AER(EP).P-516

MINISTERO DELLA DIFESA

Segretariato Generale della Difesa e Direzione Nazionale degli Armamenti
Direzione degli Armamenti Aeronautici e per l'Aeronavigabilità

CRITERIA FOR THE DEFINITION OF THE AIRWORTHINESS REQUIREMENTS

THE PRESENT REGULATION SUPERSEDES AND REPLACES THE REGULATION OF THE SAME NUMBER, EDITION 13/05/2019, AND RELEVANT AMENDMENTS AND SUPPLEMENTS

Edition 9th January 2025

LIST OF EFFECTIVE PAGES

NOTE: This regulation is valid if it consists of the pages listed below, duly updated.

Copy of this Technical Publication may be found at the address:

https://www.difesa.it/amministrazione-trasparente/segredifesa/armaereo/pubblicazioni-tecniche/34942.html

The issue dates of the original and amended pages are:

Original……………….. 0……………….. 9th January 2025

This regulation consists of a total of N° 790 pages as specified below:

Page N°	Amendment N°
Frontpage………………..	0
A…………………………..	0
i…… ……………………	0
1 – 6 ……………………	0
Annex A: front page + 662	0
Annex B: 1-12	0
Annex C: 1-5	0
Annex D: 1-14	0
Annex E: 1-5	0
Annex F: 1-6	0
Annex G: 1-4	0
Annex H: 1-8	0
Annex I: 1-13	0
Annex J: 1-7	0
Annex K: 1-14	0
Annex L: 1-11	0
Annex M: 1-17	0

INDEX

ANNEX LIST:

1. INTRODUCTION

1.1 GENERAL

The Italian Directorate for the Aeronautical Armaments and Airworthiness (DAAA) is responsible of procuring to the Armed Forces and Armed State Corps aeronautical systems (aircraft, products and appliances), suitable in terms of technical-operational capabilities, associated costs and delivery timeline.

In this context, the procured systems shall be compliant with the airworthiness and performance requirements respectively defined in the Certification, Qualifcation and Homologation bases in accordance with the processes defined in the regulations AER(EP).P-2, AER(EP).P-21 and AER(EP).P-22.

1.2 SCOPE

The present regulation provides the criteria for the definition of the airworthiness requirements of the military aircraft and related products and appliances procured by DAAA.

1.3 APPLICABILITY

The present regulation is applicable to all military aircraft and related products and appliances flying under DAAA responsibility.

In particular, the level of adherence to the present regulation depends on the aircarft and related products and appliances nature and features, as hereby detailed:

- for aircraft, products and appliances originated from a civil design and provided with a civil certification, DAAA has the faculty of retaining the existing certification codes (CS, FAR, etc.), adding Special Conditions and Exemptions based on the specific mission requirements and performance derived from the applicable operational requirement. The present regulation can be utilised to tailor the Special Conditions and Exemptions and to verify the completeness of the certification basis.
- for aircraft, products and appliances originated from a military design, not accompanied by extant certification codes, the present regulation constitutes the starting point for the definition of the certification/homologation bases.

1.4 VALIDITY

The present TP shall enter into force on the date of its approval.

1.5 DEFINITIONS

Unless differently specified/integrated in the body of this regulation and the relevant Annexes, refer to the regulation AER.Q-2010 and EMAD 1 (http://www.eda.europa.eu/experts/airworthiness/mawa-documents) for the abbreviations, vocabulary and expressions.

1.6 RELATED STANDARDS AND REGULATIONS

- AER(EP).0-0-2 — Definition and regulation of the Air Armaments General Directorate (ARMAEREO) TP System
- AER.P-2 — Homologation, Type Certification and Type Qualification for military aircraft, Approval of Installation Suitability
- AER(EP).P-6 — Instructions for the compilation of Technical Specifications for Military Aircrafts
- AER(EP).P-21 — Certification and Qualification of Military Aircraft and related Products, Parts and Appliances and Design and Production Organizations in the EMAR construct
- AER(EP).P-22 — Certification of Military Remotely Piloted Aircraft Systems
- AER(EP).P-23 — Airworthiness and Safety Residual Risk Identification and Acceptance
- AER.Q-2010 — Definitions of Abbreviations, Terms and Expressions used in DAAA
- EMACC — European Military Airworthiness Certification Criteria handbook
- STANAG 4702 — Rotary wing unmanned aircraft systems airworthiness requirements
- STANAG 4703 — Light Unmanned Aircraft Systems Airworthiness Requirements

2. AIRWORTHINESS CRITERIA

2.1 AIRWORTHINESS CERTIFICATION CRITERIA

The European Military Airworthiness Certification Criteria (EMACC), latest edition, and the relevant applicable guidelines shall be taken into consideration and used as guideline for deriving the airworthiness certification criteria.

As reference, EMACC Edition February 2018 is included in Annex A of the present regulation; however, the Applicant shall always consult with DAAA in order to concur the EMACC edition to be adopted throughout the certification/homologation programme.

2.2 IN-FLIGHT REFUELLING

In addtion to the requirement defined by EMACC, DAAA has implemented a standard procedure for the authorization of Air-to-Air Refuelling operations.

Such procedures are included in Annex B of the present regulation.

2.3 SEMI-PREPARED RUNWAYS

In addtion to the requirement defined by EMACC, DAAA has implented further requirements pertaining to the certification of semi-prepared runways.

The outcomes of such activitiy are enclosed in Annex C.

2.4 NECK LOADS IN CASE OF EJECTION

In addtion to the requirement defined by EMACC, DAAA has identified further safety requirements pertaining to the computation of the neck loads in case of ejection.

The outcomes of such activitiy are enclosed in Annex D.

2.5 SAFE EJECTION IN THE CERTIFICATION CONTEXT

In addtion to the requirement defined by EMACC, DAAA has carried further airworthiness requirements pertaining to the Crew Escape System, with the scope of providing a clear definition of “safe ejection”.

The outcomes of such activitiy are enclosed in Annex E.

2.6 TETHERED GAS BALLOONS

In addtion to the requirement defined by EMACC, DAAA has implemented specific airworthiness requirements pertaining to the Tethered Gas Ballon (in particular the systems employed for parachuting training), which are recognized and registered as military aircraft.

The outcomes of such activitiy are enclosed in Annex F.

2.7 CYBER SECURITY FOR AIR SYSTEMS: UNAUTHORIZED ELECTRONIC INTERFERENCE (IE)

In addtion to the requirement defined by EMACC, DAAA has carried a research on the airworthiness requirements pertaining to the certification of the aircraft and the connected Information Technology Ground Systems (STI) in the presence of unauhtorized electronic interference (i.e. the threats belonging to the Cyber Security domain), with the scope of defining a bespoke certification basis.

The outcomes of such activitiy are enclosed in Annex G.

2.8 INTENTIONAL ELECTRO-MAGNETIC INTERFERENCE (IEMI)

In addtion to the requirement defined by EMACC, DAAA has carried a research on the airworthiness requirements pertaining to the certification of the aircraft and the connected Information Technology Ground Systems (STI) in the presence of intentional electro-magnetic interference, with the scope of defining a bespoke certification basis.

The outcomes of such activitiy are enclosed in Annex H.

2.9 CERTIFICATION APPROACH FOR MINI/MICRO UNMANNED AIRCRAFT SYSTEMS

In addtion to the requirement defined by EMACC, DAAA has defined a minimum set of airworthiness requirements, grouped into the so-caleld Integrity Assessment Checklist (IAC), pertaining to the certification of the Remotely Piloted Aircraft Systems/Unmanned Aircraft Systems (RPAS/UAS) belonging to the weight classes “Mini” and “Micro”, i.e. with a Maximum Take Off Weight (MTOW) below 25 Kg.

In particular, for the class “Mini” (MTOW between 2 and 25 Kg), the IAC may be considered an alternative to STANAGs 4703/4702, when the system maturity does not consent a satisfactory complance to the STANAGs.

This minimum set of requirements is reported in Annex I.

2.10 CERTIFICATION REQUIREMENTS FOR LOITERING MUNITIONS

In addtion to the requirement defined by EMACC, DAAA has conducted a study on the airworthiness and safety requirements applicable to Loitering Munitions.

Annex J outlines such criteria.

These criteria will complement:

- the performance requirements set by the qualification basis;
- if necessary and required in the relevant contract, the integration activities onto the aircraft, as directed in the dedicated section of the EMACC Handbook.

2.11 CERTIFICATION REQUIREMENTS FOR AIR TRAFFIC INTEGRATION

In addtion to the requirement defined by EMACC, DAAA has implemented bespoke airworthiness requirements pertaining to the certification and authorization, from a technical perspective, of the following Air Traffic Integration capabilities:

- Instrument Flight Rules (IFR);
- Reduced Vertical Separation Minima (RVSM);
- Performance Based Navigation (PBN);
- Communication Navigation and Surveillance in terms of Automatic Dependent Surveillance Broadcast (ADS-B).

The outcomes of such activitiy are enclosed in Annex K.

2.12 CERTIFICATION REQUIREMENTS FOR ELECTRONIC FLIGHT BAGS

In addtion to the requirement defined by EMACC, DAAA has implemented bespoke airworthiness requirements pertaining to the utilization of portable Electronic Flight Bag (EFB) on military aircraft.

The outcomes of such activitiy are enclosed in Annex L.

2.13 SAFETY TARGETS

In addtion to the requirement defined by EMACC, DAAA has implemented bespoke safety requirements, to be adopted to every programme.

Such requirements are enclosed in Annex M.

2.14 CERTIFICATION REQUIREMENTS FOR GLIDERS

In addtion to the requirement defined by EMACC, DAAA has determined to set the certification basis extracted from EASA DS-21LD, as hereby defined:

For a sailplane or powered sailplane with a maximum take-off mass of 850 kg or less	
CS-22 Amendment 3 AND IF APPLICABLE SC-D22-D01[1] 'Special Condition on Airworthiness Standards for CS-22 Sailplanes with hand rudder control of longitudinal type'	
Engine	**Propeller**
Installed on the powered sailplane and declared as being compliant within the sailplane declaration of design compliance	
CS-E Amendment 6	CS-P Amendments 2
OR	OR
Subpart H of CS-22 Amendment 3	Subpart J of CS-22 Amendment 3

This table also applies in case of powered gliders, where specific requirements shall be imposed to the engine and the propeller eligible to carry an individual certification.

In these cases, a certification of the entire aircraft is also possible, pending agreement with the DAAA.

2.15 CERTIFICATION REQUIREMENTS FOR PARACHUTES

On top of what defined in terms of fit-for-purpose requirements in the Technical Specification annexed to the inherent procurement contract, the parachutes shall also be subject to the certification requirements defined in the ENAC regulation NAV-16D.

In particular, this regulation refers to the EASA ETSO C23d for the identification of the airworthiness requirements to be obeyed by the emergency parachutes.

Alternative means to comply with the safety requirements captured in the mentioned ETSO may be proposed and discussed with the DAAA.

2.16 CERTIFICATION REQUIREMENTS FOR GYROPLANES

Military gyroplanes certification basis shall be drawn and adapted from the British Civil Airworthiness Requirements Section T (or equivalent civil regulation) and entail additional consdierations for what regards the engine and the propeller, as per powered gliders. A certification of the entire aircraft (without an individual activity for engine and propeller) is also possible, pending agreement with the DAAA.

2.17 CERTIFICATION REQUIREMENTS FOR AIRSHIPS

Military airships certification basis shall be composed by taking elements from the Annex F (TGB) and from CS-22 for what regards the certification of the engine and the propeller, as captured for the powered gliders and the gyroplanes. A certification of the entire aircraft (without an individual activity for engine and propeller) is also possible, pending agreement with the DAAA.

AER(EP).P-516

ANNEX A

EUROPEAN MILITARY AIRWORTHINESS CERTIFICATION CRITERIA (EMACC)

NOTE: This Annex includes EMACC Edition February 2018; however, the Applicant shall always consult with DAAA in order to concur the EMACC edition to be adopted throughout the certification/homologation programme

EUROPEAN MILITARY AIRWORTHINESS CERTIFICATION CRITERIA (EMACC)

EMACC Handbook

Edition Number	**3.0**
Edition Date	**1 February 2018**
Status	**Endorsed**

MILITARY AIRWORTHINESS AUTHORITIES FORUM

DOCUMENT CONTROL

DOCUMENT APPROVAL

The following table identifies the persons who have approved this document

Edition No:		MAWA Forum / Advisory Group	Authorised by	DATE
3.0	Prepared by	DPAG	Guy Bodet DPAG Chair	17 January 2018
	Endorsed for Release	MAWA Forum	Henk Corporaal MAWA Forum Chair	1 February 2018

DOCUMENT CHANGE RECORD

Edition Number	Edition Date	Status	Reason for change *(detailed)*	Sections or pages affected
1.0	30/11/2010	Working Draft	Draft issue for review by TF4.	All sections
1.1	17/12/2010	Working Draft	Formal Issue as part of Contract 09-ARM-008	-
1.2	24/02/2011	Working Draft	Change of title and Embodiment of TF4 comments	Title page, Sections 5.2.4, 5.3.1, 9.4.6 & 14.2.3
1.3	28/11/2012	Working Draft	Draft issue for review by TF4 as part of Contract 10.ARM.OP.23	All Sections
2.0	24/01/2013	Endorsed	Endorsement for release by MAWA Forum	-
2.1	17/09/2015	Draft	Formal Issue as part of Contract 14.CPS.OP.040	Sections 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 16, 18, 19, 20.
2.1	12/10/2015	Endorsed	Endorsement for release by MAWA Forum	-
3.0	1/02/2018	Endorsed	Revise all Criteria to align with MIL-Hdbk 516C	All Sections

STATUS

The Status of the document can take 3 values:

Working Draft: First version provided during the elaboration of the document by Task Force.

Draft: Draft version when issued by Task Force and proposed to MAWA Forum.

Endorsed: The document is endorsed by the participating Member States for release.

EDITION

Edition will have the following template: **Edition X.Y**

The value of **X** will change after a **major** modification of the document

The value of **Y** will change after a **minor** modification of the document

TABLE OF CONTENTS

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 aircraft systems. It is a foundational document to be used by the relevant military airworthiness authority or authorities or other entity to define the aircraft'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 aircraft system when an airworthiness determination is necessary, especially when there is a change to the functional or product baseline.

Rotary wing aircraft 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 aircraft. 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 aircraft, 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 aircraft is designed, and to the "expendability" of the UAS/ROA in close proximity to the control system, personnel, property, or other equipment.

Similarly, aircraft 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 aircraft; 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 meet 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 EMACC 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.

The TCB should be created using a 'Top-down' approach, ensuring that all appropriate sections of this EMACC Handbook are captured. In some cases an aircraft or modification may appear to have a narrow scope, and therefore may seem to only affect a small number of sections of this Handbook, however it is important to capture the effect that changes to one system may have on the design, function or operating environment for other systems.

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.

Some criteria within this EMACC Handbook are merged with other criteria to simplify the content of this Handbook while maintaining similarity with MIL-HDBK-516. Where a section is merged with another, it is important to review both sections to ensure that the merged criterion is adequately captured within the TCB.

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), where available. 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 6 dated: 05/02/10
Section No: 2: "Flight"	Issue 5 dated: 31/01/07
Section No: 3: "Structure"	Issue 6 dated: 05/02/10
Section No: 4: "Design and Construction"	Issue 6 dated: 05/02/10
Section No: 5: "Powerplant"	Issue 5 dated: 31/01/07
Section No: 6: "Equipment"	Issue 6 dated: 05/02/10
Section No: 7: "Operating Limitations and Information"	Issue 5 dated: 31/01/07
Section No: 8: "Gas Turbine Auxiliary Power Unit Installation"	Issue 5 dated: 31/01/07
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 2 dated: 31/01/07
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 5 dated: 20/04/09**
Part No: 11: Engines	**Issue 1 dated: 27/01/06**
Part No: 13: Military Common Fit Equipment	**Issue 2 dated: 15/01/10**
Part No: 15: Items with no Specific Military Requirements	**Issue 4 dated: 27/01/06**

2.3 STANAGs

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 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 reference STANAGs as of 3rd June 2010.

STANAG Reference No.	Edition	STANAG Title	Relevant section of EMACC Handbook	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

STANAG Reference No.	Edition	STANAG Title	Relevant section of EMACC Handbook	Ratified by pMS	Ratified with reservation/comment / not implementing
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
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

STANAG Reference No.	Edition	STANAG Title	Relevant section of EMACC Handbook	Ratified by pMS	Ratified with reservation/comment / not implementing
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
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

STANAG Reference No.	Edition	STANAG Title	Relevant section of EMACC Handbook	Ratified by pMS	Ratified with reservation/comment / not implementing
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
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

STANAG Reference No.	Edition	STANAG Title	Relevant section of EMACC Handbook	Ratified by pMS	Ratified with reservation/comment / not implementing
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	
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	

STANAG Reference No.	Edition	STANAG Title	Relevant section of EMACC Handbook	Ratified by pMS	Ratified with reservation/comment / not implementing
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
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

STANAG Reference No.	Edition	STANAG Title	Relevant section of EMACC Handbook	Ratified by pMS	Ratified with reservation/comment / not implementing
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
7068	Edition 2: Amdt.1	Aircraft stores certification procedure.		Czech Republic Germany Greece Luxemburg Netherlands Spain UK	Belgium
4671	Edition 1	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 4;
- EASA CS 25 - Large Aeroplanes Amendment 18;
- EASA CS 27 - Small Rotorcraft Amendment 3;
- EASA CS 29 - Large Rotorcraft Amendment 3;
- EASA CS E - Engines Amendment 4;
- 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 aircraft, 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 aircraft Subsystems, dated 30th October 1998; and,
- JSSG-2010 Crew Systems.

It should be noted that some JSSG documents are not freely available. In some cases it has therefore not been possible to perform an in-depth review of the sections of JSSG documents. Where a section of a JSSG has not been reviewed, references within this Handbook state '(Unverified)'. Care should be taken when referencing such unverified sections to ensure that the referenced section is appropriate.

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

All definitions, unless otherwise referenced, are to be considered within the context of this document.

Where appropriate, consistency has been maintained between this definitions list and the European Military Airworthiness Document - EMAD 1 - Acronyms and Definitions Document; Edition 1.3; dated 10 Oct 2017, referred to in this list simply as 'EMAD 1'.

TERM	DEFINITION/EXPLANATION
Aircraft	Any vehicle that is capable of atmospheric flight including the installed equipment (hardware and software). (As defined in EMAD 1)
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. (As defined in EMAD 1)
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 in specific EMARs, Authority means a National Military Airworthiness Authority (NMAA) responsible for the airworthiness of military aircraft hereto and "the Authorities" means all the military Authorities responsible for airworthiness hereto. (As defined in EMAD 1)
Certification	Recognition that a production, part or appliance, organisation or person complies with the applicable airworthiness requirements followed by a declaration of compliance. (As defined in EMAD 1)
Certifcation 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. (As defined in EMAD 1)
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. (As defined in EMAD 1)
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. (As defined in EMAD 1)

TERM	DEFINITION/EXPLANATION
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. (As defined in EMAD 1)
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. (As defined in EMAD 1)
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)
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 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.
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/Debonding	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.
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.
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.
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.
Failure	The inability of an item to perform within previously specified limits.
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?

TERM	DEFINITION/EXPLANATION
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.
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 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 aircraft control, related to aircrew workload and situational awareness, must be safely achieved.
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.
Install/Installation	To connect or set in position and prepare for use or to load and configure software into an information system.
Integrate/Integration	The process of bringing together component sub-systems into one system (an aggregation of subsystems cooperating so that the system is able to deliver the overarching functionality) and ensuring that the subsystems function together.
Item	Any level of hardware assembly (i.e., system, sub-system, module, accessory, component, unit, part, etc.).
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. (As defined in EMAD 1)
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. (As defined in EMAD 1)
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.
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.
Other Structure	Structure which is judged not to be a Structural Significant Item. "Other Structure" is defined both externally and internally within zonal boundaries.

TERM	DEFINITION/EXPLANATION
Pilot Induced Oscillations	Oscillations of aircraft movement caused or exacerbated by pilot input.
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.
Residual Strength	The strength of a damaged structure.
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.
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 Element	Two or more structural details which together form an identified manufacturer's assembly part.
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 focusses 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 Military Type Certificate. (As defined in EMAD 1)
Unmanned Aerial Vehicle	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. (As defined in EMAD 1)
UAV System (May also be called a UAS or RPAS)	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.

3.2 ABBREVIATIONS AND ACRONYMS

14CFR	Title 14, Code of Federal Regulations
AAR	Air-to-Air Refuelling
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 Refueling 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 Defense
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 Miliatry 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
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
RNP	Required navigation performance
ROA	Remotely operated aircraft
RVSM	Reduced vertical separation minima
RTO	Rejected take-off
SAE	Society of Automotive Engineers
SAWE	Society of Allied Weight Engineers
SDIMP	Software development integrity master plan
SD	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
T.O.	Technical order
TSO	Technical standard order
UAS	Unmanned air system
UAV	Unmanned aircraft
VCF	Vehicle control function
VCMS	Vehicle control and management system
VL/ML	Limit speed
VNAV	Vertical navigation

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 established, 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 Requirements allocation.

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

Consideration should be given to:

a. Defining processes for requirements allocation and design criteria definition/tailoring;
b. High level mission and safety requirements;
c. Extending the design criteria to cover use and impact of (complex) GSE as part of the maintenance philosophy.
d. Requirements to satisfy Extended Range Twin Operations (ETOPS) where appropriate.

Considerations for preparation of AMC:

1. Production of process documentation;
2. Ensuring traceability between design criteria, requirements, solutions and verification/validation activities;
3. Consistency between design criteria and airworthiness and safety requirements.

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

Information Sources			
			CS 23.601 CS 23.611 CS 23.1309 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 Safety critical hardware and software.

The airworthiness and safety design criteria shall address all components, system and subsystem levels, including interfaces, latencies, software and information assurance.

Consideration should be given to:

a. Identification of critical safety items within the design solution;

b. Safety critical functions and functional chains.

Considerations for preparation of AMC:

1. Documentation records that safety critical software, hardware and associated design criteria and critical characteristics resulting from this process are verified.

2. Documentation records that security requirements and mitigation techniques that affect flight safety are incorporated into safety critical software and hardware.

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 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 Commercial derivative aircraft.

For commercial derivative aircraft, the aircraft'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, including environment, and flight envelope of the aircraft 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.

Considerations for preparation of AMC:

1. Military aircraft airworthiness certification documentation details the difference between Civil and Military usage, defines all appropriate certification requirements that apply to those differences, and demonstrates compliance against those requirements.

Information Sources	

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.

Safety of flight related 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;

c. Single points of failure.

Considerations for preparation of AMC:

1. Hazard analysis verifies that safety critical hazards have been identified;
2. Operating limitations are defined;
3. Analysis includes and specifies known parameters and assumptions where appropriate.

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

4.1.5 Operating environment.

The air system, including the aircraft and control station equipment, is qualified to operate in the intended natural and induced environments.

Consideration should be given to:

The air system, including the aircraft and control station equipment, is qualified to operate in the intended natural and induced environments such as:
a. Temperature;
b. Humidity;
c. Precipitation:
d. Icing:
e. Fungus:
f. Salt fog;
g. Particulate and liquid contamination;
h. Shock and vibration;
i. Explosive atmosphere.

Considerations for preparation of AMC:
1. Analysis, demonstration and test verify that equipment provides required function and performance.
2. Qualification testing which verifies that equipment is qualified for its intended environments.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 2.20 00-970 P1 7.2.2 00-970 P1 7.2.3 00-970 P1 7.2.4 00-970 P1 7.2.6 00-970 P1 7.2.8 00-970 P1 7.2.9 00-970 P1 7.3.2
		STANAG Reference:	4671.603 4671.881 4671.1181 4671.U1703 4671.905 4671.1203 4671.613
FAA Doc:		*EASA CS Reference:*	CS 23.603 CS 23.609 CS 23.613 CS 23.773 CS 23.1093 CS 23.1419 CS 25.603 CS 25.609 CS 25.613 CS 25.773 CS 25.1093 CS 25.1324 CS 25.1419 CS 25.1420 CS 25.1435

Information Sources			
			CS 25.1527

4.1.6 Flight and safety critical functions.

The design criteria identifies flight and safety critical functions, modes and states for the air system, including the aircraft.

The aircraft detects and responds appropriately, predictably, safely and in a timely manner to:

- Flight or safety critical function degraded states or failures.
- Aircraft flight or safety critical function degraded states or failures, with or without operator intervention.
- Loss of flight and safety critical command and control data link(s) between the operator and aircraft.

Considerations for preparation of AMC:

1. Inspection of documentation verifies that design criteria and processes identify flight and safety critical functions, modes and states; flight and safety critical function degraded states and failures; and loss of flight and safety critical command and control data link(s).
2. Inspection of documentation verifies that design criteria and processes ensure air system responses are appropriate for the intended airspace.
3. Analysis verifies that flight and safety critical functions, modes and states for the air system, including the aircraft, are identified.
4. Analysis verifies that flight and safety critical function degraded states and failures are identified.
5. A combination of ground testing and simulation verifies that the air system (including aircraft) detects and responds appropriately, predictably, safely and in a timely manner.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P9 S2 U1788 00-970 P9 S2 U1613 00-970 P9 S2 UK901c
		STANAG Reference:	4671.171 4761.U1490
FAA Doc:		*EASA CS Reference:*	

4.1.7 Flight Termination System.

Design criteria ensure that the flight termination function operates reliably and in a timely manner when commanded.

Consideration should be given to:

a. Pilot accessibility to Termination System operation.

b. Likelihood of uncommanded operation of Termination System.

Considerations for preparation of AMC:

1. Design criteria are in place to ensure that the flight termination function operates reliably and appropriately, and only when required.
2. Test and simulation data verifies that the flight termination function operates appropriately, only when required, and results in the expected defined flight state(s).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P9 S3 U1412a 00-970 P9 S3 U1412b
		STANAG Reference:	4671.U1742
FAA Doc:		*EASA CS Reference:*	

4.2 TOOLS AND DATABASES.

4.2.1 Tool and database processes.

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;

b. Use of competent and accredited design organisations.

Considerations for preparation of AMC:

1. Ensuring processes are in place to demonstrate that tools and databases are validated and under configuration control.
2. Analysis, modelling and simulation tools and databases are of appropriate accuracy and fidelity for the intended applications.
3. Validation basis of design analysis, models and simulations is substantiated and based on actual hardware/software test data.

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 Selection of materials.

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, ageing, etc) on material properties adequately assessed for intended design.

Considerations for preparation of AMC:
1. Documentation confirms that materials are adequately covered by specifications as approved by the procuring agency.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 3.2.3-3.2.4 00-970 P1 3.2.8-3.2.20 00-970 P1 4.1.4 00-970 P1 4.1.8-4.1.12 00-970 P1 4.1.13-4.1.33 00-970 P1 6.2.54 00-970 P7 S2 L200 3-4 00-970 P13 1.4.5.9
		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 characteristics.
Key product characteristics (including critical characteristics) 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 and Flight Critical Components along with any associated tolerances;
d. Manufacturing process controls for specific key product characteristics.

Considerations for preparation of AMC:
1. Key product characteristic (including critical characteristics) and tolerance definitions are verified by inspection and analysis of program design documentation at the applicable levels of the product hierarchy;
2. 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		
DoD/MIL Doc:	ASC/EN Manufacturing Development Guide, Section 6.5, "Key Characteristics and Processes" AFI 63-501	*Def-Stan 00-970 Reference:*	00-970 P1 3.1.1 00-970 P1 4.0.1 00-970 P1 4.1.4 00-970 P1 4.3.1 00-970 P1 S6
		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

Information Sources			
			CS 29.602 CS 29.603 CS 29.609 CS 29.1309

4.4.2 Critical processes.
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 organisational approval (e.g. EMAR 21, EASA Part 21).

Considerations for preparation of AMC:
1. Design and process control documentation which records critical process capabilities and control plans.

Information Sources			
Comm'l Doc:	ASME Y14.5 "Dimensioning and Tolerancing" AS 9100		
DoD/MIL Doc:	ASC/EN Manufacturing Development Guide, Section 6.6, "Variability Reduction," for additional information on Cpk, Critical Processes, and Process Control Plans AFI 63-501	*Def-Stan 00-970 Reference:*	00-970 P1 4.1.8 00-970 P1 4.6.1-4.6.14 00-970 P1 4.7.1-4.7.9
		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 Critical process controls.
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.

Considerations for preparation of AMC:
1. First article inspections or first article tests to ensure design conformance.
2. Manufacturing process control data, and/or periodic hardware quality audits.

Information Sources			
Comm'l Doc:	ASME Y14.5 "Dimensioning and Tolerancing" AS 9100		
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:*	00-970 P1 4.1.4 00-970 P1 4.6 00-970 P1 4.7
		STANAG Reference:	4671.605 4671.613 4671.621
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 Quality system.
Production allowances and tolerances shall be within acceptable limits and assure conformance to design.

Consideration should be given to:
a. Suitable processes to ensure that the 'as-built' configuration matches the 'as designed' configuration.

b. Manufacturer approval in accordance with EASA CS 21A Sub-part G, or equivalent, assuring conformance to design through the application of suitable assurance processes.

Considerations for preparation of AMC:
1. Quality System policies, processes and procedures;
2. Internal and 3rd party audit against an appropriate standard (e.g. ISO 9001);
3. Continual recording of tolerances to ensure that variance does not creep over time.

Information Sources			
Comm'l Doc:	ASME Y14.5 "Dimensioning and Tolerancing" AS 9100		
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:*	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
		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 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 Merged with 4.4.3

4.5 OPERATOR'S AND MAINTENANCE MANUALS/TECHNICAL ORDERS.

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

Consideration should be given to:
a. Procedures for identifying and documenting all restrictions, warnings, and cautions.
b. Procedures for identifying which documents particular restrictions, warnings, and cautions should be recorded in (i.e. aircrew or groundcrew manual etc).
c. Regularly review of procedures for applicability and to ensure complete coverage of the aircraft.
d. Provision for updating original information as necessary.

Considerations for preparation of AMC:
1. Aircraft Flight Manual (or other document where appropriate) should record procedures, limitations, restrictions, warnings, cautions and notes.

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

Information Sources			
			CS 29.1529 CS 29.1541 CS 29.1581 CS 29.1589 CS 29 Appendix A

4.5.2 Line Deleted

4.5.3 Maintenance of safety.

Procedures shall be in place for establishing and managing 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 aircraft

Considerations for preparation of AMC:

1. Operator and maintenance manuals (i.e., change pages) provide processes for the recording of traceability to change events.

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 Functional baseline.

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.

Considerations for preparation of AMC:
1. Inspection of documentation verifies that the functional baseline has been documented and approved.
2. Inspection of the approved engineering documentation and engineering release system verifies adequate capture of the functional baseline.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-961E, Defense 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:*	

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

Consideration should be given to:
a. Methods used to document the allocated baseline - requirements capture.
b. Methods used to maintain, and amend as necessary, the allocated 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.

Considerations for preparation of AMC:
1. Inspection of documentation verifies that the allocated baseline has been documented and approved.
2. Inspection of the approved engineering documentation and engineering release system verifies adequate capture of the allocated baseline.

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

Information Sources			
	5.5.1 Configuration Baselines for definitions and purposes of configuration baselines		
FAA Doc:	14CFR reference: 23.21, 25.21, 23.601, 25.601, 23.1301, 25.1301	*EASA CS Reference:*	

4.6.3 Product baseline.

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.

Considerations for preparation of AMC:

1. Inspection of documentation verifies that the product baseline has been documented and approved.

2. Inspection of the approved engineering documentation and engineering release system verifies adequate capture of the product baseline.

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

4.6.4 Safety critical item configuration management.

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 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.

Considerations for preparation of AMC:

1. Inspection of CSA records and reports for CI/CSCIs verifies accuracy of the configuration status accounting system and that the system is able to track and record changes to the configuration.

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

Information Sources			
		Reference:	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

SECTION 5 - STRUCTURES

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

The aircraft 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, AAR 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 Design flight and ground loads.

Verify that the loads used in the design of the aircraft include the maximum, minimum and most critical combination of loads that can result from authorized ground and flight loading conditions for the aircraft. These include loads during piloted or autonomous manoeuvres, loss of control manoeuvres, gusts, pressurization, 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 (to include rapid depressurization) 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.

Consideration should be given to:

a. The loads used should consider critical combinations of configurations, gross weights, centres of gravity, thrust, power, altitudes, speeds, control surface deflections, control input variation and environmental factors and are used in the design of the aircraft.

b. Loads should be established for both primary and secondary structural components by selection of flight parameters likely to produce critical applied loads.

c. Symmetric and asymmetric flight operations considered should include symmetric and unsymmetrical fuel and payload loadings and adverse trim conditions.

d. Loads should also consider normal and failure modes of operation, including rapid pressurization and depressurization, and loads expected to be seen throughout the specific lifetime of usage.

Considerations for preparation of AMC:

Verification methods include analysis and inspection of documentation. Multiple variables and factors are needed to account for development of maximum and minimum load factors. The following compliance paragraphs are applicable to all standards.

a. Load factor selection considers the following items:
(1) Mission and flying techniques employed to execute the required mission.
(2) Weapon types and possible delivery methods.
(3) Anticipated weight and power plant growth.
(4) Maximum speed and time spent at maximum speed.
(5) Utilization of external stores and external fuel tanks.
(6) Training.
(7) Past experience with similar types of aircraft, mission, etc.
b. Load factors are defined which include appropriate ranges for symmetrical, asymmetrical, directional manoeuvres, and atmospheric turbulence for each configuration. The defined load factors are attainable by the aircraft, which should be demonstrated by analysis.

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
		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

Information Sources			
			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 Use of probabilistic vs deterministic loads.

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 aircraft, 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.

Consideration should be given to:

a. Combined load-strength probability analysis to predict the risk of detrimental structural deformation and structural failure in order to substantiate deterministic values.

b. Ensuring limit design loads are the maximum loads anticipated on the aircraft during its lifetime of service.

Considerations for preparation of AMC:

a. Correlated ground and flight loads analyses to provide details of magnitudes and distribution of all applied external loads.

b. Wind tunnel tests for development of aerodynamic loads.

c. Stiffness and ground vibration tests to update flexibility vs. rigid characteristics of analytical models.

d. Flight controls and aerodynamic flight tests inform aircraft simulation models.

e. Loads calibration tests to develop ground/flight load equations.

Information Sources			
Comm'l Doc:			
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

Information Sources			
			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

5.1.3 Foreign Object Damage (FOD).
Loads used in the design of the airframe shall include loads due to FOD from birds, hail, runway, taxiway, and ramp debris.

Consideration should be given to:
a. The aircraft should be designed to withstand the impact of FOD during any phase of taxi, take-off, flight and landing without loss of the aircraft, incapacitation of the pilot or crew and without detectable or undetectable damage to structural elements that result in reductions in structural strength below ultimate load carrying capability throughout the flight envelope (including manoeuvres).
b. The aircraft, including main and tail rotor systems, should be designed to ensure the capability of continued safe flight and landing following impact. Windshields should be designed to withstand impact without penetration. Fairings that may be used to shield or enclose flight critical components (e.g., flight control computers) should be designed with sufficient strength to ensure capability of continued safe flight and landing.

Considerations for preparation of AMC:
Verification methods include analysis, test, and inspection of documentation. Probabilistic analyses are performed to address FOD occurrences. Lab tests such as bird strike tests are performed to validate analytical model(s) and/or structural capabilities.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006 3.2.24	*Def-Stan 00-970 Reference:*	00-970 P1 3.1.2 00-970 P1 3.1.25 00-970 P1 4.9 00-970 P5 UK25.473b 00-970 P5 UK25.631a 00-970 P5 UK25.721b 00-970 P7 L206 2.11
		STANAG Reference:	4671 U631

Information Sources			
FAA Doc:		*EASA CS Reference:*	

5.1.4 Repeated loads.

All sources of repeated loads shall be considered 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 be included as sources of repeated loads: Manoeuvres, including load spectra covering, Gusts, Suppression Systems, Vibration and Acoustics, Landings, Buffeting, Effects of Pressurisation, Repeated Operations of Movable Structures, Stored Loads, Heat Flux and other loads including all ground loads.

Consideration should be given to:

a. Manoeuvres - Designed such that final spectra accounts for variables such as manoeuvre capability, tactics, and flight control laws reflecting projected average usage with the design utilization distribution and also usage such that 90% of the fleet (95% for all fatigue damaging conditions for rotorcraft) is expected to meet the service life.

b. Gusts - Designed such that gust load spectra developed by continuous turbulence analysis methods.

c. Suppression system which enhances ride qualities such as active oscillation control, gust alleviation, flutter suppression and terrain following.

d. Vibration and aeroacoustics.

e. Landings - Designed with cumulative occurrences of sink speed per 1000 landings, by type of landing, typical of projected service usage.

f. For rotorcraft - Designed with consideration of CF loads due to rotor start and stop cycle and torsional loads due to rotor braking cycles.

g. Buffet due to non-linear flow caused by vortex shedding during high angle of attack manoeuvers, rotary-wing blade stall and transonic shock instabilities - Designed such that analytical predictions of the structural response are generated during flight operations in the buffet regime and adjusted as needed by test data.

h. Ground operation loads - Designed with: (1) the number of hard and medium braking occurrences per full stop landing along with associated braking effects; (2) number of pivoting occurrences; and (3) definition of roughness characteristics of the airfield(s) to be utilized and the number of taxi operations on each airfield.

i. Pressurization - Designed with the total number of cycles projected for one service life.

j. Impact, operational, and residual loads occurring from the normal operation of movable structures such as control surfaces.

k. Store carriage and employment loads.

l. Heat flux.

Considerations for preparation of AMC:

Verification methods include analysis, test, and inspection of documentation, including:

1. Ground and flight loads analyses, correlated with test data.
2. For rotorcraft, flight load survey testing to gather loads data (e.g. maximum, minimum, average, frequency etc) for each regime in the usage spectrum.
3. Wind tunnel tests for development of buffet loads.
4. Buffet flight tests to verify analytical buffet predictions.
5. Incorporation of loads associated with the vibration and aeroacoustic environments.

Information Sources	

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

5.1.5 Propulsion loads.

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.

Consideration should be given to:

Flight loading conditions should be based on aircraft response to pilot induced or autonomous manoeuvres, loss of control manoeuvres, pressurization and turbulence. These conditions should consider both required, and expected to be encountered, critical combinations of configurations, gross weights, centres of gravity, thrust, power, altitudes, speeds, critical combinations of control system (surfaces and rotor system) deflections, control input variation and environmental factors and are used in the design of the aircraft. Considered flight loading conditions should include symmetric and asymmetric flight operations and should be established for both primary and secondary structural components by selection of flight parameters likely to produce critical applied loads. Symmetric and asymmetric flight operations include symmetric and unsymmetrical fuel and payload loadings and adverse trim conditions. Loads also consider normal and failure modes of operation, including rapid pressurization and depressurization, and loads expected to be seen throughout the specific lifetime of usage.

Considerations for preparation of AMC:

Verification methods include analysis and inspection of documentation. Multiple variables and factors account for development of maximum and minimum load factors. The following compliance paragraphs are applicable to all standards.

a. Load factor selection considers the following items:

(1) Mission and flying techniques employed to execute the required mission.

(2) Weapon types and possible delivery methods.

(3) Anticipated weight and power plant growth.

(4) Maximum speed and time spent at maximum speed.

(5) Utilization of external stores and external fuel tanks.

(6) Training.

(7) Past experience with similar types of aircraft, mission, etc..
b. Load factors are defined which include appropriate ranges for symmetrical, asymmetrical, directional manoeuvres, and atmospheric turbulence for each configuration. Analysis verifies that the load factors are attainable by the aircraft.

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
		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

5.1.6 Flight control and automatic control device loads.
In the generation of loads, consideration shall 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) including but not limited to such identified system degradations and failures as Tire failures, Propulsion system failures, Radome failures, Mechanical failures, Hydraulic failures, Flight control system failures, Transparency failures, Hung stores and other failures.

Consideration should be given to:
a. Stability augmentation.
b. Load and flutter alleviation.
c. Pilot cueing software and vibration control devices.

Considerations for preparation of AMC:
1. Verification methods include analyses, inspection of documentation, simulations, wind tunnel and ground and flight test.
2. Analyses and tests to verify normal operation and emergency associated modes of operation.
3. Correlated ground and flight loads analyses.
4. Wind tunnel tests for development of aerodynamic loads.
5. Flight controls and aerodynamic flight tests to ensure that aircraft simulation models are up-to-date.

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

Information Sources			
			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 CS 29.683 CS 29.1329

5.1.7 Analysis and testing of realistic flight loading conditions.

Flight loading conditions shall reflect all flight operations including but not limited to symmetric, asymmetric, directional and evasive manoeuvres, turbulence, AAR 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 include symmetric and asymmetric fuel and payload loadings as well as adverse trim conditions.

Consideration should be given to:

a. Both primary and secondary structural components.

b. Symmetric and asymmetric fuel and payload loadings (including external stores) and adverse trim conditions.

c. Symmetric manoeuvres including steady pitching, abrupt pitching, flaps down pull-outs, aerial delivery pull-outs, and emergency stores release.

d. Directional manoeuvres which include sideslips, rudder kicks, rudder reversals, asymmetrical thrust with zero sideslip, engine failure, and engine out operation.

g. Vertical and lateral gusts.

h. Pressurization.

m. Aeroelastic deformations.

Considerations for preparation of AMC:
1. Correlated flight loads analyses of magnitudes and distribution of all applied external loads.
2. Service and maximum loads expected to be encountered are established for operation under all flight conditions.
3. Wind tunnel tests for development of aerodynamic loads.
4. Stiffness and ground vibration tests to update flexibility vs. rigid characteristics of loads analytical model.
5. Flight controls and aerodynamic flight tests to update aircraft simulation models.
6. Loads calibration tests to develop flight load equations.

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

5.1.8 Analysis and testing of realistic ground loading conditions.
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).

Consideration should be given to:
a. Maximum landing touchdown vertical sink speeds
b. Crosswinds at take-off and landing
c. Landing touchdown roll, yaw, pitch attitude, and sink speed combinations
d. Bumps and dips during taxiing
e. Forces applied during jacking of the aircraft.
f. Ground loading conditions expected to be encountered in critical combinations of configurations.
g. Symmetric and asymmetric fuel and payload loadings and adverse trim conditions.
h. Ground operations consisting of taxing, turning, pivoting, braking, landing (including arrestment) and take-off.

i. Ground handling conditions consisting of towing, jacking, and hoisting.
j. Dynamic response and shimmy during ground operations as well as for rough runway conditions.
k. Ground winds as a result of weather and jet blast.

Considerations for preparation of AMC:
1. Tests are utilized to correlate analytical model and substantiate the design loads. Such as:
a. Correlated ground loads analyses including dynamic response analyses.
b. Dynamic stability/taxi analyses.
c. Ground vibration tests and landing gear shimmy lab tests.
d. Loads calibration tests.
2. Demonstrate the safe operation of the aircraft to the maximum attainable operating limits consistent with the structural design and to verify that loads used in the structural analysis and static tests are not exceeded at the structural design limits of the airspeed and load factor envelope.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.2.10, 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)	*Def-Stan 00-970 Reference:*	00-970 P1 3.1.4 00-970 P1 3.4.6 00-970 P1 3.1.7
		STANAG Reference:	4671.301 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 23.305 CS 23.561 CS 25.301 CS 25.303 CS 25.362 CS 25.561 CS 27.301 CS 27.305 CS 27.561 CS 29.301 CS 29.305 CS 29.561

5.1.9 Crash loads.

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 shall also not inhibit personnel egress.

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 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.

Considerations for preparation of AMC:
1. Correlated ground loads analyses which detail of magnitudes and distribution of all critical design loads are established.
2. Ground loads test demonstrations to correlate analytical models and substantiate the design loads.

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 development) 32 JSSG-2006 A.3.4.2, A.3.4.2.1, A.3.4.2.2, A.3.4.2.3, A.3.4.2.4, A.3.4.2.5, A.3.4.2.6, A.3.4.2.7, A.3.4.2.8, A.3.4.2.9, A.3.4.2.10, A.3.4.2.11, A.3.4.2.12, A.3.4.2.13	*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 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 Aeroelastic design - general.

Verify that the aircraft, 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 aircraft 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.

Consideration should be given to:

a. Ensuring that the margin of safety is maintained in equivalent airspeed (Ve) at all points on the VL/ML envelope of the aircraft, both at constant Mach number and separately, at constant altitude.

Considerations for preparation of AMC:

1. Flutter analyses of the complete aircraft.
2. Analyses involving variable fuel conditions for external tanks.
3. Divergence and buzz analyses as well as panel flutter analyses.
4. Wind tunnel and unsteady pressure model tests.
5. Laboratory tests such as component ground vibration and stiffness tests.
6. Complete aircraft ground vibration modal tests.
7. Aeroservoelastic ground tests.
8. Flight flutter tests and flight aeroservoelastic stability tests.

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; Section 29.687.	*EASA CS Reference:*	CS 23.409 CS 23.629 CS 23.677 CS 23.687 CS 25.409 CS 25.629 CS 25.677 CS 27.687 CS 29.687

5.2.2 Aeroelastic design - aeroservoelasticity.
aircraft components which are exposed to the airstream shall be designed to prevent any aeroelastic or aeroservoelastic 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 aircraft systems, such as the control systems coupling with the airframe, shall be controlled to prevent the occurrence of any aeroservoelastic instability.

Considerations for preparation of AMC:
a. Aeroservoelastic stability analyses correlated with aeroservoelastic ground tests that are conducted for the critical flight conditions, taking into account the flight control systems gain scheduling and control surface effectiveness.
b. Flight aeroservoelastic stability tests of the aircraft and its flight augmentation system.

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 Aeroelastic design - control surfaces and other components.

The 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.

All control surfaces and parts thereof shall be free from single-degree-of-freedom flutter, such as buzz.

All other aircraft components exposed to the airstream, such as spoilers, dive brakes, scoops, landing gear doors, weapon bay doors, ventral fins, movable inlet ramps, movable fairings, and blade antennae shall be free from aeroelastic instability.

Consideration should be given to:
a. Exposure to any natural or manmade environment throughout the service life of the airframe.
b. Ensuring control surface free play limits are not exceeded during the service life of the airframe.
c. Establishment of maximum allowable inertia properties.
d. Establishment of mass balance design requirements.

Considerations for preparation of AMC:
1. Flutter analyses including non-linear analyses of the aircraft's control surfaces and tabs.
2. Parametric variation flutter analyses.
3. Mass measurements of all control surfaces and tabs.
4. Rigidity, stiffness and wear tests which are conducted for both normal and design failure conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006 3.7	*Def-Stan 00-970 Reference:*	00-970 P1 3.5.10 00-970 P1 L45 3.5 00-970 P1 4.8 00-970 P7 L500
		STANAG Reference:	4671.629
FAA Doc:		*EASA CS Reference:*	CS 23.629 CS 25.629 CS 27.629 CS 29.629

5.2.4 Aeroelastic design - fail safe.
Following a structural failure, as well as for aircraft augmentation system failures, the aircraft shall be free from flutter, limited amplitude oscillations, divergence, and other related aeroelastic or aeroservoelastic instabilities, including limit cycle oscillations.

Consideration should be given to:
a. The designed margin of safety is maintained in equivalent airspeed (Ve) at all points on the VL/ML envelope of the aircraft, both at constant Mach number and separately, at constant altitude.
b. The total (aerodynamic plus structural) damping coefficient, for any critical flutter mode or for any significant dynamic response mode for all altitudes and flight speeds from minimum cruising speeds up to VL/ML.

Considerations for preparation of AMC:
a. Flutter analyses of the complete aircraft including external stores.
b. Divergence and buzz analyses as well as panel flutter analyses.

c. Wind tunnel and unsteady pressure model tests.
d. Laboratory tests such as component ground vibration and stiffness tests, mass measurements of control surfaces/tabs, balance weight attachment verification tests, damper qualification tests, thermoelastic tests as well as control surface, tab, and actuator rigidity, free play, and wear tests.
e. Complete aircraft ground vibration modal tests as well as aeroservoelastic ground tests.
f. Flight flutter tests and flight aeroservoelastic stability tests of the aircraft which substantiate the aircraft is free from aeroelastic instabilities.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006 3.7	*Def-Stan 00-970 Reference:*	00-970 P1 3.5.10 00-970 P1 L45 3.5 00-970 P1 4.8 00-970 P7 L500
		STANAG Reference:	4671.629
FAA Doc:		*EASA CS Reference:*	CS 23.629 CS 25.629 CS 27.629 CS 29.629

5.2.5 Environment design - sonic fatigue.
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.

Verify that the airframe structure (including cavities), equipment, and equipment provisions withstand the aeroacoustic loads and vibrations induced by the aeroacoustic environment for the aircraft specified service life and usage without cracking or functional impairment.

Consideration should be given to:
a. All aeroacoustic loads sources associated with the aircraft and its usage.
b. The application of an uncertainty factor for predicted aeroacoustic sound pressure levels.

Considerations for preparation of AMC:
Verification methods include analyses and tests. The following compliance instruments are applicable in addressing the standards:
a. Predictions of the near field aeroacoustic loads and fatigue life encompassing the aircraft service life and usage and the identified aeroacoustic load sources.
b. Wind tunnel, jet models which define acoustic levels.
c. Component acoustic fatigue tests based on fatigue life predictions.
d. Ground and flight aeroacoustic measurements from full scale test aircraft including internal noise measurements.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006: A.3.5.1, A.4.5.1	*Def-Stan 00-970 Reference:*	

Information Sources			
		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

5.2.6 Merged with 5.2.5

5.2.7 Environment design - personnel exposure to aircraft noise.

Requirements associated with Sound Pressure levels and personnel exposure are detailed at section 9.4.6.

