (2) Any additional information, instrument markings, and placards required for the safe operation of rotorcraft if it has unusual design, operating or handling characteristics.

(3) Placards intended for use by the flight crew should be placed at an appropriate location in the control station.

(b) Each marking and placard prescribed in sub-paragraph (a) -

- (1) Must be displayed in a conspicuous place; and
- (2) May not be easily erased, disfigured, or obscured.

(c) The units of measurement used on placards must be the same as those used on the indicators.

CS-LURS.1557 Miscellaneous markings and placards

(a) *Cargo compartments, and ballast location.* Each cargo compartment, and each ballast location must have a placard stating any limitations on contents, including weight, that are necessary under the loading requirements.

(b) *Fuel and oil filler openings.* The following apply:

- (1) Fuel filler openings must be marked at or near the filler cover with the minimum fuel grade, fuel designation, fuel capacity of the tank, and for each 2-stroke engine without a separate oil system, fuel/oil mixture ratio.
- (2) Oil filler openings must be marked at or near the filler cover;
 - (i) With the grade; and
 - (ii) Whether the oil is detergent or non-detergent.

(c) *Fuel tanks.* The useable fuel capacity in volumetric units of each tank must be marked at the selector and on the fuel quantity indicator.

(d) .Not applicable

(e) The system voltage of each direct current electrical installation must be clearly marked adjacent to its external power connection.

(f) When installed, equipment that may be hazardous to people on the ground must be clearly marked .

CS-LURS.1565 Main and Tail rotors

All main and tail rotors must be marked so that their discs are conspicuous under normal daylight ground conditions.

FLIGHT MANUAL AND APPROVED MANUAL MATERIAL

CS-LURS.1581 General

(a) *Furnishing information.* A Flight Manual must be furnished with each UAS, and it must contain the following:

- (1) Information required by CS-LURS.1583 through 1589.

- (2) Other information that is necessary for safe operation because of design, operating, or handling characteristics.
- (3) Information that is necessary for the FTS per CS-LURS.1412 and the contingency procedure per CS-LURS.1413.

- (b) *Approved information.* Each part of the manual listed in CS-LURS.1583 through 1589, that is appropriate to the UAS, must be furnished, verified, and approved, and must be segregated, identified, and clearly distinguished from each unapproved part of that manual.
- (c) *Non-approved Information.* Non-approved information must be presented in a manner acceptable to the Certifying Authority.
- (d) *Units.* The units of measurement used in the manual must be the same as those used on the indicators.
- (e) *Table of contents.* Each UAS Flight Manual must include a table of contents if the complexity of the manual indicates a need for it.

CS-LURS.1583 Operating limitations

- (a) *Airspeed and rotor limitations.* Information necessary for the marking of airspeed and rotor limitations on, or near, their respective indicators must be furnished. The significance of each limitation and of the color coding must be explained.
- (b) *Powerplant limitations.* The following information must be furnished:
 - (1) Limitations required by CS-LURS. 1521.
 - (2) Explanation of the limitations, when appropriate.
 - (3) Information necessary for marking the instruments required by CS-LURS.1549 to 1553.
 - (4) For two-stroke engines, fuel/oil ratio.
- (c) *Weight and loading distribution.* The weight and centre of gravity limits required by CS-LURS.25 and 27, respectively, must be furnished. If the variety of possible loading warrants the necessity, instructions must be included to allow ready observance of the limitations.
- (d) *Kinds of operation.* Each kind of operation for which the rotorcraft and its equipment installations are approved including the approved operational envelope according CS-LURS.23 must be listed.
- (e) *Altitude.* The altitude established under CS-LURS. 1527 and an explanation of the limiting factors must be furnished.

CS-LURS.1585 Operating procedures

- (a) Part of the manual containing operating procedures must have information concerning any normal and emergency procedures and other information necessary for safe operation, including take-off and landing procedures and associated airspeeds. The manual must contain any pertinent information including-
 - (1) The kind of take-off surface used in the tests and each appropriate climbout speed; and
 - (2) The kind of landing surface used in the tests and appropriate approach and glide airspeeds.

- (b) For helicopters for which a V_{NE} (power-off) is established under CS-LURS. 1505, information must be furnished to explain the V_{NE} (power-off) and the procedures for reducing airspeed to not more than the V_{NE} (power-off) following failure of engine.
- (c) For each rotorcraft showing compliance with CS-LURS. 1353(g)(2) or (g)(3), the operating procedures for disconnecting the battery from its charging source must be furnished.
- (d) If the unusable fuel supply in any tank exceeds 5 % of the tank capacity, information must be furnished which indicates that when the fuel quantity indicator reads "zero" in level flight, any fuel remaining in the fuel tank cannot be used safely in flight.
- (e) Information on the total quantity of useable fuel for each fuel tank must be furnished.
- (f) The airspeed and rotor speeds for minimum rate of descent and best glide angle as prescribed in CS-LURS.71 must be provided.

CS-LURS.1587 Performance information

(see AMC CS-LURS.1587(a))

- (a) The UAS must be furnished with the following information, determined in accordance with CS-LURS.51 to 79 and 143(c) :
 - (1) Enough information to determine the limiting height-speed envelope.
 - (2) If a predefined and unpopulated forced landing area is used to fulfill CS-LURS.1412, performance data shall be provided, to enable the pilot to ensure that the RPA is able to reach the appropriate predefined and unpopulated forced landing areas defined in CS-LURS.561
 - (3) Information relative to -
 - (i) The hovering ceilings and the steady rates of climb and descent, as affected by any pertinent factors such as airspeed, temperature, and altitude;
 - (ii) The maximum safe wind for operation near the ground. If there are combinations of weight, altitude and temperature for which performance information is provided and at which the rotorcraft cannot land and take-off safely with the maximum wind value, those portions of the operating envelope and the appropriate safe wind conditions shall be identified in the flight manual.
 - (iii) The maximum atmospheric temperature at which compliance with the cooling provisions of CS-LURS.1041 to -1045 is shown; and
 - (iv) Glide distance as a function of altitude when autorotating at the speeds and conditions for minimum rate of descent and best glide as determined in CS-LURS.71.
- (b) The UAS Flight Manual must contain, in its performance information section, any pertinent information concerning the take-off weights and altitudes used in compliance with CS-LURS.51.

CS-LURS.1589 Loading information

There must be loading instructions for each possible loading condition between the maximum and minimum weights determined under CS-LURS.25 that can result in a centre of gravity beyond any extreme prescribed in CS-LURS.27.

BOOK 1 - SUBPART H
NOW RESERVED FOR DETECT AND AVOID REQUIREMENTS
This subpart (originally for command and control datalink) has been deleted and integrated in subparts F and I
BOOK 1 - SUBPART I
CONTROL STATION
<p>CS-LURS.1700 Aircraft and Control Station pairing</p> <p>There must be a positive indication at the control station that the intended aircraft has been paired and full control established prior to flight.</p>
<p>CS-LURS.1702 Systems and equipment used by the crew See AMC CS-LURS.1702 (to be derived from AMC 25.1302)</p> <p>This paragraph applies to equipment intended for crew members' use in the operation of the UA at the control station. This installed equipment must be shown, individually and in combination with other such equipment, to be designed so that qualified crew members trained in its use can safely perform their tasks associated with its intended function by meeting the following requirements:</p> <ul style="list-style-type: none"> (a) controls must be installed to allow accomplishment of these tasks and information necessary to accomplish these tasks must be provided. (b) controls and information intended for crew use must: <ul style="list-style-type: none"> (1) Be presented in a clear and unambiguous form, at resolution and precision appropriate to the task. (2) Be accessible and usable by the crew in a manner consistent with the urgency, frequency, and duration of their tasks, and (3) Enable crew awareness, if awareness is required for safe operation, of the effects on the UA or systems resulting from crew actions. (c) Operationally-relevant behaviour of the installed equipment must be: <ul style="list-style-type: none"> (1) Predictable and unambiguous, and (2) Designed to enable the crew to intervene in a manner appropriate to the task. (d) To the extent practicable, installed equipment must enable the crew to manage errors resulting from the kinds of flight crew interactions with the equipment that can be reasonably expected in service, assuming the flight crew is acting in good faith. This sub-paragraph (d) does not apply to skill-related errors associated with manual control of the aircraft. (e) The equipment must allow the crew member to perform his duties without unreasonable concentration or fatigue;
<p>CS-LURS.1705 Control Station controls</p>

Controls must be-

- (a) Located to provide convenient operation and to prevent confusion and inadvertent operation; and
- (b) Located and arranged so that there is full and unrestricted movement of each control

CS-LURS.1707 Motion and effect of controls

- (a) Controls should be designed according to accepted Human Factors principles
- (b) Where the control station is configured to allow direct manual control of the aircraft, then controls must be designed so that they operate in accordance with the following movements and actuation:
 - (i) Flight controls, , must operate with a sense of motion which corresponds to the effect on the rotorcraft.

CS LURS.1709 Flight and navigation instruments

- (a) Reserved
- (b) The applicant must demonstrate by flight test, that sufficient information is provided to the pilot to maintain control of the rotorcraft within the determined approved operational envelope according CS-LURS.23.
- (c) Any equipment used to determine the approved operational envelope according CS-LURS.23 must be certificated under this Airworthiness code.

CS-LURS.1711 Electronic Display Instrument Systems

(See AMC LURS.1711 to be derived from AMC 23.1311)

- (a) Electronic display indicators, including those with features that make isolation and independence between powerplant instrument systems impractical, must –
 - (1) Meet the arrangement and visibility requirements of CS-LURS.1721;
 - (2) Be easily legible under all lighting condition encountered in the control station, including direct sunlight during the entire useful life
 - (3) Not inhibit the primary display of the data required by CS-LURS.1709 in any normal mode of operation.
 - (4) Not inhibit the primary display of engine data as required by CS-LURS.1749 during the engine starting mode of operation;
 - (5) Loss of a single display of flight data required by CS-LURS.1709 must be mitigated by
 - (i) Emergency procedures leading to continued safe flight and landing; or
 - (ii) Back-up indication
 - (6) Incorporate sensory cues for the pilot that are equivalent to those in the instrument being replaced by the electronic display indicators;
 - (7) Incorporate visual displays of instrument markings, required by CS-LURS.1741 to CS-LURS.1753, or visual displays that alert the pilot to abnormal operational

values or approaches to established limitation values, for each parameter required to be displayed by this CS.

(b) Specific limitations on display system useful life must be addressed in the Instructions for Continued Airworthiness.

(c) As used in this section "instrument" includes devices that are physically contained in one unit, and devices that are composed of two or more physically separate units or components connected together.

(d) As used in this section "primary" display refers to the display of a parameter that is located in the instrument panel such that the pilot looks at it first when wanting to view that parameter.

CS-LURS.1721 Arrangement and visibility

- (a) Each flight, navigation, powerplant instrument and datalink status information must be clearly arranged and plainly visible to the UA Pilot.
- (b) Instrument panel vibration may not damage or impair the readability or accuracy of any instrument

CS-LURS.1722 Warning, caution, and advisory lights

If warning, caution or advisory lights are installed in the Control station, they must, unless otherwise approved by the Agency, be -

- (a) Red, for warning lights (lights indicating a hazard which may require immediate corrective action);
- (b) Amber, for caution lights (lights indicating the possible need for future corrective action);
- (c) Green, for safe operation lights; and
- (d) Any other colour, including white, for lights not described in sub-paragraphs (a) through (c), provided the colour differs sufficiently from the colours prescribed in sub-paragraphs (a) to (c) to avoid possible confusion.

CS-LURS.1723 Airspeed indicator

The airspeed indicator must indicate true airspeed, at sea level in a standard atmosphere, with a maximum error of not more than the greater of

- (1) $\pm 5\%$ percent of the calibrated airspeed; or
- (1) ± 9.3 km/h (5 kts).

CS-LURS.1727 Magnetic direction indicator.

For each installed Magnetic Direction Indicator:

The compensated installation must not have a deviation in level flight, greater than 10° on any heading except that when the radio is transmitting the deviation may

exceed 10° but must not exceed 15°

- (a) A placard meeting the requirements of this section must be installed on or near the magnetic direction indicator.
- (b) The placard must show the calibration of the instrument in level flight with the engines operating.
- (c) The placard must state whether the calibration was made with radio receivers on or off.

Each calibration reading must be in terms of magnetic heading in not more than 45 degree increments.

CS-LURS.1729 Automatic pilot system

- (a) Each manually operated control for the system's operation must be readily accessible to the UA pilot.
- (b) If the automatic pilot system can be coupled to airborne navigation equipment, means must be provided to indicate to the pilots the current mode of operation. Selector switch position is not acceptable as a means of indication.

CS-LURS.1731 Instruments using a power supply

There must be a means to indicate to the UA Pilot that the electrical power supplies are adequate for safe operation. For direct current systems, an ammeter in the battery feeder may be used.

CS-LURS.1737 Fuel and battery capacity instruments

(See AMC CS-LURS.1737(a)(2))

- (a) *Fuel quantity indicator.* Each fuel quantity indicator must be installed to clearly indicate to the UA crew the quantity of fuel in each tank in flight. In addition-
 - (1) Each fuel quantity indicator must be calibrated to read "zero" during level flight when the quantity of fuel remaining in the tank is equal to the unusable fuel supply determined under CS-LURS.959;
 - (2) When two or more tanks are closely interconnected by a gravity feed system and vented, and when it is impossible to feed from each tank separately, at least one fuel quantity indicator must be installed; (see AMC CS-LURS.1737)
- (b) *Fuel shutoff:*
 - (1) There must be means to guard against inadvertent operation of each shutoff, and to make it possible for the crew to reopen it in flight after it has been closed.
 - (2) The control for this valve must be within easy reach of appropriate crewmembers

(c) *Fuel tank selector valves* must: -

- (1) Require a separate and distinct action to place the selector in the 'OFF' position; and have the tank selector positions located in such a manner that it is impossible for the selector to pass through the 'OFF' position when changing from one tank to another

For electrically powered UA

(e) *Battery capacity indicator* Each battery capacity indicator must be installed to clearly indicate to the UA pilot the electrical capacity available for flight..

