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EUROPEAN MILITARY AIRWORTHINESS CERTIFICATION CRITERIA (EMACC)

EMACC Handbook

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SECTION 1 - SCOPE

1.1. PURPOSE

This document establishes the airworthiness certification criteria to be used in the determination of airworthiness of all manned and unmanned, fixed and rotary wing air vehicle systems. It is a foundational document to be used by the relevant military airworthiness authority or authorities or other entity to define the air system's airworthiness certification basis.

1.2. APPLICABILITY

The criteria within this document may be tailored and applied at any point throughout the life of an air vehicle system when an airworthiness determination is necessary, especially when there is a change to the functional or product baseline.

Rotary wing air vehicle and unmanned air system/remotely operated aircraft (UAS/ROA) features demand unique safety-of-flight (SOF) system requirements. Therefore, unique criteria are included for these types of systems to ensure that minimum levels of design for safe operation and maintenance are established. The UAS/ROA operating system can be built into the vehicle or be part of the control station for remotely operated aircraft. The UAS/ROA system comprises the control station, data links, flight control system, communications systems/links, etc., as well as the air vehicle. UAS/ROA vary greatly in size, weight, and complexity. Because they are unmanned, SOF risks associated with loss of aircrew may not apply. However, as with manned air vehicles, SOF risk associated with personnel, damage to equipment, property, and/or environment must be considered. As such, the airworthiness criteria may be tailored for this unique application, including when a UAS/ROA is designed to be "expendable" or where the UAS/ROA will conduct missions with "minimum life expectancy." Consideration should be given to the environment in which the UAS/ROA will be operated (controlled test range, national airspace, fleet usage, including ship based applications), to the airframe life for which the air vehicle is designed, and to the "expendability" of the UAS/ROA in close proximity to the control system, personnel, property, or other equipment.

Similarly, air vehicles intended for use in ship-borne operations have unique requirements in areas such as structural integrity, propulsion system dynamic response and tolerance to steam ingestion, control systems response to approach and landings in high turbulence conditions, electromagnetic environmental effects, deck handling, support and servicing, and pilot field of view.

Commercial derivative aircraft (CDA) are initially approved for safety of flight by a National approving Authority for Civil Aviation and may have an approved Type Certificate (or equivalent document). Any non-Civil approved alteration to a CDA may render all civil certifications invalid. While alterations to CDA are covered by rules unique to each Nation (both Civil and Military regulations), the operating Nations' service always has the responsibility for the airworthiness certification approval under public aircraft rules. Therefore, when planning any alterations to a civil certified CDA, the modifier should contact the appropriate National Military Airworthiness Authority at the earliest opportunity.

In all instances, complete and accurate documentation of both applicability and system specific measurable criteria values is critical to ensuring consistent, timely, and accurate airworthiness assessments.

1.2.1. Tailoring to Create the Certification Basis

Not all of the airworthiness criteria within this document apply to every type of air vehicle; platform-unique, previously undefined criteria, may also need to be added to fully address safety aspects of unique configurations. Therefore, it may be necessary to tailor the total set of criteria to identify a complete (necessary and sufficient) subset of applicable airworthiness criteria, creating the system's certification basis. This certification basis should be fully documented and maintained under strict configuration control.

To meet individual Nation needs, tailoring may be required to ensure the following aspects are respected:

- The approach to governance and the associated contracting model(s);
- The approach to development, production and ongoing upkeep of the product basis of certification, including the acceptable approaches to means of compliance;
- Sufficient flexibility and adaptability within the criteria to met the operational needs, scenarios and role for the Product(s).

The primary objective in tailoring is to maintain the intent and context of the criteria. It is not an exercise intended to relax and/or degrade the criteria. Indeed, for military operations, tailoring may result in a more arduous certification basis. Where possible, it is recommended that a risk based approach to the evaluation of the potential impacts (if any) of the tailoring exercise is conducted.

Guidance for tailoring the criteria within the EMACC is provided within the Type Certification Basis Tailoring Guidebook. As an overview tailoring rules are as follows:

a. Identify each criterion as either applicable or non-applicable, considering system or product complexity, type, data, and intended use. Document the rationale for identifying any criteria as non-applicable;

b. Applicable criteria may not be deleted in any manner. However, if a portion of otherwise applicable criteria does not apply or is modified, identify the applicable and non-applicable portions and any modification, and document the rationale. It is not recommended that the criteria be modified, but in the event a criteria is modified, it is essential that the intent and context is maintained;

c. Supplement applicable criteria with specific measurable parameters, where appropriate (i.e., they add value to the definition of airworthiness requirements);

d. Develop additional criteria, as appropriate, for any capabilities or systems (including the whole/complete system) not fully addressed by the criteria contained in this document.

Consideration should be given to defining quantitative airworthiness parameters that are compatible with performance requirements.

Consideration should be given to operational requirements for safe operation when defining the certification basis

1.3. Cross References

The criteria included in this document are written with the intent that an experienced engineer, trained in the specific technical area under consideration, should be able to interpret, tailor, apply, and evaluate a particular system's compliance with the criteria.

1.4. INFORMATION SOURCES

Each Airworthiness Certification Criteria is matched with corresponding Title 14, Code of Federal Regulations reference (14CFR reference) and Joint Service Specification Guides (JSSG). In addition, cross-references are provided to the relevant sections within EASA Certification Specifications (CS), Defence Standard 00-970 and NATO STANAG documents.

The FAA Code of Federal Regulations Part and EASA CS (i.e. 23, 25, 27, 29) referenced is dependent on aircraft type and must be consistent with aircraft size and usage. The list shown is not exhaustive. The user is cautioned to refer to the reference material only as a guide and not for the purposes of citing requirements. The user is also advised to use additional FAA and EASA Advisory Circulars, Def-Stan 00-970 leaflets or other acceptable means of compliance documents to assist in understanding the implementation of the relevant regulatory requirements.

With respect to the cross-referencing of NATO STANAGs, Nations should examine their ratification status for each STANAG prior to assuming that the document is applicable.

This document will be periodically updated through review and cross-checking of the referenced documents. Users should always refer to the current version of the referenced documents. Where a conflict exists between the reference documents and this document then this should be brought to the attention of the EMACC sponsor.

SECTION 2 - APPLICABLE DOCUMENTS

2.1. GENERAL

The documents listed below are not necessarily all of the documents referenced herein but are those necessary to understand the information provided by this handbook. Refer to the current version of these documents, unless otherwise indicated.

2.2. DEFENCE STANDARDS

The following specifications, standards, and handbooks form a part of this document to the extent specified herein:

- Defence Standard 00-56 - Safety Management Requirements for Defence Systems;
- Defence Standard 00-970 - Design and Airworthiness Requirements for Service Aircraft.

The table below details the issue status of the various sections of Defence Standard 00-970 as used in the cross-references in this document.

Part No: 0: Procedures for Use, Content and Definitions	**Issue 6 dated: 22/01/10**
Part No: 1: Fixed Wing	
Section No: 1: "General"	Issue 12 dated: 10/01/14
Section No: 2: "Flight"	Issue 11 dated: 10/01/14
Section No: 3: "Structure"	Issue 12 dated: 10/01/14
Section No: 4: "Design and Construction"	Issue 12 dated: 10/01/14
Section No: 5: "Powerplant"	Issue 11 dated: 10/01/14
Section No: 6: "Equipment"	Issue 12 dated: 10/01/14
Section No: 7: "Operating Limitations and Information"	Issue 11 dated: 10/01/14
Section No: 8: "Gas Turbine Auxiliary Power Unit Installation"	Issue 11 dated: 10/01/14
Section No: 9: "Military Specific Systems"	Issue 6 dated: 05/02/10
Part No: 7: Rotorcraft	
Section No: 1: "General and Operational Requirements"	Issue 3 dated: 29/01/10
Section No: 2: "Structural Strength and Design for Flight"	Issue 3 dated: 29/01/10
Section No: 3: "Structural Strength and Design for Operation on Specified Surfaces"	Issue 3 dated: 24/12/10
Section No: 4: "Detail Design and Strength of Materials"	Issue 2 dated: 31/01/07
Section No: 5: "Aero-Elasticity and Strength of Materials"	Issue 2 dated: 31/01/07
Section No: 6: "Flight and Ground Handling Qualities"	Issue 2 dated: 31/01/07
Section No: 7: "Installations"	Issue 3 dated: 29/01/10
Section No: 8: "Maintenance"	Issue 2 dated: 31/01/07
Section No: 9: "Flight Tests - Handling"	Issue 2 AL1 dated: 04/12/07
Section No: 10: "Flight Tests - Installations and Structures"	Issue 2 dated: 31/01/07
Part No: 9: UAV Systems	**Issue 10 dated: 10/01/14**
Part No: 11: Engines	**Issue 5 dated: 10/01/14**
Part No: 13: Military Common Fit Equipment	**Issue 8 dated: 10/01/14**
Part No: 15: Items with no Specific Military Requirements	**Issue 8 dated: 10/01/14**

2.3. STANAGs

Each EMAR 516B Airworthiness Certification Criteria is matched with corresponding Title 14, Code of Federal Regulations reference (14CFR reference) and Joint Service Specification Guides (JSSG). In addition, cross-references are provided to the relevant sections within EASA Certification Specifications (CS), Defence Standard 00-970 and NATO STANAG documents.

The user is cautioned to look at the reference material only as a guide and not for purposes of citing requirements. The user is also advised to use additional Advisory Circulars, Def-Stan 00-970 leaflets or other acceptable means of compliance documents to assist in understanding the implementation of the relevant regulatory requirements.

With respect to the cross-referencing of NATO STANAGs, pMS should examine their ratification status for each STANAG prior to assuming that the document is applicable. Users should always refer to the current version of the referenced documents. For NATO STANAG, this is reflected in the NATO Standardization Document Database (NSDD). The table below details the ratification status for pMS for all referenced STANAGs as of 3rd June 2010.

STANAG Reference No.	Edition	STANAG Title	Relevant section of EMAR 516	Ratified by pMS	Ratified with reservation/comment / not implementing
2445	Edition 3	Criteria for the clearance of Helicopter Underslung Load Equipment (HUSLE) and Underslung Loads (USL's).	8.10	Belgium Czech Republic Germany Hungary Italy Netherlands Poland UK	Luxemburg Spain
3098	Edition 10, Amdt.3	Aircraft jacking.	8.5.12	Belgium France Germany Greece Netherlands Poland	Spain UK
3105	Edition 6, Amdt.1	Pressure refuelling connections and defueling for aircraft.	8.3	Czech Republic Germany Greece Hungary Italy Netherlands UK	Belgium France Spain
3109	Edition 5, Amdt.6	Symbol marking of Aircraft servicing and Safety/Hazard points.	16	Belgium Czech Republic France Germany Greece Italy Netherlands Spain UK	Hungary

STANAG Reference No.	Edition	STANAG Title	Relevant section of EMAR 516	Ratified by pMS	Ratified with reservation/comment / not implementing
3198	Edition 4, Amdt.4	Functional requirements of Aircraft oxygen equipment and pressure suits.	8.2.8, 18.3	France Germany Greece Italy Netherlands Spain UK	Belgium
3217	Edition 6	Operations of controls and switches at Aircrew stations.	9.2	Belgium Bulgaria Czech Republic Estonia Romania UK	Germany Poland Spain
3224	Edition 7	Aircraft interior and exterior lighting Night Vision Goggle (NVG) and Non-NVG compatible.	9.2	Czech Republic Germany Netherlands Spain	Estonia Greece UK
3230	Edition 7	Emergency markings on Aircraft.	9.1	Czech Republic Germany Netherlands Poland Slovenia UK	Belgium Greece Hungary Italy Portugal Spain
3278	Edition 8, Amdt.1	Aircraft towing attachments and devices.	8.5.12	Czech Republic Germany Netherlands	Belgium France Greece Poland UK
3294	Edition 4, Amdt.1	Aircraft fuel caps and fuel cap access covers.	8.3 16.1	Belgium France Germany Italy Netherlands Portugal Spain UK	Greece
3368	Edition 3, Amdt.1	Internal Aircraft engine starting system.	8.6	Belgium France Germany Netherlands UK	Greece Italy Portugal Spain
3372	Edition 6, Amdt.2	Low Pressure air and associated electrical connectors for aircraft.	8.1	Belgium Germany Greece Netherlands Portugal UK	Spain

STANAG Reference No.	Edition	STANAG Title	Relevant section of EMAR 516	Ratified by pMS	Ratified with reservation/comment / not implementing
3400	Edition 3, Amdt.5	Restraint of cargo in Fixed Wing Aircraft.	20.1	Belgium France Greece Italy Netherlands Portugal Spain UK	
3436	Edition 4, Amdt.4	Colours and markings used to denote operating ranges of Aircraft instruments.	9.2	Belgium France Germany Greece Italy Netherlands UK	Portugal Spain
3447	Edition 3. Amdt.4	Aerial refuelling equipment dimensional and functional characteristics	8.7	Belgium France Germany Greece Netherlands Portugal Spain UK	
3455	Edition 4, Amdt.1	Basic symbols for Aircraft electrical circuits.	12.2	Belgium Czech Republic France Germany Greece Italy Netherlands Portugal Spain UK	Hungary
3456	Edition 6, Amdt.1	Aircraft electrical power systems characteristics.	12.2	France Greece Netherlands Spain UK	Belgium Germany Portugal
3510	Edition 3, Amdt.2	The provision of hydraulic power for servicing Aircraft hydraulic systems.	8.1	Belgium France Germany Italy Netherlands Portugal	Greece Spain UK
3516	Edition 5	Electromagnetic Interference, test methods for Aircraft electrical and electronic equipment.	13	Germany Netherlands Spain UK	Czech Republic Poland

STANAG Reference No.	Edition	STANAG Title	Relevant section of EMAR 516	Ratified by pMS	Ratified with reservation/comment / not implementing
3548	Edition 3	Tie-down fitting on air transported and air dropped equipment and cargo carried internally by Fixed Wing Aircraft.	20.1	Belgium France Portugal Spain UK	Germany
3610	Edition 2, Amdt.1	Characteristics of controlled breathable air supplied to Aircraft.	9.5 8.2.10	France Greece Italy Netherlands Spain UK	
3614	Edition 5	Electromagnetic Environmental effects (E3) – Requirements for Aircraft systems and equipment.	13	Czech Republic Germany Netherlands Poland Spain UK	Portugal
3616	Edition 2	Responsibility for the design and provision of adaptors necessary for the compatibility of air cargo loading, securing, unloading and dropping systems in Fixed Wing Aircraft.	9.8	Belgium France Germany Greece Italy Netherlands Portugal UK	
3659	Edition 4	Electrical bonding requirements for metallic Aircraft systems.	12.2.6, 13.2.8	Belgium Germany Greece Spain UK	Czech Republic Italy Poland
3681	Edition 3, Amdt.1	Criteria for Pressure fuelling/defuelling of Aircraft.	8.3	Belgium Germany Greece Italy Netherlands Portugal Spain UK	Czech Republic France Poland
3682	Edition 5, Amdt.2	Electrostatic safety connection procedures for aviation fuel handling and liquid fuel loading/unloading operations during ground transfer and aircraft fuelling/defueling.	8.3	Belgium Germany Greece Italy Netherlands Portugal Spain UK	

STANAG Reference No.	Edition	STANAG Title	Relevant section of EMAR 516	Ratified by pMS	Ratified with reservation/comment / not implementing
3701	Edition 3, Amdt.2	Aircraft interior colour schemes.	9.2	Germany Netherlands UK	Belgium France Greece Spain
3705	Edition 3, Amdt.2	Human Engineering design criteria for controls and displays in Aircrew stations.	9.2	Belgium Germany Netherlands UK	Greece Spain
3828	Edition 3	Minimum requirements for Aircrew protection against the Hazards of Laser target designators.	9.2, 9.3.4	Belgium Czech Republic Estonia	Bulgaria Germany Greece Hungary Italy Luxemburg Romania Slovakia UK
3847	Edition 1, Amdt.5	Helicopter In-Flight Refuelling (HIFR) equipment.	8.7	France Germany Netherlands UK	
3896	Edition 5	Aircraft emergency rescue information (Fire Protection).	8.4	Belgium Czech Republic France Greece Italy Spain UK	
3950	Edition 2 Amdt.1	Helicopter design criteria for crew crash protection and anthropometric accommodation.		Belgium France Germany Greece Netherlands UK	Czech Republic Italy Spain
3967	Edition 2	Design and performance requirements for aviation fuel filter separator, coalescer and separator elements.	8.3	Belgium Italy Netherlands	Portugal Spain UK
3971	Edition 6	Air to Air Refuelling – ATP-56(A).	8.7	Belgium Czech Republic Greece Italy Netherlands Poland Spain	Bulgaria Estonia France Romania UK

STANAG Reference No.	Edition	STANAG Title	Relevant section of EMAR 516	Ratified by pMS	Ratified with reservation/comment / not implementing
7011	Edition 2	Automated fuel system monitoring and control equipment.	8.3	Belgium Germany Netherlands Spain	France Greece Italy UK
7029	Edition1	Characteristics of Aircraft fuelling hoses and couplings.	8.3	Belgium Germany Greece Italy Netherlands Portugal UK	
7039	Edition 1 Amdt.2	Test procedures to ensure compatibility of equipment with Aircraft systems.	13	Belgium France Germany Portugal UK	
7116	Edition 1	Verification methodology for the electromagnetic hardness of Aircraft.	13	Czech Republic Germany Netherlands Romania Spain UK	Bulgaria Estonia Latvia Lithuania Slovakia
7139	Edition 3	Aircraft engine controls, switches, displays, indicators, gauges and Arrangements.	9.2	Estonia Germany Spain	Belgium Bulgaria Czech Republic Italy Lithuania Netherlands Poland Romania Slovakia UK
7140	Edition 1	Aircraft flight instruments – Layout and display.	9.2	Germany Spain	Belgium France Greece Netherlands UK
7187	Edition 1	On Board Oxygen Generating System (OBOGS) performance standards.		Netherlands	Belgium Bulgaria Czech Republic Estonia Germany Lithuania Romania Slovakia Spain UK

STANAG Reference No.	Edition	STANAG Title	Relevant section of EMAR 516	Ratified by pMS	Ratified with reservation/comment / not implementing
7068	Edition 2: Amdt.1	Aircraft stores certification procedure.		Czech Republic Germany Greece Luxemburg Netherlands Spain UK	Belgium
4671	Edition 2	Unmanned aerial vehicle systems airworthiness requirements (USAR).	Various		
4101	Edition 2	Towing Attachments		Belgium Netherlands Portugal Spain UK	Germany

2.4. EASA Certification Specifications

The following specifications, standards, and handbooks form a part of this document to the extent specified herein:

- EASA CS 23 - Normal, Utility, Aerobatic and Commuter Category Aircraft Amendment 3;
- EASA CS 25 - Large Aeroplanes Amendment 14;
- EASA CS 27 - Small Rotorcraft Amendment 3;
- EASA CS 29 - Large Rotorcraft Amendment 3;
- EASA CS E - Engines Amendment 3;
- EASA CS P - Propellers Amendment 1.

2.5. Department of Defence Specifications

The following specifications, standards, and handbooks form a part of this document to the extent specified herein:

- JSSG-2000B Air System, dated 21st September 2004;
- JSSG-2001A Air Vehicle, dated 22nd October 2002;
- JSSG-2005 Avionic Subsystem, Main Body;
- JSSG-2006 Aircraft Structures, dated 30th October 1998;
- JSSG-2007B Engines, Aircraft, Turbine, dated 6th December 2007;
- JSSG-2008 Vehicle Control and Management System (VCMS);
- JSSG-2009 Air Vehicle Subsystems, dated 30th October 1998;
- JSSG-2010 Crew Systems;

2.6. FEDERAL AVIATION ADMINISTRATION CODE OF FEDERAL REGULATION (CFR)

The following specifications, standards, and handbooks form a part of this document to the extent specified herein:

- TITLE 14 Aeronautics and Space
  - Part 23, Airworthiness Standards: Normal, Utility, Acrobatic and Commuter Category Aeroplanes;
  - Part 25, Airworthiness Standards: Transport Category: Airplanes;
  - Part 27, Airworthiness Standards: Normal Category Rotorcraft;
  - Part 29, Airworthiness Standards: Transport Category: Rotorcraft.

SECTION 3 - DEFINITIONS & ABBREVIATIONS

3.1. DEFINITIONS

This EMACC Handbook relies on definitions laid down in EMAD 1 and the following definitions unless otherwise referenced, are to be considered to be within the context of this document only.

Accidental Damage (AD)

Physical deterioration of an item caused by contact or impact with an object or influence which is not a part of the aircraft, or by human error during manufacturing, operation of the aircraft, or maintenance practices.

Age Exploration

A systematic evaluation of an item based on analysis of collected information from in-service experience. It verifies the item's resistance to a deterioration process with respect to increasing age.

Air System

An air vehicle plus the training and support systems for the air vehicle, and any weapons to be employed on the air vehicle.

Air Vehicle

An air vehicle includes the installed equipment (hardware and software) for airframe, propulsion, air vehicle applications software, air vehicle system software, communications/identification, navigation/guidance, central computer, fire control, data display and controls, survivability, reconnaissance, automatic flight control, central integrated checkout, antisubmarine warfare, armament, weapons delivery, auxiliary equipment, and all other installed equipment.

Aircraft Structure.

The structure of an aircraft includes the fuselage, wing, empennage, landing gear, rotorcraft rotor and drive systems, propellers, control systems and surfaces, airframe-engine interface components including engine mounts), nacelles, air induction components, weapon mounts, structural operating mechanisms, components that perform a structural function, and other components as described in the contract specification.

Airworthiness

The ability of an aircraft, or other airborne equipment or system, to operate in flight and on ground without significant hazard to aircrew, ground crew, passengers (where relevant) or to other third parties.

Airworthiness Limitations

A section of the Instructions for Continued Airworthiness that contains each mandatory replacement time, structural inspection interval, and related structural inspection task. This section may also be used to define a threshold for the fatigue related inspections and the need to control corrosion to Level 1 or better. The information contained in the Airworthiness Limitations section may be changed to reflect service and/or test experience or new analysis methods.

Authority

Unless otherwise defined, Authority means a national military airworthiness authority responsible for the airworthiness of military aircraft hereto and "the authorities" means all the military authorities responsible for airworthiness hereto.

Baseline Operational Loads/Environment Spectrum (baseline spectrum).

The baseline operational loads/environment spectrum is an update of the design spectrum based on measured data from operational aircraft (e.g., data obtained from the loads/environment spectra survey).

Baseline Service Life.

The baseline service life is the period of time (e.g., years, flight cycles, hours, landings, etc.) established subsequent to design, during which the structure is expected to maintain its structural integrity when flown to the baseline loads/environment spectrum.

Certification.

Recognition that a production, part or appliance, organisation or person complies with the applicable airworthiness requirements followed by a declaration of compliance.

Certification Review Item

A document recording Deviations, Special Conditions, new Means of Compliance or any other certification issue which requires clarification and interpretation, or represents a major technical or administrative issue.

Conditional Probability of Failure

The probability that a failure will occur in a specific period provided that the item concerned has survived to the beginning of that period.

Configuration Control

A systematic process that ensures that changes to released configuration documentation are properly identified, documented, evaluated for impact, approved by an appropriate level of authority, incorporated, and verified

Configuration Management

A management process for establishing and maintaining consistency of a product's performance, functional, and physical attributes with its requirements, design and operational information throughout its life

Continuing Airworthiness

All of the processes ensuring that, at any time in its operating life, the aircraft complies with the airworthiness requirements in force and is in a condition for safe operation

Continued (design) Airworthiness

All tasks to be carried-out to verify that the conditions under which a type-certificate or a supplemental type-certificate has been granted continue to be fulfilled at any time during its period of validity

Control Surface Float Angle

The position a control surface will 'Float' to under aerodynamic load but with zero hinge moment (i.e. stick free stability

Corrosion.

Corrosion is the deterioration of a material or its properties due to the reaction of that material with its chemical environment.

Corrosion Prevention and Control Program (CPCP)

A program of maintenance tasks implemented at a threshold designed to control an aircraft structure to Corrosion Level 1 or better.

Credible Combination of Failures

All credible combination of failure(s), based on the outcome of a safety analysis process, which can include a single event/failure, which may result in an unacceptable level of safety

Critical Location.

A critical location in an aircraft structure is one that has been identified through analysis, test, or service history as a being especially sensitive to the presence of damage.

Damage.

Damage to aircraft structure is any crack, flaw, corrosion, disbond, delamination, and/or other feature that degrades, or has the potential to degrade, the performance of the affected component.

Damage Tolerance.

Damage tolerance is the attribute of a structure that permits it to retain its required residual strength for a period of un-repaired usage after the structure has sustained specific levels of fatigue, corrosion, accidental, and/or discrete source damage. An item is judged to be damage tolerant if it can sustain damage and the remaining structure can withstand reasonable loads without structural failure or excessive structural deformation until the damage is detected. A qualification standard for aircraft structure.

Design Loads/Environment Spectrum.

The design loads/environment spectrum is the spectrum of external loads and environments (chemical, thermal, etc.) used in the design of the aircraft and is representative of the spectrum that the typical force aircraft is expected to encounter within the design service life.

Design Service Life.

The design service life is the period of time (e.g., years, flight cycles, hours, landings, etc.) established at design, during which the structure is expected to maintain its structural integrity when flown to the design loads/environment spectrum.

Delamination/Disbond

Structural separation or cracking that occurs at or in the bond plane of a structural element, within a structural assembly, caused by in service accidental damage, environmental effects and/or cyclic loading.

Deterministic Design Method

A Deterministic design method is a uses recognised calculations and engineering techniques in formulating the values applied to a known and justified load (as opposed to using applicable experience, reliability and sample data).

Direct Adverse Effect on Operating Safety

Direct

To be direct, the functional failure or resulting secondary damage must achieve its effect by itself, not in combination with other functional failures (no redundancy exists and it is a primary dispatch item).

Adverse Effect on Safety

Safety shall be considered as adversely affected if the consequences of the failure condition would prevent the continued safe flight and landing of the aircraft and/or might cause serious or fatal injury to human occupants.

Operating

This is defined as the time interval during which passengers and crew are on board for the purpose of flight.

Discard

The removal from service of an item at a specified life limit.

Durability.

Durability is the ability of the aircraft structure to resist cracking, corrosion, thermal degradation, delamination, wear, and the effects of foreign object damage for a prescribed period of time.

Economic Life.

The economic life is the period during which it is more cost-effective to maintain and repair an aircraft than to replace it. Economic life can be applied on a component, aircraft, or force basis.

Economic Effects

Failure effects which do not prevent aircraft operation, but are economically undesirable due to added labour and material cost for aircraft or shop repair.

Electrical Wiring Interconnection System (EWIS)

An electrical connection between two or more points including the associated terminal devices (e.g., connectors, terminal blocks, splices) and the necessary means for its installation and identification.

Equivalent Flight Hours.

Equivalent flight hours are the actual flight hours accumulated by an aircraft adjusted for the actual usage severity compared to the design spectrum or to the baseline spectrum.

Environmental Deterioration (ED)

Physical deterioration of an item's strength or resistance to failure as a result of chemical interaction with its climate or environment.

Equivalent Initial Flaw Size (EIFS) Distribution.

The equivalent initial flaw size distribution is a characterization of the initial quality of the aircraft structure. The EIFS distribution is derived by analytically determining the initial flaw size distribution that must be used to obtain the measured flaw size distribution discovered following exposure to the test or actual usage stress spectra.

Factor of Safety

Factor of Uncertainty as referred to within JSSG 2006 is the same as the Factor of Safety, i.e. a figure that is applied to prescribed Limit Loads used in calculating the Ultimate Load.

Fail-Safe Structure.

A fail-safe structure is a structure that retains its required residual strength for a period of unrepaired usage after the failure or partial failure of safety-of-flight structure.

Failure

The inability of an item to perform within previously specified limits.

Failure Cause

Why the functional failure occurs.

Failure Condition

The effect on the aircraft and its occupants, both direct and consequential, caused or contributed to by one or more failures, considering relevant adverse operational or environmental conditions.

Failure Effect

What is the result of a functional failure?

Fatigue Damage (FD)

The initiation of a crack or cracks due to cyclic loading and subsequent propagation.

Fatigue Related Sampling Inspection

Inspections on specific aircraft selected from those which have the highest operating age/usage in order to identify the first evidence of deterioration in their condition caused by fatigue damage.

Fault

An identifiable condition in which one element of a redundant system has failed (no longer available) without impact on the required function output of the system (MSI). At the system level, a fault is not considered a functional failure.

Fault-Tolerant System

A system that is designed with redundant elements that can fail without impact on safety or operating capability.

Fracture-Critical Part.

As shown on figure 1, a fracture-critical part is a safety-of-flight structural component that is not single load path nor sized by durability or damage tolerance requirements but requires special emphasis due to the criticality of the component.

Fracture-Critical Traceable Part.

As shown on figure 1, a fracture-critical traceable part is a safety-of-flight structural component that is either single load path or sized by durability or damage tolerance requirements.

Function

The normal characteristic actions of an item.

Functional Baseline

The approved configuration documentation describing a system's or top level configuration item's performance (functional, inter-operability, and interface characteristics) and the verification required to demonstrate the achievement of those specified characteristics.

Functional Check

A quantitative check to determine if one or more functions of an item performs within specified limits.

Functional Failure

Failure of an item to perform its intended function within specified limits.

Graceful Degradation

In the presence of a failure(s), system characteristics are such that there is a gradual, observable and manageable reduction in functionality.

The progression and sustainment of air vehicle control, related to aircrew workload and situational awareness, must be safely achieved.

Hidden Function

1. A function which is normally active and whose cessation will not be evident to the operating crew during performance of normal duties.
2. A function which is normally inactive and whose readiness to perform, prior to it being needed, will not be evident to the operating crew during performance of normal duties.

Initial Quality.

Initial quality is a measure of the condition of the aircraft structure relative to flaws, defects, or other discrepancies in the basic materials or introduced during manufacture of the aircraft structure.

Inherent Level of Reliability and Safety

That level which is built into the unit and, therefore, inherent in its design. This is the highest level of reliability and safety that can be expected from a unit, system, or aircraft if it receives effective maintenance to achieve higher levels of reliability generally requires modification or redesign.

Inspection - Detailed (DET)

An intensive examination of a specific item, installation or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate. Inspection aids such as mirrors, magnifying lenses, etc. may be necessary. Surface cleaning and elaborate access procedures may be required.

Inspection - General Visual (GVI)

A visual examination of an interior or exterior area, installation or assembly to detect obvious damage, failure or irregularity. This level of inspection is made from within touching distance unless otherwise specified. A mirror may be necessary to enhance visual access to all exposed surfaces in the inspection area. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or drop-light and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.

Inspection - Special Detailed (SDI)

An intensive examination of a specific item, installation, or assembly to detect damage, failure or irregularity. The examination is likely to make extensive use of specialized Inspection Techniques and/or equipment. Intricate cleaning and substantial access or disassembly procedure may be required.

Inspection - Zonal

A collective term comprising selected general visual inspections and visual checks that is applied to each zone, defined by access and area, to check system and Powerplant installations and structure for security and general condition.

Interval (Initial - Repeat)

Initial Interval - Interval between the start of service-life and the first task accomplishment Repeat Interval - The interval (after the initial interval) between successive accomplishments of a specific maintenance task.

Item

Any level of hardware assembly (i.e., system, sub-system, module, accessory, component, unit, part, etc.).

Letter Checks

Letter checks are named collections of tasks (e.g., A-Check, C-Check, etc.) assigned the same interval.

L/HIRF

Lightning/High Intensity Radiated Field

L/HIRF Characteristics

Those properties of L/HIRF protection components that are necessary to perform their intended L/HIRF protection function(s).

L/HIRF Protection Components

Any self-contained part, combination of parts, subassemblies, units, or structures that perform a distinctive function necessary to provide L/HIRF protection.

L/HIRF Protection Systems

Systems comprised of components that avoid, eliminate, or reduce the consequences of an L/HIRF event.

Lubrication and Servicing

Any act of lubricating or servicing for the purpose of maintaining inherent design capabilities.

Maintenance

Any one or combination of overhaul, repair, inspection, replacement, modification or defect/fault rectification of an aircraft or component, with the exception of pre-flight inspection

Maintenance Manual

That part of the Military Air System document set which identifies the particular maintenance procedures and periodicity necessary to maintain the airworthiness of the Military Air System

Maintenance Significant Item - (MSI)

Items identified by the manufacturer whose failure a. could affect safety (on ground or in flight), and/or b. is undetectable during operations, and/or c. could have significant operational impact, and/or d. could have significant economic impact

Maintenance-Critical part.

A maintenance-critical part is a structural component whose failure will not cause a safety-of-flight condition but is sized by durability requirements and would not be economical to repair or replace.

Mission-Critical part.

As shown on figure 1, a mission-critical part is a structural component in which damage or failure could result in the inability to meet critical mission requirements or could result in a significant increase in vulnerability.

Multiple Load Path.

Multiple load path is structural redundancy in which the applied loads are distributed to other load carrying members in the event of failure of individual elements.

Multiple Element Fatigue Damage

The simultaneous cracking of multiple load path discrete elements working at similar stress levels.

Multiple Site Fatigue Damage

The presence of a number of adjacent, small cracks that might coalesce to form a single long crack.

Non-metallic's

Any structural material made from fibrous or laminated components bonded together by a medium. Materials such as graphite epoxy, boron epoxy, fibre glass, Kevlar epoxy, acrylics and the like are non-metallic's. Non-metallic's include adhesives used to join other metallic or non-metallic structural materials.

Non-destructive Inspection (NDI).

Non-destructive inspection is an inspection process or technique that reveals conditions at or beneath the external surface of a part or material without adversely affecting the material or part being inspected.

Onset of Widespread Fatigue Damage (WFD).

Onset of widespread fatigue damage is the point at which there are cracks at multiple structural details, and these are of sufficient size and density, such that the structure will no longer meet its damage tolerance requirement (e.g., maintaining required residual strength after partial structural failure).

Operating Crew Normal Duties

Operating Crew

Qualified flight compartment and cabin attendant personnel who are on duty.

Normal Duties

Those duties associated with the routine operation of the aircraft, on a daily basis, to include the following: a. Procedures and checks performed during aircraft operation in accordance with the Aircraft Flight Manual. b. Recognition of abnormalities or failures by the operating crew through the use of normal physical senses (e.g., odour, noise, vibration, temperature, visual observation of damage or failure, changes in physical input force requirements, etc.).

Operational Check

An operational check is a task to determine that an item is fulfilling its intended purpose. Does not require quantitative tolerances. This is a failure finding task.

Operational Effects

Failure effects which interfere with the completion of the aircraft mission. These failures cause delays, cancellations, ground or flight interruptions, high drag coefficients, altitude restrictions, etc.

Other Structure

Structure which is judged not to be a Structural Significant Item. "Other Structure" is defined both externally and internally within zonal boundaries.

Potential Failure

A defined identifiable condition that indicates that a degradation process is taking place that will lead to a functional failure.

Protective Device

Any device or system that has a function to avoid, eliminate or reduce the consequences of an event or the failure of some other function.

Probability of detection (POD).

A POD is a statistical measurement of the likelihood, with a specified confidence level, of finding a flaw of a defined size using a specific inspection technique.

Producibility.

Producibility means that materials, processes, and/or joining methods are able to support current and future production rates without adversely affecting costs and/or quality.

P to F Interval

Interval between the point at which a potential failure becomes detectable and the point at which it degrades into a functional failure.

Risk Analysis.

Risk analysis is an evaluation of a potential hazard severity and probability of occurrence. For aircraft structural applications, the potential hazards include structural failures that can cause injury or death to personnel, damage to or loss of the aircraft, or reduction of mission readiness/availability.

Redundant Functional Elements

Two or more independent physical elements of a system/item providing the same function.

Residual Strength

The strength of a damaged structure.

Restoration

That work necessary to return the item to a specific standard. Restoration may vary from cleaning or replacement of single parts up to a complete overhaul.

Rotorcraft Dynamic Component.

A rotorcraft dynamic component is a structural part of the rotorcraft's drive train or lift system that experiences dynamic loading.

Safe-life.

Safe-life of a structure defines a number of events such as flights, landings, or flight hours, during which there is a low probability that the strength will degrade below its design ultimate value due to fatigue cracking. It is applicable to structure which is not practical to design or qualify as damage tolerant.

Safety (adverse effect)

Safety shall be considered as adversely affected if the consequences of the failure condition would prevent the continued safe flight and landing of the aircraft and/or might cause serious or fatal injury to human occupants.

Safety-of-flight structure.

Safety-of-flight structure is that structure whose failure could cause loss of the aircraft or aircrew, or cause inadvertent store release. The loss could occur either immediately upon failure or subsequently if the failure remained undetected.

Safety/Emergency Systems or Equipment

A device or system that:

1) enhances the evacuation of the aircraft in an emergency or,

2) If it does not function when required, results in a Failure Condition that might have an adverse effect on safety.

Scheduled Maintenance Check

Any of the maintenance opportunities which are pre-packaged and are accomplished on a regular basis.

Single load path.

Single load path is the distribution of applied loads through a single member, the failure of which would result in the loss of the structural capability to carry the applied loads.

Slow damage growth structure.

Slow damage growth structure is structure in which damage is not allowed to attain the critical size required for unstable rapid damage propagation. Safety is assured through slow damage growth for specified periods of usage depending upon the degree of inspectability. The strength of slow damage growth structure with damage present is not degraded below a specified limit for the period of unrepaired service usage.

Stability.

Stability means that materials, processes, and joining methods have matured to where consistent and repeatable quality, and predictable costs have been achieved to meet system production requirements. Also, process parameters and methods are understood, and robust and documented approaches for control of these factors (i.e., specifications) exist.

Structural Integrity.

Structural integrity is the condition which exists when a structure is sound and unimpaired in providing the desired level of structural safety, performance, durability, and supportability.

Structural Operating Mechanisms.

Structural operating mechanisms are those operating, articulating, and control mechanisms which transmit structural forces during actuation and movement of structural surfaces and elements.

Structural Significant Item - (SSI)

Any detail, element or assembly, which contributes significantly to carrying flight, ground, pressure or control loads and whose failure could affect the structural integrity necessary for the safety of the aircraft.

Scheduled Structural Health Monitoring (S-SHM)

The act to use/run/read-out a SHM device at an interval set at a fixed schedule

Structural Assembly

One or more structural elements which together provide a basic structural function.

Structural Detail

The lowest functional level in an aircraft structure. A discrete region or area of a structural element, or a boundary intersection of two or more elements.

Structural Element

Two or more structural details which together form an identified manufacturer's assembly part.

Structural Function

The mode of action of aircraft structure. It includes acceptance and transfer of specified loads in items (details /elements /assemblies) and provides consistently adequate aircraft response and flight characteristics.

Structural Health Monitoring (SHM)

The concept of checking or watching a specific structural item, detail, installation or assembly using on board mechanical, optical or electronic devices specifically designed for the application used. SHM does not name any specific method or technology

Supportability.

Supportability means that thermal, environmental, and mechanical deterioration of materials and structures fabricated using the selected manufacturing processes and joining methods have been identified and that acceptable quality and cost-effective preventive methods and/or in-service repair methods are either available or can be developed in a timely manner.

Task Applicability

A set of conditions that leads to the identification of a task type when a specific set of characteristics of the failure cause being analyzed would be discovered and/or corrected as a result of the task being accomplished.

Task Effectiveness

A specific set of conditions that leads to the selection of a task already identified to be applicable. Avoids, eliminates, or reduces the negative consequences of the failure to an extent that justifies doing the task at the selected interval.

Threshold

See "Interval - Initial".

Threshold Period

A period during which no occurrences of the failure can reasonably be expected to occur after the item enters into service.

Time Limited Dispatch

Time Limited Dispatch (TLD) refers to the process of obtaining type design approval of engines with degraded electronic engine control systems.

TLD analysis focuses on redundancy when these systems are to be dispatched with Faults present for limited time intervals before maintenance actions are required

CS-E CSE 1030 and associated AMC refers

Type Certification Basis

An agreed set of airworthiness requirements a product must be compliant with in order to obtain a Type Certificate

UAV

A reusable aircraft which is designed to operate by being remotely piloted (no human pilot or passengers on board) or automatically flying a pre-programmed flight profile.

UAV System (May also be called a UAS)

UAV System (May also be called a UAS)

Comprises individual UAV System elements consisting of the unmanned aerial vehicle (UAV), the UAV control station and any other UAV System elements necessary to enable flight, such as a command and control data link, communication system and take-off and landing element. There may be multiple UAV, UCS, or take-off and landing elements within a UAV System

Visual Check

A visual check is an observation to determine that an item is fulfilling its intended purpose. Does not require quantitative tolerances. This is a failure finding task.

Wear Damage
Physical deterioration of the surface of an item due to relative motion between two parts in contact.

3.2. ABBREVIATIONS AND ACRONYMS

14CFR	Title 14, Code of Federal Regulations
AC	Advisory circulars
ADS	Aeronautical Design Standard
AFGS	Air Force Guide Specification
AFI	Air Force Instruction
AFPD	Air Force Policy Directive
AFR	Air Force Regulation
AMC	Acceptable Means of Compliance
APC	Aircraft pilot coupling
APS	Auxiliary power system
APU	Auxiliary power unit
AR	Army Regulation
ARSAG	Aerial Refuelling Systems Advisory Group
BARO VNAV	Barometric vertical navigation
BIT	Built-in-test
CAD	Cartridge actuated devices
CDR	Critical design review
CFD	Computational fluid dynamics
CFR	Code of Federal Regulations
CofG	Centre of gravity
CI	Configuration item
CNS/AT	Communication, navigation, surveillance/air traffic management
Comm'l	Commercial
CSA	Configuration status accounting
CSCI	Computer software configuration item
CSI	Critical safety item
DoD	Department of Defence
DOD	Domestic object damage
EASA	European Aviation Safety Agency
ECP	Engineering change proposal
ECS	Environmental control system
E3	Electromagnetic environmental effects
EHMS	Engine health monitoring systems
EMACC	European Military Airworthiness Certification Criteria
EMAR	European Military Airworthiness Requirements
EMAR 21	Certification of military aircraft and related products, parts and appliances, and design and production organisations
EMI	Electromagnetic interference
EMP	Electromagnetic pulse
EMS	Environmental management system
EPS	Emergency power system
FAA	Federal Aviation Administration
FAR	Federal Acquisition Regulation
FCA	Functional configuration audit

FMECA	Failure modes, effects, and criticality analysis
FMET	Failure modes and effects testing
FOD	Foreign object damage
FRACAS	Failure report and corrective action system
FSCAP	Flight safety critical aircraft part
g	Acceleration or load factor in units of acceleration of gravity
GSE	Ground Support Equipment
HCF	High cycle fatigue
HERF	Hazards of electromagnetic radiation to fuel
HERO	Hazards of electromagnetic radiation to ordnance
HERP	Hazards of electromagnetic radiation on personnel
HUD	Head-up display
ICD	Interface control document
I/O	Input/output
JACG	Joint Aeronautical Commanders Group
JFS	Jet fuel starter
JSSG	Joint Service Specification Guide
LCF	Low cycle fatigue
LEP	Laser eye protection
MAWA	Military Airworthiness Authorities
MSL	Mean sea level
MWL	Maximum wear limit
NATO	North Atlantic Treaty Organization
NBC	Nuclear, biological, and chemical
NDI	Non-destructive inspection
NFPA	National Fire Protection Association
NVIS	Night vision imaging system
OEM	Original Equipment Manufacturer
OFP	Operational flight program
PAD	Pyrotechnic actuated devices
PCA	Physical configuration audit
PDR	Preliminary design review
PFR	Primary flight reference
PIO	Pilot-induced oscillations
PLA	Power lever angle
PLOC	Probability loss of control
POD	Probability of detection
PTO	Power take-off
PVI	Pilot vehicle interface
RAT	Ram air turbine
RF	Radio frequency
RNAV	Radio navigation
RNAV VNAV	area navigation vertical navigation
RNP	Required navigation performance
ROA	Remotely operated aircraft
RVSM	Reduced vertical separation minima
RTO	Refused takeoff
SAE	Society of Automotive Engineers
SAWE	Society of Allied Weight Engineers

SDIMP	Software development integrity master plan
SDP	Software development plan
SFAR	Special Federal Aviation Regulation
SOF	Safety-of-flight
SPM	System program manager
SRS	Software requirements specification
SSHA	Subsystem hazard analysis
STANAG	Standardization agreement
STLDD	Software top-level design document
TBD	To be determined
TEMP	Test and evaluation master plan
TO	Technical order
TSO	Technical standard order
UAS	Unmanned air system
UAV	Unmanned air vehicle
VCF	Vehicle control function
VCMS	Vehicle control and management system
VL/ML	Limit speed

SECTION 4 - SYSTEMS ENGINEERING

This section details the minimum necessary criteria to establish, verify, and maintain an airworthy design. The criteria go beyond pure airworthiness certification, covering best practice with respect to ensuring initial design certification, continuing airworthiness and through life quality management.

Included within the scope of this section are:

- Definition of a robust set of design criteria addressing all aspects of safety, at the system, sub-system and component levels, including coverage of system integration and software aspects;
- The use and validation of design and performance verification analysis tools, prediction methods, models, and/or simulations;
- The process for materials selection and validation of material properties;
- Manufacturing and quality processes and procedures;
- The production and management of the operator maintenance manual;
- Platform design & build standard and configuration control.

The criteria are expected to form part of an over-arching process that has been establish, undertaken and maintained. The process will be selected to suit the specific needs and constraints of the capability, product and/or service, typically EMAR 21.

It is expected that the selected process can be integrated into the companion qualification process.

TYPICAL CERTIFICATION SOURCE DATA

1. Reliability, quality, and manufacturing program plans
2. Contractor policies and procedures
3. Durability and damage tolerance control plans
4. Work instructions
5. Process specifications
6. Production/assembly progress reports
7. Quality records
8. Defect/failure data
9. Failure modes, effects, and criticality analysis (FMECA) documentation
10. Tech data package
11. As-built list to include part numbers/serial numbers for all critical safety items/components
12. List of deviations/waivers and unincorporated design changes
13. List of approved class I engineering change proposals (ECPs)
14. Proposed DD Form 250, Material Inspection and Receiving Report
15. Configuration management plans/process description documents
16. Diminishing Manufacturing Sources Plan
17. Obsolete Parts Plan
18. Test reports
19. Test plans
20. FAA Airworthiness Directives and Advisory Circulars
21. Manufacturer-issued service bulletins
22. Civil aviation authority certification plan
23. Civil aviation authority certification basis
24. Civil aviation authority certification report

25. System Safety Analysis Report

CERTIFICATION CRITERIA

4.1. DESIGN CRITERIA.

4.1.1 The design criteria, including requirements and rules, shall adequately address safety for mission usage, full permissible flight envelope, duty cycle, interfaces, induced and natural environment, inspection capability, and maintenance philosophy.

Consideration should be given to:

a. Defining processes for requirements allocation and design criteria definition/tailoring;

b. Ensuring traceability between design criteria, requirements, solutions and verification/validation activities;

c. High level mission and safety requirements;

d. Extending the design criteria to cover use and impact of (complex) GSE as part of the maintenance philosophy.

e. Requirements to satisfy Extended Range Twin Operations (ETOPS) where appropriate.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Appropriate design criteria paragraphs of JSSG-2000, 2001, 2005, 2006, 2007, 2008, 2009, 2010, and others	*Def-Stan 00-970 Reference:*	00-970 P1 S1 00-970 P1 S2 00-970 P1 S4 00-970 P1 S6 00-970 P1 S7 00-970 P7 S9 L900/1 4 00-970 P7 S9 L906 7.14
		STANAG Reference:	4671.21 4671.45 4671.141 4671.143 4671.251 4671.301 4671.601 4671.611 4671.1309 4671.1529
FAA Doc:	14CFR references: 23.21-23.3, 25.21-25.33	*EASA CS Reference:*	CS 23.21 CS 23.45 CS 23.141 CS 23.143 CS 23.251 CS 23.301 CS 23.601 CS 23.611 CS 23.1309

Information Sources			
			CS 23.1529 CS 25.21 CS 25.101 CS 25.143 CS 25.251 CS 25.301 CS 25.601 CS 25.611 CS 25.1309 CS 25.1529 CS 27.21 CS 27.45 CS 27.141 CS 27.143 CS 27.251 CS 27.301 CS 27.601 CS 27.611 CS 27.1309 CS 27.1529 CS 29.21 CS 29.45 CS 29.141 CS 29.143 CS 29.251 CS 29.301 CS 29.601 CS 29.611 CS 29.1309 CS 29.1529

4.1.2 The design criteria shall address all components, system and subsystem interfaces, and software.

Consideration should be given to:
a. Identification of critical safety items within the design solution;
b. Safety critical functions and functional chains.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Appropriate design criteria paragraphs of JSSG-2000, 2001, 2005, 2006, 2007, 2008, 2009, 2010, and others	*Def-Stan 00-970 Reference:*	00-970 P1 S1 00-970 P1 2.16.19 00-970 P1 3.1.3 00-970 P1 3.10.33-3.10.37 00-970 P1 S4 00-970 P1 S6 00-970 P1 6.5.33-6.5.47
		STANAG Reference:	4671.601 4671.1301

Information Sources			
			4671.1309 4671.1351
FAA Doc:	14CFR references: 23.21, 23.601-23.629, 25.601-25.631	*EASA CS Reference:*	CS 23.601 CS 23.1301 CS 23.1309 CS 23.1351 CS 25.601 CS 25.1301 CS 25.1309 CS 25.1703 CS 25.1705 CS 27.601 CS 27.1301 CS 27.1309 CS 27.1351 CS 29.601 CS 29.1301 CS 29.1309 CS 29.1351

4.1.3 For commercial derivative air vehicles, the air vehicle's certification basis shall address all design criteria appropriate for the planned military usage.

Consideration should be given to:

a. Ensuring the intended military utilisation and flight envelope of the air vehicle are shown to be wholly within the existing commercial certification basis;

b. Identifying any military "delta" conditions and environments over and above those covered by the commercial certification.

c. Requirements to satisfy Extended Range Twin Operations (ETOPS) where appropriate.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Appropriate design criteria paragraphs of JSSG-2000, 2001, 2005, 2006, 2007, 2008, 2009, 2010, and others	*Def-Stan 00-970 Reference:*	The Def Stan 00-970 requirement appropriate to the aircraft and role being considered.
		STANAG Reference:	The STANAG requirement appropriate to the aircraft and role being considered.
FAA Doc:	14CFR references: 23.21, 23.601-23.629, 25.601-25.631	*EASA CS Reference:*	The EASA requirement appropriate to the aircraft and role being considered.

4.1.4 Failure conditions shall be adequately addressed in the design criteria.

Consideration should be given to:

a. Hazard Identification and Analysis;

b. Definitions of operating envelopes, classes of airspace, restrictions and placard limitations.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 1.1.13 00-970 P1 1.1.14 00-970 P1 S4 00-970 P1 S6 Par. 1.1
		STANAG Reference:	4671.572-4671.575 4671.1309
FAA Doc:		*EASA CS Reference:*	CS 23.571-23.575 CS 23.1309 CS 25.571 CS 25.1309 CS 27.571 CS 27.573 CS 27.1309 CS 29.571 CS 29.573 CS 29.1309

4.2. TOOLS AND DATABASES.

4.2.1 All tools, methods, and databases used in the requirements definition/allocation, design, risk control and assessments of safety shall be adequately validated and/or certified.

Consideration should be given to:

a. Ensuring all design and performance verification analysis tools, prediction methods, models, and/or simulations are applied appropriately and exhibit accuracy commensurate with their application.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Appropriate design criteria paragraphs of JSSG-2000, 2001, 2005, 2006, 2007, 2008, 2009, 2010, and others	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	Refer to technical point of contact for this discipline (listed in section A.2)	*EASA CS Reference:*	

4.3. MATERIALS SELECTION.

4.3.1 The material selection process shall use validated and consistent material properties data, including design mechanical and physical properties such as material defects, and corrosion and environmental protection requirements.

Consideration should be given to:

a. The impact of processing (joints, coating, aging) on material properties adequately assessed for intended design.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.307 4671.603 4671.609 4671.613 4671.1123
FAA Doc:	DOT/FAA/AR-MMPDS-01	*EASA CS Reference:*	CS 23.307 CS 23.603 CS 23.609 CS 23.613 CS 23.1123 CS 25.307 CS 25.603 CS 25.609 CS 25.613 CS 25.1123 CS 27.307 CS 27.603 CS 27.609 CS 27.613 CS 27.1123 CS 29.307 CS 29.603 CS 29.609 CS 29.613 CS 29.1123

4.4. MANUFACTURING AND QUALITY.

4.4.1 Key product characteristics for manufacturing shall be identified.

Consideration should be given to:

a. Identifying all critical safety items (CSI).
b. Analysing CSI installations taking account of, for instance: weight bearing requirements, physical space and access, and thermal and other environmental conditions.
c. Recording the key characteristics of those CSIs along with any associated tolerances.
d. Identifying approaches for verification of these characteristics during manufacture, operation and maintenance.

Information Sources			
Comm'l Doc:	ASME Y14.5 "Dimensioning and Tolerancing" AS 9100		00-970 P1 3.1.1 00-970 P1 4.0.1 00-970 P1 4.1.4 00-970 P1 4.3.1

Information Sources			
			00-970 P1 S6
DoD/MIL Doc:	ASC/EN Manufacturing Development Guide, Section 6.5, "Key Characteristics and Processes" AFI 63-501	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.305 4671.601 4671.603 4671.609 4671.1309
FAA Doc:	14CFR reference: 23.601-23.605, 25.601-25.603	*EASA CS Reference:*	CS 23.305 CS 23.601 CS 23.603 CS 23.609 CS 23.1309 CS 25.302 CS 25.305 CS 25.601 CS 25.603 CS 25.609 CS 25.1309 CS 27.305 CS 27.309 CS 27.601 CS 27.602 CS 27.603 CS 27.609 CS 27.1309 CS 29.305 CS 29.309 CS 29.601 CS 29.602 CS 29.603 CS 29.609 CS 29.1309

4.4.2 Key product characteristic requirements shall be ensured by appropriate manufacturing processes.

Consideration should be given to:

a. Listing critical processes and organisations approved to carry them out;
b. Ensuring that approved organisations have sufficient capacity and competency;
c. Utilising an existing organisation approval (e.g. EMAR 21, EASA Part 21).

Information Sources			
Comm'l Doc:	ASME Y14.5 "Dimensioning and Tolerancing" AS 9100		00-970 P1 4.1.8 00-970 P1 4.6.1-4.6.14 00-970 P1 4.7.1-4.7.9
DoD/MIL Doc:	ASC/EN Manufacturing	*Def-Stan 00-970*	

Information Sources			
	Development Guide, Section 6.6, "Variability Reduction," for additional information on Cpk, Critical Processes, and Process Control Plans AFI 63-501	*Reference:*	
		STANAG Reference:	4671.601 4671.605 4671.613 4671.621
FAA Doc:	14CFR references: 23.601-23.605, 25.601-25.603	*EASA CS Reference:*	CS 23.601 CS 23.605 CS 23.613 CS 23.621 CS 25.601 CS 25.605 CS 25.613 CS 25.621 CS 27.601 CS 27.602 CS 27.605 CS 27.613 CS 27.621 CS 29.601 CS 29.602 CS 29.605 CS 29.613 CS 29.621

4.4.3 All critical manufacturing process controls shall exist to assure key product characteristic requirements are met.

Consideration should be given to:

a. The approval granted to the manufacturing facility should be in accordance with EASA CS 21A Sub-part G, or equivalent, and this approval should cover process controls;
b. Non-destructive inspection (NDI) accept/reject criteria

Information Sources			
Comm'l Doc:	ASME Y14.5 "Dimensioning and Tolerancing" AS 9100		00-970 P1 4.1.4 00-970 P1 4.6 00-970 P1 4.7
DoD/MIL Doc:	ASC/EN Manufacturing Development Guide AFI 63-501 Joint Aeronautical Commander's Group's Performance Based Product Definition Guide, Section 5.0, "Performance Based Approach," for additional information on Product Acceptance Criteria.	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.605 4671.613 4671.621

Information Sources			
FAA Doc:	14 CFR references: 23.601-23.605, 25.601-25.603	*EASA CS Reference:*	CS 23.605 CS 23.613 CS 23.621 CS 25.605 CS 25.613 CS 25.621 CS 27.602 CS 27.605 CS 27.613 CS 27.621 CS 29.602 CS 29.605 CS 29.613 CS 29.621

4.4.4 Production allowances and tolerances shall be within acceptable limits and assure conformance to design.

Consideration should be given to:

a. A suitable process is in place to ensure that the 'as-built' configuration matches the 'as designed' configuration.

b. The approval granted to the manufacturing facility should be in accordance with EASA CS 21A Sub-part G, or equivalent, and this approval should assure conformance to design through the application of suitable assurance processes.

Information Sources			
Comm'l Doc:	ASME Y14.5 "Dimensioning and Tolerancing" AS 9100		00-970 P1 2.1.27 00-970 P1 4.1.4 00-970 P1 4.4.54 00-970 P1 4.5.4 00-970 P1 4.4.62 00-970 P1 4.18.4 00-970 P7 L805 7
DoD/MIL Doc:	ASC/EN Manufacturing Development Guide, Section 5, "Quality Systems," and Section 6.6 "Variability Reduction" AFI 63-501 Joint Aeronautical Commander's Group's "Engineering and Manufacturing Practices for Defect Prevention" FAR Part 46, "Quality Assurance"	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.603 4671.605 4671.619 4671.623 4671.625
FAA Doc:	14CFR reference: 23.601-23.605, 25.601-25.603	*EASA CS Reference:*	CS 23.603 CS 23.605 CS 23.619 CS 23.623

Information Sources			
			CS 23.625 CS 25.603 CS 25.605 CS 25.619 CS 25.623 CS 25.625 CS 27.602 CS 27.603 CS 27.605 CS 27.619 CS 27.623 CS 27.625 CS 29.602 CS 29.603 CS 29.605 CS 29.619 CS 29.623 CS 29.625

4.4.5 Line Deleted

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006 Appendix A: A.3.11.6, A.4.11.6	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	Refer to technical point of contact for this discipline (listed in section A.2)	*EASA CS Reference:*	

4.5. OPERATOR'S AND MAINTENANCE MANUALS/TECHNICAL ORDERS.

4.5.1 Processes shall be in place to identify and document all restrictions, warnings, and cautions.

Consideration should be given to:

a. Processes should contain procedures for identifying and documenting all restrictions, warnings, and cautions;

b. Processes should contain procedures for identifying which documents particular restrictions, warnings, and cautions should be recorded in (i.e. aircrew or ground crew manual etc);

c. Processes should be regularly reviewed for applicability and to ensure complete coverage of the air vehicle;

d. Processes should include provision for updating original information as necessary;

e. Reference should be made to Line 16.1.2 - 'Verify that cautions and warnings are included in maintenance manuals, aircrew checklists, and ground crew checklists'.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-38784, Standard Practice for Manuals, Technical: General Style and Format Requirements	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1501 4671.1529 4671.1541 4671.1581 4671.1589 4671 Appendix G
FAA Doc:	14CFR reference: 23.1581, 25.1581, 23.1541, 25.1541	*EASA CS Reference:*	CS 23.1501 CS 23.1529 CS 23.1541 CS 23.1581 CS 23.1589 CS 23 Appendix G CS 25.1501 CS 25.1529 CS 25.1541 CS 25.1581 CS 25.1591 CS 25J.1521 CS 25 Appendix H CS 27.1501 CS 27.1529 CS 27.1541 CS 27.1581 CS 27.1589 CS 27 Appendix A CS 29.1501 CS 29.1529 CS 29.1541 CS 29.1581 CS 29.1589 CS 29 Appendix A

4.5.2 Line Deleted

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-38784, Standard Practice for Manuals, Technical: General Style and Format Requirements.	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	14CFR reference: 23.21, 25.21, 23.601, 25.601, 23.1301, 25.1301	*EASA CS Reference:*	

4.5.3 Procedures shall be in place for establishing and managing flight vehicle integrity.

Consideration should be given to:

a. Structural, propulsion, and systems integrity through-life.
b. Ensuring that the correct mix of specialists is involved from across the maintenance and operational aspects of the platform, and that representation is consistent.
c. The intended usage of the air vehicle

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-515, Weapon System Integrity Guide MIL-STD-1530, Aircraft Structural Integrity Program MIL-HDBK-87244, Avionics/Electronics Integrity JSSG-2001A: 3.3.5.1, 3.3.7.1 JSSG-2009: Appendix I	*Def-Stan 00-970 Reference:*	00-970 Pt 1 3.2.2 00-970 Pt 1 3.2.3 00-970 Pt 1 3.2.21 00-970 Pt 1 3.2.22 00-970 Pt 1 3.2.29
		STANAG Reference:	4671.570 4671.572 4671.573
FAA Doc:		*EASA CS Reference:*	CS 23.571 CS 23.572 CS 23.573 CS 25.302 CS 25.571 CS 27.571 CS 27.573 CS 29.571 CS 29.573

4.6. CONFIGURATION IDENTIFICATION.

4.6.1 The functional baseline shall be properly documented, established, and brought under configuration control.

Consideration should be given to:
a. Methods used to document the functional baseline - requirements capture;
b. Methods used to maintain, and amend as necessary, the functional baseline ensuring that an audit trail is kept of changes;
c. Methods used to establish and maintain configuration control;
d. Methods used to assure configuration control - QA processes.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-961E, Defence and Program Unique Specifications Format and Content, Appendix A MIL-HDBK-61A, Configuration Management, sections 3, and 5.5.1 Configuration Baselines for definitions and purposes of	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	

Information Sources			
	configuration baselines		
FAA Doc:	14CFR reference: 23.21, 25.21, 23.601, 25.601, 23.1301, 25.1301	*EASA CS Reference:*	

4.6.2 The product baseline shall be properly documented, established, and brought under configuration control.

Consideration should be given to:

a. Methods used to document the product baseline - requirements capture;

b. Methods used to maintain, and amend as necessary, the product baseline ensuring that an audit trail is kept of changes;

c. Methods used to establish and maintain configuration control;

d. Methods used to assure configuration control - QA processes.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-961E, Defence and Program Unique Specifications Format and Content, Appendix A MIL-HDBK-61A, Configuration Management, sections 3, and 5.5.1 Configuration Baselines for definitions and purposes of configuration baselines	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	14CFR reference: 23.21, 25.21, 23.601, 25.601, 23.1301, 25.1301	*EASA CS Reference:*	

4.7. CONFIGURATION STATUS ACCOUNTING.

4.7.1 A configuration management system shall have the capability to track the configuration of safety-critical items.

Consideration should be given to:

a. Ensuring that all safety-critical items (including the engine) have been included;

b. Provision of QA checks for system effectiveness;

c. Provision of a clear and unambiguous interface showing when events are due;

d. Ability to demonstrate the history of items included.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-61A, Configuration Management, section 7 Configuration Status Accounting for purpose of CSA, lifecycle considerations, and information to be captured.	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	14CFR reference: 23.21,	*EASA CS*	

Information Sources			
	25.21, 23.601, 25.601, 23.1301, 25.1301	*Reference:*	

SECTION 5 - STRUCTURES

This section covers criteria for the design, installation, arrangement and compatibility of the air vehicle structure.

The air vehicle structure includes the fuselage, wing (fixed or rotating), empennage, structural elements of landing gear, the control system, control surfaces, drive system, rotor systems, radome, antennae, engine mounts, nacelles, pylons, thrust reversers (if not part of the engine), air inlets, aerial refuelling mechanisms, structural operating mechanisms, structural provisions for equipment/payload/cargo/personnel, etc.

TYPICAL CERTIFICATION SOURCE DATA

1. Design criteria
2. Loads analyses
3. Internal load and stress analyses
4. Materials, processes, corrosion prevention, non-destructive evaluation and repair data
5. Results from any design development tests conducted
6. Proof test results
7. Flutter, mechanical stability and aeroservoelastic analyses
8. Loads wind tunnel test data
9. Flutter wind tunnel test data
10. Ground vibration test results
11. Damage tolerance and durability analyses
12. Component/full-scale static and fatigue test results
13. Live fire test results and ballistic analysis
14. Bird strike test and analysis results
15. Arresting wire strike test and analysis results
16. User and maintainer manuals, or equivalent
17. Flight operating limits
18. Strength summary and operating restrictions
19. Damage tolerance and durability test results
20. Full-scale durability test results
21. Functional test results
22. Flight loads test results
23. Instrumentation and calibration test results
24. Control surface, tabs and damper test results
25. Thermoelastic test results
26. Limit-load rigidity test results
27. Flight flutter test results
28. Mass properties control and management plan (interface)
29. Weight and balance reports (interface)
30. Inertia report
31. Design trade studies and analyses
32. Fuel system test results
33. Results of actual weighing
34. Weight and balance handbook, or equivalent
35. Hazard analysis

36. Environmental criteria and test results
37. Vibration and acoustic test results
38. Aircraft tracking program
39. Landing gear and airframe drop test plans and results
40. Mechanical stability test plans and results
41. Whirl test plans and results
42. Tie-down test plans and results
43. Structural description report
44. Tipover and rollover stability analyses
45. External store interface and release data
46. Ground and/or air transport rigging procedures, interface loads, and associated inspection requirements
47. Failure modes, effects, and criticality analysis (FMECA) documentation
48. Ground and rotor blade clearance dimensional data
49. Loss of lubrication testing
50. Heat generation/rejection analysis
51. Airframe and component fatigue analyses and test results
52. Hydraulic and Control System “RAP” test results

CERTIFICATION CRITERIA

5.1. LOADS.

5.1.1 Verify that the limit loads used in the design of the aircraft include the maximum and most critical combinations of loads that can result from authorized ground and flight loading conditions for the air vehicle. These include loads during piloted or autonomous manoeuvres, loss of control manoeuvres, gusts, turbulence, take-off, landing, catapult (if applicable), shipboard and land based arrestments (if applicable), ground operations, maintenance activity, systems failures from which recovery is expected, and loads expected to be seen throughout the specific lifetime of usage.

Typical system failures shall include:
Tyre failures, Propulsion system failures, Radome failures, Mechanical failures, Hydraulic failures, Flight control system failures, Transparency failures, Hung stores and other failures.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.2.9, A.4.2.9	*Def-Stan 00-970 Reference:*	00-970 P1 3.1.2 00-970 P1 3.1.4 00-970 P1 3.1.6 00-970 P1 3.1.16 00-970 P1 3.1.22 00-970 P1 3.2.15 00-970 P1 3.3.2 00-970 P1 3.4.2 00-970 P1 3.5.3 00-970 P1 3.5.5 00-970 P1 3.6.2 00-970 P1 4.1.3

Information Sources			
		STANAG Reference:	4671.143 4671.301 4671.305 4671.321 4671.333 4671.345 4671.361
FAA Doc:	14CFR reference: Section 23.141, 23.301, 23.305, 23.321, 23.333, 23.343, 23.361 ; Section 25.143, 25.301, 25.321, 25.303, 25.331, 25.341, 25.343, 25.349, 25.361 ; Section 27.301, 27.305, 27.321, , 27.341, 27.473 ; Section 29.301, 29.305, 29.321, 29.341, 29.473.	*EASA CS Reference:*	CS 23.143 CS 23.301 CS 23.305 CS 23.321 CS 23.333 CS 23.343 CS 23.361 CS 25.143 CS 25.301 CS 25.303 CS 25.321 CS 25.331 CS 25.341 CS 25.343 CS 25.349 CS 25.361 CS 27.143 CS 27.301 CS 27.305 CS 27.473 CS 29.143 CS 29.301 CS 29.305 CS 29.321 CS 29.473

5.1.2 Ultimate loads used in airframe design shall be obtained through the multiplication of limit loads by prescribed factors of safety.

The factor of safety is not typically lower than 1.5. If a factor of safety is less than 1.5, justification should be agreed with the Certifying Authority.

For crash case conditions, specific ultimate load factors are to be applied allowing a structural design to give each occupant every reasonable chance of escaping serious injury.

The aircraft structure shall be designed so that the ultimate loads do not generate stresses higher than relevant allowable stress values (i.e. rupture).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.2.10,	*Def-Stan 00-970*	00-970 P1 3.1.2

Information Sources			
	3.2.10.1-6, A.4.2.10, Figure 4 & 5 JSSG-2006: Figure 4, pg 459, "Discrete bumps and dips for slow speeds up to 50 knots- single and double excitations". (for standard development) JSSG-2006: Figure 5, pg 460, "Discrete bumps and dips for high speeds above 50 knots- single and double excitations". (for standard development)	*Reference:*	00-970 P1 3.1.4 00-970 P1 3.1.5 00-970 P1 3.1.6 00-970 P1 3.1.11 00-970 P1 3.5.3
		STANAG Reference:	4671.301 4671.303 4671.305 4671.307
FAA Doc:	14CFR reference: Section 23.301, 23.303, 23.305, 23.561 Section 25.301, 25.303, 25.362, 25.561 Section 27.301, 27.303, 27.305, 27.561 Section 29.301, 29.303, 29.305, 29.561	*EASA CS Reference:*	CS 23.301 CS 23.303 CS 23.305 CS 23.561 CS 25.301 CS 25.303 CS 25.362 CS 25.561 CS 27.301 CS 27.303 CS 27.305 CS 27.561 CS 29.301 CS 29.303 CS 29.305 CS 29.561 CS 23.307 CS 25.305 CS 25.307 CS 27.307 CS 29.307

5.1.3 Verify that the limit loads, to be used in the design of elements of the airframe subject to deterministic design criteria, shall be the maximum and most critical combination of loads which can result from authorized ground and flight use of the air vehicle, including maintenance activity and system failures from which recovery is expected.

This requirement defines the load capability that the airframe must possess to achieve adequate structural safety and economic operation. Where such loads are the result of randomly occurring loads, the minimum frequency of occurrence of these loads must be defined. This insures the inclusion of loads which are of sufficient magnitude to size elements of the airframe and whose frequency of occurrence warrants their inclusion. It is typically only necessary to include loads whose frequency of occurrence is greater than or equal to 1 x 10-7 per flight.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	JSSG-2006: A.3.2.11, A.4.2.11	*Def-Stan 00-970 Reference:*	00-970 P1 3.1.10 00-970 P1 3.1.12 00-970 P1 3.2.11 00-970 P1 3.2.12 00-970 P1 3.2.13 00-970 P1 3.2.14
		STANAG Reference:	4671.23 4671.301 4671.307
FAA Doc:	14CFR reference: Section 23.23, 23.301, 23.305, 23.307 ; Section 25.23, 25.301, 25.303, 25.305, 25.307 ; Section 27.301, 27.305, 27.307 ; Section 29.301, 29.305, 29.307	*EASA CS Reference:*	CS 23.23 CS 23.301 CS 23.305 CS 23.307 CS 25.23 CS 25.301 CS 25.303 CS 25.305 CS 25.307 CS 27.301 CS 27.305 CS 27.307 CS 29.301 CS 29.305 CS 29.307

5.1.4 The airframe shall be designed taking account of the loads required under structural impacts such as bird strike, hail, runway, taxiway, ramp debris, propeller and uncontained fan blade impact; uncontained engine failure, uncontained high energy rotating machinery failure and other sources of foreign object damage (FOD), in order to assure the capability of continued safe flight and landing of the aeroplane after collision. The structural airframe load requirements shall be based upon impact object characteristics, parameters and data (such as impact object weight, aircraft altitude and speed), that shall be defined by the appropriate certifying authority.

Two approaches may be followed:

a. The airframe shall be designed in accordance with a statistical assessment of FOD strikes scenarios as follows:

i. FOD environments shall not result in the loss of the air vehicle, or shall not incapacitate the pilot or crew with a frequency compatible with the aircraft safety requirements;

ii. FOD environments shall not cause unacceptable damage to the airframe with a frequency equal to or greater than that allowed by the safety requirements;

b. FOD requirements shall be tailored in accordance with civil airworthiness codes.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.2.24	*Def-Stan 00-970 Reference:*	00-970 P1 3.2.2 00-970 P1 3.2.4 00-970 P1 3.2.9 00-970 P1 3.2.10

Information Sources			
			00-970 P1 4.9.1 00-970 P1 4.9.2 00-970 P1 4.9.3 00-970 P1 4.9.4 00-970 P1 4.9.5 00-970 P1 4.9.6 00-970 P1 4.9.7 00-970 P1 4.9.8 00-970 P1 4.9.9 00-970 P1 4.9.10 00-970 P1 4.9.11 00-970 P1 4.9.12
		STANAG Reference:	4671.609 4671.631 4671.775
FAA Doc:	14CFR reference: Section 23.775 Section 25.631, 25.773, 25.775 Section 27.239 Section 29.631	*EASA CS Reference:*	CS 23.775 CS 25.571 CS 25.631 CS 25.773 CS 25.775 CS 25.875 CS 27.239 CS 29.631

5.1.5 Merged with 5.1.2

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.2.12, A.4.2.12	*Def-Stan 00-970 Reference:*	00-970 P1 3.5.3 00-970 P1 3.1.2 00-970 P1 3.1.4 00-970 P1 3.1.5
		STANAG Reference:	4671.301 4671.303 4671.305 4671.307
FAA Doc:	14CFR reference: Section 23.301, 23.303, 23.305, 23.307 Section 25.301, 25.303, 25.305, 25.307 7 Section 27.301, 27.303, 27.305, 27.307 Section 29.301, 29.303, 29.305, 29.307	*EASA CS Reference:*	CS 23.301 CS 23.303 CS 23.305 CS 23.307 CS 25.301 CS 25.303 CS 25.305 CS 25.307 CS 27.301 CS 27.303 CS 27.305 CS 27.307

Information Sources			
			CS 29.301 CS 29.303 CS 29.305 CS 29.307

5.1.6 All sources of repeated loads and associated frequencies shall be identified and included in the development of the service loads spectra and shall not detract from the airframe service life.

The following operational and maintenance conditions shall typically be included as sources of repeated loads:

• Manoeuvres
• Gusts
• Suppression Systems
• Vibration and Acoustics
• Landings
• Buffeting
• Effects of Pressurisation
• Repeated Operations of Movable Structures
• Stored Loads
• Heat Flux
• Other loads including all ground and transportation loads.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.2.14.3, A.4.2.14	*Def-Stan 00-970 Reference:*	00-970 P1 3.2.11 00-970 P1 3.2.13 00-970 P1 3.2.14
		STANAG Reference:	4671.570 4671.572 4671.573
FAA Doc:	14CFR reference: Section 23.571, 23.572, 23.573, 23.574 ; Section 25.571 ; Section 27.571 ; Section 29.571.	*EASA CS Reference:*	CS 23.571 CS 23.572 CS 23.573 CS 23.574 CS 25.571 CS 27.571 CS 27.573 CS 29.571 CS 29.573

5.1.7 The aircraft airframe shall be designed for the power or thrust of the installed propulsion system. This includes the ground and flight conditions of intended use, including system failures, and the capabilities of the propulsion system and crew. This should also take into account the flight and ground loads, including gyroscopic loads and forces associated with the power or thrust of the installed propulsion system, over all ranges of thrust and torque from zero to maximum.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.2.17, A.4.2.17	*Def-Stan 00-970 Reference:*	00-970 P1 3.1.13

Information Sources			
		STANAG Reference:	4671.321 4671.371
FAA Doc:	14CFR reference: Section 23.371 Section 25.321, 25.371	*EASA CS Reference:*	CS 23.371 CS 25.321 CS 25.371

5.1.8 In the generation of loads, consideration should be given to flight control and automatic control devices, including load alleviation and ride control devices. This shall include all Flight Control and ACS operating modes (operative, inoperative, and transient) and identified system degradations.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.2.18 and A.4.2.18	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.54 00-970 P1 3.10.55 00-970 P1 3.10.56 00-970 P1 3.10.57 00-970 P1 3.10.58 00-970 P1 3.10.59
		STANAG Reference:	4671.141 4671.321 4671.331 4671.337 4671.395 4671.459 4671.683 4671.1329
FAA Doc:	14CFR reference: Section 23.321, 23.331, 23.337, 23.683, 23.1329 ; Section 25.321, 25.331 25.337 25.395, 25.683 25.1329 ; Section 27.141, 27.321, 27.337 27.395, 27.683 27.1329 ; Section 29.141, 29.321, 29.337 29.395, 29.683 29.1329.	*EASA CS Reference:*	CS 23.141 CS 23.321 CS 23.331 CS 23.337 CS 23.395 CS 23.683 CS 23.1329 CS 25.321 CS 25.331 CS 25.337 CS 25.395 CS 25.683 CS 25.1329 CS 27.141 CS 27.321 CS 27.337 CS 27.395 CS 27.1329 CS 29.141 CS 29.321 CS 29.337 CS 29.395

Information Sources			
			CS 29.683 CS 29.1329

5.1.9 Flight loading conditions shall reflect all flight operations including but not limited to symmetric, asymmetric, directional and evasive manoeuvres, turbulence, aerial refuelling and delivery, speed and lift control, braking wheels in air, extension and retraction of landing gear, pressurisation, aero elastic deformation effects and dynamic response during flight operations.

Symmetric and asymmetric flight operations shall include symmetric and asymmetric fuel and payload loadings as well as adverse trim conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.4.1, A.3.4.1.1-15 JSSG-2006: Power Spectrum Equation on pg 264 under A.3.4.1.6 (for standard development) JSSG-2006: Table XI “Turbulence Field Parameters,” pg 441 (for standard development)	*Def-Stan 00-970 Reference:*	00-970 P1 3.1.2 00-970 P1 3.1.16 00-970 P1 3.1.29 00-970 P1 4.20.18 00-970 P1 4.20.19
		STANAG Reference:	4671.321 4671.331
FAA Doc:	14CFR reference: Section 23.321, 23.331 ; Section 25.301, 25.321, 25.331 ; Section 27.321 ; Section 29.321.	*EASA CS Reference:*	CS 23.321 CS 23.331 CS 25.301 CS 25.321 CS 25.331 CS 27.321 CS 29.321

5.1.10 Ground loads (static and dynamic) are considered to be external loads and inertia forces that act upon an aeroplane structure. Of the many ground load conditions that exist, which include but are not limited to Taxiing, Turns, Pivoting, Braking, Takeoffs, Landings, ground/embarked operations, ski equipped air vehicles manoeuvres, maintenance and such uncontrollable effects as ground winds, crashes and uncontrolled ditching, each specified ground load condition and it's external reactions must be placed in equilibrium with the linear and angular inertia forces present.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.4.2, 3.4.2.1-11, 3.4.2.12 and 15, 4.4.2	*Def-Stan 00-970 Reference:*	00-970 P1 3.11.2 00-970 P1 3.1.13 00-970 P1 4.20.17
		STANAG Reference:	4671.301 4671.471 4671.473 4671.497 4671.499 4671.511
FAA Doc:	14CFR reference:	*EASA CS*	CS 23.471

Information Sources			
	Section 23.471, 23.473, 23.497, 23.499, 23.505, 23.511 ; Section 23.511, 25.471, 25.473, 25.489, 25.511, 25.519 ; Section 27.471, 27.473, 27.497, 27.501, 27.549 ; Section 29.473, 29.481, 29.497, 29.501, 29.511.	*Reference:*	CS 23.473 CS 23.497 CS 23.499 CS 23.505 CS 23.511 CS 25.471 CS 25.473 CS 25.489 CS 25.511 CS 25.519 CS 27.471 CS 27.473 CS 27.497 CS 27.501 CS 27.549 CS 29.471 CS 29.473 CS 29.481 CS 29.497 CS 29.501 CS 29.511

5.1.11 the airframe, although it may be damaged in emergency landing conditions on land or water, shall be designed to protect personnel during crash landings.

The intent of this requirement is to establish crash load factors for structural requirements of airframe installations and backup structures required to protect personnel during crash landings.

The airframe should provide a protective shell surrounding the personnel, and should minimise the loads experienced by personnel so that (hopefully) they will be less than human tolerance limits. Mass items are to be supported in such a manner so as to prevent lethal or injurious blows to personnel.

Consideration should be given to:
a. Seat installations;
b. Fuel tanks and installations;
c. Fixed and removable equipment;
d. Cargo;
e. Litters;
f. Bunks.

The airframe shall also not inhibit personnel egress from an airframe.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	ADS-36 (Army use) JSSG-2006: A.3.4.2.11, Table XIV, “Seat Crash Load Factors,” pg 443 (for standard	*Def-Stan 00-970 Reference:*	00-970 P1 3.1.13 00-970 P1 4.22.2 00-970 P1 4.22.6 00-970 P1 4.22.8

Information Sources			
	development) 32		00-970 P1 4.22.11 00-970 P1 4.22.23 00-970 P1 4.22.26 00-970 P1 4.22.27 00-970 P1 4.22.28 00-970 P1 4.22.51 00-970 P1 4.22 53
		STANAG Reference:	4671.301
FAA Doc:	14CFR reference: Section 23.471, 23.473, 23.497, 23.499, 23.505, 23.511; Section 23.511, 25.471, 25.473, 25.489, 25.511, 25.519; Section 27.471, 27.473, 27.497, 27.501, 27.549;	*EASA CS Reference:*	CS 23.561 CS 23.562 CS 25.561 CS 25.562 CS 27.561 CS 27.562 CS 29.561 CS 29.562

5.2. STRUCTURAL DYNAMICS.

5.2.1 Verify that the air vehicle, in all configurations including store carriage and system failures, is free from flutter, whirl flutter, divergence, and other related aeroelastic or aeroservoelastic instabilities, including transonic aeroelastic instabilities at any point within the flight envelope enlarged at all points by an airspeed margin of safety.

Also, verify that all aerodynamic surfaces and components of the air vehicle are free from aeroelastic divergence and that the inlet, transparency, and other aerodynamically loaded panels are designed to prevent flutter and limited amplitude oscillations when exposed to high transonic or supersonic flow.

Adequate tolerances shall be established for quantities which affect flutter; including speed, damping, mass balance and control system stiffness.
The aeroservoelastic model shall be validated by tests or other approved methods to be agreed with the authority.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.1.2, A.3.7.1, A.3.7.1.2, A.3.7.1.4, A.3.7.1.5, A.3.7.1.6, A.3.7.1.7, A.3.7.2, A.3.7.3, A.3.3.9, A.4.3.9, A.4.7	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.98 00-970 P1 3.10.99 00-970 P1 4.8.4 00-970 P1 4.8.10
		STANAG Reference:	4671.629 4671.1329
FAA Doc:	14CFR reference: Section 23.409, 23.629, 23.677, 23.687; Section25.409, 25.629, 25.677; Section 27.687;	*EASA CS Reference:*	CS 23.409 CS 23.629 CS 23.677 CS 23.687 CS 25.409

Information Sources			
	Section 29.687.		CS 25.629 CS 25.677 CS 27.687 CS 29.687

5.2.2 Air vehicle components which are exposed to the airstream shall be designed to prevent any aeroelastic instability.

All control surfaces and tabs shall be designed for the most severe combination of airspeed and tab deflection likely to be obtained within the flight envelope for any usable loading condition.

Tab controls must be irreversible unless the tab is properly balanced and has no unsafe flutter characteristics.

All control surfaces and tabs shall contain sufficient static and dynamic mass balance, or sufficient bending, torsional, and rotational rigidity; or a combination of these means to prevent flutter; or limited-amplitude instabilities of all critical modes under all flight conditions for normal and failure operating conditions of the actuating systems.

In addition, interactions of air vehicle systems, such as the control systems coupling with the airframe, shall be controlled to prevent the occurrence of any aeroservoelastic instability.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.7.1.1, A.3.7.1.3, A.3.7.1.8, A.3.7.2, A.3.7.3, A.3.7.4, A.3.7.5, A.4.7, A.4.7.5	*Def-Stan 00-970 Reference:*	00-970 P1 3.9.42 00-970 P1 3.9.43 00-970 P1 3.9.44 00-970 P1 3.10.98 00-970 P1 3.10.99
		STANAG Reference:	4671.409 4671.677 4671.687
FAA Doc:	14CFR reference: Section 23.409, 23.677, 23.687; Section 25.409, 25.677; Section 27.687; Section 29.687.	*EASA CS Reference:*	CS 23.409 CS 23.677 CS 23.687 CS 25.409 CS 25.651 CS 25.677 CS 27.629 CS 27.687 CS 29.629 CS 29.687

5.2.3 The airframe structure (including cavities), equipment, and equipment provisions shall withstand the aeroacoustic loads and the vibrations induced by aeroacoustic loads (including acoustic fatigue) for the defined service life and usage of the aircraft without cracking or functional impairment.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	JSSG-2006: A.3.5.1, A.4.5.1	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.251 4671.570
FAA Doc:	14CFR reference: Section 23.25; Section 25.251; Section 25.251, 27.771; Section 29.251, 29.771	*EASA CS Reference:*	CS 23.251 CS 25.251 CS 25.771 CS 27.251 CS 27.771 CS 29.251 CS 29.771

5.2.4 Moved to 9.4.6

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.5.2, A.4.5.2	*Def-Stan 00-970 Reference:*	00-970 5.2.4 00-970 P1 4.15.78 00-970 P1 4.15.79 00-970 P1 4.24.30 00-970 P1 4.26.76 00-970 P1 4.26.80
		STANAG Reference:	4671.1703
FAA Doc:		*EASA CS Reference:*	CS 23.853 CS 23.1431 CS 25.771 CS 25.856 CS 27.771 CS 29.771 CS 29.853

5.2.5 The airframe shall be designed such that the structure and components withstand the vibrations resulting from all vibration sources for the defined service life and usage of the aircraft.

Typical sources of vibration to which the airframe may be exposed are listed below.

a. Forces and moments transmitted to the aircraft structure mechanically or aerodynamically from the propulsion systems, secondary power sources, propellers, jet effluxes and aerodynamic wakes, downwashes and vortices (including those from protuberances, speed brakes, wings, flaps, etc.) and cavity resonances;

b. Forces from gun recoil or gun blast;

c. Buffeting forces;

d. Unbalances, both residual and inherent, of rotating components such as propellers, and rotating components of engines;

e. Forces from store and cargo carriage and ejection;

f. Forces due to operation from airfields and ships;

g. Structural response due to gusts.

There shall be no vibration or buffeting severe enough to result in structural damage, fatigue cracking or excessive vibration of the airframe structure or components, under any appropriate speed and power conditions within the flight envelope.

Excessive vibrations are those structural displacements which result in components of the air vehicle systems not being fully functional.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.5.1 - A3.5.2, A.4.6.2	*Def-Stan 00-970 Reference:*	00-970 P1 4.8.2 00-970 P1 4.8.3 00-970 P1 4.8.5 00-970 P1 4.8.10 00-970 P1 4.8.11 00-970 P1 4.8.12
		STANAG Reference:	4671.251 4671.570 4671.572 4671.573 4671.629 4671.963
FAA Doc:	14CFR reference: Section 23.251, 23.629, 23.963; Section 25.251, 25.305, 25.683, 25.963; Section 27.251, 27.659; Section 29.251, 29.659.	*EASA CS Reference:*	CS 23.251 CS 23.629 CS 23.963 CS 25.251 CS 25.305 CS 25.683 CS 25.875 CS 25.963 CS 27.251 CS 27.659 CS 29.251 CS 29.659

5.2.6 Verify that equipment and structure behind and near vents and louvers are designed for the effects of flow through the vents and louvers during conditions of normal and reverse flows.

Hot gases from auxiliary power units as well as from propulsion systems may be drawn into the airframe through vents and louvers under some conditions thus damaging equipment and structure. If necessary to maintain their required usefulness, equipment and structure behind and near vents and louvers shall be designed for the effects of flow through the vents and louvers during conditions of normal and reverse flows. Thermal, sand abrasion, rain, ice and other foreign object damage effects are to be covered.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.3.8	*Def-Stan 00-970 Reference:*	00-970 P1 4.3.2 00-970 P1 4.3.8 00-970 P1 4.3.85 00-970 P1 4.24.9

Information Sources			
			00-970 P1 4.24.32 00-970 P1 4.24.35
		STANAG Reference:	4671.365 4671.609
FAA Doc:	14CFR reference: Section 23.365, 23.609, 23.831, 23.859; Section 25.365, 25.609, 25.831, 25.859; Section 27.609, 27.831, 27.859; Section 29.609, 29.831, 29.859.	*EASA CS Reference:*	CS 23.365 CS 23.609 CS 23.831 CS 23.859 CS 25.365 CS 25.609 CS 25.831 CS 25.859 CS 27.609 CS 27.831 CS 27.859 CS 29.609 CS 29.831 CS 29.859

5.3. STRENGTH.

5.3.1 The airframe structure must be able to support p x limit loads (proof loads) without detrimental, permanent deformation. At any load up to proof loads, the deformation may not interfere with safe operation if the aircraft. The ratio p is typically defined between 100% and 115% as to be agreed by the Certifying Authority.

The airframe structure must be able to support ultimate loads without failure for at least three seconds, except local failures or structural instabilities between limit and ultimate load are acceptable only if the structure can sustain the required ultimate load for at least three seconds.

Verification of sufficient strength is required for operations, maintenance functions, occurrences of system failures, and any tests that simulate load conditions, including modifications, new or revised equipment installations, major repairs, extensive reworks, extensive refurbishment, or remanufacture.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.2.13, A.3.10.5, A.3.10.9, A.3.10.10 (for standard development); A.4.10.5, A.4.10.5.1, A.4.10.5.2, A.4.10.9, A.4.10.10 (for compliance development)	*Def-Stan 00-970 Reference:*	00-970 P1 3.1.1 00-970 P1 3.1.4 00-970 P1 3.1.8 00-970 P1 3.1.8a 00-970 P1 3.1.10 00-970 P1 3.1.11 00-970 P1 3.1.14 00-970 P1 3.1.22 00-970 P1 3.1.27 00-970 P1 3.2.2 00-970 P1 3.2.4 00-970 P1 3.2.11

Information Sources			
			00-970 P1 3.2.13 00-970 P1 3.2.57 00-970 P1 3.7.43 00-970 P1 4.1.6 00-970 P1 4.1.41 00-970 P1 4.4.35 00-970 P1 4.4.37
		STANAG Reference:	4671.305 4671.307 4671.321 4671.570 4671.572 4671.573 4671.575 4671.603 4671.613 4671.629 4671.681
FAA Doc:	14CFR reference: Section 23.305, 23.307, 23.573, 23.575, 23.603, 23.613, 23.629, 23.681 ; Section 25.305, 25.307, 25.571, 25.603, 25.613, 25.629, 25.681 ; Section 27.305, 27.307, 27.309, 27.603, 27.613 ; Section 29.305, 29.307, 29.309, 29.571, 29.603, 29.613 ;	*EASA CS Reference:*	CS 23.305 CS 23.307 CS 23.573 CS 23.575 CS 23.603 CS 23.613 CS 23.629 CS 23.681 CS 25.305 CS 25.307 CS 25.603 CS 25.613 CS 25.629 CS 25.681 CS 27.305 CS 27.307 CS 27.309 CS 27.603 CS 27.613 CS 29.305 CS 29.307 CS 29.309 CS 29.603 CS 29.613

5.3.2 Materials selection for use within the airframe structure shall be selected taking into account the criticality of the application within the airframe structure and the limits of the material properties. Appropriate selection will take into account, fabrication processes, repair techniques, environmental changes and the variability of materials through established fabrication and processes, and verification of suitability shall be demonstrated through appropriate testing, verification and analyses.

The allowable structural properties shall include all applicable statistical variability and environmental effects, such as exposure to climatic conditions of moisture and temperature; exposure to corrosive and corrosion causing environments; airborne or spilled chemical warfare agents; and maintenance induced environments commensurate with the usage of the airframe. Specific material requirements are:
a. Where applicable, average values of crack growth data (da/dN) should be used in the crack growth analysis;
b. Where applicable, minimum values of fracture toughness should be used for residual strength analysis;
c. "A" basis design allowables should be used in the design of all critical parts. "A" basis design allowables should also be used in the design of structure not tested to ultimate load in full scale airframe static testing. "B" basis design allowables may be used for all other structure.

The processes used to prepare and form the materials for use in the airframe as well as joining methods shall be commensurate with the material application. Further, the processes and joining methods shall not contribute to unacceptable degradation of the properties of the materials when the airframe is exposed to operational usage and support environments.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1568 MIL-HDBK-1587 JSSG-2006: A.3.2.19, A.3.2.19.1, A.3.2.19.2 (for standard development) JSSG-2006: A.4.2.19, A.4.2.19.1, A.4.2.19.2 (for compliance development)	*Def-Stan 00-970 Reference:*	00-970 P1 3.2.8 00-970 P1 3.2.9 00-970 P1 3.2.10 00-970 P1 3.2.42 00-970 P1 4.1.2 00-970 P1 4.1.4 00-970 P1 4.1.13 00-970 P1 4.1.14 00-970 P1 4.5.2 00-970 P1 4.5.4 00-970 P1 4.6.2 00-970 P1 4.7.6
		STANAG Reference:	4671.573 4671.603 4671.605 4671.613 4671.625
FAA Doc:	14CFR reference: Section 23.573, 23.603, 23.605, 23.625 ; Section 25.573, 25.603, 25.605, 25.625 ; Section 27.573, 27.603, 27.605, 27.625 ; Section 29.573, 29.603, 29.605, 29.625 .	*EASA CS Reference:*	CS 23.573 CS 23.603 CS 23.605 CS 23.613 CS 23.625 CS 25.307 CS 25.603 CS 25.605 CS 25.613 CS 25.625 CS 27.603 CS 27.605 CS 27.613 CS 27.625

Information Sources			
			CS 29.603 CS 29.605 CS 29.613 CS 27.625

5.3.3 Appropriate use of nominal data, design and material selection shall ensure required stresses, strain and structural strength within airframe component members. The airframe structure must be able to provide sufficient static strength for reacting all loading conditions loads without degrading the structural performance capability of the airframe. Sufficient strength shall be provided for operations, maintenance functions, and any tests that simulate load conditions.

Consideration should be given to the following aspects (typical values are provided):

a. All structure are designed to nominal dimensional values or 110 percent of minimum values, whichever is less;

b. The determination of margins of safety is based on the allowable of §5.3.2;

c. Thermal stresses and strains are determined for structures that experience significant heating or cooling whenever expansion or contraction limited by external or internal constraints. Thermal stresses and strains are combined with concurrent stresses produced by other load sources in a conservative manner;

d. In laminated composites, the stresses and ply orientation are compatible and residual stresses of manufacturing are accounted for, particularly if the stacking sequence is not symmetrical;

e. For each fitting and attachment whose strengths are not proven by limit and ultimate load tests in which actual stress conditions are simulated in the fitting and surrounding structure, the design stress values are increased in magnitude by multiplying these loads or stress values by a fitting factor. The fitting factor is 1.15 for all bolted and welded joints and for structure immediately adjacent to the joints. A fitting factor does not have to be used for continuous lines of rivets installed in sheet-metal joints;

f. The design stress values for bolted joints with clearance (free fit) that are subjected to relative rotation under limit load or shock and vibration loads, are increased in magnitude by multiplying by a 2.0 bearing factor times the stress values. This bearing factor does not have to be multiplied by the fitting factor;

g. Structural doors and panels as well as access doors and components with one or more quick-opening latches or fasteners do not fail, open, vibrate, flap or flutter in flight. The most critical combinations of latches or fasteners are designed for left unsecure;

h. Castings are classified and inspected, and all castings conform to applicable process requirements. A casting factor of 1.33 is used. The factors, tests and inspections of this section are applied in addition to those necessary to establish foundry quality control. The use of castings or C/Hipped parts for primary or critical applications and/or castings with a casting factor less than 1.33, have successfully completed a developmental and qualification program. These castings meet the analytical requirements without a casting factor and meet the service life requirements for both crack initiation and crack growth for flaws representative of the casting and manufacturing process;

i. Due to the nature of some structural designs or materials, high variability may be encountered around the nominal design. Such design features must have a minimum level of structural integrity at the acceptable extremes of dimensions, tolerances, material properties, processing windows, processing controls, end or edge fixities, eccentricities, fastener flexibility, fit up stresses, environments, manufacturing processes, etc. In addition to meeting the standard strength requirements, the structure must have no detrimental deformation of the maximum once per lifetime load and no structural failure at 125 percent of design limit load for the critical combinations of the acceptable extremes.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.3.1.1,	*Def-Stan 00-970*	00-970 P1 3.1.3

Information Sources			
	A.3.10.4, A.3.10.4.1, A.3.10.4.2, A.3.10.4.3, A.3.10.4.4, A.3.10.5 (for standard development) JSSG-2006: A.4.10.4, A.4.10.4.1, A.4.10.4.2, A.4.10.4.3, A.4.10.4.4 (for compliance development)	*Reference:*	00-970 P1 3.1.4 00-970 P1 3.1.7 00-970 P1 3.1.8 00-970 P1 3.1.8a 00-970 P1 3.1.9 00-970 P1 3.4.15 00-970 P1 4.3.85 00-970 P1 4.3.86 00-970 P1 4.6.10 00-970 P1 4.7.4 00-970 P1 4.7.5 00-970 P1 4.7.6
		STANAG Reference:	4671.301 4671.321 4671.607 4671.613 4671.621 4671.623 4671.625 4671.627 4671.783
FAA Doc:	14CFR reference: Section 23.301, 23.607, 23.613, 23.621, 23.625, 23.627, 23.783 ; Section 25.301, 25.607, 25.613, 25.621, 25.625, 25.783 ; Section 27.25, 27.301, 27.607, 27.613, 27.621 ; Section 29.25, 29.301, 29.607, 29.613, 29.621, 29.783.	*EASA CS Reference:*	CS 23.301 CS 23.607 CS 23.613 CS 23.621 CS 23.623 CS 23.625 CS 23.627 CS 23.783 CS 25.301 CS 25.607 CS 25.613 CS 25.621 CS 25.623 CS 25.625 CS 25.783 CS 27.25 CS 27.301 CS 27.573 CS 27.607 CS 27.613 CS 27.621 CS 27.623 CS 29.25 CS 29.301 CS 29.573 CS 29.607 CS 29.613 CS 29.621

Information Sources			
			CS 29.623 CS 29.783

5.4. DAMAGE TOLERANCE AND DURABILITY (FATIGUE).

5.4.1 The airframe structure and associated components, whose failure would be catastrophic, must be shown by analysis supported by test evidence and, if available, service experience, to meet the fatigue requirements of a damage tolerant or, if not applicable a safe life design methodology over the design service life of the aircraft. The fatigue evaluation must include the requirements of subparagraph a., b., and c. and also must include a determination of the probable locations and modes of damage caused by fatigue, considering environmental effects, intrinsic/discrete flaws, or accidental damage.

a. The airframe shall have adequate (as defined by the type of aircraft and application) residual strength in the presence of flaws for the period of service usage before they are detected.
b. The damage tolerance evaluation must include a determination of the probable locations and modes of damage due to fatigue, corrosion, or accidental damage. Damage at multiple sites due to fatigue must be included where the design is such that this type of damage can be expected to occur. The evaluation must incorporate repeated load and static analyses supported by test evidence. The extent of damage for residual strength evaluation at any time within the operational life of the aeroplane must be consistent with the initial detectability and subsequent growth under repeated loads.
c. Replacement time evaluation and/or inspection interval. It must be shown that the probability of catastrophic fatigue failure provides an acceptable level of safety, as defined by the relevant authority, within a replacement time or inspection interval as specified within the relevant continued airworthiness documentation.

Based on the evaluations required by this paragraph, established as necessary to avoid catastrophic failure, inspections, replacement times, combinations thereof, or other procedures must be included in the relevant airworthiness limitations section of the appropriate continued airworthiness documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.12 Damage Tolerance, pg 398 JSSG-2006: A.4.12 Damage Tolerance, pg 400 (for compliance development)	*Def-Stan 00-970 Reference:*	00-970 P1 3.2.2 00-970 P1 3.2.3 00-970 P1 3.2.8 00-970 P1 3.2.9 00-970 P1 3.2.10 00-970 P1 3.2.11 00-970 P1 3.2.12 00-970 P1 3.2.13
		STANAG Reference:	4671.305 4671.570 4671.572 4671.573 4671.575
FAA Doc:	14CFR reference: 23.571, 23.572, 23.573; 25.571; 27.571; 29.571.	*EASA CS Reference:*	CS 23.571 CS 23.572 CS 23.573 CS 23.575 CS 25.571

Information Sources			
			CS 27.571 CS 27.573 CS 29.571 CS 29.573

5.4.2 The durability capability of the airframe shall be adequate to resist fatigue cracking, corrosion, thermal degradation, delamination, and wear during operation and maintenance such that the operational and maintenance capability of the airframe is not degraded and the service life and usage conditions are not adversely affected. These requirements apply to metallic and non-metallic structures, including composites, with appropriate distinctions and variations as indicated. Durability material properties shall be consistent and congruent with those properties of the same material, in the same component, used by the other structures disciplines.

Consideration should be given to:

a. Fatigue cracking/delamination damage.

For one lifetime when the airframe is subjected to the environment and service usage, except where it is desired to meet special life provisions, the airframe shall be free of cracking, delaminations, disbonds, deformations, or defects which:

i. Require repair, replacement, inspection to maintain structural integrity, or undue inspection burden for ship based aircraft.

ii. Cause interference with the mechanical operation of the aircraft.

iii. Affect the aircraft aerodynamic characteristics.

iv. Cause functional impairment.

v. Result in sustained growth of cracks/delaminations resulting from steady-state level flight or ground handling conditions.

vi. Result in water intrusion.

vii. Result in visible damage from a single impact.

b. Corrosion prevention and control.

i. The airframe shall operate in corrosion producing environments.

ii. Corrosion (including pitting, stress corrosion cracking, crevice, galvanic, filiform, and exfoliation) which affects the operational readiness of the airframe through initiation of flaws which are unacceptable from a durability, damage tolerance, and residual strength viewpoint shall not occur during the defined service life and usage for the aircraft.

iii. Corrosion prevention systems shall remain effective during the service life and usage of the aircraft in defined chemical, thermal and climatic environments.

iv. Specific corrosion prevention and control measures, procedures and processes must be identified and established commensurate with the operational and maintenance capability required of the airframe.

c. Thermal protection assurance.

Thermal protection systems shall remain effective during the service life and usage the aircraft in defined chemical, thermal and climatic environments.

d. Wear and erosion.

The function of structural components, elements, and major bearing surfaces shall not be degraded by wear during the service life and usage of the aircraft.

The criteria applies to the following typical components:

i. Structural surfaces which move

ii. Structural and maintenance access panels and other removable parts

iii. Doors and ramps

iv. Other structure

v. Leading edges

vi. Radomes
vii. Housings
viii. Other protrusions

e. Special life requirement structure.

The following structural components shall comply with special life requirements:
i. Limited life structure
ii. Extra life structure.

f. Non-destructive testing and inspection (NDI).

NDI shall be utilized during the design, development, production, and deployment phases of the program to assure that the system is produced and maintained with sufficient structural integrity to meet performance requirements. Other requirements apply as appropriate.

The methods of fabrication used must produce a consistently sound structure. If a fabrication process (such as gluing, spot welding, or heat treating) requires close control to reach this objective, the process must be performed under an approved process specification. In addition, each new aircraft fabrication method must be substantiated by a test programme.

To ensure sufficient durability over the useful operating life of the aircraft, protective measures should be applied to the materials and structure, particular with respect to environmental degradation, corrosion and abrasion.

The variability of material properties (including hazardous materials) and fabrication processes shall be considered for when determining the durability capability of the airframe structure, ensuring that the workmanship employed is of a high standard and that reference is made to the relevant specifications and design data. Consistent material properties at the fabrication process stage will ensure that variability between materials, structures and components is reduced.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.11 Durability, pg 378 JSSG-2006: A.4.11 Durability, pg 379 (for compliance development)	*Def-Stan 00-970 Reference:*	00-970 P1 3.2.4 00-970 P1 3.2.5 00-970 P1 3.2.7 00-970 P1 3.2.8 00-970 P1 3.2.9 00-970 P1 3.2.10 00-970 P1 3.10.55
		STANAG Reference:	4671.572 4671.573 4671.603 4671.609
FAA Doc:	14CFR reference: Section 23.573, 23.603, 23.609 ; Section 25.603, 25.609 ; Section 27.603, 27.609 ; Section 29.603, 29.609.	*EASA CS Reference:*	CS 23.573 CS 23.603 CS 23.609 CS 25.603 CS 25.609 CS 27.573 CS 27.603 CS 27.609 CS 29.573 CS 29.603

Information Sources			
			CS 29.609

5.4.3 A Durability Control Program shall be established for the aircraft structure. This program shall identify and define all the tasks necessary to ensure compliance with the durability requirements (including damage tolerance). The disciplines of fracture mechanics, fatigue, materials and processes selection, environmental protection, corrosion prevention and control, design, manufacturing, quality control, non-destructive inspection, and probabilistic methods shall be considered when the durability (including damage tolerance) control processes are developed. This program shall include the requirement to perform durability (including damage tolerance) design concept, material, weight, performance, and cost trade studies early during the aircraft's design so as to obtain structurally-efficient and cost-effective designs.

This program shall also include the definition of means for tracking each individual aircraft fatigue consumption and crack growth life, as well as the definition of a suitable inspection program to be included in the instructions for continued airworthiness.

The durability (including damage tolerance) control process should include as a minimum the following tasks:

a. A disciplined procedure for durability design should be implemented to minimise the possibility of incorporating adverse residual stresses, local design details, materials, processing, and fabrication practices into the problems (i.e., to find these problems which otherwise have historically been found during durability testing or early in service usage).

b. Basic data (i.e., initial quality distribution, fatigue allowables, KIC, KC, KISCC, da/dn, etc.) utilized in the initial trade studies and the final design and analyses should be obtained from existing sources or developed as part of the contract.

c. A criteria for identifying and tracing maintenance critical parts should be established by the contractor and should require approval by the procuring agency. It is envisioned that maintenance critical parts will be expensive, non-economical-to-replace parts. A maintenance critical parts list should be established by the contractor and should be kept current as the design of the airframe progresses.

d. A criteria for identifying and tracing fatigue/fracture critical parts should be established by the contractor and should require approval by the procuring agency. It is envisioned that fatigue/fracture critical parts will be expensive or safety of flight structural parts. A fatigue/fracture critical parts list should be established by the contractor and should be kept current as the design of the airframe progresses.

e. Design drawings for the maintenance critical parts and fatigue/fracture critical parts should identify critical locations, special processing (e.g., shot peenings), and inspection requirements.

f. Material procurement and manufacturing process specifications should be developed and updated as necessary to ensure that initial quality and fracture toughness properties of the critical parts exceed the design value.

g. Experimental determination sufficient to estimate initial quality by microscopic or fractographic examination should be required for those structural areas where cracks occur during full scale durability testing.

h. Durability analyses, corrosion cracking assessment, damage tolerance analyses, development testing, and full scale testing should be performed in accordance with this specification.

i. Complete non-destructive inspection requirements, process control requirements, and quality control requirements for maintenance, fatigue/fracture critical parts should be established by the contractor and should require approval by the procuring agency. This task should include the proposed plan for certifying and monitoring subcontractor, vendor, and supplier controls.

j. The durability and damage tolerance control process should include any special non-destructive inspection demonstration programs conducted in accordance with the requirements of this specification.

k. Traceability requirements should be defined and imposed by the contractor on those fatigue and fracture critical parts that receive prime contractor or subcontractor in-house processing and fabrication operations which could degrade the design material properties.

l. For all fracture critical parts that are designed for a degree of inspectability other than in-service non-inspectable, the contractor should define the necessary inspection procedures for field use for each appropriate degree of inspectability as specified in the specification. Consideration should be given to Individual Aircraft Tracking task.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-6870 for guidance in the development of Non-destructive Inspection procedures. JSSG-2006: A.3.13, pg 417 JSSG-2006: A.4.13, pg 419 (for compliance development) MIL-HDBK-1568 MIL-STD-1530C	*Def-Stan 00-970 Reference:*	00-970 P1 3.2.6 00-970 P1 3.2.7 00-970 P1 3.2.13
		STANAG Reference:	4671.573 4671.575
FAA Doc:	14CFR reference: Section 23.575; Section 25.571; Section 27.571; Section 29.571.	*EASA CS Reference:*	CS 23.575 CS 25.571 CS 27.571 CS 27.573 CS 29.571 CS 29.573

5.4.4 Throughout the service life of the aircraft, corrosion prevention measures shall be provided against deterioration or loss of strength in materials by providing resistance and protection from any effects of environmental degradation.

Evaluations into material strength, detailed design and fabrication shall show that all forms of corrosion, including and not limited to pitting, stress corrosion cracking, crevice, galvanic, filiform, and exfoliation will not result in catastrophic failure to the aircraft.

Protective finishes applied to materials and structure, including the appropriate selection of materials against deterioration or loss of strength, along with applicable processes, procedure and control methods shall be commensurate within the operational and maintenance philosophy applied to the aircraft during service life and should be recorded within the relevant Airworthiness Limitations section of the Continued Airworthiness documentation.

An Environmental Protection Control Plan shall be prepared consistent with the design service life defining corrosion prevention and control requirements and all the measures that minimise the potential for environmental degradation (including corrosion) throughout the structure. The plan shall take into account at least the following:

a. An evaluation of the susceptibility of the aircraft structure to environmental degradation (including corrosion) shall be conducted identifying locations where the structure might be susceptible to environmental degradation (including corrosion) and the expected type(s) of degradation and corrosion (e.g., exfoliation, uniform, crevice, intergranular, and stress-corrosion cracking, etc.) that could occur at these locations. To identify potential environmental degradation and corrosion damage locations, the evaluation shall account for the materials, manufacturing processes, corrosion prevention systems (e.g. coatings, sealants, etc.), preventative maintenance approaches (e.g., hangaring, wash cycles, wash fluids, etc.), the inspectability of the location, and structural fabrication techniques as well as the expected operational environments to which the aircraft are subjected.

b. The criteria for the selection of corrosion resistant materials and their subsequent treatments shall be defined.

c. Organic and inorganic coatings for all airframe structural components and parts, and their associated selection criteria shall be defined.

d. Procedures for requiring drawings to be reviewed by and signed off by materials and processes personnel shall be defined.

e. Finishes for the airframe shall be defined. General guidelines shall be included for selection of finishes in addition to identifying finishes for specific parts, such that the intended finish for any structural area is identified.

f. The organizational structure, personnel, and procedures for accomplishing these tasks shall be defined and established.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.11.2 Corrosion Prevention and Control, pg 389 JSSG-2006: A.4.11.2 Corrosion Prevention and Control, pg 392 (for compliance development) MIL-HDBK-1568 MIL-STD-1530C	*Def-Stan 00-970 Reference:*	00-970 P1 3.2.4 00-970 P1 3.2.8 00-970 P1 3.2.9 00-970 P1 3.2.10 00-970 P1 3.2.12
		STANAG Reference:	4672.575 4671.603 4671.609 4671.613 STANAG 7011
FAA Doc:	14CFR reference: Section 23.575, 23.603, 23.609 Section 25.571, 25.603, 25.609 Section 27.571, 27.603, 27.609 Section 29.571, 27.603, 27.609.	*EASA CS Reference:*	CS 23.575 CS 23.603 CS 23.609 CS 25.571 CS 25.603 CS 25.609 CS 27.571 CS 27.573 CS 27.603 CS 27.609 CS 29.571 CS 29.573 CS 29.603 CS 29.609

5.5. MASS PROPERTIES.

5.5.1 Mass properties shall fully support safe vehicle operations at each appropriate combination of mass and centre of gravity within the range of loading conditions for which certification is requested. This shall be shown -

• By tests upon an aeroplane of the type for which certification is requested, or by calculations based on, and equal in accuracy to, the results of testing; and;

• By systematic investigation of each probable combination of mass and centre of gravity, if compliance cannot be reasonably inferred from combinations investigated.

Ranges of mass and centres of gravity within which the aeroplane may be safely operated shall be established and shall include the range for lateral centres of gravity if possible loading conditions can result in significant variation of their positions.

Consideration should be given to all masses, measured using agreed standards, with defined and appropriate tolerances, between:-

a. The minimum mass; and

b. The maximum mass at which the aeroplane can reach the altitude considered.

Information Sources			
Comm'l Doc:	SAWE RP No. 7: 3.2.6 and 3.3		
DoD/MIL Doc:	JSSG-2006: 3.2.5	*Def-Stan 00-970 Reference:*	00-970 P1 3.3.13 00-970 P1 3.3.14 00-970 P1 3.4.16
		STANAG Reference:	4671.21 4671.23 4671.25 4671.29 4671.321 4671.343 4671.659
FAA Doc:	14CFR reference: Section 23.21, 23.23, 23.25, 23.29, 23.321, 23.343, 23.659; Section 25.21, 25.25, 25.29, 25.321, 25.343; Section 7.21, 27.23, 27.25, 27.29, 27.321, 27.659; Section 29.21, 29.25, 29.29, 29.321, 29.659.	*EASA CS Reference:*	CS 23.21 CS 23.23 CS 23.25 CS 23.29 CS 23.321 CS 23.343 CS 23.659 CS 25.21 CS 25.25 CS 25.29 CS 25.321 CS 25.343 CS 27.21 CS 27.23 CS 27.25 CS 27.29 CS 27.321 CS 27.659

Information Sources			
			CS 29.21 CS 29.25 CS 29.29 CS 29.321 CS 29.659

5.5.2 Centre of gravity margins shall be properly defined to handle aerodynamic, centre of gravity, and inertia changes resulting from fuel usage, store expenditure, asymmetric fuel and store loading, fuel migration at high angle-of-attack and roll rates, and aerial refuelling, and release of external sling loads, and air drop of internal cargo.

Information Sources			
Comm'l Doc:	SAWE RP No. 7: 3.4.9, 3.5, 3.2.7.3.1, and 3.2.7.3.1.4		
DoD/MIL Doc:	JSSG-2006: 3.2.6	*Def-Stan 00-970 Reference:*	00-970 P1 3.3.14 00-970 P1 3.4.16
		STANAG Reference:	4671.21 4671.23 4671.29 4671.321 4671.1519
FAA Doc:	14CFR reference: Section 23.21, 23.29, 23.529, 23.1519; Section 25.21, 25.23, 25.27, 25.29, 25.1519; Section 27.21, 27.27, 27.29, 27.1519; Section 29.21, 29.27, 29.29, 29.1519.	*EASA CS Reference:*	CS 23.21 CS 23.29 CS 23.529 CS 23.1519 CS 25.21 CS 25.23 CS 25.27 CS 25.29 CS 25.1519 CS 27.21 CS 27.27 CS 27.29 CS 27.1519 CS 29.21 CS 29.27 CS 29.29 CS 29.1519

5.5.3 The mass and centre of gravity ranges determined for the aeroplane shall be established as operating limitations and furnished in the aeroplane flight and maintenance manuals.

Verify that flight and maintenance manuals (or equivalent) are consistent and contain all required checklists and loading data necessary to conduct required mass and balance checks while complying with specific mass and balance requirements.

Information Sources			
Comm'l Doc:	SAWE RP No. 7 3.4.9 and DI-MGMT-81502		

Information Sources			
DoD/MIL Doc:	DI-MGMT-81502; TO 1-1B-50 "USAF Weight and Balance"; TM 55-1500-342-23 "Army Aviation Maintenance Engineering Manual - Weight and Balance"; NA 01-1B-50 "USN/USMC Aircraft Weight and Balance Control" 35	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1519 4671.1583 4671.1589
FAA Doc:	14CFR reference: Section 23.1519, 23.1583, 23.1589, 23.1501; Section 25.1583, 25.1501; Section 27.1583, 27.1501; Section 29.1583, 29.1501.	*EASA CS Reference:*	CS 23.1519 CS 23.1583 CS 23.1589 CS 23.1501 CS 25.1583 CS 25.1501 CS 27.1583 CS 27.1501 Cs 29.1583 CS 29.1501

5.6. FLIGHT RELEASE.

5.6.1 The structural evidence supporting the type certificate (or equivalent document) shall based on up-to-date design criteria and mass properties, and the completion of all required analyses; laboratory, ground, and flight tests relating to loads, strength, durability, damage tolerance, structural dynamics, and stiffness.

The structural data generated by the required analysis and test shall substantiate the integrity and flight worthiness of the design.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.5, A.3.6, A.3.7, A.4.7, A.4.10.5.3, A.4.10.5.4, A.4.10.5.5	*Def-Stan 00-970 Reference:*	00-970 P1 3.1.25 00-970 P1 3.5.9 00-970 P1 3.7.11 00-970 P1 4.8.4 00-970 P1 4.8.10 00-970 P1 4.8.12 00-970 P1 4.10.12 00-970 P1 4.15.77 00-970 P1 4.15.78 00-970 P1 4.15.80 00-970 P1 4.26.80
		STANAG Reference:	4671.21 4671.251 4671.307 4671.629 4671.963 4671.965
FAA Doc:	14CFR reference: Section 23.251, 23.343,	*EASA CS Reference:*	CS 23.251 CS 23.343

Information Sources			
	23.629, 23.963, 23.965; Section 25.251, 25.305, 25.629, 25.683, 25.771, 25.963, 25.965; Section 27.251, 27.771, 27.963, 27.965; Section 29.251, 29.771, 29.963, 29.965.		CS 23.629 CS 23.963 CS 23.965 CS 25.251 CS 25.305 CS 25.629 CS 25.683 CS 25.771 CS 25.963 CS 25.965 CS 27.251 CS 27.771 CS 27.963 CS 27.965 CS 29.251 CS 29.771 CS 29.963 CS 29.965

SECTION 6 - FLIGHT TECHNOLOGY

This Section covers the flight mechanics functional areas consisting of stability & control, flying qualities, vehicle management functions, flight control functions, external aerodynamics, internal aerodynamics and performance. The air vehicle aerodynamic and stability configuration, engine/inlet/nozzle compatibility, performance and integrated control airworthiness of an air vehicle should be assessed using the criteria provided in the text below (not all items apply in each case; similarly, items may have to be added for vehicles employing new or innovative technology/techniques).

TYPICAL CERTIFICATION SOURCE DATA

1. Design criteria
2. Design studies and analyses
3. Design, installation, and operational characteristics
4. Simulation tests, modelling, and results (including simulation verification, validation and accreditation data)
5. Design approval and function/system compatibility tests
6. Component and functional level qualification and certification tests
7. Electromagnetic environmental effects
8. Installed propulsion compatibility tests
9. Acceptance criteria for test results
10. Failure modes, effects, and criticality analysis/testing (FMECA/FMET)
11. Hazard analysis and classification
12. Safety certification program
13. Computational, theoretical, and/or semi-empirical prediction methods
14. Configuration: aerodynamic design and component location
15. Wind tunnel test results and correction methods
16. Mathematical representation of system dynamics
17. Ground resonance and loop stability tests
18. Aeroservoelastic design criteria and analysis
19. Performance analysis
20. Flight manual
21. Natural environmental sensitivities
22. Flight path guidance analysis and simulation to include ship launch and recovery routines if applicable (including sensor or processor failure modes and effects on flight control)
23. Interface/integration control documents
24. Function, subfunction, and component specifications
25. Selection criteria and patterns selected for screens constructed to demonstrate inlet/engine compatibility
26. Flight test plan
27. Detailed flight profiles 28. Aircraft/engine operating limitations
29. Software development plan
30. Software development and product specifications
31. Software test plans, test procedures, and test reports
32. Software configuration control/management plan and procedure
33. Control laws
34. Flight test reports
35. Aerodynamic and air data uncertainty sensitivity studies
36. Thrust-drag bookkeeping system

37. Mass properties: weights, CofG.'s, and inertia's

CERTIFICATION CRITERIA

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001 Air Vehicle JSSG-2008 Vehicle Control and Management Systems	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	NOTE: As each section applies, flight technology must be checked for a variety of 14CFR references and ACs. Due to the complexity of different design configurations, each section in Subpart C of 14CFR reference 23/25 should be consulted for applicability.	*EASA CS Reference:*	

6.1. STABILITY AND CONTROL.

6.1.1. Control power

6.1.1.1 The air vehicle shall be safely controllable and manoeuvrable during all flight phases, with sufficient control power at all weights, altitudes and ambient temperatures (including icing conditions if applicable) within the air vehicle's operational limitations.

