1. Objective

1.1 The objective of this document / certification criteria is to provide the minimum requirements for airworthiness (safety and security requirements) of the UAS and enable the evaluation of UAS for certification under this Scheme.

2. Scope

2.1 This Certification Criteria is applicable to UAS being manufactured by indigenous manufacturers and importers of UAS in India. For the purpose of ease, indigenous manufacturers, importers and assemblers of UAS are being termed as manufacturer under this UAS Certification Scheme.

2.2 This Scheme is applicable to Civil Unmanned Aircraft Systems.

2.3 The current Drone Rules 2021 cover all scenarios of drone operations including flying in visual line of sight, flying beyond the visual line of sight, day operations, night operations, flying below and above 400 feet, flying in segregated airspace and flying alongside the manned aircraft.

2.4 This version of the Scheme covers the certification of UAS for the following scenarios.

2.4.1 Flying in visual line of sight
2.4.2 Flying in day and night
2.4.3 Flying below 400 feet

2.5 As per Drone Rules 2021

2.5.1 UAS has been categorized into three categories as Aeroplane, Rotorcraft and Hybrid.

2.5.2 UAS has been further sub-categorized into the following three sub-categories:

i. Model Remotely Pilot Aircraft
ii. Remotely Piloted Aircraft
iii. Autonomous Unmanned Aircraft System

2.5.3 UAS has been classified based on maximum all-up weight including payload as follows:

i. Nano: Less than or equal to 250 grams
ii. Micro: Greater than 250 grams and less than or equal to 2 kg
iii. Small: Greater than 2 kg and less than or equal to 25 kg
iv. Medium: Greater than 25 kg and less than or equal to 150 kg
v. Large: Greater than 150 kg.

2.5.4 Type certification is not required for model remotely piloted aircraft and nano unmanned aircraft system. All other UAS shall require type certification before their operation.

2.6 The certification is available for Categories of Micro, Small and Medium. This Certification Criteria is applicable to these three categories of UAS.

i. Micro: Greater than 250 grams and less than or equal to 2 kg.
ii. Small: Greater than 2 kg and less than or equal to 25 kg.
iii. Medium Greater than 25 kg and less than or equal to 150 kg;
iv. Large: Greater than 150 kg* (to be processed on a case-by-case basis)

* Large drones greater than 500 Kg, shall be governed by Aircraft Rules, 1937.

2.7 A product, which has been subject to important changes or overhaul aiming to modify its original performance, purpose or type after it has been put into service, having a significant impact on its compliance with certification criteria for UAS must be considered as a new product and is required to treated as a new model.

2.8 UAS which have been repaired or exchanged (for example following a defect), without changing the original performance, purpose or type, are not to be considered as new products

3. Normative References

3.1 The referenced documents (refer Annexure B) are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

4. Competence Requirements

Competence Requirements for the Remote Pilot shall be as per Drone Rules 2021

5. Requirements

5.1 The UAS shall comply with the requirements as given in Annexure A and evaluated as per methods of evaluation described in Annexure A

Table 1

Requirements (Technical Criteria) for UAS

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
1	**General**			
1.1	i. Classificationof UAS	Micro / Small / Medium / Large	**Stage 1:** Verify the statement submitted by the manufacturer stating the classification of the UAS.	UAS is classified in accordance with maximum all up weight (including all compatible payloads and fully fuelled / charged power sources) and no additional weight will be permitted.
	ii. Category ofthe UAS	a) Aeroplane b) Rotorcraft c) Hybrid (A combination of Aeroplane and Rotorcraft categories)	**Stage 1:** Verify the statement submitted by the manufacturer.	
	iii. Sub Category	a) RASP b) Autonomous UAS	**Stage 1:** Verify the statement submitted by the manufacturer.	
1.2	Weight	i) Empty weight • Weight without fuel / battery and without payload. • Weight with fuel / battery but no payload.	**Stage 1:** Report of test by calibrated measurement equipment to be verified by TQ Cert with respect to empty weight of the UAS.	Manufacturer to weigh the UAS sample with / without maximum fuel /battery, compatible payloads using calibrated measuring equipment and calibration certificate of the equipment to be submitted.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
				Manufacturer to weigh the UAS sample with / without fuel / battery but no payload
		ii) Maximum all up weight • Weight with maximum fuel/ largest battery and with all compatible payloads (Fixed + Variable)	**Stage 1:** Verification of appropriate analysis done by the manufacturers for calculating CG, for all configurations of the UAS, in the design documents submitted by the manufacturers	Manufacturer to weigh the UAS sample with maximum fuel / largest battery and compatible payloads using calibrated measuring equipment and calibration certificate of the equipment to be submitted. UAS is categorized in accordance with maximum all up weight (including all compatible payloads) and no additional weight will be permitted.
		iii) Relevant CG limits for each configuration	Verification of appropriate analysis done by the manufacturers for calculating CG, for all configurations of the UAS, in the design documents submitted by the manufacturers	
1.3	Type of Launch and/ or Recovery Mechanism (If	Launch and Recovery type (as applicable)	**Stage 2:** Physical inspection of the UAS to verify if the UAS type is as per the declaration of the	

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
	installed)		manufacturer in the submitted design document.	
			Stage 2: Physical inspection of the launch and recovery system to verify if the launch and recovery system is as per the declaration of the manufacturer in the submitted design document	
1.4	Dimensions	Wing Span / Max Diagonal Length	**Stage 1**: Measure the wing span / max diagonal length using calibrated measuring instruments and verify with submitted design documents.	Measure dimension of UAS in all configurations. Example: Folded, Ready to Launch, With and Without Payload etc.
1.5	Life of UAS	i) Airframe	**Stage 1:** Verification of design document determining the life of the airframe	
		ii) Engine	**Stage 1:** Verification of design document determining the life of the engine or Manufacturer to submit OEM documents giving details of life of the engine.	
		iii) Battery	**Stage 1:** Cells and batteries used in UAS shall comply to the regulatory requirements of MeitY.	

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			Documentary evidence of IS Battery tests for battery used in UAS to be submitted for verification. **Stage 2:** Physical verification of the evidence submitted	
		iv) Propeller / Rotor	**Stage 1:** Verification of design document determining the life of the propeller / rotor.	Additionally, validation of design results from manufacturer or through ground / bench tests with test bed values (if any) should also be submitted.
		v) Number of Maximum Permissible Landings	**Stage 1:** Verification of design document determining the number of maximum permissible landings.	Additionally, validation of design results from manufacturer or through ground / bench tests (if any) should also be submitted.
1.6	Payloads	Compatible Payload Details	**Stage 1:** Manufacturer to submit a list of all compatible payloads with complete details like weight, specifications, purpose of usage.	No other payload shall be permitted other than those approved by the TQ Cert. Based on the recommendation of TQ Cert, DGCA may update the more compatible payloads in the Type Certificate provided that maximum all up weight of the UAS is not exceeded

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
				Note: For the purpose of certification, payload does not include chemicals or other liquids used in spraying drones. Such liquids may be sprayed by following applicable rules and regulations. In such cases, TQ Cert shall assess the UAS with any one of the liquids intended to be used. Any agricultural chemical inputs in the market may be permitted to be used in the UAS by submitting authorization / undertaking by the user/manufacturer
2	Performance			
2.1	Speeds	i) Minimum operating speed the minimum specified operating speed of UAS at standard sea level conditions shall be at least 10% above the actual stall speed	**Stage 2**: To be witnessed during flight testing: a) Verify that minimum operating speed is at least 10% more than stall speed by design in the submitted design document b) In case the concept of stall speed is not applicable, the	Annexure D: Guidelines for flight test

