

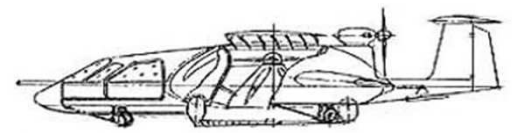
Certification Requirements for hybrid aircraft

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11.10.2013

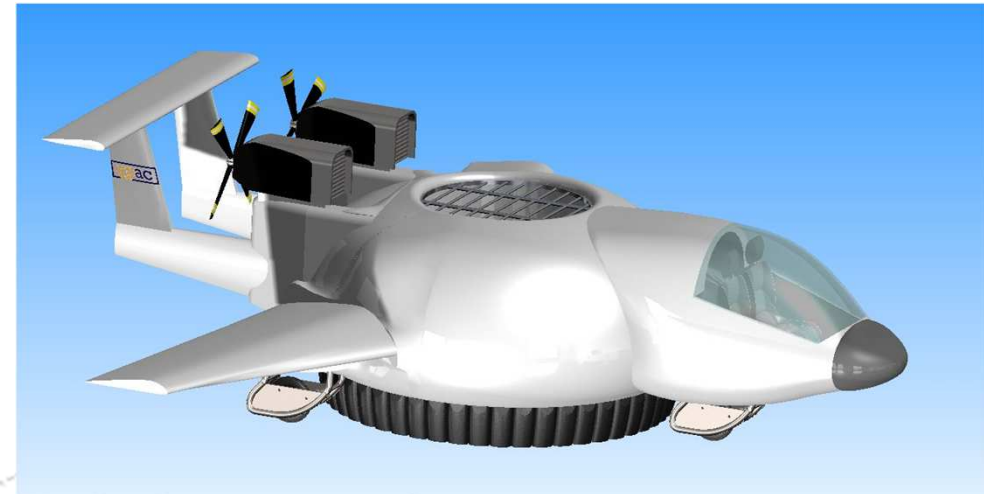


Hybrid aircraft: ESTOLAS



ESTOLAS

- ESTOLAS: Extremely Short Take Off and Landing All Surface
- Ability to take-off and land on any natural surface such as desert, snow, ice, marsh, ice, water
- Hybrid vehicle: Combination of features of aircraft and helicopter
- Multiple variants for different applications



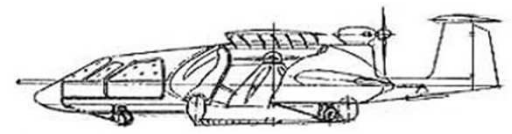
ESTOLAS aircraft

ESTOLAS aircraft variants			
Small	Medium	Heavy	Super heavy
Hybrid aircraft used as an alternative for light helicopters but with the property of longer range.	Hybrid aircraft used as an alternative for heavy helicopters with the capability to transport heavy goods	Hybrid aircraft for transportation of freight, for places with small airports, open space or water in the vicinity	Hybrid transport for transportation of very heavy goods for places with small airports, open space or water in the vicinity