CS-LURS.1743 Instrument markings: general

For each installed instrument -

- (a) When markings are on the cover glass of the instrument, there must be means to maintain the correct alignment of the glass cover with the face of the dial; and
- (b) Each arc and line must be wide enough, and located, to be clearly visible.

CS-LURS.1745 Airspeed indicator

For each installed Airspeed Indicator:

(a) Each airspeed indicator must be marked as specified in sub-paragraph (b), with the marks located at the corresponding indicated airspeeds.

(b) The following markings must be made:

- (1) A red radial line-
 - (i) For rotorcraft other than helicopters, at V_{NE} ; and
 - (ii) For helicopters at V_{NE} (power-on).
- (2) A red cross-hatched radial line at V_{NE} (power-off) for helicopters, if V_{NE} (power-off) is less than V_{NE} (power-on).
- (3) For the caution range, a yellow arc.
- (4) For the safe operating range, a green arc

CS-LURS.1749 Powerplant instruments

The following shall be provided

- (a) All instrumentation required to assure operation of the engine within the certified limits and
- (b) UA crew alerts of any failures that require UA crew awareness and intervention.

For each installed powerplant instrument, as appropriate to the type of instrument -

(a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line;

- (b) Each normal operating range must be marked with a green arc or green line, not extending beyond the maximum and minimum safe limits;
- (c) Each take-off and precautionary range must be marked with a yellow arc or yellow line;
- (d) Each engine range that is restricted because of excessive vibration stresses must be marked with red arcs or red lines

CS-LURS.1751 Oil quantity indicator

Each installed oil quantity indicator must be marked with enough increments to indicate readily and accurately the quantity of oil.

CS-LURS.1752 UAV electrical systems warning and indication

- (a) There must be a means to give immediate warning to the UAS crew of a failure of any UA electrical power generating device.
- (b) A means must exist in the control station to indicate to the UAS crew the electric power system quantities essential for safe operation
- (c) A warning which is unambiguous and clearly distinguishable to the UAS crew shall be immediately provided for any control station power supply failure which could result in an unsafe condition in any phase of UAS flight, including landing and take off

CS-LURS.1753 Fuel quantity indicator

If the unusable fuel supply for any tank exceeds 5 % of the tank capacity, a red arc must be marked on its indicator extending from the calibrated zero reading to the lowest reading obtainable in level flight

CS-LURS.1755 Control markings

- (a) Each control, other than primary flight controls or control whose function is obvious, must be plainly marked as to its function and method of operation.
- (b) For powerplant fuel controls-
 - (1) Each fuel tank selector control must be marked to indicate the position corresponding to each tank and to each existing cross feed position;
 - (2) If safe operation requires the use of any tanks in a specific sequence, that sequence must be marked on, or adjacent to, the selector for those tanks; and
- (c) Useable fuel capacity must be marked as follows:
 - (1) For fuel systems having no selector controls, the useable fuel capacity of the system must be indicated at the fuel quantity indicator.
 - (2) For fuel systems having selector controls, the useable fuel capacity available at each selector control position must be indicated near the selector control.
- (d) For accessory, auxiliary, and emergency controls -
 - (1) Each essential visual position indicator, such as those showing rotor pitch, must be marked so that each crew member can determine at any time the position of the unit to which it relates; and
 - (2) Each emergency control must be red and must be marked as to method of operation.

CS-LURS.1759 Limitations placard

There must be a placard in clear view of the UA Pilot that specifies the kinds of operations (VFR day, NO ICING) for which the rotorcraft is approved.

POWERPLANT CONTROLS

CS-LURS.1761 Powerplant controls: general

- (a) Powerplant controls must be located and arranged under CS-LURS.777 and marked under CS-LURS.1555.
- (b) Each flexible powerplant control must be of an acceptable kind.
- (c) Each control must be able to maintain any set position without-
 - (1) Constant attention; or
 - (2) Tendency to creep due to control loads or vibration.
- (d) Controls of powerplant valves required for safety must have
 - (1) For manual valves, positive stops or in the case of fuel valves suitable index provisions, in the open and closed position; and
 - (2) For power-assisted valves, a means to indicate to the flight crew when the valve-
 - (i) Is in the fully open or fully closed position, or
 - (ii) Is moving between the fully open and fully closed position.

CS-LURS.1763 Engine controls

- (a) The power or supercharger control must give a positive and immediate responsive means of controlling its engine or supercharger.
- (b) If a power control incorporates a fuel shut-off feature, the control must have a means to prevent the inadvertent movement of the control into the shut-off position. The means must -
 - (1) Have a positive lock or stop at the idle position; and
 - (2) Require a separate and distinct operation to place the control in the shut-off position.

CS-LURS.1765 Ignition switches

- (a) Each ignition circuit must be independently switched, and must not require the operation of any other switch for it to be made operative.
- (b) Ignition switches must be arranged and designed to prevent inadvertent operation.

<p>(c) The ignition switch must not be used as the master switch for other circuits.</p>
<p>CS-LURS.1767 Mixture control</p> <p>The control must require a separate and distinct operation to move the control toward lean or shut-off position.</p>
<p>CS-LURS.1769 Rotor brake controls</p> <p>(a) It must be impossible to apply the rotor brake inadvertently in flight.</p> <p>(b) There must be means to warn the crew if the rotor brake has not been completely released before take-off.</p>
<p>CS-LURS.1771 Control Station Master switch arrangement</p> <p>(a) There must be a master switch or switches arranged to allow ready disconnection of all electric power sources on the UA. The point of disconnection must be adjacent to the sources controlled by the switch.</p> <p>(b) The master switch arrangement must be so installed that it is easily discernible and accessible to the UA Pilot during operation.</p>
<p>CS-LURS.1775 Control station handover (See AMC.1775 (b), AMC.1775 (c) and AMC.1775 (d))</p> <p>Where the UA System is designed for UA hand over between multiple control stations:</p> <p>(a) The in-control control station must be clearly identified to all UAS crew members.</p> <p>(b) Positive control must be maintained during handover.</p> <p>(c) The command and control functions that are transferred during handover must be approved by the Certifying Authority and defined in the UA System Flight Manual.</p> <p>(d) Handover between multiple control stations must not lead to unsafe conditions.</p> <p>(e) The in-control control station must have the required functionality to accommodate emergency situations.</p>
<p>CS-LURS.1777 Command and control of multiple UA (see AMC CS-LURS.1777) Reserved</p>

APPENDICES

APPENDIX A

INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

A.LURS.1 General

- (a) This appendix specifies requirements for the preparation of instructions for continued airworthiness as required by CS-LURS. 1529.
- (b) The instructions for continued airworthiness for each RPAS must include the instructions for continued airworthiness for each engine and rotor (hereinafter designated "products"), for each appliance required by any applicable CS or operating rule, and any required information relating to the interface of those appliances and products with the RPAS. If instructions for continued airworthiness are not supplied by the manufacturer of an appliance or product installed in the RPAS, the instructions for continued airworthiness for the RPAS must include the information essential to the continued airworthiness of the rotorcraft.

A.LURS.2 Format

- (a) The instructions for continued airworthiness must be in the form of a manual or manuals as appropriate for the quantity of data to be provided.
- (b) The format of the manual or manuals must provide for a practical arrangement.

A.LURS.3 Content

The contents of the manual or manuals must be prepared in the English language. The instructions for continued airworthiness must contain the following manuals or paragraphs, as appropriate, and information:

- (a) RPAS maintenance manual or paragraph:
 - (1) Introduction information that includes an explanation of the RPAS's features and data to the extent necessary for maintenance.
 - (2) A description of the RPAS and its systems and installations including its engine, rotors, and appliances.
 - (3) Basic control and operation information describing how the RPAS components and systems are controlled and how they operate, including any special procedures and limitations that apply.
 - (4) Servicing information that covers details regarding servicing points, capacities of tanks, reservoirs, types of fluids to be used, pressures applicable to the various systems, location of access panels for inspection and servicing, locations of lubrication points, the lubricants to be used, equipment required for servicing, tow instructions and limitations, mooring, jacking, and leveling information.

(b) Maintenance instructions

(1) Scheduling information for each part of the RPAS and its engines, auxiliary power units, rotors accessories, instruments and equipment that provides the recommended periods at which they should be cleaned, inspected, adjusted, tested, and lubricated, and the degree of inspection, the applicable wear tolerances and work recommended at these periods. However, it is allowed to refer to an accessory, instrument or equipment manufacturer as the source of this information if it is shown that the item has an exceptionally high degree of complexity requiring specialized maintenance techniques, test equipment, or expertise. The recommended overhaul periods and necessary cross references to the airworthiness limitations paragraph of the manual must also be included. In addition, an inspection program that includes the frequency and extent of the inspections necessary to provide for the continued airworthiness of the RPAS must be included.

(2) Troubleshooting information describing problem malfunctions, how to recognize those malfunctions, and the remedial action for those malfunctions.

(3) Information describing the order and method of removing and replacing products and parts with any necessary precautions to be taken.

(4) Other general procedural instructions including procedures for system testing during ground running, symmetry checks, weighing and determining the centre of gravity, lifting and shoring, and storage limitations.

(c) Diagrams of structural access plates and information needed to gain access for inspections when access plates are not provided.

(d) Details for the application of special inspection techniques including radiographic and ultrasonic testing where such processes are specified.

(e) Information needed to apply protective treatments to the structure after inspection.

(f) All data relative to structural fasteners such as identification, discard recommendations, and torque values.

(g) A list of special tools needed.

A.LURS.4 Airworthiness Limitations Section

The instructions for continued airworthiness must contain a paragraph titled Airworthiness Limitations, that is segregated and clearly distinguishable from the rest of the document. This paragraph must set forth each mandatory replacement time, structural inspection interval, and related structural inspection procedure approved under CS-LURS.571. If the instructions for continued airworthiness consists of multiple documents, the paragraph required by this sub-paragraph must be included in the principal manual. This paragraph must contain a legible statement in a prominent location that reads:
"The airworthiness limitations section is approved and variations must also be approved".

APPENDIX B

COMBUSTION ENGINES

B-LURS.1 Applicability

(See AMC -B-LURS.1)

- (a) This appendix B is applicable to engines for Unmanned Very Light Rotorcraft (helicopters).
- (b) Where specific requirements for turbine engines are mentioned, the following restrictions are applicable to simplify the certification requirements:
 - (1) The engine certificated under these requirements is used to power Light Unmanned Rotorcraft Systems only.
 - (2) no bleed air, no reverse functions
 - (3) no flight in icing or hail conditions
 - (4) no aerobatic operation
 - (5) the turbine is not used to drive accessories, that are essential for any other means than the turbine itself

B-LURS.3 Instruction manual

Instructions for installing and operating the engine must be established. In particular, the following instructions must be included:

- (a) The operating limitations, including any relevant limitation on temperatures for cylinder heads, coolant outlet, oil.
- (b) The power ratings and procedures for correcting for non-standard atmosphere.
- (c) The recommended procedures, under normal and extreme ambient conditions for-
 - (1) Starting;
 - (2) Operating on the ground; and
 - (3) Operating during flight.
- (d) For two-stroke engines, fuel/oil ratio.

B-LURS.5 Engine power ratings and operating limitations

Engine power ratings and operating limitations must be based on the operating conditions demonstrated during the tests prescribed in this appendix B. They include limitations relating to speeds, temperatures, pressures, fuels and oils which the applicant finds necessary for the safe operation of the engine.

B-LURS.7 Selection of Engine power ratings

- (a) Requested engine power ratings must be selected by the applicant.
- (b) Each selected rating must be for the lowest power that all engines of the same type may be expected to produce under the conditions used to determine that rating.

B-LURS.9 Engine Critical Parts

- (a) A critical part is a part, the failure of which could have a catastrophic effect upon the rotorcraft, and for which critical characteristics have been identified which must be controlled to ensure the required level of integrity.
- (b) If the engine type design includes critical parts, a critical parts list must be established. Procedures must be established to define the critical design characteristics, identify processes that affect those characteristics, and identify the design change and process change controls necessary for showing compliance with the quality assurance requirements of Part 21.

B-LURS.11 Materials

The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must-

- (a) Be established on the basis of experience or tests;
- (b) Meet approved specifications that ensure their having the strength and other properties assumed in the design data; and
- (c) Take into account the effects of environmental conditions, such as temperature and humidity, expected in service.

B-LURS.13 Fabrication methods

- (a) The methods of fabrication used must produce consistently sound structures. If a fabrication process (such as gluing, spot welding, or heat-treating) requires close control to reach this objective, the process must be performed according to an approved process specification.
- (b) Each new fabrication method must be substantiated by a test program.

B-LURS.15 Fasteners

- (a) Each removable bolt, screw, nut, pin or other fastener whose loss could jeopardize the safe operation of the engine must incorporate two separate locking devices. The fastener and its locking devices may not be adversely affected by the environmental conditions associated with the particular aircraft installation.
- (b) No self-locking nut may be used on any bolt subject to rotation in operation unless a non-friction locking device is used in addition to the self-locking device.
- (c)

B-LURS.17 Protection of structure

Each part of the engine structure must be suitably protected against deterioration or loss of strength in service due to any cause, including weathering, corrosion and abrasion.

