

**WEBINAR**

**EQUIPMENT DEVELOPMENT and QUALIFICATION  
PROCESS IN AERONAUTICAL APPLICATIONS**

**Feb 09, 2021**

**INSTRUCTORS**

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**Gülnihal Odabaşı Erinç**



**Part I Introduction to Development Process**

**Part II Safety Aspect**

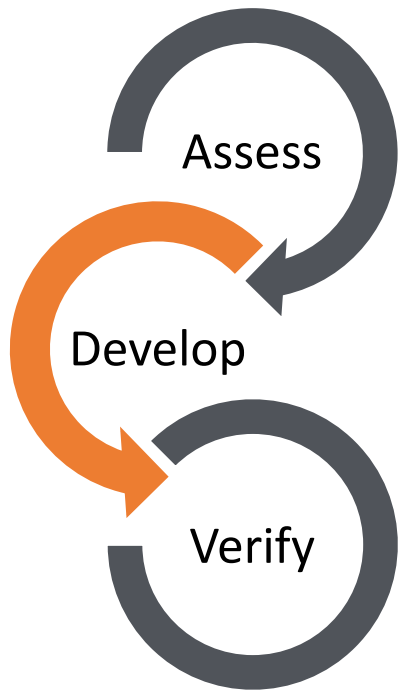
**Part III Environmental Qualification Aspect**

**Part IV Organizational Aspect**

TAOS Certification & Engineering LLC is a boutique company providing training, consulting and outsourced services in the area of;

- Airworthiness Certification
- Organization Infrastructure (Design and Production)
- System Safety Engineering and Safety Risk Management

TAOS also has extensive auditing experience in international and domestic aircraft design and production projects.



Gap Analysis on People, Processes, Tools based on Military and Civil Regulations

Provides road map for development of infrastructure and competencies

Provides trainings, coaching, support to establish necessary certification and D&D processes

## **Nazan Gözay Gürbüz (BSME, MSME, EMBA)**

- Founder of TAOS Certification and Engineering LLC
- Airworthiness and System Safety Specialist
- Head of Independent System Monitoring (EASA Form 4) at Traces Aerospace (EASA DOA Holder)
- Has worked in both Industry and Authority side for 23 years in aircraft development and modification projects (TUSAŞ, STM, TRACES Aerospace)
- Has provided many trainings related to airworthiness certification, Part 21, DOA and POA, system safety and risk management (SAE-ARP- 4754A and 4761, MIL-STD-882)
- Has provided consultancy to many companies for establishment of their design assurance system according to Part 21
- Active member of SAE International S-18 Aircraft & Systems Development and Safety Assessment Committee since Jan 2008 and has provided key contributions to development of SAE-ARP-4754A and (B) Aircraft Development Processes and SAE-ARP-4761(A) Safety Assessment Processes.

## **Gülnihal Odabaşı Erinç (BSME, MSME, PHD)**

- Has worked in defence industry in design and analysis for different projects (Roketsan, Tübitak)
- Has worked as Airworthiness Specialist (Environment Control Systems) at Authority side in aircraft development and modification projects (STM)
- Has contributed to consultancy for establishment of design assurance system according to Part 21 (TAOS)

***PART I***

***INTRODUCTION TO  
DEVELOPMENT PROCESS***

# General Aviation Rules related to Equipment



## ICAO (International Civil Aviation Organization) Annex 8 – Airworthiness of Aircraft

*The design shall not have any features or characteristics that render it unsafe under the anticipated operating conditions. (Part II – 1.2.2)*

*Under all anticipated operating conditions, the aeroplane shall not possess any feature or characteristic that renders it unsafe. (Part III – 1.4)*

*The aeroplane shall be provided with approved instruments and equipment necessary for the safe operation of the aeroplane in the anticipated operating conditions. (Part III – 8.1)*

## Part 21 – Certification Procedures

### Subpart K – Parts and Appliances

*The showing of compliance of parts and appliances to be installed in a type-certificated product shall be made:*

*(a) in conjunction with the type-certification procedures; or*

*(b) where applicable, under the ETSO authorisation procedures of Subpart O; or*

*(c) in the case of standard parts, in accordance with officially recognised Standards.*

## Certification Standards

### CS/FAR 25, 29, etc.

### Subpart F - Equipment

#### CS/FAR 25.1301 Function and Installation

#### CS/FAR 25.1309 Equipment, Systems and Installations

*(a) Each item of installed equipment must--*

*(1) Be of a kind and design appropriate to its intended function*

*(3) Be installed according to limitations specified for that equipment*

*(a) The aeroplane equipment and systems must be designed and installed so that:*

*(1) Those required for type certification or by operating rules, or whose improper functioning would reduce safety, perform as intended under the aeroplane operating and environmental conditions.*

*(2) Other equipment and systems are not a source of danger in themselves and do not adversely affect the proper functioning of those covered by sub-paragraph (a)(1) of this paragraph.*



Type Certificate (TC) Holders  
Supplemental TC Holders

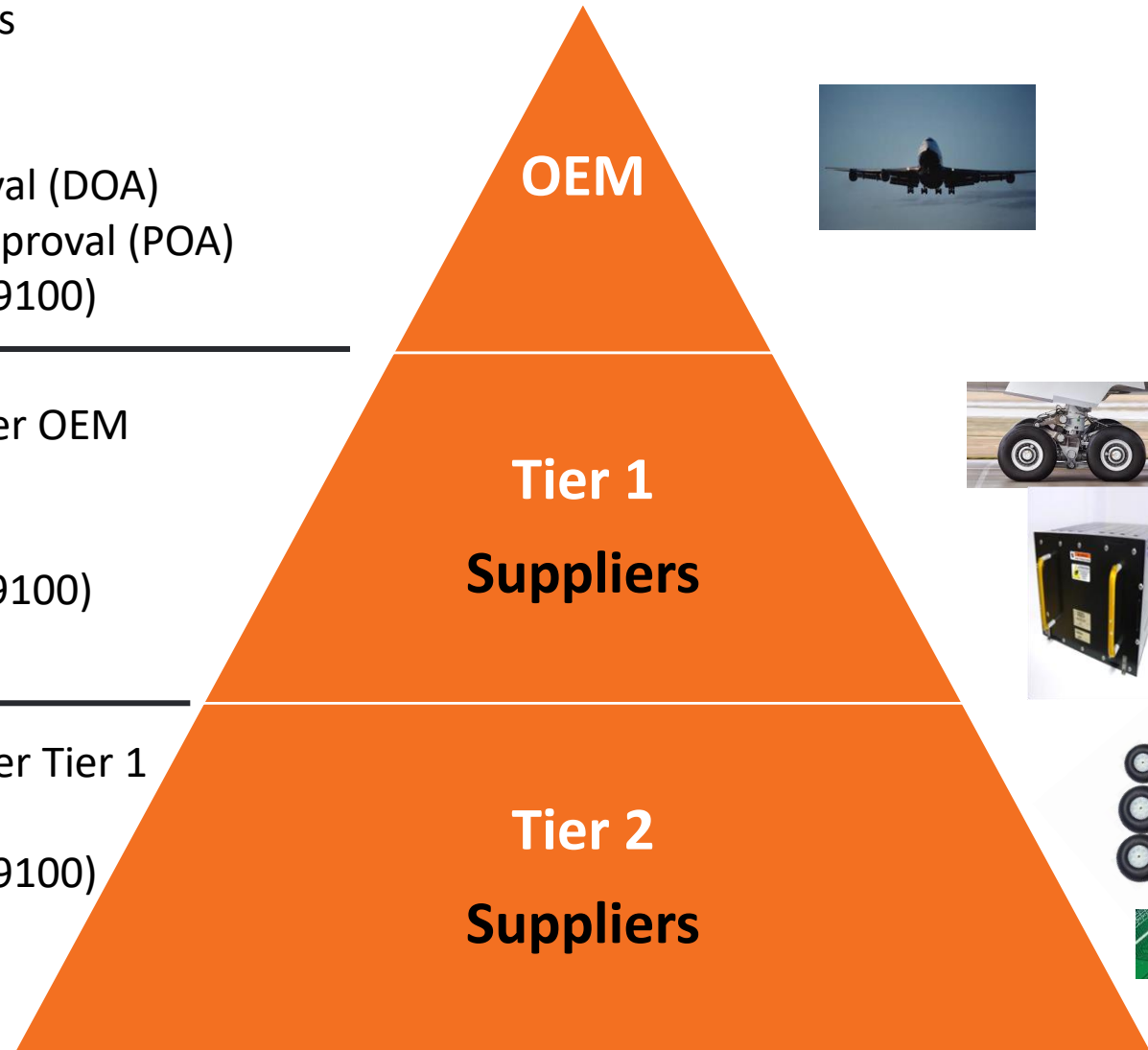
Design Organization Approval (DOA)  
Production Organization Approval (POA)  
Quality Certificates (Eg. AS 9100)