Different variants of the ESTOLAS aircraft

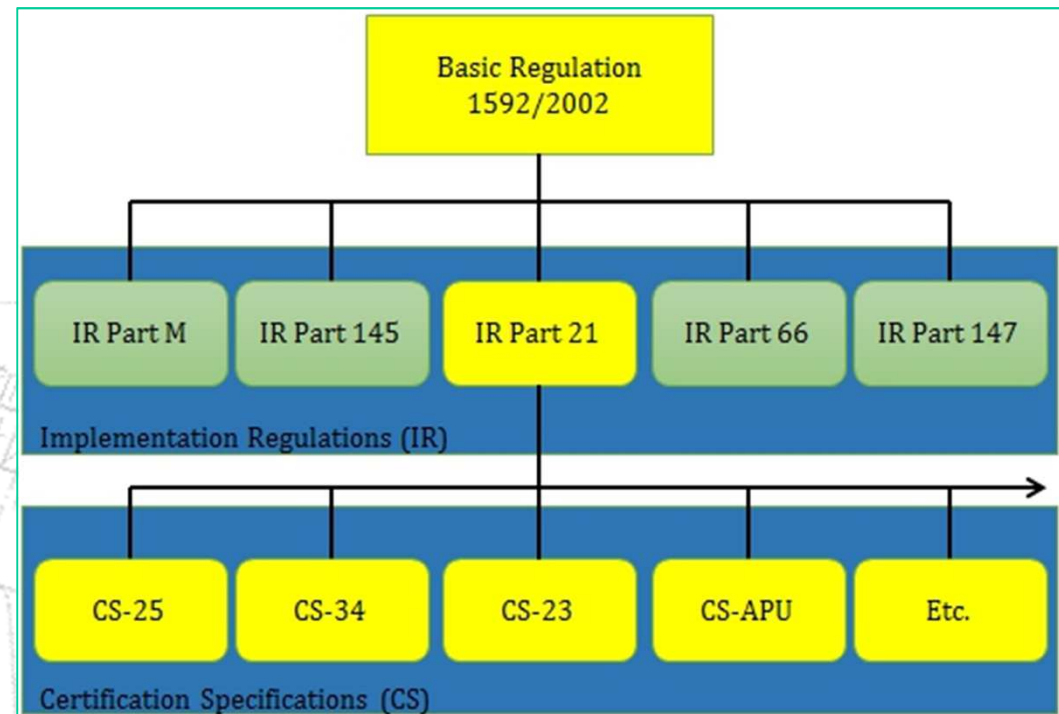
A novel concept for an extremely short take off and landing all-surface (ESTOLAS) hybrid aircraft: from a light passenger aircraft to a very high payload cargo/passenger version. Work programme topics addressed: AAT.2012.6.3-1, AAT.2012.6.3-2

Certification Agencies and Processes



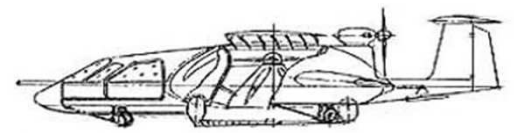
ESTOLAS

- European Aviation Safety Agency (EASA): Europe
- Federal Aviation Administration (FAA): United States
- Joint-Aviation Requirements (JAR) and Federal Aviation Regulations (FARs): provisions designed, monitored and implemented by aviation authorities
- EASA Implementation Rules (IRs): Define basic regulation
- Certification Specification (CS): Certification of aircraft and related products, parts and appliances



Hierarchy of the EASA rules and regulations

EASA Certification Specification (CS)



ESTOLAS

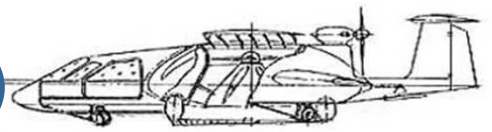
- Each CS applies to a particular aircraft type or product
- These codes include the requirements for systems and engines of the aircraft

Section	Title/Contents
CS-22	Gliders and motorized gliders
CS-23	Normal, utility, commuter & aerobatic planes
CS-25	Large aero planes
CS-27	Small rotorcraft
CS-29	Large rotorcraft
CS-34	Aircraft engine emission and fuel venting
CS-36	Aircraft noise
CS-APU	Auxiliary power units
CS-AWO	All weather operations
CS-E	Engines
CS-ETSO	European technical standard orders
CS-Definition	Definitions & abbreviations
CS-P	Propellers
CS-VLA	Very light aero planes
CS-VLR	Very light rotorcraft
AMC-20	General AMC for air worthiness of products, parts and appliances