5.2.8 Environment design - vibration.

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 aircraft systems not being fully functional.

Considerations for preparation of AMC:

Verification methods include analyses and tests. The following compliance instruments are applicable in addressing the standards:

a. Updated predictions of the vibration environment.

b. Component tests verifying analytical fatigue life predictions and which demonstrate that components meet service usage requirements in the vibration environment.

c. Ground and flight vibration tests which identify the response characteristics of the aircraft to forced vibrations and impulses.

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

5.2.9 Environment design - vents and louvers.

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.

Considerations for preparation of AMC:

Verification methods include analyses, tests and review of documentation, including: Analytical predictions of the effects of gas temperatures and airflow environment through vents and louvers, updated by component tests.

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 00-970 P1 4.24.32

Information Sources			
			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 Static strength verification.

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 105% 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.

Considerations for preparation of AMC:

1. 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.
2. Validation information includes formal checked and approved internal loads and strength analysis reports. Analytical distributions on major components are correlated with test instrumentation measurements of stress and strain from static test and the structural strength analysis is updated.

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

Information Sources			
			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 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 and Processes

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 using estimated minima derived using appropriate statistical compensations that take account of the criticality of the part and the nature of the selected material. 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.

Considerations for preparation of AMC:

1. Use of standardized test methods to establish metallic and composite material systems properties.
2. Documentation of materials and processes development and characterization and the selection process.
3. Second source materials (when established as a program requirement) are qualified and demonstrated through testing to have equivalent performance and fabrication characteristics as the selected baseline material.
4. Environmentally conditioned tests performed at the appropriate development test level to meet relevant design conditions.
5. Materials and processes characteristics for critical parts comply with the requirements of parts control processes.
6. Environmental compliance with all applicable environmental statutes and laws for all materials systems and processes selected is verified. This includes life cycle management of hazardous materials.

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	*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

Information Sources			
	compliance development)		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 CS 29.603 CS 29.605 CS 29.613 CS 27.625

5.3.3 Stress and strain design controls.

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 and 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.

Considerations for preparation of AMC:
1. Validation information includes formal checked and approved internal loads and strength analysis reports.
2. All castings are shown to satisfy the casting factor requirements by analysis.
3. 100 percent inspection by visual and magnetic particle or penetrant or approved equivalent non-destructive inspection methods.
4. High variability structure is shown to satisfy the requirements by analyses considering critical combinations of component characteristics.

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

Information Sources			
		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 CS 29.623 CS 29.783

5.4 DAMAGE TOLERANCE AND DURABILITY (FATIGUE)

5.4.1 Damage tolerance.

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 (1), (2), and (3) 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.

(1) 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.
(2) 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.
(3) 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.

Considerations for preparation of AMC:
1. Analyses and tests are performed to verify that the airframe structure meets the damage tolerance requirements.
2. Damage tolerance testing of a complete airframe to demonstrate compliance with requirements.
3. Fatigue reliability is appropriately considered within the fatigue methodology to avoid airworthiness impacts.
4. Flight load survey testing for each regime in the usage spectrum.

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 Durability.

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 (including consideration of adverse effects on safety, economic, operational, maintenance, repair, and modification costs throughout the intended service life). 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.

Considerations for AMC:
Verification methods include analysis, test, demonstration and inspection of documentation.
a. Durability analyses and tests are performed to verify that the airframe structure meets the durability requirements. A full scale airframe is durability tested to show that the structure meets the required service life which satisfies the following:
(1) The airframe is as close to structurally identical to the operational airframe, as practices allow. Significant differences require additional tests. When changes are not significant and additional testing cannot be accomplished, the re-design, repair, or modification is designed to three (3) lifetimes of the service life and usage.
(2) Two (2) lifetimes of testing plus the indicated inspections verify adequate durability.
(3) Test anomalies which occur within the duration of the test are evaluated for production and retrofit modifications. Test anomaly analysis is correlated to test results and adjusted results are shown to meet the durability requirements. Modifications are also shown to satisfy durability and damage tolerance requirements by either test or analysis at the discretion of the acquisition activity.
(4) The test is subjected to the design flight-by-flight loads spectra. Truncation, elimination, or substitution of load cycles is allowed subject to approval by the acquisition activity.
(5) Inspections are performed as an integral part of the durability tests and at the completion of testing and include design inspections, special inspections, and post-test teardown inspections.

(6) A minimum of two (2) lifetimes of durability testing is required to certify the airframe structure. A third lifetime testing is performed to support damage tolerance, repairs and modifications, usage changes, and life extension potential.
(7) Durability testing demonstrates that the onset of widespread fatigue damage will not occur during the design service life.
b. A flight-by-flight durability stress spectra and chemical and thermal environment spectra is developed and spectra interaction effects are accounted for.
c. For rotorcraft, a fatigue methodology and composite worst case usage spectrum are established and documented for the platform, including consideration of maneuvering loads, maneuver to maneuver load cycles, centrifugal (CF) loads due to rotor start and stop cycles, and torsional loads due to rotor braking cycles. Fatigue reliability is appropriately considered within the fatigue methodology to avoid airworthiness impacts (specifically, the methodology includes appropriate considerations of strength, loads, and usage variability). In addition to expanding the load factor, aeromechanical, or aero-elastic stability limitations, envelope expansion flight testing establishes airspeed, gross weight, center of gravity, and density altitude restrictions for each configuration to avoid level flight fatigue damage. Flight load survey testing is performed for each regime in the usage spectrum. For safe-life components, fatigue strength curve shapes and coefficients of variation are established in the fatigue methodology based on historical testing of similar components or based on coupon testing with appropriate adjustments due to full-scale component size and fabrication/design details. Component fatigue laboratory testing is performed to establish endurance limits with appropriate confidence, typically using identical instrumentation as used in the flight load survey testing. Fatigue substantiation analysis is performed in accordance with the applicable platform fatigue methodology based on flight and laboratory test data.

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 CS 29.609

5.4.3 Durability and damage tolerance control processes.

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 peening), 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 nondestructive 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 inservice 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.

Considerations for AMC:
1. Documented durability and damage tolerance control process.
2. Criteria for identifying and tracing fatigue/fracture critical parts are established and are approved by the procuring agency.
3. Complete nondestructive inspection requirements, process control requirements, and quality control requirements are established for maintenance.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-6870 for guidance in the development of Nondestructive 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 Corrosion prevention and control.
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.

Considerations for preparation of AMC:

1. The criteria for the selection of corrosion resistant materials and their subsequent treatments are defined.
2. The specific corrosion control and prevention measures are defined and established.
3. Organic and inorganic coatings for all airframe structural components and parts, and their associated selection criteria are defined.
4. Finishes for the airframe are defined.

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-6870 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	*EASA CS Reference:*	CS 23.575 CS 23.603 CS 23.609

Information Sources			
	Section 27.571, 27.603, 27.609 Section 29.571, 27.603, 27.609.		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 Evaluation of Mass Properties

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.

Considerations for preparation of AMC:

1. The mass properties (masses and centre of gravities) are verified by inspections, analyses, and actual vehicle weighing. Pieces and parts are verified by calculation as drawings are released and actual weighing when parts are available.

2. The Mass Properties are verified to reflect the current configuration of the aircraft and comply with defined mission requirements.

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

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

5.5.2 Weight and centre of gravity.

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 AAR, and release of external sling loads, and air drop of internal cargo.

Considerations for preparation of AMC:
1. The centre of gravity is verified to remain in the approved envelope for all mission scenarios.
2. The provisions for determining the weight, centre of gravity, and inertias are verified to adhere to stated requirements through inspections, analysis and test.
3. The centre of gravity envelope is verified to encompass all possible mission and production variations to ensure safe flight.
4. The fuel system calibration methodology is verified by determination of trapped fuel weight and centre of gravity, determination of unusable fuel weight and centre of gravity, determination of the usable fuel mass properties (weight and centre of gravity), and comparison of on-board fuel indicating equipment to actual usable fuel mass properties.

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		

Information Sources			
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 Manuals.

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.

Considerations for preparation of AMC:
1. Information contained within manuals is verified through analysis and test with actual part weighing of inventory items.

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

Information Sources			
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 Substantiation of release.

The structural evidence supporting the type certificate (or equivalent document) shall be 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.

Considerations for preparation of AMC:
1. Structural analysis (external loads, internal loads and strength, limited durability and damage tolerance, structural dynamics) is correlated to all available ground and flight testing.
2. Inspection and maintenance intervals are established to ensure continued safe operations
3. Wind tunnel tests. Component ground vibration, acoustic and stiffness tests. Mass measurements of control surfaces/tabs. Control surface, tab, and actuator rigidity, free play, and wear tests. Complete aircraft ground vibration modal tests. Aeroservoelastic ground tests. Updated predictions of near field aeroacoustic, vibration and internal noise. Ground loads test demonstrations, shimmy ground tests, rough runway tests.
4. Successful completion of appropriate flight flutter, vibroacoustics, loads testing (100%) and ultimate loads static tests.
5. Structural analyses are validated and updated for all testing such that the predictive methods ensure adequate strength levels and understanding of the structural behaviour.

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

Information Sources			
			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, 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.	*EASA CS Reference:*	CS 23.251 CS 23.343 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

Flight technology comprises the flight mechanics functional areas consisting of stability and control, flying qualities, flight control functions, external aerodynamics, internal aerodynamics and performance. The aircraft aerodynamic and stability configuration, engine/inlet/nozzle compatibility, performance and integrated control airworthiness of an aircraft 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).

EXAMPLES OF 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/failure modes and effects 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, sub-function, 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. Control laws.
30. Flight test reports.
31. Aerodynamic and air data uncertainty sensitivity studies.
32. Force and Moment Accounting system.
33. Mass properties: weights, centres of gravity, and inertias.

CERTIFICATION CRITERIA, STANDARDS AND METHODS OF COMPLIANCE

The following criteria, standards and methods of compliance apply to all aircraft and represent the minimum requirements necessary to establish, verify, and maintain an airworthy design.
The documents referenced under any criterion, standard and/or method of compliance may provide other standards. References provide supporting rationale, guidance, lessons learned and other important information useful in properly understanding, interpreting, and applying the relevant criterion, standard and/or method of compliance.

6.1 FLYING QUALITIES.

Flying qualities are those characteristics of the complete aircraft which allow the pilot/operator to perform to his/her satisfaction the flying tasks required to safely accomplish the mission, with an acceptable workload, while operating in the real world environment for which it is intended to operate. These characteristics are equally applicable for assuring the flight safety of an Unmanned Air System (UAS).

6.1.1 Preliminary steps in application of flying qualities.

6.1.1.1 Determining operational missions.

The operational mission requirements of the aircraft system, for which flight safety is to be assured, shall be determined and adequately defined.

Consideration should be given to:
a. Speed profiles,
b. Altitude profiles,
c. Environmental requirements,
d. Manoeuvre and flight handling requirements,
e. Dynamic and/or static stability requirements
f. Payload (fuel, cargo, munitions, etc.) requirements,
g. Take-off and landing performance requirements, including take-off/landing distance, climb performance and engine-off requirements,
h. Requirements for use of specific equipment (e.g. defensive aids, weapons, hoists, under-slung loads, fuel tank inerting systems, oxygen generation systems, etc.).

Considerations for preparation of AMC:
1. Verification methods include inspection of requirements, design, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797, section 4.1.1. ADS-33-PRF section 3.1.1 and 3.1.3. JSSG 2001B 3.1.1, 3.1.2	*Def-Stan 00-970 Reference:*	00-970 P1 S2.1.10 00-970 P1 S2.1.6 00-970 P1 S7.1.2 00-970 P5 UK25.321a 00-970 P7 L600 S5 00-970 P7 L600 S8
		STANAG Reference:	4671.U17 4671.U19 4671.1501
FAA Doc:		*EASA CS Reference:*	CS 23.21 CS 23.141

Information Sources			
			CS 23.1583 CS 25.21 CS 25.143 CS 25.1583 CS 27.21 CS 27.141 CS 27.1583 CS 29.21 CS 29.141 CS 29.1583

6.1.1.2 Determining applicable flight phases.

The aircraft's applicable flight phases shall be determined where safety of flight is to be assessed for the aircraft's operational mission(s).

Consideration should be given to:

a. Common aircraft flight phases including; Flight Planning, Push-back, Taxi, Take-off, Climb, Cruise, Descent, Final Approach, and Landing.

Considerations for preparation of AMC:

1. Verification methods include inspection of requirements, design, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 4.1.2 ADS-33-PRF section 3.1.1, 3.1.3 and 3.11. JSSG 2001B 3.1.1, 3.1.2	*Def-Stan 00-970 Reference:*	00-970 P1 S2.1.10 00-970 P1 S2.1.6 00-970 P1 S7.1.2 00-970 P5 UK25.321a 00-970 P7 L600 S5 00-970 P7 L600 S8
		STANAG Reference:	4671.U17 4671.U19 4671.1501
FAA Doc:		*EASA CS Reference:*	CS 23.21 CS 23.141 CS 23.1583 CS 25.21 CS 25.143 CS 25.1583 CS 27.21 CS 27.141 CS 27.1583 CS 29.21 CS 29.141 CS 29.1583

6.1.1.3 Defining aircraft states.

The aircraft's applicable aircraft States shall be determined where safety of flight is to be assessed.

This shall include determination of:
a. Configuration of internal and external stored assessing all possible combinations.
b. Configuration of aircraft loadings.
c. The aircraft's moments and products of inertia.
d. aircraft configurations.
e. aircraft normal states.
f. aircraft extreme states.
g. aircraft failure states.
h. aircraft special failure states.

Consideration should be given to:
a. The aircraft's average (mean, median and/or mode as considered appropriate) configuration for the expected aircraft missions.
b. The upper and lower limits of specific parameters of aircraft configuration (e.g. Longitudinal and Lateral Centre of Gravity masses and positions).
c. Limits of manoeuvre-based parameters, for example accelerations due to pitch, roll and yaw.

The State of the aircraft is defined by the selected configuration together with the functional status of each of the aircraft components or systems, throttle setting, weight, moments of inertia, centre–of–gravity position, and external store complement.
The trim setting and the positions of the pitch, roll, and yaw controls are not included in the definition of aircraft state since they are often specified in the requirements.

Considerations for preparation of AMC:
1. Verification methods include inspection of requirements, design, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 4.1.3.1-4.1.3.8 ADS-33-PRF section 3.1.6 JSSG 2001B 3.1.1, 3.1.2	*Def-Stan 00-970 Reference:*	00-970 P1 S2.1.10 00-970 P1 S2.1.6 00-970 P1 S7.1.2 00-970 P5 UK25.321a 00-970 P7 L600 S5 00-970 P7 L600 S8
		STANAG Reference:	4671.U17 4671.U19 4671.1501
FAA Doc:		*EASA CS Reference:*	CS 23.21 CS 23.141 CS 23.1583 CS 25.21 CS 25.143 CS 25.1583 CS 27.21 CS 27.141 CS 27.1583 CS 29.21 CS 29.141

Information Sources			
			CS 29.1583

6.1.1.4 Defining the regions of handling.

The aircraft's region of handling shall be determined where safety of flight is to be assessed.
This should include:
a. Regions of Satisfactory Handling,
b. Regions of Tolerable Handling, and,
c. Regions of Recoverable Handling.

Consideration should be given to:
a. Definitions of 'Satisfactory', 'Tolerable' and 'Recoverable' handling. Such definitions could be considered equivalent to Cooper-Harper ratings as follows:
i. Satisfactory = Rating 1-3,
ii. Tolerable = Rating 4-6,
iii. Recoverable = Rating 7-9

Considerations for preparation of AMC:
1. Verification methods include inspection of requirements, design, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 4.1.4 JSSG 2001B 3.1.1, 3.1.2	*Def-Stan 00-970 Reference:*	00-970 P1 S2.1.10 00-970 P1 S2.1.6 00-970 P1 S7.1.2 00-970 P5 UK25.321a 00-970 P7 L600 S5 00-970 P7 L600 S8
		STANAG Reference:	4671.U17 4671.U19 4671.1501
FAA Doc:		*EASA CS Reference:*	CS 23.21 CS 23.141 CS 23.1583 CS 25.21 CS 25.143 CS 25.1583 CS 27.21 CS 27.141 CS 27.1583 CS 29.21 CS 29.141 CS 29.1583

6.1.1.5 Modelling, simulation, analysis tools and databases.

Modelling, simulation and analysis tools and databases shall have appropriate fidelity and shall accurately represent the aircraft for evaluating airworthiness criteria and safety of flight.

Consideration should be given to:

a. The demonstration of an effective verification, validation and accreditation (VV&A) process.
b. Configuration control across all such tools to assure currency and traceability.
c. Verification and validation that predicted data, as well as offline and piloted simulation results, are generated by the most appropriate and accurate tools and processes.

Considerations for preparation of AMC:
1. Verification methods include inspection of maturity, fidelity and accuracy of analysis, modelling and simulation tools and databases, as well as the processes in place to assure their currency, traceability and configuration control. Analysis, modelling and simulation tools and databases, including the verification and validation of their results, reflect industry best practices for the purpose of their intended use.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001B 3.1.1, 3.1.2	*Def-Stan 00-970 Reference:*	00-970 P1 S2.1.10 00-970 P1 S2.1.6 00-970 P1 S7.1.2 00-970 P5 UK25.321a 00-970 P7 L600 S5 00-970 P7 L600 S8
		STANAG Reference:	4671.U17 4671.U19 4671.1501
FAA Doc:		*EASA CS Reference:*	CS 23.21 CS 23.141 CS 23.1583 CS 25.21 CS 25.143 CS 25.1583 CS 27.21 CS 27.141 CS 27.1583 CS 29.21 CS 29.141 CS 29.1583

6.1.2 Primary flying qualities.
Flying qualities shall be defined and assessed for safety of flight for all Aircraft States (as referenced in section 6.1.1.3 of this handbook) encountered in the Flight Phases and tasks (as referenced in section 6.1.1.2 of this handbook) of the operational missions (as referenced in section 6.1.1.1 of this handbook).
This should specifically include (but is not limited to):
a. Ensuring that all aircraft states have been considered for all expected environmental conditions.
b. Ensuring that allowable levels of aircraft normal states have been defined and assessed.
c. Ensuring that allowable levels of aircraft extreme states have been defined and assessed.
d. Ensuring that primary requirements for aircraft failure states have been defined and assessed.

Consideration should be given to:

a. Combinations of Aircraft States, Flight Phases/Tasks and Operational Missions both within the bounds of the aircraft specification (and therefore expected to be encountered in the operation of the aircraft) and outside of the bounds of the aircraft specification.
b. The definition and assessment of flying qualities where combinations are considered within the bounds of the aircraft specification.
c. The specification of combinations considered outside of the bounds of the aircraft specification, (for example as a defined flight envelope or as a limitation in the Aircraft Flight Manual).
d. Preventative measures to prevent the aircraft entering a combination considered outside of the aircraft specification.

Considerations for preparation of AMC:
1. Verification methods include analysis, simulation, and inspection of requirements, design, and configuration documentation.
2. Aircraft states will typically be defined as follows:
i. Normal aircraft states typically cover operation of the aircraft within its defined limits (e.g. centre of gravity limits, airspeeds, etc.);
ii. Extreme aircraft states typically include operation of the aircraft in exceedance of 1 or more of its defined limits;
iii. Failure aircraft states typically include operation with 1 or more failure. Where failures are determined to be reasonably probable, it may be appropriate to include such failures within the Normal aircraft state.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.1. ADS-33-PRF section 3.1 . JSSG 2001B 3.1.1, 3.1.2	*Def-Stan 00-970 Reference:*	00-970 P1 S2.1.10 00-970 P1 S2.1.6 00-970 P1 S7.1.2 00-970 P5 UK25.321a 00-970 P7 L600 S5 00-970 P7 L600 S8
		STANAG Reference:	4671.U17 4671.U19 4671.1501
FAA Doc:		*EASA CS Reference:*	CS 23.21 CS 23.141 CS 23.1583 CS 25.21 CS 25.143 CS 25.1583 CS 27.21 CS 27.141 CS 27.1583 CS 29.21 CS 29.141 CS 29.1583

6.1.3 Flying qualities in degraded environmental conditions.
The effect that degraded environmental conditions have on the aircraft's flight handling qualities shall be defined and assessed considering the effect on the safety of flight.

Consideration should be given to:
a. The environmental conditions for which the aircraft is cleared to fly (as detailed in the aircraft specification) and the transitory environmental conditions that could be anticipated in the normal operation of the aircraft in the environments that it is cleared to fly in.
b. Degraded environmental conditions including (as appropriate):
i. Degradation of the ambient environmental parameters (temperature, humidity, pressure etc.)
ii. Operation in degraded visual environments (e.g. white-out and brown-out conditions)

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001B 3.2	*Def-Stan 00-970 Reference:*	00-970 P1 S2.1.11 00-970 P1 S7.2 00-970 P7 L100 S8.1 00-970 P7 L600 S6 00-970 P7 L101
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.3.1 Flying qualities in icing conditions.
Flying qualities in icing conditions shall be defined and assessed for safety of flight.

Consideration should be given to:
a. The icing conditions for which the aircraft is cleared to fly (as specified in the aircraft specification) and the transitory icing conditions that could be anticipated in the normal operation of the aircraft in the environments that it is cleared to fly in.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001B 3.2 MIL-HDBK-516C 6.1.3.1	*Def-Stan 00-970 Reference:*	00-970 P1 S2.1.11 00-970 P1 S7.2 00-970 P7 L100 S8.1 00-970 P7 L600 S6, 00-970 P7 L101
		STANAG Reference:	4671.U292 4671.905 4671.929 4671.1419
FAA Doc:		*EASA CS*	CS 23.1419

Information Sources			
		Reference:	CS 25.1419 CS 27.1419 CS 29.1419

6.1.4 Control margin.

Control margins and their effect on flight handling shall be defined and assessed for safety of flight.

Consideration should be given to:

a. Limits in control authority for each flight control surface both in isolation and in conjunction with other surfaces. Where appropriate, this should include:

i. Consideration of limits on flight control surfaces that cause a moment around different aircraft axes--for example the concurrent application of longitudinal control surfaces (e.g. ailerons) and lateral control surfaces (e.g. elevators), and,

ii. Consideration of limits on flight control surfaces that cause a moment around the same aircraft axis--for example the concurrent application of lateral control surfaces (e.g. elevators and horizontal tail plane).

Considerations for preparation of AMC:

1. Verification methods include analysis, simulation, and inspection of requirements, design, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001B 3.3.11.1.3 MIL-HDBK-516B 6.1.4	*Def-Stan 00-970 Reference:*	00-970 P1 S4.10.8 00-970 P7 L600 S12 00-970 P7 L601 S6 00-970 P7 L602 S6 00-970 P7 L603 S6 00-970 P7 L607 S6
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.5 General flying qualities

6.1.5.1 Approach to dangerous flight conditions.

Flight handling qualities in approaches to dangerous flight conditions shall be defined and assessed for safety of flight.

Consideration should be given to:

a. The pilots' ability to readily and safely return to the Service Flight Envelope without exceptional skill or technique.

Considerations for preparation of AMC:

1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516C 6.1.5.1	*Def-Stan 00-970 Reference:*	00-970 P1 S2.1.32 00-970 P1 S2.24 00-970 P7 L600 S8.3
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.5.2 Buffet.
Buffet characteristics shall be defined and assessed for safety of flight.

Consideration should be given to:
a. Prevention of degradation of the aircraft flight handling qualities below those stated in the aircraft specification for the specified aircraft states, phases/tasks and missions.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001B C.3.3 MIL-HDBK-516C 6.1.5.2	*Def-Stan 00-970 Reference:*	00-970 P5 UK25.143a 00-970 P7 L600 S13.1.1
		STANAG Reference:	4671.251 4671.253
FAA Doc:		*EASA CS Reference:*	CS 23.251 CS 25.251

6.1.5.3 Release of stores.
The effect of release of stores shall be defined and assessed for safety of flight.

Consideration should be given to:
a. Prevention of the degradation of the aircraft flight handling qualities below those stated in the aircraft specification for the specified aircraft states, phases/tasks and missions.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516C 6.1.5.3	*Def-Stan 00-970 Reference:*	00-970 P1 S2.24.17 00-970 P1 S2.24.18 00-970 P1 S7.1.7 00-970 P5 UK25.143a 00-970 P5 UK25.3.1.1

Information Sources			
			00-970 P7 L600 S13.1.2 00-970 P7 L601 S6.4.2 00-970 P7 L602 S6.4.2 00-970 P7 L604 S5.1 00-970 P7 L903 S7.8.2 00-970 P7 L903 S7.5.2
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.5.4 Effects of armament delivery and special equipment.
The effects of armament delivery and special equipment on flight handling shall be defined and assessed for safety of flight

Consideration should be given to:
a. Prevention of degradation of the aircraft flight handling qualities below those stated in the aircraft specification for the specified aircraft states, phases/tasks and missions.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516C 6.1.5.4	*Def-Stan 00-970 Reference:*	00-970 P1 S2.17.7 00-970 P1 S2.17.33 00-970 P1 S2.24.19, 00-970 P5 UK25.143a
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.5.5 Failures.
Safety of flight following failures shall be verified.

Consideration should be given to:
a. The probability of a single or combination of failures that would cause the aircraft to be in an unsafe condition.
b. The effect of failure(s) for the specified range of aircraft states, phases/tasks and missions.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	JSSG 2001B section 3.3.11.1.1.3 MIL-HDBK-516C 6.1.5.5	*Def-Stan 00-970 Reference:*	00-970 P1 S1.1.13 00-970 P1 S1.1.34 00-970 P1 S2.1.22 00-970 P1 S2.1.38 00-970 P1 S2.8.25 00-970 P1 S2.10.17 00-970 P1 S2.14.22 00-970 P1 S2.14.24 00-970 P1 S2.15.19 00-970 P7 L100 S9.1.1 00-970 P7 L600 S3.5.1 00-970 P7 L600 S7.2.2 00-970 P7 L600 S8.1.1
		STANAG Reference:	4671.51 4671.143 4671.367 4671.459 4671.572 4671.573 4671.787 4671.903 4671.933 4671.953 4671.1331 4671.1351 4671.1461 4671.U1485 4671.1585
FAA Doc:		*EASA CS Reference:*	CS 23.51 CS 23.143 CS 23.145 CS 23.147 CS 23.367 CS 23.441 CS 23.573 CS 23.574 CS 23.672 CS 23.841 CS 23.853 CS 23.933 CS 23.937 CS 23.953 CS 23.959 CS 23.1306 CS 23.1308 CS 23.1309 CS 23.1353 CS 23.1461

Information Sources			
			CS 25.105 CS 25.143 CS 25.149 CS 25.207 CS 25.302 CS 25.307 CS 25.362 CS 25.365 CS 25.367 CS 25.571 CS 25.603 CS 25.629 CS 25.671 CS 25.672 CS 25.734 CS 25.735 CS 25.831 CS 25.841 CS 25.869 CS 25.933 CS 25.937 CS 25.952 CS 25.981 CS 25.991 CS 25.1307 CS 25.1316 CS 25.1322 CS 25.1331 CS 25.1333 CS 25.1351 CS 25.1353 CS 25.1438 CS 25.1461 CS 27.75 CS 27.79 CS 27.141 CS 27.143 CS 27.395 CS 27.571 CS 27.573 CS 27.602 CS 27.603 CS 27.672 CS 27.674 CS 27.691 CS 27.903 CS 27.991

Information Sources			
			CS 27.1353 CS 27.1461 CS 29.55 CS 29.59 CS 29.61 CS 29.62 CS 29.77 CS 29.79 CS 29.83 CS 29.87 CS 29.141 CS 29.143 CS 29.395 CS 29.547 CS 29.573 CS 29.602 CS 29.672 CS 29.674 CS 29.691 CS 29.903 CS 29.908 CS 29.917 CS 29.923 CS 29.991 CS 29.1303 CS 29.1309 CS 29.1331 CS 29.1353 CS 29.1355 CS 29.1461 CS 29.1517

6.1.5.6 Pilot induced oscillations.

It shall be verified that there are no pilot induced oscillation (PIO) tendencies

Note that:

a. PIO (also known as aircraft-pilot coupling (APC)) is an interaction between a pilot and aircraft that causes sustained aircraft oscillations to occur over a range of amplitudes and frequencies.

b. Such oscillations can occur about each of the aircraft's directional axes (longitudinal, lateral and normal), and as such oscillations about each axis should be considered..

c. Oscillations can occur in stable, straight and level flight, or while performing a manoeuvre such as a banked turn or a descent

Consideration should be given to:

a. The effect of control surface movement and trim settings when determining the presence of PIO tendencies.

b. Variations in other aircraft parameters such as the aircraft's moments of inertia (mass and Centre of Gravity) and the engine(s) thrust vector (magnitude and direction of thrust).

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.1.6 ADS-33-PRF section 3.1.16 JSSG 2001B section C.3.7 MIL-HDBK-516C 6.1.5.6	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.5.7 Residual oscillations.
It shall be verified that residual oscillations characteristics are safe.
Note that:
a. Residual oscillations are the oscillations in aircraft movement following completion of a manoeuvre.
b. Such oscillations can occur about each of the aircraft's directional axes (longitudinal, lateral and normal).

Consideration should be given to:
a. Oscillation about each aircraft axis both in isolation and in combination.
b. Variations in other aircraft parameters such as the aircraft's moments of inertia (mass and Centre of Gravity) and the engine(s) thrust vector (magnitude and direction of thrust).

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.1.7 ADS-33-PRF section 3.1.17 JSSG 2001B Appendix C.3.8 MIL-HDBK-516C 6.1.5.7	*Def-Stan 00-970 Reference:*	00-970 P1 S2.21.8 00-970 P1 S2.22.1 00-970 P1 S2.22.7 00-970 P1 S2.25.14 00-970 P1 S2.25.45 00-970 P1 S2.25.50 00-970 P7 L600 S11.7.1
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.5.8 Ride qualities.
The aircraft ground handling/ride qualities 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, take-off, 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 take-off (including rejected take-off) 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.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.1.8 MIL-HDBK-516C 6.1.5.8	*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

Information Sources			
			CS 25.745 CS 27.231 CS 27.235 CS 27.239 CS 27.241 CS 29.231 CS 29.235 CS 29.239 CS 29.241

6.1.6 Longitudinal flying qualities

6.1.6.1 Longitudinal response to the pitch controller.

It shall be verified that the longitudinal response to the pitch controller is safe.

Specific aspects that should be considered include:

a. Lower-order equivalent system dynamics (including phugoid dynamics and short-period dynamics);
b. Time response of the pitch controller;
c. Frequency response of the pitch controller;
d. Closed-loop analysis with a pilot model;
e. Pilot Induced Oscillations (PIO);
f. Normal acceleration at the pilot station;
g. Adequacy of longitudinal control power;
h. Safety of longitudinal control forces and displacements.

Consideration should be given to:

a. The effect of variations in flight dynamics of pitch controlling flight surfaces (e.g. the angle-of-attack of wing surfaces, airspeed, etc.) and other pitching moments (e.g. the engine thrust vector).

Considerations for preparation of AMC:

1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.2.1 MIL-HDBK-516C 6.1.6.1	*Def-Stan 00-970 Reference:*	00-970 P7 L601 S2.3
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.6.2 Longitudinal response to the designated flight path controller.

It shall be verified that the longitudinal response to the designated flight path controller is safe.

Consideration should be given to:

a. The effect of variations in flight dynamics of pitch controlling flight surfaces (e.g. the angle-of-attack of wing surfaces, airspeed, etc.) and other pitching moments (e.g. the engine thrust vector).

Considerations for preparation of AMC:

1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516C 6.1.6.2	*Def-Stan 00-970 Reference:*	00-970 P7 L601 S2.3
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.7 Lateral-directional flying qualities.
Directional flying qualities (i.e. bank and yaw qualities) shall be defined and assessed for safety of flight.

Consideration should be given to:
a. The assessment of handling qualities for bank and yaw both separately and together. Rotation about the longitudinal aircraft axis (bank) often induces rotation about the normal aircraft axis (yaw) and vice-versa (i.e. adverse yaw).
b. Variations in flight configurations. Variation in the aircraft's moments of inertia (mass and Centre of Gravity) and engine thrust settings will have an effect on the directional handling qualities for example.

Considerations for preparation of AMC:
1. Verification methods include analysis, simulation, and inspection of requirements, design, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.3 JSSG 2001B section 3.3.11.1 MIL-HDBK-516C 6.1.7	*Def-Stan 00-970 Reference:*	00-970 P1 S2.8 00-970 P5 UK25.147a 00-970 P7 L602
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.147 CS 25.147 CS 27.143 CS 29.143

6.1.7.1 Lateral-directional modal characteristics.
Oscillatory directional flying qualities shall be assessed for safety of flight.

Consideration should be given to:
a. Handling qualities for bank and yaw both separately and together. Rotation about the longitudinal aircraft axis (bank) often induces rotation about the normal aircraft axis (yaw) and vice-versa (i.e. adverse yaw).
b. Variations in flight configurations. Variation in the aircraft's moments of inertia (mass and Centre of Gravity) and engine thrust settings will have an effect on the directional handling qualities for example.

c. The frequency and amplitude of flight handling oscillatory characteristics including other oscillatory aircraft characteristics (such as fuel sloshing, cargo movement, pilot/auto-pilot inputs etc.). Oscillations should have a frequency sufficiently different so as not to induce resonance.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.3.1 including 5.2.3.1.1-5.2.3.1.5. ADS-33-PRF, 3.4.9 MIL-HDBK-516C 6.1.7	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.7.2 Lateral-directional dynamic response characteristics.
The aircraft's dynamic response to directional inputs shall be defined and assessed as safe.

Consideration should be given to:
a. Combinations of yaw and bank inputs. Yaw and bank outputs should be considered for yaw inputs, bank inputs and yaw and bank inputs concurrently.
b. Instantaneous inputs. Both small and large instantaneous inputs should be considered.
c. Progressive inputs.
d. Oscillatory inputs, at a variety of frequencies and amplitudes to ensure that resonance can be suitably prevented.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.3.2 including 5.2.3.2.1-5.2.3.2.8 ADS-33-PRF sections 3.3.2, 3.3.3, 3.3.4, 3.3.5, 3.3.6, 3.3.8, 3.4.6, 3.4.7 and 3.4.8 JSSG 2001B section 3.3.11.1 MIL-HDBK-516C 6.1.7.2	*Def-Stan 00-970 Reference:*	00-970 P1 S2.8 00-970 P5 UK25.147a 00-970 P7 L602
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.147 CS 25.147 CS 27.143 CS 29.143

6.1.7.3 Roll PIO.
PIO in roll shall be prevented.

Consideration should be given to:
a. Direct and Indirect sources of roll. All inputs that can lead to a roll output should be considered (e.g. ailerons, asymmetric spoilers/airbrakes, rudder etc.) to ensure that all potential sources of PIO in roll are assessed.
b. Oscillating pilot inputs. A suitable variety of control input frequencies and magnitudes should be considered to ensure that PIO in roll is suitably prevented.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.3.3 ADS-33-PRF section 3.1.16 MIL-HDBK-516C 6.1.7.3	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.7.4 Yaw PIO.
PIO in yaw shall be prevented.

Consideration should be given to:
a. Direct and Indirect sources of yaw. All inputs that can lead to a yaw output should be considered (e.g. elevators, horizontal tail-plane (or all-moving tail-plane), canards, engine thrust vector, etc.) to ensure that all potential sources of PIO in roll are assessed.
b. Oscillating pilot inputs. A suitable variety of control input frequencies and magnitudes should be considered to ensure that PIO in yaw is suitably prevented.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.3.4 ADS-33-PRF section 3.1.16 MIL-HDBK-516C 6.1.7.4	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.7.5 Lateral-directional dynamic response characteristics.
The effectiveness of the pilot's control of roll shall be safe.

Consideration should be given to:

a. Direct and Indirect sources of roll. All inputs that can lead to a roll output should be considered (e.g. ailerons, asymmetric spoilers/airbrakes, rudder etc.) to ensure that all potential sources of roll are considered.
b. Concurrent application of multiple inputs. Where it is possible for more than one source of roll to be applied by the pilot concurrently, the concurrent application of the sources should be considered.
c. Failures. For failures or other events that could reasonably occur in service that could affect the pilot's effective control of roll (for example the asymmetric jettison of stores or asymmetric failure of flight control surfaces) the effect of the event on the pilot's ability to control the aircraft should be considered.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 sections 5.2.3.5 including 5.2.3.5.1-5.2.3.5.3 JSSG 2001B section 3.3.11.1 MIL-HDBK-516C 6.1.7.5	*Def-Stan 00-970 Reference:*	00-970 P1 S2.8 00-970 P5 UK25.147a 00-970 P7 L602
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.147 CS 25.147 CS 27.143 CS 29.143

6.1.7.6 Lateral-directional control with speed changes.
Directional control of the aircraft shall be safe despite changes in the aircraft's speed.

Consideration should be given to:
a. Varying flying conditions. Directional control should be maintained through changes in speed in both straight and level flight, and through pitch, roll and yaw manoeuvres.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.3.6 including 5.2.3.6.1 ADS-33-PRF section 3.4.8.4 JSSG 2001B section 3.3.11.1 MIL-HDBK-516C 6.1.7.2	*Def-Stan 00-970 Reference:*	00-970 P1 S2.8 00-970 P5 UK25.147a 00-970 P7 L602
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.147 CS 25.147 CS 27.143 CS 29.143

6.1.7.7 Yaw control forces in wave-off (go-around).
Yaw control forces during wave-off/go-around shall be safe.

Consideration should be given to:
a. The effect of side-winds expected in service.
b. The effect of asymmetric flying control surfaces that could be reasonably be anticipated in service.
c. The effect of asymmetric thrust due to the failure of one or more engines (as would be reasonably anticipated in service).

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.3.7 MIL-HDBK-516C 6.1.7.2	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.7.8 Lateral-directional control forces and displacements.
Forces and Displacements induced in the directional controls shall be assessed as safe.

Consideration should be given to:
a. The pilot's ergonomic environment. Considerations may include the dimensions of the cockpit/flight-deck, seat position(s), positions of controls, the effect of any equipment that may be added/removed such as ballistic protection, etc.
b. Variations in pilots' anthropomorphic dimensions. Ranges of anthropomorphic dimensions considered should reflect the variation in sizes of aircrew anticipated to pilot the aircraft in service.
c. Clothing and Aircrew Equipment Assemblies (e.g. helmets, respirators, Chemical, Biological, Radiological and Nuclear (CBRN) equipment, etc.).
d. The magnitude and direction of control input forces, reflecting the strength of aircrew anticipated to pilot the aircraft in service.
e. Both instantaneous application of control forces as well as progressive application.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.3.8 including sections 5.2.3.8.1 - 5.2.3.8.6 ADS-33-PRF section 3.6 JSSG 2001B section 3.4.3 MIL-HDBK-516C 6.1.7.8	*Def-Stan 00-970 Reference:*	00-970 P1 S4.19.2 00-970 P1 S4.19.2 00-970 P7 L600 S10.1.4
		STANAG Reference:	

Information Sources			
FAA Doc:		*EASA CS Reference:*	CS 23.143 CS 25.143 CS 27.151 CS 29.151

6.1.7.9 Steady sideslips.
The steady sideslips that the aircraft can undergo shall be assessed as safe.

Consideration should be given to:
a. Altitude and yaw angles. Safety of sideslips should be assured through the range of aircraft attitudes where steady sideslip can occur, considering a variety of pitch, roll and yaw angles.
b. Aircraft configuration. The effect of variation in aircraft configuration (such as moments of inertia, engine thrust, flap setting, etc.) should be considered.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.3.9 including sections 5.2.3.9.1 - 5.2.3.9.4 ADS-33-PRF section 3.4.10 MIL-HDBK-516C 6.1.7.9	*Def-Stan 00-970 Reference:*	00-970 P1 S4.10.8 00-970 P5 UK25.349a 00-970 P7 L602 S3
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.7.10 Lateral-directional control in crosswinds.
Directional control and safety of flight shall be assured for crosswinds up to the limit(s) detailed in the aircraft specification and/or through the wind vectors (magnitudes and directions/azimuths) detailed in the aircraft specification.

Consideration should be given to:
a. The definition of limits. In specifying the limits for crosswinds, it may be more appropriate to prescribe a single magnitude crosswind limit, where the wind vector is assumed to be acting perpendicular to the aircraft's heading, or to prescribe a vector-plot of allowable wind-speed magnitudes and directions. The former approach is typically more appropriate for fixed wing aircraft where the crosswind magnitude is relatively small in comparison to the aircraft's airspeed while the latter approach is typically more appropriate to rotary wing aircraft where the aircraft's airspeed can be much smaller (for example in hover or approach to land).
b. Flight configuration. Variation in the aircraft's moments of inertia (mass and Centre of Gravity) and engine thrust settings will have an effect on the directional handling qualities for example.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.3.10 including 5.3.2.10.1-5.2.3.10.3. ADS-33-PRF section 3.9.3 MIL-HDBK-516C 6.1.7.10	*Def-Stan 00-970 Reference:*	00-970 P1 S2.5.22 00-970 P1 S2.5.23 00-970 P1 S2.22.28-2.22.32.
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.237 CS 27.143 CS 29.143

6.1.7.11 Lateral-directional control with asymmetric thrust.
Directional control and safety of flight shall be assured for asymmetric thrust.

Consideration should be given to:
a. Instantaneous and progressive thrust asymmetry. Thrust asymmetry can have a variety of causes; for example total or partial failure can cause an engine to produce less thrust than other engines, or throttle settings can purposefully create differences in thrust. Progressive asymmetry should therefore be considered in addition to instantaneous asymmetry.
b. Increases in drag caused by a 'wind-milling' or stopped engine. For propeller engines, the ability to feather the propellers should not be assumed.
c. Engine criticality. Often, compliance is shown for the failure of the 'critical engine' only. Since the engines installed on an aircraft often have the same thrust capabilities and drag characteristics, the engine whose failure causes the greatest thrust asymmetry is generally the furthest outboard.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.3.11 including 5.3.2.11.1-5.2.3.11.5. MIL-HDBK-516C 6.1.7.11	*Def-Stan 00-970 Reference:*	00-970 P1 S2.14.
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.147 CS 25.147

6.1.7.12 Wings-level turn.
The performance of a wings-level turn using the yaw controller should be assessed as safe.

Consideration should be given to:
a. Turn co-ordination. Generally, the introduction of yaw in forward flight to turn an aircraft would cause the aircraft to bank due to the greater airspeed of the wing on the outside of the turn (causing a wing-up moment) and the lesser airspeed of the wing on the inside of the turn (causing a wing-down moment). The performance of a wings-level turn may therefore require preventative control of roll.

Considerations for preparation of AMC:

1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.3.12 including 5.3.2.12.1-5.2.3.12.4. MIL-HDBK-516C 6.1.7.12	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.7.13 Lateral translation.
Lateral translation of the aircraft shall be assessed as safe.

Consideration should be given to:
a. All sources of lateral velocities and accelerations, including:
(1) The introduction of lateral accelerations along the aircraft due to the yawing motion of flight manoeuvres.
(2) Lateral velocities alongside a significant longitudinal velocity (i.e. slight lateral translation in forward flight).
(3) Lateral velocities without a significant longitudinal velocity (i.e. lateral translation when in hover).

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.3.13 including 5.3.2.13.1-5.2.3.13.4. MIL-HDBK-516C 6.1.7.13	*Def-Stan 00-970 Reference:*	00-970 P7 L602
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.8 Cross-axis responses.
The aircraft's cross-axis responses to control inputs shall be defined and assessed for safety of flight.
This shall include (but is not limited to):
a. Definition and assessment of longitudinal (roll) control forces in sideslip flight.
b. Definition and assessment of directional (roll and yaw) control forces in dive and pull-out flight.
c. Definition and assessment of all cross-axis control forces in roll manoeuvres.
d. Definition and assessment of Pitch and Roll control crosstalk (i.e. the movement of the pitch controller inducing a roll and movement of the roll controller inducing a pitch change).
e. Definition and assessment of the aircraft's 'Control Harmony' (the balancing of control input forces) to ensure that required input forces are not disproportionate from one axis control to another.
f. Definition and assessment of control cross-coupling safety.

Consideration should be given to:

a. The force that can be applied at each of the aircraft's controls and the force required for a given level of control output--forces should be balanced proportionately. The strength of pilots (and the variation in that strength) should therefore also be considered.

Considerations for preparation of AMC:
1. Verification methods include analysis, simulation, and inspection of requirements, design, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.4 including sections 5.2.4.1-5.2.4.6 ADS-33-PRF section 3.3.9 and 3.4.5 MIL-HDBK-516C 6.1.8	*Def-Stan 00-970 Reference:*	00-970 P1 S2.9
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.9 High angle-of-attack.
The aircraft's flight at high angles of attack shall be assessed and confirmed as safe..
This shall include (but is not limited to):
a. The adequacy of pilot warning(s) when approaching a stall.
b. Aircraft stability and safety of flight when approaching a stall.
c. Aircraft stability and safety of flight during a sustained stall.
d. Aircraft stability and safety of flight through stall prevention measures and through recovery from a stall.
e. Aircraft stability and safety of flight through any departures from controlled flight.
f. Aircraft stability and safety of flight through the recovery from post-stall gyrations and spins.

Consideration should be given to:
a. The existing crew workload and any other distractions that may prevent the crew from realising that they are approaching or are in a stall, when considering the adequacy of pilot warnings.
b. The amount of time and altitude required to recover from a stall, considering the type of aircraft and the likely manoeuvres that it will perform in service.
c. The failure of sensors or other devices that are required for stall warning, prevention or recovery.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797 section 5.2.5 including sections 5.2.5.1-5.2.5.6 MIL-HDBK-516C 6.1.8	*Def-Stan 00-970 Reference:*	00-970 P1 S2.9
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.10 Shipboard operations.

Shipboard operations shall be assessed for safety of flight.

This shall include (but is not limited to):

a. Deck handling.

b. Catapult launches (where specified).

c. Carrier approach and landing.

d. Failed arrest (bolter).

e. Go around (wave-off).

f. Engine failure (of multi-engine aircraft).

g. Launches and recoveries.

h. Permitted wind envelopes.

i. Vertical launch and recovery of multiple aircraft at adjacent spots.

j. Adequacy of visual cues at planned spots at day and night both with and without the aid of Night Vision Devices (NVDs).

k. The effect of the ship's air-wake.

l. The effect of the aircraft's control law modes.

m. Run-on landings.

n. Pilot workload.

o. The motion of the ship and the application of suitable limits for operation.

p. Use of ship-assisted recovery devices.

q. Vertical replenishment and other externally slung loads.

r. Rotorcraft performance in ship motion and ship air-wake conditions.

Consideration should be given to:

a. The aircraft states and configurations where shipborne operations may occur.

b. The characteristics of the different ships where shipborne operations may occur and their effect on the aircraft's safety of flight.

Considerations for preparation of AMC:

1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, design, test, or configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001B 3.4.8 MIL-HDBK-516C 6.1.10 including 6.1.10.1-6.1.10.18	*Def-Stan 00-970 Reference:*	00-970 P7 L606 S3
		STANAG Reference:	4671.1194
FAA Doc:		*EASA CS Reference:*	

6.1.11 Vertical/Short Take-Off and Landing (V/STOL) aircraft.

Where applicable, V/STOL characteristics shall be defined and assessed for safety of flight.

This shall include (but is not limited to):

a. Ensuring that V/STOL operations are safe, specifically;

i. Ensuring that Short Take-Off (STO) is safe.

ii. Ensuring that Vertical Take-Off (VTO) is safe.

iii. Ensuring that any V/STOL shipboard recovery pattern is safe.

iv. Ensuring that V/STOL powered-lift landing is safe.
v. Ensuring that hover is safe.
vi. Ensuring that V/STOL vertical landing is safe.
vii. Ensuring that V/STOL ground handling is safe.
viii. Ensuring that V/STOL transition/conversion is safe.
iv. Ensuring that V/STOL hovering translation is safe.
b. Ensuring that V/STOL dynamic flight handling characteristics are safe, specifically;
i. Flying qualities in pitch, roll and yaw axes and in normal/vertical, longitudinal and lateral translation including cross-axis coupling and angular control.
ii. Flying qualities in the transition region..

Consideration should be given to:
a. The aircraft states and configurations where V/STOL operations may occur.
b. The effect that different landing conditions may have on the safety of the aircraft (e.g. shipborne operations, landing in dust, snow etc.).

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516C 6.1.11 including 6.1.11.1-6.1.11.2	*Def-Stan 00-970 Reference:*	00-970 P1 S2.19
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.12 Characteristics of the primary flight control system

6.1.12.1 Transfer to alternate control modes.
Transfer to and from alternate control modes shall be verified as safe.

Consideration should be given to:
a. The aircraft states and configurations where transfer between modes may occur.
b. The change of the control/handling input/output ratio from one mode to another, the required change in control inputs by the pilot(s) to compensate and the effect of a pilot not realising that the control mode has changed.
c. The effect of transfer of control mode when performing a manoeuvre or in a critical flight phase.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516C 6.1.12.1	*Def-Stan 00-970 Reference:*	00-970 P1 S2.7.10 00-970 P1 S4.10.11

Information Sources			
			00-970 P1 S4.10.13 00-970 P1 S4.10.23 00-970 P1 S4.10.24 00-970 P7 L903 S7.8.2 00-970 P7 L904 S7.5.2
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.12.2 Augmentation systems.
Augmentation systems shall be verified as safe.