Consideration should be given to ensuring sufficient control power:

a. At minimum controllable speeds;
b. For rotation on takeoff;
c. To handle control surface miss-trim on takeoff;
d. To prevent or stop over-rotation in takeoff;
e. To provide safe control for go-around with engine(s) failure (critical engine(s) inoperative);
f. To provide safe manoeuvre margins during trimmed flight on approach
g. For sufficient trim capability;
h. To provide safe control margins in the event of abnormal or asymmetric fuel function operation;
i. To safely handle transient effects;
j. To safely handle problems arising from asymmetric or symmetric failures of trim controls and any adverse control surface positioning or special use surface(s)/devices;
k. To safely handle unwanted deployment or activation of thrust reverser or vectored thrust equipment whenever the possibility is not extremely improbable;
l. Sufficient for unique vehicle performance;
m. To safely handle engine failures during take-off ground roll;
n. To climb performance (including OEI);
o. To reduced thrust settings;
p. To make a smooth transition from one flight condition to another (including turns and slips) without danger of exceeding the limit load factor, under any probable operating condition, (including, for multi-engined aeroplanes, those conditions normally encountered in the sudden failure of any engine).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A 13.11.1, C.3.1, C.3.13.4.2 & C.4.1, MIL-STD-1797A para 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8 and 5.9 MIL-HDBK-516B 6.1.1	*Def-Stan 00-970 Reference:*	00-970 P1 2.1 00-970 P1 2.4.21 00-970 P1 2.4.22 00-970 P1 2.4.23 00-970 P1 2.4.27 00-970 P1 2.4.28 00-970 P1 2.4.29 00-970 P1 2.6 00-970 P1 2.8 00-970 P1 2.21 00-970 P1 2.22
		STANAG Reference:	4671.51 4671.143 4671.161 4671.203 4671.677
FAA Doc:		*EASA CS Reference:*	CS 23.143 CS 23.161 CS 25.143 CS 25.161 CS 27.143 CS 27.161 CS 29.143 CS 29.161

6.1.2. Stability characteristics and transients.

6.1.2.1 The Air Vehicle, with or without any augmentation or active control functions operating, shall exhibit adequate stability (Static and Dynamic) characteristics and margins, throughout the operating range. If the control functions do not possess adequate redundancy, the basic air vehicle must provide the required stability characteristics and safety margins in the event of any reasonably credible combination of failures.

Consideration should be given to the following:

a. All ranges of the flight envelope and all air vehicle configurations;

b. Operation of any active control functions and augmentation systems (in all modes);

c. Complete or partial loss of any function of the flight control system as a consequence of any single failure;

d. Failure-induced transient motions and trim changes either immediately upon failure or upon subsequent transfer to alternate modes;

e. Configuration changes required or recommended following failure;

f. Basic air vehicle (unaugmented) stability;

g. The application of disturbances to the air vehicle on the control functions;

h. Performance with and without stores fitted;

i. Definition, assessment and approval of appropriate limits for handling characteristics.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A 3.3.11.1 - 3.3.11.3 MIL-HDBK-516B 6.1.2.1	*Def-Stan 00-970 Reference:*	00-970 P1 2.15.17 00-970 P1 2.16.21 00-970 P1 2.16.23 00-970 P1 2.16.24 00-970 P1 2.16.35 00-970 P1 2.16.40
		STANAG Reference:	4671.171 4671.231 4671.233
FAA Doc:		*EASA CS Reference:*	CS 23.171 CS 23.173 CS 23.175 CS 23.177 CS 23.181 CS 23.672 CS 25.171 CS 25.173 CS 25.175 CS 25.177 CS 25.181 CS 25.671 CS 25.672 CS 27.171 CS 27.173 CS 27.175 CS 27.177 CS 27.672 CS 29.171 CS 29.173 CS 29.175 CS 29.177 CS 29.181 CS 29.672

6.1.2.2 Engagement and disengagement of augmentation and active control functions (such as AFCS and Terrain Following) shall not create any transients that are unsafe or require pilot intervention to maintain control of the Air Vehicle.

Consideration shall be given to the following:

• Transient motions and trim changes due to configuration changes, or from the intentional engagement or disengagement of any portion of the primary flight control system in equilibrium flight, due to pilot or automatic flight control system action;

• Mode switching does not result in any large transients;

• Functions are provided in the control system that allow transients within its design flight regime or manoeuvres;

• Transients do not violate limiters necessary for stable and controlled flight, or for structural considerations;

• Reselection of the mode after operation of any protective device.

• All ranges of the flight envelope and all air vehicle configurations, including asymmetric thrust on multi engined aircraft.
• Performance with and without stores fitted;
• Definition, assessment and approval of appropriate limits for handling characteristics.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.3.11.1 thru 3.3.11.1.3; and Appendix C	*Def-Stan 00-970 Reference:*	00-970 P1 2.16.20 00-970 P1 2.16.21 00-970 P1 2.16.22 00-970 P1 2.16.37
		STANAG Reference:	4671.171
FAA Doc:	14CFR reference: 25.171-25.181	*EASA CS Reference:*	CS 23.171-23.181 CS 25.171-25.181 CS 27.171-27.177 CS 29.171-29.181

6.1.2.3 For Air Vehicles with autonomous vehicle control, the net stability, with the guidance and control systems operating, shall be within safe margins under all operating conditions.

Consideration should be given to:
a. The establishment of safe control system performance, in terms of phase and gain margin;
b. The ability of the control system to accommodate failures without adversely affecting the safety of the air vehicle;
c. The stability of the air vehicle whilst on the ground.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	TBD: Refer to technical point of contact for this discipline (listed in section A.2) MIL-HDBK-516B 6.1.2.3	*Def-Stan 00-970 Reference:*	00-970 P1 2.16.23 00-970 P1 2.16.24
		STANAG Reference:	4671.141 4671.171 4671.231 4671.233
FAA Doc:		*EASA CS Reference:*	CS 23.171 CS 23.173 CS 23.175 CS 23.177 CS 23.181 CS 25.171 CS 25.173 CS 25.175 CS 25.177 CS 25.181 CS 27.171 CS 27.173 CS 27.175 CS 27.177

Information Sources			
			CS 29.171 CS 29.173 CS 29.175 CS 29.177 CS 29.181 CS 23.1329* *(unverified- NL516)

6.1.3. Flying, handling, and ride qualities.

6.1.3.1 The air vehicle shall have safe flying qualities / characteristics when subjected to atmospheric disturbances.

Consideration should be given to:

a. All types of atmospheric disturbance (including ship airwake / burble, wake of other Air Vehicles, turbulence and gust loading.)

b. Failure of any lift augmentation devices;

c. Appropriate limits for turbulence and gust loading to be approved and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A 3.3.11.1.2 MIL-HDBK-516B 6.1.3.1	*Def-Stan 00-970 Reference:*	00-970 P1 2.6.26 00-970 P1 2.17.28
		STANAG Reference:	4671.141 4671.341 4671.1583
FAA Doc:		*EASA CS Reference:*	CS 23.341 CS 23.361* CS 23.1505 CS 25.341 CS 25.1517 CS 27.341 CS 27.1505 CS 29.341 CS 29.1505 *(unverified- NL516)

6.1.3.2 All control law concepts employed shall be demonstrably safe and compatible with any mission/tactical requirements.

Consideration should be given to such things as:

a. Time response limits.

b. Phase lag.

c. Affects of high AOA.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	JSSG 2001A 3.3.11.1.1 - 3.3.11.3, Appendix C MIL-HDBK-516B 6.1.3.2	*Def-Stan 00-970 Reference:*	00-970 P1 2.17.32
		STANAG Reference:	4671.143
FAA Doc:		*EASA CS Reference:*	CS 23.143 CS 23.321-459 CS 23.1501-1529 CS 25.143 CS 25.321-459 CS 25.1501-1533 CS 27.143 CS 27.321-427 CS 27.1501-1529 CS 29.143 CS 29.321-427 CS 29.1501-1529

6.1.3.3 The air vehicle shall exhibit safe static and dynamic stability (in both Longitudinal and Lateral-Directional axes).

Consideration should be given to:

a. Classical, safe, second-order response in pitch

b. First-order, well-behaved response in roll without roll ratcheting or other roll sensitivities

c. Equivalent system time delay

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.1.3.3	*Def-Stan 00-970 Reference:*	00-970 P1 2.21.4 00-970 P1 2.21.6 00-970 P1 2.22.3 00-970 P1 2.22.7 L49
		STANAG Reference:	4671.171
FAA Doc:		*EASA CS Reference:*	CS 23.171 CS 23.181 CS 23.253 CS 25.171 CS 25.181 CS 25.253 CS 27.171 CS 29.171

6.1.3.4 Aeroelastic, non-linear, discontinuous and unsteady aerodynamic effects shall be considered in the design of the Air Vehicle and demonstrated to be safe.

Consideration should be given to:

a. Hinge moments, which can limit control deflection;

b. Aeroelastic deformations that affect controllability;

c. High supersonic speed (aeroelasticity and large hinge moments at high dynamic pressure tend to restrict the control capability);
d. Low speed, high angle-of-attack (high lateral stability, large aileron yaw and high dynamic pressure (aeroelastic deformation) are common critical flight conditions).
e. Roll control effectiveness at high dynamic pressure.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.3.11.1 thru 3.3.11.1.3; and Appendix C MIL-HDBK-516B 6.1.3.4	*Def-Stan 00-970 Reference:*	00-970 P1 2.17.28 00-970 P4 4.8
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.321-459 CS 23.629 CS 23.1501-1529 CS 25.321-459 CS 25.629 CS 25.1501-1533 CS 27.321-427 CS 27.629 CS 27.1501-1529 CS 29.321-427 CS 29.629 CS 29.1501-1529

6.1.3.5 There shall be no tendency for pilot-induced or limit-cycle oscillations (i.e. sustained or uncontrollable oscillations) to occur resulting from the efforts of the pilot or automatic flight control system to control the air vehicle. Air Vehicle pilot coupling (APC) and pilot-induced oscillation (PIO) tendencies and flight characteristics shall not adversely affect the safety of the air vehicle.

Consideration should be given to:
a. Residual oscillations resulting from nonlinearities such as friction, hysteresis and poor resolution;
b. Negative static stability and low damping, which may contribute to and amplify any oscillations;
c. High speed, high dynamic pressure or high altitude conditions, which are critical;
d. Pitch PIO in landing caused by control system phase shift;
e. Roll PIO cause by high roll control gain;
f. Verification by manned and unmanned simulation, analysis and test. Manned simulation used to verify control laws, flying qualities and departure resistance prior to flight and as an adjunct to flight testing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A 3.3.11.1 - 3.3.11.3 MIL-HDBK-516B 6.1.3.5	*Def-Stan 00-970 Reference:*	00-970 P1 2.17.31 00-970 P1 2.21.14 00-970 P1 2.22.2 00-970 P1 2.22.12
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.181

6.1.3.5.1 Any phase and gain margins within the control system, including any transient responses shall be safe and meet limits set independently. Consideration should be given to the effects of atmospheric disturbances (such as gusts, turbulence...etc).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A Appendix C.3.7 MIL-HDBK-516B 6.1.3.5.1	*Def-Stan 00-970 Reference:*	00-970 P1 2.6.1 00-970 P1 2.8.1 00-970 P1 2.16.1
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.321-459 CS 25.321-459 CS 25.341 CS AMC 25.341 CS 27.321-427 CS 29.321-427

6.1.3.5.2 The air vehicle shall not exhibit unsafe limit cycle oscillations, unbounded oscillations, unsafe triggering mechanisms during mode transitions, or unsafe sudden/steep gain changes.

Consideration should be given to:
a. High gain conditions;
b. All possible air vehicle configurations;
c. Controls fixed and controls free stability;
d. Configuration changes/transitions;
e. Pilot workload and the ability of the air vehicle in the military role;
f. The entire ground and flight envelope.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A Appendix C.3.7, C.3.8 MIL-HDBK-516B 6.1.3.5.2	*Def-Stan 00-970 Reference:*	00-970 P1 2.16 00-970 P1 2.17.28 00-970 P1 2.17.31 00-970 P1 2.21.4 00-970 P1 2.21.8 00-970 P1 2.22.7
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.321-459 CS 25.321-459 CS 27.321-427 CS 29.321-427

6.1.3.6 The air vehicle ground handling characteristics shall be safe.

Consideration should be given to the following:
a. All specified mission environments including prepared, unprepared, sloping ground, wet, snow, ice...etc conditions;

b. All normal and abnormal centre-of-gravity locations for realisable fuel states during taxi, takeoff, and landings;
c. Potential failure conditions (weight on wheel normal and failed conditions);
d. Positive steering control, including Steering/ Directional control with the nose wheel remaining on the ground whether using nose wheel steering, differential braking or asymmetric thrust;
e. Steering sensitivities;
f. Steering fade in/out;
g. Ground control paths;
h. The ability to taxi through 360 degrees with the nose wheel remaining on the ground whether using nose wheel steering, differential braking or asymmetric thrust;
i. Determination of safe field lengths for takeoff (including rejected takeoff) and landing;
j. Controllability whilst taxiing in crosswinds;
k. Ability to withstand heavy landing / shock loading;
l. Use of transportation equipment (UAS);
m. Effects on control surfaces of ground gusts and taxiing down wind;
n. Dynamic Roll Over;
o. Ground Resonance;
p. Embarked operations.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-156B 6.1.3.6	*Def-Stan 00-970 Reference:*	00-970 P1 2.3.18 00-970 P1 2.3.19 00-970 P1 2.3.20
		STANAG Reference:	4671.55(c) 4671.75 4671.231 4671.233 4671.235 4671.249 4671.415
FAA Doc:		*EASA CS Reference:*	CS 23.231 CS 23.233 CS 23.235 CS 23.237 CS 23.239 CS 23.499 CS 23.749 CS 25.231 CS 25.233 CS 25.235 CS 25.237 CS 25.239 CS 25.499 CS 25.745 CS 27.231 CS 27.235 CS 27.239 CS 27.241

Information Sources			
			CS 29.231 CS 29.235 CS 29.239 CS 29.241

6.1.3.7 The air vehicle shall have safe aerodynamic/flight characteristics in all possible air vehicle configurations (including stores) and in the event of any lift augmentation device failure.

Consideration should be given to:

a. High angles of attack;
b. Pitch up tendencies;
c. Wing rocking tendencies;
d. Adequate stall warning and recovery, both in level flight and turn;
e. Stall prevention systems;
f. Ability of air vehicle to structurally withstand and recover from vibration and buffet;
g. Unusual flight attitudes;
h. Spin recovery (in accordance with aircraft specification);
i. Minimum permissible speeds;
j. Provision of indicators to show lift and drag device position.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.1.3.7	*Def-Stan 00-970 Reference:*	00-970 P1 2.11.4 00-970 P1 2.12.21 00-970 P1 2.10.11 00-970 P1 2.10.17 00-970 P1 2.10.20 00-970 P1 2.10.28
		STANAG Reference:	4671.50 4671.141 4671.201 4671.203 4671.221
FAA Doc:		*EASA CS Reference:*	CS 23.201 CS 23.203 CS 23.221 CS 25.201 CS 25.203 CS 25.253* CS 25.697 CS 25.699 *(unverified- NL516)

6.1.3.8 Air Vehicle hinge moment characteristics shall not adversely affect the safety of the air vehicle throughout the combined range of attainable angles of attack (both positive and negative) and sideslip.

Consideration should be given to prevention of loss of control and to recovery from any situation, including:

a. Deep stall trim conditions;

b. All manoeuvring;

c. Factors such as pilot strength, regions of control-surface-fixed instability, inertial coupling, fuel slosh, the influence of symmetric and asymmetric stores, stall/post-stall/ spin characteristics, atmospheric disturbances and Aircraft Failure States;

d. Failure transients and manoeuvring flight appropriate to the Failure State;

e. The degree of effectiveness and certainty of operation of limiters, e.g. control malfunction or mismanagement, and transients from failures in the propulsion, flight control and other relevant systems;

f. All configuration including Stores (symmetric and asymmetric).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A 3.3.11.1.3 MIL-HDBK-516B 6.1.3.8	*Def-Stan 00-970 Reference:*	00-970 P1 3.1.28 00-970 P1 3.9.9 00-970 P1 4.10.8
		STANAG Reference:	4671.393 4671.395
FAA Doc:		*EASA CS Reference:*	CS 23.393 CS 23.395 CS 25.393 CS 25.395

6.1.3.9 The air vehicle shall not demonstrate any unsafe stability and control dynamics during both symmetrical and asymmetrical flight manoeuvres in all possible air vehicle configurations (including stores).

Consideration should be given to the following:

a. Control surface float angles;

b. Control surface blow-back;

c. Control surface nonlinearities;

d. The vehicle control system or actuation functions to overcome actual moments;

e. Establishing levels of flying quantities for the vehicle;

f. Control surface hinge moment limiting.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.1.3.9	*Def-Stan 00-970 Reference:*	00-970 P1 2.6.7 00-970 P1 2.6.16 00-970 P1 2.8.8 00-970 P1 2.14.10
		STANAG Reference:	4671.143
FAA Doc:		*EASA CS Reference:*	CS 23.171 CS 23.173 CS 23.175

Information Sources			
			CS 23.177 CS 23.181 CS 25.171 CS 25.173 CS 25.175 CS 25.177 CS 25.181 CS 25.651 CS 27.171 CS 27.173 CS 27.175 CS 27.177 CS 29.171 CS 29.173 CS 29.175 CS 29.177 CS 29.181

6.1.3.10 Stability and control characteristics of the basic air vehicle design, as well as unique features, shall be safe within the entire flight envelope.

Consideration should be given to:
a. All air vehicle configurations (including stores);
b. Atmospheric disturbances effects (turbulence, cross wind);
c. Manual or powered (including FBW) flying controls.

Basic features include phase and gain margins, transitions, gain changes, mode changes, switching & schedule changes, non-linearities
Unique features include but are not limited to stealth, autopilots, auto trim, threat avoidance, speed brakes, flaps etc.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A 3.3.11.1 MIL-HDBK-516B 6.1.3.10	*Def-Stan 00-970 Reference:*	00-970 P1 2.6.13 00-970 P1 2.6.14 00-970 P1 2.6.16 00-970 P1 2.6.17 00-970 P1 2.6.19 00-970 P1 2.8.13 00-970 P1 2.8.19
		STANAG Reference:	4671.141 4671.143
FAA Doc:		*EASA CS Reference:*	CS 23.171 CS 23.173 CS 23.177 CS 23.181 CS 25.171 CS 25.173

Information Sources			
			CS 25.177 CS 25.181 CS 27.171 CS 27.173 CS 27.177 CS 29.171 CS 29.173 CS 29.177

6.1.3.11 The air vehicle stability or command/ control augmentation systems and devices shall not introduce any objectionable handling characteristics due to rate limiting.

Consideration should be given to:

a. Rate limits associated with stability augmentation, flight control, automatic or power operated systems;
b. Surface deflections and Saturation of components;
c. Normal and failure states;
d. Atmospheric disturbances;
e. Manoeuvring flight with the flight envelope (including AOA, side slip and load factor);
f. Post stall recovery.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A 3.3.11.1.3 MIL-HDBK-516B 6.1.3.11	*Def-Stan 00-970 Reference:*	00-970 P1 2.16.43
		STANAG Reference:	4671.141 4671.171
FAA Doc:		*EASA CS Reference:*	CS 23.672 CS 25.672 CS 25.1329 CS 27.672 CS 29.672

6.1.4. Mission evaluations including flight path guidance.

6.1.4.1 The air vehicle shall respond safety in all axes to all commands from the flight path guidance system and auto pilot.

Consideration should be given to the following:

a. Flight path guidance devices and processors shall not produce a periodic flight path divergence within the operational flight envelope;
b. All possible air vehicle configurations, including stores;
c. Atmospheric disturbances (e.g. cross wind and turbulence);
d. Asymmetric effects of any OEI conditions on multi-engined aircraft;
e. Use of mathematical modelling supported by flight trials.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A 3.3.11.1 - 3.3.11.1.3, Appendix C	*Def-Stan 00-970 Reference:*	00-970 P1 2.16.21 00-970 P1 2.16.22

Information Sources			
	MIL-HDBK-516B 6.1.4.2		00-970 P1 2.16.24 00-970 P1 2.16.25 00-970 P1 2.16.28 00-970 P1 2.16.33
		STANAG Reference:	4671.143 4671.1329
FAA Doc:		*EASA CS Reference:*	CS 23.1329 CS 25.123 CS 25.1329 CS 27.1329 CS 29.1329

6.1.4.2 The air vehicle flight path guidance systems shall safely compensate for degraded modes/failures of operation.

Consideration should be given to:

a. The impact of any credible combination of failures;

b. Providing indication to crew members whenever failures occur that require or limit any flight crew action or decision;

c. A realistic time delay between the failure and initiation of pilot corrective action.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A 3.3.11.1.3, Appendix C.3.1 MIL-HDBK-516B 6.1.4.2	*Def-Stan 00-970 Reference:*	00-970 P1 2.16.18 00-970 P1 2.16.36 00-970 P1 2.16.42
		STANAG Reference:	4671.171 4671.1329
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 23.1329 CS 25.1309 CS 25.1329 CS 27.1309 CS 27.1329 CS 29.1309 CS 29.1329

6.1.4.3 All transitions to and from normal flight path guidance and autopilot modes, whether argument or manually selected shall not create any unsafe transients, deviation of flight path or require pilot intervention. This shall be true for all air vehicle or stores configurations.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A Appendix C.3.12.6, C.3.12.6.1 MIL-HDBK-516B 6.1.4.3	*Def-Stan 00-970 Reference:*	00-970 P1 2.16.18 00-970 P1 2.16.20
		STANAG Reference:	4671.171
FAA Doc:		*EASA CS Reference:*	CS 23.1329 CS 25.1329

Information Sources			
			CS 27.1329 CS 29.1329

6.1.5. Other effects.

6.1.5.1 Hazardous roll-yaw-pitch coupling(s) shall not occur as a result of aerodynamic, kinematic or inertial effects.

Consideration should be given to:

a. All possible air vehicle configurations, including stores;

b. Any environmental conditions such as cross wind or turbulence;

c. The ability to remain in control without the need for exceptional piloting skill;

d. The use of flight envelope protection for UAS;

e. Definition, assessment and approval of appropriate limits for handling characteristics.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A Appendix C.3.1.1, C.3.1.8 MIL-HDBK-516B 6.1.5.1	*Def-Stan 00-970 Reference:*	00-970 P1 2.6.17 00-970 P1 2.6.19 00-970 P1 2.6.21 00-970 P1 2.6.25 00-970 P1 2.6.26 00-970 P1 2.8.8 00-970 P1 2.8.13 00-970 P1 2.8.15 00-970 P1 2.8.17 00-970 P1 2.8.24 00-970 P1 2.22.23 00-970 P1 2.22.29
		STANAG Reference:	4671.141 4671.U334(b)
FAA Doc:		*EASA CS Reference:*	CS 23.427 CS 25.427 CS 27.427 CS 29.427

6.1.5.2 Hazardous roll-yaw-pitch coupling(s) shall not occur as a result of engine coupling of symmetric or asymmetric (in the event of engine failure) thrust or gyroscopic effects.

Consideration should be given to:

a. All possible air vehicle configurations, including stores;

b. All flight regimes in which the air vehicle may operate (e.g. takeoff, approach);

c. Any environmental conditions, such as cross wind and turbulence;

d. The affect of a second failure on air vehicles that have more than two engines;

e. The ability to maintain height, heading and attitude without the need for exceptional piloting skill;

f. For air vehicles fitted with a propeller, the affects a failure of the propeller feathering system.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	JSSG 2001A Appendix C3.1.12, C3.1.12.1, C.3.1.12.2, C.3.1.12.5, C.3.1.12.6 MIL-HDBK-516B 6.1.5.2	*Def-Stan 00-970 Reference:*	00-970 P1 2.8.21 00-970 P1 2.8.23 00-970 P1 2.22.37 00-970 P1 2.22.41 00-970 P1 2.22.43 00-970 P1 2.25.80
		STANAG Reference:	4671.U334(b) 4671.367
FAA Doc:		*EASA CS Reference:*	CS 23.367 CS 25.367 CS 25.629 CS 25.937

6.1.5.3 Stall, or loss of control, warning and any associated limiting and prevention functions shall be safe within all areas of the flight envelope, including during the carriage of stores.

Consideration should be given to:

a. A clear and distinctive stall warning with sufficient margin to prevent inadvertent stalling with the flaps and landing gear in any normal position in straight and turning flight;

b. The warning may be furnished either through the inherent aerodynamic qualities of the aeroplane or by a device that will give clearly distinguishable indications under expected conditions of flight.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001 3.3.11.1 - 3.3.11.1.3, Appendix C MIL-HDBK-516B 6.1.5.3	*Def-Stan 00-970 Reference:*	00-970 P1 2.10.11 00-970 P1 2.10.27 00-970 P1 2.10.28 00-970 P1 2.10.30
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.207 CS 25.207

6.1.5.4 Where necessary to maintain safe flight, aircrew members shall be given immediate and easily interpreted indications whenever wrong configurations occur that require or limit any flight crew action or decision.

Consideration should be given to:

a. Wing sweep;

b. Flap;

c. Landing gear;

d. Doors;

e. Stability augmentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001 3.3.11.1 - 3.3.11.1.3, Appendix C, 3.4.3.1.6	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.35 00-970 P1 4.15.37 00-970 P1 4.19.59

Information Sources			
	MIL-HDBK-516B 6.1.5.4	*STANAG Reference:*	4671.703 4671.729
FAA Doc:		*EASA CS Reference:*	CS 23.672 CS 23.703 CS 23.729 CS 23.783 CS 23.1322 CS 25.672 CS 25.703 CS 25.729 CS 25.783 CS 25.1322 CS 27.672 CS 27.729 CS 27.1322 CS 29.672 CS 29.729 CS 29.783 CS 29.1322

6.1.5.5 Air vehicle response to inceptor inputs shall be proportional and shall not exhibit any non-linearities (such as oversensivity or sluggishness) between pilot applied deflection and force and air vehicle response.

Consideration should be given to:

a. Heaviness and effectiveness of the inceptors;

b. Harmonisation of the flying controls;

c. Inceptor tendency to over balance;

d. Inceptor tendency to oscillate;

e. Self centring ability of the inceptors;

f. Sensitivity of the controls at high speed.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001 3.3.11.1 - 3.3.11.1.3, Appendix C MIL-HDBK-516B 6.1.5.5 MIL-HDBK-1797 4.1.12.2, 4.2.1.2	*Def-Stan 00-970 Reference:*	00-970 P1 2.17.29 00-970 P1 2.22.14 00-970 P1 2.25.78
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.397 CS 25.331 CS 25.397 CS 27.397 CS 29.397

6.1.5.6 Actuator dynamic performance shall not degrade vehicle flying qualities below acceptable limits.

Consideration should be given to:

a. Accurate modelling.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001 3.3.11.1 - 3.3.11.1.3, Appendix C MIL-HDBK-516B 6.1.5.6	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.26
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.5.7 Sensor dynamics shall not degrade vehicle flying qualities below acceptable limits.

Consideration should be given to:
a. Accurate modelling;
b. Rigid and flexible body motions;
c. Protection from FOD and bird strike;
d. Accidental and battle damage;
e. Normal disturbances (e.g. side slip, asymmetric manoeuvres).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A 3.3.11.1 - 3.3.11.1.3, Appendix C Mil-HDBK-516B 6.1.5.7	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.20
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.5.8 Cockpit or vehicle controller dynamics shall be correctly modelled and these dynamics shall not degrade vehicle flying qualities below acceptable limits.

Consideration should be given to:
a. The heaviness and effectiveness of the inceptors;
b. Harmonisation of the flying controls;
c. Any tendency of the inceptors to over balance, oscillate, snatch or twitch and the condition at which this occurs;
d. The self centring tendency of each inceptor and the effects of any jamming or circuit friction;
e. Sensitivity of the controls at high speed;
f. All ranges of the flight envelope and aircraft configurations (including the carriage and release of stores);
g. Any affects of single component failures;
h. Environmental effects (e.g. turbulence, cross winds);
i. The desired level of piloting skill.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A 3.3.11.1 - 3.3.11.1.3, Appendix C MIL-HDBK-516B 6.1.5.8	*Def-Stan 00-970 Reference:*	00-970 P1 2.17.27 00-970 P1 2.17.29 00-970 P1 2.21.28

Information Sources			
			00-970 P1 2.22.37-42 00-970 P1 2.24.16-21 00-970 P1 4.10.25
		STANAG Reference:	4671.395 4671.397
FAA Doc:		*EASA CS Reference:*	CS 23.395 CS 23.397 CS 25.395 CS 25.397 CS 27.395 CS 27.397 CS 29.395 CS 29.397

6.1.5.9 No single failures (with operator in-the-loop) shall result in any unsafe air vehicle flying characteristics.

No credible combination of failures (with operator in-the-loop) shall result in departure or loss of control.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 3.3.11.1 - 3.3.11.1.3, Appendix C MIL-HDBK-516B 6.1.5.9	*Def-Stan 00-970 Reference:*	00-970 P1 2.15.11 00-970 P1 2.15.13 00-970 P1 2.15.14 00-970 P1 2.15.29 00-970 P1 2.24.21
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.672 CS 23.1309 CS 25.672 CS 25.1309 CS 27.672 CS 29.672 CS 29.1309

6.1.5.10 Control gradient forces and dynamics shall be safe and suitable for the entire range of applications and flight regimes, even in the event of a failure. This shall be established by mathematical modelling, rig testing, simulator and flight testing or a combination thereof.

Consideration should be given to the following types of failure :

a. Jamming;

b. Runaways;

c. Loss.

Consideration should be given to the following flight regimes:

a. Takeoff;

b. Climb;

c. Cruise;

d. Normal turns;

e. Descent;
f. Landing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 3.3.11.1 - 3.3.11.1.3, Appendix C MIL-HDBK-516B 6.1.5.9, 6.1.5.10	*Def-Stan 00-970 Reference:*	00-970 P1 2.15.11 00-970 P1 2.15.12 00-970 P1 2.15.13 00-970 P1 2.15.14 00-970 P1 2.15.29
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.671 CS 23.672 CS 25.671 CS 25.672 CS 27.671 CS 27.672 CS 29.671 CS 29.672

6.1.5.11 The air crew shall have unimpeded visual characteristics within appropriate limits, to be approved and verified, in all ground and flight conditions.

Consideration should be given to:
a. Cockpit design compatible with aircraft attitude for all intended operations.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 3.3.11.1 - 3.3.11.1.3, Appendix C MIL-HDBK-516B 6.1.5.11	*Def-Stan 00-970 Reference:*	00-970 P1 4.17.9 00-970 P1 4.17.10
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.773 CS 25.773 CS 27.773 CS 29.773

6.1.5.12 Air vehicle flying qualities for ship launch/recovery wind envelopes and ship pitch and roll limits shall be safe.

Consideration should be given to the following:
a. Approach and Fly-away techniques;
b. Ship Superstructure air wake and effects;
c. Visual references;
d. Day and night, all weather operations (including NVG operations);
e. Variations in weight altitude and ambient temperature;
f. Deck movement;
g. Induced turbulence;
h. Enforced out of wind approach and landing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.1.5.12	*Def-Stan 00-970 Reference:*	00-970 P1 2.25.11 00-970 P7 L908
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.5.13 Aircrew workload shall be commensurate with the need to maintain safe flight in all normal (including high workload flight phases) and failure operating conditions.

Consideration should be given to:

a. Fight path control;
b. Collision avoidance;
c. Navigation;
d. Communications;
e. Operation and monitoring of all essential air vehicle systems;
f. Command decisions;
g. Accessibility and ease of operation of air vehicle controls;
h. Day and night, all weather operations (including NVG operations).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A 3.3.11.1 - 3.3.11.1.3, 3.4.3, Appendix C MIL-HDBK-516B 6.1.5.13	*Def-Stan 00-970 Reference:*	00-970 P1 2.21.5 00-970 P1 2.25.13
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1523 CS 25.1523 CS 27.1523 CS 29.1523 AMC 25.1302

6.1.5.14 Vehicle flying qualities on back-up power (electrical or hydraulic) shall be safe within acceptable limits.

Consideration should be given to:

a. Primary flight controls (whether they be electrically or hydraulically actuated);
b. Power plant controls;
c. Stability augmentation systems;
d. Air data systems;
e. Radio communication equipment;
f. Navigation equipment;
g. Display systems (including NVG and HUD).

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	JSSG 2001A 3.3.11.1 - 3.3.11.1.3, Appendix C MIL-HDBK-516B 6.1.5.14	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.4 00-970 P1 6.6.6 00-970 P1 6.11.53
		STANAG Reference:	4671.1351
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 23.1351 CS 25.1309 CS 25.1351 CS 27.1309 CS 27.1351 CS 29.1309 CS 29.1351

6.1.6. Envelopes.

6.1.6.1 merged with 6.1.2.1

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A 3.3.11.1 - 3.3.11.1.3, Appendix C MIL-HDBK-516B 6.1.6.1	*Def-Stan 00-970 Reference:*	00-970 P1 2.3.18 00-970 P1 2.3.20 00-970 P1 2.3.21 00-970 P1 2.6.13 00-970 P1 2.6.14 00-970 P1 2.6.16 00-970 P1 2.6.17 00-970 P1 2.6.19 00-970 P1 2.8.13 00-970 P1 2.8.19
		STANAG Reference:	4671.141 4671.171 4671.231 4671.233
FAA Doc:		*EASA CS Reference:*	CS 23.171 CS 23.173 CS 23.177 CS 23.181 CS 23.231 CS 23.233 CS 25.171 CS 25.173 CS 25.177 CS 25.181 CS 25.231 CS 25.233 CS 27.171 CS 27.173

Information Sources			
			CS 27.177 CS 27.231 CS 29.171 CS 29.173 CS 29.177 CS 29.231

6.1.6.2 The air data system and associated redundancy management provides for safe flight including during and after air data component failures.

Consideration should be given to the following:

a. Provision of a standby or reversionary system;

b. Satisfactory provision of failure indications and warnings;

c. Mechanically induced damage to probes and pressure ports, and the effects of rain, icing, and other hostile environments.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001A 3.3.11.1 - 3.3.11.1.3, Appendix C MIL-HDBK-516B 6.1.6.2	*Def-Stan 00-970 Reference:*	00-970 P1 2.15.27 00-970 P1 6.3.4 00-970 P1 6.3.5 00-970 P1 6.3.20
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1323 CS 23.1325 CS 23.1326 CS 25.1323 CS 25.1325 CS 25.1326 CS 27.1323 CS 27.1325 CS 29.1323 CS 29.1325

6.1.6.3 The flight-critical parameters list shall be complete and reasonable.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.1.6.3	*Def-Stan 00-970 Reference:*	00-970 P1 7.5.3
		STANAG Reference:	4671.1501 4671.1583 4671.1585 4671.1587
FAA Doc:		*EASA CS Reference:*	CS 23.1501 CS 23.1583 CS 23.1585

Information Sources			
			CS 23.1587 CS 25.1501 CS 25.1583 CS 25.1585 CS 25.1587 CS 27.1501 CS 27.1583 CS 27.1585 CS 27.1587 CS 27.1589 CS 29.1501 CS 29.1583 CS 29.1585 CS 29.1587

6.1.6.4 The air vehicles flight manual, supplements and any associated placards shall contain the air vehicle / engine operating limitations.

These limitations shall include:
• Performance (e.g. airspeed limitations, power plant limitations, weight limitations);
• Flight characteristics under normal and emergency conditions;
• Control functions under normal and emergency conditions (e.g. procedures and speeds for continued takeoff following engine failure, safe landing limits for OEI);
• Any other critical items to ensure safe flight.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.1.6.4	*Def-Stan 00-970 Reference:*	00-970 P1 7.5.3
		STANAG Reference:	4671.1501 4671.1581
FAA Doc:		*EASA CS Reference:*	CS 23.1501-1589 CS 25.1501-1533 CS 27.1501-1589 CS 29.1501-1589

6.1.7. Store carriage and separation.

6.1.7.1 Store carriage, release and separation shall not result in unacceptable air vehicle stability and control characteristics or unacceptable flying qualities.

Consideration should be given to:
a. Air vehicle weight and centre of gravity remaining within approved limits during the carriage of stores and after release of any store or combination of stores;
b. Flying qualities, loss of air vehicle control while under symmetrical and asymmetrical manoeuvres;
c. Normal or emergency release or jettison of any store or combination of stores resulting in exceedance of any aircraft flight limitations;
d. Normal or emergency release or jettison of any store or combination of store do not result in contact between the released store and other stores or the aircraft;

e. Both internal and external stores locations;
f. The most extreme asymmetric loading of stores (including symmetric thrust);
g. Sequencing of stores release and jettison;
h. Release of internally carried stores shall not be possible until the bomb bay doors are fully open;
i. Indication to the crew in the event of a failed separation (hangfire or misfire).

Information Sources			
Comm'l Doc:			00-970 P1 S2.17 00-970 P1 2.24.17 00-970 P1 2.24.18 00-970 P13 3.2.9 00-970 P13 3.2.10 00-970 P13 3.2.11 00-970 P13 3.2.12 00-970 P13 3.2.13 00-970 P13 3.2.17 00-970 P13 3.2.21
DoD/MIL Doc:	JSSG 2001A 3.3.11.1 - 3.3.11.1.3, Appendix C MIL-HDBK-516B 6.1.7.1	*Def-Stan 00-970 Reference:*	00-970 P1 S2.17 00-970 P1 2.24.17 00-970 P1 2.24.18 00-970 P13 3.2.9 00-970 P13 3.2.10 00-970 P13 3.2.11 00-970 P13 3.2.12 00-970 P13 3.2.13 00-970 P13 3.2.17 00-970 P13 3.2.21
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25/29: Subparts B and G* *(unverified- LC516)

6.1.7.2 Merged with 6.1.7.1

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Merged with 6.1.7.1	*Def-Stan 00-970 Reference:*	Merged with 6.1.7.1
		STANAG Reference:	
FAA Doc:	Merged with 6.1.7.1	*EASA CS Reference:*	Merged with 6.1.7.1

6.1.7.3 Merged with 6.1.7.1

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Merged with 6.1.7.1	*Def-Stan 00-970*	Merged with 6.1.7.1

Information Sources			
		Reference:	
		STANAG Reference:	
FAA Doc:	Merged with 6.1.7.1	*EASA CS Reference:*	Merged with 6.1.7.1

6.1.8 Modelling and simulation data, databases and tools shall be validated to ensure predictions of air vehicle stability and control and flying and handling qualities characteristics correctly and accurately represent the air vehicle characteristics.

Consideration should be given to:

a. Trim;

b. Dynamic manoeuvres;

c. Flight control modes and failures;

d. Validation across the flight envelopes and for all air vehicle configurations;

e. Use of test pilots during early simulations and eventual flight testing;

f. Frequency-response or time-response methods.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2008 Section 8 (unverified) MIL-HDBK-6.1.8 MIL-STN-1797 4.1.9, 4.1.10	*Def-Stan 00-970 Reference:*	00-970 P1 7.5.3
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.2. VEHICLE CONTROL FUNCTIONS (VCF).

This section covers the installation, integration, interface, and operation of the Vehicle Control Function (VCF). This includes all air vehicle augmentation systems, Flight Control Systems (FCS), autopilot, etc.

Included with the scope of the this section are:

- VCF architecture design;
- VCF functional characteristics;
- Control law authority;
- Control surface actuation systems;
- Hydraulic & electrical VCF power source;
- Flight critical components;
- VCF software;
- VCF failure monitoring.

When implementing VCF, the general air worthiness criteria for air vehicle equipment, systems and installations should always be considered, as well as the overall air vehicle flight control and flight performance. Some criteria in this chapter are supported in the text by examples of specific considerations. These examples are by no means to be considered as exhaustive.

All criteria should at least be verified for:

• The most adverse combination of flight, environment and load conditions;
• Agreed acceptable/unacceptable probability of loss of function.

Where an information source is highlighted, in general it is implied that any higher level requirement on the same subject stated in the parent paragraphs is
applicable too, as well as each lower level requirement contained in any subparagraph. The links to references are by no means to be considered as
exhaustive.

6.2.1. VCF architecture design.

6.2.1.1 The design of the air vehicle VCF, including its sub-systems, shall be shown to be safe within the required performance envelope.

Consideration should be given to using a structured methodology to:
1. Define the required air vehicle performance envelope.
2. Agree the required air vehicle safety levels. Derived safety requirements can then be established for enabling systems.
3. Develop Test & Acceptance Plans to record how the derived and top level safety requirements are to be demonstrated.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2008 3 thru 3.8, 4 thru 4.8 MIL-HDBK-516B 6.2.1.2	*Def-Stan 00-970 Reference:*	00-970 P1 2.15 00-970 P1 2.16 00-970 P1 3.9 00-970 P1 3.10 00-970 P1 6.6 00-970 P1 6.11
		STANAG Reference:	4671.685 4671.1309
FAA Doc:		*EASA CS Reference:*	CS 23.141-23.257 CS 23.321-23.459 CS 23.1309 CS 23.1501-23.1529 CS 25.143-25.255 CS 25.321-25.459 CS 25.689 CS 25.1309 CS 27.141-27.251 CS 27.321-27.447 CS 27.1309 CS 27.1501-27.1529 CS 29.141-29.251 CS 29.321-29.427 CS 29.1309 CS 29.1501-29.1529

6.2.1.2 Aspects of the VCF critical to the safe operation of the Air Vehicle shall incorporate sufficient and appropriate risk mitigations to allow graceful degradation and interface with other systems to ensure power is available for continued safe operation.

Consideration should be given to one or more of the following approaches:

a. Failure Absorption;

b. Cross lane monitoring/voting and failure rejection;

c. Lane self monitoring and failure rejection.

d. The progression and sustainment of air vehicle control, related to aircrew workload and situational awareness.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2008 3.1.7 - 3.1.7.3, 4.1.7 - 4.1.73 MIL-HDBK-516B 6.2.1.2	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.18 00-970 P1 6.11.3 00-970 P1 6.12.2
		STANAG Reference:	4671.1309 4671.1329 4671.1412 4671.1413
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 25.1310 CS 27.1309 CS 29.1309 CS 25.671* CS 25.672* *(unverified-Dutch 516)

6.2.1.3 The VCFs shall have appropriate levels of risk mitigations typically achieved through separation, redundancy, fault tolerance and self test to prevent any unsafe function resulting in a loss of control.

Considerations should be given to software elements.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2008 3.0, 4.0, 3.1, 4.1, 3.1.11-3.1.11.2, 4.1.11-4.1.11.2 MIL-HDBK-516B 6.2.1.3	*Def-Stan 00-970 Reference:*	00-970 P1 2.14.19 00-970 P1 2.15.17 00-970 P1 4.4.7 00-970 P1 4.4.46 00-970 P1 6.2.33 00-970 P1 6.5.29 00-970 P1 6.5.33 00-970 P7 L725 3.2.1
		STANAG Reference:	4671.1309 4671.1323 4671.1490
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309

Information Sources			
			CS 27.1309 CS 29.1309

6.2.1.4 Each aspect of the VCF (such as flaps, trim, autostabilisers, hydraulics) shall be suitably separated and protected to ensure graceful degradation of the VCF in the presence of failures and combination of failures.

Consideration should be given to:

a. The use of modelling and simulation to establish effects of failures.

b. The progression and sustainment of air vehicle control, related to aircrew workload and situational awareness.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2008 3.1.1 - 3.1.4, 4.1.1 - 4.1.4 MIL-HDBK-516B 6.2.1.4	*Def-Stan 00-970 Reference:*	00-970 P1 2.6.25 00-970 P1 2.8.25 00-970 P1 2.14.16 00-970 P1 2.14.24 00-970 P1 2.15.9 00-970 P1 2.15.11 00-970 P1 2.15.12 00-970 P1 2.15.13 00-970 P1 2.15.14 00-970 P1 2.15.15 00-970 P1 2.15.17 00-970 P1 2.15.20 00-970 P1 2.15.21 00-970 P1 2.15.23 00-970 P1 2.15.24
		STANAG Reference:	4671.459 4671.701
FAA Doc:		*EASA CS Reference:*	CS 23.672 CS 25.671 CS 25.672 CS 27.672 CS 29.672 CS 25.671* CS 25.672* *(unverified-Dutch 516)

6.2.1.5 No credible combination of failures shall result in a complete loss of an axis of control from the VCF. It is permissible for combination of failures to result in degraded control that does not require exceptional piloting skill.

Consideration should be given to:

a. Location and separation of aspects of the VCF to protect against effects of fire and mechanical damage;

b. The use of modelling and/or simulation to establish the effects on controllability of any identified failures.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2008 3.1.9, 4.1.9 MIL-HDBK-516B 6.2.1.5	*Def-Stan 00-970 Reference:*	00-970 P1 2.6.25 00-970 P1 2.8.25 00-970 P1 2.15 00-970 P1 2.15.11 00-970 P1 2.15.29 00-970 P1 2.24.21 00-970 P1 3.9.18 00-970 P1 3.10.28 00-970 P1 4.10.22 00-970 P1/5 S4 L36 00-970 P1 6.12.15 00-970 P7 L600 12.5.1 00-970 P7 L903 7.10.1 00-970 P7 L904 7.7.1
		STANAG Reference:	4671.321 4671.1309 4671.1329 4671.1603
FAA Doc:		*EASA CS Reference:*	CS 23.21 CS 23.141-23.257 CS 23.321-23.459 CS 23.672 CS 23.865 CS 23.1309 CS 23.1329 CS 23.1501-23.1529 CS 25.21 CS 25.143-25.255 CS 25.321-25.459 CS 25.671* CS 25.672 CS 25.865 CS 25.1309 CS 25.1310 CS 25.1329 CS 27.21 CS 27.141-27.251 CS 27.321-27.427 CS 27.672 CS 27.1309 CS 27.1329 CS 27.1501-27.1529 CS 29.21 CS 29.141-29.251 CS 29.321-29.427 CS 29.672, CS 29.1309,

Information Sources			
			CS 29.1329, CS 29.1501-29.1529 *(unverified-Dutch 516)

6.2.1.6 No reasonably credible combination of failures with the VCF (including AFCS if applicable) shall result in a loss of control of the Air Vehicle.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2008 3.0, 4.0, 3.1, 4.1, 3.1.11-3.1.11.2, 4.1.11-4.1.11.2 MIL-HDBK-516B 6.2.1.6	*Def-Stan 00-970 Reference:*	00-970 P1 6.5.33 00-970 P1 6.6.2 00-970 P7 L604 20.1.5
		STANAG Reference:	4671.1309
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309 CS 25.671* CS 25.672* *(unverified-Dutch 516)

6.2.2. Basic VCF.

6.2.2.1 VCF command control elements, shall be demonstrably safe for the entire range of air vehicle and air crew responses. This includes ensuring component functional characteristics are defined and do not to induce a departure or loss of control.

Consideration should be given to:

a. All flight phases;

b. All VCF command control elements which transmit crew control commands or generate and/or convey commands;

c. Altitudes up to the maximum expected in operation;

d. Mechanical, analogue and electrical component functional characteristics;

e. Compatibility between mechanical and non mechanical components;

f. Ensuring each control operates easily, smoothly and positively enough to allow proper performance of its functions;

g. Cable systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: para 3.1.1, 4.1.1, 3.1.11.10, 4.1.11.10, 3.1.11.11 thru 3.1.11.11.4, 4.1.11.11 thru 4.1.11.11.4, 3.2.2 thru 3.2.2.5.4, 4.2.2 thru 4.2.2.5.4 (Note: Unverified - no access	*Def-Stan 00-970 Reference:*	00-970 P1 2.6.14 00-970 P1 2.8.12 00-970 P1 4.10.2
		STANAG Reference:	4671.671 4671.1309

Information Sources			
	to JSSG-2008)		4671.1731
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.21 CS 23.141-23.257 CS 23.321-23.459 CS 23.671 CS 23.1309 CS 25.21 CS 25.143-25.255 CS 25.321-25.459 CS 25.671 CS 25.689 CS 25.1309 CS 27.21 CS 27.141-27.251 CS 27.321-27.427 CS 27.671 CS 27.1309 CS 29.21 CS 29.141-29.251 CS 29.321-29.427 CS 29.671 CS 29.1309

6.2.2.2 Friction levels, breakout forces, dead zones, hysteresis, and backlash of each axis of the control system (including thrust, and thrust vector angle if it is controlled by a separate inceptor) shall not preclude safety-of-flight (SOF). This includes ensuring functional characteristics do not induce a control system failure, loss of control or a departure.

Consideration should be given to:

a. Non-linear characteristics;

b. Probability of combinations of these phenomena leading to a failure condition;

c. Tests are to be made with the autostabilisers, 'q' feel systems etc., operative.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.2.2.5.1.1, 4.2.2.5.1.1 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.6.11 00-970 P1 2.8.12 00-970 P1 2.17.30 00-970 P1 2.19.22 00-970 P1 3.9.22 00-970 P1 3.9.23 00-970 P1 4.10.6 00-970 P1 4.10.7
		STANAG Reference:	4671.629(j) (AMC.629(j)) 4671.671 4671.683
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-	*EASA CS Reference:*	CS 23.141-23.257 CS 23.321-23.459 CS 23.683

Information Sources			
	25.1529		CS 25.143-25.255 CS 25.321-25.459 CS 25.683 CS 27.141-27.251 CS 27.321-27.427 CS 27.683 CS 29.141-29.251 CS 29.321-29.427 CS 29.683

6.2.2.3 Air vehicle control and manoeuvrability functions shall be properly designed to ensure safety-of-flight (SOF), and shall not require exceptional piloting skill, alertness or strength. This includes ensuring longitudinal, lateral-directional, lift, drag, performance limiting, and variable geometry control systems are safety mechanised and operate with the ease, smoothness, and positiveness appropriate to their function, throughout the flight envelope.

Consideration should be given to:

a. Operation at all altitudes, not exceeding the maximum operating altitude;

b. All practical / critical loading conditions; within the range of weights and centres of gravity;

c. Effectiveness of any device or method used to monitor control functions;

d. Resistance of Control Systems to external and internal sources of electromagnetic interference.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1.5.3, 4.1.5.3, 3.2.1 thru 3.2.1.4, 4.2.1 thru 4.2.1.4, 3.2.2.5.4, 4.2.2.5.4 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 S2.6 00-970 P1 S2.8 00-970 P1 S2.11 00-970 P1 S3.9
		STANAG Reference:	4671.671-4671.703
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.21 CS 23.141-23.257 CS 23.671-23.703 CS 25.21 CS 25.143-25.255 CS 25.671-25.703 CS 27.21 CS 27.141-27.251 CS 27.671-23.703 CS 29.21 CS 29.141-29.251 CS 29.671-23.703

6.2.2.4 Control system surfaces shall be installed so there is no mechanical interference from surrounding air vehicle structures or devices. If an adjustable stabiliser is used, it shall have stops that limit its range of travel to that allowing safe flight and landing.

Consideration should be given to:

a. The most critical clearance positions;

b. The full range of movement of surrounding devices;

c. Structural deflections resulting from the most adverse flight, manufacturing, environmental and load conditions, the means of which is to be established, agreed and verified;
d. Ensuring the control system is free from excessive friction, and excessive deflection.

For rotorcraft, there shall be sufficient clearance between the rotor blades and other parts of the structure to prevent the blades from striking any part of the structure during any operating condition.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.2.1 thru 3.2.1.4, 4.2.1 thru 4.2.1.4, 3.2.2.5 thru 3.2.2.5.1.1, 4.2.2.5 thru 4.2.2.5.1.1, 3.2.3, 4.2.3 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.9.18 00-970 P1 3.9.26
		STANAG Reference:	4671.655 4671.683
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.655 CS 23.683 CS 25.655 CS 25.683 CS 27.661 CS 27.683 CS 29.661 CS 29.683

6.2.2.5 Surface rate and hinge moments for VCF actuation shall not adversely affect air vehicle control throughout the combined range of attainable angles of attack (both positive and negative) and sideslip. This includes ensuring no actuator hinge moments or blowback can cause a departure, loss of control or pilot coupling, under all specified flight, environmental and load conditions.

Consideration should be given to:
a. The most adverse combination of flight, environment and load conditions, to be agreed and verified.
b. Deep stall trim conditions;
c. All manoeuvring;
d. Factors such as pilot strength, regions of control-surface-fixed instability, inertial coupling, fuel slosh, the influence of symmetric and asymmetric stores, stall/post-stall/ spin characteristics, atmospheric disturbances and Aircraft Failure States;
e. Failure transients and manoeuvring flight appropriate to the Failure State;
f. The degree of effectiveness and certainty of operation of limiters, e.g. control malfunction or mismanagement, and transients from failures in the propulsion, flight control and other relevant systems;
g. All configurations, including stores (symmetric and asymmetric).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1.5.6 thru 3.1.5.7, 4.1.5.6 thru 4.1.5.7, 3.2.2.1, 4.2.2.1, 3.2.1, 4.2.1, 3.2.1.1, 4.2.1.1 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.4.13 00-970 P1 3.9.9 00-970 P1 4.10.8
		STANAG Reference:	
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459,	*EASA CS Reference:*	CS 23.21 CS 23.141-23.257 CS 23.321-23.459

Information Sources			
	23.1501-23.1529, 25.1501-25.1529		CS 23.657 CS 23.1501-23.1529 CS 25.21 CS 25.143-25.255 CS 25.321-25.459 CS 25.651 CS 25.657 CS 25.1501-23.1529 CS 27.21 CS 27.141-27.251 CS 27.321-27.427 CS 27.1501-27.1529 CS 29.21 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529

6.2.2.6 Cockpit control forces shall not exceed the specified design limits and shall provide full and free movement of the control input devices, for all axes, including trim. Forces shall not be so great as to make excessive demands on the pilot's strength when manoeuvring the air vehicle and shall not be so low that the air vehicle can easily be overstressed inadvertently.

Consideration should be given to:

a. Aircraft type, intended operational use and role;

b. Specified design limit control forces, to be agreed and verified;

c. Both short and long term application of force;

d. Both one and two hands available for control;

e. Control forces for pitch, roll, yaw and trim;

f. Forces applied to the control wheel, stick, side-stick or rudder pedal;

g. Ensuring control system forces and free play do not inhibit a smooth, direct air vehicle response;

h. Specified manoeuvres, to be agreed and verified;

i. Force of the pilots operating dual controls in opposition, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.2.2.3, 4.2.2.3, 3.2.2.5.1, 4.2.2.5.1, 3.2.2.5.1.1, 4.2.2.5.1.1, 3.2.2.5.1.3, 4.2.2.5.1.3 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.4.6 00-970 P1 3.4.13 00-970 P1 4.10.4
		STANAG Reference:	
FAA Doc:	14CFR references: 23.779, 25.779, 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.21 CS 23.141-23.257 CS 23.321-23.459 CS 25.21 CS 25.143-25.255 CS 25.321-25.459 CS 27.21 CS 27.141-27.251 CS 27.321-27.427

Information Sources			
			CS 29.21 CS 29.141-29.251 CS 29.321-29.427

6.2.2.7 Functional control nonlinearities shall not preclude safety-of-flight (SOF). This includes ensuring aggregate nonlinearities of all interfaces and computational paths do not induce departure, loss of control or pilot coupling.

Consideration should be given to:

a. Gain margin to be agreed and verified (typically not worse than 6 db);

b. Phase margin to be agreed and verified (typically not worse than 45 degrees);

c. Mechanical, electrical, hydraulic, digital and analogue interface nonlinearities;

d. Avoiding oversensitivity or sluggishness in response.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.2.2.5.4 thru 3.2.2.5.4.5, 4.2.2.5.4 thru 4.2.2.5.4.5 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.17.29 00-970 P1 2.22.6 00-970 P1 2.22.15 00-970 P1 3.10.38 00-970 P1 3.10.59
		STANAG Reference:	
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.21 CS 23.141-23.257 CS 23.321-23.459 CS 25.21 CS 25.143-25.255 CS 25.321-25.459 CS 27.21 CS 27.141-27.251 CS 27.321-27.427 CS 29.21, CS 29.141-29.251 CS 29.321-29.427

6.2.2.8 Trim ranges and rates for all axes shall not preclude safety-of-flight (SOF). This includes ensuring trim rates are sufficient to enable the flight-crew to maintain low out-of-trim inceptor forces; but do not produce pilot coupling.

Consideration should be given to:

a. Trim authority limits to be agreed and verified (typically + 1.5g in pitch, + 0.5g roll, and + 0.2g yaw);

b. Operation at altitudes up to the maximum expected in operation;

c. The most critical combinations of weight and CofG (Forward CofG is usually critical at slow speeds, and aft CofG critical at high speeds);

d. Over-sensitivity in operation of the yaw and roll trim systems;

e. Maximum acceleration and deceleration likely to be encountered during normal service operation.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.2.2.5.1.3, 4.2.2.5.1.3 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.4.27 00-970 P1 2.6 00-970 P1 2.8 00-970 P1 2.17 00-970 P1 2.16.22
		STANAG Reference:	4671.161 4671.677
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.21 CS 23.141-23.257 CS 23.677 CS 25.21 CS 25.143-25.255 CS 25.677 CS 27.21 CS 27.141-27.251 CS 29.21 CS 29.141-29.251

6.2.2.9 The effects of trim failure on air vehicle control and stability shall be identified and mitigated. This includes preventing hard-overs, compensating for jams or miss-trims such as to prevent an induced departure, loss of control or pilot coupling.

Consideration should be given to:

a. Any reasonable credible combination of trim failures;

b. The response of the air vehicle to trim system runaways;

c. The controllability of the air vehicle following the runaway;

d. Use of an emergency trim system.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.2.2.5.1.3, 4.2.2.5.1.3 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.15.13
		STANAG Reference:	4671.161 4671.677
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.21, CS 23.141-23.257 CS 23.672 CS 23.677 CS 25.21 CS 25.143-25.255 CS 25.671, 25.672 CS 25.677 CS 27.21 CS 27.141-27.251 CS 27.672 CS 29.21 CS 29.141-29.251

Information Sources			
			CS 29.672

6.2.2.10 Control devices intended for intermittent operation (such as flaps, slats, speed brakes, geometry mechanisms, auxiliary control devices) shall not preclude safety-of-flight (SOF). This includes ensuring latent failures for devices used only in discrete parts of the flight envelope (modes), or that are seldom used or that are only for some type of backup capability, can not induce a departure, loss of control, or pilot coupling.

Consideration should be given to:

a. Monitoring such elements of the VCF to ensure that they are fit for use when required;

b. Provision of fail-safe reversion to manual control for recovery for non full-time systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1.8, 4.1.8, 3.2.1.3, 4.2.1.3, 3.2.1.4, 4.2.1.4, 3.2.1, 4.2.1, 3.2.2.5.4.5, 4.2.2.5.4.5, 3.1.12 thru 3.1.12.1, 4.1.12 thru 4.1.12.1 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.15.15 00-970 P1 2.15.20 00-970 P1 2.15.29 00-970 P1 3.10.73 00-970 P1 3.10.105
		STANAG Reference:	4671.701 4671.1309
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.701, CS 23.1309 CS 25.701, CS 25.1309 CS 27.674, CS 27.1309 CS 29.674, CS 29.1309

6.2.2.11 VCF safety provisions (protection functions, devices, procedures, limitations) shall not adversely affect the safety of the air vehicle.

Consideration should be given to:

a. Applicable standards (including software) to be agreed and verified;

b. Use of an appropriate system safety programme as detailed in Section 14;

c. Compatibility with weapon systems;

d. Safety provisions from both component and software induced faults;

e. Acceptable probabilities of occurrence, to be agreed and verified for;

i. Any failure condition that would prevent the continued safe flight and landing of the air vehicle.

ii. Any other failure condition that would significantly reduce the capability of the aeroplane or the ability of the flight crew to cope with adverse operating conditions.

f. Flight envelope protection for UAS.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1.5.3, 3.1.5.2, 3.1.5.4, 3.1.9, 3.1.11.1, 3.1.10, 3.1.11.1.1, 3.1.13 to 3.1.13.2, 3.1.16, 3.2.2.5.4.1, 3.2.4 thru	*Def-Stan 00-970 Reference:*	
		STANAG	4671.1309 (AMC.1309(b))

Information Sources			
	3.2.4.6, and associated section 4 paragraphs (Note: Unverified - no access to JSSG-2008)	*Reference:*	
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1309 CS 25.1309 (AMC.1309) CS 27.1309 CS 29.1309

6.2.2.12 The VCF shall include sufficient redundancy to ensure that alternate control paths are available for all control axis / modes and do not preclude safety-of-flight (SOF). This includes ensuring redundant elements are separated as far as possible, so that minor accidental or battle damage does not cause failure of the VCF.

Considerations shall be given to:

a. Failure detection, isolation, and corrective action within time limits to be agreed and verified;

b. Physical and electrical isolation between redundant elements;

c. Preventing propagation of failures among vehicle control elements;

d. Eliminating sources of common-mode failure;

e. Use of the autopilot or trim circuit to provide a measure of control of the air vehicle in the event of primary failure;

f. Location of control paths where combat damage is less probable with respect to threat and the role of the air vehicle.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: para 3.1.2.1, 4.1.2.1, 3.1.11.1, 4.1.11.1, 3.1.12 thru 3.1.12.1, 4.1.12 thru 4.1.12.1 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.9.29 00-970 P1 3.10.12 00-970 P1 3.10.30 00-970 P1 3.10.47 00-970 P1 3.10.69
		STANAG Reference:	
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.21 CS 23.141-23.257 CS 23.672 CS 25.21 CS 25.143-25.255 CS 25.671 CS 25.672 CS 27.21 CS 27.141-27.251 CS 27.672 CS 29.21 CS 29.141-29.251 CS 29.672

6.2.2.13 Ratio changers and artificial feel devices (or similar devices) shall not adversely affect safety-of-flight (SOF). This includes ensuring that no changes in artificial feel can produce departure, loss of control or pilot coupling. Control system units, components, and parts which transmit control signals mechanically shall meet the specified design limit conditions and safety factors.

Consideration should be given to:

a. Design limit conditions and safety factors, to be agreed and verified;

b. Assessing the effects from loss of the artificial feel devices;

c. The most critical case from handling considerations in terms of airspeed, altitude, mass, centre of gravity and external stores configuration.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1.7.2, 4.1.7.2, 3.1.11.11, 4.1.11.11, 3.1.11.11.1, 4.1.11.11.1, 3.1.12.1, 4.1.12.1, 3.1.14.4, 4.1.14.4 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.15.14 00-970 P1 3.9.3 00-970 P1 3.9.4 00-970 P1 3.9.31
		STANAG Reference:	
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.141-23.257 CS 23.321-23.459 CS 25.143-25.255 CS 25.321-25.459 CS 27.141-27.251 CS 27.321-27.427 CS 29.141-29.251 CS 29.321-29.427

6.2.2.14 Merged with 6.2.1.5

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1.11.1, 3.1.11.1.1, 3.1, 3.1.2, 3.1.5.5, 3.1.5.6, 3.1.7.3, 3.1.9, 3.1.11.4, 3.1.11.7, 3.1.12, 3.1.13.2, 3.1.14.4, 3.1.17, 3.2.2.2 thru 3.2.2.2.13, 3.3.3, 3.4.2, 3.5.7 and associated section 4 paragraphs (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	Merged with 6.2.1.5
		STANAG Reference:	Merged with 6.2.1.5
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	Merged with 6.2.1.5

6.2.2.15 VCF component design shall be demonstrably safe. This includes preventing degradation in VCF operation from environmental conditions; resisting the formation of fungi; ensuring VCF physical characteristics do not cause a single point failure by virtue of components design, interfaces nor integration of functions.

Consideration should be given to:

a. Environmental conditions (including humidity, temperature, pressure, altitude), to be agreed and specified;
b. Avoiding pockets, traps, wells, etc., into which water, condensed moisture or other liquids would collect;
c. Ensuring adequate drain provision;
d. Ensuring drain location adequate to prevent formation of hazardous quantities of ice on the aircraft;
e. Any deleterious effects due to tightening or slackening resulting from differential expansion;
f. Providing sufficient clearance to ensure the efficient operation of all detail fittings, such as jacks, bearings, guides, fairleads, etc., to be agreed and verified;
g. Withstanding physical, induced, chemical, biological and nuclear stresses.
h. Wherever possible, avoid materials which expand appreciably with moisture for such parts as fairleads and washers.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1.14 thru 3.1.14.9, 4.1.14 thru 4.1.14.9, 3.1.15 thru 3.1.18, 4.1.15 thru 4.1.18, 3.2.3 thru 3.2.3.3, 4.2.3 thru 4.2.3.3, 3.4 thru 3.5.2, 4.4 thru 4.5.2 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.15 00-970 P1 3.9.24 00-970 P1 3.9.25 00-970 P1 3.9.31
		STANAG Reference:	4671.603 4671.1309 4671.1329(g)
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.21 CS 23.141-23.257 CS 23.321-23.459 CS 23.603 CS 23.1309 CS 23.1329(g) CS 25.21 CS 25.143-25.255 CS 25.321-25.459 CS 25.603 CS 25.1309 CS 25.1455 CS 27.21 CS 27.141-27.251 CS 27.321-27.427 CS 27.603 CS 27.1309 CS 29.21 CS 29.141-29.251 CS 29.321-29.427 CS 29.603 CS 29.1309

6.2.2.16 Merged with 6.2.2.17

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	Merged with 6.2.2.17	*Def-Stan 00-970 Reference:*	Merged with 6.2.2.17
		STANAG Reference:	Merged with 6.2.2.17
FAA Doc:	Merged with 6.2.2.17	*EASA CS Reference:*	Merged with 6.2.2.17

6.2.2.17 The VCF shall have sufficient clearances to prevent foreign object damage (FOD). This includes ensuring no probable combination of temperature effects, air loads, structural deflections, vibration, build-up of manufacturing tolerances, wear, sag, or installation which can cause binding or jamming of any portion of the VCF, or result in insufficient clearance.

Consideration should be given to:

a. The following minimum clearances, provided for guidance, to be agreed and verified:

i. Between wiring and plumbing which carries combustible fluids (typically 152mm);

ii. Between wiring and control cables (typically 76mm);

iii. Around any control routeing and connections such as bell cranks, cables, actuator attachments, path changers, etc (typically 6mm);

iv. Between elements which move in relation to one another but which are guided or connected to the same component (typically 3mm);

v. Between elements which move in relation to one another and which are guided or connected to separate components (typically 6mm);

vi. Between elements and air vehicle structure or equipment to which they are not attached, unless structural flexibility requires a greater clearance to be provided (typically 12mm).

b. Where surrounding material such as fasteners, rivets, nuts, bolts, washers etc., exceed 6mm, the design accommodates these particulars.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: para 3.0, 4.0, 3.1, 4.1, 3.1.7.2, 4.1.7.2, 3.1.7.3, 4.1.7.3, 3.1.11.11, 4.1.11.11, 3.1.11.11.1, 4.1.11.11.1, 3.1.13, 4.1.13, 3.1.14, 4.1.14, 3.1.14.5, 4.1.14.5, 3.2.2.1, 4.2.2.1, 3.2.3, 4.2.3, 3.2.3.3, 4.2.3.3, 3.4.4, 4.4.4, 3.5.7, 4.5.7 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.2.2 00-970 P1 2.15.14 00-970 P1 3.1.19 00-970 P1 3.9.18 00-970 P1 3.9.20 00-970 P1 3.9.24-3.9.26 00-970 P1/5 S3 L24
		STANAG Reference:	4671.655 4671.683 4671.685
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.21 CS 23.141-23.257 CS 23.321-23.459 CS 23.655 CS 23.683 CS 23.685 CS 25.21 CS 25.143-25.255 CS 25.321-25.459 CS 25.655

Information Sources			
			CS 25.671 CS 25.683 CS 25.685 CS 27.21 CS 27.141-27.251 CS 27.321-27.427 CS 27.683 CS 27.685 CS 29.21 CS 29.141-29.251 CS 29.321-29.427 CS 29.683 CS 27.685

6.2.2.18 Control laws incorporated in the VCF shall be demonstrably safe, and shall provide levels of performance as stated in the air vehicle specification. The probability of loss (if gain or phase margins which result in an unrecoverable air vehicle condition) shall be significantly less than the required probability for loss of the air vehicle due to control system failure.

Consideration should be given to:

a. Operating in turbulence;

b. All predictable variations in system operating conditions and air vehicle configurations;

c. Ensuring all flight control laws are defined in unambiguous Flight Requirements Document (FRD) or Software Requirements Statement (SRS);

d. Appropriate control law strategies to recover from unusual attitudes, or from intentional manoeuvres which involve transition through a period of low or negative airspeed;

e. Using the minimum number of sensor derived feedbacks;

f. Using the most rugged sensors for primary feedbacks essential to continued safe flight;

g. Conditions of full and partial constraint (e.g., undercarriage restraint).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1, 3.1.5.2, 3.1.5.5, 3.1.5.7, 3.1.8, 3.1.11.6, 3.1.11.8, 3.1.13, 3.1.14.8, 3.1.16, 3.1.17, 3.1.18, 3.2.2.1, 3.2.2.4, 3.2.2.5.2, 3.2.2.5.4 thru 3.2.2.5.4.5, 3.2.2.6, 3.3.1, 3.3.4, 3.3.5, 3.3.7, and associated section 4 paragraphs (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.33-3.10.46 00-970 P1 3.10.81
		STANAG Reference:	4671.1329
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.21 CS 23.141-23.257 CS 23.672 CS 23.1329 CS 25.21 CS 25.143-25.255 CS 25.672 CS 25.1329

Information Sources			
			CS 27.21 CS 27.141-27.251 CS 27.672 CS 27.1329 CS 29.21 CS 29.141-29.251 CS 29.672 CS 29.1329

6.2.2.19 Control law transients for gain and mode changes shall not exceed specified limits such as to preclude safety-of flight (SOF). This includes ensuring that where changes of control law (mode) can occur in flight, either automatically or by air crew selection, they shall incur minimum disturbance to controlled flight.

Consideration should be given to:

a. Normal or lateral acceleration limits, to be agreed and verified (typically 0.05g);

b. Roll rate limits, to be agreed and verified (typically up to 5 deg/sec roll rate (recommended is 3 deg/sec));

c. Sideslip limits, to be agreed and verified (typically 5 degrees of sideslip or a period of 2 seconds);

d. Pitch force, to be agreed and verified (typically <20 lb);

e. Roll force, to be agreed and verified (typically 10lb);

f. Yaw force, to be agreed and verified (typically 10lb);

g. Stability margins, to be agreed and verified (typically 25% sensitivity changes);

h. Worst case conditions as well as nominal flight conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1, 3.1.2, 3.1.2.1, 3.1.3, 3.1.5, 3.1.5.1, 3.1.5.2, 3.1.5.4, 3.1.5.5, 3.1.5.7, 3.1.5.8, 3.1.7, 3.1.7.2, 3.1.7.3, 3.1.9, 3.1.10, 3.1.11, 3.1.11.2, 3.1.11.4, 3.1.11.5, 3.1.11.6, 3.1.11.9, 3.1.11.10, 3.1.11.11.2, 3.1.11.11.3, 3.1.12, 3.1.12.1, 3.1.13.1, 3.1.13.2, 3.1.14.2.2, 3.1.14.2.4, 3.2.2.1, 3.2.2.2, 3.2.2.5, 3.3 thru 3.3.4, 3.3.6, 3.3.6.2, and associated section 4 paragraphs (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.8.15 00-970 P1 3.10.33 00-970 P1 3.10.38 00-970 P1 3.10.41 00-970 P1 3.10.81
		STANAG Reference:	4671.1329
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.672 CS 23.1329 CS 25.672 CS 25.1329 CS 27.672 CS 27.1329 CS 29.672 CS 29.1329 CS 23.21

Information Sources			
			CS 23.141-23.257 CS 23.321-23.459 CS 25.21 CS 25.143-25.255 CS 25.321-25.459 CS 27.21 CS 27.141-27.251 CS 27.321-27.427 CS 29.21 CS 29.141-29.251 CS 29.321-29.427

6.2.2.20 The VCF shall prevent limit-cycle and pilot induced oscillations (PIO) oscillations (i.e. sustained or uncontrollable oscillations) that might compromise safety, or cause crew or passenger dangerous conditions. This includes ensuring residual oscillations do not exceed levels which significantly affect the piloting task or pilot subjective acceptance, or which can result in significant wear of the system and airframe components.

Consideration should be given to:

a. Preventing limit cycles in the control system;

b. Damping characteristics of residual pitch and lateral oscillations at the pilot's station;

c. Particular attention to points in the flight envelope where nominal phase and gain margins are less than the traditional and lower margins may result in a vehicle instability or PIO;

d. Residual oscillations resulting from nonlinearities such as friction, hysteresis and poor resolution;

e. Negative static stability and low damping, which may contribute to and amplify any oscillations;

f. High speed, high dynamic pressure or high altitude conditions, which are critical;

g. Pitch PIO in landing caused by control system phase shift;

h. Roll PIO cause by high roll control gain;

i. Verification by manned and unmanned simulation, analysis and test. Manned simulation used to verify control laws, flying qualities and departure resistance prior to flight and as an adjunct to flight testing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.5, 3.1.5.1, 3.1.5.6, 3.1.5.9, 3.1.7, 3.1.7.3, 3.1.11.11.3, 3.2.1.1, 3.2.2.1, 3.2.2.5.4, 3.2.2.5.4.2, 3.2.2.5.4.3, 3.2.2.5.4.4, 3.2.2.6, and associated section 4 paragraphs (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.8.13 00-970 P1 2.22.9 00-970 P1 2.25.44 00-970 P1 3.10.33 00-970 P1 3.10.35 00-970 P1 3.10.39 00-970 P1 3.10.81 00-970 P1 2.17.31 00-970 P1 2.21.14 00-970 P1 2.22.12 00-970 P1/5 S2 L45
		STANAG Reference:	4671.1329
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-	*EASA CS Reference:*	CS 23.21 CS 23.141-23.257 CS 23.672

Information Sources			
	25.1529		CS 23.1329 CS 25.21 CS 25.143-25.255 CS 25.672 CS 25.1329 CS 27.21 CS 27.141-27.251 CS 27.672 CS 27.1329 CS 29.21 CS 29.141-29.251 CS 29.672 CS 29.1329

6.2.2.21 Merged with 6.2.2.20

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Merged with 6.2.2.20	*Def-Stan 00-970 Reference:*	Merged with 6.2.2.20
		STANAG Reference:	Merged with 6.2.2.20
FAA Doc:	Merged with 6.2.2.20	*EASA CS Reference:*	Merged with 6.2.2.20

6.2.2.22 VCF control laws shall incorporate sufficient redundancy and failure management in order to meet the specified survivability, failure immunity and safety requirements.

Consideration should be given to:

a. Ensuring control laws and common software are treated as common-mode elements in design and proving;

b. Specified redundancy and survivability, failure immunity and safety requirements to be agreed and verified;

c. Taking special care to eliminate sources of common-mode failure where redundancy is employed;

d. Operation in natural, induced and hostile environments;

e. Ensuring the effects of failures upon the motion of the air vehicle are minimised;

f. Ensuring that nuisance disconnects do not compromise system integrity and performance.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.1, 3.1.2, 3.1.2.1, 3.1.4, 3.1.5.5, 3.1.5.7, 3.1.7, 3.1.7.2, 3.1.9, 3.1.10, 3.1.11, 3.1.11.2, 3.11.5, 3.1.11.6, 3.1.11.7, 3.1.12, 3.1.12.1, 3.1.13.1, 3.1.17, 3.2.2.4, 3.2.2.5, 3.2.2.5.1.4, 3.2.2.5.4, 3.2.5.2, 3.3.1, 3.3.2, and associated section 4 paragraphs (Note: Unverified -	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.2 00-970 P1 3.10.28-3.10.31 00-970 P1 3.10.33 00-970 P1 3.10.35 00-970 P1 3.10.37 00-970 P1 3.10.40 00-970 P1 3.10.42 00-970 P1 3.10.44 00-970 P1 3.10.81

Information Sources			
	no access to JSSG-2008)		00-970 P1/5 S3 L26
		STANAG Reference:	4671.1329
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.21 CS 23.141-23.257 CS 23.672 CS 23.1329 CS 25.21 CS 25.143-25.255 CS 25.672 CS 25.1329 CS 27.21 CS 27.141-27.251 CS 27.672 CS 27.1329 CS 29.21 CS 29.141-29.251 CS 29.672 CS 29.1329

6.2.2.23 Phase and gain margins, including any transient responses, shall be established to provide a safe level of stability and shall not be adversely affected by sensitivity changes in key stability derivatives. Phase and gain margins shall be maintained at acceptable levels for all predictable variations in system operating conditions and air vehicle configurations throughout the defined service life and usage of the aircraft.

Consideration should be given to:

a. Each control feedback loop;

b. Operating in turbulence;

c. System operating conditions and air vehicle configurations, to be agreed and verified;

d. Gain margins to be agreed and verified (typically not worse than 6 db);

e. Phase margin to be agreed and verified (typically not worse than 45 degrees);

f. Sensitivity margins to be agreed and verified;

g. Using the most rugged sensors for primary feedbacks essential to continued safe flight;

h. Factors affecting sensitivity including: poorly defined nonlinear and higher order dynamics, anticipated manufacturing tolerances, aging, wear, maintenance and non-critical materiel failures;

i. The effects of atmospheric disturbances (such as gusts, turbulence...etc).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.5, 3.1.5.7, 3.1.5.8, 3.1.5.9, 3.1.7.2, 3.1.7.3, 3.1.11.2, 3.1.11.10, 3.1.11.11.1, 3.1.17, 3.2.2.1, 3.2.2.2.9, 3.2.2.5.4, 3.2.2.5.4.2, 3.2.2.5.4.3, 3.2.2.5.4.4, 3.2.2.6, 3.3.2.1, 3.3.4, 3.5, and associated section 4 paragraphs (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.17.32 00-970 P1 3.10.33 00-970 P1 3.10.36 00-970 P1 3.10.37 00-970 P1 3.10.38 00-970 P1 3.10.81
		STANAG Reference:	4671.1329

Information Sources			
FAA Doc:	14CFR references: 23.345, 23.397, 23.672, 23.675, 23.677, 23.679, 25.345, 25.397, 25.672, 25.675, 25.677, 25.679	*EASA CS Reference:*	CS 23.672 CS 23.1329 CS 25.672 CS 25.1329 CS 27.672 CS 27.1329 CS 29.672 CS 29.1329

6.2.2.24 Functional control authorities shall not permit the air vehicle and/or crew to enter into an unrecoverable situation as a result of specified VCF performance.

Consideration should be given to:

a. Motivator and mode authority;

b. The choice of displacement and rate authority for a given function;

c. Degrees of effectiveness and certainty of operation of limiters;

d. CG control malfunction or mismanagement;

e. Transients from failures in the propulsion, flight control and other relevant systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.5.3, 4.1.5.3, 3.1.7, 4.1.7, 3.1.8, 4.1.8, 3.1.12, 4.1.12, 3.1.13.2, 4.1.13.2, 3.2.2.5, 4.2.2.5, 3.2.2.5.1.2, 4.2.2.5.1.2, 3.2.2.5.1.3, 4.2.2.5.1.3, 3.2.2.5.1.4, 4.2.2.5.1.4, 3.2.2.5.4.1, 4.2.2.5.4.1, 3.2.2.6, 4.2.2.6 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.15.17 00-970 P1 3.10.3 00-970 P1 3.10.4 00-970 P1 3.10.55 00-970 P1 4.10.8 00-970 P1/5 S3 L26
		STANAG Reference:	4671.143-4671.253 4671.1329
FAA Doc:	14CFR references: 23.345, 23.397, 23.672, 23.675, 23.677, 23.679, 25.345, 25.397, 25.672, 25.675, 25.677, 25.679	*EASA CS Reference:*	CS 23.672 CS 23.1329 CS 25.672 CS 25.1329 CS 27.672 CS 27.1329 CS 29.672 CS 29.1329

6.2.2.25 The VCF shall be designed to prevent and/or compensate for any hazardous flight condition which results from the dynamic VCF functional performance.

Consideration should be given to:

a. Capability to function throughout the duration of severe turbulence;

b. Provide performance, to the levels stated in the air vehicle specification, to be agreed and verified;

c. Operation under environmental conditions, to be agreed and verified;

d. Dynamic conditions of control laws, control logic;

e. Integrity and security of control functions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.2, 4.2, 3.3, 4.3, 3.4, 4.4, 3.5, 4.5 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.3 00-970 P1 3.10.4 00-970 P1 3.10.55 00-970 P1 6.5.2
		STANAG Reference:	4671.143-4671.253 4671.1329
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.21 CS 23.141-23.257 CS 23.672 CS 23.1329 CS 25.21 CS 25.143-25.255 CS 25.672 CS 25.1329 CS 27.21 CS 27.141-27.251 CS 27.672 CS 27.1329 CS 29.21 CS 29.141-29.251 CS 29.672 CS 29.1329

6.2.2.26 The air vehicle shall provide a facility for the air crew to safely override the design-limited VCF. If the rejection, inhibition or limitation in the authority of an engaged mode can lead to a significant reduction in performance and operational capabilities, then suitable means of warning the pilot shall be provided.

Consideration should be given to:

a. Ensuring appropriate methods of interlocks for engagement/ disengagement of mission or flight phase particular controls are provided with override capability;

b. Providing both aural and visual warnings.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.5.2, 3.1.5.4, 3.1.7, 3.1.10, 3.1.11, 3.1.11.1, 3.1.11.1.1, 3.1.11.10, 3.1.14.7, 3.2, 3.2.2.3, 3.2.2.5.1, 3.2.2.5.1.2, 3.2.2.5.1.4, 3.2.2.5.4, 3.2.2.5.4.1, 3.2.2.5.4.3, 3.2.2.5.4.4, 3.2.2.5.4.5, 3.2.2.6, 3.5.3, and associated section 4 paragraphs (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.96 00-970 P1 3.10.97 00-970 P1 4.19.19
		STANAG Reference:	4671.1309
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.672 CS 23.1329 CS 25.672 CS 25.1329

Information Sources			
			CS 27.672 CS 27.1329 CS 29.672 CS 29.1329

6.2.2.27 The air vehicle control system shall have positive interlocks to prevent hazardous operation of devices/programs, to preclude inadvertent operation.

Consideration should be given to:
a. Any Operational Flight Program (OFP)s that deal with diagnostics, and BITs;
b. Providing an unmistakable warning when the control system lock is engaged;
c. Interlock methods such as:
 i. Removal of memory or processor chip;
 ii. Double access to partitioned memory;
 iii. Removal of power;
 iv. Cockpit switches, etc.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.13, 4.1.13, 3.1.13.1, 4.1.13.1, 3.1.13.3, 4.1.13.3, 3.1.14.7, 4.1.14.7, 3.2.2.2.2, 4.2.2.2.2, 3.2.2.5.1.3, 4.2.2.5.1.3, 3.2.2.6, 4.2.2.6 (Note: Unverified - no access to JSSG-2008 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.72
		STANAG Reference:	4671.679 4671.1329
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.672 CS 23.679 CS 23.1329 CS 25.672 CS 25.679 CS 25.1329 CS 27.672 CS 27.679 CS 27.1329 CS 29.672 CS 29.679 CS 29.1329

6.2.2.28 Merged with 6.2.2.29

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Merged with 6.2.2.29	*Def-Stan 00-970 Reference:*	Merged with 6.2.2.29
		STANAG Reference:	

Information Sources			
FAA Doc:	Merged with 6.2.2.29	*EASA CS Reference:*	Merged with 6.2.2.29

6.2.2.29 VCF engage/disengage functions/devices assignments and interlocks shall be provided to prevent the engagement of incompatible modes that could create an immediate undesirable situation or hazard that are incompatible with flight conditions or air vehicle configurations (e.g., flaps, slats, airbrake, wing sweep, engine power, nozzle angle etc.). A means shall also be provided to indicate the current mode of operation as selections or de-selections are made, including any armed modes, transitions and reversions.

Consideration should be given to:

a. Protection against improper mode engagement or positioning of any control functions;

b. Protection against in-flight engagement of any surface locks affecting aircraft stability;

c. Protection against simultaneous engagement, and engagement with incompatible flight conditions or air vehicle configurations, to be agreed and verified;

d. Ensuring indications are visible under all expected lighting conditions;

e. Ensuring controls and indications are grouped and presented in a logical and consistent manner;

f. Means of mode indication other than selector switch position.

g. Ensuring proper engagement and mixing of modes;

h. Emergency disengagement of modes to the basic flying air vehicle control mode.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.5.2, 3.1.5.8, 3.1.5.9, 3.1.7.2, 3.1.7.3, 3.1.11, 3.1.11.2, 3.1.13.1, 3.1.13.3, 3.1.14, 3.1.14.7, 3.2.2.2.4, 3.2.2.2.5, 3.2.2.2.9, 3.2.2.2.11, 3.2.2.4, 3.2.2.5.1, 3.2.2.5.1.1 thru 3.2.2.5.1.4, 3.2.2.5.4.1, 3.2.2.5.4.3, 3.2.2.5.4.4, 3.2.2.6, 3.3.2.1, and associated section 4 paragraphs (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.16.21 00-970 P1 3.10.41 00-970 P1 3.10.64 00-970 P1 3.10.65 00-970 P1 3.10.68 00-970 P1 4.19.18 00-970 P1 4.19.21
		STANAG Reference:	4671.1329
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.672 CS 23.1329 CS 25.672 CS 25.1329 CS 27.672 CS 27.1329 CS 29.672 CS 29.1329

6.2.2.30 Merged with 6.2.2.31

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Merged with 6.2.2.31	*Def-Stan 00-970 Reference:*	Merged with 6.2.2.31
		STANAG	Merged with 6.2.2.31

Information Sources			
		Reference:	
FAA Doc:	Merged with 6.2.2.31	*EASA CS Reference:*	Merged with 6.2.2.31

6.2.2.31 Transient times for automatic and manual VCF engagement / disengagement and mode changes shall be within specified limits, such as to preclude safety-of-flight (SOF) and to ensure smooth engagement / disengagement.

Consideration should be given to:

a. Automatic transient times, to be agreed and verified (typically 0.1 seconds or less). Larger transient times may be justified and acceptable depending on the application;

b. Manual transient times, to be agreed and verified;

c. Operation in worse case conditions, to be agreed and verified;

d. Operation in nominal flight conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.2, 3.1.5, 3.1.5.1, 3.1.5.2, 3.1.5.4, 3.1.5.5, 3.1.7, 3.1.7.2, 3.1.7.3, 3.1.11, 3.1.11.2, 3.1.11.5, 3.1.11.10, 3.1.12, 3.1.12.1, 3.1.13.2, 3.1.14, 3.1.14.7, 3.2.2.1, 3.2.2.2.1, 3.2.2.2.2, 3.2.2.2.6, 3.2.2.2.9, 3.2.2.2.12, 3.2.2.5, 3.2.2.5.1.1, 3.2.2.5.1.2, 3.2.2.5.4, 3.2.2.5.4.3, 3.2.2.5.4.5, 3.2.2.6, 3.2.4.6, 3.2.5.1, 3.3.1, 3.3.2, 3.3.2.1, and associated section 4 paragraphs (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.16.20 00-970 P1 6.5.12 00-970 P1 6.5.13
		STANAG Reference:	4671.1329
FAA Doc:	FAA Doc: 14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1329 CS 25.1329 CS 27.1329 CS 29.1329

6.2.2.32 VCF warning and caution function/devices shall provide fast and adequate notification to the air crew for any VCF failure or condition which could result in an unsafe flight. Warnings shall be clearly distinguishable to the air crew under expected flight conditions without requiring the air crew's attention.

Consideration should be given to a warnings and caution philosophy document which includes:

a. Ensuring warnings and cautions are within the air crew's field of vision;

b. Ensuring warnings and cautions minimise air crew errors and confusion;

c. Indicating the current mode of operation, including any armed modes, transitions, and reversions;

d. Ensuring indications are grouped and presented in a logical and consistent manner;

e. Ensuring indications are visible to each pilot under all expected lighting conditions;

f. The use of a three category warning system.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.11.10, 4.1.11.10, 3.1.13.4, 4.1.13.4, 3.1.17, 4.1.17, 3.2.2.2.7, 4.2.2.2.7, 3.2.2.5.1.2, 4.2.2.5.1.2, 3.2.2.5.1.4, 4.2.2.5.1.4 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.64 00-970 P1 3.10.65 00-970 P1 3.10.68 00-970 P1 3.10.76 00-970 P1 3.10.96 00-970 P1 4.15.33 00-970 P1 4.15.35 00-970 P1 4.19.57
		STANAG Reference:	
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.672 CS 23.1329 CS 25.672 CS 25.1329 CS 27.672 CS 27.1329 CS 29.672 CS 29.1329

6.2.2.33 The location of sensors shall minimise/avoid structural mode coupling such as to prevent erroneous feedback and disruption of the VCF or air vehicle. Sensor location shall also provide adequate protection from bird-strike, accidental and battle damage.

Consideration should be given to:

a. Structural mode coupling, including vibration from configuration loading and gun fire;

b. Account for sensitivities to actual manufacturing and variations in key stability derivatives and structural mode frequencies;

c. Use of the most rugged sensors for primary feedbacks essential to continued safe flight.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.2.1, 3.1.5, 3.1.5.6, 3.1.7.2, 3.1.11, 3.1.13, 3.1.15, 3.1.17, 3.2.2.2, 3.2.2.5, 3.2.2.5.1.1, 3.2.2.5.2, 3.2.2.5.4.3, 3.2.2.5.4.4, 3.3.4, 3.3.6.2, 3.5.7, and associated section 4 paragraphs (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.23 00-970 P1 3.10.20 00-970 P1 3.10.36 00-970 P1 4.9.12 00-970 P1/5 S3 L26
		STANAG Reference:	4671.1309
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

6.2.2.34 VCF air data sensors (pitot-static probes and airstream direction sensors) shall have sufficient sensitivity tolerances such that variations in slope and bias conditions do not result in air data system error or failure. Tolerances shall be established for air data functions on the anticipated range of gain and phase errors which will exist between nominal test values or predictions and in-service operation.

Consideration should be given to:

a. Factors affecting gain and phase errors, such as poorly defined nonlinear and higher order dynamics, anticipated manufacturing tolerances, aging, wear etc.;
b. The effects of normal disturbances (e.g. sideslip, effect of asymmetric manoeuvres);
c. The following areas for air data system errors and failures:
i. Noise on air data signals;
ii. Calibration table errors in slope and bias;
iii. Intermittent signal failures (especially failures of duration counter);
iv. Lags; pneumatic, sensor, computational, electrical;
v. Out of range failures; just within range failures.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.5, 4.1.5, 3.1.5.7, 4.1.5.7, 3.1.7, 4.1.7, 3.1.7.2, 4.1.7.2, 3.1.17, 4.1.17, 3.2.1.1, 4.2.1.1, 3.2.1.2, 4.2.1.2, 3.2.2.5, 4.2.2.5, 3.3.2.5.4.2, 4.3.2.5.4.2, 3.2.2.5.4.4, 4.2.2.5.4.4 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.20 00-970 P1 6.3 00-970 P1/5 S3 L26 Para 3
		STANAG Reference:	
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1323 CS 23.1325 CS 25.1323 CS 25.1325 CS 27.1323 CS 27.1325 CS 29.1323 CS 29.1325

6.2.2.35 The VCF computer/processor(s) shall be designed to ensure that processing hardware meets the specified requirements, such as to ensure safety-of-flight (SOF). This includes providing speed of operation and levels of discrimination fully compatible with the intended performance of the control laws, and enabling all management functions to be effective without incurring significant penalties arising from time delays.

The VCF computer/processor capacity requirements shall ensure there is sufficient margin, or be capable of growth, to meet later expansion requirements.

Consideration should be given to:
a. Ensuring sufficient redundancy is incorporated to meet the safety requirements and to ensure that failures do not propagate;
b. Ensuring the processor can withstand all induced and natural environments, to be agreed and verified;
c. Processing hardware requirements to be agreed and verified, and ensure any specialised requirements are also specified;
d. VCF computer/processor capacity margins, to be agreed and verified (typically 50%);
e. Accounting for noise sources of narrow-band signals such as harmonics of microprocessor clocks and power supply choppers.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	JSSG-2008:3.0, 4.0, 3.1, 4.1, 3.1.14.6, 4.1.14.6, 3.1.18, 4.1.18, 3.2.2.2, 4.2.2.2, 3.3, 4.3, 3.3.1, 4.3.1, 3.3.2, 4.3.2, 3.3.2.1, 4.3.2.1, 3.3.2.2, 4.3.2.2, 3.3.2.3, 4.3.2.3, 3.3.4, 4.3.4 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.19
		STANAG Reference:	4671.1329
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1329 CS 25.1329 CS 27.1329 CS 29.1329

6.2.2.36 Comprehensive and all-inclusive pre-flight checklists shall be established which are sufficient to determine the flight-worthiness of the VCF. This includes ensuring pre-flight tests, diagnostics, redundancy, and monitoring include all test sequences required to determine the status of the VCF and integrated systems prior to takeoff. It shall also be possible to conduct tests and checklists in a safe manner, such as to preclude injury.

Consideration should be given to:

a. Ensuring that all redundant elements, failure detection and signal selection algorithms, etc., are correctly functioning;

b. The use of an automatic, or where unavoidable, pilot-interactive pre-flight test function;

c. Ensuring the use of built-in-test (BIT) does not degrade system performance;

d. Ensuring the time to complete pre-flight tests meets the specified requirements, to be agreed and verified (typically 30 seconds for a complete automatic end to end check of the VCF).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.12, 3.1.13, 3.1.13.1, 3.1.14.7, 3.2.2.2, 3.2.2.5, 3.2.2.5.1, 3.2.2.5.2, 3.2.2.5.3, 3.3.6.2, 3.7.1, 3.7.1.1, and associated section 4 paragraphs (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.16.49 00-970 P1 2.16.50 00-970 P1 3.9.54 00-970 P1 3.10.63 00-970 P1 3.10.69-3.10.71 00-970 P1 6.5.29-6.5.31
		STANAG Reference:	4671.1329(j) (AMC.1329 (j))
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	

6.2.2.37 VCF interfaces / integration with other functions and sub-functions shall be demonstrably safe. This includes ensuring the VCF meets the specified levels of integrity.

Consideration should be given to:

a. The interdependence of all aircraft functions within the integrated VCF;

b. Other control functions, e.g., structural mode and secondary controls, thrust and thrust vectoring;

c. Failure modes which may threaten safety-of-flight (SOF), for reasonably credible combinations of failures;

d. Specified levels of integrity, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.2, 3.1.5, 3.1.7, 3.1.8, 3.1.11, 3.1.12, 3.1.13, 3.1.14.4, 3.2.2.2, 3.2.2.4, 3.2.2.5, 3.2.2.6, 3.3, 3.2.4, and associated section 4 paragraphs (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.2 00-970 P1 3.10.6 00-970 P1 3.10.7 00-970 P1 3.10.32 00-970 P1 3.10.94 00-970 P1 3.10.95 00-970 P1 6.5.49
		STANAG Reference:	4671.1309 4671.1329
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1309 CS 23.1329 CS 25.1309 CS 25.1329 CS 27.1309 CS 27.1329 CS 29.1309 CS 29.1329

6.2.2.38 The effects of loss of VCF function(s) on air vehicle safety shall be established. This includes ensuring the probability of any reasonably credible combination of failures of VCF function(s) are acceptably improbable.

Consideration should be given to:

a. Complete hazard analysis combined with failure modes and effects testing;

b. Acceptable probability of failure limits, to be agreed and verified;

c. Where redundancy is employed, special care should be taken to eliminate sources of common-mode failure.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0 thru 3.3.8, 4.0 thru 4.3.8 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.16.40-2.16.42 00-970 P1 3.9.18 00-970 P1 3.10.28 00-970 P1 3.10.30 00-970 P1 3.10.94
		STANAG Reference:	4671.143-4671.253 4671.1309 4671.1329
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.21 CS 23.141-23.257 CS 23.672 CS 23.1309 CS 23.1329 CS 25.21 CS 25.143-25.255 CS 25.672 CS 25.1309

Information Sources			
			CS 25.1329 CS 27.21 CS 27.141-27.251 CS 27.672 CS 27.1309 CS 27.1329 CS 29.21 CS 29.141-29.251 CS 29.672 CS 29.1309 CS 29.1329

6.2.2.39 Control law limiters shall achieve the intended limiting for all VCF functions and protect the air crew and vehicle from unsafe flight. This includes ensuring that no VCF function shall induce conditions that defeat control law limiters throughout the flight envelope, and during the most adverse conditions the limiters function in.

Control law limiters may consist of structural limiters or filters, angle-of-attack and sideslip limiters, data input rate limiters, command limiters, data input max and min limiters, time limiters, persistence limiters, stale data limiters, and other limiters defined by the application at hand.

Consideration should be given to:

a. Establishing what limiters are used and where in the control scheme;

b. Any Structural Load Limiting (SLL) implemented in such a manner that the pilot may choose to exceed these limits in emergency.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.5.2, 3.1.5.8, 3.1.5.9, 3.1.7.2, 3.1.7.3, 3.1.11, 3.1.11.2, 3.1.13.1, 3.1.13.3, 3.1.14, 3.1.14.7, 3.2.2.2.4, 3.2.2.2.5, 3.2.2.2.9, 3.2.2.2.11, 3.2.2.4, 3.2.2.5.1, 3.2.2.5.1.1 thru 3.2.2.5.1.4, 3.2.2.5.4.1, 3.2.2.6, 3.3.2.1, 3.3.6.2, and associated section 4 paragraphs (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.9.32, 00-970 P1 3.10.104, 00-970 P1 4.10.8, 00-970 P1/5 S3 L28 Para 2
		STANAG Reference:	4671.375 4671.675 4671.1329
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.21 CS 23.141-23.257 CS 23.321-23.459 CS 23.672 CS 23.675 CS 23.1329 CS 23.1501-23.1529 CS 25.21 CS 25.143-25.255 CS 25.321-25.459 CS 25.672

Information Sources			
			CS 25.675 CS 25.1329 CS 25.1501-25.1529 CS CS 27.21 CS 27.141-27.251 CS 27.321-27.427 CS 27.672, 27.675 CS 27.1329 CS 27.1501-27.1529 CS 29.21 CS 29.141-29.251 CS 29.321-29.427 CS 29.672, 29.675 CS 29.1329 CS 29.1501-29.1529

6.2.2.40 Data transfer and update rates for VCF functions shall be fully compatible with control law rates and shall not adversely affect safety-of-flight (SOF). This includes ensuring time delay limits for controller input to air vehicle response are within permissible limits.

Consideration should be given to:

a. The time measured from the instant of a controller input to the time at the intersection of the line representing the maximum response slope on the time axis;

b. Any aerodynamic and aero-elastic influences;

c. Maximum permissible delay time, to be agreed and verified (typically 100 milliseconds);

d. Response in each control axis;

e. Ensuring VCF management functions are not significantly affected by time delays.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.5.1, 4.1.5.1, 3.1.5.5, 4.1.5.5, 3.1.5.6, 4.1.5.6, 3.1.7.3, 4.1.7.3, 3.1.17, 4.1.17, 3.3.2.1, 4.3.2.1, 3.3.4, 4.3.4 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.19 00-970 P1 4.10.8 00-970 P1/5 S2 L43 3.2.1
		STANAG Reference:	4671.1329
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1329 CS 25.1329 CS 27.1329 CS 29.1329

6.2.2.41 Air vehicle functional/transient interruption characteristics shall not adversely affect the time delay or margin characteristics of the VCF, such as to preclude safety-of-flight (SOF). This includes establishing which functional/transient interruption characteristics produce the most adverse conditions for each VCF function.

Consideration should be given to:

a. Any transient conditions associated with switching functions or interruptions to perform other functions;

b. All VCF functions or probable combinations of functions at limiting conditions, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.2, 3.1.5, 3.1.5.1, 3.1.5.2, 3.1.7, 3.1.7.3, 3.1.11.2, 3.1.11.10, 3.1.14.7, 3.1.17, 3.2.2.1, 3.2.2.2, 3.2.2.5, 3.2.2.5.1.1, 3.2.2.5.1.2, 3.2.2.5.4, 3.2.2.5.4.3, 3.2.2.5.4.5, 3.2.2.6, 3.2.4.6, 3.2.5.1, 3.3.6.2, and associated section 4 paragraphs (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.19 00-970 P1 4.10.8
		STANAG Reference:	4671.1329
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1329 CS 25.1329 CS 27.1329 CS 29.1329

6.2.2.42 VCF failure mode effects for critical manoeuvres and critical flight regions shall be demonstrably safe. This includes ensuring the probability of air vehicle or crew loss, or loss of air vehicle control resulting from effects, at these critical flight regimes does not adversely affect safety.

Consideration should be given to:

a. Specified levels of safety, to be agreed and verified;

b. Effects of failure from each function or probable combinations of functions conducted at critical flight regimes.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.5, 3.1.5.7, 3.1.5.8, 3.1.5.9, 3.1.9, 3.1.14, 3.2.1.3, 3.2.1.2, 3.2.2.2, 3.2.2.5, 3.2.2.5.4, 3.2.2.6, 3.3, and associated section 4 paragraphs (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.8 00-970 P1 3.10.9 00-970 P1 3.10.28 00-970 P1 3.10.30
		STANAG Reference:	4671.1329
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.672, CS 23.1329 CS 25.672, CS 25.1329 CS 27.672, CS 27.1329 CS 29.672, CS 29.1329

6.2.2.43 Available power for hinge moment, stiffness, and control surface rates shall meet the specified requirements of the actuation system and shall prevent unsafe flight.

Consideration should be given to:

a. Ensuring rates meet VCF gain and phase margins;

b. Ensuring rates preclude PIOs;

c. Static and dynamic hinge moment stiffness characteristics;

d. Dynamic control surface stiffness requirements;

e. Specified flow rate requirements of the actuation/hydraulic system (including back-up systems), to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.5.6, 4.1.5.6, 3.1.5.7, 4.1.5.7, 3.2.1, 4.2.1, 3.2.2.1, 4.2.2.1, 3.2.2.2.1, 4.2.2.2.1, 3.2.2.5.4.4, 4.2.2.5.4.4 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.8 00-970 P1 3.10.9 00-970 P1 3.10.28 00-970 P1 3.10.30
		STANAG Reference:	4671.393
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.321-23.459 CS 23.657 CS 23.1501-23.1529 CS 25.321-25.459 CS 25.651 CS 25.657 CS 25.1501-23.1529 CS 27.321-27.427 CS 27.1501-27.1529 CS 29.321-29.427 CS 29.1501-29.1529

6.2.2.44 Actuators used for VCF actuation shall be demonstrably safe. The actuators shall be designed to meet the specified safety requirements and shall ensure compatibility of all mechanical, hydraulic, pneumatic, electrical and electronic interfaces. This includes:

• Ensuring the actuator design meets the specified redundancy requirements;

• Ensuring sufficient separation and isolation is provided for VCF actuation;

• Ensuring there is sufficient protection against actuation contamination effects;

• Ensuring no valve or ram will bottom, and that the VCF provides sufficient electronic or mechanical snubbing.

Consideration should be given to:

a. Stability of the actuation system;

b. The effects of switching between redundant functions from detection and isolation;

c. Susceptibility to numerous and various types of failures induced by environmental contamination;

d. Specified redundancy requirements, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 3.10.26 00-970 P1 6.11.80 00-970 P1/5 S4 L29
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.2.2.45 The actuation system shall be demonstrably safe and shall not permit unsafe VCF actuation. This includes ensuring VCF performance / stability is not degraded beyond specified operational limits under all specified conditions (e.g.. burst pressure, normal performance, high and low temperature, pressure impulses) and environments.

Consideration should be given to:

a. Specified operational limits, to be agreed and verified;

b. The most adverse environmental conditions, to be agreed and verified;

c. The probability of loss of the actuation system, to be agreed and verified;

d. The use of pneumatic actuation devices;

e. The use of electrically powered actuators, including electro-hydrostatic actuators and electro-mechanical actuation and electric power used to actuate relatively low-duty cycle;

f. Employing control actuation redundancy.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.5.6, 4.1.5.6, 3.1.14.1, 4.1.14.1, 3.1.14.3, 4.1.14.3, 3.2.2.1, 4.2.2.1 (Note: Unverified - no access to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 6.11 00-970 P1 6.12
		STANAG Reference:	4671.1309
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

6.2.2.46 Merged with 6.2.2.44 & 6.2.2.45

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Merged with 6.2.2.44 & 6.2.2.45	*Def-Stan 00-970 Reference:*	Merged with 6.2.2.44 & 6.2.2.45
		STANAG Reference:	Merged with 6.2.2.44 & 6.2.2.45
FAA Doc:	Merged with 6.2.2.44 & 6.2.2.45	*EASA CS Reference:*	Merged with 6.2.2.44 & 6.2.2.45

6.2.2.47 All command and control channels used by the air vehicle shall be identified; these may include communications within the VCF, communications with ground control, and communications with other linked vehicles. Each of these channels shall be:

• Safely integrated with the other air vehicle systems;

• Have an acceptable probability of failure assigned to it;

• Resilient to the effects of the operating environment.

Consideration should be given to:

a. Common mode failure;

b. Data verification and correction techniques;

c. Demonstrating achievement of failure probabilities;

d. Requirements of Test and Acceptance Plan to demonstrate compliance.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1, 4.1, 3.1.8, 4.1.8, 3.1.7.3, 4.1.7.3, 3.1.11, 4.1.11, 3.1.11.7, 4.1.11.7, 3.1.11.9, 4.1.11.9, 3.1.13, 4.1.13, 3.2.2.2, 4.2.2.2, 3.2.2.5.1.2, 4.2.2.5.1.2, 3.2.2.5.3, 4.2.2.5.3, 3.3, 4.3, 3.3.1, 4.3.1, 3.3.2.3, 4.3.2.3, 3.3.3, 4.3.3	*Def-Stan 00-970 Reference:*	00-970 Pt 1 3.10.1-3.10.2 00-970 Pt 1 6.1.12-6.1.16 00-970 Pt 1 6.1.19 00-970 Pt 1 6.1.44 00-970 Pt 1 6.6.1
		STANAG Reference:	4671.141-4671.253 4671.321-4671.459 4671.1501-4671.1529 4671.U1309 4671.U1601-1617
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.141-23.253 CS 23.321-23.459 CS 23.1501-23.1529 CS 23.1309 CS 25.143-25.255 CS 25.321-25.459 CS 25.1501 -1533 CS 25.1309 CS 27.141-27.251 CS 27.321-27.427 CS 27.1501-27.1529 CS 27.1309 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529 CS 29.1309

6.2.2.48 Unauthorised access to the air vehicle command and control communications shall be prevented, and any security techniques used to achieve this shall be implemented safely. To achieve this, the air vehicle command and control communications systems shall be identified, and the required security level for each assigned. Any security techniques used to achieve the required level of security shall be shown to be safe, and shall be implemented in a safe manner.

Consideration should be given to:

a. Documenting the expected threat against each system;

b. Demonstrating that chosen security techniques are safe for the proposed use;

c. Demonstrating that the chosen security techniques are implemented safely;

d. Partitioning critical data from less critical data;

e. Encryption;

f. Physical means of security.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1.8, 4.1.8, 3.1.14.6, 4.1.14.6, 3.1.16, 4.1.16, 3.2, 4.2, 3.3.1, 4.3.1	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.1-3.10.2 00-970 P1 3.10.11 00-970 P1 3.10.19 00-970 P1 3.10.27 00-970 P1 3.10.32

Information Sources			
			00-970 P1 3.10.47-3.10.49
		STANAG Reference:	4671.141-4671.253 4671.321-4671.459 4671.1501-4671.1529 4671.1309 4671.U1601-1617
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.141-23.253 CS 23.321-23.459 CS 23.1501-23.1529 CS 23.1309 CS 25.143-25.255 CS 25.321-25.459 CS 25.1501 - 1533 CS 25.1309 CS 27.141-27.251 CS 27.321-27.427 CS 27.1501-27.1529 CS 27.1309 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529 CS 29.1309

6.2.2.49 A single space radiation upset event shall not cause loss of control of the air vehicle, and the probability of multiple upset events causing loss of control shall be acceptably low.

Consideration should be given to:

a. Identify the systems associated with vehicle control which would be susceptible to space radiation upset events;

b. Identify the potential failure modes associated with space radiation upset events on those susceptible systems;

c. Ensure Test and Acceptance Plan accounts for potential failure modes identified above;

d. Review system and component design to mitigate the effect of space radiation upset events;

e. Confirm system failure probability is acceptable;

f. Perform ground and rig testing to confirm systems integrity.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.2, 4.1.2, 3.1.3, 4.1.3, 3.1.7.3, 4.1.7.3, 3.1.8, 4.1.8, 3.1.9, 4.1.9, 3.1.11.1, 4.1.11.1, 3.1.12, 4.1.12, 3.1.13.2, 4.1.13.2, 3.1.14.4, 4.1.14.4, 3.1.17, 4.1.17	*Def-Stan 00-970 Reference:*	00-970 P1 2.15 00-970 P1 2.16.6 00-970 P1 2.16.42 00-970 P1 3.10.28-3.10.31 00-970 P1 6.2.35 00-970 P1 6.5.33 00-970 P1 6.5.46-6.5.49 00-970 P1 6.6.2
		STANAG Reference:	4671.141-4671.253 4671.321-4671.459 4671.1501-4671.1529

Information Sources			
			4671.1309
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.141-23.253 CS 23.321-23.459 CS 23.1501-23.1529 CS 23.1309 CS 25.143-25.255 CS 25.321-25.459 CS 25.1501-1533 CS 25.1309 CS 27.141-27.251 CS 27.321-27.427 CS 27.1501-27.1529 CS 27.1309 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529 CS 29.1309

6.2.2.50 Integration and operation of the air vehicle propulsion control system shall be safe for all conditions, including any occurrences of asymmetric thrust.

Consideration should be given to:

a. Identifying those systems which form part of the propulsion control system;

b. Demonstrating that the identified systems meet their assigned and derived safety probability targets;

c. Ensuring that the Test & Acceptance Plan provides adequate demonstration of safe operation throughout the approved flight envelope, including occurrences of asymmetric thrust where appropriate.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.2, 4.1.2, 3.1.5.3, 4.1.5.3, 3.1.5.5, 4.1.5.5, 3.1.7.3, 4.1.7.3, 3.1.11, 4.1.11, 3.1.13, 4.1.13, 3.1.13.3, 4.1.13.3, 3.1.17, 4.1.17, 3.2.2.2.9, 4.2.2.2.9, 3.2.2.5.1.1, 4.2.2.5.1.1, 3.2.2.5.4.5, 4.2.2.5.4.5, 3.3.1, 4.3.1	*Def-Stan 00-970 Reference:*	00-970 P1 2.14 00-970 P1 2.22.37 00-970 P1 3.9.18 00-970 P1 3.10.2 00-970 P1 3.10.28-3.10.30 00-970 P1 3.10.47-3.10.53 00-970 P1 3.10.75-3.10.77 00-970 P1 3.10.79-3.10.92 00-970 P1 11 3E50
		STANAG Reference:	4671.141-4671.253 4671.901-4671.909 4671.933-4671.943 4671.1141-4671.1143 4671.1309
FAA Doc:	14CFR references: 25.901	*EASA CS Reference:*	CS 23.141-23.253 CS 23.901-23.909 CS 23.933-23.943 CS 23.1141-23.1157 CS 23.1309 CS 25.143-25.255

Information Sources			
			CS 25.901-25.905 CS 25.933-23.945 CS 25.1141-25.1155 CS 25.1309 CS 27.141-27.251 CS 27.901-27.903 CS 27.1141-27.1151 CS 27.1309 CS 29.141-29.251 CS 29.901-29.903 CS 29.1141-29.1159 CS 29.1309

6.2.2.51 All security measures associated with VCF control functions shall be implemented in a safe manner. To achieve this, the VCF control functions shall be identified and the required security level for each assigned, along with any security measures to be implemented on them. It shall then be demonstrated that the assigned security measures do not adversely affect the control function.

Consideration should be given to:

a. Documenting the expected threat against each system;

b. Demonstrating that chosen security techniques are safe for the proposed use;

c. Demonstrating that the chosen security techniques are implemented safely;

d. Partitioning critical data from less critical data;

e. Encryption;

f. Physical means of security.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1.11, 4.1.11, 3.1.14.6, 4.1.14.6, 3.1.16, 4.1.16, 3.2, 4.2, 3.3.1, 4.3.1	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.1-3.10.2 00-970 P1 3.10.4 00-970 P1 3.10.19 00-970 P1 3.10.32 00-970 P1 3.10.47-3.10.53 00-970 P1 3.10.79-3.10.92
		STANAG Reference:	4671.1309
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

6.2.2.52 The VCF shall not adversely affect safety-of-flight (SOF) following degradation of the air data system.

Consideration should be given to:

a. Ensuring that, in the event of total loss of the air data system, an acceptable level of safety is maintained;

b. Implementation of the ADS, accuracy of the ADS, ground and air safety provisions, anti-ice or ice prevention, and bird strike vulnerability.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 2.15.27 00-970 P1 2.20.30 00-970 P1 3.10.20 00-970 P1 3.10.28 00-970 P1 4.9.12 00-970 P1 6.3 00-970 P1 13.1.5.1.10 00-970 P1 13.1.5.1.19-20
		STANAG Reference:	4671.1309 4671.1323 4671.1325 4671.1819
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 23.1323 CS 23.1325 CS 23.1326 CS 25.1309 CS 25.1323 CS 25.1325 CS 25.1326 CS 27.1309 CS 27.1323 CS 27.1325 CS 29.1309 CS 29.1323 CS 29.1325

6.2.2.53 VCF related installed equipment shall be protected where necessary, and the equipment environment shall be safe and suitable. Any VCF related equipment that require specific installation protection and/or environmental operating conditions shall be identified. The specific requirements shall be established and the air vehicle design shall take account of these. The Test and Acceptance Plan shall state how the achievement of the specific conditions shall be demonstrated.

Consideration should be given to:

1. Maintenance of a suitable temperature and humidity range;
2. Protection from EMC/EMI and lightning; including bonding;
3. Prevention of corrosion, fungal growths, and sand and dust ingress;
4. Provision of adequate vibration and shock protection;
5. Protection from the effects of nuclear, biological, chemical, and laser weapons.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1.14, 4.1.14, 3.4, 4.4, 3.5, 4.5(all)	*Def-Stan 00-970 Reference:*	00-970 P1 2.15.25 00-970 P1 3.9.24-3.9.25 00-970 P1 3.10.8-3.10.10

Information Sources			
			00-970 P1 3.10.11 00-970 P1 3.10.13 00-970 P1 4.27.7-4.27.25 00-970 P1 6.1.5 00-970 P1 6.2.40-6.2.60 00-970 P1 6.10 00-970 P13 3.11
		STANAG Reference:	4671.867 4671.1309 4671.1431
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.867 CS 23.1309 CS 23.1431 CS 25.1309 CS 25.1316 CS 25.1431 CS 27.1309 CS 29.1309 CS 29.1431

6.2.2.54 The air vehicle VCF shall not be adversely affected by inputs received from either the payload or from an interfacing ground station.

Consideration should be given to :

a. Signal or data synchronisation issues;

b. Signal or data latency issues;

c. The use and applicability of open architectures.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	ADS-51-HDBK ADS-33E-PRF Refer to Army Aviation technical point of contact for this discipline for specific guidance (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.2 00-970 P1 3.10.11-3.10.13 00-970 P1 3.10.32 00-970 P1 3.10.47-3.10.53 00-970 P1 3.10.79-3.10.93
		STANAG Reference:	4671.685 4671.1309 4671.1431 4671.1481
FAA Doc:	TBD: Refer to technical point of contact for this discipline (listed in section A.2)	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

6.2.2.55 The air vehicle VCF emergencies and their associated procedures shall be clearly related and recorded. It shall be demonstrated through testing that the emergency procedures are appropriate and safe; and the operating crews shall be made aware of them.

Consideration should be given to:

a. Ensuring that all identified emergencies have an appropriate emergency procedure;

b. That the identified emergencies provide the necessary compromise between breadth and depth - have the 'right' emergencies been identified?;
c. Ensuring the Test and Acceptance Plan provides adequate proof that the emergency procedures are appropriate and safe;
d. Recording and promulgating of the emergency procedures;
e. For UAV/UAS, a flight termination system and/or safe vehicle recovery system should be addressed.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	ADS-51-HDBK ADS-33E-PRF Refer to Army Aviation technical point of contact for this discipline for specific guidance (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.4 00-970 P1 3.10.88 00-970 P1 3.10.89
		STANAG Reference:	4671.1309 4671.1412 4671.1483 4671.1485
FAA Doc:	TBD: Refer to technical point of contact for this discipline (listed in section A.2)	*EASA CS Reference:*	CS 23.1309 CS 23.1581 CS 23.1585 CS 25.1309 CS 25.1581 CS 25.1585 CS 27.1309 CS 27.1581 CS 27.1585 CS 29.1309 CS 29.1581 CS 29.1585

6.2.2.56 For rotary wing air vehicles, there shall be adequate transient response for single axis (collective or rudder) inputs.

Consideration should be given to:
a. Agreeing the transient response values which are considered adequate;
b. Ensuring that the Test and Acceptance Plan encompasses the agreed transient values.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	ADS-51-HDBK ADS-33E-PRF Refer to Army Aviation technical point of contact for this discipline for specific guidance (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P7 S6 L600/7 00-970 P7 S6 L600/8
		STANAG Reference:	4671.141 4671.143
FAA Doc:	TBD: Refer to technical point of contact for this discipline (listed in section A.2)	*EASA CS Reference:*	CS 27.141 CS 27.143 CS 29.141 CS 29.143

6.2.2.57 Rotorcraft multi-axis inputs (e.g. collective, pedal, cyclic) shall be safe for typical operational mission manoeuvres throughout the service envelope defined for the craft.

Consideration should be given to:
a. Defining what a typical operational mission manoeuvre for the particular rotorcraft is;
b. Ensuring that the service envelope is defined;
c. Ensuring that the typical operational mission manoeuvres are contained within the service envelope;
d. Ensuring that the Test and Acceptance Plan encompasses the parameters necessary to adequately demonstrate compliance with the requirement.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	ADS-51-HDBK ADS-33E-PRF Refer to Army Aviation technical point of contact for this discipline for specific guidance (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P7 S6
		STANAG Reference:	4671.141 4671.143
FAA Doc:	TBD: Refer to technical point of contact for this discipline (listed in section A.2)	*EASA CS Reference:*	CS 27.141 CS 27.143 CS 27.151 CS 29.141 CS 29.143 CS 29.151

6.2.3. VCF power source criteria.

(Note: See section 12 for specific electrical power system criteria.)

6.2.3.1 The VCF shall not adversely affect safety-of-flight following degradation of the hydraulic system.

Consideration should be given to:
a. Hydraulic system distribution;
b. Loss of one, or part of any one, of the aircraft's hydraulic systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.2, 3.1.2.1, 3.1.3, 3.1.7.2, 3.1.7.3, 3.1.11, 3.1.11.11.3, 3.1.12, 3.1.12.1, 3.1.14.4, 3.1.14.9, 3.2.1.3, 3.2.2.2.1, 3.2.2.2.5, 3.2.3.1, and associated section 4 paragraphs	*Def-Stan 00-970 Reference:*	00-970 P1 6.11.52-6.11.55 00-970 P7 S1 L100 Para 9.1 00-970 P7 S7 L704 13.2-13.4
		STANAG Reference:	4671.1435
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

6.2.3.2 The aircraft hydraulic system(s) shall be designed to withstand defined peak pressure loads or pulses, and to operate without excessive pressure fluctuation.

Consideration should be given to:

a. The values for proof and ultimate pressure, related to Design Operating Pressure (DOP), to be agreed and verified;

b. Ensuring that cyclic pressures, including transients (surges) and those due to system volumetric changes, are contained within the agreed DOP;

c. Values for pressure fluctuation within the system, to be agreed and verified;

d. Satisfactory operation of the system to be demonstrated on a functional mock-up of the system.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.5.6, 4.1.5.6, 3.1.7.2, 4.1.7.2, 3.1.11.11.3, 4.1.11.11.3, 3.2.2.2.1, 4.2.2.2.1, 3.3 thru 3.3.4, 4.3 thru 4.3.4, 3.3.6, 4.3.6, 3.3.6.2, 4.3.6.2	*Def-Stan 00-970 Reference:*	00-970 P1 6.11.2 00-970 P1 6.11.60 00-970 P1 6.11.75 00-970 P7 S7 L704 8.1.4 00-970 P7 S7 L704 15.5.3
		STANAG Reference:	4671.1435
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1435 CS 25.1435 CS 27.1435 CS 29.1435

6.2.3.3 The aircraft backup and emergency hydraulic systems shall be designed to ensure that system pressure and flow rates are sufficient to maintain safety of flight.

Consideration should be given to:

a. The minimum system pressure and flow rates, to be agreed and verified;

b. Specifically testing to ensure that flutter does not preclude safety of flight when backup or emergency hydraulic systems are used.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.5.6, 4.1.5.6, 3.1.7.2, 4.1.7.2, 3.1.11.11.3, 4.1.11.11.3, 3.2.2.2.1, 4.2.2.2.1, 3.2.2.2.5, 4.2.2.2.5	*Def-Stan 00-970 Reference:*	00-970 P1 6.11.52-6.11.55
		STANAG Reference:	4671.1435
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

6.2.3.4 Use of the backup or emergency hydraulic systems shall not lead to loss of vehicle control function.

Consideration should be given to the following:

a. Pressure transients induced by component switch over. This includes, but is not limited to, pumps, actuators, valves, accumulators etc.;

b. Time lags induced by component switch over;

c. The ability to revert to the primary hydraulic system, if available, on failure of the backup or emergency supply.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.5.2, 4.1.5.2, 3.1.5.6, 4.1.5.6, 3.1.7.2, 4.1.7.2, 3.1.10, 4.1.10, 3.1.11.11.3, 4.1.11.11.3, 3.1.13, 4.1.13, 3.2.2.2.1, 4.2.2.2.1, 3.2.2.2.5, 4.2.2.2.5	*Def-Stan 00-970 Reference:*	00-970 P1 2.15.10 00-970 P1 6.11.53 00-970 P7 S7 L704 3.4.1
		STANAG Reference:	4671.1435
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

6.2.3.5 Merged with 6.2.3.1

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.2, 3.1.2.1, 3.1.3, 3.1.7.2, 3.1.7.3, 3.1.11.11.3, 3.1.12.1, 3.1.13, 3.1.14.4, 3.1.14.9, 3.2.1.3, 3.2.2.2, 3.2.2.2.1, 3.2.2.2.5, 3.3 thru 3.3.4, 3.3.6, 3.3.6.2, and associated section 4 paragraphs	*Def-Stan 00-970 Reference:*	Merged with 6.2.3.1
		STANAG Reference:	Merged with 6.2.3.1
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	Merged with 6.2.3.1

6.2.3.6 The aircraft electrical system shall be designed such there is sufficient electrical power to be able to perform a controlled emergency landing, or perform emergency recovery actions, following a total loss of onboard electrical generating capability.