Overview of EASA CS specifications

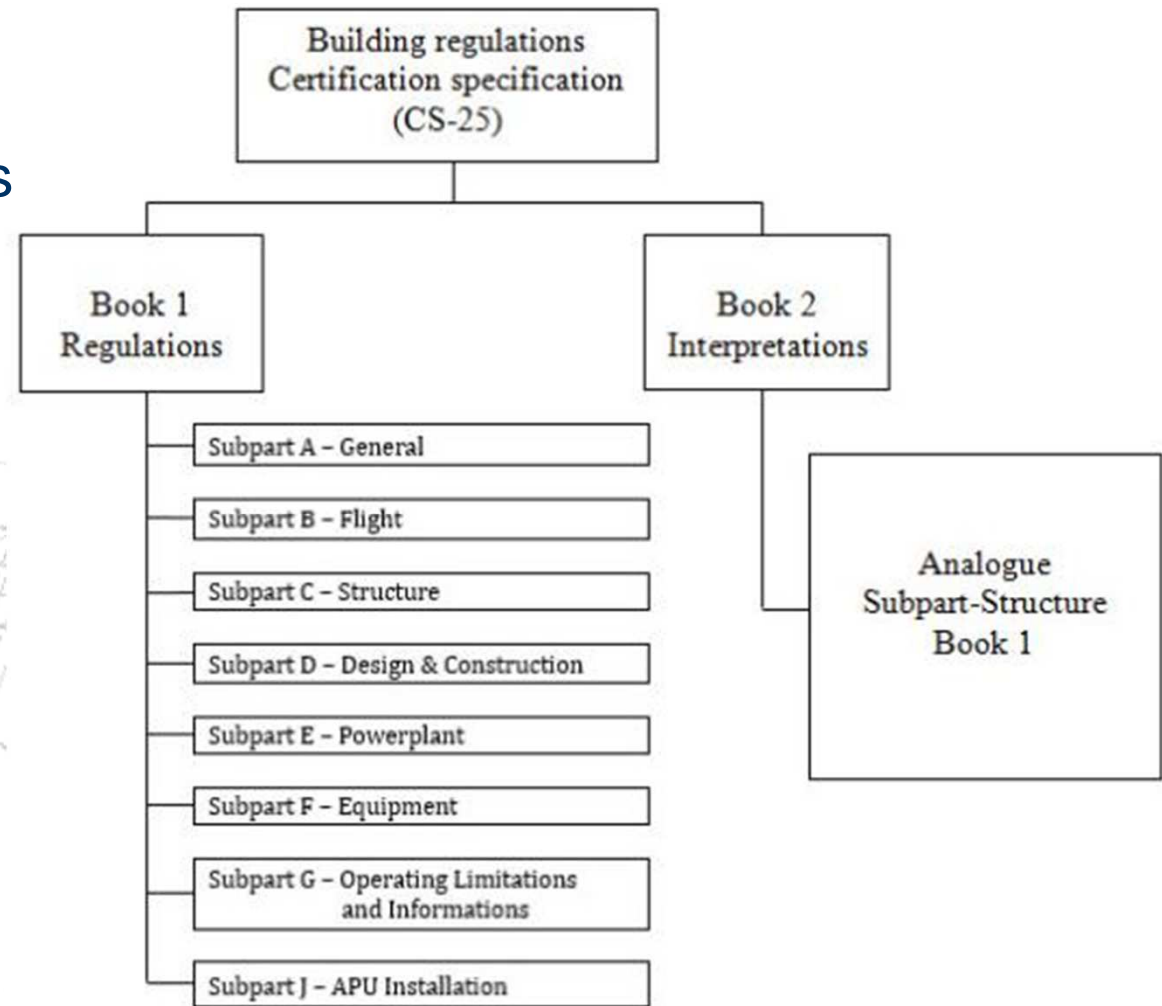
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EASA Certification Specification (CS)



ESTOLAS

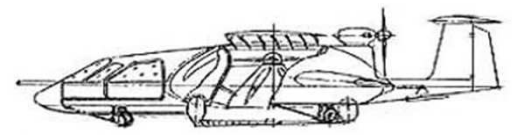
- Each of the products listed below is divided into two books.
 - Book 1 contains the main requirements.
 - Book 2 offers the Acceptable Means of Compliance (AMC).
- Applicability of a CS is defined in Subpart A – GENERAL. For e.g.:
 - CS-25: “(a) These Certification Specifications are applicable to turbine powered Large Aero planes.”