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Design and Production under OEM  
EASA POA Approvals  
OEM Approvals  
Quality Certificates (Eg. AS 9100)

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Design and Production under Tier 1  
OEM/Tier 1 Approvals  
Quality Certificates (Eg. AS 9100)



# Certifications for Parts and Equipment

## With ETSO/TSO



- Requirements:
- minimum performance,
  - hardware/software,
  - environmental,
  - marking etc.

## Without ETSO/TSO



### Authority Approvals

- ETSO Authorization
- AP to DOA
- POA

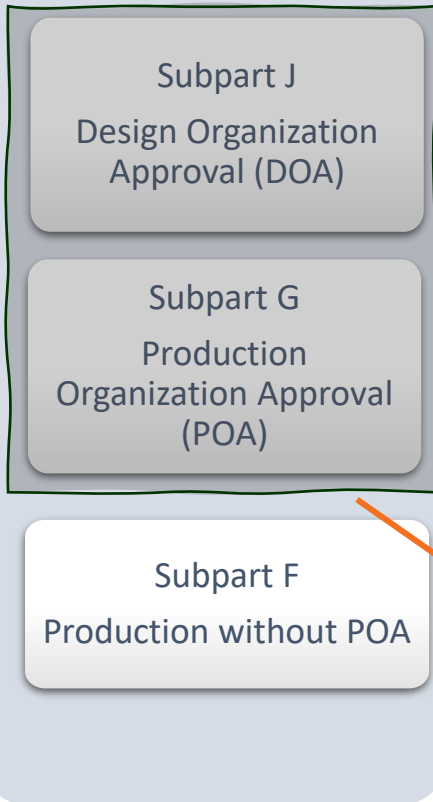
- Design and Production under OEM
- POA



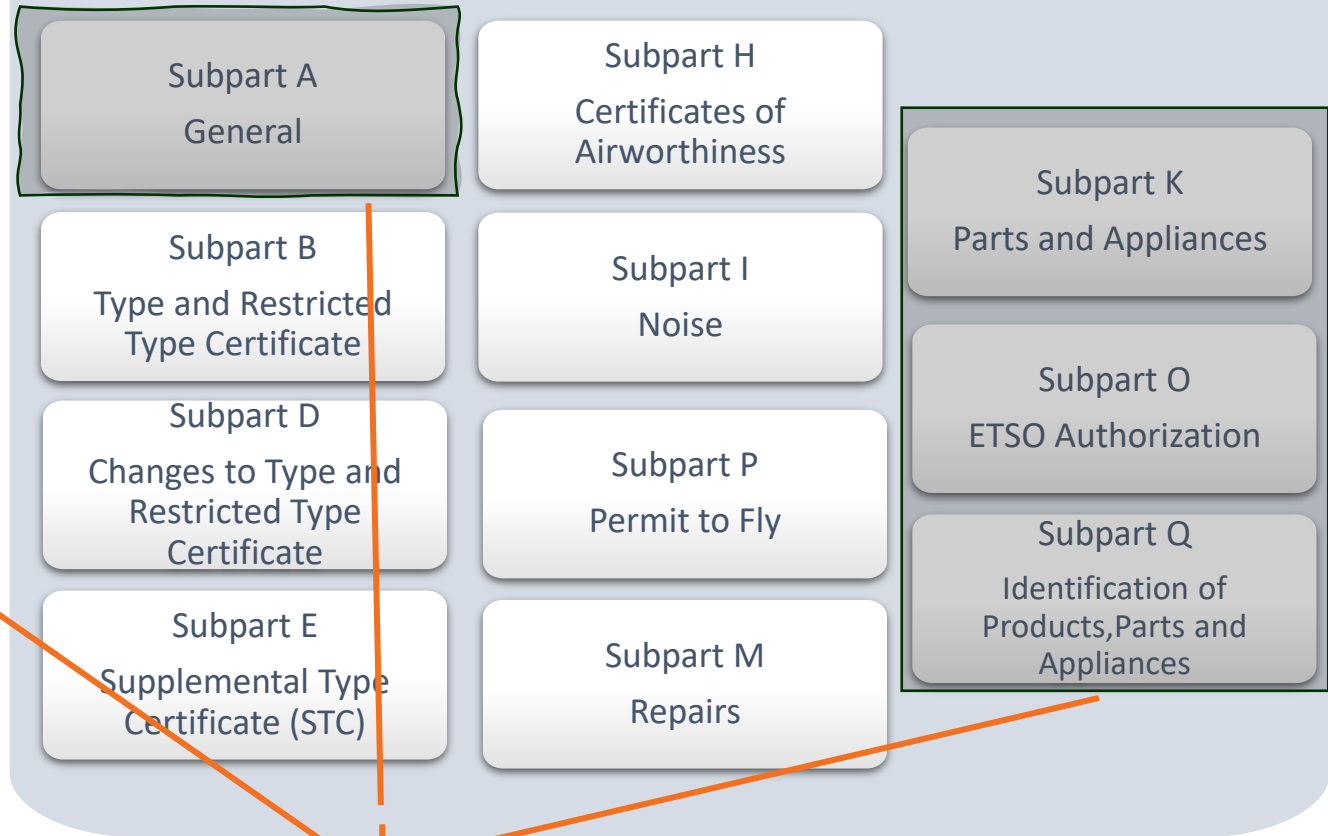
DOA  
POA

TC Holder  
STC Holder

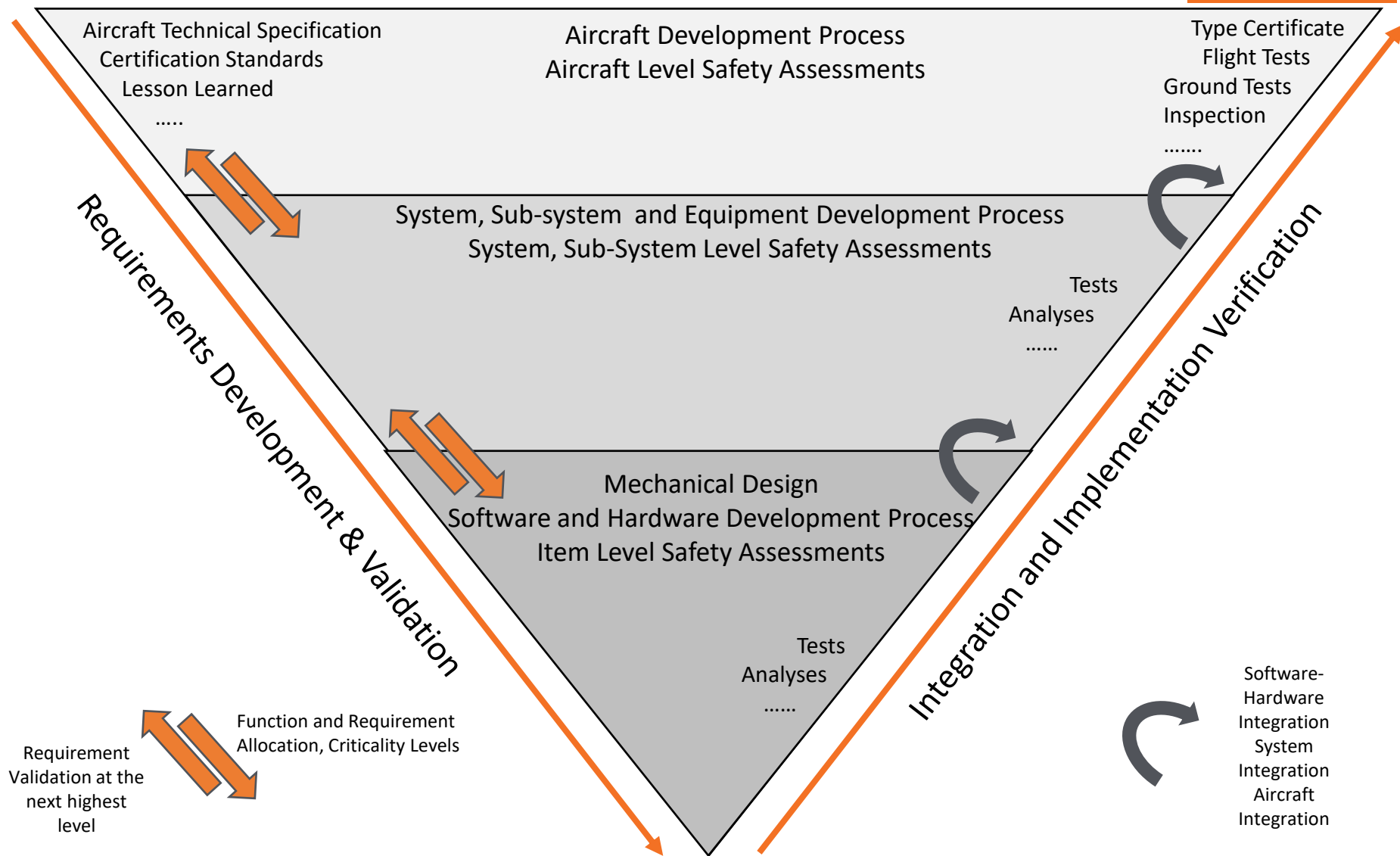
## Organizational Approvals



## Airworthiness Approvals

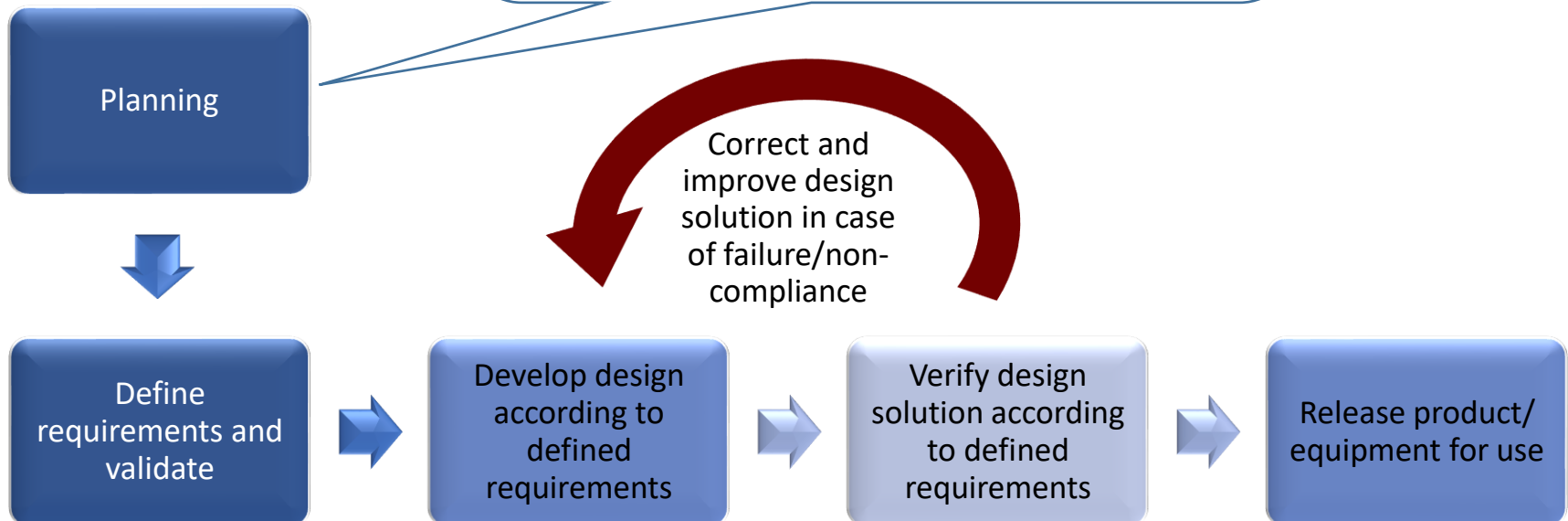