Consideration should be given to:
a. The change of the control/handling input/output ratio if the characteristics of the augmentation system were to alter of fail, the required change in control inputs by the pilot(s) to compensate and the effect of a pilot not realising that a change has occurred.
c. The effect of failure or alteration of the augmentation system when performing a manoeuvre or in a critical flight phase.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516C 6.1.12.2	*Def-Stan 00-970 Reference:*	00-970 P1 S4.8.6 00-970 P1 S4.10.11 00-970 P1 S4.10.12 00-970 P1 S4.10.13 00-970 P1 S4.10.23 00-970 P7 L600 S8.2.1 00-970 P7 L600 S8.2.3 00-970 P7 L601 S4.2.1 00-970 P7 L602 S4.2.1 00-970 P7 L903 S7.8.2 00-970 P7 L904 S7.5.2
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.672 CS 25.672 CS 27.672 CS 29.672

6.1.12.3 Cockpit controller characteristics.
The characteristics of the pilots' controllers shall be verified as safe.

Consideration should be given to:

a. The change of the control/handling input/output ratio if the characteristics of the augmentation system were to alter of fail, the required change in control inputs by the pilot(s) to compensate and the effect of a pilot not realising that a change has occurred.
c. The effect of failure or alteration of the augmentation system when performing a manoeuvre or in a critical flight phase.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001B Section 3.4.3.1.5 MIL-HDBK-516C 6.1.12.3	*Def-Stan 00-970 Reference:*	00-970 P7 L600 S9 00-970 P7 L600 S10
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.671 CS 25.671 CS 27.671 CS 29.671

6.1.12.4 Displays and instruments.
The pilots' displays and instruments shall be verified as safe.

Consideration should be given to:
a. The physical aspects of the displays and instruments and their installation, including design, construction and integration with other aircraft systems (e.g. electrical supply).
c. The Human-Machine-Interface and the displays and instruments ability to adequately convey the information most relevant to the continued safe flight of the aircraft.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797A section 5.2.8.4 JSSG 2001B Section 3.4.3.1.5 MIL-HDBK-516C 6.1.12.4	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1301 4671.1309 4671.1329 4671.1331 4671.U1721 4671.U1722 4671.U1723 4671.U1725 4671.U1726 4671.U1727

Information Sources			
			4671.U1728 4671.U1729 4671.U1730
FAA Doc:		*EASA CS Reference:*	CS 23.1301 CS 23.1303 CS 23.1305 CS 23.1309 CS 23.1311 CS 23.1321 CS 23.1322 CS 23.1323 CS 23.1325 CS 23.1326 CS 23.1327 CS 23.1329 CS 23.1331 CS 23.1335 CS 23.1337 CS 25.1301 CS 25.1302 CS 25.1303 CS 25.1305 CS 25.1309 CS 25.1321 CS 25.1322 CS 25.1323 CS 25.1325 CS 25.1326 CS 25.1327 CS 25.1329 CS 25.1331 CS 25.1333 CS 25.1337 CS 27.1301 CS 27.1303 CS 27.1305 CS 27.1309 CS 27.1321 CS 27.1322 CS 27.1323 CS 27.1325 CS 27.1327 CS 27.1329 CS 27.1335 CS 27.1337 CS 29.1301 CS 29.1303

Information Sources			
			CS 29.1305 CS 29.1309 CS 29.1321 CS 29.1322 CS 29.1323 CS 29.1325 CS 29.1327 CS 29.1329 CS 29.1331 CS 29.1333 CS 29.1335 CS 29.1337

6.1.13 Characteristics of secondary flight control systems

6.1.13.1 Trim system.
The aircraft's trim system shall be verified as safe.

Consideration should be given to:
a. Flight configurations and aircraft states where prolonged corrective/preventative control system input could be required by the pilot, and therefore where a trim system would be beneficial, including:
i. Thrust asymmetry (e.g. due to an engine failure), including effects of a vertically displaced engine (e.g. the Trident, 727 or DC-10),
ii. Longitudinally displaced centres of gravity (e.g. due to longitudinally displaced fuel, cargo, personnel)
iii. Laterally displaced centres of gravity (e.g. due to laterally displaced fuel, cargo, personnel)
iv. Asymmetric drag (e.g. due to missing non-essential panels, landing gear failed in the extended position or asymmetric external stores)
b. The aircraft's ability to perform required manoeuvres with the aircraft trimmed correctly.
c. Requirements to trim the aircraft in the longitudinal (roll), lateral (pitch) and normal (yaw) axes.
d. The increased longitudinal trim required in transonic and supersonic flight regimes, correcting Mach-tuck.
e. The performance assessment of the aircraft with the combination of trim functions, including degraded modes.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797A section 5.2.9.1 MIL-HDBK-516C 6.1.13.1	*Def-Stan 00-970 Reference:*	00-970 P1 S2.6.21 00-970 P1 S2.6.22 00-970 P1 S2.8.20 00-970 P1 S2.8.21 00-970 P1 S2.8.22 00-970 P7 L903 S7.4.1 00-970 P7 L903 S7.8 00-970 P7 L904 S7.5

Information Sources			
		STANAG Reference:	4671.161 4671.677
FAA Doc:		*EASA CS Reference:*	CS 23.161 CS 25.161 CS 27.161 CS 29.161

6.1.13.2 Operation of secondary control devices and in-flight configuration changes.

The operation of secondary control devices and the in-flight change of aircraft configuration shall be assessed as safe.

Consideration should be given to:

a. The operation of all secondary control devices both separately and together where the devices may be operated concurrently. Secondary control devices are used to influence the performance of the aircraft but are not the primary surfaces used for aircraft manoeuvres. Secondary control devices may include (but are not limited to):

i. Spoilers,

ii. Flaps,

iii. Slats,

iv. Air brakes.

b. All sources of change in aircraft configuration that could occur in-flight, including.

i. Displacement of Centre of Gravity (e.g. due to movement of fuel, cargo, passengers, etc.),

ii. Changes in the aircraft's external surfaces (e.g. due to the opening of cargo doors, bomb-bay doors, landing bay doors, jettison of external stores, etc.)

Considerations for preparation of AMC:

1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797A section 5.2.9.2 MIL-HDBK-516C 6.1.13.2	*Def-Stan 00-970 Reference:*	00-970 P1 S4.10.14 - 4.10.21 00-970 P7 L600 S9.6
		STANAG Reference:	4671.161 4671.677
FAA Doc:		*EASA CS Reference:*	CS 23.405 CS 25.405

6.1.13.3 Auxiliary dive recovery devices.

Auxiliary dive recovery devices shall be verified as safe.

Consideration should be given to:

a. The loads induced through the airframe when operating a dive recovery device. This shall consider at least:

i. The airspeeds that may be encountered during a dive and the resulting airframe loads,

ii. The operation of a dive recovery device both in isolation and together with other pitch control devices,

iii. The effect that a dive recovery device may have on the aircraft's roll control (in the event that the device is operated during a spiral dive before wings-level flight is achieved),

iv. The effect that a dive recovery device may have on the location of centre of lift, including effects at transonic and supersonic airspeeds (e.g. Mach-tuck).
b. The lower and upper limits of vertical airspeed/rate of descent, airspeed, roll-rate and normal acceleration (g) where the dive recovery device should be operated.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797A section 5.2.9.3 MIL-HDBK-516C 6.1.13.3	*Def-Stan 00-970 Reference:*	00-970 P1 S4.10.20
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.1.14 Rotorcraft unique criteria.
Aspects of flight unique to rotorcraft shall be assessed as safe. This shall include but is not limited to:
a. Translational rate response (sideways cyclic control),
b. Vertical axis response in hover (collective and throttle control/governance),
c. Hover in winds (in all aircraft axes of translation and rotation),
d. Position hold (in all aircraft axes of translation and rotation),
e. Rotor speed response (throttle control/governance),
f. Engine torque response,
g. Slope landing and take-off characteristics,
h. Ground operation,
i. Carriage, release and jettison of external slung loads,
j. Water landing characteristics,
k. Autorotation.

Consideration should be given to:
a. Characteristics that could affect the safety of the rotorcraft,
b. Characteristics that should be considered desirable for the pilot(s) ease of handling,

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, and inspection of process, requirements, design, test, and configuration documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	ADS-33-PRF sections 3.3.1, 3.3.10.1, 3.3.10.2, 3.3.10.3, 3.3.10.4, 3.3.11, 3.4.3.3, 3.4.5.1.3, 3.7.2, 3.7.3, 3.9.1, 3.9.2, 3.9.3, 3.9.4.1, 3.10 MIL-HDBK-516C 6.1.14 including 6.1.14.1-6.1.14.11	*Def-Stan 00-970 Reference:*	00-970 P7: Rotorcraft Supplement 2: Flight (Subpart B)
		STANAG Reference:	

Information Sources			
FAA Doc:		*EASA CS Reference:*	CS 27 Subpart B - Flight CS 29 Subpart B - Flight

6.1.15 Manuals.

Technical Publications including Flight, Performance and Operations Manuals and any supplements shall contain the aircraft's operating limits and instructions to assure flight safety of the aircraft.

Consideration should be given to:

a. All of the aircraft's defined conditions, configurations, load-outs etc.

b. Cautions, Warnings, Advisories, Notes, Corrective Actions and other relevant pilot information.

Considerations for preparation of AMC:

1. Aircraft Flight Manual and other technical publications as appropriate which include the aircraft's operating limits and suitable operating instructions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 S7
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1581 CS 23.1583 CS 23.1585 CS 23.1587 CS 23.1589 CS 25.1581 CS 25.1583 CS 25.1585 CS 25.1587 CS 25.1591 CS 25.1593 CS 27.1581 CS 27.1583 CS 27.1585 CS 27.1587 CS 27.1589 CS 29.1581 CS 29.1583 CS 29.1585 CS 29.1587 CS 29.1589

6.2 VEHICLE CONTROL FUNCTIONS (VCF).

6.2.1 VCF architecture design.

6.2.1.1 Functional criteria.

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

Consideration should be given to:
a. Definition of the required aircraft performance envelope;
b. Definition of the required aircraft safety levels and safety requirements of enabling systems;
c. Development of Test & Acceptance Plans or Validation & Verification Plan to record how the equipment, sub-system, system and aircraft level safety requirements are to be demonstrated;
d. Successful demonstration of achieved safety requirements (e.g. Test & Acceptance Report or Validation & Verification Report).

Considerations for preparation of AMC:
1. Document recording aircraft performance requirements (e.g. Top Level Aircraft Requirements Document);
2. Aircraft Loss Model;
3. Failure Mode and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA);
4. Test and & Acceptance Report or Validation & Verification Report.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2008 3 thru 3.8, 4 thru 4.8 MIL-HDBK-516C 6.2.1.1	*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 00-970 P5 UK25.671a 00-970 P7 L600 S3.5.1 00-970 P7 L600 S8.1.1
		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

Information Sources			
			CS 29.321-29.427 CS 29.1309 CS 29.1501-29.1529

6.2.1.2 High-level architecture function.

Aspects of the VCF critical to the safe operation of the aircraft 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:

a. The following failure mitigation approaches:

i. Failure Absorption;

ii. Cross lane monitoring/voting and failure rejection;

iii. Lane self-monitoring and failure rejection.

b. The appropriate use of redundant and fail-safe designs in systems.

Considerations for preparation of AMC:

1. Failure Mode and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA);
2. Test and & Acceptance Report or Validation & Verification Report.

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-516C 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 00-970 P5 UK25.671a 00-970 P7 L600 S3.5.1 00-970 P7 L600 S8.1.1
		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 Safety critical functions and components.

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.

Consideration should be given to:

a. The appropriate use of redundant and fail-safe designs in systems;

b. The use of Built-In Test (BIT) functions;
c. The failure of software elements.

Considerations for preparation of AMC:
1. Failure Mode and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA);
2. Test and & Acceptance Report or Validation & Verification Report.

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-516C 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 P5 UK25.671a 00-970 P7 L600 S3.5.1 00-970 P7 L600 S8.1.1 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 CS 27.1309 CS 29.1309

6.2.1.4 Integration of functions.
Each aspect of the VCF (such as flaps, trim, auto-stabilisers, 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. Definition of the required aircraft performance envelope;
b. Definition of the required aircraft safety levels and safety requirements of enabling systems;
c. Development of Test & Acceptance Plans or Validation & Verification Plan to record how the equipment, sub-system, system and aircraft level safety requirements are to be demonstrated;
d. Successful demonstration of achieved safety requirements (e.g. Test & Acceptance Report or Validation & Verification Report).

Considerations for preparation of AMC:
1. Document recording aircraft performance requirements (e.g. Top Level Aircraft Requirements Document);
2. Aircraft Loss Model;
3. Failure Mode and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA);
4. Test and & Acceptance Report or Validation & Verification Report.

Information Sources	

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 00-970 P5 UK25.671a 00-970 P7 L600 S3.5.1 00-970 P7 L600 S8.1.1
		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 Failures.

No single failure, dual failure or reasonably credible combination of failures of the VCF (including AFCS if applicable) shall result in an unacceptable Probability of Loss of Control (PLOC).

Consideration should be given to:

a. Definition of the required aircraft performance envelope;

b. Definition of the required aircraft safety levels and safety requirements of enabling systems;

c. Development of Test & Acceptance Plans or Validation & Verification Plan to record how the equipment, sub-system, system and aircraft level safety requirements are to be demonstrated;

d. Successful demonstration of achieved safety requirements (e.g. Test & Acceptance Report or Validation & Verification Report).

Considerations for preparation of AMC:

1. Document recording aircraft performance requirements (e.g. Top Level Aircraft Requirements Document);
2. Aircraft Loss Model;
3. Failure Mode and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA);

4. Test and & Acceptance Report or Validation & Verification Report.

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 P5 UK25.671a 00-970 P7 L600 S3.5.1 00-970 P7 L600 S8.1.1 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)

6.2.1.6 Reliability and redundancy.
The level of VCF redundancy and reliability shall be appropriate for the aircraft's size category and planned operational area/airspace.

Consideration should be given to:
a. Definition of the aircraft's size category;
b. The aircraft's planned operational area/airspace in both civil and military operations or combat and non-combat roles;
c. Definition of the required aircraft safety levels and safety requirements of enabling systems;
d. Development of Test & Acceptance Plans or Validation & Verification Plan to record how the equipment, sub-system, system and aircraft level safety requirements are to be demonstrated;
e. Successful demonstration of achieved safety requirements (e.g. Test & Acceptance Report or Validation & Verification Report).

Considerations for preparation of AMC:
1. Document recording aircraft requirements (e.g. Top Level Aircraft Requirements Document);
2. Aircraft Loss Model;
3. Failure Mode and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA);
4. Test and & Acceptance Report or Validation & Verification Report.

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-516C 6.2.1.6	*Def-Stan 00-970 Reference:*	00-970 P1 S2.15 00-970 P1 S2.16 00-970 P1 S3.9 00-970 P1 S3.10 00-970 P1 S6.6 00-970 P1 S6.11

Information Sources			
			00-970 P5 UK25.671a 00-970 P7 L600 S3.5.1 00-970 P7 L600 S8.1.1
		STANAG Reference:	4671.1309 4671.1329
FAA Doc:		*EASA CS Reference:*	CS 23.141 - 23.257 CS 23.321-23.459 CS 23.1501-23.1529 CS 25.143-25.255 CS 25.321-25.259 CS 25.689 CS 27.141-27.251 CS 27.321-27.247 CS 27.1501-27.1529 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529 CS 23 to CS 29 Clause 1309

6.2.1.7 Probability of loss of aircraft (PLOA).

An overall requirement for the allowed PLOA shall be defined and a sub-requirement for the allowed Probability of Loss of Control (PLOC) for the aircraft. Any estimates and assumptions used in these requirements shall be adequately substantiated/justified.

Consideration should be given to:

a. Definition of the required aircraft performance envelope;

b. Definition of the required aircraft safety levels and safety requirements of enabling systems;

c. Development of Test & Acceptance Plans or Validation & Verification Plan to record how the equipment, sub-system, system and aircraft level safety requirements are to be demonstrated;

d. Successful demonstration of achieved safety requirements (e.g. Test & Acceptance Report or Validation & Verification Report).

Considerations for preparation of AMC:

1. Document recording aircraft performance requirements (e.g. Top Level Aircraft Requirements Document);
2. Aircraft Loss Model;
3. Failure Mode and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA);
4. Test and & Acceptance Report or Validation & Verification Report.

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-516C 6.2.1.7	*Def-Stan 00-970 Reference:*	00-970 P1 S2.15 00-970 P1 S2.16 00-970 P1 S3.9 00-970 P1 S3.10 00-970 P1 S6.6 00-970 P1 S6.11 00-970 P5 UK25.671a

Information Sources			
			00-970 P7 L600 S3.5.1 00-970 P7 L600 S8.1.1.
		STANAG Reference:	4671.1309 4671.1329
FAA Doc:		*EASA CS Reference:*	CS 23.141 - 23.257 CS 23.321-23.459 CS 23.1501-23.1529 CS 25.143-25.255 CS 25.321-25.259 CS 25.689 CS 27.141-27.251 CS 27.321-27.247 CS 27.1501-27.1529 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529 CS 23 to CS 29 Clause 1309

6.2.1.8 In-line fault coverage.

Where systems utilise dual redundancy, the probability of occurrence of all faults that could affect both systems shall be defined and integrated into the probability of loss of the aircraft.

Consideration should be given to:
a. Definition of the required aircraft performance envelope;
b. Definition of the required aircraft safety levels and safety requirements of enabling systems;
c. Development of Test & Acceptance Plans or Validation & Verification Plan to record how the equipment, sub-system, system and aircraft level safety requirements are to be demonstrated;
d. Successful demonstration of achieved safety requirements (e.g. Test & Acceptance Report or Validation & Verification Report).

Considerations for preparation of AMC:
1. Document recording aircraft performance requirements (e.g. Top Level Aircraft Requirements Document);
2. Aircraft Loss Model;
3. Failure Mode and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA);
4. Test and & Acceptance Report or Validation & Verification Report.

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-516C 6.2.1.8	*Def-Stan 00-970 Reference:*	00-970 P1 S 2.15 00-970 P1 S2.16 00-970 P1 S3.9 00-970 P1 S3.10 00-970 P1 S6.6 00-970 P1 S6.11 00-970 P5 UK25.671a 00-970 P7 L600 S3.5.1 00-970 P7 L600 S8.1.1.

Information Sources			
		STANAG Reference:	4671.1309 4671.1329
FAA Doc:		*EASA CS Reference:*	CS 23.141 - 23.257, 23.321-23.459, 23.1501-23.1529, 25.143-25.255, 25.321-25.259, 25.689, 27.141-27.251, 27.321-27.247, 27.1501-27.1529, 29.141-29.251, 29.321-29.427, 29.1501-29.1529 CS 23 to CS 29 Clause 1309

6.2.1.9 Unmanned aircraft (UAV) unrestricted operation

For UAVs cleared for operation in unrestricted airspace, it shall be determined that no single failure of the UAV System can result in a degraded operational state, or unacceptable increase in the Probability of Loss of Aircraft (PLOA) or Probability of Loss of Control (PLOC).

Consideration should be given to:

a. Definition of the required UAV System performance envelope;

b. Definition of the required UAV System safety levels and safety requirements of enabling systems;

c. Development of Test & Acceptance Plans or Validation & Verification Plan to record how the equipment, sub-system, system and UAV System level safety requirements are to be demonstrated;

d. Successful demonstration of achieved safety requirements (e.g. Test & Acceptance Report or Validation & Verification Report).

Considerations for preparation of AMC:

1. Document recording aircraft performance requirements (e.g. Top Level Aircraft Requirements Document);
2. UAV System Loss Model;
3. Failure Mode and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA);
4. Test and & Acceptance Report or Validation & Verification Report.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516C 6.2.1.9	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1309 4671.1329
FAA Doc:		*EASA CS Reference:*	

6.2.1.10 UAS degraded operation.

For UAVs cleared for operation in restricted airspace, warning areas, maritime environments and combat zones, it shall be determined that no single failure of the UAV System can result in an unacceptably degraded operational state, or unacceptable increase in the Probability of Loss of Aircraft (PLOA) or Probability of Loss of Control (PLOC).

Consideration should be given to:

a. Definition of the required UAV System performance envelope;

b. Definition of the required UAV System safety levels and safety requirements of enabling systems;
c. Development of Test & Acceptance Plans or Validation & Verification Plan to record how the equipment, sub-system, system and UAV System level safety requirements are to be demonstrated;
d. Successful demonstration of achieved safety requirements (e.g. Test & Acceptance Report or Validation & Verification Report).

Considerations for preparation of AMC:
1. Document recording UAV System performance requirements (e.g. Top Level Aircraft Requirements Document);
2. UAV System Loss Model;
3. Failure Mode and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA);
4. Test and & Acceptance Report or Validation & Verification Report.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516C 6.2.1.9	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1309 4671.1329
FAA Doc:		*EASA CS Reference:*	

6.2.2 VCF Safety of Design

6.2.2.1 Safety protection functions and devices.
VCF safety provisions (protection functions, devices, procedures, limitations) shall not adversely affect the safety of the aircraft.

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 aircraft;
ii. Any other failure condition that would significantly reduce the capability of the aircraft or the ability of the flight crew to cope with adverse operating conditions.
f. Flight envelope protection for UAS.

Considerations for preparation of AMC:
1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) considering the effect of safety provisions, their probability of failure and effect of failure on the aircraft.

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,	*Def-Stan 00-970 Reference:*	00-970 P1 S2.16.41 00-970 P1 S2.16.42 00-970 P1 S3.10.48

Information Sources			
	3.1.16, 3.2.2.5.4.1, 3.2.4 thru 3.2.4.6, and associated section 4 paragraphs (Note: Unverified - no access to JSSG-2008)		00-970 P1 S3.10.86 00-970 P1 S6.2.35 00-970 P7 L700 S1.3 00-970 P7 L725 S4.1 00-970 P9 UK FW.1309b 00-970 P9 UK RW.1309a 00-970 P9 UK LFW.30a
		STANAG Reference:	4671.1309 (AMC.1309(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 23.1309 CS 25.1309 (AMC.1309) CS 27.1309 CS 29.1309

6.2.2.2 Flight critical components.

Flight-critical 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. Environments 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.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) considering the VCF components, their probability of failure and effect of failure on the aircraft.

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 00-970 P1 S6.2.35 00-970 P7 L700 S1.3

Information Sources			
			00-970 P7 L725 S4.1 00-970 P9 UK FW.1309b 00-970 P9 UK RW.1309a 00-970 P9 UK LFW.30a
		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

6.2.2.3 Pre-flight checklists.

Comprehensive and all-inclusive pre-flight checklists shall be established which are sufficient to determine the flight-worthiness of the VCF. This includes ensuring that pre-flight tests, diagnostics, redundancy, and monitoring includes all test sequences required to determine the status of the VCF and integrated systems prior to take-off. 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).

e. Identifying any need for physical and/or visual checks by the pilot or supporting ground crew and the time and effort that such physical/visual may take to be performed satisfactorily.

Considerations for preparation of AMC:

1. Design documentation comprehensively detailing the pre-flight checks that are mandated, the type of check (e.g. automatic failure detection, pilot action, visual check, etc) and a simple risk assessment for each check.

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:*	

6.2.2.4 Loss of function.

The effects of loss of VCF function(s) on aircraft safety shall be established. This includes ensuring the probability of any reasonable 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 shall be taken to eliminate sources of common-mode failure.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) considering the effect of loss of VCF functions, their probability of failure and effect of failure on the aircraft.

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 00-970 P1 S6.2.35 00-970 P7 L700 S1.3 00-970 P7 L725 S4.1 00-970 P9 UK FW.1309b 00-970 P9 UK RW.1309a 00-970 P9 UK LFW.30a

Information Sources			
		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 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

6.2.2.5 Functional modes and limiters.

Control law limiters shall achieve the intended limiting for all VCF functions and protect the air crew and aircraft 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.

Note that 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 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.

Considerations for preparation of AMC:
1. Aircraft control system design documentation.
2. Flight simulation and flight handling testing.

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,	*Def-Stan 00-970 Reference:*	00-970 P1 3.9.32, 00-970 P1 3.10.104, 00-970 P1 4.10.8,

Information Sources			
	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)		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 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

6.2.2.6 Failure mode and effects.

VCF failure mode effects for critical manoeuvers and critical flight regions shall be demonstrably safe. This includes ensuring the probability of aircraft or crew loss, or loss of aircraft 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.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) considering the effect of loss of VCF functions through critical manoeuvres and flight regions, their probability of failure and effect of failure on the aircraft.

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 00-970 P1 S6.2.35 00-970 P7 L700 S1.3 00-970 P7 L725 S4.1 00-970 P9 UK FW.1309b 00-970 P9 UK RW.1309a 00-970 P9 UK LFW.30a
		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

6.2.2.7 Environmental requirements.

VCF related installed equipment's shall be protected where necessary, and shall be safely and suitably designed for its intended environment. Any VCF related equipment's that require specific installation protection for the required environmental operating conditions shall be adequately protected.

Consideration should be given to:

a. Temperature and humidity.
b. EMC/EMI and lightning; including bonding.
c. Corrosion, fungal growths, and sand and dust ingress.
d. Vibration and shock.
e. Nuclear, biological, radiological, chemical, and laser weapons.

Considerations for preparation of AMC:

1. Analysis, test and review of documentation.
2. Definition of the expected environmental conditions at the equipment's location of installation, supported by testing as appropriate.
3. Qualification of the equipment for the expected environmental conditions at the equipment's location of installation, including testing as appropriate.

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 00-970 P1 3.10.11

Information Sources			
			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 P1 S9.11 00-970 P5 UK25.1301a - UK25.1316a 00-970 P7 Section 2 Supplement 6: Equipment
		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

6.2.2.8 Emergency procedures.

The aircraft 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 are documented in a location such that operators will be aware of them.

Consideration should be given to:

a. Ensuring that all identified emergencies have an appropriate emergency procedure.

b. Ensuring that the identified emergencies provide an appropriate level of detail.

c. Ensuring that the Test and Acceptance Plan provides adequate proof that the emergency procedures are appropriate and safe.

d. The level of detail and location of recording of the emergency procedures.

Considerations for preparation of AMC:

1. Design documentation and Aircrew Operating Manuals detailing the VCF emergencies and their associated procedures.

2. An aircraft Loss Model featuring the mitigating effect of aircrew emergency procedures and any considerations that could affect their effectiveness.

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	*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

Information Sources			
	guidance (listed in section A.2)		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

6.2.2.9 Flight termination system.

Where a Flight Termination System (FTS) is installed and utilizes the flight control system it shall be verified that that the probability of an erroneous termination command leading to a Loss of Aircraft (LOA) and/or Loss of Control (LOC) is at least one hundred times less likely than the Probability of Loss of Control (PLOC) and is included in the PLOC calculations.

Consideration should be given to:

a. All sources of an erroneous termination command.

b. All design precautions/protections preventing an erroneous termination command from leading to a Loss of Aircraft.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) identifying the probability of an erroneous termination command.

2. Aircraft Loss Model integrating the probability of an erroneous termination command into the Probability of Loss of Control (PLOC) and/or Probability of Loss of Aircraft (PLOA).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P9 UK FW.U1412a 00-970 P9 UK FW.U1412b 00-970 P9 UK RW.U1412a 00-970 P9 UK RW.U1412b
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.2.3 VCF actuator safety

6.2.3.1 Redundancy management.

Actuator redundancy management shall be shown to adequately support the aircraft's compliance with flight handling qualities (see section 6.1) and safety.

Consideration should be given to:
a. The timely and accurate switching between failed and redundant functions and the effect that any time-delay may have on the aircraft when operating in flight critical phases or when performing manoeuvres.
b. The isolation of the failed function and any residual probability for the failure to further affect control.

Considerations for preparation of AMC:
1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) including the effect of function redundancy and redundancy management on flight handling qualities.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001B: 3.1.4 MIL-HDBK-516C 6.2.3.1	*Def-Stan 00-970 Reference:*	00-970 P1 S1.1.13 00-970 P1 S2.15.12 00-970 P1 S3.9.18 00-970 P7 L100 S9.1.1 00-970 P9 UK FW.1301b 00-970 P9 UK RW.1301a
		STANAG Reference:	4671 USAR.1309
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

6.2.3.2 Failure detection and isolation.
The VCF actuation failure detection and isolation design shall be determined safe.

Consideration should be given to:
a. The timely and accurate detection and isolation of failed functions and the effect that any time-delay may have on the aircraft when operating in flight critical phases or when performing manoeuvres.
b. The isolation of the failed function and any residual probability for the failure to further affect control.

Considerations for preparation of AMC:
1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) including the effect of function failure detection and isolation on flight handling qualities.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001B: 3.1.4 MIL-HDBK-516C 6.2.3.2	*Def-Stan 00-970 Reference:*	00-970 P1 S1.1.13 00-970 P1 S2.15.12 00-970 P1 S3.9.18 00-970 P7 L100 S9.1.1 00-970 P9 UK FW.1301b 00-970 P9 UK RW.1301a
		STANAG Reference:	4671 USAR.1309

Information Sources			
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

6.2.3.3 Hydraulic contamination.

VCF actuation shall not be susceptible to hydraulic contamination effects, and shall not cause loss of actuation with subsequent loss of control.

Consideration should be given to:

a. Contamination of hydraulic systems through various sources including:

i. Designated system filling points (e.g. reservoirs);

ii. Relative movement of hydraulic connectors;

iii. Broken, cracked and/or punctured seals;

iv. Damage to hydraulic system parts (e.g. pitting of linear actuator cylinders)

b. The performance of filtration systems (if any) and the build-up of contamination in hydraulic parts over time.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) including the likelihood and effect of hydraulic system contamination on flight handling qualities.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009A: B.3.4.2.1.6 MIL-HDBK-516C 6.2.3.3, 8.1	*Def-Stan 00-970 Reference:*	00-970 P1 S4.12.36 00-970 P1 S6.11.52 00-970 P7 L704 S13.1 00-970 P9 UK FW.1301b 00-970 P9 UK RW.1301a
		STANAG Reference:	4671 USAR.1309
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

6.2.3.4 Bottoming and snubbing.

Bottoming of linear actuators shall be prevented. Snubbing of linear actuators shall be designed within tolerable limits.

Consideration should be given to:

a. The full range of linear actuator displacement that can occur in normal, extreme and failure conditions, taking account of deformation/deflection of aircraft structure and control surfaces as appropriate.

b. The range of actuator displacements where snubbing is to occur and the types of force required for the appropriate snubbing characteristics (for example the combination of Coulomb Friction, Viscous Friction and Stribeck Friction sources).

Considerations for preparation of AMC:
1. Mechanical and Kinematic analysis of the linear actuator's assembly demonstrating that bottoming cannot occur through the assembly's full range of motion, and that snubbing characteristics are appropriate. Where appropriate, this should include combinations of deflections due to in-service loads.
2. Actuator design documentation detailing the range of linear displacement of the actuator and snubbing characteristics.
3. Rig, assembly and aircraft testing demonstrating the correct prevention of bottoming and appropriateness of snubbing characteristics.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516C 6.2.3.4, 8.1	*Def-Stan 00-970 Reference:*	00-970 P1 S4.12.36 00-970 P1 S6.11.52 00-970 P7 L704 S13.1 00-970 P9 UK FW.1301b 00-970 P9 UK RW.1301a
		STANAG Reference:	4671 USAR.1309
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

6.2.3.5 Environmental requirements.
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.

Considerations for preparation of AMC:
1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) including considerations of environmental effects and failure of necessary components (e.g. radiators, cooling fans, heat exchangers etc).
2. Calculations (e.g. Computation Fluid Dynamics, hand calculations etc as appropriate) of fluid-dynamics effects such as surge due to valve opening/closing, pump start-up/shut-down, etc on the working fluid's properties (pressure, volume, flow rate, temperature, viscosity, etc), and the acceptability of this variation.
3. Stress analysis (e.g. Finite Element Analysis, hand calculations etc as appropriate) of the actuation system components including pipes, hoses, unions and equipment.

Information Sources	

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 00-970 P7 L703 00-970 P7 L704
		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 23.1435 CS 23.1438 CS 25.1309 CS 25.1435 CS 25.1436 CS 27.1309 CS 27.1435 CS 29.1309 CS 29.1435

6.2.3.6 Motor/torque tube driven and rotary actuators.

Motor, torque tube driven and other rotary actuators shall be determined to be safe.

Note that the other requirements of this section also apply to rotary actuators.

Consideration should be given to:

a. Redundancy management (see 6.2.3.1);

b. Failure detection and isolation from the system. Note that this includes functional/mechanical isolation of the failed component (i.e. fail-safe design) and isolation of the failed component from the power supply system (see 6.2.3.2);

c. Contamination (see 6.2.3.3);

d. Exceedance of actuator limits (see 6.2.3.4);

e. Environmental requirements (6.2.3.5);

f. Requirements for surface rate, hinge moment and stiffness (see 6.2.3.7); and,

g. Physical constraints and appropriate limits (see 6.2.3.8)

Considerations for preparation of AMC:

1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) including the likelihood and effect of failure of rotary actuators.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2008: Sections 3.0, 4.0, 3.1, 4.1, 3.1.5.6, 4.1.5.6, 3.1.5.7, 4.1.5.7, 3.1.9, 4.1.9, 3.1.11, 4.1.11, 3.1.11.1, 4.1.11.1, 3.1.11.1.1, 4.1.11.1.1, 3.1.12, 4.1.12, 3.1.14.1, 4.1.14.1, 3.1.14.3, 4.1.14.3, 3.2.2.1, 4.2.2.1	*Def-Stan 00-970 Reference:*	Def Stan 00-970, Part 1 Sec 3.10.26, Part 1 Sec 6.11.80, Part 1 Section 1.1.13, Part 1 Section 2.15.12, Part 1 Section 3.9.18, Part 7 Leaflet 100 Section 9.1.1, Part 9 UK FW.1301b, Part 9 UK RW.1301a
		STANAG Reference:	4671 USAR.1309

Information Sources			
FAA Doc:		*EASA CS Reference:*	CS 23.1309, 25.1309, 27.1309, 29.1309

6.2.3.7 Surface rate, hinge moment and stiffness.

Surface rate and hinge moments for VCF actuation shall not adversely affect aircraft control throughout the combined range of attainable angles of attack (both positive and negative) and sideslip in both normal and failure conditions. 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 manoeuvering 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 configuration including Stores (symmetric and asymmetric).

Considerations for preparation of AMC:

1. Identification of maximum loads on each control surface and on each hinge and actuator using calculations (hand calculations, Computational Fluid Dynamics, Finite Element Analysis, etc) and testing (wind-tunnel mock-up, ground testing, flight testing, etc), considering normal and failure conditions.

2. Assessment of the effect of loads on structure using calculations (hand calculations, Finite Element Analysis, etc), and testing (coupon, sub-assembly and assembly testing) as appropriate.

3. Where surface rates are appreciably affected, evidence (e.g. flight handling tests) demonstrating that the reduced rate does not affect flight safety, and incorporation of the effect of the reduced rates into the aircraft loss model.

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 00-970 P1 S3.9.31 00-970 P7 L203
		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 23.657 CS 23.1501-23.1529 CS 25.21 CS 25.143-25.255 CS 25.321-25.459

Information Sources			
			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

6.2.3.8 Physical constraints.

Each flight control surface and/or flight control actuator shall be adequately constrained to limit the range of motion to within the limits considered in the design of the surface and actuator.

Consideration should be given to:

a. The appropriate use of stops, including physical stops on the control surface/actuator(s) and/or stops built into the design of the actuation system (e.g. limit switches and/or software limits).

b. The strength of stops to withstand the loads that could be reacted during normal and failure conditions.

c. The load that can be reacted through the control system and through the pilot's controls before the limit is reached and the system's ability to react those loads without failure.

Considerations for preparation of AMC:

1. Mechanical analysis demonstrating the control surfaces' acceptable range of motion including the forces reacted by the control system and by the stops (where used).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 S3.9.32 00-970 P7 L203 S4.2
		STANAG Reference:	4671 USAR.655 4671 USAR.675
FAA Doc:		*EASA CS Reference:*	CS 23.655 CS 23.675 CS 25.655 CS 25.675 CS 27.675 CS 29.675

6.2.4 VCF air data safety

6.2.4.1 Accuracy and tolerances.

The accuracy and tolerance of the air data system shall be considered in the assessment of the aircraft's safety.

Consideration should be given to:

a. The air data types and sources whose integrity could impact the safety of the aircraft, including (but not limited to):

i. Dynamic pressure;
ii. Static pressure;
iii. Altitude;
iv. Angle of attack;
v. Angle of side-slip;
vi. Mach number.
b. The probability of sensor failure or other source of data corruption (e.g. Electro-Magnetic Interference, blockage/occlusion of sensor, etc) ;
c. Redundancy or other duplication of sensors, and voting parameters, and its effect on the overall probability of failure;
d. The probability of and effect of failure of air data both in isolation and concurrently with other air data failures; and,
e. The probability of and effect of degradation of air data both in isolation and concurrently with other air data degradations.

Considerations for preparation of AMC:
1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) considering the probability and effect of loss and/or degradation of air data on the safety of the aircraft.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 S2.15.21 00-970 P1 S2.15.27 00-970 P1 S2.15.28 00-970 P1 S6.3.6 - 6.3.12 00-970 P1 S6.10 00-970 P5 UK25.1301d 00-970 P7 L725 S4.1 00-970 P9 UK FW.1301b 00-970 P9 UK FW.1309b
		STANAG Reference:	4671 USAR.1309 4671 USAR.1323 4671 USAR.1325 4671 USAR.1327 4671 USAR.1337
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 23.1323 CS 23.1325 CS 23.1327 CS 23.1337 CS 25.1309 CS 25.1323 CS 25.1325 CS 25.1327 CS 25.1329 CS 25.1337 CS 27.1309

Information Sources			
			CS 27.1323 CS 27.1325 CS 27.1327 CS 27.1337 CS 29.1309 CS 29.1323 CS 29.1325 CS 29.1327 CS 29.1337

6.2.4.2 Integration.

Air data sensors shall be integrated safely in the design of the aircraft. Air data parameters from any single source or combination of sources shall be verified for accuracy prior to being transmitted, displayed to flight crew or utilised by the aircraft in any autonomous function.

Consideration should be given to:

a. Appropriate means of data verification. Such verification may include combinations of (note that this list is not exhaustive and the verification means will depend on aircraft requirements and sensor type):

i. Value limits (i.e. setting boundaries for possible limits of air data parameters);

ii. Limits on rate-of-change (i.e. identifying sensors as degraded/failed if they report a value that changes too quickly);

iii. Redundancy and voting (i.e. using multiple sensors and identifying degraded/failed sensors when a sensor reports a value different to others);

iv. Self-checking (i.e. intermittently forcing a sensor to read a known value and highlighting the sensor degraded/failed if a different value is read);

v. Other forms of Built-in-Test (BIT) as appropriate.

b. The demonstrated integrity of sensors, recorded through empirical means.

c. The Integrity of the systems interpreting the air data and verifying its accuracy.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) considering the probability and effect of loss and/or degradation of air data on the safety of the aircraft.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 S2.15.21 00-970 P1 S2.15.27 00-970 P1 S2.15.28 00-970 P1 S6.3.6 - 6.3.12 00-970 P1 S6.10 00-970 P5 UK25.1301d 00-970 P7 L725 S4.1 00-970 P9 UK FW.1301b 00-970 P9 UK FW.1309b
		STANAG Reference:	4671 USAR.1309 4671 USAR.1323 4671 USAR.1325

Information Sources			
			4671 USAR.1327 4671 USAR.1337
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 23.1323 CS 23.1325 CS 23.1327 CS 23.1337 CS 25.1309 CS 25.1323 CS 25.1325 CS 25.1327 CS 25.1329 CS 25.1337 CS 27.1309 CS 27.1323 CS 27.1325 CS 27.1327 CS 27.1337 CS 29.1309 CS 29.1323 CS 29.1325 CS 29.1327 CS 29.1337

6.2.4.3 Ground provisions.

The effective ability for ground crew to verify the state of air data systems, and their safety while doing so, shall be assured.

Consideration should be given to:

a. Ground crew access to provisions for Built-in-Test Equipment (BITE) and wiring and components for fault isolation;

b. Protection for ground crew from the elements and any other environmental hazards;

c. Isolation of power supply systems (electric, hydraulic, pneumatic, etc) to prevent potentially hazardous situations;

d. Procedures, processes or equipment to prevent damage to personnel and equipment.

Considerations for preparation of AMC:

1. Design documentation demonstrating acceptable access and safety provisions.

2. Aircraft Maintenance Manual identifying the processes and procedures for the effective and safe access by ground crew.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 S4.4.7 00-970 P1 L800 S9.1
		STANAG Reference:	

Information Sources			
FAA Doc:		*EASA CS Reference:*	

6.2.4.4 Ice prevention.

Air data sensors shall be provided with sufficient ice prevention means to prevent the build-up of moisture and ice. The ice prevention means shall ensure that air data sensors are not degraded by ice accumulation in all environments that the aircraft is cleared to operate in.

Consideration should be given to:

a. The environmental conditions in which the aircraft is cleared to operate that affect ice accretion (most notably humidity, temperature and airspeed). This should also include those conditions that the aircraft is not cleared to operate, but may encounter regardless (e.g. transient flight conditions).

b. Built-in-Test (BIT) and other fault finding means to ensure that ice prevention means are operating correctly.

c. The design of air data sensors to ensure that moisture is prevented (e.g. prevention of moisture traps).

Considerations for preparation of AMC:

1. Analysis and accompanying test documentation demonstrating that moisture and ice accretion is suitably prevented throughout a suitable range of environmental conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2001B 3.2.2	*Def-Stan 00-970 Reference:*	00-970 P1 S2.15.21 00-970 P1 S2.15.27 00-970 P1 S2.15.28 00-970 P1 S6.3.6 - 6.3.12 00-970 P1 S6.10 00-970 P1 S7.2.2 00-970 P1 S7.2.9 00-970 P5 UK25.1301d 00-970 P5 UK25.1419a 00-970 P7 L711 00-970 P7 L725 S4.1 00-970 P9 UK FW.1301b 00-970 P9 UK FW.1309b
		STANAG Reference:	4671 USAR.1309 4671 USAR.1323 4671 USAR.1325 4671 USAR.1327 4671 USAR.1337 4671 USAR.1419
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 23.1323 CS 23.1325 CS 23.1327 CS 23.1337 CS 23.1419 CS 25.1309

Information Sources			
			CS 25.1323 CS 25.1325 CS 25.1327 CS 25.1329 CS 25.1337 CS 25.1419 CS 25.1420 CS 27.1309 CS 27.1323 CS 27.1325 CS 27.1327 CS 27.1337 CS 27.1419 CS 29.1309 CS 29.1323 CS 29.1325 CS 29.1327 CS 29.1337 CS 29.1419

6.2.4.5 Safety provisions.

Adequate safety provisions shall be provided concerning the aircraft's air data system(s).

Consideration should be given to:

a. The provision of the following:

i. In-flight monitoring of the air data health and annunciation of integrity to the operator/crew when appropriate.

ii. Mitigation or accommodation for shorting or opening of power wires that removes electrical power.

iii. Mitigation or accommodation for loss of the mounting structure such as a radome that takes out more than one probe at a time.

iv. Alternate methods for air data to compensate for loss of air data.

v. Provisions to handle possible bird strikes.

Considerations for preparation of AMC:

1. Design documentation, analysis and testing (as appropriate) demonstrating the safety of the air data system installation(s).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 S2.15.21 00-970 P1 S2.15.27 00-970 P1 S2.15.28 00-970 P1 S6.3.6 - 6.3.12 00-970 P1 S6.10 00-970 P5 UK25.1301d 00-970 P7 L725 S4.1 00-970 P9 UK FW.1301b 00-970 P9 UK FW.1309b

Information Sources			
		STANAG Reference:	4671 USAR.1309 4671 USAR.1323 4671 USAR.1325 4671 USAR.1327 4671 USAR.1337
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 23.1323 CS 23.1325 CS 23.1327 CS 23.1337 CS 25.1309 CS 25.1323 CS 25.1325 CS 25.1327 CS 25.1329 CS 25.1337 CS 27.1309 CS 27.1323 CS 27.1325 CS 27.1327 CS 27.1337 CS 29.1309 CS 29.1323 CS 29.1325 CS 29.1327 CS 29.1337

6.2.5 VCF control law safety

6.2.5.1 Flight envelope.

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

Consideration should be given to:

a. Operating in turbulence;

b. All predictable variations in system operating conditions, aircraft configurations and flight envelope;

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).

Considerations for preparation of AMC:

1. Design documentation supported by flight simulation and flight testing where appropriate that demonstrates the acceptable handling of the aircraft throughout the aircraft's defined operating conditions, aircraft configurations and flight envelope.

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 00-970 P5 UK25.302a 00-970 P7 L207
		STANAG Reference:	4671.1329 4671 USAR.141 4671 USAR.U282
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

6.2.5.2 Nonlinearities.

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.

Considerations for preparation of AMC:

1. Design documentation supported by flight simulation and flight testing where appropriate that demonstrates the acceptable handling of the aircraft and prevention of non-linearities affecting safety of flight.

Information Sources	

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 00-970 P5 UK25.302a 00-970 P7 L207
		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

6.2.5.3 Transients.

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.

Considerations for preparation of AMC:

1. Design documentation supported by flight simulation and flight testing where appropriate that demonstrates the acceptable handling of the aircraft through control law transients.

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,	*Def-Stan 00-970 Reference:*	00-970 P1 2.8.15 00-970 P1 3.10.33

Information Sources			
	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)		00-970 P1 3.10.38 00-970 P1 3.10.41 00-970 P1 3.10.81 00-970 P5 UK25.302a 00-970 P7 L207
		STANAG Reference:	4671 USAR.141 4671 USAR.U282 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 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

6.2.5.4 Redundancy and failure management.

All aircraft control systems shall be assessed to identify those whose failure 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.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) considering the effect of redundancy and failure management on the overall safety of the aircraft.

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 00-970 P5 UK25.302a 00-970 P7 L207
		STANAG Reference:	4671.141-4671.253 4671.321-4671.459 4671.1501-4671.1529 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 23.1309 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

6.2.5.5 Aerodynamic and air data uncertainty.

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.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) considering the effect of air data errors/uncertainties on the overall safety of the aircraft.

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 00-970 P5 UK25.302a 00-970 P7 L207
		STANAG Reference:	4671 USAR.141 4671 USAR.U282 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

6.2.5.6 Time delays.
The aircraft VCF shall not be adversely affected by time delays.

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.

Considerations for preparation of AMC:
1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) considering the effect of time delays on the overall safety of the aircraft.

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 00-970 P5 UK25.302a 00-970 P7 L207
		STANAG Reference:	4671 USAR.141 4671 USAR.U282 4671.685 4671.1309

Information Sources			
			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

6.2.5.7 Autonomous modes.
The autonomous modes within the VCF shall be assessed to be safe.

Consideration should be given to:
a. Operating in turbulence;
b. All predictable variations in system operating conditions, aircraft configurations and flight envelope;
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).

Considerations for preparation of AMC:
1. Design documentation supported by flight simulation and flight testing where appropriate that demonstrates the acceptable handling of the aircraft throughout the aircraft's defined operating conditions, aircraft configurations and flight envelope.

Information Sources			
Comm'l 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		
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 3.10.33-46 00-970 P1 3.10.81 00-970 P5 UK25.302a 00-970 P7 L207
		STANAG Reference:	STANAG 4671 USAR.141, 4671 USAR.U282, 4671.1329
FAA Doc:		*EASA CS Reference:*	EASA CS 23.21, 23.141-23.257, 23.672, 23.1329 EASA CS 25.21, 25.143-25.255, 25.672, 25.1329 EASA CS 27.21, 27.141-27.251, 27.672, 27.1329 EASA CS 29.21, 29.141-29.251, 29.672, 29.1329

6.2.6 VCF pilot vehicle interface (PVI) safety

6.2.6.1 Crew commands.

VCF command control elements, shall be demonstrably safe for the entire range of aircraft 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.

Considerations for preparation of AMC:
1. Design documentation supported by flight simulation and flight testing where appropriate that demonstrates the acceptable handling of the aircraft and air crew feedback and response throughout the aircraft's defined operating conditions, aircraft configurations and flight envelope.

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 to JSSG-2008)	*Def-Stan 00-970 Reference:*	00-970 P1 2.6.14 00-970 P1 2.8.12 00-970 P1 4.10.2 00-970 P5 UK25.397a 00-970 P5 UK25.397b 00-970 P7 L203 00-970 P7 L207
		STANAG Reference:	4671.671 4671.1309 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

Information Sources			
			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

6.2.6.2 Functional characteristics.

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 auto-stabilisers, 'q' feel systems etc. operative.

Considerations for preparation of AMC:
1. Design documentation supported by flight simulation and flight testing where appropriate that demonstrates the acceptable handling of the aircraft including the effect of friction levels, breakout forces, dead zones, hysteresis and backlash in each control axis.