Structure of CS-25

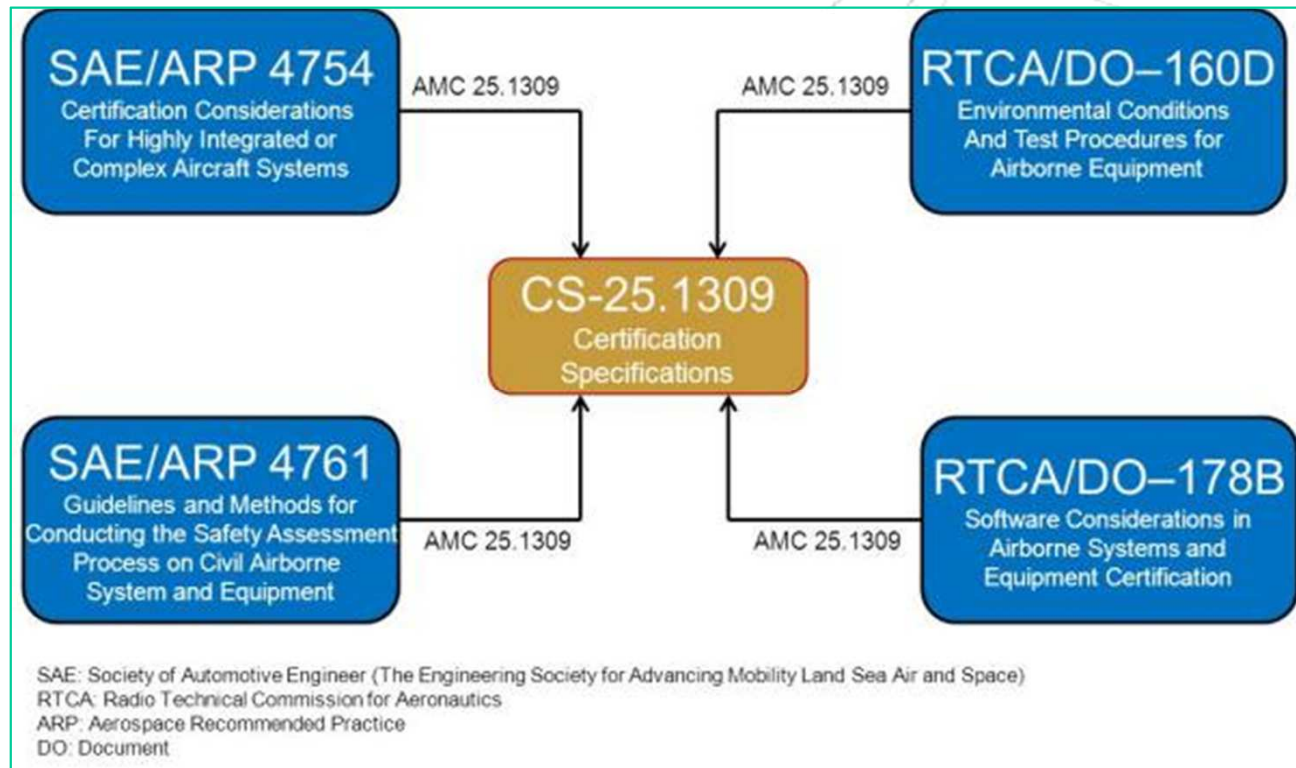
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Means of Compliance

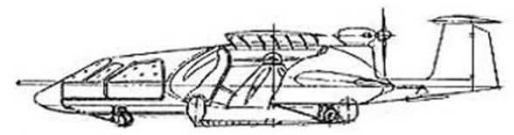


ESTOLAS

- Important requirement for aircraft certification:
 - Airworthiness demonstration
 - Identification of failures, hazards and the effects
 - Qualitative and quantitative evaluation of systems
- Different standards and specifications are used as acceptable means of compliance