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			minimum operating speed of the rotor should be considered which is needed for supporting the drone while airborne. c) OEM should demonstrate stable flight (without stall) at minimum operating speed (as applicable)	
		ii) Determine maximum operating speed at standard sea level conditions	**Stage 2:** To be witnessed during flight testing: Manufacturer to demonstrate flight with maximum speed as submitted in the design document	Annexure D: Guidelines for flight test
		iii) Determine that maximum kinetic energy on impact does not exceed 95 KJ at any combination of mass and speed	**Stage 1:** Verification of analysis showing maximum kinetic energy on impact does not exceed 95 KJ at any combination of mass and speed. Refer to the Annexure C prepared for the Kinetic Energy calculations with reference to limiting conditions of weight and speed.	**Note 1:** Calculation should be either of a free fall scenario from 400 ft with zero forward speed or maximum forward speed scenario by calculating 1.4 x Vmax. **Note 2:** Drones having higher mass and velocity combinations resulting in higher than 95 KJ kinetic energy may need to incorporate appropriate drone recovery system to ensure that the limit of 95 KJ is not exceeded.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
2.2	Range	Determine maximum range in still air	**Stage 1:** Verification of analysis submitted by manufacturer. **Stage 2:** Validation of the same during flight test	To be verified through analysis by considering actual max demonstrated endurance and cruise speed, actual max distance from take-off location achieved validated during flight tests. Annexure D: Guidelines for flight test
2.3	Endurance	a) Determine fuel and oil consumption and endurance (if applicable)	**Stage 1:** Manufacturer to submit necessary document of endurance test with fuel and oil consumption of a representative flight for verification. **Stage 2:** Verification of witnessing flight testing while ensuring 10% spare fuel remaining in the tank after landing.	Annexure D: Guidelines for flight test
		b) Determine endurance of the UAS with fully charged battery.	**Stage 1:** Manufacturer to submit necessary document of endurance test of a representative flight for verification. **Stage 2:** Verification of results by witnessing flight-testing while ensuring less than 90% battery utilization of a fully charged battery	

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			after landing.	
2.4	Operational altitude	Determine maximum attainable altitude above mean sea level condition as per standard atmospheric conditions	**Stage 1:** Manufacturer to declare maximum attainable altitude above mean sea level condition as per standard atmospheric conditions by design and demonstrate restriction of maximum attainable altitude above ground level in GCS or firmware. **Stage 2:** Maximum attainable altitude above ground level to be verified during flight-testing against the design document submitted by the manufacturer.	
2.5	Operational envelope	Determine boundaries of operational envelope within which safe flight, in normal and emergency conditions, can be demonstrated under combinations of weight, center of gravity (if applicable), altitude, temperature and airspeed	**Stage 1:** Verification of design document details. **Stage 2:** Comparison with actual flight performance and parameters. **Note:** In case of medium and above categories of UAS, additionally, operational envelope to be demonstrated during flight test.	The manufacturer to submit documents that describe the rationale behind determination of the operational envelope and explain the method of verification. The UAS performance to be considered in both, normal and emergency conditions that are defined by the manufacturer. However, the standard / available

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
				environmental conditions are only to be considered during certification.
2.6	Ceiling height	Determine ceiling height over a range of weight, center of gravity (if applicable), altitude, temperature and airspeed	**Stage 1:** Verification of design documents details. Stage 2: Comparison with actual flight performance and parameters.	Manufacturer to declare the maximum attainable height above Mean Sea Level by design.
2.7	Propeller speed and pitch for safe operation	a) Determine propeller speed and pitch (if multiple/variable pitch props are used or intended to be used in the design) limits that ensure safe operation under normal operating conditions.	**Stage 1:** Verification of the certificate/declaration provided by the manufacturer regarding propeller pitch and speed limits for safe operations.	For detachable or foldable propeller blades, test results of blade retention test at a load double the max centrifugal force should be part of the document submitted.
		b) Determine integrity of propeller and its mounting at maximum rpm	**Stage 1:** Manufacturer to submit design documents determining the integrity of the propeller and its mounting at its maximum rpm or Stage 2: TQ Cert to witness bench test to determine the stated requirement	Manufacturer to submit ground test procedure along with test results at their end
2.8	Stability and control	a) Determine that UAS is able to maintain a stable flight without pilot input	**Stage 2:** To be verified during flight testing: i. Manufacturer to demonstrate stable flight and sensor readings, which should be	Annexure D: Guidelines for flight test

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			longitudinally, directionally and laterally stable. ii. Similar tests to be carried out in Aeroplane category UAS. **Note on Stability:** The UAS should be tested in all its operating modes, both Flight Control System (FCS) augmented or manual (if available), including the Manufacturer provided demonstratable failsafe features must be longitudinally, directionally and laterally stable in any condition normally encountered in service.	
		b) Determine that pilot is able to control UAS with ease.	**Stage 2:** To be witnessed during flight: Manufacturer to demonstrate stable flight with minimal pilot inputs.	
3	Powerplant			
3.1	Powerplant (Engine Operated)	a) Determine that fan blade can withstand ultimate load of 1.5 times the centrifugal force resulting from	**Stage 1:** Verification of design analysis and relevant evaluation data of the stated requirement	

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
		operation	from manufacturer / OEM.	
		b) Determine that engine installation is such that it prevents excessive vibration from any part	**Stage 2:** Vibration measurement test i.e. flight logs to be witnessed for verification of test reports submitted by the manufacturer.	Test report to be submitted by manufacturer as per the specifications given in the design document.
		c) Ensure that exhaust is firmly mounted to the structure and free from any obstructions	**Stage 2:** Ascertain by physical inspection that exhaust is firmly mounted to the structure and free from any obstruction.	
		d) Determine that there is no fuel leak in the system under pressure during operational tests on ground	**Stage 2:** Physical inspection and witness ground test by manufacturer to demonstrate fuel system integrity under pressure during ground test	Integrity of fuel system against leakage to be tested with a factor of safety e.g. 1.5 times the operating pressure of the system.
3.2	Powerplant (Battery Operated)	a) Determine that safe cell temperatures and pressures are maintained during charging / discharging cycle	**Stage 1:** Cells and batteries used in UAS shall comply to the regulatory requirements of MeitY. Documentary evidence of IS Tests of battery used in UAS to be submitted for verification. **Stage 2:** i. Physical verification of the evidence submitted. ii. To be verified during flight test.	Ground tests with electronic load matching the operating current profile may be conducted. Note: Safe cell temperature and pressure during charging and discharging is a safety and reliability parameter of battery. Regulatory requirement of MeitY is to use BIS registered batteries. If a battery is BIS registered, it

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
				automatically complies with this clause since the test would have already got covered within the scope of IS tests.
		b) Determine that no explosive or toxic gases are emitted in normal operation	**Stage 1:** Cells and batteries used in UAS shall comply to the regulatory requirements of MeitY. Documentary evidence of IS Tests of battery used in UAS to be submitted for verification. **Stage 2:** i. Physical verification of the evidence submitted. ii. To be verified during flight test.	Note: Same as in 3.2 (a)
		c) Determine that no corrosive fluid is discharged which may damage the surrounding structures / equipment	**Stage 1:** Cells and batteries used in UAS shall comply to the regulatory requirements of MeitY. Documentary evidence of IS Tests of battery used in UAS to be submitted for verification. **Stage 2:** i. Physical verification of the evidence submitted.	Note: Same as in 3.2 (a)

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			ii. To be verified during flight test.	
		d) Ensure that motor / motor controller has overcurrent / overheating protection	**Stage 1:** i. Verify details of test bench for testing over current / overheating protection system of motor / motor controller and ascertain its suitability. ii. Verify test report of over current / overheating protection system. **Stage 2:** Witness the test to verify the stated requirement.	Bench test to be performed on a suitable test bench for verification of the motor / motor controller over current / overheating protection system.
		e) Battery Storage design and installation	**Stage 2:** Physical inspection to be conducted to ascertain and verify the following as per design documents submitted by the manufacturer: 1. Batteries shall be stored in the manner as to prevent deterioration other than standard battery chemistry and Battery Management System	To be verified from design document and relevant user manual

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			(BMS) limitations. 2. Mechanisms for charging and logging of battery voltages should be provided.	
3.2.1	Battery performance (energy, power capability)	Determine rate of discharge of battery as per manufacturers specifications (C-rate, cut off conditions, Ah and Wh, energy and power density)	**Stage 1:** Verification of test reports from an accredited testing laboratory submitted by the manufacturer determining rate of discharge of battery with charge capacity more than 85% at all times. **Stage 2:** Verification of manufactures test results by witnessing flight testing while ensuring less than 90% battery utilization of a fully charged battery after landing	
3.2.2	Battery performance (life cycle)	Determine life cycle up to 80% Depth of Discharge (DoD) for various atmospheric conditions (flying conditions of drone).	**Stage 1:** Verification of test reports from an accredited testing laboratory submitted by the manufacturer determining the mentioned specification. **Stage 2:** Verification of manufactures test results by witnessing flight testing	