B-LURS.19 Inspection provisions

There must be means to allow the close examination of each part that requires recurring inspection, adjustment for proper alignment and functioning, lubrication or rigging and de-rigging.

B-LURS.20 Functioning (turbine engines)

The engine must be free from dangerous surge and instability throughout its operating range of ambient and running conditions within the air intake pressure and temperature conditions declared by the constructor.

B-LURS.21 Engine Control System

- (a) The engine control system must operate with the ease, smoothness, and positiveness appropriate to its functions.
- (b) It must be substantiated by tests, analysis or a combination thereof that the Engine Control System performs the intended functions in a manner which –
 - (1) Enables selected values of relevant control parameters to be maintained and the engine kept within the approved operating limits over changing atmospheric conditions in the declared flight envelope, and
 - (2) Does not create unacceptable thrust or power oscillations.
- (c) It must also be demonstrated that the engine is capable to function properly in case of exposure to radio magnetic interference. The demonstrated levels have to be included in the Installation Instructions.

B-LURS.23 Engine Mounting System

Each engine component which forms part of the engine mounting and any other parts of the engine liable to be critically affected must, when the engine is properly supported by a suitable engine-mounting structure,

- (a) Be able to support limit loads without detrimental permanent deformation. At any load up to limit loads, the deformation may not interfere with safe operation.
- (b) Be able to support ultimate loads without failure. This must be shown by-
 - (1) Applying ultimate loads to the structure in a static test for at least 3 seconds; or
 - (2) Dynamic tests simulating actual load application.

B-LURS.25 Fire prevention

- (a) The design and construction of the engine and the materials used must minimize the probability of the occurrence and spread of fire during normal operation and failure

conditions and must minimize the effects of such a fire.

(b) Except as required by subparagraph (c), each external line, fitting and other component which conveys flammable fluid during engine operation must be at least fire resistant, except that flammable fluid tanks and supports which are part of and attached to the engine must be fireproof or be enclosed by a fireproof shield unless damage by fire to any non-fireproof part will not cause leakage or spillage of flammable fluid. Components must be shielded or located so as to safeguard against the ignition of leaking flammable fluid. An integral oil sump of less than 23.7 liter capacity on an engine need not be fireproof nor be enclosed by a fireproof shield.

(c) Subparagraph (b) does not apply to vent and drain lines, and their fittings whose failure will not result in, or add to, a fire hazard.

(d) An engine component designed, constructed and installed as a firewall must be:

- (1) Fireproof; and
- (2) Constructed so that no hazardous quantity of air, fluid or flame can pass around or through the firewall; and:
- (3) Protected against corrosion

(e) In addition to the requirements of subparagraphs (a) and (b), engine control systems components which are located in a designated fire zone must be at least fire resistant.

(f) Any components, modules, equipment and accessories which are susceptible to or are potential sources of static discharges or electrical fault currents must be designed and constructed so as to be grounded to the engine reference in order to minimize the risk of ignition in external areas where flammable fluids or vapors could be present.

(g) Those features of the engine which form part of the mounting structure or engine attachment points must be fireproof, either by construction or by protection, or protected so they can perform their essential functions for at least 5 minutes under any foreseeable powerplant fire conditions.

B-LURS.27 Durability
(See AMC B-LURS.27)

Engine design and construction must minimize the probability of occurrence of an unsafe condition of the engine between overhauls.

B-LURS.29 Engine cooling

Engine design and construction must provide the necessary cooling under conditions in which the rotorcraft is expected to operate.

B-LURS.31 Accessory attachment

- (a) Each accessory drive and mounting attachment must be designed and constructed so that the engine will operate properly with the accessories attached. The design of the engine must allow the examination, adjustment or removal of each essential engine accessory.
- (b) The engine shall not provide accessory drives other than used for essential engine equipment which is part of the engine Type Design.

B-LURS.33 Vibration

(See AMC -B-LURS.33)

- (a) The engine must be designed and constructed to function from idling to 103% crankshaft (for (supercharged) reciprocating or rotary engines) or 103% output shaft (for turbine engines) rotational speed at maximum take off conditions without vibration levels which may affect the integrity of parts and assemblies.
- (b) The engine must withstand a vibration survey throughout the expected operating range of rotational speed and power of the engine and up to an engine speed equivalent to take-off power on rotorcraft rotor speed plus 3%. Each accessory drive and mounting attachment must be loaded with the critical loads expected in service.
- (c) For diesel engines: due to the possible high torque peak at shutdown the test conditions in a) and b) needs to incorporate the start and shutdown sequence.

B-LURS.35 Ignition

(See AMC -B-LURS.35)

Except for compression ignition engines, the engine must be equipped with a dual ignition system having all the magnetic and electrical circuits entirely independent, or with a single ignition system of at least equal reliability to a dual system. The ignition system must function throughout the complete operating range of the engine under all starting and flight conditions.

B-LURS.37 Fuel and induction system

- (a) Each fuel specification to be approved, including any additive, and the associated limitations in flow, temperature and pressure that ensure proper engine functioning under all intended operating conditions must be declared and substantiated. (See AMC B-LURS.37(a))
- (b) The fuel system of the engine must be designed and constructed to supply the appropriate mixture of fuel to the combustion chambers throughout the complete operating range of the engine under all starting, flight and atmospheric conditions. It should also keep the rotational speed in the range, defined by the manufacturer.
- (c) The intake passages of the engine through which air, or fuel in combination with air, passes must be designed and constructed to minimize ice accretion and vapour condensation in those passages.
- (d) The type and degree of fuel filtering necessary for protection of the engine fuel system against foreign particles in the fuel must be specified. The applicant must show (e.g. within the 50-hour run prescribed in B-LURS.47(a)) that foreign particles passing through the prescribed filtering means will not critically impair engine fuel system functioning.
- (e) Each fuel system for a compression ignition engine must be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 27°C and having 0.198 cm³ of free water per liter added and cooled to the most critical condition for icing likely to be encountered in operation.
- (f) Each passage in the induction system that conducts a mixture of fuel and air, and in which fuel may accumulate, must be self-draining to prevent a liquid lock in the combustion chambers. This applies to all attitudes selected by the applicant.
- (g) The engine design has to prevent situations in which fuel may accumulate inside the engine while not in use. This applies to all attitudes that the applicant establishes as those the engine can have when the aircraft in which it is installed is in the static ground attitude.

B-LURS.39 Lubrication system

- (a) The lubrication system of the engine must be designed and constructed so that it will function properly in all attitudes and atmospheric conditions in which the rotorcraft is expected to operate. In wet-sump engines this requirement must be met when the engine contains only the minimum oil quantity, the minimum quantity being not more than half the maximum quantity.
- (b) The lubrication system of the engine must be designed and constructed to allow installing a means of cooling the lubricant.
- (c) The crankcase must be vented to preclude leakage of oil from excessive pressure in the crankcase.
- (d) If an engine depends upon a fuel/oil mixture for lubrication, then a reliable means of providing it with the appropriate mixture must be established.
- (e) If the engine lubrication depends upon oil premixed to fuel in a declared fixed percentage, then the applicant must demonstrate that this percentage can assure appropriate engine lubrication also in reduced fuel consumption conditions throughout the whole range of intended conditions in which the rotorcraft is expected to operate.

B-LURS.41 High Energy Rotor Containment

- (a) For each high-energy engine rotor, the engine must be designed to provide containment of either:
 - (1) The largest blade section as specified in -B-LURS.41 (g) (1) (i) or (g) (1) (ii).
 - (2) Maximum kinetic energy fragments from the hub failure as specified in B-LURS.41 (g) (2).
- (b) Compliance with B-LURS.41(a) and (h) of each high-energy rotor, critical and non-critical, must be substantiated by test, analysis or combination thereof as specified in B-LURS.41 (c) and (d), under the conditions of B-LURS.41 (f) and (g).
- (c) The critical rotor of each compressor and turbine rotor assembly must be substantiated by engine test.
- (d) Analyses and / or component or rig tests may be substituted only if they are validated by engine test.
- (e) Non-critical rotors may be substantiated by validated analysis.
- (f) Containment must be demonstrated at the following speed and temperature conditions:
 - (1) The highest speed which would result from either:
 - (i) Any single failure of the Engine Control System, or
 - (ii) Any single failure or likely combination of failures not considered to be Extremely Remote.
 - (2) The temperature of the containing components must not be lower than the temperature during operation of the engine at maximum power/thrust rating.
- (g) Containment must be substantiated in accordance with either or below:
 - (1) Blade containment under the following conditions:
 - (i) For centrifugal compressors and radial turbines, one whole blade unless it is substantiated that failure of a smaller portion of the blade is more likely to occur.
 - (ii) For axial compressor or turbine rotors, the blade fragment resulting from failure at the outermost retention groove, or, for integrally bladed rotor-discs, at least 80 percent of the blade.
 - (2) Hub containment under the following condition: for all types of compressors and turbines, fragments resulting from a failure which produces the maximum translational kinetic energy.

Note: The containment tests have to be performed with the engine fitted to a representative mounting system intended to be used for the typical aircraft installation.

- (h) It must be shown that the following specifications were met:
- (1) The engine did not experience a sustained external fire
 - (2) The engine did not release high-energy fragments radially through the engine casings
 - (3) The engine did not axially release any substantially whole rotors with residual high energy.
 - (4) If debris were ejected from the engine inlet or exhaust, the approximate reported maximum size, weight, energy and trajectory of the debris must be estimated and provided in the engine instructions for installation.

B-LURS.43 Calibration test
(See AMC B-LURS.43)

Each engine must be subjected to the calibration tests necessary to establish its power characteristics and the conditions for the endurance test specified in B-LURS.47 (a) to (d). The results of the power characteristics calibration tests form the basis for establishing the characteristics of the engine over its entire operating range of crankshaft rotational speeds, manifold pressures and fuel/air mixture settings. Power ratings are based on standard atmospheric conditions at sea level

B-LURS.45 Detonation test (spark ignition only)

A test must be conducted using the dual ignition system and must be repeated using each separate ignition system alone to determine whether it can function without detonation throughout the range of intended conditions of operation.

B-LURS.47 Endurance test
(See AMC B-LURS.47)

- (a) The engine must be subjected to an endurance test that includes a total of 50 hours of operation and consists of the cycles specified in subparagraph (c).
- (b) Additional endurance testing at particular rotational speed may be required depending on the results of the tests prescribed in B-LURS.33 to establish the ability of the engine to operate without fatigue failure.
- (c) Each cycle must be conducted as follows:
 - (1) For (supercharged) reciprocating or rotary engines:

Sequence	Duration (Minutes)	Operating Conditions
1	5	Starting - Idle
2	5	Take-off power
3	5	Cooling run (Idle)
4	5	Take-off power
5	5	Cooling run (Idle)
6	5	Take-off power

7	5	Cooling run (Idle)
8	15	75% of maximum continuous power
9	5	Cooling run (Idle)
10	60	Maximum continuous power
11	5	Cooling run and stop
Total:	120	

(2) For turbine engines:

Sequence	Duration (Minutes)	Operating Conditions
1	1	Starting Idle
2	10	Maximum power / Thrust
3	1	Cooling run (idle)
4	5	Maximum power / Thrust
5	1	Cooling run (idle)
6	30	Maximum continuous power
7	1	Cooling run
8	10	Acceleration and deceleration consists of 6 cycles from Ground Idling to Take off Power / Thrust, maintaining Take off Power / Thrust for a period of 30 seconds, the remaining time being at Ground Idling
9	1-3	Cooling run (idle) and stop
Total:	60-62	

(d) During or following the endurance test the fuel and oil consumption must be determined.

B-LURS.49 Operation test

(a) For (supercharged) reciprocating or rotary engines:

The operation test must include the demonstration of backfire characteristics, starting-idling, acceleration, running with a single ignition system, over-speeding and any other operational characteristics of the engine.

(b) For turbine engines:

The operation test shall include the demonstration of characteristics in case of idling, transitional characteristics among operational stages, characteristics of acceleration of design load, characteristics in case of overspeeding as well as any other operational characteristics of the engine.

B-LURS.51 Engine component test

- (a) For those systems or components that cannot be adequately substantiated by the endurance testing of B-LURS.47 (a) to (d), additional tests or analysis must be conducted to demonstrate that the systems or components are able to perform the intended functions in all declared environmental and operating conditions.
- (b) Temperature limits must be established for each component that requires temperature-controlling provisions to ensure satisfactory functioning, reliability and durability.

B-LURS.53 Tear-down inspection

After completing the endurance test and engine component tests as required:

- (a) Each engine must be completely disassembled;
- (b) Each component having an adjustment setting and a functioning characteristic that can be established independent of installation on the engine must retain each setting and functioning characteristic within the limits that were established and recorded at the beginning of the test; and
- (c) Each engine component must conform to the type design and be eligible for incorporation into an engine for continued operation.

B-LURS.55 Engine adjustment and parts replacement

- (a) The applicant may, in conducting the bench tests, use separate engines of identical design and construction in the vibration, calibration, detonation, endurance, and operation tests, except that, if a separate engine is used for the endurance test it must be subjected to the calibration test requested by B-LURS.43.
- (b) The applicant may service and make minor repairs to the engine during the bench tests accordance with the service and maintenance instructions. If the frequency of the service is excessive, or the number of stops due to engine malfunction is excessive, or a major repair, or replacement of a part is found necessary during the bench tests or as the result of findings from the tear-down inspection, the engine or its parts may be subjected to any additional test the Agency finds necessary.