Consideration should be given to :

a. The length of time required to perform emergency recovery actions;

b. The maximum time likely to be required to perform an emergency landing;

c. The amount of power required to perform the emergency actions, or carry out an emergency landing;

d. Minimising any time lag between the failure occurring and notification to the operator.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.2, 3.1.5.2, 3.1.5.4, 3.1.7.2, 3.1.10, 3.1.11, 3.1.11.11.2, 3.1.13, 3.2.2.2, 3.2.2.2.2, 3.2.2.2.5, 3.3 thru 3.3.4, 3.3.6, 3.3.6.2, and associated section 4	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.6-6.6.8 00-970 P1 6.6.18 00-970 P7 S7 L706 2.7.1-2.7.3
		STANAG Reference:	4671.1351 4671.1353

Information Sources			
	paragraphs		4671.1412 4671.1413
FAA Doc:	14CFR references: 23.1351-23.1367, 25.1351-25.1363, 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.903 CS 23.1351 CS 25.903 CS 25.1351 CS 27.903 CS 27.1351 CS 29.903 CS 29.1351

6.2.3.7 The aircraft electrical system shall be designed such that, where there are independent power sources:

• They shall not adversely interact to preclude continued safe flight of the aircraft.

• They shall provide sufficient redundant power for continued safe flight.

Consideration should be given to:

a. The total electrical power requirements of the aircraft;

b. The requirement for independent redundant sources;

c. The capacity of the individual systems to supply the required electrical power.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.2, 4.1.2, 3.1.2.1, 4.1.2.1, 3.1.3, 4.1.3, 3.1.7.2, 4.1.7.2, 3.1.11, 4.1.11, 3.1.11.11.2, 4.1.11.11.2, 3.1.12, 4.1.12, 3.1.12.1, 4.1.12.1, 3.2.2.2.2, 4.2.2.2.2, 3.2.2.2.5, 4.2.2.2.5, 3.3 thru 3.3.4, 4.3 thru 4.3.4, 3.3.6, 4.3.6, 3.3.6.2, 4.3.6.2	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.2 00-970 P1 6.6.7 00-970 P1 6.6.17 00-970 P7 S7 L706 2.7.2 00-970 P7 S7 L706 2.7.3
		STANAG Reference:	4671.1351-4671.1367
FAA Doc:	14CFR references: 23.1351-23.1367, 25.1351-25.1363, 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1309 CS 23.1351 CS 25.1309 CS 25.1351 CS 25.1362 CS 27.1309 CS 27.1351 CS 29.1309 CS 29.1351

6.2.3.8 The electrical installation shall be designed such that any power transients generated, either through normal operation or component switching, shall not preclude safe operation of the aircraft.

Consideration should be given to:

a. Switching between power sources;

b. The operation of relays and contactors;

c. The effect of short or open circuits;

d. Switching supplied equipment on or off.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.5.2, 4.1.5.2, 3.1.7.2, 4.1.7.2, 3.1.10, 4.1.10, 3.1.11.11.2, 4.1.11.11.2, 3.2.2.2.2, 4.2.2.2.2, 3.2.2.2.5, 4.2.2.2.5	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.12 00-970 P1 6.6.16 00-970 P1 6.6.104
		STANAG Reference:	4671.1351-4671.1367
FAA Doc:	14CFR references: 23.1351-23.1367, 25.1351-25.1363, 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1309 CS 23.1351 CS 25.1309 CS 25.1351 CS 25.1431 CS 27.1309 CS 27.1351 CS 29.1309 CS 29.1351

6.2.3.9 Merged with 12.1.6

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Merged with 12.1.6	*Def-Stan 00-970 Reference:*	Merged with 12.1.6
		STANAG Reference:	Merged with 12.1.6
FAA Doc:	Merged with 12.1.6	*EASA CS Reference:*	Merged with 12.1.6

6.2.3.10 Where electrical power buses are operated in parallel, the system shall be designed so that there are no single points of failure which could adversely affect more than one power source.

Consideration should be given to:

a. Load matching and balancing components;

b. Bus switching components;

c. Bus or load faults.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.2, 3.1.2.1, 3.1.3, 3.1.7.2, 3.1.7.3, 3.1.10, 3.1.11.11.2, 3.1.12, 3.1.12.1, 3.1.14.4, 3.2.1.3, 3.2.2.2.2, 3.2.2.2.5, 3.2.3.1, and associated section 4 paragraphs	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.2 00-970 P1 6.6.3 00-970 P1 6.6.37 00-970 P1 6.6.104 00-970 P7 S7 L706 2.4
		STANAG Reference:	4671.1351-4671.1367
FAA Doc:	14CFR references: 23.1351-23.1367, 25.1351-25.1363, 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

Information Sources			
	25.1529		

6.2.3.11 The electrical power system shall be designed such that its characteristics do not adversely affect continued safety of flight.

Consideration should be given to:

a. All modes of the electrical power system including: normal, abnormal and failure modes;

b. The potential effects of spikes, surges or interrupts;

c. Provision of a separate emergency direct power source for the VCF where necessary to mitigate the effects of normal system failures.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.2, 3.1.2.1, 3.1.3, 3.1.7.2, 3.1.7.3, 3.1.11.11.2, 3.1.13, 3.1.14.4, 3.2.1.3, 3.2.2.2.2, 3.2.2.2.5, 3.3 thru 3.3.4, 3.3.6, 3.3.6.2, and associated section 4 paragraphs	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.6 00-970 P1 6.6.7 00-970 P1 6.6.8 00-970 P1 6.6.18 00-970 P1 6.6.104
		STANAG Reference:	4671.1351-4671.1357
FAA Doc:	14CFR references: 23.1351-23.1367, 25.1351-25.1363, 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

6.2.3.12 Electrical power sources for the provision of direct supply to VCF shall not preclude continued safety of flight.

Consideration should be given to:

a. Numbers and type of direct supply sources;

b. Utilisation of circuit protection devices;

c. Testing methodology.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.2, 3.1.2.1, 3.1.3, 3.1.7.2, 3.1.7.3, 3.1.11, 3.1.11.11.2, 3.1.12, 3.1.12.1, 3.1.14.4, 3.2.1.3, 3.2.2.2.2, 3.2.2.2.5, 3.3 thru 3.3.4, 3.3.6, 3.3.6.2, and associated section 4 paragraphs	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.6 00-970 P1 6.6.7 00-970 P1 6.6.8 00-970 P1 6.6.104 00-970 P7 S7 L706 2.7.1-2.7.3
		STANAG Reference:	4671.1351-4671.1367
FAA Doc:	14CFR references: 23.1351-23.1367, 25.1351-25.1363, 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1351-23.1367 CS 25.1351-25.1365 CS 27.1351-27-1367 CS 29.1351-29.1363

6.2.4. Flight worthiness evaluations.

6.2.4.1 All aircraft systems shall be analysed and flight critical components identified and classified. The justification for the classification shall be recorded along with the safety criteria to be met. The required safety criteria for each identified flight critical component shall be identified, justified, and an acceptable method of demonstrating compliance recorded.

Consideration should be given to:

a. Demonstrating that all systems containing flight critical components have been identified. This includes cable systems where used;

b. Selecting the most appropriate method to demonstrate compliance (analysis, calculation, modelling, simulation or flight test);

c. Method to record and present results.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.2, 4.1.2, 3.1.2.1, 4.1.2.1, 3.1.5, 4.1.5, 3.1.13, 4.1.13, 3.1.14, 4.1.14, 3.5.3, 4.5.3	*Def-Stan 00-970 Reference:*	00-970 P1 2.1.22
		STANAG Reference:	4671.141-4671.253 4671.321-4671.459 4671.1501-4671.1529 4671.U850(b)
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.141-23.253 CS 23.321-23.459 CS 23.1501-23.1529 CS 25.143-25.255 CS 25.321-25.459 CS 25.689 CS 25.1501-25.1533 CS 25.1309 CS 27.141-27.251 CS 27.321-27.427 CS 27.1501-27.1529 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529

6.2.4.2 An analysis of flight critical systems shall be performed to identify any single points of failure and assign to them probabilities of failure. Justification shall then be made that the flight safety risk for each single point of failure is acceptable.

Consideration should be given to:

a. Justification provided for the type of analysis performed, and any that are omitted.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.2, 4.1.2, 3.1.2.1, 4.1.2.1, 3.1.5.6, 4.1.5.6, 3.1.11, 4.1.11, 3.1.11, 3.1.11.1, 4.1.11.1, 3.2.4.1, 4.2.4.1, 3.5.3, 4.5.3	*Def-Stan 00-970 Reference:*	00-970 P1 2.24.21
		STANAG Reference:	4671.1309

Information Sources			
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

6.2.4.3 All aircraft failure states that affect the flying qualities of the aircraft shall be identified and their effects recorded. The transient response of the aircraft to each failure shall be analysed, and any effect on aircraft controllability or structure shall be identified and assessed for its impact on safety to both the aircraft and its crew.

Consideration should be given to :

a. Deviation from flight path;

b. Structural loading due to transients;

c. Potential for carrying passengers;

d. Switching to redundant or emergency systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 4.0, 3.1, 4.1, 3.1.2, 4.1.2, 3.1.2.1, 4.1.2.1, 3.1.5, 4.1.5, 3.1.13, 4.1.13, 3.1.14, 4.1.14, 3.5.3, 4.5.3	*Def-Stan 00-970 Reference:*	00-970 P1 2.1.22 00-970 P1 2.14 00-970 P1 2.15
		STANAG Reference:	4671.141-4671.253 4671.321-4671.459 4671.1501-4671.1529
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.141-23.253 CS 23.321-23.459 CS 23.1501-23.1529 CS 25.123 CS 25.143-25.255 CS 25.321-25.459 CS 25.1501-25.1533 CS 25.1309 CS 27.141-27.251 CS 27.321-27.427 CS 27.1501-27.1529 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529

6.2.4.4 The extent of the safe flight envelope associated with engine failure shall be identified for each phase of flight and recorded. Sufficient testing shall be undertaken to ensure that the aircraft can be recovered safely, for each phase of flight, within the identified envelope. All associated limitations shall be noted in the flight manual.

Consideration should be given to:

a. Engine failure mode and sequence;

b. Phase of flight when failure occurs (take-off, cruise, landing);

c. Location of engine on airframe and effect of resultant thrust (or loss of thrust).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.0, 3.1, 3.1.5, 3.1.5.3, 3.1.5.7, 3.1.5.8, 3.1.5.9, 3.1.9, 3.1.14, 3.2.1.3, 3.2.1.2, 3.2.2.2, 3.2.2.5, 3.2.2.5.4, 3.2.2.6, 3.3, and associated section 4 paragraphs	*Def-Stan 00-970 Reference:*	00-970 P1 2.7 00-970 P1 2.14
		STANAG Reference:	4671.141-4671.253 4671.321-4671.459 4671.1501-4671.1529 4671.U1412
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.141-23.253* CS 23.321-23.459* CS 23.1501-23.1529* CS 25.143-25.255* CS 25.321-25.459* CS 25.105 CS 25.111 CS 25.115 CS 25.121 CS 25.1501-25.1533* CS 25.1309 CS 27.141-27.251 CS 27.321-27.427 CS 27.1501-27.1529 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529

6.2.4.5 All aircraft systems shall be assessed to identify those which could affect the flying qualities of the aircraft. These systems shall then be analysed to identify their failure modes and subsequent effects. All such failure modes that could lead to unacceptable flying qualities shall be further analysed to ensure that they do not fail in an undetected or latent manner, and that they do not suffer unannounced faults.

Consideration should be given to :

a. Recording justification for those systems considered not to affect the aircraft's flying qualities;

b. Component and system testing;

c. Aircraft ground and flight testing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1.8, 3.1.9	*Def-Stan 00-970 Reference:*	00-970 P1 2.1.38 00-970 P1 2.15 00-970 P1 2.16.16 00-970 P1 2.16.42 00-970 P1 6.2.35 00-970 P1 6.5.46-6.5.49 00-970 P1 6.6.2
		STANAG Reference:	4671.141-4671.253 4671.321-4671.459 4671.1501-4671.1529 4671.1309
FAA Doc:	14CFR references: 23.141-	*EASA CS*	CS 23.141-23.253

Information Sources			
	23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*Reference:*	CS 23.321-23.459 CS 23.1309 CS 23.1501-23.1529 CS 25.105 CS 25.143-25.255 CS 25.321-25.459 CS 25.1309 CS 25.1501-25.1533 CS 27.141-27.251 CS 27.321-27.427 CS 27.1309 CS 27.1501-27.1529 CS 29.141-29.251 CS 29.321-29.427 CS 29.1309 CS 29.1501-29.1529

6.2.4.6 The envelope for each aerodynamic configuration shall be clearly established and a sensitivity study shall be performed to determine the error bounds of the envelope beyond which unsafe handling characteristics would be apparent. The actual air data errors, or variations from actual pressures, shall be determined within each envelope for each dependant system. An analysis shall be performed to ensure that the two sets of data do not overlap leading to unsafe handling characteristics.

Consideration should be given to :

a. Displayed air data;

b. Computed air data;

c. Systems using the computed air data. These could include flight control systems, aerodynamic configuration systems, trim and auto feel systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: TBD: Refer to technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P1 2.4 00-970 P1 2.5 00-970 P1 2.6 00-970 P1 2.7 00-970 P1 2.8 00-970 P1 2.10 00-970 P1 2.15.27 00-970 P1 6.3
		STANAG Reference:	4671.1323 - 1325
FAA Doc:	14CFD References: TBD: Refer to technical point of contact for this discipline (listed in section A.2)	*EASA CS Reference:*	CS 23.1323-23.1326 CS 25.1323-25.1326

6.2.4.7 The aircraft's control and payload systems shall be analysed to determine their effect on each other. Such interaction may be direct, through system connectivity, or indirect, through cause and effect such as weapon release. Payload release can have a number of effects on the platform and its systems, and these shall be determined and analysed to ensure that they do not preclude continued safety of flight.

Consideration should be given to:

a. Aerodynamic response to weapon release (drag, vehicle climb);

b. Wing rock;

c. Effect of asymmetric loads and allowable stores configurations;

d. Under slung loads;

e. Ability of VCF to counter Centre-of-Gravity and lift force changes (control authority) during and post release . This shall include:

i. Single or salvo release.

ii. Air drop release of cargo.

g. Automatic control inputs (autopilot reaction) to balance expected payload release, or unexpected movement;

h. Vehicle control and payload system latency and synchronisation response.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: TBD: Refer to technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P1 2.1.20 00-970 P1 2.1.26 00-970 P1 2.2.14 00-970 P1 2.15.7 00-970 P1 2.15.9 00-970 P1 2.15.29
		STANAG Reference:	
FAA Doc:	14CFD References: TBD: Refer to technical point of contact for this discipline (listed in section A.2)	*EASA CS Reference:*	

6.2.5. VCF software.

(Note: VCF software verification is accomplished under section 15.)

6.2.5.1 All components and systems containing computer software configuration items (CSCI)/operational flight programs (OFP) shall be identified, documented and tested to ensure the safe operation of all modes, inputs, failure detection, reconfiguration techniques, self-check operations, interfaces, and integration under all dynamic conditions.

Consideration should be given to

a. Static code assessment methods;

b. Dynamic testing of components and systems;

c. Full ground testing of systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.3.6.2	*Def-Stan 00-970 Reference:*	00-970 P1 2.16.19 00-970 P1 3.10.47-3.10.51 00-970 P1 6.5.33-6.5.45
		STANAG Reference:	4671.1309
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-	*EASA CS Reference:*	CS 23.141-23.253 CS 23.321-23.459

Information Sources			
	23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529		CS 23.1501-23.1529 CS 23.1309 CS 25.143-25.255 CS 25.321-25.459 CS 25.1501-25.1533 CS 25.1309 CS 27.141-27.251 CS 27.321-27.427 CS 27.1501-27.1529 CS 27.1309 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529 CS 29.1309

6.2.5.2 All software shall be developed in a controlled environment and assessed for functionality and safety. Flight versions of software shall be objectively assessed for acceptable performance against the original requirement, and a clear audit trail shall provide evidence of change through the development process, including recording of test results. The controlled environment shall be maintained for the life time of the software.

Consideration should be given to the delivery of a software development plan which may include:

a. A configuration methodology;

b. A software testing and acceptance plan;

c. Independent assessment.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.2.4.6, 3.3.6-3.3.8	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.4 00-970 P1 3.10.6 00-970 P1 3.10.47-3.10.53 00-970 P1 6.5.33-6.5.49 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.141-4671.253, 4671.321-4671.459 4671.1501-4671.1529
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.141-23.253 CS 23.321-23.459 CS 23.1501-23.1529 CS 25.143-25.255 CS 25.321-25.459 CS 25.1501-25.1533 CS 27.141-27.251 CS 27.321-27.427 CS 27.1501-27.1529 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529

6.2.5.3 All critical control systems shall be identified. The design and development of these systems shall be planned and managed to demonstrate that each system is safe for all flight conditions.

Consideration should be given to:
a. System design and analysis methods, to be agreed;
b. Fail safe design, to be considered;
c. Testing and acceptance methodology, to be agreed;
d. Any special requirements relating to software, to be agreed.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1.5.2, 3.1.5.8, 3.1.9, 3.1.11.2, 3.2.1.2, 3.2.3.2	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.5 00-970 P1 3.10.6 00-970 P1 3.10.7 00-970 P1 3.10.28-3.10.31 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.141-4671.253 4671.321-4671.459 4671.1309 4671.1501-4671.1529
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.141-23.253 CS 23.321-23.459 CS 23.1501-23.1529 CS 23.1309 CS 25.143-25.255 CS 25.321-25.459 CS 25.1501-25.1533 CS 25.1309 CS 27.141-27.251 CS 27.321-27.427 CS 27.1501-27.1529 CS 27.1309 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529 CS 29.1309

6.2.5.4 Air vehicles with redundant control systems shall have those systems analysed to:
• Ensure that any single-point or potential multiple system failures have been identified;
• Ensure that any such failures remain within the specified system and vehicle levels of safety.

Consideration should be given to:
a. Identifying and agreeing those control systems which have redundancy;
b. Agreeing and assigning safety targets to those systems;
c. Agreeing a test and acceptance plan;
d. Ensuring a common mode analysis is carried out;
e. Ensuring resilience to particular risks (such as battle damage, or bird strike) to those systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1.9-3.1.11.1.1	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.2 00-970 P1 3.10.4 00-970 P1 3.10.5 00-970 P1 3.10.7 00-970 P1 3.10.12 00-970 P1 3.10.28-3.10.31 00-970 P1 3.10.47-3.10.53 00-970 P1 6.5.33-6.5.49 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.141-4671.253 4671.321-4671.459 4671.1309 4671.1501-4671.1529
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.141-23.253 CS 23.321-23.459 CS 23.1501-23.1529 CS 23.1309 CS 25.143-25.255 CS 25.321-25.459 CS 25.1501-25.1533 CS 25.1309 CS 27.141-27.251 CS 27.321-27.427 CS 27.1501-27.1529 CS 27.1309 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529 CS 29.1309

6.2.5.5 All air vehicles with systems containing software and/or firmware shall have:

• The interoperability of those systems tested for each combination of software and/or firmware to ensure compatibility;

• Each approved software and/or firmware load recorded against each system within the air vehicle;

• A configuration matrix showing software and/or firmware compatibility between the air vehicle systems.

Consideration should be given to:

a. The matrix to specify all configurations of hardware/software/firmware authorised for use in the air vehicle;

b. The test and acceptance plan to ensure that all required configurations of hardware/software/firmware are covered;

c. Any limitations arising from particular configurations, to be recorded.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.2.4.6, 3.3.6-	*Def-Stan 00-970*	00-970 P1 2.16.6

Information Sources			
	3.3.8	*Reference:*	00-970 P1 2.16.40-2.16.43 00-970 P1 3.10.2 00-970 P1 3.10.5 00-970 P1 3.10.32 00-970 P1 3.10.47-3.10.53 00-970 P1 3.10.79-3.10.93 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.141-4671.253 4671.321-4671.459 4671.1309 4671.1501-4671.1529
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.141-23.253 CS 23.321-23.459 CS 23.1501-23.1529 CS 23.1309 CS 25.143-25.255* CS 25.321-25.459* CS 25.1501-25.1533* CS 25.1309 CS 27.141-27.251 CS 27.321-27.427 CS 27.1501-27.1529 CS 27.1309 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529 CS 29.1309

6.2.5.6 The operational flight programme shall be designed and tested to ensure that any interrupts or error recovery routines do not preclude continued safety of flight. The effect of the following are of particular interest:

• Software interrupts
• Reinitialisation
• Resynchronisation
• Recheck
• Reconfiguration
• Restarts
• Resets
• Negation of environmental and generic error.

Consideration should be given to:

a. The software architecture;
b. The testing and acceptance plan;
c. Common mode failures;
d. Resilience to basic faults, such as divide by zero.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.2.4.6, 3.3.6-3.3.8	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.6-3.10.7 00-970 P1 3.10.8-3.10.10 00-970 P1 3.10.11 00-970 P1 3.10.13 00-970 P1 3.10.19 00-970 P1 3.10.28 00-970 P1 3.10.29 00-970 P1 3.10.47-3.10.53 00-970 P1 3.10.79-3.10.93 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.141-4671.253 4671.321-4671.459 4671.1309 4671.1501-4671.1529
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.141-23.253 CS 23.321-23.459 CS 23.1501-23.1529 CS 23.1309 CS 25.143-25.255 CS 25.321-25.459 CS 25.1501-25.1533 CS 25.1309 CS 27.141-27.251 CS 27.321-27.427 CS 27.1501-27.1529 CS 27.1309 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529 CS 29.1309

6.2.5.7 The software design techniques used to enable software error detection and prevention methodologies shall be effective and comprehensive, trapping all potentially unsafe flight conditions; their implementation shall not introduce other unsafe flight conditions.

Whilst not exhaustive, the following techniques shall form a core of those to be considered: self-check, failure monitoring, redundancy management, reconfiguration, voting, transient suppression, overflow protection, anti-aliasing, saturation, interlocks, memory protection, and prevention of failure propagation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.2.4.6, 3.3.6-3.3.8	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.4 00-970 P1 3.10.8-3.10.9 00-970 P1 3.10.13 00-970 P1 3.10.16 00-970 P1 3.10.19

Information Sources			
			00-970 P1 3.10.28-3.10.29 00-970 P1 3.10.47-3.10.53 00-970 P1 3.10.79-3.10.85 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.141-4671.253 4671.321-4671.459 4671.1309 4671.1501-4671.1529
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.141-23.253 CS 23.321-23.459 CS 23.1501-23.1529 CS 23.1309 CS 25.143-25.255 CS 25.321-25.459 CS 25.1501-25.1533 CS 25.1309 CS 27.141-27.251 CS 27.321-27.427 CS 27.1501-27.1529 CS 27.1309 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529 CS 29.1309

6.2.5.8 The built-in test routines shall operate failure free, safely identifying and isolating malfunctions, and reconfiguring systems where appropriate. Inadvertent activation of BIT modes that would compromise safety of flight shall be prevented, and failure detection indications shall be to the Line Replaceable Unit (LRU) or Module level.

Consideration should be given to:

a. Test and Acceptance Plan to demonstrate:

i. Prevention of unwanted, or inadvertent, activation of BIT during flight.

ii. Correct isolation of faulty equipment.

iii. Correct re-configuration, or reversion, of system where applicable.

b. Agreeing an acceptable fault detection rate and false alarm rate for the BIT.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1.11.11.2, 3.1.13	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.4 00-970 P1 3.10.8-3.10.9 00-970 P1 3.10.28-3.10.30 00-970 P1 3.10.47-3.10.53 00-970 P1 3.10.69-3.10.74 00-970 P1 3.10.75-3.10.77 00-970 P13 1.7 00-970 P13 1.8

Information Sources			
		STANAG Reference:	4671.141-4671.253 4671.321-4671.459 4671.1309 4671.1501-4671.1529
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.141-23.253 CS 23.321-23.459 CS 23.1501-23.1529 CS 23.1309 CS 25.143-25.255 CS 25.321-25.459 CS 25.1501-25.1533 CS 25.1309 CS 27.141-27.251 CS 27.321-27.427 CS 27.1501-27.1529 CS 27.1309 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529 CS 29.1309

6.2.5.9 Unauthorised access to the installed VCF software shall be denied to prevent tampering with or copying of the software. This includes access through software loading ports or through the VCF system itself.

Consideration should be given to:

a. Physical security;

b. Use of encryption systems;

c. Partitioning of critical data elements from less critical elements.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2008: 3.1.14.6	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.2 00-970 P1 3.10.4 00-970 P1 3.10.11 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.141-4671.253 4671.321-4671.459 4671.1309 4671.1501-4671.1529
FAA Doc:	14CFR references: 23.141-23.253, 25.21-25.255, 23.321-23.459, 25.321-25.459, 23.1501-23.1529, 25.1501-25.1529	*EASA CS Reference:*	CS 23.141-23.253 CS 23.321-23.459 CS 23.1501-23.1529 CS 23.1309 CS 25.143-25.255

Information Sources			
			CS 25.321-25.459 CS 25.1501-25.1533 CS 25.1309 CS 27.141-27.251 CS 27.321-27.427 CS 27.1501-27.1529 CS 27.1309 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529 CS 29.1309

6.3. AERODYNAMICS AND PERFORMANCE.

This section covers basic air vehicle performance, installed engine performance and the need to establish and document performance limits.

Included with the scope of the this section are:
• Internal and External performance
• Weight and CofG limits
• Engine/Inlet/nozzle compatibility
• Lift boundary and Stall Performance
• Take-off, climb and landing performance

Stores carriage release and jettison is considered outside the scope of this section, and is covered in Section 17.

The air vehicle should be assessed using the criteria provided in this section (not all items apply in each case; similarly, items may have to be added for vehicles employing new or innovative technology/techniques). These criteria are intended to assure flying qualities that support adequate mission performance and flight safety regardless of the design configuration or flight control system architecture. The criteria are to be applied during the design, construction, testing, and acceptance of the subject air vehicle and the modifications hereof.

6.3.1. Flight vehicle.

6.3.1.1 Following a reasonably credible combination of failures, degraded air vehicle performance shall allow recovery throughout the flight envelope within acceptable safe margins.

Consideration should be given to:
a. Failures or malfunctions within the engine, stability augmentation, automatic and power operated systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.1.1 MIL-STD-1797	*Def-Stan 00-970 Reference:*	00-970 P1 2.6.25 00-970 P1 2.15.2

Information Sources			
	MIL-HDBK-516B 14.1.1.4j-k JSSG 2001A 3.3.11.1, 3.3.11.1.1.3, 3.3.11.2, C.3.1-2, C.3.6 JSSG 2006 3.7.3 JSSG 2007 3.7.2.1, Appendix A JSSG 2008 3.1.4, 3.2.1.2, 4.3.10, A.3.3.3.2 JSSG 2000 3.3.6.1		00-970 P1 2.15.4 00-970 P1 2.15.9 00-970 P7 S6 L605/1
		STANAG Reference:	4671.21 4671.141 4671.347 4671.367 4671.U1412
FAA Doc:		*EASA CS Reference:*	CS 23.21 CS 23.141 CS 23.143 CS 23.347 CS 23.367 CS 23.672 CS 23.21 CS 25.143 CS 25.367 CS 25.672 CS 27.21 CS 27.141 CS 27.143 CS 27.672 CS 29.21 CS 29.141 CS 29.143 CS 29.672

6.3.1.2 The Air Vehicle shall meet all defined criteria for takeoff, landing and critical field length in the specified environmental (atmospheric) conditions without the need for exceptional piloting skill.

Consideration should be given to:

a. Catapult takeoffs;
b. Rejected takeoffs;
c. Balked landings;
d. Engine failure;
e. Failure of any lift argumentation devices (e.g. flaps, slats);
f. Failure of any retardation devices (e.g. brakes, reverse thrust, brake parachute);
g. Mass and Centre of Gravity;
h. Carriage of stores;
i. Ship-borne operations;
j. Hot and/or high altitude operations.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.1.2 JSSG 2001A Appendix E	*Def-Stan 00-970 Reference:*	00-970 P1 S2.4 00-970 P1 S2.5

Information Sources			
	MIL-STD-3013: 3.2, 3.2.10, 3.8, Appendix A MIL-DTL-7700	*STANAG Reference:*	4671.45 4671.51 4671.53 4671.55 4671.75 4671.77
FAA Doc:		*EASA CS Reference:*	CS 23.45 CS 23.51 CS 23.53 CS 23.55 CS 23.75 CS 23.77 CS 25.101 CS 25.105 CS 25.107 CS 25.109 CS 25.111 CS 25.113 CS 25.115 CS 25.117 CS 25.119 CS 25.125 CS 25 697 CS 25.699 CS 27.45 CS 27.51 CS 27.75 CS 29.45 CS 29.51 CS 29.75

6.3.1.3 Air Vehicles shall be able to be recovered safely (or in the case of single-engined Air Vehicles have procedures in place to minimise loss of Air Vehicle or loss of life) in the event of any engine failure during all flight regimes.

Consideration should be given to the following:

a. Engine failure on takeoff;
b. OEI performance in climb;
c. Target thresholds speeds for landing;
d. Minimum control speeds;
e. Lateral and dynamic control with asymmetric thrust;
f. Longitudinal control after engine failure;
g. Overshoot decision height;
h. Auto rotation for rotary wing Air Vehicles;
i. Design of the tail rotor on rotary wing Air Vehicles to allow autorotation in the event of an engine failure.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.1.3 JSSG 2001A Appendix E MIL-STD-3013: 3.2.11, 3.3.1.4, 4.2.2.1.2 MIL-HDBK-1797A ADS-40A-SP Air Vehicle Flight Performance Description	*Def-Stan 00-970 Reference:*	00-970 P1 2.4.23 00-970 P1 2.5.19 00-970 P1 2.5.21 00-970 P1 2.14.20 00-970 P1 2.14.22 00-970 P1 2.14.24 00-970 P1 2.4.25 00-970 P1 2.16.32 00-970 P7 L600 12.3.2 00-970 P7 L605/2 00-970 P7 L906 7.8.5
		STANAG Reference:	4671.66 4671.67 4671.1521 4671.1581
FAA Doc:		*EASA CS Reference:*	CS 23.66 CS 23.67 CS 23.1581 CS 25.121 CS 25.1581 CS 27.691 CS 27.917 CS 27.1027 CS 27.1521 CS 27.1581 CS 29.691 CS 29.917 CS 29.1027 CS 29.1521 CS 29.1581

6.3.1.4 Air Vehicle limitations shall be established to ensure safe flight and published in the flight manual (or equivalent), on placards on the air vehicle or in other air vehicle publications (such as an Operational Data Manual) as appropriate.

Consideration should be given to (amongst others):

a. Takeoff;
b. Landing;
c. Hover;
d. Climb;
e. Manoeuvre;
f. Cruise;
g. Descent;
h. Emergency conditions (including height/velocity diagrams for rotary wing air vehicles);
i. Determination of the minimum permissible speed (Vs) in every allowable stores configuration, weight and CofG.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.1.4 JSSG 2001A Appendix C: C.3.2 MIL-STD-3013: 4.1.10 MIL-DTL-7700 ADS-40A-SP Air Vehicle Flight Performance Description	*Def-Stan 00-970 Reference:*	00-970 P1 2.2.19 00-970 P1 S2.7 00-970 P1 2.25.7 00-970 P1 7.5.4 00-970 P7 L900/1
		STANAG Reference:	4671.45 4671.1501 4671.1541 4671.1581
FAA Doc:		*EASA CS Reference:*	CS 23.45 CS 23.1501 CS 23.1541 CS 23.1581 CS 25.101 CS 25.105 CS 25.117 CS 25.1501 CS 25J.1521 CS 25.1541 CS 25.1581 CS 27.45 CS 27.1501 CS 27.1541 CS 27.1581 CS 29.45 CS 29.1501 CS 29.1541 CS 29.1581 CS 27.79* CS 27.1587* CS 29.87* CS 29.1517* CS 29.1587* *(unverified-Dutch 516)

6.3.1.5 Merged with Section 17. Adequately covered by 17.2.1 and 17.2.5

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Merged with Section 17. Adequately covered by 17.2.1 and 17.2.5	*Def-Stan 00-970 Reference:*	Merged with Section 17. Adequately covered by 17.2.1 and 17.2.5
		STANAG Reference:	Merged with Section 17. Adequately covered by 17.2.1 and 17.2.5

Information Sources			
FAA Doc:	Merged with Section 17. Adequately covered by 17.2.1 and 17.2.5	*EASA CS Reference:*	Merged with Section 17. Adequately covered by 17.2.1 and 17.2.5

6.3.1.6 Appropriate Limitations and a means of being able to calculate available power and thrust throughout all gross weight, ambient temperature and altitude conditions shall be established and provided in the flight manual (or equivalent).

Consideration should be given to:

a. Available power and required power;

b. Fuel flow;

c. Ground effect;

d. OEI flight;

e. Autorotation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.1.6 MIL-STD-3013: 4.1.10 MIL-DTL-7700 ADS-40A-SP Air Vehicle Flight Performance Description ADS-10C-SP Air Vehicle Technical Description	*Def-Stan 00-970 Reference:*	00-970 P1 7.5.3
		STANAG Reference:	4671.21 4671.45 4671.333 4671.1501 4671.1581
FAA Doc:		*EASA CS Reference:*	CS 23.21 CS 23.45 CS 23.333 CS 23.1501 CS 23.1563 CS 23.1581 CS 25.21 CS 25.101 CS 25.333 CS 25.1501 CS 25.1563 CS 25.1581 CS 27.21 CS 27.45 CS 27.1501 CS 27.1581 CS 29.21 CS 29.45 CS 29.1501 CS 29.1581 CS 27.45*-27.75* CS 29.45*-29.75* *(unverified-Dutch 516)

6.3.2. Installed propulsion capability.

6.3.2.1 The compatibility of the airframe / inlet / engine shall be such that the engine provides safe and stable operation.

Consideration should be given to:

a. All flight regimes and permissible manoeuvres;

b. Interactive surge resulting from the proximity of two or more engine intakes;

c. Intake flow quality (swirl and distortion);

d. The strength of the intake assembly to withstand any engine surge;

e. Suitable airflow distribution to the engine;

f. Ingestion of gas, debris and pressure waves from rockets or missiles;

g. Vibration;

h. Design for maintenance.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.2.1 JSSG 2001A 3.3.1.1.1, 4.3.1.1.1, 3.3.1.1.1.1, 4.3.1.1.1.1, 3.3.1.1.1.2, 4.3.1.1.1.2, 3.3.1.1.2, 4.3.1.1.2 JSSG 2007B A.3.2, A.4.2, A.3.11, A.4.11, A.3.12, A.4.12, A.3.2.2, A.4.2.2, A.3.2.2.7, A.4.2.2.7	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.2 00-970 P1 5.1.41 00-970 P1 5.1.43
		STANAG Reference:	4671.901 4671.939
FAA Doc:		*EASA CS Reference:*	CS 23.901 CS 23.939 CS 25.939 CS 27.939 CS 29.939 CS-E 500, AMC E 650 CS 29.1521* *(unverified-Dutch 516)

6.3.2.2 The following shall provide stable and safe operating characteristics:

• Engine steady and transient response characteristics of the engine and engine control system, including Reheat Modulation;

• Fuel flow modulation;

• Engine responses to input signals at different frequencies;

• Engine control and vehicle control system communication;

• Fuel, air induction, exhaust and bleed air extraction systems, ambient temperatures, ambient pressures, and vibratory environment;

• Sensitivity, stability, control response, and torque predictability for engine and vehicle control during engine power changes (acceleration and deceleration);

• Auxiliary engine control functions;

• Altitude cold start and hot restart capability;

• Relight.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.2.2 JSSG 2007B 3.1.1.15, 4.1.1.15, 3.2, 4.2, 3.2.2, 4.2.2, 3.2.2.7, 4.2.2.73.3, 4.3, 3.4, 4.4, 3.5, 4.5, 3.7, 4.7, 3.11, 4.11, 3.12, 4.12	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.16 00-970 P1 5.1.79 00-970 P1 5.1.80 00-970 P1 5.1.86
		STANAG Reference:	4671.901 4671.939
FAA Doc:		*EASA CS Reference:*	CS 23.901 CS 23.939 CS 25.901 CS 25.939 CS 27.901 CS 27.939 CS 29.901 CS 23.939 CS-E 50 CS-E340 CS-E370 CS-E 380 CS-E 690 CS-E 745 CS-E910

6.3.2.3 Engine performance restrictions resulting from thermal boundaries (predominantly due to the differing thermal properties of materials used in construction) shall be established, verified and documented in the flight manual.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.2.3 JSSG 2001A 3.3.1.1	*Def-Stan 00-970 Reference:*	00-970 P11 3.E100
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS-E 520

6.3.2.4 Engine performance restrictions resulting from conditions such as inlet buzz or reheat screech shall be established, verified and documented in the flight manual (or equivalent).

Consideration should be given to:

a. Subsonic, transonic and supersonic flight

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.2.4 JSSG 2001A 3.3.1.1	*Def-Stan 00-970 Reference:*	00-970 P11 4.2.1
		STANAG	

Information Sources			
		Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.1091* CS 25.1103* *(unverified-Dutch 516)

6.3.2.5 There shall be no unacceptable impacts on air vehicle performance due to flow disturbance, distortion or blockage, especially ahead or around the engine intakes.

Consideration should be given to the following:

a. All flight regimes and permissible manoeuvres;

b. The location of items that may cause flow disturbance, distortion or blockage;

c. The effects of vibration brought about by flow distortion on the engines ability to provide stable and safe operation;

d. Engine response to intake control system failures.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.2.5 JSSG 2001A 3.3.1.1	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.17
		STANAG Reference:	4671.901 4671.939
FAA Doc:	14CFR references: 23.901-23.943, 25.901-25.945	*EASA CS Reference:*	CS 23.901 CS 23.939 CS 25.939 CS 27.939 CS 29.939 CS-E 500, CS-E 650 CS 25.1091* *(unverified-Dutch 516)

6.3.2.6 For Air Vehicle configurations that utilise engine-bleed air for intake anti-icing, its operation must not prevent the engine from providing safe and stable operation.

Consideration should be given to:

a. All flight regimes and permissible manoeuvres.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.2.6 JSSG 2007B 3.2, 4.2, 3.11, 4.11, 3.12, 4.12, 3.2.2, 4.2.2	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.35 00-970 P11 3.E690
		STANAG Reference:	4671.1093 4671.1111
FAA Doc:	14CFR references: 33.5, 33.7 AC 33-2B	*EASA CS Reference:*	CS 23.1093 CS 25.1093

Information Sources			
			CS 27.1093 CS 29.1093 CS-E 230 CS-E 690

6.3.2.7 For air vehicle configurations that utilise an inlet sand and dust separator powered by engine bleed air, its operation must not prevent the engine from providing stable and safe operation.

Consideration should be given to:

a. All flight regimes and permissible manoeuvres;

b. The engine's basic tolerance to sand and dust ingestion.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.2.7 JSSG 2007B 3.2, 4.2, 3.11, 4.11, 3.12, 4.12, 3.2.2, 4.2.2	*Def-Stan 00-970 Reference:*	00-970 P11 S4.10 00-970 P11 3.E690
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS-E 540 CS-E 690 CS-E 800 AMC E 540 CS 25.1091* CS 25.1093* CS 29.1091* CS 29.1105* *(unverified-Dutch 516)

6.3.2.8 Merged with Section 17. Adequately covered by 17.1.2

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Merged with Section 17. Adequately covered by 17.1.2	*Def-Stan 00-970 Reference:*	Merged with Section 17. Adequately covered by 17.1.2
		STANAG Reference:	
FAA Doc:	Merged with Section 17. Adequately covered by 17.1.2	*EASA CS Reference:*	Merged with Section 17. Adequately covered by 17.1.2

6.3.3. Flight limits.

6.3.3.1 All air vehicle low speed and high speed buffet characteristics shall be identified and assessed. Buffet boundaries shall be established that do not require excessive pilot skill to recover nor cause excessive vibration liable to cause structural damage to the air vehicle. These boundaries shall be published in the flight manual.

Consideration should be given to:

a. Aircrew situational awareness and workload (e.g. ability to read instruments);

b. The carriage of external stores;
c. Stall;
d. Mach number effects;
e. Deployed flaps, spoilers and landing gear.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.3.1 JSSG 2001A 6.4.6.1, Appendix C: 4.2, 4.3, 4.5 MIL-STD-3013: 3.2.2, 3.5.16 MIL-HDBK-1797A 4.1.11.1 ADS-40A-SP Air Vehicle Flight Performance Description ADS-27 Requirements for Rotorcraft Vibration Specifications, Modelling and Testing ADS-10C-SP Air Vehicle Technical Description	*Def-Stan 00-970 Reference:*	00-970 P1 2.5.11 00-970 P1 2.8.14 00-970 P1 2.10.24 00-970 P1 2.11.15 00-970 P1 2.17.8 00-970 P1 2.17.34 00-970 P1 2.24.16 00-970 P1 2.25.7
		STANAG Reference:	4671.251 4671.253 4671.333
FAA Doc:	14CFR references: 23.251, 23.333, 25.251, 25.333	*EASA CS Reference:*	CS 23.251 CS 23.253 CS 23.333 CS 25.251 CS 25.253 CS 25.333 CS 29.251* *(unverified-Dutch 516)

6.3.3.2 The angle-of-attack and velocity for which stall occurs shall be established for all air vehicle configurations and at all altitudes with adequate warning of the stall being provided to the pilot. Appropriate limits shall be published in the flight manual in appropriate reference charts.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.3.2 JSSG 2001A Appendix C: 4.2, 4.13.2, 4.13.3; Appendix D: 4.2.2; Appendix E: 11.2.2 MIL-DTL-7700	*Def-Stan 00-970 Reference:*	00-970 P1 7.5.3 00-970 P1 2.5.11 00-970 P1 S2.10 00-970 P1 2.24.8 00-970 P1 2.24.9
		STANAG Reference:	4671.21 4671.45 4671.333 4671.1501 4671.1581 4671.49
FAA Doc:		*EASA CS Reference:*	CS 23.21 CS 23.45

Information Sources			
			CS 23.333 CS 23.1501 CS 23.1563 CS 23.1581 CS 25.21 CS 25.101 CS 25.333 CS 25.1501 CS 25.1563 CS 25.1581 CS 27.21 CS 27.45 CS 27.1501 CS 27.1581 CS 29.21 CS 29.45 CS 29.1501 CS 29.1581 CS 27.45*-27.75* CS 29.45*-29.75* CS 23.49 CS 23.1583 CS 25.103 CS 25.1583 *(unverified-Dutch 516)

6.3.3.3 Angle-of-attack limits are to be established and unambiguous warning of impending dangerous flight conditions provided. Any angle-of-attack limiting device must not allow any limitations to be unintentionally exceeded, placing the air vehicle in any unsafe flight condition.

Consideration should be given to:

a. The carriage of stores;

b. Warning and cautions to be provided to the pilot and/or operator;

c. Flight envelope protection for UAS.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.3.3 JSSG 2001A 3.3.11.1.1.1, C3.13, Appendix C: 4.2	*Def-Stan 00-970 Reference:*	00-970 P1 2.4.6 00-970 P1 2.5.7 00-970 P1 2.24.7
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.207* CS 29.33* *(unverified-Dutch 516)

6.3.3.4 Centre of Gravity and gross weight limitations shall be established and proven to be safe. Limitations shall be listed in the flight manual or marked upon the air vehicle as appropriate.

Consideration should be given to:

a. All reasonably credible combinations of failures affecting weight and Centre of Gravity ranges;

b. All Air Vehicle configurations;

c. All Air Vehicle operational altitudes;

d. Different payloads if applicable;

e. The carriage of stores;

f. Use of removable ballast to achieve satisfactory Centre of Gravity limitations.

Information Sources			
Comm'l Doc:	SAWE RP#7 & 8		
DoD/MIL Doc:	MIL-HDBK-516B 6.3.3.4 JSSG 2006 3.2.3, 3.2.4, 3.2.5, 3.2.6, 4.2.3, 4.2.4, 4.2.5, 4.2.6	*Def-Stan 00-970 Reference:*	00-970 P1 2.1.23 00-970 P1 2.5.9 00-970 P1 2.7.7 00-970 P1 3.3.13 00-970 P1 3.4.16 00-970 P7 L202 00-970 P7 L900/1 00-970 P7 L902 00-970 P7 L903
		STANAG Reference:	4671.23 4671.25 4671.29 4671.31 4671.1519
FAA Doc:		*EASA CS Reference:*	CS 23.23 CS 23.25 CS 23.29 CS 23.31 CS 23.1519 CS 25.23 CS 25.25 CS 25.27 CS 25.29 CS 25.31 CS 25.1519 CS 27.25 CS 27.27 CS 27.29 CS 27.31 CS 27.1519 CS 29.25 CS 29.27 CS 29.29 CS 29.31 CS 29.1519

6.3.3.5 Safe flight limitations shall be established and published in the flight manual for vortex ring state, advancing blade compressibility and directional control margins in the presence of cross winds.

Consideration should be given to:

a. Air Vehicle behaviour with both power on and power off;

b. Critical directions and magnitudes for cross winds.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.3.5 ADS-51-HDBK ADS-33E-PRF ADS-40A-SP Air Vehicle Flight Performance Description ADS-10C-SP Air Vehicle Technical Description	*Def-Stan 00-970 Reference:*	00-970 P7 L601/4
		STANAG Reference:	4671.21 4671.143 4671.1581
FAA Doc:		*EASA CS Reference:*	CS 27.21 CS 27.33 CS 27.143 CS 27.177 CS 27.1509 CS 27.1581 CS 29.21 CS 29.33 CS 29.143 CS 29.177 CS 29.1509 CS 27.1581

SECTION 7 - PROPULSION AND PROPULSION INSTALLATIONS

This section covers the design, installation, arrangement and compatibility of the complete air vehicle propulsion system and subsystem components.

Included within the scope of this section are:

Propulsion Safety Management Criteria, necessary to identify, analyse and mitigate propulsion system risks.

General Engine System Criteria, necessary to ensure that the engine and associated subsystems functionality, performance and operation allows safe operation of the air vehicle. The scope of this section encompasses both installed and uninstalled propulsions system and covers:

- Normal engine operation and performance;
- Degraded engine operation and performance;
- Consideration of all installation effects (functional, physical and compatibility) due to air vehicle/engine integration;
- Engine subsystems, components, computer resources and software;
- Performance across all intended operational environments.

Alternate Propulsions Systems Criteria for propeller driven systems, rotary wing platforms and reciprocating engines.

The certification team will need to align and review all of the propulsion criteria when defining the certification requirements for engines, propellers, and Rotary Wing and Fixed Wing integration. For guidance, a cross reference matrix of the EMACC Handbook Section 7 structure to an equivalent EASA Civil Structure has been produced below.

	Civil Structure			
PROPULSION AND PROPULSION INSTALLATIONS (EMACC Structure)	**Engines**	**Propellers**	**FW Installation**	**RW installation**
CERTIFICATION CRITERIA				
7.1 Propulsion safety management.				
7.1.1 Verify that safety-critical propulsion system risks are identified, probabilities are validated, and risk controls are in place.	x	x	x	x
7.1.2 Verify that an engine out condition on multi-engine aircraft allows safe recovery of the aircraft.			x	x
~~7.1.3 Verify that single engine direct lift systems comply with specified safety requirements.~~				
7.1.4 Verify that technical data includes all operational and maintenance procedures and limitations necessary for safe operation of the air vehicle.	x	x	x	x
7.1.5 Verify that the engine configuration is controlled.	x	x	x	x
7.1.6 Verify that critical safety items (CSI) and critical characteristics are identified.	x	x	x	x
7.2 Gas turbine engine applications.				
7.2.1 Performance.				
7.2.1.1 Verify that engine performance is adequate for safe operation of the air vehicle. This includes consideration of all installation effects imposed by the air vehicle, and all intended operational environments.	x	x	x	x

	Civil Structure			
PROPULSION AND PROPULSION INSTALLATIONS (EMACC Structure)	**Engines**	**Propellers**	**FW Installation**	**RW installation**
7.2.1.2 Verify that degraded engine performance meets requirements for safety considerations. Degraded engine performance includes performance in any backup control mode, as well as performance after bird, ice, and sand ingestion.	x	x	x	x
7.2.2 Operability.				
7.2.2.1 Verify that positive stability margin exists at all flight conditions or that placards are documented in the flight manual.	x	x	x	x
7.2.2.2 Verify that the engine has adequate stability during throttle transients. The entire range of required transients should be considered, including those during land and ship approaches, aerial refuelling, and quick stops; for rotorcraft, bob-up and remask, and nap of the earth ridgeline crossings.	x	x	x	x
7.2.2.3 Verify that air start requirements are met and documented in the flight manual. Air starts include spool-down, windmill, cross-bleed and starter-assisted as appropriate for the air vehicle system.	x	x	x	x
7.2.2.4 Verify that the engine recovers from instability induced by external influences (such as inlet distortion and steam and armament gas ingestion) after the external influence is removed, without employing measures such as commanded idle or shutdown and without exceeding thermal or structural limits.	x	x	x	x
7.2.3 Structures.				
7.2.3.1 Verify that the engine structure does not exhibit detrimental permanent set or deflect to the extent that operation or performance is impaired when operated to limit load conditions (singly or in combination) within the flight and ground envelope. Verify that the engine structure does not experience catastrophic failure under ultimate load conditions or combinations of ultimate loading.	x	x		
7.2.3.2 Verify that the engine has positive durability margins over the defined operational interval and duty cycle to preclude adverse safety, economic, or operational impacts.	x	x		
7.2.3.3 Verify that all safety- and mission-critical parts are designed to be damage tolerant over the defined operational interval and duty cycle.	x	x		
7.2.3.4 Verify that the allowables for materials are minimums and are established considering statistical variability, the expected environments, fabrication processes, repair techniques, and quality assurance procedures. Verify that conditions and properties for material repairs satisfy design requirements.	x	x		
7.2.3.5 Verify that the engine is designed such that pertinent environmental variables and all sources of repeated loads are considered and these considerations are included in the development of the design duty cycle.	x	x		
7.2.3.6 Verify that all inspection intervals and life-limited components are identified in the technical manuals and a process to track life consumption is operational and current.	x	x		
7.2.4 Engine subsystems, components, computer resources and software.				
7.2.4.1 Subsystems.				
7.2.4.1.1 Verify that the engine control system maintains safe engine operation under all required conditions.	x	x		
7.2.4.1.2 Verify that multiple propulsion subsystems are physically, systemically, and operationally isolated from each other to prevent the failure of more than one propulsion subsystem due to any single or common cause.			x	x
7.2.4.1.3 Verify that the control system maintains both stable engine operation and response during all steady state and transient conditions.	x	x		
7.2.4.1.4 Verify that any failure of the engine controls and associated subsystems results in a fail-operational or fail-safe condition.	x	x		
7.2.4.1.5 Verify that the engine control system failures do not cause unexpected engine transients; or result in unacceptable controllability, stability, or handling qualities; or require any urgent or excessive pilot action.	x	x	x	x
7.2.4.1.6 Verify that the engine fuel system safely provides the required fuel supply to the combustor, augmentor, and fueldraulics subsystems under all required conditions.	x	x	x	x
7.2.4.1.7 Verify that the engine ignition system provides a safe ignition source for the main combustor and augmenter.	x	x		
7.2.4.1.8 Verify that the engine anti-ice/de-ice system prevents damaging ice build-up or provides safe and non-damaging ice removal at all engine speeds/power levels and will not result in heat-induced damage to the engine's front frame structure.	x	x		
7.2.4.1.9 Verify that engine cooling and thermal management systems safely remove excess heat from the engine and its subsystems (see 8.2.16).	x	x	x	x

	Civil Structure			
PROPULSION AND PROPULSION INSTALLATIONS (EMACC Structure)	**Engines**	**Propellers**	**FW Installation**	**RW installation**
7.2.4.1.10 Verify that the engine variable geometry systems safely operate under all engine operating conditions.	x	x	x	x
7.2.4.1.11 Verify that the engine lubrication system safely operates under all engine operating conditions.	x	x	x	x
7.2.4.1.12 Verify that the lubrication system is free from excessive discharge at the breather.	x	x	x	x
7.2.4.1.13 Verify that the lubrication system and bearing compartments do not support combustion.	x	x	x	x
7.2.4.1.14 Verify that the engine health monitoring and prognostics systems provide adequate warnings in a timely manner to reduce occurrences of in-flight shutdowns and power losses.	x	x	x	x
7.2.4.2 Components: mechanical and electrical.				
7.2.4.2.1 Verify that any uncontained failure of an engine control or subsystem component with rotating parts does not adversely affect the continued safe operation of the air vehicle.	x	x	x	x
7.2.4.2.2 Verify that changes in bearing thrust balance do not result in the bearing operating in failure prone regions of operation.	x	x	x	x
7.2.4.2.3 Verify that all engine mounted tubing, manifolds and clamps are safely affixed and routed on the engine.	x	x		
7.2.4.2.4 Verify that all engine mounted tubing, manifolds and clamps do not contain natural frequencies within the engine and subsystems operating ranges.	x	x	x	x
7.2.4.2.5 Verify that all pressure vessels, tubes and manifolds have design margin for their maximum operating conditions.	x	x		
7.2.4.2.6 Verify that engine gearboxes have design margin for their maximum operating conditions.	x	x		
7.2.4.2.7 Verify that failure of any gearbox mounted component (oil pumps, fuel pumps, starters, generators, etc.) does not result in failure of the gearbox itself.	x	x		
7.2.4.2.8 Verify that failure of the engine power take-off (PTO) coupling assembly does not adversely affect safe operation of the air vehicle.	x	x		
7.2.4.2.9 Verify that all engine mounted electrical components and cabling are safely affixed and routed on the engine.	x	x		
7.2.4.2.10 Verify that all engine mounted electrical components and cabling can safely operate in the lightning and electromagnetic effects environment of the air vehicle.	x	x		
7.2.4.2.11 Verify that all engine mounted electrical components and associated cabling do not react to engine or air vehicle induced vibratory and acoustic excitations.	x	x		
7.2.4.2.12 Verify that electrical power is supplied to all safety critical engine systems under all flight conditions.	x	x	x	x
7.2.4.3 Engine controls and monitoring devices that use computers and software meet all applicable criteria of Section 15	x	x	x	x
7.2.5 Installations.				
7.2.5.1 Physical Installation.				
7.2.5.1.1 Verify that all engine/air vehicle physical interfaces such as mechanical, fluid, and electrical connections are safe.			x	x
7.2.5.1.2 Verify that the aircraft/engine mounts contain adequate design margin to secure the engine properly under all operating conditions and failure modes.			x	x
7.2.5.1.3 Verify that, when applicable, the installed power-take-off (PTO) shaft system is free of any potentially damaging resonant conditions (refer to section 8.6 for additional details) for all loads and modes of operation.			x	x
7.2.5.1.4 Verify that the probability of failure due to uncontained rotating parts damaging air vehicle safety of flight (SOF)/critical safety items (CSIs) is acceptable.			x	x
7.2.5.1.5 Verify that clearance between the air vehicle and engine (including associated components, plumbing, and harnesses) is maintained under all operating conditions within the ground and flight envelopes.			x	x
7.2.5.1.6 Verify that drain systems have sufficient capacity, operate throughout required ground and flight attitudes and regimes, and expel/store the fluids in a safe manner.			x	x
7.2.5.1.7 Verify the engine air inlet components have adequate structural margin to withstand the over-pressures generated by inlet/compressor anomalies.			x	x

	Civil Structure			
PROPULSION AND PROPULSION INSTALLATIONS (EMACC Structure)	**Engines**	**Propellers**	**FW Installation**	**RW installation**
7.2.5.1.8 Verify accessibility to propulsion-system-related equipment for the performance of required servicing, inspections, and maintenance.			x	x
7.2.5.1.9 Verify that airframe and propulsion systems eliminate sources of self-induced foreign/domestic object damage (FOD/DOD) to engines.			x	x
7.2.5.2 Functional installation.				
7.2.5.2.1 Verify that functional compatibility of the integrated system is safe.			x	x
7.2.5.2.2 Verify that the engine can safely supply all customer extractions (bleed air, horsepower, electrical power, etc.) under all operating conditions.			x	x
7.2.5.2.3 Verify customer bleed air contamination does not exceed safe limits.			x	x
7.2.5.3 Inlet compatibility.				
7.2.5.3.1 Verify that the air induction system(s) functions under all expected ground, flight, and environmental (including ice, sand, and dust, as applicable) conditions without adversely affecting engine operation or resulting in engine damage.			x	x
7.2.5.4 Exhaust system compatibility.				
7.2.5.4.1 Verify that exhaust systems direct exhaust gases to the atmosphere clear of the flight crew, boarding or discharging passengers, externally mounted equipment, fluid drains, air intakes, stores, rotor blades, and airframe structure.			x	x
7.2.5.4.2 Verify that thrust reverser/thrust vectoring systems are fail-safe and compatible with engine and air vehicle systems.			x	x
7.2.5.5 Environmental compatibility.				
7.2.5.5.1 Verify that engine bay/nacelle cooling and ventilation provisions are adequate to maintain the temperatures of power plant components, engine fluids, other bay/nacelle equipment and structure within the temperature limits established for these components and fluids, under ground and flight operating conditions, and after normal engine shutdown. (These provisions should be compatible with the fire protection certification criteria of 8.4.)			x	x
7.2.5.5.2 Verify the installed vibratory compatibility of the engine/airframe system.			x	x
7.2.5.5.3 Verify compatibility with shipboard jet blast deflectors.			x	x
7.2.5.6 Installation other.				
7.2.5.6.1 Verify that the air vehicle propulsion controls and crew station information are adequate for proper crew control and operation of the propulsion system.			x	x
7.3 Alternate propulsion systems.				
7.3.1 Propeller driven systems.				
7.3.1.1 Verify that adequate margins exist for the performance, strength, and durability of the following: propeller and propeller system components, including the propeller drive shaft, reduction gearbox, torque measurement system, negative torque system, propeller brake, and mechanical over-speed governor.		x		
7.3.1.2 Verify that any critical propeller speeds (e.g., speeds that excite resonant frequencies and cause detrimental blade stresses) are outside the engine operating range or identified limitations are placed in the appropriate operators and maintenance technical manuals (T.O.'s).		x		
7.3.1.3 Verify the safety and functionality of the hardware and software components of propeller reversing systems and pitch controls for all steady state, transient, and emergency operating conditions.		x		
7.3.1.4 Verify the safety of all physical and functional interfaces between the propeller and any system that drives the propeller.		x	x	
7.3.1.5 Verify that the manual and automatic feathering systems are operational for all steady state, transient, and emergency operating conditions.		x		
7.3.1.6 Verify the compatibility of the propeller and engine control systems under all steady state, transient, and emergency operating conditions.		x		
7.3.1.7 Verify that the propeller system is free of destructive vibrations at all steady state and transient operating conditions and is capable of balancing to remove vibration that could cause equipment to operate below specified requirements or cause excessive crew discomfort.		x		
7.3.1.8 Verify that the propeller ice control system prevents the dangerous accumulation of ice during all operating conditions.		x		
7.3.1.9 Verify that the propeller can tolerate bird strikes.		x		

	Civil Structure			
PROPULSION AND PROPULSION INSTALLATIONS (EMACC Structure)	**Engines**	**Propellers**	**FW Installation**	**RW installation**
7.3.2 Rotary wing systems.				
7.3.2.1 Verify that the rotary wing and all associated components and systems (drive shaft, reduction gearbox, torque measurement system, negative torque system, brake system, and mechanical overspeed governor) provide sufficient power, torque, strength, and durability for safe operation at sea level hover and margin for vertical climb and hover throughout the flight envelope.				x
7.3.2.2 Verify that the rotor system provides safe controllability of the air vehicle under all expected operating conditions.				x
7.3.2.3 Verify that, for rotary wing air vehicles, the effects of high-energy, low-frequency vibrations, generated by main rotor blade passage (fundamental and harmonic) frequencies at all engine and related component operating speeds and powers, do not adversely affect the operation of the engine and the drive system.				x
7.3.2.4 Verify, for rotary wing air vehicles, that a satisfactory interface is achieved between the engine (including subsystems/accessories) and the airframe relative to both high-frequency engine-excited and low-frequency air vehicle rotor(s) excited vibrations.				x
7.3.2.5 Verify that the transmission/gearbox lubrication system safely operates under all air vehicle operating conditions.				x
7.3.2.6 Verify that unfavourable dynamic coupling modes do not occur when the engine, engine accessories, rotor system, and all dynamic transmission components are operated as a combined dynamic system.				x
7.3.2.7 Verify that the engine's control/rotor system torsional stability has required gain and phase margins and main rotor torque damping during steady-state and transient operation.				x
7.3.2.8 Verify that the torque and misalignment capabilities of drive shaft couplings are suitable for all possible combinations of torque and speed when installed in the aircraft at the maximum permissible misalignment.				x
7.3.2.9 Verify that the rotors can be held from rotating in winds at specified velocities and directions, during engine non-operation, power up, and ground idle conditions.				x
7.3.2.10 Verify that the normal and emergency braking systems (consisting of aerodynamic rotor drag and subsequent mechanical braking) are capable of stopping the rotor, from 100% speed, within specified times after engine shutdown.				x
7.3.2.11 Verify that rotor system condition monitoring provides warning of impending failure that could result in loss of the air vehicle or prevent a safe landing.				x
7.3.2.12 Verify that the drive system permits engagement and disengagement of the engines from the load absorbers as required for all applicable modes of air vehicle operation				x
7.3.2.13 Verify that, during a loss of the primary lubrication system, the gearboxes continue to function and transmit required power until appropriate pilot action can be accomplished.				x
7.3.2.14 Verify that inadvertent operation of externally phased intermeshing-rotor systems cannot occur if the rotors become dephased and that cockpit indications are provided to the pilot.				x
7.3.2.15 Verify that failure or seizure of any individual accessory does not cause damage to any power drive subsystem components during all phases of air vehicle operation.				x
7.3.3 Reciprocating engines.				
7.3.3.1 Verify that reciprocating engines meet 14 Code of Federal Regulation (CFR) certification as used for the military mission.				

TYPICAL CERTIFICATION SOURCE DATA

1. Design criteria
2. Design studies and analyses
3. Design, installation, and operational characteristics
4. Engine ground and simulated altitude tests
5. Engine design function/system compatibility tests
6. Engine component and functional level qualification and certification tests
7. Electromagnetic environmental effects
8. Installed propulsion compatibility tests

9. Acceptance test results
10. Failure modes, effects, and criticality analysis/testing (FMECA/FMET)
11. Hazard analysis and classification
12. Safety certification program
13. Engine endurance and accelerated mission testing
14. Engine and component structural and aeromechanical tests
15. Flight test plans and results
16. Engine structural integrity program (ENSIP) analyses and tests
17. Engine life management plans
18. Over-speed and over-temperature tests
19. Overall engine and component performance analyses
20. Flight manual
21. Natural environmental sensitivities
22. Inlet airflow distortion/engine stability assessments and audits
23. Interface/integration control documents
24. Function, subfunction, and component specifications
25. Selection criteria and inlet distortion patterns selected to demonstrate inlet/engine compatibility.
26. Engine control system rig tests
27. Engine health monitoring system design reports and tests
28. Aircraft/engine operating limitations
29. Engine software development plan and product specifications
30. Engine software test plans, test procedures and test reports
31. Engine software configuration control/management plan and procedure
32. Propulsion and Power Flight Clearance Plan, JSSG-2007A, Table XLVIIIb
33. Diminishing manufacturing sources plan
34. Obsolete parts plan

CERTIFICATION CRITERIA

7.1. PROPULSION SAFETY MANAGEMENT.

This section details Propulsion Safety Management Criteria, necessary to identify, analyse and mitigate propulsion system risks.

7.1.1 The propulsion system certification documentation shall be reviewed to ensure that a satisfactory safety analysis has been completed.

Consideration should be given to:
a. Integrating the engine safety analysis into the platform safety management system;
b. All constituent sub-systems (typically control systems);
c. Direct lift engine systems and any safety requirements over and above those for a standard installation;
d. Ensuring the safety-critical propulsion system risks are identified, probabilities are validated, and risk controls (which may be related to airframe specific measures including configuration features) are in place;
e. Contribution to, or mitigation of propulsion risks introduced by integrating systems (typically ground support systems).

Information Sources			
Comm'l Doc:	SAE ARP 5580		
DoD/MIL Doc:	JSSG-2007A: A.3.2, A.3.2.1, A.3.3.1, A.3.3.2, A.3.3.7, A.3.5.1, A.3.11, A.3.12, A.4.2, A.4.2.1, A.4.3.1, A.4.3.2, A.4.3.7, A.4.5.1, A.4.11, A.4.12, propulsion system failure analysis and reliability.	*Def-Stan 00-970 Reference:*	00-970 P1 3.9 00-970 P1 3.10 00-970 P1 4.19.34 00-970 P1 5.1.140 00-970 P11 S3 E690 00-970 P11 S4.1
		STANAG Reference:	4671.1529 4671.901
FAA Doc:	14CFR references: 33.5, 33.35, 33.7, 33.8 AC 33-2B	*EASA CS Reference:*	CS-E 25 CS-E 510 CS 23.901 CS 23.903 CS 23.1529 CS 25.901 CS 25.903 CS 25.1529 CS 27.1529 CS 29.1529

7.1.2 An engine out condition on a multi-engine aircraft shall not prevent the safe recovery of the aircraft.

Consideration should be given to all phases of flight including:
a. Take-off;
b. Cruise;
c. Landing;
d. Requirements to satisfy Extended Range Twin Operations (ETOPS) where appropriate.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.2, A.4.2, A.3.11, A.4.11, A.3.12, A.4.12	*Def-Stan 00-970 Reference:*	00-970 P1 2.4.22 00-970 P1 2.4.23 00-970 P1 2.14 00-970 P1 3.4.11 00-970 P1 4.14.13 00-970 P1 5.1.3 00-970 P1 6.12.15 00-970 P1 7.1.2 00-970 P13 1.5.1.5
		STANAG Reference:	4671.U2 4671.143 4671.367 4671.745 4671.1413
FAA Doc:	14CFR references: 33.35, 33.5, 33.7, 33.8 AC 33-2B	*EASA CS Reference:*	CS 23.143 CS 23.367 CS 23.745 CS 23.903 CS 23.1309

Information Sources			
			CS 25.143 CS 25.105 CS 25.107 CS 25.109 CS 25. 117 CS 25.121 CS 25.362 CS 25.367 CS 25.901 CS 25.1309 CS 27.33 CS 27.51 CS 27.75 CS 27.143 CS 27.917 CS 27.1309 CS 29.33 CS 29.53 CS 29.63 CS 29.79 CS 29.83 CS 29.143 CS 29.917 CS 29.1309

7.1.3 Merged with 7.1.1

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Merged with 7.1.1	*Def-Stan 00-970 Reference:*	Merged with 7.1.1
		STANAG Reference:	Merged with 7.1.1
FAA Doc:	Merged with 7.1.1	*EASA CS Reference:*	Merged with 7.1.1

7.1.4 The technical data provided by the manufacturer shall include all propulsion system related operational and maintenance procedures and limitations necessary for safe operation and maintenance of the air vehicle.

Consideration should be given to:

a. Normal and emergency operating procedures;
b. Requirements for unscheduled maintenance;
c. Requirements for routine maintenance;
d. Information relating to component lifting requirements.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 2.1 00-970 P1 4.2.20 00-970 P1 4.4.3 00-970 P1 5.1.8 00-970 P11 3.E20 00-970 P11 3.E510 00-970 P11 3.E515
		STANAG Reference:	4671.1501-4671.1589(USAR)
FAA Doc:	14CFR references: 23.1585	*EASA CS Reference:*	CS 23.1501-23.1589 CS 25.1501-25.1589 CS 27.1501-27.1589 CS 29.1501-29.1589 CS-E 20 CS-E 510 CS-P 150 CS-P 160

7.1.5 Merged with Section 4.6 & 4.7

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Line should be deleted, or merged with Section 4.6/7, as it requires use of normal organisational quality processes rather than aircraft, or engine, certification activity.	*Def-Stan 00-970 Reference:*	Merged with Section 4.6& 4.7
		STANAG Reference:	Merged with Section 4.6& 4.7
FAA Doc:		*EASA CS Reference:*	Merged with Section 4.6 & 4.7

7.1.6 Engine-related critical safety items (CSI) and critical characteristics shall be identified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2007A: 3.4.1.4 DoD 4140.1-R, Section C8.5, DoD Supply Chain Materiel Management Regulation DoD Aviation Critical Safety Item (CSI)/Flight Safety Critical Aircraft Part (FSCAP) NAVAIRINST 4200.25D Management of Critical Application Items Including Critical Safety Items. Critical Item Management Desktop Guide (to NAVAIR 4200.25D) (Draft) JACG Instruction on	*Def-Stan 00-970 Reference:*	00-970 P11 3.E515
		STANAG Reference:	4671.1529

Information Sources			
	Management of Aviation Critical Safety Items.		
FAA Doc:		*EASA CS Reference:*	CS-E 20 CS-E 510 CS-E 515 CS-P 150 CS-P 160 CS 23.1529 CS 25.1529 CS 27.1529 CS 29.1529

7.2. GAS TURBINE ENGINE APPLICATIONS.

This section details General Engine System Criteria, necessary to ensure that the engine and associated subsystems functionality, performance and operation allows safe operation of the air vehicle. The scope of this section encompasses both installed and uninstalled propulsions system and covers:

- Normal engine operation and performance;
- Degraded engine operation and performance;
- Consideration of all installation effects (functional, physical and compatibility) due to air vehicle/engine integration;
- Engine subsystems, components, computer resources and software;
- Performance across all intended operational environments.

7.2.1. Performance.

7.2.1.1 Engine performance shall be adequate for safe operation of the air vehicle. This includes consideration of all installation effects due to air vehicle/engine integration, and all intended operational environments.

Consideration should be given to:

a. Engine steady and transient response characteristics of the engine and engine control system, including Reheat Modulation;

b. Fuel flow modulation ;

c. Engine responses to input signals at different frequencies ;

d. Engine control and vehicle control system communication ;

e. Fuel, air induction, exhaust and bleed air extraction systems, ambient temperatures, ambient pressures, and vibratory environment;

f. Performance rating structure;

g. Performance deterioration throughout normal operating conditions;

h. Performance deterioration due to particular ingestion conditions (rain, hail, birds, sand, ice, snow, etc.);

i. Sensitivity, stability, control response, and torque predictability for engine and vehicle control during engine power changes (acceleration and deceleration);

j. Auxiliary engine control functions;

k. Altitude cold start and hot restart capability;

l. Relight.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.2, A.4.2, A.3.2.1, A.4.2.1, A.3.2.1.1, A.4.2.1.1, A.3.3.1, A.4.3.1, A.3.3.2, A.4.3.2, A.3.3.7, A.4.3.7, A.3.11, A.4.11, A.3.12, A.4.12 and JSSG-2001B 3.3.1.1/4.3.1.1	*Def-Stan 00-970 Reference:*	00-970 P1 2.4 00-970 P1 2.5 00-970 P1 5.1.33-5.1.39 00-970 P1 5.1.127-5.1.134 00-970 P1 5.1.135
		STANAG Reference:	4671. 901 4671.1301 4671.1309
FAA Doc:	14CFR references: 33.5, 33.35, 33.7, 33.8, AC 33.2B	*EASA CS Reference:*	CS 23.901 CS 23.1301 CS 23.1309 CS 25.901 CS 25.943 CS 25.1301 CS 25.1309 CS 27.901 CS 27.1301 CS 27.1309 CS 29.901 CS 29.1301 CS 29.1309 CS-E 20 CS-E 40 CS-E 300 CS-E 430 CS-E 440 CS-E 690 CS-E 740

7.2.1.1.1 The ability of any aircraft to operate in, or in the vicinity of, a volcanic ash cloud shall be clearly understood and detailed in the aircraft operating manuals. It is understood that military operational imperatives may override this regulatory criteria as necessary.

Consideration should be given to:

Engine abrasion corrosion;
Blockage of engine cooling ducts/vents or paths;
Aircraft skin and transparency abrasion;
Damage to systems from ingestion of particles (air conditioning, electronic cooling, contamination of surfaces or fluids)
Blockage of air data system (pitot or static systems);

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG	

Information Sources			
		Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.1593

7.2.1.2 Degraded engine performance shall meet the relevant requirements for safety.

In addition to considerations defined in 7.2.1.1, consideration should be given to:
a. Performance in any backup control mode;
b. Performance after bird, excessive ice, rain, or sand ingestion;
c. Performance for time limited dispatch.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: Backup control: A.3.7.2.1.1, A.4.7.2.1.1; Bird ingestion: JSSG-2007A A.3.3.2.1, A.4.3.2.1; Ice ingestion: A.3.3.1.4, A.4.3.1.4; and Sand ingestion: A.3.3.2.4, A.4.3.2.4	*Def-Stan 00-970 Reference:*	00-970 P11 3.E50 00-970 P11 3.E540 00-970 P11 3.E780 00-970 P11 3.E790 00-970 P11 3.E800
		STANAG Reference:	4671.903
FAA Doc:	14CFR references: 33.1, 33.68, 33.89 AC 33-76	*EASA CS Reference:*	CS-E 20e CS-E 50 CS-E 540 CS-E 580 CS-E 700 CS-E 780 CS-E 790 CS-E 800 CS-E 820 CS-E 1030

7.2.2. Operability.

7.2.2.1 Adequate positive stability margin shall exist in all flight conditions, or placards shall be documented in the flight manual.

Consideration should be given to:
a. Ensuring positive engine surge margin at conditions that are critical to the safety of the flight vehicle, such as crosswind takeoffs, takeoffs on cold days following a rapid reaction start, and extreme manoeuvres.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.2.2.6, A.4.2.2.6, A.3.2.2.11, A.4.2.2.11, A.3.3.2.5, A.4.3.2.5, A.3.3.2.6, A.4.3.2.6, A.3.3.2.7, A.4.3.2.7	*Def-Stan 00-970 Reference:*	00-970 P1 2.13.14 00-970 P1 5.1.12 00-970 P1 5.1.15 00-970 P1 5.1.138 00-970 P1 5.1.140 00-970 P11 3.E500

Information Sources			
			00-970 P11 3.E745
		STANAG Reference:	4671. 939 4671.1521 4671.1541 4671.1581 4671.1583
FAA Doc:	14CFR references: 33.65, 33.73 (stability), 33.5 (distortion)	*EASA CS Reference:*	CS 23.939 CS 23.1521 CS 23.1541 CS 23.1581 CS 23.1583 CS 25.939 CS 25.1521 CS 25.1541 CS 25.1581 CS 25.1583 CS 27.939 CS 27.1521 CS 27.1541 CS 27.1581 CS 27.1583 CS 29.939 CS 29.1521 CS 29.1541 CS 29.1581 CS 29.1583 CS-E 25 CS-E 50 CS-E 500 CS-E 745

7.2.2.2 The engine shall have adequate stability during throttle transients to achieve required manoeuvres safely.

Consideration should be given to the full range of activities which include, but are not limited to:

a. Land and ship approaches, aerial refuelling, quick stops, use of reverse thrust, and VSTOL;

b. For rotorcraft, bob-up and remask, and nap of the earth ridgeline crossings.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.2.2.6, A.4.2.2.6, A.3.2.2.7, A.4.2.2.7 MIL-HDBK-516: criteria 7.2.4.1.3	*Def-Stan 00-970 Reference:*	00-970 P1 2.13.14 00-970 P13 3.5.68 00-970 P13 3.5.73 00-970 P1 2.19.26-2.19.32 00-970 P1 5.1.15 00-970 P1 5.1.138 00-970 P1 5.1.140 00-970 Pt 11 3.E500

Information Sources			
			00-970 Pt 11 3.E740 00-970 Pt 11 3.E745
		STANAG Reference:	4671.939
FAA Doc:	14CFR references: 33.65, 33.73, 33.89	*EASA CS Reference:*	CS 23.939 CS 25.939 CS 27.939 CS 29.939 CS-E 50 CS-E 500 CS-E 740 CS-E 745 CS-E 890

7.2.2.3 The requirements for an in-flight engine relight, or air-start, ability shall be met, and the associated procedures and any limitations documented in the flight manual.

Consideration should be given to:

a. Engine spool-down;

b. Windmill start;

c. Start using cross-bleed, or starter-assisted as appropriate;

d. Hot and cold relights.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.2.2.3.2, A.4.2.2.3.2	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.57 00-970 P1 5.1.86-5.1.89 00-970 P1 5.1.136 00-970 P1 5.1.140 00-970 P11 S2.5 00-970 P11 3E.910
		STANAG Reference:	4671.903 4671.1585
FAA Doc:	14CFR references: 33.89	*EASA CS Reference:*	CS 23.903 CS 23.1581 CS 23.1585 CS 25.903 CS 25.1581 CS 25.1585 CS 27.903 CS 27.1581 CS 27.1585 CS 29.903 CS 29.1581 CS 29.1585 CS-E 370 CS-E 500

Information Sources			
			CS-E 910

7.2.2.4 The engine shall recover from any instability induced by external influences (such as inlet distortion, steam, or armament gas ingestion) after the external influence is removed, without employing measures such as commanded idle or shutdown, and without exceeding thermal or structural limits.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.2.2.3.5, A.4.2.2.3.5, A.3.2.2.11.2, A.4.2.2.11.2, A.3.7.2.1, A.4.7.2.1	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.41 00-970 P1 5.1.139 00-970 P13 3.2.36 00-970 P11 4.5 00-970 P11 4.6.1
		STANAG Reference:	4671.1091
FAA Doc:	14CFR references: 33.27, 33.28, 33.91	*EASA CS Reference:*	CS 23.1091 CS 25.1091 CS 27.1091 CS 29.1091 CS-E 50* CS-E 500 CS-E 540

7.2.3. Structures.

7.2.3.1 The engine structure shall not:

• Exhibit detrimental permanent set or deflect to the extent that operation or performance is impaired when operated to limit load conditions (singularly or in combination) within the flight or ground envelope;

• Experience catastrophic failure under ultimate load conditions or combinations of ultimate loading.

Consideration should be given to:

a. Definitions of limit and ultimate loads;

b. Integrity of engine case and pressure vessels including pressure balance and blade containment;

c. Engine mounts and associated structure.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-1783B: A.4.10/A.5.10 through A.4.10.14/A.5.10.14, A.4.5.3, A.5.5.3	*Def-Stan 00-970 Reference:*	00-970 P11 2.11.2 00-970 P11 3.70 00-970 P11 3.100 00-970 P11 3.510 00-970 P11 3.680 00-970 P11 3.810 00-970 P11 S4
		STANAG Reference:	4671.361 4671.363 4671.371
FAA Doc:	14CFR references: 33.75,	*EASA CS*	CS 23.305

Information Sources			
	33.91, 33.23	*Reference:*	CS 23.361 CS 23.363 CS 23.371 CS 25.361 CS 25.362 CS 25.363 CS 25.371 CS 27.361 CS 27.549 CS 29.361 CS 29.549 CS-E 70 CS-E 100 CS-E 510 CS-E 680 CS-E 810

7.2.3.2 The engine shall have a positive durability margin over the defined operational interval and duty cycle to preclude adverse safety impacts.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-1783B: A.4.9/A.5.9 through A.4.9.3/A.5.9.3 for LCF/durability/economic life design and compliance methods MIL-HDBK-1783B: A.4.13/A.5.13 through A.4.13.3.3/A.5.13.3.3 for high cycle fatigue/vibration guidance MIL-HDBK-1783B: A.4.12/A.5.12 for creep guidance MIL-HDBK-1783B: A.4.11/A.5.11 for deterioration guidance MIL-HDBK-1783B: A.4.14/A.5.14 for noise guidance MIL-HDBK-1783B: A.4.15/A.5.15 for foreign object damage/domestic object damage (FOD/DOD) guidance MIL-HDBK-1783B: A.4.16/A.5.16a and b, for durability and compliance criteria for repaired	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P11 2.13 00-970 P11 3.25 00-970 P11 3.70 00-970 P11 3.90 00-970 P11 3.140 00-970 P11 3.270 00-970 P11 3.340 00-970 P11 3.440 00-970 P11 3.510 00-970 P11 3.650 00-970 P11 3.700 00-970 P11 3.740 00-970 P11 4.7 00-970 P11 4.9.1 00-970 P11 4.12.1 4671.901

Information Sources			
	components		
FAA Doc:	14CFR references: 33.14, 33.5, 33.63, 33.83, 33.19	*EASA CS Reference:*	CS-E 25 CS-E 70 CS-E 90 CS-E 140 CS-E 270 CS-E 340 CS-E 440 CS-E 510 CS-E 650 CS-E 700 CS-E 740

7.2.3.3 All safety and mission-critical parts shall be designed to be damage tolerant over the defined operational interval and duty cycle.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-1783B: A.4.7/A.5.7 through A.4.8.6/A.5.8.6 for application of damage tolerance and inspection methods	*Def-Stan 00-970 Reference:*	00-970 P1 3.25 00-970 P1 3.70 00-970 P1 3.80 00-970 P1 3.130 00-970 P1 3.510 00-970 P1 3.515 00-970 P1 3.570 00-970 P1 3.700 00-970 P11 4.7
		STANAG Reference:	
FAA Doc:	14CFR references: 33.75	*EASA CS Reference:*	CS-E 25 CS-E 70 CS-E 80 CS-E 130 CS-E 510 CS-E 515 CS-E 570 CS-E 700

7.2.3.4 Material properties shall be based on the minimum specified for each material used and established considering statistical variability, the expected environments, fabrication processes, repair techniques and quality assurance procedures. The conditions and properties for material repairs shall satisfy design requirements.

Consideration should be given to:

a. Demonstrating material properties through test, modelling or analysis;

b. Validation of models.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	MIL-HDBK-1783B: A.4.6/A.5.6 for material characterization guidance	*Def-Stan 00-970 Reference:*	00-970 P1 3.25 00-970 P1 3.70 00-970 P1 3.100 00-970 P1 3.515 00-970 P1 3.640 00-970 P1 3.650 00-970 P1 3.840 00-970 P11 4.7
		STANAG Reference:	
FAA Doc:	14CFR references: 33.15	*EASA CS Reference:*	CS-E 25 CS-E 70 CS-E 100 CS-E 515 CS-E 640 CS-E 650 CS-E 840

7.2.3.5 The engine shall be designed such that pertinent environmental variables and all sources of repeated loads are considered, and these considerations included in the development of the design duty cycle.

Consideration should be given to:

a. Defining the expected flight envelope;

b. Defining the type of mission and mission envelope;

c. Any power take-off requirements;

d. Expected environmental conditions (rain, sand, steam, temperature, etc.);

e. Any military deltas over and above the CS-E requirements.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-1783B: A.4.3/A.5.3 through A.4.5.3/A.5.5.3, for design service life and usage	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.33-5.1.39 00-970 P11 2.3 00-970 P11 2.13 00-970 P11 3.25 00-970 P11 3.30 00-970 P11 3.90 00-970 P11 3.100 00-970 P11 3.210 00-970 P11 3.500 00-970 P11 3.510 00-970 P11 3.515 00-970 P11 3.680 00-970 P11 4
		STANAG Reference:	4671.903
FAA Doc:	14CFR references: 33.4	*EASA CS Reference:*	CS-E 25 CS-E 30 CS-E 90

Information Sources			
			CS-E 100 CS-E 210 CS-E 500 CS-E 510 CS-E 515 CS-E 680

7.2.3.6 Engine inspection intervals and life-limited components shall be identified in the technical manuals.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-1783B: A.4.19/A.5.19 for component life management guidance. MIL-HDBK-1783B: A.5.9.1.1 through A.5.9.1.6 for accelerated mission testing concepts	*Def-Stan 00-970 Reference:*	00-970 P11 2.13 00-970 P11 3.25 00-970 P11 3.510 00-970 P11 3.515
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS-E 25 CS-E 510 CS-E 515

7.2.4. Engine subsystems, components, computer resources and software.

7.2.4.1 Subsystems.

7.2.4.1.1 The engine control system shall maintain safe and stable engine operation under all required conditions.

Consideration should be given to:

a. Keeping the engine within the approved operating limits over changing atmospheric conditions in the declared flight envelope;

b. Modulating engine power or thrust with adequate sensitivity and accuracy over the declared range of engine operating conditions and transients;

c. Avoiding unacceptable thrust or power oscillations;

d. Control mode transitions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.7.2/A.4.7.2, control systems design and verification.	*Def-Stan 00-970 Reference:*	00-970 P11 3E.40 00-970 P11 3E.50 00-970 P11 3E.510 00-970 P11 S4
		STANAG Reference:	4671.903
FAA Doc:	14CFR references: 33.27, 33.28, 33.91	*EASA CS Reference:*	CS-E 40 CS-E 50 CS-E 510

Information Sources			
			CS 25.20

7.2.4.1.2 Multiple propulsion sub-systems of the same engine shall be physically, systemically, and operationally isolated from each other to prevent the failure of more than one propulsion sub-system due to any single or common cause.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.7.2/A.4.7.2, control systems guidance.	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.8 00-970 P11 3E.50 00-970 P11 3E.510 00-970 P11 S4
		STANAG Reference:	4671.903 4671.1309
FAA Doc:	14CFR references: 33.27, 33.28, 33.91	*EASA CS Reference:*	CS-E 50 CS-E 510 CS 23.903 CS 23.1143 CS 23.1309 CS 25.903 CS 25.1143 CS 25.1309 CS 27.1143 CS 27.1309 CS 29.903 CS 29.1143 CS 29.1309

7.2.4.1.3 The engine control system shall maintain both stable engine operation and response during all steady state and transient conditions.

Consideration should be given to:

a. Defining the steady state conditions (take-off, cruise, dash, etc.);

b. All specified operating environments (such as ice, rain, snow, volcanic ash, etc.);

c. Defining the required responsiveness;

d. Reheat modulation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.7.2/A.4.7.2, control systems guidance. MIL-HDBK-516 criteria 7.2.2.2	*Def-Stan 00-970 Reference:*	00-970 P1 2.13.14 00-970 P1 5.1.15 00-970 P1 5.1.18 00-970 P1 5.1.138 00-970 P1 5.1.140 00-970 P11 3E.50 00-970 P11 3E.500 00-970 P11 3E.740 00-970 P11 3E.745 00-970 P11 3E.890

Information Sources			
			00-970 P11 S4
		STANAG Reference:	4671.939
FAA Doc:	14CFR references: 33.27, 33.28, 33.91	*EASA CS Reference:*	CS-E 50 CS-E 500 CS-E 740 CS-E 745 CS-E 890 CS 23.939 CS 25.939 CS 27.939 CS 29.939

7.2.4.1.4 Any failure of the engine controls and associated sub-systems shall result in a fail-safe condition.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.7.2/A.4.7.2, control systems guidance.	*Def-Stan 00-970 Reference:*	00-970 P11 3E.50 00-970 P11 3E.140 00-970 P11 3E.210 00-970 P11 3E.510 00-970 P11 S4
		STANAG Reference:	4671.1141 4671.1309
FAA Doc:	14CFR references: 33.27, 33.28, 33.91	*EASA CS Reference:*	CS-E 50 CS-E 140 CS-E 210 CS-E 510 CS-E 560 CS-E 590 CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

7.2.4.1.5 Engine control system failures shall not cause unexpected engine transients; result in unacceptable controllability, stability, or handling qualities; or require any urgent or excessive pilot action.

Consideration should be given to:

a. The dynamic latency and response should ensure safe operation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.7.2, A.4.7.2,	*Def-Stan 00-970*	00-970 P11 3E.50

Information Sources			
	A.3.7.6, A.4.7.6	*Reference:*	00-970 P11 3E.140 00-970 P11 3E.210 00-970 P11 3E.500 00-970 P11 3E.510 00-970 P11 S4
		STANAG Reference:	4671.1141 4671.1309
FAA Doc:	14CFR references: 33.27, 33.28, 33.91	*EASA CS Reference:*	CS-E 50 CS-E 140 CS-E 210 CS-E 500 CS-E 510 CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

7.2.4.1.6 The engine fuel system shall safely provide the required fuel supply to the combustor and reheat sub-systems under all required conditions.

Information Sources			
Comm'l Doc:	SAE-AS1055B, Fire Testing		
DoD/MIL Doc:	JSSG-2007A: A.3.7.3.2/A.4.7.3.2, Fuel Systems Performance, engine fuel system design and verification testing JSSG-2007A: A.3.1.8.1/A.4.1.8.1, Flammable Fluid Systems - fire resistance testing requirements and procedures.	*Def-Stan 00-970 Reference:*	00-970 P11 3E.130 00-970 P11 3E.140 00-970 P11 3E.210 00-970 P11 3E.250 00-970 P11 3E.440 00-970 P11 3E.470 00-970 P11 3E.510 00-970 P11 3E.560 00-970 P11 3E.660 00-970 P11 3E.740 00-970 P11 S4
		STANAG Reference:	4671.951
FAA Doc:	14CFR references: 33.17, 33.67, 33.87(a)(7), 33.89, 33.91	*EASA CS Reference:*	CS-E 130 CS-E 140 CS-E 210 CS-E 250 CS-E 440 CS-E 470 CS-E 510 CS-E 560 CS-E 660 CS-E 740

7.2.4.1.7 The engine ignition system shall provide a safe ignition source for the main combustor and reheat system.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.2.2.3.5/A.4.2.2.3.5, Auto-Relight and A.3.7.5/A.4.7.5, Ignition Systems	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.86 00-970 P11 3E.210 00-970 P11 3E.240 00-970 P11 3E.450 00-970 P11 3E.500 00-970 P11 3E.510 00-970 P11 3E.910 00-970 P11 S4
		STANAG Reference:	4671.1165
FAA Doc:	14CFR references: 33.89, 33.69	*EASA CS Reference:*	CS-E 450 CS-E 500 CS-E 510 CS-E 910

7.2.4.1.7.1 The battery operated engine ignition system shall provide a safe and dependable ignition source for the main combustor and augmenter.

Consideration should be given to:

a. Capacity of batteries and generators to provide total load required by aircraft;
b. Inoperative generator(s);
c. Completely depleted batteries;
d. Routing of ground wires;
e. Independence of the ignition system from any other electrical system not used for assisting, controlling, or analysing the ignition system;
f. Means to warn appropriate crew members if the malfunctioning of any part of the electrical system is causing the continuous discharge of any battery necessary for engine ignition;
g. Each engine ignition system of a turbine powered aircraft must be considered an essential electrical load.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.1165

7.2.4.1.8 The engine anti-ice/de-ice system shall prevent damaging ice build-up, or provide safe and non-damaging ice removal, at all engine speeds/power levels and shall not result in heat-induced damage to the engine's front frame structure.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.7.1/A.4.7.1, Anti-ice and De-ice Systems	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.35 00-970 P1 5.1.36

Information Sources			
			00-970 P1 5.1.42 00-970 P11 3E.230 00-970 P11 3E.780 00-970 P11 S4
		STANAG Reference:	4671.929
FAA Doc:	14CFR references: 25.1419	*EASA CS Reference:*	CS-E 780

7.2.4.1.9 The engine cooling and thermal management systems shall safely remove excess heat from the engine and its sub-systems.

Consideration should be given to:

a. The full operational envelope of the air vehicle;

b. Those components (electronic controls, sensors, lubrication system, etc.) which could become damaged, or operate erratically, if subjected to excessive thermal load;

c. Installation effects such as nacelle ventilation, surface temperatures, oil-fuel cooling, electronics functioning.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.2.2.13/A.4.2.2.13	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.73 00-970 P1 5.3.5 00-970 P11 3E.60 00-970 P11 3E.260 00-970 P11 3E.740 00-970 P11 3E.860 00-970 P11 S4
		STANAG Reference:	4671.1041
FAA Doc:	14CFR references: 27.1121	*EASA CS Reference:*	CS-E 20 CS-E 60 CS-E 100(a) CS-E 660 CS-E 700 CS-E 740 CS-E 860 CS-E 870 CS 25.961 CS 25.1041 CS 29.961 CS 29.1041

7.2.4.1.10 Engine variable geometry systems shall operate safely under all engine operating conditions.

Consideration should be given to:

a. Variable intakes;

b. Variable exhaust nozzles, including re-heat;

c. Variable engine guide vanes;

d. Engine performance in the presence of incorrect inlet/nozzle/guide vane positioning.

Information Sources			
Comm'l Doc:	SAE-AS1055B, Fire Testing		
DoD/MIL Doc:	JSSG-2007A: A.3.7/A.4.7, variable geometry system design and verification testing.	*Def-Stan 00-970 Reference:*	00-970 P2 2.1 00-970 P1 5.1.23 00-970 P1 5.1.45 00-970 P1 5.1.48 00-970 P1 5.1.89 00-970 P11 3E.130 00-970 P11 3E.140 00-970 P11 3E.650 00-970 P11 S4
		STANAG Reference:	4671.903
FAA Doc:	14CFR references:27.695, 29.695, 33.17, 33.72, 43.1	*EASA CS Reference:*	CS-E 140 CS-E 650

7.2.4.1.11 The engine lubrication system shall operate safely under all engine and airframe operating conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.7.8/A.4.7.8, Lubrication System	*Def-Stan 00-970 Reference:*	00-970 P1 5.3 00-970 P11 3E.25 00-970 P11 3E.130 00-970 P11 3E.270 00-970 P11 3E.440 00-970 P11 3E.570 00-970 P11 3E.740 00-970 P11 S4
		STANAG Reference:	4671.1011-4671.1027
FAA Doc:	14CFR references: 33.5, 33.71, 33.87, 33.89	*EASA CS Reference:*	CS 25.1011-25.1027 CS 29.1011-29.1027 CS-E 25 CS-E 130* CS-E 570 CS-E 640 CS-E 680 CS-E 740 CS-E 770

7.2.4.1.12 The lubrication system shall be free from excessive discharge at the breather.

Consideration should be given to defining 'excessive', or acceptable, in this context.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	JSSG-2007A: paraA.3.7.8.3/A.4.7.8.3, Breather Mist - engine breather exhaust emissions design and verification testing.	*Def-Stan 00-970 Reference:*	00-970 P1 5.3.71-5.3.74 00-970 P11 3E.270 00-970 P11 3E.570 00-970 P11 S4
		STANAG Reference:	4671.1017
FAA Doc:		*EASA CS Reference:*	CS-E 270 CS-E 570

7.2.4.1.13 The lubrication system and bearing compartments shall not support combustion.

Consideration should be given to:

a. System components such as: tanks, lines, fittings, sumps and gearboxes;

b. Components subject to both fuel and oil, such heat exchangers.

Information Sources			
Comm'l Doc:	SAE-AS1055B, Fire Testing		
DoD/MIL Doc:	JSSG-2007A: A.3.1.8.1/A.4.1.8.1, Flammable Fluid Systems - fire resistance and fireproof testing.	*Def-Stan 00-970 Reference:*	00-970 P11 3E.130 00-970 P11 3E.210 00-970 P11 3E.510 00-970 P11 3E.570 00-970 P11 S4
		STANAG Reference:	4671.1011
FAA Doc:		*EASA CS Reference:*	CS-E 130 CS-E 210 CS-E 510 CS-E 570

7.2.4.1.14 The engine health monitoring and prognostics systems shall provide adequate warnings in a timely manner to reduce occurrences of in-flight shutdowns and power losses.

Consideration should be given to:

a. Oil and magnetic chip sampling programmes;

b. Monitoring engine parameters, and recording if possible;

c. Involvement of off-board components/IT systems in the processing of safety-related information.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.7.6/A.4.7.6, Engine Health Monitoring Systems (EHMS), the Interface Control Document (ICD) and the pilot's operating manual	*Def-Stan 00-970 Reference:*	00-970 P11 3E.25 00-970 P11 3E.50 00-970 P11 3E.60 00-970 P11 3E.515 00-970 P11 S4
		STANAG Reference:	4671.U1787
FAA Doc:	14CFR references: 33.28	*EASA CS Reference:*	CS-E 25 CS-E 50 CS-E 60

Information Sources			
			CS-E 515

7.2.4.2 Components: mechanical and electrical.

7.2.4.2.1 Any uncontained failure of an engine control or sub-system component containing rotating parts shall have an adequately low risk of affecting the continued safe operation of the air vehicle.

Components under consideration should include, but not be limited to, pumps, turbochargers, or other rotating drives.

Consideration should be given to:
a. System safety analysis in accordance with Section 14.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.7/A.4.7, Subsystems, engine subsystem component design and verification. MIL-HDBK-1783B: A.4.8/A.5.8, Damage Tolerance; A.4.10.3/A.5.10.3, Containment, component containment design requirements.	*Def-Stan 00-970 Reference:*	00-970 P11 3E.20 00-970 P11 3E.25 00-970 P11 3E.50 00-970 P11 3E.80 00-970 P11 3E.160 00-970 P11 3E.170 00-970 P11 3E.210 00-970 P11 3E.510 00-970 P11 3E.515 00-970 P11 S4
		STANAG Reference:	4671.1461
FAA Doc:	14CFR references: 33.19, 33.94	*EASA CS Reference:*	CS-E 80 CS-E 210 CS-E 510 CS-E 515

7.2.4.2.2 Changes in bearing thrust balance shall not result in the bearing operating in failure prone regions of operation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-1783B: A.4.10.10/A.5.10.10, Pressure balance	*Def-Stan 00-970 Reference:*	00-970 P11 3E.100 00-970 P11 3E.440 00-970 P11 3E.500 00-970 P11 3E.520 00-970 P11 3E.740 00-970 P11 S4
		STANAG Reference:	
FAA Doc:	14CFR references: 33.93	*EASA CS Reference:*	CS-E 100 CS-E 440 CS-E 500 CS-E 520 CS-E 740

7.2.4.2.3 All engine mounted tubing, manifolds, clamps, electrical components and cabling shall be safely affixed and routed on the engine.

Information Sources			
Comm'l Doc:	SAE ARP 994, Tubing/Plumbing Routing		
DoD/MIL Doc:	JSSG-2007A: A.3.1.1.3/A.4.1.1.3, Interface Loads, A.3.11/A.4.11, Controls and Externals Verification, the Interface Control Document (ICD)	*Def-Stan 00-970 Reference:*	00-970 P11 3E.20 00-970 P11 3E.25 00-970 P11 3E.80 00-970 P11 3E.110 00-970 P11 S4
		STANAG Reference:	4671.901
FAA Doc:	14CFR references: 33.5	*EASA CS Reference:*	CS-E 20 CS-E 25 CS-E 80 CS-E 110

7.2.4.2.4 No engine mounted tubing, manifolds, clamps, electrical components or associated cabling shall react to engine, or air vehicle induced, vibratory or acoustic excitations. Where this cannot be achieved, sufficient design margin against strength, life and functional requirements needs to be proven for these operating ranges.

Consideration should be given to:

a. Ensuring engine mounted equipment does not contain natural frequencies within the engine and sub-systems operating ranges.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.11/A.4.11, Controls and Externals Verification.	*Def-Stan 00-970 Reference:*	00-970 P11 3E.20 00-970 P11 3E.100 00-970 P11 3E.330 00-970 P11 3E.340 00-970 P11 3E.520 00-970 P11 3E.650 00-970 P11 S4 00-970 P7 C706 2.2 00-970 P7 C706 5.1.1
		STANAG Reference:	4671.901 4671.1351
FAA Doc:	14CFR references: 29.993	*EASA CS Reference:*	CS-E 20 CS-E 100 CS-E 330 CS-E 340 CS-E 520 CS-E 650

7.2.4.2.5 All pressure vessels, tubes and manifolds shall meet maximum operating strength and life requirements.

Information Sources			
Comm'l Doc:	SAE-AS1055B, Fire Testing		
DoD/MIL Doc:	JSSG-2007A: A.3.7.3.2, A.4.7.3.2 and A.3.7.8, A.4.7.8, pressure vessel proof and burst testing. JSSG-2007A: A.3.1.8.1, A.4.1.8.1, Flammable Fluid Systems, fire resistance and fire proof testing. MIL-HDBK-1783B: A.4.10/A.5.10	*Def-Stan 00-970 Reference:*	00-970 P11 3E.20 00-970 P11 3E.25 00-970 P11 3E.570 00-970 P11 3E.640 00-970 P11 3E.700 00-970 P11 S4
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS-E 20 CS-E 25 CS-E 570 CS-E 640 CS-E 700

7.2.4.2.6 Engine gearboxes shall meet maximum operating strength and life requirements.

Consideration should be given to:
a. Maximum torque and power transmission requirements;
b. Acceleration and gyroscopic loads.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.7.16/A.4.7.16, Gearbox.	*Def-Stan 00-970 Reference:*	00-970 P11 3E.20 00-970 P11 3E.80 00-970 P11 3E.100 00-970 P11 3E.160 00-970 P11 3E.440 00-970 P11 3E.510 00-970 P11 3E.515 00-970 P11 3E.740 00-970 P11 S4
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS-E 20 CS-E 80 CS-E 100 CS-E 160 CS-E 440 CS-E 510 CS-E 515 CS-E 740

7.2.4.2.7 The failure of any gearbox mounted component (oil pumps, fuel pumps, starters, generators, etc.) shall not result in failure of the gearbox itself.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.7.16/A.4.7.16, Gearbox.	*Def-Stan 00-970 Reference:*	00-970 P11 3E.20 00-970 P11 3E.80 00-970 P11 3E.160 00-970 P11 3E.210 00-970 P11 3E.510 00-970 P11 3E.515 00-970 P11 3E.590 00-970 P11 S4
		STANAG Reference:	4671.1309
FAA Doc:		*EASA CS Reference:*	CS-E 20 CS-E 80 CS-E 160 CS-E 210 CS-E 510 CS-E 515 CS-E 590

7.2.4.2.8 Merged with 7.2.5.1.3

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.1.1.10/A.4.1.1.10, Power Take-Off and A.3.7.16/A.4.7.16, Gearbox. MIL-HDBK-516 criteria 7.2.5.1.3	*Def-Stan 00-970 Reference:*	Merged with 7.2.5.1.3
		STANAG Reference:	Merged with 7.2.5.1.3
FAA Doc:		*EASA CS Reference:*	Merged with 7.2.5.1.3

7.2.4.2.9 Merged with 7.2.4.3

Information Sources			
Comm'l Doc:	SAE-AS-50881, for required clearances for electrical cables, and requirements for appropriate selection and installation of wiring and wiring devices.		Merged with 7.2.4.3
DoD/MIL Doc:	JSSG-2007A: A.3.1.1.3/A.4.1.1.3, Interface Loads and A.3.7.4/A.4.7.4, Electrical System. MIL-STD-464A, for requirements for proper bonding and grounding	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	Merged with 7.2.4.3

Information Sources			
FAA Doc:	14CFR references: 33.5	*EASA CS Reference:*	Merged with 7.2.4.3

7.2.4.2.10 All engine mounted electrical components and cabling shall operate safely in a lightning and electromagnetic effects environment in accordance with all the applicable criteria of Section 13.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	For guidance on engine EMI, EMP, and Lightning design and verification testing: JSSG-2007A: A.3.3.3/A.4.3.3 MIL-STD-461E MIL-STD-464A.	*Def-Stan 00-970 Reference:*	00-970 P1 6.10 00-970 P11 3E.20 00-970 P11 3E.80 00-970 P11 3E.135 00-970 P11 3E.170 00-970 P11 S4
		STANAG Reference:	4671.867
FAA Doc:	14CFR references: 33.28	*EASA CS Reference:*	CS 23.867 CS 23.1301 CS 23.1309 CS 25.581 CS 25.899 CS 25.1301 CS 25.1309 CS 25.1316 CS 25.1705 CS 27.867 CS 27.1301 CS 27.1309 CS 29.867 CS 29.1301 CS 29.1309 CS-E 20 CS-E 80 CS-E 135 CS-E 170

7.2.4.2.11 Merged with 7.2.4.2.4

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.11/A.4.11, Controls and Externals Verification and A.3.7.4/A.4.7.4, Electrical System.	*Def-Stan 00-970 Reference:*	Merged with 7.2.4.2.4
		STANAG Reference:	Merged with 7.2.4.2.4
FAA Doc:	14CFR references: 29.993, 33.5	*EASA CS Reference:*	Merged with 7.2.4.2.4

7.2.4.2.12 Electrical power shall be supplied to all safety critical engine systems at all ground and flight operating conditions, including transients. In case of power supply failures, at least safe shutdown / rundown of the engine needs to be assured, not preventing restart / recovery.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.7.4/A.4.7.4, Electrical System.	*Def-Stan 00-970 Reference:*	00-970 P11 3E.50 00-970 P11 3E.510 00-970 P11 S4
		STANAG Reference:	4671.1351
FAA Doc:	14CFR references: 29.993, 33.5	*EASA CS Reference:*	CS-E 50 CS-E 510

7.2.4.2.13/7.2.4.3 Engine controls and monitoring devices that use computers or software shall be defined by the applicable criteria of Section 15.

Information Sources			
Comm'l Doc:	IEEE/EIA 12207.0, IEEE/EIA 12207.1, IEEE/EIA 12207.2 and RTCA DO 178 and 254		
DoD/MIL Doc:	JSSG-2007A: 3.8/4.8 Software Resources.	*Def-Stan 00-970 Reference:*	00-970 P11 S4 00-970 P11 3E.20 00-970 P11 3E.25 00-970 P11 3E.50 00-970 P11 3E.80 00-970 P11 3E.110 00-970 P11 3E.135
		STANAG Reference:	4671.1367
FAA Doc:	14 CFR reference: 33.28	*EASA CS Reference:*	CS-E 20 CS-E 25 CS-E 50 CS-E 80 CS-E 110 CS-E 135

7.2.5. Installations.

7.2.5.1 Physical Installation.

7.2.5.1.1 All engine/air vehicle physical interfaces such as mechanical, fluid, and electrical connections shall meet all safety related requirements to permit safe operation.

Consideration should be given to:

a. Ensuring interfaces remain securely connected and do not leak when subjected to the operating conditions (vibration, temperature, etc.) of the air vehicle;

b. Ensuring interfaces are free of any contact with neighbouring components that result in a wear or chafing condition;

c. Ensuring interfaces can withstand the maximum combination of static and dynamic loading throughout the defined flight and ground envelopes and environments;

d. Ensuring all safety critical engine to air vehicle interfaces are fault tolerant or fail safe with no reasonable credible combination of failures having an unacceptable probability of air vehicle loss;
e. Accessibility for necessary inspections and maintenance (engine and airframe).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.1.1.3, A.4.1.1.3, Interface Loads. JSSG-2001B: 3.3.1.1.1/4.3.1.1.1	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.15 00-970 P1 5.1.16
		STANAG Reference:	4671.901
FAA Doc:	14CFR references: 33.5	*EASA CS Reference:*	CS-E 25 CS 23.901 CS 25.901 CS 27.901 CS 29.901

7.2.5.1.2 The air vehicle / engine mounts shall be designed with adequate safety margin to permit safe operation of the engine, and to ensure the engine remains properly secured under all operating conditions (including intentional shutdown) and known failure conditions.

Consideration should be given to:
a. Withstanding all limit loads, resulting from air vehicle manoeuvres and engine failures, without permanent deformation;
b. Withstanding all ultimate tensile strength loads without complete fracture;
c. Preventing the engine from entering the flight deck or passenger compartments in the event of a crash landing;
d. Meeting established durability, strength and damage tolerance design requirements;
e. If flexible mountings are used to isolate such vibrations, the maximum deflections of such mountings to be taken into account in the design of the relevant components;
f. Ensuring any reasonable credible combination of equipment failures does not result in further damage likely to produce a hazardous engine effect.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.1.1.4, A.4.1.1.4, Mounts MIL-HDBK-1783B, Engine Structural Integrity (Unverified)	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.15 00-970 P1 5.1.16
		STANAG Reference:	4671.901
FAA Doc:	14CFR references: 33.5, 33.23	*EASA CS Reference:*	CS-E 25 CS-E 80 CS-E 100 CS 23.901 CS 25.901 CS 27.901 CS 29.901

7.2.5.1.3 Any installed power-take-off (PTO) shaft system shall withstand vibratory induced loads from start-up to maximum operating speed under any combined expected torsional (power extraction) and air vehicle manoeuvre induced loading. The system shall contain no natural (resonant) frequencies within the normal operating range; or shall have adequate damping provisions to prevent resonances, damage or failure.

Consideration should be given to
a. Establishing suitable critical speed margins that accommodate manufacturing variation, wear and unknown system dynamics.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: C.3.4.3.10.2/ C.4.4.3.10.2 JSSG-2007A: A.3.716/ A4.7.16	*Def-Stan 00-970 Reference:*	00-970 P11 3E.80 00-970 P11 3E.520 00-970 P11 3E.650 00-970 P11 S4
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1163 (d) CS 25.1163 (c) CS-E 80 CS-E 520 CS-E 650

7.2.5.1.4 Design precautions shall be taken to reduce the risk of damaging air vehicle safety of flight (SOF)/critical safety items (CSIs) due to uncontained engine failures, to an acceptable level. This covers:
- Uncontained rotating parts;
- Other uncontained engine failures (such as torching flame and exploding pressure vessel).

Consideration should be given to:
a. Minimising the probability and severity of uncontained rotating parts failure: including turbine blade failure and of disc fragmentation;
b. Safety effects beyond the engine boundary (such as combustion chamber breakthrough) in relation to the crew, the structure, and to flight and mission critical equipment.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001B: 3.3.10/4.3.10	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.123
		STANAG Reference:	4671.903
FAA Doc:		*EASA CS Reference:*	CS 25.903(d)(1) CS 29.903(d)(1) AMC-E 510(d)(iii)

5.2.5.1.5 The installed engine shall maintain a positive clearance between the air vehicle and the engine (except at physical interface points) under all operating conditions within the ground and flight envelopes. This shall include associated components, plumbing, and harnesses.

Consideration should be given to:
a. Adequate provision for flexibility where relative movement between components within the propulsion system and between such components and the air vehicle can occur;

b. Use of flexible hose assemblies or equivalent means for fluid lines under pressure which are subjected to relative movement;
c. Thermal expansion or contraction of parts to the extremes of movement within the operating envelope of the engine;
d. Movement resulting from likely fault conditions of either the fixed or rotating parts;
e. Minimum static clearances, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001 B: 3.3.1.1/4.3.1.1	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.26 00-970 P1 5.1.27
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS-E 520(b)

7.2.5.1.6 The propulsion system shall include sufficient drain provisions capable of handling fluid/vapour leakage, venting, and spillage throughout required ground and flight attitudes and regimes, that is consistent with the system's safety, fire and explosion prevention, maintainability and survivability requirements.

Consideration should be given to:
a. Ensuring capacities are sufficient for flow requirements and volume capacities for projected missions;
b. Suitable drainage provisions for all closed compartments in the engine installation (such as the engine accessory section, spaces enclosing fuel, oil and hydraulic lines and equipment, vent areas and other pockets where fluids may collect);
c. Ensuring all drains should be identified with labels or other markings to assist in diagnostics and safety;
d. Inadvertent liquid spillage and accidents as well as combat air vehicle battle damage should be considered when sizing and locating drains;
e. Routeing overboard drain lines to permit fluid to exit free of the air vehicle fuselage, nacelle, wing and pylon and protecting them from chafing when passing through bulkheads and cowlings.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.1.1.8, A.4.1.1.8, for design and verification guidance for drains. JSSG-2001B: 3.3.1.1/4.3.1.1	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.70 00-970 P1 5.1.71 00-970 P1 5.2.47 00-970 P1 5.3.17 00-970 P1 5.3.42
		STANAG Reference:	4671.999
FAA Doc:		*EASA CS Reference:*	CS-E 270 CS 23.999 CS 25.999 CS 27.999 CS 29.999

7.2.5.1.7 The engine air inlet components shall have adequate structural margin to withstand over-pressures (inlet stall) generated by inlet/compressor anomalies without causing degradation in performance; permanent deformation or vibration harmful to the engine.

Consideration should be given to:

a. The maximum induced inlet stall pressures generated by inlet/engine anomalies;

b. The effects of inlet temperature and pressure distortion on engine surge margin;

c. Providing inlet airflow distortion limits throughout the air vehicle operating envelope (typically 1.5x inlet stall pressure);

d. Ensuring distortion limits are defined in terms of both spatial and planar content;

e. Hammershock and interactive surge.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001 B: 3.3.1.1/4.3.1.1	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.17
		STANAG Reference:	4671.1103
FAA Doc:		*EASA CS Reference:*	CS-E 70 CS-E 100 CS 23.939 CS 25.939 CS 27.939 CS 29.939

7.2.5.1.8 Provision shall be made for access to propulsion-system-related equipment in order to permit servicing, inspections, and maintenance. This shall include accessibility for: inspection of principal structural elements and control systems; replacement of parts normally requiring replacement; adjustment; and lubrication as necessary for continued airworthiness.

Consideration should be given to:

a. The maintainer's anthropometric dimensions and strength limitations, all environmental conditions, and any required mission equipment (chemical protective gear, gloves, etc.);

b. Accessibility of filters for cleaning and removal of screen / element;

c. Accessibility of all replenishment points for consumables and to permit examination of all relevant contents indicators;

d. Accessibility of adjustment points and special engine health monitoring provisions and techniques (e.g. intrascope/boroscope, magnetic chip detectors);

e. Minimising the number of access panels;

f. Removal and replacement of engine accessories (e.g. fuel pump(s), fuel control unit, starter motor, igniters, igniter boxes etc.), without having to remove the engine change unit;

g. Sufficient ground clearance to permit engine removal from the underside of the air vehicle without using pits or jacking;

h. Ensuring the inspection means for each item must be practicable for the inspection interval for the item;

i. Particular attention shall be paid to the provision of adequate space and access to break points, utilised during engine removal and replacement.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001B: 3.3.1.1/4.3.1.1	*Def-Stan 00-970*	00-970 P1 5.1.97-5.1.119

Information Sources			
		Reference:	
		STANAG Reference:	4671.901
FAA Doc:		*EASA CS Reference:*	AMC-E 560(6) AMC-E 570(1) AMC-E 570(3) CS 23.611 CS 23.901 CS 25.611 CS 25.901 CS 27.611 CS 27.901 CS 29.611 CS 29.901

7.2.5.1.9 Airframe equipment, fasteners, etc., upstream of the installed propulsion system, and the propulsion system itself, shall be designed and installed to eliminate sources of self-induced foreign/domestic object damage (FOD/DOD) to the engines.

Consideration should be given to:

a. Ensuring the design of the air intake assembly (including all fasteners) minimises the possibility of generating foreign objects (including ice and slush accretion);

b. Minimising the number of components of equipment fitted in the intake assembly (e.g. variable intake mechanisms) which could enter the engine if they become detached;

c. Ensuring features in the complete intake assembly into which foreign objects can be trapped and subsequently released into the engine are avoided or easily inspected.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001B: 3.3.1.1.1/4.3.1.1.1	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.44-5.1.46 00-970 P11 S3.E540
		STANAG Reference:	4671.903
FAA Doc:		*EASA CS Reference:*	CS-E 540 CS-E 570(d)&(f) CS-E 580 CS 23.1091(c)(2) CS 25.1091(e) CS 27.1091(d)(2) CS 29.1091(f)(2)

7.2.5.2 Functional installation.

7.2.5.2.1 The engine / air vehicle interfaces and interfacing subsystems shall be safe and maintain functional compatibility throughout all normal operating and flight conditions; and shall remain safe given any reasonable credible combination of failures.

Consideration should be given to:

a. Assessing the functional capabilities of the total integrated propulsion system relative to the mission requirements of the air vehicle;

b. Defining more than one compatibility envelope, such as might be the case with a weapon/store deployment, launch operation and plume ingestion;
c. Verifying what the various supplying systems provide to the interface; and what the receiving systems require from the interface in order to satisfy its requirements as well as physical definitions for establishing proper fit, alignment and loading.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001B: 3.3.1.1/4.3.1.1	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.4 00-970 P1 5.2.213
		STANAG Reference:	4671.901
FAA Doc:		*EASA CS Reference:*	AMC-E 650 (9) CS 23.901 CS 25.901 CS 27.901 CS 29.901

7.2.5.2.2 The engine shall be capable of safely supplying all systems (power, bleed air and electrical extractions) under all operating conditions. Air vehicle bleed airflow and quality shall be maintained and the engine shall not introduce foreign matter or contaminants into the bleed air supply that could cause damage. Air vehicle power extraction and electrical power extraction shall meet the requirements across the entire flight envelope.

Consideration should be given to:
a. Damage to critical parts where bleed air is used to cool or to pressurise areas of the engine;
b. The use of bleed air and power extraction during air starts ;
c. Both PTO and gearbox power extraction requirements;
d. Power extraction during windmilling;
e. Ensuring the power take-off drives and bleed air extraction level is representative of the maximum required at that condition;
f. The position of the bleed port internal pickup points to ensure low susceptibility to FOD, and ingestion of sand, dust, ice, moisture, and any other foreign materials contained in the air.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.2, A.4.2 and A.3.7, A.4.7, engine performance and operability impacts of customer extractions. JSSG-2007A: A.3.1.1.7, A.4.1.1.7, bleed air interface design and verification. JSSG-2007A: A.3.1.1.10, A.4.1.1.10 and A.3.7.16, A.4.7.16, PTO horsepower extraction. JSSG-2007A: A.3.7.4.1, A.4.7.4.1, electrical power	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.74 00-970 P1 5.1.75
		STANAG Reference:	4671.901

Information Sources			
	design and verification requirements.		
FAA Doc:		*EASA CS Reference:*	CS-E 745(a)(1)

7.2.5.2.3 Bleed air contamination / ingress of foreign matter shall not exceed safe limits in order to prevent hazardous contamination of the air vehicle breathable air supply.

Consideration should be given to:
a. Specifying the maximum concentration of engine generated contaminants permitted in the bleed air;
b. Identifying defects which could affect the purity of the bleed air;
c. Ensuring engine failures do not cause contamination of bleed air;
d. Safe limits to ensure both unacceptable quantity or unacceptable size of contamination / foreign matter is precluded.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.1.1.7.1, A.4.1.1.7.1, customer bleed air contaminants guidance	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.75 00-970 P11 S3.E690
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS-E 510(g)(2)(ii), CS-E 580, CS-E 690(b) CS 23.1111

7.2.5.3 Inlet compatibility.

7.2.5.3.1 The air induction system(s) shall function under all expected ground, flight, and environmental conditions without adversely affecting engine operation or resulting in engine damage. This shall include ensuring inlet ice accretion and separation, distortion, sand and dust ingestion, and water ingestion do not adversely impact engine performance and operability.

Consideration should be given to:
a. Tolerable performance following:
   i. Armament Gas Ingestion (AGI) (i.e. gases or pressure waves from guns, rockets and missiles);
   ii. Operation in volcanic ash.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.3.2.4, A.4.3.2.4, for sand and dust design and verification; A.3.3.2.3, A.4.3.2.3, for ice ingestion guidance; A.3.2.2.11, A.4.2.2.11, distortion guidance; and A.3.3.2.5, A.4.3.2.5, for atmospheric liquid water ingestion guidance. JSSG-2001B: 3.3.1.1.1/4.3.1.1.1	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.41
		STANAG Reference:	4671.901(d)(2) 4671.1091

Information Sources			
FAA Doc:		*EASA CS Reference:*	CS-E 650(c)(1) CS-E 790(d)(3) CS 23.901(d)(2) CS 23.1091 CS 25.1091 CS 27.1091 CS 29.1091

7.2.5.4 Exhaust system compatibility.

7.2.5.4.1 The exhaust system, including relevant ducting, shall be designed and installed such that exhaust gases are directed to the atmosphere, and do not:

• Impinge on the air vehicle structure, equipment or stores, to the extent that their maximum temperatures are exceeded, unless adequate protection is provided;

• Impinge on or mix (except when designed) with any flammable fluid drainage or vapour discharge to the extent that the fluid/vapour auto ignition temperature is achieved or exceeded;

• Impose an unavoidable hazard to flight/ground crew or boarding/discharging passengers;

• Impede a pre-flight/launch activity.

Where applicable, the jet wake shall also be compatible with ground or shipboard equipment.