# Development Process

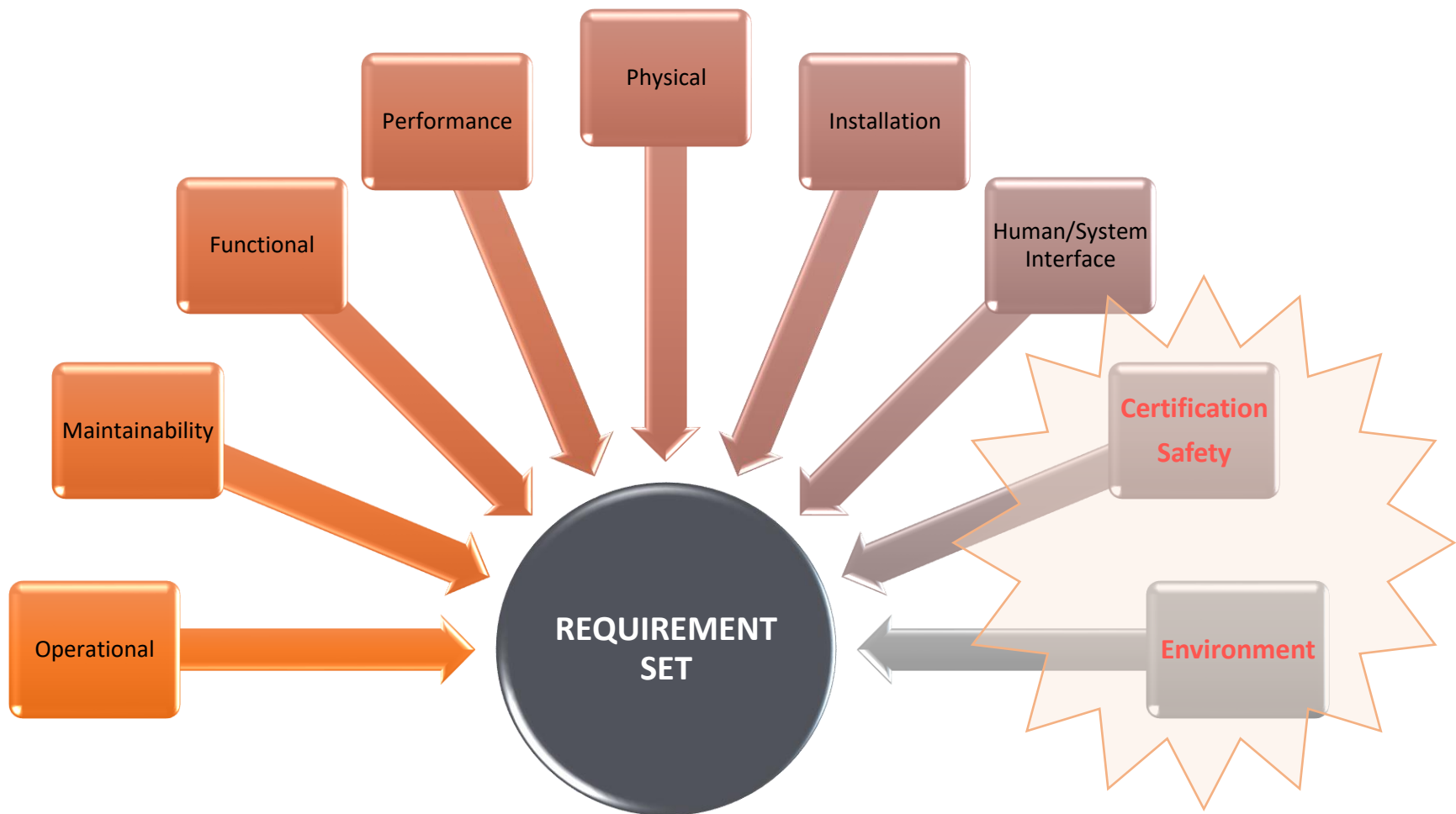


# General Equipment Development Process

- Development Plan, Equipment Qualification Plan
- V&V Plans
- Configuration Management Plan
- Quality Plan and/or DOID
- RAMS Plans
- Software Development Plan iaw DO-178
- Hardware Development Plan iaw DO-254
- ...



# Type of Requirements to be complied



## VALIDATION

The determination that the requirements for a product are correct and complete.

*Are we building the right aircraft / system / function / item?*

### ***Method of Compliance***

- Traceability
- Analysis
- Modeling
- Test
- Similarity
- Engineering Review

## VERIFICATION

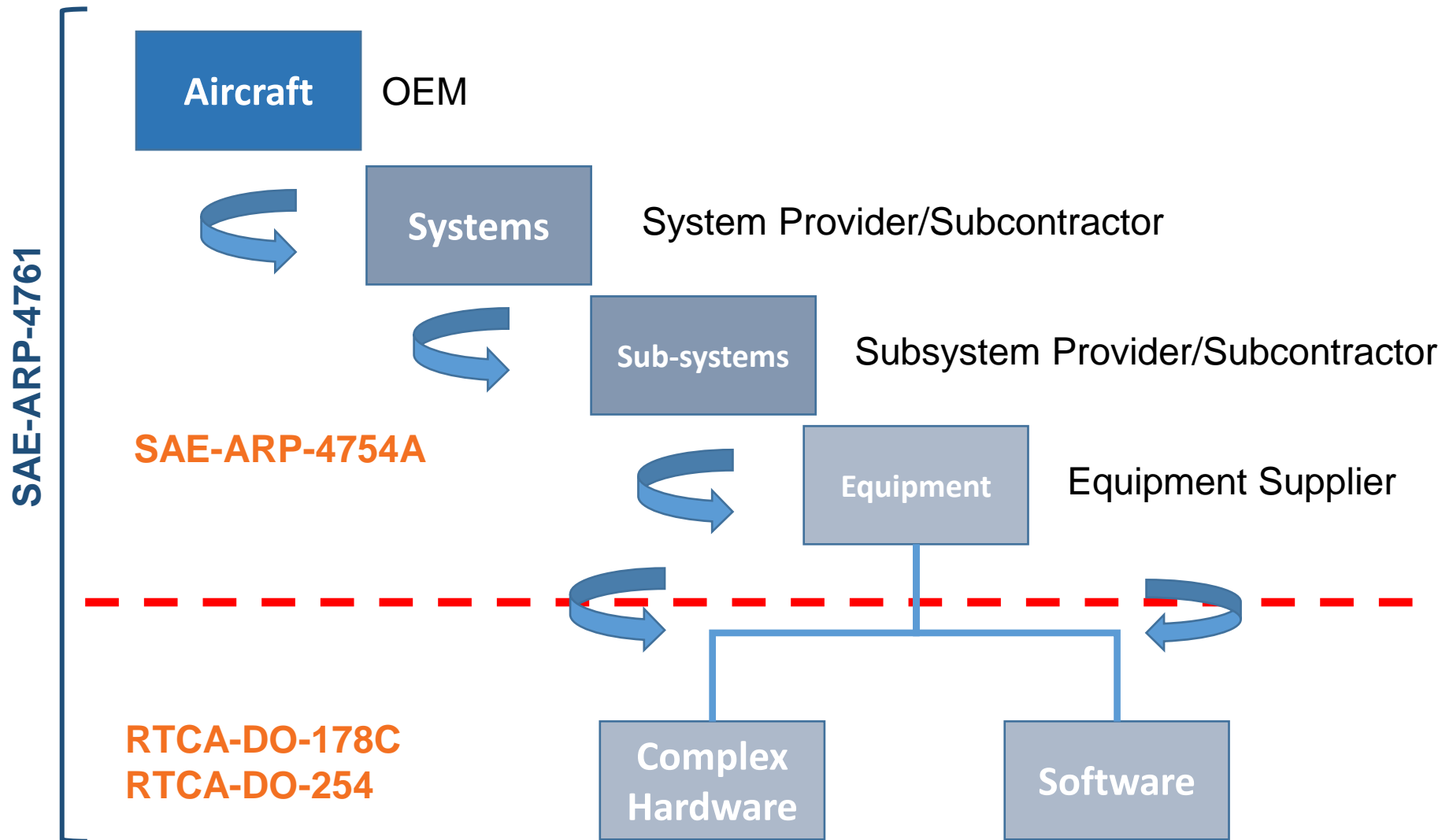
The evaluation of an implementation of requirements to determine that they have been met.

*Did we build the aircraft / system / function / item right?*

### ***Method of Compliance :***

- Inspection or Review
- Analysis
- Modeling
- Test or Demonstration
- Similarity / Service Experience

# Cascading Relationship







- ✓ Understand the applicable regulation and standards
- ✓ Plan development and design processes
- ✓ Capture all applicable requirements
- ✓ Define requirement validation process
- ✓ Define requirement verification process
- ✓ Define audit/assessments process
- ✓ Train your staff about development processes

# ***PART II***

# ***SAFETY ASPECT***

## **Failure:**

- An occurrence which affects the operation of a component, part or element such that it can no longer function as intended. Eg. a loss of function or a malfunction of a system or a part

## **Error**

- Incorrect action by a crewmember or maintenance person, or a mistake in requirements, design, or implementation