ELECTRICAL ENGINES (from STANAG 4703, Appendix 3)

GENERAL

B-LURS.101 Instruction manual

An instruction manual containing the necessary information essential for installing, operating, servicing and maintaining the engine must be provided.

B-LURS.103 Engine ratings and operating limitations

Engine ratings and operating limitations are to be established and based on the operating conditions demonstrated during the tests prescribed in this

Appendix. They include power ratings and operational limitations relating to voltage, current, speeds and temperatures which are necessary for the safe operation of the engine.

B-LURS.105 Selection of engine power ratings

Each selected rating must be for the lowest power that all engines of the same type may be expected to produce under the conditions to determine that rating.

DESIGN AND CONSTRUCTION

B-LURS.111 Materials

The suitability and durability of materials used in the engine must

- (a) Be established on the basis of experience or tests; and
- (b) Conform to approved specifications that ensure their having the strength and other properties assumed in the design data.

B-LURS.113 Durability

Engine design and construction must minimize the probability of occurrence of an unsafe condition of the engine between overhauls.

- (a) The effects of cyclic loading, environmental and operational degradation must not reduce the integrity of the engine below acceptable levels.
- (b) The effects of likely subsequent part failures must not reduce the integrity of the engine below acceptable levels.

B-LURS.115 Engine cooling

Engine design and construction must provide the necessary cooling under conditions in which the UAV is expected to operate.

B-LURS.117 Engine mounting attachments and structure

- (a) The maximum allowable loads for engine mounting attachments and related structure must be specified, taking account of the flight and ground loads calculated from the UAV design usage spectrum.
- (b) The engine mounting attachments and related structure must be able to withstand the specified loads without failure, malfunction or permanent deformation.

B-LURS.119 Accessory attachment

Each accessory drive and mounting attachment must be designed and constructed so that the engine will operate properly with the accessories attached. The design

of the engine must allow the examination, adjustment or removal of each essential engine accessory.

B-LURS.121 Vibration

The engine must be designed and constructed to function throughout its normal operating range of speeds and engine powers without inducing excessive stress in any of the engine parts because of vibration and without imparting excessive vibration forces to the structure of the UAV.

B-LURS.123 Electromagnetic Compatibility

The electrical engine must be electromagnetically compatible with the electromagnetic environment of the installation.

B-LURS.125 Humidity

The electrical engine must function properly in a humid environment (RTCA-DO-160D should be used as a reference to tailor a humidity test).

B-LURS.127 Installation

The electrical engine must not introduce unacceptable hazards to the UAV subsystems (as per the UAV Hazard Reference System)

BENCH TEST

B-LURS.131 Calibration test

Each engine must be subjected to the calibration tests necessary to establish its power characteristics and the conditions for the endurance test specified in B-LURS.133. The results of the power characteristics calibration tests form the basis for establishing the characteristics of the engine over its entire operating range of rotational speeds.

B-LURS.133 Endurance test

- (a) The electric engine assembly, as installed in the UAV, must be subjected to an endurance test (with representative rotors and transmissions) that includes a total of 50 hours of operation and consists of the cycles specified in B-LURS.133(c).
Tests should be performed with representative rotors and transmissions or a motor break, representing the rotors and transmissions
- (b) N/A
- (c) The endurance test procedure must be agreed by the Certifying Authority and shall be more severe than the engine design duty cycle. If the UAV is designed to stress

engine above maximum continuous power, this must be addressed in the endurance test procedure. As an example, each cycle could be conducted as follows:

Sequence	Environmental Temperature	Duration [min]	Power setting
1.1	Cold	2	Maximum continuous power
1.2	Cold	43	Nominal power
1.3	Cold	2	Maximum continuous power
1.4	Cold	43	Nominal power
TOTAL DURATION CYCLE 1: 90 [min]			
2.1	Ambient	2	Maximum continuous power
2.2	Ambient	43	Nominal power
2.3	Ambient	2	Maximum continuous power
2.4	Ambient	43	Nominal power
TOTAL DURATION CYCLE 2: 90 [min]			
3.1	Hot	2	Maximum continuous power
3.2	Hot	43	Nominal power
3.3	Hot	2	Maximum continuous power
3.4	Hot	43	Nominal power
TOTAL DURATION CYCLE 3: 90 [min]			
4.1	Ambient	3	Maximum continuous power
4.2	Ambient	102	Nominal power
TOTAL DURATION CYCLE 4: 105 [min]			
TOTAL SEQUENCE DURATION (1 to 4): 375 [min]			
Iterate the previous 4-cycle sequence 8 times.			
Cold temperature setting = minimum temperature according to the design usage spectrum.			
Ambient temperature setting = ISA sea level temperature (15°C)			
Hot temperature setting = maximum temperature according to the design usage spectrum.			

B-LURS.135 Operation test

The operation test must include the demonstration starting, loiter and cruise related power settings, acceleration, over-speeding and any other operational characteristics of the engine.

B-LURS.137 Engine component test

- (a) For engine components that cannot be adequately substantiated by endurance testing in accordance with B-LURS.133(a) to (c), the Applicant must ensure that additional tests are conducted to establish that components are able to function reliably in all normally anticipated flight and atmospheric conditions.
- (b) Temperature limits must be established for each component that requires temperature controlling provisions to ensure satisfactory functioning, reliability and durability.

B-LURS.139 Teardown inspection

After the endurance test has been completed the engine must be completely disassembled. No essential component may show rupture, cracks or excessive wear.

B-LURS.141 Engine adjustment and parts replacement

Service and minor repairs to the engine may be made during the bench tests. If major repairs or replacements of parts is necessary during the tests or after the teardown inspection, or if essential parts have to be replaced, the engine must be subjected to any additional tests the Certifying Authority may require.

APPENDIX C

Interaction of Systems and Structures

C-LURS.1 General

The following criteria must be used for showing compliance with CS LURS.302 for rotorcrafts equipped with flight control systems, autopilots, stability augmentation systems, load reduction/alleviation systems, and fuel management systems. If this appendix is used for other systems, it may be necessary to adapt the criteria to the specific system.

(a) The criteria defined herein only address the direct structural consequences of the system responses and performances and cannot be considered in isolation but should be included in the overall safety evaluation of the rotorcraft. These criteria may in some instances duplicate standards already established for this evaluation. These criteria are only applicable to structure whose failure could prevent continued safe flight and landing and the emergency recovery capability required by CS LURS.1412. Specific criteria that define acceptable limits on stability requirements when operating in the system degraded or inoperative mode are not provided in this appendix.

(b) Depending upon the specific characteristics of the rotorcraft, additional studies may be required that go beyond the criteria provided in this appendix in order to demonstrate the capability of the rotorcraft to meet other realistic conditions

(c) The following definitions are applicable to this appendix.

Structural performance: Capability of the rotorcraft to meet the structural requirements of CS-LURS.

Flight limitations: Limitations that can be applied to the rotorcraft flight conditions following an in-flight occurrence and that are included in the flight manual (e.g., speed limitations, etc.).

Operational limitations: Limitations, including flight limitations, that can be applied to the rotorcraft operating conditions before dispatch (e.g., fuel, payload and Master Minimum Equipment List limitations).

Probabilistic terms: The probabilistic terms (probable, improbable, extremely improbable) used in this appendix are the same as those used in CS LURS.1309.

Failure condition: The term failure condition is the same as that used in CS LURS.1309, however this appendix applies only to system failure conditions that affect the structural performance of the rotorcraft (e.g., system failure conditions that induce loads, change the response of the rotorcraft to inputs such as gusts or pilot actions, or lower flutter margins).

C-LURS.2 Effects of Systems on Structures

(a) **General.** The following criteria will be used in determining the influence of a system and its failure conditions on the rotorcraft structure.

(b) **System fully operative.** With the system fully operative, the following apply:

(1) Limit loads must be derived in all normal operating configurations of the system from all the limit conditions specified in Subpart C, taking into account any special behavior of such a system or associated functions or any effect on the structural performance of the rotorcraft that may occur up to the limit loads. In particular, any significant nonlinearity must be accounted for in a realistic or conservative way when deriving limit loads from limit conditions.

(2) The rotorcraft must meet the strength requirements of CS- LURS, using the specified factors to derive ultimate loads from the limit loads defined above. The effect of nonlinearities must be investigated beyond limit conditions to ensure the behavior of the system presents no anomaly compared to the behavior below limit conditions. However, conditions beyond limit conditions need not be considered when it can be shown that the rotorcraft has design features that will not allow it to exceed those limit conditions.

(3) The rotorcraft must meet the aeroelastic stability requirements of CS LURS.629.

(c) **System in the failure condition.** For any system failure condition not shown to be extremely improbable, the following apply:

(1) At the time of occurrence. Starting from 1-g level flight conditions, a realistic scenario, including pilot corrective actions, must be established to determine the loads occurring at the time of failure and immediately after failure.

(i) For static strength substantiation, these loads multiplied by an appropriate factor of safety that is related to the probability of occurrence of the failure are ultimate loads to be considered for design. The factor of safety (F.S.) is defined in Figure 1.

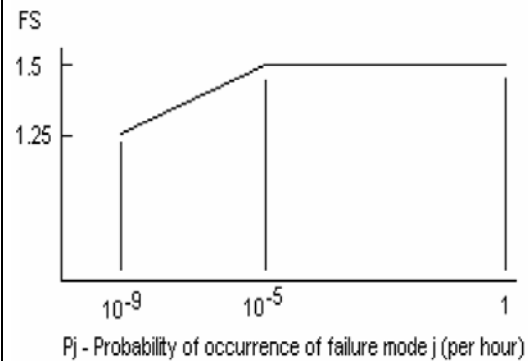


Figure 1
Factor of safety at the time of occurrence

(ii) Freedom from aeroelastic instability must be shown.

(iii) Failures of the system that result in forced structural vibrations (oscillatory failures) must not produce loads that could result in detrimental deformation of primary structure.

(2) For the continuation of the flight. For the rotorcraft, in the system failed state and considering any appropriate reconfiguration and flight limitations, the following apply:

(i) The design limit loads of Subpart C or the maximum loads expected under the limitation prescribed for the remainder of the flight must be determined.

(ii) For static strength substantiation, each part of the structure must be able to withstand the loads in subparagraph (2)(i) of this paragraph multiplied by a factor of safety depending on the probability of being in this failure state. The factor of safety is defined in Figure 2.

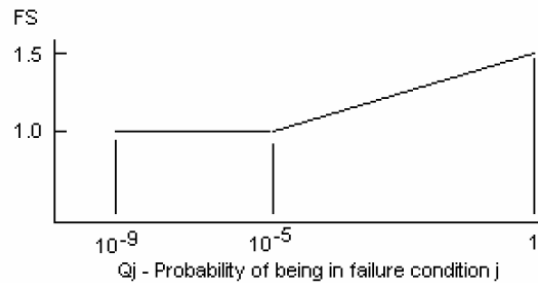


Figure 2

Factor of safety for continuation of flight

$Q_j = (T_j)(P_j)$ where:

T_j =Average time spent in failure condition j (in hours)

P_j =Probability of occurrence of failure mode j (per hour)

Note: If P_j is greater than 10^{-3} , per flight hour then a 1.5 factor of safety must be applied to all limit load conditions specified in Subpart C.

(iii) If the loads induced by the failure condition have a significant effect on fatigue or damage tolerance then their effects must be taken into account.

(iv) Freedom from aeroelastic instability must be shown.

(d) Failure indications. For system failure detection and indication, the following apply:

(1) The system must be checked for failure conditions, not extremely improbable, that degrade the structural capability below the level required by CS-LURS or significantly reduce the reliability of the remaining system. As far as reasonably practicable, the crew must be made aware of these failures before flight. Certain elements of the control system, such as mechanical, electrical and hydraulic components, may use special periodic inspections, and electronic components may use daily checks, in lieu of detection and indication systems to achieve the objective of this requirement. These certification maintenance requirements must be limited to components that are not readily detectable by normal detection and indication systems and where service history shows that inspections will provide an adequate level of safety.

(2) The existence of any failure condition, not extremely improbable, during flight that could significantly affect the structural capability of the rotorcraft and for which the associated reduction in airworthiness can be minimized by suitable flight limitations, must be signaled to the crew. For

example, failure conditions that result in a factor of safety between the rotorcraft strength and the loads of Subpart C below 1.25 must be signaled to the crew during flight.

(e) Dispatch with known failure conditions. If the rotorcraft is to be dispatched in a known system failure condition that affects structural performance, or affects the reliability of the remaining system to maintain structural performance, then the provisions of CS LURS.302 must be met for the dispatched condition and for subsequent failures. Flight limitations and expected operational limitations may be taken into account in establishing Qj as the combined probability of being in the dispatched failure condition and the subsequent failure condition for the safety margins in Figure 2. These limitations must be such that the probability of being in this combined failure state and then subsequently encountering limit load conditions is extremely improbable. No reduction in these safety margins is allowed if the subsequent system failure rate is greater than 10⁻³ per hour.