Consideration should be given to:

a. Preventing hazards including: fire hazards, carbon monoxide contamination in personnel compartments, discharge which may cause a glare seriously affecting pilot vision at night;

b. The effects of thrust vectoring and thrust reversal;

c. Deflection of exhaust gases by crosswinds etc., during ground manoeuvring;

d. Separating each exhaust system from adjacent (external) flammable parts with fireproof shields;

e. Locating or shielding hot exhaust system parts to prevent ignition of flammable fluids or vapours following leakage of other systems;

f. Compatibility with ground or shipboard equipment such as the Jet Blast Deflector (JBD);

g. Jet wake temperature and velocity characteristics for various power settings and nozzle vector angles.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001B: 3.3.1.1.2/4.3.1.1.2, Nozzle and Exhaust Systems, 3.4.8/4.4.8 Ship Compatibility JSSG-2007A: A.3.1.8.2, A.4.1.8.2, A.3.1.8.5, A.4.1.8.5 and A.3.1.8.7, A.4.1.8.7, fire prevention, air and gas leakage and jet wake; A.3.7.10, A.4.7.10, engine exhaust nozzle system design and verification	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.52
		STANAG Reference:	4671.1121
FAA Doc:		*EASA CS Reference:*	CS 23.1121 CS 25.941(a) CS 25.1121 CS 27.1121

Information Sources			
			CS 29.1121

7.2.5.4.2 Thrust reverser/thrust vectoring systems shall be compatible with the engine and air vehicles structure, such that operation does not adversely impact engine performance, operability or damage to the aircraft structure; and shall be fail-safe, such that no unsafe condition will result during normal operation of the system, or from any reasonable credible combination of failures.

Consideration should be given to:

a. Forces and moments and dynamic response from the thrust reverser/thrust vectoring systems;

b. Ensuring engine limitations approved for reverse thrust are not exceeded;

c. Means to prevent the engine from producing more than idle thrust when the reversing system malfunctions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.1.1.12 to A.4.1.1.13, for exhaust system and thrust reverser interfaces design and verification guidance; A.3.7.10, A.4.7.10, Exhaust Nozzle System and A.3.7.10.2, A.4.7.10.2, Vectored Nozzle	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.54 00-970 P1 5.1.55
		STANAG Reference:	4671.U1761
FAA Doc:		*EASA CS Reference:*	CS-E 890 CS 23.933 CS 25.933

7.2.5.5 Environmental compatibility.

7.2.5.5.1 The engine bay/nacelle cooling and ventilation provisions shall be sufficient to maintain the temperatures of power plant components, engine fluids, other bay/nacelle equipment and structure within the temperature limits established for these components and fluids, under ground and flight operating conditions, and after normal engine shutdown.

Consideration should be given to:

a. Compatibility with the fire protection certification criteria of Section 8.4;

b. Air and gas leakage;

c. Ensuring specified temperature limits are not exceeded;

d. The effect of solar radiation with the air vehicle being parked in direct sunlight;

e. The appropriate aerodynamic heating in flight.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.1.8.5/A.4.1.8.5, A.3.2.2.13/A.4.2.2.13	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.33 00-970 P1 5.1.73 00-970 P1 5.3.5
		STANAG Reference:	4671.1041
FAA Doc:		*EASA CS Reference:*	CS-E 260 CS-E 270(d) CS-E 660

Information Sources			
			CS-E 860 CS 23.1041 CS 23.1043 CS 23.1045 CS 25.1041 CS 25.1043 CS 25.1045 CS 27.1041 CS 27.1043 CS 27.1045 CS 29.1041 CS 29.1043 CS 29.1045 CS 29.1047 CS 29.1049

7.2.5.5.2 The installed vibratory compatibility of the engine/airframe system shall be such that airframe induced engine vibration does not exceed engine limits.

Consideration should be given to:

a. Specified engine limits for the air vehicle and engine operational envelope;

b. Ensuring carcass vibration characteristics do not exceed those established during the type certification of the engine;

c. Acoustic noise vibration.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001B: 3.3.1.1.2/4.3.1.1, exhaust integration design and verification requirements.	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.22 00-970 P1 5.2.37 00-970 P1 5.2.96 00-970 P1 5.3.77
		STANAG Reference:	4671.901
FAA Doc:		*EASA CS Reference:*	CS-E 100(c) CS-E 650 CS 23.901 CS 25.901 CS 27.901 CS 29.901

7.2.5.5.3 Merged with 7.2.5.4.1

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Merged with 7.2.5.4.1	*Def-Stan 00-970 Reference:*	Merged with 7.2.5.4.1
		STANAG Reference:	

Information Sources			
FAA Doc:	Merged with 7.2.5.4.1	*EASA CS Reference:*	Merged with 7.2.5.4.1

7.2.5.6 Installation other.

7.2.5.6.1 The air vehicle propulsion controls and crew station information shall be adequate to permit proper crew control and operation of the propulsion system.

Consideration should be given to:

a. Ensuring air vehicle propulsion controls meet the installation, arrangement and design requirements (See Section 9.2);

b. Provision of instrumentation necessary to ensure operation in compliance with the Engine operating limitations;

c. Provision of additional instrumentation or indicators which are necessary for use by the crew because of unusual features of the propulsion system (e.g. variable intake);

d. Ensuring that no reasonable credible combination of failures adversely affects the instrumentation necessary for safe control of the engine and propulsion unit systems;

e. Adequate provisions for instrument installation;

f. Novel systems with integrated aircraft and thrust control strategies;

g. The following functions: start/stop each engine independently; independently control/set thrust for each engine; assess engine operating condition to the extent necessary for flight safety; maintain any set position or power demand without constant attention by the flight crewmember(s) and without creep due to control loads or vibration;

h. Suitable and sufficient warnings, cautions and advisories shall be provided to operators and maintainers to identify hazardous failure conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001B: 3.4.3.1.6/4.4.3.1.6, 3.4.3.1.5/4.4.3.1.5 MIL-STD-411 (Unverified)	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.18-5.1.25 00-970 P1 5.1.54
		STANAG Reference:	4671.U1701
FAA Doc:		*EASA CS Reference:*	CS-E 50, CS-E 60 CS 23.1141 CS 23.1143 CS 23.1145 CS 25.1141 CS 25.1143 CS 25.1145 CS 27.1141 CS 27.1143 CS 27.1145 CS 29.1141 CS 29.1143 CS 29.1145

7.3. ALTERNATE PROPULSION SYSTEMS.

This section covers the installation, integration, interface, arrangement of alternate propulsion systems, including: propeller driven systems, rotary wing systems and reciprocating engines.

Included with the scope of the this section are:
• Propeller performance, strength and durability;
• Propeller / air vehicle compatibility;
• Propeller bird-strike tolerability;
• Rotary wing power, torque, strength and durability;
• Rotary wing torsional stability;
• Rotary wing control and braking;
• Reciprocating engine certification.

7.3.1. Propeller driven systems.

7.3.1.1 Adequate margins shall exist for the performance, strength, and durability of the propeller and propeller system components. This may include but is not limited to the propeller drive shaft, reduction gearbox, torque measurement system, negative torque system, propeller brake, and mechanical over-speed governor.

Consideration should be given to:
a. Ensuring all propellers meet or exceed the minimum performance required to ensure the capability;
b. All propeller steady-state and transient operating limits (maximum, minimum) are specified for all modes of operation;
c. Ensuring structural design considerations include the application of appropriate limit and ultimate load factors;
d. Ensuring the control system avoids critical propeller speeds where practicable.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: L.3.4.12/L.4.4.12 and L.3.4.12.4/L.4.4.12.4, performance and structural design and compliance methods	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.905 4671.907
FAA Doc:		*EASA CS Reference:*	CS-E 25 CS-E 180 CS-E 340 CS-E 390 CS-E 500 CS-E 510 CS-E 650 CS-E 710 CS-E 745 CS-E 810 CS-E 840 CS-E 890 CS-E 920 CS-P 160

Information Sources			
			CS-P 350 CS-P 370 CS-P 390 CS-P 400 CS-P 410 CS-P 440 CS-P 530 CS-P 550 CS 23.907 CS 25.907

7.3.1.2 All critical propeller speeds shall be outside the engine operating range; or shall be identified and included as limitations within the appropriate operators and maintenance technical manuals (T.O.'s); such as to ensure safe operation under normal operating conditions.

Consideration should be given to:

a. Critical speeds existing below the operating range, and ensuring they are below the minimum steady state operating speed (typically by at least 20 percent);

b. Critical speeds existing above the maximum operating speed, and ensuring they are above the maximum allowable transient shaft rotational speed (typically by at least 20 percent).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: L.3.4.12/L.4.4.12 and L.3.4.12.6/L.4.4.12.6	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.60
		STANAG Reference:	4671.33 4671.907
FAA Doc:	14CFR references: 33.43, 33.83, 33.63	*EASA CS Reference:*	CS-E 340 CS-E 650 CS-P 400 CS-P 410 CS-P 530 CS 23.33 CS 23.905 CS 23.907 CS 25.33 CS 23.905 CS 23.907

7.3.1.3 For variable and reversible pitch propellers, hardware and software components shall not allow unsafe or unsatisfactory control of the propeller for all steady state, transient, and emergency operating conditions. This includes ensuring that no reasonable credible combination of failures will result in unwanted travel of the propeller blades to a position below the In-Flight Low-Pitch Position.

Consideration should be given to:

a. The use of adequate emergency features to mitigate for any failures;

b. Ensuring risk levels meet the safety thresholds.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: L.3.4.12/L.4.3.12 and L.3.4.12.5/L.4.3.12.5	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.63
		STANAG Reference:	4671.933(b)
FAA Doc:	14CFR references: 35.21	*EASA CS Reference:*	CS-P 210 CS 23.933(b) CS 25.933(b)

7.3.1.4 All physical and functional interfaces between the propeller and any system that drives the propeller shall be established and controlled to prevent unsafe operation; and to ensure compatibility under all steady state, transient, and emergency operating conditions.

Consideration should be given to:

a. The propeller, engine, and airframe interface, all related modules and components, their arrangements, functional relationships, interface loadings, weight, and position;

b. Ensuring the allowable range of characteristics of the propeller at the engine interface is specified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: L.3.4.12/L.4.3.12; L.3.4.12.1/L.4.4.12.1; L.3.4.12.5/L.4.4.12.5 and L.3.4.12.2/L.4.3.12.2	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.18 00-970 P1 5.1.20 00-970 P1 5.1.59 00-970 P1 5.1.60
		STANAG Reference:	4671.901
FAA Doc:	14CFR references: 35.21, 35.39, 35.41	*EASA CS Reference:*	CS-E 20(d) CS-E 50 CS-E 180 CS-P 150(a) CS-P 210 CS-P 230 CS-P 390 CS-P 400

7.3.1.5 Manual and automatic feathering systems shall be operational for all steady state, transient, and emergency operating conditions. This shall include the ability to feather and unfeather in flight.

Consideration should be given to:

a. Any likely wear and leakage;

b. Ensuring any feathering and unfeathering limitations are documented in the appropriate manual(s).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: L.3.4.12.1, L.4.4.12.1	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.63 00-970 P1 5.3.15
		STANAG Reference:	4671.905 4671.1027

Information Sources			
FAA Doc:		*EASA CS Reference:*	CS 23.1027 CS 25.1027 CS-E 570(f)(3) CS-P 220

7.3.1.6 Merged with 7.3.1.4

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Merged with 7.3.1.4	*Def-Stan 00-970 Reference:*	Merged with 7.3.1.4
		STANAG Reference:	Merged with 7.3.1.4
FAA Doc:		*EASA CS Reference:*	Merged with 7.3.1.4

7.3.1.7 Each propeller, other than a conventional fixed pitch wooden propeller, shall be free of aero-elastic effects (including flutter and dynamic response) and vibrations that could cause the equipment to operate below specified requirements or cause excessive crew discomfort; and shall be free of destructive vibrations at all steady-state and transient operating conditions.

Consideration should be given to:

a. Capability of the propeller to balance in order to remove vibration;

b. Ensuring vibration stresses do not exceed those shown by the propeller manufacturer to be safe for continuous operation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: L.3.4.12.6, L.4.4.12.6, guidance on vibration and balance.	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.907
FAA Doc:		*EASA CS Reference:*	CS-E 340(b) CS-P 530 CS 23.907 CS 25.907

7.3.1.8 The propeller ice control system shall provide sufficient protection such as to minimise the risk of ice formation adversely affecting performance for all operating conditions.

Consideration should be given to:

a. The use of either electrical, fluid, gas, compound, or mechanical ice control systems;

b. Protection of all areas forward of the propeller that are likely to accumulate and shed ice into the propeller disc;

c. Shedding of ice from the propeller, or prevention of build up, before accumulations can occur that would have an adverse effect when shed.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	JSSG-2009: L.6.3.1, for guidance on propeller anti-icing systems.	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.35
		STANAG Reference:	4671.905
FAA Doc:		*EASA CS Reference:*	CS-E 230 CS-E 780 CS 25.875 CS 25.929

7.3.1.9 The propeller blades and spinner shall be capable of withstanding the impact of birds at the most critical location and flight conditions without causing a major or hazardous propeller effect.

Consideration should be given to:

a. Specifying the mass and number of the birds applicable to the intended installation of the propeller in the air vehicle specifications;

b. The most critical location and the flight conditions which will cause the highest blade loads.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.9 00-970 P1 5.1.39
		STANAG Reference:	4671.U631
FAA Doc:		*EASA CS Reference:*	CS-E 800 CS-P 360 AMC-P 360

7.3.2. Rotary wing systems.

7.3.2.1 The rotary wing and all associated components and systems (including but not limited to the drive shaft, reduction gearbox, torque measurement system, negative torque system, brake system, and mechanical overspeed governor) shall provide sufficient power, torque, strength, and durability to allow safe operation throughout the air vehicle and engine envelopes without any degradation in structural strength or durability.

Consideration should be given to:

a. Safe operation at sea level hover and margin for vertical climb and hover throughout the flight envelope;

b. Sufficient strength and durability of the rotary wing and its associated components and systems for the expected life of the air vehicle;

c. Ensuring the power drive subsystem is of a robust design capable of operating beyond its maximum rated condition for those instances where excursions may occur such as autorotation, other emergency conditions and defined transients;

d. The most severe input power condition (torque and speed) for all allowed operating modes exclusive of transient conditions;

e. Strength and durability limitations include the application of appropriate limit and ultimate load factors.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	JSSG-2007A: A.3.7.16, A.4.7.16 JSSG-2009: K.4.4.11, for drive system bench and system level testing.	*Def-Stan 00-970 Reference:*	00-970 P7 L700 4.4 00-970 P7 L905 8.1 00-970 P7 L1001 8.1 00-970 P7 L732
		STANAG Reference:	
FAA Doc:	14CFR references: 33.43, 33.83, 33.63	*EASA CS Reference:*	CS 27.1309 CS 29.1309

7.3.2.2 The rotor system shall provide safe control of the air vehicle under all operating conditions including loss of lubricant and OEI and autorotations.

Consideration should be given to:

a. Sufficient power response levels to maintain safe control;

a. The behaviour of the engine(s)/control system(s) in response to rapid power demands, e.g. collective, cyclic and yaw control inputs;

c. For rotorcraft certificated for a 30 second OEI power rating, a means must be provided to automatically activate and control the 30 second OEI power and prevent any engine from exceeding the installed engine limits associated with the 30 second OEI power rating approved for the rotorcraft.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.7.16, A.4.7.16	*Def-Stan 00-970 Reference:*	00-970 P7 L1001 8.1(b)
		STANAG Reference:	
FAA Doc:	14CFR references: 27.1143	*EASA CS Reference:*	CS 27.1143 CS 29.1143

7.3.2.3 For rotary wing air vehicles, the effects of high-energy, low-frequency vibrations, generated by main rotor blade passage (fundamental and harmonic) frequencies at all engine and related component operating speeds and powers, shall not adversely affect the operation of the engine and the drive system.

Consideration should be given to:

a. Ensuring airframe induced engine vibration does not exceed specified engine limits within the air vehicle and engine operational envelope;

b. High frequency vibration modes generated by the engine do not cause potentially damaging vibration to the propulsion subsystems or other parts of the air vehicle;

c. Vibration levels of engine and drive train components over the entire operational range of aircraft and rotor speeds, aircraft gross weights, and Centre of Gravity limits.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.4.1.8, A.4.4.1.8; A.3.4.1.8.1, A.4.4.1.8.1 JSSG-2009: K.3.4.11.1/ K.4.4.11.1	*Def-Stan 00-970 Reference:*	00-970 P7 L700 2.2
		STANAG Reference:	
FAA Doc:	14CFR references: 29.907	*EASA CS*	CS 27.251

Information Sources			
		Reference:	CS 27.907 CS 29.251 CS 29.907

7.3.2.4 For rotary wing air vehicles, each engine (including subsystems/accessories) shall be designed, constructed and installed to prevent the harmful vibration of any part of the engine or air vehicle. The addition of the rotor and the rotor drive system to the engine may not subject the principal rotating parts of the engine to excessive vibration stresses. A satisfactory interface shall be achieved between the engine and the airframe, such that no excessive vibration forces are imparted to the aircraft structure.

Consideration should be given to:

a. Both high-frequency engine-excited and low-frequency air vehicle rotor(s)-excited vibrations;

b. If flexible mountings are used to isolate vibrations, the maximum deflections of such mountings are taken into account in the design of the relevant propulsion unit components.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.4.1.8, A.4.4.1.8, for engine vibration and dynamic response. JSSG-2009: K.3.4.11.1/ K.4.4.11.1	*Def-Stan 00-970 Reference:*	00-970 P7 L700 2.2
		STANAG Reference:	
FAA Doc:	14CFR references: 29.907	*EASA CS Reference:*	CS 27.251 CS 27.907 CS 29.251 CS 29.907 CS-E 100(c)

7.3.2.5 The rotor drive transmission/gearbox lubrication system shall provide clean and cooling lubricant to all components subjected to rolling and/or sliding contact (e.g. bearings, gears, and splines); be free from leakage; and shall operate safely and effectively under all air vehicle operating conditions. The transmission/gearbox lubrication system shall also be sufficiently independent of the lubrication systems of the engine(s) in order to sustain sufficient lubrication during autorotation.

Consideration should be given to:

a. The requirements for the essential functional elements of the lubrication system which should include: gearbox breathers, lubrication filtering, filling provisions, gearbox oil drain, lubricant selection, cooling system, valves and pressure pumps, oil level indication, oil leakage;

b. Pressurised systems to ensure lubricant is provided at the required pressure and flow rate to all required components and accessories;

c. Operation over the range of temperatures, attitudes, and manoeuvres for which the air vehicle is designed;

d. Provision of cooling oil to remove heat generated due to friction at gear meshes and bearings;

e. Provision of an oil film to reduce wear between sliding elements.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: K.4.4.11.4, for lubrication element, component, and system level	*Def-Stan 00-970 Reference:*	00-970 P7 L705 3.2.9 00-970 P7 L705 4.2.1 00-970 P7 L705 4.3

Information Sources			
	testing.		00-970 P7 L705/1 6
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 27.1027 CS 29.1027

7.3.2.6 When the engine, engine accessories, rotor, propeller, or fan system(s), and all power drive subsystem dynamic components are operated as a combined dynamic system, there shall be no unfavourable dynamic coupling modes (i.e. that are destructive or limit the air vehicle) for all permitted ground and flight modes.

Consideration should be given to:

a. Recognising the fact that one component can induce destructive vibrations in another component through interconnecting shafting;

b. Providing adequate allowances for the occurrence of transient loads arising from changes of input or of working state (e.g. freewheel slippage or actuation or abrupt changes of power);

c. If flexible mountings are used to isolate vibrations, the maximum deflections of such mountings are taken into account in the design of the relevant propulsion unit components.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P7 L700 2.2 00-970 P7 L705 2.1.2 00-970 P7 L705 4.1.3
		STANAG Reference:	
FAA Doc:	JSSG-2007A: A.3.4.1.8, A.4.4.1.8 JSSG-2009: K.3.4.11.1/ K.4.4.11.1	*EASA CS Reference:*	CS 27.251 CS 29.251

7.3.2.7 The engine's control/rotor system torsional stability shall have required gain and phase margins and main rotor torque damping during steady-state and transient operation. No dangerous torsional or flexural vibrations shall occur at any permissible torque and at any rotational speed up to the maximum engine overspeed or the maximum permissible rotor speed, whichever is greater.

Consideration should be given to:

a. The most critical combinations of power, rotational speed, and control displacement;

b. Ensuring control system gain and phase margins meet the specified requirements.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.4.1.8, A.4.4.1.8 JSSG-2009: K.3.4.11.1/ K.4.4.11.1	*Def-Stan 00-970 Reference:*	00-970 P7 L705/2 8.5 00-970 P7 L1001 8.6
		STANAG Reference:	
FAA Doc:	14CFR references:29.939	*EASA CS Reference:*	CS 27.939 CS 29.939

7.3.2.8 The drive shaft couplings shall be designed for continuous, maintenance-free operation at the maximum permissible misalignment of coupled drive shafts (when installed in the air vehicle), for all possible combinations of torque and speed.

Consideration should be given to:

a. The maximum torque that could be delivered at the worst permissible misalignment;

b. The use of dry type couplings to avoid the necessity of doing maintenance checks before every flight;

c. Replacement of coupling mechanisms should not require realignment of the associated shafting.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.1.1.9, A.4.1.1.9, A.3.7.16, A.4.7.16 JSSG-2009: K.3.4.11.2 / K.4.4.11.2	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	14CFR references: 33.5	*EASA CS Reference:*	CS-E 25 CS 27.917 CS 29.917(c)(4)

7.3.2.9 A means shall be provided of preventing rotation of the rotor during engine non-operation, power up, and ground idle conditions, when exposed to winds at specified velocities and directions.

Consideration should be given to:

a. A wind environment encompassing both atmospheric and weather induced conditions, wind-over-deck from carrier vessel movement, and downwash and jetwash conditions from other air vehicles;

b. If a rotor brake is fitted, any limitations on use must be specified, and control must be guarded to prevent inadvertent operation;

c. The use of engine control interlock safeguards to prevent inadvertent actuation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: I.3.4.9.4.1, I.4.4.9.4.1, K.3.4.11.3/ K.4.4.11.3	*Def-Stan 00-970 Reference:*	00-970 P7 S7 L732/1 4.1
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 27.921 CS 29.921

7.3.2.10 Normal and emergency braking systems (consisting of aerodynamic rotor drag and subsequent mechanical braking) shall be capable of stopping the rotor, from 100% speed, within specified times after engine shutdown.

Consideration should be given to:

a. The specified minimum stopping time can be based on a structural analysis to protect power drive subsystem gears and components from overloads due to sudden stops;

b. If a rotor brake is fitted, any limitations on use must be specified, and control must be guarded to prevent inadvertent operation;

c. Thermal Analysis to establish the risk of combustible materials reaching their 'Flash point' temperature adjacent to the Rotor Brake Energy absorption elements.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: K.3.4.11.3/ K.4.4.11.3	*Def-Stan 00-970 Reference:*	00-970 P7 S7 L705 3.1.4 00-970 P7 S7 L705 3.2.10
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 27.921 CS 29.921

7.3.2.11 Rotor system condition monitoring shall provide warning of impending failure that could result in loss of the air vehicle or prevent a safe landing. Elements of condition monitoring shall be specified and may include: debris monitoring, lubrication system oil pressure and temperature monitoring, health and usage monitoring (HUM).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: K.3.4.11.5/ K.4.4.11.5 JSSG-2007: A.3.7.8.2.4/ A.4.7.8.2.4	*Def-Stan 00-970 Reference:*	00-970 P7 L732 3.2.5 00-970 P7 L732 4.2.3 00-970 P7 L700 7.4.2 00-970 P7 L703/5 16.2.1 00-970 P7 L727
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 27.1305 CS 29.1305, CS 29.1309(c) CS 29.1465

7.3.2.12 The drive system clutching devices shall permit engagement and disengagement of the engines from the load absorbers as required for all applicable modes of air vehicle operation.

For rotary-wing air vehicles in autorotation mode, the engine(s) not supplying torque shall be immediately and automatically disengaged from the power drive subsystem. For multi-engine air vehicles conducting single engine operations, the engines not supplying torque shall be similarly disengaged to permit continued operation of the rotor system and accessory drive for 2 hours without damage to the overrunning mechanism.

Consideration should be given to:

a. Determining the torsional spring rate (angular deflection of the outer race relative to the inner race) of the clutch;

b. Engagement and disengagement characteristics including measurement of torque fluctuations, and peak values resulting from slip and sudden engagement where appropriate;

c. Defining the fatigue characteristics of the clutch;

d. Overrunning and cold temperature engagement performance;

e. Clutch durability.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: K.3.4.11.7/ K.4.4.11.7	*Def-Stan 00-970 Reference:*	00-970 P7 L705/2 4.8 00-970 P7 L705/2 4.9

Information Sources			
			00-970 P7 L705/2 5.3 00-970 P7 L705/2 10.1.8
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 27.923 CS 29.923

7.3.2.13 Rotary drive system gearboxes shall continue to function safely for a specified duration following loss of the primary lubrication system, and shall be in a condition such that the gearbox is still capable of transmitting the required power.

The specified duration shall be sufficient to permit the safe landing and/or recovery of the air vehicle, typically at least 30 minutes.

Consideration should be given to:
a. Maintaining sufficient torque and rotational speed for that duration to allow continued safe flight;
b. Ensuring the gearbox continues to function although not necessarily without damage.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.7.8.1.3, A.4.7.8.1.3 JSSG-2009 K.3.4.11.8/K.4.4.11.8	*Def-Stan 00-970 Reference:*	00-970 P7 L705 4.2 00-970 P7 L705 4.3
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 27.927(c) CS 27.1027 CS 29.927(c) CS 29.1027

7.3.2.14 For intermeshing-rotor systems, phased externally, means shall be provided in the power drive subsystem to prevent operation with dephased rotors. Means shall be included for cockpit indication that the rotors are locked in phase.

Consideration should be given to:
a. If the rotors must be phased for intermeshing, each system must provide constant and positive phase relationship under any operating condition;
b. If a rotor dephasing device is incorporated, there must be means to keep the rotors locked in proper phase before operation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 K.3.4.11.9/K.4.4.11.8 9	*Def-Stan 00-970 Reference:*	00-970 P7 L605 2.1.2
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 29.917(c)

7.3.2.15 Failure or seizure of any individual accessory shall not cause damage to any power drive subsystem components. For rotary-wing air vehicles, accessories shall be driven whenever the rotor system is rotating including during autorotation.

Cover plates shall be provided for use when accessories are not installed.

Consideration should be given to:

a. Protecting accessory drive splines from wear with non-metallic inserts or positively lubricated with oil when functioning.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 K.3.4.11.10/K.4.4.11.10	*Def-Stan 00-970 Reference:*	00-970 P7 L700 4.3 00-970 P7 L705 3.1.9
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 29.908

7.3.3. Reciprocating engines.

Turbocharged reciprocating engine operating characteristics shall be investigated in flight to assure that no adverse characteristics, as a result of an inadvertent overboost, surge, flooding, or vapour lock, are present during normal or emergency operation of the engine(s) throughout the range of operating limitations of both air vehicle and engine.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.903
FAA Doc:	14CFR reference 33 subpart C for design requirements for commercial applications. 14CFR reference 33 subpart D for verification requirements for commercial applications.	*EASA CS Reference:*	CS 23.939 CS-E Subpart B CS-E Subpart C

SECTION 8 - AIR VEHICLE SUBSYSTEMS

TYPICAL CERTIFICATION SOURCE DATA

1. Design criteria
2. Functional operations test results
3. Performance test results
4. Failure modes, effects, and criticality analyses (FMECA)
5. Hazard analysis
6. Component and system SOF certifications/qualifications
7. Design studies and analysis
8. Installation and operational characteristics
9. Flight manual and limitations
10. Electromagnetic environmental effects analysis and test results
11. Diminishing manufacturing sources plan 12. Obsolete parts plan

CERTIFICATION CRITERIA
(Note: For subsystems that use computer resources, see section 15 for additional, specific criteria.)

8.1. HYDRAULIC AND PNEUMATIC SYSTEMS.

This section covers the design, installation, arrangement and compatibility of the complete air vehicle Hydraulic and Pneumatic systems.

Included within the scope of this section are:

1. If there is more than one hydraulic system or pneumatic system, that safe operation can be continued if any one hydraulic or pneumatic system fails.
1.1. That any single-point failure locations are identified and their consequences of failure are acceptable, eliminated, or mitigated.
2. That interfaces and redundancies with the flight control, electrical, and avionics systems are evaluated and verified to be safe.
3. That normal, back-up, and emergency hydraulic or pneumatic system operation.
4. That hydraulic fluid temperatures do not exceed the maximum allowable temperature.
5. That adequate crew station information is available to notify the flight crew of the hydraulic and pneumatic systems' operating conditions.
6. That flight and maintenance manuals include normal, back-up and emergency operating procedures, limitations, restrictions, servicing, and maintenance information.
7. That the plumbing installation and component installations are safe for flight.
8. That the air vehicle hydraulic and pneumatic systems' size/power meets demand.
9. That undesirable pressure fluctuations are precluded from the system.
10. That methods and procedures exist for controlling and purging impurities from the hydraulic and pneumatic systems and that the systems' level of
contamination is acceptable.

8.1.1 Where there is more than one hydraulic or pneumatic system, safe operation shall be continued if any one hydraulic or pneumatic system fails.

Consideration should be given to:

a. Common mode failures, especially where a common pressure source is used;
b. Ensuring stable and convergent aircraft handling with degraded systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: B.3.4.2, B.4.4.2, B.3.4.2.1.10, B.4.4.2.1.10, B.3.4.2.1.16, B.4.4.2.1.16, Emergency Operation and Appendix M: M.3.4.13/M.4.4.13, Pneumatic Subsystems.	*Def-Stan 00-970 Reference:*	00-970 P1 2.15.22 00-970 P1 2.15.25 00-970 P1 6.11.52 00-970 P1 6.11.53-6.11.55 00-970 P1 6.12.3-6.12.4 00-970 P1 6.12.6 00-970 P1 6.12.15 00-970 P7 L703 2.2 00-970 P7 L704/0 2.1
		STANAG Reference:	4671.1301 4671.1309 4671.1437
FAA Doc:	14CFR references: 25.1435 b4	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 23.1437 CS 25.1301 CS 25.1309 CS 25.1310 CS 25.1435 CS 25.1436 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309 ARP 4752 (Design and installation of commercial transport aircraft hydraulic systems)

8.1.1.1 Merged with 14.2.3.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: B.3.4.2/B.4.4.2 Hydraulic Power Subsystem; and Appendix M: M.3.4.13/M.4.4.13 Pneumatic Subsystem	*Def-Stan 00-970 Reference:*	00-970 P1 6.11.25 00-970 P1 6.11.52 00-970 P1 6.11.53-6.11.55 00-970 P1 6.12.3-6.12.4 00-970 P1 6.12.6 00-970 P1 6.12.15
		STANAG Reference:	4671.1301 4671.1309 4671.1435 4671.1437

Information Sources			
FAA Doc:		*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 23.1435 CS 23.1437 CS 23.1438 CS 25.1301 CS 25.1309 CS 25.1435 CS 25.1436 CS 25.1438 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309 CS 29.1435 ARP 4752 (Design and installation of commercial transport aircraft hydraulic systems)

8.1.2 All interfaces and redundancies with the flight control, electrical, and avionics systems shall be evaluated and shown to be safe.

Consideration should be given to:

a. Identifying and documenting all interfaces and redundancies with quoted systems; ensuring that the interfaces are adequately described;

b. Producing a test and acceptance plan that:

i. Demonstrates that the requirements have been achieved safely;

ii. Demonstrates that the redundancy scheme works appropriately.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: B.3.4.2, B.4.4.2, B.3.4.2.1.10/ B.4.4.2.1.10 Emergency Operation; B.3.4.2.1.9/B.4.4.2.1.9 Leakage Control; B.3.4.2.2/B.4.4.2.2 Interface requirements; B.3.4.2/B.4.4.2 Hydraulic power subsystem; and Appendix M: M.3.4.13/M.4.4.13 Pneumatic Subsystem.	*Def-Stan 00-970 Reference:*	00-970 P1 6.11.25 00-970 P1 6.11.50 00-970 P1 6.11.51 00-970 P1 6.11.52 00-970 P1 6.12.5 00-970 P1 6.12.33 00-970 P1 6.12.34
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:		*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309

Information Sources			
			CS 25.1435 CS 25.1436 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309 ARP 4752 (Design and installation of commercial transport aircraft hydraulic systems)

8.1.3 Normal, back-up, and emergency hydraulic or pneumatic systems, including vacuum systems, shall operate safely and ensure graceful degradation.

Consideration should be given to:

a. Ensuring the requirements have been correctly interpreted in the design;

b. Ensuring sufficient hydraulic and pneumatic power is available to the requisite systems at all times;

c. Transition from main system to back-up or emergency system should be smooth;

d. Test and acceptance plan should consider all aspects of the operational flight envelope.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix B: B.3.4.2.1.2/B.4.4.2.1.2 System Fluid Capacity; B.3.4.2.1.10/B.4.4.2.1.10 Emergency Operation; and Appendix M: M.3.4.13, M.4.4.13	*Def-Stan 00-970 Reference:*	00-970 P1 6.11.2 00-970 P1 6.11.4 00-970 P1 6.11.25 00-970 P1 6.11.52 00-970 P1 6.11.53 00-970 P1 6.11.54 00-970 P1 6.11.55 00-970 P1 6.12.33 00-970 P1 6.12.34 00-970 P7 L704/0 3.4
		STANAG Reference:	4671.1301 4671.1309 4671.1435
FAA Doc:		*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 23.1435 CS 25.1301 CS 25.1309 CS 25.1310 CS 25.1433 CS 25.1436 CS 27.1301 CS 27.1309 CS 27.1435 CS 29.1301 CS 29.1309

Information Sources			
			CS 29.1435 ARP 4752 (Design and installation of commercial transport aircraft hydraulic systems)

8.1.4 Hydraulic fluid temperatures shall not exceed the maximum allowable temperature.

Consideration should be given to:

a. Ensuring that the maximum allowable hydraulic fluid operating temperature is included in the air vehicle requirements; this should include the transient operation of brakes (typically wheels, stators and/or rotors);

b. The test plan should take account of worst case scenarios (in terms of events likely to cause the fluid to heat up - i.e. rapid repeated manoeuvres);

c. Any cooling system that may be required.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: B.3.4.2.1.14/B.4.4.2.1.14 High Temperature Operation; B.3.4.2.1.14.1/B.4.4.2.1.14.1 Thermal Relief; B.3.4.2.1.15/B.4.4.2.1.15 Fire and Explosion Proofing	*Def-Stan 00-970 Reference:*	00-970 P1 6.11.13 00-970 P1 6.11.14 00-970 P1 6.11.79 00-970 P7 L704/0 8.1.7 00-970 P7 L704/0 8.2 00-970 P7 L704/1 3.3
		STANAG Reference:	4671.1309
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 25.1435 CS 27.1309 CS 29.1309 ARP 4752 (Design and installation of commercial transport aircraft hydraulic systems)

8.1.5 Adequate information shall be available to notify the flight crew of the hydraulic and pneumatic systems' operating conditions.

Consideration should be given to:

a. Ensuring the flight crew notification requirements are in the requirements documentation;

b. Provision of continuous system information, or notification of exceptions and fault conditions (warnings and cautions);

c. Provision of explicit warnings (low pressure, over temperature);

d. Provision of information relating to system: contents, pressure, and temperature.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix B: B.3.4.2.1.3/B.4.4.2.1.3 System Fluid Monitoring; B.3.4.2.1.4.3/B.4.4.2.1.4.3 System Pressure Indication; B.3.4.2.1.4.4/B.4.4.2.1.4.4 System Low-Pressure Warning; B.3.4.2.2.3/B.4.4.2.2.3 Instrumentation interface(s); and Appendix M: M.3.4.13.3/M.4.4.13.3 Status Indication.	*Def-Stan 00-970 Reference:*	00-970 P1 6.11.16 00-970 P1 6.11.18 00-970 P1 6.12.9 00-970 P7 L703 2.8 00-970 P7 L704/0 8.4
		STANAG Reference:	4671.1309 4671.1721 4671.1813
FAA Doc:	14CFR references: 23.1435 a2, 25.1435 b1	*EASA CS Reference:*	CS 23.1309 CS 23.1435 CS 25.1309 CS 25.1435 CS 25.1436 CS 27.1309 CS 29.1309 CS 29.1435 ARP 4752 (Design and installation of commercial transport aircraft hydraulic systems)

8.1.6 Flight and maintenance manuals shall include normal, back-up and emergency operating procedures, limitations, restrictions, servicing, and maintenance information.

Consideration should be given to:

a. Verification process of information placed in manuals;

b. Verification process to include checks for completeness of information coverage and accuracy of information.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.6.2	*Def-Stan 00-970 Reference:*	00-970 P1 7.5.1 00-970 P1 7.5.3
		STANAG Reference:	4671.1501 4671.1529 4671.1581 4671.1583 4671.1585 4671.1587 4671.1589 4671.1591
FAA Doc:	Refer to technical point of contact for this discipline (listed in section A.2)	*EASA CS Reference:*	CS 23.1529 CS 23.1581

Information Sources			
			CS 23.1583 CS 23.1585 CS 23.1587 CS 23.1589 CS 25.1529 CS 25.1581 CS 25.1583 CS 25.1585 CS 25.1587 CS 25.1591 CS 27.1529 CS 27.1581 CS 27.1583 CS 27.1585 CS 27.1587 CS 27.1589 CS 29.1529 CS 29.1581 CS 29.1583 CS 29.1585 CS 29.1587 CS 29.1589 ARP 4752 (Design and installation of commercial transport aircraft hydraulic systems)

8.1.7 The hydraulic and pneumatic plumbing installations and component installations shall be compatible with their environment.

Consideration should be given to:

a. Pipes (flexible & solid), couplings, fixings, and brackets;

b. System temperatures and pressures, vibration and fatigue;

c. Air vehicle flight envelope and operating environment;

d. Location of pipes and components from the perspective of:

i. Damage due to foreign objects (bird strike);

ii. Clearance from other components or parts of the air vehicle, especially moving parts;

iii. Effects from other components or parts of the air vehicle that are adjacent to the installations;

e. Compatibility of hydraulic oils used and system seals or other rubber components.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: B.3.4.2.1.1/B4.4.2.1.1 Fluid Selection; B.3.4.2.1.2/4.4.2.1.2 System fluid capacity; B.3.4.2.1.4/B.4.4.2.1.4 System	*Def-Stan 00-970 Reference:*	00-970 P1 6.11 00-970 P1 6.11.36-6.11.41 00-970 P1 6.11.44-6.11.49 00-970 P1 6.11.57-6.11.58 00-970 P1 6.11.62-6.11.64

Information Sources			
	Pressure; B.3.4.2.1.5/B.4.4.2.1.5 Pressure Control; B.3.4.2.1.14.1/B.4.4.2.1.14.1 Thermal Relief; B.3.4.2.1.15/B.4.4.2.1.15 Fire and Explosion Proofing; B.3.4.2.1.17/B.4.4.2.1.17 Clearances, M.3.4.13.2/M.4.4.13.3 Pressure, M.3.4.13.4/M.4.4.13.4 Moisture Content, M.6.4 Component Information		00-970 P1 6.11.70-6.11.75 00-970 P1 6.12.1 00-970 P1 6.12.15-6.12.17 00-970 P1 6.12.26-6.12.27 00-970 P1 6.12.32-6.12.33 00-970 P7 L703 7.3 00-970 P7 L704/0 10
		STANAG Reference:	4671.1309 4671.1435 4671.1438
FAA Doc:	14CFR references: 23.1435 a1, a3, c1, c2, 25.1435 a2, a4, a5	*EASA CS Reference:*	CS 23.1309 CS 23.1435 CS 25.1309 CS 25.1435 CS 25.1436 CS 25.1438 CS 27.1309 CS 27.1435 CS 29.1309 CS 29.1435 ARP 4752 (Design and installation of commercial transport aircraft hydraulic systems)

8.1.8 The air vehicle hydraulic and pneumatic systems' size and power capacities shall be established and sufficient to ensure safe operations.

Consideration should be given to:

a. System flow rates and pressures, including resistance to cavitation;

b. Fluid volumes, and overall system capacity, is sufficient for all transient and thermal effects;

c. Leakage;

d. Air vehicle operating envelope and environment.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix B: B.3.4.2/B.4.4.2 Hydraulic Power Subsystem; B.3.4.2.1.2/B.4.4.2.1.2 System Fluid Capacity; and Appendix M: M.3.4.13/M.4.4.13 Pneumatic Subsystems.	*Def-Stan 00-970 Reference:*	00-970 P1 6.11.2-6.11.3 00-970 P1 6.11.5-6.11.8 00-970 P1 6.11.9-6.11.10 00-970 P1 6.11.70 00-970 P1 6.11.80-6.11.81 00-970 P1 6.12.2 00-970 P1 6.12.5 00-970 P1 6.12.33 00-970 P7 L703 6.1
		STANAG	4671.1309

Information Sources			
		Reference:	4671.1435 4671.1438
FAA Doc:	Refer to technical point of contact for this discipline (listed in section A.2)	*EASA CS Reference:*	CS 23.1309 CS 23.1435 CS 23.1438 CS 25.1309 CS 25.1435 CS 25.1436 CS 25.1438 CS 27.1309 CS 27.1435 CS 29.1309 CS 29.1435 ARP 4752 (Design and installation of commercial transport aircraft hydraulic systems)

8.1.9 Undesirable pressure fluctuations shall be precluded from the system.

Consideration should be given to:
a. Defining what is an 'unacceptable' pressure fluctuation - fluctuation may be positive or negative;
b. Location of pressure relief valves, non-return valves.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix B: B.3.4.2.1.5/B.4.4.2.1.5 Pressure Control; B.3.4.2.1.5.1/B.4.4.2.1.5.1 Peak Pressure; and B.3.4.2.1.5.2/B.4.4.2.1.5.2 Pressure Ripple; and Appendix M: M.3.4.13.2/M.4.4.13.2 Pressure.	*Def-Stan 00-970 Reference:*	00-970 P1 6.11.2 00-970 P1 6.11.9 to 6.11.12 00-970 P1 6.11.60 00-970 P1 6.11.70 00-970 P1 6.11.80 to 6.11.81 00-970 P1 6.12.5 00-970 P1 6.12.20 to 6.12.22 00-970 P1 6.12.33 00-970 P7 L704 6.1 00-970 P7 L704/0 8.1.4 00-970 P7 L704/1 3.2
		STANAG Reference:	4671.1309 4671.1435
FAA Doc:	14CFR references: 23.1435 a3, 25.1435 b2	*EASA CS Reference:*	CS 23.1309 CS 23.1435 CS 25.1309 CS 25.1435 CS 25.1436 CS 25.1438 CS 27.1309 CS 27.1435

Information Sources			
			CS 29.1309 CS 29.1435 ARP 4752 (Design and installation of commercial transport aircraft hydraulic systems)

8.1.10 Methods and procedures shall exist for controlling and purging impurities from the hydraulic and pneumatic systems and for determining that the systems' level of contamination is acceptable.

Consideration should be given to:
a. Contamination by solid , liquid, or gaseous materials;
b. Resilience of system to contaminants before malfunction occurs;
c. Suitable demonstration of free-gas removal from hydraulic systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: B.3.4.2.1.6/B.4.4.2.1.6 System Level Contamination Prevention; B.3.4.2.1.7/B.4.4.2.1.7 System Air Removal; and B.3.4.2.1.8/B.4.4.2.1.8 Moisture Removal; M.3.4.13/M.4.4.13 Pneumatic Subsystem.	*Def-Stan 00-970 Reference:*	00-970 P1 6.11.8 00-970 P1 6.11.15 00-970 P1 6.11.19 00-970 P1 6.11.26-6.11.34 00-970 P1 6.11.35 00-970 P1 6.12.7 00-970 P7 L704 9.1
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	ARP 4752 (Design and installation of commercial transport aircraft hydraulic systems)

8.2. ENVIRONMENTAL CONTROL SYSTEM (ECS).

This section covers the design, installation, arrangement, compatibility and use of Environmental Control Systems on Air Vehicles for the purposes of:
- Cabin Pressurisation
- Cooling and temperature control of both crew and systems
- De-icing
- De-fogging canopies and windows

Included within the scope of this section are:
- Safety in general
- Failure modes, including bleed air leaks and shut-off
- Contamination of Air Supply, including Smoke and NBC aspects
- Human Factors and Ergonomics
- Training and documentation of emergency procedures and operations

8.2.1 Ensure that the Environmental Control System (ECS) design incorporates system safety requirements of the air vehicle.

Consideration should be given to systems providing:

a. Pressurisation;

b. Heating and Cooling (of crew/passengers and equipment);

c. De-icing;

d. De-fogging;

e. Uncontaminated breathing air;

f. Engine bleed air for use in ECS;

g. Pneumatic systems related to ECS;

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.3.3, 4.3.3	*Def-Stan 00-970 Reference:*	00-970 P1 4.24 00-970 P1 4.25 00-970 P1 4.26 00-970 P1 6.12.3 00-970 P1 6.12.4 00-970 P1 6.12.5 00-970 P1 6.12.14
		STANAG Reference:	4671.USAR 1307(a) 4671.USAR 1431 4671.USAR 1485
FAA Doc:		*EASA CS Reference:*	CS 23.831 CS 23.1437 CS 25. 831 CS 25. 832 CS 25.841 CS 25.833 CS 25.855 CS 25.857 CS 25. 859 CS 25.1309 CS 25.1438 CS 27. 831 CS 27.1309(b) CS 25. 859 CS 29.831 CS 29 855 CS 29.857

8.2.2 Ensure that the installed ECS meets safety requirements and maintains system integrity with the weapon system/air vehicle's Safety of Flight when operating throughout the design envelope.

Consideration should be given to:

a. Component level testing demonstrates Safe Operation under all anticipated environments and loadings;

b. Integration testing, including compatibility and interoperability testing to verify safe operation of all ECS subsystems;

c. Undertaking ground demonstration and test prior to flight.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.3.6, 4.3.6 JSSG-2001: 3.3.10, 3.3.10.1	*Def-Stan 00-970 Reference:*	00-970 P1 1.1 00-970 P1 4.24 00-970 P1 4.25 00-970 P1 6 6.12.14 00-970 P1 6 6.12.15 00-970 P1 6 6.12.16 00-970 P1 6 6.12.17 00-970 P1 6 6.12.18 00-970 P1 6 6.12.19
		STANAG Reference:	4671.USAR 1307(b) 4671.USAR 1485
FAA Doc:		*EASA CS Reference:*	CS 23.831 CS 23.1437 CS 25.831 CS 25.832 CS 25.841 CS 25.859 CS 25.1309 CS 25.1438 CS 27.831 CS 27.859 CS 29.831 CS 29.859 CS 29.1309

8.2.3 Merged with Line 8.2.5

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix D: D.3.4.4.5.2/D.4.4.4.5.2 D.3.4.4.5.3/D.4.4.4.5.3	*Def-Stan 00-970 Reference:*	Merged with Line 8.2.5
		STANAG Reference:	Merged with Line 8.2.5
FAA Doc:	14CFR references: 23.831, 25.831	*EASA CS Reference:*	Merged with Line 8.2.5

8.2.4 Ensure that the air vehicle normal and emergency pressurisation requirements are met and are indicated or monitored to ensure Safety of Flight.

Consideration should be given to UAS applications (e.g. high altitude operations for structural implications) in which it might be appropriate to relay data to a ground station to ensure pressurisation requirements are indicated and can be monitored.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	JSSG-2009 Appendix D: D.3.4.4.1, D.4.4.4.1	*Def-Stan 00-970 Reference:*	00-970 P1 S3 L14 Par. 2
		STANAG Reference:	4671.841 4671.843 4671.1795 4671.1307(e)
FAA Doc:		*EASA CS Reference:*	CS 23.365* CS 23.841 CS 23.843 CS 25.841 CS 25.843

8.2.5 Ensure that in the event of the loss of some or all ECS functions, the effects on air vehicle safety, air vehicle performance, or the safety and performance of other air vehicle systems are understood and acceptable.

Consideration should be given to:

a. The design of the ECS to ensure that the installed system can function under all anticipated conditions;

b. The provision of an emergency supply of fresh air in the event of a potential failure of the primary ECS;

c. The removal of smoke or gases from occupied compartments under emergency/single failure conditions;

d. The provision of emergency cooling for avionic and equipment compartments;

e. An independent means to shut off bleed air flow from each bleed air source;

f. All pneumatically operated services relating to ECS which are essential to SOF shall be provided with an alternative source of power;

g. All ECS emergency systems shall be fully independent of the primary;

h. The effects of no single failure of the ECS shall jeopardise the safety of the air vehicle, or its occupants, across the flight envelope;

i. In the absence of an alternative system and following a single failure, the ECS shall be able to continue to operate sufficiently long enough to safely land the air vehicle;

j. Analysis should be undertaken to determine the possible modes, probability and effects of ECS failure.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix D: D.3.4.4.5*, D.3.4.4.12*, D.4.4.3.3*, D.4.4.4.5*, D.4.4.4.12*, D.3.4.4.5.2/D.4.4.4.5.2* D.3.4.4.5.3/D.4.4.4.5.3* D.3.4.4.12.2/D.4.4.4.12.2* D.3.4.4.5.2/ D.4.4.4.14.2* D.3.4.4.14.3/D.4.4.4.14.3* D.3.4.4.5.1/D.4.4.4.5.1	*Def-Stan 00-970 Reference:*	00-970 P1 4.24 00-970 P1 4.25 00-970 P1 4.26.62 00-970 P1 6.2.24 00-970 P1 6.2.25 00-970 P1 6.9 00-970 P1 6.12.1 00-970 P1 6.12.2 00-970 P1 6.12.3 00-970 P1 6.12.4 00-970 P1 6.12.5 00-970 P1 7.2 00-970 P7 L731
		STANAG	4671.USAR 1307(c)(f)

Information Sources			
		Reference:	4671.USAR 1485
FAA Doc:		*EASA CS Reference:*	CS 23.831 CS 23.1309(b)(4) CS 25.831 CS 25.1309 CS 25.1435 CS 27.831 CS 27.1309 CS 29.831 CS 29.1309

8.2.6 Ensure that the air vehicle flight manual and training curriculum includes normal and emergency procedures in relation to the ECS.

Consideration should also be given to maintenance training; in particular testing and ground operations of the ECS.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1307(g) 4671.1581 4671.U1485
FAA Doc:		*EASA CS Reference:*	CS 23.1581 CS 25.1581 CS 27.1581 CS 29.1581

8.2.7 Verify that adequate controls and displays for the ECS are installed in the crew station or other appropriate locations to allow the ECS to function as intended.

Consideration should be given to:
a. UAS applications in which it might be appropriate for ECS controls to be located in any ground control station;
b. The ECS controls for pneumatic pressure and temperature within the occupied compartment should be readily accessible to all applicable flight crew;
c. The operation of ECS controls should not cause instability;
d. Relevant ECS pneumatic pressure and temperature status indicators, warnings, cautions and advisories should be provided and visible to all applicable flight crew;
e. For UAV operations, the operator should have full access to the relevant status indicators, warnings, cautions and advisories;
f. The ECS pneumatic pressure and temperature status indicators, warnings, cautions and advisories should be appropriately labelled.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: D.3.4.4.3/D.4.4.4.3 ECS crew station interface	*Def-Stan 00-970 Reference:*	00-970 P1 4.15 00-970 P1 4.19 00-970 P1 4.24.22 00-970 P1 6.12 00-970 P7 L731 Par. 6.1
		STANAG Reference:	4671.USAR 1307(h) 4671.USAR 1485
FAA Doc:		*EASA CS Reference:*	CS 23.1309(b)(3) CS 25.831 CS 25.859 CS 25.1301 CS 25.1309(c) CS 25.1322 CS 25.1541 CS 25.1543 CS 29.1309(c) CS 25.1436

8.2.8 Ensure that the installed air vehicle ECS meets the requirements relating to provision of an atmosphere appropriate for personnel including adequate crew/occupant ventilation and protective flight garment supply systems (oxygen equipment, pressure suits, and anti-g garments or ventilation garments).

Consideration should be given to:

a. The effects of, and possible presence of, over temperature, whether due to leakage or system malfunction;

b. Where fluid systems are used, for temperature control, consideration should also be given to fluid corrosive properties, freezing and boiling, expansion and contraction, heat transfer properties, consequences of leakage including loss of fluid, system capacity and control in respect of the environmental control media;

c. Flight crew/passenger dynamic performance requirements;

d. Flight crew/passenger physiological requirements (Human Factors);

e. Air quality and the avoidance of the build up of harmful and hazardous concentrations of gases or vapours, including ozone;

f. Minimum occupied cabin pressure levels.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix D: D.3.4.4.3, D.4.4.3.3, D.3.4.4.5.4/D.4.4.4.5.4 ECS Suit ventilation and pressurization	*Def-Stan 00-970 Reference:*	00-970 P1 4.24 00-970 P1 6.13.1
		STANAG Reference:	3198
FAA Doc:		*EASA CS Reference:*	CS 25.831 CS 25.832 CS 25.841 CS 29.831

8.2.9 Ensure sub-systems provided for environmental protection provide for the safe operation of the air vehicle within the specified flight environment (e.g. windshield rain/snow/ice removal, ice protection and defog).

Consideration should be given to:

a. De-frost and de-misting systems;

b. Rain removal;

c. Transparency cleaning;

d. De-icing systems;

e. Clear windshield/panel provision in the event of ECS single failure;

f. Air intake de-icing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	D.3.4.4.8/D.4.4.4.8 970 P1 13 1.5.1.1 Transparent area fog and frost protection; D.3.4.4.9/D.4.4.4.9 Rain removal; D.3.4.4.10/D.4.4.4.10 * Transparency cleaning; D.3.4.4.11/D.4.4.4.11 Ice protection	*Def-Stan 00-970 Reference:*	00-970 P1 4 4.24.6 00-970 P1 7.2
		STANAG Reference:	4671.USAR 1419
FAA Doc:		*EASA CS Reference:*	CS 23.1419 CS 25.773 CS 25.1093 CS 25.1419 CS 27.1419 CS 29.773 CS 29.859 CS 29.975 CS 29.1093 CS 29.1105 CS 29.1419

8.2.10 Each crewmember's air supply must be protected from all forms of contamination, including that resulting from oil leakage from the engine(s) and under Nuclear/Biological/Chemical (NBC) environment conditions.

Consideration should be given to:

a. Automatic and manual means to shut off air flow to occupied compartments;

b. Fresh air ventilation for contamination and odour removal;

c. The provision of overboard exhaust outlets sufficient to eliminate odours from galley and toilet areas;

d. Emergency provision of fresh air ventilation in the potential event of a failure relating to the primary ECS;

e. Means to prevent the build-up of explosive gases;

f. Means to counter NBC contamination;

g. The sealing of adjacent compartments to protect against smoke, gun gas and fuel vapours;

h. Bleed air must be taken from a source where it cannot be contaminated by harmful or hazardous gases or vapours in the event of a single failure.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: D.3.4.4.2.8/D.4.4.4.2.8 D.3.4.4.5.1/D.4.4.4.5.1 D.3.4.4.5.2/D.4.4.4.5.2 D.3.4.4.6.1/D.4.4.4.6.1 D.3.4.4.6.3/D.4.4.4.6.3	*Def-Stan 00-970 Reference:*	00-970 P1 4.24.4 00-970 P1 4.24.9 00-970 P1 4.24.10 00-970 P1 4.24.11 00-970 P1 4.24.48 00-970 P13 3.11 00-970 P7 L731 Par. 3 2.4
		STANAG Reference:	USAR 3610
FAA Doc:		*EASA CS Reference:*	CS 23.831 CS 23.1109 CS 23.1111 CS 25.831 CS 25.832 CS 25.857 CS 25.859 CS 25.1121 CS 29.831 CS 29.855 CS 29.859 CS 29.1121

8.2.11 Ensure that the bleed air or other compressed air duct system is monitored for leaks and structural integrity.

Consideration should be given to ensuring that, should a duct fail, any hot air leaking from damaged bleed air ducting would not:

a. Act as a source of ignition for flammable liquids, vapours or materials;

b. Cause damage to:

   i. Structurally Significant Items;
   ii. Items that impact Safety of Flight;
   iii. Critical System Items.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix D: D.3.4.4.12, D.4.4.4.12, D.3.4.4.12.8/D.4.4.4.12.8 MIL-HDBK-221: 2.8	*Def-Stan 00-970 Reference:*	00-970 P1 4.24.25 00-970 P1 4.24.37 00-970 P1 4.25 00-970 P1 4.26.69
		STANAG Reference:	4671.USAR 1307(j)
FAA Doc:		*EASA CS Reference:*	CS 25.1103 CS 25.1438

Information Sources			
			CS 29.1103

8.2.12 Ensure that bleed air shut-off provision is located at, or as close as possible to, the air vehicle bleed air source.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: D.3.4.4.12.2/D.4.4.4.12.2 D.3.4.4.12.3/D.4.4.4.12.3 D.3.4.4.12.4/D.4.4.4.12.4 D.3.4.4.12.10/D.4.4.4.12.10	*Def-Stan 00-970 Reference:*	00-970 P1 4.24.25 00-970 P1 6.12
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.2.13 Where the air vehicle is pressurised, ensure that pressurisation rate control prevents pressure surges in the air vehicle cockpit.

Consideration should be given to:

a. Means to maintain automatic pressurisation levels;

b. The maximum flow rate shall be determined and not be less than the maximum allowable production linkage rate;

c. The minimum flow rate required for all flight conditions;

d. The flow control system shall ensure that the sub-system flow will not exceed the value specified in the air vehicle specification;

e. Pressure relief valve(s) (or equivalent) should be provided to automatically limit the positive pressure differential to a pre-determined level;

f. Means to prevent a negative pressure differential.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: D.3.4.4.1.1/D.4.4.4.1.1* D.3.4.4.1.4/D.4.4.4.1.4* D.3.4.4.1.5/D.4.4.4.1.5* D.3.4.4.1.6/D.4.4.4.1.6* D.3.4.4.1.7/D.4.4.4.1.7*	*Def-Stan 00-970 Reference:*	00-970 P1 4.24.42
		STANAG Reference:	4671.841
FAA Doc:		*EASA CS Reference:*	CS 23.841 CS 23.843* CS 25.841 CS 25.843*

8.2.14 Ensure, if required, that nuclear, biological, and chemical (NBC) equipment and/or procedures are provided for protecting or maintaining ECS cooling and so that ventilation air is free from contaminants.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: D.3.4.4.2.8/D.4.4.4.2.8 *	*Def-Stan 00-970 Reference:*	00-970 P1 4.24.4 00-970 P1 4.24.48

Information Sources			
	D.3.4.4.5.1/D.4.4.4.5.1 D.3.4.4.5.2/D.4.4.4.5.2 D.3.4.4.6.1/D.4.4.4.6.1 D.3.4.4.6.3/D.4.4.4.6.3		00-970 P13 3.11 00-970 P7 L731/3
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.831 CS 25.831 CS 27.831 CS 29.831

8.2.15 Ensure that the air vehicle's thermal management system is stable for all flight conditions and environments.

Consideration should be given to normal and emergency conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix D: D.3.4.4.2, D.3.4.4.18 * D.4.4.4.2, D.4.4.4.18 * JSSG-2001: 3.3.10, 3.3.10.1	*Def-Stan 00-970 Reference:*	00-970 P1 4.24.2 00-970 P1 4.24.14-4.24.20 00-970 P1 4.24.40
		STANAG Reference:	4671.1307(k)
FAA Doc:		*EASA CS Reference:*	CS 23.1125 CS 27.833 CS 29.833

8.2.16 Merged with 8.2.5

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix D: D.3.4.4.5, D.4.4.4.5, D.3.4.4.5.1/D.4.4.4.5.1 D.3.4.4.5.2/D.4.4.4.5.2 FAR: FAR 21.183; * FAR 21.189; * FAR 23.1041, * FAR 23.1043-1045, * FAR 23.1047; * FAR 25.1041 *	*Def-Stan 00-970 Reference:*	Merged with 8.2.5
		STANAG Reference:	Merged with 8.2.5
FAA Doc:		*EASA CS Reference:*	Merged with 8.2.5

8.2.17 Ensure that all surface touch temperatures remain within required limits to preclude any operational limitations to safety of flight operations of the air vehicle.

Consideration should be given to safety of personnel from risk of sustaining burns.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix D: D.3.4.4.4, D.4.4.4.4	*Def-Stan 00-970 Reference:*	00-970 P1 4.24.14 00-970 P1 4.24.19 00-970 P1 4.24.20 00-970 P7 L731
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.3. FUEL SYSTEM.

This section covers the design, installation, arrangement and compatibility of the complete air vehicle fuel system and subsystem components including fuel tanks, fuel lines, valves, pumps, etc.

Included within the scope of this section are:
• Refuelling / defueling operations;
• Fuel jettison (dump);
• Fuel transfer;
• Ignition prevention;
• Fault detection, isolation;
• Pressurisation;
• Venting and drainage provisions.

Some criteria in this chapter are supported in the text by examples of specific considerations. These examples are by no means to be considered as exhaustive.

• The most critical combination of air vehicle altitudes, attitudes and other conditions with respect to fuel feed, quantity of unusable fuel and fuel CofG;
• The effects of negative pressure on the fuel system;
• The effects of operation using alternate, restricted or emergency fuel(s), or with fuel(s) saturated with water.

8.3.1 The fuel system design, including interfaces, shall be functionally and physically compatible with other air vehicle systems.

Consideration should be given to:
a. Interfaces with other air vehicle systems such as: engine, tankage, vent system, cooling systems, scavenge etc;
b. Ensuring all materials used in the fuel subsystem are compatible with the air vehicle designated fuels.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.4.4.1/4.4.4.1; Appendix E: E.3.4.5.1.1, E.4.4.5.1.1, E.3.4.5.1.2, E.4.4.5.1.2, E.3.4.5.1.3, E.4.4.5.1.3, E.3.4.5.1.3.11, E.4.4.5.1.3.11, E.3.4.5.2.1,	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.4 00-970 P1 5.2.17
		STANAG Reference:	4671.953 4671.993

Information Sources			
	E.4.4.5.2.1, E.3.4.5.2.2, E.4.4.5.2.2, E.3.4.5.3, E.4.4.5.3		4671.994 4671.995
FAA Doc:	14CFR references: 23.951-23.979, 23.991-23.1001, 25.951-25.981, 25.991-25.1001	*EASA CS Reference:*	CS 23.951-23.1001 CS 25.951-25.1001 CS 27.951-27.1001 CS 29.951-29.1001

8.3.1.1 Prior to installation, all fuel system components, either individually or as part of a subsystem, shall undertake and pass all required safety-related qualification tests and analysis, in order to ensure their suitability for use in all expected usage and environmental conditions. If required, this shall include verification of the survivability of external fuel tanks following fragment impact, forced ejection, overpressure following ignition of fuel vapours, and are fire resistant.

Consideration should be given to:

a. Conducting all required safety-related qualification tests such as: proof, burst, vibration, containment, over-speed, acceleration, explosive atmosphere, pressure cycling, and temperature cycling as required for airworthy performance.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 5.2.17-5.2.22 00-970 P1 5.2.34 00-970 P1 5.2.35 00-970 P1 5.2.37
		STANAG Reference:	4671.951 4671.963 4671.965
FAA Doc:		*EASA CS Reference:*	CS 23.963 CS 23.965 CS 25.952 CS 25.963 CS 25.965 CS 27.963 CS 27.965 CS 29.963 CS 29.965

8.3.1.2 Merged with 8.3.17

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	Merged with 8.3.17
		STANAG Reference:	Merged with 8.3.17
FAA Doc:		*EASA CS Reference:*	Merged with 8.3.17

8.3.2 The fuel system shall be compatible with all designated air vehicle fuel(s) (and additives if used), and shall function satisfactorily under all foreseeable flight and environmental conditions without restriction or fuel system degradation.

Consideration should be given to:

a. Compatibility of materials used in the fuel subsystem;

b. The use of alternate fuel(s), restricted fuel(s) or emergency fuel(s), and any associated air vehicle limitations / restrictions, or possible fuel system degradation;

c. Fuel system operation with fuel(s) saturated with water.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E: E.3.4.5.1.1, E.4.4.5.1.1, E.3.4.5.1.2, E.4.4.5.1.2, E.3.4.5.1.3, E.4.4.5.1.3, E.3.4.5.1.4, E.4.4.5.1.4, E.3.4.5.2.1, E.4.4.5.2.1, E.3.4.5.2.2, E.4.4.5.2.2	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.3 00-970 P1 5.2.4 00-970 P1 5.2.15 00-970 P7 L702 2.1
		STANAG Reference:	4671.951-4671.1001*
FAA Doc:	14CFR references: 23.951-23.979, 23.991-23.1001, 25.951-25.981, 25.991-25.1001 AC 20-29	*EASA CS Reference:*	CS 23.951-23.1001 CS 23.1309 CS 25.951-25.1001 CS 25.1309 CS 27.951-27.1001 CS 27.1309 CS 29.951-29.1001 CS 29.1309

8.3.3 Covered by Section 14.

Information Sources			
Comm'l Doc:	DoD/MIL Doc: JSSG-2009 Appendix E: E.3.4.5.1.12, E.4.4.5.1.12		
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	Covered by Section 14.
		STANAG Reference:	Covered by Section 14.
FAA Doc:	14CFR references: 23.951-23.979, 23.991-23.1001, 25.951-25.981, 25.991-25.1001	*EASA CS Reference:*	Covered by Section 14.

8.3.4 The complete fuel system (including all fuel lines, components, tanks etc.) shall be installed, adequately supported, and have sufficient clearances, such that no unsafe conditions or hazards are created during normal air vehicle operations.

Consideration should be given to:

a. Ensuring each fuel line is installed and supported to prevent excessive vibration;

b. Protecting fuel system components in an engine nacelle or in the fuselage from damage which could result in spillage;

c. Ensuring each fuel line connected to components of the air vehicle, between which relative motion could exist, have provisions for flexibility;
d. Means to prevent chafing between the tank and its supports;
e. Ensuring fuel tanks are supported so that tank loads (resulting from the mass of fuel in the tanks) are not concentrated on unsupported tank surfaces.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.3.3.1, 4.3.3.1, 3.3.8, 4.3.8	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.17 00-970 P1 5.2.30 00-970 P1 5.2.32 00-970 P1 5.2.37 00-970 P1 5.2.43-5.2.53 00-970 P1 5.2.96
		STANAG Reference:	4671.951 4671.963 4671.993
FAA Doc:	14CFR references: 23.963, 23.993, 23.994, 25.963, 25.993, 25.994	*EASA CS Reference:*	CS 23.963 CS 23.993 CS 23.994* CS 25.963 CS 25.993 CS 25.994* CS 27.963 CS 27.993 CS 29.963 CS 29.993

8.3.5 All fuel system components, lines and connections, (both as completely assembled and installed within the air vehicle), shall be capable of withstanding the specified proof pressure limits, without resulting in fuel leakage, critical system performance degradation or critical life limited durability.

Consideration should be given to:
a. Withstanding a negative pressure (typically of one atmosphere (14.7 psi)), without permanent deformation;
b. Specified proof pressure limits for engine feed, fuel transfer, pressure refuelling, tank pressure and vent lines;
c. The use of flexible hose assemblies for each flexible connection in fuel lines that may be under pressure or subjected to axial loading;
d. Ensuring no flexible hose that might be adversely affected by exposure to high temperatures is used where excessive temperatures will exist during operation or after shut-down of an engine or auxiliary power unit;
e. A means with fail-safe features to prevent the build up of an excessive pressure difference between the inside and outside of the fuel tank.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E: E.3.4.5.1.5, E.4.4.5.1.5, E.3.4.5.1.6, E.4.4.5.1.6,	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.40 00-970 P1 5.2.55 00-970 P1 5.3.96

Information Sources			
	E.3.4.5.1.7, E.4.4.5.1.7, E.3.4.5.1.8, E.4.4.5.1.8, E.3.4.5.6.1, E.4.4.5.6.1		00-970 P1 5.2.152
		STANAG Reference:	4671.963 4671.965 4671.993
FAA Doc:	14CFR references: 23.993, 25.993	*EASA CS Reference:*	CS 23.963 CS 23.965 CS 23.993 CS 25.963 CS 25.965 CS 25.993 CS 27.963 CS 27.965 CS 27.993 CS 29.963 CS 29.965 CS 29.993

8.3.6 Fuel shall be available to the engines on an uninterrupted basis under all air vehicle ground and flight conditions. Each fuel system shall be constructed and arranged to ensure a continuous flow of fuel at a rate and pressure established for proper engine functioning under each likely operating condition, including any manoeuvre for which certification is requested and during which the engine is permitted to be in operation.

If an engine can be supplied with fuel from more than one tank, the fuel system shall prevent the interruption of fuel flow when the tank feeding the engine is depleted of usable fuel.

For multi-engine air vehicles, it should be possible to cut off fuel flow to any engine without affecting the flow to the remaining engines.

Consideration should be given to:

a. The most critical combination of air vehicle altitudes, attitudes and other conditions with respect to fuel feed and quantity of unusable fuel;

b. Periods of flight under negative increments of normal acceleration;

c. Rates and pressures to be agreed with the engine manufacturer;

d. Air vehicle flight conditions which affect the sizing of lines, rating of pumps, power consumption, valves, and the general system configuration.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E: E.3.4.5.2.1, E.4.4.5.2.1, E.3.4.5.2.2, E.4.4.5.2.2, E.3.4.5.2.4, E.4.4.5.2.4, E.3.4.5.2.5, E.4.4.5.2.5	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.3 00-970 P1 5.2.24 00-970 P1 5.2.116 00-970 P2 5.2.216 00-970 P7 L702 2.1
		STANAG Reference:	4671.951(a) 4671.955(a) 4671.959
FAA Doc:	14CFR references: 23.951, 23.953, 23.955, 23.959,	*EASA CS Reference:*	CS 23.951 CS 23.955

Information Sources			
	25.951, 25.953, 25.955, 25.959		CS 23.959 CS 25.943 CS 25.951 CS 25.955 CS 25.959 CS 27.951 CS 27.955 CS 27.959 CS 29.951 CS 29.955 CS 29.959

8.3.7 The rate of fuel transfer into the engine feed tanks, or to permit fuel management functions (e.g. centre of gravity (CofG) management, cooling etc.) shall be sufficient to meet the operational ground and flight envelope requirements, and shall not limit air vehicle performance.

Consideration should be given to;

a. Ensuring the fuel transfer subsystem is not affected by operation of fuel jettison system;

b. An acceptable compromise fuel flow rate for afterburning fighter air vehicles, in which the transfer rate need not match maximum engine capability;

c. Gravity feed as a useful fall-back option in the event of fuel pump failure.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E: E.3.4.5.2.3, E.4.4.5.2.3, E.3.4.5.4, E.4.4.5.4, E.3.4.5.4.1, E.4.4.5.4.1	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.24 00-970 P1 5.2.25 00-970 P1 5.2.119 00-970 P7 L702 5.1
		STANAG Reference:	4671.951 4671.953 4671.955
FAA Doc:	14CFR references: 23.951, 23.952, 23.953, 23.955, 23.961, 25.951, 25.952, 25.953, 25.955, 25.961	*EASA CS Reference:*	CS 23.951 CS 23.955 CS 23.961* CS 25.951 CS 25.952 CS 25.955 CS 25.961* CS 27.951 CS 27.955 CS 27.961 CS 29.951 CS 29.955 CS 29.961

8.3.8 The fuel system should be designed so that in both normal and failed operation, the aircraft CofG is maintained within a range compatible with other systems and aircraft control & handling.

Consideration should be given to:

a. Release of stores, aerial refuelling (if applicable), fuel transfer, fuel dumping operations, wing sweep operations, catapult launches, arrested landings, and engine feed;
b. The use of fuel measurement, control software and / or crew system manual control to maintain air vehicle CofG requirements for all mission phases;
c. The most critical combination of air vehicle altitudes, attitudes and other conditions with respect to fuel distribution on CofG.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E: E.3.4.5.5, E.4.4.5.5	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.148 00-970 P1 5.2.149 00-970 P13 3.5.79
		STANAG Reference:	4671.23 4671.29
FAA Doc:	14CFR references: 23.1001, 25.1001	*EASA CS Reference:*	CS 23.21 CS 23.23 CS 23.29 CS 23.1001* CS 25.21 CS 25.23 CS 25.27 CS 25.29 CS 25.1001* CS 27.21 CS 27.27 CS 27.29 CS 29.21 CS 29.27 CS 29.29

8.3.9 The fuel system shall be designed such that no air vehicle operation (i.e. refuelling, de-fuelling, transfer, fuel feed, fuel dump, engine feed etc.), can cause fuel pressures to exceed the system's proof pressure limits (both minimum and maximum).

Consideration should be given to:
a. Ensuring the maximum allowable values for surge pressure should be specified to maintain the required margin of safety of the system;
b. Surge pressures which may occur when refuelling valves on the air vehicle are closed, and during rapid power reduction;
c. Thermal expansion pressure relief for all closed plumbing segments where pressure greater than the operating pressure could result;
d. Ensuring any fuel shut-off device(s) do not produce excessive surge pressures;
e. Proof and ultimate pressures to be agreed and verified, typically at least of 1.33 - 1.5 times and 2.0 times the surge pressure likely to occur respectively;
f. Effects of negative pressure.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E:	*Def-Stan 00-970*	00-970 P1 5.2.40

Information Sources			
	E.3.4.5.1.7, E.4.4.5.1.7, E.3.4.5.1.8, E.4.4.5.1.8, E.3.4.5.8, E.4.4.5.8	*Reference:*	00-970 P1 5.2.55 00-970 P1 5.2.185 00-970 P1 5.2.202 00-970 P13 3.5.79
		STANAG Reference:	4671.955 4671.963 4671.979
FAA Doc:	14CFR references: 23.963, 23.979, 25.963, 25.979	*EASA CS Reference:*	CS 23.963* CS 23.979 CS 25.963 CS 25.979 CS 27.955 CS 27.965 CS 29.955 CS 29.965

8.3.10 The air vehicle flight and maintenance manuals shall contain information concerning normal and emergency procedures and other pertinent information necessary for safe operation of the fuel system. This shall include all applicable operating procedures, limitations, restrictions, servicing, maintenance information, warnings and cautions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.2.6, 4.2.6; Appendix E, E.3.4.5.6.8, E.4.4.5.6.8	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.11 00-970 P1 7.3.3 00-970 P1 7.4.28 00-970 P1 7.4.31
		STANAG Reference:	4671.1581 4671.1583 4671.1585
FAA Doc:		*EASA CS Reference:*	CS 23.973* CS 23.1581 CS 23.1583 CS 23.1587 CS 25.973* CS 25.1581 CS 25.1583 CS 25.1587 CS 27.973* CS 27.1581 CS 27.1583 CS 27.1587 CS 29.973* CS 29.1581 CS 29.1583 CS 29.1587

8.3.11 The fuel system design and procedures shall be sufficient for controlling and purging impurities from the fuel system, in order to maintain contamination at acceptable levels, at all times. Fuel system components shall function reliably in the presence of contaminants, up to a specified level of contamination.

Consideration should be given to:

a. Fuel contaminated to a degree (with respect to particle size and density) that is greater than that established for the engine during its type certification;

b. Ensuring procedures for controlling and purging impurities are included in the Maintenance T.O.s;

c. Provisions to drain water from sump areas in the tanks or provide in-flight scavenge capability;

d. Ensuring drain location adequate to prevent formation of hazardous quantities of ice on the aircraft;

e. Ensuring the cleanliness of the fuel tank;

f. Use of fuel filters / strainers with sufficient mesh size to prevent the passage of any object that could restrict fuel flow or damage any fuel system component;

g. Use of materials in the fuel system which do not support bacterial or fungal growths.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E: E.3.4.5.6.2, E.4.4.5.6.2, E.3.4.5.6.3, E.4.4.5.6.3, E.3.4.5.1.3, E.4.4.5.1.3 MIL-F-8615	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.114 00-970 P1 5.2.115 00-970 P7 L702 25.2
		STANAG Reference:	4671.951(c) 4671.971 4671.977 4671.997
FAA Doc:	14CFR references: 23.971, 23.973, 23.977, 23.997, 25.971, 25.973, 25.977, 25.997 AC 20-119	*EASA CS Reference:*	CS 23.951(c) CS 23.971 CS 23.973 CS 23.977 CS 23.997 CS 25.951(c) CS 25.971 CS 25.973 CS 25.977 CS 25.997 CS 25.1455 CS 27.951(c) CS 27.971 CS 27.973 CS 27.977 CS 27.997 CS 29.951(c) CS 29.971 CS 29.973 CS 29.977 CS 29.997

8.3.12 The fuel system shall be designed and arranged to prevent ignition / explosion as a result of: lightning strike (either directly, or indirectly as result of component failure (e.g. overvoltage) following a lightning strike); electrostatic discharge; fuel leaks, and the introduction of electrical power into fuel tanks. All fuel subsystem components located in an explosive atmosphere shall be capable of operating without initiating an explosion, including under electrical fault conditions.

Consideration should be given to:

a. Electrical bonding of fuel system / subsystem tubing and components to eliminate static charge accumulation, provide controlled current return paths, and provide lightning protection;

b. Limiting fuel velocities within lines;

c. Limiting tank entry fuel velocity;

d. Using materials that will not cause an internal arc when lightning attaches to the exterior.

e. Avoiding metallic chain lanyards inside the tank;

f. Different types of lightning including: direct lightning strikes; swept lightning; and corona or streamering;

g. Isolating electrical equipment from the fuel to minimise the possibility of fuel leakage and fuel vapour coming into contact with electrical equipment.

h. Ensuring all components inside of a fuel tank have energy levels low enough to prevent an ignition source and prevent introduction of an ignition source through the wiring or components;

i. Preventing ignition of fuel and fuel vapour.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E: E.3.4.5.1.9, E.4.4.5.1.9, E.3.4.5.1.11, E.4.4.5.1.11, E.3.4.5.7, E.4.4.5.7, E.3.4.5.8.12, E.4.4.5.8.12	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.23 00-970 P7 L702 4.1
		STANAG Reference:	4671.863 4671.867 4671.954 4671.975 4671.967(b)
FAA Doc:	14CFR references: 23.863, 23.954, 23.971, 23.975, 25.863, 25.954, 25.971, 25.975, 25.981 AC 20-53A, AC 25.981-2, AC 25.981-1B, AC 25-16	*EASA CS Reference:*	CS 23.863 CS 23.954 CS 23.975 CS 25.863 CS 25.954 CS 25.975 CS 25.981 CS 27.863 CS 27.954 CS 27.975 CS 29.863 CS 29.954 CS 29.975

8.3.12.1 Merged with 8.3.12

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E: E.3.4.5.1.9, E.4.4.5.1.9, E3.4.5.1.11 & E4.4.5.1.11;	*Def-Stan 00-970 Reference:*	Merged with 8.3.12
		STANAG	Merged with 8.3.12

Information Sources			
	Appendix G: 3.4.7, G4.4.7	*Reference:*	
FAA Doc:	14CFR references: 23.954, 23.975, 25.954, 25.975, 25.981 AC 20-53A, AC 25-16, AC 25.981-1B, AC 25.981-2	*EASA CS Reference:*	Merged with 8.3.12

8.3.12.2 Secondary fuel and vapour tight barriers shall be provided between fuel tanks, fire hazard areas, and inhabited areas, in order to isolate and remove flammable vapours to a safe location in the event of primary barrier (tank wall) failure and minimise the probability of ignition and the resultant hazard if ignition does occur. A means to determine whether the primary barrier has failed shall be provided.

Consideration should be given to:

a. Protection between the fuel tank and areas where there is a high probability that fuel leakage can be ignited, including the following compartments: personnel, cargo, gun, engine compartments or any compartment which contains an ignition source;

b. Adequate fault isolation provisions to detect a failure of the primary fuel barrier;

c. Ensuring an adequate cavity between the firewall and the fuel tank;

d. Sufficient draining and ventilation provisions in all areas surrounding fuel tanks to remove the fire hazard due to fuel spillage or leakage;

e. The potential for secondary barriers to interfere with fuel bay venting.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E: E.3.4.5.6.11, E.4.4.5.6.11	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.25 00-970 P1 5.2.47 00-970 P1 5.2.49 00-970 P1 5.2.52
		STANAG Reference:	4671.863 4671.967
FAA Doc:	14CFR references: 23.863, 23.967, 23.1185, 25.863, 25.967, 25.1185, 25.981 AC 25-981-2, AC 25-981-1B	*EASA CS Reference:*	CS 23.863 CS 23.967 CS 25.863 CS 25.967 CS 25.981 CS 25.1185 CS 27.863 CS 27.967 CS 29.863 CS 29.967 CS 27.1185

8.3.12.3 Fuel system drainage provisions shall permit safe drainage of the entire fuel system; such that all areas surrounding fuel tanks or containing fuel system components are properly drained; and all normal and accidental fuel leakage is removed to a safe location outside of the air vehicle.

Consideration should be given to:

a. Ensuring fuel is discharged clear of all parts of the air vehicle;

b. Ensuring the drain valve has manual or automatic means for positive locking in the closed position;

c. Ensuring the drain valve(s) is readily accessible and can be easily opened and closed, for example for fuel system contamination checks;

d. Locating or protecting the drain valve to prevent fuel spillage in the event of a landing with landing gear retracted.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E: E.3.4.5.6.2, E.4.4.5.6.2, E.3.4.5.1.10, E.4.4.5.1.10	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.79-5.2.81 00-970 P1 5.2.87 00-970 P1 5.2.89 00-970 P1 6.11.20
		STANAG Reference:	4671.967 4671.977 4671.997 4671.999
FAA Doc:	14CFR references: 23.977, 23,997, 23.999, 25.977, 25.997, 25.999	*EASA CS Reference:*	CS 23.977 CS 23.997 CS 23.999 CS 25.977 CS 25.997 CS 25.999 CS 27.977 CS 27.997 CS 27.999 CS 29.977 CS 29.997 CS 29.999

8.3.12.4 The fuel system drains and vents shall be located such that:

• Fuel jettison, fuel venting, fuel leaks, or fuel spills can not be ingested by the engine;

• Flow into hazardous ignition areas or onto the environmental management system is avoided and does not become reingested into the air vehicle.

Consideration should be given to:

a. Avoiding potential ignition sources, including hot brakes, bleed air ducts, engine, APU, etc.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E: E.3.4.5.2.6, E.4.4.5.2.6	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.87 00-970 P1 5.2.88 00-970 P1 5.2.127-5.2.129 00-970 P7 L702 27.8
		STANAG Reference:	4671.999 4671.1001(c)
FAA Doc:	14CFR references: 23.971, 23.999, 23.1001, 25.971, 25.999, 25.1001	*EASA CS Reference:*	CS 23.971* CS 23.999 CS 23.1001* CS 25.971* CS 25.999 CS 25.1001 CS 27.999

Information Sources			
			CS 29.999 CS 29.1001

8.3.13 Each fuel tank shall be able to withstand, without failure, the vibration, inertia, fluid and structural loads that it may be subjected to in operation.

Each fuel tank required to be crashworthy shall be capable of withstanding, without leakage, the required impact velocity.

Consideration should be given to:
a. The expected operational usage and natural and induced environments, such as: slosh (delta moment loads), vibration, tubing misalignment, deflection loads, thermal loads, flight loads, pressure changes from rapid altitude changes, and other;
b. The maximum survivable impact velocity of a human being which is currently understood to be approximately 60 ft/sec;
c. Ensuring fuel tanks, attachments, manifolds, fuel lines, and fittings are designed to allow relative movement and separation between the tank and structure without fuel spillage during a survivable crash.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E: E.3.4.5.6, E.4.4.5.6, E.3.4.5.6.13, E.4.4.5.6.13	*Def-Stan 00-970 Reference:*	00-970 P1 4.22.60 00-970 P1 5.2.150 00-970 P1 5.2.152 00-970 P7 L702 11.2
		STANAG Reference:	4671.963(a) 4671.965 4671.993
FAA Doc:	14CFR references: 23.963, 23.965, 23.993, 25.963, 25.965, 25.993 AC 25.963-1	*EASA CS Reference:*	CS 23.963 CS 23.965 CS 23.993 CS 25.963 CS 25.965 CS 25.993 CS 27.963 CS 27.965 CS 27.993 CS 29.963 CS 29.965 CS 29.993

8.3.14 The fuel tanks shall be designed to withstand the maximum pressure likely to occur; such that the structural limits are not exceeded during normal operations, or due to a single failure within the fuel system.

Consideration should be given to:
a. The combination of the internal pressure applied to transfer fuel or to prevent fuel boiling and the local external pressure;

b. The pressure developed during refuelling and defuelling, including a fuel system failure during refuelling operations;

c. Use of fuel vents to maintain internal tank pressure within limits.

d. The pressure differential at all heights up to the maximum attainable;

e. Hydrostatic loads arising from aircraft manoeuvre limits.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.2.9.1, 4.2.9.1, and Appendix E: E.3.4.5.1.7, E.4.4.5.1.7, E.3.4.5.1.8, E.4.4.5.1.8, E.3.4.5.1.12, E.4.4.5.1.12	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.37 00-970 P1 5.2.40 00-970 P7 L702 13.1-L702 13.2
		STANAG Reference:	4671.965(a)
FAA Doc:	14CFR references: 23.957, 23.963, 23.965, 25.957, 25.963, 25.965 AC 25.963-1	*EASA CS Reference:*	CS 23.963* CS 23.965 CS 25.963 CS 25.965 CS 27.965 CS 29.965

8.3.15 The air vehicle (including the refuel, vent and fuel tank systems) shall be capable of being safely refuelled and defueled.

Consideration should be given to:

a. Maximum refuelling rates;

b. Normal and single failure conditions;

c. Hot refuelling, i.e. with an engine or APU operating;

d. Gravity refuel interface provisions;

e. Preventing external leakage of fuel;

f. Maximum tank pressures (including vents) and the maximum pressure of fuel supplied;

g. The sequence of filling tanks (including isolation of tanks) where appropriate;

h. Provision of shut off valve(s);

i. Preventing refuelling overflow (including tank pressure, fuel drainage, tank vents etc.).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E: E.3.4.5.1.12, E.4.4.5.1.12, E.3.4.5.8.1, E.4.4.5.8.1, E.3.4.5.8.4, E.4.4.5.8.4, E.3.4.5.8.5, E.4.4.5.8.5, E.3.4.5.8.6, E.4.4.5.8.6, E.3.4.5.8.7, E.4.4.5.8.7, E.3.4.5.8.8, E.4.4.5.8.8	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.168 00-970 P1 5.2.169 00-970 P1 5.2.175 00-970 P1 5.2.176 00-970 P1 5.2.178 00-970 P1 5.2.187 00-970 P1 5.2.188 00-970 P1 5.2.213 00-970 P1 5.2.214 00-970 P7 L701/3 2.2
		STANAG Reference:	4671.23.863 4671.23.973 4671.23.975

Information Sources			
			4671.23.977 4671.23.979
FAA Doc:	14CFR references: 23.863, 23.973, 23.975, 23.979, 25.863, 25.973, 25.975, 25.979	*EASA CS Reference:*	CS 23.863* CS 23.973* CS 23.975* CS 23.977* CS 23.979 CS 25.863* CS 25.973* CS 25.975* CS 25.977* CS 25.979 CS 27.863* CS 27.973* CS 27.975* CS 27.977* CS 29.863* CS 29.973* CS 29.975* CS 29.977* CS 29.979

8.3.16 The fuel system shall be designed to prevent fuel spills during refuel operations.

Consideration should be given to:
a. Provision of an expansion space above the fuel level with sufficient capacity to allow for the expected thermal expansion of the fuel;
b. Shut-off means must prevent the quantity of fuel in each tank from exceeding the maximum quantity approved for that tank;
c. Indication at each fuelling station of failure of the shut-off means, to stop fuel flow at the maximum level;
d. Means to prevent the escape of hazardous quantities of fuel from the system if the fuel entry valve fails;
e. Procedures to identify a failed condition to prevent fuel spills;
f. Refuelling pre-checks to provide assurance that level control valves are operable and will close when each tank reaches the full or preset fuel level.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E: E.3.4.5.1.12, E.4.4.5.1.12, E.3.4.5.6.1, E.4.4.5.6.1, E.3.4.5.8.1, E.4.4.5.8.1, E.3.4.5.8.11, E.4.4.5.8.11, E.3.4.5.8.14, E.4.4.5.8.14, E.3.4.5.9, E.4.4.5.9	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.164 00-970 P1 5.2.179
		STANAG Reference:	4671.973
FAA Doc:	14CFR references: 23.969, 23.975, 25.969, 25.975	*EASA CS Reference:*	CS 23.969* CS 23.973 CS 23.975*

Information Sources			
			CS 23.979 CS 25.969* CS 25.973 CS 25.975* CS 25.979 CS 27.969* CS 27.973 CS 27.975 CS 29.969* CS 29.973 CS 29.975* CS 29.979

8.3.17 Adequate controls and displays for the fuel system functions shall be provided for the appropriate crewmember(s) to indicate the necessary fuel system functions and warn of hazardous conditions.

Consideration should be given to:

a. All required fuel system functions and tracked parameters (e.g. fuel pressure, fuel temperature, fuel quantity, CofG monitoring, pump status, fuel unbalance, low level fuel, etc.);

b. The location of the temperature sensors should be carefully considered so that a true fuel temperature will be indicated;

c. The position of the fuel quantity indicators to ensure accurate data readings;

d. Ensuring all displays and controls meet the specified requirements (arrangement, location, type, size, guards etc.).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E: E.3.4.5.1.12, E.4.4.5.1.12, E.3.4.5.8.11, E.4.4.5.8.11, E.3.4.5.12, E.4.4.5.12, E.3.4.5.12.1, E.4.4.5.12.1, E.3.4.5.12.2, E.4.4.5.12.2, E.3.4.5.12.3, E.4.4.5.12.3, E.3.4.5.12.4, E.4.4.5.12.4, E.3.4.5.12.5, E.4.4.5.12.5	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.25 00-970 P1 5.2.110 00-970 P1 5.2.115 00-970 P1 5.2.121 00-970 P1 5.2.133 00-970 P1 5.2.138 00-970 P1 5.2.139 00-970 P1 5.2.143 00-970 P1 5.2.144 00-970 P1 5.2.146 00-970 P1 5.2.147 00-970 P1 5.2.148 00-970 P7 L702 29.1
		STANAG Reference:	4671.1725 4671.1727 4671.1729
FAA Doc:		*EASA CS Reference:*	CS 23.955 CS 23.963 CS 23.979 CS 23.991 CS 23.1141 CS 23.1305

Information Sources			
			CS 23.1311 CS 23.1553 CS 25.979 CS 25.1141 CS 25.1161 CS 25.1305 CS 25.1553 CS 27.1141 CS 27.1305 CS 27.1553 CS 29.979 CS 29.1141 CS 29.1305 CS 29.1553

8.3.18 The fuel system shall include the necessary built-in-test (BIT), fault detection and isolation provisions, in order to identify critical failure modes to the operators and maintainers.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.2.9, 4.2.9 and Appendix E: E.3.4.5.8.11, E.4.4.5.8.11, E.3.4.5.12.5, E.4.4.5.12.5	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.120 00-970 P1 5.2.154
		STANAG Reference:	4671.965 4671.979
FAA Doc:	14CFR references: 23.979, 25.979	*EASA CS Reference:*	CS 23.965 CS 23.979 CS 25.965 CS 25.979 CS 27.965 CS 29.965 CS 29.979

8.3.19 Fuel jettison (dump) outlets shall be located such that jettisoned fuel does not impinge on air vehicle surfaces or become re-ingested into the air vehicle. Fuel jettison operations shall be safe and shall not adversely affect the controllability of the air vehicle.

Consideration should be given to:

a. Safe location of the fuel jettison in relation to potential ignition sources (hot brakes, bleed air ducts, engine, APU, etc);

b. The implications of the fuel dump system failures.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 5.2.129 00-970 P1 5.2.217
		STANAG Reference:	4671.1001
FAA Doc:		*EASA CS*	CS 23.1001(c)

Information Sources			
		Reference:	CS 25.1001 CS 29.1001

8.4. FIRE AND HAZARD PROTECTION.

This Section covers the prevention, detection, and extinguishing of fires and explosion suppression provisions for the Air Vehicle.

It considers passive methods such as materials specification, and separation of flammable fluids from sources of ignition; and active methods such as detection and notification to the crew, and fire extinguishing systems.

8.4.1 The fire protection system shall be safely integrated within the air vehicle, both physically and functionally.

Consideration should be given to:

a. Ensuring that the fire protection system components and elements can withstand the hazards they are designed to detect or control;

b. Protection in this context encompasses both detection and extinguishing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7, G.4.4.7, G.3.4.7.1, G.4.4.7.1, G.3.4.7.2, G.4.4.7.2, G.3.4.7.29, G.4.4.7.29 MIL-HDBK-221: 2.7, 2.12, 2.13, 2.16, 2.17	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.1 00-970 P1 4.26.2 00-970 P1 4.26.9 00-970 P1 4.26.24 00-970 P1 4.26.25-4.26.30 00-970 P1 4.26.55 00-970 P1 4.26.60 00-970 P1 4.26.62 00-970 P13 1.12.1-1.12.4 00-970 P13 1.12.5
		STANAG Reference:	4671.850 4671.1203 4671.1309
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	CS 23.851 CS 23.855 CS 23.859 CS 23.1203 CS 23.1309 CS 23.1359 CS 25.851 CS 25.854 CS 25.858 CS 25.589 CS 25.867 CS 25.1203 CS 25.1207

Information Sources			
			CS 25.1309 CS 25.1705 CS 25.1713 CS 27.859 CS 27.1195 CS 27.1309 CS 29.851 CS 29.859 CS 29.1195 CS 29.1203 CS 29.1309

8.4.1.1 All single-point failure conditions shall be identified and the consequences of their failure shall be acceptable, eliminated or mitigated.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.26.24
		STANAG Reference:	4671.1309
FAA Doc:		*EASA CS Reference:*	CS 25.1203 CS 25.1309 CS 29.1309

8.4.1.2 All components, either individually or as part of a subsystem, shall have passed all safety-related qualification tests (e.g. proof, burst, vibration, containment, over-speed, acceleration, explosive atmosphere, pressure cycling and temperature cycling as required for airworthy performance).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.26.24 00-970 P1 4.26.55 00-970 P1 4.26.56 00-970 P1 4.26.61 00-970 P1 4.26.62
		STANAG Reference:	4671.1203 4671.1309 4671.1359
FAA Doc:		*EASA CS Reference:*	CS 23.855 CS 23.1199 CS 23.1203 CS 23.1309 CS 23.1359 CS 25.857 CS 25.858 CS 25.1203 CS 25.1309

Information Sources			
			CS 25.1705 CS 25.1713 CS 27.859 CS 27.1195 CS 27.1309 CS 29.855 CS 29.1199 CS 29.1203 CS 29.1309 CS 29.1359

8.4.1.3 Adequate crew-station information shall be available to notify the flight crew of the status of the fire and hazard protection system and any warnings and cautions related to detection of fire or smoke.

Consideration should be given to:

a. Where more than one zone or area is monitored, provision of indication to crew of detection location;

b. Provision of status information of detection system.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.19.60 00-970 P1 4.26.24 00-970 P1 4.26.60 00-970 P1 4.26.61 00-970 P1 4.26.62
		STANAG Reference:	4671.1203 4671.1817
FAA Doc:		*EASA CS Reference:*	CS 23.855 CS 23.1203 CS 23.1305 CS 25.854 CS 25.857 CS 25.858 CS 25.1203 CS 25.1305 CS 27.1195 CS 29.855 CS 29.1203 CS 29.1305

8.4.2 Each component of the air vehicle shall be properly zoned according to the fire and explosion hazards and protection shall be provided to counter the hazards such that no fire or explosion hazards exist under normal operating conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7, G.4.4.7	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.2 00-970 P1 4.26.5

Information Sources			
	MIL-HDBK-221: 2.11		00-970 P1 4.26.6 00-970 P1 4.26.10 00-970 P1 4.26.11 00-970 P1 4.26.22 00-970 P1 4.26.41 00-970 P7 L712 2.1
		STANAG Reference:	4671.865 4671.1181 4671.1203 4671.1309 4671.1359
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	CS 23.859 CS 23.865 CS 23.903 CS 23.1181-23.1182 CS 23.1203 CS 23.1309 CS 23.1359 CS 23.1451 CS 25.857 CS 25.859 CS 25.865 CS 25.869 CS 25.1181 CS 25.1187 CS 25.1203 CS 25.1207 CS 25.1309 CS 25.1713 CS 27.859 CS 27.1309 CS 27 Annex C CS 29.859 CS 29.1181 CS 29.1187 CS 29.1203 CS 29.1309 CS 29.1359

8.4.3 The design of sub-systems, other than fire protection, shall have taken into consideration any potential for fire hazards.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.1, G.4.4.7.1 MIL-HDBK-221: 2.1, 2.2.1.2, 2.2.1.4, 2.2.1.5, 2.2.1.6,	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.6 00-970 P1 4.26.10 00-970 P1 4.26.11 00-970 P1 4.26.37-4.26.40 00-970 P1 4.26.41

Information Sources			
	2.2.1.7, 2.2.1.8, 2.2.2 through 2.2.9, 2.5, 2.6, 2.7.3, 2.7.11, 2.7.13, 2.10.2 though 2.10.8		00-970 P1 4.26.46-4.26.49 00-970 P1 4.26.53 00-970 P1 4.26.66 00-970 P1 4.26.71-4.26.73 00-970 P1 4.26.82-4.26.83
		STANAG Reference:	4671.613 4671.850 4671.865 4671.903 4671.967 4671.994 4671.1061 4671.1103 4671.1121 4671.1141 4671.1163 4671.1181-4671.1193 4671.1307 4671.1309 4671.1351-4671.1367
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	CS 23.775, 23.859, 23.865, 23.903, 23.967, 23.994, 23.1061, 23.1103, 23.1121-23.1125, 23.1163, 23.1181-23.1193, 23.1309, 23.1351, 23.1359-23.1365, 23.1451 CS 25.857, 25.859, 25.865, 25.867, 25.869, 25.903, 25.963, 25.994, 25.1017, 25.1121, 25.1141, 25.1181-25.1193, 25.1309, 25.1351, 25.1365, 25.1713-25.1731 CS 27.859, 27.861, 27.1121, 27.1183-27.1194, 27.1309, 27.1365 CS 29.803, 29.807, 29.859, 29.861, 29.903, 29.1023, 29.1091, 29.1121, 29.1183-29.1194, 29.1309, 29.1351, 29.1359

8.4.3.1 In areas where a fluid system might leak flammable fluids or vapours, the design shall minimise the probability of ignition of the fluids and vapours and minimise the resultant hazards if ignition does occur.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.3, G.4.4.7.3, G.3.4.7.6, G.4.4.7.6	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.4 00-970 P1 4.26.6 00-970 P1 4.26.14-4.26.18

Information Sources			
			00-970 P1 4.26.20 00-970 P1 4.26.32 00-970 P1 4.26.34 00-970 P1 4.26.63-4.26.69 00-970 P7 L712 2.4
		STANAG Reference:	4671.863 4671.967 4671.1061 4671.1091 4671.1103 4671.1121 4671.1163 4671.1183 4671.1307 4671.1309 4671.1337 4671.1361 4671.1367
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	CS 23 Clauses: 23.853, 23.859, 23.863, 23.967, 23.1061, 23.1091, 23.1103, 23.1121, 23.1163, 23.1183, 23.1309, 23.1337 CS 25 Clauses: 25.859, 25.863, 25.869, 25.952, 25.1091, 25.1121, 25.1163, 25.1183, 25.1185, 25.1187, 25.1309, 25.1337 CS 27 Clauses: 27.859, 27.863, 27.1091, 27.1121, 27.1183, 27.1185, 27.1187, 27.1309, 27.1337 CS 29 Clauses: 29.859, 29.863, 29.1091, 29.1103, 29.1121, 29.1125, 29.1163, 29.1183, 29.1185, 29.1187, 29.1309, 29.1337

8.4.3.2 Air vehicle components that are critical for safe flight, which are susceptible and potentially exposed to heat and fire, shall withstand fire and heat to a predetermined safe level.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.6, G.4.4.7.6, G.3.4.7.21, G.4.4.7.21	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.3 00-970 P1 4.26.14 - 4.26.16 00-970 P1 4.26.20 00-970 P1 4.26.34 00-970 P1 4.26.38 - 39 00-970 P1 4.26.46 00-970 P1 4.26.83

Information Sources			
			00-970 Pt 7 L712 2.5
		STANAG Reference:	4671.850 4671.863 4671.865 4671.1191 4671.1193 4671.1203 4671.1351 4671.1359 4671.1367
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	CS 23 Clauses: 23.863, 23.865, 23.1141, 23.1182, 23.1191, 23.1193, 23.1201, 23.1203, 23.1309, 23.1359 CS 25 Clauses: 25.863, 25.865, 25.869, 25.1141, 25.1182, 25.1189, 25.1191, 25.1193, 25.1201, 25.1203, 25.1207, 25.1309, 25.1713 CS 27 Clauses: 27.861, 27.863, 27.1191, 27.1193, 27.1194, 27.1309, 27.1365 CS 29 Clauses: 29.861, 29.863, 29.1191, 29.1193, 29.1194, 29.1309, 29.1359

8.4.4 Provisions for drainage and ventilation of combustible fluids or vapours shall be adequate to preclude the occurrence of fire or explosion hazards.

Consideration should be given to:

a. Capacity of each drain or vent is adequate for its expected task;

b. Location of each drain or vent to preclude the occurrence of fire or explosion;

c. Drainage and ventilation provisions should be located so that combustibles are removed from the air vehicle to a safe location on the ground and cannot re-enter the air vehicle in flight or ground operations;

d. Drains and vents from areas that might carry flammable fluids should not be manifolded with drains from areas that do not carry a potentially flammable fluid.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.3, G.4.4.7.3, G.3.4.7.4, G.4.4.7.4, G.3.4.7.5, G.4.4.7.5, G.3.4.7.18, G.4.4.7.18 MIL-HDBK-221: 2.4	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.14 00-970 P1 4.26.19 00-970 P1 4.26.20 00-970 P1 4.26.35 00-970 P1 4.26.36 00-970 P1 4.26.67 00-970 P1 4.26.68 00-970 P1 4.26.70 00-970 P1 4.26.73 00-970 P1 4.26.82

Information Sources			
			00-970 P1 6.11.20 00-970 P13 3.5.26 00-970 P13 1.4.4.14
		STANAG Reference:	4671.903 4671.967 4671.971 4671.975 4671.999 4671.1001 4671.1013 4671.1017 4671.1021 4671.1061 4671.1091 4671.1103 4671.1121 4671.1189 4671.1193 4671.1309
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	CS 23 Clauses: 859, 967, 971, 975, 999, 1001, 1013, 1017, 1021, 1061, 1091, 1103, 1121, 1189, 1193, 1309 CS 25 Clauses: 859, 967, 971, 973, 975, 869, 999, 1001, 1013, 1017, 1021, 1091, 1121, 1187, 1189, 1193, 1309 CS 27 Clauses: 859, 963, 973, 999, 1021, 1091, 1121, 1183, 1187, 1193, 1309 CS 29 Clauses: 859, 963, 973, 975, 999, 1013, 1017, 1021, 1091, 1103, 1121, 1187, 1189, 1193, 1309

Merged with 8.4.4

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.3, G.4.4.7.3, G.3.4.7.4, G.4.4.7.4, G.3.4.7.17, G.4.4.7.17, G.3.4.7.18, G.4.4.7.18, G.3.4.7.22, G.4.4.7.22	*Def-Stan 00-970 Reference:*	Merged with 8.4.4
		STANAG Reference:	Merged with 8.4.4
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	Merged with 8.4.4

Merged with 8.4.4

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.3, G.4.4.7.3, G.3.4.7.5, G.4.4.7.5 MIL-HDBK-221: 2.4.5	*Def-Stan 00-970 Reference:*	Merged with 8.4.4
		STANAG Reference:	Merged with 8.4.4
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	Merged with 8.4.4

8.4.6 Engine nacelle cooling and ventilation provisions shall be adequate to provide required heat rejection and maintain nacelle conditions necessary to avoid both hot surface ignition sources and collection of flammable fluids or vapours.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.4, G.4.4.7.4, G.3.4.7.18, G.4.4.7.18 MIL-HDBK-221: 2.11.2.4, 2.11.2.5	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.19 00-970 P1 4.26.20 00-970 P1 4.26.37 00-970 P1 4.26.39 00-970 P1 4.26.40
		STANAG Reference:	4671.1193
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	CS 23.1182 CS 23.1193 CS 25.1182 CS 25.1187 CS 25.1193 CS 27.1187 CS 27.1193 CS 29.1187 CS 29.1193

8.4.7 All potential fire zones shall be designated as such and suitable fire warnings and protection shall be provided.

Consideration should be given to:

a. Engine, auxiliary power unit (APU) and other compartments, such as engine-driven airframe accessory area;

b. Cargo and baggage compartments;

c. Bomb bays.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.19, G.4.4.7.19, G.3.4.7.20, G.4.4.7.20, G.3.4.7.24, G.4.4.7.24,	*Def-Stan 00-970 Reference:*	00-970 P1 4.19.60 00-970 P1 4.26.2 00-970 P1 4.26.11 00-970 P1 4.26.24

Information Sources			
	G.3.4.7.27, G.4.4.7.27 MIL-HDBK-221: 2.12, 2.13 (All except any reference to Halon), 2.17		00-970 P1 4.26.25 - 4.26.27 00-970 P7 L712 2.1
		STANAG Reference:	4671.1181 4671.1203
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	CS 23.855 CS 23.859 CS 23.1181 CS 23.1195 CS 23.1203 CS 23.1305 CS 25.857 CS 25.858 CS 25.859 CS 25.1181 CS 25.1182 CS 25.1195 CS 25.1203 CS 25.1305 CS 27.859 CS 27.1195 CS 27 Appendix C CS 29.855 CS 29.859 CS 29.1181 CS 29.1195 CS 29.1203 CS 29.1305

8.4.8 Essential flight controls, engine mounts, and other flight structures located in designated fire zones or adjacent areas shall be verified to withstand the effects of fire.

Consideration should be given to:

a. Lines or components containing flammable fluids.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.20, G.4.4.7.20, G.3.4.7.21, G.4.4.7.21 MIL-HDBK-221: 2.7.4	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.6 00-970 P1 4.26.16 00-970 P1 4.26.39 00-970 P7 L712 2.6
		STANAG Reference:	4671.850 4671.865 4671.1309
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	CS 23.865 CS 23.1309 CS 25.865 CS 25.867 CS 25.869

Information Sources			
			CS 25.1309 CS 27.861 CS 27.1309 CS 29.861 CS 29.1309

8.4.9 Each electrically powered fire protection sub-system shall be provided with power at all times during air vehicle operations, including engine start and battery operations.

Consideration should be given to:

a. Fire detection, extinguishing, and explosion suppression systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.10, G.4.4.7.10 MIL-HDBK-221: 2.12, 2.13	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.3 00-970 P1 6.6.8 00-970 P1 6.6.88 00-970 P1 6.6.89
		STANAG Reference:	4671.850 4671.1203 4671.1309 4671.1359
FAA Doc:	214CFR references: 3.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	CS 23.855 CS 23.859 CS 23.1203 CS 23.1309 CS 23.1359 CS 25.854 CS 25.858 CS 25.859 CS 25.869 CS 25.1203 CS 25.1309 CS 25.1310 CS 25.1362 CS 25.1705 CS 27.859 CS 27.1195 CS 27.1309 CS 29.859 CS 29.1195 CS 29.1203 CS 29.1309 CS 29.1359

8.4.10 Air vehicle explosion suppression requirements shall be established and suitable for fire and hazard protection.

Consideration should be given to:

a. Passive explosion suppression for all fire protection zones, e.g. ventilation, drainage, containment, detection, suppression and isolation, as appropriate;
b. Active fire suppression for zones where passive protection is not adequate, e.g. fire zones, flammable leakage zones or flammable zones.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.8, G.4.4.7.8, G.3.4.7.9, G.4.4.7.9, G.3.4.7.26, G.4.4.7.26, G.3.4.7.27, G.4.4.7.27, G.3.4.7.28, G.4.4.7.28 MIL-HDBK-221: 2.17	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.2 00-970 P1 4.26.73 00-970 P7 L712
		STANAG Reference:	
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	

8.4.11 The fire detection system shall be designed to preclude false warnings.

Consideration should be given to:
a. Performance characteristics of the detector or sensor;
b. Location of the detectors and the potential for their false stimulation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.9, G.4.4.7.9, G.3.4.7.10, G.4.4.7.10, G.3.4.7.11, G.4.4.7.11, G.3.4.7.12, G.4.4.7.12, G.3.4.7.13, G.4.4.7.13, G.3.4.7.14, G.4.4.7.14, G.3.4.7.15, G.4.4.7.15	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.24
		STANAG Reference:	4671.1203 4671.1309
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	CS 23.863 CS 23.1309 CS 25.858 CS 25.863 CS 25.1203 CS 25.1309 CS 25.1731 CS 27.863 CS 27.1309 CS 29.863 CS 29.1203 CS 29.1309

8.4.12 The performance of the fire suppression system shall be adequately safe and suitable for the aircraft installation.

Consideration should be given to:
a. Analysis which establishes agent concentrations and duration levels that extinguish a fire;

b. The suppression capability of the chosen agent, and any chemical reaction or other effect on the aircraft structure;

c. The ability to direct multiple discharges into a single zone;

d. The location and quantity of areas or zones to be protected, including cargo areas and dry zones;

e. Provision of, or capability for, tell-tale indicators on switches and extinguishant containers.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.24, G.4.4.7.24, G.3.4.7.25, G.4.4.7.25, G.3.4.7.26, G.4.4.7.26 MIL-HDBK-221: 2.12	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.5 00-970 P1 4.26.9 00-970 P1 4.26.25 - 4.26.30 00-970 P1 4.26.62 00-970 P13 3.9.5 00-970 Pt 7 L712 3.13.1
		STANAG Reference:	4671.863 4671.1309 4671.1817
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	CS 23.1195 CS 23.1197 CS 23.1199 CS 23.1201 CS 23.1309 CS 25.851 CS 25.854 CS 25.857 CS 25.1195 CS 25.1197 CS 25.1199 CS 25.1201 CS 25.1207 CS 25.1309 CS 27.859 CS 27.1309 CS 29.851 CS 29.1195 CS 29.1197 CS 29.1199 CS 29.1201 CS 29.1309

8.4.13 Fireproof protective devices shall be provided to isolate a fire within a defined fire zone from any portion of the air vehicle where a fire could create a hazard.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.20, G.4.4.7.20 MIL-HDBK-221: 2.7.8, 2.11	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.11 00-970 P1 4.26.13 00-970 P1 4.26.16 00-970 P1 4.26.22

Information Sources			
			00-970 P1 4.26.23 00-970 P1 4.26.83
		STANAG Reference:	4671.1103 4671.1191 4671.1193
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	CS 23.859 CS 23.1103 CS 23.1191 CS 23.1192 CS 23.1193 CS 25.859 CS 25.1091 CS 25.1183 CS 25.1189 CS 25.1191 CS 25.1193 CS 25.1207 CS 27.859 CS 27.1191 CS 29.859 CS 29.1103 CS 29.1191 CS 29.1193

8.4.14 The interior finishes and materials within the cockpit and passenger or crew cabins shall deter combustion and any toxic by-products of combustion shall be at acceptable levels.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.7, G.4.4.7.7, G.3.4.7.22, G.4.4.7.22 MIL-HDBK-221: 2.7.9	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.74 - 4.26.77 00-970 P1 4.26.79 - 4.26.81
		STANAG Reference:	
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411 AC 25.853-1, AC 25.869-1	*EASA CS Reference:*	CS 23.853 CS 23.855 CS 25.853 CS 25.855 CS 25.856 CS 25.857 CS 27.853 CS 27.855 CS 29.853 CS 29.855

8.4.15 Hazardous quantities of smoke, flames, or extinguishing agents shall be prevented from entering inhabited areas, UAS/ROA control station, or UAS/ROA flight-critical sensor bays.

Consideration should be given to:

a. The human effects of extinguishing agents.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.22, G.4.4.7.22 MIL-HDBK-221: 2.4.2, 2.19	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.56 00-970 P1 4.26.59 00-970 P1 4.26.62 00-970 P1 1.4.6.6 00-970 P1 1.6.12.4 00-970 P1 1.6.12.5
		STANAG Reference:	4671.775 4671.850 4671.1191 4671.1703
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411 AC 25-9	*EASA CS Reference:*	CS 23.831 CS 23.851 CS 23.1197 CS 25.831 CS 25.851 CS 25.855 CS 25.857 CS 25.1197 CS 27.831 CS 29.831 CS 29.851 CS 29.855 CS 29.1197

8.4.16 Proper separation shall be provided between oxidisers and flammable fluid systems or electrical components.

Consideration should be given to:

a. Zonal analysis should be carried out to determine routeing and positioning of oxidiser, flammable fluid, and electrical systems;

b. Where possible, electrical systems, including wiring, should be above flammable fluid lines or components to mitigate effects of leaks;

c. Protection levels can be increased through use of shrouds and covers;

d. Ground and flight tests should be carried out to ensure clearance requirements are maintained under all conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.16, G.4.4.7.16, G.3.4.7.17, G.4.4.7.17 MIL-HDBK-221: 2.7.2, 2.7.10, 2.10.4.2, 2.10.2.1	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.41 00-970 P1 4.26.42 00-970 P1 4.26.43 00-970 P1 4.26.44 00-970 P1 4.26.45 00-970 P1 6.2.59 00-970 P1 6.6.3

Information Sources			
			00-970 P1 6.6.90
		STANAG Reference:	
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	CS 23.863 CS 23.1361 CS 23.1365 CS 23.1441 CS 23.1445 CS 23.1451 CS 25.863 CS 25.869 CS 25.1441 CS 25.1453 CS 25.1707 CS 27.863 CS 27.952 CS 27.1351 CS 29.863 CS 29.952

8.4.17 Provisions shall be available to shut off flammable fluids and de-energise all electrical ignition sources in the identified fire zone(s) for all mission phases including ground operations.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.17, G.4.4.7.17, G.3.4.7.19, G.4.4.7.19 MIL-HDBK-221: 2.1.1.5, 2.2.6, 2.4.8, 2.11.1.4, 2.11.2.7	*Def-Stan 00-970 Reference:*	00-970 P1 4.24.4 00-970 P1 4.26.17 00-970 P1 4.26.21
		STANAG Reference:	4671.995 4671.1189 4671.1743 4671.1753
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	CS 23.859 CS 23.1142 CS 23.1145 CS 23.1189 CS 25.859 CS 25.1145 CS 25.1185 CS 25.1189 CS 25.1727 CS 27.859 CS 27.1145 CS 27.1185 CS 27.1189 CS 29.859 CS 29.1142 CS 29.1145

Information Sources			
			CS 29.1185 CS 29.1189

8.4.18 Ground fire fighting access provisions shall be compatible with standard ground fire fighting systems and that fire suppression can be accomplished through this access provision.

Consideration should be given to:

a. Quantity and location of ground access points;

b. Effectiveness of access point in terms of:

i. Ground crew being able to access it;

ii. Evenness of extinguishant spread through the fire zone.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.7, G.4.4.7.7, G.3.4.7.13, G.4.4.7.13, G.3.4.7.31, G.4.4.7.31 MIL-HDBK-221: 2.11.2.10, 2.11.3.6	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.25 to 4.26.30 00-970 P1 4.26.86 00-970 P1 4.26.87
		STANAG Reference:	
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411 AC 20-42C	*EASA CS Reference:*	CS 23.1181 - 23.1203 CS 25.1181 - 25.1207 CS 27.1183 - 27.1203 CS 27 Appendix C CS 29.1181 - 29.1203

8.4.19 Where practicable the air vehicle shall provide safety features to mitigate post-crash fire and explosion hazards.

Consideration should be given to:

a. Fuel and other flammable fluids;

b. Hot surfaces;

c. Sources of ignition, including sparks from scraping along the ground.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.7, G.4.4.7.7 MIL-HDBK-221: 2.7.3.2, 2.15	*Def-Stan 00-970 Reference:*	00-970 P1 4.22.18 00-970 P1 4.22.44 00-970 P1 4.22.58 00-970 P1 4.22.60 00-970 P1 4.22.64 00-970 P1 4.26.29 00-970 P1 6.6.67 00-970 P1 6.6.87 00-970 P1 6.6.88
		STANAG Reference:	4671.944
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869,	*EASA CS Reference:*	CS 23.721 CS 23.994

Information Sources			
	23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411 AC 25-17, AC 25.994.1		CS 23.1453 CS 25.721 CS 25.787 CS 25.855 CS 25.963 CS 25.994 CS 25.1145 CS 25.1453 CS 27.855 CS 27.952 CS 27.963 CS 27.973 CS 29.855 CS 29.952 CS 29.963 CS 29.973

8.4.20 The air vehicle shall have provisions to detect and control overheat conditions that are potential fire and explosion hazards.

Consideration should be given to:

a. Locations where overheat sensors might be required;

b. The type of warning and crew response, or automatic response, required.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7.23, G.4.4.7.23, G.3.4.7.28, G.4.4.7.28 MIL-HDBK-221: 2.20	*Def-Stan 00-970 Reference:*	00-970 P1 4.24.25 00-970 P1 4.26.3 00-970 P1 4.26.24 00-970 P1 4.26.32 00-970 P1 4.26.69 00-970 P1 6.6.87 00-970 P1 6.6.88
		STANAG Reference:	4671.863 4671.1111 4671.1307 4671.1309 4671.1353
FAA Doc:	14CFR references: 23.851-23.865, 25.851-25.869, 23.1181-23.1203, 25.1181-25.1207, 23.1411, 25.1411	*EASA CS Reference:*	CS 23.863 CS 23.1111 CS 23.1309 CS 23.1353 CS 25.863 CS 25.1103 CS 25.1203 CS 25.1309 CS 25.1353 CS 25.1365 CS 25.1731

Information Sources			
			CS 27.863 CS 27.1309 CS 27.1353 CS 29.863 CS 29.1309 CS 29.1353

8.4.21 If unoccupied cargo holds or bomb bays are present, then fire protection, fire detection/ suppression, and smoke detector requirements shall be met.

Consideration should be given to:
a. Specification of materials used;
b. Location and quantity of fire/smoke detectors;
c. Fire suppression requirements.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-7: 3.7.3.4 JSSG-2009-Appendix G: 3.4.7, 3.4.7.22, 3.4.7.25, 3.4.7.28	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.56 00-970 P1 4.26.57 00-970 P1 4.26.59 00-970 P1 4.26.60 00-970 P1 4.26.61 00-970 P1 4.26.76 00-970 P1 4.26.80 00-970 P1 4.26.81 00-970 P1 L712 8.1 00-970 P1 L712 8.2
		STANAG Reference:	
FAA Doc:	14CFR references: 25.855, 25.857, 25.858, 25.859	*EASA CS Reference:*	CS 23.855 CS 25.855 CS 25.857 CS 25.858 CS 27.855 CS 29.855

8.5. LANDING GEAR AND DECELERATION SYSTEMS.

This section covers the installation, integration, interface, arrangement and operation of the air vehicle landing gear and deceleration systems (not including reverse thrusters or air brakes).

Included with the scope of the this section are:
• Arrangement, dynamics, and clearances;
• Landing gear structure;
• Tyre load and speed rating;
• Wheel loadings;
• Brake assemblies;
• Brake control and anti-skid control;
• Directional control;

• Landing gear actuation control;
• Auxiliary deceleration devices;
• Ground handling;
• Specialised Sub-systems.

When designing landing gear and deceleration systems, the general air worthiness criteria for air vehicle equipment and systems, as well as the overall air vehicle flight control and flight performance should always be considered. Some criteria in this chapter are supported in the text by examples of specific considerations. These examples are by no means to be considered as exhaustive.

All criteria should at least be verified for:
• All normal and emergency (failure) conditions;
• All environmental conditions;
• The most critical combination of air vehicle weight (up to maximum weight) and centre of gravity position;
• Operation over surfaces other than smooth, hard runways;
• All configurations of external stores, weapons, engines and propellers.

Where an information source is highlighted, in general it is implied that any higher level requirement on the same subject stated in the parent paragraphs is applicable too, as well as each lower level requirement contained in any subparagraph. The links to references are by no means to be considered as exhaustive.

8.5.1. Ground Floatation

8.5.1.1 The landing gear shall have safe ground floatation capability.

Consideration should be given to:
a. Operation from surfaces other than smooth, hard runways;
b. The design of the air vehicle structure and landing gear should consider the loads from operation over the roughest ground that may reasonably be expected in normal operation;
c. The air vehicle capability should be expressed though a recognised rating scheme;
d. Loads applied by the landing gear system to the airfield surface which do not exceed the bearing strength of the airfield surface.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.2.1, A.4.4.1.2.1 AFGS-87139: 3.2.1.1.b	*Def-Stan 00-970 Reference:*	00-970 P1 4.13.4 00-970 P1/6 S4 L48, 50
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.235 CS 25.491

8.5.2. Arrangement, dynamics, and clearances.

8.5.2.1 The landing gear shall be arranged so that no part of the air vehicle structure can contact the ground (except that intended to, such as arresting hooks and tail bumpers) in all practicable take-off and landing attitudes. This includes ensuring sufficient ground clearance of all configurations of external stores, weapons, engines and propellers.