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 00-970 P7 L204 S3.4 00-970 P7 L204 S3.5
		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, 25.1501-25.1529	*EASA CS Reference:*	CS 23.141-23.257 CS 23.321-23.459 CS 23.683 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

Information Sources			
			CS 29.141-29.251 CS 29.321-29.427 CS 29.683

6.2.6.3 Cockpit/operator control forces.

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 aircraft and shall not be so low that the aircraft 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 or rudder pedal;
g. Ensuring control system forces and free play do not inhibit a smooth, direct aircraft response;
h. Specified manoeuvres, to be agreed and verified;
i. Force of the pilots operating dual controls in opposition, to be agreed and verified.

Considerations for preparation of AMC:

1. Design documentation supported by flight simulation and flight testing where appropriate that demonstrates the acceptable handling of the aircraft and cockpit control forces throughout the aircraft's defined operating conditions, aircraft configurations and flight envelope.

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 00-970 P5 UK25.397a 00-970 P5 UK25.397b 00-970 P7 L203 00-970 P7 L207
		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 CS 29.21 CS 29.141-29.251

Information Sources			
			CS 29.321-29.427

6.2.6.4 Ratio changers and artificial feel devices.

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, c of g and external stores configuration.

Considerations for preparation of AMC:

1. Design documentation supported by flight simulation and flight testing where appropriate that demonstrates the acceptable handling of the aircraft--taking account of ratio changers and artificial feel devices--throughout the aircraft's defined operating conditions, aircraft configurations and flight envelope.

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 00-970 P7 L203 00-970 P7 L207
		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

6.2.6.5 Warning, caution, and advisory functions.

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 including:

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

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

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

iv. Ensuring indications are grouped and presented in a logical and consistent manner;
v. Ensuring indications are visible to each pilot under all expected lighting conditions;
vi. The use of a three category warning system.

Considerations for preparation of AMC:
1. Design documentation supported by flight simulation and flight testing where appropriate that demonstrates the acceptable handling of the aircraft including the suitability of control warning and caution devices throughout the aircraft's defined operating conditions, aircraft configurations and flight envelope.

Information Sources			
Comm'l Doc:			
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

6.2.7 VCF integrated systems safety

6.2.7.1 Control surface positions.

Control system surfaces shall be installed so there is no mechanical interference from surrounding aircraft structures or devices, or jamming with other control system components or surrounding equipment/structure. If an adjustable stabiliser is used, it shall have stops that limit its range of travel to that allowing safe flight and landing.

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.

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.
e. Jamming of control systems without interference with other components (for example overcentre positions of control components).

Considerations for preparation of AMC:
1. Design documentation supported by kinematic and/or clearance analysis, rig, ground and/or flight testing (as appropriate) and deflection calculations (e.g. hand calculations and/or Finite Element Analysis) demonstrating that control surfaces do not suffer from interference, jamming or excessive deformation.

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 00-970 P1 S3.9.31 00-970 P1 S3.9.32 00-970 P7 L203 S3.3.3
		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

6.2.7.2 Intermittent devices.
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, cannot 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.

Considerations for preparation of AMC:
1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) incorporating the probability and effect of functional failure of latent devices on flight handling qualities and safety of flight.

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 00-970 P1 S3.6 00-970 P7 L203 S3.3.1

Information Sources			
		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

6.2.7.3 Foreign object damage (FOD).

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, 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 routing 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 aircraft 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.

Considerations for preparation of AMC:

1. Design documentation supported by kinematic and/or clearance analysis, rig, ground and/or flight testing (as appropriate) and deflection calculations (e.g. hand calculations and/or Finite Element Analysis) demonstrating that sufficient clearance exists between control system components and surrounding aircraft structure.

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	*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 L24 00-970 P1 S3.9.31

Information Sources			
	access to JSSG-2008)		00-970 P1 S3.9.32 00-970 P7 L203 S3.3.3
		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 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

6.2.7.4 Structural mode interaction (SMI).

The location of sensors shall minimise/avoid structural mode coupling such as to prevent erroneous feedback and disruption of the VCF or aircraft. 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.

Considerations for preparation of AMC:

1. Design documentation, supported by calculations (e.g. hand calculations, Finite Element Analysis and/or dynamic/modal analysis) and assembly, rig, ground and/or flight testing (as appropriate) that demonstrates that Structural Mode Interaction is suitably minimised/prevented.

Information Sources			
Comm'l Doc:			

Information Sources			
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 L26 00-970 P1 S4.8 00-970 P7 L500
		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

6.2.7.5 Integration with avionics systems.

Interfaces between VCF and avionics equipment shall be demonstrated to be safe. The integration of VCF and avionics equipment shall be demonstrated to be safe.

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 combination of failures;

d. Required levels of system integrity.

Considerations for preparation of AMC:

1. Design documentation, supported by rig (system rigs, 'Iron Bird', etc), ground and flight testing (as appropriate) demonstrating the function and safety of avionics interfaces.

2. Appropriate assurance of software development incorporating an appropriate assurance level (e.g. Design Assurance Level), utilising a suitable standard (e.g. DO-178C 'Software Considerations in Airborne Systems and Equipment Certification').

3. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) incorporating the probability and effect of functional failure of avionics interfaces on flight handling qualities and safety of flight.

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 00-970 P1 S6.2, 00-970 P7 L725
		STANAG	4671.1309

Information Sources			
		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 23.1309 CS 23.1329 CS 25.1309 CS 25.1329 CS 27.1309 CS 27.1329 CS 29.1309 CS 29.1329

6.2.7.6 Integration with propulsion systems.

Integration and operation of the aircraft 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.

Considerations for preparation of AMC:

1. Design documentation, supported by rig (system rigs, 'Iron Bird', etc), ground and flight testing (as appropriate) demonstrating the function and safety of the propulsion control system.

2. Appropriate assurance of software development incorporating an appropriate assurance level (e.g. Design Assurance Level), utilising a suitable qualification (e.g. DO-178C 'Software Considerations in Airborne Systems and Equipment Certification').

3. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) incorporating the probability and effect of functional failure of the propulsion control system on flight handling qualities and safety of flight.

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

Information Sources			
			CS 23.933-23.943 CS 23.1141-23.1157 CS 23.1309 CS 25.143-25.255 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

6.2.7.7 Vehicle recovery.

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, etc.).
c. Location of engine on airframe and effect of resultant thrust (or loss of thrust).

Considerations for preparation of AMC:

1. Design documentation supported by flight simulations and flight testing (as appropriate) demonstrating in which areas of the flight envelope engine failure appreciably affects the aircraft's safety of flight (i.e. causing an appreciable increase in the Probability of Loss of Control (PLOC)).
2. Design documentation supported by flight simulations and flight testing (as appropriate) identifying which flight condition is considered to be recoverable and which are considered to be non-recoverable, identifying necessary actions required by flight crew.
3. Aircraft Flight Manual (or other suitable document) detailing the limitations for continued safe flight.

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-	*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 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

6.2.7.8 Latencies and synchronizations.

The aircraft VCF shall not be adversely affected by inputs received from either the payload or from an interfacing ground station.

Consideration should be given to :
1. Signal or data synchronisation issues.
2. Signal or data latency issues.
3. The use and applicability of open architectures.

Considerations for preparation of AMC:
1. Design documentation, supported by rig (system rigs, 'Iron Bird', etc), ground and flight testing (as appropriate) demonstrating the function and safety of avionics interfaces, and the resilience of the avionic system to signal transmission delays and/or desynchronisation.

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) TBD: Refer to technical point of contact for this discipline (listed in section A.2)	*Def-Stan 00-970 Reference:*	00-970 P1 S3.10.2 00-970 P1 S3.10.11-3.10.13 00-970 P1 S3.10.32 00-970 P1 S3.10.47-3.10.53 00-970 P1 S3.10.79-3.10.93
		STANAG Reference:	4671.685 4671.1309 4671.1431 4671.1481
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

6.2.7.9 Automatic take-off and landing.

Automatic take-off and/or landing systems shall be assured as safe.

Consideration should be given to:
a. The probability and effect of failure of sensors and air data systems.
b. The probability and effect of failure of avionics equipment both incorporated in the automatic take-off/landing system and of other aircraft systems.
c. The adequacy of air crew warning should the automated system fail, requiring reversion to manual control, and the potential for an unacceptable increase in pilot workload.

Considerations for preparation of AMC:
1. Design documentation, supported by rig (system rigs, 'Iron Bird', etc), ground and flight testing (as appropriate) demonstrating the function and safety of the take-off/landing system.
2. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) incorporating the probability and effect of functional failure of air data sensors, the air data system and the aircraft's avionics systems on the failure of the take-off/landing system and subsequent Probability of Loss of Control (PLOC).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 S3.10 00-970 P5 UK25.302a 00-970 P7 L604
		STANAG Reference:	4671 USAR.1329, 4671 USAR.U1490, 4671 USAR.U1492
FAA Doc:		*EASA CS Reference:*	CS 23.1329 CS 25.1329 CS 27.1329 CS 29.1329

6.2.8 VCF engage, disengage, and interlocks safety

6.2.8.1 Interlocks.
The aircraft control system shall have positive interlocks to prevent hazardous operation of inoperative devices/programs, to preclude their 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.

Considerations for preparation of AMC:
1. Design documentation supported by rig (e.g. system rig, 'Iron Bird' etc), ground and flight testing as appropriate that demonstrates that processes for the locking-out of inoperative devices/programs preclude their inadvertent operation.
2. Aircraft Flight Manual or other suitable document which includes processes for the locking-out of inoperative devices/programs when performing activities (e.g. maintenance) on those systems.

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

6.2.8.2 Incompatible modes.

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 aircraft 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 aircraft 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 aircraft control mode.

Considerations for preparation of AMC:

1. Design documentation supported by rig (e.g. system rig, 'Iron Bird' etc), ground and flight testing as appropriate that demonstrate that incompatible modes cannot be engaged.

Information Sources	

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

6.2.8.3 Engage, disengage and mode transition transient times.

Transient times for automatic and manual VCF mode change shall be within specified limits, such as to maximise Safety of Fight (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 maybe 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.

Considerations for preparation of AMC:

1. Design documentation supported by rig (e.g. system rig, 'Iron Bird' etc), ground and flight testing as appropriate that demonstrate mode engagement, disengagement and transient times are optimised, within specified limits and do not preclude the aircraft's SOF.

See also section 6.2.5.3

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2008 3.0, 3.1, 3.1.5.2, 3.1.5.4, 3.1.5.5, 3.1.7.2, 3.1.7.3, 3.1.11, 3.1.11.5, 3.1.12, 3.1.12.1, 3.1.13.2, 3.1.14, 3.2.2.1, 3.2.2.2.1, 3.2.2.2.2, 3.2.2.2.6, 3.2.2.2.12, 3.2.2.5.4, 3.2.2.5.4.3, 3.2.2.6, 3.3.1, 3.3.2, 3.3.2.1, and associated section 4 paragraphs	*Def-Stan 00-970 Reference:*	00-970 P1 S6.5.12
		STANAG Reference:	4671 USAR.1329

Information Sources			
FAA Doc:		*EASA CS Reference:*	CS 23.1329 CS 25.1329 CS 27.1329 CS 29.1329

6.2.9 VCF command and control communications safety

6.2.9.1 Integration.

All command and control channels used by the aircraft 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:

1. Safely integrated with the other aircraft systems.
2. Have an acceptable probability of failure assigned to it.
3. Resilient to 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.

Considerations for preparation of AMC:

1. Design documentation clearly identifying the command and control channels utilised by the aircraft, redundancy (if any), probability and effect of failure and considerations of the operating environment.

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

Information Sources			
			CS 27.1309 CS 29.141-29.251 CS 29.321-29.427 CS 29.1501-29.1529 CS 29.1309

6.2.9.2 Security.

Unauthorised access to the aircraft command and control communications shall be prevented, and any security techniques used to achieve this shall be implemented safely. To achieve this, the aircraft 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:
1. Documenting the expected threat against each system.
2. Demonstrating that chosen security techniques are safe for the proposed use.
3. Demonstrating that the chosen security techniques are implemented safely.
4. Partitioning critical data from less critical data.
5. Encryption.
6. Physical means of security.

Considerations for preparation of AMC:
1. Design documentation clearly identifying the command and control channels utilised by the aircraft, security levels for each channel, and security techniques implemented to ensure protection against intrusive threats.
2. Rig (system, 'Iron Bird' etc), ground and flight testing as appropriate, demonstrating that practical attempts at unauthorised access are prevented.

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 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

Information Sources			
			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

6.2.9.3 Lost communications and failures.

Aircraft guidance, navigation and control functions shall implement robust and safe contingency logic for dealing with lost-communications and on-board failures.

Consideration should be given to:

a. The probability of single and combined failures including both lost-communications and on-board failures.

b. The effect of failures on the continued safe flight of the aircraft through all flight phases.

c. The vehicle's ability to continue and complete its mission, and the effect that any failure may have on the overall mission reliability of the aircraft.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) considering the probability of lost-communications and on-board failures and their effect on the aircraft's continued safe flight.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671 USAR.U1603 4671 USAR.U1613
FAA Doc:		*EASA CS Reference:*	

6.2.9.4 Loss of command.

Loss of command signal from a control station shall not unacceptably degrade the aircraft's operational state.

Consideration should be given to:

a. The continued safe flight of the aircraft, including the Probability of Loss of Control (PLOC) and Probability of Loss of Aircraft (PLOA).

b. The continued missionworthiness of the aircraft and the ability for the aircraft to successfully complete its assigned mission.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) considering the probability of lost-communications and on-board failures and their effect on the aircraft's continued safe flight.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671 USAR.U1603 4671 USAR.U1613
FAA Doc:		*EASA CS Reference:*	

6.2.9.5 Sensor operability.
For UAS equipped with remote control capability, sensors used to provide feedback to a remote operator shall be fully operational under natural and induced environmental conditions.

Consideration should be given to:
a. The full range of environmental conditions that could be encountered, incorporating any protections against such conditions afforded by the aircraft (e.g. Environmental Conditioning Systems), including but not limited to:
i. Temperature;
ii. Humidity;
iii. Pressure;
iv. Vibration; and,
v. Electromagnetic interference.

Considerations for preparation of AMC:
1. Design documentation supported by equipment, rig, ground and flight testing (as appropriate) demonstrating that the required equipment remains functional in the environmental conditions in which it will be subjected to.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671 USAR.U1701
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

6.2.10 VCF hydraulic power source safety
(Note: See section 8.1 for specific hydraulic systems criteria)

6.2.10.1 Hydraulic distribution.
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.

Considerations for preparation of AMC:
1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) considering the probability and effect of hydraulic system on the function of the VCF, and therefore on the overall Probability of Loss of Control (PLOC) and Probability of Loss of Aircraft (PLOA).

See also section 8.1 for Hydraulic Systems requirements.

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

6.2.10.2 Hydraulic system dynamics.
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).
b. Cyclic pressures, including transients (surges) and those due to system volumetric changes.
c. Pressure fluctuation within the system.

Considerations for preparation of AMC:
1. Design documentation, supported by rig, ground and flight testing as appropriate, demonstrating that system pressures--including cyclic and surge pressures and other fluctuations--are fully defined.
2. Fluid and stress analysis (using hand calculations, Finite Element Analysis and Computational Fluid Dynamics as appropriate) supported by rig, ground and flight testing demonstrating that the system can withstand system pressures with an appropriate factor of safety.

See also section 8.1 for Hydraulic Systems requirements.

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,	*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

Information Sources			
	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		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

6.2.10.3 Flow/pressure irregularities.

The aircraft backup and/or 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 should 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.

Considerations for preparation of AMC:

1. Documentation supported by analysis (hand calculations, system computational models and/or computational fluid dynamics), rig, ground and flight testing as appropriate to demonstrate that system pressure and flow rates are adequate to provide sufficient power to the aircraft flight controls to maintain safety of flight.

See also section 8.1 for Hydraulic Systems requirements.

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

6.2.10.4 Transients/fluctuations.

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.

Considerations for preparation of AMC:

1. Design documentation supported by rig, ground and flight testing as appropriate demonstrating the safe switch-over from the primary hydraulic system to the back-up/emergency system.

See also section 8.1 for Hydraulic Systems requirements.

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

6.2.10.5 Merged with 6.2.10.1

6.2.11 VCF electrical power system safety

(Note: See section 12 for specific electrical power system criteria)

6.2.11.1 Backup.

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 on-board 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.

Considerations for preparation of AMC:

1. Documentation supported by analysis, rig, ground and flight testing demonstrating the safe switch-over to emergency/back-up electrical supply systems, effective aircraft control using those systems, and ability for the aircraft to perform a controlled emergency actions and/or recovery actions.

See also section 12 for Electrical Systems requirements.

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 paragraphs	*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 4671.1412

Information Sources			
			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

6.2.11.2 Independent sources.

The aircraft electrical system shall be designed such that, where there are independent power sources:

a. They shall not adversely interact to preclude continued safe flight of the aircraft.

b. 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.

Considerations for preparation of AMC:

1. Design documentation supported by rig, ground and flight testing as appropriate demonstrating the independence and redundancy of the electrical systems and the ability for each system to provide power to the specified equipment (which may include electrical load shedding).

See also section 12 for Electrical Systems requirements.

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

6.2.11.3 Transients.

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 or short or open circuits.
d. Switching supplied equipment on or off.

Considerations for preparation of AMC:
1. Design documentation supported by rig, ground and flight testing as appropriate demonstrating the function and safety of electrical systems and equipment, including the effects of the worst-case power transients.

See also section 12 for Electrical Systems requirements.

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

6.2.11.4 Merged with 12.1.6

6.2.11.5 Bus separation.

Where electrical power busses 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. In addition, such a failure shall not cause any loss of function of the Vehicle Control System.

Consideration should be given to:
a. Load matching and balancing components.
b. Bus switching components.
c. Bus or load faults.
d. Redundancy in power supply to VCF equipment.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) identifying the successful independence of power busses, robustness to single failures and continued operation of Vehicle Controls following failures of the electrical system.

See also section 12 for Electrical Systems requirements.

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, 25.1501-25.1529	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

6.2.11.6 Effects of failure modes.

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.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) identifying the probability and effects of failures of the electrical system on the VCF.

2. Design documentation demonstrating that VCF equipment functions with supplied electrical power in normal, abnormal and failure modes of the aircraft's electrical supply system.

See also section 12 for Electrical Systems requirements.

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

Information Sources			
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

6.2.11.7 Uninterruptible power.

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. Utilization of circuit protection devices.

c. Testing methodology.

Considerations for preparation of AMC:

1. Design documentation demonstrating that VCF equipment functions with supplied electrical power in normal, abnormal and failure modes of the aircraft's electrical supply system.

See also section 12 for Electrical Systems requirements.

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

6.2.12 VCF electronic systems safety

6.2.12.1 Computer design.

The VCF computer/processor(s) shall be designed to ensure that processing hardware meets the specified requirements so 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. In addition, 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;
c. Processing hardware requirements, and any specialized requirements;
d. VCF computer/processor capacity margins (typically 50%);
e. Accounting for noise sources of narrow-band signals such as harmonics of microprocessor clocks and power supply equipment.

Considerations for preparation of AMC:
1. Design documentation, supported by avionics rig testing and aircraft ground and flight testing as appropriate demonstrating the verification of computer components against their defined requirements.

Information Sources			
Comm'l Doc:			
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

6.2.12.2 Electronic sensors.
Electronic sensors utilised in the VCF shall be assured as safe.

Consideration should be given to:
a. The reliability of each sensor in isolation;
b. Redundancy and failure management of the electronic sensors and systems;

Considerations for preparation of AMC:
1. Design documentation, supported by rig (system rigs, 'Iron Bird', etc), ground and flight testing (as appropriate) demonstrating the appropriate and safe use of electronic sensors in the design of the VCF.
2. Appropriate equipment qualification using a suitable standard (e.g. MIL-STD-810, DO-160, etc) demonstrating that the electronic sensors function through the range of environments and other conditions in which they are required to operate.
2. Failure Modes and Effects Analysis (FMEA) / Failure Modes, Effects and Criticality Analysis (FMECA) / Fault Tree Analysis (FTA) demonstrating that the probability and effect of failure of VCF electronic sensors does not unacceptably increase the Probability of Loss of Control (PLOC) or Probability of Loss of Aircraft (PLOA).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 S3.10.6 00-970 P1 S3.10.8 00-970 P1 S3.10.20 00-970 P1 S3.10.28 00-970 P7 L711 S6.5.1

Information Sources			
			00-970 P9 UK FW.1309b
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

6.3 AERODYNAMICS AND PERFORMANCE.

6.3.1 Engine-airframe compatibility.

The installed propulsion system design shall consider engine and airframe compatibility in order to ensure safe operation of the aircraft.

Consideration should be given to:
a. Flow disturbances entering the engine from the inlet.
b. Flow disturbances entering the engine from the afterburner/nozzle.
c. Flow, mechanical and thermal interfaces with the airframe and subsystems.
d. Operation of flight, engine and subsystem controls.

Considerations for preparation of AMC:
1. Propulsion system instabilities are identified during design and development through test, analysis, and demonstration.
2. Exhaust system back pressure and nozzle matching effects are verified by analysis, test, and demonstration.
3. Thermal boundary, fuel, air induction, exhaust and bleed air extraction system, ambient temperature, ambient pressure, vibratory environment, and altitude cold start and hot restart capability effects are verified by analysis, test, and demonstration.
4. Steady state and transient response characteristics of the engine and engine control system, engine response to input signals at different frequencies, fuel flow modulation, engine control and vehicle control system communication, and auxiliary engine control function effects to propulsion system instabilities are verified by analysis, test, and demonstration.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1797A JSSG 2007A Section 3.1.1.1 MIL-HDBK-516C 6.3.1	*Def-Stan 00-970 Reference:*	00-970 P1 S5.1.15 00-970 P1 S5.1.16 00-970 P1 S5.1.17 00-970 P5 UK25.903a 00-970 P7 L700 S2.1 00-970 P9 S2 UK FW.901d
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.901 CS 23.903 CS 25.903 CS 27.901 CS 27.903

Information Sources			
			CS 29.901 CS 29.903

6.3.2 Performance information.

The aircraft performance information provided to the pilot/operator shall be suitably complete and accurate to ensure safe flight.

Consideration should be given to:

a. The types and level of detail of information relevant to the pilots' continued safe flight of the aircraft.

b. The information that may be required through all of the aircraft's flight phases (preparation, taxi, launch, take-off, climb, cruise, descent, approach and landing/recovery).

c. The information that may be required through manoeuvres (turning, hover, in-flight refuelling, etc.).

d. The information that may be required in emergencies or in the event of equipment failures.

Considerations for preparation of AMC:

1. An aircraft force and moment accounting system.
2. Aerodynamic, propulsion, and mass properties databases, based on the latest information available.
3. Predictions of:

a. Trimmed lift and drag in and out of ground effect,

b. Installed thrust, power available, and power required,

c. Fuel flow and fuel quantity,

d. Inertias, centre of gravity, and weights.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516C 6.3.2	*Def-Stan 00-970 Reference:*	00-970 P1 S7.3
		STANAG Reference:	4671.1501 4671.1505 4671.1507 4671.1513 4671.1519 4671.1521 4671.1525 4671.1527 4671.1581 4671.1583 4671.1585 4671.1587 4671.1589
FAA Doc:		*EASA CS Reference:*	CS 23.1501 CS 23.1505 CS 23.1507 CS 23.1511 CS 23.1513 CS 23.1519 CS 23.1521 CS 23.1525

Information Sources			
			CS 23.1527 CS 23.1581 CS 23.1583 CS 23.1585 CS 23.1587 CS 23.1589 CS 25.1501 CS 25.1503 CS 25.1505 CS 25.1507 CS 25.1516 CS 25.1517 CS 25.1519 CS 25.1521 CS 25.1525 CS 25.1527 CS 25.1531 CS 25.1533 CS 25.1581 CS 25.1583 CS 25.1585 CS 25.1587 CS 25.1591 CS 27.1501 CS 27.1503 CS 27.1505 CS 27.1509 CS 27.1519 CS 27.1521 CS 27.1525 CS 27.1527 CS 27.1581 CS 27.1583 CS 27.1585 CS 27.1587 CS 27.1589 CS 29.1501 CS 29.1503 CS 29.1505 CS 29.1509 CS 29.1517 CS 29.1519 CS 29.1521 CS 29.1525 CS 29.1527 CS 29.1581 CS 29.1583

Information Sources			
			CS 29.1585 CS 29.1587 CS 29.1589

6.3.3 Performance limits.
All aircraft performance flight limits shall be provided to the pilot/operator to ensure safe operation.

Consideration should be given to:
a. Limits relevant to the pilots' continued safe flight of the aircraft.
b. Limits that may be required through all of the aircraft's flight phases (preparation, taxi, launch, take-off, climb, cruise, descent, approach and landing/recovery).
c. Limits that may be required through manoeuvres (turning, hover, in-flight refuelling, etc.).
d. Limits relevant in emergencies or in the event of equipment failures.

Considerations for preparation of AMC:
1. An aircraft force and moment accounting system.
2. Aerodynamic, propulsion, and mass properties databases, based on the latest information available.
3. Predictions of:
a. Trimmed lift and drag in and out of ground effect,
b. Installed thrust, power available, and power required,
c. Fuel flow and fuel quantity,
d. Inertias, centre of gravity, and weights.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516C 6.3.3	*Def-Stan 00-970 Reference:*	00-970 P1 S7.3
		STANAG Reference:	4671.1501 4671.1505 4671.1507 4671.1513 4671.1519 4671.1521 4671.1525 4671.1527 4671.1581 4671.1583 4671.1585 4671.1587 4671.1589
FAA Doc:		*EASA CS Reference:*	CS 23.1501 CS 23.1505 CS 23.1507 CS 23.1511 CS 23.1513 CS 23.1519 CS 23.1521 CS 23.1525

Information Sources			
			CS 23.1527 CS 23.1581 CS 23.1583 CS 23.1585 CS 23.1587 CS 23.1589 CS 25.1501 CS 25.1503 CS 25.1505 CS 25.1507 CS 25.1516 CS 25.1517 CS 25.1519 CS 25.1521 CS 25.1525 CS 25.1527 CS 25.1531 CS 25.1533 CS 25.1581 CS 25.1583 CS 25.1585 CS 25.1587 CS 25.1591 CS 27.1501 CS 27.1503 CS 27.1505 CS 27.1509 CS 27.1519 CS 27.1521 CS 27.1525 CS 27.1527 CS 27.1581 CS 27.1583 CS 27.1585 CS 27.1587 CS 27.1589 CS 29.1501 CS 29.1503 CS 29.1505 CS 29.1509 CS 29.1517 CS 29.1519 CS 29.1521 CS 29.1525 CS 29.1527 CS 29.1581 CS 29.1583

Information Sources			
			CS 29.1585 CS 29.1587 CS 29.1589

6.3.4 Performance information.

Failures that appreciably affect the performance of the aircraft shall be identified and defined in the Aircraft Flight Manual or other aircraft document. For such failures, the effect on the aircraft's performance shall be characterised and defined in the same document.

Consideration should be given to:

a. Failures that could affect the continued safe flight of the aircraft.

b. Failures affecting performance through all of the aircraft's flight phases (preparation, taxi, launch, take-off, climb, cruise, descent, approach and landing/recovery).

c. Failures affecting performance through manoeuvres (turning, hover, in-flight refuelling, etc.).

Considerations for preparation of AMC:

1. An aircraft force and moment accounting system.
2. Aerodynamic, propulsion, and mass properties databases, based on the latest information available.
3. Predictions of:

a. Trimmed lift and drag in and out of ground effect,

b. Installed thrust, power available, and power required,

c. Fuel flow and fuel quantity,

d. Inertias, centre of gravity, and weights.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516C 6.3.4	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

SECTION 7 - PROPULSION AND PROPULSION INSTALLATIONS

This section covers the design, installation, arrangement and compatibility of the complete aircraft 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 aircraft. 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 aircraft/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 Risk Management.				
7.1.1 Safety-critical propulsion system	x	x	x	x
7.1.2 Engine Out			x	x
7.1.3 Technical data				
7.1.5 Critical safety items	x	x	x	x
7.1.6 Propulsion system operation	x	x	x	x
7.2 Gas turbine engine applications.				
7.2.1 Performance.				
7.2.1.1 Installed performance	x	x	x	x
7.2.1.1.1 Volcanic Conditions				
7.2.1.2 Degraded performance	x	x	x	x
7.2.2 Operability.				
7.2.2.1 Stability margin	x	x	x	x

7.2.2.2 Transient operation	x	x	x	x
7.2.2.3 Air start	x	x	x	x
7.2.2.4 Stall recoverability	x	x	x	x
7.2.3 Structures.				
7.2.3.1 Engine structure.	x	x		
7.2.3.2 Through life Durability	x	x		
7.2.3.3 Damage tolerance	x	x		
7.2.3.4 Material characterization.	x	x		
7.2.3.5 Design service life	x	x		
7.2.3.6 Life management	x	x		
7.2.4 Engine subsystems, components, computer resources and software.				
7.2.4.1 Subsystems.				
7.2.4.1.1 Engine control system	x	x		
7.2.4.1.2 Isolation of subsystems			x	x
7.2.4.1.3 Stability	x	x		
7.2.4.1.4 Failure modes	x	x		
7.2.4.1.5 Failure criticality	x	x	x	x
7.2.4.1.6 Fuel system	x	x	x	x
7.2.4.1.7 Ignition system	x	x		
7.2.4.1.7.1 Battery operated ignition systems at a platform level	x	x		
7.2.4.1.8 Anti-ice/de-ice systems	x	x		
7.2.4.1.9 Cooling and thermal management	x	x	x	x
7.2.4.1.10 Variable geometry systems	x	x	x	x
7.2.4.1.11 Lubrication system operation	x	x	x	x
7.2.4.1.12 Lubrication system discharge	x	x	x	x
7.2.4.1.13 Lubrication system non-combustion	x	x	x	x
7.2.4.1.14 Propulsion monitoring system	x	x	x	x
7.2.4.1.15 Engine bleed air system	x	x	x	x
7.2.4.2 Components: mechanical and electrical.				
7.2.4.2.1 Controls and subsystems rotating components	x	x	x	x
7.2.4.2.2 Bearing thrust balance	x	x	x	x
7.2.4.2.3 Tubing/plumbing routing	x	x		
7.2.4.2.4 Tubing/plumbing vibratory response	x	x	x	x
7.2.4.2.5 Externals maximum operating conditions	x	x		
7.2.4.2.6 Gearboxes	x	x		
7.2.4.2.7 Gearbox mounted component failures	x	x		
7.2.4.2.8 PTO shaft	x	x		
7.2.4.2.9 Electrical components and cable routing	x	x		
7.2.4.2.10 Electromagnetic environment	x	x		
7.2.4.2.12 Electrical power	x	x	x	x
7.2.4.2.13 Computer resources and software	x	x	x	x
7.2.5 Installations.				
7.2.5.1 Physical Installation.				

7.2.5.1.1 Physical interfaces			x	x
7.2.5.1.2 Engine mounts			x	x
7.2.5.1.3 Power-take-off (PTO) shaft vibratory response			x	x
7.2.5.1.4 Uncontained rotating parts			x	x
7.2.5.1.5 Engine/aircraft clearances			x	x
7.2.5.1.6 Drains and ventilation systems			x	x
7.2.5.1.7 Engine stall loads			x	x
7.2.5.1.8 Installed engine accessibility			x	x
7.2.5.1.9 FOD/DOD			x	x
7.2.5.2 Functional installation.				
7.2.5.2.1 Functional compatibility			x	x
7.2.5.2.2 Power demands/extractions			x	x
7.2.5.2.3 Bleed air contamination			x	x
7.2.5.2.4 Engine shutdown			x	x
7.2.5.3 Inlet compatibility.				
7.2.5.3.1 Inlet compatibility			x	x
7.2.5.4 Exhaust system compatibility.				
7.2.5.4.1 Exhaust gas impingement			x	x
7.2.5.4.2 Thrust reverser/thrust vectoring			x	x
7.2.5.5 Environmental compatibility.				
7.2.5.5.1 Engine bay/nacelle cooling and ventilation			x	x
7.2.5.5.2 Vibratory compatibility			x	x
7.2.5.6 Installation other.				
7.2.5.6.1 Crew/operator station compatibility			x	x
7.3 Alternate propulsion systems.				
7.3.1 Propeller driven systems.				
7.3.1.1 Design margins		x		
7.3.1.2 Critical speeds		x		
7.3.1.3 Reversing and pitch controls		x		
7.3.1.4 Propeller interfaces		x	x	
7.3.1.5 Feathering system		x		
7.3.1.7 Vibration and balancing		x		
7.3.1.8 Ice control system		x		
7.3.1.9 Bird strike resistance		x		
7.3.1.10 Environmental conditions		x		
7.3.2 Rotary wing systems.				
7.3.2.1 Design margins				x
7.3.2.2 Safe controllability				x
7.3.2.3 Main rotor blade passage frequencies				x
7.3.2.4 Engine/airframe vibratory response				x
7.3.2.5 Lubrication system				x
7.3.2.6 Dynamic coupling				x
7.3.2.7 Control system stability				x
7.3.2.8 Misalignment				x

7.3.2.9 Rotor securing				x
7.3.2.10 Braking				x
7.3.2.11 Condition monitoring				x
7.3.2.12 Load absorbers				x
7.3.2.13 Loss of lubrication				x
7.3.2.14 Rotor meshing				x
7.3.2.15 Accessory drives				x
7.3.2.16 Environmental conditions				x
7.3.2.17 Drive system design				x
7.3.2.18 Space envelope				x
7.3.2.19 Protection from environmental elements				x
7.3.2.20 Accessibility				x
7.3.2.21 Faults and warnings				x
7.3.2.22 Contamination				x
7.3.3 Reciprocating engines.				
7.3.3.1 Reciprocating engines				
7.3.4 Other propulsion systems				

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 RISK MANAGEMENT.

This section details Propulsion Risk Management Criteria, necessary to identify, analyse and mitigate propulsion system risks.

7.1.1 Safety-critical propulsion system.
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).
f. Ensuring maintenance and inspection requirements are documented in the technical data.

Considerations for preparation of AMC:
1. Failure Modes Effects and Criticality Analysis (FMECA) and System Safety Hazard Analysis.
2. A Documented system safety approach to describe the practices to manage propulsion risks to the required in-flight shutdown rates.
3. Review of technical data to ensure maintenance and inspection requirements and special procedures have been documented.

Information Sources			
Comm'l Doc:	SAE ARP 5580		
DoD/MIL Doc:	JSSG-2007A: A.3.1, A.4.1; A.3.2, A.4.2; A.3.2.1, A.4.2.1; A.3.3.1, A.4.3.1; A.3.3.2, A.4.3.2; A3.4, A.4.4; A.3.5.1, A.4.5.1; A.3.7, A.4.7; A.3.7.2.1, A.4.7.2.1; A.3.11, A.4.11; A.3.12, A.4.12; Table XLIXa	*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

Information Sources			
FAA Doc:	14CFR references: 33.5, 33.35, 33.75, 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 Engine Out

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 CS 25.143 CS 25.105 CS 25.107 CS 25.109 CS 25. 117 CS 25.121 CS 25.362

Information Sources			
			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 Technical data.

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 aircraft.

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 lifing requirements.

Considerations for preparation of AMC:

1. Inspection of the maintenance and inspection of the technical orders and flight manuals provides assurance that all information is current and up to date.
2. Review of the system and process used to maintain the technical orders and flight manuals provides assurance that critical information will be correctly updated in a timely manner.

Information Sources			
Comm'l Doc:			
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

Information Sources			
			CS 27.1501-27.1589 CS 29.1501-29.1589 CS-E 20 CS-E 510 CS-P 150 CS-P 160

7.1.4 Merged with Section 4.6

7.1.5 Critical safety items.

Engine-related critical safety items (CSI) and critical characteristics shall be identified.

Consideration should be given to:

a. Propulsion system parts, assemblies, or installations containing critical characteristics whose failure, malfunction, or absence may cause a catastrophic or critical failure.

b. Control inputs which could result in an uncommanded engine shutdown that jeopardizes safety.

Considerations for preparation of AMC:

1. Inspection of the Critical Safety Item (CSI) list and FMECA to ensure that all items have been accounted for.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2007A: 3.4.1.4 DoDM 4140.01, Vol 11, Enc 3, Procedures 3, CSI-Specific Procedures NAVAIRINST 4200.56 Critical Item Management Desktop Guide (to NAVAIR 4200.56) JACG Aviation Critical Safety Item Management Handbook	*Def-Stan 00-970 Reference:*	00-970 P11 3.E515
		STANAG Reference:	4671.1529
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

7.1.6 Propulsion system operation.

Engine thrust or power, fuel consumption, endurance, and structural integrity should be characterized with representative installation effects over the expected flight and manoeuvre envelope and shown to support the safe operation of the aircraft.

Consideration should be given to:

a. Inlet effects due to:
i. External protuberances (sensors, probes);
ii. Anti-ice devices;
iii. Sand and dust separators;
iv. Exhaust system effects due to infrared (IR) or noise suppressors;
v. Extractions due to bleed air and mechanical power.
b. Operational environments such as cold and hot days, and weather such as rain, snow, or ice.
c. Operational environments can also include bird, ice, sand, volcanic ash ingestion, as well as hot gas ingestion from any source (including armament gases).
d. The manoeuvre envelope, including rotational velocities, accelerations, and gyroscopic moment conditions.

Considerations for preparation of AMC:
1. A combination of engine test, analysis and review of documentation.
2. Verification of baseline performance, installation effects and deterioration caused by the operational environment at representative ground and altitude conditions.
3. Analysis performed with a model based on measured test data for characterization of performance at conditions that have not been tested.
4. Analysis to verify that component deflections under gyroscopic loading conditions do not impair operation of the engine under ultimate loading levels and meet life requirements under limit load conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007: A.3.2, A.4.2 (Performance and Operability); A.3.3, A.4.3 (Environmental Conditions); A.3.4, A.4.4 (Integrity)	*Def-Stan 00-970 Reference:*	00-970 Pt1 Sec 5.1.33 to 5.1.39 00-970 Pt 11 Sec 2.3 00-970 Pt 11 Sec 2.10 00-970 Pt 11 Sec 2.11 00-970 Pt 11 Sec 2.13.4
		STANAG Reference:	4671.USAR: 901 4671.USAR: 903
FAA Doc:	14 CFR 33.23, 33.5, 33.35, 33.7, 33.75, 33.8, 33.91	*EASA CS Reference:*	CS-E 510 CS-E 515 CS-E 40 CS-E 100 CS-E 170 CS-E 250 CS-E 560 CS-P 150 CS 23.901 CS 25.901 CS 27.901 CS 29.901

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 aircraft. 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 aircraft/engine integration;
- Engine subsystems, components, computer resources and software;
- Performance across all intended operational environments.

7.2.1 Performance.

7.2.1.1 Installed performance.

Engine performance shall be adequate for safe operation of the aircraft. This includes consideration of all installation effects due to aircraft/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
m. Pressure and drag effects due to engine installation protuberances such as sensors and probes

Considerations for preparation of AMC:
1. A combination of engine tests and analyses.
2. Testing at representative ground and altitude conditions to characterize and verify baseline performance.
3. Analyses performed with a model based on measured test data for characterization of performance at conditions that have not been tested.
4. The trend toward system integration may lead to Electronic Engine Control Systems that:
i. Have other control functions integrated within the Engine Control System, such as an integrated Engine and Propeller Control System or,
ii. Depend on aircraft resources.

Examples of these aircraft supplied resources include recording of rotorcraft One Engine Inoperative data and aircraft central computers that perform some or all of the Engine control functions.
The applicant is responsible for specifying the specifications for the EECS for these aircraft supplied resources in the Engine instructions for installation and substantiating the adequacy of those specifications (AMC E 20 Engine Configuration and Interfaces).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007: A.3.1, A.4.1; A.3.7, A.4.7; A.3.2, A.4.2; A.4.2.1, A.4.2.1.1; A.3.3.1, A.4.3.1; A.3.3.2, A.4.3.2; A.3.11, A.4.11; A.3.12, A.4.12; Table XLIXa 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, FAA 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 Volcanic Conditions
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;
a. Blockage of engine cooling ducts/vents or paths;
b. Aircraft skin and transparency abrasion;
c. Damage to systems from ingestion of particles (air conditioning, electronic cooling, contamination of surfaces or fluids)
e. Blockage of air data system (pitot or static systems);

Considerations for preparation of AMC:
1. A combination of engine tests and analyses.
2. Analyses performed with a model based on measured test data for characterization of performance at conditions that have not been tested.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.1593

7.2.1.2 Degraded performance.
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

Considerations for preparation of AMC:
1. A combination of engine tests and analyses.

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: 33.65 Surge and stall characteristics; 33.73 Power or thrust response; and 33.89 Operation test	*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 Stability margin.

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 take-offs, take-offs on cold days following a rapid reaction start, and extreme manoeuvers.

b. All destabilizing effects, such as: engine deterioration, non-standard day effects, steam ingestion, armament gas ingestion, liquid water ingestion, and transient response.

Considerations for preparation of AMC:

1. Rig and/or engine tests to measure fan and compressor stall lines.
2. A stability methodology developed by testing fan/compressor sensitivity to distortion and other destabilizing influences.
3. Inlet model tests conducted to quantify the levels of performance, distortion, and inlet stability.

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 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

Information Sources			
			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 Transient operation.

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, AAR, quick stops, use of reverse thrust, and VSTOL;

b. For rotorcraft, bob-up and re-mask, and nap of the earth ridgeline crossings.

Considerations for preparation of AMC:

1. Analysis, electronic and closed loop bench tests, engine tests, vehicle integration tests, flight tests and inspection of documentation.

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 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 Air start.

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:
1. Engine spool-down.
2. Windmill start.
3. Start using cross-bleed, or starter-assisted as appropriate.
4. Hot and cold relights.

Considerations for preparation of AMC:
1. Initial verification through ground testing in altitude test cells.
2. Verification though flight test.

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 CS-E 910

7.2.2.4 Stall recoverability.

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.

Consideration should be given to:
a. Automatic relight system for single engine applications.

Considerations for preparation of AMC:
1. Verification of control system detection by engine ground and bench testing.
2. Self-recovery is demonstrated from engine ground and altitude cell testing.

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: 33.28, 33.65	*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 Engine structure.

The engine structure shall not:

1. 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 or ground envelope.
2. 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.

Considerations for preparation of AMC:

1. Verification methods include analysis, test, demonstration, simulation, inspection and review of documentation for:
 - Factor of safety (SF)
 - Rotor integrity
 - Gyroscopic moments
 - Disk burst speed
 - Blade and disk deflection
 - Blade out
 - Engine mounts

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-1783B: A.3.4.1.6, A.4.4.1.6 Strength; A.3.1.1.4.3, A.4.1.1.4.3 Engine Stiffness; A.3.4.1.2.1, A.4.4.1.2.1 Externally Applied Forces	*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

Information Sources			
			00-970 P11 S4
		STANAG Reference:	4671.361 4671.363 4671.371
FAA Doc:	14CFR references: 33.75, 33.91, 33.23	*EASA CS Reference:*	CS 23.305 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 Through life Durability.

The engine shall have a positive durability margin over the defined operational interval and duty cycle to preclude adverse safety impacts.

Consideration should be given to:

a. Cycle fatigue life margins.
b. Vibratory stresses.
c. Degradation due to material corrosion.
d. Foreign object/domestic object damage
e. Requirements regarding inspection procedures/intervals during operation.

Considerations for preparation of AMC:

1. Verification methods include analysis, test, demonstration, simulation, inspection and review of documentation for:
- Low cycle fatigue margin (LCF)
- High cycle fatigue margin (LCF)
- Corrosion
- Creep
- Vibration
- Acoustic environment

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007: A.3.4.1.5, A.4.4.1.5, Durability; A.3.4.1.5.2, A.4.4.1.5.2, LCF;	*Def-Stan 00-970 Reference:*	00-970 P11 2.13 00-970 P11 3.25 00-970 P11 3.70

Information Sources			
	A.3.3.1.5,A.4.3.1.5, Corrosive atmosphere; A.3.4.1.8,A.4.4.1.8, Vibration and dynamic response; A.3.4.1.5.1, A.4.4.1.5.1, High cycle fatigue (HCF) life guidance; A.3.2.1.4, A.4.2.1.4, Performance retention guidance; A.3.4.1.10, A.4.4.1.10 Acoustic noise; A.3.3.2.2, A.4.3.2.2, Foreign object damage (FOD)		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
		STANAG Reference:	4671.901
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 Damage tolerance.
All safety and mission-critical parts shall be designed to be damage tolerant over the defined operational interval and duty cycle.

Consideration should be given to:
a. Ensuring that safety and mission critical parts are serialized, properly marked and tracked, and subjected to the required process control and NDI procedures.
b. Requirements regarding inspection procedures/intervals during operation.

Considerations for preparation of AMC:
1. Verification methods include analysis, test, demonstration, simulation, inspection and review of documentation for:
- Fracture critical component
- Initial flaw size
- Residual strength
- Damage tolerance controls.

2. Damage Tolerance assessments should be performed to minimise the potential for Failure from material, manufacturing and service-induced anomalies within the Approved Life of the part. (AMC E 515 Engine Critical Parts)

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	JSSG-2007: A.3.4.1.4, A.4.4.1.4 Parts classification; A.3.4.1.7, A.4.4.1.7 Damage tolerance; 3.4.1.7 through 3.4.1.7.4 and A.4.4.1.7 through A.4.4.1.7.4, Composites damage tolerance	*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 characterization.

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. Fracture toughness and crack growth rate.

Considerations of AMC:

1. Test and modelling programs to establish material structural properties.
2. Anticipated properties under damage states (e.g., fretting) have been verified.
3. Critical structural properties are dependent upon the manufacturing processes. This should be accounted for during testing to ensure accurate comparison.
4. Damage states in the parts which may occur during field usage have been verified for their potential effect on high cycle fatigue life.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007: A.3.4.1.3, A.4.4.1.3 Material characterization	*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	

Information Sources			
		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 Design service life.

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.

Considerations for preparation of AMC:

1. The specification and/or the Structural Integrity Program (e.g., strength and life report), as appropriate, document the design duty cycle details and life analyses.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007: A.3.4.1.2, A.4.4.1.2 Design 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 CS-E 100 CS-E 210 CS-E 500 CS-E 510

Information Sources			
			CS-E 515 CS-E 680

7.2.3.6 Life management.

Engine inspection intervals and life-limited components shall be identified in the technical manuals.

Consideration should be given to:

a. Ensuring the required maintenance actions (component inspection, repair, or replacement requirements) have been defined.

b. Allowance for Probability of Detection (POD) of the individual inspection processes.

c. The assumed in-service inspection procedures and intervals should be integrated into the Service Management Plan and included, as appropriate, in the airworthiness limitations section of the instructions for continued airworthiness.

Considerations for preparation of AMC:

1. Documentation of the Engine Life Management Plan, applicable maintenance manuals and the parts life tracking program.

2. POD based upon the statistical review of sufficient quantities of relevant testing or experience (EASA AMC E 515).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007: A.3.4.1.1, A.4.4.1.1 Design service life.	*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:	14 CFR 33.4	*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 Engine control system.

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 of 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. Ensuring that the architecture accommodates all control mode operations, including failure conditions.

Considerations for preparation of AMC:

1. A Failure Modes, Effects and Criticality Analysis (FMECA) and a System Safety Hazard Analysis (SSHA) of the control system.
2. Closed loop bench testing, using production qualified components to ensure the system can properly interact with all other systems and components on the engine.
3. Engine sea level and altitude testing.
4. Flight testing to ensure the engine performs as required and that there are no unaccounted for installation effects.
5. Alternative compliance approaches include similarity to other military systems or previous civil (e.g., FAA) airworthiness certification support documentation.

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 CS 25.20

7.2.4.1.2 Isolation of subsystems.
An engine's subsystems shall be isolated from each other to prevent cascading failures which could result in the loss of more than one propulsion sub-system due to any single or common cause.

Consideration should be given to:
a. Ensuring controls and subsystem components are:
i. Physically isolated or protected to minimize collateral or secondary damage in the event of failure.
ii. Systemically and operationally isolated.

Considerations for preparation of AMC:
1. Inspection of design review and test data, drawings and installed hardware provide information to evaluate adequate physical isolation of engine subsystem components.
2. Mock-ups can be used if they adequately represent fielded systems.
3. A Failure Modes, Effects and Criticality Analysis (FMECA)

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

Information Sources			
			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 Stability.

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 ice, rain, snow, volcanic ash, etc.);

c. Defining the required responsiveness.

d. Reheat modulation

Considerations for preparation of AMC:

1. Phase and gain stability margins are verified through analysis, open and closed loop modelling, bench testing (wet rig) and full-up engine testing.
2. Closed loop models are validated using closed loop bench and full-up engine testing.
3. Ground and flight testing.

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 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

Information Sources			
			CS 23.939 CS 25.939 CS 27.939 CS 29.939

7.2.4.1.4 Failure modes.

Any failure of the engine controls and associated sub-systems shall result in a fail-safe condition.

Consideration should be given to:

a. Ensuring that loss of redundancy does not affect control system capability. Failures may be accommodated by the following:

- Fail-operational capability provides full-up engine performance.
- Fail-safe capability allows continued engine operation at a degraded level of performance sufficient to sustain safe aircraft operation.
- Failure accommodation on multi-engine platforms may include engine shutdown if loss of aircraft does not result.

Considerations for preparation of AMC:

1. A Failure Modes, Effects and Criticality Analysis (FMECA).

2. Closed loop and fault injection bench testing to ensure the control system can correctly identify and accommodate all known failures.