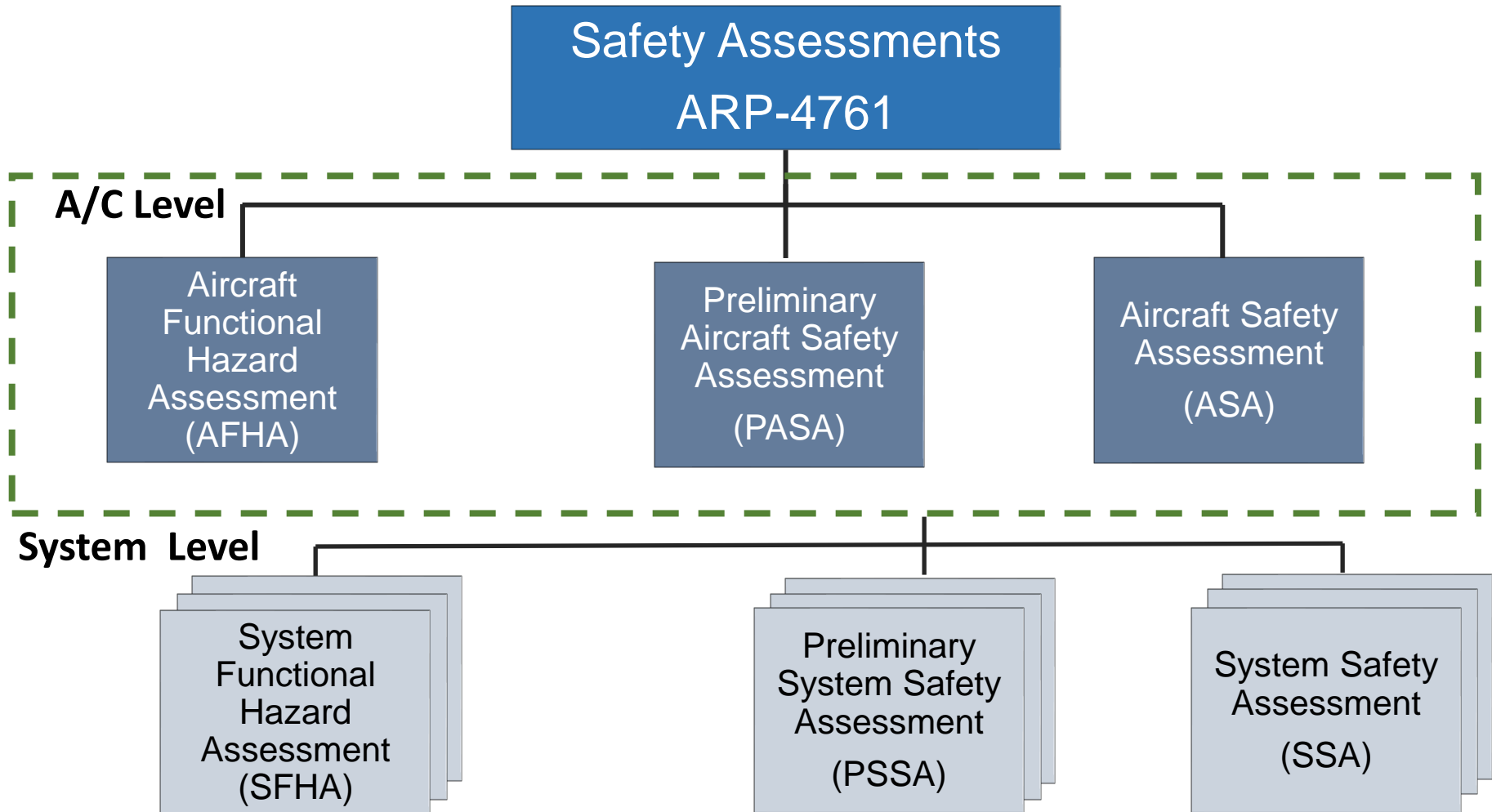
## **Failure Condition/Hazard:**

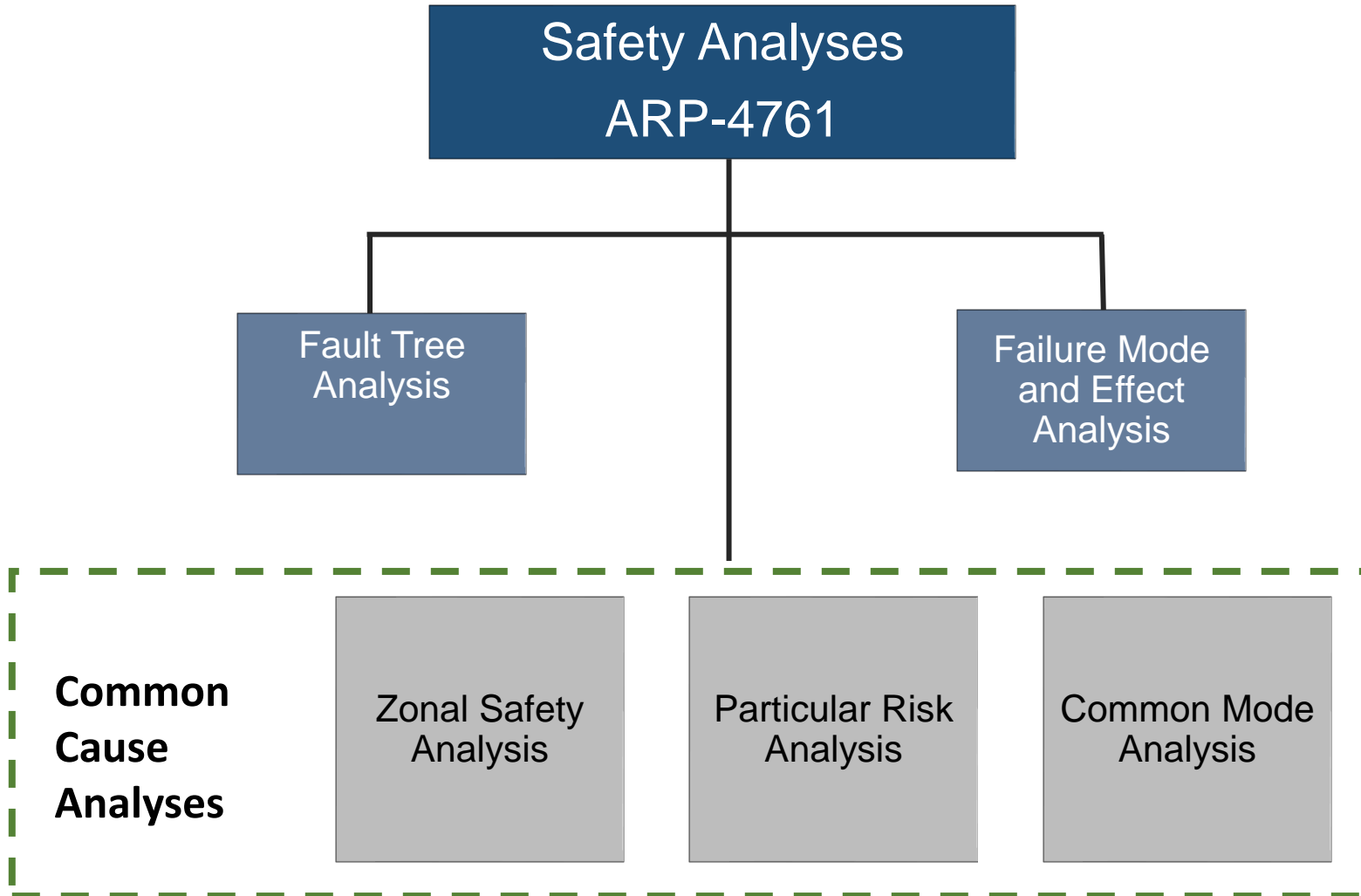
- A condition having an effect on the aircraft and/or its occupants, either direct or consequential, which is caused or contributed to by one or more failures or errors.

## The classifications for **failure conditions**

<b>CATASTROPHIC</b>	<b>HAZARDOUS</b>	<b>MAJOR</b>	<b>MINOR</b>
Results multiple fatalities, usually with the loss of the airplane	Capability of the airplane or the ability of the flight crew to cope with adverse operating conditions reduced to the extent : <ul style="list-style-type: none"><li>• a large reduction in safety margins or functional capabilities;</li><li>• physical distress or excessive workload such that the flight crew cannot be relied upon to perform their tasks accurately or completely; or</li><li>• serious or fatal injuries to a relatively small number of persons other than the flight crew.</li></ul>	Capability of the airplane or the ability of the flight crew to cope with adverse operating conditions reduced to the extent : <ul style="list-style-type: none"><li>• a significant reduction in safety margins or functional capabilities;</li><li>• a significant increase in flight crew workload or in conditions impairing the efficiency of the flight crew;</li><li>• discomfort to the flight crew; or</li><li>• physical distress to passengers or cabin crew, possibly including injuries</li></ul>	No significant reduction in airplane safety, and flight crew actions are well within their capabilities.