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
4	Structure			
4.1	Strength requirements	a) Demonstrate that airframe structure shall be able to withstand flight limit loads without failure, malfunction or permanent deformation.	**Stage 1:** Verification of static load test report/theoretical analysis (if applicable) and design documents as submitted by the manufacturer. Demonstration through static load test applicable for Medium and above categories. For all others theoretical analysis to suffice.	For determination of anticipated flight loads, appropriate standard software may be used. Static Structural Analysis may be done with Aircraft Handbook Calculation Methods or Finite Element Methods (FEA) (Software) can also be used. Visual inspection to be conducted on engine / motor mounting and structure after the tests for deformation, if any. Static test to limit load based on maximum all up weight.
		b) Applicant has to provide analysis of the structure showing that a factor of safety of 1.5 has been used	**Stage 1:** Verification of analysis and design documents as submitted by the manufacturer.	Static Structural Analysis may be done with Aircraft Handbook Calculation Methods or Finite Element Methods (FEA) (Software) can also be used.
		c) Determine that each user removable bolt, screw, nut, pin or other fastener whose loss could	**Stage 1:** Verification of Design Review Analysis Document to establish that Primary Structure	

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
		jeopardize the safe operation of the UAS, shall incorporate a locking device or redundancy.	Elements (PSEs) have been identified and their drawings or work instructions have provision of lock nuts or adhesive or other mechanisms as applicable. **Stage 2:** Physical verification to be conducted by the inspection agency on sample UAS.	
		d) Determine that UAS is free from excessive vibrations under any operational speed and power condition.	**Stage 1:** Verify the submitted documents, regarding vibration measurement tests i.e. flight logs at manufacturers end **Stage 2:** Witness the vibration measurement tests i.e flight logs	
		e) Determine that propeller blade clearance is sufficient from structure and/or components, and from ground	**Stage 1:** Verification of design documents details regarding blade tip clearances. **Stage 2:** Validation on sample UAS during physical inspection.	
4.2	Shock absorbing mechanism of UAS, if applicable	a) It must be shown that the limit load factors selected for design will not be exceeded.	**Stage 1:** Verification of design analysis submitted by the manufacturer.	Impact/Static Analysis Report of Landing gear using Finite Element Analysis (FEA) software can also be considered.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
		b) The landing gear may not fail, but may yield, in a test showing its reserved energy absorption capacity	**Stage 1:** Verify the design document. **Stage 2:** Witness the drop test.	Demonstration of safe landing of the aircraft when dropped from a height as determined by the manufacturer and demonstrated accordingly. This should also be reflected in operational limitations to be followed by the operator.
5	Material and Construction			
5.1	Type of material for construction	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;	**Stage 1:** Review of material test reports from accredited testing laboratory to ascertain the compliance criteria. However, in the absence of above documentation the manufacturer may submit appropriate analysis or Finite Element Analysis (FEA) whichever applicable.	Strength experimental analysis approved by ASTM / any other appropriate standard) to be carried out for the materials to find out the strength of the material
		The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must: b) meet approved specifications, which will ensure that strength and other properties assumed in the	**Stage 1:** Review of material test reports from accredited testing laboratory (as per ISO/IEC 17025) to ascertain the compliance criteria. However, in the absence of above	Strength experimental analysis approved by ASTM / any other permitted standard) to be carried out for the materials to find out the strength of the material.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
		design data are correct;	documentation the manufacturer may submit appropriate analysis or Finite Element Analysis (FEA) whichever applicable.	
		The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must: c) take into account the effects of environmental conditions, such as temperature and humidity, expected in service.	**Stage 1:** Review of material test reports from accredited testing laboratory (as per ISO/IEC 17025) to ascertain the compliance criteria. However, in the absence of above documentation the OEM may submit appropriate analysis.	Strength experimental analysis approved by ASTM / any other appropriate standard) to be carried out for the materials to find out the strength of the material.
5.2	Fabrication Method	a) Methods of fabrication used must produce consistently sound structures	**Stage 1:** Review of QC process specification and/or procedures submitted by the manufacturer for establishing consistency in quality of fabrication. **Stage 2:** Additionally, physical inspection may be conducted to verify if such processes are in place adequately.	Design document from manufacturer should have description about fabrication and integration procedure in Manufacturing Process Record.
		b) In a fabrication process, such as gluing, spot welding, heat-treating, etc. requires close control, the process must be performed	**Stage 1:** Review of the approved QC process specification and/or procedures submitted by the manufacturer for establishing	

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
		according to an approved process specification.	consistency in quality of fabrication. **Stage 2:** Additionally, physical inspection may be conducted to verify if such processes are in place adequately.	
		c) Fabrication method must be substantiated by a test program Note: Requirement of a test program is applicable for a new fabrication method - which is not yet established/proved in any industry	**Stage 1:** Review of the test program, QC process specification and / or procedures submitted by the manufacturer.	
5.3	Means of protection Against deterioration or loss of strength in operation due to any cause i.e. weathering, corrosion and abrasion.	a) Effect of in-service wear on the loading of critical components should be determined	**Stage 1:** By design review or analysis **Stage 2:** Physical inspection after ground and flight tests.	Manufacturer to identify critical components for anticipated in-service wear.
		b) Effect of temperature and moisture should be determined in computing the material design values	**Stage 1:** Verification of test reports from accredited testing laboratory **For Temperature:** Verification of test reports from an accredited testing lab submitted by	Specimen / Coupon Tests

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			the manufacturer for temperature range of -10°C and +50°C, as per IS 9000 Part 2 & 3 or equivalent standard **For Humidit**y: Verification of test reports from an accredited testing lab submitted by the manufacturer for 90% Relative Humidity at +40°C, as per IS 9000 Part 4 or **IEC 60068 2 78 or equivalent standard**	
5.4	Fire resistant identification plate on UAS for inscribing UIN.	a) Determination of ID plate material which should be fire resistant	**Stage 1:** Review of the declared material type of the ID plate and supported by test reports from accredited testing laboratories. In case the manufacturer is using certified fire-resistant materials, then a certificate and/or appropriate test report certifying the same from the material manufacturer may be accepted	
		b) Determine location of ID plate along with its secure fixing on UAS	**Stage 1:** The Location of ID Plate Manufacturer has to be mentioned in the Detailed Drawing.	

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			Stage 2: Ascertain by physical inspection the location of the fire-resistant identification plate and whether it is securely fixed on UAS.	
6	Data Link			
6.1	Type of data link used for communication (C2 data link, frequency band etc.)	a) Determine full functioning of data link communication	**Stage 1:** Verify the following from documents submitted by the manufacturer. i) Verification of ETA from WPC. ii) Verify that specification and full functioning / characteristics of data link are clearly mentioned and described in the documents. iii) Verify associated test reports / results as applicable to ascertain implementation of full functionality of data link. **Stage 2:** Witness the test / demonstration of verification as per below compliance.	Data link loss is declared if the link is lost for more than the time specified by the manufacturer or set by the user as per manufacturer's recommendations. Annexure D: Guidelines for flight test. Note: 1. Data link specifications and functionalities should be clearly described / explained / elucidated in the submitted documents. 2. All tests are to be carried out as per test plans/test cases to test and demonstrate the functionality.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			i) Data submitted by the OEM/ Manufacturer to be verified during a distance communication test from all possible azimuth angles. ii) C2-Data Link capability vs performance comparison through test cases need to be demonstrated by OEM. iii) Functional verification of Manufacturer's Specifications on Stability & Control, Redundancy (Single or dual channel) and Back Up, (if any). iv) Manufacturer to demonstrate the contingencies implemented including return to home functionality when data link is lost or other applicable contingencies.	
		b) Demonstration of system to alert the remote pilot with aural and visual signal, for any loss of command and control data link	**Stage 1:** Verify from the description / explanation in documents (flight manual) submitted by the manufacturer.	Annexure D: Guidelines for flight test Note: 1. The functionalities of system alert to remote pilot with aural