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 Failure criticality.

Engine control system failures and accommodations shall not result in unacceptable controllability, stability, or handling qualities; or require any urgent or excessive operator action.

Consideration should be given to:

a. The dynamic latency and response should ensure safe operation.

b. Appropriate warnings and cautions to notify the operator of failures.

c. Recording of critical and non-critical failures.

Considerations for preparation of AMC:

1. Flight testing for degraded engine control modes (e.g., reversionary, backup) verifies acceptable handling qualities.

2. Closed loop bench and fault injection testing.

3. A Failure Modes, Effects and Criticality Analysis (FMECA).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.7.2, A.4.7.2, A.3.7.6, A.4.7.6	*Def-Stan 00-970 Reference:*	00-970 P11 3E.50 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 Fuel system.

The engine fuel system shall safely provide the required fuel supply to the combustor and reheat sub-systems under all required conditions.

Consideration should be given to:

a. Ensuring in-line filtration systems include cleaning, replacement and bypass indication.

b. Ensuring all fuel carrying components and lines are fire resistant.

Considerations for preparation of AMC:

1. Complete analysis of fuel system requirements versus capabilities, using worse case flight conditions, establishes the system design parameters.

2. Bench (wet rig) testing demonstrates the fuel systems ability to produce required flows, pressures and temperatures.

3. Ground engine testing demonstrates the fuel system's ability to provide properly conditioned fuel to the engine.
4. A fuel filter flow and contamination test ensures that the filter adequately cleans debris from the fuel.
5. Applicable fuel system performance testing (suction lift, cavitation, vapour to liquid ratio (V/L), lubricity, etc.).
6. Proof and burst pressure component testing.

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 SAE AS4273 SAE AS1055	*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 Ignition system.
The engine ignition system shall provide a safe and effective ignition source for the main combustor and reheat system.

Consideration should be given to:
a. Flameout detection and auto-relight, or manual activation of the ignition systems.
b. Sufficient insulation of external cabling to prevent inadvertent conduction.

Considerations for preparation of AMC:
1. Verification of the ignition system's ability to provide adequate spark energies to the main combustor and augmenter.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.2.2.3.5/A.4.2.2.3.5, Auto-	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.86 00-970 P11 3E.210

Information Sources			
	Relight and A.3.7.5/A.4.7.5, Ignition Systems		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 Battery operated ignition systems at a platform level.
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 Anti-ice/de-ice systems.
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.

Consideration should be given to:
a. Temperature monitoring systems to prevent damage due to over-heat.

Considerations for preparation of AMC:
1. Analysis of the aircraft mission defines the engine's icing environment.

2. Bench and engine tests of the anti-ice or de-ice plumbing, valves and sensors.
3. Analysis and inspection of all critical control system components verifies resistance to moisture collection and freezing.
4. Bench testing of the control system demonstrates that it can identify the existence of icing conditions and turn on the anti-ice or de-ice system.

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 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 Cooling and thermal management.

The engine cooling and thermal management systems shall safely remove excess heat from the engine and its sub-systems and integrate with the aircraft thermal management system (if applicable).

Consideration should be given to:
a. The full operational envelope of the aircraft.
b. Those components (electronic controls, sensors, lubrication system, etc.) which could become damaged, or operate erratically, if subjected to excessive thermal load.
c. Installation affects such as nacelle ventilation, surface temperatures, oil-fuel cooling and electronics functioning.
d. Thermal load dissipation for the entire aircraft, including post-shutdown conditions such as engine soakback.

Considerations for preparation of AMC:
1. Analysis and modelling of engine components determine their thermal loading and heat rejection characteristics.
2. Verify the engine components' ability to continue operation when exposed to engine induced thermal loads.
3. Analysis and modelling of the combined aircraft and engine thermal management systems ensures there are no conditions that result in exceedance of established loss of aircraft (LOA) rates.
4. Engine testing is used to validate the results of thermal modelling and analyses.
5. Aircraft installation surveys are performed to verify that component maximum operating temperatures and maximum non-operating temperatures are not exceeded.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.2.2.13/A.4.2.2.13, A.3.7.3.3, A.4.7.3.3	*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

Information Sources			
			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 Variable geometry systems.
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.
e. Ensuring all variable geometry components and lines that carry fuel are fire resistant and those that carry oil are fire proof.

Considerations for preparation of AMC:
1. Analysis and bench testing of each variable geometry system.
2. Engine and flight testing of the variable geometry system.

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. A.3.1.8.1, A.4.1.8.1 Flammable Fluid Systems - fire resistance and fire proof 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: 25.671, 27.695, 29.695, 33.17, 33.72,	*EASA CS*	CS-E 140 CS-E 650

Information Sources			
	43.1	*Reference:*	

7.2.4.1.11 Lubrication system operation.
The engine lubrication system shall operate safely under all engine and airframe operating conditions.

Consideration should be given to:
a. Oil supply, scavenge, cooling, filtration and de-aeration under all engine operating conditions.
b. Ensuring that the engine safely operates in a low or no lubrication condition for specified periods.
c. In-line filtration system inclusion of cleaning, replacement and a bypass indication.
d. Monitoring of system debris within lubricant.
e. Ensuring all oil carrying components, lines and manifolds are fire proof.

Considerations for preparation of AMC:
1. Lubrication system bench, engine and flight testing demonstrate its ability to provide the operating pressures, temperatures and flows required in the engine specification.
2. Lubrication system simulator test verifies operational attitudes.
3. An oil de-aeration test ensures the system deaerator removes entrained air from the oil.
4. Analysis, bench and engine testing of all monitored lubrication system information.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007A: A.3.7.8/A.4.7.8, Lubrication System, 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 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 Lubrication system discharge.
The lubrication system shall be free from excessive discharge at the breather.

Consideration should be given to:
a. Health and safety Threshold Limit Values.
b. Location and orientation of the breather exhaust port to minimise ground personnel's exposure.

Considerations for preparation of AMC:
1. Analysis of breather emissions establishes test parameters.
2. Instrumented engine testing measures breather emissions.

Information Sources			
Comm'l Doc:			
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 Lubrication system non-combustion.
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.
c. Ensuring all oil carrying components, lines and manifolds are fire proof.

Considerations for preparation of AMC:
1. Analysis of bearing compartments, tanks, lines, gearboxes and sumps establish the system design parameters.
2. Analysis and bench testing verifies fuel and oil carrying component failures do not allow mixing of the two systems.

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, A.3.7.8, A.4.7.8 Lubrication System	*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 Propulsion monitoring system.
The propulsion monitoring system 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. Ensuring all safety/mission-critical faults and warnings are supplied to the operator/maintainer.
c. Involvement of off-board components/IT systems in the processing of safety-related information.
d. Ensuring the propulsion monitoring and control systems provide accurate information and do not allow false positive faults to occur.

Considerations for preparation of AMC:
1. Analysis and fault injection bench testing verifies the capability of the monitoring system.
2. Engine/aircraft testing provides assurance that the pilot/operator is provided clear notification of any critical failure.
3. Engine fault download testing verifies the operators/maintainers have full access to failure data.

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 CS-E 515

7.2.4.1.15 Engine bleed air system.
Engine bleed air system operation, including malfunctions, shall not adversely affect safety of flight, particularly addressing degraded states.

Consideration should be given to:
a. Prevention of over-temperature, surge, stall, or other detrimental factors occurring to the Engine due to air bleed extraction during all flight conditions in the aircraft operating envelope.

Considerations for preparation of AMC:
1. Bleed air interface airflow and quality is verified by test and demonstration.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2007: A.3.1.1.7, A.4.1.1.7	*Def-Stan 00-970 Reference:*	00-970 Pt1 5.1.74 00-970 Pt1 5.1.75 00-970 Pt11 3.E690
		STANAG Reference:	4671 USAR.1111
FAA Doc:	14CFR references: 33.28	*EASA CS Reference:*	CS-E 745 CS-E 690 CS-E 510 CS-E 20 CS 23.1111

Information Sources			
			CS 25.1103

7.2.4.2 Components: mechanical and electrical.

7.2.4.2.1 Controls and subsystems rotating components.

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 aircraft.
High-energy controls and subsystem rotating components shall be designed to be damage tolerant, or provisions for containment of failed parts should be included.

Consideration should be given to:
a. Including, but not be limited to, pumps, turbochargers, or other rotating drives.
b. Damage tolerance methodologies.
c. System safety analysis in accordance with Section 14.

Considerations for preparation of AMC:
1. Analysis of components' damage tolerance design characteristics.
2. Analysis of components' protections (shields, locations, orientations, etc.)

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 15 CS-E 80 CS-E 210 CS-E 510 CS-E 515

7.2.4.2.2 Bearing thrust balance.

Changes in bearing thrust balance shall not result in the bearing operating in failure prone regions of operation

Consideration should be given to:
a. Maximum expected changes in load and load direction (crossover) across the entire operating envelope.

Considerations for preparation of AMC:

1. Analysis followed by bearing rig and full-up instrumented engine testing to ensure:

- Engine bearing radial and thrust loading is within design limitations
- Satisfactory operation of the bearing and rotor support system.

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 Tubing/plumbing routing.
All engine mounted tubing, manifolds, clamps, electrical components and cabling shall be safely affixed and routed on the engine.

Consideration should be given to:
a. Potential interference or contact with neighbouring components or the engine structure.
b. Wear or chafing conditions.
c. Ensuring orientation and routing of tubes/lines carrying combustible fluid meet engine specification requirements by providing separation from all potential sources of extreme temperatures or ignition.

Considerations for preparation of AMC:
1. Inspection of engine externals drawings and hardware, design mock-ups and an as-drawn manufactured engine installation.

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 Tubing/plumbing vibratory response.

No engine mounted components or associated cabling shall react to engine, or aircraft 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. Tubing, manifolds, clamps, electrical components etc.

b. Ensuring engine mounted equipment does not contain natural frequencies within the engine and sub-systems operating ranges

Considerations for preparation of AMC:

1. Analysis and vibration surveys (ping testing) and vibration (shaker table) testing on external components, tubes/manifolds and lines.

2. Analysis and engine testing results confirms the externals capability to withstand excitations resulting from a blade out condition.

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 Externals maximum operating conditions.

All pressure vessels, tubes and manifolds shall meet maximum operating strength and life requirements.

Consideration should be given to:

a. Fire resistant lines.

b. Fireproof oil carrying components.

c. Redundant, visually verifiable locking features for Safety Critical electrical connectors.

Considerations for preparation of AMC:

1. Burst pressure component testing to ensure adequate safety margin across the entire flight envelope.

2. Verification of the existence of redundant locking features for critical connections.
3. Analysis of design review information to ensure damage tolerance capability.

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 Gearboxes.
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
c. All internal gears are free from damaging resonance

Considerations for preparation of AMC:
1. Analysis, bench and engine testing to verify the gearbox ability to support all mounted components.
2. Analysis and testing to verify the gearbox is capable of simultaneous operation of all the drives at maximum permissible torque or power rating, with the required factor of safety.

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

Information Sources			
			CS-E 100 CS-E 160 CS-E 440 CS-E 510 CS-E 515 CS-E 740

7.2.4.2.7 Gearbox mounted component failures.

The failure of any gearbox mounted component (e.g. oil pumps, fuel pumps, starters, generators) shall not result in failure of the gearbox itself.

Consideration should be given to:

a. Provision of disengagement (e.g., shear sections) prior to causing secondary damage to the gearbox or other components.

b. Components, whose continued operation is required to maintain safe aircraft operation, do not contain shear sections.

Considerations for preparation of AMC:

1. Analysis and inspection of the gearbox and mounted components ensures adequate disengagement provisions.

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 PTO shaft.

Failure of the engine power take-off (PTO) coupling assembly or driveshaft shall not adversely affect safe operation of the aircraft.

Consideration should be given to:

a. Design of the PTO/driveshaft coupling assembly prevents that assembly from unacceptably damaging surrounding hardware (e.g., anti-flail design).

Considerations for preparation of AMC:
1. Analysis and inspection of the PTO drawings and hardware.
2. Testing to verify driveshaft coupling assembly life and anti-flail capability.

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:*	00-970 Pt 11 Sec 3E Clauses 80, 520, and 650. 00-970 Pt 11 Sec 4
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS-E 80 CS-E 520 CS-E 650

7.2.4.2.9 Electrical components and cable routing.
All engine mounted electrical components and cabling shall be safely affixed and routed on the engine.

Consideration should be given to:
a. Prevention of wear or chaffing.
b. Separation between combustible fluids and potential ignition sources.
c. Locking features for safety critical electrical connectors.

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.		
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:*	00-970 Pt 11 Sec 3E Clauses 20, 25, 80, 110, and 135. 00-970 Pt 11 Sec 4
		STANAG Reference:	4671.1367
FAA Doc:	14CFR references: 33.5	*EASA CS Reference:*	CS 23.1163 CS 25.1163 CS 27.1163 CS 29.1163 CS-E 20 CS-E 25 CS-E 80 CS-E 110 CS-E 135

7.2.4.2.10 Electromagnetic environment.

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.

Consideration should be given to:

a. The shielding capability incorporated into the design of the internal environment (i.e. Faraday Cage).

a. Components such as electronic controls, alternators/generators, cables, wires, sensors.

b. Safe operation when exposed to the worst case expected electromagnetic (EMI), nuclear (EMP) or lightning induced energy environments.

c. Prevention of emissions of EMI that could affect the continued safe operation of any engine or aircraft electrical system or component.

Considerations for preparation of AMC:

1. Analysis of the aircraft EMI, EMP and lightning threat/exposure environment and the engine EMI generation characteristics.
2. Control and electrical subsystem closed loop bench testing to verify the engine EMI, EMP and lightning operational capabilities.
3. Evaluation of the engine's ability to meet specification requirements when installed inside the aircraft.

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

7.2.4.2.12 Electrical power.

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.

Consideration should be given to:

a. Engine driven alternator/generator capability should be adequate to provide safe and reliable electrical power at all specified engine speeds.

b. Seamless transition to and from back-up power for all engine safety critical systems and components.

Considerations for preparation of AMC:

1. Analysis of the engine's total power consumption.
2. Analysis, bench and engine testing demonstrate the ability to meet the electrical power generation requirements of the engine specification, when not installed in the aircraft.
3. Flight testing demonstrates the engine's ability to meet the electrical power generation requirements.
4. Analysis and test of the aircraft's power generation and battery systems.

.

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 Computer resources and software.

For subsystems that use computer systems and software, see Section 15 for additional specific criteria, standards and methods of compliance.

Consideration should be given to:

a. The interrelationship of software requirements (DALs) and power system design (i.e. single or multi-engine).

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	4671.1367

Information Sources			
		Reference:	
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 Physical interfaces.

All engine/aircraft 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 aircraft;

b. Ensuring interfaces are free of any contact with neighbouring components that result in a wear or chaffing 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 aircraft interfaces are fault tolerant or fail safe with no reasonable credible combination of failures having an unacceptable probability of aircraft loss;

e. Accessibility for necessary inspections and maintenance (engine and airframe).

Considerations for preparation of AMC:

1. Inspection of the hardware and a demonstration of installing the engine ensures that interface requirements defined in the engine Interface Control Document (ICD) are met.
2. Analysis, full-up engine and flight tests ensure interface loads are within design limitations.
3. Physical interface requirements are verified by inspection of program documentation.
4. Analysis and inspection of the interfaces, with the engine installed in the aircraft.
5. System interfaces are analysed to withstand maximum loading at worst case single failure operating and loading conditions.
6. System interface critical analysis assumptions are verified.

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 Engine mounts.

The aircraft / 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 aircraft manoeuvres and engine failures, without permanent deformation;

b. Withstand 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 shall 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.

Considerations for preparation of AMC:

1. Analysis, full-up engine and flight testing ensure the mounts retain the engine under all operation and known failure conditions.

2. Engine mount testing ensures adequate design safety margins.

3. Analysis of the engine mount design review data and drawings ensures a damage tolerant design.

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 Power-take-off (PTO) shaft vibratory response.

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 aircraft 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.

Considerations for preparation of AMC:

1. Inspection of design criteria establishes suitable critical speed margins that accommodate manufacturing variation, wear and unknown system dynamics.
2. Analysis (e.g., dynamic model) of end to end system predicts compliance with the speed margin goal.
3. Analysis results evaluate the capability of the system components to withstand excitations.
4. Component tests validate response, stiffness and other characteristics used in the analysis.

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 Uncontained rotating parts.

Design precautions shall be taken to reduce the risk of damaging aircraft safety of flight (SOF)/critical safety items (CSIs) due to uncontained engine failures, to an acceptable level. This covers:
1. Uncontained rotating parts;
2. 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.
c. Vibratory loads and their impact on engine mount design.

Considerations for preparation of AMC:
1. Inspection of the safety analyses documentation verifies that hazards associated with uncontained failures are reduced to an acceptable level.

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)

7.2.5.1.5 Engine/aircraft clearances.

The installed engine shall maintain a positive clearance between the aircraft 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 aeroplane 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.

Considerations for preparation of AMC:

1. Engine/aircraft clearance requirements are verified by inspection of design documentation.
2. System clearances are validated by inspection of system design analysis and simulation.
3. System design analysis and simulations are validated by first article inspections and flight tests.

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 Drains and ventilation systems.

The propulsion system shall include sufficient drain provisions capable of handling fluid/vapor 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. 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 aircraft battle damage should be considered when sizing and locating drains;

e. Routing overboard drain lines to permit fluid to exit free of the aircraft fuselage, nacelle, wing and pylon and protecting them from chafing when passing through bulkheads and cowlings.

f. In degraded modes, the drain system should minimise the potential for fire and/or explosion.

Considerations for preparation of AMC:

1. Propulsion drain and ventilation system sizing is validated by inspection of design documents and analysis identifying flow requirements and volume capacities for projected missions.

2. System operation at ground attitudes and under flight conditions is validated by analysis of in-flight pressure gradients and attitudes.
3. Analysis assumptions (e.g., pressure gradients, attitudes) are validated by ground and flight test.
4. Storage or expulsion hazards of fluids are recorded in System Safety documentation with mitigations defined where appropriate.

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 Engine stall loads.

The engine air inlet components shall have adequate structural margin to withstand over-pressures (inlet stall), under worst case conditions, 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 aircraft 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.

Considerations for preparation of AMC:
1. Engine air inlet components requirements are verified by inspection of design documents.
2. Maximum induced inlet stall pressures generated by inlet/engine anomalies are validated by inspection of analyses and/or test.
3. Capability of the components to withstand required inlet stall pressure is verified through component proof analysis and test.

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*	CS-E 70

Information Sources			
		Reference:	CS-E 100 CS 23.939 CS 25.939 CS 27.939 CS 29.939

7.2.5.1.8 Installed engine accessibility.

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 aircraft 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 provision of adequate space and access to break points, utilised during engine removal and replacement.

Considerations for preparation of AMC:

1. Inspection of design criteria establishes required servicing, inspections and maintenance requirements.
2. Analysis of virtual models or physical mock-ups verifies accessibility to required servicing, inspection and maintenance areas.
3. Maintenance demonstration verifies the ability to accomplish required tasks.

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 5.1.97-5.1.119
		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

Information Sources			
			CS 27.611 CS 27.901 CS 29.611 CS 29.901

7.2.5.1.9 FOD/DOD.

Design practices and processes ensure that 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 propulsion system.

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.

Considerations for preparation of AMC:

1. Inspection and analysis of documentation (e.g., FMEA, FMECA, SHA, SSHA) of systems within or upstream of the inlet verifies the absence of FOD/DOD generating failure modes.

2 Inspection verifies that manufacturing and maintenance procedures contain FOD/DOD control practices.

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 Functional compatibility.

The engine / aircraft 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 aircraft;

b. Defining more than one compatibility envelope, such as might be the case with a weapon/store deployment, launch operation and plume ingestion;

Considerations for preparation of AMC:
1. Engine/aircraft functional interface requirements are verified by inspection of program documentation.
2. Integrated system functional compatibility is verified by simulation, test and demonstration of system functionality at integration test facilities and on the aircraft during ground and flight test.
3. Engine/aircraft functional hazards and probability of aircraft loss are recorded in System Safety documentation with mitigations defined where appropriate.
4. 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.
5. Multi-engine aircraft configurations should consider verifying interactions between engines to provide 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 Power demands/extractions.
The engine shall be capable of safely supplying all systems (power, bleed air and electrical extractions) under all operating conditions. Aircraft 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. Aircraft 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.

Considerations for preparation of AMC:
1. Bleed air interface airflow and quality, PTO horsepower extraction and gearbox horsepower extraction are verified by demonstration and test.

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 design and verification requirements.	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.74 00-970 P1 5.1.75
		STANAG Reference:	4671.901
FAA Doc:		*EASA CS Reference:*	CS-E 745(a)(1)

7.2.5.2.3 Bleed air contamination.

Bleed air contamination / ingress of foreign matter shall not exceed safe limits in order to prevent hazardous contamination of the aircraft 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 does not cause contamination of bleed air;

d. Safe limits ensure both unacceptable quantity and unacceptable size of contamination / foreign matter is precluded.

Considerations for preparation of AMC:

1. Customer bleed air contamination is verified by analysis and tests.

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

7.2.5.2.4 Engine shutdown.

Engines shall have the ability to safely and reliably shutdown in the event of a platform initiated fuel shutoff.

Consideration should be given to:
a. Prevention of damage to engine due to loss of fuel.
b. Post shutdown fire.

Considerations for preparation of AMC:
1. Analysis, rig testing (dry bench) and engine testing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2009 E.3.4.5.2.6	*Def-Stan 00-970 Reference:*	00-970 P7 Ch702 24.3
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1189 CS 25.1189

7.2.5.3 Inlet compatibility.

7.2.5.3.1 Inlet compatibility.

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, 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.

Considerations for preparation of AMC:
1. Analysis and installed engine testing verify inlet performance for all expected environmental conditions.
2. For icing environments, analysis, icing tunnel or ground icing tests and/or flight tests reveal acceptable icing build up and/or levels of shedding that are compatible with the engine(s).

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
FAA Doc:		*EASA CS Reference:*	CS-E 650(c)(1) CS-E 790(d)(3) CS 23.901(d)(2)

Information Sources			
			CS 23.1091 CS 25.1091 CS 27.1091 CS 29.1091

7.2.5.4 Exhaust system compatibility.

7.2.5.4.1 Exhaust gas impingement.

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 aircraft 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; or 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.

Considerations for preparation of AMC:

1. Exhaust plume interaction with structure, fluid/vapour discharge, and all personnel is validated by inspection of plume and thermal analysis and models and ground and flight testing.

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 Combatibility 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:* *STANAG Reference:*	00-970 P1 5.1.52 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.

Thrust reverser/thrust vectoring systems shall be compatible with the engine and aircraft 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.

Considerations for preparation of AMC:

1. Verify the design is free from single or combined failures modes that would create an unacceptable risk hazard.
2. Analysis of reverser flow field patterns verifies acceptable conditions relative to impingement, inlet ingestion (e.g., propulsive, environmental control system, ventilation, auxiliary power system), and FOD/Sand and Dust generation.
3. Ground tests demonstrate reverser safety features and compatibility with engines and airframe. Flight tests demonstrate safe reverser deployment and operation.

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 Engine bay/nacelle cooling and ventilation.

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 and any ducting system throughputs;

c. Ensuring specified temperature limits are not exceeded;

d. The effect of solar radiation with the aircraft being parked in direct sunlight;

e. The appropriate aerodynamic heating in flight.

Considerations for preparation of AMC:
1. Temperature limit requirements are recorded in design documentation.
2. System thermal performance is demonstrated by design analysis, thermal models and simulations.
3. Engine bay/nacelle environments are verified by thermal surveys during ground and flight tests.

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 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 Vibratory compatibility.
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 aircraft 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.

Considerations for preparation of AMC:
1. Airframe induced engine vibration is established by analysis, and ground and flight vibration tests which identify the response characteristics of the aircraft/engine to forced vibrations and impulses.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001B: 3.3.1.1.2/4.3.1.1,	*Def-Stan 00-970*	00-970 P1 5.2.22

Information Sources			
	exhaust integration design and verification requirements.	*Reference:*	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

7.2.5.6 Installation other.

7.2.5.6.1 Crew/operator station compatibility.

The aircraft 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 aircraft 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.

Considerations for preparation of AMC:

1. Crew/operator station propulsion control capabilities are validated by inspection of design documentation, analyses and hardware and software tests in integration facilities and on the aircraft.

2. Warnings, cautions and advisories to operators and maintainers for hazardous failure conditions are validated.

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	4671.U1701

Information Sources			
		Reference:	
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 this section are:
• Propeller performance, strength and durability;
• Propeller / aircraft 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 Design margins.

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) for all modes of operation;
c. Structural design considerations include the application of appropriate limit and ultimate load factors;
d. Ensuring the control system avoids critical propeller speeds where practicable.

Considerations for preparation of AMC:
1. Analysis verifies durability and positive margins of safety for all operating conditions.
2. Durability tests are as follows:

- Component Testing to establish component capability to perform its function for the period established in the model specification.
- Whirl Stand Testing to calibrate sea level performance characteristics, demonstrate durability, overspeed capability, vibratory stress and overspeed feathering.
- System Tests such as preliminary aircraft test of the propeller, installation static functional check, Steady State check, transient check to determine the stability of the control system, ground vibratory stress survey, flight vibratory stress survey.

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 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 Critical speeds.

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, and ensuring they are above the maximum allowable transient shaft rotational speed (typically be at least 20 percent).

Considerations for preparation of AMC:
1. Analysis verifies critical speeds of the propeller system. Typical test are as follows:

- Whirl Stand Tests.
- Propeller and Engine Test Stand Tests.
- Flight Vibratory Stress Survey.

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 Reversing and pitch controls.
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.

Considerations for preparation of AMC:
1. Demonstration of satisfactory control of the propeller is accomplished through control response test, steady state check, and transient check.

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)

Information Sources			
FAA Doc:	14CFR references: 35.21	*EASA CS Reference:*	CS-P 210 CS 23.933(b) CS 25.933(b)

7.3.1.4 Propeller interfaces.

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 Feathering system.

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).

c. An emergency means of initiating feathering, independent of the normal means for such operations.

d. The time required for the propeller to achieve full feather position.

Considerations for preparation of AMC:

1. Demonstration of satisfactory control of the propeller, accomplished through control response test, steady state check, and transient check.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: L.3.4.12.1,	*Def-Stan 00-970*	00-970 P1 5.1.63

Information Sources			
	L.4.4.12.1	*Reference:*	00-970 P1 5.3.15
		STANAG Reference:	4671.905 4671.1027
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

7.3.1.7 Vibration and balancing.

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.

Considerations for preparation of AMC:

1. Analysis shows all critical vibratory modes, their frequencies and stresses as a function of blade angle and rpm.
2. The vibratory characteristics of the propeller are verified from the data obtained during the vibratory stress surveys.
3. Data representing all bending and twisting modes as well as unbalance are identified and compared to design calculated values and to specified limits.
4. Verification of balancing methods based on analysis of vibration data obtained during propeller and engine stand tests and flight tests.

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 Ice control system.

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 propeller that are likely to accumulate and shed ice into the propeller disc.

Considerations for preparation of AMC:
1. Analysis, component and rig testing verify that the ice control system provides the necessary level of protection against ice formation.
2. Analysis and testing verify ice protection does not damage the propeller system or compromise any other flight critical aircraft (sub)system/component.

Information Sources			
Comm'l Doc:			
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 Bird strike resistance.
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 structural failure or inability to control the propeller.

Consideration should be given to:
a. Specifying the mass and number of the birds applicable to the intended installation of the propeller in the aircraft specifications;
b. The most critical location and the flight conditions which will cause the highest blade loads.

Considerations for preparation of AMC:
1. Component/rig tests or analysis based on relevant acceptable birdstrike tests verify the structural integrity and controllability of the propeller and spinner under bird ingestion conditions.

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

7.3.1.10 Environmental conditions.
The propeller system shall safely and reliably operate in worldwide environments as required by the system specification.

Consideration should be given to:
a. Ice accretion and separation, distortion, sand and dust ingestion, water ingestion.

b. Design usage including missions and mission mix, usage parameters, externally applied forces, operating envelope, engine attitude limits, ambient temperature distribution corrosive atmosphere conditions, acoustic environment, and engine performance retention characteristics.

Considerations for preparation of AMC:
1. Propeller system components are verified for expected usage and environmental conditions using analyses, component test, and ground/flight tests.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: L.1 - Air vehicle propeller subsystem requirements and guidance.	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.59
		STANAG Reference:	4671 USAR.33 4671 USAR.905
FAA Doc:		*EASA CS Reference:*	CS-P 50 CS-P 150 CS-P 160 CS-P 170 CS-P 230 CS-P 370 CS-P 440 CS 23.929 CS 25.929

7.3.2 Rotary wing systems.

7.3.2.1 Design margins.

The rotary wing and all associated components and systems (including but is 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 aircraft 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 aircraft;
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.

Considerations for preparation of AMC:
1. Rig testing verifies the rotary wing's ability to provide adequate power.
2. Analysis verifies the expected strength and durability of the rotary wing and its associated components and systems.

3. Instrumented aircraft/engine testing verifies that the rotary wing and all associated components and systems operate safely as an integrated system.
4. Typical drive system tests include, but are not limited to:
- Integrity/Overstress.
- 200 hr Production Configuration.
- System Level Pre-Flight Acceptance.
- 200 hr Verification Military Qualification Test (MQT).

Information Sources			
Comm'l Doc:			
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 Safe controllability.
The rotor system shall provide safe control of the aircraft 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 30second OEI power rating, a means must be provided to automatically activate and control the 30second OEI power and prevent any engine from exceeding the installed engine limits associated with the 30second OEI power rating approved for the rotorcraft.

Considerations for preparation of AMC:
1. Rig testing verifies that the rotary wing provides the expected response.
2. Typical rotor system tests include, but are not limited to, ground testing, flight testing, and component testing.

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 Main rotor blade passage frequencies.
For rotary wing aircraft, 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 do not exceed specified engine limits within the aircraft 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 aircraft;
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.

Considerations for preparation of AMC:
1. Verification is by engine test and ground/flight test.
2. During ground/flight test, vibration levels of engine and drive train components are monitored throughout the operating range.

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, P7 L732 3.1.8, P7 L1001 8.5
		STANAG Reference:	
FAA Doc:	14CFR references: 29.907	*EASA CS Reference:*	CS 27.251 CS 27.907 CS 29.251 CS 29.907

7.3.2.4 Engine/airframe vibratory response.
For rotary wing aircraft, each engine (including subsystems/accessories) shall be designed, constructed and installed to prevent the harmful vibration of any part of the engine or aircraft. 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 propulsion system-excited and low-frequency vibrations.
b. If flexible mountings are used to isolate vibrations, the maximum deflections of such mountings take into account in the design of the relevant propulsion unit components.

Considerations for preparation of AMC:
1. Vibration levels of the propulsion system, including the drive system and airframe components are monitored throughout the operating range.

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:	

Information Sources			
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 Lubrication system.

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 aircraft 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. Pressurized 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 aircraft 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.

Considerations for preparation of AMC:

1. Analysis includes a functional description of the lubrication system.
2. Schematics showing all components and indicating minimum flow rates to each oil jet.
3. Cooling system or heat balance analysis includes consideration of the highest ambient air condition specified in the aircraft specification, the minimum gearbox oil flow, the maximum allowable oil temperatures and the minimum cooling airflow as a basis for sizing the cooling system.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: K.4.4.11.4, for lubrication element, component, and system level testing.	*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 00-970 P7 L705/1 6
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 27.1027 CS 29.1027

7.3.2.6 Dynamic coupling.

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 aircraft) for all permitted ground and flight modes.

Consideration should be given to:

a. Recognizing 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 take into account in the design of the relevant propulsion unit components.

Considerations for preparation of AMC:
1. Verification is through similarity analysis or a combination of analyses, static and dynamic testing.
2. Analysis of critical speeds in relation to operational speeds throughout the range of possible shaft misalignments.
3. Measurement of stresses at the critical speed to ensure they are within design limits.
4. Show the absence of dynamic coupling modes that are destructive or limit the use of the aircraft for all permitted ground and flight modes.
5. Define all power drive subsystem spring constants, inertia and damping coefficients for use in torsional stability assessments.
6. Gear resonance test; the dynamic stress levels in each gear are measured in locations sensitive to all significant vibratory modes.

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 Control system stability.
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 the greater.

Consideration should be given to:
a. The most critical combinations of power, rotational speed, and control displacement;
b. Control system gain and phase margins meet the specified requirements.

Considerations for preparation of AMC:
1. Analysis includes linearized models of the engine control loops and the rotor system.
2. The control design is verified throughout the operational envelope of the helicopter.
3. Open and closed loop bench testing of the control.
4. Engine control system stability evaluation by flight test.
5. Testing to show stable response throughout the operational envelope of the helicopter.

Information Sources	

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 Misalignment.

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 aircraft), 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.
d. Couplings are the dry type to avoid the necessity of doing maintenance checks before every flight.

Considerations for preparation of AMC:

1. Vibration and stress analyses of all components subjected to potential stress or vibration induced failure.
2. Prediction of the range of values for steady, cyclic and vibratory stresses.
3. Loading reflects the influence of all environmental and operational factors on the life calculation methods of all fatigue sensitive coupling components.
4. Endurance Testing.
5. Fault Tolerance Demonstration.

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 Rotor securing.

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 aircraft;
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.

Considerations for preparation of AMC:
1. Analyses include heat generation, provisions for isolation from flammable materials or fluids, energy absorption rate and effects on the dynamic response of the transmission.
2. Component bench and system level testing.
3. Component endurance tests.

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 Braking.
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 and provide a gust-lock capability.

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.
d. Ensuring there are no critical vibratory modes for the braking system.

Considerations for preparation of AMC:
1. Verify margins against heat generation limits, provisions for isolation from flammable materials or fluids, and transmission energy absorption rate limit.
2. Component bench and system level testing to demonstrate the capability to keep the rotors from rotating when exposed to the specified conditions.
3. System level test to demonstrate the ability of the engine interlock safeguard system to prevent actuation during specified periods.

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 S2 L705 3.1.4, 00-970 P7 S2 L705 3.2.10
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 27.921 CS 29.921

7.3.2.11 Condition monitoring.
Drive system condition monitoring shall provide warning of impending failure that could result in loss of the aircraft 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).

Considerations for preparation of AMC:
1. Debris monitor testing to demonstrate the ability to detect debris of the size, shape and material specified, the characteristic of debris considered abnormal and its insensitivity to normal wear.
2. Oil pressure and temperature. Full up rig and flight testing to demonstrate the required monitoring capability of the lubrication system.
3. Health monitoring. Testing to identify a characteristic normal baseline for applying diagnostic indicators to isolate mechanical component faults.
4. Usage monitoring. Testing to demonstrate acceptable and accurate in-flight monitoring of the power drive subsystem operational usage.

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 Load absorbers.
The drive system clutching devices shall permit engagement and disengagement of the engines from the load absorbers as required for all applicable modes of aircraft operation.

For rotary-wing aircraft in autorotation mode, the engine(s) not supplying torque shall be immediately and automatically disengaged from the power drive subsystem. For multi-engine aircraft 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 clutch's fatigue characteristics;
d. Overrunning and cold temperature engagement performance;
e. Clutch durability.

Considerations for preparation of AMC:
1. Bench tests to demonstrate compliance:

- Static torque test.
- Cyclic fatigue (stroking) test.
- Overrunning test.
- Cold temperature engagement test.
- Clutch durability test.

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 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 Loss of lubrication.
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 aircraft, typically at least 30 minutes.

Consideration should be given to:
a. Sufficient torque and rotational speed is maintained for that duration to allow continued safe flight;
b. The gearbox continues to function although not necessarily without damage.

Considerations for preparation of AMC:
1. A thirty minute loss-of-lubrication overrunning test consistent with a loss-of-lubricant test spectrum demonstrates the ability of continued safe operation.

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 Rotor meshing.

For intermeshing-rotor systems, phased externally, means shall be provided in the power drive subsystem to prevent operation with de-phased 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.

Considerations for preparation of AMC:

1. Analysis and demonstration are accomplished during system verification for the aircraft.

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 Accessory drives.

Failure or seizure of any individual accessory shall not cause failure of the gearbox(s) or cause damage to any power drive subsystem components. For rotary-wing aircraft, accessories shall be driven whenever the rotor system is rotating including during autorotation. Any failure of flight-critical accessories shall be annunciated to the pilot/operator.

Cover plates shall be provided for use when accessories are not installed.

Consideration should be given to:

a. Accessory drive splines should be protected from wear with non-metallic inserts or should be positively lubricated with oil when functioning.

Considerations for preparation of AMC:

1. Testing and inspection during gearbox system level verification.
2. Pilot/operator annunciation is verified by inspection, analysis of drawings and by demonstration.

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

7.3.2.16 Environmental conditions.

The rotor/drive system shall operate safely and reliably in world-wide environments as required by the system specification.

Consideration should be given to:

a. All intended natural and induced environments, including: temperature, humidity, precipitation, icing, fungus, salt fog, particulate and liquid contamination, shock and vibration, and explosive atmosphere conditions.

Considerations for preparation of AMC:

1. Rotor/drive system components are verified for expected usage and all intended and induced environmental conditions using analyses, component test, and ground/flight tests.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-810 MIL-HDBK-310	*Def-Stan 00-970 Reference:*	00-970 P7 L705 1.4.1
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 29.917

7.3.2.17 Drive system design.

The drive systems shall be capable of operating beyond the maximum rated torque and speed under emergency conditions as defined by the aircraft specification.

Consideration should be given to:

a. Durability, dynamic response and structural integrity requirements specified.

b. Excursions from normal operational conditions such as autorotation.

Considerations for preparation of AMC:

1. Bench and system level tests to ensure structural integrity, endurance, performance, and capability to withstand all specified transient excursions, operational and environmental conditions, including emergency conditions and autorotation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 K.3.4.11	*Def-Stan 00-970 Reference:*	00-970 P7 L705 1.4.1 00-970 P7 L705 3.2.3
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 29.917

7.3.2.18 Space envelope.

The space envelope provided for the transmission systems shall be such as to cause no hazard to exposed shafts, oil lines, sensors, or other vulnerable parts which could occur due to contact with drive system components.

Consideration should be given to:

a. Chafing and wear between rotating/moving parts and static components.

b. Where relative movement between components within the transmission systems and between such components and the rotorcraft can occur, there shall be adequate provision for flexibility.

Considerations for preparation of AMC:

1. Inspection after aircraft drive/rotor system qualification testing is accomplished to assure minimum clearances are maintained and that components do not have wear/chafing due to contact with each other.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P7 L705 2.1.3 00-970 P7 L705 2.1.4
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

7.3.2.19 Protection from environmental elements.

The transmission and associated drive system components shall be adequately protected/sealed from environmental elements (e.g., water, dust, and other contaminants), and external cleaning procedures shall be in place that will not breach the sealing of those components.

Considerations for preparation of AMC:

1. Analysis of the designs, along with component level tests, verify that protective provisions have been incorporated to prevent contaminants from penetrating critical areas.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P7 L705 2.1.7
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 29.609

7.3.2.20 Accessibility.

Reasonable accessibility to rotor and drive system-related equipment shall be provided for the performance of required servicing, inspections, and maintenance.

Considerations should be given to:

a. Maintainer's anthropometric dimensions and strength limitations.

b. All environmental conditions, and any required mission equipment (e.g., chemical protective gear, gloves).

Considerations for preparation of AMC:

1. Inspection of design criteria (to include Interface Control Document data) to verify that required servicing, inspections and maintenance requirements have been established.

2. Analysis of virtual models and/or physical mock-ups to verify accessibility to required servicing, inspection and maintenance areas.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 3.2.6 Maintainability.	*Def-Stan 00-970 Reference:*	00-970 Pt7 L705 2.1.6 00-970 Pt7 L705 2.2.3
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 27.901 CS 29.901

7.3.2.21 Faults and warnings.

The rotor and drive system health monitoring and prognostics systems shall provide adequate warnings in a timely manner to ensure safety of flight.

Consideration should be given to:

a. Ensuring all safety/mission-critical faults and warnings are available to operators/maintainers.

b. Providing immediate notification of critical faults to the operator.

c. Recording all faults requiring maintenance action for post-flight download.

d. Providing critical rotor and drive system information, such as speed, control operating mode and fluid quantities and pressures, to the maintainer.

e. Ensuring the rotor and drive system health monitoring system provides accurate information and minimizes false positive faults.

Considerations for preparation of AMC:

1. Analysis and fault injection bench testing verify the capability of the monitoring system.
2. Aircraft level testing to verify that the operator is provided clear notification of any critical failure.
3. Fault download testing to verify that the maintainers have full access to failure data.
4. Information provided to the flight crew regarding the warnings and other information that may be provided, and the required action. Such information should be consistent with the content of the engine Interface Control Document (ICD) and operator manual.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	ADS-79-HDBK	*Def-Stan 00-970 Reference:*	00-970 Pt7 L727 00-970 Pt7 L705 2.1.6 00-970 Pt7 L705 2.1.8 00-970 Pt7 L705 2.2.4 00-970 Pt7 L705 3.2.5 00-970 Pt7 L705 4.2.4 00-970 Pt7 L705 4.3.4
		STANAG Reference:	4671.USAR.1309 4671.USAR.1337
FAA Doc:		*EASA CS Reference:*	CS 27.1305 CS 27.1337

Information Sources			
			CS 29.1305 CS 29.1309 CS 29.1337

7.3.2.22 Contamination.

Contaminants shall not become trapped in rotating components, on external surfaces, or around seals without the ability to run off or be removed.

Consideration should be given to:
a. Adequate drainage to prevent pooling of fluids.
b. Conditions expected to prevail when drainage is required.

Considerations for preparation of AMC:
1. Inspection of the design of components and external surfaces should determine if any areas that could trap contaminants/fluids exist.
2. If contaminants/fluids can be trapped, verify that procedures are adequate to remove those contaminants/fluids.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG 2009 G.3.4.7.5 Drainage	*Def-Stan 00-970 Reference:*	00-970 Pt7 L705 2.1.7 00-970 Pt7 L700 5.1.2
		STANAG Reference:	4671.USAR.1309 4671.USAR.1337
FAA Doc:		*EASA CS Reference:*	CS 27.1187 CS 29.1187

7.3.3 Reciprocating engines.

7.3.3.1 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 aeroplane and engine.

Considerations for preparation of AMC:
1. Aircraft operating limitations (defined in the aircraft's Type Certification and Aircraft Flight Manual) should not exceed limitations of engine operating characteristics.

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.	*EASA CS Reference:*	CS 23.939 CS-E Subpart B

Information Sources			
	14CFR reference 33 subpart D for verification requirements for commercial applications.		CS-E Subpart C

7.3.4 Reciprocating engines.

7.3.4.1 Other propulsion systems.

Other propulsion systems (e.g., rotary, wankel, electric) shall meet the requirements to achieve an Engine Type Certificate and operate safely.

Consideration should be given to:

a. New/Novel propulsion systems and sub-systems.

b. Understanding the interactions with other aircraft systems and the requirements placed on them.

Considerations for preparation of AMC:

1. AAMC may be required to verify that new/novel propulsion systems meet the safety requirements to warrant issue of an Engine Type Certificate.

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-E 10 CS 27.901 CS 29.901

SECTION 8 - AIRCRAFT SYSTEMS

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.

8.1.1 Redundant hydraulic system operation.

Where there is more than one hydraulic and/or pneumatic system, or where a system's design includes redundant elements, the system shall be designed such that safe operation will continue following failure of any one system or element thereof.

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.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analyses (FMEA) should identify all failures of a system's elements and their effect on the operation of the systems.

Information Sources			
Comm'l Doc:	SAE ARP4752		
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 2.15.23 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 2.1
		STANAG	4671.1301

Information Sources			
		Reference:	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

8.1.1.1 Merged with 14.2.3.

8.1.2 Interfaces and redundancies.

All interfaces and redundancies with other 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. Redundancy scheme works appropriately.

Considerations for preparation of AMC:

1. System Interface Documents (SID) should define system parameters at its interface with other systems under normal operating conditions, and all anticipated degraded/failed conditions. One SID per system interface is preferred, but where practical to do so, one ICD may define a system's parameters multiple systems. Where the parameters of one system affect the parameters of its interfacing system, it may be practical for one SID to define the parameters of both systems.

2. Failure Modes and Effects Analyses (FMEA) should identify all failures of a system and their effect on the interface parameters with other systems.

Information Sources			
Comm'l Doc:	SAE ARP4752		
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 1.1.12 to 1.1.14 00-970 P1 6.10 00-970 P1 6.11.50 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

Information Sources			
FAA Doc:		*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 25.1301 CS 25.1309 CS 25.1435 CS 25.1436 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309

8.1.3 Transition to backup systems.

Power operated and augmented systems and equipment shall be shown to operate as expected throughout the degraded operation of Normal hydraulic, pneumatic and vacuum systems and throughout operation via back-up, and emergency systems.

Consideration should be given to:

a. Ensuring the requirements have been correctly interpreted in the design.

b. Ensuring that sufficient hydraulic and pneumatic power is available to the requisite systems at all times.

c. Ensuring that transition from Normal operation to back-up or emergency systems does not affect any operating characteristic of the power operated systems, and at a minimum does not have a negative effect on flight safety.

Considerations for preparation of AMC:

1. Ground testing should verify that all anticipated combinations of degraded operation of hydraulic, pneumatic and vacuum systems, and operation via back-up and/or emergency systems does not prevent the acceptable operation of power-operated systems.

2. Flight testing should verify that all anticipated combinations of degraded operation of hydraulic, pneumatic and vacuum systems, and operation via back-up and/or emergency systems does not affect any operating characteristic of the power operated systems during all flight phases and configurations, and at a minimum does not have a negative effect on flight safety.

Information Sources			
Comm'l Doc:	SAE ARP4752		
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	4671.1301

Information Sources			
		Reference:	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 CS 29.1435

8.1.4 Fluid operating temperatures.

Hydraulic fluid temperatures shall not exceed the maximum allowable temperature during any foreseeable operating condition.

Consideration should be given to:

a. Ensuring that the permitted hydraulic fluid specifications are clearly defined.

b. Ensuring that the maximum allowable hydraulic fluid operating temperature is defined and that this temperature takes account of all relevant hydraulic fluid characteristics for all permitted fluid specifications.

c. Ensuring that the maximum allowable hydraulic fluid operating temperature takes account of the maximum allowed temperature for hydraulic system components and, where relevant, systems/equipment interfacing or in proximity with the hydraulics system.

d. Accounting for all anticipated combinations of aircraft operation that affect the temperature of hydraulic fluid, including heating elements (hydraulic pumps, brakes, etc.), cooling elements (e.g. heat exchangers) and any credible combination of failures that could affect the system's temperature management.

e. Accounting for all operating environments in which the aircraft is anticipated to operate, including temperatures, pressures and humidities.

Considerations for preparation of AMC:

1. Analysis should verify that all anticipated combinations of aircraft operation, including credible combinations of failures of relevant systems/equipment does not cause hydraulic fluid temperatures to exceed their maximum allowable value, for all permitted hydraulic fluid specifications.

2. Ground and/or Flight testing should verify the accuracy of the performed analyses, including combinations of at least the following:

a. Prolonged application of brakes during ground taxi;

b. Acceleration to and subsequent deceleration from V1 (i.e. Rejected Take-off at speeds up to V1);

c. Failure and degraded operation of hydraulic fluid cooling elements (heat exchangers, ram-air ducts, etc.), including operation at low speeds; and,

d. High ambient temperatures and heat-soaking of the aircraft.

Information Sources	

Information Sources			
Comm'l Doc:	SAE ARP4752		
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 8.2 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

8.1.5 Operator interface.

Adequate information shall be available to notify the flight crew of the hydraulic and pneumatic systems' operating conditions.

Consideration should be given to:

a. Clear presentation of relevant information to crew, including status indication, and warning, caution and advisory information.

b. Ensuring that changes in the hydraulic and pneumatic systems' operating conditions are highlighted to the crew in a clear and unambiguous manner.

c. Ensuring that any required pilot input or intervention is clearly and unambiguously identified.

d. Ensuring that, where pilot action is required in accordance with an emergency procedure, checklist or other Technical Publication, the relevant section of the Technical Publication is clearly defined such that the pilot can intervene with minimal delay.

e. Ensuring that any credible combination of failures does not prevent the accurate notification of system operating conditions.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify the controls and displays provided to crew. For controls, detail should be provided regarding the mode of operation and function of each control. For displays, detail should be provided regarding all information displayed to the crew, and where appropriate, the conditions that would lead to specific indications.
2. System Description Documents (SDD) should clearly define the possible system operating conditions and the operating parameters that trigger each condition.
3. Analysis (e.g. System Simulations) should demonstrate that system status information and changes in system operating conditions are provided to the crew throughout all foreseeable aircraft operating conditions.
4. Rig and/or Ground Testing should verify the accuracy of the performed analysis, including the effect of system/equipment failures.
5. Flight Simulations, Ground Testing and/or Flight Testing should verify that the system status information and changes in operating conditions are displayed clearly and unambiguously, and that emergency procedures, checklists and other Technical Publications can be used effectively.

Information Sources			
Comm'l Doc:	SAE ARP4752		

Information Sources			
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

8.1.6 Technical manuals.

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. The level of detail necessary to provide accurate technical information while remaining concise;

b. The information, at the appropriate level of detail, required to allow personnel to operate and maintain the aircraft as safely and effectively as possible at an acceptable workload.

c. Ensuring that all required operating procedures are defined, taking account of requirements for military operation (e.g. in-flight rectification).