Consideration should be given to:

a. Failure events such as deflated tyres and total collapse of the shock-absorbers;

b. Servicing equipment whilst the aircraft is parked.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.1.1, A.4.1.1.1, A.3.4.1.1.6, A.4.4.1.1.6, A.3.4.1.1.3, A.4.4.1.1.3, Appendix A: A.3.4.1.1.1/A.4.4.1.1.1 Gear arrangement; A.3.4.1.1.3/A.4.4.1.1.3 Extended Clearances; and A.3.4.1.1.6/A.4.4.1.1.6 Clearance with flat tyre and flat strut. AFGS-87139: 3.2.1.2 Arrangement and 3.2.1.3.a Clearances.	*Def-Stan 00-970 Reference:*	00-970 P1 2.3.12 00-970 P1 4.13 00-970 P1 5.1.62 00-970 P1 5.1.101 00-970 P1 9.8.29
		STANAG Reference:	4671.481 4671.733 4671.925
FAA Doc:	14CFR reference: 13.1-13.2.4, 23.1501, 23.1529, 25.1501, 25.1503-25.1533, 25.1529, 25.1541, 25.1543, 25.1557, 25.1563	*EASA CS Reference:*	CS 23.733 CS 23.925 CS 25.733 CS 25.925 CS 27.411 CS 27.733 CS 29.411 CS 29.733

8.5.2.2 Verify that the landing gear provides safe control of the air vehicle so that no part of the air vehicle structure can unintentionally contact the ground during ground manoeuvres. This includes the ability to maintain directional stability and control.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.1.2/A.4.4.1.1.2 Pitch Stability; and A.3.4.1.1.7/A.4.4.1.1.7 Gear Stability AFGS-87139: 3.2.1.2 Arrangement and 3.2.5.1 General	*Def-Stan 00-970 Reference:*	00-970 P1 2 2.3 00-970 P1 4.10.11 00-970 P1 4.11.2 00-970 P1 4.11.28 00-970 P1 4.11.66 00-970 P1 4.13.7
		STANAG Reference:	4671.231 4671.233 4671.235 4671.586
FAA Doc:	14CFR reference: 25.233	*EASA CS Reference:*	CS 23.231 CS 23.233 CS 23.235 CS 25.231 CS 25.233 CS 25.235

Information Sources			
			CS 27.231 CS 27.241 CS 27.663 CS 27.751 CS 29.231 CS 29.241 CS 29.663 CS 29.751

8.5.2.3 Retractable landing gear shall be designed so that the retraction / extension mechanism operates safely in any expected set of adverse conditions, including emergency operation. This includes ensuring sufficient clearance is maintained to prevent unintended contact and / or result in the landing gear becoming stuck in the up position, for all motion of the gear and door actuation and locking system.

Consideration should be given to:

a. The gear kinematics;

b. The clearance of the tyres at their maximum size;

c. Set of adverse conditions to be agreed and verified, such as:

i. Speed, temperature, attitude, air vehicle speed, operating mode of the air vehicle (takeoff, touch and go), and air vehicle altitude;

ii. Operation on runways or landing grounds which are snow-covered, chemically treated or sandy;

iii. Prevention of any corrosion which might follow operation from such surfaces.

d. Verification by air vehicle measurements, followed with air vehicle demonstration during checkout and flight-testing;

e. Tyre growth while rotating.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.1.4/A.4.4.1.1.4 Retraction Clearances AFGS-87139: 3.2.1.2 Arrangement and 3.2.1.3.b Clearances (retractable landing gears)	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.52 00-970 P1 4.11.57 00-970 P1 4.11.60 00-970 P1 4.11.74 00-970 P1 4.12.41 00-970 P7 L301 3.4
		STANAG Reference:	4671.729 4671.733 4671.745
FAA Doc:	14CFR references: 23.745	*EASA CS Reference:*	CS 23.733 CS 23.745 CS 25.733 CS 25.745 CS 25.729 CS 27.733 CS 27.745 CS 27.729

8.5.2.3.1 Equipment and structure that are essential to the safe operation of the aeroplane and that are located on the landing gear and in the wheel wells shall be protected from the damaging effects of possible wheel brake temperatures.

Consideration shall be given to:

a. Use of protective covers;

b. Means to ensure dissipation of excess temperature;

c. Location and proximity of sensitive structure or equipment;

d. Location and proximity of flammable substances or materials.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.735

8.5.2.4 The landing gear shall not cause the air vehicle to experience any adverse dynamics or pitching motions, such as to prevent continued safe flight / ground operations in any likely condition (including but not limited to shimmy, porpoising and yaw skids). This shall include the prevention of any vibrations or buffeting that may cause structural damage to the air vehicle, interfere with its satisfactory control, or cause excessive fatigue to the flight crew.

Consideration should be given to:

a. The maximum braking torque which can be applied during retraction;

b. The most adverse combination of normal acceleration, aerodynamic load and position of the landing gear;

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.1.2/A.4.4.1.1.2 Pitch Stability; A.3.4.1.1.7/A.4.4.1.1.7 Gear Stability; A.3.4.1.4.2/A.4.4.1.4.2 Directional Control; A.3.4.1.4.3/A.4.4.1.4.3 Emergency directional control; A.3.4.1.4.5.1/A.4.4.1.4.5.1 Steering characteristics AFGS-87139: 3.2.1.2.b Arrangement; and 3.2.1.4 Damping	*Def-Stan 00-970 Reference:*	00-970 P1 2.24.16 00-970 P1 2.19.30(VTOL) 00-970 P1 4.10.19 00-970 P1 4.11.28 00-970 P1 4.11.59
		STANAG Reference:	4671.723 4671.726 4671.727 4671.729 4671.731 4671.733 4671.735 4671.1309
FAA Doc:	14CFR references: 23.721-23.745, 25.721-25.737	*EASA CS Reference:*	CS 23.251 CS 23.723 CS 23.726 CS 23.729 CS 23.731 CS 23.733 CS 23.735 CS 23.1309 CS 25.251

Information Sources			
			CS 25.473(d) CS 25.493(d) CS 25.723 CS 25.729 CS 25.731 CS 25.733 CS 25.735 CS 25.1309

8.5.2.5 The landing gear shall be arranged to ensure the air vehicle will not tip back onto its tail in all normal operating conditions.

Consideration should be given to when the brakes are applied while the air vehicle is rolling backwards or the air vehicle is over-rotated on takeoff or landing, or during towing operations.

For reverse braking, further consideration should be given to:
a. Maximum brake limit loads, to be agreed and verified;
b. Pitching moments, to be agreed and verified;
c. Ground reactions of the nose and tail wheels.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.3.1.14/A.4.4.1.3.1.14 Empennage protection; and A.3.4.1.2.2.1.3/A.4.4.1.2.2.1.3 Landing gear towing	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.9 00-970 P 1/6 S4 L42
		STANAG Reference:	
FAA Doc:	14CFR references: 23.509, 25.507, 25.509	*EASA CS Reference:*	CS 23.509 CS 25.507 CS 25.509

8.5.2.6 Verify that the landing gear kneeling capability allows the air vehicle to kneel safely.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.10/A.4.4.1.10 Specialized subsystems AFGS-87139: 3.1.9 Specialized subsystems.	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.5.2.6.1 Verify that the servicing procedures for landing gear kneeling and unkneeling are safe and properly sequenced.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.10/A.4.4.1.10	*Def-Stan 00-970 Reference:*	

Information Sources			
	Specialized subsystems AFGS-87139: 3.1.9 Specialized subsystems	*STANAG Reference:*	
FAA Doc:		*EASA CS Reference:*	

8.5.3. Landing gear structure.

8.5.3.1 The landing gear shall be designed to collapse in a controlled, energy-absorbing manner so that in the event of any structural failure, no failure mode will result in penetration of the cabin, fuel tanks, or any other bay that may explode. This includes any space on the air vehicle which is occupied by the crew or other personnel, and / or spillage of enough fuel to constitute a fire hazard.

Consideration should be given to:

a. The distance between the main auxiliary unit in order to:

i. Maximise energy absorption;

ii. Minimise the forces created in the event of a near vertical crash.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.3.1.3/A.4.4.1.3.1.3 Failure Tolerance AFGS-87139: 3.2.2.1.e General (limits on structural failure modes)	*Def-Stan 00-970 Reference:*	00-970 Pt 1/6 S4 L75
		STANAG Reference:	
FAA Doc:	14CFR reference: 23.721 & 25.721 cover fuel spillage	*EASA CS Reference:*	CS 23.561 CS 23.721 CS 25.561 CS 25.721 CS 27.561 CS 29.561

8.5.3.1.1 The safe operation of the aeroplane shall be preserved in case of damaging effects on systems or structures from:

a. Tyre debris;

b. Tyre burst damage;

c. Flailing tyre strip;

d. Wheel flange debris

Consideration shall be given to provide protection against the effects of:

a. Tyre debris;

b. Tyre burst damage;

c. Flailing tyre strip;

d. Wheel flange debris.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	

Information Sources			
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.734

8.5.3.2 The landing gear shall be designed so the shock absorbing mechanism allows for safe ground operations, takeoff and landing conditions.

This includes:

a. Ensuring sufficient energy absorption and dissipation is achieved during landing;

b. Adequate support is provided for the structure of the air vehicle during ground manoeuvring;

c. Suitable suspension is provided for the air vehicle to allow for passenger comfort;

d. Ensuring the shock absorbing mechanism does not bottom out.

Consideration should be given to the maximum take-off / landing weight of the air vehicle for all combinations of each of the arbitrary extreme values of miss-service, to be agreed and verified.

Information Sources			
Comm'l Doc:	SAE AS 6053 Tests, Impact, Shock Absorber, Landing Gear, Aircraft (formerly MIL-T-6053)		
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.3.1.8/A.4.4.1.3.1.8 Energy Absorption 3.4.1.3.1.11/4.4.1.3.1.11 Repeated Operation AFGS-87139: 3.2.2.1 General and 3.2.2.2 Shock absorption MIL-L-8552	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.2 00-970 P1 4.11.22 00-970 P1 4.11.42 00-970 P1 4.11.43 00-970 P1 4.11.44
		STANAG Reference:	4671.235 4671.723 4671.725 4671.729
FAA Doc:	14CFR reference: 23.721-23.745, 13.1-13.2.4, 23.1501, 23.1529, 25.721-25.737, 25.1501, 25.1503-25.1533, 25.1529, 25.1541, 25.1543, 25.1557, 25.1563	*EASA CS Reference:*	CS 23.729 CS 23.1501 CS 23.1529 CS 25.1501 CS 25.1503-1533* CS 25.1529 CS 25.1541* CS 25.1543* CS 25.1557* CS 25.1563* CS 27.235 CS 27.729 CS 27.1529 CS 29.235 CS 29.729 CS 29.1529

8.5.3.3 The landing gear shall be design so that miss-servicing does not compromise safety, result in unsafe loading event or cause damage to the air vehicle during takeoff, landing or taxiing operations.

Consideration should be given to:
a. Miss-servicing of the wheels, tyres, shock absorbing mechanism;
b. Levels of miss-serving, to be agreed and verified;
c. Loading events including fuel, weapons, other stores etc.;
d. Sudden and adverse movement of the shock absorbing mechanism.

Information Sources			
Comm'l Doc:	SAE AS 6053 Tests, Impact, Shock Absorber, Landing Gear, Aircraft (formerly MIL-T-6053)		
DoD/MIL Doc:	AFGS-87139: 3.2.1.3 Clearances MIL-L-8552 Landing Gear, Aircraft Shock Absorbers (Air-Oil Type)	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.35 00-970 P1 4.12.9
		STANAG Reference:	4671.729
FAA Doc:	14CFR reference: 13.1-13.2.4, 23.1501, 23.1529, 25.1501, 25.1503-25.1533, 25.1529, 25.1541, 25.1543, 25.1557, 25.1563	*EASA CS Reference:*	CS 23.729 CS 25.729

8.5.3.4 The landing gear shall be designed to allow for safe landing operations (emergency and normal) in all specified landing conditions, at all operating weights. This includes ensuring sufficient energy absorption and dissipation is achieved during landing.

Consideration should be given to:
a. Specified landing conditions, both emergency and normal, to be agreed and verified;
b. Failure events such as flat tyres / roll on rims and bottomed out shock absorbing mechanisms;
c. Regard to crew and passenger comfort, structural integrity, and efficient functioning of equipment, during ground manoeuvring;
d. Maximum air vehicle landing weights to be agreed and verified;
e. External stores and role equipment;
f. Trampling arrester gear pendant wires;
g. All combinations of air vehicle sink rate and landing weight.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.3.1.7/A.4.4.1.3.1.7 Flat tyre and flat strut operation; A.3.4.1.3.1.8/A.4.4.1.3.1.8 Energy absorption; A.3.4.1.3.1.11/A.4.4.1.3.1.11 Repeated operation AFGS-87139: 3.6 Environmental Conditions, 3.2.2.1 General and 3.2.2.2 Shock absorption	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.2 00-970 P1 4.11.7
		STANAG Reference:	4671.473 4671.479 - 4671.485 4671.497 4671.499 4671.723 - 4671.731

Information Sources			
FAA Doc:	14CFR references: 23.721-23.731, 23.473, 23.477, 23.479, 23.481, 23.483, 23.485, 25.721-25.731, 25.101, 25.511, 25.1583	*EASA CS Reference:*	CS 27.737 CS 29.479 - 29.485 CS 29.497 CS 29.501 CS 29.505 CS 29.511 CS 29.521 CS 29.723 - 29.731 CS 29.737 CS 29.757

8.5.3.5 The landing gear shall be designed so that divergent shimmy, or related dynamic instabilities, does not occur at any speeds up to those specified.

Consideration should be given to:

a. The worst possible centre of gravity and loading conditions of the air vehicle;

b. All relevant positions of steerable and castering wheels;

c. Maximum speeds to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2006 3.4.2.7, 4.4.2.7 JSSG-2009 Appendix A: A.3.4.1.1.7/A.4.4.1.1.7 Gear Stability; and A.3.4.1.4.5.1/A.3.4.1.4.5.1 Steering Characteristics. AFGS-87139: 3.2.1.2 Arrangement and 3.2.1.4 Damping.	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.14 00-970 P1 4.11.29 00-970 P7 L301 5.2
		STANAG Reference:	4671.479
FAA Doc:	14CFR reference: 23.721-23.745, 25.721-25.737-shimmy is not covered, the rest of the paragraphs imply coverage	*EASA CS Reference:*	CS 23.729 - 23.745 CS 25.721 CS 25.723 CS 25.729 CS 25.731 CS 25.733 CS 25.735 CS 27.727 CS 27.729 CS 27.731 CS 29.723 CS 29.725 CS 29.727 CS 29.729 CS 29.731

8.5.4. Tyre Load and Speed Rating

8.5.4.1 The landing gear wheels shall have tyres whose load ratings (at specified tyre pressure) are sufficient for all landing and ground operations defined in the air vehicle specification. This includes ensuring the load ratings allow for the most critical combination of air vehicle weight (up to maximum weight) and centre of gravity position.

Consideration should be given to:

a. The most adverse combination of wheel loading which could be caused by variation of the correct tyre pressure (to be specified);

b. From fitting combinations of largest and smallest possible tyres arising from wear and growth;

c. Heat load from the brakes leading to premature tyre failure.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.2.2/A.4.4.1.2.2 Ground handling; A.3.4.1.3.1.4/A.4.4.1.3.1.4 Strength; and A.3.4.1.11.1.1/A.4.4.1.11.1.1 Air vehicle tire performance. AFGS-87139: 3.1.8 Ground handling (operations), 3.2.4.1 Tires MIL-PRF-5041	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.7 00-970 P1 4.11.10 00-970 P1 4.11.11 00-970 P1 4.11.12 00-970 P1 4.11.24 00-970 P1 4.11.35
		STANAG Reference:	4671.473 4671.511 4671.733
FAA Doc:	14CFR reference: 23.473, 23.726, 23.733, 25.473, 25.726, & 25.733	*EASA CS Reference:*	CS 23.473 CS 23.511 CS 23.726 * CS 23.733 CS 25.473 CS 25.499 CS 25.511 CS 25.733 CS 27.497 CS 27.733 CS 29.497 CS 29.511 CS 29.733

8.5.5. Wheel Loadings

8.5.5.1 The landing gear wheels shall be designed to withstand the worse-case loads for all specified ground operations. This includes ensuring sufficient strength for all specified air vehicle gross weight conditions and environmental conditions.

Consideration should be given to:

a. Specified landing conditions (normal and emergency), to be agreed and verified;

b. Environmental conditions, to be agreed and verified;

c. The most critical combination of air vehicle gross weights and flight configurations;

d. The most adverse combination of wheel loading which could be caused by variation of the correct tyre pressure (to be specified);
e. From fitting combinations of largest and smallest possible tyres arising from wear and growth.

Information Sources			
Comm'l Doc:	SAE ARP-1493		
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.2.2/A.4.4.1.2.2 Ground handling; A.3.4.1.3.1.4/A.4.4.1.3.1.4 Strength; A.3.4.1.11.2.1/A.4.4.1.11.2.1 Air vehicle wheel performance; and A.3.4.1.11.2.4/A.4.4.1.11.2.4 Nonfrangibility criteria (flat tire operation) AFGS-87139: 3.1.8 Ground handling (operations) and 3.2.4.2 Wheels MIL-B-8584 MIL-W-5013 Wheel and Brake Assemblies - inactive for new design	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.11 00-970 P1 4.11.12 00-970 P7 L303 5.1
		STANAG Reference:	4671.473 - 4671.511 4671.723 - 4671.733
FAA Doc:	14CFR reference: 23.721-23.732, 25.721-25.732, 23.471-23.511 & 25.471-25.511, 25.101 (see 13.1-13.2.4)	*EASA CS Reference:*	CS 29.473 - 29.511 CS 29.723 - 29.731 CS 29.737 CS 29.753

8.5.6. Wheel overheating / over-pressurisation protection

8.5.6.1 The brake system shall provide a means of preventing wheel or tyre explosion at each braked wheel, caused by high pressure or high temperature brake conditions.

Consideration should be given to:
a. The use of fusible plugs fitted in the braked wheels to relieve the tyre pressure (a minimum of 3 fusible plugs shall be fitted if the temperature of the tyre bead seat, or of any critical pressurised areas of the wheel, reaches a predetermined level during abnormal taxi or braking conditions);
b. A safe method of automatically releasing tyre pressure whenever brake energies exceed maximum landing stop conditions;
c. The chosen device(s) should release tyre pressure before critical failure conditions occur;
d. A means for each brake assembly to indicate when the heat sink is worn to the permissible limit.

Information Sources			
Comm'l Doc:	SAE ARP-1493		
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.11.2.3/A.4.4.1.11.2.3 Brake Overheat Capability; and A.3.4.1.11.2.6/A.3.4.1.11.2.6 Pressure-release criteria; A.3.4.1.11.3.1/A.4.4.1.11.3.1	*Def-Stan 00-970 Reference:*	00-970 P1 4.12.43 00-970 P1 4.12.44 00-970 P7 L310 3.2.6 00-970 P7 L310 3.2.8
		STANAG	4671.735

Information Sources			
	Air vehicle stopping and turn-around performance; and A.3.4.1.11.3.7/A.4.4.1.11.3.7 Temperature interface criteria AFGS-87139: 3.2.4.2.c Wheel overheat capability MIL-W-5013 Wheel and Brake Assemblies - inactive for new design	*Reference:*	
FAA Doc:	14CFR reference: 11.2.2 & 11.2.2.1 Included in each specific 14CFR reference per section	*EASA CS Reference:*	CS 23.735 CS 25.731 CS 25.735

8.5.7. Brake Assemblies

8.5.7.1 The air vehicle braking system shall provide sufficient kinetic energy absorption and braking torque throughout the defined wear range to meet the accelerate-stop distance and braked roll requirements, to be agreed and verified. For commuter aircraft this includes that sufficient rejected takeoff brake kinetic energy absorption is achieved.

Consideration should be given to:

a. The most critical combination of air vehicle landing weight and speed;

b. Design takeoff weight (for rejected takeoff only);

c. Various landing configurations, to be agreed and verified;

d. Varying runway surfaces and conditions (including dry and wet), to be agreed and verified;

e. Stopping distances at sea level and at such other temperatures and altitudes as the air vehicle specification requires;

f. Factors affecting braking including aerodynamic drag, engine thrust, taxiing and previous repeated brake operations.

Arresting cables, barrier nets or other unconventional braking/arresting devices shall not be considered when verifying brake energy absorption.

For rotorcraft, with wheel type landing gear, a braking device shall be installed that is adequate to counteract any normal unbalanced torque when starting or stopping the rotor; and hold the rotorcraft parked on a 10° slope on a dry, smooth pavement.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.11.3.1/A.4.4.1.11.3.1 Air vehicle stopping and turn-around performance. AFGS-87139: 3.2.3.1.a & b Brake system (General) MIL-W-5013 Wheel and Brake Assemblies - inactive for new design	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.6 00-970 P1 4.12.19
		STANAG Reference:	4671.55 4671.493 4671.735
FAA Doc:	14CFR reference: 23.45, 23.55, 23.493, 23.735, 25.45,	*EASA CS*	CS 23.55

Information Sources			
	25.55, 25.493, 25.735, 25.101	*Reference:*	CS 23.493 CS 23.735 CS 25.101* CS 25.493 CS 25.735 CS 27.493 CS 27.735 CS 29.493 CS 29.735

8.5.7.2 The brake system, associated systems and components must be designed and constructed to include sufficient redundancy so that in the event of any reasonably credible combination of failures, it shall be possible to stop the air vehicle within a given distance.

Consideration should be given to:

a. Electrical, pneumatic, hydraulic, or mechanical connecting or transmitting element failure;

b. The use of reserve power supply for power operated systems;

c. The most critical combination of air vehicle landing weight and speed;

d. Various landing configurations, to be agreed and verified;

e. Varying runway surfaces and conditions (including dry and wet), to be agreed and verified.

Information Sources			
Comm'l Doc:	SAE ARP-1493		
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.11.2.4/A.4.4.1.11.2.4 Nonfrangibility criteria (flat tire operation); A.3.4.1.11.3.3/A.4.4.1.11.3.3 Structural failure criteria; and A.3.4.1.11.3.4/A.4.4.1.11.3.4 Secondary braking capability (fail-safe). AFGS-87139: para 3.2.3.1.c Brake system, General and 3.2.4.3 Brakes; MIL-W-5013 Wheel and Brakes - presently inactive for new designs	*Def-Stan 00-970 Reference:*	00-970 P1 4.12.11
		STANAG Reference:	4671.735
FAA Doc:	14CFR reference: 11.2.2.1	*EASA CS Reference:*	CS 23.735 CS 25.735

8.5.7.3 The brake system shall provide sufficient static holding torque to prevent wheel rotation in the most critical combination of runway condition and engine thrust.

Consideration should be given to:

a. The prevention of variations in torque;

b. Asymmetric thrust conditions.

Information Sources			
Comm'l Doc:	SAE ARP-1493		

Information Sources			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.7/A.4.4.1.7 Restraint capability. AFGS-87139: para 3.2.3.1.b Brake System, General, and 3.2.4.3 Brakes; MIL-W-5013 Wheels and Brakes - presently inactive for new designs, MIL-B-8584 Design of Brake Systems	*Def-Stan 00-970 Reference:*	00-970 P1 4.12.6 00-970 P1 4.12.14
		STANAG Reference:	4671.735
FAA Doc:	14CFR references: 23.735, 25.735	*EASA CS Reference:*	CS 23.735 CS 25.735

8.5.7.4 Merged with 8.5.6

Information Sources			
Comm'l Doc:	Merged with 8.5.6		
DoD/MIL Doc:	Merged with 8.5.6	*Def-Stan 00-970 Reference:*	Merged with 8.5.6
		STANAG Reference:	Merged with 8.5.6
FAA Doc:	Merged with 8.5.6	*EASA CS Reference:*	Merged with 8.5.6

8.5.8. Brake control and anti-skid control

8.5.8.1 The air vehicle braking system should have a separate and independent braking capability, sufficient to arrest the air vehicle in safe manner.

Consideration should be given to:

a. The most critical combination of air vehicle landing weight and speed;

b. Various landing configurations, to be agreed and verified;

c. Varying runway surfaces and conditions (including dry and wet), to be agreed and verified.

Information Sources			
Comm'l Doc:	SAE ARP-1070		
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.4.4.2/A.4.4.1.4.4.2 Alternate independent braking; AFGS-87139: para 3.2.3.2.a Brake actuation system and 3.2.4.3 Brakes; MIL-B-8584 Design of Brake Systems;	*Def-Stan 00-970 Reference:*	00-970 P1 4.12.11 00-970 P1 4.12.12 00-970 P13 3.13.2
		STANAG Reference:	
FAA Doc:	14CFR reference: 11.2.2 & 11.2.2.1;	*EASA CS Reference:*	CS 23.75 CS 25.125 CS 25.735

8.5.8.2 The braking control interface shall be designed to allow brake actuation forces to be applied in a smooth and controllable manner and so the braking effect increases or decreases proportionally to the force applied. This includes ensuring there is no appreciable delay between operation of the control and operation of the brakes, and that the latter does not induce any undue tendency for the air vehicle to nose-over. In addition, brakes shall disengage once the braking force applied has been released.

Consideration should be given to:

a. The maximum forces that are likely to be applied to the controls/actuators;

b. Maximum travel and travel for initial braking;

c. Deceleration rate/application force gradient (mean) and tolerance.

d. Application in all normal, abnormal and emergency conditions, to be agreed and verified;

e. Verification by mock-up evaluation, air vehicle taxi and flight testing;

f. Brake pack friction characteristics;

g. Brake temperature.

Information Sources			
Comm'l Doc:	SAE ARP-1070		
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.4.2/A.4.4.1.4.2 Directional Control; and A.3.4.1.4.4.1/A.4.4.1.4.4.1 Braking control interface. AFGS-87139: 3.2.3.1 General, 3.2.3.2 Brake actuation system; 3.2.3.3 Anti-skid brake control; and 3.2.4.3 Brakes MIL-B-8584 Design of Brake Systems	*Def-Stan 00-970 Reference:*	00-970 P1 4.12.10 00-970 P7 L310 2.2 00-970 P7 L310 2.2.4
		STANAG Reference:	4671.231 4671.405 4671.735 4671.1731
FAA Doc:	14CFR reference: inferred in 23.45, 23.55, 23.493, 23.735, 25.45, 25.55, 25.493, 25.735 & 25.101	*EASA CS Reference:*	CS 23.231 CS 23.405 CS 23.735 CS 25.231 CS 25.405 CS 25.735 CS 27.735 CS 29.735

8.5.8.3 If a parking brake is required, it shall be capable of holding the air vehicle against a given force, for a given time period, in stated conditions (to be agreed and verified). For rotorcraft, the parking brake shall also be able to counteract any normal unbalanced torque when starting or stopping the rotor.

Consideration should be given to:

a. Fore and aft forces with or without idling thrust on all engines;

b. The location and protection of the park brake control to prevent inadvertent operation;

c. The provision of an indication in the cockpit when the parking brake is not fully released.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.9.5/4.4.1.9.5 Parking Brake	*Def-Stan 00-970 Reference:*	00-970 P1 4.12.15 00-970 P1 4.12.16 00-970 P1 4.12.17

Information Sources			
	AFGS-87139: 3.2.3.2.d Brake actuation system MIL-B-8584 Design of Brake Systems		00-970 P7 L310 2.3
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.735 CS 29.735

8.5.8.4 The wheel brake system, in conjunction with associated systems, shall provide safe means of operation on all landing surfaces on which the air vehicle is required to operate, together with a means of safely stopping the air vehicle within the required runway length, width, and surface condition. The system shall not be adversely affected by the use of other decelerating aids such as reverse thrust or brake parachute.

Consideration should be given to:

a. When the brakes are new and when they have reached the limit of their allowable wear and adjustment;

b. Various landing configurations, to be agreed and verified;

c. Varying runway surfaces and conditions (including dry and wet), to be agreed and verified;

d. Any fluid lost from the brake hydraulic system following a failure in, or in the vicinity of, the brakes shall be insufficient to cause or support a hazardous fire on the ground or in flight;

e. Ensuring reasonably credible combinations of failures have been identified and their consequences of failure have been eliminated or mitigated;

f. Verification by analysis, laboratory, and air vehicle testing.

For rotorcraft, with wheel type landing gear, a braking device shall be installed that is adequate to counteract any normal unbalanced torque when starting or stopping the rotor.

Information Sources			
Comm'l Doc:	SAE ARP-1070		
DoD/MIL Doc:	JSSG-2009 para 3.2.7.4.4.2/4.2.7.4.4.2 Damage tolerant-fail safe evident subsystems and components; and Appendix A: A.3.4.1.4.3/A.4.4.1.4.3 Emergency directional control, A.3.4.1.4.4.2/A.4.4.1.4.4.2 Alternative independent braking, A.3.4.1.4.4.3/A.4.4.1.4.4.3 Skid control; and A.3.4.1.11.3.1/A.4.4.1.11.3.1 Air vehicle stopping and turn-around performance; AFGS-87139: para 3.2.3.1 General; 3.2.3.2 Brake actuation system; 3.2.3.3 Anti-skid brake control; and 3.2.4.3 Brakes. MIL-B-8584 Design of Brake Systems	*Def-Stan 00-970 Reference:*	00-970 P1 4.12.17 00-970 P1 4.12.18 00-970 P1 4.12.19 00-970 P1 4.12.25 00-970 P1 4.12.26 00-970 P1 4.12.27
		STANAG Reference:	4671.55 4671.75 4671.735

Information Sources			
FAA Doc:	14CFR reference: 11.1-11.2.6, 23.45, 23.55, 23.493, 23.735, 25.187, 25.45, 25.55, 25.493, & 25.735.	*EASA CS Reference:*	CS 25.735 CS 27.75 CS 27.735 CS 29.75 CS 29.735

8.5.8.5 The anti-skid system and associated systems shall be designed so that no reasonably credible combination of failures will result in a unacceptable loss of braking ability or directional control of the air vehicle.

Consideration should be given to:

a. Any electrical, pneumatic, hydraulic, or mechanical connecting or transmitting element failure, or if any single source of hydraulic or other brake operating energy supply is lost;

b. Cross coupling of the anti-skid units to maintain directional control of the air vehicle;

c. Braking and cornering forces, through the control speed range;

d. Varying runway surfaces and conditions (including dry and wet), to be agreed and verified;

e. Verification by computer simulations and the results substantiated by on-air vehicle checkouts and flight testing.

Information Sources			
Comm'l Doc:	SAE ARP-1070		
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.4.4.4/ A.4.4.1.4.4.4 skid control with power interruption; and A.3.4.1.4.4.5/A.4.4.1.4.4.5 anti-skid engagement and disengagement; AFGS-87139: para 3.2.3.3 Anti-skid brake control and 3.2.4.3 Brakes; MIL-B-8584 Design of Brake Systems	*Def-Stan 00-970 Reference:*	00-970 P1 4.12.24 00-970 P1 4.12.25 00-970 P1 4.12.26
		STANAG Reference:	4671.735
FAA Doc:		*EASA CS Reference:*	CS 23.735 CS 25.109 (AMC 25.109(c)(2)) CS 25.735

8.5.8.6 The anti-skid system shall be compatible with the air vehicle and its subsystems and shall operate satisfactorily in the installed environment. The anti-skid system shall prevent tyre flat-spotting, maintain wheel rotation and to never permit a completely locked brake.

Consideration shall be given to:

a. Natural and induced environments, to be agreed and verified;

b. A means of controlling brake pressure such that wheel rotation is maintained within the required performance;

c. Braking and cornering forces, through the control speed range;

d. Varying runway surfaces and conditions (including dry and wet), to be agreed and verified;

e. The effects of heat build-up on the brakes.

f. Inadvertent operation without anti-skid;

g. Verification by computer simulation analysis and air vehicle testing subsequent to final production tuning.

Information Sources			
Comm'l Doc:	SAE ARP-1070		
DoD/MIL Doc:	JSSG-2009 para 3.2.7.2/4.2.7.2 Environment, Appendix A: A.3.4.1.4.4.3/A.4.4.1.4.4.3 Skid Control; AFGS-87139: para 3.2.3.1 General; 3.2.3.2 Brake actuation system; 3.2.3.3 Anti-skid brake control; and 3.2.4.3 Brakes. MIL-B-8584 Design of Brake Systems	*Def-Stan 00-970 Reference:*	00-970 P1 4.12.25 00-970 P1 4.12.26 00-970 P1 4.12.27
		STANAG Reference:	4671.735
FAA Doc:	14CFR reference: 23.45, 23.55, 23.493, 23.735, 25.45, 25.55, 25.493, & 25.735	*EASA CS Reference:*	CS 23.735 CS 25.735

8.5.8.7 Merged with 8.5.8.2

Information Sources			
Comm'l Doc:	Merged with 8.5.8.2		
DoD/MIL Doc:	Merged with 8.5.8.2	*Def-Stan 00-970 Reference:*	Merged with 8.5.8.2
		STANAG Reference:	Merged with 8.5.8.2
FAA Doc:		*EASA CS Reference:*	Merged with 8.5.8.2

8.5.8.8 Merged with 8.5.8.2

Information Sources			
Comm'l Doc:	Merged with 8.5.8.2		
DoD/MIL Doc:	Merged with 8.5.8.2	*Def-Stan 00-970 Reference:*	Merged with 8.5.8.2
		STANAG Reference:	Merged with 8.5.8.2
FAA Doc:		*EASA CS Reference:*	Merged with 8.5.8.2

8.5.8.9 Merged with 8.5.8.4

Information Sources			
Comm'l Doc:	Merged with 8.5.8.4		
DoD/MIL Doc:	Merged with 8.5.8.4	*Def-Stan 00-970 Reference:*	Merged with 8.5.8.4
		STANAG	Merged with 8.5.8.4

Information Sources			
		Reference:	
FAA Doc:	Merged with 8.5.8.4	*EASA CS Reference:*	Merged with 8.5.8.4

8.5.8.10 Merged with 8.5.8.6

Information Sources			
Comm'l Doc:	Merged with 8.5.8.6		
DoD/MIL Doc:	Merged with 8.5.8.6	*Def-Stan 00-970 Reference:*	Merged with 8.5.8.6
		STANAG Reference:	Merged with 8.5.8.6
FAA Doc:		*EASA CS Reference:*	Merged with 8.5.8.6

8.5.8.11 Operation of the anti-skid system shall not induce any dynamic instability, or unacceptable vibration, of any part of the air vehicle during all phases of brake operation. This includes all normal, alternate and emergency braking operations.

Consideration shall be given to:

a. Minimising the fatigue effects on the whole air vehicle;

b. Cross coupling of the anti-skid units to maintain directional control of the aeroplane;

c. Switching between braking systems;

d. Verification by computer simulations and the results substantiated by on-air vehicle checkouts and flight testing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: para 3.4.2.7 Dynamic response during ground/ship-based operations and 4.4.2 Ground loading conditions; JSSG-2009 Appendix A: A.3.4.1.4.4.3/A.4.4.1.4.4.3 Skid Control; AFGS-87139: para 3.2.1.4 Damping and 3.2.3.3 Anti-skid brake control.	*Def-Stan 00-970 Reference:*	00-970 P1 4.12.26 00-970 P1 4.12.29
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.5.9. Directional control.

8.5.9.1 The air vehicle shall have a means of providing directional control from the landing gear, which will permit the air crew to manoeuvre the air vehicle during ground operations. A secondary and / or emergency directional control system shall also be provided which will allow the air vehicle to maintain directional control in an emergency.

Consideration should be given to:

a. Crosswind speed, to be agreed and verified;

b. Ground manoeuvres, to be agreed and verified;

c. Use of differential braking.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.4.2/A.4.4.1.4.2 Directional control; and A.3.4.1.4.3/A.4.4.1.4.3 Emergency directional control AFGS-87139: 3.2.5.1 General; 3.2.5.2 Nose gear steering system MIL-S-8812	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.5 00-970 P1 4.11.24 00-970 P1 4.11.27 00-970 P1 4.14.13 00-970 P7 L302/1 3.1
		STANAG Reference:	4671.233 4571 745
FAA Doc:	14CFR reference: 23.45, 23.497, 23.499, & 23.745	*EASA CS Reference:*	CS 23.233 CS 23.745 CS 25.233 CS 25.745

8.5.9.2 The air vehicle steering control system shall be designed to protect against steering failure of the nose / tail wheel steering control, so no reasonably credible combination of failures, including hydraulic or electrical power, shall cause the air vehicle to lose control and / or depart the runway. This includes detecting, correcting and preventing steering hardovers.

Consideration should be given to:

a. Interference with the required motion of the rudder pedals or with any part of the flying controls;

b. Unacceptable oscillation or vibration;

c. Turning of the wheels about the steering axis when the nose wheel unit is retracting or retracted;

d. Verification by analysis, computer simulations, systems checkout and demonstration;

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.4.5.2/A.4.4.1.4.5.2 Response to nose wheel steering failure; and A.3.4.1.4.5.3/A.4.4.1.4.5.3 Emergency steering AFGS-87139: 3.2.5.1 General, 3.2.5.2 Nose gear steering system MIL-S-8812	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.30 00-970 P1 4.14.6 00-970 P1 4.14.9 00-970 P1 4.14.13
		STANAG Reference:	4671.745
FAA Doc:		*EASA CS Reference:*	CS 23.745 CS 25.745 CS 25.1309

8.5.9.3 Engaging or disengaging the nose / tail wheel steering system shall not adversely affect the directional control of the air vehicle, such that directional headings are maintained for all specified manoeuvres and speeds.

Consideration should be given to:

a. Crosswind speed, to be agreed and verified;
b. Ground manoeuvres, to be agreed and verified;
c. All ground speeds up to the maximum speed at which the nose-wheel can remain in contact with the ground;
d. Exceptional pilot skill should not be required during takeoff and landing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.4.5.1/A.4.4.1.4.5.1 Steering Characteristics MIL-S-8812 AFGS-87139: 3.2.5.1 General and 3.2.5.2 Nose gear steering system.	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.27 00-970 P1 4.11.28 00-970 P1 4.14.8 00-970 P1 4.14.9 00-970 P1 4.14.10
		STANAG Reference:	4671.745
FAA Doc:		*EASA CS Reference:*	CS 23.745 CS 23.1309 CS 25.745 CS 25.1309 CS 27.1309 CS 29.1309

8.5.9.4 Merged with 8.5.9.2

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.4.5.2/A.4.4.1.4.5.2 Response to nose wheel steering failure MIL-S-8812	*Def-Stan 00-970 Reference:*	Merged with 8.5.9.2
		STANAG Reference:	Merged with 8.5.9.2
FAA Doc:		*EASA CS Reference:*	Merged with 8.5.9.2

8.5.9.5 The steering system shall be designed to meet the required steering characteristics to enable the air vehicle to perform all specified ground manoeuvring and parking operations, during taxiing, take-off and landing.

Consideration should be given to:
a. Steering characteristics, to be agreed and verified;
b. Crosswind speed, to be agreed and verified;
c. Ground manoeuvres, to be agreed and verified;
d. The most adverse combinations of mass and CofG;
e. Braking devices;
f. In the event of an engine failure;
g. Sensitivity to high-speed, ground rolling effects.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A:	*Def-Stan 00-970*	00-970 P1 4.11.24

Information Sources			
	A.3.4.1.4.5.1/A.4.4.1.4.5.1 Steering Characteristics MIL-S-8812	*Reference:*	00-970 P1 4.11.25 00-970 P1 4.11.26 00-970 P1 4.11.27 00-970 P1 4.14.2 00-970 P1 4.14.3 00-970 P1 4.14.5 00-970 P1 4.14.14 00-970 P1 4.14.16
		STANAG Reference:	4671.497 4671.499 4671.745
FAA Doc:	14CFR reference: 23.45, 23.497, 23.499, 23.745, 25.233, 25.45, 25.497, 25.499, & 25.745	*EASA CS Reference:*	CS 23.45 CS 23.497 CS 23.499 CS 23.745 CS 25.45 CS 25.495 CS 25.497 CS 25.499 CS 25.745 CS 27.497 CS 29.497

8.5.10. Landing gear actuation control.

8.5.10.1 Merged with 8.5.2.3

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.1.3/A.4.4.1.1.3 Extended clearances; A.3.4.1.1.4/A.4.4.1.1.4 Retraction Clearances; and A.3.4.1.5.1/A.4.4.1.5.1 Retraction and extension actuation interface AFGS-87139: 3.2.6.1 Retraction-extension system and 3.2.6.2 Actuation system indication	*Def-Stan 00-970 Reference:*	Merged with 8.5.2.3
		STANAG Reference:	Merged with 8.5.2.3
FAA Doc:	14CFR reference: 23.729 & 25.729	*EASA CS Reference:*	Merged with 8.5.2.3

8.5.10.2 Retractable landing gear shall be designed with an emergency means of extension in the event of any reasonably credible combination of failures in the normal retraction system failure.

This includes:

• Failure of any single source of hydraulic, electric, or equivalent energy supply;

• Loss of any landing gear fairing door;

• Reversal of commands, such that the later selection shall override the former and the undercarriage shall obey the revised command.

Consideration should be given to:

a. The reliability of the final actuator. The necessity to duplicate this operation shall be agreed by the air vehicle Authority;

b. The doors are loaded to represent the most adverse suction loads occurring at the same time;

c. The fact that air vehicle with multiple landing gears may be able to land with one landing gear retracted;

d. The most adverse deflections in the structure occurring at any time during flight;

e. Verification by air load analysis, simulator testing and flight testing;

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.5.3/A.4.4.1.5.3 Single failure criteria; A.3.4.1.5.4/A.4.4.1.5.4 Actuation reversal; A.3.4.1.5.6/A.4.4.1.5.6 Operation with loss of door; and A.3.4.1.5.7/A.4.4.1.5.7 Emergency extension AFGS-87139: 3.2.6.1 Retraction-extension system; and 3.2.6.2 Actuation system indication	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.56 00-970 P1 4.11.60
		STANAG Reference:	4671.729
FAA Doc:	14CFR reference: 23.729 & 25.729	*EASA CS Reference:*	CS 23.729 CS 25.729 CS 27.729 CS 29.729

8.5.10.3 If a retractable landing gear is used, a means to visually indicate the landing gear position (as well as necessary switches / devices to actuate the indicator), shall be provided to the flight crew. This includes a means to indicate that the landing gear and their associated doors are secured in the extended (or retracted) position.

Consideration should be given to:

a. The type of position indicators, to be agreed and verified;

b. Standard lighting configurations, to be agreed and verified;

c. The location of switches / devices used to actuate the indicators.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.5.8.1/A.4.4.1.5.8.1 Gear position status indicators; and A.3.4.1.5.4/A.4.4.1.5.4 Actuation reversal AFGS-87139: 3.2.6.1 Retraction-extension system; and 3.2.6.2 Actuation system indication	*Def-Stan 00-970 Reference:*	00-970 P1 4.19.16
		STANAG Reference:	4671.729 4671.1793
FAA Doc:	14CFR reference: 23.729 &	*EASA CS*	CS 23.729

Information Sources			
	25.729	*Reference:*	CS 25.729 (AMC 25.729(c)) CS 27.729 CS 29.729

8.5.10.4 If a retractable landing gear is used, a warning device shall be provided to inform the flight crew of an imminent landing without the gear fully extended and locked.

For systems with both visual and aural warnings, there should be provisions for temporarily suppressing the aural warning.

Consideration should be given to:
a. An aural or equally effective landing gear warning device;
b. A device which functions continuously, or is periodically repeated;
c. A cut-out device to prevent operation of the device at altitudes, to be agreed and verified;
d. The warning must be given in sufficient time to allow the landing gear to be locked down or a go-around to be made;
e. The position of the indicator so it is easily visible to the pilot / flight crew.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.5.8.1/A.4.4.1.5.8.1 Gear position status indication AFGS-87139: 3.2.6.1 Retraction-extension system; and 3.2.6.2 Actuation system indication	*Def-Stan 00-970 Reference:*	00-970 P1 4.19.16
		STANAG Reference:	4671.1793
FAA Doc:	14CFR reference: 23.729 & 25.729	*EASA CS Reference:*	CS 23.729 CS 25.729 (AMC 25.729(c)) CS 25.1322 CS 27.729 CS 29.729

8.5.10.5 Retractable landing gear shall extend / retract within the maximum time limits at all airspeeds required for takeoff, landing and go-around.

Consideration should be given to:
a. Maximum extension time limits, to be agreed and verified (typically between 10 and 15 seconds);
b. Maximum retraction time limits, to be agreed and verified (typically between 5 and 10 seconds);
c. Maximum design limit speeds with landing gear down and minimum approach speed;
d. The most adverse combinations of attitude, acceleration, atmospheric conditions, and engine power applicable.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.5.5.1/A.4.4.1.5.5.1	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.53 00-970 P1 4.11.54

Information Sources			
	Retraction; and A.3.4.1.5.5.2/A.4.4.1.5.5.2 Extension AFGS-87139: 3.2.6.3 Retraction-extension time		00-970 P1 L54
		STANAG Reference:	
FAA Doc:	14CFR references: 23.729, 25.729, 25.1515, 25.1583	*EASA CS Reference:*	CS 25.1515 CS 25.1583

8.5.10.6 Emergency landing gear extension shall be within the maximum time limits required for emergency landing.

Consideration should be given to:

a. Maximum extension / retraction time limits, to be agreed and verified;

b. Maximum design limit speeds with landing gear down and minimum approach speed;

c. The most adverse combinations of attitude, acceleration, atmospheric conditions, and engine power applicable.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.5.7/A.4.4.1.5.7 Emergency extension AFGS-87139: 3.2.6.3 Retraction-extension time	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.54 00-970 P1 L54
		STANAG Reference:	
FAA Doc:	14CFR reference: 23.729, 25.729, 25.1515, 25.1583	*EASA CS Reference:*	CS 25.1515 CS 25.1583

8.5.10.7 Retractable landing gear shall provide a positive means (without the use of hydraulic pressure) to lock the landing gear in the final selected position (both for safe landing and retracted positions), under all appropriate flight conditions, to be agreed and verified.

Consideration should be given to:

a. Whether it can be shown that lowering of the landing gear or doors, or flight with the landing gear or doors extended, at any speed, is not hazardous;

b. Whether the operating mechanism is irreversible;

c. The fact that air vehicle with multiple landing gears may be able to land with one landing gear retracted.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.5.9.1/A.4.4.1.5.9.1 Gear position restraint and A.3.4.1.5.1/A.4.4.1.5.1 Retraction and extension actuation interface AFGS-87139: 3.2.6.4 Position restraint	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.65 00-970 P7 L306 4.1 00-970 P7 L306 4.2
		STANAG Reference:	4671.729(b)
FAA Doc:	14CFR reference: 23.729, 25.729	*EASA CS Reference:*	CS 23.729(b) CS 25.729(b)

Information Sources			
			CS 27.729(b) CS 29.729(b)

8.5.10.8 Retractable landing gear shall provide a positive secondary means (ground retention device) to prevent unintentional retraction during ground operations, to be agreed and verified and during air vehicle servicing or repair. If power is supplied to retract the landing gear with a ground retention device left in place, this shall not result in damage to the air vehicle or landing gear structure.

Consideration should be given to:

a. The provision of visual indicators to ensure the ground retention devices are removed prior to flight;

b. Ground operations, to be agreed and verified;

c. All expected ground conditions, to be agreed and verified;

d. Verification of the effectiveness and adequacy of the ground retention device during flight test.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.5.9.1/A.4.4.1.5.9.1 Gear position restraint and A.3.4.1.5.1/A.4.4.1.5.1 Retraction and extension actuation interface AFGS-87139: 3.2.6.4 Position restraint	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.66 00-970 P7 L306 4.3 00-970 P7 L306 4.4
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.5.10.9 Merged with 8.5.10.8

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.5.10/A.4.4.1.5.10 Ground safety restraint; and A.3.4.1.5.1/A.4.4.1.5.1 Retraction and extension actuation interface AFGS-87139: 3.2.6.4 Position restraint	*Def-Stan 00-970 Reference:*	Merged with 8.5.10.8
		STANAG Reference:	Merged with 8.5.10.8
FAA Doc:		*EASA CS Reference:*	Merged with 8.5.10.8

8.5.10.10 For retractable landing gear, no reasonably credible combination of failures shall lead to unacceptable landing gear operations.

This includes:

• Both extension and retraction, and;

• All phases of operation such as unlocking, translation and locking;

• Failure or jamming of doors and lock mechanisms.

Consideration should be given to:

a. The fact that air vehicle with multiple landing gears may be able to land with one landing gear retracted;
b. The most adverse deflections in the structure occurring at any time during flight;
c. The door is loaded to represent the most adverse suction loads occurring at the same time;
d. Verification to eliminate single point failures by inspection of drawing, design logic and schematics;
e. Extension with failures induced, verified by demonstration;

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.2.7.4.4.2/4.2.7.4.4.2 Damage tolerant-fail safe evident subsystems and components; and Appendix A: A.3.4.1.5.3/A.4.4.1.5.3 Single failure criteria AFGS-87139: 3.2.6.1 Retraction-extension system and 3.2.6.2 Actuation system indication	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.72
		STANAG Reference:	4671.729
FAA Doc:	14CFR reference: 23.729, 25.729	*EASA CS Reference:*	CS 23.729 CS 25.729 CS 27.729 CS 29.729

8.5.11. Auxiliary deceleration devices.

8.5.11.1 If provided, the arresting hook system shall be designed to decelerate the air vehicle to a stop, for all-landing configurations and attitudes, under specified conditions as defined in the air vehicle specification. This may include: refused take-offs (RTOs), fly-in engagements, brake overruns, etc. During operation, the arresting hook system shall cause no more than minor superficial damage to the air vehicle and / or minimal structural damage to removable parts of the arresting hook and its suspension system.

Consideration should be given to:
a. The effects of crosswind speed, to be agreed and verified;
b. The most critical combination of air vehicle landing weight, speed, CofG, to be agreed and verified;
c. Nose wheel bounce and reaction;
d. The shape of the hook shall be optimised for the arresting gear having the largest diameter hook cable;
e. The strength of the installation shall be determined by the arresting gear giving the greatest hook load;
f. The effects of vibration on the suspension arm caused by impact with the runway;
g. The most adverse air vehicle pitch angle and suspension arm angle.

For UAVs, any on-board Landing Energy Absorber System (LEAS) shall be such as to control the release of absorbed energy to avoid unnecessary damage to the UAV.

Information Sources			
Comm'l Doc:	SAE ARP-1538		
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.8.1.1 thru A.3.4.1.8.1.8/A.4.4.1.8.1.1 thru A.4.4.1.8.1.8 Hook/Arresting	*Def-Stan 00-970 Reference:*	00-970 P1 2.3.21 00-970 P1 2.4.3 00-970 P1 2.5.22 00-970 P1 4.11.24

Information Sources			
	system information MIL-A-18717 MIL-A-83136		00-970 P1 4.11.26 00-970 P1 4.11.35 00-970 P1 L46 3.5.7 00-970 P13 3.6.7 00-970 P13 3.6.8 00-970 P13 3.6.20 00-970 P13 3.6.24 00-970 P13 3.6.25 00-970 P13 3.6.26 00-970 P13 S4 L10 00-970 P9 UK471a 00-970 P9 UK471d
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.5.11.2 The arresting hook system shall provide sufficient hook hold-down force and damping to prevent the hook skipping over the arresting cable, for all landing configurations and attitudes. This includes ensuring the length of the arresting hook suspension arm shall be adequate for all expected engagements.

Consideration should be given to:

a. Limits on off-centre and alignment at engagement, to be agreed and verified;

b. Probability of successful engagement, to be agreed and verified;

c. The most critical combination of air vehicle landing weight, speed, CofG;

d. The most adverse air vehicle pitch angle and suspension arm angle.

Information Sources			
Comm'l Doc:	SAE ARP-1538		
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.8.1.1 thru A.3.4.1.8.1.8/A.4.4.1.8.1.1 thru A.4.4.1.8.1.8 Hook/Arresting system information MIL-A-18717 MIL-A-83136 AFGS-87139: 3.2.7.1 Arresting hook system	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.35 00-970 P1 S4 L41 00-970 P1 S4 L46 00-970 P13 3.6.7 00-970 P13 3.6.8 00-970 P13 3.6.10 00-970 P13 3.6.13 00-970 P13 3.6.20 00-970 P13 3.6.24 00-970 P13 3.6.25 00-970 P13 3.6.26 00-970 P13 S4 L10 00-970 P9 UK471a 00-970 P9 UK471d
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.5.11.3 If an arresting hook is fitted, it shall be possible to lower the hook within time limits, to be agreed and verified. An indication shall also be provided to inform the flight crew of the hook position. This includes indication to show:

• Whether the hook is extended or retracted;

• Whether proper engagement of the uplock has been achieved;

• Whenever the hook position is inconsistent with the control position.

Consideration should be given to:

a. Varying time limits for in-flight and taxiing;

b. The placement of the release handle to ensure it is not in close proximity to the parking brake control handle.

Information Sources			
Comm'l Doc:	SAE ARP-1538		
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.8.5 thru A.3.4.1.8.8/A.4.4.1.8.5 thru A.4.4.1.8.8 MIL-A-18717 MIL-A-83136 AFGS-87139: 3.2.7.1 Arresting hook system.	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.35 00-970 P1 S4 L41 00-970 P13 3.6.12 00-970 P13 3.6.14 00-970 P13 S4 L10
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.5.11.4 The landing gear shall be arranged so that no part of the air vehicle structure, landing gear or stores snags the arresting cable (except that intended to such as arresting hook). This includes ensuring sufficient clearance of all configurations of external stores, weapons, engines, aerials and propellers. Where impact cannot be avoided the design shall be such that the damage to the hook cable and to the air vehicle will not affect their safety or operational efficiency.

Consideration should be given to:

a. Diameter of the landing gear wheels;

b. Failure events such as deflated / burst tyres;

c. Any projections in front of the wheels;

d. The most adverse configuration of stores;

e. Traversing an arresting cable at all speeds up to maximum take-off speed;

f. Provision of suitable guards;

g. The imposition of operational limitations such as the prohibition of formation take-off, limitation of trampling speed, restrictions on aeroplane loading configurations and restrictions on landing areas;

h. Trampling tests to verify the required clearance, and / or confirm whether parts of the air vehicle will be struck by the arresting cable.

Information Sources			
Comm'l Doc:	SAE ARP-1538		
DoD/MIL Doc:	MIL-A-18717 MIL-A-83136 AFGS-87139: 3.2.7.1 Arresting hook system.	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.33 00-970 P1 4.13.7 00-970 P1 4.13.8 00-970 P1 S4 L43 00-970 P1 S4 L60 00-970 P1 6.1.18

Information Sources			
			00-970 P13 S4 L10 00-970 P7 S1 L300 2.1 00-970 P7 S1 L302/2 8.1
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.5.11.5 The drag parachute installation and attachments shall be designed to meet the operational requirements, to be agreed and verified, without causing excessive loads or damage to the air vehicle, in all anticipated environmental conditions.

This includes:

• The time to fully inflate / achieve operational readiness of the parachute;

• Drag performance of the parachute;

• Compatibility of the control for streaming and jettison of the parachute.

Consideration should be given to:

a. The position of the parachute;

b. Crosswind limits, to be agreed and verified;

c. Operation in rain, snow and ice, and after prolonged flying at low temperature conditions;

d. The provision of a device to ensure there is no possibility of the parachute and cable remaining attached to the air vehicle if streaming occurs before the pilot's control is operated;

e. Parachute instability;

f. Varying loads under normal and emergency landing conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.8.2/A.4.4.1.8.2 Drag Chutes; and AFGS-87139 3.2.7.2 Drag Chutes.	*Def-Stan 00-970 Reference:*	00-970 P1 2.3.21 00-970 P1 2.4.3 00-970 P1 2.5.22 00-970 P1 4.11.24 00-970 P1 4.11.26 00-970 P1 4.11.35 00-970 L42 4.6 00-970 L46 3.5.7 00-970 P13 3.13.2 00-970 P13 3.13.3 00-970 P13 3.13.5-3.13.7 00-970 P13 3.13.9-3.13.11 00-970 P13 3.13.14 00-970 P13 3.13.15 00-970 P9 UK471a 00-970 P9 UK471d
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.5.11.6 Auxiliary deceleration systems shall be designed to meet the operational requirements, to be agreed and verified. Systems shall also be designed so that no unsafe condition or adverse loadings will result during normal operation of the system, or from any failure (or likely combination of failures) of the deceleration system, under any operating condition including ground operation.

Consideration should be given to:

a. The use of auxiliary deceleration devices alone or in combination with other deceleration devices;

b. The adequacy of directional control and pilot comfort over rough surfaces;

c. The effects of crosswind speed, to be agreed and verified;

d. Ensuring exceptional skill is not required to control the aeroplane whilst using the deceleration device;

e. Ensuring engine limitations approved for reverse thrust shall not be exceeded;

f. Position of the control for the auxiliary deceleration system.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	AFGS-87139: 3.2.7.1 Arresting hook system; and 3.2.7.2 Drag chutes.	*Def-Stan 00-970 Reference:*	00-970 P1 2.3.21 00-970 P1 2.4.3 00-970 P1 2.5.22 00-970 P1 4.11.24 00-970 P1 4.11.26 00-970 P1 4.11.35 00-970 P1 L46 3.5.7 00-970 P1 5.1.53 00-970 P1 5.1.54 00-970 P1 5.1.55 00-970 P1 5.1.138 00-970 P9 UK471a 00-970 P9 UK471d
		STANAG Reference:	4671.933
FAA Doc:		*EASA CS Reference:*	CS 23.933 CS 23.934 CS 23.1155 CS 25.109 CS 25.125 CS 25.507 CS 25.933 CS 25.934 CS 25.1155 CS 29.62

8.5.12. Ground handling.

8.5.12.1 The air vehicle jacking points shall be designed and positioned to enable the air vehicle to be raised sufficiently and safely, in order to undertake maintenance activities to the landing gear. This includes ensuring sufficient strength and stability, to allow for the vertical and horizontal loads, for all specified air vehicle gross weight conditions and environmental conditions.

Consideration should be given to:

a. The most critical combinations of aeroplane weight and centre of gravity;

b. Stability in any operational configuration and carrying any authorised combination of stores;

c. Vertical and horizontal load limits, to be agreed and verified;

d. Allowing for some ground slope and some abnormal air vehicle attitudes, to be agreed and verified;

e. Ensuring the jacking points are clearly marked to the appropriate standard;

f. Horizontal loads present at the jacking points in the following conditions:

i. On land at the conditions stated in the requirement and at such greater angles but lesser masses as may be appropriate to effect crash recovery;

ii. At sea in the sea conditions given in the air vehicle specification;

iii. Crosswinds, limits to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.2.2.1.1/A.4.4.1.2.2.1.1 Axle jacking; and A.3.4.1.2.2.1.2/A.4.4.1.2.2.1.2 Fuselage jacking AFGS-87139: 3.2.8.1 Jacking NATO STANAG 3098	*Def-Stan 00-970 Reference:*	00-970 P1 3.11.3 00-970 P1 4.4.11-4.4.16 00-970 P7 L308 S3 05-18
		STANAG Reference:	3098 4671.507
FAA Doc:	14CFR reference: 23.507	*EASA CS Reference:*	CS 23.507 CS 25.519(b)

8.5.12.2 The jacking interface shall meet the requirements of the appropriate standards, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	NATO STANAG 3098 AFGS-87139: 3.2.8.1 Jacking	*Def-Stan 00-970 Reference:*	00-970 P1 3.11.3 00-970 P1 4.4.12-4.4.16 00-970 P7 L308 S3 17-3
		STANAG Reference:	3098 4671.507
FAA Doc:	14CFR reference: 23.507, 25.519	*EASA CS Reference:*	CS 23.507 CS 25.519(b)

8.5.12.3 The air vehicle landing gear towing interface shall be designed and positioned to enable the air vehicle to be towed / pushed safely, in all specified directions / inclines. This includes ensuring sufficient strength to allow for the most severe towing loads, for all specified air vehicle gross weight conditions, environmental conditions and over the roughest ground that may reasonably be expected in normal operation.

Consideration should be given to:

a. Towing load limits to be agreed and verified;

b. Specified towing equipment to be agreed and verified;

c. The use of towing arms / tow bars, and with the exception of those for use on aircraft carriers, embodiment of a load limiting device to prevent the load transmitted to the air vehicle from causing structural damage;

d. Inertia forces as needed to balance the air vehicle;

e. The most adverse environmental conditions, to be agreed and verified;

f. Ensuring all towing points are readily accessible to ground personnel and are marked to the appropriate standard;

g. Ensuring dimensions of towing fittings meet the appropriate standards;
h. Compatibility with the nose gear steering system such as to prevent damage;
i. Provision to enable the air vehicle to be towed in an emergency.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	NATO STANAG 3278 NATO STANAG 4101 MIL-STD-805 JSSG-2009 Appendix A: A.3.4.1.2.2.1.3/A.4.4.1.2.2.1.3 Landing gear towing; A.3.4.1.2.2.1.5/A.4.4.1.2.2.1.5 Towing interface AFGS-87139: 3.2.8.2 Towing	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P1 3.11.4-3.11.7 00-970 P1 4.4.21-4.4.23 00-970 P7 L308 S4 00-970 P7 L308/1 S2.1 3278 4101 4671.509
FAA Doc:	14CFR reference: 23.509 & 25.509	*EASA CS Reference:*	CS 23.509 CS 25.509 CS 25.745

8.5.12.4 The air vehicle landing gear shall have a provision to enable the air vehicle to be towed in an emergency. This includes ensuring sufficient strength to allow for the most severe towing loads, for all specified air vehicle gross weight conditions, environmental conditions and over the roughest ground that may reasonably be expected.

Consideration should be given to:
a. Verification by demonstration on the air vehicle during the ground test program, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.2.2.1.4/A.4.4.1.2.2.1.4 Emergency towing AFGS-87139: 3.2.8.2 Towing	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P1 3.11.4-3.11.7 00-970 P1 4.4.21-4.4.23 00-970 P7 L308 S4 00-970 P7 L308/1 S2.1 4671.509
FAA Doc:	14CFR reference: 23.509 & 25.519	*EASA CS Reference:*	CS 23.509 CS 25.509 CS 25.745

8.5.12.5 Air vehicle mooring provisions shall allow the air vehicle to meet the appropriate standards to ensure safety. This includes ensuring sufficient strength to withstand mooring loads for all specified air vehicle gross weight conditions and environmental conditions.

Consideration should be given to:
a. Wind speeds, to be agreed and verified (typically between 65 and 80 knots);
b. The number of mooring points required;
c. Different mooring patterns, attachment details and mooring methods;

d. Mooring the air vehicle on land and on board ships;

e. The need for securing jacked or trestled aeroplanes in adverse wind and sea conditions;

f. The need to perform undercarriage retraction tests whilst moored.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.2.2.1.6/A.4.4.1.2.2.1.6 Mooring provisions AFGS-87139: 3.2.8.3. Mooring	*Def-Stan 00-970 Reference:*	00-970 P1 3.12.2-3.12.5 00-970 P1 3.12.10
		STANAG Reference:	4671.415
FAA Doc:	14CFR reference: 25.519, 23.519	*EASA CS Reference:*	CS 23.415 CS 25.519

8.5.12.6 Specified requirements and functional characteristics of specialised subsystems shall facilitate safe landing, takeoff and taxiing. This includes, but is not limited to skis, skids, kneeling and floatation gear.

Considerations shall be given to:

a. Specified requirements and characteristics to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.10.1 thru A.3.4.1.10.2/A.4.4.1.10.1 thru A.4.4.1.10.2 Flotation and snow ski gear AFGS-87139: 3.2.9.1 General	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.24
		STANAG Reference:	4671.477-481 4671.497
FAA Doc:	14CFR reference: 23.737, 25.737	*EASA CS Reference:*	CS 23.505 CS 23.737 CS 23.751 CS 25.1309 CS 27.505 CS 27.737 CS 27.751 CS 29.505 CS 29.737 CS 29.751

8.5.12.7 Subsumed by 14.2.3

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.2.7.4.4.1/4.2.7.4.4.1 Safety and mission critical functions; and Appendix A: A.3.4.1.3.1.3/A.4.4.1.3.1.3 Failure tolerance AFGS-87139: 3.5 System safety	*Def-Stan 00-970 Reference:*	Subsumed by 14.2.3
		STANAG Reference:	Subsumed by 14.2.3

Information Sources			
FAA Doc:	14CFR reference: 23.471-23.511, 25.471-25.519, 25.1309	*EASA CS Reference:*	Subsumed by 14.2.3

8.5.12.8 The landing gear shall be arranged to ensure the air vehicle does not turnover or ground loop for all specified operating conditions.

Consideration should be given to:

a. The most adverse combination of mass and C of G;

b. Failure events such as deflated tyres and total collapse of the shock-absorbers;

c. All configurations of external stores;

d. Specified operating conditions to be agreed and verified;

e. Crowned and adversely sloped taxiways and runways.

f. Crosswind speed to be agreed and verified;

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.1.1/A.4.4.1.1.1 Gear Arrangement; and A.3.4.1.1.2/A.4.4.1.1.2 Pitch Stability AFGS-87139: 3.2.1.2 Arrangement	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.25 00-970 P1 4.11.26
		STANAG Reference:	4671.485
FAA Doc:	14CFR reference: 23.473, 23.477, 23.485, 25.473, 25.477, 25.485	*EASA CS Reference:*	CS 23.485 CS 25.485 CS 27.485 CS 29.485

8.5.12.9 The landing gear shall be arranged such as to prevent possible Foreign Object Damage (FOD) to the engines or auxiliary power unit during takeoff, landing and taxiing.

Consideration should be given to:

a. The relative position of the engine inlets / auxiliary power unit inlet and the landing gear;

b. Additional protection of the engine inlets / auxiliary power unit inlet;

c. Means of demonstration / analysis to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.2.3/A.4.4.1.2.3 Ground FOD AFGS-87139: 3.2.1.1 General, 3.2.1.2 Arrangement; and 3.2.1.3 Clearances.	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.9
		STANAG Reference:	4671.1091
FAA Doc:		*EASA CS Reference:*	CS 23.1091 CS 25.1091 CS 27.1091 CS 29.1091

8.5.12.10 The landing gear systems shall be compatible with the air vehicle structure, weight, balance and interfacing subsystems. This includes ensuring the arrangement, location and interface supports the air vehicle at all specified loading conditions, for all specified operating conditions, within specified environmental conditions.

Consideration should be given to:

a. The most adverse combination of C of G and gross weight;

b. Environmental conditions, to be agreed and verified;

c. Specified operating conditions, to be agreed and verified;

d. Specified loading conditions, to be agreed and verified;

e. Loads from operation over the roughest ground that may reasonably be expected in normal operation;

f. Brake torque characteristics,

g. The brake metering system and its components,

h. Hydraulic flow requirements,

i. Air vehicle and landing dynamic characteristics, including shock absorber, brake, and tyre dynamics;

j. Total aeroplane stopping performance requirements;

k. Relevant characteristics of the tyres;

l. The air vehicle electrical and electronic systems;

m. Air vehicle interface requirements to be agreed and verified.

Information Sources			
Comm'l Doc:	Level II Interface and Functional Requirements as stated in contractual interface documentation.		
DoD/MIL Doc:	AFGS-87139: 3.2.1.1 General; 3.2.1.2 Arrangement; and 3.2.1.3 Clearances.	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.2 00-970 P1 4.12.6
		STANAG Reference:	4671.23-4671.29
FAA Doc:	14CFR reference: 23.471-23.511, 25.471-25.519	*EASA CS Reference:*	CS 23.23-23.29 CS 25.23-25.29 CS 27.25 CS 27.27 CS 29.25 CS 29.27

8.5.12.11 The integrity of all landing gear systems and components shall ensure they are not adversely affected by single-point failures, dormant failures, or primary system loss, such as to prevent the air vehicle from safely landing or stopping within the specified landing distance. This includes ensuring that the consequences of the failure are eliminated, mitigated, or evaluated to be at a risk level acceptable to the procuring activity.

Consideration should be given to:

a. Integrity of the structure, braking, steering control and retraction / extension systems;

b. The inclusion of sufficient redundancy within the given systems;

c. The use of reserve power supply for power operated systems;

d. Any reasonably credible combination of failures in externally provided power or governing control logic (for example electrical, hydraulic, etc.);

e. Any reasonably credible combination of failures in interfacing systems;

f. Acceptable levels of risk, to be agreed and verified.

Information Sources			
Comm'l Doc:	Level II single point/redundancy requirements.		
DoD/MIL Doc:	JSSG-2009: 3.2.7 - 3.2.7.6.5, 4.2.7 - 4.2.7.6.5	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.62
		STANAG Reference:	4671.1309
FAA Doc:	TSO C77b	*EASA CS Reference:*	CS 23.1309 CS 23.1309 CS 27.1309 CS 29.1309

8.5.12.12 The landing gear structure and components shall be shown by analysis, supported by test evidence, to ensure continued Safety of Flight (SOF) following partial failure due to fatigue, leakage, corrosion, defects, or damage.

Consideration should be given to:

a. The typical loading spectra, temperatures, and humidity expected in service;

b. The identification of principal structural elements and detailed design points, the failure of which could cause catastrophic failure.

Information Sources			
Comm'l Doc:	Level II Damage Tolerance requirements.		
DoD/MIL Doc:	AFGS-87139: 3.2.2.1 General; 3.2.2.2 Shock absorption; and 3.2.2.3 Tail bumpers.	*Def-Stan 00-970 Reference:*	00-970 P1 4.1.4
		STANAG Reference:	4671.570
FAA Doc:		*EASA CS Reference:*	CS 23.574 CS 25.571 CS 27.571 CS 27.573 CS 29.571 CS 29.573

8.5.12.13 Failure of the landing gear system or components shall be evident to the flight and/or maintenance crew in order to prevent the air vehicle from being operated unsafely. In addition, partial failures shall become readily detectable under routine inspection.

Consideration should be given to:

a. Inspection schedule, to be agreed and verified;

b. The use of BITE;

c. The use of accessible self diagnostic maintenance panels;

d. An automatic test facility for maintenance of complex systems.

Information Sources			
Comm'l Doc:	Level II Damage Tolerance requirements and Maintainability requirements.		
DoD/MIL Doc:	AFGS-87139: 3.2.2.1 General;	*Def-Stan 00-970*	00-970 P1 4.4.3

Information Sources			
	3.2.2.2 Shock absorption; and 3.2.2.3 Tail bumpers.	*Reference:*	00-970 P1 4.4.6 00-970 P1 4.4.7
		STANAG Reference:	4671.570
FAA Doc:	14CFR reference: 25.1309, 25.571	*EASA CS Reference:*	CS 23.573 CS 23.1309 CS 25.571 CS 25.611 CS 27.571 CS 27.573 CS 27.611 CS 29.571 CS 29.573 CS 29.611

8.5.12.14 Lifting points shall be designed and positioned to enable the air vehicle to be lifted safely. This includes ensuring sufficient strength and stability, to allow for the vertical and horizontal loads, for all specified air vehicle gross weight conditions.

Consideration should be given to:
a. Labelling of lifting restrictions and lifting points;
b. Air vehicle attitude during lifting;
c. Vertical and horizontal load limits, to be agreed and verified;
d. Air vehicle lifting by ground crew using mechanical lifts, slings or manually.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1472, paragraphs 5.9.11.3 through 5.9.11.3.9 (unverified)	*Def-Stan 00-970 Reference:*	00-970 P1 3.11.2 00-970 P7 L308 2.1
		STANAG Reference:	4671.507
FAA Doc:		*EASA CS Reference:*	

8.5.12.15 The crew/operator station shall provide means for the flight crew to assess the operational condition of the landing and deceleration systems.

Consideration should be given to:
a. The use of specified audio and visual means, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P 4.15.33
		STANAG Reference:	4671.729 4671.1793 4671.1835
FAA Doc:		*EASA CS*	CS 23.729

Information Sources			
		Reference:	CS 23.1563 CS 25.729 (AMC 25.729(c)) CS 25.1322 CS 27.729 CS 29.729

8.5.12.16 The air vehicle flight and maintenance manuals shall contain information concerning normal, non-normal and emergency procedures and other pertinent information necessary for safe operation for all landing gear and deceleration systems. This includes operating procedures, limitations, restrictions, servicing, and maintenance information.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1585 4671.1587
FAA Doc:		*EASA CS Reference:*	CS 23.1585 CS 23.1587 CS 25.1583 CS 25.1585 CS 25.1587 CS 27.1585 CS 29.1585

8.5.12.17 The air vehicle landing gear and deceleration systems shall have passed all specified safety related qualification tests to ensure Safety of Flight (SOF). This may include but is not limited to proof, burst, vibration, acceleration, explosive atmosphere, pressure cycling, and temperature cycling tests.

Consideration should be given to:

a. A specified safety related qualification test schedule, to be agreed and verified;

b. Ensuring that all components, either individually or as part of a landing gear and deceleration subsystem have been tested.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.11.22 00-970 P1 4.12.4 00-970 P1 4.14.19 00-970 P1 4.14.20
		STANAG Reference:	4671.723-4671.727
FAA Doc:		*EASA CS Reference:*	CS 23.723-23.727 CS 25.723 CS 27.723-27.727 CS 29.723-29.727

8.5.12.18 Installation of the air vehicle landing gear and deceleration systems shall permit all interface, functions, form, fit, and performance criteria as designed. Safe installation shall be verified by appropriate system and component tests.

Consideration should be given to:

a. Ensuring all tests must be conducted on systems which are fully representative of the final service standard, particularly tyre and oleo pressures;

b. Functioning of both normal and emergency systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.11.74 00-970 P1 4.11.76
		STANAG Reference:	4671.729
FAA Doc:		*EASA CS Reference:*	CS 23.729 CS 25.729 CS 27.729 CS 29.729

8.6. AUXILIARY/EMERGENCY POWER SYSTEM(S) (APS/EPS).

This section covers Auxiliary Power Units (APUs) that are used for ground and in-flight applications; airframe accessory gearboxes; engine starting system components; power-take-off (PTO) shafts; emergency power systems; and ram air turbines (RATs). In the context of this document, the term “auxiliary power subsystem” refers to those subsystems that generate, convert and or transmit power on the air vehicle other than the main propulsion system(s) and which are provided to interfacing subsystems, such as electrical and hydraulic, for further conversion and distribution'.

8.6.1 Verify that system components are safe for the intended use and environment. This is a 'Top-Level' safety criteria that lists references and requirements covering the use and integrity of system components in a given environment.

Consideration should be given to safety criteria in terms of:

a. Design Service Life;

b. Environment;

c. Crash-worthiness;

d. Material and Processes (including chemical/mechanical compatibility of toxic substances & fuels such as hydrazine);

e. Coatings and Finishes;

f. Use of Prohibited Materials and Processes;

g. Producability;

h. Damage Tolerance;

i. Strength;

j. Durability and Economic Life;

k. Corrosion;

l. Fatigue;

m. Dielectric Materials;

n. Creep.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.2.7 - 3.2.7.6.5, 4.2.7 - 4.2.7.6.5	*Def-Stan 00-970 Reference:*	00-970 P1 S4 L93 (Equipment Construction) 00-970 P1 5.1.42 00-970 P1 5.1.44 00-970 P1 5.1.33-5.1.39 00-970 P1 S6 (Equipment Requirements) 00-970 P1 8.1.3 00-970 P7 S7 L700 00-970 P7 S10 L1001 00-970 P7 S10 L1002
		STANAG Reference:	4671.USAR 1353
FAA Doc:	14CFR reference: 25.1309; 25.571	*EASA CS Reference:*	CS 25J.1207 CS 25.571 CS 25.1309 CS-APU 80 CS-APU 210 CS-E 500-590 CS-E-1000

8.6.2 Ensure that the Auxiliary Power System (APU) or Emergency Power System (EPS) operates safely under installed operating conditions over the design envelope.

Consideration should be given to:

a. Systems associated with the safe operation of the APU/EPS such as: fuel, oil, and bleed air.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix C: C.3.4.3, C.4.4	*Def-Stan 00-970 Reference:*	00-970 P1 8.1.3 00-970 P1 5.2.136 00-970 P1 5.2.137 00-970 P7 S7 L700 00-970 P7 S10 L1001 00-970 P7 S10 L1002
		STANAG Reference:	
FAA Doc:	14CFR reference: 23.901, 25.901, 25.903 (f) TSO C77b 4.4.1 - 4.5.2	*EASA CS Reference:*	CS 25J.903(a) CS 25J.939(a) CS 25J943 CS 25J951 CS 25J952 CS 25J1019 CS 25J1023 CS 25J1025

Information Sources			
			CS 25J116 CS 25J1521 CS 25J1527 CS-APU 40 CS-APU 80 CS-APU 420 CS-APU 430 CS-APU 440 CS-APU 450 CS-APU 460 CS-APU 470 CS-E Sub part A

8.6.2.1 Ensure that Auxiliary Power System/Emergency Power System protective safety features (for example; auto shutdown) are available and effective in protecting the equipment against hazardous malfunctions.

Consideration should be given to conditions such as:

a. Over-speed;

b. Over-temperature;

c. Inadvertent activation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix C: C.3.4.3.12.1, C.4.4.3.12.1	*Def-Stan 00-970 Reference:*	00-970 P1 1.1.39 00-970 P1 4.15.27 00-970 P7 S7 L712 00-970 P7 S7 L705
		STANAG Reference:	4671.USAR 1353
FAA Doc:	TSO C77b 4.6.2	*EASA CS Reference:*	CS 25J.1141(c) CS 25J.1189 CS-APU 270 CS-APU 280 CS-APU 450 CS-APU 460 CS-APU 530 CS-E 50 CS-E 400 CS-E 830 CS-E 860-870 CS-E 920

8.6.3 Ensure that the functional and physical compatibility of the integrated Auxiliary Power System/Emergency Power System is safe.

Consideration should be given to:

a. Physical compatibility issues - size, weight, clearance, vibration, materials compatibility etc.;

b. Functional compatibility issues - power outputs, voltage, phase, frequency, pressures, RPM etc.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix C: C.3.4.3, C.4.4.3	*Def-Stan 00-970 Reference:*	00-970 P7 S7 L700 00-970 P1 S8 (Gas Turbine APU Installation Par. 8.0.1; 8.0.3 and 8.1.3)
		STANAG Reference:	4671.USAR 903 4671.USAR 1353
FAA Doc:	14CFR references: 23.901, 25.901, 25.903 (f) TSO C77b 4.4.1 - 4.5.2, Sections 6 and 7	*EASA CS Reference:*	CS 25J.939 CS 25.1309 (Equipment, Systems and Installations) CS-APU 40 CS-E 20

8.6.4 Ensure that Auxiliary Power System/Emergency Power System High-Energy rotating components are designed to:

a. Be damage tolerant;

b. Restrain/Contain the resultant debris arising from the failure of any component;

c. Ensure that any uncontained fragments are not able to damage Safety of Flight (SOF) components, Critical System Items (CSI) or present a hazard to the safety of personnel.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix C: C.3.4.3.10.1, C.4.4.3.10.1	*Def-Stan 00-970 Reference:*	00-970 P1 1.1.39 00-970 P7 S1 L100 00-970 P7 S7 L700
		STANAG Reference:	4671.USAR 1461
FAA Doc:	14CFR reference: 23.903 (b); 23.1461, 25.901(c); 25.1461	*EASA CS Reference:*	CS 25.1461 CS-APU 290 CS-APU 470 CS-E 80 CS-E 510

8.6.4.1 Ensure that containment or other provisions preclude a failed power-take-off (PTO) system from causing secondary damage, due to flailing or whipping, to critical safety items (CSI) or to nearby safety of flight component/systems, including fuel and hydraulic lines.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix C: C.3.4.3.10.1, C.4.4.3.10.1	*Def-Stan 00-970 Reference:*	00-970 P1 1.1.39 00-970 P7 S7 L700 00-970 P7 S7 L705
		STANAG Reference:	4671.USAR 1461
FAA Doc:	14CFR reference: 25.901 (c); 25.1167 (a), (c)	*EASA CS Reference:*	CS 25.1461 CS-APU 290

Information Sources			
			CS-APU 470 CS-E 80 CS-E 510

8.6.5 Ensure that Auxiliary Power System(APS)/Emergency Power System(EPS) equipment in the installed configuration is free of damaging vibrations at all operating conditions throughout the APS/EPS operational envelope.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix C: C.3.4.3.10.2, C.4.4.3.10.2	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.16 00-970 P1 8.1.3 00-970 P7 S7 L700 00-970 P7 S10 L1002
		STANAG Reference:	
FAA Doc:	14CFR reference: 25.901 (c), 25.903 (f) TSO C77b 5.10	*EASA CS Reference:*	CS 25J.1193 CS-APU 80 CS-APU 300 CS-E 100 CS-E 650

8.6.5.1 Ensure, when applicable, that the PTO system is capable of operating safely when installed at the maximum allowable conditions of misalignment and imbalance.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix C: C.3.4.3.10.2, C.4.4.3.10.2	*Def-Stan 00-970 Reference:*	00-970 P1 8.1.3 00-970 P7 S7 L700 00-970 P7 S10 L1002
		STANAG Reference:	
FAA Doc:	14CFR reference: 25.1167 (a),(c)	*EASA CS Reference:*	CS 25.1167 CS-APU 210 CS-APU 410 CS-APU 420 CS-E 520

8.6.6 Ensure that the emergency power system (including the APU or jet fuel starter (JFS) when deemed flight essential) is capable of responding to failures and providing adequate levels of bleed air, shaft, electrical and/or hydraulic power in sufficient time to meet design requirements.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix C: C.3.4.3.4, C.4.4.3.4	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.18-6.6.19 00-970 P1 8.1.3 00-970 P7 S7 L706 00-970 P7 S10 L1001 00-970 P7 S10 L1002
		STANAG	4671.USAR 901

Information Sources			
		Reference:	4671.USAR 1353
FAA Doc:	14CFR reference: 23.943, 25.901 (f), 25.943 TSO C77b: 4.1, 4.4.1, 4.4.2, 4.4.3, 4.7	*EASA CS Reference:*	CS-APU 440 CS-E 370

8.6.7 Ensure that Emergency/Auxiliary Power System installations adequately address safety:

Consideration should include:

a. Structural mounting;

b. Wiring and plumbing support, routeing, and clearances;

c. System/component and compartment drainage;

d. System/component and compartment cooling and ventilation;

e. System/components designed for appropriate level of fire hardening;

f. Accessibility to all required inspection and servicing features and areas.

Information Sources			
Comm'l Doc:	For b. above: ARP994, Tubing/Plumbing Routing - tubing and line support, routing and clearance requirements SAE AS50881A, Wiring, Aerospace Vehicle - wiring support and routing requirements		
DoD/MIL Doc:	JSSG-2009: For a. above: 3.2.7; 4.2.7; 3.2.7.4.4; 4.2.7.4.4; 3.2.7.5; 4.2.7.5 For b., c., and d. above: 3.3.8; 4.3.8 For e. above: 3.3.3; 4.3.3; 3.3.8; 4.3.8; and Appendix G: G.3.4.7; G.4.4.7 For f. above: 3.2.6; 4.2.6	*Def-Stan 00-970 Reference:*	00-970 P1 4.3.8 00-970 P1 4.26.22 00-970 P1 4.26.27 00-970 P1 4 L86 00-970 P1 5.1.70-5.1.72 00-970 P7 S7 L700 00-970 P7 S7 L712
		STANAG Reference:	4671.USAR 901 4671.USAR 1353
FAA Doc:	For a. above: 14CFR references: 25.901 (c), (d); and TSO C77b: 4.8, 5.1.3, 5.2.5 For b. above: 14CFR references: 23.993, 23.1017, 25.901 (c), 25.993, 25.1017 For c. above: 14CFR references: 25.1187; and TSO C77b: 5.27, 5.42, 5.52 For d. above: 14CFR references: 23.1041 - 23.1045, 23.1103 (a), 25.1041 - 25.1045, 25.1103 (a); and TSO C77b (5.3) For e. above: 14CFR references: 23.1181 - 23.1203, 25.1181 - 25.1207; and TSO C77b (5.2) For f. above:	*EASA CS Reference:*	CS 23.1181-1203 CS 25J.901 CS 25J.952 CS 25J.953 CS 25J.961 CS 25J.977 CS 25J.991 CS 25J.993 CS 25J.994 CS 25J.995 CS 25J.997 CS 25J.1011 CS 25J.1017 CS 25J.1019

Information Sources			
	14CFR references: 23.901, 23.1021, 25.901, 25.102123.901, 23.1021, 25.901, 25.1021		CS 25J.1021 CS 25J.1025 CS 25J.1041-25.J1045 CS 25J.1103 CS 25J.1106 CS 25J.1165 CS 25J.1181-25.J1207 CS 25J.1337 CS 25J.1551 CS 25J.1557 CS-APU 30 CS-APU 210 CS-APU 220 CS-APU 270 CS-APU 300 CS-APU 310 CS-E 80 CS-E 100 CS-E 130 CS-E 250 CS-E 270 CS-E 340 CS-E 690

8.6.8 Ensure that Emergency/Auxiliary Power System inlet and exhaust hazards, such as air flow velocities, temperatures, acoustics and exhaust by-products, do not pose unacceptable hazards to:

a. Personnel on the ground, in the air vehicle when it is operating, or in the case of Rotary Wing, when the doors are open, or when suspended outside on a winch cable;

b. Air vehicle subsystems;

c. Air vehicle structure.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix C: C.3.4.3.11, C.4.4.3.11	*Def-Stan 00-970 Reference:*	00-970 P1 8.1.3 00-970 P1 5.1.74 00-970 P7 S7 L700 00-970 P7 S7 L712 00-970 P7 S10 L1002
		STANAG Reference:	4671.USAR 1121 4671.USAR 1353
FAA Doc:	14CFR reference: 23.1091; 23.1103; 23.1121; 23.1123, 25.1091, 25.1103; 25.1121; 25.1123 TSO C77b: 5.3.1, 5.3.3, 5.6	*EASA CS Reference:*	CS 25J.939(c) CS 25J.1091 CS 25J.1103 CS 25J.1121 CS 25J.1123 CS-APU 230 CS-APU 260 CS-APU-80

Information Sources			
			CS-APU-470 CS-E 510

8.6.9 Ensure that hazards to personnel are properly documented (including warnings and precautions) in the appropriate flight, operator and maintenance manuals.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.3.3: 4.3.3	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	14CFR reference: 23.1541; 23.1581 (a) (2), 25.1541; 25.1581 (a) (2)	*EASA CS Reference:*	CS 25.1581(a)(2) CS-APU 20 CS-APU 30 CS-E 20 CS-E 30 CS-E 510

8.6.10 Ensure that compatibility of the accessory drive system with the air vehicle accessories and engine drive system is adequately evaluated for torsional vibrations and loads as well as possible misalignments.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.2.7; 4.2.7; 3.2.7.4.4; 4.2.7.4.4; 3.2.7.5; 4.2.7.5	*Def-Stan 00-970 Reference:*	00-970 P1 S8 (Gas Turbine APU Installation) 00-970 P7 L705 00-970 P7 705/2
		STANAG Reference:	
FAA Doc:	14CFR reference: 25.1167	*EASA CS Reference:*	CS 25J.1163 CS 25.1167

8.6.11 Ensure that all Emergency/Auxiliary Power System critical failure modes and hazards have acceptable levels of risk.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.3.3, 4.3.3	*Def-Stan 00-970 Reference:*	00-970 P7 S7 L700
		STANAG Reference:	4671.USAR 1309
FAA Doc:	14CFR reference: 25.901 (c) TSO C77b (5.1)	*EASA CS Reference:*	CS 25.1309(b) CS-APU 210 CS-E 510

8.6.12 Ensure that the crew station provides for adequate control and monitoring of the Emergency/Auxiliary Power System.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix C: C.3.4.3.8, C4.4.3.8	*Def-Stan 00-970 Reference:*	00-970 P1 4.15 00-970 P1 4.19 00-970 P1 5.1.18 00-970 P1 5.1.22-5.1.23 00-970 P1 8.1.3
		STANAG Reference:	4671.USAR 1701
FAA Doc:	14CFR reference: 23.1141; 23.1142; 23.1549; 25.1141; 25.1142; 25.1549	*EASA CS Reference:*	CS 25J.903 CS 25J.1141 CS 25J.1305 CS 25J.1549 CS-APU 100 CS-E 50 CS-E 60 CS-E 510

8.6.13 Ensure that equipment service life, overhaul, and operating limits of Emergency/Auxiliary Power System are safe and that life-limited components have a reliable means of tracking the limiting parameter.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.2.7.4.4, 4.2.7.4.4, 3.2.7.6, 4.2.7.6	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.USAR 1529
FAA Doc:	14CFR reference: 23.1522; 23.1549; G23.3; 25.1522; 25.1549 : H25.3 TSO C77b: 4.3; 4.4.1; 4.6.1; 5.7	*EASA CS Reference:*	CS 25 Appendix H 25.4 CS-APU 150 CS-APU 310 CS-E 515

8.6.14 Ensure that the flight, operator and maintenance manuals for Emergency/Auxiliary Power Systems include normal and emergency operating procedures, limitations, servicing and maintenance information.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.6.2	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.USAR 1581
FAA Doc:	14CFR reference: 23.1581 - 23.1585; G23.3 - G23.4; 25.1581 - 25.1585; H25.3 - H25.4	*EASA CS Reference:*	CS 25.1585 CS 25J1501 CS 25J1521 CS 25.J1583 CS 25 Appendix H 25.3 CS 25 Appendix H 25.4 CS-APU 20

Information Sources			
			CS-APU 30 CS-E 20 CS-E 30 CS-E 510

8.7. AERIAL REFUELING SYSTEM.

An aerial refuelling capability shall not jeopardise the safety of personnel or integrity of the air vehicle regardless of its configuration.

This section covers the installation, integration, interface and operation of the air vehicle Aerial Refuelling (AR) system. Included with the scope of this section are:
- Tanker (or delivery) air vehicles;
- Receiver air vehicles;
- AR sub-systems including interoperability (i.e. fuel system, displays, lighting, receptacles...etc);
- Flight performance and handling (including compatibility of tanker and receiver air vehicles);
- Helicopter In-Flight Refuelling (HIFR);

The refuelling of Rotary Wing platforms on the ground (i.e. Rotors Running) is specifically excluded from this section and covered in Section 8.3 (Fuel Systems).

Where necessary specific air vehicle system integration criteria are included in this section. However, more general system integration issues (HF, EMC, Electrical...etc) are covered elsewhere in the handbook.

AR operation involves a tanker air vehicle to dispense fuel and at least one receiver air vehicle; typically tankers are fixed-wing air vehicles, but receivers can be either fixed or rotary wing air vehicles (including UAS). Typically air refuelling systems use one of two techniques: Flying Boom and Receptacle; or Hose and Drogue. Some tanker air vehicles may be equipped with systems to enable them to dispense fuel from both types of system and some receiver air vehicles may also be equipped to receive fuel from either system. Consideration shall therefore be given to:
- AR role-equipped Tanker aircraft in isolation;
- AR role-equipped Receiver aircraft in isolation;
- AR role-equipped Tanker and Receiver aircraft in AR contact;
- AR Tanker or Receiver aircraft with role equipment removed

8.7.1 The aerial refuelling subsystem shall interface safely with the air vehicle's subsystem(s) in order for it to continue to properly perform its intended function(s). The aerial refuelling subsystems of tanker and receiver aircraft shall not adversely impact the performance capability of this (these) or other subsystem(s) while the aerial refuelling subsystem is operating properly or when the aerial refuelling subsystem experiences a single failure. Safe operation of the AAR system shall be demonstrated under normal and under failure conditions.

Consideration should be given to both tanker and receiver air vehicles in isolation as well as combined effects during air refuelling, for example:
a. Physical, electrical and material interfaces (including fuels);
b. Visual Cues, including lighting;
c. Structural Integrity;
d. Aerodynamics and dynamics;

e. Stability and control when approaching to make contact, in contact, when transferring fuel, and withdrawing from contact with the tanker;
f. Failure cases, such as the effect of engine failures shall be considered;
g. Maintenance and Operations Procedures and Manuals;
h. Human Factors; including pilot and crew workload;
i. Environment;
j. EMC;
k. All roles and configurations (including with and without removable Air Refuelling role equipment).

Air Refuelling operations are defined to include all in-flight refuelling operations, including HIFR (Helicopter In-Flight Refuelling).

Information Sources			
Comm'l Doc:	ATP-56		
DoD/MIL Doc:	JSSG-2001: 3.4.7.2.1, 3.4.7.2.2 JSSG-2009 Appendix F JSSG-2001B: 3.4.6.2.1, 3.4.6.2.2	*Def-Stan 00-970 Reference:*	00-970 P13 3.5 00-970 P7 S7 L701/4
		STANAG Reference:	3447 3847 3971 7191
FAA Doc:		*EASA CS Reference:*	

8.7.1.1 Operator and maintenance documentation for the air vehicle and the targeted tanker(s)/receiver(s) shall detail safe aerial refuelling procedures. This includes appropriate instructions/information and placards noting restrictions and limitations in the use of the air vehicle's aerial refuelling system(s) under all operating conditions (ground/in flight; normal/emergency).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.4.7.2.1, JSSG-2001: 3.4.7.2.2 JSSG-2001B: 3.4.6.2.1, 3.4.6.2.2	*Def-Stan 00-970 Reference:*	00-970 P13 3.5 00-970 P13 3.5 (Part A Tankers) 00-970 P13 3.5 (Part B Receivers) 00-970 P13 3.5.79 00-970 P1 7.5 00-970 P13 S4 L9 00-970 P7 S2 L1005 00-970 P7 S7 L701
		STANAG Reference:	3447 3971
FAA Doc:	Note: Use 14CFR reference sections corresponding to Structural and Installation requirements. Use all systems 14CFR references as applicable, i.e., Electrical.	*EASA CS Reference:*	CS 25 Subpart G (Operating Limitations and Information)

8.7.1.2 Verify that there is dimensional, physical, electrical, and material compatibility between each aerial refuelling interface and the targeted tanker's/receiver's aerial refuelling interface to permit safe engagement.

Consideration should be given to:

a. The dimensional, physical, electrical, and material compatibility of the hose/drogue, probe/receptor (i.e. between Tanker and Receiver aircraft);

b. The dimensional, physical, electrical, and material compatibility of all aerial refuelling equipment with the host aircraft (tanks, cables, fittings, pipes etc).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.4.7.2.1, JSSG-2001: 3.4.7.2.2 (Unverified) JSSG-2001B: 3.4.6.2.1, 3.4.6.2.2 NATO STANAG 3447 for probe or drogue equipped receivers dimensional guidance NATO STANAG 7191 UARRSI technical exhibit, for boom or receptacle equipped receivers dimensional guidance	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.5-3.5.6 00-970 P13 3.5.14 00-970 P13 S4 L9
		STANAG Reference:	3447 3487 7191
FAA Doc:		*EASA CS Reference:*	

8.7.1.2.1 Verify that the area around the AAR probe or receptacle is free from obstructions that might cause damage to the air refuelling subsystem and/or air vehicle, or become a hindrance to the air refuelling operation.

Consideration should be given to:

a. Structural fastener heads should be flush with the surrounding structural surface;

b. Structure and panels in the vicinity of the AR Probe/Receptacle interfaces that could snag the AR boom or drogue;

c. In the case of HIFR the hose and suspension devices should be included.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: 3.3.11, 4.3.11 JSSG-2010: 3.5.3.3, 4.5.3.3	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.5-3.5.6 00-970 P13 3.5.14 00-970 P13 S4 L9
		STANAG Reference:	3447 3487 7191
FAA Doc:		*EASA CS Reference:*	

8.7.1.2.2 If and when aerial refuelling role equipment hardware needs to be removed and the aircraft is required to conduct operations without it fitted, verify that interfaces with other systems can be properly covered, sealed, isolated, etc. to preclude providing a new leak or ignition source in the air vehicle.

Consideration should be given to:

a. Electrical, hydraulic and fuel system components, leads, pipes and assemblies;

b. Impact of removal on the air vehicle's integrity and remaining systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix F: F.3.4.6.1.5, F.4.4.6.1.5	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.1.3 Verify that the aerial refuelling system interface, its attachment to airframe structure, and the structure surrounding the interface can withstand the loads expected to be experienced throughout the defined flight envelope of the carriage aircraft and during normal and abnormal aerial refuelling operations (engagement, disengagement and fuel transfer) with the tanker/receiver interface(s) without being damaged or creating FOD due to failure.

Consideration should be given to:

a. For boom and receptacle aerial refuelling subsystems, loads expected during normal engagements within the defined contact envelope and normal disengagements within the disconnect envelope; loads experienced when a single failure occurs in the latching mechanism of the receptacle and the boom nozzle must be forcibly pulled out of the receptacle in all flight conditions.

b. For probe and drogue aerial refuelling subsystems, loads expected during normal engagements/disengagements at the most severe receiver closure/fallback rates; those experienced due to inadvertent/off-centre engagements/disengagements; and those experienced when a single failure occurs in the latching mechanism of the aerial refuelling coupling and the probe nozzle must be forcibly pulled out of the receptacle in all flight conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.4.7.2.1, 3.4.7.2.2 JSSG-2001B: 3.4.6.2.1, 3.4.6.2.2 (unverified - NL516) JSSG-2009 Appendix F: F.3.4.6.2.2.5, F.4.4.6.2.2.5, F.3.4.6.2.3.5, F.4.4.6.2.3.5 JSSG-2006: 3.4.1.7, 4.4.1.7 AFGS-87154 load guidance MIL-A-8865A: 3.9.1.3.1 and 3.9.2.2 for load guidance	*Def-Stan 00-970 Reference:*	00-970 P13 S4 L9
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25..963 CS 25.1435 CS 26.963

Information Sources			

8.7.1.4 Verify that adequate controls are provided and properly located for the appropriate crewmember(s)/operator(s) to activate and control the identified functions of the aerial refuelling system.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix F: F.3.4.6.2.1.3, F.4.4.6.2.1.3 JSSG-2010: 3.2.14, 4.2.14 (Unverified)	*Def-Stan 00-970 Reference:*	00-970 P13 3.5 00-970 P13 3.5.59 00-970 P13 S4 L9 6.5.1 00-970 P1 4.19 00-970 P1 4.19.38 00-970 P13 3.5.7
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.771 CS 25.1353

8.7.1.4.1 Verify that displays are provided and properly located for the appropriate crewmember(s)/operator(s) to show the information necessary to complete the aerial refuelling operation without creating hazards to aircraft or personnel.

Consideration should be given to:

a. Display visibility, location, background/ambient lighting conditions including day and night operation;

b. NVIS compatibility (see also 8.7.1.4.5 and 8.7.4.5);

c. Clarity of displays and, if relevant, choice of colours and icons (consider international standards and interoperability requirements).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.2.13, 4.2.13	*Def-Stan 00-970 Reference:*	00-970 P1 4.19.38 00-970 P13 S3.5 00-970 P13 3.5.7 00-970 P13 S4 L9 6.5.1
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.1.4.2 Verify that the intensity of display lights is variable and, if a requirement, compatible with Night Vision Imaging Systems or other imaging devices.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.5.2.1.2, 4.5.2.1.2 (Unverified)	*Def-Stan 00-970 Reference:*	00-970 P1 4.3.3 00-970 P1 4.15.48
		STANAG Reference:	3224 3800

Information Sources			
FAA Doc:		*EASA CS Reference:*	

8.7.1.4.3 Verify that when an aerial refuelling system is installed (on either tanker or receiver), the field of view of the crew member(s)/operator(s)/automated system(s) is adequate for them/it to carry out required operations.

Consideration should be given to:

a. Normal operation of the aerial refuelling system (i.e. probe or pod fitted / stowed / extended);

b. Failure of retractable elements to return to the fully stowed configuration;

c. During landing and other critical flight phases.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.3.2.1, 4.3.2.1 (unverified) JSSG-2009 Appendix F 3.4.6.2.3.2	*Def-Stan 00-970 Reference:*	00-970 P1 4.17.6 00-970 P13 3.5.22
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.1.5 Verify that cues (visual, optical or equivalent) are provided on the air vehicle to assist the crewmember(s)/operator(s)/automated system(s) of the targeted tanker(s)/ receiver(s) and the crewmember(s)/operator(s)/automated system(s) of the air vehicle to accomplish the aerial refuelling process under all anticipated attitudes and environmental conditions.

This is a high level objective covered in more detail in the subsections that follow.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.4.7.2.1, 3.4.7.2.2 JSSG-2001B 3.4.6.2.1, 3.4.6.2.2 (unverified NL516) AFGS-87154	*Def-Stan 00-970 Reference:*	00-970 P1 4.17.6 00-970 P13 3.5.22 00-970 P13 3.5.29 00-970 P13 3.5.30 00-970 P13 3.5.34 00-970 P13 S4 L9
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.1541

8.7.1.5.1 Verify that all visual cues used for aerial refuelling (e.g. markings and exterior lights) are compatible with the expected environmental conditions and fluid exposures (fuel, hydraulic fluid, air vehicle cleaning solvents, etc.).

Consideration should be given to:

a. Compatibility of markings with existing surface finish scheme;

b. Markings should not lead to degradation of the air vehicle's protective surface finish;

c. Ensuring that lights continue to work and be visible (without degradation or colour change) when subjected to environmental effects;

d. Weathering, corrosion, abrasion, mechanical damage;
e. Maintenance activities including washing;
f. Induced environment: contaminants such as fuel, oils, solvents etc.;
g. Natural Environmental; sunlight, rain, pressure, ice etc.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.2.5 00-970 P1 4.3.2 00-970 P1 4.3.5 00-970 P1 4.3.20 00-970 P13 S4 L9
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.1.5.2 Exterior aerial refuelling lights should be provided on the air vehicle for the guidance of the targeted tanker and receiver aircrew, operators and automated systems during the in-flight refuelling operation. The nature of lighting arrangements required vary depending on the Tanker/Receiver systems (Probe & Drogue, Boom & Receptacle) being used for aerial refuelling. In providing any lighting, ensure that appropriate air vehicle crewmember(s)/operator(s)/automated system(s) can view/receive exterior aerial refuelling lights and cues as provided on the targeted tanker/receiver air vehicle(s), as intended, throughout the aerial refuelling operations in all anticipated lighting conditions and attitudes.

Consideration should be given to:
a. For receiver receptacle based subsystems, receptacle/slipway illumination, illumination of the surface area immediately aft of the receptacle, wing leading edge illumination, and illumination of surface features possibly in the path of the boom;
b. For tanker boom-based subsystems, boom nozzle illumination, flood light illumination, wing and underbody illumination, wing pod and engine nacelle illumination, and receiver pilot director/status lights;
c. For receiver probe-based subsystems; probe illumination;
d. For tanker drogue based subsystems, drogue illumination, flood light illumination, wing, underbody and root-end of hose to show markings illumination, wing pod and engine nacelle illumination in conjunction with drogue subsystem status lights;
e. Rendezvous lights;
f. Refuelling sequencing and tanker subsystem status lights;
g. Crew's field of view, reflections and glare;
h. Ability to vary intensity of lights fully down to zero;
i. Duplication of lamps to prevent single failure resulting in inability to complete refuelling operation;
j. Lighting within drogues should not require power from the tanker for operation;
k. Need for compatibility with Night Vision Imaging Systems (note linkage to 8.7.1.4.5)
l. Ground/Ship based lighting for HIFR.

In the HIFR environment where the helicopter is refuelling in the hover from ground or ship based sources; no specific additional aircraft lighting is required beyond that carried for conventional flight operations.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P13 3.5.39 00-970 P13 3.5.41 00-970 P13 3.5.56 00-970 P13 3.5.74 00-970 P1 4.17.6 00-970 P13 3.5.30-3.5.35 00-970 P13 S4 L9 00-970 P7 S1 L104 00-970 P7 S2 L1005
		STANAG Reference:	3971
FAA Doc:		*EASA CS Reference:*	

8.7.1.5.3 Verify that all exterior lights necessary to perform in-flight refuelling operations can be varied in intensity, individually or as a group, fully down to zero to meet the needs of targeted tanker/receiver crewmember(s)/operator(s)/automated system(s) and the air vehicle crewmember(s)/operator(s)/automated system(s). Verify also that, where required, these exterior aerial refuelling lights are compatible with night vision imaging systems (NVIS) or automated systems.

Consideration should be given to:

a. Ability of the system to be controlled in response to differing ambient lighting conditions;

b. Tanker/receiver orientation and changes in orientation during refuelling operation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P13 3.5.39 00-970 P13 3.5.41 00-970 P13 3.5.56 00-970 P13 3.5.74 00-970 P1 4.17.6 00-970 P13 S4 L9 00-970 P13 1.1.1.4
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.1.6 Ensure that a communication system(s) is available to transmit data / information between the crewmember(s)/operator(s)/ automated system(s) of the air vehicle and the crewmember(s)/operator(s)/automated system(s) of the targeted tanker/receiver air vehicle(s) during the aerial refuelling operation and that it is able to exchange data and information in the required time frame.

Consideration should be given to:

a. The relative close proximity of transmitter and receiver communication systems;

b. The need to restrict some forms of communication such as HF during AAR operations;

c. The need to transmit / receive classified information securely or covertly.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.4.7.2.1, 3.4.7.2.2 JSSG-2001B: 3.4.6.2.1, 3.4.6.2.2 NAVAIR 00-80T-110 section 2.4.4 and 3.6.5	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.28 00-970 P13 S4 L9
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.1.6.1 Verify that any data communication system provided on the air vehicle is compatible with the air vehicles involved in the operation.

Consideration should be given to:

a. Potential impacts on flight control and electrical systems on the host tanker as well as targeted tanker(s)/receiver(s);

b. The relative close proximity of transmitters and receivers used in the communication systems;

c. The need to restrict some forms of communication such as HF during AAR operations;

d. The need to transmit / receive classified information securely or covertly.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.4.7.2.1,3.4.7.2.2 - (Unverified) JSSG 2009 Appendix F: F.4.4.6.2.2.8	*Def-Stan 00-970 Reference:*	00-970 P1 6.10 00-970 P13 S4 L9 6.4.4 00-970 P13 3.5.2.1 00-970 P13 3.5.28 00-970 P13 3.5.2
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.1309

8.7.1.7 Identify in detail the fuel types (including permitted deviations) the systems are capable of transferring and receiving.

Consideration should be given to:

a. Fuel specifications and tolerances including permitted deviations;

b. The use of additives;

c. The need to transport, pump and transfer different types of fuel including those not useable by the host air vehicle;

d. Compatibility of different fuels with IFR system components;

e. Segregation of different types or blends of fuel.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.4.7.2.1, 3.4.7.2.2	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.127 00-970 P1 5.2.3 00-970 P1 5.2.4 00-970 P1 S5 L4

Information Sources			
			00-970 P1 S5 L7 00-970 P13 S4 L9 1.3.3
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.1.7.1 Verify that there is adequate isolation of fuel systems in cases where tankers are required to carry and/or transfer a fuel which cannot be utilised by the tanker's own propulsion system(s).

Consideration should be given to:

a. Types and blends of fuel, its specification and the use of additives;

b. Compatibility of different fuels with IFR system components;

c. Means of segregation of different types of fuel.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix F: F.3.4.6.1.6, F.4.4.6.1.6	*Def-Stan 00-970 Reference:*	00-970 P13 S4 L9 6.3.4
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.1.8 Verify that the delivery pressure and flow rate of the transferred/received fuel are identified and constrained within the design limits of intended tankers and receivers.

Consideration should be given to:

a. Effects of single failures in tanker and receiver fuel systems;

b. Developing delivered fuel flow rate versus delivered fuel pressure curve;

c. Providing capability to regulate delivery pressure to suit different platforms;

d. Minimum flow rates;

e. Providing capability to regulate flow rates;

f. Ensuring maximum capacity and capability of the fuel vent system is adequate;

g. RW and FW requirements may differ;

h. Effects of surge due to:

 i. Effects of pump imitation;

 ii. Flow induced static build-up;

 iii. Valve closures in tanker and receiver;

 iv. Disengagement of receiver at maximum rate of flow.

Information Sources			
Comm'l Doc:	ARSAG International, Doc. No.00-03-01, "Pressure Defs & Terms, Mar '03.doc" (4.7)00-970 P1 Sec 9.5.2 (Unverified)		
DoD/MIL Doc:	JSSG-2001: 3.4.7.2.1 JSSG-2001: 3.4.7.2.2, (Unverified)	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.2 00-970 P13 3.5.8 00-970 P13 S4 L9

Information Sources			
	MIL-A-19736: 3.5.2.1 and 3.8.7 (Unverified) MIL-STD-87166: 3.1.1 and 4.1.1 (cancelled; use for guidance) (Unverified)	*STANAG Reference:*	3447
FAA Doc:		*EASA CS Reference:*	

8.7.1.8.1 Verify by testing and calculation that the plumbing/components in each aerial refuelling system (as completely assembled and installed within the air vehicle) can withstand exposure to the specified proof pressure limit without resulting in fuel leakage or degradation of system performance.

Information Sources			
Comm'l Doc:	ARSAG 00-03-01, "Pressure Defs & Terms, Mar '03.doc" 3.5 and 4.7 (unverified)		
DoD/MIL Doc:	JSSG-2009 Appendix F: F.3.4.6.1.3, F.4.4.6.1.3	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.9 00-970 P13 3.5.10 00-970 P13 S4 L9
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.1.8.2 Verify that surge pressures generated during the aerial refuelling process do not exceed proof pressure limits for the aerial refuelling system(s) of any air vehicle involved in the aerial refuelling operation.

Note that proof pressure can be defined as "a maximum pressure at which the fuel system may function satisfactorily including pressure transients (surges) which the aircraft can continually sustain throughout its life without external leakage, failure and/or malfunction, or permanent deformation".

Consideration should be given to:
a. Effects of single failures in tanker and receiver fuel systems;
b. Developing delivered fuel flow rate versus delivered fuel pressure curve;
c. Effects of surge due to:
   i. Effects of pump initiation;
   ii. Flow induced static build-up;
   iii. Valve closures in tanker and receiver;
   iv. Disengagement of receiver at maximum rate of flow.

Information Sources			
Comm'l Doc:	ARSAG 00-03-01, "Pressure Defs & Terms, Mar '03.doc" (3.5 and 4.7) (Unverified)		
DoD/MIL Doc:	JSSG-2001: 3.4.7.2.1, JSSG-2001: 3.4.7.2.2 (Unverified) JSSG-2001B: 3.4.6.2.1, 3.4.6.2.2	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.79 00-970 P13 3.5.8 00-970 P13 S4 L9
		STANAG Reference:	3447 3847

Information Sources			
	MIL-A-19736A: 3.5.2.3 (Unverified)		
FAA Doc:		*EASA CS Reference:*	CS 25.951 CS 25.963

8.7.1.8.2.1 Verify that fuel systems have mechanisms to ensure that surge pressure conditions for both Tanker and Receiver (fixed or rotary wing) during AAR do not exceed design safety limits during normal or abnormal operation.

Consideration should be given to:

a. Effects of single failures in tanker and receiver fuel systems;

b. Effects of surge due to:

i. Effects of pump initiation;

ii. Flow induced static pressure build-up;

iii. Valve closures in tanker and receiver (manually or automatically activated) which could terminate flow into the receiver;

iv. Disengagement of receiver at maximum rate of flow;

v. Normal and abnormal flow disconnects.

Information Sources			
Comm'l Doc:	ARSAG 00-03-01, "Pressure Definitions & Terms, Mar '03.doc," 3.7 and 4.7 (Unverified)		
DoD/MIL Doc:	JSSG-2001: 3.4.7.2.1, JSSG-2001: 3.4.7.2.2 (Unverified) MIL-A-19736A: 3.5.2.3 (Unverified)	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.79 00-970 P13 3.5.9 00-970 P13 3.5.12 00-970 P13 S4 L9
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.963

8.7.1.8.2.2 Verify that the fuel tank vent system can accommodate the maximum refuel/transfer rate and pressures associated with aerial refuelling transfer rates encountered during aerial refuelling normal operations and single-point failure conditions.

Consideration should be given to:

a. Managing the impact of instantaneous peak surge pressures arising from valve closure in both Tanker and Receiver aircraft, and also Receiver disengagement at high fuel flow rates.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix F: F.3.4.6.1.6, F.4.4.6.1.6	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.83 00-970 P13 3.5.10 00-970 P13 S4 L9 00-970 P13 3.5
		STANAG Reference:	

Information Sources			
FAA Doc:		*EASA CS Reference:*	CS 25.975 CS 25.979 CS 29.975 CS 29.979

8.7.1.9 Verify that any fuel spillage occurring during aerial refuelling operations is kept to a minimum and does not adversely affect the safe operation of any air vehicle.

Consideration should be given to:

a. Refuelling throughout the permitted flight envelope, including normal and abnormal conditions and attitudes;

b. Fuel spray dispersion pattern created during engagement and disengagement of the aerial refuelling interfaces;

c. Abnormal disengagements at full flow rates;

d. Effect on other air vehicles in the vicinity;

e. Impact of single point failures including breakage of refuelling probe/nozzle.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.2.3 JSSG-2001B: 4.2.3	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.79 00-970 P13 3.5.15 00-970 P13 3.5.21
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.1.9.1 Ensure that any fuel spray resulting from aerial refuelling operations entering receiver engine(s), hazardous ignition areas, environmental management systems, and air data systems does not compromise safety of aircraft or personnel.

Consideration should be given to:

a. Minimising loss of fuel during engagement and disconnection (normal and abnormal);

b. Minimising the potential for fuel spray to enter the aircraft (encroachment into bays and apertures);

c. Potential hazard areas such as:

  i. Receiver engines; for example: via intakes, inlets and ducts;

  ii. Sources of ignition;

  iii. Environmental management systems;

  iv. Air data and sensor systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.2.3, 3.3.10 JSSG-2009 Appendix F: F.3.4.6.2.2.2, F.3.4.6.2.3.2, F.4.4.6.2.2.2,	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.79(5) 00-970 P13 3.5.15
		STANAG Reference:	

Information Sources			
	F.4.4.6.2.3.2		
FAA Doc:		*EASA CS Reference:*	CS 23.1191 CS 25.1191 CS 25.1707

8.7.1.9.2 Ensure that any fuel spray resulting from aerial refuelling operations that comes into contact with lights, optical windows, antennae, or any other sensitive device does not degrade them, their operation or the safety of air vehicles or personnel.

Consideration should be given to the following potential hazard areas:

a. Lights (especially high energy discharge lights);

b. Optical windows and apertures including wipers and sweepers;

c. Antennae.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.2.3, 3.3.10 JSSG-2009 Appendix F: F.3.4.6.2.2.2, F.4.4.6.2.2.2, F.3.4.6.2.3.2, F.4.4.6.2.3.2	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.77 00-970 P13 3.5.21
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.773

8.7.2 Ensure through hazard reduction analysis and inspection that each aerial refuelling system can be installed and operated under normal and single-failure conditions throughout the approved flight envelope, including aerial refuelling operations, without causing adverse flying characteristics, exceeding structural load limits, the loss of the air vehicle or creating a potential hazard to personnel in the identified environment (induced and natural).

Consideration should be given to the following areas:

a. Hydraulic systems;

b. Environmental control;

c. Aircraft and subsystem structures;

d. Fuel systems;

e. Aircraft management systems;

f. Reducing subsystem and component related hazards (including Fire and Explosion) design, inspection and analysis means of risk reduction.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.2.7.4.4.1, 4.2.7.4.4.1, 3.2.7.4.4.2, 4.2.7.4.4.2, 3.3.8, 4.3.8 MIL-STD-87166: 3.1.3 and 4.1.3 guidance on expected environments (cancelled; use for guidance)	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.39-3.5.41 00-970 P13 S4 L9
		STANAG Reference:	
FAA Doc:		*EASA CS*	CS 25.561 CS 25.789

Information Sources			
		Reference:	CS 25.1309

8.7.2.1 Ensure that the Aerial Refuelling systems onboard air vehicles have been designed to minimise hazards from lightning, static electricity, fuel leaks, ignition sources and ground potential differences.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix F: F.3.4.6.1.7, F.4.4.6.1.7	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.39 00-970 P1 4.27.36-4.27.39 00-970 P13 3.5.16 00-970 P13 3.5.18 00-970 P13 3.5.26 00-970 P13 S4 L9 00-970 P1 S6 59-113 and 411 (for EMI/EMC)
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.581 CS 25.954 CS 25.1316

8.7.2.1.1 Ensure that on air vehicles equipped with a receptacle installation, it has a fuel- and vapour-proof pressure box below it to collect the fuel spray that may occur during aerial refuelling, and that on air vehicles fitted with probe compartments, ensure that the compartment is fuel and vapour-proof so that any fuel and vapour which may collect as a result of aerial refuelling operations is not able to migrate to other areas.

Consideration should be given to:

a. Receptacle pressure box or probe compartment design;

b. Sealing and proofing of the compartment to prevent migration beyond the compartment of any fluid build up as a result of spray;

c. Safe venting and drainage of vapour/fluids;

d. Potential ignition sources.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.3.8, 4.3.8; and Appendix F: F.3.4.6.2.2.4, F.4.4.6.2.2.4	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.5 00-970 P1 4.3.8 00-970 P13 3.5.16 00-970 P13 3.5.26 00-970 P13 S4 L9
		STANAG Reference:	3614
FAA Doc:		*EASA CS Reference:*	CS 25.954

8.7.2.1.2 Ensure that all fluids that may collect within aerial refuelling subsystem compartments are capable of being safely drained without causing hazards to the air vehicle, other aircraft or creating a potential hazard to personnel in all flight and ground conditions.

Consideration should be given to:
a. Air refuelling receptacle pressure boxes;
b. Retractable air refuelling probe compartments;
c. Air refuelling subsystem pods or equipment compartments.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.3.8, 4.3.8; and Appendix F: F.3.4.6.2.2.3, F.4.4.6.2.2.3	*Def-Stan 00-970 Reference:*	00-970 P1 4.3.8 00-970 P1 4.26.19 00-970 P13 S4 L9
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.975

8.7.2.1.3 For aircraft equipped with air refuelling subsystems to enable them to operate as either tanker or receiver, ensure that any aerial refuelling subsystem compartments or enclosed spaces have adequate air flow/exchange so as to prevent the build-up of flammable vapours, which would constitute a fire/explosion hazard.

Consideration should be given to:
a. Receptacle pressure boxes;
b. Probe compartments;
c. Air refuelling subsystem pods;
d. Air refuelling subsystem compartments.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.3.8, 4.3.8; and Appendix F: F.3.4.6.2.3.3, F.4.4.6.2.3.3	*Def-Stan 00-970 Reference:*	00-970 P1 S3 L15 00-970 P1 4.3.2 00-970 P1 4.3.8 00-970 P1 4.24.10 00-970 P1 4.26.19-4.26.20 00-970 P1 4.26.36 00-970 P1 4.26.68 00-970 P1 4.26.73 00-970 P1 5.2.47 00-970 P1 5.2.87 00-970 P13 3.5.79 00-970 P1 S5 L9 5.1 00-970 P13 3.5.16 00-970 P13 S4 L9
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.975

8.7.2.1.4 Ensure that an aerial refuelling pump does not create a potential ignition source during dry-run contacts between tanker and receiver aircraft.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.3.3, 4.3.3,Appendix F: 3.4.6.1.7, 4.4.6.1.7, Appendix G: 3.4.7.23, 4.4.7.23	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.32 00-970 P1 4.26.38 00-970 P1 4.26.63
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.981

8.7.2.1.4.1 When aerial refuelling components interface with the fuel or hydraulic system, verify that pressures and temperatures within the fuel/hydraulic systems remain within safe limits under normal aerial refuelling operations and with single-point failure conditions.

Consideration should be given to:

a. Ram Air Turbine-driven pumps in aerial refuelling pods;

b. Aerial refuelling pumps;

c. Probe door actuation/retraction mechanisms;

d. Probe extension/retraction mechanisms;

e. Receptacle door/toggle latch mechanisms.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix F: F.3.4.6.1.1, F.4.4.6.1.1	*Def-Stan 00-970 Reference:*	00-970 P13 S4 L9
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.1309

8.7.2.1.5 Ensure that a secondary liquid and vapour-tight barrier is in place between the aerial refuelling fuel tanks and all identified fire and ignition hazard areas/inhabited areas. A means should be provided to highlight if the secondary barrier has failed.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix E: E.3.4.5.6.11, E.4.4.5.6.11; and Appendix F: F.3.4.6.1.6, F.4.4.6.1.6, F.3.4.6.1.7, F.4.4.6.1.7	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.26 00-970 P13 3.2.47
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.2.1.5.1 Verify that no ground or flight hazards are created if fuel leakage occurs in the air vehicle fuel system and/or other aerial refuelling system plumbing during aerial refuelling operations.