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			(a) That the system alerts the remote pilot with aural or visual signal for any loss of command and control data link. (b) Verify associated test reports to ascertain implementation of the functionality. **Stage 2:** Witness the test of verification as per below compliance. Verify by flight demonstration whether aural and visual signal to alert the UAS Pilot during loss of command and control of data link is implemented satisfactorily.	or visual warning for any loss of command and control of data link should be clearly described / explained in the submitted documents. Such functionality may be configurable as per the operational requirements. 2. All tests are to be carried out as per a test plans/ test cases to test and demonstrate the functionality for verification
		c) Determine that communication range is sufficient to have a permanent connection with the UAS	**Stage 1:** Verify from the description / elucidation given in the documents submitted by the manufacturer. (a) That the communication range is sufficient to have a permanent connection with the UAS in all attitude and operational limits of	Annexure D: Guidelines for flight test Note: 1. Sufficiency of communication range to have permanent connection with UAS including under various battery power

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			the UAS specification. (b) Permanent connection with the UAS in all attitude and operational limits are maintained under various battery power conditions. (c) Verify associated test reports to ascertain implementation of the functionality. **Stage 2:** Witness the test / demonstration for verification as per below compliance. i) Manufacturer to demonstrate communication range between the UAS and C2 Data Link for positive, negative and boundary case distances from the GCS for having permanent connection in an environment free from interference. ii) Similar test to be performed under various battery /power	conditions should be clearly described / explained / elucidated in the submitted documents. 2. All tests are to be carried out as per a test plans/test cases to test and demonstrate the functionality for verification.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			conditions and performance demonstrated.	
		d) Determine that when data link is lost or in other contingencies, the UAS follows a predefined path to ensure safe end of flight within the required area restrictions	**Stage 1:** Verify from the description / elucidation in the documents submitted by the manufacturer. i) That the functionality and how it is implemented is described / explained in detail in the UAS flight manual. ii) Description of function performed in case of link loss or in other contingencies (Contingencies should be listed) clearly explained in UAS Flight Manual iii) TQ Cert to assess the sufficiency of contingency plan. iv) Verify associated test reports to ascertain implementation of the functionality. **Stage 2:** Witness the test /	Data link loss is declared if the link is lost for more than the time specified by the manufacturer or set by the user as per manufacturer' recommendations. Annexure D: Guidelines for flight test Note: 1. In the event of data link loss or in other contingencies, the UAS follows a predefined path to ensure safe end of flight within the required area restrictions should be clearly described / explained / elucidated in the submitted documents. 2. All tests are to be carried out as per a test plans/test cases to test and demonstrate the functionality for verification.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			demonstration for verification as per below compliance. i) Demonstrate the contingencies implemented including return to home functionality when data link is lost or other applicable contingencies.	
		e) Determine the capability of system to inform remote pilot by means of a warning signal in the event of data link loss	**Stage 1:** Verify from the description / elucidation in documents (flight manual) submitted by the manufacturer: (a) That the system has capability to inform remote pilot by means of a warning signal in the event of data link loss. (b) Verify associated test reports to ascertain implementation of the functionality. **Stage 2:** Witness the test of verification as per below compliance.	Annexure D: Guidelines for flight test Note: 1. The capability of system to inform remote pilot by means of a configurable warning signal in the event of data link loss should be clearly described / explained / elucidated in the submitted documents. 2. All tests are to be carried out as per test plans/test cases to test and demonstrate the functionality for verification.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			i) Demonstrate by flight whether aural and visual signals to alert the UAS Pilot during loss of data link is implemented satisfactorily.	
		f) A command and control data link loss strategy must be established, approved and presented in the UAS Flight Manual	**Stage 1:** Verify from the documents submitted by the manufacturer. (a) That a command and control data link loss strategy has been included in the flight manual. (b) The strategies clearly explain the functions performed in case of link loss. (c) TQ Cert to verify UAS flight manual and assess / ascertain the sufficiency. (d) Verify associated test reports to ascertain implementation of the strategy. 2. Witness the test of verification	Note: 1. Command and control data link loss strategy and its implementation should be clearly described / explained / elucidated in the submitted documents. 2. All tests to be carried out as per test plans/test cases to test and demonstrate the functionality for verification.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			as per below compliance. (a) Demonstrate, implementation of the contingencies as per strategy when command control data link is lost.	
7	Secure Flight Module (FM) and Tracking Mechanism			
7.1	Firmware tamper avoidance	a) Protection of onboard computer firmware from tampering (software) UAS should not function if firmware is changed by any procedure other than authorized update procedure.	**Stage 1:** Verify the documents submitted by the manufacturer. **Stage 2:** Witness the test of verification as per below compliance. A. Verification of Secure Boot: Manufacturer to produce a certificate of compliance indicating compliance with all conditions mentioned below: i) Flight Module Security Implementation a) Flight Module should have as defined in Annexure E. b) Flight modules should follow the communication requirement (if	Note: (i) Flight Module (FM) would be the building block on which the UAS tracking mechanism would be built. Building FM compliant with Clauses 7.1 and 7.2 would enable smoother transition to the tracking mechanism when mandated by Drone Rules.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			applicable) as defined in Annexure E. c) FM should have a root of trust mechanism implemented (using, for example, TPM or TEE for Level 1 compliance) which is used to sign the data generated inside the FM. d) The verification key of the root of trust may be recorded and retained. (This key will also be used for verifying the origin of logs generated by the FM). ii) Calculation of Checksums a) Manufacturer to submit checksums of the firmware to the TQ Cert and these checksums may be called 'registered checksums'. b) Code part and data part checksums to be calculated separately to enable updating of	

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			data/parameters in the future easily. c) All checksums should be calculated using a Secure Hash Algorithm (SHA2 or SHA3). d) Registered checksums should be stored securely in the flight module such that they cannot be updated without the authorisation of the manufacturer. e) These registered checksums may be digitally signed by TQ Cert and retained. iii) Power on Self-Test (POST) a) Manufacturers should implement a Power On Self-Test (POST). b) It should include calculation of checksums of the firmware (code and data part) and the checksum should be matched with the registered checksum stored in the	

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			flight module which was supplied at the time of certification. c) The result of the POST should be logged. d) Mismatch of checksum should prevent the UAS from booting and be logged. iv) Testing of Firmware protection (software) a) Attempt modifying the firmware (code and data) in an unauthorised manner. The firmware update should fail. In case the firmware gets updated in an unauthorised manner, then verify that in UAS fails the POST. Test to be conducted in presence of TQ Cert.	
		b) Safety and security of firmware update	**Stage 1:** Verify the certificates submitted by the manufacturer for ensuring safety and security of the firmware.	

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			Stage 2: Witness the firmware update process as per the process explained below. A. Secure Upgrade Test: i) The update should be permitted only if it is signed by the manufacturer's digital certificate. ii) UAS should be able to verify the authenticity of the update by verifying it with the public key of the manufacturer. iii) Firmware change should be recorded in the logs. iv) After the UAS is upgraded, the registered checksum should be updated in the flight module securely. v) The checksums of the updated firmware (code and data) to be digitally signed by TQ Cert and retained.	
		c) Secure change of flight parameters	**Stage 1:** Verify the documents submitted by the manufacturer citing the process for instituting a	This is not applicable if manufacturer has not defined an additional method of changing flight