Considerations for preparation of AMC:

1. Operational Technical Publications for the flight crew (Aircraft Flight Manual, Emergency Procedures, Checklists etc.) should clearly define all required normal, back-up and emergency operating procedures, limitations and restrictions.

2. Maintenance Technical Publications for ground crew (Aircraft Maintenance Manual, Master Minimum Equipment List, Maintenance Schedule, etc.) should clearly define all required servicing and maintenance information.

3. Flight Simulations, Ground Testing and/or Flight Testing should verify that all Operational Technical Publications are clear and unambiguous and can be followed by a flight crew through all flight phases and conditions without incurring excessive crew workload and serve their intended function.

4. Rig and/or Ground Testing should verify that all Maintenance Technical Publications are clear and unambiguous and can be followed by a competent maintenance engineer in a manner which ensures the continuing airworthiness of the aircraft.

Information Sources			
Comm'l Doc:	SAE ARP4752		
DoD/MIL Doc:	JSSG-2000: 3.6.2	*Def-Stan 00-970*	00-970 P1 7.5.1

Information Sources			
		Reference:	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 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

8.1.7 Hydraulic/pneumatic components, lines and fittings.

The hydraulic and pneumatic components, lines and fittings and their installation shall be safe.

Consideration should be given to:

a. All system components, including:

i. Reservoirs;

ii. Pressure generation equipment (pumps, bleed air extraction equipment, ram-air ducts, turbines, etc);

iii. Pressure storage equipment (e.g. accumulators);

iv. Power transfer/conversion equipment (Power Transfer Units, motors, actuators, etc.);

v. Pipes and hoses (flexible & rigid);

vi. Couplings (including design to prevent reverse installation or inadvertent cross-connection);

vii. Fixings, brackets and miscellaneous ironmongery; and,

viii. Other components which form part of the hydraulic/pneumatic system.

b. System parameters including operating pressure and temperature.

c. All anticipated ambient environments including temperatures, pressures, vibration and fatigue through the aircraft's anticipated operating environment and conditions.
d. Consideration of single failures and credible combinations of failures including:
i. Damage due to foreign objects (bird strike, uncontained engine rotors, etc.);
ii. Damage due to contamination of the working fluid;
iii. Interference between moving parts and other parts (moving and stationary); and,
iv. System overpressure (due to excessive force on hydro-locked components, thermal expansion of compressible fluids, failure of pressure regulation devices, etc.).
e. Compatibility of hydraulic fluids and system seals or other components.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should clearly define the operating parameters for the system and the appropriateness of components.
2. Assembly Clearance Analyses should verify the clearance of all components through all normal operating and failure conditions, taking account of the maximum possible displacements of all moving parts.
3. Equipment Testing should verify that all components meet their specifications.
4. Analysis should verify that the systems are able to operate safely and meet all performance requirements throughout all foreseeable flight phases and conditions.
5. Rig testing should verify the accuracy of system analysis and should verify that systems are able to operate safely and meet all performance requirements throughout all foreseeable flight phases and conditions.
6. Ground and Flight Testing should verify the safe operation of the hydraulic/pneumatic system(s) and their ability to adequately provide power to other systems.
7. Failure Modes and Effects Analyses (FMEA) should identify all failures of the system and their effect on its safe operation.

Information Sources			
Comm'l Doc:	SAE ARP4752		
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 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	*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 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

Information Sources			
			CS 25.1435 CS 25.1436 CS 25.1438 CS 27.1309 CS 27.1435 CS 29.1309 CS 29.1435

8.1.8 Power levels.

The aircraft hydraulic and pneumatic systems' size and power capacities shall be sufficient to provide adequate power to all power-operated systems.

Consideration should be given to:

a. Ensuring adequate hydraulic/pneumatic power to all power-operated systems through all flight phases and all foreseeable operating conditions.

b. The categorisation of power-operated systems (for example as 'essential' and 'non-essential') and load shedding such that those systems considered essential for continued safe flight remain adequately powered throughout any credible combination of failure, including multiple engines inoperative.

c. Providing adequate margin in power generation and/or storage devices such that any foreseeable combination of undetected failures (e.g. multiple leaks throughout the system) does not impair adequate supply of power.

d. Taking account of power-losses within the power-supply system (e.g. due to hydro-dynamic pressure loss).

Considerations for preparation of AMC:

1. System Description Documents (SDD) should clearly define the operating parameters for the system including maximum continuous power output (in Watts or equivalent unit) and transient power capacity (in Joules or equivalent unit).
2. System Interface Documents (SID) should define the parameters for continuous power output (in Watts or equivalent unit) and transient power capacity (in Joules or equivalent unit) of the power supply system, and the corresponding maximum requirement for the power-operated system.
3. Equipment Testing should verify that all power generating and power storing components meet their specifications.
4. Analysis should verify that the systems are able to operate safely and meet all performance requirements throughout all foreseeable flight phases and conditions.
5. Rig testing should verify the accuracy of system analysis and should verify that systems are able to operate safely and meet all performance requirements throughout all foreseeable flight phases and conditions.
6. Ground and Flight Testing should verify the safe operation of the hydraulic/pneumatic system(s) and their ability to adequately provide power to other systems.
7. Failure Modes and Effects Analyses (FMEA) should identify all failures of the system and their effect on its safe operation.

Information Sources			
Comm'l Doc:	SAE ARP4752		
DoD/MIL Doc:	JSSG-2009 Appendix B: B.3.4.2/B.4.4.2 Hydraulic Power Subsystem;	*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

Information Sources			
	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.		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 6.2
		STANAG Reference:	4671.1309 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

8.1.9 Pressure variance.

Pressure fluctuations shall be taken into account in the design of the system.

Consideration should be given to:

a. The magnitude and frequency of all pressure fluctuations in the system, including those arising from:

i. Start-up and shutdown of pumps/compressors;

ii. Opening/closing of valves;

iii. Cavitation;

iv. Operation of power-operated systems/equipment; and,

v. Large system pressures due to high flow, choked flow and waterfall effects.

b. The effectiveness of pressure management including devices (such as pressure relief valves, surge suppressors (including devices where surge suppression is a secondary function such as accumulators), burst discs/diaphragms, etc.), and controlled operation of system components (e.g. slow-starting pumps, slow-closure of valves, etc.), and the effect of failure of this pressure management.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define the maximum continuous and transient surge pressures of the system, including both magnitude, and frequency.

2. System Interface Documents (SID) should define the maximum continuous and transient surge pressures at the interface between the hydraulic/pneumatic system and other systems.

3. Equipment Testing should verify that components meet their specifications in all respects relevant to surge pressure generation/management, including the opening/closure time of valves, start-up/shutdown time of pumps, and the pressures induced at the component's highest flow rate.

4. Analysis should identify the anticipated continuous and transient surge pressures taking account of component characteristics when integrated into the system throughout all foreseeable flight phases and conditions.

5. Rig testing should verify the accuracy of system analysis and should verify that system pressures do not exceed expected values throughout all foreseeable flight phases and conditions.
6. Ground and Flight Testing should verify the safe operation of the system and should verify that system pressures do not exceed expected values throughout all foreseeable flight phases and conditions.
7. Failure Modes and Effects Analyses (FMEA) should identify all failures of the system and their effect on its safe operation.

Information Sources			
Comm'l Doc:	SAE ARP4752		
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 CS 29.1309 CS 29.1435

8.1.10 Impurities.
The system shall include means for controlling and purging impurities and for determining that the system's level of contamination is acceptable.

Consideration should be given to:
a. Contamination by any foreign matter, including solid, liquid, and/or gaseous materials.
b. Prevention of contamination including the use of seals, diaphragms, gators, etc.
c. Management of contamination and prevention of system deterioration, including filters, magnetic plugs, top/bottom reservoir pick-ups, air release valves, etc.
d. Means for identifying levels of contamination, including; contamination of filters etc., continuous or scheduled particulate measurement, periodic testing, etc.
e. Means for purging of contaminated systems, including isolating and purging components, lines and fittings, replacing contaminated filters.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define the system's means for controlling and purging impurities and that maximum allowed levels of contamination within the system.
2. System Interface Documents (SID) should define the maximum anticipated levels of contamination of the system.
3. Equipment Testing should verify that components are able to operate throughout all expected operating environments without introducing unacceptable levels of contamination to the system.
4. Analysis should verify that the system is able to operate safely despite contamination.
5. Failure Modes and Effects Analyses (FMEA) should identify all failures of the system, including contamination, and their effect on its safe operation.
6. Maintenance Technical Publications (Aircraft Maintenance Manual, Master Minimum Equipment List, Maintenance Schedule, etc.) should clearly define all required servicing and maintenance information, including the process for, and required frequency of system checks and purging.

Information Sources			
Comm'l Doc:	SAE ARP4752		
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:*	

8.1.11 Component testing.

All aspects of component requirements shall be validated to ensure that they support the requirements of the system. Testing shall be performed on each component to ensure compliance with all component requirements and on each assembly, sub-system and system to ensure compliance with system requirements.

Consideration should be given to:
a. All relevant aspects of the component specification, including:
i. Strength/stress;
ii. Performance;
iii. Physical parameters (size, critical dimensions and tolerances, mass/weight, Centre of Gravity, moments of inertia, heat capacity, etc.);
iv. Endurance/Longevity (fatigue, Mean Time Before Failure, etc.).
b. Component's compliance with relevant requirements/standards (e.g. EN 10255:2004).
c. Testing in compliance with relevant requirements/standards (e.g. IEC 60193).

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the components used throughout the system and the function of components, assemblies, sub-systems and systems, including any key performance requirements.
2. Equipment Testing should verify that components meet their specifications in all respects.

3. Analysis should identify system characteristics when integrated into the system throughout all foreseeable flight phases and conditions.
4. Rig testing should verify the accuracy of system analysis and should verify compliance with all system requirements throughout all foreseeable flight phases and conditions.
5. Ground and Flight Testing should verify the safe operation of the system and should verify compliance with all system requirements throughout all foreseeable flight phases and conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 1.2 00-970 P1 6.11.59 00-970 P1 6.11.60 00-970 P1 6.11.67 00-970 P1 6.11.68 00-970 P1 6.11.70 00-970 P1 6.11.71 00-970 P1 6.11.72 00-970 P1 6.11.74 00-970 P1 6.11.76 00-970 P1 6.11.77 00-970 P1 6.11.80 00-970 P1 6.11.81 00-970 P1 6.11.82 00-970 P1 6.11.83 00-970 P1 6.12.28 00-970 P1 6.12.29 00-970 P1 6.12.30 00-970 P1 6.12.31 00-970 P1 6.12.32 00-970 P1 6.12.33 00-970 P1 6.12.34 00-970 P1 6.12.35 00-970 P1 6.12.36 00-970 P1 6.12.37 00-970 P1 6.12.38 00-970 P7 L1000 00-970 L730 S2.2.1 00-970 L730 S3.2.1 00-970 L730 S4.1 00-970 L719 S5 00-970 L719 S6 00-970 L704 S14 00-970 L704 S15.2 00-970 L704 S15.3 00-970 L704 S15.5.2 00-970 L704 S15.5.3 00-970 L1004
		STANAG	

Information Sources			
		Reference:	
FAA Doc:		EASA CS Reference:	CS 23.1435 CS 23.1438 CS 25.1435 CS 25.1436 CS 27.1435 CS 29.1435

8.2. ENVIRONMENTAL CONTROL SYSTEM (ECS).

8.2.1 Design for Safety

The Environmental Control System (ECS) shall be designed to meet an appropriate level of system safety.

Consideration should be given to:

a. The ECS, its interfacing systems and systems providing associated functions, including:

i. Pressurisation;

ii. Heating and Cooling (of crew/passengers and equipment);

iii. De-icing;

iv. De-fogging;

v. Uncontaminated breathing air;

vi. Engine bleed air for use in ECS; and,

vii. Pneumatic systems related to ECS.

b. The appropriate level of system safety taking into account the performance of the system in normal and failure states, and its effect on airworthiness.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analyses (FMEA) should identify all failures of the system's elements and their effect on the airworthiness of the aircraft.

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

Information Sources			
			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 Integration

The ECS shall be integrated into the aircraft in such a way that Safety of Flight is not compromised throughout the flight envelope.

Consideration should be given to:

a. Components and their integration under all anticipated environments and loadings.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analyses (FMEA) should identify all failures of the system's elements and their effect on the airworthiness of the aircraft; and,
2. Rig, ground and flight testing should demonstrate the correct integration of system components.

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

Information Sources			
			CS 29.831 CS 29.859 CS 29.1309

8.2.3 Merged with Line 8.2.5

8.2.4 Pressurisation

The ECS shall provide normal and emergency pressurisation to support Safety of Flight.

Consideration should be given to:

a. An appropriate level of redundancy, taking account of the effect of failure of the pressurisation system on the aircraft and its occupants; and,

b. Monitoring of the pressurisation system, both on board the aircraft, and where appropriate, remotely.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analyses (FMEA) should identify all failures of the system's elements and their effect on the airworthiness of the aircraft; and,
2. Rig, ground and flight testing should demonstrate the correct function of the normal and emergency pressurisation systems.

Information Sources			
Comm'l Doc:			
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 Degraded system operation

The effect of loss of some or all ECS functions on aircraft safety and performance shall be acceptable.

Consideration should be given to:

a. An appropriate level of redundancy, taking account of the effect of failure of the ECS on the aircraft and its occupants.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analyses (FMEA) should identify all failures of the system's elements and their effect on the airworthiness of the aircraft; and,
2. Rig, ground and flight testing should demonstrate the correct function of the normal and emergency ECS functions.

Information Sources			
Comm'l Doc:			

Information Sources			
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 4.24.23 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 6.12.1 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 00-970 P13 Clause 1.5
		STANAG Reference:	4671.USAR 1307(c)(f) 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 Technical manuals.

Aircraft technical publications associated with the ECS shall include normal, back-up and emergency operating procedures, limitations, restrictions, servicing, and maintenance information.

Consideration should be given to:

a. The level of detail necessary to provide accurate technical information while remaining concise;

b. The information, at the appropriate level of detail, required to allow personnel to operate and maintain the aircraft as safely and effectively as possible at an acceptable workload.

Considerations for preparation of AMC:

1. Operational Technical Publications for the flight crew (Aircraft Flight Manual, Emergency Procedures, Checklists etc.) should clearly define all required normal, back-up and emergency operating procedures, limitations and restrictions.

2. Maintenance Technical Publications for ground crew (Aircraft Maintenance Manual, Master Minimum Equipment List, Maintenance Schedule, etc.) should clearly define all required servicing and maintenance information.

3. Flight Simulations, Ground Testing and/or Flight Testing should verify that all Operational Technical Publications are clear and unambiguous and can be followed by a flight crew through all flight phases and conditions without incurring excessive crew workload and serve their intended function.

4. Rig and/or Ground Testing should verify that all Maintenance Technical Publications are clear and unambiguous and can be followed by a competent maintenance engineer in a manner which ensures the continuing airworthiness of the aircraft.

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 Operator interface.

Adequate controls and displays at the appropriate locations shall be available to notify the flight crew of the ECS systems.

Consideration should be given to:

a. Clear presentation of relevant information to crew, including status indication, and warning, caution and advisory information.

b. UAS applications in which it might be appropriate for ECS controls to be located in any ground control station;

c. The ECS controls for pneumatic pressure and temperature within the occupied compartment should be readily accessible to all applicable flight crew;

d. The operation of ECS controls should not cause instability;

e. For UAV operations, the operator should have full access to the relevant status indicators, warnings, cautions and advisories;

f. Accessibility, labelling, and ease of use of ECS controls;

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify the controls and displays provided to crew. For controls, detail should be provided regarding the mode of operation and function of each control. For displays, detail should be provided regarding all information displayed to the crew, and where appropriate, the conditions that would lead to specific indications.

2. Flight simulation, ground and flight testing demonstrating that controls and displays support safe flight.

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

Information Sources			
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 Personnel accommodation

The ECS shall provide 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 effect and adequate prevention of malfunction, including excessive or insufficient pressure, temperature, oxygen content, and the presence of harmful compounds such as smoke, carbon monoxide and ozone; and,

b. Flight crew/passenger physiological requirements (Human Factors), including requirements for certain occupants such as medical evacuation patients.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analyses (FMEA) should identify all failures of the system's elements and their effect on the airworthiness of the aircraft; and,
2. System Description Document (SDD) detailing the selected physiological limits for each atmospheric variable, and the ECS' operation within these limits; and,
3. Analysis, ground and flight testing demonstrating the safe provision of appropriate atmosphere within the defined limits for each atmospheric variable.

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 P13 Clause 1.4.1
		STANAG Reference:	3198
FAA Doc:		*EASA CS Reference:*	CS 25.831 CS 25.832 CS 25.841 CS 29.831

8.2.9 Environmental protection

Sub-systems provided for environmental protection (windshield rain/snow/ice removal, ice protection and defog, etc.) shall ensure the safe operation of the aircraft within the specified flight environment.

Consideration should be given to:
a. Environmental conditions for which the aircraft is cleared to fly;
b. Environmental conditions in which the aircraft is not cleared to fly but through which the aircraft may be forced to operate for short periods (e.g. landing in deteriorated weather conditions or an inadvertent icing encounter);
c. Automation of control systems which minimise the workload of pilots when flying through degraded environmental conditions;
d. Provision of means for monitoring external surfaces and conditions (e.g. icing) by the crew throughout the design envelope; and,
e. The effect and adequate prevention of malfunctions which may jeopardise safety of flight.

Considerations for preparation of AMC:
1. The Aircraft Specification should specify the environmental conditions for which the aircraft is cleared to fly, and through which the aircraft may be expected to operate for short periods;
2. Rig, ground and flight testing should demonstrate the adequate performance of environmental protection systems throughout the environmental conditions for which the aircraft is cleared to fly, and through which the aircraft may be expected to operate for short periods.

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 00-970 P1 13 1.5.1.1
		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 Personnel air quality
Each crewmember's air supply shall 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/or manual means to shut off contaminated air flow;

b. Fresh air ventilation and overboard exhaust for contamination, harmful vapour, gases and odour; and,
c. Means to prevent, manage and protect occupants against NBC contamination.

Considerations for preparation of AMC:
1. Failure Modes and Effects Analyses (FMEA) should identify all failures of the system's elements and their effect on the airworthiness of the aircraft; and,
2. Rig, ground and flight testing should demonstrate the effective ventilation of ambient air and purging of crew air supplies.

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 P1 13 1.5.1.1 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 Leak monitoring/detection
The bleed air system and other compressed air duct systems shall be monitored for leaks and structural integrity.

Consideration should be given to:
a. Ensuring that, should a duct fail, any hot air leaking from damaged bleed air ducting would not:
i. Act as a source of ignition for flammable liquids, vapours or materials;
ii. Cause damage to Structurally Significant Items, items that impact Safety of Flight, or Critical System Items.
b. The necessary integrity/reliability of any leak monitoring/detection system, and the need for redundant systems, particularly in high-risk areas (e.g. where flammable fluids, vapours or gases may be present).

Considerations for preparation of AMC:
1. Failure Modes and Effects Analyses (FMEA) should identify all failures of the system's elements and their effect on the airworthiness of the aircraft; and,
2. Rig, ground and flight testing should demonstrate the effective leak monitoring and detection of bleed air systems.

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 CS 29.1103

8.2.12 Bleed air shut-off
Means for bleed air shut-off shall be provided at, or as close as possible to, the bleed air source.

Consideration should be given to:
a. The fail-safe design of shut-off means (i.e. ensuring that shut-off remains possible despite failures of power systems);
b. Minimising the possibility of a leak upstream of the provided shut-off means, and the effect on safety should such a leak develop;
c. The use of multiple redundant vales may, especially in safety-critical applications, or where integrity/reliability cannot be ensured with a single shut-off valve.

Considerations for preparation of AMC:
1. Failure Modes and Effects Analyses (FMEA) should identify all failures of the system's elements and their effect on the airworthiness of the aircraft; and,
2. Rig, ground and flight testing should demonstrate the effective shut-off of the bleed air system(s), when automatically and/or manually actuated, and the effective display of system status.

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 Pressurization stabilization control
Pressure surges in the aircraft cockpit, control station (where appropriate) and avionics bays shall be prevented.

Consideration should be given to:
a. Means to maintain automatic pressurisation levels throughout all flight conditions; and,
b. Means to prevent excessive pressure differentials (positive and negative) while providing controlled pressure relief.

Considerations for preparation of AMC:
1. The Aircraft Specification should specify limits to all variables which could affect the aircraft's differential pressure (Rate of Climb, Rate of Descent, etc);
2. System Description Documents should detail the means for pressure control including the means for minimisation of differential pressures and surge pressures;
3. Rig, ground and flight testing should demonstrate the appropriate control of pressure levels throughout a variety of flight phases, including high rates of climb and descent.

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:* *STANAG Reference:*	00-970 P1 4.24.42 4671.841
FAA Doc:		*EASA CS Reference:*	CS 23.841 CS 23.843* CS 25.841 CS 25.843*

8.2.14 Nuclear, biological and chemical (NBC) protection provisions
Nuclear, biological, and chemical (NBC) protection equipment and/or procedures shall be provided so that ventilation air is free from contaminants to the levels and in the environments specified in the aircraft specification.

Consideration should be given to:
a. The environments against which protection is required;
b. The limits to which protection is to be considered acceptable; and,
c. The action (if any) required by the crew to put in place or maximise NBC protection, and the effect of their inaction (e.g. due to high crew workload or incapacitation).

Considerations for preparation of AMC:
1. The Aircraft Specification should specify the NBC environments for which protection is required and the acceptable limits for NBC exposure of the occupants;
2. System Description Documents (SDD) should specify equipment and procedures for NBC protection;
3. Aircraft Technical Publications should specify procedures for minimising NBC exposure; and,
4. Simulations, ground and flight testing should demonstrate that NBC procedures can be followed by the crew effectively.

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 Thermal management

The thermal management system shall be stable for all flight conditions and environments.

Consideration should be given to:

a. The full range of anticipated flight environments;

b. Normal and emergency conditions; and,

c. The thermal effect of aircraft systems, including operation of high-power electrical equipment.

Consideration for preparation of AMC:

1. The Aircraft Specification should specify the environments in which the aircraft is expected to operate, including anticipated cold-soaking and hot-soaking, and any other environment that could affect the aircraft's thermal management (e.g. prolonged flight in hover or ground runs, where airflow is minimal);
2. Thermal analysis should show that the heating and cooling capacity of the ECS can adequately heat and cool the relevant compartments with systems and equipment generating the appropriate amount of heat to reflect their operating conditions in normal and reasonably anticipated failure states; and,
3. Rig, ground and flight testing should verify the accuracy of thermal modelling, and should demonstrate that aircraft compartments, systems and equipment do not exceed specified temperature limits.

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

8.2.17 Surface touch temperatures

Surface touch temperatures shall be acceptable and shall preclude any operational limitations to safety of flight operations of the aircraft.

Consideration should be given to:

a. The surfaces that could reasonably be touched inadvertently;

b. Providing protection in the form of guards and warning labels as appropriate;

c. Maintaining the comfort of the aircraft's occupants; and,

d. Ensuring the safety of personnel from risk of sustaining burns, including cold burns.

Considerations for preparation of AMC:
1. The Aircraft Specification should specify maximum and minimum touch temperatures for all surfaces. This should distinguish between occupied and non-occupied compartments where appropriate;
2. Thermal analysis should show that the heating and cooling capacity of the ECS can adequately heat and cool the relevant compartments such that surface touch temperatures remain within acceptable limits with systems and equipment generating the appropriate amount of heat to reflect their operating conditions in normal and reasonably anticipated failure states; and,
3. Rig, ground and flight testing should verify the accuracy of thermal modelling, and should demonstrate that aircraft compartments, systems and equipment do not exceed specified temperature limits.

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.

8.3.1 Integration
The fuel system design, including interfaces, shall be functionally and physically compatible with other aircraft systems.

Consideration should be given to:
a. Interfaces with other aircraft systems (engine, cooling, electrical, pneumatic, etc.); and,
b. Ensuring all materials used in the fuel subsystem are compatible with the aircraft designated fuels.

Considerations for preparation of AMC:
1. System Interface Documents (SID) should identify interface parameters between the Fuel System and each interfacing system; and,
2. Failure Modes and Effects Analysis (FMEA) should identify the possible failures of the Fuel System and its interfacing systems, and the effects of those failures.

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, 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	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.4 00-970 P1 5.2.17
		STANAG Reference:	4671.953 4671.993 4671.994 4671.995

Information Sources			
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

8.3.2 Qualification tests

All fuel system components shall pass all required qualification tests to ensure their suitability for use in all expected usage and environmental conditions.

See also section 8.3.6 regarding pressure capability, and 8.3.10 regarding over-pressure protection.

Consideration should be given to:

a. A wide variety of qualification tests such as: proof, burst, vibration, containment, over-speed, acceleration, explosive atmosphere, pressure cycling, and temperature cycling;

b. Conducting qualification in accordance with appropriate existing standards, where such standards exist; and,

c. Creating appropriately detailed procedures for qualification where existing standards do not exist.

Considerations for preparation of AMC:

1. Qualification Test Procedures (QTP) should define the qualification tests necessary to demonstrate the suitability of components to perform their intended function;
2. Qualification Test Reports (QTR) should record the conduct and results of qualification testing in accordance with the relevant QTP or other existing, relevant standard;
3. Declarations of Design Performance (DDP) should record the scope of qualification, the intended function, and suitability to perform that function for each component; and,
4. Rig, ground and flight testing should demonstrate the correct function of all components when installed as part of the system.

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

8.3.1.1 Merged with 8.3.17

8.3.3 Compatibility with approved fuels

The fuel system shall function satisfactorily with all designated fuels including additives and expected contaminants.

Consideration should be given to:

a. Compatibility of materials used in the fuel system;

b. The use of alternate fuels, restricted fuels and emergency fuels, and any associated aircraft limitations, restrictions, or possible fuel system degradation; and,

c. Fuel system operation with fuel contamination, including particulates, microbes and water.

Considerations for preparation of AMC:

1. The Aircraft Specification should list the aircraft's approved fuels, and maximum allowable levels of contamination, including particulates, microbial growth and water (free, emulsified and dissolved);

2. Declarations of Design Performance should list the fuels for which components are approved and list any limitations associated with specific fuel types;

3. Analysis should identify any limitations and restrictions associated with using specified fuels; and,

4. Rig, ground and flight testing should demonstrate the correct function of the fuel system with appropriate fuel types.

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 - 2.2
		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

8.3.4 Covered by Section 14.

8.3.5 Fuel system strength.

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 aircraft operations.

Consideration should be given to:

a. Ensuring each fuel line is installed and supported to prevent excessive vibration;

b. Protecting fuel system components from damage which could result in spillage;

c. Ensuring each fuel line connected to components of the aircraft, between which relative motion could exist, have provisions for flexibility;

d. Means to prevent chafing of fuel system components against surrounding structure and components;

e. Ensuring fuel tanks are adequately supported.

Considerations for preparation of AMC:
1. Static and Dynamic analysis (e.g. Finite Element Analysis) should demonstrate that all fuel system components can withstand the loads expected in service without permanent deformation, or deformation that would cause unacceptable clearance between aircraft components. The loads that should be considered include fuel system pressures, loads due to aircraft acceleration, loads due to vibration and any loads arising from relative motion of parts, including thermal expansion/contraction.
2. System Description Documents (SDD) should define the preventative means provided for protection against spillage. Such means may include the double-walling of fuel lines, and provision of monitorable drain lines.
3. SDD should define the provisions made to allow for relative movement between parts of the aircraft.
4. SDD should define the provisions made to prevent chafing of fuel system components.
5. Static analysis should demonstrate that fuel tanks and supporting structure are suitably strong to withstand loads resulting from the mass of carried fuel and expected aircraft acceleration.
6. Rig, ground and flight testing should demonstrate the accuracy of static and dynamic analysis.

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 23.305 CS 23.963 CS 23.993 CS 23.994* CS 25.305 CS 25.963 CS 25.993 CS 25.994* CS 27.305 CS 27.963 CS 27.993 CS 29.305 CS 29.963 CS 29.993

8.3.6 Pressure capability.
All fuel system components, lines and connections, (both as completely assembled and installed within the aircraft), 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. The magnitude and frequency of fuel system pressures, including both positive and negative pressures and surge pressures that the various sections of fuel lines will be subjected to in service.
b. The effect of component failures on fuel system pressures, and for failures that could be realistically expected in service, the magnitude and frequency of those pressures.
c. 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.

Consideration for preparation of AMC:
1. System Description Documents (SDD) should define the maximum and minimum pressures expected in the fuel system, and their frequency of occurrence. This should include pressures that could result from failures that could be realistically expected in service.
2. Static strength analysis should demonstrate the ability for all fuel lines and fittings to withstand the maximum and minimum expected pressures without leakage or permanent deformation.
3. Fatigue analysis should demonstrate the ability for all fuel lines and fittings to withstand the magnitude and frequency of fuel system pressures without failure during the components expected lives.
4. Rig, ground and flight testing should demonstrate the accuracy of the defined fuel system pressures (both magnitude and frequency), and the accuracy of static and fatigue analysis.

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, 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	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.40 00-970 P1 5.2.55 00-970 P1 5.3.96 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

8.3.7 Fuel flow.
The fuel system shall provide a continuous flow of fuel at a rate and pressure established for proper engine functioning throughout the aircraft's operating envelope.

Consideration should be given to:
a. Critical combinations of aircraft altitudes, attitudes, accelerations, fuel tank quantities, and fuel system component failures;
b. Flow rates and pressures required at the engine interface.

Considerations for preparation of AMC:

1. System Interface Documents (SID) should define the fuel flow rates and pressures required at the engine interface for the various aircraft flight conditions.
2. Analysis (e.g. Computational Fluid Dynamics (CFD)) should demonstrate that the fuel system provides a continuous provision of fuel at flow-rates and pressures exceeding the requirements at the engine interface for all required aircraft operating conditions.
3. Rig, ground and flight testing should demonstrate the accuracy of analysis for fuel system flow-rates and pressures at the engine interface for the most critical aircraft operating conditions.
4. Technical Publications should clearly identify any aircraft operating conditions through which the required fuel system flow-rate and pressure is not provided at the engine interface, and should identify any resulting limitation (e.g. degradation of flight handling characteristics).

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, 25.951, 25.953, 25.955, 25.959	*EASA CS Reference:*	CS 23.951 CS 23.955 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

8.3.8 Fuel transfer rates.

The rate of fuel transfer from one aircraft fuel tank to another shall be sufficient to meet the operational ground and flight envelope requirements, and shall not limit aircraft performance.

Consideration should be given to;

a. Ensuring compatibility between the fuel transfer subsystem and other fuel sub-systems (jettison, engine feed system, AAR refuelling/dispensing systems, etc.);
b. Providing adequate redundancy, which may include an alternate/reversionary (back-up) transfer system and/or gravity feed.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should record the maximum expected flow-rates into and from a fuel tank, including those through engine feed, jettison, AAR refuel and dispensing, ground refuel and tank-to-tank fuel transfer. The SDD should also identify the expected and possible combinations of sub-system operation, and should identify the protections in place to prevent fuel tank overflow and inadvertent fuel tank emptying.
2. Analysis (e.g. Computational Fluid Dynamics (CFD)) should identify the expected fuel flow rates into and from each tank via each of the fuel sub-systems.
3. Rig, ground and flight testing should demonstrate the accuracy of analysis for fuel sub-system flow rates, and the correct operation of each means to prevent fuel tank overflow and inadvertent tank emptying.

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

8.3.9 Centre of gravity.
The fuel system shall 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, AAR (if applicable), fuel transfer and other lateral deviations of CG due to fuel asymmetry in separate tanks, 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 aircraft CofG requirements for all mission phases;
c. The most critical combination of aircraft altitudes, attitudes and other conditions with respect to fuel distribution on CofG.

Considerations for preparation of AMC:
1. The Aircraft Specification should specify the aircraft's permitted CofG envelope(s).

2. System Description Documents (SDD) should specify the fuel system's permitted CofG envelope(s). Where different CofG envelopes exist (for example where weight restrictions or flight manoeuvre limits are specified) the limits/restrictions associated with each envelope should be clearly specified.
3. Analysis should demonstrate that all permitted combinations of fuel distribution, cargo distribution (including jettisonable cargo, and the result of its jettison), passengers, crew, and any other factor that could appreciably affect the aircraft CofG, do not result in an aircraft CofG outside permitted limits.
4. Rig, ground and flight testing should demonstrate that any integrated provisions intended to prevent aircraft loading outside of the permitted CofG envelope function satisfactorily.
5. Technical Publications should clearly identify any distribution or combination of distributions which could result in an aircraft CofG exceeding permitted limits, and should identify any resulting limitation (degradation of flight handling characteristics, prohibition of flight functions, etc.).

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

8.3.10 Over-pressure protection.
The fuel system shall be designed such that no aircraft operation (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). See also section 8.3.6.

Consideration should be given to:
a. Providing means to prevent the exceedance of defined pressure limits, including both the exceedance of pressure magnitude and frequency of occurrence (see also section 8.3.6 for criteria regarding the definition of these limits).
b. Ensuring that fuel system components cannot cause excessive pressures under normal and failure conditions.
c. Providing redundant and fail-safe design elements to ensure that any failure that does occur does not result in a hazardous operating condition.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should define the maximum and minimum pressures expected in the fuel system, and their frequency of occurrence. This should include pressures that could result from failures that could be realistically expected in service.
2. SDD should identify any over-pressure devices integrated in the design of the fuel system, the conditions upon which these devices will operate and the result of the operation of these devices (if any).
3. Failure Modes and Effects Analysis (FMEA) should demonstrate that the effect, probability and overall risk of failure of any over-pressure protection is acceptable.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 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.3.4.5.8, E.4.4.5.8	*Def-Stan 00-970 Reference:*	00-970 P1 5.2.40 00-970 P1 5.2.55 00-970 P1 5.2.185 00-970 P1 5.2.202 00-970 P1 5.2.203 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

8.3.11 Technical manuals.
Flight and maintenance manuals shall include normal, back-up and emergency operating procedures, limitations, restrictions, servicing, and maintenance information and other information necessary for safe operation of the fuel system.

Consideration should be given to:
1. The level of detail necessary to provide accurate technical information while remaining concise;
2. The information, at the appropriate level of detail, required to allow personnel to operate and maintain the aircraft as safely and effectively as possible at an acceptable workload.

Considerations for preparation of AMC:
1. Operational Technical Publications for the flight crew (Aircraft Flight Manual, Emergency Procedures, Checklists etc.) should clearly define all required normal, back-up and emergency operating procedures, limitations and restrictions.
2. Maintenance Technical Publications for ground crew (Aircraft Maintenance Manual, Master Minimum Equipment List, Maintenance Schedule, etc.) should clearly define all required servicing and maintenance information.
3. Flight Simulations, Ground Testing and/or Flight Testing should verify that all Operational Technical Publications are clear and unambiguous and can be followed by a flight crew through all flight phases and conditions without incurring excessive crew workload and serve their intended function.

4. Rig and/or Ground Testing should verify that all Maintenance Technical Publications are clear and unambiguous and can be followed by a competent maintenance engineer in a manner which ensures the continuing airworthiness of the aircraft.

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

8.3.12 Contamination.

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. Ensuring that the fuel system is adequately protected from blockages.

b. Ensuring that the engine feed system incorporates appropriate filtration to ensure that contamination of fuel provided at the engine interface remains within acceptable limits.

c. Providing means to remove contamination (particles, water, fungal growth, etc.) from the fuel system and its filters.

d. Defining maintenance procedures to identify and control the contamination within the aircraft fuel tanks.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify the design features of the fuel system intended to prevent blockage in the fuel system lines and fittings, minimise the level of contamination of fuel provided to the engines, and allow maintenance personnel to monitor and remove contamination from the fuel tanks.

2. System Interface Documents (SID) should define maximum allowed levels of contamination of fuel provided by the fuel system to the engines.
3. Technical Publications should define maintenance procedures for minimising and managing fuel tank and fuel system contamination.

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

8.3.13 Electrical and electromagnetic effects.

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. Minimising electro-static build-up within fuel lines and within the fuel tank;
c. Preventing electrical arcing;

d. Isolating electrical equipment from the fuel to minimise the possibility of fuel leakage and fuel vapour coming into contact with electrical equipment.
e. 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;
f. Preventing ignition of fuel and fuel vapour (risk mitigation, e.g. Inerting).

Considerations for preparation of AMC:
1. System Description Documents should identify the aspects of fuel system design provided to reduce the risk due to electromagnetic effects.
2. Functional Hazard Analyses (FHA) should identify the risk of ignition/explosion due to lightning strikes, electrical faults and other electro-magnetic effects.

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

8.3.13.1 Merged with 8.3.13

8.3.13.2 Secondary barriers.
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.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should clearly identify the primary barrier and secondary barrier provided between each fuel tank and adjacent hazardous area.
2. SDD should identify the means provided for failure detection of the primary barrier.
3. Failure Modes and Effects Analysis (FMEA) should define the residual risk of ignition/explosion taking into account the failure probability of the primary and secondary barriers and the probability of undetected failure of the primary barrier.
4. Technical Publications should identify the maintenance procedures for detecting the failure of the primary barrier.

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

8.3.13.3 Drainage.
Fuel system drainage provisions shall permit safe drainage of the entire fuel system on the ground; 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 aircraft.
Refer also to 8.3.13.2 regarding in-flight draining of leakage, and 8.3.13.4 regarding jettison..

Consideration should be given to:
a. Ensuring fuel is discharged clear of all parts of the aircraft;
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.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should identify the location of drain points both inside of the fuel tank, and on the aircraft's external skin.
2. Analysis should identify the quantity of fuel remaining in each tank when drained down to the point of the lowest drain, in all aircraft attitudes that could reasonably be expected to occur when the aircraft is on the ground with fuel tanks drained.
3. Ground testing should demonstrate the accuracy of analysis, determining the quantity of fuel remaining in each tank when drained down to the point of the lowest drain in the most critical (resulting in the highest undrainable fuel quantity) aircraft attitude for each tank.
4. Ground testing should demonstrate that, when operated correctly, the drain valves discharges drained fuel clear of all parts of the aircraft.
4. Technical Publications should identify the maintenance procedures for operation of fuel tank drains, including subsequent closure of the drains.

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

8.3.13.4 Safe fuel release.
The fuel system jettison discharge points, vents and any components outside of the fuel tanks shall be located such that fuel (jettisoned, vented, leaked, or otherwise) cannot be ingested by the engines, flow into hazardous ignition areas, flow onto the environmental management system or become reingested into the aircraft.

Consideration should be given to:
a. Avoiding potential ignition sources, including hot brakes, bleed air ducts, engine, APU, etc.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify the points through which fuel is jettisoned, or may otherwise be released from the aircraft (e.g. due to an open drain, failed vent system or through general leakage).
2. Functional Hazard Analysis should identify the risk due to released fuel coming into contact with any part of the aircraft.

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 CS 29.999 CS 29.1001

8.3.14 Fuel tank strength.

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, including those required for crashworthiness. See also section 8.3.5.

Consideration should be given to:
a. All sources of loads on the aircraft fuel tanks, and possible combination of load types.
b. Requirements for crashworthiness.
c. The strength of surrounding structure.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should identify the load cases that the fuel tanks are expected to withstand in service, including where appropriate, combinations of load types.
2. Static and Dynamic analysis (e.g. Finite Element Analysis) should demonstrate that all fuel tanks can withstand the loads expected in service without permanent deformation or failure.
3. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, determining the structural integrity of the fuel tanks under critical loading conditions.

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

Information Sources			
			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 27.952 CS 27.963 CS 27.965 CS 27.993 CS 29.952 CS 29.963 CS 29.965 CS 29.993

8.3.15 Tank pressure.

The fuel tanks shall be designed to withstand the maximum pressure that could occur with any single failure within the fuel system without permanent deformation or failure.

Consideration should be given to:

a. All possible tank differential pressures, including high internal tank pressure (due to refuelling, fuel transfer, AAR refuelling receipt, etc.) and low external tank pressure (e.g. due to operation at high altitude), low internal tank pressure (due to defuel, fuel transfer, AAR refuelling dispense, etc.) and high external tank pressure (e.g. due to operation at low altitude), and where appropriate, differences in pressure between adjacent fuel tanks. These considered pressures should take account of hydrostatic pressure, including where appropriate those during accelerated flight conditions.

b. Failure of any component that could result in a change of tank pressure, and the effect of failure on tank differential pressures. Such components will depend on the fuel system architecture but are likely to include refuel valves, high-level sensors, vent lines and fuel pumps, and may also include power distribution or system management components.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define the fuel tank maximum differential pressures, the load cases that are expected to result in high differential tank pressures, and the failures that may lead to large changes in differential tank pressures or exceedance of tank pressure limits.
2. System Safety Assessments (SSA) should identify single component failures that could affect tank differential pressures, including single failures that could result in the effective failure of multiple components (e.g. power distribution or system management components).
3. Analysis (e.g. Computational Fluid Dynamics) should identify the effect of each component failure, and where one single failure can result in the effective failure of multiple components, the effect of each multiple component failure case on the fuel tank differential pressures.
4. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, demonstrating that critical component failure cases do not result in excessive tank differential pressures.

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 23.1309 CS 25.963 CS 25.965 CS 25.1309 CS 27.965 CS 27.1309 CS 29.965 CS 29.1309

8.3.16 Refuelling/defueling.
The aircraft shall be capable of being safely refuelled and defueled.

Consideration should be given to:
a. Refuel pressures and flow-rates up to the maximum permitted limits.
b. Requirements for refuelling with crew and/or passengers on board the aircraft, and with engine(s) and/or APU(s) running.
c. Provision of standardised gravity and/or pressure refuelling interface(s).
d. Provision of refuel control systems, including manual and/or automatic refuel shut-off valves sequencing of filling tanks and isolation of tanks.
e. Procedures for ground crew to follow to support the effective and safe refuel of the aircraft.
f. Adequate prevention of leakage and spillage of fuel.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should define the provisions made for refuelling and defueling the aircraft and the allowable refuelling and defuelling pressure limits.
2. Functional Hazard Analysis (FHA) should identify the hazards associated with refuelling and defueling the aircraft.
3. Technical Publications should identify the operating procedures regarding the safe refuel and defuel of the aircraft, including information regarding the refuelling/defueling of the aircraft with crew and/or passengers on board, and with engine(s) and/or APU(s) running.

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,	*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

Information Sources			
	E.3.4.5.8.7, E.4.4.5.8.7, E.3.4.5.8.8, E.4.4.5.8.8		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 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

8.3.17 Spill prevention.

The fuel system shall be designed to prevent fuel spills during refuelling/defueling operations and during subsequent normal manoeuvres on the ground and in flight.

Consideration should be given to:

a. Providing automatic shut-off means to prevent the quantity of fuel in each tank from exceeding the maximum quantity for that tank;

b. Providing means for over-flow detection, to automatically shut-off refuel in the event of an overflow, or alert refuelling ground crew;

c. Providing indication to inform ground crew when fuel tank(s) are full;

d. Providing ground and flight crew operating procedures to prevent the spillage of fuel following refuel.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the means provided to prevent the quantity of fuel in each tank from exceeding its maximum allowed quantity.
2. SDD should detail the means provided for detection of refuel over-flow and subsequent automatic shut-off and/or alerting of ground crew.
3. SDD should detail the means provided for informing ground crew that fuel tanks are full.

4. Technical Publications should define procedures for refuelling/defueling of aircraft, including prevention of spills.
5. Technical Publications should define operating procedures to prevent the spillage of fuel during and following refuel.

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* 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

8.3.18 Operator interface.
Adequate controls and displays shall be available to notify the flight crew of the fuel systems and its necessary functions to warn for hazardous conditions.

Consideration should be given to:
a. Clear presentation of relevant information to crew, including status indication, and warning, caution and advisory information.
b. 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.);
c. The location of the temperature sensors should be carefully considered so that a true fuel temperature will be indicated;
d. The position of the fuel quantity indicators to ensure accurate data readings;
e. Ensuring all displays and controls meet the specified requirements (arrangement, location, type, size, guards etc.).

Considerations for preparation of AMC:
1. System Description Documents (SDD) should identify the controls and displays provided to crew. For controls, detail should be provided regarding the mode of operation and function of each control. For displays, detail should be provided regarding all information displayed to the crew, and where appropriate, the conditions that would lead to specific indications.

2. Rig, ground and flight testing should demonstrate that controls perform their intended function(s) and that displays provide accurate and useful information to the crew.

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 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

8.3.19 Diagnostics.

The fuel system shall include the necessary built-in-test (BIT), fault detection and isolation provisions, in order to identify critical failures to the operators and maintainers.

Consideration should be given to:

a. Providing power-on BIT (which performs a diagnostic process on power-on of a given component/system), on-demand BIT (which performs a diagnostic process when operated by an operator), and/or continuous BIT (which performs continuous diagnostic processes).
b. Providing means for manual and/or automatic fault isolation, and operation of back-up systems, taking consideration of the benefit of minimising pilot work-load while ensuring that the pilot remains informed of the aircraft's flightworthiness and mission-worthiness.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the provisions for BIT.
2. Technical Publications should detail the procedures for operating BIT equipment (if any), the procedures for managing information provided by BIT, and for managing the fuel system during flight.

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 aircraft surfaces or become re-ingested into the aircraft. Fuel jettison operations shall be safe and shall not adversely affect the controllability of the aircraft.

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 Reference:*	CS 23.1001(c) CS 25.1001 CS 29.1001

8.3.20 Merged with 8.3.14.

8.4. FIRE AND HAZARD PROTECTION.

8.4.1 Integration.
The fire protection system shall not introduce additional hazards. In addition, risks associated with existing hazards shall not be increased by integration of the fire protection system.

Consideration should be given to:
a. Ensuring that the fire protection system components and elements can withstand the hazards they are designed to control and mitigate;
b. Protection in this context encompasses both detection and extinguishing.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the general architecture and design of the fire protection system, and should identify the specific hazards that the system is designed to control and mitigate, and where applicable identify any key hazards that the system is not designed to control or mitigate.
2. System Safety Analysis (SSA) should assess the overall safety of the system and should identify and assess the hazards caused by the fire protection system, and the effect of the system on the aircraft's existing hazards.
3. Declarations of Design and Performance (DDP) should identify the physical and functional requirements of each item of equipment of the system, and should declare conformance with each requirement.
4. Rig, ground and flight testing should confirm the correct and safe integration of the fire protection system.

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 Clause 1.12.1-1.12.4 00-970 P13 1.6.12.1 to1.6.12.4 and 1.6.12.5
		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

Information Sources			
			CS 23.1359 CS 25.851 CS 25.854 CS 25.858 CS 25.859 CS 25.867 CS 25.1203 CS 25.1207 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 Failure modes and effects.

All single-point failure conditions of the fire and hazard protection system shall be identified and the consequences of their failure shall be acceptable, eliminated or mitigated.

Consideration should be given to:

a. Defining and demonstrating compliance with an acceptable failure rate for each component, sub-system and system.

b. The effect of single-point failures on other elements of the system, and possible further failures and other effects.

Considerations for preparation of AMC:

1. Failure Modes and Effects Analysis (FMEA) should identify all single-point failures within the fire and hazard protection system and should identify controls and mitigations to ensure that consequences of their failure are acceptable.

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 23.1309 CS 25.1203 CS 25.1309 CS 27.1309 CS 29.1309

8.4.1.2 Qualification tests.

All components shall undergo an appropriate Qualification Test Programme (QTP) to demonstrate their suitability to perform their intended function.

Consideration should be given to:

a. System Validation and Verification (V&V), i.e. the definition of requirements at all levels (system, sub-system, assembly and component) such that the overall requirements for the system are met (Validation) and the demonstration of compliance against the defined requirements at all levels (Verification).

b. The range of design and performance requirements that may apply to a given system, sub-system, assembly and component, which may include requirements for proof and/or burst pressure, vibration, containment, over-speed, acceleration, explosive atmosphere, pressure cycling, and temperature cycling.

c. Demonstrating compliance against appropriate established standards (e.g. ISO 14186:2013 Air cargo -- Fire containment covers -- Design, performance and testing requirements)

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define Qualification Requirements (QR), including requirements for component performance, which may include requirements for proof and/or burst pressure, vibration, containment, over-speed, acceleration, explosive atmosphere, pressure cycling, and temperature cycling.
2. Qualification Programme(s) (QP) should specify the testing to be completed for each component, assembly, sub-system or system as appropriate and the requirement(s) that each test will demonstrate compliance against.
3. Qualification Test Procedures (QTP) should define at an appropriate level of detail the procedures to be followed for qualification testing of each component, assembly, sub-system or system as appropriate.
4. Qualification Test Reports (QTR) should record the completion of qualification testing in accordance with QTPs and acceptable demonstration of compliance against each QR.
5. Declarations of Design and Performance (DDP) should identify the physical and functional requirements of each equipment of the system, and should declare conformance with each requirement.

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

Information Sources			
			CS 25.1309 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 Operator interface.

Adequate crew-station information shall be available to notify the flight crew of the status if the fire and hazard protection system and any warnings related to detection of fire or smoke.