Consideration should be given to:

a. Fuel leakage arising from failure of the sealing mechanism at the single-point refuelling adapter;

b Fuel leakage arising from failure of the pressure defuelling adapter;

c. Fuel leakage arising from failure of any other aerial refuelling system interface(s);

d. Fuel leakage arising from failure of a part of the fuel system

e. Ensuring any fuel leakage does not allow fuel or fuel vapour to enter the cockpit or cabin;

f. Ensuring any fuel leakage is safely drained or vented and does not allow fuel or fuel vapour to come into contact with potential sources of ignition.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix F: F.3.4.6.1.6, F.4.4.6.1.6	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.77 00-970 P13 3.5.11 00-970 P13 S4 L9 00-970 P13 3.5.16
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.975

8.7.2.1.5.2 When the plumbing of the aerial refuelling system interfaces with the fuel system plumbing of the air vehicle or of other aerial refuelling systems, verify that a leak in the aerial refuelling system plumbing does not impact the fuel system's fuel management functions (engine feed, thermal management, centre of gravity control, etc.) when operating normally or in cases of a single point failure.

Consideration should be given to providing a means to isolate the air refuelling sub-system from the main fuel system in the event that a failure occurs (e.g. probe breakage).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix F: F.3.4.6.1.1, F.4.4.6.1.1, F.3.4.6.1.5, F.4.4.6.1.5	*Def-Stan 00-970 Reference:*	00-970 P13 S4 L9 00-970 P13 3.5.18
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.2.1.6 Aerial refuelling systems, fitted to both the tanker and receiver aircraft must be able to accommodate/dissipate static discharges typically resultant from the electrical potential difference of air vehicles prior to, during and after engagement.

Consideration should be given to:

a. Coupling of electrical components;

b. Bonding of all airframe conductive (i.e. metal) structures;

c. Full bonding to the airframe of all AAR equipment;

d. Use of a conductive refuelling interfaces (i.e. Hose & Drogue);

e. Establishing electrical contact between tanker and receiver aircraft, to discharge static prior to commencing fuel transfer;

f. Establish potential restrictions on the use of aircraft (both tanker and receiver) telecommunication systems which may provide an electromagnetic hazard.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.2.3	*Def-Stan 00-970*	00-970 P1 4.27

Information Sources			
		Reference:	00-970 P13 3.5.14 00-970 P13 S4 L9
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.899

8.7.2.1.7 Ensure that the aerial refuelling system onboard both the tanker and receiver aircraft, in the stowed or operational condition is designed to withstand lightning strikes without causing damage to air vehicle as appropriate, loss of air vehicle, or creating hazards to personnel.

Consideration should be given to:

a. Prior identification of lightning strike zones, design of electromagnetic protection and preventative measures on both the airframe and AAR subsystem - with Hose, probe or boom in the stowed or extended position;

b. Full bonding to the airframe main grounding system of all AAR equipment and associated subsystems;

c. Use of a conductive refuelling interface (i.e. Hose & Drogue);

d. Potential effects on aircraft systems due to a lightning strike;

e. Fuel venting and jettisoning systems shall be located and designed so as to minimise the risk of their being struck by lightning;

f. Where transparent components such as windows, windscreens, etc., contain electrically heated films or elements, precautions shall be taken to prevent a lightning strike or an electro-static discharge puncturing the transparency;

g. Maintaining the AAR system in an operational condition following a lightning strike.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.2.1, 3.3.10.1.1 JSSG-2009 Appendix G: 3.4.7.6, 4.4.7.6	*Def-Stan 00-970 Reference:*	00-970 P1 4.27.23-4.27.40 00-970 P13 3.5.14 00-970 P13 S4 L9 5.2.2
		STANAG Reference:	3614
FAA Doc:	14CFR reference: 23.954, 25.954	*EASA CS Reference:*	CS 25.581 CS 25.954 CS 25.1316

8.7.2.2 The in-flight egress, ground emergency egress, and assisted egress of any crewmember of either tanker or receiver aircraft is not to be hindered when the aerial refuelling system interface cannot be returned to its fully stowed configuration.

Consideration should be given to the impact of and on:

a. Ejection envelopes; emergency exits, windows, panels, frangible sections, doors and ramps that might be used for emergency escape;

b. Receiver receptacle installations: the opening/closing of receptacle/slipway doors or the transition of roll-over installations during opening and closing;

c. Tanker boom subsystems: moving the boom from the “stowed” position and moving it throughout its control envelope;

d. Receiver probe installations: all positions and transitions between the “stowed” and “fully extended” positions;

e. Tanker drogue subsystems: all positions and transitions between the "stowed" and "fully extended" positions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix F: F.3.4.6.2.2.2, F.4.4.6.2.2.2, F.3.4.6.2.3.2, F.4.4.6.2.3.2	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.809

8.7.2.3 Ensure safe ground or in-flight operations of AAR systems under all configuration options without causing the loss of the aircraft or creating hazards to personnel through the utilisation of built-in-test (BIT) and fault isolation provisions. The BIT and fault isolation provisions are to be made available to all appropriate crewmember(s), operator(s) and maintenance personnel.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.2.9, 3.2.9.1, 4.2.9	*Def-Stan 00-970 Reference:*	00-970 P13 S4 L9 7.4.1
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.1309

8.7.2.4 Verify that 'critical operational functions and functional modes' are provided in the aerial refuelling system to ensure the aerial refuelling process can be conducted without creating hazards to aircraft or personnel.

Consideration should be given to:

a. Initiation of safe emergency disconnects of the AAR system when required by either party (tanker or receiver) when in AAR contact;

b. Safe cessation of fuel flow when in contact;

c. For probe equipped AC it should be possible to initiate safe emergency extensions or retractions of the AAR probe system if required.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix F: F.3.4.6.2.2.7, F.4.4.6.2.2.7, F.3.4.6.2.3.1.2, F.4.4.6.2.3.1.2	*Def-Stan 00-970 Reference:*	00-970 P13 S4 L9 6.5.1 00-970 P13 S4 L9 8.2.1
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.979 CS 25.1301 CS 25.1302 CS 25.1309

8.7.2.5 Verify that electrical failures within the aerial refuelling system do not adversely affect any air vehicle's electrical system (tanker or receiver).

Consideration should be given to providing a means to electrically isolate the air refuelling sub-system from the main electrical system in the event that a failure occurs.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix F: F.3.4.6.1.1, F.4.4.6.1.1	*Def-Stan 00-970 Reference:*	00-970 P1 7.1.4 00-970 P13 3.5.18 00-970 P1 S6
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.3 Verify that the flight control/handling qualities of the air vehicle are not negatively impacted or degraded below safe limits when the aerial refuelling sub-system is installed or operating under normal aerial refuelling and single-failure conditions.

Consideration should be given to:

a. Normal installation and operating conditions for either tanker or receiver in isolation, with the Air Refuelling sub-system in either stowed or deployed configuration

b. Failure modes including ensuring the air vehicle can safely land when the air refuelling sub-system interface cannot be returned to its fully stowed configuration.

c. Ensuring that satisfactory flight stability and handling qualities are achievable for the tanker/receiver aerial refuelling interface within the specified aerial refuelling envelope.

d. When role equipment hardware associated with an aerial refuelling system is removed. For tankers, this may include pods, palletized systems, and fuel tanks that must be removed to reconfigure the tanker for another mission. For receivers, this may include probe installations that are not permanent.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P13 3.5
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25 Subpart B CS 25 Subpart G

8.7.3.1 Ensure that the flight control/handling qualities of air vehicles (tanker or receiver) are not negatively impacted when the aerial refuelling system is installed or operating under either normal aerial refuelling or single-failure conditions.

Consideration should be given to the following areas:

a. Receiver receptacle installations: the opening/closing of receptacle/slipway doors or the transition of roll-over installations during opening and closing;

b. Tanker boom subsystems: moving the boom from the “stowed” position and moving it throughout its control envelope (prior to receiver engagement and after a contact has been made);

c. Receiver probe installations: all positions and transitions between the “stowed” and “fully extended” positions;

d. Tanker drogue subsystems: all positions and transitions between the “stowed” and “fully extended” positions (with and without fuel in the hose).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.3.11.1.1.1	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.39 00-970 P13 3.5.50 00-970 P13 S4 L9
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.3.1.1 Aircraft flight control/handling qualities, in the event that the air refuelling system interface cannot be returned to its fully stowed configuration, are not to be degraded below safe limits, causing the loss of the aircraft or creating hazards to personnel . In addition, the extended air refuelling system is not to endanger the safe landing of the aircraft.

Consideration is to be given to:

a. A full programme of tests must be carried out to assess the handling characteristics over the aircraft's operating envelope;

b. Receiver receptacle installations: the opening/closing of receptacle/slipway doors or the transition of roll-over installations during opening and closing;

c. Tanker boom subsystems: moving the boom from the “stowed” position and moving it throughout its control envelope (prior to receiver engagement and after a contact has been made);

d. Receiver probe installations: all positions and transitions between the “stowed” and “fully extended” positions;

e. Tanker drogue subsystems: all positions and transitions between the “stowed” and “fully extended” positions (with and without fuel in the hose);

f. Use of a chase or receiver aeroplane equipped with a video or cine camera during the AAR tests;

g. Identify the potential effect of the jettison/loss of any part or subpart of the AAR system with regard to fire hazard or impact damage to the aircraft.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.3.11.1.1.1	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.39 00-970 P13 3.5.51 00-970 P13 S4 L9
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.3.1.2 For tanker aircraft equipped with aerial refuelling pods, verify that any ram air turbine (RAT) failure mode does not degrade flight control/handling qualities of the air vehicle below acceptable limits, potentially causing the loss of air in the aircraft or creating hazards to personnel.

Consideration should be given to all phases of operation including

a. Takeoff;
b. Operational profile, including AAR operations;
c. Landing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix F: 3.4.6.1.1, 4.4.6.1.1, 3.4.6.1.2, 4.4.6.1.2	*Def-Stan 00-970 Reference:*	00-970 P13 S4 L9 00-970 P13 3.5.18
		STANAG Reference:	
FAA Doc:	14CFR reference: 25.1309	*EASA CS Reference:*	

8.7.3.2 Tankers and receivers should demonstrate satisfactory flight stability and handling characteristics throughout the aircraft's cleared aerial refuelling flight envelope at all permitted configurations.

Consideration should be given to:
a. Movement in Centre of Gravity (CofG) during engagement and refuelling operation;
b. Instability due to probe / boom deployment or proximity to tanker or other refuelling aircraft;
c. Internal redistribution of fuel;
d. Ability of system to cope with single failures of the fuel system;
e. Variations in aircraft configurations (note linkage to 8.7.3);
f. Stability of tanker's hose, boom and probe.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.1.1.1.1, 3.3.11.1.1 JSSG-2009 Appendix F: F.3.4.6.2.2.2	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.19 00-970 P13 3.5.21 00-970 P13 3.5.23 00-970 P13 3.5.79
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25 Subpart B CS 25 Subpart G

8.7.3.3 Ensure that flight control/handling qualities of tanker and receiver aircraft are not negatively affected by the removal of aerial refuelling systems or components. Note that some aircraft may be fitted with aerial refuelling equipment as non permanent 'role equipment'.

Consideration should be given to:
a. Impact on the air vehicle's flying qualities;
b. Impact of removal of only part or parts of the aerial refuelling system on the air vehicle's flying qualities and remaining systems;
c. Coverage in aircrew notices and permitted / authorised flight configuration documents;
d. Removal of:
   i. Aerial Refuelling Pods;
   ii. Fuel Tanks;
   iii. Palletised Systems;
   iv. Probe Installations (non permanent).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.3.11.1.1.1	*Def-Stan 00-970 Reference:*	00-970 P13 3.5.39
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.1309

8.8. DELETED - PROPULSION INSTALLATIONS MOVED TO SECTION 7.2.5

8.9. MECHANISMS

This section covers the design, installation, integration and compatibility of all mechanical actuation subsystems that provide motion and position locking functions for stowable and deployable surfaces such as folding wing panels, folding rotor blade systems, folding tail rotors/pylons in ground and air applications for both operational and maintenance purposes. Additionally, equipment involved in the securing, fastening, and mechanizing of air vehicle doors, hatches, ramps, etc. is also covered; including items such as locks, latches, bearings, hinges, linkages, indicators, and actuators.

Equipment that is mechanical in form, fit, and function, but not covered by any other system-level requirements should be included herein.

Included within the scope of this section are:
• Inadvertent activation prevention;
• Latches and locking mechanisms;
• Positive engagement indication;
• Operation without power;
• Depressurization prevention;
• Actuation times and cycles;
• Safety devices and positive locking features.

Some criteria in this chapter are supported in the text by examples of specific considerations. These examples are by no means to be considered as
exhaustive.

• Operation of mechanisms in the worst case environmental conditions the air vehicle is likely to experience in service;
• For structural verification, ensuring methods are consistent with the approach taken with respect to the airframe structure specification;
• Ensuring the safety of the maintainer as well as the equipment and air vehicle itself are safeguarded during operation actuation mechanisms;
• Integrating a common cycle requirement between related systems that operate in conjunction with each other, such as blade and wing stow subsystems
on the same air vehicle.

8.9.1 All SOF critical mechanisms shall perform their allocated air vehicle functions under their specified operating environments and conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix I, 3.4.9.1, 3.4.9.4 MIL-M-87222 Mechanical Systems for Aircraft Doors and Canopies - inactive for new design	*Def-Stan 00-970 Reference:*	00-970 P1 4.19.59 00-970 P1 4.20.1 00-970 P1 4.20.7 00-970 P1 4.20.8 00-970 P1 4.20.10 00-970 P1 4.20.18 00-970 P1 4.23.9 00-970 P1 4.23.10 00-970 P1 4.23.40
		STANAG Reference:	4671.601 4671.783 4671.843 4671.905 4671.1301 4671.1309
FAA Doc:		*EASA CS Reference:*	CS 23.601 CS 23.783 CS 23.807 CS 23.843 CS 23.905 CS 23.1301 CS 23.1309 CS 25.601 CS 25.807 CS 25.809 CS 25.810 CS 25.843 CS 25.1301 CS 25.1309 CS 27.601 CS 27.807 CS 27.1301 CS 27.1309 CS 29.601 CS 29.783 CS 29.809 CS 29.1301 CS 29.1309

8.9.2 Damage or permanent deformation to mechanisms or support structures shall not result from the most critical jam load condition.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix I,	*Def-Stan 00-970*	00-970 P1 4.20.5

Information Sources			
	3.4.9.1, 3.4.9.4 MIL-M-87222 Mechanical Systems for Aircraft Doors and Canopies: 3.1.4.9; 3.1.5.9; 4.1.4.9; 4.1.5.9 - inactive for new design	*Reference:*	00-970 P1 4.20.8 00-970 P1 4.20.18 00-970 P1 4.23.40
		STANAG Reference:	4671.601 4671.1301 4671.1309
FAA Doc:		*EASA CS Reference:*	CS 23.601 CS 23.783, CS 23.807 CS 23.1301 CS 23.1309 CS 25.601 CS 25.783 CS 25.809 CS 25.1301 CS 25.1309 CS 27.601 CS 27.807 CS 27.1301 CS 27.1309 CS 29.601 CS 29.783 CS 29.809 CS 29.1301 CS 29.1309

8.9.3 Failure of any mechanism shall not cause the loss of control of the air vehicle or prevent continued safe flight and landing.

Consideration should be given to:

a. Structural damage from the departing door, hatch, or mechanism to either the attachment points or from striking other parts of the structure;

b. Potential severing of hydraulic lines, electrical cables, or fuel lines.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix I, 3.4.9.1, 3.4.9.4 MIL-M-87222 Mechanical Systems for Aircraft Doors and Canopies: 3.1.2.4; 4.1.2.4 - inactive for new design	*Def-Stan 00-970 Reference:*	00-970 P1 4.20.1 00-970 P1 4.20.7 00-970 P1 4.20.8 00-970 P1 4.20.10 00-970 P1 4.23.9 00-970 P1 4.23.22
		STANAG Reference:	4671.601 4671.783 4671.1301 4671.1309
FAA Doc:		*EASA CS Reference:*	CS 23.601 CS 23.783 CS 23.1301

Information Sources			
			CS 23.1309 CS 25.601 CS 25.783 CS 25.1301 CS 25.1309 CS 27.601 CS 27.1301 CS 27.1309 CS 29.601 CS 29.783 CS 29.1301 CS 29.1309

8.9.4 Inadvertent loosening or opening of mechanisms shall not restrict the operation of any flight control system.

Consideration should be given to:

a. Air vehicle doors, door latches, locks, or fasteners;

b. Any adverse effect on the aerodynamic performance or flying qualities of the air vehicle with the door etc. loose or open.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix I, 3.4.9.1.3, 3.4.9.4, 3.4.9.3 MIL-M-87222 Mechanical Systems for Aircraft Doors and Canopies: 3.1.2.6; 4.1.2.6 - inactive for new design	*Def-Stan 00-970 Reference:*	00-970 P1 4.20.1 00-970 P1 4.20.7 00-970 P1 4.20.8 00-970 P1 4.20.10 00-970 P1 4.23.9 00-970 P1 4.23.22
		STANAG Reference:	4671.601 4671.783 4671.1301 4671.1309
FAA Doc:		*EASA CS Reference:*	CS 23.601 CS 23.607 CS 23.783 CS 23.1301 CS 23.1309 CS 25.601 CS 25.607 CS 25.783 CS 25.1301 CS 25.1309 CS 27.601 CS 27.607 CS 27.1301 CS 27.1309 CS 29.601

Information Sources			
			CS 29.607 CS 29.783 CS 29.1301 CS 29.1309

8.9.5 No single failure shall allow any latch to open inadvertently.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix I, 3.4.9.1.3, 3.4.9.4 MIL-M-87222 Mechanical Systems for Aircraft Doors and Canopies: 3.1.5.1; 4.1.4.2 - inactive for new design	*Def-Stan 00-970 Reference:*	00-970 P1 4.20.1 00-970 P1 4.20.7 00-970 P1 4.20.8 00-970 P1 4.23.9 00-970 P1 4.23.40 00-970 P1 4.23.41
		STANAG Reference:	4671.601 4671.783 4671.1301 4671.1309
FAA Doc:		*EASA CS Reference:*	CS 23.601 CS 23.783 CS 23.1301 CS 23.1309 CS 25.601 CS 25.783 CS 25.1301 CS 25.1309 CS 27.601 CS 27.1301 CS 27.1309 CS 29.601 CS 29.783 CS 29.1301 CS 29.1309

8.9.6 Any locking system shall be incapable of locking, or indicating it is locked, unless all the latches are properly latched in the fully secured position.

Consideration should be given to:

a. Establishing the independence of the locking and latching mechanisms;

b. The correct door, or hatch, locking and latching sequence is clearly identified in the aircraft documentation;

c. A locked indication should only be produced when the door or hatch is fully locked and latched.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix I, 3.4.9.1, 3.4.9.4 MIL-M-87222 Mechanical	*Def-Stan 00-970 Reference:*	00-970 P1 4.20.1 00-970 P1 4.20.7 00-970 P1 4.20.8

Information Sources			
	Systems for Aircraft Doors and Canopies: 4.1.5.7 - inactive for new design		00-970 P1 4.20.10 00-970 P1 4.23.10
		STANAG Reference:	4671.601 4671.783 4671.1301 4671.1309
FAA Doc:		*EASA CS Reference:*	CS 23.601 CS 23.783 CS 23.1301 CS 23.1309 CS 25.601 CS 25.783 CS 25.1301 CS 25.1309 CS 27.601 CS 27.1301 CS 27.1309 CS 29.601 CS 29.783 CS 29.1301 CS 29.1309

8.9.7 All air vehicle doors, whose inadvertent opening would present a probable hazard to continued safe flight and landing, shall have provisions to prevent depressurisation of the air vehicle to an unsafe level if the doors are not fully closed, latched, and locked.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix I, 3.4.9.1, 3.4.9.4 MIL-M-87222 Mechanical Systems for Aircraft Doors and Canopies: 3.1.5.8; 4.1.5.8 - inactive for new design	*Def-Stan 00-970 Reference:*	00-970 P1.4.20.1 00-970 P1 4.20.7 00-970 P1 4.20.8
		STANAG Reference:	4671.601 4671.1301 4671.1309
FAA Doc:		*EASA CS Reference:*	CS 23.601 CS 23.1301 CS 23.1309 CS 25.365 CS 25.601 CS 25.783 CS 25.1301 CS 25.1309 CS 27.601 CS 27.1301 CS 27.1309 CS 29.601 CS 29.1301 CS 29.1309

8.9.8 The indication system shall continuously monitor and provide: an 'unsafe' indication when the door, latching, or locking system is unsecured; and a 'safe' indication when the system is secured.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix I, 3.4.9.1, 3.4.9.4 MIL-M-87222 Mechanical Systems for Aircraft Doors and Canopies: 3.1.7.1; 4.1.7.1 - inactive for new design	*Def-Stan 00-970 Reference:*	00-970 P1 4.20.1 00-970 P1 4.20.7 00-970 P1 4.23.10
		STANAG Reference:	4671.601 4671.783 4671.1301 4671.1309
FAA Doc:		*EASA CS Reference:*	CS 23.601 CS 23.783 CS 23.1301 CS 23.1309 CS 25.601 CS 25.783 CS 25.1301 CS 25.1309 CS 27.601 CS 27.1301 CS 27.1309 CS 29.601 CS 29.783 CS 29.1301 CS 29.1309

8.9.1 Merged with 9.1

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix I, 3.4.9.1, 3.4.9.4.11 MIL-M-87222 Mechanical Systems for Aircraft Doors and Canopies: 3.1.9.4; 4.1.9.4 - inactive for new design	*Def-Stan 00-970 Reference:*	Merged with 9.1
		STANAG Reference:	Merged with 9.1
FAA Doc:		*EASA CS Reference:*	Merged with 9.1

8.9.10 All door seals shall prevent rain or water leakage into the air vehicle during all flight and ground operations, and while the air vehicle is parked and depressurised under storm conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix I: 3.4.9.1.10; 3.4.9.4 MIL-M-87222 Mechanical Systems for Aircraft Doors and	*Def-Stan 00-970 Reference:*	00-970 P1 4.3.4 00-970 P1 4.20.1 00-970 P1 4.20.16 00-970 P1 7.2.6

Information Sources			
	Canopies: 3.1.10.2; 4.1.10.2 - inactive for new design		00-970 P13 3.11.21
		STANAG Reference:	4671.601 4671.609 4671.1301 4671.1309
FAA Doc:		*EASA CS Reference:*	CS 23.601 CS 23.609 CS 23.1301 CS 23.1309 CS 25.601 CS 25.609 CS 25.1301 CS 25.1309 CS 27.601 CS 27.609 CS 27.1301 CS 27.1309 CS 29.601 CS 29.609 CS 29.1301 CS 29.1309

8.9.11 All actuation subsystems shall be able to operate and complete all functional actions safely under all expected mission and environmental conditions. This shall include the ability to be locked and unlocked; provide for folding, unfolding, and deploying; and be folded, unfolded, and deployed, without damage, within the following ground wind environments:

• Atmospheric and weather induced conditions;

• Wind-over-deck (i.e. from carrier vessel movement);

• Downwash and jetwash conditions from other vehicles expected in the operational ground/deck environment.

Any removable surface securing locks used shall be such that one man can secure the surface in the above ground wind environments.

Consideration should be given to:

a. The worst case environmental conditions the air vehicle is likely to experience in service, to be agreed and verified;

b. Winds from any horizontal direction (accommodating ship pitch and roll motions), up to the agreed wind speed limits / sea state.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009, Appendix I: 3.4.9.1.10; 3.4.9.4; I.4.4.9.4.1	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.9.12 Actuation mechanisms that also provide a structural load path, shall incorporate redundant means of securing and locking the mechanism in position, in order to maintain Safety-of-Flight (SOF).

Consideration should be given to:

a. Safety of flight and critical single load path systems;

b. Ensuring verification methods are consistent with the approach taken with respect to the airframe structure specification;

c. Integrating verification within the air vehicle structural test programs.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009, Appendix I: 3.4.9.1.10; 3.4.9.4; 3.4.9.4.2; 4.4.9.4.2	*Def-Stan 00-970 Reference:*	00-970 P1 3.4.15
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.9.13 The locked-unlocked condition of mechanisms used during ground operations or in the interior of the vehicle (cargo or cockpit spaces) shall be visually displayed in the cockpit, on the air vehicle, and in all remote operator control locations during ground operations.

Consideration should be given to:

a. Ensuring cockpit positive engagement indication systems are closely coordinated with the parties responsible for cockpit display design;

b. The use of indicating sensors linked to the actual surface being operated, rather than having the sensor mounted on the actuating unit itself.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009, Appendix I: 3.4.9.4; 3.4.9.4.3; 4.4.9.4.3	*Def-Stan 00-970 Reference:*	00-970 P1 4.20.7
		STANAG Reference:	4671.783 4671.1721
FAA Doc:		*EASA CS Reference:*	CS 23.783 CS 25.783 CS 29.783

8.9.14 Each utility actuation mechanism shall permit controlled operation of both normal and emergency functions; and where possible, shall provide a separate means for “motion” and “locking” control, such that both actuation power and control for moving the mechanism to its commanded position, is independent from the power and control used to hold the mechanism in its initial and final commanded state.

Consideration should be given to:

a. Provisions for preventing inadvertent actuation of a control, such as guards etc.;

b. Motion is typically of a limited (2 position) nature and may require positive locking in one or all positions;

c. Susceptibility of locking and motive functions to extraneous interference causing inadvertent commands or motion (such as electromagnetic interference (EMI)).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009, Appendix I: 3.4.9.1.10; 3.4.9.4; 3.4.9.4.4; 4.4.9.4.4	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.9.15 Actuation subsystems that have provision for manual operation shall include safety devices in order to prevent injury to maintainers in case of inadvertent application of power during a manually powered operation. For those actuation subsystems that require the maintainer to be in very close proximity during stowage or deployment (such as boarding ladders), means of controlling deployment speed to a specified safe rate shall also be incorporated.

Consideration should be given to:

a. Incorporating a means of ensuring subsystem shutdown, rather than a hiatus in subsystem operation, (such as thermal overheat switches) in order to prevent continued subsystem operation, where such operation could result in an inadvertent deployment;

b. Safety devices which provide retention capability to keep mechanisms in the locked and hold position;

c. Ensuring the safety of the maintainer as well as the equipment and air vehicle itself are safeguarded during operation of the actuation system.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009, Appendix I: 3.4.9.1.10; 3.4.9.4; 3.4.9.4.5; 4.4.9.4.5	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

8.9.16 Utility actuation mechanisms (e.g. wing/tail folding/spreading etc.) shall be capable of operating from the ground power supplied to the air vehicle, as well as air vehicle supplied power, without affecting performance, control, or indication.

Consideration should be given to:

a. Ensuring control, actuation, indication and functional performance parameters are the same for both ground and air vehicle powered actuation;

b. Ensuring there is no change in how the systems perform, nor in how the controls or indication logic and/or sequencing acts;

c. Identifying any malfunction which could give a false indication, i.e. safe indication for an unsafe condition.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009, Appendix I: 3.4.9.1.10; 3.4.9.4; 3.4.9.4.6;	*Def-Stan 00-970 Reference:*	

Information Sources			
	4.4.9.4.6	*STANAG Reference:*	
FAA Doc:		*EASA CS Reference:*	

8.9.17 All actuation subsystems shall safely perform their specific functions within the specified times and cycles.

Allowable intervals between actuation cycles shall also be specified, as well as total cycles expected during the application lifetime.

Consideration should be given to:
a. Specified actuation times and cycles for each system actuation, to be agreed and specified;
b. Ensuring the time between successive operations of the same cycle is not degraded over time and can be consistently repeated, for the design service life;
c. Ensuring the time between initiation of the command to the completion of the action is within the design allowable;
d. Ensuring specified times and cycles are compatible with the air vehicle operational requirements.;
e. Integrating a common cycle requirement between related systems that operate in conjunction with each other, such as blade and wing stow subsystems on the same air vehicle.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009, Appendix I: 3.4.9.1.10; 3.4.9.4; 3.4.9.4.7; 4.4.9.4.7	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.9.18 Utility actuation mechanisms (e.g. wing/tail folding/spreading etc.) shall incorporate some means to prevent damage to adjacent movable surfaces (e.g. flaps) during folding and unfolding operations.

Consideration should be given to:
a. Use of mechanical interlocks or control logic to prevent actuation power/movement when other mechanical surfaces or flight control surfaces are in a position to be damaged or compromised;
b. The environmental effects (such as wind, temperature and snow/ice).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009, Appendix I: 3.4.9.1.10; 3.4.9.4; 3.4.9.4.8; 4.4.9.4.8	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.9.19 Attachment of actuation subsystems to the air vehicle, shall not form an integral part of the air vehicle structure (such as a wing rib etc.), but shall be a replaceable attachment, designed such that:

• In case of an overload or fatigue failure event, failure of the attachment shall occur in lieu of air vehicle primary structural component failure;

• No structural failure of the mechanical system actuation system, or its attachment fitting, causes damage to air vehicle structure;

• Replacement of mechanical system attachment does not require the replacement of major structures (such as bulk head, keel beams, etc.).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009, Appendix I: 3.4.9.1.10; 3.4.9.4; 3.4.9.4.9; 4.4.9.4.9	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.9.20 Sufficient clearances shall be maintained between the wing / rotor blade folding mechanism and all other air vehicle and ground equipment, in both the deployed and stowed positions, and during the deployment operation, in order to prevent damage to the surface, attached equipment, and to other areas of the air vehicle.

Consideration should be given to:

a. Ensuring adequate clearances with the air vehicle; both stationary, and in motion;

b. The most critical combination of unsymmetrical landing gear deflections, flat tyres, or compressed landing-gear-ground-interface-device (skid, air cushions);

c. Worn states of various components;

d. The environmental effects (such as wind, temperature and snow/ice).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009, Appendix I: 3.4.9.1.10; 3.4.9.4; 3.4.9.4.10; 4.4.9.4.10	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.9.21 Utility actuation mechanisms (e.g. wing/tail folding/spreading etc.) used during ground operations shall have a purely manual backup available for motive power and locking/unlocking purposes, if the primary mode of operation is automatic or powered (or both), in order to permit operation during power-off conditions.

Subsystems used for purely in-flight applications shall also have means incorporated to allow cockpit-controlled activation for ground maintenance actions.

Consideration should be given to:

a. Provisions to prevent hazards to maintenance personnel or damage critical components that could cause blade/wing/tail surface control loss or damage to electrical connectors, control lines, or such during normal, manual, or externally powered blade-folding and spreading;

b. Power-off conditions due to maintenance, or emergency conditions (e.g. failed power units);

c. Externally-applied-load backdrive protection;

d. Maintainer-induced overload protection;

e. Ensuring successful operation with a coating of ice covering any locking mechanism or locked/unlocked indicating mechanism.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009, Appendix I: 3.4.9.1.10; 3.4.9.4; 3.4.9.4.11; 4.4.9.4.11	*Def-Stan 00-970 Reference:*	00-970 P1 4.20.11
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.9.22 The locked-unlocked condition of mechanisms used during ground operations or in the interior of the vehicle (cargo or cockpit spaces) shall be visually displayed, externally, internally, or both if required, by purely mechanical, non-electric means. The provisions shall be discernible under operating lighting conditions, by a crew member using a flashlight or an equivalent lighting source.

Consideration should be given to:

a. Direct visual inspection of the locking mechanism itself;

b. Use of flags, distinctively coloured cylinders, and distinctively coloured portions of the air vehicle surface that are revealed by the actuating mechanism itself for external identification;

c. Identification during day or night conditions;

d. Ensuring devices are visible from any area that a maintainer could be expected to be during the actuation cycle.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 I: 3.4.9.4.13; 4.4.9.4.13	*Def-Stan 00-970 Reference:*	00-970 P1 4.20.7
		STANAG Reference:	4671.783
FAA Doc:		*EASA CS Reference:*	CS 23.783 CS 25.783 CS 29.783

8.9.23 For ground operation with power off, means shall be provided to hold the air vehicle doors in the open or closed position. Manually operated hold-open latches provided to secure doors in the open position, shall incorporate a lock, and shall be located in an area where personnel can access safely. Subsequent power operation of the doors, with these means left in place, shall not result in damage.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 3.4.9.1.c, 3.4.9.1.13	*Def-Stan 00-970 Reference:*	00-970 P1 4.20.3 00-970 P1 4.20.11
		STANAG Reference:	4671.783
FAA Doc:		*EASA CS*	CS 23.783

Information Sources			
		Reference:	CS 25.783 CS 29.783

8.9.24 All powered doors shall operate safely, in order to prevent injury or damage during their actuation cycle. Controls shall be capable of stopping or reversing door movement at any time in the cycle at the option of the operator by selecting the appropriate control option. In the event of power loss / interruption in any associated system, doors shall not change position; and door controls shall go to the stop position and not require reprogramming upon resumption of power. In the event of a malfunction or failure part way through a cycle, door controls shall automatically stop the sequence.

Consideration should be given to:

a. Conducting failure modes and effects analysis to predict the consequence of hydraulic, pneumatic, electrical or mechanical failures;

b. Use of a positive mechanical device to prevent change in selected door positions due to fluid bleeding down after fluid power is shut off or loss of electrical power.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 3.4.9.1.2, 3.4.9.1.9.a, 3.4.9.1.9.d	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

8.9.25 Merged with 8.9.24

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	Merged with 8.9.24
		STANAG Reference:	Merged with 8.9.24
FAA Doc:		*EASA CS Reference:*	Merged with 8.9.24

8.9.26 Actuation systems designed for ground-only operation (such as a boarding ladder) shall be fitted with locking mechanisms which incorporate a means of operational command interrupt, in order to prevent in-flight actuation, which might cause damage or departure of the system from the air vehicle. All mechanical and powered locks and actuators shall be designed to prevent undesired surface positioning in flight.

In the case of flight critical surfaces (such as wings/rotor blades), control of the “fold” sequence shall require two separate deliberate pilot actions, in order to prevent inadvertent actuation.

Consideration should be given to:

a. Utilising a “weight-on-wheels” (WOW) switch to prevent operation of ground-only actuating subsystems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 3.4.9.4.2	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.9.27 Actuation systems shall incorporate positive locking features, (i.e. which do not depend on any power source to remain engaged), with provision to:

• Prevent inadvertent actuation following the activation and subsequent relief of safety devices (such as thermal switches, fuses etc.); and,

• Lock folding wings, blades or other folding/stowing surfaces in the folded/stowed position.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 3.4.9.4.2	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.9.28 If permitted for use, removable surface securing locks shall be capable of withstanding rough handling without damage, and shall have strength equal to or exceeding that of the air vehicle.

Consideration should be given to:

a. Surface securing devices to be used in lieu of integral locks, only when specifically authorised;

b. Ensuring external securing devices are designed to reduce or eliminate the possibility of FOD during removal/installation;

c. Ensuring external bladefold securing devices are transportable within the air vehicle to remote staging and operating areas;

d. Use in situations where high wind/sea state conditions occur and it is not feasible to move the air vehicle to a safer location or within a hangar;

e. Withstanding maintainer induced loads (such as potential jam/forcing conditions), as well as normal environmental loads, such as wind, or shipboard movement.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 3.4.9.4.12	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.9.29 Airframe bearing selection and installation shall permit safe mechanical operation / function in each application, and shall be capable of:

• Joining mechanical elements;

• Transmitting design loads through the full range of the system operating parameters;

• Permitting rotation, misalignment, or both while maintaining a specified dimensional relationship between the joined elements;

• Reducing friction and wear; and making them more predictable.

Airframe bearings shall be standardised to the maximum extent possible without compromising performance

Consideration should be given to:

a. Selecting standard bearings in all applications, wherever possible, in order to minimise the cost of procurement and testing, reduce schedule and technical risk, and obtain multiple sources of supply;

b. The use of existing bearing selection parameters, such as MIL-HDBK-1599 Table 201-VII;

c. Ensuring bearings are durable, and are suitable for each application (e.g. whether to use anti-friction or plain bearings).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 App 1.3.4.9.2 MIL-HDBK-1599	*Def-Stan 00-970 Reference:*	00-970 P1 4.5
		STANAG Reference:	4671.603 4671.613 4671.657 4671.693
FAA Doc:		*EASA CS Reference:*	CS 23.603 CS 23.613 CS 23.657 CS 23.693 CS 25.603 CS 25.613 CS 25.657 CS 25.693 CS 27.603 CS 27.613 CS 29.603 CS 29.613

8.10. EXTERNAL CARGO HOOK SYSTEMS (ROTARY WING).

This section covers the design, installation, arrangement, compatibility and use of Cargo Hooks for carriage of underslung loads by the Air Vehicle.

Included within the scope of this section are:

• The Operational Design Case (definition of the operational requirement in terms of number of items, total weight, size etc).

• Dynamic and static structural loads and load paths (normal, ultimate and proof). Impact on structural fatigue, loading and wear.

• Handling qualities and performance throughout the operating envelope (including on ground) caused by the installation and loads carried; including movement and dynamic effects, relative position, inertia and abnormal release.

• Normal and emergency conditions including egress from air vehicle on land and at sea.

• Limit of suspended load (weight and distance from aircraft) and impact on structure including harmonic resonance and the effect of gusts and oscillations.

• Electromagnetic compatibility (EMC) / electromagnetic interference (EMI) impact of installation to and from aircraft and other systems (normal and emergency).

• Safety of personnel in the air and on the ground.

• Provides sufficient and suitable controls, switches and indicators for the crew to monitor, manage and control the system in all modes of operation.

• Positioning, content and method of fixing warning and advisory decals, notices and placards on the aircraft, the installation and components.

• Precise definition of extent of installation (i.e. that which is aircraft structure and that which is installation or role equipment).

• Impact on existing and need for additional maintenance inspections.

8.10.1 Ensure that operation of the cargo hook system in normal, automatic and emergency modes does not adversely affect safety of the air vehicle.

Consideration should be given to:

a. The Operational Design Case (definition of the requirement in terms of number of items, total weight, size etc);

b. Static and dynamic impact of all normal, automatic and emergency modes of operation on the stability and handling of the air vehicle;

c. The effects of failures of any single element;

d. Strength (proof and ultimate) factors to be employed;

e. Resonance and turbulence;

f. Fatigue strength of parts of the structure affected by forces resulting from underslung loads.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Refer to technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P7 S2 L205 00-970 P7 S2 L205/1 00-970 P7 S2 L205/2 00-970 P7 S10 L1017
		STANAG Reference:	2445 2286
FAA Doc:	14CFR reference Parts 27 and 29	*EASA CS Reference:*	CS 27.865 CS 29.865

8.10.2 Verify that cockpit switches and indicators for the cargo hook system provide for normal, automatic and emergency release of cargo.

Consideration should be given to:

a. Providing sufficient and suitable controls, switches and indicators for the crew to monitor, manage and control the system;

b. Requirements for safety of personnel in the air and on the ground;

c. Appropriate positioning and function of cockpit switches and indicators, together with clear and unambiguous labelling and indication;
This applies for all modes of operation, in all weathers, operating environments, day and night.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Refer to technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P7 S1 L105 11.3 00-970 P7 S7 L714 2.4 00-970 P7 L205 2.7
		STANAG Reference:	
FAA Doc:	14CFR references: 133 Amendment No. 133-11, 133 Amendment No. 133-9 (Rotorcraft External-Load Operations)	*EASA CS Reference:*	CS 27.865(b) CS 27.865(c) CS 29.865(b) CS 29.865(c)

8.10.3 Verify that cargo can be hooked safely to the hook and that the manuals contain the maximum and minimum loads for safe movement of cargo.

Consideration should be given to:
a. Requirements for safety of personnel in the air and on the ground;
b. Operating publications, safe load placards and signage.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Refer to technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P7 S2 L205 00-970 P7 S2 L205/1 00-970 P7 S2 L205/2 00-970 P7 S10 L1017
		STANAG Reference:	2445 2286
FAA Doc:	14CFR references: 133 Rotorcraft External-Load Operations, subpart D- Airworthiness Requirements, sec.133.45	*EASA CS Reference:*	CS 27.25 CS 27.865 CS 27.1581 CS 27.1583 CS 29.25 CS 29.865 CS 29.1581 CS 29.1583

8.10.4 Verify that the electromagnetic environment of the air vehicle is compatible with safe loading and release of external under-slung cargo on external cargo hooks under normal, emergency and failure mode conditions.

Consideration should be given to:
a. Intended normal operating electromagnetic environment - e.g. land based, ship-based;
b. Electromagnetic compatibility (EMC) / electromagnetic interference (EMI) impact of installation to and from aircraft and other systems (normal and emergency);
c. Impact on other systems, subsystems and installations including electrical, hydraulic and pneumatic loading in normal, emergency and instances of single failure;

d. Safety of personnel in the air and on the ground;
e. Publication of limits and notices in aircrew, crew and maintenance manuals;
f. Positioning, content and method of fixing warning and advisory decals, notices and placards on the aircraft, the installation and components;
g. Impact on existing and need for additional testing or maintenance inspections.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Refer to technical point of contact for this discipline, listed in section A.2	*Def-Stan 00-970 Reference:*	00-970 P7 S7 L708 00-970 P7 S10 L1003 00-970 P7 S10 L1011 00-970 P7 S10 L1017 00-970 P7 S10 L1017/1 00-970 P2 L205 2.8
		STANAG Reference:	3516
FAA Doc:	14CFR references: 27.865 (Part 27 Airworthiness Standards: Normal Category Rotorcraft, subpart D-Design and Construction) 14CFR references: 29.865 (Part 29 Airworthiness Standards: Transport Category Rotorcraft, Subpart D-Design and Construction)	*EASA CS Reference:*	CS 27.865 CS 29.865

8.10.5 Verify that the air vehicle structure can support all loads imposed by the external transport of cargo during operational usage under normal, emergency and failure mode conditions.

Consideration should be given to:
a. Dynamic and static structure loads and load paths (normal, ultimate and proof). Structural fatigue, loading and wear;
b. Normal and emergency conditions;
c. Limit of suspended load (weight and distance from aircraft) and impact on structure including harmonic resonance and the effect of gusts and oscillations;
d. Publication of limits and notices on placards, in aircrew, crew and maintenance manuals.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Refer to the technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P7 S2 L205 00-970 P7 S2 L205/1 00-970 P7 S2 L205/2 00-970 P7 S10 L1017 8.1.4
		STANAG Reference:	
FAA Doc:	14CFR references: 27.865, 29.865	*EASA CS Reference:*	CS 27.25 CS 27.865 CS 29.25 CS 29.865

8.10.6 Verify that limits for the external cargo hook and supporting structure are defined and published in all applicable operator and maintenance manuals.

Consideration should be given to:

a. Dynamic and static structure loads and load paths (normal, ultimate and proof);

b. Normal and emergency conditions;

c. Limit of suspended load (weight and distance from aircraft) and impact on structure including harmonic resonance and the effect of gusts and oscillations.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Refer to the technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P7 S2 L205 00-970 P7 S2 L205/1 00-970 P7 S2 L205/2
		STANAG Reference:	
FAA Doc:	14CFR references: 27.865, 29.865	*EASA CS Reference:*	CS 27.25 CS 27.865 CS 27.1581 CS 27.1583 Appendix A27.3 CS 29.25 CS 29.865 CS 29.1581 CS 29.1583

8.10.7 Verify that flight performance and control of the air vehicle is not adversely affected by load movement experienced during external load operations or the emergency jettison of external cargo

Consideration should be given to:

a. Dynamic and static load conditions;

b. Normal and emergency conditions;

c. Limit of suspended load (weight and distance from aircraft) and impact on structure including harmonic resonance and the effect of gusts and oscillations.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Refer to the technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P7 S2 L205 00-970 P7 S2 L205/1 00-970 P7 S2 L205/2 00-970 P7 S2 L205 7.2 00-970 P7 S10 L1017 00-970 P7 S10 L1017/1
		STANAG Reference:	
FAA Doc:	14CFR references: 27.865, 29.865	*EASA CS Reference:*	CS 27.865 CS 29.865

8.11. EXTERNAL RESCUE HOIST (ROTARY WING).

This section covers the design, installation, arrangement, compatibility and use of External Rescue Hoists by the Air Vehicle.

The operation of Rescue Hoists can have a significant impact on the static and dynamic stability of the air vehicle as well as posing a hazard to other systems through electromagnetic incompatibility. In addition, the installation itself can pose hazards to personnel (tripping, obstruction, embark, egress), structural integrity and other systems from electrical loading. Many of these aspects are covered in general terms such as 'verify that sub-system operation in normal, automatic, and emergency modes does not adversely affect safety of the air vehicle system'. However, the following aspects, which come under the scope of other sections of the EMACC handbook, or are of an operational nature, should also be considered:

• Dynamic and static structure loads and load paths (normal, ultimate and proof). Structural fatigue, loading and wear.
• Handling qualities and performance throughout the operating envelope (including on ground) caused by the installation and loads carried; including movement and dynamic effects, relative position, inertia and abnormal release.
• Normal and emergency conditions including embarkation and egress to/from air vehicle on land and at sea.
• Limit of suspended load (weight and distance from aircraft) and impact on structure including harmonic resonance and the effect of gusts and oscillations.
• Electromagnetic compatibility (EMC) / electromagnetic interference (EMI) impact of installation to and from aircraft and other systems (normal and emergency).
• Impact on other systems, subsystems and installations including electrical, hydraulic and pneumatic loading in normal, emergency and instances of single failure.
• Provides sufficient and suitable controls, switches and indicators for the crew to monitor, manage and control the system in all modes of operation.
• Ensuring that ingress and egress of people and equipment (as defined in the requirement) can be achieved without endangering people or safe operation of the air vehicle.
• Safety of personnel in the air and on the ground.
• Publication of limits and notices in aircrew, crew and maintenance manuals.
• Positioning, content and method of fixing warning and advisory decals, notices and placards on the aircraft, the installation and components.
• Precise definition of extent of installation (i.e. that which is aircraft structure and that which is installation or role equipment).
• Impact on existing and need for additional maintenance inspections.

8.11.1 Verify that the external rescue hoist system does not adversely affect the safety of personnel or the air vehicle system.

Consideration should be given to:
a. Handling qualities and performance throughout the operating envelope (including on ground) caused by the installation and loads carried; including movement and dynamic effects, relative position, inertia and abnormal release;
b. Normal and emergency conditions including egress from air vehicle on land and at sea;
c. Limit of suspended load (weight and distance from aircraft) and impact on structure including harmonic resonance and the effect of gusts and oscillations;

d. Impact on other systems, subsystems and installations including electrical, hydraulic and pneumatic loading in normal, emergency and instances of single failure;
e. Provides sufficient and suitable controls, switches and indicators for the crew to monitor, manage and control the system in all modes of operation;
f. Safety of personnel in the air and on the ground;
g. Publication of limits and notices in aircrew, crew and maintenance manuals;
h. Positioning, content and method of fixing warning and advisory decals, notices and placards on the aircraft, the installation and components;
i. Precise definition of extent of installation (i.e. that which is aircraft system and that which is installation or role equipment);
j. Impact on existing and need for additional maintenance inspections.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Refer to technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P7 S7 L714 00-970 P7 S7 L723 00-970 P7 S10 L1017 00-970 P7 S10 L1017/1
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 27.1309 CS 29.1309

8.11.2 Verify that the external rescue hoist system operates safely under normal rated and emergency loading conditions.

Consideration should be given to:
a. Dynamic and static structure loads and load paths (normal, ultimate and proof). Structural fatigue, loading and wear;
b. Handling qualities and performance throughout the operating envelope (including on ground) caused by the installation and loads carried; including movement and dynamic effects, relative position, inertia and abnormal release;
c. Normal and emergency conditions including egress from air vehicle on land and at sea;
d. Limit of suspended load (weight and distance from aircraft) and impact on structure including harmonic resonance and the effect of gusts and oscillations;
e. Impact on other systems, subsystems and installations including electrical, hydraulic and pneumatic loading in normal, emergency and instances of single failure;
f. Publication of limits and notices on placards, in aircrew, crew and maintenance manuals.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Refer to technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P7 S7 L714 00-970 P7 S7 L723 00-970 P7 S10 L1017 00-970 P7 S10 L1017/1
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 27.1309 CS 29.1309

8.11.3 Verify that electromagnetic compatibility, interference levels and interoperability of the air vehicle and rescue hoist installation will enable safe operation under normal, emergency and failure mode conditions.

Consideration should be given to:

a. Intended normal operating electromagnetic environment - e.g. land based, ship-based;

b. Electromagnetic compatibility (EMC) / electromagnetic interference (EMI) impact of installation to and from aircraft and other systems (normal and emergency);

c. Impact on other systems, subsystems and installations including electrical, hydraulic and pneumatic loading in normal, emergency and instances of single failure;

d. Safety of personnel in the air and on the ground;

e. Publication of limits and notices in aircrew, crew and maintenance manuals;

f. Positioning, content and method of fixing warning and advisory decals, notices and placards on the aircraft, the installation and components;

g. Impact on existing and need for additional testing or maintenance inspections.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Refer to technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P7 S7 L723 00-970 P7 S7 L704 00-970 P7 S7 L708 00-970 P7 S10 L1003 00-970 P7 S10 L1011 00-970 P7 S10 L1017 00-970 P7 S10 L1017/1
		STANAG Reference:	3516
FAA Doc:		*EASA CS Reference:*	CS 27.865 CS 29.865 CS 29.1353 CS 29 1363

8.12. FAST ROPE INSERTION/EXTRACTION SYSTEM (FRIES) (ROTARY WING).

This section covers the design, installation, arrangement, compatibility and use Abseil and Fast Rope Insertion/Extraction Systems (FRIES) systems.

Included in the scope of this section are:

a. aircraft installation
b. role equipment (i.e. attachment frames, gantries or hooks and ropes)
c. personal equipment.

Original aircraft certification criteria often relates only to aircraft installation and interface aspects. Role equipment is often added by aftermarket suppliers and certified separately. Whist FRIES, Fast Rope and Abseiling installations do not tend to be technically complex, the Operational Design Case (number of people, modes of dispatch, etc) must be clearly articulated and defined. The following considerations, which come under the scope of other sections of the EMACC handbook, or are of an operational nature, should also be considered:

• Dynamic and static structural loads and load paths (normal, ultimate and proof). Structural fatigue, loading and wear.
• Handling qualities and performance throughout the operating envelope (including on ground) caused by the installation and loads carried; including movement and dynamic effects, relative position, inertia, snagging and abnormal release.
• Normal and emergency conditions including egress from air vehicle on land and at sea.
• Limit of suspended load (weight and distance from aircraft) and impact on structure including harmonic resonance and the effect of gusts and oscillations.
• Impact on other systems, subsystems and installations.
• Safety of personnel in the air and on the ground.
• Publication of limits and notices in aircrew, crew and maintenance manuals.
• Positioning, content and method of fixing warning and advisory decals, notices and placards on the aircraft, the installation and components.
• Precise definition of extent of installation (i.e. that which is aircraft structure and that which is installation or role equipment).
• Impact on existing and need for additional maintenance inspections.

8.12.1 Verify that any aircraft provision and installation for Abseil or Fast Rope Insertion / Extraction Systems has been properly designed and developed for such purposes and can facilitate such operations without endangering personnel or the aircraft.

Consideration should be given to:
a. Impacts on aircraft weight, balance and control during normal operation and in emergency situations (for example: engine failure);
b. Installation and positioning of attachment points;
c. Strength of surrounding structure to withstand static and in particular dynamic loading, often with varying load paths;
d. Inclusion of inspection regimes in maintenance documentation;
e. Ability of crewmembers to supervise and observe FRIES operation effectively;
f. Ability of crewmembers to terminate FRIES or Abseil operations immediately, should safety be jeopardised.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Refer to technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P7 S2 L205/1 00-970 P7 S4 L407/4 00-970 P7 S7 L714 2.1.4 00-970 P7 S10 L1017 00-970 P7 S10 L1017/1
		STANAG Reference:	2445
FAA Doc:		*EASA CS Reference:*	CS 27.865 CS 29.865

8.12.2 Verify that aircraft structure and fittings used for the purposes of FRIES, Fast Rope and Abseil insertion and extraction of personnel, possess adequate structural margins of safety.

Consideration should be given to:

a. Static and dynamic loading scenarios (catering for lateral, horizontal and compound load components as well as vertical);
b. Proof, Limit and Ultimate load factors to be applied;
c. Aircraft failure modes (i.e. engine failure during FRIES operation);
d. Impacts on aircraft weight, balance and fatigue;
e. Impact on surrounding structure;
f. Requirements to jettison FRIES equipment safely during routine or emergency situations;
g. Inclusion of inspection regime in maintenance documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Refer to technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P7 S2 L205 00-970 P7 S2 L205/1 00-970 P7 S7 L714
		STANAG Reference:	2445
FAA Doc:		*EASA CS Reference:*	CS 27.865 CS 29.865

SECTION 9 - CREW SYSTEMS

The crew systems area consists of the following elements: pilot-vehicle interface, aircrew station (accommodations, lighting, furnishings, and equipment), human-machine interface, UAV/ROA control station (operator accommodations, lighting, and equipment), the life support system, the emergency escape and survival system, the transparency system, crash survivability, and air transportability.

TYPICAL CERTIFICATION SOURCE DATA

1. Escape system requirements and validation
2. Crew station layout/geometry review
3. Human factors
4. Failure modes, effects, and criticality analysis (FMECA)
5. Life support system requirements and validation
6. Crash survivability requirements and validation
7. Lighting system design, analysis, test reports
8. Transparency integration
9. Air transportability, cargo, and airdrop systems
10. Load analyses
11. Aeroservoelastic analyses
12. Test plans
13. Test reports
14. Proof test results
15. Simulation test, modelling and results

CERTIFICATION CRITERIA

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010 Crew Systems	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	AC 20-41A, AC 20-60	*EASA CS Reference:*	

9.1. ESCAPE AND EGRESS SYSTEM.

This section covers the provision of means whereby the occupant(s) can leave the air vehicle during in-flight, water, and ground emergencies.

Included within the scope of this section are:

• Escape systems & assisted escape systems (ejection seat, parachutes, escape capsules or modules etc.);
• Escape path clearance systems (canopy jettison (including thrusters and rockets);
• Emergency escape exits and routes;
• Emergency egress assist devices (slides, descent reels, life rafts, rope etc.);

• Onboard and ground rescue egress equipment (crash axe, canopy penetrator, fire rescue axe, powered saw etc.)

Some criteria in this chapter are supported in the text by examples of specific considerations. These examples are by no means to be considered as exhaustive.

Verification should at least consider:
• The number or air vehicle occupants;
• The anthropometric range and mass of the aircrew;
• Consistency of exit sign design.

9.1.1 The escape system, or means to effect emergency escape, shall allow safe operation and egress from the air vehicle for ground, ditching and in flight (if required); and shall be integrated and compatible with the air vehicle and other sub-systems.

For assisted escape systems (automated ejection seats, escape capsules or modules) this includes ensuring no rigid objects (i.e. canopies and hatches) are located in the ejection path; and any movable objects which can enter the path are arranged that they are moved clear when the seat is fired.

Emergency egress systems shall be free of physical restrictions that could prevent occupants from rapidly releasing from their restraint systems, departing their seats, traversing egress routes, and passing through emergency exits.

If escape path clearance mechanisms are used they should minimise the risk to aircrew and their equipment. The escape path shall permit the safe egress of the most critical combination of aircrew and equipment specified for use with that escape system.

Consideration should be given to:
a. The possible need for shielding of objects above shoulder height (e.g. canopy rails) to minimise injuries which may be caused on ejecting under lateral "g" conditions;
b. Ensuring applied and inertial forces during escape are safe for speeds, which are to be agreed and verified;
c. Ensuring head and neck loads (neck tension, compression, shear force and combined neck moment and loads) that may be experienced during escape are safe;
d. Ensuring accelerations imposed on an ejection seat occupants do not exceed specified limits, which are to be agreed and verified;
e. Ensuring environmental hazards (overpressure, acoustic noise, flame, fragmentation etc.) to which the aircrew might be exposed on the escape path or due to the clearance mechanisms, are controlled and compatible with human exposure limits, which are to be agreed and verified;
f. Ensuring failure of the escape path clearance system does not prevent escape nor expose the air crew to undue risk of unacceptable injury;
g. Ensuring the method of escape path clearance produces minimal interference with the crew tasks;
h. The anthropometric range and mass of the aircrew;
i. Preventing the possibility of inadvertent operation;
j. Location and design of emergency controls;
k. The use of command ejection system;
l. Egress is achievable with all credible positions and/or attitudes following an abnormal landing;
m. Ensuring the means of moving objects clear of the ejection path is independent of any other system;
n. Ability to see outside the exit when exit is closed;

o. Ability to see the ground where the evacuee might land;
p. Engine(s) running at ground idle.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-3: 3.3.4 (Note: Unverified - no access to JSSG 2010-3) JSSG-2010-7: 3.7.3.5.3 JSSG-2010-11: 3.11.7, 3.11.7.2, 7.3.3.3.5.3 (Note: Unverified - no access to JSSG 2010 - 8, 9, 11, 13, 14) NATO Working Party 61	*Def-Stan 00-970 Reference:*	00-970 P1 4.23.8-4.23.11 00-970 P1 4.23.14-4.23.25 00-970 P1 4.23.32-4.23.36 00-970 P1 4.23.40-4.23.49 00-970 P1/5 S4 L63 00-970 P 13 1.6.15.8 00-970 P 13 1.6.15.9 ARGARD 330
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.803 CS 23.805 CS 23.807 CS 25.803 CS 25.807 CS 25.810 CS 27.805 CS 27.807 CS 29.803 CS 29.805 CS 29.807 CS 29.809

9.1.1.1 Air vehicle escape systems and subsystems shall be designed and demonstrated to meet the specified reliability and confidence.

Consideration should be given to:
a. Escape systems including ejection seats, capsules, modules, and escape path clearance systems;
b. Subsystems including Cartridge Actuated and Pyrotechnic Actuated Devices (CAD/PAD);
c. A programme of reliability tests, to be agreed and verified;
d. Specified system and subsystem reliability levels, to be agreed and verified;
e. Specified confidence intervals, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010 (Unverified - restricted access to parts of JSSG-2010) MIL-C-83124 (Unverified) MIL-C-83125 (Unverified) MIL-C-83126 (Unverified)	*Def-Stan 00-970 Reference:*	00-970 P1 4.22.67 00-970 P1 4.23.34 00-970 P1 S4 L75 Par. 18
		STANAG Reference:	
FAA Doc:		*EASA CS*	

Information Sources			
		Reference:	

9.1.2 Each crew and passenger area shall contain escape exits and escape routes of appropriate size, type, number, location and ease of opening, to permit rapid emergency evacuation of all air vehicle occupants following landing / ditching of the air vehicle. It shall be possible for all occupants to egress the air vehicle, within specified time limits.

Consideration should be given to:

a. Size, type, number, location and ease of opening of exits to be agreed and verified;

b. Specified time limits for ground / ditching evacuation, to be agreed and verified (typically 30-90 seconds);

c. Evacuation when all exits are functional, and when only half of the exits are functional;

d. Conducting an evacuation demonstration utilising the maximum number of occupants for which certification is desired;

e. Evacuation with landing gear extended or retracted;

f. Ensuring window-type emergency exits are not obstructed by seats or seat backs;

g. Minimum passenger aisle width;

h. Aircrew and passenger clothing and personal equipment;

i. Passenger entrance, crew, and service doors may be considered as emergency exits if they meet the requirements;

j. The use of devices for ground emergency egress assist;

k. The number of seats abreast on each side of the aisle;

l. Emergency evacuation routes for service compartment located below the main deck, which may be occupied during the taxi or flight but not during takeoff or landing;

m. Ensuring integral stairs in emergency exits do not impair the effectiveness of emergency egress;

n. The possibility of the air vehicle being on fire, and at maximum seating capacity;

o. Engine(s) running at ground idle;

p. The impact of a lockable pilot compartment door.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	NATO Draft Working Party 61B JSSG-2010 (Unverified - restricted access to parts of JSSG-2010)	*Def-Stan 00-970 Reference:*	00-970 P1 4.20.2 00-970 P1 4.22.3 00-970 P1 4.23.2 00-970 P1 4.23.4 00-970 P1 4.23.6 00-970 P1 4.23.7 00-970 P1 4.23.44 00-970 P1/5 S4 L63 00-970 P 13 1.6.15.8 00-970 P 13 1.6.15.9
		STANAG Reference:	
FAA Doc:	14CFR reference 25.803	*EASA CS Reference:*	CS 23.803 CS 23.805 CS 23.807 CS 23.813 CS 23.815

Information Sources			
			CS 25.772 CS 25.803 CS 25.807 CS 25.810 CS 25.813 CS 25.815 CS 25.817 CS 25.819 CS 27.805 CS 27.807 CS 29.803 CS 29.805 CS 29.807 CS 29.813 CS 29.815

9.1.3 All emergency exits shall be adequately marked so that their intended use and their means of operation are readily apparent to air crew and passengers and also, where appropriate, to rescue personnel approaching the air vehicle from outside.

Consideration should be given to:
a. Ensuring the design of exit signs are consistent throughout the air vehicle;
b. Ensuring the identity and location of each passenger emergency exit are recognisable from a distance, to be agreed and verified;
c. Identification in different light conditions, i.e. darkness, dense smoke;
d. Colour of external and internal markings;
e. Colour contrast;
f. Reflectance.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.8, 4.8, 3.9, 4.9, 3.11, 4.11, 3.12, 4.12, 3.13, 4.13, 3.14, 4.14 (Note: Unverified - no access to JSSG 2010 - 8, 9, 11, 13, 14)	*Def-Stan 00-970 Reference:*	00-970 P1 4.23.5
		STANAG Reference:	3230
FAA Doc:	14CFR reference: 23.803-23.815, 25.801-25.819, 23.1411, 23.1415, 25.1411, 25.1415, 25.813, 23.813, 25 Appendix F; 25 Appendix J 25.1423	*EASA CS Reference:*	CS 23.807(b) CS 23.811 CS 25.809 CS 25.810 CS 25.811 CS 27.807(b) CS 29.811

9.1.4 Emergency egress assist devices (slides, descent reels, life rafts, rope etc), their stowage and means of deployment shall be demonstrably safe. This includes safe use by the intended air crew and passengers; and ensuring deployment handles/actuators capable of creating a safety-of-flight (SOF) or injury hazard are designed to prevent inadvertent actuation.

Consideration should be given to:

a. The number and anthropometric range of occupants;
b. The egress time requirements, to be agreed and verified;
c. The operational environmental requirements, to be agreed and verified;
d. Applicable physical and power integration requirements, to be agreed and verified;
e. The use of different emergency assist devices may be dependant upon:
  i. The type and size of exit;
  ii. Whether it is intended for use by passengers or air crew;
  iii. The height of the exit from the ground;
f. Engine(s) running at ground idle.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.8, 4.8, 3.9, 4.9, 3.11, 4.11, 3.12, 4.12, 3.13, 4.13, 3.14, 4.14 (Note: Unverified - no access to JSSG 2010 - 8, 9, 11, 13, 14)	*Def-Stan 00-970 Reference:*	00-970 P1 6.8.22
		STANAG Reference:	
FAA Doc:	14CFR reference: 23.803-23.815, 25.801-25.819, 23.1411, 23.1415, 25.1411, 25.1415	*EASA CS Reference:*	CS 23.1411 CS 23.1415 CS 25.810 CS 25.1411 CS 25.1415 CS 27.1411 CS 27.1415 CS 29.1411 CS 29.1415

9.1.5 Emergency egress and rescue processes and procedures shall be developed, incorporated in system documentation, and implemented in training. This shall include provision of documentation that informs and enforces ground/ditching egress procedures for aircrew, passengers and rescue personnel.

Consideration should be given to:
a. Ensuring ground/ditching egress processes provide timely egress for aircrew and passengers;
b. Effectiveness of processes for rescue personnel including canopy, hatch/door removal by external actuation or cutting;
c. Engine(s) running at ground idle.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.8, 4.8, 3.9, 4.9, 3.11, 4.11, 3.12, 4.12, 3.13, 4.13, 3.14, 4.14 (Note: Unverified - no access to JSSG 2010 - 8, 9, 11, 13, 14)	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	14CFR reference: 23.803-23.815, 25.801-25.819, 23.1411, 23.1415, 25.1411, 25.1415	*EASA CS Reference:*	CS 23.1581 CS 23.1585 CS 25.1581 CS 25.1585 CS 27.1581 CS 27.1585 CS 29.1581

Information Sources			
			CS 29.1585

9.1.6 Egress equipment shall be provided to aid escape in the event exits are blocked, damaged, or when exit opening actuation fails; making it possible to create exits in aircraft transparencies and designated aircrew compartments.

Consideration should be given to:

a. Provision of either onboard devices such as crash axe, canopy penetrator, etc.; or

b. Ground recue tools such as fire rescue axe, powered saw.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	No information available in current JSSG. Information to be included in next revision of JSSG.	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	121.309, 121.310	*EASA CS Reference:*	

9.2. CREW STATIONS AND AIRCRAFT INTERIORS.

This section covers the design, arrangement and geometry of aircrew station accommodations, furnishings and equipment. This element also covers UAV Control Station (UAS) requirements, where appropriate.

Included within the scope of this section are:

- Arrangement and location of controls, displays and other human interfaces;
- Fields of view (minimising reflections, glare etc.);
- Control operability, including range of travel, restriction of movement;
- Materials used for air vehicle interiors (flame resistance, non-toxic);
- Intercommunication;
- Speech intelligibility.

Some criteria in this chapter are supported in the text by examples of specific considerations. These examples are by no means to be considered as exhaustive.

Verification should at least consider:

- Differing visual requirements of single seater, tandem or side by side configurations;
- The anthropometric range and mass of the aircrew;
- Type and role of air vehicle i.e. commercial, fighter, attack, bomber, transporter, maritime reconnaissance;
- Mission activities/tasks including take-off, landing and aerial refuelling.

9.2.1 Controls and displays shall be arranged and located to provide convenient operation (functional and visible). Cockpit or operators station geometry (including seats) and human interfaces shall accommodate the specified multivariate flight and mission crew population.

Consideration should be given to:

a. Anthropometric range of occupants and/or operators, to be agreed and verified;
b. The normal reach and sight of the operator when harnessed in his seat and wearing the appropriate clothing and equipment specified for that particular air vehicle;
c. Controls, which are in regular use in flight, should not be positioned aft of the pilot's shoulder line;
d. Ensuring no part of the controls lay in the region between the plane of rotation of any inboard propeller and the surface generated by a line passing through the centre of the propeller hub making an angle of 5º forward or aft of the plane of rotation of the propeller;
e. Ensuring specified flight instruments are grouped as required;
f. Ensuring specified flight instruments are centred about the vertical plane of the pilot’s forward vision, as required.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.1, 4.1, 3.2, 4.2, 3.3, 4.3, 3.4, 4.4, 3.5, 4.5, 3.14, 4.14 (Note: Unverified - no access to JSSG 2010 - 1, 2, 3, 4, 14) JSSG-2001: 3.4.3.1.1, typical anthropometric dimensions and ranges considered acceptable to accommodate the US pilot population JSSG-2001: 3.4.3.1.5, guidance on controls and displays MIL-STD-1472, section 5.6, design criteria and features recommended to provide human accommodation	*Def-Stan 00-970 Reference:*	00-970 P1 4.16.5 00-970 P1 4.19.44 00-970 P1 4.19.46 00-970 P1 4.19.48-4.19.50 00-970 P1 4.19.51 00-970 P7 S1 L105 3.1
		STANAG Reference:	4671.1703 4671.1721 4671.1731
FAA Doc:	14CFR references: 23.777, 25.777	*EASA CS Reference:*	CS 23.771 CS 23.777 CS 23.1321 CS 25.771 CS 25.777 CS 25.1321 CS 27.771 CS 27.777 CS 27.1321 CS 29.771 CS 29.777 CS 29.1321

9.2.1.1 All displays and indications shall be easily legible from the operator's position, for the full range of ambient lighting conditions.

Consideration should be given to:
a. Varying operator's eye positions given the anthropometric range of occupants, to be agreed and verified;

b. Ensuring displays are readable under all expected illumination conditions from full darkness to direct sunlight, including during NVG operations if required;
c. Ensuring the clarity of information is not adversely affected by reflection;
d. Minimising reflection of instruments and consoles in windshields and other enclosures;
e. The expected electronic display brightness level at the end of an electronic display indicator's useful life;
f. Minimising direct or indirect glare from lights.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.1, 4.1, 3.2, 4.2, 3.3, 4.3, 3.4, 4.4, 3.5, 4.5, 3.14, 4.14 (Note: Unverified - no access to JSSG 2010 - 1, 2, 3, 4, 14) MIL-STD-1472, section 5.2 addresses visual displays of various types	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.49 00-970 P1 4.15.54 00-970 P1 4.15.55 00-970 P1 4.16.5 00-970 P1 4.19.46 00-970 P1 4.19.51 00-970 P1 L105.15.2
		STANAG Reference:	4671.1721
FAA Doc:	14CFR references: 23.777, 25.777	*EASA CS Reference:*	CS 23.777(b) CS 25.699 CS 25.777 CS 27.777(b) CS 29.777

9.2.1.2 The air vehicle shall provide the aircrew with sufficient interior and exterior fields of view to maintain flight, safely perform all flight and mission-critical functions and tasks, and avoid ground or flight obstacles. Internal visual capabilities shall afford the intended population an unobstructed view of the flight instruments and other critical components and displays. The unimpaired external vision and/or transmitted visual indications available to the aircrew shall be free from unsafe blind spots that can introduce hazardous conditions, and shall meet the specified requirements and minimum angles appropriate to air vehicle class, type and operational role.

Consideration should be given to:
a. External vision / rectilinear plot to be agreed and verified (within plus and minus 180º in azimuth and plus and minus 90º in elevation);
b. The zero reference in azimuth, to be agreed and verified (typically the plane of pilot's vision parallel to the horizontal in cruising flight);
c. Differing visual requirements of single seater, tandem or side by side configurations;
d. Type and role of air vehicle, i.e. commercial, fighter, attack, bomber, transporter, maritime reconnaissance;
e. Mission activities/tasks including takeoff, landing and aerial refuelling;
f. Ensuring controls, consoles, instrument panels, headup display ancillary equipment and other structures are located so as not to critically restrict vision;
g. Ensuring the windscreen directly in front of the pilots is as free of structure as possible;
h. Seat adjustment to allow the pilot to place his eyes at the level of the aircraft design eye position;
i. Avoiding blind spots from posts, canopy bow, windshield frames, heads up display (HUD) supports, etc;
j. Anthropometric range of occupants and/or operators, to be agreed and verified.

For UAVs, the design of the control station must facilitate the command and control of the UAV by the UAV crew for safe operations.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.1, 4.1, 3.2, 4.2, 3.3, 4.3, 3.4, 4.4, 3.5, 4.5, 3.14, 4.14 (Unverified) JSSG-2010: 4.3.2, rectilinear plots (Unverified) JSSG-2010-3: 3.3.2, rectilinear plots (Unverified) JSSG-2001: 3.4.3.1.7 and 3.4.3.1.8, interior and exterior vision, respectively	*Def-Stan 00-970 Reference:*	00-970 P1 4.16.12 00-970 P1 4.16.19 00-970 P1 4.17.2 00-970 P1 4.17.4 00-970 P1 4.17.6-4.17.10 00-970 P1 4.17.12-15 00-970 P1/5 S4 L63, 00-970 P1/5 S4 L104 2.1 00-970 P1/5 S4 L104 2.2 00-970 P1/5 S4 L104 3.6 00-970 P1/5 S4 L104 4
		STANAG Reference:	4671.1701
FAA Doc:	14CFR references: 23.771-23.781, 25.771-25.781	*EASA CS Reference:*	CS 23.773(a) CS 25.773 CS 27.773(a) CS 29.773(a)

9.2.2 Each control shall be designed, located and arranged, with respect to the pilots' and/or operators' seat, to allow unrestricted movement throughout the full range of travel, without interference from other controls, structures, aircrew bodies, their clothing or equipment. Controls shall be operable by the full anthropometric range of aircrew population. This shall include operation of all controls essential for crew survival (including ejection controls) from crewmember restrained positions under all flight conditions, air vehicle attitudes and throughout the complete range of "g" force loads.

Consideration should be given to:

a. The anthropometric range of occupants, to be agreed and verified;

b. Sufficient clearance between controls to permit unrestricted operation by the largest specified gloved hand;

c. Sufficient clearance to prevent interference between the largest specified flight boot and air vehicle structure for the yaw control;

d. The location and actuation of the stick/wheel control to consider arm reach;

e. Ensuring ejection controls (automatic and/or manual) are readily accessible and activation is possible with either hand;

f. Provisions are incorporated to guard against accidental activation of ejection system/controls;

g. Specified flight conditions and vehicle attitudes to be agreed and verified.

For UAVs, controls shall located and arranged so that the UAV crew, when at their workstation have full and unrestricted movement of each control without interference from either their clothing or the UCS structure. Controls needed for continued safe flight and landing shall remain available to the UAV crew in normal, abnormal and emergency conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.1, 4.1, 3.2, 4.2, 3.3, 4.3, 3.4, 4.4, 3.5, 4.5, 3.14, 4.14 (Unverified) JSSG-2001: 3.4.3.1.1, typical	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.22 00-970 P1 4.16.5-4.16.9 00-970 P1 4.16.18 00-970 P1 4.19.2

Information Sources			
	anthropometric dimensions and ranges considered acceptable to accommodate the US pilot population JSSG-2010-3: 4.3.3, Table VI, definition and application of zones (Unverified)		00-970 P1 4.19.31-4.19.32 00-970 P1 S4 L63
		STANAG Reference:	4671.1731
FAA Doc:	14CFR references: 23.771-23.781, 25.771-25.781	*EASA CS Reference:*	CS 23.777 CS 23.779 CS 25.777 CS 25.779 CS 27.777 CS 27.779 CS 29.777 CS 29.779

9.2.3 Visual caution and warning displays shall be located in the operator's prime field of vision, and shall alert the operator of all hazardous situations in a fashion that permits rapid detection sufficient for the operator to take actions necessary for safe flight.

Consideration should be given to:

a. Locating visual cautions and warnings within the 30º cone of vision of the operator’s normal line of sight;

b. The possibility of locating visual cautions and warnings outside the pilots 30° cone of vision when space is limited, or the required number is excessive;

c. Alerting the operator to all specified hazardous situations which could present a hazard to the safety of the occupants, endanger human life, or cause substantial damage to the air vehicle, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	14CFR references: 23.1321-23.1322, 25.1321-25.1322	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.35 00-970 P1 4.15.49 00-970 P1 4.15.59
		STANAG Reference:	4671.1721 4671.1785
FAA Doc:	14CFR references: 23.1321-23.1322, 25.1321-25.1322	*EASA CS Reference:*	CS 23.1321 CS 23.1322 CS 25.1321 CS 25.1322 CS 27.1321 CS 27.1322 CS 29.1321 CS 29.1322

9.2.4 Emergency action controls shall be appropriately marked, in accordance with the specified requirements.

Consideration should be given to:

a. Specified marking requirements to be agreed and verified (including colours and wording);

b. Emergency controls to be included, to be agreed and verified;

c. Outlining functional groups;

d. Ensuring no other controls are the same colour as emergency controls.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.1, 4.1, 3.2, 4.2, 3.3, 4.3, 3.4, 4.4, 3.9.7, 3.14, 4.14 (Unverified)	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.22-4.15.25 00-970 P9 UK 1555a 00-970 P19 UK 1845
		STANAG Reference:	4671.1845 3230
FAA Doc:	14CFR references: 23.1555, 23.1561, 25.1555, 25.1561 ASCC Air Standard 10/23E (Unverified)	*EASA CS Reference:*	CS 23.1555 CS 25.1555 CS 27.1555 CS 29.1555

9.2.5 Merged with 9.2.2

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Merged with 9.2.2	*Def-Stan 00-970 Reference:*	Merged with 9.2.2
		STANAG Reference:	Merged with 9.2.2
FAA Doc:		*EASA CS Reference:*	Merged with 9.2.2

9.2.6 Materials (including finishes or decorative surfaces applied to the materials) used for air vehicle interiors shall be at least flame resistant and non toxic. It shall be shown to meet the appropriate flame propagation and burn-through resistance, toxicity, and smoke limiting requirements. Air vehicle interiors include:

a. Interior compartments occupied by crew or passengers (including lavatories and galleys); and

b. Areas that are not continuously occupied (including cargo and baggage compartments).

Consideration should be given to:

a. Flame propagation, burn-through and smoke limiting requirements, to be agreed and verified;

b. Additional requirements for air vehicles with passenger capacities of 20 or more, to be agreed and verified;

c. Interior components including aircraft panels, privacy curtains, foams in seat pads and cushions, personnel and cargo retention belts and straps, fabrics (coated and uncoated), flooring, cargo liners, transparencies, insulation, and any other components of the aircraft interior.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.1, 4.1, 3.2, 4.2, 3.3, 4.3, 3.4, 4.4, 3.5, 4.5, 3.14,	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.16

Information Sources			
	4.14 (Unverified) JSSG-2001: 3.4.3.1.1, typical anthropometric dimensions and ranges considered acceptable to accommodate the US pilot population JSSG-2010-3: 4.3.3, Table VI, definition and application of zones (Unverified)	*STANAG Reference:*	
FAA Doc:	14CFR references: 23.771-23.781, 25.771-25.781	*EASA CS Reference:*	CS 23.853 CS 23.855 CS 25.853 CS 25.855 CS 27.853 CS 27.855 CS 29.853 CS 29.855

9.2.7 A means of intercommunication shall be provided between the flight-deck and other aircrew.

Consideration should be given to:
a. A means for the flight-deck to alert aircrew when required;
b. An intercom system accessible for immediate use at any crew station;
c. Provision of two way communication between all crew compartments;
d. Communication with aircrew outside of the air vehicle for use by ground personnel, if required.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-4 (Unverified)	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.7
		STANAG Reference:	
FAA Doc:	14CFR references: 121.319	*EASA CS Reference:*	

9.2.8 All audio communication systems shall have speech intelligibility of sufficient quality to ensure safe and effective air vehicle operation.

Consideration should be given to:
a. The efficiency of communications needed and the type material to be transmitted;
b. Specified communications requirements, to be agreed and verified (depending on level of intelligibility needed):
  i. Phonetically Balanced (PB) word test, typically 43-90%;
  ii. Modified Rhyme Test (MRT), typically 75-97%;
  iii. Minimum Articulation Index (AI), typically 0.3-0.7.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.15.78 00-970 P1 4.15.79 00-970 P1 S4 L65 00-970 P1 S4 L66 00-970 P1 S6 L1 Sec 2 00-970 P1 S1 L108
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

9.3. AIR VEHICLE LIGHTING.

This section covers the provision, controllability and luminance of all internal and external air vehicle light systems and illumination. Air vehicle lighting allows crewmembers to see information from displays and instruments, to operate controls, to move safely throughout and emergency egress the compartment and to perform all other mission-critical functions where sight is necessary.

Included within the scope of this section are:
• External and internal illumination (cargo compartment, loading and ramp areas, passageways, passenger seating area, avionics bays, auxiliary power plant compartment etc.);
• Emergency lighting;
• Intensity, balance and luminance of interior lighting;
• External lights necessary to permit operation in commercial airways (taxi & landing, position, riding, anti-collision etc.);
• Readability and discernability of instruments;
• Compatibility with NVIS and LEP.

Some criteria in this chapter are supported in the text by examples of specific considerations. These examples are by no means to be considered as exhaustive.

Verification should at least consider:
• All environmental lighting conditions;
• The chromaticity requirements;
• Average luminance ratio.

9.3.1 Air vehicle lighting systems shall provide adequate illumination (both internal and external) for crew, wing men, passengers, maintainers, and ground support personnel to perform all anticipated tasks safely, throughout all environmental lighting conditions.

Consideration should be given to:
a. Specified tasks including normal ingress and emergency egress for all occupants within the cockpit/crewstation;
b. Lighting for the cargo compartment, loading and ramp areas, passageways, passenger seating area, avionics bays, auxiliary power plant compartment, and all flight critical maintenance areas;
c. Ensuring emergency lighting meets the specified requirements for passengers and air crew;
d. Chart, utility and worktable lighting;

e. Where applicable, provision of required lighting to perform troop jumps (i.e. three light system);
f. The performance of cockpit floodlighting system, if fitted;
g. Ensuring lighting meets the specified requirements for aerial refuelling (See Section 8.7.1.4);
h. All illuminance requirements, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-5: 3.5.2.1.1, 3.5.2.1.8.4, 3.5.2.1.8.6, 3.5.2.1.8.6.1-3, 3.5.3.7, 3.5.3.8 MIL-STD-1472F: 5.2.1.2 and 5.8.2.1 thru 5.8.2.3 and Table XVI, criteria for the operator station lighting system (Unverified) MIL-STD-3009: 4.2.2 table 1, criteria for the operator station lighting system (Unverified)	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P1 4.15.54 4671.1705
FAA Doc:	14CFR references: 23.1381-23.1401, 25.1381-25.1403	*EASA CS Reference:*	CS 23.812 CS 23.1381 CS 23.1383 CS 25.812 CS 25.1381 CS 25.1383 CS 27.1381 CS 27.1383 CS 29.812 CS 29.1381 CS 29.1383

9.3.2 Internal lighting shall be fully controllable and uniform and shall not permit glare, shadows, or reflections that interfere either with the aircrew member's interior or exterior vision. This shall include provision of sufficient control to allow each aircrew to control the intensity, and balance of interior lighting; provision of housing for lighting systems to prevent leakage of stray light and to shield lamp filaments from direct view; and ensuring lighting systems not exceed the specified average luminance ratio.

For UAVs, work place lights shall be installed so that their direct rays, and rays reflected from any surface, are shielded from the UAV crew's eyes.

Consideration should be given to:
a. Specified average luminance ratio, to be agreed and verified (typically 2:1);
b. Minimising reflections from the canopy, windshields, and windows;
c. Ensuring it is possible to control the intensity of illumination of all instruments and panels from full intensity to zero;
d. Provision of individual dimmer switches within easy reach of each crew member to control the lighting at his station;
e. Grouping dimmer switches together where more than one is required at a crew station;
f. Ensuring illumination from wing icing detection lights do not cause glare or reflection that would handicap crewmembers in the performance of their duties.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-5: 3.5.2.1.1 -3 .5.2.1.4	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.55 00-970 P1 4.15.63
		STANAG Reference:	4671.1705 3224 Annex B
FAA Doc:	14CFR references: 23.1381-23.1401, 25.1381-25.1403	*EASA CS Reference:*	CS 23.1381 CS 23.1383 CS 25.1381 CS 25.1383(a) CS 25.1403 CS 27.1381 CS 27.1383 CS 29.1381 CS 29.1383

9.3.3 The air vehicle shall be provided with all external lights necessary to permit operation without restriction.

Consideration should be given to:

a. Operation within civil airspace, which includes provision of taxi and landing lights, navigation lights, riding (anchor) lights (where applicable) and an anti-collision light system;

b. Ensuring each light meets the specified performance requirements for location, arrangement, coverage, aimability, colour and intensity;

c. Ensuring the colour chromaticity meets the International Commission on illumination chromaticity;

d. Visibility of each riding (anchor) light to be agreed and verified (typically 3·2 km - 4.0 km) (at night under clear atmospheric conditions);

e. Ensuring the anti-collision lights do not impair the flight-crew members’ vision or detract from the conspicuity of the position lights.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-5: 3.5.3.1, 3.5.3.2.1, 3.5.3.2.2, 3.5.3.4	*Def-Stan 00-970 Reference:*	00-970 P1 6.7.1-6.7.17
		STANAG Reference:	3224 Annex C 4671.1383-4671.1404
FAA Doc:	14CFR references: 23.1381-23.1401, 25.1381-25.1403	*EASA CS Reference:*	CS 23.1383-23.1401 CS 25.1383-25.1401 CS 27.1383-27.1399 CS 29.1383-29.1401

9.3.4 Air vehicle lighting shall be sufficient to illuminate all visual displays, signals, instruments etc. related to flight-critical tasks throughout all environmental lighting conditions; and if applicable, shall be compatible with NVIS and Laser Eye Protection (LEP), so as not to degrade air crew visibility in order to maintain safety-of-flight (SOF).

Consideration should be given to:

a. Air vehicle lighting luminance requirements, to be agreed and verified;

b. Verification of LEP and NVIS compatibility;

c. The effects of direct or indirect glare, and / or reflections;

d. Ensuring lights do not have a direct or indirect affect on the image intensification capabilities of the NVIS;
e. Readability and discernability of instruments, including ensuring all illuminated instrument indicia are daylight readable when not energised (with the exception of self-luminous displays).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-5 JSSG-2010: 3.1, 4.1, 3.2, 4.2, 3.3, 4.3, 3.4, 4.4, 3.5, 4.5, 3.14, 4.14 JSSG-2010-5: 3.5.2.1.8, cockpit and crew station lighting MIL-STD-3009: 5.7.2.2, addresses NVIS compatible aircraft lighting and Visual acuity charts (Unverified)	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P1 6.7.1 3828 4671.1705
FAA Doc:	14CFR references: 23.1381-23.1401, 25.1381-25.1403	*EASA CS Reference:*	CS 23.1381-23.1401 CS 25.1381-25.1403 CS 27.1381-27.1401 CS 29.1381-29.1401

9.4. HUMAN PERFORMANCE.

This section covers recognition of human factors engineering principles within the air vehicle design to enable the crewmember to monitor and control the system flight path management, navigation, caution, warning, advisory, communications, identification, propulsion, and mission and utilities subsystems, without undue discomfort or fatigue, and to reduce the potential for, and minimise the consequences of, a crew-induced error.

Included within the scope of this section are:
• Location and arrangement of the primary flight display suite;
• Accuracy and completeness of flight and technical manuals;
• Presentation of emergency checklists and procedures
• Crew system interfaces;
• Sound pressure levels.

Some criteria in this chapter are supported in the text by examples of specific considerations. These examples are by no means to be considered as exhaustive.

Verification should at least consider:
• Acceptable crew workload limits;
• Workload, task and hazard analysis;
• The anticipated range of environmental conditions;
• The anthropometric range of occupants and/or operators.

9.4.1 Aircrew, operator and maintenance tasks and/or functional operations, and procedures and/or pilot / air vehicle interfaces shall be demonstrably safe.

Consideration should be give to:

a. Workload and hazard analysis to ensure trained personnel can perform the tasks in a safe manner;

b. Ensuring all identified hazards have been reduced to a level consistent with safe operation of the system;

c. Acceptable crew workload limits, to be agreed and verified;

d. Ensuring all tasks / procedures are defined and documented;

e. Operation over the anticipated range of environmental conditions, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.1, 4.1, 3.2, 4.2 (Unverified - no access to JSSG-2010-1 or 2) JSSG-2010-1 - Handbook 3.2.1 and 4.2.1 for Method of Compliance. Table 2 of the document provides a list of Figures of Merit (Unverified) JSSG-2001: 3.4.3 Human/vehicle interface MIL-HDBK-46855, guidance on human workload assessment techniques (Unverified)	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1701
FAA Doc:	14CFR references: 23.1311-23.1322, 25.1321-25.1322	*EASA CS Reference:*	

9.4.1.1 The primary flight display suite shall afford crewmembers with the necessary flight and navigational data required to safely perform all basic and unique flight manoeuvres, in both normal and emergency conditions.

Consideration should be given to:

a. Flight and navigational data required depending on air vehicle type and role. This may include, but is not limited to the following: airspeed, heading, altitude, attitude, angle-of-attack, vertical speed;

b. Flight manoeuvres, to be agreed and verified, but typically include takeoff, navigation and landing;

c. Provision of at least one set of Primary Flight Reference (PFR) data per operators station;

i. Systems that operate the first pilot's instruments should be independent from other flight crew stations;

d. Ensuring Head-Up Displays (HUD), Helmet Mounted Displays (HMD) and Head-Down Displays (HDD) are installed iaw the required standards.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Air Force Flight Standards Agency white paper (Single Medium Flight Instrument Display Endorsement Process, Jan 01) provides procedures for requesting and getting PFR endorsement (Unverified)	*Def-Stan 00-970 Reference:*	00-970 P1 4.16.18 00-970 P1 4.19.2 00-970 P1 4.19.46
		STANAG Reference:	4671.1723

Information Sources			
	JSSG-2010-3: 3.2, 4.2 (Unverified) MIL-STD-1787: Appendix E, Figures 91, 92, and 93 list the parameters for basic flight performance, unusual attitude and recovery performance, and dynamic manoeuvring performance (Unverified)		
FAA Doc:	14CFR references: 23.1311-23.1322, 25.1321-25.1322	*EASA CS Reference:*	CS 23.1303 CS 23.1311 CS 25.1303 CS 25.1333 CS 27.1303 CS 29.1303

9.4.2 All air vehicle operating instructions, flight handbooks/checklists, flight/performance management and planning systems, and other relevant documentation, appropriate to the air vehicle, shall not be in conflict with system descriptions and procedures (normal and emergency) and actual system performance. Technical manuals/orders and publications shall be accurate, in accordance with the aircraft design and complete for all tasks that may impact flight safety. Emergency procedures shall be clearly identified, and corrective action shall not create other hazardous situations.

Consideration should be given to:

a. Ensuring all documentation is produced to the required standard, to be agreed and verified;

b. Identifying and segregating approved parts of any documented instruction, procedure, limitation etc. from each unapproved part (if applicable).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.1, 4.1, 3.2, 4.2 MIL-DTL-7700G, Flight manuals/checklists accordance	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1581
FAA Doc:	14CFR references: 23.1581-23.1589, 25.1581-25.1587	*EASA CS Reference:*	CS 23.1581-23.1589 CS 25.1581-25.1587 CS 27.1581-27.1589 CS 29.1581-29.1589

9.4.3 Merged with 9.2.1.2

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Merged with 9.2.1.2	*Def-Stan 00-970 Reference:*	Merged with 9.2.1.2
		STANAG Reference:	Merged with 9.2.1.2
FAA Doc:	Merged with 9.2.1.2	*EASA CS*	Merged with 9.2.1.2

Information Sources			
		Reference:	

9.4.4 Crew system interfaces shall be designed and installed to reduce the potential for and minimise the consequences of human error. This includes consideration of human factors engineering principles in order to prevent confusion, distraction and fatigue which may cause inadvertent operation. Crew system interfaces shall provide a means of simple correction in the event of a crew-induced error.

Consideration should be given to:

a. Anthropometric range of occupants and/or operators, to be agreed and verified;

b. Pilot-vehicle and human-computer interfaces;

c. Grouping and arrangement of interfaces including displays, controls etc.;

d. Ensuring emergency controls are adequately protected;

e. Selecting control knobs of distinctive shape to assist both visual and tactual identification;

f. Operating controls with cold or gloved hands;

g. Ensuring Armament Control Systems incorporate protection against human factors causing inadvertent firing or release of weapons or countermeasures.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1472F 5.1 through 5.4 and 5.4.3, guidance for the human factors design of equipment that minimizes the occurrence of human error. MIL-STD-1472F: 5.1.14, design guidance for human computer interface and associated methods for the minimization of human error. JSSG-2001: 3.4.3 Human/vehicle interface	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.2-4.15.64 00-970 P1 4.19.46 00-970 P1 4.19.51
		STANAG Reference:	4671.1701 4671.1733
FAA Doc:		*EASA CS Reference:*	CS 23.777 CS 23.781 CS 25.777 CS 25.781 CS 27.777 CS 29.777(a)

9.4.5 Merged with 9.4.2

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Merged with 9.4.2	*Def-Stan 00-970 Reference:*	Merged with 9.4.2
		STANAG Reference:	Merged with 9.4.2
FAA Doc:	Merged with 9.4.2	*EASA CS Reference:*	Merged with 9.4.2

9.4.6 Sound pressure exposure levels in areas of the air vehicle occupied by personnel during flight shall not exceed safe limits, in order to prevent hearing damage and to allow effective communication.

Consideration should be given to:
a. Internal noise level requirements, to be agreed and verified (typically 85 dB(A));
b. Ensuring noise levels are controlled as required by human factors requirements;
c. Ensuring sound treatments are integrated with the airframe structure and with airframe subsystems to achieve an optimum balance of weight, cost, and complexity;
d. Combined noise levels from the air conditioning system and all other sources, i.e. engine, are lower than the maximum acceptable levels;
e. Individual hearing protection.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.5.2, A.4.5.2	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.4 00-970 P1 4.15.78-4.15.79 00-970 P1 4.15.81 00-970 P1 4.24.30 00-970 P1/5 S4 L65-66
		STANAG Reference:	4671.1703
FAA Doc:		*EASA CS Reference:*	CS 23.1431 CS 25.771 CS 27.771 CS 29.771

9.5. LIFE SUPPORT SYSTEMS.

This section covers the installation, integration, interface and functionality of air vehicle life support systems and personal protective equipment. Life support systems provide air vehicle occupants with breathing and anti-g provisions, and natural, induced, and combat hazard protection for air vehicle missions; during and after any in-flight emergency; and as appropriate after escape from the air vehicle. This may include oxygen systems which provide protection against hypoxia, inhalation of toxic smoke and fumes, and the effects of high 'g' accelerations; pressure suits for protection against high altitude / depressurization; ocular protection against foreign matter, irritants, or laser threats; ballistic protection systems for air vehicle occupants, particularly armour; protection from the effects of Nuclear, Biological, Chemical (NBC) and/or laser environments; and floatation and drowning prevention.

Included within the scope of this section are:
• Physiological requirements of life support systems;
• Emergency oxygen systems;
• Flotation devices and signalling equipment.

Some criteria in this chapter are supported in the text by examples of specific considerations. These examples are by no means to be considered as exhaustive.

Verification should at least consider:
• Natural and induced environmental conditions, and specifically those which degrade human physical and cognitive capabilities;

• The specified worst-case crewmember breathing scenario, to be agreed and verified.

9.5.1 Air vehicle life support systems and personal protective equipment shall be designed, installed and integrated, such that they are fully functional and accessible for the intended personnel throughout the operational envelope of the air vehicle.

Life support systems and personal protective equipment may include:

a. Oxygen systems which provide protection against hypoxia (i.e. from high altitude), inhalation of toxic smoke and fumes, the effects of high 'g' accelerations;

b. Pressure suits/pressure breathing for protection against high altitude / depressurisation (including the bends) and high normal acceleration;

c. Ocular protection against foreign matter, irritants, or laser threats;

d. Ballistic protection systems for air vehicle occupants, particularly armour;

e. Protection from the effects of Nuclear, Biological, Chemical (NBC) and/or laser environments.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.6, 4.6, 3.9, 4.9, 3.10, 4.10, 3.13, 4.13 JSSG-2010-9 Personal Protective Equipment Handbook 3.9.1, 4.9.1	*Def-Stan 00-970 Reference:*	00-970 P1 6.13 00-970 P13 3.10 00-970 P13 3.11
		STANAG Reference:	3198
FAA Doc:	14CFR references: 23.1301, 23.1441, 25.1301, 25.1441	*EASA CS Reference:*	CS 23.1301 CS 23.1441 CS 25.1301 CS 25.1441 CS.27.1301 CS 29.1301

9.5.2 Air vehicle life support systems and personal protective equipment shall include sufficient provisions and protection to satisfy the specified physiological requirements, in order to permit air vehicle occupants to maintain air vehicle control under all anticipated environmental conditions. The physiological needs of air vehicle occupants shall be met in normal flight, as defined by the mission roles of the air vehicle; during and after any in-flight emergency; and as appropriate after escape from the air vehicle.

Consideration should be given to:

a. Specified physiological requirements, to be agreed and verified;

b. Natural and induced environmental conditions, and specifically those which degrade human physical and cognitive capabilities;

c. Maintaining core body temperature, including protection from cold weather/water;

d. Preventing hypoxia without inducing unacceptable physiological effects, such as acceleration atelectasis or delayed optic barotrauma;

e. Breathing gas pressures and concentrations to meet respiratory demands without imposing excessive resistance to breathing;

f. Mask cavity temperature and pressure;

g. Protection from chemical or biological threats;

h. Maintaining consciousness during manoeuvring loads and for extreme cabin altitudes;

i. Floatation and drowning prevention for an unconscious crewmember;

j. Fire protection/resistance properties of aircrew personal protective equipment and clothing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.6, 4.6, 3.9, 4.9, 3.13, 4.13 (Unverified - no access to JSSG-2010: 6, 9, 13) JSSG-2010: 3.10, 4.10 JSSG-2010-9: Personal Protective Equipment Handbook (Unverified - no access to JSSG-2010-9)	*Def-Stan 00-970 Reference:*	00-970 P1 S6.13 00-970 P13 S3.10 00-970 P13 S3.11 00-970 P1/5 S6 L29
		STANAG Reference:	3198
FAA Doc:	14CFR references: 23.1301, 23.1441, 25.1301, 25.1441	*EASA CS Reference:*	CS 23.1441 CS 25.1441

9.5.3 Where air vehicle life support systems interface with other air vehicle subsystems, no operational mode of any life support system shall degrade other air vehicle subsystems sufficiently to cause an unsafe condition; and no operational or failure mode of air vehicle subsystems shall cause a life support system failure, or condition that can injure occupants, fail to meet physiological needs, or prevent sustained flight.

Consideration should be given to:

a. Specified design limits for the life support system where there is an interface with other air vehicle subsystems;

b. Failure Modes Effects and Criticality Analysis (FMECA) to identify potential failure mode causes, to include those that could be induced by life support system or subsystem operations;

c. The effect of a software/firmware failure to the oxygen subsystem, and in other subsystems that interface with the oxygen subsystem such as built-in-test.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.6, 4.6, 3.9, 4.9, 3.10, 4.10, 3.13, 4.13 JSSG-2010-9 Personal Protective Equipment Handbook (Unverified - no access to JSSG-2010-9)	*Def-Stan 00-970 Reference:*	00-970 P1 6.13 00-970 P13 3.10 00-970 P13 3.11
		STANAG Reference:	
FAA Doc:	14CFR references: 23.1301, 23.1441, 25.1301, 25.1441	*EASA CS Reference:*	CS 23.1441 CS 25.1441

9.5.4 The oxygen system, which is used in the event of an emergency shall provide a supply of breathing gas to all air vehicle occupants. The duration of supply shall be sufficient to protect all occupants during descent for the maximum time possible. As a minimum this shall be the longest anticipated time taken to descend from the maximum altitude to a safe altitude. Emergency oxygen flow should be automatically initiated and alert the occupants that it is activated.

Consideration should be given to:

a. The longest anticipated time to descend to 10,000 ft from the maximum altitude, to be agreed and verified;

b. The specified worst-case crewmember breathing scenario, to be agreed and verified;

c. Whether the cabin is pressurised or depressurised.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.10.2.2 Other oxygen subsystems JSSG-2010: 3.13, 4.13 (Unverified - no access to JSSG-2010-13) Refer to technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P1 6.13.5.31-6.13.5.32
		STANAG Reference:	3198 S4b. Par. 11
FAA Doc:		*EASA CS Reference:*	CS 23.1441 CS 25.1441

9.5.4.1 An emergency oxygen supply shall be available for use during high altitude escape and shall have sufficient stored oxygen capacity to protect crew members during descent for the maximum time possible. As a minimum this shall be the longest anticipated time taken to descend from the maximum altitude to a safe altitude. Emergency oxygen flow shall be automatically initiated and supplied to crew members on escape.

Consideration should be given to:

a. The longest anticipated time to descend to 10,000 ft from the maximum altitude, to be agreed and verified;

b. The specified worst-case crewmember breathing scenario, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 6.13.5.31-6.13.5.32
		STANAG Reference:	3198 S4b. Par. 12
FAA Doc:		*EASA CS Reference:*	

9.5.5 Emergency floatation devices (life rafts, life preservers etc.) shall be plainly marked as to their method of operation. All survival equipment shall be approved, and shall be plainly marked for identification and method of operation. Emergency floatation and signalling equipment shall be installed so that it is readily available to the crew and passengers. This includes stowage provisions, which shall be marked for the benefit of occupants and to facilitate easy removal of the equipment. Each signalling device shall be accessible, function satisfactorily and free of any hazard in its operation.

Consideration should be given to:

a. Life raft provision on air vehicles with extended overwater operations;

b. Placing markings and instructions as near as possible to the relevant control, release mechanism etc.;

c. Survival equipment including pyrotechnic signalling devices (i.e. flares);

d. Size and colour or lettering / numbering shall meet the specified requirements, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-11: 3.11.7.3 (Unverified - no access to	*Def-Stan 00-970 Reference:*	00-970 P1 6.8.18 00-970 P1 7.4.13

Information Sources			
	JSSG-2010-11)		00-970 P1/5 S6 L34
		STANAG Reference:	
FAA Doc:	14CFR references: 25.1561, 23.1561, 23.1415, 121.339	*EASA CS Reference:*	CS 23.1411 CS 23.1415 CS 23.1561 CS 25.1411 CS 25.1415 CS 25.1561 CS 27.1411 CS 27.1415 CS 27.1561 CS 29.1411 CS 29.1415 CS 29.1561

9.5.6 Each life raft released automatically or by a crew member shall be attached to the air vehicle by a static line to keep it alongside the air vehicle. Should the air vehicle become totally submerged, this line shall be sufficiently weak to break away from the air vehicle before submerging the raft to which it is attached.

Consideration should be given to:

a. Whether to use a fully occupied or empty raft for verification of this criteria, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 6.8.13 00-970 P1 6.8.14 00-970 P1 6.8.21 00-970 P1/5 S6 L34
		STANAG Reference:	
FAA Doc:	14CFR references: 25.1561, 23.1561, 23.1415, TSO C70a	*EASA CS Reference:*	CS 23.1415 CS 25.1415 CS 27.1415 CS 29.1415

9.6. TRANSPARENCY INTEGRATION.

This section covers the installation, integration, interface and operation of air vehicle transparency systems, including criteria relevant to crew exterior vision and crew protection from the external environment.

Included with the scope of the this section are:

• Remote camera systems, flat transparency windows, windscreens, and/or canopy systems;
• Transparency/canopy frames, canopy actuators, canopy latch/locking systems.

Some criteria in this chapter are supported in the text by examples of specific considerations. These examples are by no means to be considered as exhaustive.

9.6.1 Canopies, or other transparency systems, along with their associated support structure, actuation, latching, and locking mechanisms shall be compatible with the air vehicle escape system to permit safe egress and escape.

Consideration should be given to:

a. Canopies, or other transparency systems, and their associated mechanisms cannot be rendered inoperative through ice accretion;

b. Canopies, or other transparency systems, and their associated mechanisms cannot be rendered inoperative through thermal effects on the ground. See Line 9.6.3 for thermal effects in flight.

Information Sources			
Comm'l Doc:	For a new transparency in an existing aircraft, it is recommended that reference be made to the existing aircraft specifications.		
DoD/MIL Doc:	JSSG-2010-14: 3.14, 4.14 JSSG-2010-11 MIL-STD-1474	*Def-Stan 00-970 Reference:*	00-970 P1 4.18.3 00-970 P1 4.19.28 00-970 P1 4.20.2-4.20.4 00-970 P1 4.20.10-4.20.14 00-970 P1 4.23.20-4.23.23 00-970 P1 4.23.40-4.23.45
		STANAG Reference:	
FAA Doc:	14CFR references: 23.775, 25.775	*EASA CS Reference:*	CS 23.807 CS 25.809 CS 27.807

9.6.2 The transparency system shall meet the survivability requirements for bird-strike impact.

Consideration should be given to:

a. Defining the meaning of a birdstrike in terms of bird weight, combined velocity, impact angle etc.;

b. Acceptable breakage characteristics of the transparency.

Information Sources			
Comm'l Doc:	ASTM F330, Bird Impact Testing of Aerospace Transparent Enclosures		
DoD/MIL Doc:	JSSG-2010-14: 3.14, 4.14 JSSG-2006-3.2.24.1	*Def-Stan 00-970 Reference:*	00-970 P1 4.9.4 00-970 P1 4.9.6 00-970 P1 4.9.7 00-970 P1 4.18.8 00-970 P13 1.1.2.5
		STANAG Reference:	4671.775
FAA Doc:	14CFR references: 23.775, 25.775	*EASA CS Reference:*	CS 23.775 CS 25.631 CS 25.773 CS 25.775 CS 27.775

Information Sources			
			CS 29.631 CS 29.775

9.6.3 The structural/thermal capability of the transparency system shall be adequate for all loads and flight conditions.

Consideration should be given to:

a. EMACC Section 5 - Structures - covers airframe structural impacts including impact loads from hail and should be considered with this line;

b. Wire strikes are a significant hazard for certain platform types, and although more properly an operating risk, consideration should be given to mitigating their effects;

c. The potential effect of specialised coatings;

d. The ability of the transparency to withstand ice shed from propeller tips.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-14: 3.14, 4.14 JSSG-2006-3.2.22	*Def-Stan 00-970 Reference:*	00-970 P1 4.18.6 00-970 P1 4.18.8 00-970 P13 1.1.2.5
		STANAG Reference:	4671.775
FAA Doc:	14CFR references: 23.775, 25.775	*EASA CS Reference:*	CS 23.775 CS 25.775 CS 25.875

9.6.4 Transparency system shape shall be compatible, and not interfere, with crew-member and equipment positions and motions used during normal and emergency conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-14: 3.14, 4.14	*Def-Stan 00-970 Reference:*	00-970 P1 4.9.6 00-970 P1 4.16.6 00-970 P1 4.23.46
		STANAG Reference:	
FAA Doc:	14CFR references: 23.775, 25.775	*EASA CS Reference:*	

9.6.5 The optical characteristics of the transparencies (windshield, canopy, windows, as applicable), including transmissivity, angular deviation, optical distortion, haze, multiple imaging, binocular disparity, birefringence, and minor optical defects shall be compatible with the safety-critical optical systems used by the aircrew and provide a safe optical environment for the crew.

Consideration should be given to:

a. Specialised coatings.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	JSSG-2010-14: 3.14, 4.14 JSSG-2010-14: 3.1.4.1, for additional transparency optical characteristics and recommended values	*Def-Stan 00-970 Reference:*	00-970 P1 4.17.2 00-970 P1 4.18.6 00-970 P1 4.18.18 00-970 P7 S1 L104 3.1
		STANAG Reference:	4671.775
FAA Doc:	14CFR references: 23.775, 25.775	*EASA CS Reference:*	CS 23.773 CS 25.773 CS 27.773 CS 29.773

9.6.6 The power required to open the canopy shall be available under normal and emergency conditions, and manual actuation of the canopy shall be possible when air vehicle or external power is not available.

Consideration should be given to:

a. Provision of external means to open canopy by a ground rescue crew;

b. Entering and leaving the aircraft with all power off.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-14: 3.14, 4.14	*Def-Stan 00-970 Reference:*	00-970 P1 4.20.11 00-970 P1 4.23.23 00-970 P1 6.6.2 00-970 P1 6.6.6 00-970 P1 6.6.8 00-970 P1 6.6.88
		STANAG Reference:	
FAA Doc:	14CFR references: 23.775, 25.775	*EASA CS Reference:*	

9.6.7 The environmental management system interface shall provide the necessary defogging, pressurisation, heating, cooling, humidity control, and ventilation of the transparency system under normal and emergency conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-14: 3.14, 4.14; JSSG 2010-3: 3.3.2, 4.3.2	*Def-Stan 00-970 Reference:*	00-970 P1 4.17.2 00-970 P1 4.17.3 00-970 P1 4.24.2 00-970 P1 4.24.6 00-970 P1 4.24.28-4.24.29 00-970 P1 4.24.50 00-970 P1 4.24.53-4.24.54 00-970 P13 1.1.2.1
		STANAG Reference:	4671.775
FAA Doc:	14CFR references: 23.775, 25.775	*EASA CS Reference:*	CS 23.773 CS 25.773

Information Sources			
			CS 25.1438 CS 27.773 CS 29.773

9.6.8 Provision shall be made to ensure that the pilots' transparencies remain adequately clear from obscurants at all times, and that such provisions do not cause temporary or permanent optical degradation of the transparencies.

Consideration shall be given to:

a. Rain removal;

b. Removal of insect debris, dust, dirt, sand, and salt from sea spray;

c. De-fogging and de-icing;

d. Anti-fogging, anti-icing, and snow removal.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-14: 3.14, 4.14	*Def-Stan 00-970 Reference:*	00-970 P1 4.17.8-4.17.15 00-970 P1 4.17.23 00-970 P1 4.18.18 00-970 P7 S1 L104 2.3 00-970 P13 1.1.2.1 00-970 P13 1.1.2.2 00-970 P13 1.1.2.5 00-970 P13 1.5.1.23 00-970 P13 1.5.1.24
		STANAG Reference:	4671.775
FAA Doc:	14CFR references: 23.775, 25.775	*EASA CS Reference:*	CS 23.773 CS 23.775 CS 25.773 CS 27.773 CS 29.773

9.7. CRASH SURVIVABILITY.

This section covers the provision of suitable and sufficient crash protection and procedures in order to minimise injury to the pilot, air crew, and passengers in the event of an air vehicle crash scenario.

Included within the scope of this section are:

- The seating system(s) design (including energy absorbing seats, stretchers);
- Restraint system design and configuration;
- Functionality of exits post crash;
- Injury prevention from items of mass (including engines, gearboxes, rotor blades etc.);
- Provision of fire fighting equipment (fire extinguishers, breathing and eye protection equipment etc.);
- Ditching provisions (including floatation devices);
- Pre crash warnings and crash recovery procedures;
- Crew extraction devices.

Some criteria in this chapter are supported in the text by examples of specific considerations. These examples are by no means to be considered as exhaustive.

Verification should at least consider:
• The number or air vehicle occupants;
• Ensuring that body mass figures used are appropriate, and allow a sufficient margin for fully equipped troops;
• Type and role of air vehicle;
• The ability of personnel to operate appropriate emergency devices while wearing personal protective equipment; this relates to aircrew and rescue crews.

9.7.1 The seating system, or systems including stretchers, to be used on the air vehicle shall be appropriate for their proposed use and the design of the floor and load paths to the seat, or stretcher, attachments shall be capable of sustaining the loads of the seat or stretcher system in applicable crash load conditions.

Consideration should be given to:
a. Body mass, including kit, of seat occupants;
b. Static and dynamic load conditions;
c. Ensuring that the Test and Acceptance Plan adequately covers all seating/stretcher systems to be used and the associated structure.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.7, 4.7 JSSG-2006-3.4.2.11	*Def-Stan 00-970 Reference:*	00-970 P1 4.22.2 00-970 P7 L307
		STANAG Reference:	
FAA Doc:	14CFR references: 23.561, 23.562, 25.561, 25.562, 25.563	*EASA CS Reference:*	CS 23.561 CS 23.562 CS 23.785 CS 25.561 CS 25.562 CS 25.785 CS 27.561 CS 27.562 CS 27.785 CS 29.561 CS 29.562 CS 29.785

9.7.2 There shall be no intrusion into the stroke clearance envelope of energy absorbing seats that could impede the seat stroke.

Consideration should be given to:
a. Equipment;
b. Structure;
c. Other materiel including stowage of carry-on kit;
d. The ability of occupants to tuck feet under the seat.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.22.2
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.785 CS 27.785 CS 29.785

9.7.3 The escape system environment and the requisite crash loading of the seats, or stretchers, shall be defined. The restraint system shall be defined in terms of properly restraining the seat or stretcher occupant for each defined environment.

Consideration should be given to:

a. Type of seat restraint - lap belt, or lap and shoulder;

b. Air vehicle occupants may be in a stretcher, or litter, as opposed to a seat;

c. Ensuring that body mass figures used are appropriate, and allow a sufficient margin for fully equipped troops;

d. Ensuring that there is sufficient margin between required allowances for body mass now and projected body mass for lifetime of the platform.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.7, 4.7 JSSG-2006-3.4.2.11	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.11 00-970 P1 4.21 00-970 P1 4.22.2 00-970 P1 4.22.42 00-970 P1 4.22.43 00-970 P7 S1 L111
		STANAG Reference:	
FAA Doc:	14CFR references: 23.561, 23.562, 25.561, 25.562, 25.563	*EASA CS Reference:*	CS 23.561 CS 23.562 CS 23.785 CS 25.561 CS 25.562 CS 25.785 CS 27.561 CS 27.562 CS 27.785 CS 29.561 CS 29.562 CS 29.785

9.7.4 The strike envelope of the occupant during defined crash loads shall be kept free of objects, including deforming platform structure, that are risks to survival or which may cause serious injury rendering the crewmember(s), or other occupants, unable to perform post-crash egress functions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.7, 4.7	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.17-4.15.18 00-970 P1 4.22.9-4.22.13 00-970 P1 4.22.20 00-970 P1 4.22.44
		STANAG Reference:	
FAA Doc:	14CFR references: 23.561, 23.562, 25.561, 25.562, 25.563	*EASA CS Reference:*	CS 23.561 CS 23.562 CS 23.785 CS 25.561 CS 25.562 CS 25.785 CS 27.561 CS 27.562 CS 27.785 CS 29.561 CS 29.562 CS 29.785

9.7.5 The design crash loads for the platform shall be defined and it shall be shown that the designated emergency exits are operable up to, and including, these defined loads.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.7, 4.7	*Def-Stan 00-970 Reference:*	00-970 P1 4.22.4 00-970 P1 4.22.6 00-970 P1 4.22.8 00-970 P1 4.22.44 00-970 P1 4.22.56
		STANAG Reference:	
FAA Doc:	14CFR references: 23.561, 23.562, 25.561, 25.562, 25.563	*EASA CS Reference:*	CS 23.783 CS 23.807 CS 25.563 CS 25.801 CS 25.809 CS 26.801 CS 27.801 CS 28.801 CS 29.783 CS 29.801 CS 29.809

9.7.6 Under emergency landing, ditching, and crash load conditions, items of mass shall not cause serious injury to occupants or prevent their escape by any recognised escape route. Items of mass shall include cargo or baggage carried by the air vehicle.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.7, 4.7 JSSG-2006-3.4.2.11	*Def-Stan 00-970 Reference:*	00-970 P1 4.22.44 00-970 P1 4.22.46 00-970 P1 4.22.49-4.22.50 00-970 P1 4.22.51-4.22.52
		STANAG Reference:	
FAA Doc:	14CFR references: 23.561, 23.562, 25.561, 25.562, 25.563, 25.787, 25.789, 23.787, 25.801, 25.1411, 25.1421	*EASA CS Reference:*	CS 23.561 CS 23.787 CS 25.561 CS 25.787 CS 25.789 CS 25.1421 CS 27.561 CS 27.787 CS 29.561 CS 29.787

9.7.7 The air vehicle shall be equipped with fire extinguishers appropriate for their expected use, along with breathing and eye protection equipment, and fire fighting equipment; or justification provided for their omission.

Consideration should be given to:

a. Category of air vehicle;

b. Type, location, and number of fire extinguishers provided;

c. Numbers of crew and passengers.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.7, 4.7 JSSG 2010-9: 3.9.3	*Def-Stan 00-970 Reference:*	00-970 P13 1.4 00-970 P13 1.6.12 00-970 P13 1.6.13-1.6.13.2
		STANAG Reference:	
FAA Doc:	14CFR references: 25.851	*EASA CS Reference:*	CS 23.851 CS 25.851 CS 29.851 CS 23.1197 CS 25.1197 CS 25.1439 CS 29.1439

9.7.8 Where certification with 'ditching provision' is required, the requisite safety equipment shall be installed. On all aircraft without assisted escape systems this shall include sufficient life rafts for all occupants, and individual floatation devices for each occupant.

Consideration should be given to:

a. Number and location of life rafts;

b. Provision of over capacity of life rafts to account for damage or access after ditching;

c. Numbers and location of other safety equipment which might be required by ditching provisions.

d. Any structural damage due to ditching shall not adversely affect survivability including launch of life rafts.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.7, 4.7	*Def-Stan 00-970 Reference:*	00-970 P1 6.8
		STANAG Reference:	
FAA Doc:	14CFR references: 23.561, 23.562, 25.561, 25.562, 25.563	*EASA CS Reference:*	CS 23.1411 CS 23.1415 CS 25.563 CS 25.801 CS 25.1411 CS 25.1415 CS 27.801 CS 27.1411 CS 27.1415 CS 29.801 CS 29.1411 CS 29.1415

9.7.9 A method to provide a pre-crash warning between aircrew and all other compartments shall be available. The warning shall be available in all occupied, or occupiable sections of the aircraft, without aircrew or other occupants leaving their seated position.

Consideration should be given to:

a. Making redundant warning - visual and auditory for example;

b. Provision of warnings at all duty stations, in toilets, galleys, and all other areas where crew or passengers might be expected.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010: 3.7, 4.7	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.6 00-970 P1 4.15.33 00-970 P1 4.15.39 00-970 P1 6.6.88 00-970 P13 1.2.4.1- 1.2.5.1
		STANAG Reference:	
FAA Doc:	Def Stan 00-970 Pt 1 Sec 4.15.6 Def Stan 00-970 Pt 1 Sec 4.15.33 Def Stan 00-970 Pt 1 Sec 4.15.39	*EASA CS Reference:*	CS 23.771 CS 25.819 CS 25.1307 CS 25.1423 CS 29.1307

Information Sources			
	Def Stan 00-970 Pt 1 Sec 6.6.88 Def Stan 00-970 Pt 13 Sec 1.2.4.1 and 1.2.5.1		

9.7.10 For rotary wing air vehicles, occupiable volume reduction resulting from design crash loads shall provide reasonable protection against occupant injury; this applies to structural deformation, and other intrusion into occupiable space.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.3.10.2.1, 4.3.10.2.1 JSSG-2010-7: 3.7.3.2.1	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.17-4.15.18 00-970 P1 4.22.9-4.22.13 00-970 P1 4.22.29-4.22.41 00-970 P1 4.22.51-4.22.52
		STANAG Reference:	
FAA Doc:	14CFR reference: 27.562	*EASA CS Reference:*	CS 27.561 CS 27.562 CS 27.785 CS 27.787 CS 29.561 CS 29.562 CS 29.785 CS 29.787

9.7.11 The mechanisms used for emergency crew extraction and for fire fighting shall be properly marked, easily identified, and shall be operable while wearing personal protective equipment.

Consideration should be given to:

a. Ejection mechanisms;

b. Emergency exit use by aircrew, passengers, and rescue crews;

c. Lighting of emergency exits and fire fighting equipment;

d. Ability of personnel to operate appropriate emergency devices while wearing personal protective equipment; this relates to aircrew and rescue crews.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1472: 5.5, 5.6 JSSG-2001: 3.4.3, 4.4.3 JSSG-2010-9: 3.9.5, 4.9.5 JSSG-2010-13: 3.13.6, 4.13.16	*Def-Stan 00-970 Reference:*	00-970 P13 1.6.11.5 00-970 P13 1.6.12.1 00-970 P13 1.6.13.1-1.6.13.2 00-970 P13 1.6.15.1 00-970 P13 1.6.15.3 00-970 P13 1.6.15.5 00-970 P13 1.6.15.6 00-970 P13 1.6.15.7
		STANAG Reference:	3230
FAA Doc:	14CFR reference 25.811	*EASA CS*	CS 23.811

Information Sources			
		Reference:	CS 23.812 CS 23.1557 CS 23.1561 CS 25.811 CS 25.812 CS 25.1557 CS 25.1561 CS 27.1557 CS 27.1561 CS 29.811 CS 29.812 CS 29.1557 CS 29.1561

9.8. AIR TRANSPORTABILITY AND AIRDROP.

This section covers the technical requirements for air transportation and in air jettison/airdrop of cargo and personnel.

Included within the scope of this section are:
- The design, size and layout of cargo compartments;
- NAVAIR NATOPS/cargo-loading manuals;
- Cargo restraint mechanisms (i.e. tie-down rings);
- The effects of cargo on air vehicle C of G;
- Cargo preparation, handling, carriage, and delivery procedures;
- Personnel airdrop systems;
- Jettisonable cargo.

Some criteria in this chapter are supported in the text by examples of specific considerations. These examples are by no means to be considered as exhaustive.

Verification should at least consider:
- The maximum mass to be carried, and its location within or on the air vehicle;
- The largest, and heaviest load combinations;
- Different shapes of cargo;
- Air transportation of hazardous materials.

9.8.1 It shall be shown that the air vehicle structure can support all loads (internal or external, as applicable) imposed by the transported items during operational usage.

Consideration should be given to:
a. Identification of the maximum mass to be carried, and its location within or on the air vehicle;
b. Floor loadings should be considered along with transfer of the loads to the structure;
c. Cargo tie-down, or restraint mechanism, loadings and attachments to structure should be considered;
d. The means by which compliance should be demonstrated- whether full scale model testing or mathematical simulation.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.1.7.2 JSSG-2006-3.3.4 JSSG-2006-3.3.3.2	*Def-Stan 00-970 Reference:*	00-970 P1 3.1 00-970 P1 4.22.49 00-970 P1 4.22.62-4.22.64
		STANAG Reference:	4671.787
FAA Doc:		*EASA CS Reference:*	23.787 23.1557 23.1583 25.787 25.1557 25.1583 27.787 27.865 27.1557 27.1583 29.787 29.865 29.1557 29.1583

9.8.2 There shall be passageways of sufficient width between properly loaded cargo and the aircraft structure to enable aircrew access and passenger egress during flight-critical and emergency functions.