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			change in any given parameter. **Stage 2:** Witness the test for the change process as detailed below. A. Testing of Parameter Update: i) UAS should be able to verify the authenticity of the update by verifying it with the public key of the manufacturer. ii) Change should be recorded in the logs. iii) After the UAS is upgraded, the registered checksum should be updated in the flight module securely. iv) The checksums of the updated firmware (code and data) to be digitally signed by TQ Cert for their records. v) Try to update the parameters that affect compliance conditions using the manufacturer's standard operating procedure. The	parameters and such parameters can be changed only via firm update. 1. Manufacturers should update parameters that do not affect compliance conditions using a Manufacturer's Standard Operating Procedure. For e.g.: Using GCS, APIs, etc. Manufacturer may decide schedule for Firmware update if needed.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			parameter should remain unaffected. vi) Try to update the parameters in the firmware that affect compliance conditions using an invalid digital signature. The update should fail.	
7.2	Hardware Tamper Avoidance	a) Protection of onboard computer from tampering (physical)	**Stage 1:** Verify the documents submitted by the manufacturer explaining the tamper protection mechanism along with its justification **Stage 2:** Witness the test for the tamper protection as detailed below. A. Hardware Tamper Detection and Response: i) Verify the physical presence of tamper prevention, detection and response mechanisms by inspection of the UAS. ii) Replace crucial flight-critical components using	1. The onboard computer and its ports (USB, UART, bus, etc.) should not be accessible to unauthorised user. 2. Manufacturers may electronically pair crucial flight-critical components like radio, GPS, etc. with the flight controller and detect the use of unauthorised components. 3. In case a flight-critical component cannot be electronically paired, the manufacturer should take utmost care of using hardware protection mechanisms and appropriate design elements to minimise the tampering of the same.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			unauthorised procedure and check if UAS is arming. Physical tampering should be detected by UAS and use of unauthorised flight critical components should be logged. iii) In case of unauthorised replacement of an electronically paired, flight-critical component, the UAS should not arm. iv) In case of non-electronically paired, flight-critical components, verify by visual inspection if the manufacturer has implemented hardware protection mechanisms and designed UAS in a way to minimise tampering.	
		b) Mechanism to replace crucial hardware like radio modules, GPS and flight controller	**Stage 1:** Verify the documents submitted by the manufacturer explaining the process of replacement **Stage 2:** Witness the test for the integrity of the hardware	1. SOP for hardware change should also include verifying authenticity and functional integrity of the new component being introduced. 2. Manufacturers should uniquely pair either electronically or

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			A. Testing of Secure Hardware Change: i) In case of unauthorised replacement of an electronically paired, flight-critical component, the UAS should not arm. ii) In case of non-electronically paired, flight-critical components, verify by visual inspection if the manufacturer has implemented hardware protection mechanisms and designed UAS in a way to detect hardware change. iii) In case of secure hardware change, validate SOP by the manufacturer for completeness.	non-electronically with a unique flight controller and record the same. 3. Manufacturer should establish Standard Operating Procedure to replace hardware and should only enable the same via an authorised person. 4. Every change of hardware should be recorded by the manufacturer and documents should be available to TQ Cert or DGCA for inspection and surveillance.
8	Instruments / Equipment			
8.1	All on-board electrical and electronics equipment's/ components	Following are to be complied in respect of all on-board electrical and electronics equipment::	**Stage 1:** Verification of design documents submitted by the manufacturer:	1. Internal wiring shall be routed, supported, clamped or secured in a manner that reduces the likelihood of

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
		i) Adequate source of electrical energy, where electrical energy is necessary for operation of UAS ii) Wiring is installed in such a manner that operation of any equipment will not adversely affect the simultaneous operation of any other equipment iii) Wiring lay out is according to the wiring diagram iv) All wiring is suitable for the current and voltage going through v) No kinks in the wiring exist vi) Wiring routing is not along the sharp edges vii) Soldering connections between cables are not there viii) All equipment are connected with adequately secured connections	(a) Availability of wireframe diagram, wiring diagram, loom layout diagram. These diagrams should be included in the standard list of diagrams / drawings. (b) Specification of the wires used (in the cables/looms) which carry heavy current and the equipment's where it is used. TQ Cert to verify that the cables are suitable for the specified current. (c) Verification of schemes used for cable terminations and cable joints. Soldering should not be used for connections between cables or termination of safety critical circuits. (d) Verification of types of connectors used for cable termination of on-board equipment's contractors used to connect the equipment's are self-locking or has mechanism to	excessive strain on wire and on terminal connections; loosening of terminal connections; and damage of conductor insulation. 2. For soldered terminations in safety critical circuits, the conductor shall be positioned or fixed so that reliance is not placed upon the soldering alone to maintain the conductor in position. 3. An external terminal for charging shall be designed to prevent an inadvertent shorting and misalignment and a reverse polarity connection when connected to the charger. 4. For battery packs that are intended for removal from the UAS for external charging or replacement with a charged battery pack 5. The external terminal for charging shall be designed to

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
		to prevent loosening during vibrations ix) Minimum operating current x) Maximum operating current	prevent loosening due to vibration. (e) The external terminal for charging is designed to prevent inadvertent shorting, possibility of reverse polarity connection, misalignment etc. **Stage 2:** Physical verification / visual inspection of the following in the UAS: (a) Visual Inspection to be performed to ascertain that the UAS is built as per wire diagram. Internal wiring is as per the wiring and loom layout diagram. (b) Cable routing is supported, clamped or secured in a manner that reduces the likelihood of excessive strain on wire and on terminal connections. (c) No kink in the wiring.	prevent inadvertent shorting, a reverse polarity connection, misalignment, or access by the user. Note: 1. Manufacturer to suitably mention and explain incorporation of all above points in the design document. 2. Standards (if applicable): IS 616 or IS 13252

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			(d) Wiring routing is not along the sharp edges. (e) Soldering connection between cables/wires is not there. (f) All equipment is connected with adequately secured connectors to prevent loosening during vibrations. (g) The external terminal for charging is designed to prevent inadvertent shorting, possibility of reverse polarity connection, misalignment etc.	
	a) Global Navigation Satellite System (GNSS) receivers (if applicable)	Determine whether the capability of GPS receiver meets the requirements and functionality of the UAS	**Stage 1:** Verification of the following from design documents submitted by the manufacturer a) Verify from documents specification of the GPS receiver and whether it meets the requirement of the UAS functionality.	Note: 1. Specification and capability of GPS receiver should be clearly mentioned and described in the submitted documents. 2. Functionality tests and demonstration to be carried out as per a test plans/test cases for verification.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			(b) Verification of the test report of the functionalities of GPS receiver. **Stage 2:** Witness the test of verification as per below compliance. (a) Verification of GPS receiver functionality by flight test.	
	b) Flashing anti-collision strobe lights Mandatory for Night Flight Operations and Optional for Day Flight Operations	Provision for flashing anti-collision light in the UAS	**Stage 1:** Verification of the following from design / technical documents submitted by the manufacturer: (a) To be verified from documents if anti-collision lights are installed. (b) Verification of specification of anti-collision lights. **Stage 2:** Witness the test of verification as per below compliance. (a) Verification of operation of anti-collision lights during flight test.	

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
	c) Actuators d) Servo controllers e) Other UAS components	Determine whether Actuators, Servo controllers, and Other Components are installed in the UAS.	**Stage 1:** Verification of the following from design / technical documents submitted by the manufacturer: (a) To be verified from documents if Actuators, Servo controllers, and Other Components are installed in the UAS. Manufacturer to clearly mention the same in the documents. (b) If installed, verification of specification and detailed description of operation of these components from the documents. (c) Verify functional test reports of these components in various operating condition and operating envelope of the UAS **Stage 2:** Witness the test o verification as per below compliance. (a) Verification of operation of	Note: 1. Specification and detailed operations of Actuators, Servo controllers, and other flight control Components should be clearly mentioned and described / explained in the submitted documents. 2. Functionality tests and demonstration to be carried out as per a test plans/test cases in respect of each component for verification.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			Actuators, Servo controllers, and Other Components during flight test.	
	f) Geo-fencing capability (Mandatory)	Determine whether Geofencing capability has been implemented.	**Stage 1:** Verify from the description / elucidation in the documents (flight manual) submitted by the manufacturer: (a) Detailed explanation of geo fencing capability and how it is implemented in the UAS to be verified from the documents. (b) UAS Pilot should be able to define a Geo-fence from the UAS GCS. (c) Verification from test reports the implementation of geofencing capabilities at different latitude and longitude of geo-fence points. **Stage 2:** Witness the test of verification as per below compliance. (a) Witness demonstration that	Manufacturer should be able to demonstrate that the UAS Pilot should be able to define a Geo-fence from the UAS GCS and should be able to demonstrate that the UAS does not breach the Geofence during flight Note: 1. Geo-fencing capabilities and how it is achieved in the UAS should be clearly described / explained / elucidated in the submitted documents (Flight Manual). 2. All tests are to be carried out as per test plans/test cases to test geo-fencing capabilities at different latitude and longitude of geo-fence points

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			Remote Pilot is able to define a Geo-fence from the UAS GCS. (b) Demonstrate that the UAS does not breach the Geo-fence during flight.	
	g) SSR transponder (Mode 'C' or 'S') or ADS-B OUT equipment applicable for UAS intending to operate above 400 feet AGL	Determine whether UAS has SSR transponder (Mode 'C' or 'S') or ADS-B OUT equipment Justification: SSR transponder (Mode 'C' or 'S') is a secondary radar system. It enables the ATCO to identify and see the aircraft altitude or flight level automatically. ADS-B Out is onboard equipment. It works by broadcasting information about an aircraft's GPS location, altitude, ground speed and other data to ground stations and other aircraft. It enables ATCO precise tracking of aircraft For safety and security, it is essential for ATCO to know details like	To be demonstrated or validated as per applicable standards. **Stage 1:** Verify from the description / elucidation in the documents (flight manual) submitted by the manufacturer: (a) Manufacturer to declare if UAS has SSR transponder (Mode 'C' or 'S') or ADS-B OUT equipment. (b) If present, verify ETA copy and associated test reports as applicable. (c) Verify specification, technical description and principle of operations of the equipment from design document.	