**No Safety Effect**





## DAL allocation without architectural consideration

FHA's Failure Condition Severity Classification	FDAL Assignment
Catastrophic	A
Hazardous/Severe Major	B
Major	C
Minor	D
No Safety Effect	E

## DAL allocation with architectural considerations

Top-Level Failure Condition Classification	Functional Failure Sets with a Single Member	Functional Failure Sets with Multiple Member	
		OPTION 1	OPTION 2
Catastrophic	<b>FDAL A</b>	<b>FDAL A</b> for one Member  Additional Member(s) no lower than <b>FDAL C</b>	<b>FDAL B</b> for two Members  Additional Member(s) no lower than <b>FDAL C</b>
Hazardous/ Severe Major	<b>FDAL B</b>	<b>FDAL B</b> for one Member  Additional Member(s) no lower than <b>FDAL D</b>	<b>FDAL C</b> for two Members  Additional Member(s) no lower than <b>FDAL D</b>
Major	<b>FDAL C</b>	<b>FDAL C</b> for one Member	<b>FDAL D</b> for two Members
Minor	<b>FDAL D</b>	<b>FDAL D</b> for one Member	
No Safety Effect	<b>FDAL E</b>	FDAL E	



**What does it do?  
(Functions)**

**What can cause it to go wrong?**



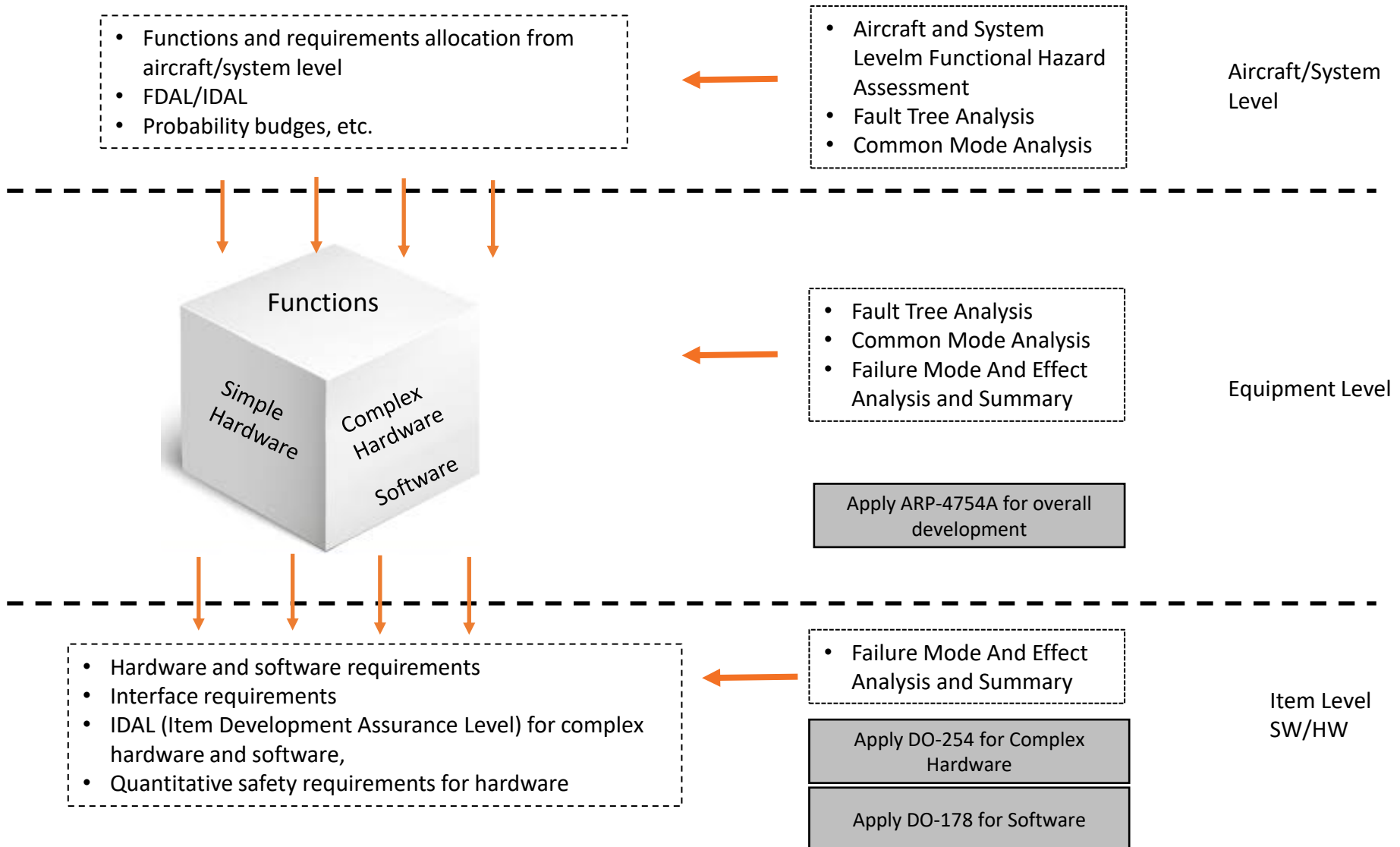
**What can go wrong?**

**What happens if it goes wrong?**

**What is the criticality level?**

**Is it safety critical?**

# Equipment Development





- ✓ Define system safety process applicable to your product
- ✓ Create safety-oriented thinking in your organization
- ✓ Plan system safety activities for your projects
- ✓ Integrate system safety process into development and design processes
- ✓ Train your staff and promote safety

***PART III***  
***ENVIRONMENTAL***  
***QUALIFICATION ASPECT***

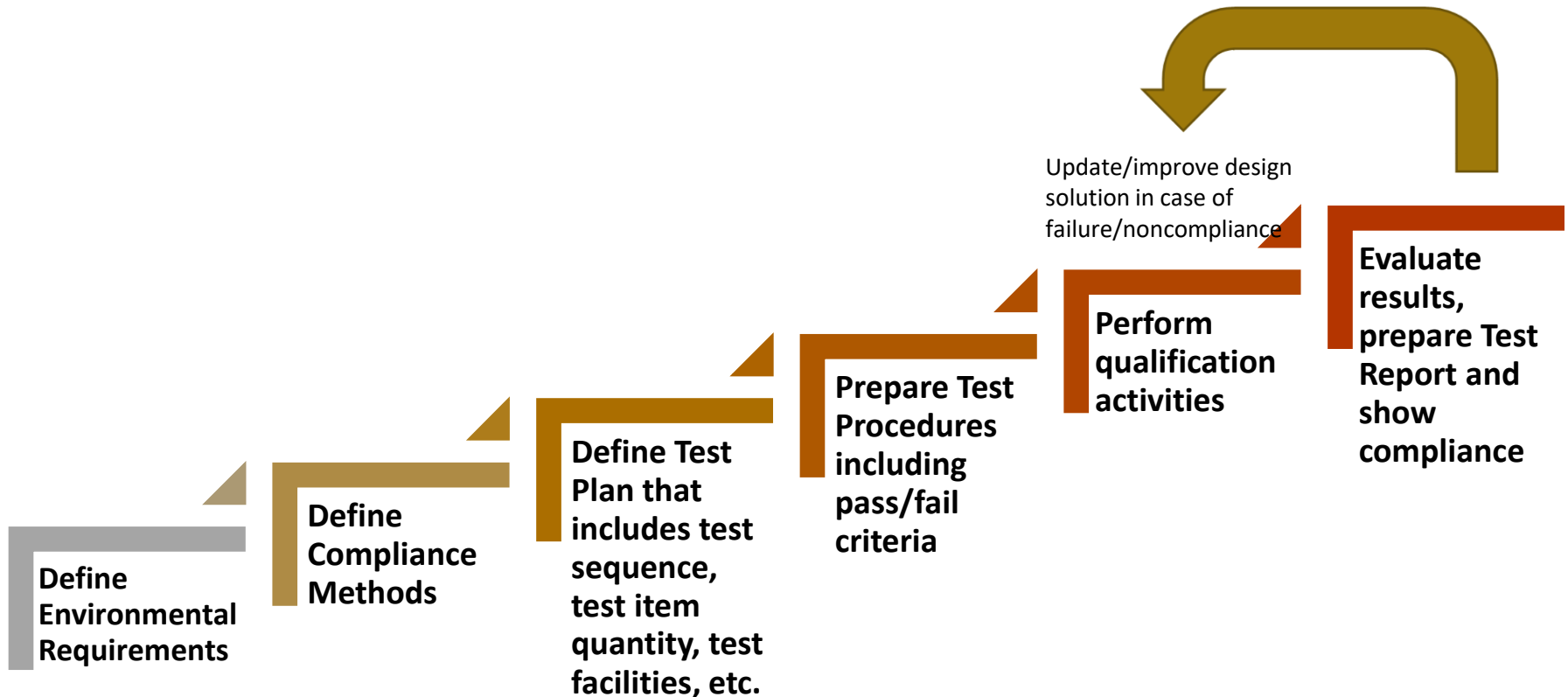
***Environmental Qualification*** shall demonstrate that equipment will perform its required function during and following defined environmental condition which are likely to be encountered in service.