APPENDIX D

HIRF Environments and Equipment HIRF Test Levels

This appendix specifies the HIRF environments and equipment HIRF test levels for electrical and electronic systems under CS-LURS.1317. The field strength values for the HIRF environments and laboratory equipment HIRF test levels are expressed in root-mean-square units measured during the peak of the modulation cycle.

a) HIRF environment I is specified in the following table:

TABLE I.—HIRF ENVIRONMENT I

Frequency	Field strength (volts/meter)	
	Peak	Average
10 kHz–2 MHz	50	50
2 MHz–30 MHz	100	100
30 MHz–100 MHz	50	50
100 MHz–400 MHz ...	100	100
400 MHz–700 MHz ...	700	50
700 MHz–1 GHz	700	100
1 GHz–2 GHz	2,000	200
2 GHz–6 GHz	3,000	200
6 GHz–8 GHz	1,000	200
8 GHz–12 GHz	3,000	300
12 GHz–18 GHz	2,000	200

Frequency	Field strength (volts/meter)	
	Peak	Average
18 GHz–40 GHz	600	200

In this table, the higher field strength applies at the frequency band edges.

b) HIRF environment II is specified in the following table:

TABLE II.—HIRF ENVIRONMENT II

Frequency	Field strength (volts/meter)	
	Peak	Average
10 kHz–500 kHz	20	20
500 kHz–2 MHz	30	30
2 MHz–30 MHz	100	100
30 MHz–100 MHz	10	10
100 MHz–200 MHz ...	30	10
200 MHz–400 MHz ...	10	10
400 MHz–1 GHz	700	40
1 GHz–2 GHz	1,300	160
2 GHz–4 GHz	3,000	120
4 GHz–6 GHz	3,000	160
6 GHz–8 GHz	400	170
8 GHz–12 GHz	1,230	230
12 GHz–18 GHz	730	190
18 GHz–40 GHz	600	150

In this table, the higher field strength applies at the frequency band edges.

c) HIRF environment III is specified in the following table:

TABLE III.—HIRF ENVIRONMENT III

Frequency	Field strength (volts/meter)	
	Peak	Average
10 kHz–100 kHz	150	150
100 kHz–400 MHz	200	200
400 MHz–700 MHz ...	730	200
700 MHz–1 GHz	1,400	240
1 GHz–2 GHz	5,000	250
2 GHz–4 GHz	6,000	490
4 GHz–6 GHz	7,200	400
6 GHz–8 GHz	1,100	170
8 GHz–12 GHz	5,000	330
12 GHz–18 GHz	2,000	330
18 GHz–40 GHz	1,000	420

In this table, the higher field strength applies at the frequency band edges.

- d) Equipment HIRF Test Level 1.
 - (1) From 10 kilohertz (kHz) to 400 megahertz (MHz), use conducted susceptibility tests with continuous wave (CW) and 1 kHz square wave modulation with 90 percent depth or greater. The conducted susceptibility current must start at a minimum of 0.6 milliamperes (mA) at 10 kHz, increasing 20 decibels (dB) per frequency decade to a minimum of 30 mA at 500 kHz.
 - (2) From 500 kHz to 40 MHz, the conducted susceptibility current must be at least 30 mA.
 - (3) From 40 MHz to 400 MHz, use conducted susceptibility tests, starting at a minimum of 30 mA at 40 MHz, decreasing 20 dB per frequency decade to a minimum of 3 mA at 400 MHz.
 - (4) From 100 MHz to 400 MHz, use radiated susceptibility tests at a minimum of 20 volts per meter (V/m) peak with CW and 1 kHz square wave modulation with 90 percent depth or greater.
 - (5) From 400 MHz to 8 gigahertz (GHz), use radiated susceptibility tests at a minimum of 150 V/m peak with pulse modulation of 4 percent duty cycle with a 1 kHz pulse repetition frequency. This signal must be switched on and off at a rate of 1 Hz with a duty cycle of 50 percent.
- e) Equipment HIRF Test Level 2. Equipment HIRF test level 2 is HIRF environment II in table II of this appendix reduced by acceptable aircraft transfer function and attenuation curves. Testing must cover the frequency band of 10 kHz to 8 GHz.
- f) Equipment HIRF Test Level 3.
 - (1) From 10 kHz to 400 MHz, use conducted susceptibility tests, starting at a minimum of 0.15 mA at 10 kHz, increasing 20 dB per frequency decade to a minimum of 7.5 mA at 500 kHz.
 - (2) From 500 kHz to 40 MHz, use conducted susceptibility tests at a minimum of 7.5 mA.

(3) From 40 MHz to 400 MHz, use conducted susceptibility tests, starting at a minimum of 7.5 mA at 40 MHz, decreasing 20 dB per frequency decade to a minimum of 0.75 mA at 400 MHz.

From 100 MHz to 8 GHz, use radiated susceptibility tests at a minimum of 5 V/m.

BOOK 2:

ACCEPTABLE MEANS OF COMPLIANCE (AMC)

Book 2
Acceptable Means of Compliance
AMC - SUBPART A
GENERAL
<p>AMC CS-LURS General</p> <p>The FAA AC 27-1B may provide additional guidance to this AMC.</p>
<p>AMC CS-LURS.1 Applicability</p> <p>a) For the purposes of this CS-LURS a Light Unmanned Rotorcraft is assumed to be conventional if it has one of the following configurations:</p> <ol style="list-style-type: none"> 1. single main rotor and a single anti torque device (typically a conventional tail rotor or fenestron) or; 2. multiple main rotors. 3. Unconventional configurations such as compound helicopters, gyroplanes and tilt rotors are not addressed by this code. 4. Specific configurations, such as hydraulic systems, pop-out emergency floatation gear, wheeled undercarriages, retracting undercarriages, “Notar style” devices, load and related attaching means will be addressed with a special condition. <p>b) Visual line-of-sight operation means an operation in which the remote crew maintains direct visual contact with the aircraft to manage its flight and meet separation and collision avoidance responsibilities. Beyond VLOS Operations are not addressed for Operational reasons. Apart from the absence of Detect and Avoid requirements, the design requirements are not limiting. Note that future Detect and Avoid requirements may also have an impact on related CS-LURS requirements.</p> <p>c) A Light Unmanned Rotorcraft System Type Design includes a single Rotorcraft design and a single Control System design.</p> <p>d) The variety of possible configurations, design solutions and intended operation is wide in this range of Unmanned Rotorcraft Systems. Hence the chosen system design may result in operational limitations. These limitations shall be recorded in the approval (e.g. TCDS, STC, Exemption, Permission etc.)</p> <p>e) The extent of the applicability of the CS-LURS Requirements shall be agreed with the certifying authority based on a total system safety assessment performed by the applicant.</p>

The total system safety assessment will include:

- Airworthiness
- Intended Operation
- Airspace
- Flight Crew Licensing
- Maintenance

AMC-SUBPART B

FLIGHT

AMC CS-LURS.23 Approved Operational Envelope

AMC CS-LURS.1 limits the CS-LURS to VLOS, due to the missing Detect & Avoid Technology.

For future development, CS-LURS.23 refers to an approved operational envelope which should be understood as:

- VLOS
- BLOS
- Any other envelope having an effect to the operation

AMC CS-LURS.29 Empty weight and corresponding centre of gravity

For the term “payload” refer to CS-LURS.1481.

In case of permanent installed equipment not required for the continued safe flight and landing, this equipment must be consider as part of the type design.

AMC CS-LURS.143 Controllability and manoeuvrability

- b) Flight Control System (FCS)

For the definition of the Flight Control System refer to AMC CS-LURS.1329

- c) Reserved
- d) Reserved

AMC CS-LURS.171 Stability

This AMC should be used by the Applicant and the Certifying Authority as guidance to demonstrate compliance with UAV stability requirements concerning longitudinal / lateral stability and transient response.

The accuracy and stability quantitative requirements should be established according to the design usage spectrum.

CS-LURS. 171(a) Accuracy

The UAV system must be capable of maintaining the desired flight parameters in smooth air with a sufficiently small static error, to be agreed by the Applicant and the Certifying Authority. This should be demonstrated by model-based analyses and verified by flight tests, for the following parameters, throughout the normal flight envelope:

- attitude: pitch and roll angles;
- airspeed, heading or track, turn rate, and altitude.

For the definition of the Flight Control System refer to AMC CS-LURS.1329

CS-LURS.171(b) Transient response

It must be demonstrated for the entire flight envelope that :

Pitch and Roll response following an abrupt command input or gusts, are suitably damped so as not to cause exceedance of the:

- limit load factor,
- maximum torque allowed by the control surface actuators.

Transition to a selected altitude, or engagement of an altitude hold function should not cause a deviation (overshoot) of the commanded value by a tolerance greater than 3 times the tolerance agreed with the Certifying Authority under AMC CS-LURS.171 (a).

Transition to a selected heading or engagement of a heading hold function should not cause transient deviation (overshoot) of the commanded value by a tolerance greater than 3 times the tolerance agreed with the Certifying Authority under paragraph AMC CS-LURS.171 (a).

Transition to a selected airspeed or selection of an airspeed hold function, within the permissible flight envelope protection, should not cause the air speed to:

- fall below the minimum allowed air speed,
- exceed a defined margin agreed with the Certifying Authority slightly above VC-max and sufficiently below VD.

CS-LURS.171(e) Pilot Induced Oscillations

The absence of PIO tendencies which may lead to unsafe conditions should be demonstrated in flight for each FCS operational mode, with particular attention to manual direct piloting mode (where applicable). Model based simulations with the UA Pilot in the loop may be used to integrate flight test evidence in extreme operational conditions.

AMC-SUBPART C

STRENGTH REQUIREMENTS

AMC LURS.307(a) Proof of Structure

1. Substantiating load tests made in accordance with CS LURS.307(a) should normally be

taken to ultimate design load.
 The results obtained from strength tests should be so corrected for departures from the mechanical properties and dimensions assumed in the design calculations as to establish that the possibility of any structure having a strength less than the design value, owing to material and dimensional variation, is extremely remote

AMC LURS.361 Engine torque

In case the maximum continuous power of a reciprocating, rotary or turbine engine or the peak torque of an electrical engine is limited (reduced) with respect to its nominal value by a rotorcraft system, a lower value – but not less than the limited value – of the maximum continuous power or the peak torque may be used for the calculation of the limit torque instead of the nominal maximum continuous power requested by CS-LURS.361(a)(1)(2)(3)(4) or the nominal maximum peak torque requested by CS-LURS.361(a)(5), provided the Onboard Automatic Limitation System (OALS) is taken into account in the demonstration of compliance with CS-LURS.302.

AMC LURS.547(a) Main Rotor Structure

A rotor is an assembly of rotating components which includes the rotor hub, blades, blade dampers, the pitch control mechanisms, and all other parts which rotate with the assembly.

AMC LURS.549(b)(1) Fuselage, landing gear, rotor pylon and engine structures

When the engine is certified under the requirements of appendix B to this CS.LURS then the requirements of CS LURS.361 should be taken into account for the engine structure when demonstrating compliance with CS LURS 549(b)(1).

AMC LURS.561 (b) and (c)

Crashworthiness

1. Explanation
 - a. The intent of Subparagraph CS-LURS.561(b) is to protect third parties on the ground, outside the forced landing area selected under CS-LURS.1412(a)(2), when such an area is chosen for assuring the emergency recovery capability of the rotorcraft required by CS-LURS.1412(a). In this case Subparagraph (b) requires that Subparagraph (c) be verified.
 - b. Subparagraph CS-LURS.561(c) requires design features that aim to protect third parties on the ground, in case of a forced landing, from projection of parts and

fire/explosion hazards.

- c. Self-containment features must be included in the rotorcraft design as much as practical, in order to minimise the risk that some dangerous parts such as high speed rotating masses (e.g. rotors, engine and transmission moving parts) come loose after a forced landing and are not contained inside the rotorcraft.
- d. Subparagraph 561(c)(1) refers to those dangerous parts that could detach or break and that could be projected away from the rotorcraft outside the forced landing area. Items of mass to be considered include, but are not limited to, rotors, transmissions, engines, payloads along with their components and breakable parts. The probability that these parts or pieces travel outside the forced landing area should be minimised.
- e. Subparagraph 561(c)(2) requires that the rotorcraft does not constitute a source of ignition or leak of flammable fluids in hazardous quantities, in order to protect third parties on the ground, from fire hazard.
- f. Subparagraph 561(c)(3) aims to protect third parties outside the forced landing area from the adverse effects of a possible explosion after the forced landing or impact with the ground.
- g. While specific design features in conjunction with structural analysis can be developed for complying with Subparagraphs 561(c)(2) (ref. Para. 2.3 of this AMC), in order to comply with Subparagraphs 561(c)(1) and (c)(3) design features such as self-containment features could be not enough. As a matter of fact even if self containment features could be effective in avoiding the projection of small fragmented pieces, they could be not effective for avoiding the projection of large and relatively heavy parts such as rotor blades, or for avoiding explosion at the time or immediately after an impact with the ground. Therefore, in these cases a forced landing area should be defined in order to protect third parties on the ground from projection of dangerous non containable parts and from the effect of possible post landing/impact explosions.

2. Procedure

2.1 Engineering judgement, also based on service experience, should be exercised in order to identify effective self-containment design features for compliance with Subparagraph LURS.561(c). This should be done by a documented design review.