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
		location, altitude, ground speed etc. of all UAVs flying in the controlled airspace. Without knowing these, controlling of aircraft operation by ATC would be difficult and can lead to midair collision with disastrous consequences. That is why, SSR Transponder (Mode C or S) or ADSB Out equipment is a mandatory requirement for many busy areas of controlled airspace. Therefore, UAVs operating in controlled airspace must have SSR Transponder (Mode C or S) or ADS-B Out equipment	(d) Verify functional characteristics and specification of the equipment from the test reports. **Stage 2:** Witness the test of verification as per below compliance. (a) Witness and verify functionality of the equipment during flight trial. (b) Verify original copy of the ETA **Note:** 1. Specification, detailed technical description and principle of operations of the equipment should be clearly described / explained / elucidated in the design documents. 2. All tests to verify the equipment specifications and functionalities are to be carried out as per a test plans/test	

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			cases.	
	h) Detect and Avoid capability (Optional)	Determine whether Detect and Avoid capability option has been implemented. Justification: There is no pilot physically onboard a UAS. The primary safety concern with drones is the inability of remote operator to see and avoid other aircraft. This can result in near-misses or midair collisions with dangerous consequences. This is more applicable to drones operating in high traffic density area (controlled airspace) and BVLOS category. Onboard Detect and Avoid system would enable the drone to detect any approaching aircrafts/drones and avoid. Detect and Avoid capability is therefore, recommended for Drones operating in controlled airspace and for BVLOS category	**Stage 1:** Verify from the description / elucidation in the documents (flight manual) submitted by the manufacturer: (a) Manufacturer to specify if Detect and Avoid capability option has been implemented in the UAS. (b) If present, verify specification, technical description and principle of operations from design documents/ UAS Flight Manual. (c) Verify implementation of Detect and Avoid capability option from test reports. **Stage 2:** Witness the test of verification as per below compliance. (a) Manufacturer to demonstrate with flight the implementation of Detect and Avoid capability option.	Note: 1. Detailed technical description and principle of operations of Detect and Avoid capabilities should be clearly described / explained in the design documents / Flight Manual. 2. All tests to verify detect and avoid capabilities are to be carried out as per a test plans/test cases.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
	i) Flight controller with flight data logging Capability	Determine whether UAS has flight controller with flight data logging capability	**Stage 1:** Verify from the description / elucidation in the documents (flight manual) submitted by the manufacturer: (a) Manufacturer to specify if UAS has flight controller with flight data logging capability. (b) If present, verify specifications and data logging capabilities from the design documents. (c) Verify data log of a representative flight. Stage 2: Witness the test of verification as per below compliance. (a) Data log of a representative flight should be verified after conducting flight test.	Note: 1. Technical description of data logging capabilities should be clearly described / explained in the design documents.
	j) Barometric equipment with capability for remote	Determine whether UAS has Barometric equipment with capability for remote subscale setting.	**Stage 1:** Verify from the description / elucidation in the documents (flight manual)	Note: 1. Detailed technical description

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
	subscale setting Applicable for BVLOS operations	Justification: Barometric equipment in drone enables altitude tracking during flying and setting of flight level, altitude (QNH) and height (QFE). Remote subscale settings enable setting these parameters remotely from GCS. Barometric equipment is a safety feature and required for safe operation, maintaining correct altitude separation in high-density flying area and in BVLOS operation. Failure to set the appropriate barometric sub-scale pressure may result in a significant deviation from the cleared altitude or Flight Level which is unsafe. Barometric equipment with remote subscale setting is therefore recommended for drones operating in controlled airspace and for BVLOS categories	submitted by the manufacturer: Manufacturer to declare if UAS has Barometric equipment with capability for remote subscale setting (a) If present, verify specification, technical description and principle of operations from design documents/ UAS Flight Manual. (b) Verify from test reports the specifications and functionalities of Barometric equipment. Stage 2: Witness the test of verification as per below compliance. (a) Manufacturer to demonstrate with flight the Barometric equipment capability for remote subscale setting	and principle of operations of Barometric equipment should be clearly described / explained in the design documents. 2. All tests to verify remote barometric subscale setting capabilities are to be carried out as per a test plans/test cases

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
	k) RFID and GSM Sim Card (Optional)	Determine whether UAS has provision for RFID and GSM SIM Card Justification: GSM or RFID tags are used for remote communication with drones. RFID tags are used to transmit the owner's name, phone number, registration number, GPS location and other information. RFID (reader) is also used for identification, locating and tracking of inventory spread over large areas. The GSM antenna and SIM card is used to send to and receive data from UAV through GSM module. Presently, transmission number, registration number, GPS location etc. is not compulsory in existing drone rules. Hence, RFID is an optional feature. As regards to GSM, manufacturer to decide how the data would be sent and received from drone. Hence,	**Stage 1:** Verify from the description in the documents submitted by the manufacturer: (a) Verify from design documents, whether the manufacturer has implemented RFID and GSM SIM card in the UAS. If implemented, **RFID** (b) Verification of specification of RFID from UAS design documents. **GSM SIM** (c) Verify specification of GSM SIM from the documents **Stage 2:** Witness the test of verification as per below compliance. **RFID**	1. Independent tamper proof hardware in the UAS (air) unit should be implemented on the UAS

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
		GSM is also optional	(a) Manufacturer to show and demonstrate working of RFID on the UAS **GSM SIM** (b) Software dashboard to be provided to the regulators/ TQ Cert and real time tracking demonstrated as per a test plan	
9	Qualification Testing			
9.1	Environmental tests	Determine that instruments and equipment withstand the following: a) Effects of voltage spikes from power source;	**Stage 1:** If UAS is powered from an external source: Verification of test reports from an accredited testing lab submitted by the manufacturer for Surge Immunity as per ANSI/IEEE C62.41 / IEC 61000-4-5 / IS 14700 or equivalent standard. **Stage 2:** If UAS powered from on-board source: Review of design analysis report	

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			submitted by the manufacturer: (a) Details of the nominal voltage and current range of the electrical power supply on-board the UAS at various load conditions including the payloads. (b) Details of peak voltage and current range of the electrical power supply on-board the UAS at various load conditions including the payloads in various flight conditions. (c) The design analysis and technical analysis report should justify and clearly bring out that there is no possibility of voltage spikes from the power source.	
		Determine that instruments and equipment withstand the following: b) Susceptibility to HIRF; Applicable if UAS is intended to be	**Stage 1:** Verify from the documents submitted by the manufacturer: (a) Verification of authenticated test reports from an accredited testing lab submitted by the	As a safety feature, manufacturer should ensure bonding of the components and grounding them properly to the airframe.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
		operated in environment with HIRF	manufacturer for Radiated Immunity as per IEC 61000-4-3 Equivalent standard. (b) Manufacturer should ensure bonding of the components and grounding them properly to the airframe. The same should be verified from the documents. **Stage 2:** Verification of original test report. (a)Original test report should be verified during flight trial. (b) Bonding of components to be physically verified in the UAS.	
		Determine that instruments and equipment withstand the following: c) Temperature and humidity variations;	**Stage 1:** Verify from the documents submitted by the manufacturer: **For Temperature:** Verification of authenticated test	Note: (a) Manufacturer to prepare a test plan across the full operational environmental range (temperature and humidity).