Consideration should be given to:

a. Clear presentation of relevant information to crew, including status indication, and warning, caution and advisory information.

b. Where more than one zone or area is monitored, provision of indication to crew of detection location;

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify the controls and displays provided to crew. For controls, detail should be provided regarding the mode of operation and function of each control. For displays, detail should be provided regarding all information displayed to the crew, and where appropriate, the conditions that would lead to specific indications.
2. Demonstrating the controls and display show the status of the fire and hazard protection system and the warnings and cautions related to the aircraft hazards
3. Technical Publications (e.g. Aircraft Flight Manual) should adequately describe the information made available to the crew regarding the status of the fire and hazard protection system and should provide detailed procedures for crew to follow upon the display of warnings and cautions related to the aircraft hazards against which the system is designed to provide hazards control and/or mitigation.

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

Information Sources			
			CS 25.1203 CS 25.1305 CS 27.1195 CS 29.855 CS 29.1203 CS 29.1305

8.4.2 Hazard protection zones.

Each compartment of the aircraft shall be zoned according to the fire and explosion hazards present within that compartment. Each hazard shall be controlled and mitigated such that no fire or explosion hazard has unacceptable risk under normal operating conditions.

Consideration should be given to:

a. Identifying the different zones of the aircraft, the compartments which make up each zone, and the adequacy of partitions between zones.

b. Identifying an acceptable level of risk for the hazards of each zone.

c. Analysing the hazards associated with each zone, including the fire and explosion protection such that hazards are controlled and mitigated to an acceptable level.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define each hazard protection zone, their compartments, and the acceptable level of risk for each zone.

2. System Safety Assessment (SSA) should analyse the hazards associated with each zone and demonstrate that the hazard controls and mitigations support an acceptable level of risk.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	JSSG-2009 Appendix G: G.3.4.7, G.4.4.7 MIL-HDBK-221: 2.11	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.2 00-970 P1 4.26.5 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

Information Sources			
			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

8.4.2.1 Control station protection.

Each compartment of the Control Station (if applicable, i.e. for UAV, RPAS, etc.) shall be zoned according to the fire and explosion hazards present within that compartment. Each hazard shall be controlled and mitigated such that no fire or explosion hazard has unacceptable risk under normal operating conditions or single failure conditions.

Consideration should be given to:

a. Identifying the different zones of the Control Station, the compartments which make up each zone, and the adequacy of partitions between zones.

b. Identifying an acceptable level of risk for the hazards of each zone.

c. Analysing the hazards associated with each zone, including the fire and explosion protection such that hazards are controlled and mitigated to an acceptable level.

d. Identifying single failures that could cause hazards or affect the risk of existing hazards.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define each hazard protection zone, their compartments, and the acceptable level of risk for each zone.

2. System Safety Assessment (SSA) should analyse the hazards associated with each zone and demonstrate that the hazard controls and mitigations support an acceptable level of risk.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P9 UK FW.U1701c 00-970 P9 UK FW.U1701d 00-970 P9 UK RW.U1701c 00-970 P9 UK RW.U1701d
		STANAG	

Information Sources			
		Reference:	
FAA Doc:		*EASA CS Reference:*	

8.4.3 Hazard consideration in designs.

The fire and hazard protection system shall be designed in such a way that it mitigates the hazards identified in the System Safety Assessments of the aircraft's systems into an acceptable level of risk.

Consideration should be given to:
a. Identifying fire hazards associated with each aircraft system and the acceptable level of risk for each hazard.
b. Identifying an acceptable level of risk for the hazards of each zone.
c. The effect of the fire and hazard protection system on the hazards associated with each system and the way these hazards are controlled and mitigated to an acceptable level.

Considerations for preparation of AMC:
1. System Description Documents (SDD) for the fire and hazard protection system should summarize the hazards introduced by each individual system, and by the integration of the different systems into the aircraft.
2. System Safety Assessment (SSA) should analyse the hazards associated with the fire and hazard protection system and demonstrate that, at aircraft level, the level of risk is acceptable.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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, 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	*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 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

Information Sources			
			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 Minimization of ignition risk.

In areas where flammable fluids or vapours may be present, the design shall minimise the probability of ignition of the fluids and vapours and the consequences of such an ignition.

Consideration should be given to:

a. For each hazard associated with ignition risk:

i. Identifying potential causes (i.e. ignition threats);

ii. Identify potential consequences (e.g. fire, explosion, failure of other components/systems, etc.)

iii. Identify risk reduction means, i.e. control measures (which reduce the probability of a hazardous event's occurrence) and recovery measures (which reduce the severity of the consequence of the hazardous event's occurrence).

b. Incorporating control and recovery measures effectively, which may involve changes to the design of the aircraft, or its operation or maintenance.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should, for each system, define the fire hazards and acceptable level of risk for each system.

2. System Safety Assessment (SSA) should, for each system, analyse associated hazards and demonstrate that the hazard controls and mitigations support an acceptable level of risk.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 Safety critical components.

Aircraft 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 level.

Consideration should be given to:

a. Identifying an appropriate level for fire and heat exposure, including but not limited to: environmental conditions expected in service; hazards within the zone(s) within which components are located (see section 8.4.2); change in material properties due to changes in temperature (Young's modulus, yield stress, etc.); effects due to thermal expansion and contraction; requirements for burn-through; and, incorporation of safety margins.

b. Demonstrating the suitability of the components throughout and following exposure to heat and fire up to the identified level.
c. Demonstrating that the risk of exceeding the identified level for fire and heat exposure is acceptable.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should define the limits for fire and heat exposure associated with each zone.
2. Analysis should demonstrate the suitability of components throughout and following exposure to heat and fire up to the identified level.
3. Testing (usually coupon, equipment and rig testing) should demonstrate the accuracy of the performed analysis for components whose failure would have a large effect on the safety of the aircraft, or where there is a high risk of fire and heat exposure.
4. System Safety Assessment (SSA) should analyse the hazards associated with fire and heat exposure and demonstrate that the hazard controls and mitigations support an acceptable level of risk.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 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 Drainage and ventilation.
Where required to reduce the risk of fire and explosion hazards to acceptable levels, adequate drainage and ventilation shall be provided.

Consideration should be given to:
a. The capacity of each drain or vent; ensuring that it is adequate to drain the expected quantities of fluid and/or vapour;
b. The location of each drain or vent to maximise the performance of the drain/vent, minimise the risk of blockage and remove fluid and vapours to a safe location which prevents the re-entering of fluids/vapours into the aircraft on ground and in flight;
c. The prevention of transfer of fluids/vapours from one compartment to another via the drains/vents.
d. The prevention of connecting drains/vents carrying flammable fluids/vapours with those that do not carry flammable fluids/vapours through manifolds.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should identify drainage and ventilation provisions for each compartment.
2. Analysis should demonstrate the suitability of drains and vents for the type and quantities of fluids and/or vapours for which they are designed.
3. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis and the suitability of the drains and vents for removal of fluids and vapours to a safe location.
4. System Safety Assessment (SSA) should analyse the hazards associated with fire and explosion incorporating drainage and ventilation into the assessment of risk.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 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

Information Sources			
			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

8.4.4.1 Merged with 8.4.4.

8.4.5 Merged with 8.4.4.

8.4.6 Engine fire zone provisions.

Engine nacelle cooling and ventilation provisions shall be adequate to avoid hot surface ignition sources and collection of flammable fluids or vapours.

Consideration should be given to:

a. Heat transfer from the engine to the nacelle and surrounding compartments, and heat transfer from the nacelle and surrounding compartments to other areas of the aircraft and its surrounding environment. The modes of heat transfer will likely include conduction (through the nacelle, through the surrounding aircraft structure, etc.), radiation (e.g. from engine surfaces to compartment surfaces), and convection (including the compartment ventilation).

b. Identifying acceptable limit temperatures for the surfaces and content of each compartment, taking into account the flash points and auto-ignition temperatures of the fluids and vapours expected in each compartment.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify acceptable temperature limits for the surfaces and content of each compartment.
2. Analysis should demonstrate adequate thermal management for the engine and surrounding compartments.
3. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis and the performance of thermal management provisions.
4. System Safety Assessment (SSA) should analyse the hazards associated with fire and explosion incorporating engine nacelle cooling and ventilation provisions into the assessment of risk.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 Merged with 8.4.1.3 and 8.4.2.

8.4.8 Merged with 8.4.3.2.

8.4.9 Electrically powered fire protection.

Each electrically powered fire protection sub-system shall be provided with power at all times during aircraft operation, including engine start and battery operations.

Consideration should be given to:
a. All functions of the fire protection system including fire detection, extinguishing, and explosion suppression systems.
b. The duration for which the aircraft could be expected to operate without electrical power generation or external power sources, and ensuring capacity to power the fire protection sub-systems for that duration.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should define the electrical power source(s) which power the fire suppression sub-systems, and the duration for which the aircraft is expected to operate without electrical power generation or external power sources.
2. Analysis should demonstrate that the electrical power system is capable of providing adequate electrical power to the fire protection sub-systems for the required duration, taking account of any other electrical loads.
3. Rig, ground and flight testing should demonstrate the accuracy of the analysis performed, and should demonstrate the function of the fire protection sub-systems using each source of electrical power.

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

Information Sources			
		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 Explosion suppression.
Where required to reduce the risk of explosion hazards to acceptable levels, adequate explosion suppression shall be provided.

Consideration should be given to:
a. Passive explosion suppression, such as explosion suppressing foam.
b. Active explosion suppression, such as suppressant agent discharge systems.
c. Hazards associated with an explosion and the rapid dispersion of explosion suppression agents, and the effect that dispersion would have on aircraft components and structure.
d. The overall level of risk associated with explosions and the effect of incorporation of explosion suppression systems.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should identify explosion suppression provisions for each compartment that require such provisions.
2. Analysis should demonstrate the suitability of explosion suppression systems for the environments in which they are located and the hazards that they are designed to mitigate.
3. Testing (typically lab or rig testing) should demonstrate the accuracy of the performed analysis and the suitability of the explosion suppression systems for the environments in which they are located and the hazards that they are designed to mitigate.

4. System Safety Assessment (SSA) should analyse the hazards associated with explosion, incorporating the explosion suppression system into the assessment of risk.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 False warnings.
The fire detection system shall be designed to preclude false warnings.

Consideration should be given to:
a. Providing redundancy to reduce the probability of a false warning due to system/component failure.
b. Incorporating active system monitoring (i.e. Built In Test Equipment (BITE)) to actively detect system failures and mitigate their effect.
c. Ensuring that components are suitable for the environmental conditions that are expected in service.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should identify the aspects of the fire detection system intended to preclude false warnings.
2. System Safety Assessment (SSA) should demonstrate that system/component failure cannot result in false warning.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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

Information Sources			
			CS 29.1203 CS 29.1309

8.4.12 Fire suppression.

Where required to reduce the risk of explosion hazards to acceptable levels, adequate fire suppression shall be provided.

Consideration should be given to:

a. Active fire suppression systems (such as suppressant agent discharge systems) and/or passive fire suppression systems (such as fire suppressing foam).

b. Performance requirements for the system(s), including (but not limited to) agent concentrations and durations required to adequately suppress fire(s), the size of zone(s) for which suppression is required, and the types of fire for which suppression is required.

c. The compatibility between the fire suppression agent and the aircraft, accounting for the type of zone(s) for which suppression is required (engine bay, cargo bay, dry bay, fuel tank, etc.) and the effect that the agent may have on aircraft components and structure..

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify fire suppression provisions for each compartment.
2. Analysis should demonstrate the suitability of fire suppression systems for the environments in which they are located and the hazards that they are designed to mitigate.
3. Testing (typically lab or rig testing) should demonstrate the accuracy of the performed analysis and the suitability of the fire suppression systems for the environments in which they are located and the hazards that they are designed to mitigate.
4. System Safety Assessment (SSA) should analyse the hazards associated with fire, incorporating the fire suppression system into the assessment of risk.

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

Information Sources			
			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 Fire isolation.

Fireproof protective devices shall be provided to contain a fire within a defined fire zone.

Consideration should be given to:

a. The temperatures that protective devices would be required to withstand in the event of a fire, and the required duration for withstanding these temperatures.

b. Requirements for fail-safe design, such that containment is achieved in the event of failure of the protection device.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify the fireproof protective devices incorporated in the aircraft design to contain a fire within a fire zone.
2. System Safety Assessment (SSA) should analyse the hazards associated with each zone and demonstrate that the risk associated with fires in adjacent zones is acceptable.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 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

Information Sources			
			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 Fire resistance.

The finishes and materials of the aircraft sub-systems shall deter combustion. Any toxic by-products of combustion of any aircraft material shall be at acceptable levels.

Consideration should be given to:

a. The flammability/combustibility of materials throughout the aircraft, particularly those located in fire zones and occupied compartments.

b. The use of materials and finishes that are flame retardant and/or self-extinguishing.

c. The adequate ventilation of compartments and the potential build-up of toxic by-products.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define the materials and finishes used throughout the aircraft and their appropriate fire resistance.

2. Analysis should demonstrate that toxic by-products cannot reach levels hazardous to health, taking account of provisions for aircraft ventilation.

3. Testing (usually lab, coupon, equipment and rig testing) should demonstrate the adequate fire resistance of materials and finishes used throughout the aircraft.

4. System Safety Assessment (SSA) should analyse the hazards associated with fire taking into account the flammability/combustibility of materials and finishes.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 25.831 CS 25.853 CS 25.855 CS 25.856 CS 25.857 CS 25.859 CS 25.863 CS 25.869 CS 25.1713

Information Sources			
			CS 27.853 CS 27.855 CS 29.853 CS 29.855

8.4.15 Protection of inhabited and critical areas.

The fire and hazard protection system shall prevent hazardous quantities of smoke, flames, or extinguishing agents from entering inhabited and critical areas, including the cockpit/flight deck, passenger compartments, control station (for UAV, RPAS, etc.), or flight-critical sensor bays.

Consideration should be given to:

a. Identifying an acceptable level risk of smoke, flame or extinguishing agents, taking account of physiological effects of the hazards on the aircraft's occupants, and any effects the hazards may have on the aircraft's equipment, components and structure.

b. Minimising the risk of such hazards, ensuring that the risk is at least below the acceptable level.

c. Ensuring that any risk reduction measures (controls and/or mitigations) incorporated into the aircraft's design, operation, or maintenance supports the intended reduction of risk.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify the protection provided to prevent hazardous quantities of smoke, flames, extinguishing agents, etc. in inhabited and critical areas.
2. Analysis should demonstrate that the protection provided to prevent hazardous quantities of smoke, flames, extinguishing agents, etc. in inhabited and critical areas provides adequate protection.
3. Testing (usually coupon, lab, and rig testing) should demonstrate the accuracy of the performed analysis and demonstrate that hazardous quantities of smoke, flames, extinguishing agents, etc. in inhabited and critical areas is adequately prevented.
4. System Safety Assessment (SSA) should analyse the hazards associated with each zone and demonstrate that the risk associated with smoke, flames, extinguishing agents, etc. in inhabited and critical areas is acceptable.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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	*EASA CS Reference:*	CS 23.831 CS 23.851 CS 23.1197 CS 25.831

Information Sources			
	AC 25-9		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 Equipment separation.

Adequate separation shall be provided between equipment containing oxidisers, flammable fluid systems, and electrical components.

Consideration should be given to:

a. The routeing and positioning of equipment containing oxidisers, flammable fluid systems and pipe-work, and electrical system components and cables;

b. Preventing the placement of flammable fluid lines above potential ignition sources (such as electrical components and cables) and equipment containing oxidisers to minimise the risk of combustion;

c. Incorporating hazard control design elements, such as double-walled pipes, drip fences/points (away from ignition sources and oxidisers), shrouds and covers;

d. Providing adequate separation distances, taking account of deflection under all loading conditions on-ground and in-flight.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify compartments or zones of the aircraft where oxidisers, flammable fluid systems, and electrical components/cables are each prohibited and allowed. Where a compartment or zone may contain a combination of oxidisers, flammable fluid systems, and/or electrical components/cable, SDD should identify the hazard control design elements which reduce the risk of combustion hazards.
2. Analysis should demonstrate that the separation between oxidisers, flammable fluid systems, and electrical components/cables is adequate.
3. Rig and ground testing should demonstrate the accuracy of performed analysis, and should demonstrate that normal operation of flammable fluid systems does not cause unacceptable risk of combustion.
4. Ground and flight testing should demonstrate that, under all expected loading conditions on-ground and in-flight, deflections of components and structure does not cause unacceptable reduction of separation distances.
5. System Safety Assessment (SSA) should analyse the hazards associated with each zone and demonstrate that combustion risk is acceptable.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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

Information Sources			
			00-970 P1 6.2.59 00-970 P1 6.6.3 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 Fluid and electrical shut off.

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.

Consideration should be given to:

a. All flammable fluid and electrical system components within the identified fire zones, including pipe-work and cables which run through the zones.

b. Providing means to shut-off sources of power (for electrical systems) and motive flow (for flammable fluid systems), rather than only providing isolation of sub-systems, noting the benefits that this may have in the case of leaks and short-circuits.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify provisions for shut-off of electrical and flammable fluid system sub-systems and sources of power.
2. Testing (usually lab and rig testing) should demonstrate that the provided shut-off means adequately prevent ignition.
3. System Safety Assessment (SSA) should analyse the hazards associated with each zone and demonstrate that ignition risk is acceptable.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 4.246.4 00-970 P1 4.26.17 00-970 P1 4.26.21
		STANAG Reference:	4671.995 4671.1189

Information Sources			
			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 CS 29.1185 CS 29.1189

8.4.18 Ground access.

Ground firefighting access provisions shall be compatible with standard ground firefighting systems and shall adequately support effective fire suppression.

Consideration should be given to:
a. The quantity and location of ground access points;
b. The effectiveness of access points in terms of:
i. Accessibility by ground crew;
ii. Effectiveness of fire suppression through each access point.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should identify provisions for ground firefighting access, including (if necessary) the types of ground firefighting systems with which each point is compatible.
2. Analysis should demonstrate that the use of standard ground firefighting systems, through any given ground access point, or combination of access points, is able to adequately suppress fire within an acceptable amount of time, without introducing additional hazards to the aircraft, its occupants, or ground firefighting personnel.
3. Testing (usually lab and rig testing) should demonstrate the accuracy of performed analysis, and should demonstrate that provisions for ground firefighting access are appropriate.
4. System Safety Assessment (SSA) should analyse the hazards associated with ground firefighting and demonstrate that the risk to the aircraft, its occupants and ground firefighting personnel is acceptable.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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,	*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

Information Sources			
	G.3.4.7.31, G.4.4.7.31 MIL-HDBK-221: 2.11.2.10, 2.11.3.6	*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 Post-crash protection.

Risk associated with post-crash fire and explosion hazards shall be acceptable. Where practicable, safety features shall be provided to control and mitigate these 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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify safety features incorporated into the design of the aircraft to control and mitigate post-crash fire and explosion hazards.
2. Analysis should demonstrate the effectiveness of any incorporated safety features.
3. Testing (usually lab and rig testing) should demonstrate the accuracy of performed analysis and the effectiveness of any incorporated safety features.
4. System Safety Assessment (SSA) should analyse the hazards associated with post-crash fire and explosion and demonstrate that the risk to the aircraft, its occupants and ground firefighting personnel is acceptable.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 4.22.57 00-970 P1 4.22.63 00-970 P1 4.26.29 00-970 P1 6.6.67 00-970 P1 6.6.87 00-970 P1 6.6.88 00-970 P13 1.6.11.04
		STANAG Reference:	4671.944
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 25-17, AC 25.994.1	*EASA CS Reference:*	CS 23.721 CS 23.994 CS 23.1453 CS 25.721 CS 25.787 CS 25.855 CS 25.963

Information Sources			
			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 Detection and control of overheating.

The aircraft 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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify provisions for detection and control of overheat conditions.

2. Analysis should demonstrate the adequacy of overheat control provisions to effectively reduce the temperature of the relevant aircraft components.

3. Testing (usually lab and rig testing) should demonstrate the effective detection and control of overheat conditions.

4. System Safety Assessment (SSA) should analyse the hazards associated with overheat conditions and resulting hazards and demonstrate that the level of risk is acceptable.

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

Information Sources			
			CS 25.863 CS 25.1103 CS 25.1203 CS 25.1309 CS 25.1353 CS 25.1365 CS 25.1731 CS 27.863 CS 27.1309 CS 27.1353 CS 29.863 CS 29.1309 CS 29.1353

8.4.21 Merged with 8.4.2

8.5. LANDING GEAR AND DECELERATION SYSTEMS.

8.5.1. Ground Floatation

The landing gear shall have safe ground floatation capability. It shall be designed with the load bearing capabilities of the intended operating surfaces in mind.

Consideration should be given to:

a. Operation from surfaces other than smooth, hard runways, or operation on/from aircraft carriers;

b. The design of the aircraft structure and landing gear and the loads arising from operation over the roughest ground that may reasonably be expected in normal operation;

c. The use of a recognised rating scheme to quantify the aircraft's characteristics;

d. Loads applied by the landing gear system to the airfield surface.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define the surface characteristics of all surfaces from which the aircraft is designed to operate.

2. Analysis should demonstrate that the aircraft's characteristics allow it to operate from all expected surfaces without excessive deformation of the surface, or without preventing further movement of the aircraft. Such analysis should take account of critical aircraft weights and CofG positions, critical landing gear configurations, and critical tire pressures.

3. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis, and should demonstrate that the aircraft can operate from all expected surfaces.

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 S4 L48, L50
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.235 CS 25.491

8.5.2. Arrangement, dynamics, and clearances.

8.5.2.1 Ground clearances.

The landing gear shall be arranged so that no part of the aircraft can contact the ground, except those intended to, (wheels, skids, arresting hooks, tail bumpers, etc.) in all expected take-off and landing attitudes, aircraft configurations (external stores, weapons, etc.) , and with reasonably anticipated failures (deflated tyres, collapsed shock absorbers, etc.).

Consideration should be given to:

a. The full range of conditions through which the aircraft is permitted to take-off and land, including wind velocities (including gusting), permitted aircraft weights and CofG positions, landing surface conditions (irregularities, objects on the ground, slopes, etc.);

b. The range of positions that moveable components and equipment (control surfaces, search lights, etc) may be in on landing.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should clearly identify the aircraft components whose contact with the ground is routinely expected, is expected in exceptional circumstance, and is not expected/prohibited.

2. Analysis should demonstrate, for all expected take-off and landing attitudes, aircraft configurations, reasonably anticipated failures, take-off and landing conditions, and positions of moveable components, that only expected parts of the aircraft contact the ground.

3. Analysis should demonstrate that all parts which may contact the ground are suitably strong to withstand the loads that may occur during such contact without unacceptable deformation.

4. Flight test should demonstrate that no unexpected part of the aircraft contacts the ground during take-off and landing, particularly for critical take-off and landing attitudes, aircraft configurations, reasonably anticipated failures, take-off and landing conditions, and positions of moveable components.

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 P13 3.8.29
		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

Information Sources			
			CS 29.411 CS 29.733

8.5.2.2 Aircraft stability and control on the ground.

The landing gear shall provide safe control of the aircraft during ground manoeuvres including taxy, take-off and landing, preventing unintentional contact with the ground, turn-over or ground loops.

Consideration should be given to:

a. The effect of variations in aircraft mass and CofG position;

b. The effect of variations in landing gear parameters such as tyre pressure, shock absorber pressure, etc.

c. The variety of surfaces for which operation on the ground is permitted, including reasonably anticipated objects on the ground and surface conditions (irregularities, slope, hardness, etc.).

Considerations for preparation of AMC:

1. Testing should demonstrate that aircraft stability and control on the ground is acceptable for all permitted aircraft masses and CofG positions, landing gear parameters and surfaces.

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 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 Wheel well clearances.

Retractable landing gear and surrounding landing gear bays/wheel wells (including doors) shall be designed to ensure that sufficient clearance is maintained to prevent the landing gear becoming stuck in any position.

Consideration should be given to:

a. Kinematics of the landing gear and any other moving parts (e.g. doors);

b. The maximum size of the tyres, including unworn tread, the highest possible differential pressure (taking account of large internal tyre pressures, e.g. due to maximum inflation and subsequent temperature effects, and low external air pressures, e.g. due to high altitude) and centripetal forces due to tyre rotation;

c. The effect of objects/substances which could foul mechanisms (ice/slush, sand, mud, chemicals, etc.)

Considerations for preparation of AMC:

1. Analysis should demonstrate that for all possible combinations of movement of moving parts (landing gear, doors, etc.), adequate clearance is maintained.

2. Rig, ground and flight testing should verify the accuracy of the performed analysis and should demonstrate that adequate clearance is maintained.

3. Rig, ground and flight testing should verify adequate clearance is maintained despite build-up of objects/substances that could foul the landing gear mechanisms.

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 Wheel well temperatures.

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 the maximum wheel brake temperatures encountered during (normal and abnormal) operation.

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.

Considerations for preparation of AMC:
1. System Description Documents should identify the expected maximum temperature of each wheel brake.
2. Analysis should demonstrate that the expected maximum temperature of each wheel will not be exceeded.
3. Rig, ground and flight testing should demonstrate that equipment located in each wheel well operates safely when subjected to the expected maximum temperature.

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 Dynamic stability for ground operation.
The landing gear shall not cause the aircraft to experience any adverse dynamics or pitching motions (including but not limited to vibrations, buffeting, shimmy, porpoising and yaw skids), which prevent continued safe operations, cause structural damage, interfere with satisfactory control, or cause excessive fatigue to the flight crew, on the ground or during transition to and from flight.

Consideration should be given to:
a. All forces including dynamic and inertia forces that may occur on the ground and during transition to and from flight (gyroscopic forces due to motion of rotating wheels, torque loads due to arresting spinning wheels, oscillation of landing gear pistons, etc.) ;
b. Interaction between internal landing gear loads (e.g. torque forces due to braking) and external loads from other sources (e.g. aerodynamic loads, thrust and thrust reversal, etc.).
Considerations for preparation of AMC:
1. Analysis and/or testing should identify the forces (both static and dynamic) that may occur during operation of the aircraft on the ground and during transition to and from flight.
2. Analysis should demonstrate that combinations of forces, and the interaction of forces and aircraft systems and structure cannot result in unacceptable oscillation (e.g. resonance).
3. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis, and should demonstrate that operation on ground and transition to and from flight does not cause unacceptable oscillatory motion or loads.

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	*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

Information Sources			
	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		
		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 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 Tip over.

The landing gear shall be designed to ensure the aircraft will not tip forward or back during ground operations, including acceleration, braking (including while reversing) and during towing.

Consideration should be given to:

a. Instantaneous and progressive application of braking forces during ground manoeuvres.
b. Aircraft accelerations during towing manoeuvres.
c. The effect of variations of aircraft mass and CofG positions (in all aircraft axes).
d. The effect of thrust and control surface loads.

Considerations for preparation of AMC:

1. Analysis should identify that, for critical combinations of aircraft weight and CofG position, resultant loads due to thrust, control surface forces, brake forces, and aircraft accelerations will not cause the aircraft to tip forward (in the case of tail-wheeled aircraft) or back (in the case of nose-wheeled aircraft).
2. Rig, ground and flight testing should demonstrate the accuracy of performed analysis and demonstrate that the aircraft does not tip forward or back during ground manoeuvres involving large accelerations (ground rolls with high thrust, heavy braking, etc.) and large control surface displacements.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A:	*Def-Stan 00-970*	00-970 P1 4.11.9

Information Sources			
	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	*Reference:*	00-970 P1 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 Kneeling.

The landing gear kneeling system shall allow the aircraft to kneel safely.

Consideration should be given to:

a. Preventing kneeling when such action could result in aircraft tip-over.

b. Preventing kneeling when such action could result in damage to the aircraft or surrounding equipment (e.g. Ground Support Equipment).

Considerations for preparation of AMC:

1. Analysis should demonstrate that kneeling can be conducted safely, and that adequate protections are in place to prevent the unsafe kneeling of the aircraft.
2. Rig, ground and flight testing should demonstrate that kneeling can be conducted 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 Kneeling procedures.

Servicing procedures for landing gear kneeling and unkneeling shall be safe and properly sequenced.

Consideration should be given to:

a. Managing and minimising risks that could affect safe kneeling and unkneeling, including management of aircraft weight and CofG position whilst the aircraft is knelt.

Considerations for preparation of AMC:

1. Technical Publications should include detailed processes for kneeling and unkneeling the aircraft, including considerations for managing risk.

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:	

Information Sources			
FAA Doc:		*EASA CS Reference:*	

8.5.3. Landing gear structure.

8.5.3.1 Safe failure of landing gear structure.

The landing gear shall be designed such that no structural failure could result in penetration of any occupied compartment, fuel tank, or any other bay that may cause a fire, ignition or explosion hazard.

Consideration should be given to:

a. The deflection of landing gear structure away from critical bays.

b. Energy absorption of nearby panels and other structure without penetration.

Considerations for preparation of AMC:

1. Analysis should demonstrate that interactions between landing gear structure and surrounding aircraft structure during expected landing gear failure modes will not result in penetration of critical bays.
2. Coupon, assembly and rig testing should demonstrate the accuracy of performed analysis, and should show that critical bays are not penetrated due to landing gear failure.

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 P1/6 S4 L75 00-970 P1 S4 L47
		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 Safe failure of landing gear components.

Failure of landing gear components shall not cause catastrophic failure of surrounding aircraft structure.

Consideration should be given to:

a. The effect and mitigation of instantaneous failure of high energy landing gear parts including wheels and tyres rotating at high speed.

Considerations for preparation of AMC:

1. System Safety Analysis (SSA) should demonstrate that the risk of failure of aircraft structure due to failure of landing gear components is acceptable.
2. Analysis, supported by testing, should demonstrate that failure of any landing gear component cannot result in failure of surrounding aircraft structure.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.734

8.5.3.2 Shock strut energy absorption.

The landing gear shall be designed so the shock absorbing mechanism allows for safe ground operations, take-off and landing.

Consideration should be given to:

a. Ensuring sufficient energy absorption and dissipation is achieved during landing;
b. Providing adequate support for aircraft structure during ground manoeuvring;
c. Maximising passenger comfort;
d. Ensuring the shock absorbing mechanism does not bottom out.
e. The effect of variation in aircraft weight and CofG position.
f. The effect of variation in tyre and shock absorber pressures.

Considerations for preparation of AMC:

1. Analysis should demonstrate that the energy absorption capacity of the landing gear is adequate, without bottoming out, to absorb the energy associated with ground operations, take-off and landing, including the maximum anticipated aircraft velocities and critical aircraft weights and CofG positions.
2. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis, and should demonstrate that energies associated with ground operations, take-off and landing are absorbed without bottoming out of landing gear components.

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

Information Sources			
			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 Incorrect servicing allowance.

The landing gear shall be designed so that incorrect servicing does not compromise safety, result in unsafe loading or cause damage to the aircraft during take-off, landing or taxiing operations.

Consideration should be given to:

a. Incorrect servicing of the wheels, tyres, shock absorbing mechanism;

b. Appropriate and realistic levels of incorrect servicing;

c. Loading types including fuel, weapons, stores, etc;

d. Sudden movement of the shock absorbing mechanism.

Considerations for preparation of AMC:

1. Analysis should demonstrate that, with shock struts incorrectly serviced and parameters influencing performance (shock absorber pressure, fluid quantity, etc.) reasonably beyond allowed values, system characteristics do not have a negative effect on safety, or cause damage to the aircraft during take-off, landing or taxiing.

2. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that incorrect servicing of the landing gear does not have a negative effect on safety, or cause damage to the aircraft during take-off, landing or taxi operations.

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 Landing operating limits.

The landing gear shall be designed to allow for safe landing operations (emergency and normal) in all specified landing conditions, at all operating weights.

Consideration should be given to:
a. All expected landing conditions in both emergency and normal operating conditions;
b. The effect of failures, such as flat tyres / roll on rims and bottomed out shock absorbing mechanisms;
c. Crew and passenger comfort and functioning of equipment during ground manoeuvring;
d. The effect of maximum aircraft landing weights;
e. The effect of external stores and role equipment;

Considerations for preparation of AMC:
1. Analysis should demonstrate that the landing gear allows for safe landing operations in all specified landing conditions, at all operating weights.
2. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and demonstrate that the landing gear design allows for safe landing operations.

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
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 Landing gear stability and shimmy prevention.
The landing gear shall be designed in such a way that unacceptable shimmy, or other dynamic instabilities, do not occur at any speed encountered during operation.

Consideration should be given to:
a. The full range of aircraft masses and CofG positions;
b. The expected range of landing gear parameters (tyre pressure, shock absorber pressure, etc.);
c. The effect of other (external) forces acting on the aircraft, including lift, drag and thrust.

Considerations for preparation of AMC:
1. Analysis should demonstrate that the landing gear design does not cause unacceptable shimmy or other dynamic instability through the full range of expected aircraft speeds, loading conditions, landing gear parameters and external forces.

2. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis and should demonstrate that no unacceptable shimmy or other dynamic instability occurs through critical combinations of aircraft speed, loading conditions, landing gear parameters and external forces.

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

The landing gear tyres shall have an appropriate load and speed rating for all expected ground operations and take-off and landing conditions.

Consideration should be given to:

a. The effect of reasonably expected tyre over- and under-inflation;

b. The effect of combinations of worn (at wear limits) and un-worn (new) tyres;

c. The effect of total deflation of a single tyre in a multi-wheel bogie or similar arrangement;

d. The effect of heavy braking (e.g. rejected take-off at V1).

Considerations for preparation of AMC:

1. Analysis should demonstrate that tyres have an appropriate load and speed rating for all expected ground operations and take-off and landing conditions, including reasonable tyre over- and under-inflation, combinations of worn and un-worn tyres, total deflation of a single tyre in a multi-wheel bogie or similar arrangement, and effects of heavy braking.

2. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis, and should demonstrate the appropriateness of the selected tyres for critical ground operations and take-off and landing conditions.

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 14CFR reference: 23.473, 23.726, 23.733, 25.473, 25.726, & 25.733	*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:		*EASA CS Reference:*	CS 23.473, 23.511, 23.726 *, 23.733 CS 25.473, 25.499, 25.511, 25.733 CS 27.497, 27.733 CS 29.497, 29.511, 29.733

8.5.5 Wheel Loadings

The landing gear wheels shall be designed to withstand the worst-case loads for all specified ground operations.

Consideration should be given to:

a. All expected landing conditions (normal and emergency);

b. All expected environmental conditions;

c. All combinations of aircraft weight and configuration;

d. The effect of over- and under-inflation of tyres, including total deflation of a single tyre in a multi-wheel bogie or similar arrangement;

e. The effect of combinations of worn (at wear limits) and un-worn (new) tyres.

Considerations for preparation of AMC:

1. Analysis should demonstrate that wheels are appropriate for all expected ground operations and take-off and landing conditions, including reasonably expected tyre over- and under-inflation, combinations of worn and un-worn tyres, total deflation of a single tyre in a multi-wheel bogie or similar arrangement, and effects of heavy braking.

2. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis, and should demonstrate the appropriateness of the wheels for critical ground operations and take-off and landing conditions.

Information Sources			
Comm'l Doc:			

Information Sources			
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 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)	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.11, 4.11.12, P7 L303 5.1
		STANAG Reference:	4671.473 - 511, 4671.723 - 733
FAA Doc:		*EASA CS Reference:*	CS 29.475 - 521 CS 29.723 - 731 CS 29.737 CS 29.753

8.5.6 Wheel overheating and over-pressurisation protection

Wheel or tyre explosion due to over-pressure (e.g. due to over-inflation) and over-heat (e.g. due to heavy braking) shall be prevented.

Consideration should be given to:

a. The incorporation of pressure relief valves (to prevent failure due to over-inflation) and fusible plugs (to prevent failure due to over-heat);

b. Providing an appropriate margin for over-inflation and over-heat so that wheel-tyre assemblies are suitably protected, and inadvertent triggering of the protection devices is minimized.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should, for each wheel/tyre assembly, identify the provided means of preventing wheel or tyre failure/explosion due to over-inflation (e.g. Over-inflation Pressure Relief (OPR) valve);

2. SDD should identify the provided means of preventing wheel or tyre failure/explosion due to excessive heat (e.g. fusible plugs);

3. Analysis should demonstrate that the provided failure prevention means operate effectively through all expected failure conditions with an appropriate margin for over-inflation and over-heating.

4. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis, and should demonstrate that over-pressure and over-heat prevention means operate effectively prior to failure of the wheel/tyre.

Information Sources			
Comm'l Doc:			
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 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: para 3.2.3.1 General, 3.2.4.2.c Wheel overheat capability and 3.2.4.3.a Brakes MIL-W-5013 Wheel and Brake Assemblies - inactive for new design 14CFR reference: 11.2.2 & 11.2.2.1 Included in each specific 14CFR reference per section	*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 Reference:	4671.735
FAA Doc:		*EASA CS Reference:*	CS 23.731 CS 23.735 CS 25.731 CS 25.735

8.5.7. Brake Assemblies

8.5.7.1 Brake energy capability.

The aircraft braking system shall provide sufficient energy conversion and dissipation, and braking torque throughout the defined wear range to allow safe ground, take-off and landing operations, including accelerate-stop distance and braked roll requirements.

Consideration should be given to:

a. All expected combinations of aircraft weight and speed;

b. All expected aircraft configurations (e.g. air brakes deployed/retracted);

c. Reasonable failures and pilot errors that could reduce aircraft deceleration (air brakes failed, thrust reverse failed, parachute failed, incorrect engine thrust setting, etc.).

d. All expected runway surfaces and conditions (dry, wet, muddy, sandy, etc.);

e. The effect of expected environmental conditions, such as temperature, altitude, etc;

f. The effect of repeated brake operations.

Considerations for preparation of AMC:

1. Analysis should demonstrate that the energy conversion and dissipation, and brake torque performance of the brakes, throughout the defined wear range, exceeds the maximum energy conversion and dissipation and brake torque requirements for ground, take-off and landing operations.

2. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that the performance of the braking system is adequate to allow safe ground, take-off and landing operations.

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, 25.55, 25.493, 25.735, 25.101	*EASA CS Reference:*	CS 23.55 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 Brake redundancies.

The brake system, associated systems and components shall be designed to include sufficient redundancy so that in the event of any reasonably credible combination of failures, it shall be possible to stop the aircraft within an acceptable distance.

Consideration should be given to:

a. Failure of power supply and transmission systems (electrical, hydraulic, pneumatic, mechanical, etc.), brake components, and control systems;

b. The acceptable level of performance degradation associated with single failures and combinations of failures.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify the redundancy included in the design of the brake system, the failures (single and combination) through which braking is still possible, and the maximum degradation of braking system performance associated with each failure.
2. Analysis should demonstrate that the increase in stopping distance associated with degradation of the braking system performance due to failures is acceptable.
3. System Safety Assessment (SSA) should demonstrate that the risks associated with degradation of the braking system performance due to failures is acceptable.
4. Rig, ground and/or flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that increase in stopping distance due to degraded brake system performance is acceptable.

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);	*Def-Stan 00-970 Reference:*	00-970 P1 4.12.11
		STANAG	4671.735

Information Sources			
	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	*Reference:*	
FAA Doc:	14CFR reference: 11.2.2.1	*EASA CS Reference:*	CS 23.735 CS 25.101, 25.109, 25.125 and 25.735

8.5.7.3 Brake torque.

The brake system shall provide sufficient static (i.e. holding) torque to prevent wheel rotation throughout normal ground operations, including preparation for take-off.

Consideration should be given to:

a. The effect of ground surface conditions (e.g. slope) and contamination of braking surfaces (water, ice, mud, etc.);

b. Combinations of forces that could result in forward/rearward movement (e.g. engine thrust), and/or movement about the aircraft's normal axis (asymmetrical engine thrust, rotor acceleration, etc.).

Considerations for preparation of AMC:

1. System Description Document (SDD) should identify the static torque for each brake assembly, taking account the effects of brake surface contamination;
2. Analysis should demonstrate that the static torque of each brake assembly is sufficient to hold the aircraft stationary through critical combinations of forces on the aircraft;
3. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that the brakes can hold the aircraft stationary throughout all normal ground operations.

Information Sources			
Comm'l Doc:	SAE ARP-1493		
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 14CFR references: 23.735, 25.735 SAE ARP-1493	*Def-Stan 00-970 Reference:*	00-970 P1 4.12.6 00-970 P1 4.12.14
		STANAG Reference:	4671.735

Information Sources			
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

8.5.8. Brake control and anti-skid control

8.5.8.1 Brake control redundancies.

The aircraft shall have a secondary braking capability, separate and independent from the primary stopping means, sufficient to arrest the aircraft in a safe manner.

Consideration should be given to:
a. Incorporation of a secondary, separate braking system, and/or auxiliary braking devices (air brakes, thrust reversal, parachute, etc.);
b. The required level of performance of the secondary braking system.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should identify the secondary brake system included in the design of the aircraft, and the braking performance associated with the secondary system.
2. Analysis should demonstrate that the increase in stopping distance associated with use of the secondary braking system is acceptable.
3. System Safety Assessment (SSA) should demonstrate that the risks associated with the use of the secondary braking system due to failures is acceptable.
4. Rig, ground and/or flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that increase in stopping distance due to use of the secondary braking system is acceptable.

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:* *STANAG Reference:*	00-970 P1 4.12.11 00-970 P1 4.12.12 00-970 P13 3.13.2
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 Braking control.

Braking control shall be designed such that input forces can be applied in a smooth and controllable manner, and such that the resulting aircraft deceleration is broadly proportional to the applied input force, during both engagement and disengagement of the brakes.

Consideration should be given to:
a. The full range of forces that are likely to be applied to the controls, and the resulting travel of the controls;
b. Areas of non-proportionality, for example where small input forces may not result in noticeable deceleration, and large input forces where a limit of deceleration may be reached.

c. Symmetry of braking forces for laterally displaced brake units, so that symmetric input force does not result in unacceptable yaw.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should identify the anticipated range of input forces, and resulting output forces and braking torques.
2. Analysis should demonstrate that the relationship between braking input forces, output forces/torques and resulting aircraft deceleration is acceptable and broadly proportional throughout the permitted brake wear range.
3. Rig, ground and flight testing should demonstrate the accuracy of performed analysis and should demonstrate that input forces can be applied in a smooth and controlled manner, and that resulting aircraft deceleration is broadly proportional to the applied input force.

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:* *STANAG Reference:*	00-970 P1 4.12.10 00-970 P7 L310 2.2 00-970 P7 L310 2.2.4 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 Parking brake.
The parking brake (where fitted) shall hold the aircraft stationary through normal ground operations, including engine starting and aircraft ground running, on all expected surfaces (e.g. slopes).

Consideration should be given to:
a. The effect of thrust and unbalanced torque forces during engine ground running;
b. The duration through which the aircraft will be required to be held stationary by the parking brake, without chocks;
c. The effect of contamination of braking surfaces (water, mud, etc.).

Considerations for preparation of AMC:
1. System Description Documents (SDD) should identify the aircraft's parking brake provision(s).
2. Analysis should identify the braking torque/force required to hold the aircraft stationary during ground operations, including the effect of contamination of braking surfaces, and the ability for the parking brake to provide this force.

3. Rig, ground and flight testing should demonstrate the accuracy of performed analysis and should demonstrate that the aircraft can be held stationary on the ground through normal ground operations.

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 AFGS-87139: 3.2.3.2.d Brake actuation system MIL-B-8584 Design of Brake Systems	*Def-Stan 00-970 Reference:*	00-970 P1 4.12.15 00-970 P1 4.12.16 00-970 P1 4.12.17 00-970 P7 L310 2.3
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.735 CS 29.735

8.5.8.4 Safe stopping performance.

The aircraft shall have safe stopping performance for all expected ground operations, take-off and landing configurations, including expected runway conditions (dry, wet, snow, ice, etc.) aircraft loading conditions, and credible combinations of failures.

Consideration should be given to:

a. The effect of brake wear, alternative braking modes, and other performance degradation effects.

b. Combinations of deceleration devices such as wheel brakes, air brakes, thrust reversers, parachutes, etc.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define the deceleration devices fitted to the aircraft, and the conditions in which each device will be used to achieve the required stopping performance.

2. Analysis should demonstrate acceptable stopping performance for all expected ground operations, take-off and landing configurations, aircraft loading conditions, and credible combinations of failures.

3. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that the performance of the deceleration systems is adequate to allow safe ground, take-off and landing operations.

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	*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			
	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		
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 Anti-skid system.

The anti-skid system (where fitted) shall be designed such that no reasonably credible combination of failures will result in an unacceptable loss of braking ability or directional control of the aircraft.

Consideration should be given to:

a. Failure of power supply and transmission systems (electrical, hydraulic, pneumatic, mechanical, etc.), brake components, and control systems;

b. Cross coupling of the anti-skid units to maintain directional control of the aircraft;

c. All expected runway surfaces and conditions (dry, wet, etc.);

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify the aircraft's anti-skid provision(s).
2. Analysis should demonstrate that the increase in stopping distance associated with operation and failure of the anti-skid system is acceptable.
3. System Safety Assessment (SSA) should demonstrate that the risks associated with failure of the anti-skid system are acceptable.
4. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that operation and failure of the anti-skid system does not result in acceptable loss of braking ability or directional control of the aircraft.

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

Information Sources			
			(AMC 25.109(c)(2)) CS 25.735

8.5.8.6 Locked wheel prevention.

The anti-skid system (where fitted) shall prevent excessive relative motion between wheel/tyre assemblies and the ground for all expected ground operations, take-off and landing conditions.

Consideration shall be given to:

a. The expected range of surface conditions and aircraft loading conditions and speeds for ground operation, take-off and landing;

b. The optimum and allowed values for relative motion between the wheel-tyre assembly and the ground (i.e. slip ratio) and prevention of flat spotting.

c. The integration of the anti-skid system with the aircraft, and the environments within which it operates.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify the aircraft's anti-skid provision(s).
2. Analysis should demonstrate that the anti-skid system prevents locked wheels during operation on the ground, take-off and landing for all expected aircraft conditions.
3. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that locked wheels during operation on the ground, take-off and landing are prevented for all expected aircraft conditions.

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

8.5.8.8 Merged with 8.5.8.2

8.5.8.9 Merged with 8.5.8.4

8.5.8.10 Merged with 8.5.8.6

8.5.8.11 Anti-skid coupling (dynamic effects).

Operation of the anti-skid system shall not induce unacceptable dynamic instability or vibration, in any part of the aircraft during any brake operation.

Consideration shall be given to:

a. Minimising the fatigue effects on the aircraft;
b. Maximising braking and landing gear performance, and the comfort of occupants.

Considerations for preparation of AMC:
1. Analysis (e.g. brake system simulations) should identify the various characteristics (i.e. magnitude and frequency) of forces caused by operation of the anti-skid system in expected conditions.
2. Dynamic structural analysis should demonstrate that the oscillatory forces caused by the anti-skid system do not cause resonance with the aircraft or the landing gear, and that resulting dynamic effects (loads, displacements, velocities and accelerations) through the aircraft do not unacceptably affect the structural integrity of the aircraft, or the comfort of occupants.
3. Fatigue analysis should demonstrate that oscillatory forces caused by the anti-skid system do not have an unacceptable effect on the structural integrity or fatigue life of the aircraft or the landing gear.
4. Rig, ground and flight testing should demonstrate the accuracy of performed analysis and should demonstrate that operation of the anti-skid system does not cause unacceptable dynamic effects through the aircraft, unacceptably affect the structural integrity of the aircraft and its landing gear, or the comfort of occupants.

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 Backup for directional control.

The aircraft shall have primary and separate secondary/emergency means for directional control during ground operations.

Consideration should be given to:
a. Ensuring separation between the two directional control systems, so that failure of one system cannot lead to failure of the other system;
b. The conditions through which the aircraft will operate on the ground, including aircraft loading conditions, surface conditions, wind velocities and environmental conditions;
c. Ensuring that the aircraft is adequately controllable using either system, and during the transition from using one system to the other.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should identify the provided means for directional control on the ground, and should classify each means as primary or secondary/emergency.
2. SDD should identify the actuation method for each means of directional control.

3. Analysis should demonstrate that the aircraft is safely controllable on the ground using either primary or secondary/emergency system throughout all of the conditions through which the aircraft is expected to operate.
4. System Safety Analysis (SSA) should demonstrate the separation of each directional control system, and that failure of one system cannot lead to failure of the other system.
5. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis, and should demonstrate that the aircraft is safely controllable on the ground using either system through critical operating conditions.
6. Technical Publications should identify the methods and procedures for operating the direction control systems on the ground.

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 Steering control system.
The steering control system shall be designed to protect against steering failure such that no credible combination of failures may cause loss of control of the aircraft.

Consideration should be given to:
a. Detecting, preventing and mitigating the effect of failures, including those resulting in full-scale deflection of steering controls;
b. Ensuring that, given a failure of the steering system resulting in any magnitude of deflection, the resulting directional movement can be corrected instinctively and acceptably by the pilot using other controls.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should identify the full possible range (including the effect of failures) of steering angles.
2. System Safety Analysis (SSA) should demonstrate that the risk of loss of control of the aircraft resulting from any credible combination of steering failures is acceptable.
3. Analysis should demonstrate that sufficient control authority is available to counteract the effect of any magnitude of deflection of aircraft steering, for any expected aircraft condition.
4. Rig, ground and flight testing should demonstrate that the aircraft is controllable despite any possible magnitude of deflection of the steering system.

Information Sources	

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 Steering engagement.

Directional control of the aircraft shall be maintainable with minimal pilot effort throughout engagement and disengagement of the steering system through all expected manoeuvres and speeds.