Consideration should be given to:

a. Dimensions of largest permissible cargo to be established;

b. Producing cargo load plans showing possible locations for largest, and heaviest load combinations;

c. Sufficient width to be judged with worst possible, but allowable, cargo configuration;

d. Movement of cargo during crash/ditching.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.1.7.2 MIL-HDBK-1791 illustrates the minimum acceptable aircrew access clearances for C-130 aircraft. AFI 11-2C-130 Vol 3, addenda A, defines C-130 passenger safety aisle requirements MIL-STD-1472 defines anthropometric data	*Def-Stan 00-970 Reference:*	00-970 P13 1.6.15.1
		STANAG Reference:	3400
FAA Doc:		*EASA CS Reference:*	CS 23.813 CS 23.815 CS 25.813 CS 25.815 CS 25.819 CS 25.857

Information Sources			
			CS 29.813 CS 29.815

9.8.3 The aircraft cargo-loading manuals for the aircraft shall include shear, bending, crushing, or puncture load limits such that the cargo does not impart excessive loads into the air vehicle structure during any phase of the loading process.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.1.7.2 JSSG-2001: 3.4.5, 3.4.63 NATOPS, TO 1C-XX-9, the aircraft loading manuals include cargo loading limits in the desired formats.	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

9.8.3.1 For internal loads, the cargo floor tie-down rings, or other restraint mechanisms, and the supporting structure shall be suitably strong, and the load limits shall be included in applicable operators and maintenance manuals.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006	*Def-Stan 00-970 Reference:*	00-970 P4
		STANAG Reference:	3400
FAA Doc:		*EASA CS Reference:*	23.561 23.787 23.1583 25.561 25.787 25.1583 27.561 27.787 27.1583 29.561 29.787 29.1583

9.8.4 Correctly positioned cargo shall meet the weight and balance requirements of the air vehicle to establish and maintain safe flight.

Consideration should be given to:

a. The maximum mass to be carried, and its location within or on the air vehicle, to be identified, and published in the appropriate manual.
b. Cargo load plans to be produced showing possible locations for largest, and heaviest load combinations.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	NATOPS, TO 1C-XX-1, TO 1C-XX-9, TO 1C-xx-5 contain approximate permissible cargo centre of gravity graphs (chimney curves) for mission equipped aircraft. JSSG-2000: 3.1.7.2 JSSG-2001: 3.4.5	*Def-Stan 00-970 Reference:*	00-970 P1 2.1.23 00-970 P1 2.1.26 00-970 P1 3.3.14 00-970 P1 4.16.24
		STANAG Reference:	4671.23 4671.787
FAA Doc:		*EASA CS Reference:*	CS 23.23 CS 23.787 CS 23.1557 CS 23.1583 CS 23.1589 CS 25.23 CS 25.25 CS 25.27 CS 25.787 CS 25.1557 CS 25.1583 CS 27.25 CS 27.27 CS 27.787 CS 27.1557 CS 27.1583 CS 27.1589 CS 29.25 CS 29.27 CS 29.787 CS 29.1557 CS 29.1583 CS 29.1589

9.8.5 With the exception of items designated for airdrop, properly loaded and restrained cargo shall not change the position of the air vehicle's CofG during flight.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.1.7.2 JSSG-2001: 3.4.5, MIL-HDBK-1791, restraint criteria for transported cargo MIL-A-8865B, restraint criteria for transported cargo	*Def-Stan 00-970 Reference:*	00-970 Pt 4
		STANAG Reference:	3400 4761.787

Information Sources			
FAA Doc:		*EASA CS Reference:*	CS 23.561 CS 23.787 CS 25.561 CS 25.787 CS 27.561 CS 27.787 CS 29.561 CS 29.787

There shall be restraints of sufficient capacity provided in sufficient quantity to restrain all items of cargo safely.

Consideration should be given to:
a. The quantity of restraints shall be sufficient for the entire cargo, or combination of cargoes;
b. The capacity of the restraints shall be sufficient to restrain the payload to the specified level of force in the forward, aft, lateral, and vertical-up directions;
c. Aircraft with crew, passengers and cargo located in the same cabin or on the same deck.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.1.7.2 JSSG-2001: 3.4.5 JSSG-2006-3.4.2.11 MIL-T-25959, standard restraint devices MIL-PRF-27260, standard restraint devices	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	STANAG 3400
FAA Doc:		*EASA CS Reference:*	

9.8.7 All the operator and maintenance manuals (T.O.'s) shall be accurate, consistent with the aircraft data, and provide the cargo preparation, handling, carriage, and delivery procedures necessary for safe ground and flight operations.

Consideration should be given to:
a. Identifying and validating platform specific aircrew manuals;
b. Identifying and validating platform specific ground crew manuals;
c. Identifying and validating applicable National operating rules or manuals;
d. Identifying and validating applicable International or Treaty manuals.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.1.7.2 JSSG-2001: 3.4.5	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

9.8.8 The cargo compartment dimensions shall allow enough room to load, transport, and/or airdrop required items safely.

Consideration should be given to:

a. Ensuring that sufficient clearance is provided between all cleared cargo loads and the aircraft structure and fittings;

b. Cargo volume envelope excludes crew and passenger access and escape paths;

c. Ensuring that aircraft manuals reflect the largest allowable dimensions for cargo.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-1791: 4.2, 5.2 JSSG-2009: Appendix J	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

9.8.9 The air vehicle shall be loaded with cargo ready for air-dropping without damage to the airframe; and air vehicle flight performance or control shall not be hazardously affected by movement of its C of G due to air-dropping of that cargo.

Consideration should be given to:

a. The need to provide external stability struts to prevent the air vehicle from settling on its tail while being loaded;

b. The maximum mass to be carried, and its location within or on the air vehicle, to be identified and published in the appropriate manual;

c. Cargo load plans shall be produced showing possible locations for largest, and heaviest load combinations;

d. Cargo load plans shall identify the order in which the loading should occur to enable subsequent safe air-drop.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-1791: 4.2, 5.2 JSSG-2009: Appendix J	*Def-Stan 00-970 Reference:*	00-970 P1 2.1.23 00-970 P1 2.1.26 00-970 P1 3.3.14 00-970 P1 4.16.24
		STANAG Reference:	4671.23 4671.1519 4671.1583 4671.1589
FAA Doc:		*EASA CS Reference:*	CS 23.23 CS 23.787 CS 23.1519 CS 23.1583 CS 23.1589 CS 25.23 CS 25.25 CS 25.27

Information Sources			
			CS 25.787 CS 25.1519 CS 25.1583 CS 27.25 CS 27.27 CS 27.787 CS 27.1519 CS 27.1583 CS 27.1589 CS 29.25 CS 29.27 CS 29.787 CS 29.1519 CS 29.1583 CS 29.1589

9.8.10 The air vehicle personnel air-drop systems shall be able to withstand the loads imposed by personnel during air-drop, and possible malfunctions of personnel air-drop equipment.

Consideration should be given to loads associated with:

a. The location of air-drop attachment points and supporting structure;

b. Effects of opening any door or ramp for egress; this would include the use of air deflectors;

c. Mechanisms used to retrieve paratroopers who have jumped but not separated from the air vehicle.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-1791: 4.2, 5.2 JSSG-2009: Appendix J JSSG-2006-6.1.2, 6.1.6	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

9.8.11 The air vehicle shall provide the capability to safely recover a paratrooper who has jumped but not separated from the air vehicle.

Consideration should be given to:

a. The likely weight of a laden paratrooper;

b. Storage and availability of retrieval equipment.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Refer to technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

9.8.12 For personnel airdrop, acceptable risk levels shall exist to avoid paratrooper collision, adverse vortex interaction, and adverse multi-ship formation effects induced by the air vehicles.

Consideration should be given to:
a. Defining the acceptable risk level for the activity;
b. Determining paratrooper exit spacing/timing to minimise risk;
c. Determining acceptable air vehicle proximities during multi-ship formation air-drops;
d. Ensuring that National rules and regulations, or operational procedures, reflect any required safety limitations.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Refer to technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P1 2.17 00-970 P1 2.17.6 00-970 P1 2.17.8 00-970 P1 2.17.28 00-970 P1 2.17.32 00-970 P1 2.24.19
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

9.8.13 For authorised air-drop or jettisonable cargo, the loaded items shall be dropped or jettisoned safely during flight.

Consideration should be given to:
a. Defining the acceptable risk level for the activity;
b. Proximity of dropped or jettisoned cargo to air vehicle structure after the cargo leaves the aircraft. This should account for any induced motion such as tumbling;
c. Determining, where necessary, spacing or timing gaps between multiple items of cargo to minimise risk;
d. Different weights and shapes of cargo;
e. Configuration of aircraft for air-drop or jettison procedures. For example, account should be taken of flaps and undercarriage position and their effect on airflow;
f. Ensuring that National rules and regulations, or operational procedures, reflect any required safety limitations.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-1791: 4.2, 5.2 JSSG-2009: Appendix J	*Def-Stan 00-970 Reference:*	00-970 P1 2.17 00-970 P1 2.17.6 00-970 P1 2.17.8 00-970 P1 2.17.32 00-970 P1 2.24.19
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

9.8.14 Any necessary in-flight movement or operation of transported items or role equipment shall not adversely affect aircraft flight systems or cause injury to aircrew or passengers.

Consideration should be given to:

a. All in-flight movements or operation of transported items shall be fully justified;

b. If moved during flight, transported items must remain under strict control at all times;

c. Transported items, if moved, must remain within the weight and balance limits for the air vehicle. See Line 9.8.4 for details;

d. Transported items, if moved, must remain within the designated cargo volume of the air vehicle keeping the crew access and passenger escape routes clear at all times. See Line 9.8.2 for details;

e. Transported items, if operated mechanically, must remain within the air vehicle weight and balance limits, and the designated cargo volume. See Lines 9.8.2 and 9.8.4 for details;

f. Transported items, if operated electrically, must be electro-magnetically compatible with the air vehicle. See Section 13 for details;

g. In-flight movement or operation of transported equipment shall only be in accordance with National rules or operational procedures.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-1791: 4.2, 5.2 JSSG-2009: Appendix J	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

9.9. LAVATORIES, GALLEYS, AND AREAS NOT CONTINUOUSLY OCCUPIED.

This section covers air vehicle compartments, and areas that may be accessible to crew, passengers or maintainers, but that may not be occupied at all times during flight.

Included within the scope of this section are:

1. That food service carts, refuse carts, and waste containers used to receive any combustible materials contain a fire ignited within.
2. That all compartments have separate and approved smoke and/or fire detectors to alert the crew at the pilot or flight engineer station for both in-flight and ground operations; that each compartment has dedicated hand fire extinguishers; and that if unoccupied cargo holds are present, fire protection and fire detection/suppression requirements are met.
3. That the fire alarm and intercom/public address system can be heard in all lavatories, galleys, and other compartments.
4. That the human factors design for operation of installed equipment minimises the probability of human error that could create a safety hazard in the aircraft.
5. That all equipment installed in lavatories, galleys, and other areas can be safely operated in the aircraft environment, and is designed to withstand all potential aircraft environmental exposures, including rapid decompression, without creating a safety hazard.
6. That occupants cannot become trapped in lavatories, galleys, and other compartments during emergency evacuation situations, and that emergency lighting is available to aid egress.

9.9.1 Food service carts, refuse carts, and waste containers used to receive any combustible materials shall be capable of containing any fire likely to occur within it.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.26.53
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.853 CS 25.853 CS 29.853

9.9.2 All lavatories, galleys, and areas not continuously occupied shall have:

- Separate and approved smoke and/or fire detectors to alert the crew at the pilot or flight engineer station for both in-flight and ground operations;
- Dedicated hand fire extinguishers; and
- For unoccupied cargo holds, fire protection and fire detection/suppression requirements shall be met.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-7: 3.7.3.4 JSSG-2009 Appendix G: 3.4.7.9	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.55 00-970 P1 4.26.56 00-970 P1 4.26.60 00-970 P1 4.26.61-4.26.62
		STANAG Reference:	
FAA Doc:	14CFR references: 25.855, 25.857, 25.858, 25.859, 25.854	*EASA CS Reference:*	CS 23.855 CS 23.859 CS 25.851 CS 25.854 CS 25.855 CS 25.857 CS 25.858 CS 25.859 CS 27.855 CS 27.859 CS 29.855 CS 29.859

9.9.3 The fire alarm and intercom/public address system shall be audible in all lavatories, galleys, and other compartments not continuously occupied.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	

Information Sources			
FAA Doc:		*EASA CS Reference:*	CS 25.819 CS 25.1423

9.9.4 Merged with 9.4.1 for equipment and 9.4.2 for supporting documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	Merged with 9.4.1 for equipment and 9.4.2 for supporting documentation.
		STANAG Reference:	Merged with 9.4.1 for equipment and 9.4.2 for supporting documentation.
FAA Doc:		*EASA CS Reference:*	Merged with 9.4.1 for equipment and 9.4.2 for supporting documentation.

9.9.5 All equipment installed in lavatories, galleys, and other areas not continuously occupied shall be safe to operate in the aircraft environment, and shall be designed to withstand all potential aircraft environmental exposures, including rapid decompression, without creating a safety hazard.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.1.31 00-970 P1 4.3.5 00-970 P1 4.3.6
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.789 CS 25.1301 CS 25.1309 CS 25.1365 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

9.9.6 Occupants shall not become trapped in lavatories, galleys, or other compartments during emergency evacuation situations, and emergency lighting shall be available to aid egress.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-PRF-85676	*Def-Stan 00-970 Reference:*	00-970 P1 4.22.3 00-970 P13 1.6.11.5
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.803 CS 23.812

Information Sources			
			CS 25.803 CS 25.812 CS 25.819 CS 25.820 CS 29.803 CS 29.812

SECTION 10 - DIAGNOSTICS SYSTEMS

This section covers the functionality and integration of air vehicle diagnostics; and specifically the detection, isolation, and reporting of loss or degradation of system functions. Some diagnostic systems covered include built-in-tests (BIT), built-in-test-equipment (BITE) and health and usage monitoring systems (HUMS).

Included within the scope of this section are:
• Development and application of FMECA;
• Measurement of SOF parameters;
• Diagnostic sensor calibration and operation;
• Self induced failure prevention.

TYPICAL CERTIFICATION SOURCE DATA

1. Failure modes, effects, and criticality analysis (FMECA)
2. Acceptance test procedures
3. Pre-flight test results
4. Built-in-test software
5. Flight test plan
6. Testability analysis reports
7. BIT demos reports
8. Test & evaluation master plan (TEMP)
9. Failure report and corrective action system (FRACAS) data
10. Test reports
11. System safety analysis report

CERTIFICATION CRITERIA

10.1. FAILURE MODES.

10.1.1 Critical functional failure modes shall be identified, and provisions incorporated within the air vehicle design for their detection.

Consideration shall be given to:
a. Conducting a recognised system safety analysis (e.g. Fault Tree Analysis);
b. Conducting FMECA (or acceptable similar analysis) in order to identify all safety and mission critical failures;
c. Identifying all possible modes of failure, including malfunctions and damage from external sources;
d. The probability of multiple failures, and the probability of undetected faults;
e. The resulting effects on the air vehicle and third parties, considering the stage of flight and operating conditions;
f. The air crew's capability of determining faults.

Information Sources			
Comm'l Doc:	SAE AIR 4845 details the FMECA process.		
DoD/MIL Doc:	JSSG-2000: 3.3.2 JSSG-2001: 3.3.7, 3.3.7.1	*Def-Stan 00-970 Reference:*	00-970 P1 2.25.76 00-970 P1 4.12.8

Information Sources			
			00-970 P1 6.2.35 00-970 P7 L725 4
		STANAG Reference:	4671.1309 4671.1788
FAA Doc:	14CFR references: 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351	*EASA CS Reference:*	CS 23.1309 CS 25.1309

10.1.2 Detection of critical functional failures, including built-In-test (BIT) features, shall activate caution and warning functions and message indicators in a timely manner, to enable appropriate corrective action to be taken.

Consideration should be given to:

a. Ensuring information needed (to the crew or other equipment) is provided in time to preclude further uncontrolled degradation to safety, mission accomplishment, and survivability;

b. Use of visual and/or aural indication;

c. Ensuring systems and controls and associated monitoring and warning means are designed to minimise crew errors.

d. A warnings philosophy for new designs which standardises the warnings criticality level with the matching warning indication and recording criteria.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.3.2 JSSG-2001: 3.3.7, 3.3.7.1	*Def-Stan 00-970 Reference:*	00.970 P1 2.5.30 00-970 P1 4.4.7 00-970 P7 L207 8.5 00-970 P7 L725 3 00-970 P9 UKU 249e
		STANAG Reference:	4671.1309 4671.1728 4671.1787
FAA Doc:	14CFR references: 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

10.2. OPERATION.

10.2.1 Diagnostic systems shall accurately monitor all appropriate safety-of-flight (SOF) parameters, in order to permit proper diagnosis.

Consideration should be given to:

a. The fidelity & integrity of both air vehicle and ground diagnostic systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.6.2	*Def-Stan 00-970 Reference:*	00-970 P1 4.4.7 00-970 P9 USAR U1787

Information Sources			
		STANAG Reference:	4671.1607 4671.1787
FAA Doc:	14CFR references: 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351	*EASA CS Reference:*	CS 29.1465

10.2.2 Diagnostic sensor operation and calibration procedures shall permit accurate measurement of all critical parameter values, within specified tolerances.

Consideration should be given to:

a. Establishing specified tolerances for each critical parameter values being monitored;

b. Ensuring diagnostic sensor calibration methods deliver the required integrity.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.3.2 JSSG-2001: 3.3.7,3.3.7.1	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	14CFR references: 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351	*EASA CS Reference:*	

10.2.3 Failure of the diagnostic system itself shall not adversely affect safety-of-flight (SOF), induce undetected failures, or otherwise damage the air vehicle.

Consideration should be given to:

a. Ensuring the diagnostic system design is minimally invasive;

b. Ensuring systems and controls are designed to minimise crew errors;

c. Ensuring dangerous-condition-prevention devices do not limit flight within the Operational Flight Envelope.

d. Ensuring the failure of diagnostic function does not initiate a sequence of actions that provide a more adverse effect on flight safety.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.3.2 JSSG-2001: 3.3.7,3.3.7.1 JSSG-2001 Air vehicle: 3.3.7 Diagnostics AFGS 87256 Integrated Diagnostics provides general guidance regarding diagnostics	*Def-Stan 00-970 Reference:*	00-970 P1 2.25.76
		STANAG Reference:	4671.1309
FAA Doc:	14CFR references: 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309 CS 29.1465

10.2.4 All critical safety systems shall be monitored to ensure they are fully functional prior to their activation.

Consideration should be given to:

a. Use of Built-In-Test (BIT) and/or continuous health monitoring.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.3.2 JSSG-2001: 3.3.7,3.4.4.1.6	*Def-Stan 00-970 Reference:*	00-970 P9 UK1309
		STANAG Reference:	4671.1309
FAA Doc:	14CFR references: 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

10.2.5 Operator and maintenance manuals containing diagnostic systems shall be complete and shall provide accurate diagnostic information.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.6.2	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1581 4671.1787
FAA Doc:	14CFR references: 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351	*EASA CS Reference:*	CS 29.1465

10.2.6 Air vehicles shall be equipped with flight data recorders and cockpit voice recorders where appropriate.

Consideration should be given to:

1. The essential parameters to be recorded as determined by the National Regulatory Authority.
2. Any potential security aspects associated with the required installation and parameters to be recorded.
3. Location of microphone for audio recordings.
4. Power supply to recording device.
5. Prevention of erasure, or over-writing, of recording after a crash impact.
6. Crash survivability of recording device.
7. Any conspicuity requirements, including underwater detection if required.
8. Ability for pre-flight checking of recorder to ensure correct functioning.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	

Information Sources			
FAA Doc:		*EASA CS Reference:*	CS 25.1457 CS 25.1459

SECTION 11 - AVIONICS

This section covers the design, installation, arrangement and compatibility of the complete air vehicle avionics system. This includes manned air vehicle avionics, as well as airborne and ground segment avionics for UAVs.

TYPICAL CERTIFICATION SOURCE DATA

1. Design criteria
2. Design studies and analyses
3. Design, installation, and operational characteristics
4. Design approval and system compatibility tests
5. Simulation tests and modelling results
6. Component and system level qualification and certification tests
7. Electromagnetic environmental effects
8. Hazard analysis and certification
9. Failure modes and effects analysis
10. Avionics flight-critical hardware and software
11. Avionics preliminary design review (PDR) and critical design review (CDR) open items
12. Avionics integration tests and results
13. Avionics/electronics integrity program documentation
14. Flight test simulation plan
15. System/subsystem self-test design and capabilities
16. Acceptance test plans, procedures, and results
17. Qualification test plans, procedures, and results
18. Functional configuration audit (FCA) and physical configuration audit (PCA) data
19. Test reports
20. Environmental analysis and test results
21. Diminishing manufacturing sources plan 22. Obsolete parts plan

CERTIFICATION CRITERIA

(Note: For subsystems that use computer resources, see section 15 for additional, specific criteria.)

11.1. AVIONICS ARCHITECTURE.

11.1.1 Ensure that Avionics Subsystems have the number and type of sensors, data processors, data buses, controls and displays, and communications devices adequate for Safety of Flight and air traffic management considerations.

Consideration should be given to safety critical functions such as:

a. Air data system, including provisions for displaying primary flight parameters;

b. Propulsion system instrumentation, with the ability to monitor performance, fuel status, and integrity of the system;

c. Display of other air vehicle or vehicle management system parameters as required for safe flight;

d. An installed interoperable communications subsystem capable of supporting Safety of Flight and Air Traffic Management operations with the required integrity (including security) and continuity of service throughout the intended missions;

e. A navigation subsystem capable of meeting Safety of Flight and Air Traffic Management performance, integrity, availability and continuity of service requirements for long range reference, local area reference, and landing/terminal reference;
f. An installed surveillance and identification subsystem capable of meeting the Safety of Flight and Air Traffic Management performance, integrity, and continuity of service requirements for identification, relative positioning, trajectory, timing, and intent;
g. Normal, Emergency and Critical Failure Mode conditions.
h. Operation in, or in the vicinity of, a volcanic ash cloud.

Information Sources			
Comm'l Doc:	For air data system: RTCA DO-236A, guidance on CNS/ATM related air data system requirements For radio subsystems: RTCA DO-186A is the civil standard for VHF radio RTCA DO-219 RTCA SC-189 For navigation subsystems: RTCA DO-236A, for CNS/ATM related navigation system requirements RTCA DO-200A: 2.3.2, 2.3.3, 2.3.5, and 2.4.1 (RNP Data Processing) RTCA DO-236 For surveillance and identification subsystems: RTCA DC-181C is the civil standard for Mode S RTCA DO-185A Is the civil standard for TCAS II RTCA DO-212		
DoD/MIL Doc:	JSSG-2005: 3.2.1.5 and 4.2.1.5	*Def-Stan 00-970 Reference:*	00-970 P1 6.3.2 00-970 P1 6.3.4
		STANAG Reference:	4671.1301 4671.1707 4671.1723 4671.1725
FAA Doc:	AC-23.1301, 23.1309, 25.1301, 25.1309, RTCA DO-200A AC 27-1B, Certification of Normal Category Rotorcraft AC 29-2C, Certification of	*EASA CS Reference:*	CS 23.1301 CS 25.1301 CS 27.1301 CS 29.1301

Information Sources			
	Transport Category Rotorcraft AC 20-145 Guidance for Integrated Modular Avionics (IMA) AC 20-130A, Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors For air data system: FAA IG 91-RVSM, 7.c(4), 7.C(5), 7.c(8), 7.d, 8.b(5), 8.b(6), 8.b(7), 8.c, and 8.d. (RVSM) AC-23.1323, 23.1325, 23.1326, 25.1323, 25.1325, 25.1326 AC 90-97 7 (Baro VNAV) AC 20-129 6 (RNAV VNAV) For propulsion system instrumentation: 14CFR reference: 23.1301, 13.1305, 23.1309, 25.1301, 25.1305, 25.1309 and FAA AC-1307-1C section 8.5 provide more extensive guidance. AC-27-1 and AC-29-2 provide guidance on helicopter equipment, primarily in subpart "F" For display system guidance: AC 23.1301, 23.1309, 23.1351d, 25.1301, 25.1309, 25.1351d 14CFR reference: 23.1301, 23.1307, 25.1301 and 25.1307 provide additional guidance. AC-27-1 and AC-29-2 provide guidance on helicopter equipment, primarily in subpart “F” For radio subsystems: AC 20-140, Guidelines for Design Approval of Aircraft Data Communications Systems For navigation subsystems:		

Information Sources			
	AC-25.1303, AC 90-96 AC_90-96 (BRNAV only) AC_90-96A (Draft containing both BRNAV and PRNAV requirements) FAAO 8400.12A 10.a-b, & 15a (RNP-10) AC 20-129 Airworthiness Approval of Vertical Navigation (VNAV) Systems for use in the U.S. National Airspace System (NAS) and Alaska, 9-12-88, 6 (RNAV VNAV) For surveillance and identification subsystems: TSO C112, AC 20-131A, TSO C151a		

11.1.2 Ensure that for any single safety-critical sensor, connection, processor, or display unit, redundancy is incorporated such that any credible combination of failures does not result in loss of safety-critical data or display of unsafe or misleading data.

Consideration should be given to:

a. Normal, Emergency and Critical Failure Mode conditions;

b. An installed surveillance and identification subsystem capable of meeting the Safety of Flight and Air Traffic Management performance, integrity, and continuity of service requirements for identification, relative positioning, trajectory, timing, and intent.

Information Sources			
Comm'l Doc:	ARP 4761 sections 4.2 FMEA, 4.4 CCA, 4.4.2 PRA, and 4.4.3 CMA		
DoD/MIL Doc:	JSSG-2005: 3.2.1.4.1, 4.2.1.4.1	*Def-Stan 00-970 Reference:*	00-970 P1 6.2.36
		STANAG Reference:	4671.1309 4671.1331
FAA Doc:	AC-23.1309, 23.1311, 23.1331, 25.1309, 25.1331 14CFR references: 23.1309, 23.1311, 23.1331, 25.1309, 25.1331 AC-27-1 and AC-29-2 provide guidance on helicopter equipment, primarily in subpart "F"	*EASA CS Reference:*	CS 23.1309 CS 23.1311 CS 23.1331 CS 25.1309 CS 25.1331 CS 27.1309 CS 29.1309 CS 29.1331

11.1.3 Ensure that avionics data buses shall have sufficient redundancy, reliability, and integrity to meet system safety and flight-critical requirements to preclude:

• Loss of safety-critical functioning;

• Display of unsafe or misleading information to the operator or maintainer;

• Undetected failure modes.

Consideration should be given to:
a. Normal, Emergency and Critical Failure Mode conditions;
b. Multiple/independent paths for critical signals.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2005: 3.2.2, 4.2.2	*Def-Stan 00-970 Reference:*	00-970 P1 6.2 00-970 P7 L725/2
		STANAG Reference:	4671.1309
FAA Doc:	AC-27-1 and AC-29-2 provide guidance on helicopter equipment, primarily in subpart "F" For prevention of loss of flight critical functioning: AC-23.1301, 23.1309, 25.1301, 25.1309 For prevention of unsafe or misleading information: AC-23.1301, 23.1309, 23.1311, 25.1301, 25.1309 14CFR references: 23.1301, 23.1309, 23.1311, 25.1301, 25.1309 For prevention of undetected failure modes: AC-23.1301, 23.1309, 25.1301, 25.1309	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

11.1.4 Ensure the overall avionics system operates in a predictable, deterministic or bounded manner and limits latency of any time-critical data, including primary flight data, as needed to support all safety-critical functions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2005: 3.3.5, 4.3.5 For undetected failure modes, and timing or latency anomalies: JSSG-2005:3.2.1.3.2, 4.2.1.3.2 For interface/interconnect failures: JSSG-2005: 3.2.2.2, 4.2.2.2, 3.2.2.3, 4.2.2.3	*Def-Stan 00-970 Reference:*	00-970 P7 L725/2
		STANAG Reference:	4671.1309 4671.1331 4671.1723
FAA Doc:	AC-23.1301, 23.1309, 23.1329, 23.1335, 25.1301, 25.1309, 25.1329, 25.1335 AC-27-1 and AC-29-2 provide guidance on helicopter	*EASA CS Reference:*	CS 23.1309 CS 23.1331 CS 25.1309 CS 25.1331 CS 27.1309

Information Sources			
	equipment, primarily in subpart "F" AC 20-145, Guidance for Integrated Modular Avionics (IMA) that Implement TSO-C153 Authorized Hardware Elements.		CS 29.1309 CS 29.1331

11.1.5 Ensure that all modes of operation are safe for the integrated system and ensure that the following events do not result in unsafe system operation:

a. Undetected failure modes (failures not automatically detected by diagnostics);

b. Timing or latency anomalies;

c. Interface/interconnect failures.

Consideration should be given to graceful degradation covering normal, backup, and emergency modes.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2005: 3.3.5, 4.3.5 For undetected failure modes, and timing or latency anomalies: JSSG-2005: 3.2.1.3.2, 4.2.1.3.2 For interface/interconnect failures: JSSG-2005: 3.2.2.2, 4.2.2.2, 3.2.2.3, 4.2.2.3	*Def-Stan 00-970 Reference:*	00-970 P1 6.2.35 00-970 P1 6.2.36 00-970 P7 L725 4.1
		STANAG Reference:	4671.1309 4671.1607
FAA Doc:	AC-23.1301, 23.1309, 23.1329, 23.1335, 25.1301, 25.1309, 25.1329, 25.1335 AC-27-1 and AC-29-2 provide guidance on helicopter equipment, primarily in subpart "F" AC 20-145, Guidance for Integrated Modular Avionics (IMA) that Implement TSO-C153 Authorized Hardware Elements.	*EASA CS Reference:*	CS 23.1309 CS 23.1329 CS 25.1309 CS 25.1329 CS 27.1309 CS 27.1329 CS 29.1309 CS 29.1329

11.1.6 Ensure that the avionics system integrated diagnostics provides the fault coverage, low false alarm rates, fault isolation, and fault detection needed to detect bad data and failed components that would degrade safe operation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2005: 3.2.1.3.2, 4.2.1.3.2	*Def-Stan 00-970 Reference:*	00-970 P7 L725 3.4/3.5
		STANAG Reference:	4671.1787

Information Sources			
FAA Doc:	AC-23.1309, 25.1309 14CFR reference 23.1309, 25.1309 AC-27-1 and AC-29-2 provide guidance on helicopter equipment, primarily in subpart "F" AC 29-2C, Certification of Transport Category Rotorcraft	*EASA CS Reference:*	

11.2. AVIONICS SUBSYSTEMS.

11.2.1 Ensure that critical flight, status and warning information is provided to the crew in a timely, clear and unambiguous form.

Consideration should be given to:

a. Legibility of primary flight displays. Ensure that primary flight information is provided to the crew at all times and is readable in all mission environments (including NVG where applicable) and lighting conditions (including full sunshine on displays, sun in the eyes, and total darkness);

b. Accuracy. Ensure that accuracy of flight-critical information meets SOF requirements;

c. Warnings, cautions, and advisories. Ensure that cautions and warnings are legible in all mission environments and are provided in an organized, prioritized system, and that the presentation of high-priority information is not masked by older or lower priority warnings and cautions;

d. Symbology. Ensure that instruments and symbols used to display flight-critical information employ accepted formats, directions, etc.;

e. BIT features. Ensure that BIT features of equipment alert the flight crew of flight-critical equipment status.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	DoD/MIL Doc: For legibility of primary flight displays: AFI 11-202 Vol 3: 2.6, 2.6.1, 2.6.1.1, 2.6.1.2, and 2.6.1.2.1 provides Air Force instructions on PFRs. MIL-HDBK-87213 section 3.1.1 provides guidance on legibility of displays; section 3.2.1.6 provides guidance on verification of displays in high ambient lighting environments. JSSG-2005: 3.2.1.8, 4.2.1.8, 3.2.1.8.1, and 4.2.1.8.1, provides additional avionics systems requirements guidance.	*Def-Stan 00-970 Reference:*	00-970 P1 6.2.1-6.2.6 00-970 P1 6.2.33
		STANAG Reference:	4671.1309 4671.1323 4671.1327 4671.1721 4671.1727 4671.1785 3705

Information Sources			
	For accuracy: MIL-HDBK-87213: 3.2.1.25.4.1 and App A For warnings, cautions, and advisories: JSSG-2005: 3.2.1.8.5, 4.2.1.8.5 MIL-HDBK-87213 For symbology, primary flight information guidance is provided in: MIL-STD-1787 section 4.2 MIL-STD-1787 Appendix A For BIT features: JSSG-2005: 3.2.1.3.2, 4.2.1.3.2 FAA Doc: AC-27-1 and AC-29-2 provide guidance on helicopter equipment, primarily in subpart “F” For legibility of primary flight displays: AC 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351 23.1311, 23.1321, 25.1321 14CFR references: 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351, 23.1311, 23.1321, 25.1321 provide related FAA criteria For accuracy: 14CFR reference 23.1311, 23.1323, 23.1325, 23.1326, 23.1327, 25.1323, 25.1325, 25.1326, 25.1327 For warnings, cautions, and advisories: 14CFR reference 23.1311, 23.1322, 25.1322 For symbology: AC-1311-1A section 9 14CFR reference 23.1321, 23.1541, 25.1321 and 25.1541 For BIT features: 14CFR reference 23.1309, 25.1309		
FAA Doc:	AC-27-1 and AC-29-2 provide guidance on helicopter equipment, primarily in subpart	*EASA CS Reference:*	CS 23.1309 CS 23.1321 CS 23.1322

Information Sources			
	"F" For legibility of primary flight displays: AC 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351 23.1311, 23.1321, 25.1321 14CFR references: 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351, 23.1311, 23.1321, 25.1321 provide related FAA criteria For accuracy: 14CFR reference 23.1311, 23.1323, 23.1325, 23.1326, 23.1327, 25.1323, 25.1325, 25.1326, 25.1327 For warnings, cautions, and advisories: 14CFR reference 23.1311, 23.1322, 25.1322 For symbology: AC-1311-1A section 9 14CFR reference 23.1321, 23.1541, 25.1321 and 25.1541 For BIT features: 14CFR reference 23.1309, 25.1309		CS 23.1323 CS 23.1326 CS 23.1327 CS 23.1541 CS 25.1309 CS 25.1321 CS 25.1322 CS 25.1323 CS 25.1326 CS 25.1327 CS 25.1541 CS 27.1309 CS 27.1321 CS 27.1322 CS 27.1323 CS 27.1327 CS 27.1541 CS 29.1309 CS 29.1321 CS 29.1322 CS 29.1323 CS 29.1326 CS 29.1327 CS 29.1541

11.2.2 Ensure that avionic subsystem controls, such as that for controlling avionic modes and system function, are defined for all safety-critical functions have adequate redundancy and/or reliability in order to maintain required control.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2005: 3.2.1.8.6, 4.2.1.8.6 FAA References: Nil	*Def-Stan 00-970 Reference:*	00-970 P 1/5 S2 00-970 P 1/6 S6 L12
		STANAG Reference:	4671.1731
FAA Doc:	AC-25.777 AC-27-1 and AC-29-2 provide guidance on helicopter equipment, primarily in subpart "F"	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

11.2.3 Ensure that data links providing SOF/flight-critical functioning maintain data integrity and continuity of service throughout the intended missions and satisfies fault-tolerant SOF requirements. In addition, ensure that data link integrity precludes the display of unsafe or misleading information to the operator or maintainer, and satisfies fault-tolerant SOF requirements.

Consideration should be given to:

a. Unmanned air vehicle (UAV)/remotely operated aircraft (ROA) command and control data links;

b. Manned systems with automatic/semi-automatic (man-in-the-loop) landing, formation, or other control functions with off-board aiding that are used for safety- and flight-critical requirements.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2005: 3.2.2, 4.2.2	*Def-Stan 00-970 Reference:*	00-970 P1 6.5.1
		STANAG Reference:	4671.1309 4671.1601-4671.1617
FAA Doc:	14CFR reference 23.1301, 23.1309, 25.1301, 25.1309 AC 29-140, Guidelines for Design Approval of Aircraft Data Communications Systems	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

11.2.4 Ensure that each avionics subsystem and the overall avionics system is qualified and certified to operate throughout the required air vehicle operational environment without imposing a SOF risk.

Consideration should be given to the use of any off-the-shelf (OTS) equipment which may not be:

a. Qualified to the full air vehicle operating envelope, or;

b. If commercial OTS, qualified to the military combat aircraft environment such as:

- i. High manoeuvre loads;
- ii. High vibration loads e.g. gun-fire;
- iii. Supersonic speeds, etc.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2005: 3.2.3, 4.2.3 MIL-STD-810 can be used as guidance in selection and tailoring of appropriate requirements for specified environments. MIL-STD-810 provides guidance and test methods for verification.	*Def-Stan 00-970 Reference:*	00-970 P1 S6.2 00-970 P1 6.2.40-6.2.61 00-970 P7 L725 2.3.1 00-970 P7 L725 6.1-6.4
		STANAG Reference:	4671.1309
FAA Doc:	AC-23.1309, 25.1309	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

11.2.5 Ensure that the Avionics System operates safely and with the required power characteristics.

Consideration should be given to Normal, Emergency and Critical Failure Mode conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2005: 3.2.2.5, 4.2.2.5	*Def-Stan 00-970 Reference:*	00-970 P1 6.2.35 00-970 P1 6.2.36 00-970 P1 6.2.37 00-970 P7 L725 4.1

Information Sources			
		STANAG Reference:	4671.1309 4617.1351
FAA Doc:	AC-23.1351, 25.1351	*EASA CS Reference:*	CS 23.1351 CS 25.1351 CS 27.1351 CS 29.1351

11.3. AVIONICS AIR VEHICLE INSTALLATION.

11.3.1 Ensure that the avionics equipment installation, including arrangement and crashworthiness, is adequate for SOF.

Consideration should be given to:

a. Normal, Emergency and Critical Failure Mode conditions;

b. Systems that operate the first pilot's instruments should be independent from other flight crew stations.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2005: 3.2.3, 4.2.3	*Def-Stan 00-970 Reference:*	00-970 P1 6.2.9-6.2.18 00-970 P7 L725 2.3.1
		STANAG Reference:	4671.1309
FAA Doc:	14CFR reference 23.1309, 23.1321, 25.1309, 25.1321	*EASA CS Reference:*	CS 23.1309 CS 23.1321 CS 25.1309 CS 25.1321 CS 25.1333 CS 27.1309 CS 27.1321 CS 29.1309 CS 29.1321

11.3.2 Ensure that flight manual and maintenance manual limits are adequate to conduct safe flight, including emergency operations and failure mode conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG -2005: 3.2.2, 4.2.2	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1501 4671.1581
FAA Doc:	14CFR reference 23.1501, 25.1501 AC 27-1B, Subpart G, Certification of Normal Category Rotorcraft AC 29-2C, Certification of	*EASA CS Reference:*	CS 23.1501 CS 25.1501 CS 27.1501 CS 29.1501

Information Sources			
	Transport Category Rotorcraft		

11.3.3 Ensure that antenna patterns and performance for safety/flight-critical transmitting and receiving systems provide adequate coverage to ensure:

a. Flight-critical functioning is retained;

b. Unsafe information is not displayed to the operator or maintainer;

c. Adequate availability and continuity of service for SOF operations.

Consideration should be given to Normal, Emergency and Failure Mode conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2005: 3.3.5, 4.3.5	*Def-Stan 00-970 Reference:*	00-970 P1 6.1.17 00-970 P7 L707 2.1
		STANAG Reference:	4671.1309 4671.1607 4671.1615
FAA Doc:	14CFR reference 23.1309	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

SECTION 12 - ELECTRICAL SYSTEM

This section covers the design, installation, arrangement and compatibility of the complete air vehicle electrical system. It covers both the electrical power generation system and electrical wiring system, including power distribution.

(Note: For subsystems that use computer resources, see section 15 for additional specific criteria.)

TYPICAL CERTIFICATION SOURCE DATA

1. Design criteria
2. Design studies and analyses, including electrical loads analysis
3. Failure modes, effects, and criticality analysis (FMECA)
4. Hazard analyses
5. Functional operations test results
6. Performance test results
7. Installation and operational characteristics
8. Component and system qualifications
9. Flight manual, flight test procedures, and limitations
10. Wiring diagrams, which may include information regarding

• Wire types, wire sizes and current/voltage carried, wire identification, circuit breaker sizes and part numbers
• Harness diameters including modified harnesses
• Connector and accessories part numbers and identification
• Clamping and part numbers
• Miscellaneous parts identification and part numbers-nuts, bolts, washers, terminal lugs, environmental splices/shield terminations 11. 3D routing diagrams with several views and pictures

12. Visual assessment of the design implementation and installation
13. Component and system qualifications
14. Installed equipment list
15. Diminishing manufacturing sources plan 16. Obsolete parts plan

CERTIFICATION CRITERIA

12.1. ELECTRIC POWER GENERATION SYSTEM.

For airborne, shipborne or ground applications, the electric power generating system includes electrical power sources, main power buses, transmission cables, and associated control, regulation and protective devices.

12.1.1 Ensure that sufficient electrical power is available to meet the air vehicle systems power requirements during all modes of operation and potential failure conditions.

Consideration should be given to:

a. Individual electrical load power requirements of systems at normal flight, normal ground, maintenance, environmental extremes, peak and failure mode conditions;

b. The compound electrical load power requirements of all systems at normal, peak and failure mode conditions;

c. The balance of electrical loads across distribution systems and power generation systems, including redundancy for flight critical systems;
d. The need to shed non-essential electrical loads in a safe manner in order to preserve essential systems electrical supply in the event of failure;
e. Systems future growth and development requirements;
f. System transients due to switching, fault clearing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	TYPICAL CERTIFICATION SOURCE DATA: Source data to inform decisions supporting certification typically includes: Design Criteria; Design studies and analyses (including electrical loads analysis); Failure modes, effects, and criticality analysis (FMECA); Hazard analyses; Functional operations test results; Performance test results; Installation and operational characteristics; Component and system qualifications; Flight manual, flight test procedures, and limitations; Wiring diagrams (which may include information regarding: Wire types, wire sizes and current/voltage carried, wire identification, circuit breaker sizes and part numbers) • Harness diameters including modified harnesses • Connector and accessories part numbers and identification • Clamping and part numbers • Miscellaneous parts identification and part numbers-nuts, bolts, washers, terminal lugs, environmental splices/shield terminations) 3D routing diagrams with several views and pictures; Visual assessment of the design implementation and installation; Component and system qualifications; Installed	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P1 6.6.2 00-970 P1 6.6.16 00-970 P1 6.6.18 4671.1351

Information Sources			
	equipment list; Diminishing manufacturing sources plan; Obsolete parts plan Comm'l Doc: For guidance/principles regarding aspects of assuring effective and proper electric power generation system design, integration and compatibility: SAE AS50881 ARINC Report 609 NFPA 70 For electric power quality: SAE AS1831 DoD/MIL Doc: For guidance/principles regarding aspects of assuring effective and proper electric power generation system design, integration, compatibility and electrical system capacity MIL-E-7016 AFGS-87219 MIL-STD-1683 MIL-STD-7080 MIL-HDBK-299 MIL-HDBK-454 ADS-51-HDBK chapter/section 4-8.6 MIL-STD-464 For electric power quality: MIL-STD-704 MIL-HDBK-704 MIL-STD-1399-300 JSSG-2009: Appendix C C.3.4.3.5.2, C.4.4.3.5.2 Appendix H H.3.4.8.2, H.4.4.8.2		
FAA Doc:	14CFR references: 23.1351 25.1351	*EASA CS Reference:*	CS 23.1351 CS 25.1310 CS 25.1351 CS 27.1351 CS 29.1351

12.1.2 Ensure that the operation of the electric power generation system and its component parts is safe.

Noting the wide variety of electrical power generation systems and components, consideration should be given to the following under all anticipated environmental loadings, configurations and equipment fits (MEDEVAC, SPS):

a. Adequate implementation of cooling and ventilation provisions;

b. Status/failure indications including central warning panels;

c. Mechanical/thermal disconnect (as applicable) of generators, converters, inverters, batteries, etc.;

d. Cabin pressure failure;

e. Escape of crew and passengers;

f. Overcharging and electrical load analysis;

g. Routeing of fuel, oil and water;

h. Connection of external ground power;

i. Corrosion, toxic substances and gases from batteries.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	For guidance/principles regarding design and operation of safe electrical generation systems: AFGS-87219 MIL-G-21480 MIL-HDBK-454 MIL-STD-464 ADS-51-HDBK Chapter/Section 8-7 JSSG-2009: Appendix H H.3.4.8, H.4.4.8, H.3.4.8.4, H.4.4.8.4 FAA Doc:	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.1 00-970 P1 6.6.2 00-970 P1 6.6.28 00-970 P1 6.6.34 00-970 P1 6.6.87 00-970 P7 C706 4.2.2 00-970 P7 C706 4.6 00-970 P7 C706 7.4.2
		STANAG Reference:	4671.1351 4671.1651 4671.1367
FAA Doc:	14CFR references: 23.1351-23.1367 25.1351-25.1363	*EASA CS Reference:*	CS 23.1351-23.1367 CS 25.1351-25.1363 CS 27.1351-27.1367 CS 29.1351-29.1363

12.1.3 Ensure that operation of the integrated electrical power system for normal and emergency modes is safe.

Consideration should be given to:

a. Normal and emergency modes;

b. Use of actual or simulated drives and loads;

c. All flight and control configurations;

d. Transition between modes;

e. Bus switching;

f. Load shedding;

g. Fault condition operation (detection, clearing, and reconfiguration);

h. Assurance that no single fault affects more than one power source;

i. Electrical loads analysis;

j. Application of external power;

k. Circuit protection.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	For guidance/principles regarding/affecting design and operation of safe integrated electrical systems: AFGS-87219 MIL-STD-464 MIL-E-7016 ADS-51-HDBK (Chapter/Section 8-7) JSSG-2009: Appendix H H.3.4.8, H.4.4.8, H.3.4.8.4, H.4.4.8.4, H.3.4.8.5, H.4.4.8.5	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.2 00-970 P1 6.6.6 00-970 P1 6.6.15
		STANAG Reference:	4671.1351 4671.1651 4671.1367
FAA Doc:	14CFR references: 23.1351-23.1367; 25.1351-25.1363	*EASA CS Reference:*	CS 23.1351-23.1367 CS 25.1351-25.1363 CS 27.1351-27.1367 CS 29.1351-29.1363

12.1.4 Ensure that required power quality is maintained for all operating conditions and load combinations.

Consideration should be given to:

a. Voltage stability;

b. Frequency stability;

c. Impedance stability;

d. Current stability;

e. Power quality under electrical generation system failure mode conditions.

Information Sources			
Comm'l Doc:	SAE AS1831 for guidance/principles regarding/affecting design and operation of electrical systems to provide compatible and predictable electric power quality.		
DoD/MIL Doc:	Comm'l Doc: SAE AS1831 for guidance/principles regarding/affecting design and operation of electrical systems to provide compatible and predictable electric power quality. DoD/MIL Doc: For guidance/principles regarding/affecting design and operation of electrical systems to provide compatible and	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.1 00-970 P1 6.6.6 00-970 P1 6.6.12 00-970 P1 6.6.16 00-970 P7 C706 2.7.1-2.7.3 00-970 P7 C706 3.2-3.3
		STANAG Reference:	4671.1351 4671.1367

Information Sources			
	predictable electric power quality: AFGS-87219 MIL-STD-464 MIL-STD-704 MIL-HDBK-704 MIL-STD-1399-300 ADS-51-HDBK chapter/section 7 JSSG-2009: Appendix H H.3.4.8.1, H.4.4.8.1 MIL-HDBK-704 for test methods and procedures for verification of power quality		
FAA Doc:	14CFR references: 23.1351-23.1367 25.1351-25.1363	*EASA CS Reference:*	CS 23.1351 CS 23.1353 CS 23.1357 CS 25.1351 CS 25.1353 CS 25.1355 CS 25.1357 CS 25.1363 CS 27.1351 CS 27.1353 CS 29.1351 CS 29.1353 CS 29.1355 CS 29.1363

12.1.5 Ensure that independent, uninterruptable power sources are available to satisfy the requirements of essential redundancy for flight-critical functions following failure of the primary power system and that there are no points where a single failure or a reasonable combination of failures could result in total loss of power anywhere in the power system (including circuit boards).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Comm'l Doc: Nil DoD/MIL Doc: For guidance/principles regarding/affecting design and operation of electrical systems for uninterruptible electric power: AFGS-87219 MIL-E-7016 NAVSEA TM-S9310-AQ-SAF-010 JSSG-2009: Appendix H	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.2 00-970 P1 6.6.6 00-970 P7 C706 2.4 00-970 P7 C706 2.7.1-2.7.3
		STANAG Reference:	4671.1351 4671.1353

Information Sources			
	H.3.4.8, H.4.4.8		
FAA Doc:	14CFR references: 23.1351-23.1367; 25.1351-25.1363	*EASA CS Reference:*	CS 23.1351 (b)(3) CS 25.1351 (d) CS 25.1355 CS 25.1363 CS 29 1351

12.1.6 Ensure that where batteries are employed to provide backup power for Safety Of Flight (SOF) functions, the installation is safe and that the method for charging and checking is adequate.

Consideration should be given to:

a. Battery powered engine ignition systems and associated charging systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Comm'l Doc: Nil DoD/MIL Doc: For guidance/principles regarding/affecting the integrated design and operation of battery subsystems within aircraft electrical systems: AFGS-87219 NAVSEA TM-S9310-AQ-SAF-010 JSSG-2009: Appendix H H.6.4.2	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.82-6.6.88 00-970 P7 C706 7
		STANAG Reference:	4671.1353
FAA Doc:	14CFR references: 23.1351-23.1367; 25.1351-25.1363	*EASA CS Reference:*	CS 23.1353 CS 25.1353(c) CS 25.1165 CS 27.1353 CS 29.1353

12.1.7 Ensure that emergency backup electrical power systems can provide the required power.

Consideration should be given to ensuring required power is available for:
a. Malfunction recovery procedures;
b. All flight conditions associated with the mission profiles of the platform.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Comm'l Doc: Nil	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.6 00-970 P1 6.6.8 00-970 P1 6.6.18

Information Sources			
	DoD/MIL Doc: For guidance/principles regarding/affecting the integrated design and operation of backup power within aircraft electrical systems: AFGS-87219 MIL-E-7016 JSSG-2009: Appendix H H.3.4.8, H.4.4.8, H.3.4.8.5, H.4.4.8.5		00-970 P1 6.6.19 00-970 P7 C706 2.7.1-2.7.3 00-970 P7 C706 3.3
		STANAG Reference:	4671.1353
FAA Doc:	14CFR references: 23.1351-23.1367; 25.1351-25.1363	*EASA CS Reference:*	CS 23.1353 (h) CS 25.1351 (d)(1)&(2) CS 25.1363 CS 29.1351 (d)(1)&(2)

12.1.8 Ensure that any electrical subsystem limitations are defined and included in the appropriate manuals.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Comm'l Doc: Nil DoD/MIL Doc: For guidance/principles affecting/providing awareness of limitations of aircraft electrical systems: MIL-E-7016	*Def-Stan 00-970 Reference:*	00-970 P1 7.5(all)
		STANAG Reference:	4671.1583
FAA Doc:	14CFR references: 23.1301, 23.1309; 25.1301, 25.1309	*EASA CS Reference:*	CS 23.1583 CS 25.1583

12.1.9 Ensure that suitable normal and emergency operating procedures for electrical systems are included in the flight manual.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: Appendix H H.3.4.8, H.4.4.8 for guidance/principles regarding/providing awareness of operating characteristics and procedures for aircraft electrical systems.	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1583
FAA Doc:	14CFR references: 23.1301, 23.1309; 25.1301, 25.1309	*EASA CS Reference:*	CS 23.1585 CS 25.1585 CS 27.1585 CS 29.1585

12.1.10 Ensure that the system powers up in a safe state and in circumstances involving a loss of power, power transients or fluctuations, the system remains or reverts to a known safe state.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	For guidance/principles regarding design with knowledge of the states of aircraft electrical systems: AFGS-87219 MIL-STD-464 JSSG-2009: Appendix H 3.4.8.4, 3.4.8.5	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.104
		STANAG Reference:	4671.1351
FAA Doc:	14CFR references: 23.1351-23.1367; 25.1351-25.1363, 25.1309, 25.1529	*EASA CS Reference:*	CS 23.1351 CS 23.1353 CS 23.1357 CS 25.1351 CS 25.1353 CS 25.1355 CS 25.1357 CS 27.1351 CS 27.1353 CS 27.1357 CS 27.1361 CS 29.1351 CS 29.1355 CS 29.1357

12.2. ELECTRICAL WIRING SYSTEM, INCLUDING POWER DISTRIBUTION.

This element involves all wiring and wiring components (connectors, circuit breakers, etc.) throughout the air vehicle; and for UAV, the control station safety of flight-related wiring system. Databuses are excluded form the scope of this section and covered in Section 11.

12.2.1 Ensure that appropriate electrical system wiring and components are suitable for the physical environment in each area on the air vehicle where they are used. Ensure that electrical wiring system installation is safe regarding shock hazard protection for personnel.

Consideration should be given to:

a. Electrical wiring, including conductor material, coating and insulation system;

b. Electrical system components;

c. Electrical system support devices;

d. Electrical system design;

e. Operating environment:

i. Moisture

ii. Heat

iii. Vibration, mechanical abrasion/damage, flexing

iv. Contamination from oils, fuels, chemicals etc.

Information Sources			
Comm'l Doc:	For guidance/principles regarding design and selection of aircraft electrical system components: SAE AS50881 NFPA 70		
DoD/MIL Doc:	Comm'l Doc: For guidance/principles regarding design of aircraft electrical wiring systems: ARINC Report 609 SAE AS50881 SAE ARP1870 NFPA 70 DoD/MIL Doc: For guidance/principles regarding design of aircraft electrical wiring systems and the design and selection of aircraft electrical system components: AFGS-87219 MIL-HDBK-419 MIL-STD-1310 MIL-STD-1683 MIL-STD-7080 MIL-HDBK-299 MIL-HDBK-454 MIL-STD-464 For guidance/principles regarding : JSSG-2009: Appendix H H.6.4.1	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P1 6.6.3 00-970 P1 6.6.56 00-970 P1 6.6.57 00-970 P1 6.6.59 00-970 P1 6.6.92 00-970 P7 C706 2.5 00-970 P7 C706 6.1.5-6.1.6 00-970 P7 C706 6.2.1 4671.1365 4671.1367
FAA Doc:	14CFR references: 23.1365; 25.1353	*EASA CS Reference:*	CS 23.1365 CS 25.1360 CS 25.1365 CS 25.1707

12.2.2 Ensure that wiring is sized properly for the required current handling capability and voltage drop.

Consideration should be given to:
a. Cable material properties for both conductor and insulation;
b. Wire diameter;
c. Cable length;
d. Connector type and properties;
e. Cable bundling and separation.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	Comm'l Doc: For guidance/principles regarding proper selection/sizing of aircraft electrical system wiring components: SAE AS50881 NFPA 70 DoD/MIL Doc: JSSG-2009: Appendix H H.6.4.1 for guidance/principles regarding proper selection/sizing of aircraft electrical system wiring components	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.56 00-970 P7 C706 6.1.5
		STANAG Reference:	4671.1365(a)
FAA Doc:	14CFR references: 23.1365; 25.1353	*EASA CS Reference:*	CS 23.1365(a) CS 25.1703 CS 25.1707 CS 25.1711 CS 27.1365(a) CS 29.1353

12.2.3 Ensure that proper circuit protection is provided for wiring associated with power distribution throughout its entire run.

Consideration should also be given to circuits contained in or exiting from any electronic enclosures performing intermediate power switching or distribution functions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Comm'l Doc: For guidance/principles regarding design and selection of aircraft wiring protection: SAE AS50881 NFPA 70 DoD/MIL Doc: For guidance/principles regarding design and selection of aircraft wiring protection: MIL-HDBK-454 MIL-STD-7080 JSSG-2009: Appendix H H.3.4.8.5, H.4.4.8.5	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.37 00-970 P1 6.6.41 00-970 P1 6.6.50
		STANAG Reference:	4671.1357
FAA Doc:	14CFR references: 23.1357 25.1357	*EASA CS Reference:*	CS 23.1357 CS 25.1357 CS 27.1357 CS 29.1357

12.2.4 Ensure that redundant circuits provided for safety are sufficiently isolated.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Comm'l Doc: For guidance/principles regarding provision of isolation for aircraft electrical circuits: SAE AS50881 NFPA 70 DoD/MIL Doc: JSSG-2009: Appendix H H.6.4.1* for guidance/principles regarding provision of isolation for aircraft electrical circuits	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1309 4671.1351
FAA Doc:	14CFR references: 23.1301*, 23.1309*; 25.1301*, 25.1309*	*EASA CS Reference:*	CS 23.1309 CS 29.1309

12.2.5 Ensure that electrical system design precludes single-point failures related to wiring.

Consideration should be given to integrating redundant functions within an electronics enclosure.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Comm'l Doc: For guidance/principles relating to design of equipment to minimize single point failures in redundant circuits: SAE AS50881 NFPA 70 DoD/MIL Doc: For guidance/principles relating to design of equipment to minimize single point failures in redundant circuits: MIL-HDBK-454, Guideline 69 JSSG-2009: Appendix H H.6.4.1, 6.1	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.2 00-970 P7 C706 2.4
		STANAG Reference:	4671.1351
FAA Doc:	14CFR references: 23.1301*, 23.1309*, 23.1351-23.1367*; 25.1301*, 25.1309*, 25.1351-25.1363*, 25.1529* SFAR No. 88--Fuel Tank System Fault Tolerance Evaluation Requirements	*EASA CS Reference:*	CS 23.1351 CS 25.1351 CS 27.1351 CS 29.1351

12.2.6 Ensure that the design of the wiring system installation, including connectors, is adequate for all planned operating conditions.

Consideration should be given to:
a. Normal and emergency modes;
b. All modes of operation;
c. Operating conditions;
d. Load combinations;
e. Failure conditions;
f. Installation environment.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Comm'l Doc: For guidance/principles regarding good engineering design of wiring system installations: SAE AS50881 NFPA 70 DoD/MIL Doc: For guidance/principles regarding good engineering design of wiring system installations: JSSG-2009: 3.3, 3.3.4; Appendix E E.4.4.5.1.3, E.3.4.5.1.11, E.4.4.5.1.11, E.3.4.5.8.7, E.4.4.5.8.7, E.3.4.5.8.12, E.4.4.5.8.12; Appendix G G.3.4.7.2, G.3.4.7.6, G.4.4.7.6; Appendix H H.6.4.1, 6.1	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P1 6.6.1 00-970 P1 6.6.35 00-970 P1 6.6.52-6.6.58 00-970 P7 C706 2.2 00-970 P7 C706 5.1.1 3659 4671.1351
FAA Doc:	14CFR references: 23.1301, 23.1309, 23.1351-23.1367; 25.1301, 25.1309, 25.1351-25.1363, 25.1529 SFAR No. 88--Fuel Tank System Fault Tolerance Evaluation Requirements AC 43.13-1B CHG 1 - Acceptable Methods, Techniques and Procedures - Aircraft Inspection and Repair	*EASA CS Reference:*	CS 23.1351 CS 25.1351 CS 27.1351 CS 29.1351

12.2.6.1 Ensure that wiring in areas containing explosive vapours is protected to prevent potential ignition sources.

Consideration should be given to:
a. Electrical systems in close proximity to fuel systems;
b. Issues with ageing and deterioration of the wiring.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Comm'l Doc: For guidance/principles regarding wiring design principles/practice for prevention of ignition sources: SAE AS50881 NFPA 70 DoD/MIL Doc: For guidance/principles regarding wiring design principles/practice for prevention of ignition sources: JSSG-2009: 3.3, 3.3.4; Appendix E E.4.4.5.1.3*, E.3.4.5.1.11, E.4.4.5.1.11, E.3.4.5.8.7*, E.4.4.5.8.7*, E.3.4.5.8.12, E4.4.5.8.12; Appendix G G.3.4.7.2, G.3.4.7.6, G.4.4.7.6; Appendix H H.6.1	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P1 4.26.14 00-970 P1 4.26.32 00-970 P1 6.2.59 00-970 P1 6.6.3 00-970 P7 C712 3.7.1 4671.863(b) 4671.1359
FAA Doc:	14CFR references: 23.1351-23.1367; 25.1351-25.1363, 25.1309, 25.1529 SFAR No. 88--Fuel Tank System Fault Tolerance Evaluation Requirements	*EASA CS Reference:*	CS 23.863(b)(3) CS 25.863(b)(3) CS 27.863(b)(3) CS 29.863(b)(3)

12.2.6.2 Ensure that failure within a wiring harness that includes safety-critical wiring does not cause loss of, or unacceptable degradation to, any safety-critical functions.

Consideration should be given to:

a. Open circuit faults;

b. Shorted/crossed-circuit faults.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Comm'l Doc: For guidance/principles leading toward good design practice and minimization of loss of safety-critical functions: SAE AS50881 NFPA 70 DoD/MIL Doc: JSSG-2009: Appendix H H.6.1 for guidance/principles leading toward good design practice	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P1 6.6.2 00-970 P1 6.6.3 00-970 P7 LC706 2.4 4671.1351

Information Sources			
	and minimization of loss of safety-critical functions.		
FAA Doc:	14CFR references: 23.1351-23.1367; 25.1351-25.1363, 25.1309, 25.1529 SFAR No. 88--Fuel Tank System Fault Tolerance Evaluation Requirements	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

12.2.6.3 Ensure that the wiring design and installation procedures maintain positive separation of wiring from all fluid or gas carrying lines and flight controls.

Consideration should be taken of movement caused by:

a. Dynamic G loading;

b. Mechanical system movement;

c. Cable flexing;

d. Thermal effects;

e. Vibration.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Comm'l Doc: For guidance/principles regarding the fundamentals of sound design for effective separation of wiring from other subsystem components: SAE AS50881 NFPA 70 DoD/MIL Doc: JSSG-2009: 3.3.8; Appendix B B.3.4.2.1.17; Appendix H H.6.4.1; Appendix M M.6.4.1 for guidance/principles regarding the fundamentals of sound design for effective separation of wiring from other subsystem components	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P1 6.6.3 00-970 P1 6.6.90 4671.1351 4671.1365
FAA Doc:		*EASA CS Reference:*	CS 23.1351 CS 23.1365(d) CS 25.1717 CS 27.1351 CS 29.1351 CS 29.1353

12.2.6.4 Ensure that the routeing design and installation procedures are such that the installation of wiring is free from mechanical damage or chafing conditions.

Consideration should be given to:
a. Mechanical system movement;
b. Vibration;
c. Cable flexing;
d. Cable clipping/bundling.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Comm'l Doc: For guidance/principles regarding the prevention of wire/cable/harness chafing: SAE AS50881 NFPA 70 DoD/MIL Doc: JSSG-2009: 3.3.8; Appendix A A.3.4.1.5.8.1; Appendix B B.3.4.2.1.17; Appendix H H.6.4.1; Appendix L L.3.4.12; Appendix M M.6.4.1 for guidance/principles regarding the prevention of wire/cable/harness chafing	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.64 00-970 P1 S6 L14 4.1.3 00-970 P7 C706 6.5.1
		STANAG Reference:	4671.1351
FAA Doc:		*EASA CS Reference:*	CS 23.1351 CS 23.1365(d) CS 25.1717 CS 27.1351

12.2.6.5 Ensure that wiring design provides primary and secondary support for the wiring throughout the installation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Comm'l Doc: For guidance/principles regarding the provision of proper support for wiring: SAE AS50881 NFPA 70 DoD/MIL Doc: For guidance/principles regarding the provision of proper support for wiring: JSSG-2001: 4.3.10.1.1 JSSG-2009: 3.2.6, 3.2.9.2; Appendix H H.6.4.1, H.6.4.2	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.55 00-970 P1 6.6.64 00-970 P7 C706 6.1.4 00-970 P7 C706 6.5.1
		STANAG Reference:	4671.1365
FAA Doc:		*EASA CS Reference:*	CS 23.1365(d)

12.2.6.6 Ensure that maintainability is a factor in the design and installation procedures for wiring and components.

Consideration should be given to accessibility for inspection.

Information Sources			
Comm'l Doc:	For guidance/principles leading toward maintainable design(s): SAE AS50881 NFPA 70		
DoD/MIL Doc:	For guidance/principles leading toward maintainable design(s): SAE AS50881 NFPA 70 DoD/MIL Doc: JSSG-2001: 3.1.5, 4.1.5, 3.3.10.2.2, 4.1.8.2.5.1, 4.1.8.2.5.2, 4.4.8 JSSG-2009: Appendix H 6.4.1	*Def-Stan 00-970 Reference:*	00-970 P7 LC706 2.5
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

12.2.6.7 Ensure that all equipment and equipment racks are designed for proper electrical bonding.

Information Sources			
Comm'l Doc:	SAE ARP1870 for guidance/principles regarding the provision of proper electrical bonding		
DoD/MIL Doc:	Comm'l Doc: SAE ARP1870 for guidance/principles regarding the provision of proper electrical bonding DoD/MIL Doc: For guidance/principles regarding the provision of proper electrical bonding: MIL-HDBK-419 MIL-HDBK-454 MIL-STD-464 sections A5.10 and A5.11 MIL-STD-1310 JSSG-2001: 3.2.1, 4.2.1, 3.3.10.1.1, 4.3.10.1.1 JSSG-2009: 3.3, 3.3.4; Appendix E: E.4.4.5.1.3, E.3.4.5.1.11, E.4.4.5.1.11, E.3.4.5.8.7, E.4.4.5.8.7, E.3.4.5.8.12, E.4.4.5.8.12;	*Def-Stan 00-970 Reference:*	00-970 P1 4.27.7 00-970 P1 4.27.9 00-970 P1 6.2.25 00-970 P7 S7 L706/1 3.1
		STANAG Reference:	4671.867

Information Sources			
	Appendix G: G.3.4.7.2, G.3.4.7.6, G.4.4.7.6		
FAA Doc:		*EASA CS Reference:*	CS 23.867 CS 25.581 CS 25.899 CS 25.973 CS 25.1353 CS 25.1715 CS 27.610 CS 29.610

SECTION 13 - ELECTROMAGNETIC ENVIRONMENTAL EFFECTS (E3)

This Section covers electro-magnetic compatibility of the platform with its cleared environment and weapon loads; it considers potential effects from internal and external sources. Consideration is also given to potentially harmful electro-magnetic effects on personnel, ordnance, and fuel and the associated required safety margins.

This Section also covers the national and international requirements for meeting the electro-magnetic spectrum licensing requirements.

A common theme through many of the recommendations is the development of a suitable test plan which identifies applicable systems explicitly, considers the type of evidence required for each test, and clearly states the associated acceptance criteria for each test.

TYPICAL CERTIFICATION SOURCE DATA

1. E3 design criteria, analysis, and tradeoff studies
2. Results of E3 modelling and simulation
3. E3 failure modes, and effects, and criticality analyses
4. Electromagnetic hazard analyses
5. Equipment/subsystem E3 qualification reports
6. Details of installation and operation
7. System E3 qualification tests
8. Flight and operational manuals, and flight test procedures, and limitations
9. Safety-of-flight (SOF) certifications 10. Authorised radio frequency allocations

CERTIFICATION CRITERIA

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-464	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

13.1. COMPONENT/SUBSYSTEM E3 QUALIFICATION.

13.1.1 All flight-critical equipment shall comply with all electromagnetic environmental effects requirements. To achieve this, all flight-critical equipment shall be identified and either:

a. Shown to be compliant with all electromagnetic environmental effects requirements, including lightning susceptibility, as appropriate for the particular equipment; this includes both radiated and susceptibility requirements, or;

b. For those equipment that are not shown to be compliant, appropriate mitigations shall be introduced.

Information Sources			
Comm'l Doc:	RTCA DO-160 sections 18 through 22 SAE ARP5412, section 4		
DoD/MIL Doc:	MIL-STD-461, section 5 MIL-STD-464, section 5.4	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.11 00-970 P1 3.10.13 00-970 P1 4.27.23-4.27.40 00-970 P1 6.1.41 00-970 P1 6.6.54 00-970 P1 6.6.66 00-970 P1 6.10
		STANAG Reference:	4671.685(e) 4671.867 4671.1309 4671.1431 4671.1605 4671.1717
FAA Doc:		*EASA CS Reference:*	CS 23.867 CS 23.1301 CS 23.1309 CS 23.1431 CS 25.899 CS 25.1309 CS 25.1316 CS 25.1431 CS 25.1707 CS 27.610 CS 27.1309 CS 29.610 CS 29.1309 CS 29.1431

13.1.2 All non-flight-critical equipments shall be identified and shown to not adversely affect the safe operation of flight critical equipment;
and comply with all (conducted, radiated' and 'transient') electromagnetic environmental effects requirements that are appropriate for the particular equipment, including lightning susceptibility; this includes both radiated and susceptibility requirements.

Information Sources			
Comm'l Doc:	RTCA DO-160 sections 18 through 22		
DoD/MIL Doc:	MIL-STD-464, Section 5.2	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.11 00-970 P1 3.10.13 00-970 P1 4.27.1-4.27.40 00-970 P1 6.1.4 00-970 P1 6.1.41 00-970 P1 6.6.54 00-970 P1 6.6.66
		STANAG	4671.685(e)

Information Sources			
		Reference:	4671.867 4671.1309 4671.1431 4671.1481 4671.1605 4671.1717
FAA Doc:		*EASA CS Reference:*	CS 23.867 CS 23.1301 CS 23.1309 CS 23.1431 CS 25.581 CS 25.899 CS 25.1309 CS 25.1316 CS 25.1431 CS 25.1707 CS 27.610 CS 27.865 CS 27.1309 CS 28.1309 CS 29.610 CS 29.865 CS 29.1309 CS 29.1431

13.1.3. Merged with 13.1.2

Information Sources			
Comm'l Doc:	Merged with 13.1.2		
DoD/MIL Doc:	Merged with 13.1.2	*Def-Stan 00-970 Reference:*	Merged with 13.1.2
		STANAG Reference:	Merged with 13.1.2
FAA Doc:		*EASA CS Reference:*	Merged with 13.1.2

13.2. SYSTEM-LEVEL E3 QUALIFICATION.

13.2.1 All systems and sub-systems on the air vehicle shall be mutually electro-magnetically compatible.

Consideration should be given to:
a. Identifying all air vehicle systems;
b. Demonstrating that all systems or equipment, or parts thereof, have been included in the EMC/EMI test plan;
c. Ensuring that the EMC/EMI test plan takes cognisance of all air vehicle systems at a platform level;
d. The EMC/EMI test plan accounts for all likely combinations of concurrent system operation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-464, section 5.2	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.13 00-970 P1 4.27.1-4.27.22 00-970 P1 6.1.4 00-970 P1 6.1.41 00-970 P1 6.6.66 00-970 P1 6.10
		STANAG Reference:	4671.685 4671.1309 4671.1431 4671.1605 4671.1717
FAA Doc:		*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 23.1431 CS 25.899 CS 25.1309 CS 25.1431 CS 25.1707 CS 27.1309 CS 29.1309 CS 29.1431

13.2.2 All antenna-connected equipment shall be identified and shown to be compatible with each other and not degraded beyond their operational bounds by other on or off-board equipment to a level that would impact safety. To achieve this, the antenna-connected equipment operational bounds shall be defined, and any margins between the operational bounds and the levels where safety may become affected shall be identified.

Consideration should be given to:

a. Ensuring that all antenna-connected systems have been identified; these will include, but not be limited to: radios; radars including rad-alt, TFR, ECM and ECCM systems, and their various modes; GPS systems; navigation systems;

b. Off-board equipment considered to have the potential to interact with on-board equipment should be identified; these will include but not be limited to: ATC systems; other aircraft transmitters; terrestrial radio and TV transmitters; military systems.

c. Ensuring that the platform level EMC/EMI test plan encompasses all likely combinations of on and off-board equipment.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-464, Section 5.2	*Def-Stan 00-970*	00-970 P1 6.1.4

Information Sources			
		Reference:	00-970 P1 6.1.19 00-970 P1 6.1.41 00-970 P1 6.1.42 00-970 P1 6.10
		STANAG Reference:	4671.1309 4671.1431 4671.1605 4671.1717
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 23.1431 CS 25.1309 CS 25.1431 CS 25.1707 CS 27.1309 CS 29.1309 CS 29.1431

13.2.3 The intended external RF electro-magnetic environment for the air vehicle shall be defined, and the air vehicle shall be shown to be compatible with this environment.

Consideration should be given to:

a. Ground and air based emitters;

b. Testing, or demonstration of compliance, shall be at an air vehicle level;

c. The Test and Acceptance Plan should define how compliance will be demonstrated and what the acceptance criteria are.

Information Sources			
Comm'l Doc:	SAE ARP5583, sections 5 and 7		
DoD/MIL Doc:	MIL-STD-464, section 5.3	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.11 00-970 P1 4.27 00-970 P1 6.1.19 00-970 P1 6.10
		STANAG Reference:	4671.685 4671.867 4671.1309 4671.1431 4671.1605 4671.1717
FAA Doc:		*EASA CS Reference:*	CS 23.867 CS 23.1301 CS 23.1309 CS 23.1431 CS 25.581 CS 25.899 CS 25.1309 CS 25.1316

Information Sources			
			CS 25.1431 CS 27.610 CS 27.865 CS 27.1309 CS 29.610 CS 29.865 CS 29.1309 CS 29.1431

13.2.4 All requirements for meeting lightning protection, both the direct (physical) and indirect (electro-magnetic) effects, shall be identified, agreed and verified by testing; specific consideration should be given to all aspects of the air vehicle fuel system.

Consideration should be given to:

a. Fuel system components including, but not limited to: refuel/defuel/engine supply components; pumps; storage and collector tanks; fuel vent system and components; fuel coolers; adjacent EWIS components;

b. Structural protective measures/Bonding;

c. Inerting.

Information Sources			
Comm'l Doc:	SAE ARP5412, section 4		
DoD/MIL Doc:	MIL-STD-464, section 5.4	*Def-Stan 00-970 Reference:*	00-970 P1 3.10.11 00-970 P1 4.27 all 00-970 P1 6.10 00-970 P7 L707 5.1.3 00-970 P7 L708
		STANAG Reference:	4671.863 4671.867 4671.954 4671.1309 4671.1605 4671.1717
FAA Doc:		*EASA CS Reference:*	CS 23.867 CS 23.954 CS 23.1309 CS 25.581 CS 25.899 CS 25.954 CS 25.1309 CS 25.1316 CS 25.1707 CS 27.610 CS 27.865 CS 27.954 CS 27.1309 CS 29.610 CS 29.865

Information Sources			
			CS 29.954 CS 29.1309

13.2.5 If protection from the effects of an electro-magnetic pulse is required, the appropriate level of protection and associated acceptance criteria are to be established.

Consideration should be given to:

a. Which, if any, systems should be afforded protection from EMP effects;

b. Any nuclear hardening of components that might be required - chips or larger assemblies for example;

c. If any extra protection against EMI, over and above the base level, is required;

d. Any requirement for redundant systems for use after experiencing EMP;

e. Establishing a suitable test plan.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-464,section 5.5 MIL-STD-2169	*Def-Stan 00-970 Reference:*	00-970 P1 4.27 00-970 P1 6.2.60 00-970 P1 6.5.23 00-970 P1 6.10 00-970 P13 3.2.14 00-970 P13 3.11.6- 3.11.11
		STANAG Reference:	4671.1431
FAA Doc:		*EASA CS Reference:*	

13.2.6 The air vehicle design shall be able to control and dissipate the build-up of electrostatic charges caused by particle impingement, fluid flow, air flow, and other triboelectric charge-generating mechanisms to:

• Avoid ordnance hazards;

• Avoid personnel shock hazards;

• Control p-static interference or damage to electronics.

Consideration should be given to:

a. The static discharge spark, which can occur as contact is made and which can be quite powerful and emit RF components in its own right.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-464, section 5.7	*Def-Stan 00-970 Reference:*	00-970 P1 4.27 00-970 P1 6.1.32 00-970 P7 L708
		STANAG Reference:	4671.867 4671.1309
FAA Doc:		*EASA CS Reference:*	CS 23.867 CS 23.1309 CS 25.899 CS 25.1715 CS 27.610

Information Sources			
			CS 29.610

13.2.7 For the system, the following shall be achieved:

• The radiation pattern of on-board emitters shall be compared with safety distances associated with permitted loaded ordnance (HERO) to ensure compatibility;

• The radiation pattern of on-board emitters shall be used to produce a plan showing minimum safe distances from the platform when related to personnel (HERP), fuel (HERF) and stored ordnance (HERO);

• The minimum distance by which the air vehicle must stay away from external transmitters, both on the ground and in the air, shall be determined;

• The appropriate manuals shall clearly record the above.

Consideration should be given to:

a. Terrestrial radio and television transmitters;

b. Military transmitters;

c. Other sources of high intensity radio frequency radiation.

Information Sources			
Comm'l Doc:	SAE ARP5583, sections 5 and 7 SAE ARP5412, section 4		
DoD/MIL Doc:	MIL-STD-464, sections 5.3 and 5.4 DoDI 6055.11, Protection of DoD Personnel from Exposure to Radiofrequency Radiation and Military Exempt Lasers TO 31Z-10-4, Electromagnetic Radiation Hazard NAVSEA OP 3565, Electromagnetic Radiation Hazard TB MED 523, Control of Hazards to Health from Microwave and Radio Frequency Radiation and Ultrasound	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1581
FAA Doc:		*EASA CS Reference:*	

13.2.8 The electrical bonding shall be adequate to ensure safe air vehicle operation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-464, section 5.10	*Def-Stan 00-970 Reference:*	00-970 P1 4.27 00-970 P7 L708
		STANAG	3659

Information Sources			
		Reference:	4671.1309 4671.1431 4671.1605 4671.1717 4671.867
FAA Doc:		*EASA CS Reference:*	CS 23.867 CS 23.1309 CS 23.1431 CS 25.581 CS 25.899 CS 25.1316 CS 25.1707 CS 27.610 CS 27.865 CS 27.1309 CS 29.610 CS 29.865 CS 29.1309

13.2.9 All electrically-initiated explosive devices used on the platform shall be identified along with their associated safety margins, and the safety margins shall be met; advice shall be sought from the relevant National Regulatory Authority and/or permissions obtained where necessary.

Consideration should be given to:

a. Air vehicle transmitters;

b. Terrestrial radio and radar transmitters;

c. Airfield transmitters;

d. Military system transmitters.

Information Sources			
Comm'l Doc:	SAE ARP5583, sections 5 and 7 SAE ARP5412, section 4		
DoD/MIL Doc:	MIL-STD-464, sections 5.3 and 5.4	*Def-Stan 00-970 Reference:*	00-970 P13 3.2.14
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

13.2.10 The system shall meet the electromagnetic spectrum licensing requirements in accordance with national and international regulations, and have received electromagnetic spectrum certification.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	DoDD 4650.1, Management and Use of the Radio Frequency Spectrum DD Form	*Def-Stan 00-970 Reference:*	Joint Service Publication (JSP_ 602 Lflt 1038
		STANAG	

Information Sources			
	1494, Application for Frequency Allocation Joint Service Publication (JSP) 602 Lflt 1038 National procedures	*Reference:*	
FAA Doc:		*EASA CS Reference:*	

SECTION 14 - SYSTEM SAFETY

This section details the criteria to establish, verify, and implement a comprehensive and robust system safety programme.

Included within the scope of this section are:

- The implementation of a system safety programme;
- Safety design criteria which are required in order to ensure the air vehicle is 'safe';
- Air vehicle system software safety, and its integration with the overall safety programme

When considering the intent of the criteria in this section, which will need to be applied across the diverse technologies and sub-systems of the Air Vehicle System, a degree of concurrency, separation and apparent duplication of criterion is recognised within the EMACC handbook. This is particularly apparent within Sections 4, 14 and 15 whereby the intent of the criteria in each of these sections is arguably best deployed into the Technical Solution by a well implemented Systems Engineering approach.

A systems engineering philosophy will enable the airworthiness process to generate and define suitable safety criteria which, in particular for software and complex electronic hardware, allows hardware and software elements to be dealt with in an integrated fashion.

TYPICAL CERTIFICATION SOURCE DATA

1. System safety program plan
2. Preliminary hazard analyses
3. Subsystem hazard analyses (fault hazard analyses or fault tree analyses)
4. System hazard analyses (including hardware, software and human system integration causal factors)
5. Operating and support hazard analyses
6. Test hazard analyses
7. Occupational health hazard assessment
8. Specialised analyses such as a sneak circuit analyses and software hazard analyses
9. Type T-2 modification documentation (for correction of safety deficiencies)
10. Component/system test results (waivers/deviations and equipment conditional usage documents)
11. Minutes of system safety group meetings (open items)
12. Minutes of system safety program reviews (open items)
13. Engineering change proposals (safety related)
14. Hazard identification, evaluation and correction-tracking system files
15. Safety assessment reports
16. SOF test plans and test results
17. Test temporary engineering orders (not previously included in any safety analyses)
18. Failure modes, effects, and criticality analysis (FMECA)
19. Hazard risk index
20. MIL-STD-882, System Safety Program Requirements
21. Test review board reports
22. Safety review board reports
23. Flight readiness review reports
24. Safety requirements traceability matrix (both hardware and software)

CERTIFICATION CRITERIA

14.1. SYSTEM SAFETY PROGRAM.

This section covers the implementation of a comprehensive and robust system safety programme, which spans the system lifecycle. The aim of the system safety programme is to identify any associated system hazards / risks, and to eliminate them where possible, or mitigate the risks such that the residual risks are at acceptable levels.

Included within the scope of this section are:
• Integration of the safety programme with systems engineering processes;
• The implementation of a hazard tracking system;
• The comprehensiveness of safety analysis and processes.

Some criteria in this chapter are supported in the text by examples of specific considerations. These examples are by no means to be considered as exhaustive. However, all criteria should at least consider the use of the latest safety standards, guidance and techniques.

14.1.1 An effective system safety programme shall be implemented to manage all hardware, software, and human system integration risks, iaw specified standards, in order to achieve acceptable mishap risk, within the constraints of operational effectiveness and suitability, time, and cost.

Consideration should be given to:
a. Use of the latest safety standards and guidance.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-882D: 1.1, 4.1, 4.2, 4.3, 4.4, 4.5 DoDI 5000.2 Enclosure 3 Table E3.T1, for details of PESHE content and relation to system safety SAE ARP 4761	*Def-Stan 00-970 Reference:*	00-970 P7 L732 3.3.1 00-56
		STANAG Reference:	4671.1309
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	CS 25 AMC 25.19 7 CS 25 AMC 25.901 5 CS25 AMC 25.1309 SAE ARP 4761

14.1.1.1 The system safety programme shall be integrated effectively into all aspects of the systems engineering lifecycle, in order to ensure its beneficial influence on requirements, design and ultimately the safety of the system.

Consideration should be given to:
a. Ensuring the system safety programme is not considered in isolation;
b. Ensuring system safety requirements, analyses, time lines and other milestones are in synchronisation with the rest of the program.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-882D: 4.1 SAE ARP 4761	*Def-Stan 00-970 Reference:*	00-56
		STANAG Reference:	4671.AMC1309 (b)
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	CS25 AMC 25.1309 SAE ARP 4761

14.1.1.2 Covered by 14.2.10 (changed or modified equipment) and 14.2.1 (hazard identification and mitigation)

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-882D: 4.1, 4.2, 4.3, 4.4, 4.5 JSSG-2001: Sect. 3.3.10 discusses mishap risk baselines	*Def-Stan 00-970 Reference:*	Covered by 14.2.10
		STANAG Reference:	Covered by 14.2.10
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	Covered by 14.2.10

14.1.1.3 A tracking system shall be maintained throughout the system life cycle in order to record hazards / risks identified during the system safety process; their closure actions and/or risk reduction / mitigation; and residual risks and risk acceptance.

Consideration should be given to:

a. Use of a closed loop hazard tracking system / hazard log.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-882D: 4.1, 4.2, 4.3, 4.4, 4.5 SAE ARP 4761	*Def-Stan 00-970 Reference:*	00-970 P13 1.7.1 00-970 P13 1.8.1 00-56
		STANAG Reference:	4671 AMC.1309(b)
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	CS25 AMC 25.1309 SAE ARP 4761

14.1.1.4 The system safety programme shall be comprehensive, and as a minimum, shall address the following areas:

- Flight safety
- Ground/industrial safety
- Explosives and ordnance safety; non-nuclear munitions
- Range safety
- Nuclear safety

• Radiation/laser safety
• Test safety and support
• Software safety
• Materials
• Failure modes and effects testing and built-in-test
• Fail safe design
• Support equipment

Consideration should be given to:
a. Assessing safety design deficiencies uncovered during flight mishap or fault investigations;
b. Ensuring flight mishap rates for system do not exceed threshold limits that are established for program;
c. Establishing an FOD prevention program to minimise the risk of FOD during assembly;
d. Conducting weapons testing, certification, and obtainment of explosive hazard classifications;
e. Ensuring the appropriate safety and design standards are followed, and that safe processes are employed;
f. Establishing the key safety design requirements;
g. System safety organisation participation in test planning and post-test reviews to analyse all test-related hazards and recommended corrective actions to ensure hazard closeout or mitigation;
h. Risks associated with use of new/alternate/substituted materials or material deficiencies.
i. Operation in, or in the vicinity of, a volcanic ash cloud.
j. Requirements to satisfy Extended Range Twin Operations (ETOPS) where appropriate.

Information Sources			
Comm'l Doc:	For f. above: ANSI Z 136.1 for definitions of key laser safety design requirements		
DoD/MIL Doc:	For c. above: DOD Standard 6055.9-STD and DoD TO-11A-1-47 For e. above: DoD Directive 3150.2, 23 Dec 1996, 4.1 lists the four key design standards. For f. above: MIL-STD-1425A and MIL-HDBK-828 For h. above: Section 14.3 of this document SAE ARP 4761	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-56 4671 AMC.1309(b)
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29 a. Flight safety b. Ground/industrial safety c. Explosives and ordnance safety; non-nuclear munitions d. Range safety e. Nuclear safety f. Radiation/laser safety g. Test safety and support h. Software safety	*EASA CS Reference:*	CS25 AMC 25.1309 SAE ARP 4761

Information Sources			
	i. Materials j. Failure modes and effects testing and built-in-test k. Fail safe design l. Support equipment		

14.2. SAFETY DESIGN REQUIREMENTS.

This section outlines a number of air vehicle safety design criteria which are required in order to ensure the air vehicle is 'safe'. The objective of safety design requirements is to achieve acceptable mishap risk through a systematic application of design guidance from standards, specifications, regulations, design handbooks, safety design checklists, and other sources.

Included within the scope of this section are:
• Risks caused by single-point failures;
• Air-vehicle redundant systems design;
• Consideration of human factors within design and appreciation of human error;
• Safety implications of operating in extreme environmental conditions;
• System installation;
• Isolation of hazardous substances, components and operations;
• Ensuring risks are re-assessed following design changes.

Some criteria in this chapter are supported in the text by examples of specific considerations. These examples are by no means to be considered as exhaustive.

Considerations include:
• The agreed level of acceptable risk;
• Potential risks to personnel, equipment or property, and / or the environment;
• Following the latest safety standards, guidance and techniques.

14.2.1 A systematic safety assessment process shall be employed to identify and characterise potential hazards, devise corrective actions, and conduct residual risk assessments.

The safety assessment process should be planned and managed to provide the necessary assurance that all relevant failure conditions have been identified and that all reasonably credible combinations of failures which could cause those failures conditions have been considered.

Consideration should be given to:
a. Identify hazards through a systematic hazard analysis process, following recognised safety assessment techniques;
b. Analysis of system hardware and software, the environment (in which the system will exist), and the intended use or application (including applications of negative acceleration);
c. Use of historical hazard and mishap data, including lessons learned from other systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-882D: 4.1, 4.2, 4.3,	*Def-Stan 00-970*	00-56

Information Sources			
	4.4, 4.5, Appendix A MIL-STD-882E	*Reference:*	
		STANAG Reference:	4671 AMC.1309(b)
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	CS 25.1315 CS 25 AMC 25.1309 SAE ARP 4761

14.2.2 All mishap risks associated with the air vehicle design shall be eliminated where possible, or controlled such that the residual risks are reduced to an acceptable level.

Consideration should be given to:

a. Risks to personnel, equipment or property, and / or the environment;

b. Eliminating and / or controlling risks iaw agreed standards and best practice;

c. Implementation of a safety hazard tracking database / hazard log;

d. The level of acceptable risk, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-882D: 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, Appendix C; Appendix A, A.4.3.3.1.1 shows unacceptable conditions; Table A-IV shows mishap risk categories & acceptance levels	*Def-Stan 00-970 Reference:*	00-56
		STANAG Reference:	4671 AMC.1309(b)
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	CS25 AMC 25.1309 SAE ARP 4761

14.2.3 All mishap risks associated with single-point failures shall be eliminated where possible, or controlled such that the residual risks are reduced to an acceptable level.

No air vehicle or system loss shall result from a single failure.

Consideration should be given to:

a. Use of safety devices that will minimise mishap risk caused by single-point failures (e.g., interlocks, redundancy, fail safe design, system protection, fire suppression);

b. The level of acceptable risk, to be agreed and verified.

Information Sources			
Comm'l Doc:	SAE ARP 4761		
DoD/MIL Doc:	MIL-STD-882D: 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, Appendix C; Appendix A identifies severity levels	*Def-Stan 00-970 Reference:*	00-970 P1 1.1.13 00-970 P1 3.7.10 00-970 P1 4.11.60 00-970 P1 4.12.12 00-970 P1 6.1.28 00-970 P1 6.6.2 00-970 Pt 1 6.11.25 00-970 Pt 1 6.11.52 00-970 Pt 1 6.11.53-6.11.55 00-970 Pt 1 6.12.3-6.12.4

Information Sources			
			00-970 Pt 1 6.12.6 00-970 Pt 1 6.12.15 00-970 P7 L100 9.1.1 00-970 P7 L204 4.3 00-970 P7 L306 3.3 00-970 P7 L307 3.2.2 00-970 P7 L310 2.2.3 00-56
		STANAG Reference:	4671.933 4671.1301 4671.1309 4671.1435 4671.1437
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	CS 23.629 CS 23.933 CS 23.1301 CS 23.1309 CS 23.1435 CS 23.1437 CS 23.1438 CS 25.629(d) CS 25.933(a) CS 25.971(c) CS 25.1301 CS 25.1309 CS 25.1435 CS 25.1436 CS 25.1438 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309 CS 29.1435

14.2.4 Redundant air vehicle subsystems, required to achieve acceptable mishap risks, shall be designed so their power sources, controls, and critical components are adequately protected using acceptable methods.

Consideration should be given to:

a. Ensuring adequate protection by means of physical separation or shielding, or by other acceptable methods.

b. Requirements to satisfy Extended Range Twin Operations (ETOPS) where appropriate.

Information Sources			
Comm'l Doc:	SAE ARP 4761		
DoD/MIL Doc:	MIL-STD-882D: 4, Appendix A	*Def-Stan 00-970 Reference:*	00-56

Information Sources			
		STANAG Reference:	4671 AMC.1309(b)
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	CS 25.1707(k) CS 23 AMC 23.1309

14.2.5 All human factors design requirements shall be met; and any safety issues/risks related to human factors shall be identified and eliminated, or reduced to an acceptable level.

Consideration should be given to:

a. The full anthropometric range of air crew and passengers;

b. Aircrew workload, ergonomics and situational awareness;

c. Operations in full NBC or other restrictive clothing, e.g. gloves, respirators etc;

d. The level of acceptable risk, to be agreed and verified.

e. Requirements to satisfy Extended Range Twin Operations (ETOPS) where appropriate.

Information Sources			
Comm'l Doc:	SAE ARP 4761		
DoD/MIL Doc:	MIL-STD-882D: 4, Appendix A MIL-STD-1472 gives the human-factor design requirements	*Def-Stan 00-970 Reference:*	00-970 P1 4.23.32 00-56 00-250
		STANAG Reference:	4671 AMC.1701
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	CS 25.783(d)(8) CS 25 AMC 25.1155 4(c) CS 25 AMC 25.1309

14.2.6 The risks from failures or hazards, created by human error during the operation and / or support of the air vehicle system, shall be minimised through system design, and reduced to an acceptable level.

Consideration should be given to:

a. The level of acceptable risk, to be agreed and verified;

b. The use of safeguards to prevent inadvertent operations.

Information Sources			
Comm'l Doc:	SAE ARP 4761		
DoD/MIL Doc:	MIL-STD-882D: 4, Appendix A	*Def-Stan 00-970 Reference:*	00-970 P7 L702/1 1.2 00-56
		STANAG Reference:	4671 AMC.1701
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	CS 25.783(g) AMC 25.1309

14.2.7 Risks caused by operation in the worst-case environmental conditions shall be minimised through system design, and reduced to an acceptable level.

Consideration should be given to:

a. The worst-case conditions across the complete range of expected environmental conditions, e.g. extreme hot and extreme cold;

b. The level of acceptable risk, to be agreed and verified.
c. Operation in, or in the vicinity of, a volcanic ash cloud.

Information Sources			
Comm'l Doc:	SAE ARP 4761		
DoD/MIL Doc:	MIL-STD-882D: 4, Appendix A MIL-STD-810 gives environmental and climatic testing requirements	*Def-Stan 00-970 Reference:*	00-970 P1 3.1.7 00-970 P1 3.1.22 00-970 P1 6.1.1 00-970 P1 6.2.40-6.2.61 00-970 P1 6.11.61-6.11.85 00-970 P7 L200 1.8 00-970 P7 L301 8.3 00-56
		STANAG Reference:	4671.603(a) 4671.607(b) 4671.613(c) 4671.1309(e) 4671.1431(a)
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	CS 23.603(a) CS 23.607(b) CS 23.613(c) CS 23.1309(e) CS 23.1431(a) CS 25.603(c) CS 23.607(c) CS 23.613(c) CS 23.1309(a) CS 25.1431(a) CS 25.1435(a) CS 27.603(c) CS 27.607(a) CS 29.603(c) CS 29.607(a)

14.2.8 Risks to personnel, caused by exposure to hazards during the installation process, including those due to hazardous locations of systems in the air vehicle, shall be eliminated, or reduced to an acceptable level.

Consideration should be given to:
a. Errors in assembly, installation, or connections which could result in a safety hazard or mishap for the system;
b. Provision of equipment installation, operation and maintenance processes documentation;
c. The level of acceptable risk, to be agreed and verified.

Information Sources			
Comm'l Doc:	SAE ARP 4761		
DoD/MIL Doc:	MIL-STD-882D: 4, Appendix A	*Def-Stan 00-970 Reference:*	00-970 P1 3.9.54 00-970 P1 6.1.21 00-970 P7 L203 8.2.1

Information Sources			
			00-56
		STANAG Reference:	
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	CS M25.3(c) AMC 25.1309

14.2.9 The system shall be designed such that hazardous substances, components, and operations are isolated from other activities, areas, personnel, and incompatible materials. Any residual risks which cannot be eliminated through isolation, shall be mitigated and reduced to an acceptable level.

Consideration should be given to:
a. Minimising or eliminating hazardous material use where possible;
b. When using potentially hazardous materials, select those materials that pose the least risk throughout the life cycle of the system;
c. Isolating sources of contaminated air, hazardous exhaust gases, fumes and fuel from fuel tanks etc.;
d. Ensuring equipment is located so that access during operations, servicing, repair, or adjustment minimises personnel exposure to hazards (e.g., hazardous substances, high voltage, electromagnetic radiation, and cutting and puncturing surfaces);
e. The level of acceptable risk, to be agreed and verified.

Information Sources			
Comm'l Doc:	SAE ARP 4761		
DoD/MIL Doc:	MIL-STD-882D: 4, Appendix A	*Def-Stan 00-970 Reference:*	00-970 P1 3.7.27 00-970 P1 4.26.23 00-970 P1 6.14.3 00-970 P7 L307 4.9.4 00-970 P7 L700 4.1.10 00-970 P7 L702 12.7 00-56
		STANAG Reference:	4671.1121(a) AMC.1309 AMC.1701
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	CS 23.851(c) CS 23.967(d) CS 23.1121(a) CS 25.851(a)(8) CS 25.967(e) CS 25.1121(a) AMC 25.1309

14.2.10 Where changes or modifications are made to existing equipment or software, the effect on the baseline mishap risk shall be assessed. Any resulting hazards or changes in risks shall be eliminated or mitigated, in order to ensure an acceptable level of mishap risk is maintained.

Consideration should be given to:
a. Changes to design, configuration, production, or mission requirements (including any resulting system modifications and upgrades, retrofits, insertions of new technologies or materials, or use of new production or test techniques);
b. Changes to the environment in which the system operates;

c. Ensuring changes or other modifications do not: create new hazards; impact a hazard that had previously been resolved; make any existing hazard more severe; or adversely affect any safety-critical component.

Information Sources			
Comm'l Doc:	SAE ARP 4761		
DoD/MIL Doc:	Reference sections 14.3.3, 15.3.3.2, 15.3.3.3 of this document	*Def-Stan 00-970 Reference:*	00-56
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

14.2.11 The aircraft shall be designed, where appropriate, to include suitable physical protection measures for the flight deck, resistance to the effects of an explosive or incendiary device, survivability of systems, and the interior design should facilitate searches.

Consideration should be given to (taken from CS 25.795):

a. Ability of the flight deck door to resist forced entry;
b. Ability of the flight deck door to resist penetration by small arms or fragmentation devices;
c. Limit the effects of an explosive or incendiary device as follows:
i. Limit entry to flight deck of smoke, fumes, or noxious gases;
ii. Limit entry to passenger compartment of smoke, fumes, or noxious gases, or other means to prevent passenger incapacitation;
iii. Cargo compartment fire suppression system should:
(1) Be capable of suppressing a fire;
(2) Be designed to withstand the following effects:
(a) Impact from a ballistic object;
(b) A 103kPa (15psi) pressure load to component surfaces larger than 0.4 square metres (4 square feet);
(c) A 15 cm displacement applied anywhere along the distribution system where relative movement between the system and its attachment can occur;
d. Aircraft design should include a designated location where a bomb or other explosive device could be placed to best protect integrity of the structure and flight critical systems from damage in the case of detonation;
e. Redundant systems necessary for continued safe flight and landing should be physically separated (partially addressed through Line 6.2.2.12);
f. Interior designs should incorporate features that will deter concealment or promote discovery of weapons, explosives, or other objects from a simple inspection in the following areas of the cabin:
i. Areas above the overhead bins;
ii. Toilets must be designed to prevent the passage of solid objects greater than 5 cm (0.2 in) in diameter;
iii. Life preservers or their storage locations must be designed so that tampering is evident.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	

Information Sources			
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.795

14.3. SOFTWARE SAFETY PROGRAM.

This section covers air vehicle system software safety, and its integration with the overall safety programme.

Included within the scope of this section are:
• Safety Related Software (SRS) i.e. software that relates to a safety function or system;
• Establishing Safety Integrity Levels (SIL);
• Safety Critical Software (SCS), i.e. software that relates to a safety critical function or system, the failure of which could cause the highest risk to human life.

Complex Electronic Hardware is considered in Section 15.

Note: Software safety is additionally verified through Section 15.3

14.3.1 A comprehensive software safety program (including all key software safety issues), shall be integrated into the overall system safety program.

Consideration should be given to:
a. Establishing software integrity levels (SIL), typically iaw prescribed industry standards;
b. Identifying safety critical functions and their associated safety critical software;
c. Analysing and addressing single point failures caused by software;
d. Producing the requisite safety and software plans and other documentation.

Information Sources			
Comm'l Doc:	DO-178B to establish software integrity levels for commercial aircraft		
DoD/MIL Doc:	Joint Software System Safety Committee, “Software System Safety Handbook: A Technical & Managerial Team Approach,” Dec 1999	*Def-Stan 00-970 Reference:*	00-970 P1 6.2.63 00-970 P9 UK1309b 00-970 P13 1.7.1 00-970 P13 1.8.1
		STANAG Reference:	4671 AMC.1309(b)
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	AMC 25.1309

14.3.2 Appropriate software safety-related analyses shall be performed as part of the software development process, to satisfy the software safety programme; consisting of the following:
• Software safety analyses preparation;
• Software safety requirements analysis.

Consideration should be given to:

a. The types and quantities of required software safety analyses and their delivery schedules;

b. Ensuring the safety analyses programme has a complete systems view, including identification of software hazards, and associated software risks;

c. Review of baseline software requirements that system safety requirements for software development.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Joint Software System Safety Committee, "Software System Safety Handbook: A Technical & Managerial Team Approach," Dec 1999	*Def-Stan 00-970 Reference:*	00-970 P1 6.2.63 00-970 P13 1.7.1 00-970 P13 1.8.1
		STANAG Reference:	4671 AMC.1309(b)
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	AMC 25.1309

14.3.3 Software, as designed or modified, shall not initiate hazardous events or mishaps in either the on or off (powered) state.

Consideration should be given to:

a. Both controlled and / or monitored functions;

b. Implementing of a system safety assessment process which includes evaluation of software and identification of anomalous software control/monitoring behaviour.

Information Sources			
Comm'l Doc:	DO-178B defines software integrity levels for safety critical functions		
DoD/MIL Doc:	Joint Software System Safety Committee, "Software System Safety Handbook: A Technical & Managerial Team Approach," Dec 1999	*Def-Stan 00-970 Reference:*	00-970 P1 6.2.63 00-970 P13 3.2.33 00-970 P13 1.7.1 00-970 P13 1.8.1
		STANAG Reference:	4671 AMC.1309(b)
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	AMC 25.1309

SECTION 15 - COMPUTER RESOURCES

This section covers the design, installation, arrangement and compatibility of the complete air vehicle computer resources. This includes manned air vehicle avionics, as well as airborne and ground segment avionics for UAVs.

Included in the scope of this section are:

- Air Vehicle Processing Architecture;
- Functional design integration of processing elements;
- Air Vehicle Sub-system Processing Architecture elements.

When considering the intent of the criteria in this section, which will need to be applied across the diverse technologies and sub-systems of the Air Vehicle System, a degree of concurrency, separation and apparent duplication of criterion is recognised within the EMACC handbook. This is particularly apparent within Sections 4, 14 and 15 whereby the intent of the criteria in each of these sections is arguably best deployed into the Technical Solution by a well implemented Systems Engineering approach.

A systems engineering philosophy will enable the airworthiness process to generate and define suitable safety criteria which, in particular for software and complex electronic hardware, allows hardware and software elements to be dealt with in an integrated fashion.

TYPICAL CERTIFICATION SOURCE DATA

1. Computer resources utilisation
2. Design review/audits/meeting minutes and action items
3. Software requirements specifications (SRS)
4. Software top-level design documents (STLDD)
5. Software development plans (SDP) and/or software development integrity master plans (SDIMP)
6. Software test plans, procedures, and reports
7. Quality assurance and configuration management plans
8. Master test planning documents and scheduling
9. Software regression testing criteria/procedures (all levels)
10. Software development folders
11. Failure modes, effects, and criticality analysis and testing (FMECA/FMET) or equivalent
12. Hazard analyses (software)
13. Test reports

14, Diminishing manufacturing sources plan 15. Obsolete parts plan

CERTIFICATION CRITERIA

<u>Information Sources</u>			
Comm'l Doc:			
DoD/MIL Doc:	In addition to VCMS systems, JSSG-2008 provides useful guidance for all airborne computer resources involved in safety critical processing.	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	

Information Sources			
	Consequently in reading the reference information contained in JSSG-2008 it may be useful to interpret VCMS to mean any aircraft system involved in safety critical processing.		
FAA Doc:		*EASA CS Reference:*	

15.1. AIR VEHICLE PROCESSING ARCHITECTURE.

This section covers Air Vehicle Processing Architecture. The scope considers:

1. That the flight-essential configurations are identified and proper levels of redundancy (hardware and software) exist at the system level to preclude loss of critical processing capabilities.
2. That all processing elements of the architecture that interface (physically and functionally) with SOF functions are designed to meet SOF requirements.
3. That all hardware and software safety/flight-critical items are identified and their safety critical functions are allocated to components within the architecture.
4. That SOF hardware and software interfaces are clearly defined and documented and that control flow and information flow are established.
5. That redundancy (hardware and software) is incorporated to satisfy fault tolerant SOF requirements, including probability of loss of control (PLOC) and reliability numbers.
6. That separate and independent power sources are provided for redundant operations.
7. That single component failure does not impede redundant operations.
8. That physical and functional separation between safety/flight critical and mission critical is accounted for in the computer system architecture.
9. That no patches (object code changes not resulting from compilation of source code changes) exist for flight-critical software.

15.1.1 All flight-essential configurations shall be identified and proper levels of redundancy (hardware and software) shall exist at the system level to preclude loss of critical processing capabilities.

Consideration should be given to:
a. Identifying all the safety critical functions;
b. Allocation of an integrity level for each system;
c. Performing a system safety analysis for each safety critical function;
d. Identifying all associated system hardware and software;
e. Ensuring that the required safety level has been associated with each of the hardware and software functions;
f. Ensuring that the required redundancy is designed in to achieve the overall system safety requirements.

Information Sources			
Comm'l Doc:	RTCA DO-178B, RTCA DO-254		
DoD/MIL Doc:	JSSG-2008: 3.1.12, 3.3.1 JSSG-2008 Appendix A: 3.1.7,	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7

Information Sources			
	3.1.12, 3.3.1 for further guidance concerning redundancy, system and processing architectures MIL-STD 882D, sections 4.2, 4.7, 4.8 for further guidance concerning identification, review and tracking of safety hazards to establish program safety definitions JSSG-2008 Appendix A: 3.1.2.1 for establishing safety criticality along with CNS/ATM safety performance references in the ESC developed Generic Performance Matrices (10E-5 to 10E-7 hazard rates depending on flight phase)		00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.1.2 All processing elements of the architecture that interface (physically and functionally) with SOF functions are designed to meet SOF requirements.

For each architecture under review, consideration should be given to:

a. Identifying all the physical and functional interfaces of the architecture with SOF systems;

b. Identifying the applicable SOF requirements;

c. Demonstrating that the architecture under review is compatible with the SOF requirements of the interface. This could include, but is not be limited to: a test scheme, assessment of quantitative targets, redundancy, and a voting scheme.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	JSSG-2008: 3.3 JSSG-2008 Appendix A: 3.3 Requirement Guidance and Lessons Learned for additional information concerning processing element selection. 3.1.7.3, 3.1.8, 3.1.11, 3.14.4 and 3.2.2.6 provide guidance for integrating safety critical	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309

Information Sources			
	VCMS systems with non-safety critical processing elements		
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.1.3 All hardware and software safety/flight-critical items shall be identified and their safety critical functions verified.

Consideration should be given to:

a. Identifying the safety/flight critical functions of the architecture under review and the associated quantitative target(s);

b. Identifying both the hardware and software components of the architecture where each of the safety/flight critical functions will be performed;

c. Demonstrating that each of the identified safety/flight critical functions, and associated target, is achieved in the proposed architecture.

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254		
DoD/MIL Doc:	JSSG-2008: 3.1.16 MIL-STD-882D Appendix A: A.4.4.2 establishes hardware and software analysis in the hazard identification process	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.1.4 All SOF hardware and software interfaces shall be clearly defined and documented, and the associated control and information flows established.

Consideration should be given to:

a. Identifying all hardware and software SOF interfaces for the architecture;

b. Ensuring that interfaces do not impede or prevent system performance or degrade the system safety target;

c. Development of a test plan to consider, but not be limited to: data flow and accuracy, data latency, timing issues, handshaking protocols.

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254		
DoD/MIL Doc:	JSSG-2008: 3.3.7 JSSG-2008 Appendix A: 3.1.7.1 provides guidance for identifying subsystem interfaces and ensuring sufficient data communication timing margins. Paragraph 3.5.7 discusses the application of integrity processes in the design of system interfaces from both the hardware and software standpoint	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.1.5 Redundancy, for both hardware and software, shall be incorporated into the system architecture to satisfy fault tolerant SOF requirements, including probability of loss of control (PLOC).

Consideration should be given to:

a. Identifying and recording the quantitative safety targets for both the SOF requirements and the PLOC;

b. Identifying and recording the fault tolerance requirements for the architecture;

c. Documenting the redundancy scheme based on the requirements of a) and b);

d. Documenting the voting mechanism for the architecture;

e. Development of a suitable test plan to demonstrate the robustness of the architecture regarding the fault tolerance and redundant aspects.

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254		
DoD/MIL Doc:	JSSG-2008: 3.3.1 JSSG-2008 Appendix A: Paragraph 3.3.1 provides guidance for fault tolerant processing including fault detection and redundancy; 3.1.2, 3.1.7 and 3.1.5.7 provide guidance for allocating quantitative safety requirements to subsystem	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309

Information Sources			
	level in the context of VCMS and mission avionics allowing for variability factors; 3.1.9 gives guidance on establishing redundancy levels based on control criticality; 3.1.11+ and 3.1.12+ provide detailed guidance on the establishment of proper levels of redundancy		
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.1.6 Separate and independent power sources shall be provided for redundant operations.

Consideration should be given to:
a. Identifying all redundant operations;
b. The architecture design should clearly state the requirement for independence of power supplies to the redundant operations;
c. A test plan to verify the independence of the power supplies.

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254		
DoD/MIL Doc:	JSSG-2008: 3.2.2.2.2, 3.2.2.2.5, 3.3 JSSG-2008 Appendix A: 3.2.2.2.2 and 3.2.2.2.5 give extensive guidance on aircraft power system support to safety critical equipment	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309 4671.1351
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1310 CS 23.1351 CS 25.1301 CS 25.1309 CS 25.1351 CS 25.1355 CS 27.1301 CS 27.1309 CS 27.1351 CS 29.1301 CS 29.1309

Information Sources			
			CS 29.1351 CS 29.1355

15.1.7 A single hardware component or software function failure shall not impede redundant operations.

Consideration should be given to:
a. Carrying out a full system failure analysis (e.g. FMECA) to determine potential single points of failure;
b. Provision of mitigations for any failure modes identified under a).

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254		
DoD/MIL Doc:	JSSG-2008: 3.3.1 JSSG-2008 Appendix A: 3.3.1 provides processing architecture design strategies to mitigate component failures; 3.1.9 contains single point failure guidance regarding in-flight hazards and redundancy; 3.1.11.1 addresses safe operation in the case of multiple failures	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.1.8 Physical and functional separation between safety/flight critical and mission critical shall be justified in the computer system architecture.

Consideration should be given to:
a. Clearly identifying all safety and flight critical elements of the architecture;
b. Ensuring that non-safety or flight critical elements of the architecture do not share either hardware or software resources.

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254		
DoD/MIL Doc:	JSSG-2008: 3.1.7.1 JSSG-2008 Appendix A: 3.1.7.1 provides for basic partitioning of the architecture (hardware and software);	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309

Information Sources			
	3.1.7.2 gives guidance regarding "system arrangement" (architecture design); 3.1.7.3 directly addresses isolation of less critical elements to prevent their failure from impacting critical functions		
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.1.9 No patches (object code changes not resulting from compilation of source code changes) shall exist for flight-critical software.

Consideration should be given to :

a. Inspection of the delivered product;

b. Review of the software release and change control records.

c. Configuration control

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	JSSG-2008: 3.3.7 contains guidance on Software Change Control	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:	AC 20-115B Functional design integration of processing elements.	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.2. FUNCTIONAL DESIGN INTEGRATION OF PROCESSING ELEMENTS.

This section covers Functional design integration of processing elements. The scope considers:

1. That all parameters passed among SOF processing elements are defined and that unnecessary coupling is avoided.
2. That level of autonomy achieved by the flight-essential elements is sufficient to preclude loss of flight-critical functions due to failure in mission- or maintenance-related elements.
3. That a controlled methodology is established and applied to integrate all safety-critical elements of the processing architecture, including verification coverage.

15.2.1 All parameters passed among SOF processing elements shall be defined and unnecessary coupling shall be avoided.

Consideration should be given to:
a. Analysis of the processing elements should be performed to ensure that all parameters are defined and recorded in the appropriate software documentation;
b. Safety critical functional threads should be analysed to record processing element inter-dependencies;
c. All parameters coupled to these safety critical functional threads should be recorded and justified to prevent unnecessary coupling;
d. Development of a suitable test plan.

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254		
DoD/MIL Doc:	JSSG-2008: 3.3.6 JSSG-2008 Appendix A: 3.3.6+ and 3.1.14.6 address software structure, partitioning and CSCI integration; 3.1.5.1 gives guidance on data latency issues; 3.1.7 gives overall architecture design guidance along with specific data latency discussions in Lessons Learned subparagraph l	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.2.2 The level of autonomy achieved by the flight-essential elements shall be sufficient to preclude loss of flight-critical functions due to failure in mission or maintenance related elements.

Consideration should be given to:
a. The system design should preclude use of single-source safety critical data;
b. The system design should preclude use of single-source non-safety critical data for safety critical applications;
c. Where use is made of mission or maintenance related elements in flight-critical functions, these shall be recorded;

d. The system test plan should show that failure in mission or maintenance related elements cannot cause loss of flight-critical functions.

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254		
DoD/MIL Doc:	JSSG-2008: 3.3.1 JSSG-2008 Appendix A: 3.3.1 contains guidance addressing redundant data path management, data validity and reasonableness; 3.1.7.3 and 3.1.8 provide guidance for interfacing between safety and non-safety critical subsystems	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.2.3 A controlled methodology shall be established and applied to integrate all safety-critical elements of the processing architecture, including verification coverage.

Consideration should be given to:

a. An established and proven process should be used to record the all aspects of the architecture life cycle (hardware and software), including but not limited to: requirements, design, build, integration, and testing;

b. The contents of each document in the suite used for a) should be clearly defined;

c. The test plan for each element and each stage of development should be appropriate, building from individual elements to system level;

d. Integration of each element into the complete system;

e. Integration of the complete system into the air vehicle.

Information Sources			
Comm'l Doc:	RTCA DO 178B RTCA DO-254		
DoD/MIL Doc:	JSSG-2008: 3.3.1 JSSG-2008 Appendix A: 4.3 addresses processing element verification and 3.3.1 addresses integration; 4.1.14.4, 4.2.2.2 and 4.5.7 specify a build up approach in verification and testing	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS*	CS 23.1301

Information Sources			
		Reference:	CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.3. SUBSYSTEM/PROCESSING ELEMENT.

15.3.1. Electronics.

This section covers electronics. The scope considers:

1. That all computer resources hardware components are safe and SOF elements have redundant buses that are physically separated.
2. That all safety/flight-critical electronic components are physically and functionally separated from non-safety-critical items. (This includes items such as processors, memory, internal/external buses, input/output (I/O) management, internal/external power supplies, circuit cards, motherboards, etc.) If not separated, verify that non-safety-critical elements are treated as safety-critical items.

15.3.1.1 Merged with 15.1.3, 15.1.5 and 15.1.8

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254		
DoD/MIL Doc:	JSSG-2008: 3.3.1 JSSG-2008 Appendix A: 3.4.1 and 3.4.5 cover components and parts pedigree , 3.1.11.11.2 addresses integrity of signal transmission	*Def-Stan 00-970 Reference:*	Merged with 15.1.3, 15.1.5 and 15.1.8
		STANAG Reference:	Merged with 15.1.3, 15.1.5 and 15.1.8
FAA Doc:	AC 20-115B	*EASA CS Reference:*	Merged with 15.1.3, 15.1.5 and 15.1.8

15.3.1.2 Merged with 15.1.8

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254		
DoD/MIL Doc:	JSSG-2008: 3.3.1 JSSG-2008 Appendix A: 3.3.1 lessons learned addresses systems partitioning; 3.1.7.3	*Def-Stan 00-970 Reference:*	Merged with 15.1.8
		STANAG Reference:	Merged with 15.1.8

Information Sources			
	addresses isolation of less critical elements to prevent their failure from impacting critical functions		
FAA Doc:	AC 20-115B	*EASA CS Reference:*	Merged with 15.1.8

15.3.2. Architecture mechanisation.

This section covers Architecture Mechanisation. The scope considers:

1. That the executive/control structure execution rates are sufficient and consistently obtainable for SOF requirements given the control structure, priority assignments, and interrupts.
2. That the software design, timing, control flow, interrupt structure, and data structures meet the required processing capabilities of the SOF subsystem/system real-time architecture.
3. That all mode inputs, failure detection techniques, failure management, redundancy management, self-checks, and interfaces operate safely under all dynamic conditions.
4. That embedded SOF software provides acceptable performance and safety.
5. That the SOF software design has the necessary interrupt, reinitialization, resynchronization, recheck, and reconfiguration provisions to restart or reset safely and quickly in flight.
6. That the method of SOF software loading and verification is safe and carefully managed. (This includes the software operational flight program (OFP) loaded on individual black boxes or the air vehicle-loadable OFP.)
7. That the SOF software design has adequate self-check, failure monitoring, redundancy management, reconfiguration, voting, transient suppression,
overflow protection, anti-aliasing, saturation interlock, memory protection, and techniques for preventing failure propagation to preclude SOF issues.
8. That there is sufficient throughput margin for both input/output and processor capabilities (including memory) under worst-case mode performance
scenarios for both average and peak worst-case loading conditions.

15.3.2.1 The executive/control structure execution rates shall be sufficient and consistently obtainable for SOF requirements given the control structure, priority assignments, and interrupts.

Consideration should be given to:

a. The executive structure, or operating system, should be developed as safety/flight critical;
b. There is sufficient processing capacity to ensure that all SOF requirements are met despite priority task assignments and interrupts;
c. The test plan should take account of system loading, interrupts, and worst case timing scenarios, ensure that allowable data latencies are not exceeded and that SOF requirements are met.

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254		
DoD/MIL Doc:	JSSG-2001: 3.3.3.1 JSSG-2008: 3.3.4 JSSG-2001: 3.3.3.1 provides guidance for establishing adequate computer hardware	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG	4671.1301 4671.1309

Information Sources			
	reserve capacity JSSG-2008 Appendix A: 3.3.1 establishes timing and control allocations based on operational requirements; 3.3.4 addresses synchronization, deterministic execution and frame rate issues	*Reference:*	
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.3.2.2 The software design, timing, control flow, interrupt structure, and data structures shall meet the required processing capabilities of the SOF subsystem/system real-time architecture.

Consideration should be given to:

a. The test plan should consider sub-system/system integration, and identification of potential failure modes;

b. Tests should demonstrate that the SOF software meets the required execution rates under worst case timing conditions.

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254		
DoD/MIL Doc:	JSSG-2001: 3.3.3.1, JSSG-2008: 3.3 JSSG-2001: 3.3.3.1 provides guidance for establishing adequate computer hardware reserve capacity JSSG-2008 Appendix A: 3.3.4 addresses synchronization, deterministic execution and frame rate issues; 3.1.7 gives overall architecture design guidance along with specific data latency discussions in Lessons Learned subparagraph l; 3.1.5.1 gives guidance on data latency issues	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309

Information Sources			
			CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.3.2.3 All mode inputs, failure detection techniques, failure management, redundancy management, self-checks, and interfaces shall operate safely under all dynamic conditions.

Consideration should be given to:

a. Software modes: only those modes required for safe operational flight should be available; any other modes, such as test modes for instance, should be locked out and unavailable;

b. Fault detection: fault detection and error recovery techniques should be robust;

c. Failure and redundancy management: this should include self-checking and health checks of subordinate systems, voting mechanisms to isolate failure areas, and consequent redundancy management;

d. Integration: the integration activities should cover sub-system/system integration and system/system integration for all normal and failure states under all dynamic conditions;

e. Verification and test plan: the test plan should document the required tests, and their results, and it should also consider a sensitivity analysis; ultimately, the test plan should demonstrate safe operation under all dynamic conditions.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	JSSG-2008: 3.3.1 JSSG-2008 Appendix A: 3.3.1 lessons learned provides guidance regarding fault management and systems partitioning; 3.3.2 provides guidance regarding failure propagation and redundancy; 3.1.4 addresses survivability; 3.1.5.2 addresses mode transitions; 3.1.5.7 addresses sensitivity analysis; 3.1.7.2 discusses overall system arrangement issues impacting invulnerability and failure immunity	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8 4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301

Information Sources			
			CS 29.1309

15.3.2.4 Embedded SOF software shall provide acceptable performance and safety.

Consideration should be given to:

a. All the software requirements should be traceable through to the software programme;

b. SOF requirements separately identified within documentation;

c. A rigorous and approved software development methodology should be used, including but limited to:

i. Use of an approved software language, along with approved development and support tools.

ii. Use of formal reviews and audits of the software.

iii. Full and accurate documentation of the software - its development and testing.

iv. Robust configuration control.

v. Full test of each complete software release.