# General Equipment Qualification Process



Environmental Qualification closely follows design and verification process





## Environmental Conditions

### Climatic

Altitude  
High/Low Temperature  
Temperature Shock  
Humidity  
Rain/Waterproofness  
Sand&Dust  
Salt Fog  
Fungus  
Solar Radiation  
Icing

### Mechanical

Vibration  
Shock (Crash, gunfire)  
Acceleration

### Chemical /Deleterous

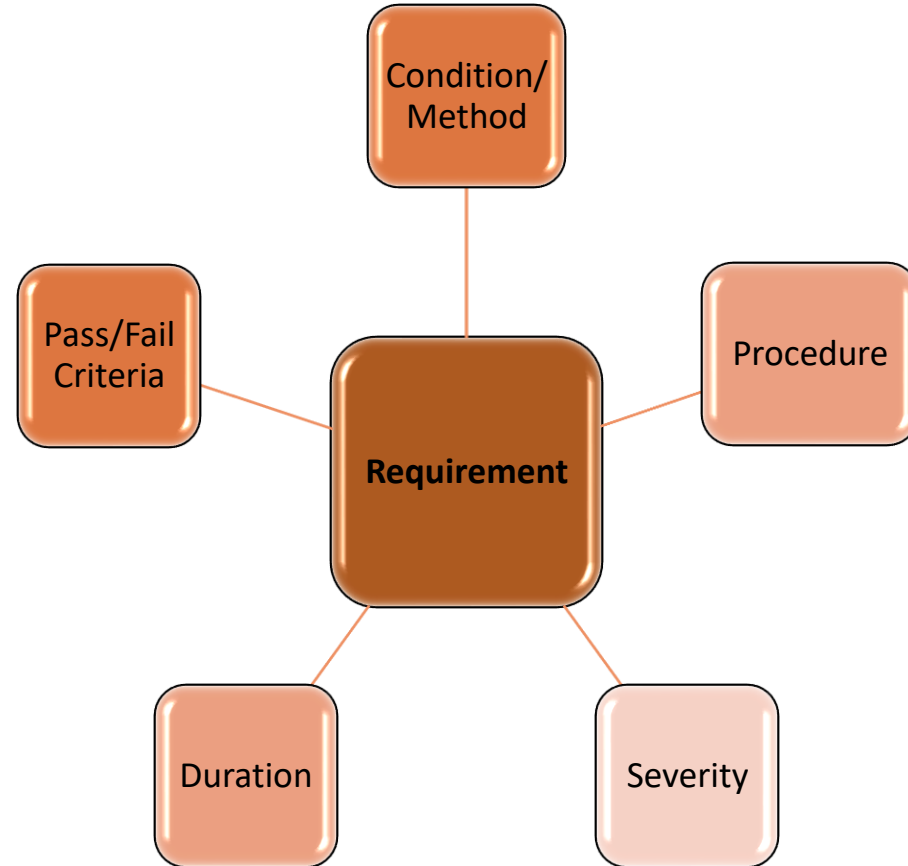
Acidic Atmosphere  
Contamination by Fluid  
Fire/Flammability  
Explosion Proofness

### Electrical

Magnetic Effect  
Power Input  
Voltage Spike  
Induced Signal  
Susceptibility  
Radio Frequency  
Susceptibility  
Emission of Radio  
Frequency Energy  
Lightning Direct Effects  
Electrostatic Discharge



- ❑ The conditions under which the installed equipment will be operated should be equal to or less severe than the environment for which the equipment is qualified
- ❑ To define correct environmental requirement following aspects should be considered;
  - Operational concept (geographical location, flight envelope, etc. )
  - Installation location
  - Packaging, container designs/configurations or means for material protection ( e.g water or air sealing, solar protection)
  - Expected performance criteria during/after exposure of defined condition



Test severities can be defined;

- by using related standards
- by data obtained on the same type of equipment on the same platform
- by data derived from appropriately similar equipment or platform

Tailored data may be used	Data used as defined in standard
High Temperature	Rain/Waterproofness
Low Temperature	Humidity
Temperature Shock	Salt Fog
Altitude	Sand & Dust
Vibration	Solar Radiation
Acceleration	Fungus
Shock	Fire&Flammability
	Explosion Proofness

## Test

Applicable when the test is practical, feasible and a close simulation of a specific environmental condition