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			reports as per IS 9000 Part 2 & 3 or equivalent standard from an accredited testing lab submitted by the manufacturer. **For Humidity:** Verification of authenticated test reports as per IS 9000 Part 4 or IEC 60068 2 78 or equivalent standard from an accredited testing lab submitted by the manufacturer. **Stage 2:** Verification of original test report. (a) Verify original copy of temperature and humidity test reports during flight trial	(b) Based on the specification and design of the UAS, manufacturer to specify the temperature and humidity ranges and other requirements of testing in the test plan. At a minimum, tests should be carried out for temperature ranges of 0 to 50º C and 90% RH at 40º C. (c) UAS should be kept in serviceable condition (not storage) during the test. (d) The temperature test to be carried out as per IS 9000 Part 2 & 3 or equivalent standard. (d) The humidity test to be carried out as per IS 9000 Part 4 or IEC 60068 2 78 or equivalent standard. (e) Authenticated test reports from an accredited testing lab should be submitted by the manufacturer.
		Determine that instruments and	**Stage 1:** Verify from the	Note:

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		equipment withstand the following: d) Shock resistant, etc.	documents submitted by the manufacturer: (a) Verification of authenticated test reports from an accredited testing lab submitted by the manufacturer for shock resistance, as per IEC 60068-2-27 or equivalent standard **Stage 2:** Verification of original test report. (a) Verify original copy of the shock test reports during flight trial	(a) The manufacturer to prepare a shock test profile and a test plan for the drone as per IEC 60068-2-27. (a) As per design and intended operating conditions / use of the UAS, manufacturer should specify shock test profile like repetition rate (number of socks per second), shock severity, peak acceleration, duration along three axes, the pulse shape etc. (b) Carry out shock test as per the test plan in an accredited lab. The test is to be carried out mounting the drone on a vibration table with the help of a fixture and without packing case.

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				Mounting on the shock testing machine should be as per IEC 60068-2-47 (c) Carry out full functional test after the drone has been subjected to the shocks. It should pass the functional test. (d) Submit authenticated lab (shock) test and functional test report.
		Determine that instruments and equipment withstand the following: e) Ingress Protection (IP) Certification	**Stage 1:** Verify from the documents submitted by the manufacturer: (a) Verify whether the manufacturer has defined IP certification. (b) In case the manufacturer has defined IP Certification, verify from documents the details of specified ingress protections codes like water, dust, chemicals, fumes etc.	

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			(c) Verify test plan and test reports of IP parameters as per the codes. (d) The tests should be carried out in accredited lab. **Stage 2:** Verification of original test report. (a) Verify original copy of the IP test reports during flight trial.	
9.2	EMI / EMC test	Determine that each electrical instrument and equipment is protected against EMI coming from the operational environment to ensure normal operation.	**Stage 1:** Verify from the documents submitted by the manufacturer: Verification of test reports from an accredited testing lab submitted by the manufacturer for Radiated Immunity, as per applicable Parts and Clauses of IEC 61000 / IS 14700 or equivalent standard. **Stage 2:** Verification of original test report. (a) Verify original copy of	Note: (a) Manufacturer to prepare a test plan for Radiated Immunity test as per IEC 61000 / IS 14700 or equivalent standard (b) Frequency, power, test parameters, acceptance limits, test chambers etc. to be specified by the manufacturer in the test plan. (c) Test to be carried out as per the test plan in an accredited lab.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			EMI/EMC test reports during flight trial.	
9.3	Software	a) Determine impact of loss of function and malfunction of UAS	**Stage 1:** Verify from the documents submitted by the manufacturer: (a) Verification of Risk analysis statement of software submitted by manufacturer. This should be accepted by TQ Cert	IEC Standard for FMEA Or SAE ARP4761 – System Safety Assessment may be followed as guidelines.
		b) Determine that sufficient independence exists between software components with respect to both function and design	**Stage 1:** Verify from the documents submitted by the manufacturer: (a) To verify statement of independence software issued by the manufacturer. (b) TQ Cert to approve the statement of independence. (c) Verify software independence test report carried out per the test plan (IV&V). **Stage 2:** If IV&V is done by	Note: (a) Manufacturer to issue a Statement of Independence of software by design as well as functionality. (b) Having defined the independence, manufacturer should prepare a test plan / test cases to test the software independence. (c) Submit IV&V report for verification.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			manufacturer, TQ Cert to validate	
9.4	Hardware	a) Determination of hardware design life cycle through established quality control procedure,	**Stage 1:** Verify from the documents submitted by the manufacturer: (a) Verify documents submitted by the manufacturer on Quality Control Procedure / Internal Quality Assurance procedures adopted during manufacturing of the UAS. **Stage 2:** Verification during flight trial. (a) Verify Quality Control Procedure / Internal Quality Assurance procedures followed by the manufacturer in their facility.	Note: (a) Manufacturer to prepare a document on Quality Control Procedure / Internal Quality Assurance procedures adopted during manufacturing of the UAS. (b) Manufacturer can follow the procedures mentioned in ISO 9001 for the above, even if they may not be ISO 9001 certified. (c) Quality Control Procedure / Internal Quality Assurance procedures shall be checked during site visit. (d) Manufacturers are required to follow the procedures in ISO 9001 even if they may not necessarily be ISO 9001 certified.
		b) Component performance and reliability to be monitored on a continuous basis.	**Stage 1:** Verify from the documents submitted by the manufacturer:	Note: (a) Manufacturers should continuously monitor component

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			(a) Verify component performance, monitoring process effectiveness submitted by the manufacturer. (b) Check that component performance, monitoring process effectiveness has been documented in the UAS Maintenance Manual. **Stage 2:** Verification during flight trial. (a) Verify record of various failures observed during product development period, failure analysis, its impact on safety & reliability, rectification carried out and measures taken to ensure no recurrence of such failures etc.	performance during the design and development process (b) Manufacturer should carryout component performance process assessment effectiveness and document in the UAS Maintenance Manual. (c) A continuous monitoring standard should be established during the entire UAS Product Development cycle. (d) Manufacturer should prepare and submit record of various failures observed during product development period, failure analysis, its impact on safety & reliability, rectification carried out and measures taken to ensure no recurrence of such failures etc.
10	Documentation			
10.1	UAS Flight manual	UAS flight manual should contain the following information: 1. Limitations / operating conditions/	**Stage 1:** TQ Cert to review the submitted flight manual and approve the content for its applicability.	

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		operating envelope 2. Normal Procedures, pre-flight checklist, etc. 3. Emergency procedures 4. Performance (at various combination of weight, altitude, temperature and wind conditions) 5. Any other relevant information required for safe operation of UAS		
10.2	UAS Maintenance Manual	UAS maintenance manual should consist of the following: 1. Maintenance procedures of the UAS. 2. Continuous Monitoring process for UAS components	**Stage 1:** TQ Cert to review the submitted maintenance manual and approve the content for its applicability.	
10.3	UAS Log book	UAS log book should consist of the following: 1. Provision to maintain UAS Operation Logs 2. Provision to maintain UAS Maintenance Logs	**Stage 1:** TQ Cert to review the submitted log book and approve the content for its applicability.	
10.4	Other design documents	1. Bill of material and country of origin	**Stage 1:** Manufacturer to submit component/sub-system level Bill of Materials (BOM), key	All analysis reports as required for substantiation. Reports should have document number, rev no,

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			specifications (as per manufacturer), and declaration of country of origin. The documentation submitted to be version-controlled. **Stage 2:** TQ Cert to verify BOM submitted by manufacturer against design documents and purchase records.	release date, preparer/ reviewer / approver.
		2. Analysis reports	**Stage 1:** Verify for appropriateness the version controlled documents to be submitted along with application that are duly approved by the authorised signatory.	All analysis reports as required for substantiation. Reports should have document number, rev no, release date, preparer/ reviewer / approver.
		3. Test reports	**Stage 1:** Verify for appropriateness the version controlled documents to be submitted along with application that are duly approved by the authorised signatory.	All test reports as required for substantiation. Reports should have document number, rev no, release date, preparer/ reviewer/approver
		4. Detailed drawings	**Stage 1:** Verify for appropriateness the version controlled documents to be submitted along with application	The manufacturer should establish a procedure for version control of design documents.