2.2 LURS.561(c)(1) and (c)(3). *Forced landing area.*

- a. Subparagraph LURS.561(c)(1) requires that the projection of parts that may constitute a potential injury to third parties outside the forced landing area is unlikely and Subparagraph LURS 561(c)(3) requires that third parties outside the forced landing area must be protected against the effect of a post landing or impact explosion.
- b. The size of the forced landing area should be established by analysis, including simulation, and/or test and well documented. The method for determining the size and shape of the forced landing area should be agreed with the Authority in order to comply with ICAO requirements on equivalent levels of safety as manned aviation (Ref. ICAO Circular 328).
- c. A circular forced landing area could be derived based on the following two cases, depending on whether it is likely or not to have dangerous fragments or parts projected away from the rotorcraft as a consequence of the emergency forced landing or impact with the ground. The evaluation whether a fragment or a part could be dangerous for third parties should be done on the basis of two parameter, i.e. the ballistic coefficient of the fragment or part (the ballistic coefficient is the ratio between the fragment or part weight and its reference surface) and its kinetic energy. If the fragment or part has a low ballistic coefficient (i.e. it is a small light piece) and has a low kinetic energy, less than or equal to 66 J, then the fragment or part is not potentially dangerous and it has not to be considered as a dangerous projected part in the calculation of the forced landing area.
- (1) *Case 1. It is likely to have dangerous fragments or parts projected as a consequence of the forced landing or impact with the ground.* In this case the forced landing (circular) area should be calculated as the circular area whose radius R_{rec} is the greater of the maximum range travelled by the part, taking into account any possible slide and rebound and simulation scatter (R_{sim}) and the radius of the circular lethal area due to a post landing or impact explosion (D), if there is such risk.

$$R_{rec} = \max \{R_{sim}, D\}$$

R_{sim} is the maximum range travelled by the projected part, taking into account any possible slide and rebound, multiplied by a safety factor that takes account of the simulation scatter and approximations. A possible step-by-step methodology for calculating the radius R_{sim} is described at point 2.2.d of this AMC.

D is the radius of the circular lethal area due to explosion, such that 100% of the population inside is expected to have an injury due to the explosion.

The radius D can be determined by the following formula:

$$D = K \cdot (W_{TNT})^{1/3}$$

W_{TNT} is the net equivalent weight of TNT corresponding to the weight W of the actual explosive material (e.g. the fuel) inside the rotorcraft at the moment of impact. The equivalent weight W_{TNT} of a particular explosive is the weight of TNT required to produce an overpressure of equal magnitude produced by a weight W of the explosive in question.

K (the *K-factor*) is a scaling factor that correspond with specific blast overpressure levels. The K -factor represents the degree of damage that is acceptable: the lower the factor, the greater the acceptance of damage. For the determination of the forced landing area, the K factor should be selected such that a maximum blast overpressure of 3.5 psi is experienced at the distance D . The K -factors in function of the blast overpressure, as well as the net TNT equivalent weights can be found in the document DOD 6055.9-STD, DOD Ammunition and Explosive Safety Standards.

- (2) Case 2. *It is not likely to have dangerous fragments or parts projected as a consequence of the forced landing or impact with the ground.* In this case no dangerous fragments or parts are expected to separate from the rotorcraft and travel outside the recovery area as a consequence of the emergency forced landing or impact with ground, therefore the forced landing area could be calculated by taking account of the impact of the rotorcraft, without any separation of parts, in conjunction with a possible post landing explosion. The radius R_{rec} of the circular forced landing area can then be obtained from the following formula:

$$R_{rec} = 2.65[(r_p + r_f) + h_p/2 \operatorname{tg} \gamma] + D$$

where:

r_p is the radius of a person ($r_p = 1$ ft is acceptable),

h_p is the height of a person ($h_p = 6$ ft is acceptable),

γ is the impact (flight path) angle equal to the angle between the landing or impact surface and the impact velocity vector of the rotorcraft.

$D = K \cdot (W_{TNT})^{1/3}$ is the radius of the circular lethal area due to explosion.

d. A deterministic analytical approach to determine a circular forced landing area due to the projection of fragments or parts should encompass at least the following steps:

- (1) Determine the most critical realistic forced landing or crash scenario in order to:
 - (i) Estimate the mass, the trajectory, the velocity, the impact energy and the attitude of the rotorcraft at the moment of landing or impact with the ground;
 - (ii) Determine the parts of the rotorcraft that are likely to impact the ground and that could brake loose as a consequence of the impact;
 - (iii) Estimate the maximum ground accelerations the rotorcraft and its parts could be subjected to during the forced landing in order to evaluate the capability of the structure to withstand those accelerations. The estimated ground loads may be considered as ultimate loads. For example, if the rotorcraft supporting structure is designed to withstand a certain level of ultimate inertia loads and, during the forced landing, such level is exceeded in some element or part of the structure, then this element or part is likely to break loose and detach during the forced landing; therefore its subsequent trajectory should be taken into account in the calculation of the radius of the forced landing area as described in the following steps;
- (2) Estimate the mass, the shape and, if necessary, the stiffness of the projected parts;
- (3) Estimate the initial position and attitude and the initial velocity vector (intensity and direction) of the projected parts immediately after their detachment;
- (4) Calculate the trajectory of the projected parts taking into account in a rational or conservative manner all the significant external forces acting on them including weight, aerodynamic forces with drag and friction with ground;
- (5) Determine the distance (range) travelled by the projected parts taking account of any possible rebound;

- (6) Vary the significant parameters and initial conditions (mass, velocity vector, stiffness, shape, initial position and attitude, coefficient of friction, etc.) of the projected parts in order to carry out a parametrical/sensitivity study of the trajectories and determine the maximum range covered by the projected parts.

Determine the radius R_{sim} of the forced landing area due to projection of parts as not less than 1.2 times the maximum range determined at point d.(6) e. In case an explosion is expected as a consequence of a forced landing, the minimum distance of any building from the centre of the forced landing area should be calculated as the radius D of the circular lethal area due to explosion done by the formula used for Case 1 at para. 2.2(c)(1), with a K-factor corresponding to a blast overpressure of 0.5 psi.

2.3 LURS.561(c)(2). *Fire hazard.*

- a. A rotorcraft design assessment should be carried out and documented in order to identify design solutions that could prevent post landing/crash fire or explosion ignition or leak of flammable fluids in hazardous quantities during an forced landing.
- (1) Electrical connections of externally mounted payload and accessories, such as cameras, should be sufficiently protected to preclude electrical fires and the devices should not be likely to penetrate a fuel compartment.
 - (2) The accessories and payload should also be designed not to have "hard points" that would unacceptably damage the rotorcraft structure under landing impacts by penetration into the fuel tanks. Design features may be employed to preclude this penetration if possibly hazardous.
 - (3) The accessories may be designed with frangible fittings, frangible devices, or comparable design features, provided the broken parts are self-contained (see Para. 2.1. of this AMC) or they are properly taken into account as potential dangerous projected parts for the evaluation of the size of the recovery area, as described at Para. 2.2(c)(1) of this AMC.
- b. The supporting structure of any fuel tank should be capable to protect the fuel tank and to withstand the ultimate inertial loads up to those experienced in a forced landing under any realistically expected crash scenario, without any significant leakage of the fuel tank. This can be demonstrated by analysis or by test.

2.4 The ground accelerations referred to paragraphs 2.2 d.(1)(iii) and 2.3 b. of this AMC, experienced by the rotorcraft and its parts in an forced landing,

may be derived in a rational or conservative manner or measured in a drop test that simulate a representative forced landing or crash scenario.

AMC LURS.571(a)(3) Fatigue evaluation of flight structure

If, based on size, weight and construction, the in-flight measurements requested by LURS.571(a)(3) are impractical to carry out on some element, a conservative estimation of the stress/strain level and/or loads to be used in the fatigue evaluation can be derived by a validated analysis.

The stress/strain level and/or loads derived by the above analysis should be validated by correlation with in flight measurement data, such as local strain measurement, accelerations and deflection as necessary, taken in other points of the structure

AMC-SUBPART D

DESIGN AND CONSTRUCTION

AMC LURS.602

Critical Parts

1 Explanation

The objective of identifying critical parts is to ensure that critical parts are controlled during design, manufacture and throughout their service life so that the risk of failure in service is minimized by ensuring that the critical parts maintain the critical characteristics on which certification is based. Many rotorcraft manufacturers already have procedures in place within their companies for handling “critical parts”. These may be required by their dealings with other customers, frequently military (e.g. US DoD, UK MoD, Italian MoD). Although these programs may have slightly different definitions of “critical parts” and have sometimes been called “flight safety parts”, “critical parts”, “vital parts”, or “identifiable parts”, they have in the past been accepted as meeting the intent of this requirement and providing the expected level of safety.

2 Procedures

The rotorcraft manufacturer should establish a critical parts plan. The policies and procedures which constitute that plan should be such as to ensure that:

- a. All critical parts of the rotorcraft are identified by means of a failure assessment and a critical parts list is established. The use of the word “could” in paragraph CS VLR.602(a) of the rule means that this failure assessment should consider the effect of flight regime (i.e. forward flight, hover, etc.). The operational environment need not be considered. With respect to this rule, the term “catastrophic” means the inability to conduct an autorotation to a safe landing, without exceptional UA Piloting skills, assuming a suitable landing surface.

b. Documentation draws the attention of the personnel involved in the design, manufacture, maintenance, inspection, and overhaul of a critical part to the special nature of the part and details the relevant special instructions. For example all drawings, work sheets, inspection documents etc, could be prominently annotated with the words 'critical part' or equivalent and the instructions for continued airworthiness and overhaul manuals (if applicable) should clearly identify critical parts and include the needed maintenance and overhaul instructions. The documentation should:

- (1) Contain comprehensive instructions for the maintenance, inspection and overhaul of critical parts and emphasize the importance of these special procedures;
- (2) Indicate to operators and overhaulers that unauthorized repairs or modifications to critical parts may have hazardous consequences;
- (3) Emphasize the need for careful handling and protection against damage or corrosion during maintenance, overhaul, storage, and transportation and the need for accurate recording and control of service life (if applicable).

Require notification to the manufacturer of any unusual wear or deterioration of critical parts and the return of affected parts for investigation when appropriate;

c. To the extent needed for control of critical characteristics, procedures and processes for manufacturing critical parts (including test articles) are defined (for example material source, forging procedures, machining operations and sequence, inspection techniques, and acceptance and rejection criteria). Procedures for changing these manufacturing procedures should also be established.

d. Any changes to the manufacturing procedures, to the design of a critical part, to the approved operating environment, or to the design loading spectrum are evaluated to establish the effects, if any, on the fatigue evaluation of the part.

e. Materials review procedures for critical parts (i.e. procedures for determining the disposition of parts having manufacturing errors or material flaws) are in accordance with paragraphs c. and d. above.

f. Critical parts are identified as required, and relevant records relating to the identification are maintained such that it is possible to establish the manufacturing history of the individual parts or batches of parts.

g. The critical characteristics of critical parts produced in whole or in part by suppliers are maintained.

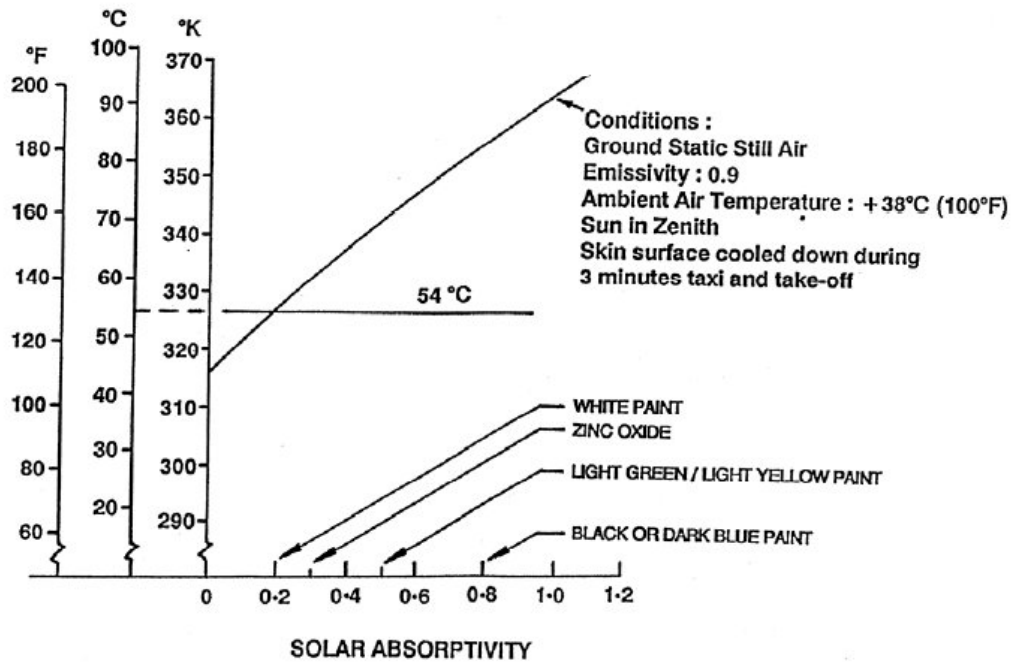
AMC LURS.613(b) Material Strength Properties and Design Values

Material specifications should be those contained in documents accepted either specifically by the Agency or by having been prepared by an organization or person which the Agency accepts has the necessary capabilities. In defining design properties these material specification values should be modified and/or extended as necessary by the constructor to take account of manufacturing practices (for example, method of construction, forming, machining, and subsequent heat treatment).

AMC LURS.613(c) Material Strength Properties and Design Values

Test Temperature :

- a. For white painted surface and vertical sunlight: 54°C. If the test cannot be performed at this temperature an additional factor of 1.25 should be used.
- b. For other coloured surfaces the curve below may be used to determine the test temperature.



Curve based on: NASA Conference Publication 2036
 NASA Contractor Report 3290

AMC LURS.615 Design Properties

When the manufacturer is unable to provide satisfactory statistical justification for A and B values, especially in the case of manufacturing of composite materials, a safety super factor should be applied to ensure that A and B values are met.

AMC LURS.629 Flutter

The FAA AC-27.1B latest revision should be used as a general guidance with the below change.