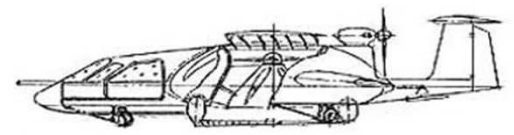


CS-25.1309 Acceptable Means of Compliance



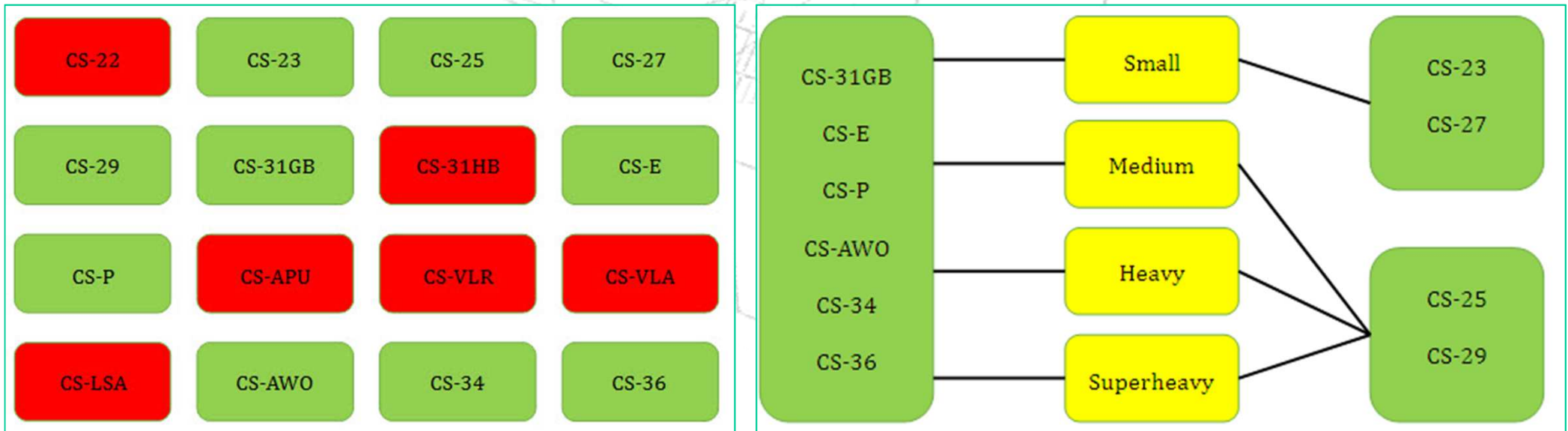
- Evaluating the applicability of each CS to ESTOLAS
- For e.g.: CS-23 applicability:
 - “(a) This airworthiness code is applicable to - (1) Aero planes in the normal, utility and aerobatic categories that have a seating configuration, excluding the pilot Seat, of nine or fewer and a maximum certificated takeoff weight of 5670 kg (12500 lb.) or less; and (2) Propeller driven twin-engine aero planes in the commuter category that have a seating configuration, excluding the pilot seat(s), of nineteen or fewer and a maximum certificated takeoff weight of 8618 kg (19 000 lb.) or less.”*
- Maximum take-off weight and seat configuration applies to the small ESTOLAS
- Not applicable to larger variants of ESTOLAS

CS Applicability to ESTOLAS

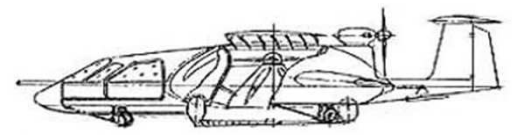


ESTOLAS

- Each ESTOLAS variant will have its own set of applicable CS
- Successful licensing of aircraft requires compliance with these regulations



Applicable CS regulations to the ESTOLAS variants.



The requirement 1309 in EASA certification specification CS-25 requires that a catastrophic failure condition is extremely improbable and not a result of a single failure.

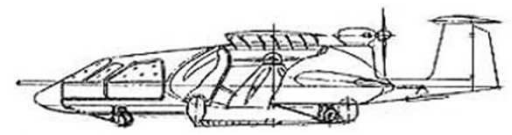
CS 25.1309 **Equipment, systems and installations**
(See AMC 25.1309)

(b) The aeroplane systems and associated components, considered separately and in relation to other systems, must be designed so that -

- (1) Any catastrophic failure condition
 - (i) is extremely improbable; and
 - (ii) does not result from a single failure; and
- (2) Any hazardous failure condition is extremely remote; and
- (3) Any major failure condition is remote.