S. No.	Parameter / Characteristics	Compliance Criteria (with Requirements)	Method of Evaluation 1. Verification of records 2. Testing and verification 2.1 On-site testing (Ground) 2.2 Flight testing 2.3 Laboratory test (with appropriate details)	Guidance on method of evaluation
			that are duly approved by the authorised signatory	Assembly level drawing showing parts list. Drawings should have document number, rev no, release date, preparer/ reviewer/approver
		5. Consolidated hardware and software independently verified and validated reports	**Stage 1:** Verify for appropriateness the version controlled documents to be submitted along with application that are duly approved by the authorised signatory.	
		6. Material procurement record	**Stage 1:** Verify for appropriateness the version controlled documents to be submitted along with application that are duly approved by the authorised signatory.	
		7. Manufacturing process records	**Stage 1:** Verify for appropriateness the version controlled documents to be submitted along with application that are duly approved by the authorised signatory.	May include manufacturing process root cards and process records

Annex B

Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

1. 14 CFR 35 - Airworthiness Standards: Propellers, Code of Federal Regulations (annual edition), Federal Aviation Administration
2. BS EN 61000-3-3:2013, Electromagnetic compatibility (EMC). Limits. Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with
3. BS EN 61000-4-6:2014, Electromagnetic compatibility (EMC). Testing and measurement techniques. Immunity to conducted disturbances, induced by radio-frequency fields.
4. BIS IS 14599: 1999(R2014), Automotive Vehicles - Performance Requirements (Measurement of Power, SFC, Opacity) Of Positive and Compression Ignition Engines - Method of Test.
5. Civil Aviation Regulations, Section 3 Air Transport Series X Part I Issue I, Dated 27 August 2018.
6. DGCA UAS Guidance Manual, Revision 2 - 2020.
7. Drone Rules 2021, Ministry of Civil Aviation dated 25 Aug. 2021
8. IEC 61000-3-3:2013+AMD1:2017 CSV, Consolidated version, Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply system, for equipment with rated current<_16 A per phase and not subject to conditional connection.
9. IEC 60068-2-6:2007, Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal).
10. IEC 61000-4-6:2013, Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields
11. IEC CISPR 24, Information technology equipment Immunity characteristics Limits and methods of measurement.
12. IEC 60947-5-1:1990 (read in conjunction with IEC 947-1), Low-voltage switchgear and control gear. Part 5: Control circuit devices and switching elements - Section One: Electromechanical control circuit devices.
13. IEC 60529:1989, Degrees of protection provided by enclosures (IP Code).
14. ISO 12405-4:2018, Electrically propelled road vehicles Test specification for lithium-ion traction battery packs and systems Part 4: Performance testing.
15. ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories.
16. IS 616:2017/IEC 60065:2014 - Audio, Video and similar electronic apparatus- Safety requirements.
17. IS 9002-10-1: Equipment for Environmental Tests for Electronic and Electrical Items, Part 10: Shock Test Machine, Section 1: Free Fall Type.
18. IS 14700-4-1: Electromagnetic Compatibility (EMC), Part 4: Testing and Measurement Techniques, Section 1: Overview of IEC 61000-4 Series.
19. IS 9002-6: Equipment for Environmental Tests for Electronic and Electrical Items, Part VI: Constant Relative Humidity Chamber (non-injection type).
20. IS 9000-16: Basic environmental testing procedures for electronic and electrical items 16 Driving rain test
21. IS 9000-4: Basic Environmental Testing Procedures for Electronic and Electrical Items, Part 4: Damp hear (Steady state).

22. IS 9000-11: Basic environmental testing procedures for electronic and electrical items, Part 11: Salt mist test.
23. IS 4691: 1985, Rotating electrical Machines Part 5 Degrees of protection provided by enclosure for rotating electrical machinery.
24. IS 12063: 1987, Classification of Degrees of Protection Provided by Enclosures of Electrical Equipment.
25. IS 13947: Part 1: 1993, Low-voltage Switchgear and Control gear - Part 1: General Rules
26. IS 14599: Automotive Vehicles - Performance Requirements (Measurement of Power, SFC, Opacity) of Positive and Compression Ignition Engines - Method of Test
27. IS 16046 (Part 1):2018 / IEC 62133-1:2017 Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes Safety Requirements for Portable Sealed Secondary Cells and for Batteries Made from Them for Use in Portable Applications Part 1 Nickel Systems.
28. IS 16046 (Part 2):2018 / IEC 62133-2:2017 Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes Safety Requirements for Portable Sealed Secondary Cells and for Batteries Made from Them for Use in Portable Applications Part 2 Lithium Systems.
29. IS 6303-4: Primary Batteries, Part 4: Safety of Lithium Batteries.
30. IS 10000-2: Methods of tests for internal combustion engines, Part 2: Standard reference conditions.
31. JSS 50101: 1996, Environmental Test methods for Service Electronic Components (Group Class 5999).
32. JSS 55555 Antifungal Test Electronics
33. MIL-STD-810 Testing, Environmental Engineering Considerations and Laboratory Tests, Vibration Testing Category 8 Aircraft Propeller.
34. NATO STANDARD AEP-83 Light Unmanned Aircraft Systems Airworthiness Requirements, Edition B Version 1 November 2016.
35. UK-CAA Policy for Light UAV Systems by D. R. Haddon, C. J. Whittaker Design & Production Standards Division, Civil Aviation Authority, UK

ANNEXURE C

KINETIC ENERGY LIMITS FOR DRONES: THE RATIONALE

1. Background

Considering the current and futuristic population of drones in our country that shall be coming under certification scheme, the all up weight and speed ranges shall be quite wide. Therefore, it would be necessary to keep in view, the possible damage on impact in such cases wherein the drone is out of control or suffers irrecoverable loss of structural integrity. The impact damage of a moving object is directly proportional to its Kinetic Energy which is a function of its mass and velocity.

2. Possible Modes of Impact Damage on Failure There are possible two scenarios of drone failure:

   i. An emergency landing under control.
   ii. Complete Loss of control.
   iii. Of the above two scenarios, the worst possible impact damage can be expected when the drone is
   iv. Completely out of control since in case of an emergency landing, partial controls are available and hence the possible damage can be contained.

The operation of a large number of drones shall be limited to a maximum height of 400 ft Above Ground Level (as per the existing restrictions in flying zones for drones). Therefore, one possible mode of impact damage can be a Free Fall of the drone from a height of 400 ft.

Additionally, in case of drones capable of high forward speeds (e.g. Fixed Wing Type), a maximum impact speed (to be calculated as 1.4 x Max Operating Speed, keeping in view a nose down condition during the failure) would need to be considered. The quantum of impact damage is directly proportional to the Kinetic Energy of the drone at the time of impact, while Kinetic Energy itself is a function of Mass of the drone and its speed.

3. The Limits

The above scenarios present the challenge of limits on Mass of the Drone as well as the maximum permitted speed so as to limit the collateral damage on impact in case of drone failure.

A limit of 95 Kilo Joules is being considered for the Kinetic Energy of drones on impact (Resourced from: UK, CAA Policy for Light UAV Systems, a policy paper by D R Haddon and C J Whittakar from Civil Aviation Authority UK). The calculations (in next paragraph) show that a mass of 80 Kg and a maximum speed of 125 KMPH shall be the limiting conditions of the drone that would result in impact energies less than 95 Kilo Joules. For limiting the impact energies beyond these operational conditions, the drone manufacturers would need to incorporate suitable recovery system, so as to reduce the speed of the drone on impact and hence lower kinetic energy.

4. The Calculations

   i. Free Fall Scenario from 400 Ft: (considering negligible drag):

   Height (H) = 400 Ft = 400/3.28 = 121.95 Meter

Acceleration due to Gravity (g) = 9.81 Meter/Second2
Mass in Kg = M
Energy = MgH = 95000 Joules
Therefore, the equation is MgH = 95000
= Mx9.81x121.95 = 95000
Hence M = 79.4 Kg, approximates to 80 Kg.

ii. Forward Speed scenario with nose down:

Let the maximum operating speed be Vmax

Speed to be taken into consideration (V) = 1.4xVmax

Equation for Kinetic Energy = ½ MV2
(Mass in Kg, V in M/Sec and KE in Joules)

Therefore K.E. = 95000 = 1/2 x 80 x V2

V = 48.7 =1.4 x Vmax.
Hence VMax = 48.7/1.4 = 34.78 M/Sec = 125 KMPH