AC 27.629. § 27.629 FLUTTER.

(b) Procedures

Freedom from flutter is to be shown for the entire rotorcraft with special attention to the blades, fins, and stabilizers

should be read as:

Freedom from flutter is to be shown for the entire rotorcraft with special attention to the blades and other surface which failure may lead to a catastrophic failure

AMC LURS.685(d)(4) Control System Details

The inside diameter of the pulley groove should be not less than 300 times the diameter of each elemental strand.

AMC LURS.725 Limit Drop Test

Reference M. Chernoff "Analysis and Design of skid gears for level landing"

Rational analysis for the limit load factor determination, such as that outlined in the reference, might be submitted to the Agency instead of the limit and reserve energy drop tests required in CS LURS.725 and CS LURS.727.

AMC LURS.867 Electrical bonding and protection against lightning and static electricity

Reserved

AMC-SUBPART E

POWERPLANT

AMC LURS.901(b) Installation

A reliability program should be provided in order to demonstrate that the product (engine and powerplant installation) can ensure a safe operation between the proposed normal inspections or overhauls.

The reliability program should be based on the evidence resulting from the endurance test required by B.LURS.47, the vibration evaluation requested by the AMC for B.LURS.33 and the safety assessment and enhanced design review requested by the AMC for B.LURS.27.

Procedures for in service monitoring (such as installation of sensors that provide information on the integrity of the in-service engine/powerplant components) are also recommended in order to support this reliability program

AMC LURS.901(c) Installation

The instructions for installing the engine referred to in CS LURS.901(c)(1) are those required under CS E 20(d) or B.LURS.3.

AMC LURS.903 (a) Engine Type Certification

Engines certificated under CS-E are accepted as complying with appendix B.

AMC LURS.907 Vibration

1 Explanation

Section CS VLR.907 is intended to require the design of the rotor drive system, including the engine, to be free from harmful vibration

The mechanical coupling of the engine to the rotor drive system could lead to a rather complex harmonic response, in terms of torsional vibration, adding resonant frequencies to the engine shaft that otherwise would be absent when the engine is operated on a test bench. In this context the phenomena of torque pulse in compression ignition (diesel) engines is particularly damaging.

Torque pulses produced by reciprocating engines can easily aggravate the relationship between engine and driven equipment in terms of torsional vibration and the resonance that can amplify this vibration to destructive levels. The problem of torque pulse is common to all reciprocating engines but is much more pronounced and is a far greater problem with diesel engines. The problems are compounded by the use of lightweight diesel engines of the type finding their way into aviation use.

The problem is significant and can result in the failure of crankshafts, spline shafts, couplings, bearings, gears and seals. The consequence of which will be a premature failure of the engine or the transmission resulting in a loss of drive to the rotor system, which at a minimum will result in an unpremeditated enforced landing.

The torque pulses introduce harmonic excitation forces that are not part of the smooth torque output of the engine and do not add to usable power output.

However, they can range as high as ten times the engine's normal operating torque, so they can add substantially to the total amount of torque transmitted through

the system and to the rate of wear and damage that results from it. Conducting a vibration survey of the powertrain system will determine the natural frequencies of the system components and the frequencies produced by the engine. Then tuning the system to damp out the vibration and shift destructive resonance speeds away from the engine operating RPM range will contain the problem. This is usually achieved by installing a tuned coupling between the engine and the item it is driving.

2. Procedure

- a. In order to determine that there are no damaging effects from excessive vibrational stresses for helicopters powered by spark ignition engines a combination of analytical vibration survey and ground and flight-testing can be used to demonstrate compliance with this requirement. In the absence of an analytical vibration survey substantially more extensive ground and flight-testing can be used.
- b. For helicopters powered by compression ignition engines care should be taken to minimize the detrimental effects caused by engine torsional vibration (torque pulses) in all components of the engine, rotor and transmission drive systems - including chain and belt drives, transmission systems and rotor hubs. A combination of analytical vibration survey, coupling selection and ground and flight-testing should be used to demonstrate compliance with the requirements.
- c. Before the commencement of the ground and flight test programs the components installed to the rotorcraft and intended to be used for the ground and flight test programs should be identified and their condition recorded, including the dimensions of any part liable to be subjected to wear.
- d. At the conclusion of the ground and flight test programs the components of the engine, rotor and transmission drive systems including; chain and belt drives, transmission systems and rotor hubs, should be free of excessive and/or abnormal wear, distortion, cracking and other forms of structural damage.
- e. If during the course of the ground and flight test programs, it becomes necessary for any reason to replace any part of the engine, rotor and transmission drive systems including; chain and belt drives, transmission systems and rotor hubs, the Agency should be informed and their advice sought on the continuing validity of that test program.

AMC.LURS.963(e) Fuel Tanks General

1. Explanation

The intent of the requirement is to prevent heating of the fuel due to conditions within the helicopter, beyond a temperature that would normally be reached due to thermal soaking as result of external ambient conditions and above which the helicopter would not be operated. These measures are intended to prevent damage to the fuel tanks, fuel system components and surrounding structure and minimize the risk of potential catastrophic explosion of the fuel tanks due to the fuel exceeding its auto-ignition temperature. The main source of heat is considered to be unused fuel being re-circulated back to the fuel tanks by the engine.

CS-VLR recognizes that compression ignition engines will be used in the class of helicopter catered for by the requirements. Modern compression ignition engines may use very high-pressure re-circulating fuel injection systems that supply a constant volume of fuel in excess of the engine's needs. The excess fuel is returned to the fuel tanks and because of the pressurization process the fuel is hot. The continuously returning fuel progressively heats up the contents of the fuel tank. If means are not taken to control the temperature rise within the stored fuel then the intent of the requirement cannot be met.

2. Procedure

In order to meet the intent of the requirement (particularly when re-circulating type engine fuel distribution systems are used) an assessment of fuel heating within the fuel tanks due to conditions within the helicopter should be made under normal operating conditions. In addition, when re-circulating type engine fuel distribution systems are used, the most adverse conditions liable to be encountered in service should be considered; i.e. high ambient temperatures, low fuel state, engine running at idle speeds for extended periods of time. If the intent of the requirement cannot be met under these conditions then means should be employed to control and limit the temperature rise within the stored fuel

AMC.LURS.999 Fuel system drains

Reserved

AMC LURS.1011(c) Oil System, General

In assessing the reliance that can be placed upon the means for providing the appropriate fuel/oil mixture to the engine to prevent a hazardous condition, account should be taken of, for example -

- a. The tolerance of the engine to fuel/oil mixture ratios other than the optimum;
- b. The procedure established for refueling and introducing the appropriate amount of oil; and
- c. The means by which the UA crew may check that the fuel contains an adequate amount of oil.

AMC – SUBPART F

Design Assurance Levels for Software and Electronic Hardware need to be assigned according to CS-LURS.1309

AMC CS-LURS.1316

The FAA AC-20.136A, “PROTECTION OF AIRCRAFT ELECTRICAL / ELECTRONIC SYSTEMS AGAINST THE INDIRECT EFFECTS OF LIGHTNING”, recommends guidance how to protect aircraft electrical and electronic systems from the effects of lightning

AMC CS-LURS.1329 Flight control system (FCS)

For the purpose of this AC, the term “FCS” includes all the equipment necessary to accomplish the FGS function, including the sensors,

computers, power supplies, servo-motors/actuators, and associated wiring. It includes any indications and controllers necessary for the pilot to manage and supervise the system.

The FGS is primarily intended to assist the ground flight crew in the basic control and tactical guidance of the airplane. The system may also provide workload relief to the pilots and provide a means to fly a flight path more accurately to support specific operational requirements, such as reduced vertical separation minimum (RVSM) or required navigation performance (RNP).

SAFETY EQUIPMENT

AMC-CS-LURS.1412 Emergency recovery capability

- (a) Emergency recovery capability objective is to enable LURS to achieve an equivalent level of safety to manned aircraft.
- (b) The applicant shall evaluate all operational and failure conditions and identify relevant scenarios where the emergency recovery capability shall be provided to achieve the LoS identified in the previous paragraph.
- (c) As a minimum, emergency recovery capability must address at least three different scenarios: loss of command and control link (see CS-LURS.1413 and CS-LURS.1423), loss of normal electrical power (see CS-LURS.1412(e)) and loss of all engines required for the controllability of the RPAS when it is not shown to be extremely improbable (see CS-LURS.143).
- (d) The predefined and unpopulated forced landing area in (a)(2) of the requirement needs to be defined according to CS-LURS.561. The performance information to ensure the RPA will be able to reach the area, needs to be furnished in the Flight Manual in accordance with CS-LURS.1587.
- (e) In case the RPAS emergency recovery capability includes a Flight Termination System (FTS), the following additional consideration apply:
 - 1) The FTS shall be designed and installed in a way that a minimum integrity and availability (in normal and foreseen environmental conditions) are guaranteed. Icing effects must be considered in the FTS design.
 - 2) The FTS should be protected by a fireproof shield or positioned in a non-firezone area
 - 3) Engine failure conditions should not prejudice the proper functioning of the FTS under all operating conditions relevant to the established flight envelope and the selected area.
 - 4) It shall be possible to activate the FTS either automatically, if a certain failure condition occurs (i.e. loss of command and control link), or manually under pilot command and in both cases it shall be assessed the impact of engine and/or fuel systems and/or other systems failures on the efficiency of the FTS
 - 5) If the activation mechanism of the FTS is made of explosive material, it shall be minimized the risk of fire in the case of failure in the activation explosive material and it shall be minimized the probability of the unrequested deployment or its effects due to electromagnetic interference
 - 6) In case the FTS is a parachute it shall be provided the minimum deployment altitude if any, and the residual kinetic energy at the impact with the parachute deployed and efficient
 - 7) the FTS installation shall be accessed through a Safety Analysis
 - 8) When assessing the total probability of UAS catastrophic events, failure to activate the FTS should be taken into consideration

AMC CS-LURS.1413 Contingency procedures

The intent of this requirement is to have procedures for a degraded data link.

A degradation does not mean, the Emergency Recovery procedure according CS-LURS.1412 needs to be initiated immediately. The remote pilot should have procedures to recover from a degraded status or if a recovery is not possible how to proceed, so that the UAV does not present any hazard to 3rd parties. If the RPA is in the degraded status AMER the emergency recovering procedure according CS-LURS.1412 will to be initiated either by the pilot or by the onboard systems.

COMMAND AND CONTROL DATALINK

AMC CS-LURS.1421 General

(a) Command and control information consists of commands and parameters transmitted to the UAS(s) from the CONTROL STATION(s), and transmission of all relevant operating parameters required for operation of the system from the UAS(s) to the CONTROL STATION(s).

In this context, commands to the UAS include any parameter that is necessary to enable the operation of the system.

(b) Command and control information transmitted to the UA from the CONTROL STATION (transmitted via the ‘uplink’) should be shown to be shown to enable positive control of the UAS during all normal operations, and transmitted at a rate consistent with safe operation.

(c) Command and control information transmitted from the UA (transmitted via the ‘downlink’), should be shown to enable positive control of the UAS during all normal operations, and transmitted at a rate consistent with safe operation.

(d) Bandwidth and the latency of the overall communications system are to be considered when determining transmission rates consistent with safe operation. It should be noted that the terms ‘uplink’ and ‘downlink’ do not imply only a line of sight radio frequency channel, but include any configuration of any type(s) of communication device(s) capable of transmitting the required information.

(e) It should be shown that a remote communications system is sufficient and robust enough to allow the safe operation of the system and if not, the air vehicle can fly on to a safe landing following failure..

(g) Any ATC communications system should be shown as compliant with CS-LURS.1301 and CS-LURS.1309 as installed equipment.

(i) The functionality of payload data links with no safety of flight impact need not to be assessed under CS-LURS.1601.

(j) Where data is to be transmitted to a location other than the CONTROL STATION (such as a remote viewing terminal), it should be shown that the communications paths used will not interfere with safe operation of the system.

AMC CS-LURS.1423 Command and control data link loss

This requirement is to cover a total datalink loss, due to a failure of hard-ware/software.

As the UAV should not be a hazard to the people and property on the ground and in the air the procedures defined in CS-LURS 1412 Emergency recovery capability will be initiated.

The design should take into account, that in this degraded state the Control Station will have no information about the physical status of the UAV.

AMC CS-LURS.1425 Command and control data link modes

This requirement should cover defective trans-mission channel due to environmental and operational conditions

a)(1) Normal Transmission Mode

The datalink is capable for the intended operation while fulfilling the requirements for a safe flight of the RPAS.

a)(2) Degraded message error rate (DMER) mode

Is defined, where the UAV will not be able to transmit and/or receive the amount of information required for a normal mission.

a)(3) Critical message error rate (CMER) mode

Is defined, where the UAV is still under the remote pilot control, but a significant latency between ATC orders and UAV maneuvers exists.

a)(4) Automatic message error rate (AMER) mode

Is defined, where the UAV is flying automatically without any possible control from the remote pilot.

CS-LURS.1425 requires that in order to specify the Normal Transmission Mode, the Degraded message error rate (DMER) mode and the Critical message error rate (CMER) mode the:

Required Communication Performance (RCP) according CS-LURS.1427, and the,

Required Command and control data priorities according CS-LURS.1429 will be defined by the RPAS designer.

AMC CS-LURS.1427 Required Communication Performance (RCP)

Throughput is defined as:

The measure of the efficiency of a link expressed as the data transfer rate of useful and non-redundant information i.e. the number of successful transactions completed per unit of time, taking into account the overhead bits and the need to retransmit packets containing errors.