Information Sources			
Comm'l Doc:	IEEE STD 12207 provides industry best practice software development guidance. RTCA DO-178B RTCA DO-254		
DoD/MIL Doc:	JSSG-2008: 3.3.6 JSSG-2008: 3.1.14.6, 3.2.4.6, 3.3.6+ and 3.3.7+ provide guidance regarding software design and development for safety critical systems ASC Engineering Technical Guide version 1.1 dated 11 October 2002 established an integrity program for software development	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.3.2.5 The SOF software design shall have the necessary interrupt, re-initialization, re-synchronization, re-check, and re-configuration provisions to restart or reset safely and quickly in flight.

Consideration should be given to:

a. The system hardware and software should be designed to work together to allow resets or restarts without significant effects;

b. The architecture should be structured to allow: the required interrupts; data synchronisation & re-synchronisation; and system re-initialisation and recovery to a safe state;

c. The test and acceptance plan should consider the timelines required for each activity and ensure that they can be completed before the air vehicle departs from controlled flight. The time available will depend on the phase of flight at the time of the occurrence;
d. Recovery activity should not result in loss of safety critical data.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	JSSG-2008: 3.3 JSSG-2008 Appendix A: 3.1.12.1 discusses redundancy management support for restart; 3.2.4.6 addresses software support for failure recovery; 3.1.17 provides guidance regarding failure propagation of computational failures; 3.3.2.2 discusses microprocessor timing and synchronization; 3.3.4 details issues surrounding synchronization rates; 4.1.13.2 provides lessons learned in verification of in-flight monitoring capability	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8 4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.3.2.6 The method of SOF software loading and verification shall be safe and carefully managed (This includes the software operational flight program (OFP) loaded on individual black boxes or the air vehicle-loadable OFP).

Consideration should be given to:
a. The SOF OFP should be fully documented and produced using a robust and approved methodology;
b. A robust configuration control process should be employed to record and manage which OFP is loaded where;
c. A comprehensive test plan for the OFP is developed and followed leading to successful rig and aircraft ground tests before flight. This should encompass use of approved field loading devices.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	JSSG-2008: 3.1.16 JSSG-2008 Appendix A: 3.3.2 gives guidance for single point	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8

Information Sources			
	OFP load and verification; 3.3.7 addresses software change control; 3.3.8 addresses software certification of hardware compatibility; 3.1.14.6 discusses system invulnerability to software errors	*STANAG Reference:*	4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.3.2.7 To preclude SOF issues, the SOF software design shall have adequate techniques for: self-check; failure monitoring; redundancy management; reconfiguration; voting; transient suppression; overflow protection; anti-aliasing; saturation interlock; memory protection; and means for preventing failure propagation.

Consideration shall be given to:

a. Initially agreeing and documenting the architecture design along with the required protection and resilience attributes;

b. Use of a robust and approved design methodology;

c. The test and acceptance plan should:

i. Capture initial requirements and detail acceptance criteria.

ii. Detail plans to review and audit development and final versions of the software.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	JSSG-2008: 3.3.6 JSSG-2008 Appendix A: 3.1.11.9, 3.1.13, 3.1.17 and 3.3.2.1 provide guidance for integrity and BIT checks often implemented in software; 3.1.12.1 gives detailed guidance for redundancy management; 3.3.6.2 provides guidance for robust integrated CSCI design	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301

Information Sources			
			CS 27.1309 CS 29.1301 CS 29.1309

15.3.2.8 There shall be sufficient throughput margin for both input/output and processor capabilities (including memory) under worst-case mode performance scenarios for both average and peak worst-case loading conditions.

Consideration should be given to:

a. Establishing the minimum necessary processing capacity to complete all the SOF critical tasks without incurring any unsafe system behaviour. This should include data throughput, memory, bus, and I/O capacity using worst case scenarios;

b. Ensure adequate margin to allow for data latency, bus scheduling, re-start, etc.;

c. Agree spare capacity to allow for future system changes, upgrades, or additional functionality.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	JSSG-2008: 3.3.5 JSSG-2008 Appendix A: 3.3.5 contains guidance regarding reserve capacity; 3.1.14.6 contains guidance for worst case throughput and I/O spare; 3.5.7 establishes performance parameters for spare capacity and margin	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.3.2.9 A controlled methodology shall be established and applied to integrate all functional elements of a highly coupled, integrated OFP.

Consideration should be given to:

a. An established and proven methodology to be used to record all aspects of the OFP life cycle, including but not limited to: requirements, design, build, integration, and testing;

b. The contents of each document in the suite used for a) should be clearly defined;

c. The test and acceptance plan for each element and each stage of development should be appropriate, building from individual elements to system level;

d. Integration of each element into the complete system;

e. Integration of the complete system into the air vehicle.

Information Sources			
Comm'l Doc:	RTCA DO-178B		

Information Sources			
DoD/MIL Doc:	JSSG-2008: 3.3.6 JSSG-2008 Appendix A: 3.3.6 addresses breaking down complex software into manageable CSCIs; 3.2.2.2 discusses subsystem integration; 4.3 discusses verification of integrated processing capabilities; 3.3.1 provides guidance for integrated architecture design	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.3.3. Processing architecture verification for SOF items.

This section covers Processing Architecture Verification. The scope considers:

1. The operation of BIT and redundancy/failure management algorithms.
2. That critical hardware/software discrepancies are identified and corrected or mitigated.
3. That adequate configuration management controls are in place to ensure proper/ functionally compatible software loading for the intended use on the air vehicle.
4. That all data or communications are secure against unwanted intrusions and that security techniques used are implemented safely.

15.3.3.1 The BIT and redundancy/failure management algorithms shall operate correctly.

Consideration should be given to:
a. The software coverage required for the BIT;
b. The required BIT success rate for the software covered;
c. Detection requirements for second and subsequent failures;
d. The failure and redundancy management algorithms successfully managing the failure condition enabling continued SOF;
e. Failures between systems or sub-systems should be detected and prevented;
f. The test and acceptance plan should include sub-system/system and system/system integration testing along with acceptance criteria.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	JSSG-2008: 3.3.6.2 JSSG-2008 Appendix A: 3.3.6.2 establishes guidance	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8

Information Sources			
	for CSCI failure detection and execution of BIT; 3.1.13 (Requirement Guidance a. 2.) defines types of BIT and a list of typical items tested; 3.1.12 addresses redundancy management	*STANAG Reference:*	4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 25.1701 CS 25.1707 CS 25.1709 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.3.3.2 Critical hardware/software discrepancies shall be identified and corrected or mitigated.

Consideration should be given to:
a. Use of a robust and approved design and development control methodology to document and record all aspects of the design and its testing through to acceptance;
b. The above methodology should ensure that follow-up action on identified discrepancies is tracked through to a successful conclusion;
c. The test plan coverage should be appropriate and suitable to the elements under consideration;
d. All interfaces should be well documented and compatible (hardware/hardware, hardware/software, and software/software);
e. Use of a peer review audit system comprising independent reviewers.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	JSSG-2008: 3.3.7 JSSG-2008 Appendix A: 3.3.8 provides guidance under lessons learned for tracking and mitigating software discrepancies	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.3.3.3 Adequate configuration management controls shall be in place to ensure proper/ functionally compatible software loading for the intended use on the air vehicle.

Consideration should be given to:

a. A matrix of allowable hardware/software versions is maintained; this should encompass all allowable inter and intra system loads;

b. A robust configuration control process should be employed to record and manage what software is loaded where;

c. Provision of a means to easily cross check a) and b) above;

d. Allowable versions of system software should be carefully controlled to prevent inappropriate versions or combinations being loaded onto the air vehicle.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	JSSG-2008: 3.1.16 JSSG-2008 Appendix A: 3.1.16 provides guidance regarding OFP version control and integrity	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

15.3.3.4 All data, or communications, shall be secure against unwanted intrusions and that security techniques used shall be implemented safely.

Consideration should be given to:

a. The degree of security required and means of implementing it (software or hardware); intrusions could include malicious (theft, or data corruption) or accidental access;

b. Use of encryption systems;

c. Any security techniques used should be clearly identified in the documentation, and proven not to affect SOF functionality;

d. Physical security means.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	JSSG-2008: 3.3.7 JSSG-2008 Appendix A: 3.1.14.6.i and 4.1.14.6.d guidance addresses analysis, allocation and verification of security requirements; 3.3.4 directly addresses unauthorized modification and	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7 00-970 P13 1.8
		STANAG Reference:	4671.1301 4671.1309

Information Sources			
	tampering with components; 3.3.7 establishes a place for traceable security requirements AFPam 63-1701 provides guidance for implementation of Systems Security Engineering		
FAA Doc:	AC 20-115B	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

SECTION 16 - MAINTENANCE

This section considers criteria for servicing and maintenance activity and oversight.

TYPICAL CERTIFICATION SOURCE DATA

1. Maintenance manuals/checklists (equivalent or supplement to -2 T.O.'s)
2. Inspection requirements (equivalent or supplement to -6 T.O.'s)
3. Life-limited/time replacement plan/list
4. Subsystem hazard analysis (SSHA)
5. Failure modes, effects, and criticality analysis (FMECA)
6. Maintenance records (including failure report and corrective action system (FRACAS))
7. Air Force Regulation (AFR) 8-2, T.O. 00-5-1
8. Test reports 9. Test plans

CERTIFICATION CRITERIA

16.1. INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

16.1.1 Instructions for Continued Airworthiness shall be prepared.

Consideration should be given to ensuring that Instructions for Continued Airworthiness contain a section titled Airworthiness Limitations that is segregated and clearly distinguishable from the rest of the document.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1529 4671 Appendix G
FAA Doc:		*EASA CS Reference:*	CS 23.1529, CS 23 Appendix G CS 25.1529 CS 25 Appendix H CS 27.1529 CS 27 Appendix A CS 29.1529 CS 29 Appendix A

16.2. MAINTENANCE MANUALS/CHECKLISTS.

This section considers the provision of servicing and maintenance manuals and checklists, and the incorporation of information within them.

16.2.1 Servicing instructions shall be provided for all systems that require servicing.

Consideration should be given to fuel, engine oil, hydraulic systems, landing gear struts, tyres, oxygen, escape system, etc.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.6.1, 3.6.2 JSSG-2001: 3.1.5	*Def-Stan 00-970 Reference:*	00-970 P1 4.4.25 00-970 P1 4 4.26
		STANAG Reference:	4671.1501 4671.1529 4671 Appendix G
FAA Doc:	14CFR references: 23.1501, 23.1529, 25.1501, 25.1503-25.1533, 25.1529, 25.1541, 25.1543, 25.1557, 25.1563 14CFR reference Part 23, Appendix G and Part 25, Appendix H, Instructions for Continued Airworthiness	*EASA CS Reference:*	CS 23.1501, CS 23.1523 CS 23 Appendix G CS 25.1501 CS 25.1529 CS 25 Appendix H CS 27.1501 CS 27.1529 CS 27 Appendix A CS 29.1501 CS 29.1529 CS 29 Appendix A

16.2.2 Cautions and warnings shall be included in maintenance manuals, aircrew checklists, and ground crew checklists.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.4.25
		STANAG Reference:	4671.1501 4671.1529 4671.1541 4671.1581 4671 Appendix G

Information Sources			
FAA Doc:	23.1501, 23.1529, 25.1501, 25.1503-25.1533, 25.1529, 25.1541, 25.1543, 25.1557, 25.1563	*EASA CS Reference:*	CS 23.1501 CS 23.1529 CS 23.1581 CS 23.1589 CS 23 Appendix G CS 25.1501 CS 25.1529 CS 25.1581 CS 25.1591 CS 25 Appendix H CS 27.1501 CS 27.1529 CS 27.1581 CS 27.1589 CS 27 Appendix A CS 29.1501 CS 29.1529 CS 29.1581 CS 29.1589 CS 29 Appendix A

16.2.3 Maintenance checklists shall be available for critical maintenance tasks.

Consideration should be given to procedures for replenishments such as fuel and oxygen; towing procedures including restrictions; jacking and trestling procedures; engine operation during maintenance (engine running guards and tie down etc), lifting procedures, flight servicing, etc.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.6.1, 3.6.2 JSSG-2001: 3.1.5	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1529 4671 Appendix G
FAA Doc:	23.1501, 23.1529, 25.1501,	*EASA CS*	CS 23.1529

Information Sources			
	25.1503-25.1533, 25.1529, 25.1541, 25.1543, 25.1557, 25.1563	*Reference:*	CS 23 Appendix G CS 25.1529 CS 25 Appendix H CS 27.1529 CS 27 Appendix A CS 29.1529 CS 29 Appendix A

16.2.4 Under normal operation condition, support equipment shall not adversely affect the safety of the air vehicle.

Air vehicle support equipment can include equipment or vehicles which are directly connected to the air vehicle or used in close proximity to it; examples of such include but are not limited to: towing arms, towing vehicles, ground power sets (electrical, hydraulic, or pneumatic), special to type test equipment or rigs, replenishment equipment, weapon loading vehicles and equipment, and cargo handling vehicles and equipment.

Consideration should be given to:

a. Authorisation of all support equipment required to support the air vehicle with any limitations documented;
b. Clear identification of any maintenance requirements for the support equipment and appropriate record keeping;
c. Abnormal operation of special to type test equipment (STTE).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.6.1, 3.6.2 JSSG-2001: 3.1.5	*Def-Stan 00-970 Reference:*	00-970 P1 4.4.10 00-970 P1 6.11.21
		STANAG Reference:	4671.635 4671.1529 4671 Appendix G
FAA Doc:	23.1501, 23.1529, 25.1501, 25.1503-25.1533, 25.1529, 25.1541, 25.1543, 25.1557, 25.1563	*EASA CS Reference:*	CS 23.1529 CS 23 Appendix G CS 25.1529 CS 25 Appendix H CS 27.1529 CS 27 Appendix A CS 29.1529 CS 29 Appendix A

16.2.5 Maintenance manuals shall incorporate procedures for system/component removal.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1529 4671 Appendix G
FAA Doc:	14CFR reference Part 23, Appendix G and 14CFR reference Part 25, Appendix H	*EASA CS Reference:*	CS 23.1529 CS 23 Appendix G CS 25.1529 CS 25 Appendix H CS 27.1529 CS 27 Appendix A CS 29.1529 CS 29 Appendix A

16.2.6 Maintenance manuals shall include procedures for testing of normal/emergency system operation after removal/replacements of parts.

Consideration should be given to:

a. Degree of testing required, dependent on component replaced.

b. Testing may be required after disturbing of system, perhaps as a means of accessing other areas of the air vehicle.
c. Any inter-system testing that may be required.
d. Any requirement for testing after changing an air vehicle software load.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.6.1, 3.6.2 JSSG-2001: 3.1.5	*Def-Stan 00-970 Reference:*	00-970 P1 4.10.29
		STANAG Reference:	4671.1529 4671 Appendix G
FAA Doc:	14CFR reference Part 23 Appendix G and 14CFR reference Part 25, Appendix H	*EASA CS Reference:*	CS 23.1529 CS 23 Appendix G CS 25.1529 CS 25 Appendix H CS 27.1529 CS 27 Appendix A CS 29.1529 CS 29 Appendix A

16.2.7 Maintenance manuals shall provide adequate troubleshooting procedures to diagnose and allow correction of expected system/component failures.

Consideration should be given to:
a. Ensuring any special to type test equipment or tools required are also listed.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.6.1, 3.6.2 JSSG-2001: 3.1.5	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	2445 4671.1501 4671.1529
FAA Doc:	14CFR reference Part 23, Appendix G and 14CFR reference Part 25, Appendix H	*EASA CS Reference:*	CS 23.1529 CS 23 Appendix G CS 25.1529 CS 25 Appendix H CS 27.1529 CS 27 Appendix A CS 29.1529 CS 29 Appendix A

16.3. INSPECTION REQUIREMENTS.

This section considers continuing airworthiness management. The scope covers:

a. The availability of inspection procedures in the event of unusual or specified conditions such as exceeding operating limits, requirements for oil samples and analysis, and after use of emergency procedures.
b. Verifying that life-limited items, and their replacement intervals, have been specified and are based on relevant data.
c. Verifying that all inspection intervals are identified and are based on relevant data.

16.3.1 Deleted

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.6.1, 3.6.2 JSSG-2001: 3.1.5	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1529 4671 Appendix G
FAA Doc:	23.1501, 23.1529	*EASA CS Reference:*	CS 23.1529 CS 23 Appendix G CS 25.1529 CS 25 Appendix H CS 27.1529 CS 27 Appendix A CS 29.1529 CS 29 Appendix A

16.3.2 Special inspection procedures shall be available for unusual or specified conditions, such as:
a. Exceeding operating limits;
b. Severe vibration;
c. Engine stall;
d. Foreign object damage to engine or structure;
e. Excessive loss of oil;
f. Conditions requiring oil sampling and analysis;
g. Severe braking action, hard landing, and running off runway;
h. Air vehicle subject to excessive "g" loads or manoeuvres outside the specified flight envelope;
i. Emergency procedures implemented;
j. Dropped objects or parts.
k. Operation in, or in the vicinity of, a volcanic ash cloud.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-PRF-5096: 3.2.2.3.1 gives guidance regarding special inspections after a specific occurrence. JSSG-2000: 3.6.1, 3.6.2 JSSG-2001: 3.1.5	*Def-Stan 00-970 Reference:*	00-970 P1 1.1.29
		STANAG Reference:	4671.1501 4671.1529 4671 Appendix G
FAA Doc:	23.1501, 23.1529	*EASA CS Reference:*	CS 23.1501 CS 23.1529

Information Sources			
			CS 23 Appendix G CS 25.1501 CS 25.1529 CS 25 Appendix H CS 27.1501 CS 27.1529 CS 27 Appendix A CS 29.1501 CS 29.1529 CS 29 Appendix A

16.3.3 Life-limited items and replacement intervals shall be identified using relevant test and development data.

Consideration should be given to:

a. Ensuring that all life-limited items have been identified;

b. Ensuring that appropriate lives have been allocated to the item (FMECA and R&M predictions);

c. Items fitted with elapsed time indicators, magnetic chip detectors etc. where possible to record operational usage;

d. Programme of in-service monitoring to ensure that the assigned predicted life is appropriate (not too long or too short).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.6.1, 3.6.2 JSSG-2001: 3.1.5 MIL-PRF-5096: 3.2.2.4 gives guidance regarding flying time related or time change items	*Def-Stan 00-970 Reference:*	00-970 P1 4.4.6 00-970 P1 4.4.38
		STANAG Reference:	4671.1529 4671 Appendix G
FAA Doc:	23.1501, 23.1529	*EASA CS Reference:*	CS 23.1529 CS 23 Appendix G CS 25.1529 CS 25 Appendix H CS 27.1529 CS 27 Appendix A CS 29.1529 CS 29 Appendix A

16.3.4 All required inspection intervals shall be identified using relevant test and development data.

Consideration should be given to:

a. Ensuring all areas requiring periodic inspection have been identified;

b. The inspection periodicity has been justified;

c. Appropriate inspection techniques have been identified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.6.1, 3.6.2	*Def-Stan 00-970*	00-970 P1 3.2.17

Information Sources			
	JSSG-2001: 3.1.5 MIL-PRF-5096: 3.2.1.1.1 gives guidance regarding frequency of maintenance items	*Reference:*	00-970 P1 3.2.18 00-970 P1 3.2.19 00-970 P1 4.4.6
		STANAG Reference:	4671.1529 4671 Appendix G
FAA Doc:	23.1501, 23.1529	*EASA CS Reference:*	CS 23.1529 CS 23 Appendix G CS 25.1529 CS 25 Appendix H CS 27.1529 CS 27 Appendix A CS 29.1529 CS 29 Appendix A

SECTION 17 - ARMAMENT/STORES INTEGRATION

This section covers the installation, integration, interface and operation of the air vehicle armament system, including guns/rockets, stores and in particular laser systems.

Included with the scope of the this section are:
• Fixed and free guns/rockets
• Stores - A store is any device intended for internal or external carriage, mounted on air vehicle suspension and release equipment, which may or may not be intended to be for in-flight separation from the air vehicle. Stores include missiles, rockets, bombs, nuclear weapons, mines, fuel and spray tanks (permanently attached and/or detachable), torpedoes, sonobuoys, dispensers, pods (refuelling, thrust augmentation, gun, electronic countermeasures, etc.), targets, decoys, chaff and flares, and suspension equipment.
• Laser systems fitted to the air vehicle
• Air vehicle and personnel protection from third party laser systems
• Specific safety interlock systems to prevent inadvertent operation of the air vehicle armament system.

Where necessary specific air vehicle system integration criteria are included. However, more general system integration issues (HF, EMC, Electrical...etc) are covered elsewhere in the handbook.

When designing store equipment, the general air worthiness criteria for air vehicle equipment and systems, as well as the overall air vehicle flight control and flight performance should always be considered. Some verify criteria in this chapter are supported in the text by examples of specific considerations. These examples are by no means to be considered as exhaustive. All criteria should at least be verified for:
− All normal and emergency (failure) conditions.
− All configurations to be certified, including those with other stores, and including all download configurations.

Where an information source is highlighted, in general it is implied that any higher level requirement on the same subject stated in the parent paragraphs is applicable too, as well as each lower level requirement contained in any subparagraph. The links to references are by no means to be considered as exhaustive.

TYPICAL CERTIFICATION SOURCE DATA

1. User requirements and design requirements and validation results
2. Design studies and analyses
3. Design, installation, and operational characteristics
4. Component and functional level SOF, qualification and certification tests
5. Electromagnetic environmental effects
6. Plume ingestion/propulsion compatibility tests and plume/gun gas impingement test.
7. Failure modes, effects, and criticality analysis/testing (FMECA/FMET)
8. Hazard analysis and classification including explosive atmosphere analysis/test
9. Safety certification program
10. Computational, theoretical and/or semi-empirical prediction methods
11. Configuration: aerodynamic design and component location
12. Wind tunnel test results and correction methods
13. Mathematical representation of system dynamics

14. Loads analysis, wind tunnel and flight test results 15. Flutter, mechanical stability, aeroelastic, aeroservoelastic and modal analyses, wind tunnel and flight test results
16. Performance analysis
17. Environmental compatibility analysis and tests including gun fire vibration analysis/test
18. Interface control documents
19. Store separation models, wind tunnel and flight test results
20. Flight manual
21. Flight test plan and test results
22. MIL-HDBK-1763, Aircraft/Stores Compatibility: Systems Engineering Data Requirements and Test Procedures
23. MIL-HDBK-244, Guide to Aircraft/Stores Compatibility
24. MIL-STD-1760, Aircraft/Store Electrical Interconnection System 25. MIL-A-8591, Airborne Stores, Suspension Equipment and Aircraft-Store Interface (Carriage Phase); General Design Criteria for
26. SEEK EAGLE engineering data 27. American National Standard for Safe Use of Lasers (ANSI Z136.1)
28. Nuclear Certification Impact Statement (NCIS)
29. Aircraft monitor and control (AMAC) and surveillance tests
30. Nuclear safety analysis report (NSAR)
31. Mechanical compatibility data
32. Electrical compatibility data
33. Certification requirements plan (CRP)
34. Operational flight program (OFP) source code
35. Systems integration lab data/results
36. Cooling analysis and ground/flight test results
37. MIL-STD-1530 Aircraft Structural Integrity Program
38. ASC/EN Stores Integration practice
39. Human factors to consider
40. Crew egress paths to consider
41. Aircraft weight and balance
42. Environmental analysis and test results
43. Store drawings including store mass properties (STAMP sheet)
44. Safety assessment report
45. Airworthiness qualification plan (AQP) (Army unique)
46. Airworthiness qualification specification (AQS) (Army unique)

CERTIFICATION CRITERIA

17.1. GUN/ROCKET INTEGRATION AND INTERFACE.

17.1.1 The installation and integration of guns/rockets shall not adversely affect the operational function or safety of the air vehicle. This includes the environment induced by operation of the gun/rocket with respect to muzzle blast and over-pressure, recoil, vibro-acoustics, cooling, egress, human factors and structural loads.

Consideration of the following should be given to the location of such installations:
a. The effect of flammable gas as a hazard to the air vehicle;
b. The effects of gun firing directly on the engines, structures and other systems and indirectly, by changes to rotorcraft or equipment permanent magnetism, on compass detector units;
c. The effects of the installation on the air vehicle aerodynamics and the safety of the air vehicle, crew or maintenance personnel;
d. The installation purging system;
e. The temperature conditions in the gun and ammunition compartments shall permit the air vehicle to utilise its full flight envelope without restrictions caused by exceeding the max/min. permissible temperatures of the gun and ammunition;
f. With the exception of the designed openings in the installation, the gun and ammunition compartments shall be sealed to prevent the ingress of contaminants, particularly when the rotorcraft is on or near the ground.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 17.1.1 MIL-HDBK-244A: para 5.1.6, 5.1.9.1, 5.1.9.2, 5.1.9.2.4, 5.1.10, 5.2.5, 5.3, 5.3.12.2 (unverified - Expanded 516 and NL516) MIL-HDBK-1763: para 4.1.4. 2, 4.1.4.7, 4.1.4.10; test 160, 270 (unverified- NL516)	*Def-Stan 00-970 Reference:*	00-970 P13 3.1.5* 00-970 P13 3.2.3* 00-970 P13 3.2.18* 00-970 P13 3.2.36 00-970 P13 3.3.1 00-970 P13 3.3.2* 00-970 P13 3.3.7 00-970 P13 3.3.8* 00-970 P7 L709 2.2.2 00-970 P7 L709 8 *(unverified- NL516) AIR 2004E (unverified- FR) REACH Process (unverified- FR)
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

17.1.2 Gun/rocket gases and plume shall not adversely affect the safety of the air vehicle, aircrew and maintenance personnel.

Consideration should be given to:
a. SOF hazards, including:
i. The location of gun/rockets to avoid high temperature efflux impinging on the engine or other stores and release systems;
ii. The location of gun/rockets to avoid contamination of the engine or other stores and release systems;
iii. The muzzle velocity, firing rate and type of propellant used in the gun ammunition or rocket;
iv. The ability of the engine to tolerate ingested gases to suitable limits to be agreed and verified;
v. The effect of metallic particles in the plume on air vehicle sensors and stores and release systems;

vi. The design of the engine intake;

vii. Tolerable ingestion of gases or pressure waves caused by gun/rocket operation.

b. Impingement on the air vehicle structure/skin and/or stores, including:

i. Unacceptable degradation leading to a reduction in structural integrity;

ii. Undesirable aerodynamic characteristics;

iii. The location of stores to avoid efflux from gun/rocket gases;

iv. The ventilation/purge system shall not allow the flammable gas concentration to exceed suitable limits to be agreed and verified

c. A ventilation / purge system, to prevent the accumulation of flammable gas to an explosive level, including:

i. Gun gases purging flow shall be established before firing commences;

ii. Ventilation of any tank in which empty cases are collected;

iii. Purging of gases shall happen as close to the source as possible;

iv. The ventilation/purge system should not allow the flammable gas concentration to exceed suitable limits, to be agreed and verified;

v. The ability to withstand without damage any localised ignition that may occur below the suitable limits, to be agreed and verified.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 17.1.2, 17.1.3, 17.1.4 MIL-HDBK-244A: para 5.1.9, 5.1.10.9 (unverified NL516) MIL-HDBK-1763 4.1.4.7.2, 4.1.4.7, 4.1.4.10; test 160, 270 (unverified NL516)	*Def-Stan 00-970 Reference:*	00-970 P1 6.9.25* 00-970 P13 3.1.5* 00-970 P13 3.2.3* 00-970 P13 3.2.18 00-970 P13 3.2.19 00-970 P13 3.2.36* 00-970 P13 3.2.37 00-970 P13 3.3.2* 00-970 P13 3.3.7 00-970 P13 3.3.8* 00-970 P13 3.3.12* 00-970 P13 L5 5.1 00-970 P1 L6 5.1 00-970 P13 S4 L6 00-970 P13 S4 L7 00-970 P1 L710/4 00-970 P7 L709 8 00-970 P9 UK587c 00-970 P11 S4.5 *(unverified- NL516)
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

17.1.3 Merged with 17.1.2

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	Merged with 17.1.2
		STANAG Reference:	Merged with 17.1.2
FAA Doc:		*EASA CS Reference:*	Merged with 17.1.2

17.1.4 Merged with 17.1.2

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	Merged with 17.1.2
		STANAG Reference:	Merged with 17.1.2
FAA Doc:		*EASA CS Reference:*	Merged with 17.1.2

17.2. STORES INTEGRATION.

17.2.1 The installation, integration and interface of the air vehicle and stores, shall not create unsafe conditions during ground and flight operations, including the position of store stations and creation of an unsafe environment for maintenance personnel.

The following considerations should be made when designing stores installations and the location of stores installations:

a. Clearance between stores and surroundings;
b. Store loading and unloading procedures;
c. The armament system shall be such that no single point failure shall adversely affect the safety of the air vehicle;
d. The use of differently sized/oriented connectors to avoid misconnection;
e. The installation of stores shall allow for their safe jettison, or deactivation if required, in order to protect the air vehicle or for operational/safety reasons following a malfunction;
f. The possibility to release mechanically any store and/or its jettisonable carrier without entering the cockpit (particularly for rotorcraft);
g. The store shall not become armed until it has successfully separated from its release unit or launcher;
h. The environment induced by the stores on the air vehicle, and by the air vehicle on the store during carriage and launch/separation/jettison;
i. The effect of high temperature efflux from engines, rockets or missiles impinging on the store or its release system;
j. Contamination of stores and release systems by engine exhaust, fuels, oil or any substance which could adversely affect the armament system;
k. Unacceptable aircraft flying qualities resulting from the release of stores.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.1.5, 17.2.1, 17.2.2, 17.2.3 MIL-HDBK-1763 para 4.1.4.6, 4.1.4.7, 4.1.4.8, 4.1.4.10, 4.1.4.11; test 140, 150, 160, 220 (unverified NL516) MIL-HDBK-244A para 5.1.8.1, 5.1.8.2, 5.1.8.3, 5.1.8.4, 5.1.10.3, 5.1.10.4, 5.1.10.5.2, 5.1.10.9, 5.3.12.1, 5.3.12.2, 5.3.12.3, 5.4.3 (unverified NL516) MIL-STD-1289D MIL-STD-464 MIL-HDBK-1760A MIL-STD-1760D MIL-STD-331 MIL-STD-27733 JSSG-2001: 3.3, 10.1.1, 3.4.2.1.5, and 3.4.2.2 for the testing methodology. JSSG-2000A 6.3.25 JSSG-2001A 4.1.1.2, 4.4.1.1, 4.4.1.2, App C 4.4, 4.5	*Def-Stan 00-970 Reference:*	00-970 P1 1.1.33* 00-970 P1 1.1.34* 00-970 P1 2.6.7 00-970 P1 2.7.8 00-970 P1 2.23.5* 00-970 P1 2.23* 00-970 P1 2.24.2 00-970 P1 2.24.18 00-970 P1 4.19.40* 00-970 P13 3.1.4 00-970 P13 3.1.5* 00-970 P13 3.2.1 00-970 P13 3.2.6 00-970 P13 3.2.8 00-970 P13 3.2.9 00-970 P13 3.2.10 00-970 P13 3.2.17 00-970 P13 3.2.18 00-970 P13 3.2.19 00-970 P13 3.2.20 00-970 P13 3.2.34* 00-970 P7 L100 16 *(unverified- NL516)
		STANAG Reference:	3109 3230
FAA Doc:		*EASA CS Reference:*	

17.2.2 Both internal and external stores shall separate safely from the air vehicle throughout the air vehicle and store launch/release/jettison flight envelope. The successful separation of stores shall not impart any adverse flying qualities (including excessive pilot workload) or result in any dangerous flight conditions.

Consideration should be given to:

a. Release of internally carried stores shall not be possible until the bomb bay doors are fully open;

b. Indication to the crew in the event of a failed separation (hangfire or misfire);

c. An appropriate release mechanism shall be used. (i.e. Ejector Release Unit (ERU) or an Electromagnetic Release Unit (EMRU));

d. Operation sequencing (i.e. undercarriage travel).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 6.3.1.5, 17.2.1, 17.2.2, 17.2.3 MIL-HDBK-244A: para 5.1.1.2, 5.1.9, 5.3.2, 5.3.6, 5.3.7, 5.3.10 (unverified NL516)	*Def-Stan 00-970 Reference:*	00-970 P1 2.6.7 00-970 P1 2.7.8 00-970 P1 2.24.2 00-970 P1 2.24.17 00-970 P1 2.24.18

Information Sources			
	MIL-HDBK-1763: para 4.1.4.5, 4.1.4.7, 4.1.4.10; test 110, 140, 160, 270, 280 (unverified NL516) JSSG-2000A 6.3.25 JSSG-2001A 4.1.1.2, 4.4.1.1, 4.4.1.2, App C 4.4, 4.5		00-970 P13 3.1.5* 00-970 P13 3.2.11* 00-970 P13 3.2.12* 00-970 P13 3.2.17* 00-970 P13 3.2.18* 00-970 P13 3.2.22* 00-970 P13 3.2.23* 00-970 P13 3.2.24* 00-970 P13 3.2.31* 00-970 P13 3.2.34* 00-970 P13 3.3.2* 00-970 P13 3.3.13* 00-970 P13 3.1.4 00-970 P13 3.2.1 00-970 P13 3.2.12 00-970 P13 3.2.17 00-970 P7 L710 5.2 *(unverified- NL516)
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

17.2.3 The air vehicle, store and release equipment installations shall meet the strength and stiffness requirements for operating safely within the Air Vehicle/Store carriage flight envelope.

Consideration should be given to:
a. Taxiing with stores;
b. Carriage;
c. Operation;
d. Release;
e. Landing with stores.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 17.2.3 MIL-HDBK-244A: para 5.1.6, 5.1.10.2, 5.1.10.3, 5.1.10.4, 5.1.10.6, 5.2.5, 5.3.10, 5.3.11, 5.3.16 (unverified NL516) MIL-HDBK-1763: para 4.1.4.2, 4.1.4.4; test 110, 120, 130, 140, 160, 200, 210, 250, 260, (unverified NL516), Test 131	*Def-Stan 00-970 Reference:*	00-970 P1 2.23 00-970 P13 3.1.5 00-970 P13 3.3.1* 00-970 P7 L710 3.1 *(unverified- NL516)
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

17.2.4 Electrical interfaces in the armament system shall not cause unsafe stores operation, including uncommanded jettison, or unsafe interactions with the air vehicle in all possible stores configurations.

Consideration should be given to:

a. It shall not be possible to make incorrect mechanical or electrical connections;

b. Incorrectly making a connection shall not lead to damage to the air vehicle, before during or after release;

c. Static lines, umbilical's, electrical fuse arming leads, fuse arming cable assemblies, shear wire assemblies and lanyards shall not become crossed or entangled with the lines of other stores;

d. The use of a Built-In-Test (BIT) facility.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 17.2.4 MIL-HDBK-244A para 5.1.3, 5.1.4, 5.2.2, 5.2.3, 5.2.4, 5.3.9, 5.4.2 (unverified NL516) MIL-HDBK-1760 MIL-HDBK-1763: para 4.1.4.6.2.g (unverified NL516)	*Def-Stan 00-970 Reference:*	00-970 P13 3.1.4* 00-970 P13 3.1.5* 00-970 P13 3.2.1, 00-970 P13 3.2.2* 00-970 P13 3.2.4, 00-970 P13 3.2.5* 00-970 P13 3.2.6* 00-970 P13 3.2.7* 00-970 P13 3.2.23 00-970 P13 3.2.24 00-970 P13 3.2.35* 00-970 P13 3.4.4* 00-970 P13 3.4.5* 00-970 P9 UK1351c *(unverified- NL516)
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

17.2.5 Merged with 17.2.1

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	Merged with 17.2.1
		STANAG Reference:	Merged with 17.2.1
FAA Doc:		*EASA CS Reference:*	Merged with 17.2.1

17.2.6 The combination of stores fitted to the air vehicle shall not reduce safety by adversely affecting flight control.

Consideration should be given to:

a. The most extreme asymmetric loading of stores (including symmetric thrust);

b. Store hang-up;

c. Sequencing of stores release and jettison;

d. Adverse affects on stability, handling and rolling characteristics.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-1763 para 4.1.4.3; test 140, 230, 250 (unverified NL516) MIL-HDBK-244A para 5.1.1.1.2, 5.1.7, 5.1.10.6.6, 5.1.10.6.7, 5.1.10.8, 5.3.7 (unverified NL516) MIL-STD-1289D JSSG-2001: 3.3, 10.1.1, 3.4.2.1.5, and 3.4.2.2 for the testing methodology. MIL-STD-464 MIL-HDBK-1760A MIL-STD-1760D MIL-STD-331	*Def-Stan 00-970 Reference:*	00-970 P1 2.6.7 00-970 P1 2.7.8 00-970 P1 2.9.7 00-970 P1 2.13.7 00-970 P1 2.14.9 00-970 P1 2.16.12 00-970 P1 2.20.11 00-970 P1 2.24.12* 00-970 P1 2.24.17* 00-970 P1 2.24.18* 00-970 P1 6.9.22* 00-970 P13 3.1.5* 00-970 P13 3.2.11* 00-970 P13 3.2.20* 00-970 P13 3.2.3* 00-970 P13 3.3.1* *(unverified- NL516)
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

17.2.7 All cleared stores configurations for the air vehicle shall be documented in the aircraft document set.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-1763 para 4.4.2.3; test 100, 240 9unverified NL516) MIL-HDBK-244A para 5.1.7.2.4 (unverified NL516) MIL-STD-1289D JSSG-2001: 3.3, 10.1.1, 3.4.2.1.5, and 3.4.2.2 for the testing methodology. MIL-STD-464 MIL-HDBK-1760A MIL-STD-1760D MIL-STD-331	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

17.2.8 Merged with 17.2.1

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Merged with 17.2.1	*Def-Stan 00-970 Reference:*	Merged with 17.2.1
		STANAG Reference:	Merged with 17.2.1
FAA Doc:		*EASA CS Reference:*	Merged with 17.2.1

17.3. LASER INTEGRATION AND INTERFACE.

17.3.1 Crew and maintenance personnel shall be protected from laser radiation (direct and reflected).

Consideration should be given to:
a. The level of laser protection ensuring the exposure is below the limits, which shall be defined and proved;
b. For UAVs, this includes ensuring approaching ground staff can be notified should the UAV be laser energised;
c. Adequate protection of aircrew from 3rd party (including friendly forces) lasers.

Information Sources			
Comm'l Doc:	ANSI Z 136.1, Safe Use of Lasers, for the safety design requirements of laser systems.		
DoD/MIL Doc:	MIL-STD-1425 for the safety design requirements of laser systems. AR-11-9, “The Army Radiation Safety Program” AFOSH STD 48-139, Laser Radiation Protection Program RCC 316-98, Laser Range Safety	*Def-Stan 00-970 Reference:*	00-970 P13 3.11.4 00-970 P13 3.11.5 00-970 P13 3.11.26 00-970 P13 3.11.27 00-970 P13 3.11.30 00-970 P7 L717 00-970 P9 UK601d
		STANAG Reference:	4671.1829
FAA Doc:	21CFR Part 1040, Performance Standards For Light-Emitting Products	*EASA CS Reference:*	

17.3.2 The installation, integration and operation of all lasers shall not adversely affect the safety of the air vehicle.

Consideration should be given to:
a. The environment induced by laser operations with respect to the air vehicle's limitations for vibroacoustics, thermal loads, and structural loads of the air vehicle;
b. The effects from both the laser chemical and any resultant exhaust gases.

Information Sources			
Comm'l Doc:	ANSI Z 136.1, Safe Use of		

Information Sources			
	Lasers, for the safety design requirements of laser systems		
DoD/MIL Doc:	MIL-STD-1425 for the safety design requirements of laser systems AFOSH STD 48-139, Laser Radiation Protection Program RCC 316-98, Laser Range Safety	*Def-Stan 00-970 Reference:*	00-970 P13 3.11.26 00-970 P13 3.11.27 00-970 P7 L717 00-970 P9 UK601d
		STANAG Reference:	
FAA Doc:	21CFR Part 1040, Performance Standards for Light-Emitting Products	*EASA CS Reference:*	

17.3.3 Merged with 17.3.2

Information Sources			
Comm'l Doc:	ANSI Z 136.1 - Safe Use of Lasers, for the safety design requirements of laser systems.		
DoD/MIL Doc:	Merged with 17.3.2	*Def-Stan 00-970 Reference:*	Merged with 17.3.2
		STANAG Reference:	Merged with 17.3.2
FAA Doc:	Merged with 17.3.2	*EASA CS Reference:*	Merged with 17.3.2

17.3.4 The installation of all lasers shall:

• Only allow operation and direction to be controlled by the crew;
• Not result in an unsafe (radiating) condition following failure or malfunction;
• Allow the crew to determine when the laser is operating and also to discern the direction of the beam.

For UAS, consideration should be given to:

a. Providing an indication in the UAS Control Station which shows the safety status of the UAS so approaching ground staff can be notified if the UAS is in an unsafe state (e.g. radiation hazard present, laser energised, etc.);

b. Providing means to ensure lasers do not adversely affect safety following the loss of a UAS control link.

Information Sources			
Comm'l Doc:	ANSI Z 136.1, Safe Use of Lasers, for the safety design requirements of laser systems		
DoD/MIL Doc:	Refer to MIL-STD-1425 for the safety design requirements of laser systems AFOSH STD 48-139, Laser Radiation Protection Program RCC 316-98, Laser Range Safety	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1829
FAA Doc:	21CFR Part 1040, Performance Standards for Light-Emitting Products	*EASA CS Reference:*	

17.3.5 Merged with 17.3.4

Information Sources			
Comm'l Doc:	ANSI Z 136.1, Safe Use of Lasers, for the safety design requirements of laser systems.		
DoD/MIL Doc:	MIL-STD-1425 for the safety design requirements of laser systems AFOSH STD 48-139, Laser Radiation Protection Program RCC 316-98, Laser Range Safety	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	21CFR Part 1040, Performance Standards for Light-Emitting Products	*EASA CS Reference:*	

17.3.6 The installation of the laser shall prevent the beam from contacting any part of the air vehicle.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

The installation of the laser shall prevent inadvertent lasing when the air vehicle is on the ground.

For UAS, consideration should be given to:
a. Providing an indication in the UAS Control Station which shows the safety status of the UAS so approaching ground staff can be notified if the UAS is in an unsafe state (e.g. radiation hazard present, laser energised, etc.).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1829
FAA Doc:		*EASA CS Reference:*	

17.4. SAFETY INTERLOCKS.

17.4.1 Appropriate design measures shall be in place to prevent the unsafe operation of stores.

Consideration should be given to the following:

a. Prevention of armament release whilst the aircraft is on the ground;
b. The use of switch guards and system interlocks;

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516 Section 15 MIL-HDBK-244A: 5.1.5.1, 5.1.5.1.2	*Def-Stan 00-970 Reference:*	00-970 P13 3.1.4* 00-970 P13 3.1.5* 00-970 P13 3.2.2* 00-970 P13 3.2.3 00-970 P13 3.2.12* 00-970 P13 3.2.22 00-970 P13 3.2.25 00-970 P13 3.2.26* 00-970 P13 3.2.27* 00-970 P13 3.2.38* 00-970 P13 3.2.39* 00-970 P13 3.3.5* 00-970 P13 3.3.6 00-970 P7 S1 L107 *(unverified- NL516)
		STANAG Reference:	3441 3558 3605
FAA Doc:		*EASA CS Reference:*	

SECTION 18 - PASSENGER SAFETY

This section covers the provision of safety features and design requirements in order to ensure the safety of passengers during flight and during emergency situations such as crash landing, ditching etc. Safety requirements for crew stations normally used for aircrew and mission essential personnel are located in section 9, Crew Systems.

Included within the scope of this section are:
• The provision of appropriate seat restraints;
• Provision and accessibility of emergency exits and descent assist devices;
• Adequacy of the emergency lighting system;
• Stowage provisions for and availability of safety equipment;
• Provision and accessibility of individual floatation devices;
• Fire resistance of the cargo compartments;
• Availability of supplementary oxygen.

TYPICAL CERTIFICATION SOURCE DATA

1. Federal Aviation Regulations
2. FAA Airworthiness Directives and Advisory Circulars
3. Joint Service Specification Guide
4. Cabin/crew station layout/geometry
5. Crash survivability requirements and validation
6. Escape system requirements and validation
7. Life support system requirements and validation
8. Tech data package

CERTIFICATION CRITERIA

18.1. SURVIVABILITY OF PASSENGERS.

18.1.1 Seats with restraints shall be provided for each passenger. Restraints shall be designed to apply body loads in a distributed fashion and location that do not cause serious injury in an emergency landing. Each seat/restraint system shall be designed to protect each occupant during an emergency landing provided the restraints are used properly.

Each passenger restraint system shall have a single point release to permit passenger evacuation.

Consideration should be given to:
a. Ensuring the harness applies restraint to strong parts of the body (e.g., pelvis and chest);
b. The problems of submarining and of dynamic overshoot (or whiplash effect);
c. Multi-directional forces acting singly or together up to the level of human tolerance;
d. Ensuring there are enough seat and restraint systems for all passengers;
e. The anthropometric range of passengers, and maximum weight;
f. Preventing major injuries, such as internal organ damage or skeletal fractures.
g. Providing means to secure each restraint system when not in use to prevent interference with rapid egress in an emergency.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-7: 3.7.3.2.2	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.11 00-970 P1 4.16.11 00-970 P1 4.21.2-4.21.6 00-970 P7 S1 L111
		STANAG Reference:	
FAA Doc:	14CFR references: 25.785, 23.2, 23.562, 23.785, 25.562	*EASA CS Reference:*	CS 23.562 CS 23.785 CS 25.562 CS 25.785 CS 27.562 CS 27.785 CS 29.562 CS 29.785

18.1.2 Merged with 18.1.1

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-7: 3.7.3.2.2	*Def-Stan 00-970 Reference:*	Merged with 18.1.1
		STANAG Reference:	
FAA Doc:	14CFR references: 25.785, 23.2, 23.562, 23.785	*EASA CS Reference:*	Merged with 18.1.1

18.1.3 Each stowage compartment shall be designed to contain the maximum weight of its contents; and shall have means to prevent its contents from becoming a hazard due to shifting, under the most critical load distributions and ultimate inertia forces (i.e. during an emergency landing).

Consideration should be given to:

a. Ultimate inertia forces acting separately relative to the surrounding structure, to be agreed and verified (typically Upward, 2.0 - 4·0g; Forward, 9·0 - 16g; Laterally, 1.5 - 8·0g; Downward, 4.5 - 20.0g; and Aft 1·5g);

b. The type and classification of the air vehicle;

c. The maximum allowed baggage or cargo weight for the compartment.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-A-8865B No information available in current JSSG. Information to be included in next revision of JSSG	*Def-Stan 00-970 Reference:*	00-970 P1 4.22.44 00-970 P1 4.22.46
		STANAG Reference:	
FAA Doc:	14CFR references: 25.561, 25.787, 25.789, 23.787	*EASA CS Reference:*	CS 23.561 CS 23.787 CS 25.561

Information Sources			
			CS 25.787 CS 25.789 CS 27.561 CS 27.787 CS 29.561 CS 29.787

18.1.4 Each passenger carrying area shall have at least one adequate and easily accessible external door that is operable from both the inside and outside. Each external door shall be located to avoid hazardous external areas when appropriate operating procedures are used. There shall be a means to safeguard each external door against inadvertent opening during flight by persons, by cargo, or as a result of mechanical or electrical failure.

If a crew member cannot see an entrance or check that it is correctly secured, a 'doors locked/unlocked' indicator shall be fitted in the cockpit. Means shall be provided to ensure that cabin pressurisation cannot be initiated unless the doors or hatches are properly closed, latched and locked.

Consideration should be given to:
a. Inspection procedures and/or detection systems to ensure doors are fully locked in flight;
b. Ensuring doors are not located in areas likely to be blocked after an emergency gear up landing;
c. Ensuring doors are reasonably free from jamming as a result of fuselage deformation in an emergency landing;
d. Prevent the entry of unauthorised persons;
e. Hazardous external areas such as proximity to rotors, propellers, engine intakes and exhausts.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-7: 3.7.5.3.1	*Def-Stan 00-970 Reference:*	00-970 P1 4.20.6 00-970 P1 4.20.7 00-970 P1 4.23.10 00-970 P7 L102 3
		STANAG Reference:	
FAA Doc:	14CFR references: 25.783	*EASA CS Reference:*	CS 23.783 CS 23.807 CS 25.783 CS 25.807 CS 27.783 CS 27.807 CS 29.783 CS 29.807

18.1.5 All exits in passenger areas shall be lockable by aircrew trained to do so, simple to open, and shall not open in flight unless mission requirements necessitate this function.

A positive means shall be provided to retain the doors, hoods or hatches in an open position.

Consideration should be given to;
a. Ensuring all exits are uncomplicated to open such that no training is required for operation;

b. Means to drain overboard any water which might run off doors, hoods or hatches secured in the open position;
c. Operation of exits in all expected environmental conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-7: 3.7.5.3.1	*Def-Stan 00-970 Reference:*	00-970 P1 4.20.3-4.20.6 00-970 P1 4.23.10 00-970 P7 3.7 00-970 P7 L102 3.8.2
		STANAG Reference:	
FAA Doc:	14CFR references: 25.813, 25.809, 23.807, 25.813	*EASA CS Reference:*	CS 23.807 CS 23.813 CS 25.807 CS 25.809 CS 25.813 CS 27.807 CS 29.807 CS 29.809 CS 29.813

18.1.6 Each non-over-wing emergency exit more than 1.8 m (6 feet) from the ground (with the air vehicle on the ground and the landing gear extended), shall have means to assist passengers to the ground quickly and safely. For exits opening to wing areas, provisions shall be incorporated to safely assist passengers from the wing surface to ground level. It shall be possible to use any decent device without passenger training but with the assistance of aircrew members.

Consideration should be given to:
a. Self-supporting slides or equivalent assisting means for each passenger emergency exit;
b. Rope or any other assisting means demonstrated to be suitable for the purpose for air crew emergency exits;
c. Provision of footholds, handholds and ladders to facilitate passage to the exits;
d. Conducting emergency egress demonstrations using non-trained personnel, representative of the expected passenger population to verify the ability to safely exit and descend to the ground.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-7: 3.7.5.3.2 JSSG-2010-13: 3.13.5 pg 67, 68	*Def-Stan 00-970 Reference:*	00-970 P1 4.23.3 00-970 P7 S1 L102 2.3
		STANAG Reference:	
FAA Doc:	14CFR references: 25.810, 121.31a	*EASA CS Reference:*	CS 25.810 CS 29.809

18.1.7 The weight of each removable passenger exit, and its means of opening shall be conspicuously marked.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	JSSG-2010-13: 3.13.5 pg 66	*Def-Stan 00-970 Reference:*	00-970 P1 4.23.5 00-970 P13 1.6.15.3
		STANAG Reference:	
FAA Doc:	14CFR references: 25.811	*EASA CS Reference:*	CS 23.811 CS 25.811 CS 27.807 CS 29.811

18.1.8 An emergency lighting system, independent of the main lighting system, shall provide sufficient illumination and guidance for passenger and crew emergency evacuation; and shall include illumination of each exit and its exterior surrounding. The energy required to supply emergency lighting shall be sufficient to allow complete egress of all passengers and crew before diminishing.

Consideration should be given to:

a. Ensuring no beam of light is directed into occupants' eyes in such a way as to compromise their ability to escape;

b. Emergency escape illumination is continually lighted or automatically energised when an emergency occurs;

c. Ensuring sufficient luminance is maintained at all exits and in the centre of aisle-ways leading to exits measured at seat arm rest height and in all aircrew stations and passenger compartments;

d. Ensuring all exit signs, arrows and placards are electrically lighted or self- luminous to the required levels;

e. Use of floor proximity emergency escape path marking;

f. Compatibility with low light enhancing systems (e.g. NVG).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-13: 3.13.5 pg 62, 65 MIL-PRF-85676	*Def-Stan 00-970 Reference:*	00-970 P7 L102 4.1 00-970 P7 L714 2.1.5 00-970 P13 1.6.11.5
		STANAG Reference:	3870
FAA Doc:	14CFR references: 25.812, 23.812, 25.1351, 25.1353, 25.1355, 25.1357, 25.1363	*EASA CS Reference:*	CS 23.812 CS 23.1351 CS 23.1353 CS 25.812 CS 25.1351 CS 25 1353 CS 25.1363 CS 27.807 CS 27.1351 CS 27.1353 CS 27.1355 CS 29.812 CS 29.1351 CS 29.1353

18.1.9 The location of each passenger emergency exit shall be indicated by a sign visible to occupants approaching along the main passenger aisle (or aisles). The quantity and location each emergency exit sign shall enable each seated passenger to recognise at least one during adverse conditions that may occur following a crash. Each emergency exit sign shall be self-illuminated or independently, internally electrically illuminated.

Consideration should be given to:

a. Ensuring exit location indications are also apparent when not lighted under normal flight conditions;

b. Means to assist the occupants in locating the exits in conditions of dense smoke and water;

c. The identity and location of each passenger emergency exit must be recognisable from a sufficient distance, typically the distance equal to the width of the cabin.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-13: 3.13.5 pg 68	*Def-Stan 00-970 Reference:*	00-970 P1 4.23.5 00-970 P7 L714 2.1.5 00-970 P13 1.6.15.3
		STANAG Reference:	
FAA Doc:	14CFR references: 25.812, 23.812, 25.811	*EASA CS Reference:*	CS 23.811 CS 23.812 CS 25.811 CS 25.812 CS 27.807 CS 29.811 CS 29.812

18.1.10 If required for the category of air vehicle, a public address system shall be installed that is powerable when the air vehicle is in flight or stopped on the ground, including after the shutdown or failure of all engines and auxiliary power units, or the disconnection or failure of all power sources dependent on their continued operation, for:

• A time duration of at least 10 minutes, including an aggregate time duration of at least 5 minutes of announcements made by flight and cabin crew members, considering all other loads which may remain powered by the same source when all other power sources are inoperative; and

• An additional time duration in its standby state appropriate or required for any other loads that are powered by the same source and that are essential to safety of flight or required during emergency conditions.

Consideration should be given to:

a. Ensuring the public address system works as required for all approved operating configurations and conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	No information available in current JSSG. Information to be included in next revision of JSSG.	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.6(e) 00-970 P1 S6 L1
		STANAG Reference:	
FAA Doc:	14CFR references: 25.1423	*EASA CS Reference:*	CS 25.1423

18.1.11 The public address system shall be accessible for immediate use by all aircrew, such that it is capable of operation within 3 seconds from the time a microphone is removed from its stowage. The system shall be intelligible at all passenger seats, lavatories, and flight attendant seats and work stations; and shall be designed so that no unused, unstowed microphone will render the system inoperative. The system shall be capable of functioning independently of any required crewmember interphone system and is readily accessible to the crewmember designated to make announcements.

Consideration should be given to:

a. Ensuring the public address system works as required for all approved operating configurations and conditions;

b. Ensuring the public address system has a microphone which is readily accessible to seated air crew, for each required floor-level passenger emergency exit which has an adjacent air crew member seat;

c. One microphone may serve more than one exit, provided the proximity of the exits allows unassisted verbal communications between seated cabin crew members.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-13: 3.13.5 pg 55	*Def-Stan 00-970 Reference:*	00-970 P1 S6 L1
		STANAG Reference:	
FAA Doc:	14CFR references: 25.1423	*EASA CS Reference:*	CS 25.1423

18.1.12 Each safety equipment control to be operated by the crew in emergency, such as controls for automatic liferaft releases, shall be plainly marked as to its method of operation. Each liferaft shall have obviously marked operating instructions. Approved survival equipment shall be marked for identification and method of operation.

Considerations should be given to:

a. Human factors analysis to verify the ability of control markings to be clearly discerned;

b. The use of illustrations, and pictorial representations to convey operation of critical safety controls where passenger language abilities vary or are unknown.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-11: 3.11.7.3	*Def-Stan 00-970 Reference:*	00-970 P1 7.4.13 00-970 P7 L103 5 00-970 P7 L721 4
		STANAG Reference:	
FAA Doc:	14CFR references: 25.1561, 23.1561, 23.1415	*EASA CS Reference:*	CS 23.1561 CS 25.1561 CS 27.1561 CS 29.1561

18.1.13 Each location, such as a locker or compartment, that carries any fire extinguishing, signalling, or other lifesaving equipment shall be marked accordingly. Stowage provisions for required emergency equipment shall be conspicuously marked to identify the contents and facilitate the easy removal of the equipment.

Considerations should be given to:

a. Human factors analysis to verify the ability of control markings to be clearly discerned;
b. Co-location of fire extinguishing, signalling, or other lifesaving equipment.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-11: 3.11.7.3	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.59
		STANAG Reference:	
FAA Doc:	14CFR references: 25.1561, 23.1561, 23.1415	*EASA CS Reference:*	CS 23.1561 CS 25.1561 CS 27.1561 CS 29.1561

18.1.14 At least one approved, individual floatation device / means (such as removable seat floatation cushions or under seat life preservers) shall be provided for each occupant, for air vehicles flying missions over water. Each individual floatation device shall be easily accessible by each seated passenger.

Consideration should be given to:
a. The functionality of floatation devices, and the ability to deploy, inflate or provide buoyancy;
b. The ability of each passenger to access a floatation device during emergency evacuation;
c. Whether or not the air vehicle is certified for ditching;
d. Provision of life lines if required.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.22.21 00-970 P7 L721
		STANAG Reference:	
FAA Doc:	14CFR references: 25.1411, 25.1415	*EASA CS Reference:*	CS 23.1411 CS 23.1415 CS 25.1411 CS 25.1415 CS 27.1411 CS 27.1415 CS 29.1411 CS 29.1415

18.1.15 The air vehicle shall be outfitted with equipment to deal with in-flight, ground, and ditching emergencies.

Consideration should be given to:
a. Ensuring the emergency equipment is tailored for the intended mission of the air vehicle;
b. Provision of emergency equipment such as: emergency and floatation equipment, hand-held fire extinguishers, crash axe, megaphones, medical kits and supplies, automatic external defibrillators, portable oxygen supply systems, means for emergency evacuation, specialised tools or fracturing equipment, survival aids and equipment, weapons, communication equipment, signalling and locator devices, and portable lights;

c. The adequacy of medical kits and supplies for treatment of injuries, medical events, or minor accidents;
d. Different emergency equipment configurations and specified content requirements for different mission needs;
e. The accessibility of emergency equipment.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-11	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.66 00-970 P1 4.23 00-970 P7 L105 17 00-970 P7 L105 20 00-970 P7 L105 21
		STANAG Reference:	
FAA Doc:	14CFR references: 121.309, 121.310	*EASA CS Reference:*	

18.1.6 Signs and placards shall be provided in the passenger compartment to meet the following requirements:

a. Where smoking is prohibited, signs shall be provided that are legible to each passenger.
b. If smoking is allowed, signs stating when it is prohibited shall be installed and operable from either pilot's seat and visible under all probable conditions of cabin lighting to each person seated in the cabin..
c. Signs stating when seat belts are to be fastened shall be installed and operable from either pilot's seat and visible under all probable conditions of cabin lighting to each person seated in the cabin.
d. Placards shall be placed on, or adjacent to, the door of each waste receptacle indicating that the disposal of cigarettes etc is prohibited.
e. Lavatories shall have 'No Smoking' placards adjacent to each ashtray.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 Pt 1 Sect 4 paras: 4.26.53, 4.26.54
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.791

18.2. FIRE RESISTANCE.

18.2.1 Sources of ignition within cargo compartments shall be located and/or designed to prevent contact with cargo.

Consideration should be given to:
a. Cargo clearances and preventive means of contacting ignition sources, i.e. shielding and insulation;
b. Ensuring all components within the cargo compartments are certified for operation in an explosive atmosphere;
c. Preventing cargo from breaking loose;

d. Means to prevent cargo or baggage from interfering with the functioning of the fire protective features of the compartment.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	No information available in current JSSG. Information to be included in next revision of JSSG. AFMAN 24-204(I) identifies flammability limits for transported cargo.	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.58 00-970 P7 L712
		STANAG Reference:	4671.787 4671.850
FAA Doc:	14CFR references: 25.787, 25.789, 23.787	*EASA CS Reference:*	CS 23.787 CS 23.855 CS 25.787 CS 25.855 CS 27.787 CS 27.855 CS 29.787 CS 29.855

18.2.2 Oxygen equipment and lines shall not be located in any designated fire zone; nor routed with electrical wiring. They shall be protected from heat that may be generated in, or escape from, any designated fire zone and be installed so that escaping oxygen cannot cause ignition of grease, fluid, or vapour accumulations present in normal operation or as a result of failure or malfunction of any system.

Oxygen pressure sources and lines between the sources and shut-off means shall be protected from unsafe temperatures. Lines carrying flammable liquids shall be positioned at as great a distance as practical from the oxygen installation. Precautions shall be taken to prevent fluid impinging on the oxygen or oxidant system.

Consideration should be given to:
a. Design precautions to minimise hazards due to damage.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-7: 3.7.3.4, 3.10, 4.10	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.14 00-970 P1 4.26.41-4.26.45 00-970 P1 6.13 00-970 P7 L712 00-970 P13 1.4
		STANAG Reference:	
FAA Doc:	14CFR references: 25.869	*EASA CS Reference:*	CS 23.1451 CS 25.869

18.3. PHYSIOLOGY REQUIREMENTS OF OCCUPANTS.

18.3.1 Air vehicles capable of flying above 10,000 feet mean sea level (MSL) shall have means to provide supplemental oxygen, and shall be capable of delivering it to each passenger. There shall be an individual dispensing unit for each passenger for whom supplemental oxygen is to be supplied.

For each passenger, the minimum mass flow of supplemental oxygen required at various cabin pressure altitudes shall not be less than the flow required to maintain, during inspiration and while using oxygen equipment (including masks) provided, the required mean tracheal oxygen partial pressures.

Oxygen quantities shall be sufficient for the duration of time that passengers may be exposed to the cabin altitudes indicated.

Consideration should be given to:
a. Supplementary oxygen provided from the air vehicle, or from a stand-alone system;
b. Minimum mass flow requirements for different cabin pressure altitudes, to be agreed and verified;
c. Ensuring dispensing units provide for effective utilisation of the oxygen being delivered to the unit, are capable of being readily placed into position on the face of the user (over nose and mouth if required) and are equipped with a suitable means to retain the unit in position on the face.
d. Requirements to satisfy Extended Range Twin Operations (ETOPS) where appropriate.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-10: 3.10.1, 4.10.1	*Def-Stan 00-970 Reference:*	00-970 P1 6.13
		STANAG Reference:	
FAA Doc:	14CFR references: 25.1439, 23.1441, 23.1443, 23.1445, 25.1447, 23.1449, 23.1450, 25.1441, 25.1443, 25.1445, 25.1449, 25.1450, 25.1453	*EASA CS Reference:*	CS 23.1441 CS 23.1443 CS 23.1445 CS 23.1447 CS 23.1449 CS 23.1450 CS 23.1453 CS 25.1441 CS 25.1443 CS 25.1445 CS 25.1447 CS 25.1449 CS 25.1450 CS 25.1453

18.3.2 Approved emergency medical kit(s) shall be installed in the air vehicle; and shall be capable of providing medical support for the designed mission.

Consideration should be given to:
a. The adequacy of medical kit contents for treatment of injuries, medical events, or minor accidents;
b. Different medical kit configurations and specified content requirements for different mission needs;
c. The accessibility of the medical kit(s).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	No information available in current JSSG. Information to be included in next revision of JSSG.	*Def-Stan 00-970 Reference:*	00-970 P1 4.15.66 00-970 P7 L105 17
		STANAG Reference:	
FAA Doc:	14CFR references: 121.309, 121.339, 121.310	*EASA CS Reference:*	

SECTION 19 - MATERIALS

This section covers material selection, application and specification for the entire flight vehicle including air vehicle structure, air vehicle subsystems, propulsion systems, electrical power systems, mission systems, crew systems, and armament/stores systems.

Included within the scope of this section are:
• Material properties and process;
• Corrosion prevention and control;
• NDI requirements;
• Wear and erosion prevention.

Some criteria in this chapter are supported in the text by examples of specific considerations. These examples are by no means to be considered as
exhaustive.

• Use of standard engineering methods and formulas, in conjunction with full scale tests, and experience of the product;
• Ensuring adequate accessibility to areas that may be subject to wear in order to conduct maintenance and inspection.

TYPICAL CERTIFICATION SOURCE DATA

1. Design criteria
2. Materials properties data and analysis
3. Environmental effects data and analysis
4. Galvanic compatibility data and analysis
5. Effects of defects data and analysis
6. Hazardous materials data
7. Material trade study results
8. Design of experiments results
9. Statistical process control data
10. Non-destructive inspection (NDI) criteria
11. NDI plan and records
12. NDI probability of detection data
13. Preproduction verification test data
14. First article destructive test data
15. Wear and erosion data
16. Material specifications
17. Process specifications
18. Finish specifications
19. Metallic materials properties development and Standardization (MMPDS)
20. MIL-HDBK-17, Polymer Matrix Composites
21. Material safety data sheets
22. Contractor policies and procedures
23. Quality records
24. Defect/failure data
25. Fracture control plan
26. Fracture critical parts list

CERTIFICATION CRITERIA

19.1. PROPERTIES AND PROCESSES.

19.1.1 Appropriate material selection shall be conducted in order to assure adequate structural properties. Material property evaluations shall be performed using a combination of recognized and standardized analyses, tests, inspections, and examinations.

Consideration should be given to:

a. Use of standard engineering methods and formulas which are known to produce acceptable results, in conjunction with full scale tests (ground and/or flight tests) and experience of the product;

b. Ensuring that material properties are adequate and sufficient for all required missions and service usage;

c. The classification of the structure;

d. The consequence of failure of the structure in terms of the overall integrity of the air vehicle;

e. The consequence of the failure of interior items of mass and the supporting structure to the safety of the occupants;

f. Structural properties such as strength, stiffness, fatigue, crack growth rates, fracture toughness, corrosion susceptibility.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006, Appendix A.3.2.19, A.4.2.19 MIL-HDBK-1587	*Def-Stan 00-970 Reference:*	00-970 P1 3.1.10 00-970 P7 L200/1 00-970 P9 USAR 613
		STANAG Reference:	4671.307 4671.603
FAA Doc:		*EASA CS Reference:*	CS 23.307 CS 23.603 CS 25.307 CS 25.603 CS 27.307 CS 27.603 CS 29.307 CS 29.603

19.1.2 Material properties shall be certified as specification compliant and specification properties shall be represented as minimum values achievable using standardized processes.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.5.6 00-970 P7 L200/1 2.2.1 00-970 P9 USAR 613
		STANAG Reference:	4671.603 4671.613
FAA Doc:	MMPDS 14CFR reference: 23.603,	*EASA CS Reference:*	CS 23.603 CS 23.613

Information Sources			
	23.613, 25.603, 25.613		CS 25.603 CS 25.613 CS 27.603 CS 27.613 CS 27.613 ESDU 00932

19.1.3 Robust & recognised design & manufacturing techniques shall be established and applied to characterise the properties of Material that are suitable for purpose, and shall make adequate allowance, where applicable, for the effects of:

a. Product shape and form;

b. Production representative processing and manufacturing variability;

c. Effects of defects;

d. Final assembly interfaces;

e. Environmental conditions, such as temperature, humidity, UV, chemical, solvent, fuel, electromagnetic radiation, and airborne particulates expected in service;

f. Repair.

Consideration should be given to:

a. Statistical analysis

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: Appendix A.3.2.19.1, A.4.2.19.1	*Def-Stan 00-970 Reference:*	00-970 P1 4.5.2 - 4.5.4 00-970 P9 USAR 613
		STANAG Reference:	4671.603 4671.613
FAA Doc:	MMPDS 14CFR reference: 23.603, 23.613, 25.603, 25.613	*EASA CS Reference:*	CS 23.603 CS 23.613 CS 25.603 CS 25.613 CS 27.603 CS 27.613 CS 29.603 CS 29.613 ESDU 00932

19.1.4 Material design values shall be based upon acceptable design allowables to prevent structural failure due to material variability.

Consideration should be given to:

a. Factors, such as material shape and form, anisotropy, heat treatment, affecting design allowables from recognised data sources.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 3.1.8 00-970 P1 4.1.4

Information Sources			
		STANAG Reference:	4671.613
FAA Doc:	14CFR reference: 23.613, 25.613	*EASA CS Reference:*	CS 23.613 CS 25.613 CS 27.613 CS 29.613

19.1.5 The durability of the air vehicle structure and components shall support operation in all environmental conditions expected in service and shall take into account any potential material property degradation as a result.

Consideration should be given to:

a. All phases of the life cycle, to include manufacture, In service operation and associated maintenance;

b. Moisture absorption; chemical, solvent, fuel, and lubricant exposure; hydrolytic instability; thermal exposure; electromagnetic and UV radiation;

c. Processes and joining methods applied to the materials used in the airframe;

d. Provision of slip resistant surface on floors likely to be come wet during service.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.2.2, 4.2.2, 3.2.3, 4.2.3 JSSG-2006: Appendix A.3.2.16, A.4.2.16, A.3.11.1, A.4.11.1.2.1, A.3.11.2, A.4.11.2, A.3.11.3, A.4.11.3, A.3.11.4, A.4.11.4 MIL-HDBK-1568 MIL-HDBK-1587 MIL-STD-889	*Def-Stan 00-970 Reference:*	00-970 P1 4.3.2 00-970 P1 4.3.4 00-970 P1 4.3.5 00-970 P1 4.3.8 00-970 P1 4.3.11 00-970 P1 4.3.17 00-970 P1 4.3.33 00-970 P1 4.3.34 00-970 P1 4.3.84 00-970 P1 4.5.6 00-970 P1 4.5.9 00-970 P1 4.6 00-970 P1 4.6.2 00-970 P7 L200 1.8 00-970 P7 L200 4.4 00-970 P7 L403 3.2.5 00-970 P9 USAR 605
		STANAG Reference:	4671.603 4671.605 4671.609 4671.613
FAA Doc:	14CFR reference: 23.609, 23.613, 25.609, 25.613	*EASA CS Reference:*	CS 23.603 CS 23.605 CS 23.609 CS 23.613 CS 25.603 CS 25.605 CS 25.609

Information Sources			
			CS 25.613 CS 25.793 CS 27.603 CS 27.605 CS 27.609 CS 27.613 CS 29.603 CS 29.605 CS 29.609 CS 29.613

19.1.6 Critical fabrication process which require close control shall be performed under an approved process specification, which allows identification, monitoring, and control of any undesirable variation.

Consideration should be given to:

a. Fabrication processes such as heat-treating, quenching, welding, brazing, soldering, forging, gluing.

b. Substantiation of fabrication methods by a test programme.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: Appendix A.3.2.19.2, A.4.2.19.2, A.3.11.1, A.4.11.1.2.1	*Def-Stan 00-970 Reference:*	00-970 P1 4.6 00-970 P9 USAR 605
		STANAG Reference:	4671.605
FAA Doc:	14CFR reference: 23.605, 25.605	*EASA CS Reference:*	CS 23.605 CS 25.605 CS 27.605 CS 29.605

19.1.7 Merged with 19.1.5

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Jssg-2006: Appendix A.3.2.19.2, A.4.2.19.2	*Def-Stan 00-970 Reference:*	Merged with 19.1.5
		STANAG Reference:	Merged with 19.1.5
FAA Doc:	14CFR reference: 23.605, 25.605	*EASA CS Reference:*	Merged with 19.1.5

19.1.8 The air vehicle design shall consider and permit repair of structure and of flight and mission critical systems, following damage.

Consideration should be given to:

a. Giving preference to structural materials which are easily repairable;

b. Ensuring all repairs comply with the relevant design requirements for the whole air vehicle;

c. Ensuring high or moderate maintenance items and items subject to wear must be repairable;

d. Battle damage.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: Appendix A.3.2.28, A.4.2.28	*Def-Stan 00-970 Reference:*	00-970 P1 4.1.41 00-970 P1 4.4.3 00-970 P1 4.4.34 - 4.4.37 00-970 P13 3.9.7 00-970 P7 L200 8.1
		STANAG Reference:	
FAA Doc:	14CFR reference 23.611	*EASA CS Reference:*	

19.1.9 Insidious failure modes (e.g. hydrogen embrittlement, crack bifurcation) shall be understood and accounted for, such that all parts of the air vehicle are so designed, protected, assembled, drained and vented that when it is maintained in accordance with the servicing schedule there will be no unacceptable loss of airworthiness as a result of induced spontaneous, progressive or delayed cracking.

Consideration should be given to:

a. Where possible, selecting materials with lower susceptibilities to corrosion, corrosion fatigue, stress corrosion or hydrogen embrittlement; and

b. Avoiding unnecessarily strong but susceptible materials.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.3.11 00-970 P1 4.3.85 00-970 P7 L200/1 5 00-970 P7 L203/5 2.4 00-970 P7 L406 1.1 00-970 P7 L406/1 4.4.1
		STANAG Reference:	4671.609 4671.613
FAA Doc:	14CFR reference: 23.609	*EASA CS Reference:*	CS 23.609 CS 25.609 CS 27.609 CS 29.609

19.2. CORROSION

19.2.1 Adequate corrosion prevention and control practices shall be in place.

Consideration should be given to:

a. Uniform surface corrosion, pitting, galvanic, crevice, filiform, exfoliation, inter-granular, fretting, high temperature oxidation (hot corrosion), corrosion fatigue, and stress corrosion cracking;

b. Preventing water leaking into, or being driven into, any part of the air vehicle;

c. The use of various design alternatives which preclude the traditional galvanic corrosion problems created by dissimilar metal bushings (e.g., beryllium copper, aluminium bronze) installed in aluminium structure;

d. The avoidance of using removable graphite composite doors/panels fastened to aluminium alloy substructure, particularly on upper surfaces where moisture/salt spray can potentially migrate through the fastener holes and cause corrosion of the aluminium substructure.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.2.17 00-970 P1 4.3.2 00-970 P1 4.3.4 00-970 P1 4.3.5 00-970 P1 4.3.8 00-970 P1 4.3.11 00-970 P1 4.3.17 00-970 P1 4.3.33 00-970 P1 4.3.34 00-970 P1 4.3.84 00-970 P1 4.6.2 00-970 P7 L402 7.6 00-970 P7 L405/1 00-970 P7 407
		STANAG Reference:	4671.571 4671.609
FAA Doc:		*EASA CS Reference:*	CS 23.573 CS 23.609 CS 25.571 CS 25.609 CS 27.571 CS 27.573 CS 27.609 CS 29.571 CS 29.573 CS 29.609

19.2.2 Corrosion prevention systems shall remain effective during the service life, including the mitigation of environmentally assisted cracking. Specific corrosion prevention and control measures, procedures, and processes shall be identified and established commensurate with the operational and maintenance capability.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.4.3 00-970 P7 L405/1 00-970 P7 L406/1 00-970 P7 L407
		STANAG Reference:	4671.571 4671.609
FAA Doc:		*EASA CS Reference:*	CS 23.609 CS 25.571 CS 25.609 CS 27.571

Information Sources			
			CS 27.573 CS 27.609 CS 29.571 CS 29.573 CS 29.609

19.2.3 Adequate prevention and control practices shall be in place for non-metallic materials degradation.

Consideration should be given to:

a. Preventing galvanic corrosion which occurs where surfaces of composites containing carbon fibres are in contact with metals.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.3.87 - 4.3.101 00-970 P7 L408
		STANAG Reference:	4671.609
FAA Doc:		*EASA CS Reference:*	CS 23.609 CS 25.609 CS 27.609 CS 27.573 CS 29.609 CS 29.573

19.2.4 Finish systems shall provide adequate corrosion protection for the airframe and its components, in order to maintain the specified operational capability of the air vehicle, and ensure it is not degraded due to finish breakdowns / failures.

Each specific surface treatment, inorganic and organic coating, and other protective finish used for corrosion prevention and control shall be identified and established.

Consideration should be given to:

a. Finishes for all specific parts, surfaces of similar and dissimilar materials, and attaching parts and fasteners etc.;

b. Treatment / finishing of non-corrosion resisting steels and other metals, e.g. cleaning, painting etc;

c. Ensuring the selection and application of all organic and inorganic surface treatments and coatings complies with air quality requirements;

d. Ensuring exterior surfaces remain aerodynamically smooth;

e. Preventing the use of organic coatings (other than fire insulating paints) for temperature control in inaccessible areas.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.2.3, 4.2.3 JSSG-2006: Appendix A.3.2.20, A.4.2.20, A.3.11.2, A.4.11.2	*Def-Stan 00-970 Reference:*	00-970 P1 4.3.77 00-970 P7 407
		STANAG	4671.609

Information Sources			
	MIL-HDBK-1568 MIL-STD-7179 MIL-STD-889	*Reference:*	
FAA Doc:	14CFR references: 23.603, 23.609, 25.603, 25.609	*EASA CS Reference:*	CS 23.609 CS 25.609 CS 27.609 CS 29.609

19.3. NON-DESTRUCTIVE INSPECTION.

19.3.1 Prior to conducting non-destructive testing and inspection (NDI), the nature of those defects which are critical to material integrity shall be characterised, and any affects on the probability of detection shall be assessed.

Consideration should be given to:

a. Nature of defects such as: size, shape, location, orientation, and any other properties which will affect detectability with the methods to be used;

b. Detailed structural analysis to identify structurally critical locations, load paths, and quality criteria necessary for meeting performance and life requirements.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 4.4.4
		STANAG Reference:	4671.575 4671.611
FAA Doc:		*EASA CS Reference:*	CS 23.611 CS 25.611

19.3.2 Non-destructive inspection (NDI) accept/reject criteria shall be validated and correlated with 'effects of defects' testing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.575 4671.613
FAA Doc:		*EASA CS Reference:*	CS 23.611 CS 25.611

19.3.3 Non-destructive inspection (NDI) manuals shall be developed to accompany the air vehicle, in order to provide an audit trail of the adequacy, thoroughness, and completeness of NDI engineering and application efforts.

NDI manuals shall include:

a. When, how often, and how the system is to be inspected for service induced damage;

b. Valid NDI methods and their application.

Consideration should be given to:
a. NDT manuals may not be type specific.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 S4 L16
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

19.3.4 Initial and recurring non destructive inspection (NDI) intervals shall be established, in order to identify and characterize specific defect types, sizes, and locations critical to material integrity.

Consideration should be given to:
a. Ensuring inspection means for each item are practicable for the inspection interval for the item, such that:
i. For inspections repeated at short intervals (such as pre-flight or daily inspections) the means of inspection should be simple, e.g. visual with the aid of easily removable or hinged access panels;
ii. For inspections required only a few times, for example once or twice in the lifetime of the air vehicle some disassembly of structure, e.g. deriveting a small skin panel is acceptable.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: Appendix A.3.11.6, A.4.11.6 MIL-HDBK-6870	*Def-Stan 00-970 Reference:*	00-970 4.7.2
		STANAG Reference:	4671.573 4671.575 4671.611 4671.613
FAA Doc:	14CFR reference: 23.611	*EASA CS Reference:*	CS 23.573 CS 23.611 CS 25.571 CS 25.611 CS 27.571 CS 27.573 CS 29.571 CS 29.573

19.4. WEAR AND EROSION.

19.4.1 Specific wear and erosion prevention practices, measures, procedures, and processes shall be identified and established, commensurate with the operational and maintenance capability, on applicable surfaces of metals, polymers, elastomers, ceramics, glasses, carbon fabrics, fibers, and combinations or composites of these materials.

Consideration should be given to:
a. Wear mechanisms such as abrasion, fretting, corrosion, and thermal wear, and combinations thereof;

b. Erosion mechanisms such as impinging fluid, solid particles (e.g. sand, dust etc.) and other environmental conditions (e.g. high sunlight/heat).
c. Eliminating / minimizing combinations of erosive, corrosive, and thermal effects on structures near heater and engine bleed air, engine exhaust, rocket and missile exhaust, and in the wake of such exhaust gases;
d. Preventing direct flame impingement from missiles and rockets on aircraft surfaces unless such surfaces are suitably protected by a coating or device;
e. Applying erosion prevention practices to all surface areas including leading edges, radomes, housings, and other protrusions as well as to surfaces exposed to particle impingement during take-offs and landings;
f. The adequacy of practices in protecting against corrosion in the environment in which the parts will operate, and their effects upon fatigue life;
g. Ensuring adequate accessibility to areas that may be subject to wear in order to conduct maintenance and inspection;
h. Applying wear prevention practices to all load bearing and load transfer interfaces;
i. Provisions for lubricating of all parts subject to wear;
j. Ensuring items subject to wear are repairable;
k. Limiting the use of dissimilar metals in contact to applications where similar metals cannot be used due to peculiar design requirements.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: Appendix A.3.2.28, A.4.2.28, A.3.11.4, A.4.11.4	*Def-Stan 00-970 Reference:*	00-970 P1 4.3.30 00-970 P1 4.3.40 00-970 P1 4.3.57 00-970 P7 407 8.5.7 00-970 P9 UK609d
		STANAG Reference:	4671.609 4671.611
FAA Doc:	14CFR reference: 23.609	*EASA CS Reference:*	CS 23.609 CS 23.611 CS 25.609 CS 25.611 CS 27.573 CS 27.609 CS 29.573 CS 29.609

SECTION 20 - OTHER CRITERIA

This section covers those equipments which may be used on or with an aircraft but which are not necessarily part of it, such as mission or role
equipment, or carry-on equipment. These equipments should be assessed and authorised for use on each aircraft that they are required for and
any limitations associated with that use clearly recorded. It also covers those pan-platform criteria that potentially affect multiple systems and consequently need greater visibility to ensure they are given adequate consideration. These include ETOPS and flight in, or near, volcanic ash clouds.

TYPICAL CERTIFICATION SOURCE DATA

1. Design criteria
2. Design studies and analyses
3. Design, installation, and operational characteristics
4. Design approval and system compatibility tests
5. Component and system level qualification and certification tests
6. Electromagnetic environmental effects
7. Hazard analysis and certification
8. Failure modes and effects analysis
9. Avionics integration tests and results
10. System/subsystem self-test design and capabilities
11. Qualification test plans, procedures, and results
12. Ground test results
13. FCA and PCA data
14. Flight manual
15. Software development plan
16. Software development and product specifications
17. Software test plans, test procedures, and test reports
18. Software configuration control/management plan and procedure
19. Flight test reports 20. Environmental analysis and test results

CERTIFICATION CRITERIA

20.1. OTHER CRITERIA: MISSION/TEST EQUIPMENT, CARGO/PAYLOAD SAFETY AND PAN-PLATFORM CRITERIA.

20.1.1 The following items shall not adversely affect the primary SOF functionality of the air vehicle:
a. Special non-SOF mission or test equipment and software including instrumentation and wiring.
b. Non-SOF mission-specific equipment and software.
c. Non-essential mission equipment (hardware and software).
d. Carry-on/carry-off equipment that will be operated in flight.

Consideration should be given to:

a. Structural capability, flying and handling qualities, electronic compatibility;
b. Ensuring that all items of equipment intended for use on the aircraft, but not part of the aircraft, are authorised for use in their intended role.

c. Ensuring that all items of equipment authorised for use on the aircraft, but not part of the aircraft, are clearly documented, along with any limitations to that use such as during particular phases of flight.
d. The impact that any special, essential, or non-essential mission or test equipment might have on the air vehicle or its systems. Particular, but not exclusive, attention should be given to equipment:
i. Floor or rack loading limits.
ii. Power requirements, and any effect that may be reflected back into the air vehicle power supply (i.e. spikes etc)
iii. EMC and EMI effects.
iv. Impact or changes to air vehicle overall weight or centre of gravity.
v. Potential fire or explosion risks.
e. Ensuring that carry-on/carry-off equipment intended for use or operation in flight is appropriately authorised and any necessary limitations to that use highlighted and recorded. Particular attention should be paid to transmitting equipment including Portable Electrical Devices (PEDs) such as laptops, ipads, mobile phones and other personal electronic devices.
f. Reviewing Section 9.8 ' Air Transportability and Airdrop'.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1481
FAA Doc:		*EASA CS Reference:*	

20.1.2 Carriage of cargo or payload shall not adversely affect safety of the air vehicle system.

Consideration should be given to:
a. Provision of suitable cargo or payload restraint mechanisms;
b. Physical size and weight of cargo or payload, and its floor loading, in comparison to vehicle hold or compartment;
c. Potential impact on the air vehicle overall weight and centre of gravity;
d. Interference with vehicle control systems;
e. Obstruction of crew or passenger exits;
f. Potential fire or explosion risks;
g. Reviewing Section 9.8; ' Air Transportability and Airdrop'.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Refer to technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P1 3.9.20 00-970 P1 4.26.56 00-970 P1 4.26.57 00-970 P7 L203 3.3
		STANAG Reference:	4671.685 4671.787 4671.1481
FAA Doc:	14CFR reference sections corresponding to Structural	*EASA CS Reference:*	CS 23.685 CS 23.787

Information Sources			
	and Installation requirements; and systems as applicable, i.e., Electrical. 20.1.3 Verify that in-flight operation of mission-specific personnel and cargo equipment (e.g., cargo hooks, rescue slings and hoists, H-bar and FRIES bar) does not adversely affect safety of the air vehicle system.		CS 25.685 CS 25.787 CS 27.685 CS 27.787 CS 29.685 CS 29.787

20.1.3 In-flight operation of mission-specific equipment shall not adversely affect the safety of the air vehicle system.

Consideration should be given to:

a. Ensuring that all other equipment used in association with mission equipment that is not part of the aircraft installation, such as lifting strops and spreader bars, is:
i. Tested and trialled appropriately and authorised for use on that aircraft.
ii. The aircraft documentation explicitly records which mission-specific equipment is authorised for use on that aircraft and any operational limitations associated with its use (i.e. operational restrictions such as speed, height, or weather).
b. Ensuring that any other limitations associated with this equipment, such as allowable weights, strop angles, use with other equipment, or lifting requirements including re-test should be clearly recorded;
c. Mission specific (cargo and personnel) equipment such as cargo hooks, rescue slings and hoist, H-Bar and FRIES bar.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Refer to technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P7 L205/1
		STANAG Reference:	4671.1481
FAA Doc:		*EASA CS Reference:*	CS 27.865 CS 29.865

20.1.4 The ability of any aircraft to operate in, or in the vicinity of, a volcanic ash cloud shall be clearly understood and detailed in the aircraft operating manuals. It is understood that military operational imperatives may override this regulatory criteria as necessary.

Consideration should be given to:

Engine abrasion corrosion;
Blockage of engine cooling ducts/vents or paths;
Aircraft skin and transparency abrasion;
Damage to systems from ingestion of particles (air conditioning, electronic cooling, contamination of surfaces or fluids)
Blockage of air data system (pitot or static systems);

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.1593

20.1.5 Where twin-engined civil derived military aircraft, or civil aircraft operated on the military register, are required to carry out extended range operations they should be suitable certified for ETOPS. However, it is recognised that military operational requirements may override this regulatory requirement as necessary. Moreover, it is also recognised that national military airworthiness/aviation authorities may determine that specific regulatory requirements may not need to be applied to a specific platform.

Consideration should be given to:

a. Aircraft configuration;
b. Aircraft duration;
c. Air to air refuelling capabilities;
d. Crew workload and operational implications;
e. Crew and passenger physiological needs including provision of: fluids, food, and suitable toilet facilities

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 Pt 11 3.E.1040
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.1535 CS-E 1040

20.1.6 There must be means for determining when the aeroplane is in a level position on the ground.

Consideration should be given to:
a. Embarked Operations on Ships Vessels etc.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.871

SECTION 21 - TRACIBILITY MATRIX TO US MIL-HDBK-516B

The EMACC Handbook has been produced based on the MIL-HDBK-516B structure as defined at Change 1 dated February 2008.

MIL-HDBK-516B was developed based on U.S experience of incidents / failures over time and there is significant overlap between individual sections of MIL-HDBK-516B.

The structure of the EMACC handbook has been rationalised, for example: through merger of existing MIL-HDBK-516B criteria; addition of new criteria; or through removal of existing MIL-HDBK-516B criteria.

In rationalising, every effort has been made to ensure the EMACC Handbook is as concise as possible without losing any of the original intent of the US/European information sources. In order to guide this process, a traceability matrix that links the EMACC Handbook structure to the original MIL-HDBK-516B Change 1 structure is provided below.

Original US MIL-HDBK-516B Structure	**Rationalised EMACC Structure**
4	
4.1	
4.1.1	4.1.1
4.1.2	4.1.2
4.1.3	4.1.3
4.1.4	4.1.4
4.2	
4.2.1	4.2.1
4.3	
4.3.1	4.3.1
4.4	
4.4.1	4.4.1
4.4.2	4.4.2
4.4.3	4.4.3
4.4.4	4.4.4
4.4.5	Criteria Removed
4.5	
4.5.1	4.5.1
4.5.2	Criteria Removed
4.5.3	Criteria Removed
4.6	
4.6.1	4.6.1
4.6.2	4.6.2
4.7	
4.7.1	4.7.1
5	
5.1.1	5.1.1
5.1.2	5.1.2
5.1.3	5.1.3
5.1.4	5.1.4
5.1.5	Criteria merged with 5.1.2
5.1.6	5.1.6
5.1.7	5.1.7
5.1.8	5.1.8
5.1.9	5.1.9
5.1.10	5.1.10

Original US MIL-HDBK-516B Structure	Rationalised EMACC Structure
5.1.11	5.1.11
5.2.1	5.2.1
5.2.2	5.2.2
5.2.3	5.2.3
5.2.4	Criteria moved to section 9.4.6
5.2.5	5.2.5
5.2.6	5.2.6
5.3.1	5.3.1
5.3.2	5.3.2
5.3.3	5.3.3
5.4.1	5.4.1
5.4.2	5.4.2
5.4.3	5.4.3
5.4.4	5.4.4
5.5.1	5.5.1
5.5.2	5.5.2
5.5.3	5.5.3
5.6.1	5.6.1
6	
6.1	
6.1.1	
6.1.1.1	6.1.1.1
6.1.2	
6.1.2.1	6.1.2.1
6.1.2.2	6.1.2.2
6.1.2.3	6.1.2.3
6.1.3	
6.1.3.1	6.1.3.1
6.1.3.2	6.1.3.2
6.1.3.3	6.1.3.3
6.1.3.4	6.1.3.4
6.1.3.5	6.1.3.5
6.1.3.5.1	6.1.3.5.1
6.1.3.5.2	6.1.3.5.2
6.1.3.6	6.1.3.6
6.1.3.7	6.1.3.7
6.1.3.8	6.1.3.8
6.1.3.9	6.1.3.9
6.1.3.10	6.1.3.10
6.1.3.11	6.1.3.11
6.1.4	
6.1.4.1	6.1.4.1
6.1.4.2	6.1.4.2
6.1.4.3	6.1.4.3
6.1.5	
6.1.5.1	6.1.5.1
6.1.5.2	6.1.5.2
6.1.5.3	6.1.5.3
6.1.5.4	6.1.5.4
6.1.5.5	6.1.5.5
6.1.5.6	6.1.5.6
6.1.5.7	6.1.5.7
6.1.5.8	6.1.5.8

Original US MIL-HDBK-516B Structure	Rationalised EMACC Structure
6.1.5.9	6.1.5.9
6.1.5.10	6.1.5.10
6.1.5.11	6.1.5.11
6.1.5.12	6.1.5.12
6.1.5.13	6.1.5.13
6.1.5.14	6.1.5.14
6.1.6	
6.1.6.1	Criteria merged with 6.1.2.1
6.1.6.2	6.1.6.2
6.1.6.3	6.1.6.3
6.1.6.4	6.1.6.4
6.1.7	
6.1.7.1	6.1.7.1
6.1.7.2	Criteria merged with 6.1.7.1
6.1.7.3	Criteria merged with 6.1.7.1
6.1.8	6.1.8
6.2	
6.2.1	
6.2.1.1	6.2.1.1
6.2.1.2	6.2.1.2
6.2.1.3	6.2.1.3
6.2.1.4	6.2.1.4
6.2.1.5	6.2.1.5
6.2.1.6	6.2.1.6
6.2.2	
6.2.2.1	6.2.2.1
6.2.2.2	6.2.2.2
6.2.2.3	6.2.2.3
6.2.2.4	6.2.2.4
6.2.2.5	6.2.2.5
6.2.2.6	6.2.2.6
6.2.2.7	6.2.2.7
6.2.2.8	6.2.2.8
6.2.2.9	6.2.2.9
6.2.2.10	6.2.2.10
6.2.2.11	6.2.2.11
6.2.2.12	6.2.2.12
6.2.2.13	6.2.2.13
6.2.2.14	Criteria merged with 6.2.1.5
6.2.2.15	6.2.2.15
6.2.2.16	Criteria merged with 6.2.2.17
6.2.2.17	6.2.2.17
6.2.2.18	6.2.2.18
6.2.2.19	6.2.2.19
6.2.2.20	6.2.2.20
6.2.2.21	Criteria merged with 6.2.2.20
6.2.2.22	6.2.2.22
6.2.2.23	6.2.2.23
6.2.2.24	6.2.2.24
6.2.2.25	6.2.2.25
6.2.2.26	6.2.2.26
6.2.2.27	6.2.2.27
6.2.2.28	Criteria merged with 6.2.2.29

Original US MIL-HDBK-516B Structure	**Rationalised EMACC Structure**
6.2.2.29	6.2.2.29
6.2.2.30	Criteria merged with 6.2.2.31
6.2.2.31	6.2.2.31
6.2.2.32	6.2.2.32
6.2.2.33	6.2.2.33
6.2.2.34	6.2.2.34
6.2.2.35	6.2.2.35
6.2.2.36	6.2.2.36
6.2.2.37	6.2.2.37
6.2.2.38	6.2.2.38
6.2.2.39	6.2.2.39
6.2.2.40	6.2.2.40
6.2.2.41	6.2.2.41
6.2.2.42	6.2.2.42
6.2.2.43	6.2.2.43
6.2.2.44	6.2.2.44
6.2.2.45	6.2.2.45
6.2.2.46	Criteria merged with 6.2.2.44 & 6.2.2.45
6.2.2.47	6.2.2.47
6.2.2.48	6.2.2.48
6.2.2.49	6.2.2.49
6.2.2.50	6.2.2.50
6.2.2.51	6.2.2.51
6.2.2.52	6.2.2.52
6.2.2.53	6.2.2.53
6.2.2.54	6.2.2.54
6.2.2.55	6.2.2.55
6.2.2.56	6.2.2.56
6.2.2.57	6.2.2.57
6.2.3	
6.2.3.1	6.2.3.1
6.2.3.2	6.2.3.2
6.2.3.3	6.2.3.3
6.2.3.4	6.2.3.4
6.2.3.5	Criteria merged with 6.2.3.1
6.2.3.6	6.2.3.6
6.2.3.7	6.2.3.7
6.2.3.8	6.2.3.8
6.2.3.9	Criteria merged with 12.1.6
6.2.3.10	6.2.3.10
6.2.3.11	6.2.3.11
6.2.3.12	6.2.3.12
6.2.4	
6.2.4.1	6.2.4.1
6.2.4.2	6.2.4.2
6.2.4.3	6.2.4.3
6.2.4.4	6.2.4.4
6.2.4.5	6.2.4.5
6.2.4.6	6.2.4.6
6.2.4.7	6.2.4.7
6.2.5	
6.2.5.1	6.2.5.1

Original US MIL-HDBK-516B Structure	Rationalised EMACC Structure
6.2.5.2	6.2.5.2
6.2.5.3	6.2.5.3
6.2.5.4	6.2.5.4
6.2.5.5	6.2.5.5
6.2.5.6	6.2.5.6
6.2.5.7	6.2.5.7
6.2.5.8	6.2.5.8
6.2.5.9	6.2.5.9
6.3	
6.3.1	
6.3.1.1	6.3.1.1
6.3.1.2	6.3.1.2
6.3.1.3	6.3.1.3
6.3.1.4	6.3.1.4
6.3.1.5	Criteria merged with Section 17 (17.2.1 + 17.2.5)
6.3.1.6	6.3.1.6
6.3.2	
6.3.2.1	6.3.2.1
6.3.2.2	6.3.2.2
6.3.2.3	6.3.2.3
6.3.2.4	6.2.3.4
6.3.2.5	6.3.2.5
6.3.2.6	6.2.3.6
6.3.2.7	6.3.2.7
6.3.2.8	Criteria merged with 17.1.2
6.3.3	
6.3.3.1	6.3.3.1
6.3.3.2	6.3.3.2
6.3.3.3	6.3.3.3
6.3.3.4	6.3.3.4
6.3.3.5	6.3.3.5
7.1	
7.1.1	7.1.1
7.1.2	7.1.2
7.1.3	Criteria merged with 7.1.1
7.1.4	7.1.4
7.1.5	Criteria merged with Section 4.6/4.7
7.1.6	7.1.6
7.2	
7.2.1	
7.2.1.1	7.2.1.1
7.2.1.2	7.2.1.2
7.2.2	
7.2.2.1	7.2.2.1
7.2.2.2	7.2.2.2
7.2.2.3	7.2.2.3
7.2.2.4	7.2.2.4
7.2.3	
7.2.3.1	7.2.3.1
7.2.3.2	7.2.3.2
7.2.3.3	7.2.3.3

Original US MIL-HDBK-516B Structure	Rationalised EMACC Structure
7.2.3.4	7.2.3.4
7.2.3.5	7.2.3.5
7.2.3.6	7.2.3.6
7.2.4	
7.2.4.1	
7.2.4.1.1	7.2.4.1.1
7.2.4.1.2	7.2.4.1.2
7.2.4.1.3	7.2.4.1.3
7.2.4.1.4	7.2.4.1.4
7.2.4.1.5	7.2.4.1.5
7.2.4.1.6	7.2.4.1.6
7.2.4.1.7	7.2.4.1.7
7.2.4.1.8	7.2.4.1.8
7.2.4.1.9	7.2.4.1.9
7.2.4.1.10	7.2.4.1.10
7.2.4.1.11	7.2.4.1.11
7.2.4.1.12	7.2.4.1.12
7.2.4.1.13	7.2.4.1.13
7.2.4.1.14	7.2.4.1.14
7.2.4.2	
7.2.4.2.1	7.2.4.2.1
7.2.4.2.2	7.2.4.2.2
7.2.4.2.3	7.2.4.2.3
7.2.4.2.4	7.2.4.2.4
7.2.4.2.5	7.2.4.2.5
7.2.4.2.6	7.2.4.2.6
7.2.4.2.7	7.2.4.2.7
7.2.4.2.8	Criteria merged with 7.2.5.1.3
7.2.4.2.9	Criteria merged with 7.2.4.3
7.2.4.2.10	7.2.4.2.10
7.2.4.2.11	Criteria merged with 7.2.4.2.4
7.2.4.2.12	7.2.4.2.12
7.2.4.3	7.2.4.3
7.2.5	
7.2.5.1	
7.2.5.1.1	7.2.5.1.1
7.2.5.1.2	7.2.5.1.2
7.2.5.1.3	7.2.5.1.3
7.2.5.1.4	7.2.5.1.4
7.2.5.1.5	7.2.5.1.5
7.2.5.1.6	7.2.5.1.6
7.2.5.1.7	7.2.5.1.7
7.2.5.1.8	7.2.5.1.8
7.2.5.1.9	7.2.5.1.9
7.2.5.2	
7.2.5.2.1	7.2.5.2.1
7.2.5.2.2	7.2.5.2.2
7.2.5.2.3	7.2.5.2.3
7.2.5.3	
7.2.5.3.1	7.2.5.3.1
7.2.5.4	
7.2.5.4.1	7.2.5.4.1
7.2.5.4.2	7.2.5.4.2

Original US MIL-HDBK-516B Structure	Rationalised EMACC Structure
7.2.5.5	
7.2.5.5.1	7.2.5.5.1
7.2.5.5.2	7.2.5.5.2
7.2.5.5.3	Criteria merged with 7.2.5.4.1
7.5.5.6	
7.2.5.6.1	7.2.5.6.1
7.3	
7.3.1	
7.3.1.1	7.3.1.1
7.3.1.2	7.3.1.2
7.3.1.3	7.3.1.3
7.3.1.4	7.3.1.4
7.3.1.5	7.3.1.5
7.3.1.6	Criteria merged with 7.3.1.4
7.3.1.7	7.3.1.7
7.3.1.8	7.3.2.8
7.3.1.9	7.3.1.9
7.3.2	
7.3.2.1	7.3.2.1
7.3.2.2	7.3.2.2
7.3.2.3	7.3.2.3
7.3.2.4	7.3.2.4
7.3.2.5	7.3.2.5
7.3.2.6	7.3.2.6
7.3.2.7	7.3.2.7
7.3.2.8	7.3.2.8
7.3.2.9	7.3.2.9
7.3.2.10	7.3.2.10
7.3.2.11	7.3.2.11
7.3.2.12	7.3.2.12
7.3.2.13	7.3.2.13
7.3.2.14	7.3.2.14
7.3.2.15	7.3.2.15
7.3.3	
7.3.3.1	7.3.3.1
8	
8.1	
8.1.1	8.1.1
8.1.1.1	Criteria included at 14.2.3
8.1.2	8.1.2
8.1.3	8.1.3
8.1.4	8.1.4
8.1.5	8.1.5
8.1.6	8.1.6
8.1.7	8.1.7
8.1.8	8.1.8
8.1.9	8.1.9
8.1.10	8.1.10
8.2	
8.2.1	8.2.1
8.2.2	8.2.2
8.2.3	Criteria merged with 8.2.5
8.2.4	8.2.4

Original US MIL-HDBK-516B Structure	Rationalised EMACC Structure
8.2.5	8.2.5
8.2.6	8.2.6
8.2.7	8.2.7
8.2.8	8.2.8
8.2.9	8.2.9
8.2.10	8.2.10
8.2.11	8.2.11
8.2.12	8.2.12
8.2.13	8.2.13
8.2.14	8.2.14
8.2.15	8.2.15
8.2.16	Criteria merged with 8.2.5
8.2.17	8.2.17
8.3	
8.3.1	8.3.1
8.3.1.1	8.3.1.1
8.3.1.2	Criteria merged with 8.3.17
8.3.2	8.3.2
8.3.3	Criteria removed
8.3.4	8.3.4
8.3.5	8.3.5
8.3.6	8.3.6
8.3.7	8.3.7
8.3.8	8.3.8
8.3.9	8.3.9
8.3.10	8.3.10
8.3.11	8.3.11
8.3.12	8.3.12
8.3.12.1	Criteria merged with 8.3.12
8.3.12.2	8.3.12.2
8.3.12.3	8.3.12.3
8.3.12.4	8.3.12.4
8.3.13	8.3.13
8.3.14	8.3.14
8.3.15	8.3.15
8.3.16	8.3.16
8.3.17	8.3.17
8.3.18	8.3.18
8.3.19	8.3.19
8.4	
8.4.1	8.4.1
8.4.1.1	8.4.1.1
8.4.1.2	8.4.1.2
8.4.1.3	8.4.1.3
8.4.2	8.4.2
8.4.3	8.4.3
8.4.3.1	8.4.3.1
8.4.3.2	8.4.3.2
8.4.4	8.4.4
8.4.4.1	Criteria merged with 8.4.4
8.4.5	Criteria included at 8.4.4
8.4.6	8.4.6
8.4.7	8.4.7

Original US MIL-HDBK-516B Structure	Rationalised EMACC Structure
8.4.8	8.4.8
8.4.9	8.4.9
8.4.10	8.4.10
8.4.11	8.4.11
8.4.12	8.4.12
8.4.13	8.4.13
8.4.14	8.4.14
8.4.15	8.4.15
8.4.16	8.4.16
8.4.17	8.4.17
8.4.18	8.4.18
8.4.19	8.4.19
8.4.20	8.4.20
8.4.21	8.4.21
8.5	
8.5.1	8.5.1
8.5.2	
8.5.2.1	8.5.2.1
8.5.2.2	8.5.2.2
8.5.2.3	8.5.2.3
8.5.2.4	8.5.2.4
8.5.2.5	8.5.2.5
8.5.2.6	8.5.2.6
8.5.2.6.1	8.5.2.6.1
8.5.3	
8.5.3.1	8.5.3.1
8.5.3.2	8.5.3.2
8.5.3.3	8.5.3.3
8.5.3.4	8.5.3.4
8.5.3.5	8.5.3.5
8.5.4	8.5.4
8.5.5	8.5.5
8.5.6	8.5.6
8.5.7	
8.5.7.1	8.5.7.1
8.5.7.2	8.5.7.2
8.5.7.3	8.5.7.3
8.5.7.4	Criteria merged with 8.5.6
8.5.8	
8.5.8.1	8.5.8.1
8.5.8.2	8.5.8.2
8.5.8.3	8.5.8.3
8.5.8.4	8.5.8.4
8.5.8.5	8.5.8.5
8.5.8.6	8.5.8.6
8.5.8.7	Criteria merged with 8.5.8.2
8.5.8.8	Criteria merged with 8.5.8.2
8.5.8.9	Criteria merged with 8.5.8.4
8.5.8.10	Criteria merged with 8.5.8.6
8.5.8.11	8.5.8.11
8.5.9	
8.5.9.1	8.5.9.1
8.5.9.2	8.5.9.2

Original US MIL-HDBK-516B Structure	Rationalised EMACC Structure
8.5.9.3	8.5.9.3
8.5.9.4	Criteria merged with 8.5.9.2
8.5.9.5	8.5.9.5
8.5.10	
8.5.10.1	Criteria merged with 8.5.2.3
8.5.10.2	8.5.10.2
8.5.10.3	8.5.10.3
8.5.10.4	8.5.10.4
8.5.10.5	8.5.10.5
8.5.10.6	8.5.10.6
8.5.10.7	8.5.10.7
8.5.10.8	8.5.10.8
8.5.10.9	Criteria merged with 8.5.10.8
8.5.10.10	8.5.10.10
8.5.11	
8.5.11.1	8.5.11.1
8.5.11.2	8.5.11.2
8.5.11.3	8.5.11.3
8.5.11.4	8.5.11.4
8.5.11.5	8.5.11.5
8.5.11.6	8.5.11.6
8.5.12	
8.5.12.1	8.5.12.1
8.5.12.2	8.5.12.2
8.5.12.3	8.5.12.3
8.5.12.4	8.5.12.4
8.5.12.5	8.5.12.5
8.5.12.6	8.5.12.6
8.5.12.7	Criteria included at 14.2.3
8.5.12.8	8.5.12.8
8.5.12.9	8.5.12.9
8.5.12.10	8.5.12.10
8.5.12.11	8.5.12.11
8.5.12.12	8.5.12.12
8.5.12.13	8.5.12.13
8.5.12.14	8.5.12.14
8.5.12.15	8.5.12.15
8.5.12.16	8.5.12.16
8.5.12.17	8.5.12.17
8.5.12.18	8.5.12.18
8.6	
8.6.1	8.6.1
8.6.2	8.6.2
8.6.2.1	8.6.2.1
8.6.3	8.6.3
8.6.4	8.6.4
8.6.4.1	8.6.4.1
8.6.5	8.6.5
8.6.5.1	8.6.5.1
8.6.6	8.6.6
8.6.7	8.6.7
8.6.8	8.6.8
8.6.9	8.6.9

Original US MIL-HDBK-516B Structure	Rationalised EMACC Structure
8.6.10	8.6.10
8.6.11	8.6.11
8.6.12	8.6.12
8.6.13	8.6.13
8.6.14	8.6.14
8.7	
8.7.1	8.7.1
8.7.1.1	8.7.1.1
8.7.1.2	8.7.1.2
8.7.1.2.1	8.7.1.2.1
8.7.1.3	8.7.1.3
8.7.1.4	Renumbered 8.7.1.5
8.7.1.4.1	Included at new Criteria 8.7.1.5.1
8.7.1.4.2	Included at new Criteria 8.7.1.5.2
8.7.1.4.3	Included at new Criteria 8.7.1.5.2
8.7.1.4.4	Included at new Criteria 8.7.1.5.3
8.7.1.4.5	Included at new Criteria 8.7.1.5.3
8.7.1.4.6	Included at new Criteria 8.7.1.5.1
8.7.1.5	Renumbered 8.7.1.6
New Criteria	8.7.1.5.1
New Criteria	8.7.1.5.2
New Criteria	8.7.1.5.3
8.7.1.6	Renumbered 8.7.1.7
8.7.1.7	Renumbered 8.7.1.8
8.7.1.8	Renumbered 8.7.1.8.2
8.7.1.8.1	Renumbered 8.7.1.8.2.1
8.7.1.9	8.7.1.9
8.7.1.9.1	8.7.1.9.1
8.7.1.9.2	8.7.1.9.2
8.7.1.10	Renumbered 8.7.3.2
8.7.2	8.7.2
8.7.2.1	8.7.2.1
8.7.2.1.1	8.7.2.1.1
8.7.2.1.2	8.7.2.1.2
8.7.2.1.3	Criteria merged with 8.7.2.1.1
8.7.2.1.4	Criteria merged with 8.7.2.1.2
8.7.2.1.5	Included at Criteria 8.7.2.1.3
8.7.2.1.6	Criteria merged with 8.7.2.1.2
8.7.2.1.7	Renumbered 8.7.2.1.4
8.7.2.1.8	Renumbered 8.7.2.1.5
8.7.2.1.9	Renumbered 8.7.2.1.6
8.7.2.1.10	Renumbered 8.7.2.1.7
8.7.2.2	Renumbered 8.7.3.1
8.7.2.2.1	Renumbered 8.7.3.1.1
8.7.2.2.2	Renumbered 8.7.3.1.2
8.7.2.3	Renumbered 8.7.2.2
8.7.2.4	Renumbered 8.7.2.3
8.7.3	Renumbered 8.7.3.3
8.7.3.1	Renumbered 8.7.1.2.2
8.7.4	Subsection relocated to 8.7.1 and 8.7.2
8.7.4.1	Renumbered 8.7.1.8.1
8.7.4.2	Renumbered 8.7.2.4

Original US MIL-HDBK-516B Structure	Rationalised EMACC Structure
8.7.4.3	Renumbered 8.7.1.4
8.7.4.4	Renumbered 8.7.1.4.1
8.7.4.5	Renumbered 8.7.1.4.2
8.7.5	Subsection relocated to 8.7.1 and 8.7.2
8.7.5.1	Renumbered 8.7.1.8.2.2
8.7.5.2	Renumbered 8.7.2.1.5.1
8.7.5.3	Renumbered 8.7.1.7.1
8.7.5.4	Renumbered 8.7.1.6.1
8.7.5.5	Renumbered 8.7.1.4.3
8.7.5.6	Renumbered 8.7.2.1.5.2
8.7.5.7	Renumbered 8.7.2.5
8.7.5.8	Renumbered 8.7.2.1.4.1
8.8 DELETED (propulsion section moved to 7.2.5)	DELETED (propulsion section moved to 7.2.5)
8.9	
8.9.1	8.9.1
8.9.2	8.9.2
8.9.3	8.9.3
8.9.4	8.9.4
8.9.5	8.9.5
8.9.6	8.9.6
8.9.7	8.9.7
8.9.8	8.9.8
8.9.9	Criteria merged with 9.1
8.9.10	8.9.10
8.9.11	8.9.11
8.9.12	8.9.12
8.9.13	8.9.13
8.9.14	8.9.14
8.9.15	8.9.15
8.9.16	8.9.16
8.9.17	8.9.17
8.9.18	8.9.18
8.9.19	8.9.19
8.9.20	8.9.20
8.9.21	8.9.21
8.9.22	8.9.22
8.9.23	8.9.23
8.9.24	8.9.24
8.9.25	Criteria merged with 8.9.24
8.9.26	8.9.26
8.9.27	8.9.27
8.9.28	8.9.28
8.9.29	8.9.29
8.10	
8.10.1	8.10.1
8.10.2	8.10.2
8.10.3	8.10.3
8.10.4	8.10.4
8.10.5	8.10.5
8.10.6	8.10.6
8.10.7	8.10.7

Original US MIL-HDBK-516B Structure	Rationalised EMACC Structure
8.11	
8.11.1	8.11.1
8.11.2	8.11.2
8.11.3	8.11.3
8.12	
8.12.1	8.12.1
8.12.2	8.12.2
9	
9.1	
9.1.1	9.1.1
9.1.1.1	9.1.1.1
9.1.2	9.1.2
9.1.3	9.1.3
9.1.4	9.1.4
9.1.5	9.1.5
9.1.6	9.1.6
9.2	
9.2.1	9.2.1
9.2.1.1	9.2.1.1
9.2.1.2	9.2.1.2
9.2.2	9.2.2
9.2.3	9.2.3
9.2.4	9.2.4
9.2.5	Criteria merged with 9.2.2
9.2.6	9.2.6
9.2.7	9.2.7
9.2.8	9.2.8
9.3	
9.3.1	9.3.1
9.3.2	9.3.2
9.3.3	9.3.3
9.3.4	9.3.4
9.4	
9.4.1	9.4.1
9.4.1.1	9.4.1.1
9.4.2	9.4.2
9.4.3	Criteria merged with 9.2.1.2
9.4.4	9.4.4
9.4.5	Criteria merged with 9.4.2
9.4.6	9.4.6
9.5	
9.5.1	9.5.1
9.5.2	9.5.2
9.5.3	9.5.3
9.5.4	9.5.4
9.5.4.1	9.5.4.1
9.5.5	9.5.5
9.5.6	9.5.6
9.6	
9.6.1	9.6.1
9.6.2	9.6.2
9.6.3	9.6.3
9.6.4	9.6.4

Original US MIL-HDBK-516B Structure	Rationalised EMACC Structure
9.6.5	9.6.5
9.6.6	9.6.6
9.6.7	9.6.7
9.6.8	9.6.8
9.7	
9.7.1	9.7.1
9.7.2	9.7.2
9.7.3	9.7.3
9.7.4	9.7.4
9.7.5	9.7.5
9.7.6	9.7.6
9.7.7	9.7.7
9.7.8	9.7.8
9.7.9	9.7.9
9.7.10	9.7.10
9.7.11	9.7.11
9.8	
9.8.1	9.8.1
9.8.2	9.8.2
9.8.3	9.8.3
9.8.3.1	9.8.3.1
9.8.4	9.8.4
9.8.5	9.8.5
9.8.6	9.8.6
9.8.7	9.8.7
9.8.8	9.8.8
9.8.9	9.8.9
9.8.10	9.8.10
9.8.11	9.8.11
9.8.12	9.8.12
9.8.13	9.8.13
9.8.14	9.8.14
9.9	
9.9.1	9.9.1
9.9.2	9.9.2
9.9.3	9.9.3
9.9.4	Criteria included at 9.4.1 (equipment) and 9.4.2 (documentation).
9.9.5	9.9.5
9.9.6	9.9.6
10.1	
10.1.1	10.1.1
10.1.2	10.1.2
10.2	
10.2.1	10.2.1
10.2.2	10.2.2
10.2.3	10.2.3
10.2.4	10.2.4
10.2.5	10.2.5
11	
11.1	
11.1.1	11.1.1

Original US MIL-HDBK-516B Structure	Rationalised EMACC Structure
11.1.2	11.1.2
11.1.3	11.1.3
11.1.4	11.1.4
11.1.5	11.1.5
11.1.6	11.1.6
11.2	
11.2.1	11.2.1
11.2.2	11.2.2
11.2.3	11.2.3
11.2.4	11.2.4
11.2.5	11.2.5
11.3	
11.3.1	11.3.1
11.3.2	11.3.2
11.3.3	11.3.3
12.1	
12.1.1	12.1.1
12.1.2	12.1.2
12.1.3	12.1.3
12.1.4	12.1.4
12.1.5	12.1.5
12.1.6	12.1.6
12.1.7	12.1.7
12.1.8	12.1.8
12.1.9	12.1.9
12.1.10	12.1.10
12.2	
12.2.1	12.2.1
12.2.2	12.2.2
12.2.3	12.2.3
12.2.4	12.2.4
12.2.5	12.2.5
12.2.6	12.2.6
12.2.6.1	12.2.6.1
12.2.6.2	12.2.6.2
12.2.6.3	12.2.6.3
12.2.6.4	12.2.6.4
12.2.6.5	12.2.6.5
12.2.6.6	12.2.6.6
12.2.6.7	12.2.6.7
13.1	
13.1.1	13.1.1
13.1.2	13.1.2
13.1.3	Criteria merged with 13.1.2
13.2	
13.2.1	13.2.1
13.2.2	13.2.2
13.2.3	13.2.3
13.2.4	13.2.4
13.2.5	13.2.5
13.2.6	13.2.6
13.2.7	13.2.7
13.2.8	13.2.8

Original US MIL-HDBK-516B Structure	Rationalised EMACC Structure
13.2.9	13.2.9
13.2.10	13.2.10
14	
14.1	
14.1.1	14.1.1
14.1.1.1	14.1.1.1
14.1.1.2	Criteria removed
14.1.1.3	14.1.1.3
14.1.1.4	14.1.1.4
14.2	
14.2.1	14.2.1
14.2.2	14.2.2
14.2.3	14.2.3
14.2.4	14.2.4
14.2.5	14.2.5
14.2.6	14.2.6
14.2.7	14.2.7
14.2.8	14.2.8
14.2.9	14.2.9
14.2.10	14.2.10
14.3	
14.3.1	14.3.1
14.3.2	14.3.2
14.3.3	14.3.3
15	
15.1	
15.1.1	15.1.1
15.1.2	15.1.2
15.1.3	15.1.3
15.1.4	15.1.4
15.1.5	15.1.5
15.1.6	15.1.6
15.1.7	15.1.7
15.1.8	15.1.8
15.1.9	15.1.9
15.2	
15.2.1	15.2.1
15.2.2	15.2.2
15.2.3	15.2.3
15.3	
15.3.1	
15.3.1.1	Criteria included at 15.1.3, 15.1.5, 15.1.8)
15.3.1.2	Criteria included at 15.1.8
15.3.2	
15.3.2.1	15.3.2.1
15.3.2.2	15.3.2.2
15.3.2.3	15.3.2.3
15.3.2.4	15.3.2.4
15.3.2.5	15.3.2.5
15.3.2.6	15.3.2.6
15.3.2.7	15.3.2.7
15.3.2.8	15.3.2.8

Original US MIL-HDBK-516B Structure	Rationalised EMACC Structure
15.3.2.9	15.3.2.9
15.3.3	
15.3.3.1	15.3.3.1
15.3.3.2	15.3.3.2
15.3.3.3	15.3.3.3
15.3.3.4	15.3.3.4
16	
16.1	
16.1.1	New criteria
16..2	
16.2.1	16.2.1
16.2.2	16.2.2
16.2.3	16.2.3
16.2.4	16.2.4
16.2.5	16.2.5
16.2.6	16.2.6
16.2.7	16.2.7
16.3	
16.3.1	Criteria removed
16.3.2	16.3.2
16.3.3	16.2.3
16.3.4	16.3.4
17	
17.1	
17.1.1	17.1.1
17.1.2	17.1.2
17.1.3	Criteria merged with 17.1.2
17.1.4	Merged with 17.1.2
17.2	
17.2.1	17.2.1
17.2.2	17.2.2
17.2.3	17.2.3
17.2.4	17.2.4
17.2.5	Criteria merged with 17.2.1
17.2.6	17.2.6
17.2.7	17.2.7
17.2.8	Criteria merged with 17.2.1
17.3	
17.3.1	17.3.1
17.3.2	17.3.2
17.3.3	Criteria merged with 17.3.2
17.3.4	17.3.4
17.3.5	Criteria merged with 17.3.4
17.3.6	17.3.6
17.3.7	17.3.7
17.4	
17.4.1	17.4.1
18	
18.1	
18.1.1	18.1.1
18.1.2	Criteria merged with 18.1.1
18.1.3	18.1.3

Original US MIL-HDBK-516B Structure	Rationalised EMACC Structure
18.1.4	18.1.4
18.1.5	18.1.5
18.1.6	18.1.6
18.1.7	18.1.7
18.1.8	18.1.8
18.1.9	18.1.9
18.1.10	18.1.10
18.1.11	18.1.11
18.1.12	18.1.12
18.1.13	18.1.13
18.1.14	18.1.14
18.1.15	18.1.15
18.2	
18.2.1	18.2.1
18.2.2	18.2.2
18.3	
18.3.1	18.3.1
18.3.2	18.3.2
19	
19.1	
19.1.1	19.1.1
19.1.2	19.1.2
19.1.3	19.1.3
19.1.4	19.1.4
19.1.5	19.1.5
19.1.6	19.1.6
19.1.7	Criteria merged with 19.1.5
19.1.8	19.1.8
19.1.9	19.1.9
19.2	
19.2.1	19.2.1
19.2.2	19.2.2
19.2.3	19.2.3
19.2.4	19.2.4
19.3	
19.3.1	19.3.1
19.3.2	19.3.2
19.3.3	19.3.3
19.3.4	19.3.4
19.4	
19.4.1	19.4.1
20	
20.1	
20.1.1	20.1.1
20.1.2	20.1.2
20.1.3	20.1.3