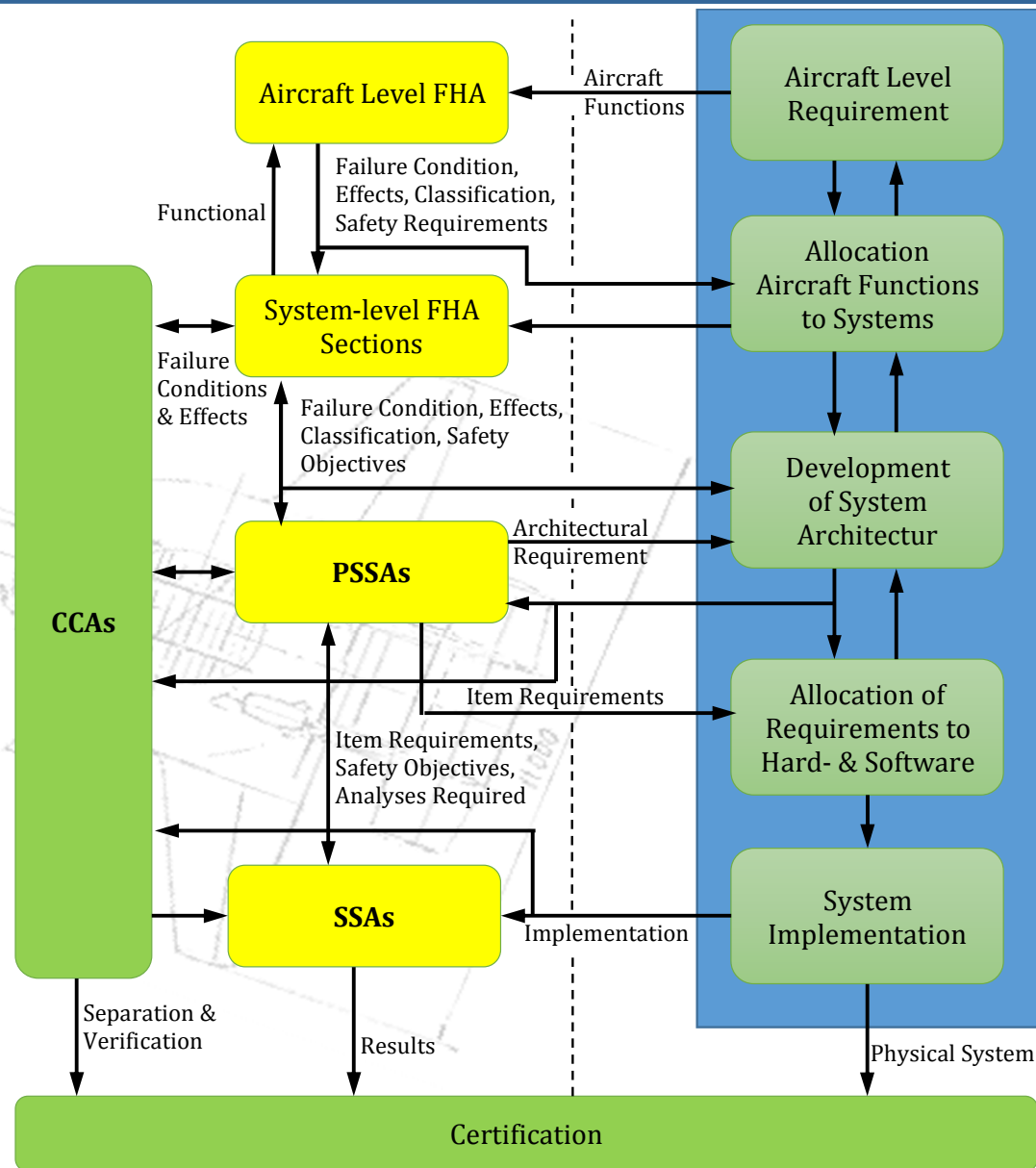
		Probability per Flight Hour
Catastrophic	Extremely improbable	<u>10⁻⁹</u>
Hazardous	Extremely remote	10 ⁻⁷
Major	Remote	10 ⁻⁵
Minor	Improbable	10 ⁻³