Communication transaction time is defined as:

The maximum time for the completion of the operational communication transaction after which the initiator should revert to an alternative procedure. There may be multiple operational communication transactions that support an RPA function. These transactions are assessed to determine the most stringent. The value for the communication trans-action time latency parameter is based on the time needed to complete the most stringent transaction.

Transaction time includes latency but this terminology is better adapted to C2 issues

Availability is defined as:

The probability that an operational communication transaction can be initiated when needed.

There are subsequent definitions related to avail-ability when a service is providing the communica-tions:

- The availability of provision per flight hour (Ap) is the mean availability defined as the probability per flight hour that the service (or the system providing the service) with all the aircraft in the coverage area is operational.
- The availability of use per flight hour (Au) is the mean availability defined as the probability per flight hour that the service (or the system providing the service) between two given parties is operational when needed

The value for the availability parameter is based on the acceptable rate of detected inability to initiate a transaction.

Integrity is defined as:

The probability a message will be received without undetected errors in a completed communication transaction.

The operational hazard assessment should include a severity-of-effects analysis of communication transactions with undetected errors in the context of the RPAS function.

In information security, “data integrity” is the property that data have not been altered in an unauthorized manner. By extension, data integrity also ensures that information is protected against unauthorized modification, deletion, creation, and replication and provides an indication of these unauthorized activities.

Integrity is therefore a major property of the RF link and also of the message carried by the RF link.

AMC CS-LURS.1429 Required Command and control data priorities

The intent of CS-LURS.1429 is to define the minimum required data which needs to be transmitted in the up- and down link to be in the Normal Transmission Mode, the DMER, CMER or the AMER.

b) requires the designer, to define the threshold where the minimum data for a maximum time are no longer available and the UAV needs to be considered as no longer under the control of the remote pilot.

In this case the Emergency recovery procedure according CS-LURS.1412 is initiated, as this situation corresponds to the loss of the datalink.

AMC CS-LURS.1587 Performance information

Reserved

AMC CS-LURS.1702 Systems and equipment used by the crew
(to be derived from AMC 25.1302)

AMC CS-LURS.1711 Electronic Display Instrument Systems
(to be derived from AMC 23.1311)

AMC CS-LURS.1737(a)(2), Fuel and Battery Capacity Instruments

A single indicator is acceptable for each group of interconnected tanks functioning as a single tank, such that individual tanks cannot be isolated.

AMC CS-LURS.1775(b) UA hand over between multiple control stations

(1) Positive control is the practice of the control station to mediate a transfer of control to the new controlling control station for before severing the control connection to the UA. I.e. The entity wishing to transfer control cannot terminate the connection to the UA until the entity wishing to gain control has acknowledged the connection and requests control.

(2) The transition time during which the UA is not under the control of any control station must be assessed in order to demonstrate that UA hand over procedure does not lead to any unsafe situation.

AMC CS-LURS.1775(c) UA hand over between multiple control stations

A specific description of the synchronization procedure in each control station should be presented in the UA System Flight Manual.

AMC CS-LURS.1775(d)
UA hand over between multiple control stations

Particular attention should be given to control station settings during control handover to ensure operating parameters are identical before and after handover.

AMC CS-LURS.1777 Command and control of multiple UA
Reserved

AMC - APPENDIX B

ENGINES

AMC B-LURS.1 Applicability

1. Engines certificated under CS-E or CS22 Subpart H are accepted as complying with appendix B.
2. If the engine is based on a commercially available unit then it may be impossible to have access to all the pertinent design data necessary to show compliance with the requirements of this appendix B. If this is the case then alternative means of compliance that would provide equivalent levels of safety should be proposed.
3. Where the engine is based on a commercially available unit, procedures should be in place showing how:
 - a. In-service airworthiness issues arising because of design and manufacturing changes made to the base engine by the original manufacturer of the engine will be prevented, and
 - b. Any design related in-service airworthiness issues are resolved.

AMC B-LURS.27 Durability

1. The intent of this requirement is to encourage the performance of a design review of the engine and a safety assessment of its components that would allow the minimization of the development of an unsafe engine condition between the established inspection intervals and overhaul periods.
2. Design review. It should be demonstrated that the engine and its installation on the rotorcraft do not have any design features or details that experience has shown to be hazardous or unreliable, the suitability of each questionable design detail and part should be shown by tests.
 1. Safety Assessment. The safety assessment and related failure analysis should normally include investigation of those engine components that could affect the functioning and integrity of the major rotating assemblies, ignition systems, and for the control system all manual and automatic controls (e.g. fuel system governors, overspeed limiters, electronic engine management systems). Possible modes of failure, including malfunctions and damage from external sources should be investigated and inspection/overhaul intervals established such as to minimize the development of unsafe condition for the engine.

The failure of individual components of the engine need not be included in the analysis if it can be demonstrated that the possibility of such failure is sufficiently remote.

AMC B-LURS.29 Engine cooling

Many air-cooled engines used in helicopters were originally designed for use in fixed wing aircraft where they could take advantage of a flow of forced cooling air, and thus be reasonably evenly cooled. However, because of the installation differences between fixed wing aircraft and helicopters it is known that air-cooled engines

installed into helicopters can be somewhat difficult to cool evenly. Hence it is possible for one or more cylinders to run hotter than the rest with adverse consequences on engine reliability, if they are allowed to overheat. Therefore the engine cylinder head temperature gauge should monitor the most critical (hottest running) cylinder

AMC B-LURS.33 Vibration

1. A vibration evaluation of the engine is requested as a preliminary fatigue assessment before the engine is installed on the rotorcraft (see paragraph 2 below). The intent of this requirement is to demonstrate that the engine is free from harmful vibration under all normal operating conditions. The torsional and bending vibration characteristics of the crankshaft and the drive shaft should be determined over the range of crankshaft speed, from idling speed to 103 % of the maximum desired take-off speed rating. And it should be demonstrated that the associated loads and stresses are below the endurance limit of the materials used for the engine construction. This investigation may be accomplished by a combination of analysis and test.

1. The mechanical coupling of the engines to the rotor drive system creates, for torsional vibration considerations, a complicated system that responds to any forced or resonant frequency. Antinodes or nodes and frequencies may exist in the engine shaft which are absent when the engine is operated on a test stand; therefore, the vibration investigation conducted under B-LURS.33 is not conclusive with respect to torsional loads. This requirement requires the substantiation of the effects of vibration on any part of the engine when installed on the rotorcraft and when subjected to the expected flight loading conditions. The load survey requested by CS-LURS.571 will provide the loads and the stresses associated to the vibration effects on the engine. The vibration evaluation should include low cycle fatigue associated with ground-air-ground cycles.

Additional AMC for turbine engines:

1. Except where the engine is of a type of construction known not to be prone to hazardous vibration, the engine must undergo a vibration survey to establish that the vibration characteristics of those components that may be subject to mechanically or aerodynamically induced vibratory excitations are acceptable throughout the declared flight envelope. The engine surveys and their extent must be based upon an appropriate combination of experience, analysis and component test and must address, as a minimum, blades, vanes, rotor discs, spacers and rotor shafts.

2. The surveys must cover the ranges of power or thrust and both the physical and corrected rotational speeds for each rotor system, corresponding to operations throughout the range of ambient conditions in the declared flight envelope, from the minimum rotational speed up to 103% of the maximum physical and corrected rotational speed permitted for rating periods of two minutes or longer and up to 100% of all other permitted physical and corrected rotational speeds, including those that are Over-speeds. If there is any indication of a stress peak arising at the highest of those required physical or corrected rotational speeds, the surveys must be extended sufficiently to reveal the maximum stress values present, except that the extension need not cover more than a further two percentage points increase beyond those speeds.

AMC B-LURS.35 Ignition

Attention should be paid to minimizing the detrimental effects of electromagnetic radiation on electronic ignition systems and related electronic engine management systems. Irrespective of whether the radiation has been generated within the rotorcraft or external to it i.e. HIRF. It is expected that demonstrations of compliance with CS-LURS.1309 and B.LURS.27 will address this issue.

AMC B-LURS.37 Fuel and Induction Systems

Attention should be paid to minimizing the detrimental effects of electromagnetic radiation on electronic fuel injection systems and related electronic engine management systems. Irrespective of whether the radiation has been generated within the rotorcraft or external to it i.e. HIRF. It is expected that demonstrations of compliance with CS-LURS.1309 and B.LURS.27 will address this issue.

AMC B-LURS.43 Calibration Test

The calibration test should be carried out before the commencement of the endurance test, (B.LURS.47) and after it has been concluded. Comparison of the before and after test results should provide an indication of engine degradation.

AMC B-LURS.47 Endurance Testing

The intent of this test is to demonstrate a minimum level of operability of the complete engine within its approved ratings, limitations, inspections and maintenance requirements. The engine should be tested in a condition representative of its installation. All required engine driven accessories necessary for its functioning when installed, such as engine driven cooling fans in the case of some air cooled engines, should be fitted to the test engine.

AMC - APPENDIX C

Interaction of Systems and Structures

1. Para. C-LURS.1(b) clarifies that the Appendix C criteria *“are only applicable to structure whose failure could prevent continued safe flight and landing and the emergency recovery capability required by CS LURS.1412”*. This AMC specifies, in turn, acceptable criteria that can be implemented in showing compliance with CS.LURS.302 and CS-LURS Appendix C, for the emergency recovery phase of CS-LURS.1412(a)(2).
2. Definition of a *“Limiting System”*. With the aim of demonstration of CS LURS.302, a Limiting System means a system whose failure, not shown to be extremely improbable, can affect the structural performance of a structure whose failure could prevent the continuation of safe flight and landing including the emergency recovery capability of the rotorcraft.
3. Normally a recovery procedure could foresee a limitation of the flight envelope due to the fact that it must be automatically activated after a certain failure of the RPA System; moreover it could foresee a preprogrammed flight trajectory. This AMC deals with the following issue: how to treat, in the context of LURS.302 and Appendix C, a failure of a limiting system affecting structural performances, and whose failure is not shown to be extremely improbable, *during the recovery phase* after, e.g., the failure of Data Link or Ground Control Station such that the pilot cannot put in place any corrective action for rotorcraft reconfiguration or flight limitations, not having the control of the rotorcraft any more. In this case

compliance with LURS.302 and Appendix C cannot take credit on rotorcraft reconfiguration or flight limitations that should be put in place directly by the pilot action after the failure of the limiting system has occurred, as currently allowed by Appendix C, C-LURS.2(c)(1): *“a realistic scenario, including pilot corrective actions, must be established to determine the loads occurring at the time of failure and immediately after failure”* and C-LURS.2(c)(2)(i): *“The design limit loads of Subpart C or the maximum loads expected under the limitation prescribed for the remainder of the flight must be determined”*.

4. Taking into account the above, there could be three options (4.a., 4.b. and 4.c. below) to be adopted in defining a recovery procedure –

a. The recovery procedure does not foresee any special automatic rotorcraft reconfiguration or flight limitation that could lead to an in flight loads reduction during the recovery phase (e.g. no limitation of the flight envelope is foreseen and a simple redirection of the rotorcraft towards the recovery area is commanded, but without any reconfiguration or flight limitation with respect to the normal flight phase). In this case the rotorcraft could be designed against LURS.302 according to Appendix C, by considering the probability for a limiting system of being in failure condition during the continuation of flight (i.e. during the recovery phase). This means that the rotorcraft has to be designed to withstand the flight loads that come up during the recovery phase following the failure of the limiting system, without any alleviation due to possible flight limitation, taking account of the factor of safety prescribed by Figure 2 of Appendix C, selected as a function of the probably Q_j for the limiting system being in the failure condition (failure rate times average time spent in failure condition).

b. The recovery procedure foresees the activation of an Onboard Automatic Limitation System (OALS) whose functions are:

- (1) Detection of the failure of the limiting system(s) to be taken into account under CS-LURS.302, and
- (2) Reconfiguration of the rotorcraft and/or limitation the flight envelope.

In this case the automatic rotorcraft reconfiguration and flight limitations could be taken into account in complying with CS-LURS.302 according to Appendix C. This means that the rotorcraft can be designed to withstand the flight loads that come up during the recovery phase following the failure of the limiting system, taking account of the rotorcraft reconfiguration and/or flight limitations due to the activation of the OALS; nevertheless, in order to select the factor of safety of Figure 2 of Appendix C, to be applied to the (reduced) flight loads, the following considerations apply –

- (i) If the failure of the OALS is extremely improbable then Q_j can be obtained as the failure rate (probability per hours) of the limiting system times the average time spent in failure condition (i.e. the recovery phase time) as described for Figure 2 of Appendix C, without taking account of the probability for the OALS to be in failure.
- (ii) If the failure of the OALS is more likely than extremely improbable, then Q_j should be calculated as the combined probability for the limiting system to be in failure condition and the probability for the OALS of being in failure condition.

Dormant failures of the OALS should be adequately taken into account in the context of CS-LURS.1309.

c. The recovery procedure is such that the time spent in flight during the recovery phase (the “exposure time”) is so low that the failure of the limiting system during the recovery phase is extremely improbable. Therefore, the less the exposure time, the greater the failure rate of the limiting system could be. In this case, compliance with CS-LURS.302 can be shown by considering the limiting system fully operative during the

recovery phase, in accordance with Appendix C, C-LURS.2.(b). This means that the probability for the limiting system being in failure condition during the recovery phase is so low (i.e. its failure during the recovery phase is extremely improbable) that the rotorcraft could be designed against the loads limited by the limiting system being fully operative during the recovery phase.