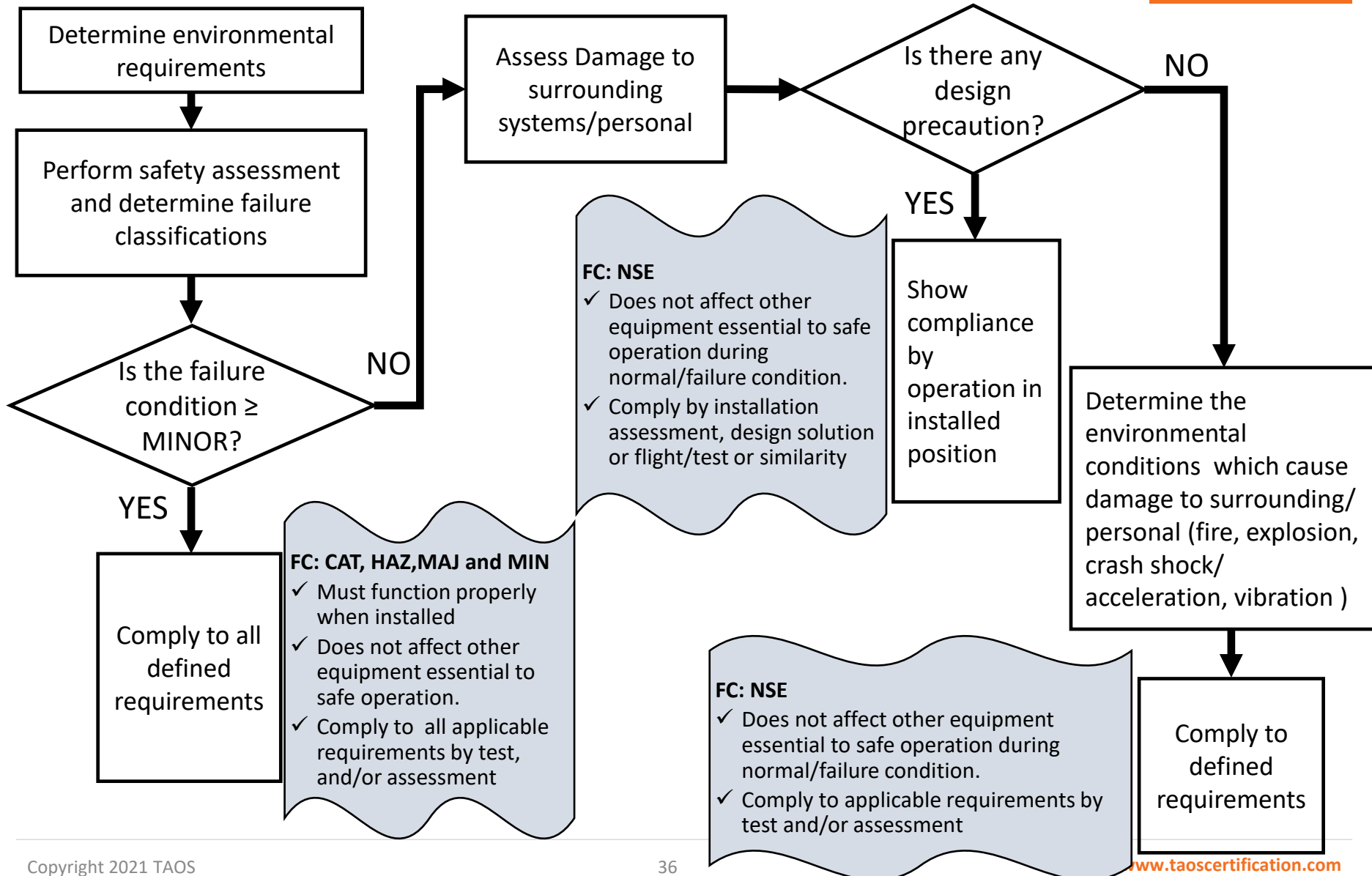
## Test + Assessment

Applicable when lower level test (e.g. coupon test, minimum integrity tests) supports analysis/evaluation to justify operational condition.

## Assessment

Applicable when testing is not practical and/or feasible. Analysis and similarity to previously qualified equipment justifies operational condition

# Compliance Methodology considering Safety



- ❑ Qualification Documents
  - Test Reports
  - Assessment Reports
  - Declaration of Design and Performance (DDP)
  - Any other reports that required by Contractor/OEM
- ❑ Hardware and Software Development Assurance Compliance Summaries according to criticality levels
- ❑ Continued Airworthines Documents (CMM, Repair Manual, etc.)

DDP shall contain at least the following information

- information identifying the article and its design and testing standard
- the rated performance of the article, where appropriate, either directly or by reference
- development assurance level, where appropriate
- environmental qualification summary and reference to relevant test reports
- reference to the appropriate maintenance, and repair manuals
- list of deviations accepted



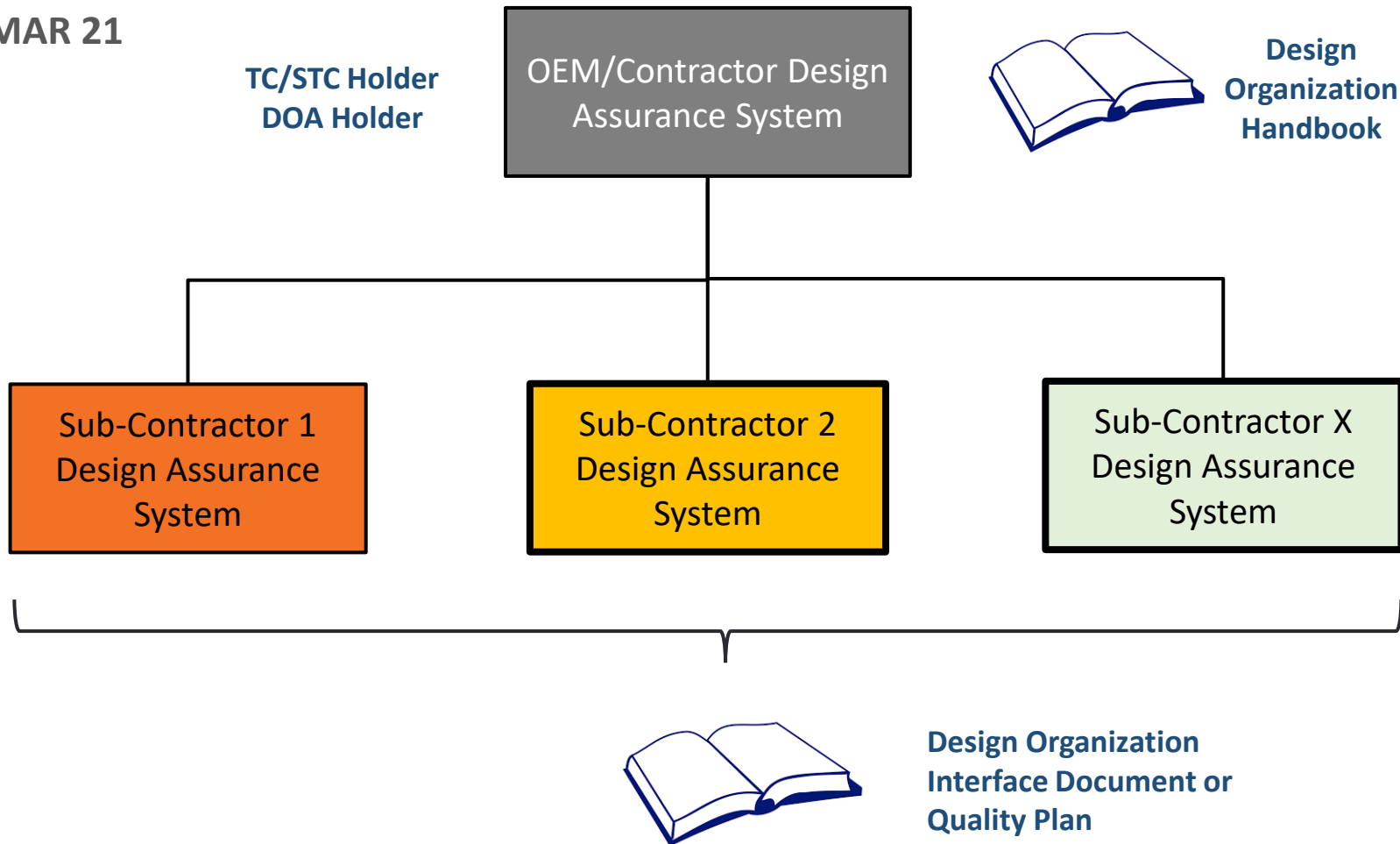
- ✓ Justify test categories properly before the beginning of compliance activities to minimize design changes.
- ✓ Try to have mature design and operational configuration before starting environmental qualification activities
- ✓ Equipment qualification is one but not the only one compliance method, laboratory, ground and flight tests are also required to show that the equipment functions as intended.

# ***PART IV***

# ***ORGANIZATIONAL ASPECT***



## Part 21 EMAR 21



## HUMAN RESOURCES

- Assign people responsible from;
  - Requirement management
  - Design
  - Analyses and Tests
  - Airworthiness (laison with Contractor) and management of overall qualification process
  - Internal and supplier auditing
  - Safety, reliability, etc.
  - Project management
  - Etc.
- identify authorized people

## FACILITIES

- Design, analyses, test tools and software
- Physical environment

Define design assurance system processes in line with OEM/contractor law criticality level

- Development and Design Processes
  - Planning
  - Requirement management and Validation
  - Review process (planning review, development review, verification review, etc.)
  - Implementation and verification
  - Configuration and change management
  - Process assurance
  - Design data release
- Defining purchasing information (Design data for suppliers)
- Concession/control of nonconforming product and corrective action process (design assessment)
- Internal and sub-contractor/supplier audits
- Occurrence reporting process
- Instructions for continued airworthiness (Maintenance and repair manuals, Service Bulletins, etc.)
- Documents and record control
- Defining design-production-maintenance interface
- Defining interface with main contractor to support certification process



- ✓ Understand the OEM/Contractor organizational expectations
- ✓ Understand the certification requirements related to organizational infrastructure
- ✓ Establish a quality management system (Eg. AS9100) that includes and meets additional Part 21 requirements
- ✓ Provide sufficient number of personnel with adequate knowledge and experience
- ✓ Establish competency-based training process

**Check our webpage [www.taoscertification.com](http://www.taoscertification.com)**

- *Training section for our system safety and certification trainings*
- *Whitepaper section for additional information*  
***(This presentation will be added in this section)***
- *News section for our recent events*

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