System Safety

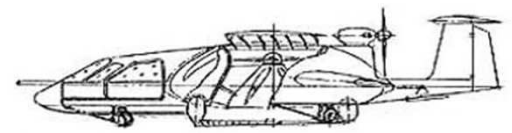


ESTOLAS

- Safety Assessment and System Development Process Model of ARP 4754: an iterative safety analysis process
 - FHA: Functional Hazard Assessment
 - PSSA: Preliminary System Safety Assessment
 - CCA: Common Cause Assessment
 - SSA: System Safety Assessment
- The analysis performed at aircraft as well as systems level
- The end result of this process is successful certification



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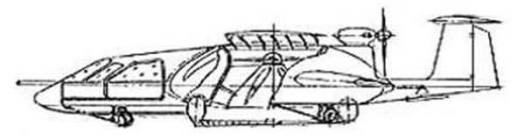


ESTOLAS

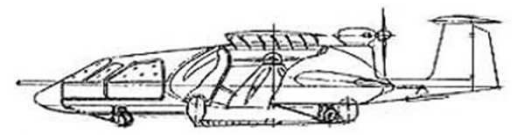
- Functional Hazard Assessment (FHA): Qualitative method used to identify functional failures and classify them according to their severity. Purposes:
 - Identification of functions
 - Determination of failure modes and the impact
 - Classification of the failure modes
 - Determination of Design Assurance Levels (DAL)

Classification of failure	Probability of occurrence (per flight hour)	Development Assurance Level (DAL)
Catastrophic	$<10^{-9}$	A
Hazardous	$<10^{-7}$	B
Major	$<10^{-5}$	C
Minor	$<10^{-3}$	D
No special effect	-	E

Failure modes, probability of occurrence and DAL values
(sources: in components following EASA CS-25, and ARP 4754)

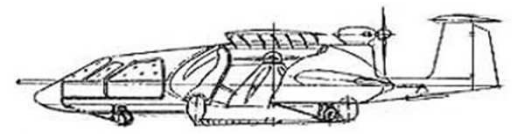


- Preliminary System Safety Assessment (PSSA):
 - Builds on the FHA
 - Combinations of FHA-identified failure modes determined
 - Usage of fault tree analysis or Markov analysis
- Common Cause Analysis (CCA):
 - Identification and grouping of critical components,
 - Test analogy within the classes,
 - Testing for failure modes within the analogy,
 - Identifying potential triggers for identified failure modes,
 - Summary of results and setting up of strategies for intervention.



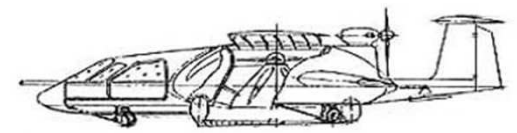
ESTOLAS

- Zonal Safety Analysis (ZSA):
 - Assesses the compliance of Safety requirements within individual zones
 - check whether the independent requirements by physical factors or facilities are being violated
 - Determine the common error sources and their effects on neighboring components
- Particular Risk Analysis (PRA):
 - Compendium of all the assessments accomplished during development
 - Threats to the airplane from external as well as internal environment
 - a single point reference for the new airplane with regard to its ability to survive all known threats
- Common Mode Analysis (CMA): To test the independence of the failure modes
- System Safety Assessment (SSA):
 - Final safety step to verify implementation of the system architecture by applying results of the FHA; PSSA and CCA



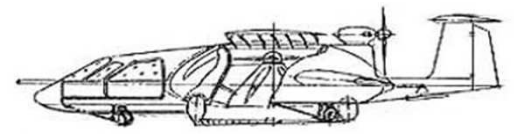
- Overview of licensing and certification requirements for aircrafts
- Applicability of regulations to ESTOLAS investigated
- System safety process defined as means of compliance for the approval of an aircraft
- Components of the safety analysis and certification process described in further detail
- A framework for the identification of applicable regulations and the process of safety analysis and certification offered

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ESTOLAS

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Thank you!