Consideration should be given to:

a. All expected ground operations and conditions;

b. The effect of intentional, inadvertent and uncommanded engagement and disengagement of the steering system.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify the controls and required pilot action necessary to engage and disengage the steering system.
2. SDD should define the characteristics of system engagement and disengagement while applying steering control inputs, and while performing on-ground directional manoeuvres (controlled through the steering system or otherwise).
3. Analysis should demonstrate that the aircraft is controllable throughout ground manoeuvres with intentional, inadvertent and uncommanded engagement and disengagement of the steering system.
4. Simulations should demonstrate that pilots can safely control the aircraft during all anticipated ground manoeuvres with intentional, inadvertent and uncommanded engagement and disengagement of the steering system.
5. Rig, ground and flight testing should demonstrate the accuracy of performed analysis and simulations, and should demonstrate that pilots can safely control the aircraft during critical ground manoeuvres with intentional, inadvertent and uncommanded engagement and disengagement of the steering system.
6. Technical Publications should identify the method(s) and process for engagement and disengagement of the wheel steering.

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	*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	4671.745

Information Sources			
	system.	*Reference:*	
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

8.5.9.5 Steering capability.

The steering system shall enable the aircraft to perform all required ground manoeuvres safely including taxy, turning, parking, take-off and landing.

Consideration should be given to:

a. The range of expected conditions for ground operations, including environmental conditions, surface conditions and aircraft loading conditions;

b. Interaction between aircraft steering and other directional control systems (rudder, tail rotor, asymmetric braking, asymmetric thrust, etc.);

c. Requirements for ground handling characteristics, including range of speeds, rates of turn, acceleration/deceleration, etc.

Considerations for preparation of AMC:

1. System Description Documents should describe the aircraft's provision for steering.
2. Analysis should demonstrate that the design of the steering system provides adequate ground handling characteristics through all expected on-ground operating conditions.
3. Rig, ground and flight testing should demonstrate the accuracy of performed analysis and should demonstrate that the characteristics of the steering system are acceptable for critical expected operating conditions and ground manoeuvres.
4. Technical Publications should identify the permitted ground manoeuvres.

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	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.24 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

Information Sources			
			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 Landing gear retraction and extension operation.

Retractable landing gear (where fitted) shall retract and extend (including emergency extension) safely, and without unintentional contact between moving parts.

Consideration should be given to:

a. The appropriate sequencing of separate movements, and prevention of out-of-sequence movement;

b. The effect of manufacturing tolerances, aircraft operation (e.g. expected deformation/creep of components) and maintenance;

c. The full range of flight conditions during which extension and retraction is required, including aerodynamic loads and aircraft accelerations.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define the provisions for landing gear retraction.
2. SDD should define the characteristics of each landing gear position (UP & LOCKED, UP, IN TRANSIT, DOWN, and DOWN & LOCKED, etc.);
3. SDD should define the sequencing required to extend and retract the landing gear, including emergency extension, and the means of prevention of failure of this sequencing;
4. Analysis (e.g. kinematic analysis) should identify the clearance distances between moving parts during extension and retraction under a variety of operating conditions, and should demonstrate that the landing gear can retract and extend under any expected operating condition without unintentional contact between moving parts.
5. Rig, ground, and flight testing should demonstrate the accuracy of performed analysis and should demonstrate that adequate clearances are maintained throughout landing gear retraction, normal extension and emergency extension through critical operating conditions (e.g. at the Maximum landing gear operating speed).
6. Technical Publications should define the procedures for operation of the landing gear, including emergency extension, and limitations associated with landing gear operation (e.g. the maximum landing gear operation speed).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.1.3, A.3.4.1.1.4, A.3.4.1.5.1, A.3.4.1.5.2, A.4.4.1.1.3, A.4.4.1.1.4, A.4.4.1.5.1, A.4.4.1.5.2	*Def-Stan 00-970 Reference:*	00-970 P1 S4.11.52
		STANAG Reference:	4761 USAR.729
FAA Doc:	14CFR reference: 23.729 & 25.729	*EASA CS Reference:*	CS 25.729 CS 27.729

8.5.10.2 Gear extension redundancy.

Retractable landing gear shall be designed with an emergency means of extension which extends the landing gear to the down and locked position despite any credible combination of failures (including failure of any single source of hydraulic, electric, or equivalent energy supply, or loss of any landing gear door) or the position of the normal landing gear selector.

Consideration should be given to:

a. Ensuring that failure of the normal landing gear extension/retraction system cannot lead to failure of the emergency extension system;

b. The variety of aerodynamic loading conditions that could affect the landing gear and associated panels/doors during flight;

c. Ensuring that the means for actuation of the emergency landing gear extension system is adequately simple such that a pilot can extend the landing gear quickly and easily, but adequately complex such that risk of inadvertent extension is minimised.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the provided means for emergency landing gear extension.

2. Analysis should demonstrate that the emergency extension means is capable of extending the leading gear to the down and locked position during any stage of flight and in any aircraft configuration or environmental condition, and keeping the landing gear locked down for the remainder of any flight.

3. System Safety Analysis (SSA) should demonstrate that no failure of the normal landing gear extension/retraction system may lead to failure of the emergency extension system.

4. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that the emergency extension system is capable of extending the landing gear to the down and locked position during critical phases of flight, and in critical aircraft loading conditions.

5. Technical Publications should clearly define the provided means for emergency landing gear extension, detailing the required method for its actuation, and any limitations/restrictions that apply to its operation.

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 Gear status.

Visual indication shall be provided to indicate to the pilot(s) the position of each retractable landing gear set. Such indication shall clearly and unambiguously indicate when the landing gear and associated doors are in the locked up, locked down, and in transit positions.

Consideration should be given to:

a. The type, colour and configuration of position indicators;

b. Ensuring that incorrect indication is prevented.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify the means of landing gear indication provided to the pilots, and the conditions which must be met in order for each indication to be displayed.
2. Analysis should demonstrate that each landing gear position indication can only be displayed when the landing gear is in the respective condition.
3. System Safety Assessment (SSA) should demonstrate that the risks associated with incorrect landing gear indication, including errors in maintenance and environmental effects (e.g. corrosion and fouling of sensors) is acceptable.
4. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that the landing gear position indication is clear and unambiguous, and that the landing gear indication reflects the position of the landing gear at all times.

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 & 25.729	*EASA CS Reference:*	CS 23.729 CS 25.729 (AMC 25.729(c)) CS 27.729 CS 29.729

8.5.10.4 Position warning system.

Warning devices shall be provided to provide clear warning when the aircraft is close to the ground and close to landing speeds without the landing gear in the down and locked position. It shall be possible for the pilot(s) to suppress aural warning.

Consideration should be given to:

a. Ensuring that any single warning device is adequate to clearly and unambiguously communicate the aircraft condition to all pilots;

b. Defining appropriate limits for ground proximity and speed, such that pilots are able to extend the landing gear by normal or emergency means prior to landing.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define the warning devices incorporated to provide clear warning when the aircraft is close to the ground and close to landing speeds without the landing gear in the down and locked position.
2. SDD should define the limit(s) for ground proximity and speed at which the warning devices will operate when the landing gear is not in the down and locked position.
3. SDD should define the means for suppressing aural warnings.
4. Analysis should demonstrate that the warnings provide the pilots with sufficient advanced warning of the unsafe aircraft configuration to allow any pilot to extend the landing gear by primary means, and in the event of failure, by the emergency extension means prior to landing.
5. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that the pilots are provided with adequate warning of the unsafe landing condition with enough time to extend the landing gear by normal and emergency means.

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 Gear position speed.
Retractable landing gear shall extend (in both normal and emergency modes) and retract within acceptable time limits at all airspeeds required for take-off, landing and go-around.

Consideration should be given to:
a. Defining maximum time limits for retraction, normal extension and emergency extension of the landing gear, from selection by the pilot(s) to the landing gear achieving the relevant position;
b. Accounting for system performance and aircraft conditions.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should define the maximum allowed time for retraction, normal extension and emergency extension of the landing gear, from selection by the pilot(s) to the landing gear achieving the relevant position.
2. Analysis should demonstrate that the landing gear retracts and extends under normal and emergency operating conditions within the maximum time limit under all expected operating conditions.
3. System Safety Assessment (SSA) should demonstrate that the risk associated with degraded operation of the landing gear extension/retraction mechanism is acceptable.
4. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that the landing retracts and extends within the maximum allowed time under normal and emergency modes through critical operating conditions.

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 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	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.53 00-970 P1 4.11.54 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 Merged with 8.5.10.5.

8.5.10.7 Gear position restraint.

Retractable landing gear shall provide an automatic means to lock the landing gear in the selected position which does not require any power (electric, hydraulic etc.) after reaching the locked position, and which can secure the gear in each position under all expected ground and flight conditions.

Consideration should be given to:

a. Ensuring that adequate means are provided to ensure that risk associated with unsecured landing gear is acceptable;

b. Incorporating multiple means of securing the landing gear, such as mechanical (springs, over-centre joints, etc.) and hydraulic methods (e.g. hydraulic locking), particularly in the extended position;

c. Ensuring that the emergency extension system can release and/or overcome any restraint securing the landing gear in the retracted position, and can secure the gear in the extended position.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the provided means for securing the landing gear in each selectable position.
2. Analysis should demonstrate that extension and retraction will always result in the securing of the landing gear in the respective position, under any expected operating condition.
3. Analysis should demonstrate that when secured in any selectable position, no expected operating condition or combination of failures could result in the landing gear becoming unsecured without total failure of the landing gear structure.
4. Analysis should demonstrate that the provided means for emergency extension can release and/or overcome any restraint securing the landing gear in the retracted position, and can secure the gear in the extended position.
5. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that the landing gear can be secured in all selectable positions through critical operating conditions.

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	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.65 00-970 P7 L306 4.1 00-970 P7 L306 4.2

Information Sources			
	Retraction and extension actuation interface AFGS-87139: 3.2.6.4 Position restraint	*STANAG Reference:*	4671.729(b)
FAA Doc:	14CFR reference: 23.729, 25.729	*EASA CS Reference:*	CS 23.729(b) CS 25.729(b) CS 27.729(b) CS 29.729(b)

8.5.10.8 Gear position restraint for ground operations.

Retractable landing gear shall incorporate a secondary means to secure each landing gear in the extended position and prevent unintentional retraction during ground operations. Such secondary means shall secure each landing gear in the extended position despite selection of landing gear retraction without structural damage to any part of the aircraft, and shall incorporate visual indications to clearly indicate to operators that the means are fitted.

Consideration should be given to:

a. The adequacy of visual indicators, such that the security of landing gear in the down position is clear and unambiguous to ground and flight crew when performing normal pre-flight/ground checks;

b. The strength of the landing gear and resulting loads, ensuring that the strength is adequate to withstand the forces arising from attempted landing gear retraction with the secondary securing means in place, on the ground, on jacks, and in flight.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify the provided means for secondary securing of the landing gear in the extended position on the ground, including the means for visual indication to operators.
2. Analysis should demonstrate that attempted retraction of the landing gear with the secondary securing means fitted cannot result in landing gear retraction (e.g. due to failure of the securing means) or permanent deformation of any part of the aircraft in any expected ground or flight condition (including aircraft on jacks).
3. Rig, ground and flight testing should demonstrate the accuracy of performed analysis and should demonstrate the adequacy of provided visual indication means and that selection of landing gear retraction with the provided security means fitted does not result in landing gear retraction or permanent deformation of any part of the aircraft.
4. Technical Publications should detail the process for fitment and removal of the means to secure the landing gear in the extended position.
5. Technical Publications should detail the visual indication means provided to operators to indicate that the secondary securing means is fitted to the landing gear.

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	*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:	

Information Sources			
	restraint		
FAA Doc:		*EASA CS Reference:*	

8.5.10.9 Merged with 8.5.10.8

8.5.10.10 Fail-safe provisions.

For retractable landing gear, no credible combination of failures shall lead to failure of the positive engagement of the landing gear in any selectable position, or failure of the emergency extension means.

Consideration should be given to:

a. Combination of detectable and dormant failures;

b. Failure of power supply systems (electrical, hydraulic, mechanical, etc.).

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should demonstrate that the risk of failure of landing gear positive engagement, and failure of the emergency extension means is acceptable.

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 Aircraft arrestment performance.

The aircraft shall be designed to be compatible with specified arresting systems (if any) (including both barrier/barricade and cable types) such that use of any such system can decelerate the aircraft to a stop for all expected conditions without damage to the aircraft or the arresting system(s).

Consideration should be given to:

a. The range of arresting systems with which the aircraft will be permitted to operate.

b. The range of expected manoeuvres where the arresting system may operate, including landing (fly-in engagements, brake overruns, etc.) and take-off (e.g. Rejected Take-off (RTO));

c. The range of expected conditions where the arresting system may operate, including all expected aircraft weights, CofG positions and speeds, air velocities (including crosswinds, tailwinds, etc.), surface conditions, and environmental conditions;

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define the arresting systems (if any) with which the aircraft is permitted to operate, and the permitted manoeuvres that utilise such systems.
2. SDD should define the aspects of the aircraft design which allow operation with arresting systems.
3. Analysis should demonstrate that the aircraft can perform the permitted manoeuvres with the permitted arresting systems, and should define the resulting loads through the aircraft for all expected operating conditions.
4. Analysis should demonstrate that the loads associated with critical manoeuvres and critical arresting systems are reacted through the aircraft structure without permanent deformation of any part of the aircraft or arresting system.
5. Rig, ground and flight testing should demonstrate the accuracy of performed analysis and should demonstrate that critical manoeuvres using critical arresting systems decelerates the aircraft to a stop without permanent deformation of any part of the aircraft or arresting system.

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	*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 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 P13 S4 L10 00-970 P9 UK471a
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.5.11.2 Arresting hook system.

The arresting hook system (where fitted) shall provide sufficient hook hold-down force and damping to prevent the hook skipping over the arresting cable, for all expected landing configurations and attitudes.

Consideration should be given to:

a. The minimum expected height of the arresting cable from the ground, taking account of the effect of depression of the cable by aircraft wheels, effects of landing off-centre, and the range of cable tensions that may be encountered;

b. The maximum height of the arresting hook pivot point from the ground, taking account of expected variations in aircraft weight and CofG position, aerodynamic forces and engine thrust.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define the provisions for arresting hook hold-down and damping.
2. Analysis should demonstrate that the arresting hook cannot skip over an arresting cable for all expected landing configurations and attitudes.
3. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that the arresting hook does not skip over an arresting cable for critical landing configurations and attitudes.
4. System Safety Assessment (SSA) should demonstrate that the risk of the arresting hook skipping over an arresting cable is acceptable.

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 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 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
		STANAG Reference:	4671 U590
FAA Doc:		*EASA CS Reference:*	

8.5.11.3 Hook actuation.
If an arresting hook is fitted, it shall be possible for flight crew to lower, and if necessary, raise the hook within an acceptable time. An indication shall also be provided to inform the flight crew of the hook position.

Consideration should be given to:
a. Defining an acceptable time limit for hook extension and retraction;
b. Ensuring that the provided means to control the hook is appropriate;
c. Ensuring that indications provided to flight crew clearly and unambiguously identify whether the hook is secured in deployed and retracted positions.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should define the means for actuation of the hook provided to the flight crew, and the required time for deployment and retraction of the hook.
2. Analysis should demonstrate that the time to deploy and retract the hook is acceptable for all flight conditions.

3. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis and should demonstrate that the time to deploy and retract the hook is acceptable for critical flight conditions, and that indications provided to the flight crew clearly communicate the position and status of the hook.
4. Technical Publications should identify the procedure for extending and retracting the arresting hook.

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 L41 00-970 Pt 13 3.6.12 00-970 Pt 13 3.6.14 00-970 Pt 13 S4 L10
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.5.11.4 Snag prevention.
The aircraft shall be designed such that no part of the aircraft except the arresting hook, including structure, landing gear or stores, snags the arresting cable under normal operating conditions and with any landing gear set rolling on rims (e.g. following tyre failure(s)).

Consideration should be given to:
a. The maximum height of the arresting cable from the ground, taking into account the various arresting systems with which the aircraft is permitted to operate;
b. The minimum height of aircraft structure and stores from the ground, taking into account the various permitted loading configurations, aircraft weights, CofG positions and aerodynamic forces.
c. Critical positions of movable parts of the aircraft (e.g. control surfaces, landing gear doors, etc.)

Considerations for preparation of AMC:
1. Analysis should identify the clearance between critical parts of the aircraft and the ground during ground operations and should demonstrate that no part of the aircraft except the arresting hook can snag on arresting cables under any expected operating condition including with any landing gear set rolling on rims (e.g. following tyre failure(s)).
2. Rig, ground and flight testing should demonstrate the accuracy of performed analysis by verifying the clearance between critical parts of the aircraft and the ground during ground operations.

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 00-970 P13 S4 L10 00-970 P7 S1 L300 2.1 00-970 P7 S1 L302/2 8.1

Information Sources			
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.5.11.5 Drag parachutes.

Drag parachutes (where fitted) shall provide adequate drag force to decelerate the aircraft without causing excessive loads or damage to the aircraft, or an unacceptable effect on the handling/stability of the aircraft under any permitted operating condition.

Consideration should be given to:

a. The full range of operating conditions within which drag parachute operation is permitted, including aircraft loading conditions (mass and CofG position), aircraft speeds, environmental conditions (e.g. temperature, rain, snow, dust, etc.), wind velocities and gust conditions.

b. Providing automatic and/or manual means for jettison of the drag parachute.

c. The stability of the parachute, and variation in the resulting loads on the aircraft's structure.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define the provisions made for deployment of drag parachutes.
2. Analysis should demonstrate that drag parachutes can be deployed and decelerate the aircraft effectively without causing excessive loads or damage to the aircraft, or an unacceptable effect on the handling/stability of the aircraft under any permitted operating condition.
3. Analysis should demonstrate that the loads that can be induced by the drag parachute do not cause permanent deformation of any part of the aircraft.
4. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that the drag parachute can be deployed during landing without causing excessive loads or damage to the aircraft, or an unacceptable effect on the handling/stability of the aircraft under any permitted operating condition.
5. Technical Publications should detail the procedure for operating drag parachutes, and should clearly define any limitations or restrictions associated with their use.

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. MIL-D-9056	*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

Information Sources			
			00-970 P9 UK471a 00-970 P9 UK471d
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.5.11.6 Auxiliary deceleration systems.

Any other auxiliary deceleration systems (thrust reversers, speed brakes, etc.) shall provide adequate aircraft deceleration without causing any unsafe condition due to system operation or failure under any expected operating condition.

Consideration should be given to:

a. Concurrent use of multiple deceleration systems;

b. Maximising aircraft control;

c. The full range of resulting loads arising from operation of deceleration systems, and where systems can be operated concurrently, combination of these loads;

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define the various deceleration systems fitted to the aircraft, including systems where deceleration is a secondary function (e.g. flight control surfaces).
2. Analysis should demonstrate that concurrent operation of aircraft deceleration systems cannot result in excessive loads on the aircraft structure.
3. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that concurrent operation of deceleration systems does not result in excessive loads on the aircraft or unacceptable handling characteristics.
4. Technical Publications should detail the procedures for operation of deceleration systems, and any restrictions or limitations on their concurrent operation.

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*	CS 23.933

Information Sources			
		Reference:	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

8.5.11.7 Merged with 8.5.11.1.

8.5.12. Ground handling.

8.5.12.1 Jacking provisions.

Aircraft jacking points (where required) shall enable the aircraft to be raised to a height such that required maintenance activities can be conducted effectively. Where necessary, any restrictions/limitations associated with jacking of the aircraft (e.g. permitted jacks, aircraft weight, CofG position, environmental condition, ground slope, wind velocities, operation of flying control surfaces, etc.) shall be stated in the appropriate manual.

Consideration should be given to:

a. Critical combinations of aircraft weight and CofG;

b. The minimum and maximum required heights for jacking for maintenance activities;

c. Ensuring that jacking points are compatible with maintenance jacks that meet appropriate standards (e.g. AS4775B).

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define the provided provisions for aircraft jacking, including the minimum and maximum permitted jacking heights.
2. Analysis should demonstrate that jacking of the aircraft in accordance with defined procedures cannot result in any unsafe condition (e.g. over-stress of aircraft parts, failure of any approved jack, or unintentional movement of the aircraft).
3. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis, and should demonstrate that the aircraft can be jacked safely in accordance with defined procedures.
4. Technical Publications should define the procedures for safe aircraft jacking, including any restrictions/limitations associated with jacking of the aircraft (e.g. aircraft weight, CofG position, environmental condition, ground slope, wind velocities, operation of flying control surfaces, etc.).

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
		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 Merged with 8.5.12.1.

8.5.12.3 Towing.

Aircraft towing points (where required) shall enable the aircraft to be towed and pushed safely in all expected directions, in all expected aircraft conditions and on all expected ground surfaces, including slopes. Where necessary, any restrictions/limitations associated with towing or pushing of the aircraft (e.g. towing/pushing equipment, towing/pushing speeds, aircraft weight, CofG position, environmental condition, ground slope, wind velocities, operation of flying control surfaces, etc.) shall be stated in the appropriate manual.

Consideration should be given to:
a. Critical combinations of aircraft weight and CofG;
b. Ensuring that towing points are compatible with towing equipment that meet appropriate standards (e.g. ARP1915E);
c. Incorporating design features that prevent load transmitted to the aircraft from causing structural damage (e.g. shear pins);
d. Ensuring that towing points are readily accessible for ground personnel and are appropriately marked;
e. Ensuring compatibility with any steering systems.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should define the provided provisions for aircraft towing and pushing.
2. Analysis should demonstrate that towing/pushing of the aircraft in accordance with defined procedures cannot result in any unsafe condition (e.g. over-stress of aircraft parts, failure of any approved towing/pushing equipment, or unintentional movement of the aircraft).
3. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis, and should demonstrate that the aircraft can be towed and pushed safely in accordance with defined procedures.
4. Technical Publications should define the procedures for safe aircraft towing and pushing, including any restrictions/limitations associated with towing/pushing of the aircraft (e.g. towing/pushing equipment, towing/pushing speeds, aircraft weight, CofG position, environmental condition, ground slope, wind velocities, operation of flying control surfaces, etc.).

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:*	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
		STANAG Reference:	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 Emergency towing.

Aircraft towing points shall be provided to enable the aircraft to be towed and pushed safely in an emergency, with the aircraft loaded at the maximum permitted weight and critical CofG positions, in any environmental condition and over the roughest ground that may reasonably be expected.

Consideration should be given to:
a. Specifying permitted equipment for emergency towing;
b. Minimising any damage to the aircraft that may result from emergency towing;
c. Ensuring that towing points are readily accessible for ground personnel and are appropriately marked;
d. Ensuring compatibility with any steering systems.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should define the provided provisions for aircraft emergency towing and pushing.
2. System Safety Analysis should demonstrate that risk associated with emergency towing/pushing of the aircraft in accordance with defined procedures is acceptable.
3. Technical Publications should define the procedures for safe aircraft emergency towing and pushing.

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:*	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
		STANAG Reference:	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 Mooring.

Aircraft mooring points (where required) shall enable the aircraft to be moored safely at any permitted aircraft weight. Where necessary, any restrictions/limitations associated with mooring of the aircraft (e.g. permitted mooring equipment, CofG position, environmental condition, wind velocities, operation of flying control surfaces, etc.) shall be stated in the appropriate manual.

Consideration should be given to:
a. The number of mooring points required;
b. Different mooring patterns, attachment details and mooring methods;
c. Mooring on land and on board ships.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should define the provided provisions for aircraft mooring.
2. Analysis should demonstrate that mooring of the aircraft in accordance with defined procedures cannot result in any unsafe condition (e.g. over-stress of aircraft parts, failure of any approved mooring equipment, or unintentional movement of the aircraft).

3. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis, and should demonstrate that the aircraft can be moored safely in accordance with defined procedures.
4. Technical Publications should define the procedures for safe aircraft mooring including any restrictions/limitations associated with mooring of the aircraft (e.g. permitted mooring equipment, CofG position, environmental condition, wind velocities, operation of flying control surfaces, etc.).

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 Specialised systems.

Specialised landing gear systems (where required) shall be safe for all expected functions. Where necessary, any restrictions/limitations associated with operation or use of such specialised equipment shall be stated in the appropriate manual.

Considerations should be given to:
a. The purpose and functions of such specialised landing gear systems, and the missions or operational situations for which the systems could be used;
b. Aircraft handling characteristics with specialised landing gear systems installed;
c. The various ways in which the incorporation of such specialised systems could affect the aircraft's existing systems/structure.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should define any specialised landing gear systems which are fitted or may be fitted to the aircraft.
2. System Safety Assessment (SSA) should demonstrate that the risk associated with aircraft operation, including ground operations, landing and take-off with specialised landing gear in any possible configuration/position is acceptable.
3. Analysis should demonstrate that loads arising from aircraft operation including ground operations, landing and take-off with specialised landing gear in any possible configuration/position cannot result in failure/detachment of any part of the specialised system or permanent deformation of any other part of the aircraft.
3. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis, and should demonstrate that the aircraft can be operated safely with specialised landing gear in any possible configuration/position.
4. Technical Publications should define the procedures for operation of specialised landing gear systems, including any restrictions/limitations associated with their use (e.g. aircraft weight, CofG position, environmental condition, ground slope, wind velocities, operation of flying control surfaces, etc.).

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009 Appendix A: A.3.4.1.10.1 thru	*Def-Stan 00-970 Reference:*	00-970 P1 4.11.24

Information Sources			
	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	*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 Merged with 14.2.3.

8.5.12.8 Merged with 8.5.2.2.

8.5.12.9 Ground Foreign Object Damage (FOD).

The landing gear shall be arranged to minimise the risk of Foreign Object Damage (FOD) or water ingestion to the engines or auxiliary power unit during take-off, 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. The various foreign objects that could damage the engines or auxiliary power unit, including those present on ground surfaces (gravel, mud, etc.), and those that could result from failure of aircraft parts (e.g. tyre/wheel shrapnel).

Considerations for preparation of AMC:

1. Analysis should demonstrate that the arrangement of the landing gear is such that FOD or water ingestion to the engines or auxiliary power unit is minimised during take-off, landing and taxiing.
2. System Safety Analysis (SSA) should demonstrate that the risk of FOD or water ingestion due to the location of the landing gear is acceptable, including failures of the landing gear.
3. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that the location of the landing gear does not cause any unacceptable FOD or water ingestion to the engines or auxiliary power unit.

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 aircraft structure, weight, balance and interfacing subsystems. This includes ensuring the arrangement, location and interface supports the aircraft 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. Aircraft 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 aircraft electrical and electronic systems;
m. Aircraft interface requirements to be agreed and verified.

Considerations for preparation of AMC:
1. System Interface Documents (SID) should define all interfaces between the landing gear and other parts of the aircraft, including both structures and systems interfaces.
2. Analysis should demonstrate that the loads through the landing gear resulting from any expected operating condition are reacted through the aircraft structure without any permanent deformation of any part of the aircraft.
3. System Safety Analysis (SSA) should demonstrate that the risk associated with integration of landing gear power operated systems into the aircraft systems is acceptable.
4. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that operation of the aircraft in critical operating conditions is safe, and does not result in permanent deformation of any part of the aircraft, or failure of any power supply system or power operated system.

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 Landing gear system integrity.

No credible combination of failure of the landing gear (including single-point failures, dormant failures, and failure of any interfacing system) shall result in any uncommanded or unsafe effect or function of the landing gear.

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.

Considerations for preparation of AMC:

1. System Interface Documents (SID) should define all interfaces between the landing gear and other parts of the aircraft, including both structures and systems interfaces, and the risk of functional failure of those interfacing structures/systems.
2. System Safety Analysis (SSA) should demonstrate that the risk associated with credible combinations of failure of the landing gear and interfacing structures/systems is acceptable, and that no uncommanded or unsafe effect or function of the landing gear can result.
3. Rig, ground and flight testing should demonstrate that severe risks do not result in uncommanded or unsafe effects or functions of the landing gear.

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 23.471-23.511 CS 23.1309 CS 25.471-25.511 CS 25.1309 CS 27.471-27.521 CS 27.1309 CS 29.471-29.521 CS 29.1309

8.5.12.12 Damage tolerance.

No partial failure of the landing gear (due to fatigue, leakage, corrosion, defects, damage, etc.) shall result in reduction of flight safety.

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.

Considerations for preparation of AMC:
1. System Safety Analysis (SSA) should demonstrate that no partial failure results in reduction of flight safety.

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:	4671.57
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 Failures and leakage.
Failure and partial failure (e.g. leakage) of the landing gear system or components shall be evident to the flight and/or maintenance personnel.

Consideration should be given to:
a. The required inspection schedule, to minimise aircraft operation with failures;
b. Incorporation of Built In Test Equipment (BITE).

Considerations for preparation of AMC:
1. Technical Publications should define the inspection procedures and schedule for landing gear systems.
2. System Safety Assessment (SSA) should demonstrate that risk associated with aircraft operation, including the effect of dormant landing gear failures, is acceptable.

Information Sources			
Comm'l Doc:	Level II Damage Tolerance requirements and Maintainability 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 4.4.3 00-970 P1 4.4.6 00-970 P1 4.4.7
		STANAG Reference:	4671.57
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

Information Sources			
			CS 27.611 CS 29.571 CS 29.573 CS 29.611

8.5.12.14 Lift points.

Aircraft lifting points (where required) shall enable the aircraft to be lifted to a height such that required maintenance activities can be conducted effectively. Where necessary, any restrictions/limitations associated with lifting of the aircraft (e.g. permitted lifting equipment, aircraft weight, CofG position, environmental condition, ground slope, wind velocities, operation of flying control surfaces, etc.) shall be stated in the appropriate manual.

Consideration should be given to:

a. Critical combinations of aircraft weight and CofG;

b. The minimum and maximum required heights for lifting for maintenance activities;

c. Ensuring that lifting points are compatible with lifting equipment that meet appropriate standards (e.g. AS5944).

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define the provided provisions for aircraft lifting, including the minimum and maximum permitted lifting heights.
2. Analysis should demonstrate that lifting of the aircraft in accordance with defined procedures cannot result in any unsafe condition (e.g. over-stress of aircraft parts, failure of any approved lifting equipment, or unintentional movement of the aircraft).
3. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis, and should demonstrate that the aircraft can be lifted safely in accordance with defined procedures.
4. Technical Publications should define the procedures for safe aircraft lifting, including any restrictions/limitations associated with lifting of the aircraft (e.g. aircraft weight, CofG position, environmental condition, ground slope, wind velocities, operation of flying control surfaces, etc.).

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 P1 4.4.10 00-970 P1 4.4.17 to 4.4.20 00-970 P7 L308 2.1
		STANAG Reference:	4671.507
FAA Doc:		*EASA CS Reference:*	

8.5.12.15 Operator interface.

Adequate means at crew/operator station shall be available to the flight crew to assess the operational condition of the landing and deceleration systems.

Consideration should be given to:

a. Clear presentation of relevant information to crew, including status indication, and warning, caution and advisory information.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should identify the controls and displays provided to crew. For controls, detail should be provided regarding the mode of operation and function of each control. For displays, detail should be provided regarding all information displayed to the crew, and where appropriate, the conditions that would lead to specific indications.
2. Rig, ground and flight testing should demonstrate the effectiveness of the provided operator interface.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P 4.15
		STANAG Reference:	4671.729 4671.1793 4671.1835
FAA Doc:		*EASA CS Reference:*	CS 23.729 CS 23.1563 CS 25.729 (AMC 25.729(c)) CS 25.1322 CS 27.729 CS 29.729

8.5.12.16 Technical manuals.
Flight and maintenance manuals shall include normal, back-up and emergency operating procedures, limitations, restrictions, servicing, and maintenance information and other information necessary for safe operation of the fuel system.

Consideration should be given to:
1. The level of detail necessary to provide accurate technical information while remaining concise;
2. The information, at the appropriate level of detail, required to allow personnel to operate and maintain the aircraft as safely and effectively as possible at an acceptable workload.

Considerations for preparation of AMC:
1. Operational Technical Publications for the flight crew (Aircraft Flight Manual, Emergency Procedures, Checklists etc.) should clearly define all required normal, back-up and emergency operating procedures, limitations and restrictions.
2. Maintenance Technical Publications for ground crew (Aircraft Maintenance Manual, Master Minimum Equipment List, Maintenance Schedule, etc.) should clearly define all required servicing and maintenance information.
3. Flight Simulations, Ground Testing and/or Flight Testing should verify that all Operational Technical Publications are clear and unambiguous and can be followed by a flight crew through all flight phases and conditions without incurring excessive crew workload and serve their intended function.
4. Rig and/or Ground Testing should verify that all Maintenance Technical Publications are clear and unambiguous and can be followed by a competent maintenance engineer in a manner which ensures the continuing airworthiness of the aircraft.

Information Sources			
Comm'l Doc:			

Information Sources			
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 Qualification testing.
All landing gear and deceleration system components, either individually or as part of a landing gear and deceleration subsystem, shall pass all required qualification tests to ensure their suitability for use in all expected usage and environmental conditions.

Consideration should be given to:
a. A wide variety of qualification tests such as: proof, burst, vibration, containment, over-speed, acceleration, explosive atmosphere, pressure cycling, and temperature cycling.
b. Conducting qualification in accordance with appropriate existing standards, where such standards exist; and,
c. Creating appropriately detailed procedures for qualification where existing standards do not exist.

Considerations for preparation of AMC:
1. Qualification Test Procedures (QTP) should define the qualification tests necessary to demonstrate the suitability of components to perform their intended function;
2. Qualification Test Reports (QTR) should record the conduct and results of qualification testing in accordance with the relevant QTP or other existing, relevant standard;
3. Declarations of Design Performance (DDP) should record the scope of qualification, the intended function, and suitability to perform that function for each component; and,
4. Rig, ground and flight testing should demonstrate the correct function of all components when installed as part of the system.

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.

The landing gear system as installed to the aircraft shall pass all required tests to demonstrate its suitability for use in all expected usage and environmental conditions.

Consideration should be given to:

a. Ensuring all tests must be conducted on systems which are fully representative of the type design;

b. Functioning of both normal and emergency systems.

Considerations for preparation of AMC:

1. Test Procedures should define the tests necessary to demonstrate the suitability of the landing gear to perform its intended functions;

2. Test Reports should record the conduct and results of testing in accordance with the relevant Test Procedure.

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

8.5.13 Parachute landing system.

8.5.13.1 Safe and reliable operation.

Parachute landing systems (where fitted) shall be safe and reliable.

Note that parachute landing systems are parachute systems designed to provide means for aircraft landing, as opposed to parachutes which slow the aircraft, for example during landing, as covered by section 8.5.11.5.

Consideration should be given to:

a. Appropriate levels of safety and reliability, taking into account the frequency and circumstance of parachute landing system operation.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define any provided parachute landing system(s).

2. System Safety Analysis (SSA) should demonstrate that the risk associated with operation of the parachute landing system is acceptable.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 Part 9 00-970 UK FW.U599a
		STANAG Reference:	4671 USAR.U290 4671 USAR.U291 4671 USAR.U292

Information Sources			
			4671 USAR.U293
FAA Doc:		*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

8.5.13.2 Aborted landing.

At any stage of the parachute landing procedure prior to deployment of the landing parachute, it shall be possible to abort the parachute landing and continue to normal flight.

Consideration should be given to:

a. The range of aircraft operating conditions through which the parachute landing procedure may be initiated, and therefore aborted.

b. Any specific flight handling or performance requirements applicable to the transition from aborted landing to safe continued flight.

Considerations for preparation of AMC:

1. Technical Publications should define the parachute landing procedure, including the stages through which landing may be aborted, and any procedures required for safe continued flight.

2. System Safety Assessment (SSA) should demonstrate that the risk associated with aborting parachute landing from any stage prior to deployment of the parachute is acceptable.

3. Analysis should demonstrate that it is possible to abort a parachute landing at any stage prior to parachute deployment and return to safe continued flight at any expected operating condition.

4. Rig and flight testing should demonstrate the accuracy of performed analysis and should demonstrate that it is possible to abort a parachute landing at any stage prior to parachute deployment and return to safe continued flight at critical operating conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671 USAR.U290
FAA Doc:		*EASA CS Reference:*	

8.5.13.3 Merged with 5.1.1.

8.5.13.3.1 Parachute deployment.

Parachute deployment systems/devices shall not adversely affect the airworthiness of other aircraft systems or the structural integrity of the aircraft.

Consideration should be given to:

a. The airworthiness of all power supply systems and power operated systems in the vicinity of the parachute landing system, and those systems which interface with the parachute landing system;

b. Parachute deployment loads in combination with existing aircraft loads and their effect on static and fatigue strength.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate that the installation, operation and failure of parachute landing systems (including parachute deployment systems) does not adversely affect the airworthiness of existing aircraft systems.
2. Analysis should demonstrate that the incorporation of parachute deployment loads into existing aircraft loads does not compromise the structural integrity of the aircraft, or unacceptably reduce the aircraft's fatigue life.

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

8.5.13.4 Minimization of dragging.
Dragging of the aircraft following parachute landing shall be minimized.

Consideration should be given to:
a. The full range of conditions in which parachute landing may be performed, including surface conditions, wind velocities and aircraft weights;
b. The effect of inadvertent landing in an unexpected attitude (e.g. inverted);
c. The incorporation of design features to minimize dragging, including detachment/jettison of parachutes following landing.

Considerations for preparation of AMC:
1. Analysis should demonstrate that any dragging following parachute landing is acceptable in any permitted parachute landing condition.
2. Rig and flight testing should demonstrate the accuracy of performed analysis and should demonstrate that any dragging following parachute landing is acceptable, and the correct function of any preventative design features.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG	4671 USAR.U292

Information Sources			
		Reference:	
FAA Doc:		*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

8.5.13.5 Environmental exposure.

The parachute landing system shall be unaffected by any environment to which the aircraft may be exposed.

Consideration should be given to:

a. All environments to which the aircraft may be exposed including those within which the aircraft may operate as well as other environments, for example those present during aircraft transportation or storage.

Considerations for preparation of AMC:

1. Analysis should demonstrate that the parachute landing system is suitably resistant to all expected environments.
2. Technical Publications should detail any maintenance activity that may be required to protect the parachute landing system against specific harsh environments, for example those that may occur during aircraft transportation or storage.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 S6.2.40 - 6.2.61 00-970 P1 S7.2.2 - 7.2.3, 00-970 P7 S2 Supplement 4 L732 1.4.1
		STANAG Reference:	4671 USAR.603
FAA Doc:		*EASA CS Reference:*	CS 23.603 CS 25.603 CS 25.613 CS 25.1309 CS 27.307 CS 27.603 CS 29.307 CS 29.603

8.6. AUXILIARY/EMERGENCY POWER SYSTEM(S) (APS/EPS).

Auxiliary Power Systems (APS) are systems which routinely provide power (mechanical, electrical, hydraulic, pneumatic, etc.) for other aircraft systems (e.g. engines), but which do not provide propulsion. APS may be used on the ground and/or in flight.

Emergency Power Systems (EPS) are systems which provide power (mechanical, electrical, hydraulic, pneumatic, etc.) for other aircraft systems in the event of an emergency. Like APS, EPS do not provide propulsion, and may be used on the ground and/or in flight. Typical EPS include emergency batteries, and Ram Air Turbines (RAT).
Some APS may also be considered to be EPS, if their use in an emergency is considered essential for continued safe flight.

8.6.1 Suitability of components.
APS/EPS components shall be safe for their intended use and environment.

Consideration should be given to:
a. All appropriate safety criteria, which may include:
i. Design Service Life;
ii. Environment;
iii. Crash-worthiness;
.iv. Material and Processes (including chemical/mechanical compatibility of toxic substances & fuels such as hydrazine);
v. Coatings and Finishes;
vi. Use of Prohibited Materials and Processes;
vii. Producibility;
viii. Damage Tolerance;
ix. Strength;
x. Durability and Economic Life;
xi. Corrosion;
xii Fatigue;
xiii. Dielectric Materials;
xiv. Creep.
b. The level(s) of safety to be met, taking into account the overall design and usage of the aircraft, levels of system redundancy, requirements for maintenance, and any other factor that could affect the required level of safety.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the APS/EPS installed on the aircraft, and the components which make up each system.
2. System Safety Assessments (SSA) should detail the safety requirements to be met by each APS/EPS, and should demonstrate that the safety requirements are adequately met, taking into account appropriate safety criteria.
3. Declaration of Design Performance (DDP) should demonstrate that each APS/EPS component meets the relevant design and safety requirements.
4. Rig, ground and flight testing should demonstrate that the APS and/or EPS installed on the aircraft functions correctly through its intended use and in its intended environment.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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

Information Sources			
			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: 23.573; 23.1309; 25.1309; 25.571; 27.1309; 29.1309	*EASA CS Reference:*	CS 23.1309 CS 25J.1207 CS 25.571 CS 25.1309 CS 27.1309 CS 29.1309 CS-APU 80 CS-APU 210 CS-E 500-590 CS-E-1000

8.6.2 System operation.

The APS and EPS shall operate safely through all expected (normal and emergency) operating conditions.

Consideration should be given to:

a. Acceptable operating characteristics, taking into account interfacing system requirements;

b. The effect of normal and emergency conditions, for example flight in abnormal flight configurations and flight at and beyond Never Exceed Speeds (VNE);

c. The effect of environmental conditions including hot and cold environments, dust, sand, salt spray, etc.

Considerations for preparation of AMC:

1. System Description Documents should detail the conditions in which operation of the APS and EPS is permitted, in particular those conditions where APS/EPS operation is automatic.

2. Systems Interface Documents (SID) should detail the interface characteristics between the APS/EPS and power transmission system, including the effects of abnormal operation.

3. Analysis should demonstrate that the APS/EPS provides power with acceptable characteristics throughout all expected operating conditions.

4. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis, and should demonstrate the correct functioning of power transmission systems and power operated systems when powered by the APS and/or EPS.

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

Information Sources			
			00-970 P7 S10 L1002
		STANAG Reference:	
FAA Doc:	14CFR reference: 23.901, 25.901, 25.903 (f), 25.1167(a),(c) TSO C77b 4.4.1 - 4.5.2	*EASA CS Reference:*	CS 25.1167 CS 25J903(a) CS 25J939(a) CS 25J943, 25J951, CS 25J952, CS 25J1019, CS 25J1023, CS 25J1025, CS 25J1106, CS 25J1521, CS 25J1527 CS-APU-40; CS-APU-80 CS-APU 210 CS-APU 410 420; 430; 440; 450; 460 and 470 CS-E Sub part A# CS-E 520

8.6.2.1 Safety features.

The APS and EPS shall incorporate safety features to control and mitigate the risks associated with their operation to an acceptable level.

Consideration should be given to:

a. System failure modes;

b. The required level(s) of safety, taking into account the overall design and usage of the aircraft and any other factor that could affect the required level of safety.

c. Conditions for the correct functioning of any safety features installed.

d. Ensuring that failure of APS/EPS or any associated power conversion or transmission components cannot result in the failure of other power generation, supply or operated systems.

Considerations for preparation of AMC:

1. System Safety Assessments (SSA) should detail the risks associated with each APS/EPS, the safety requirements to be met by each APS/EPS, and should demonstrate that the safety requirements are adequately met, taking into account appropriate safety criteria.

2. Rig, ground and flight testing should demonstrate that the APS and/or EPS installed on the aircraft, including its safety features, functions correctly when used as intended in its intended environment.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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, S1, 1.1.34 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*	CS 25J.1141(c) CS 25J.1189

Information Sources			
		Reference:	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 Functional and physical compatibility.

The APS and EPS shall be functionally and physically compatible to the aircraft in which it is to be integrated.

Consideration should be given to:

a. Appropriate aspects of functional compatibility, taking into account the aircraft and APS/EPS design, including power outputs, voltage, phase, frequency, pressures, RPM etc.

b. Appropriate aspects of physical compatibility, taking into account the aircraft and APS/EPS design, including size, weight, clearance, vibration, materials compatibility etc.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the physical and functional characteristics of the APS and/or EPS. This should include nominal, maximum and minimum power outputs, the size and weight of the APS and/or EPS, and the location of installation.
2. Technical Publications should detail the process for installation and functional testing of the APS and/or EPS.
3. Rig, ground and flight testing should demonstrate that the APS and/or EPS can be installed correctly in accordance with the associated Technical Publications, and should demonstrate that the APS and/or EPS functions correctly when installed.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.27; 4.2.7; 3.2.7.4.4; 4.2.7.4.4; 3.2.7.7.5; 4.2.7.7.5; 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, 23.1309, 25.901, 25.1309, 25.903 (f), 27.1309, 29.1309 TSO C77b 4.4.1 - 4.5.2, Sections 6 and 7	*EASA CS Reference:*	CS 23.1309 CS 25.1167 CS 25J939 CS 25J1163 CS 25.1309 Equipment, Systems and Installations CS 27.1309 CS 29.1309 CS-APU-40

Information Sources			
			CS-E 20

8.6.4 System safety

The APS and EPS shall be designed in such a way that the probability of failure of any component that could present an unacceptable hazard, or unacceptable risk to the safety of personnel or that could prevent continued safe flight is extremely remote.

Consideration should be given to:

a. Design and maintenance philosophies which minimise the risk of failure of the APS and/or EPS (damage tolerance, safe life, etc.).

b. Possibility for failure of components which would present a hazard to safety of personnel or continued safe flight, including the uncontained failure of high-energy rotors and whipping/flailing of failed hydraulic and pneumatic lines.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should highlight the incorporation of high-energy rotors, and other components whose failure would present a hazard to safety of personnel or continued safe flight, in the design of the APS and/or EPS.
2. Failure Modes and Effects Analysis (FMEA) should detail the failure modes of the APS and/or EPS, and should detail the subsequent effects of their failure.
3. System Safety Assessments (SSA) should demonstrate that the incorporation of the APS and/or EPS to the aircraft does not present a hazard to safety of personnel or continued safe flight.
4. Analysis should demonstrate that the failure of the APS and/or EPS does not result in any unexpected effects (for example that high-energy rotors are successfully contained).
5. Rig testing should demonstrate the accuracy of the analysis performed, and should demonstrate that failure of the APS and/or EPS does not result in any unexpected effects (for example that high-energy rotors are successfully contained).

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	JSSG-2009: 3.3.3, 4.3.3; Appendix C: C.3.4.3.10.1, C.4.4.3.10.1	*Def-Stan 00-970 Reference:*	00-970 P1 S1 1.1.34 00-970 P1 S1 1.1.39 00-970 P7 S1 L100 00-970 P7 S7 L700 00-970 P7 S7 L705
		STANAG Reference:	4671 USAR 1309 4671.USAR 1461
FAA Doc:	14CFR reference: 23.903 (b); 23.1461, 25.901(c); 25.1461; 25.1167 (a),(c); TSO C77b (5.1) AC 20-128, TSO C77b: 5.9; 6.6; 6.7; 6.8	*EASA CS Reference:*	CS 25.1309(b), 25.1461 CS-APU 210, 290 and 470 CS-E 80 and 510

8.6.4.1 Merged with 8.6.4.

8.6.5 Vibration.

Through all expected operating conditions, the APS and EPS shall be suitable for the vibration environment as installed on the aircraft, and shall not introduce vibration to the aircraft that could affect the integrity of surrounding structure or systems.

Consideration should be given to:
a. The existing vibration environment, including sources, magnitudes and frequencies, and its effect on the APS and/or EPS.
b. Vibrations resulting from installation and operation of the APS and/or EPS in normal, emergency and failed modes.

Considerations for preparation of AMC:
1. Analysis should demonstrate that the APS and/or EPS is suitable for the vibration environment to which it is installed, through all expected operating conditions.
2. Fatigue analysis should demonstrate that the installation of the APS and/or EPS does not appreciably affect the structural or systems integrity of the APS/EPS or surrounding structures or systems.
3. Rig, ground and flight testing should demonstrate the accuracy of the analysis performed, that the vibration environment to which the APS and/or EPS is installed is acceptable, and that the APS/EPS does not introduce vibrations that could appreciably affect the structural or systems integrity of the APS/EPS or surrounding structures or systems.

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 Merged with 8.6.2 for operational aspects and 8.6.3 for functional and physical aspects.

8.6.6 EPS Performance.

The EPS shall be capable of responding to failures and providing sufficient power within an appropriate time to allow continued safe flight.

Consideration should be given to:
a. The time required for the EPS to respond to failures, including the time for pilot action (if any), and system start-up.
b. Prioritisation of power supply types, for example prioritising power to systems which are more critical to continued safe flight.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the required time for EPS response to system failures, highlighting the time required between the failure of a primary system and the sufficient supply of power by the EPS.
2. System Safety Analysis (SSA) should demonstrate that the time required between failure of a primary power supply system and the sufficient supply of power by the EPS is acceptable for continued safe flight.

3. Rig, ground and flight testing should demonstrate that the operation of the EPS following a failure of each primary power source allows continued safe flight.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 Reference:	4671.USAR 901 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 Safety considerations.

Installation of the APS and EPS shall take into account:

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 levels of fire hardening;

f. Accessibility to all required inspection and servicing features and areas.

Consideration should be given to:

a. Maintaining appropriate margins of safety throughout expected aircraft and APS/EPS operation.

b. Taking deviations from nominal dimensions (adverse tolerances, manufacturing concessions, etc.) into account.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should provide detail regarding: APS and/or EPS structural mounting; wiring and plumbing support; routeing and clearances; system/component and compartment drainage; system/component and compartment cooling and ventilation; system/components designed for appropriate levels of fire hardening; and accessibility to all required inspection and servicing features and areas.

2. Rig, ground and flight testing should demonstrate that the installation of APS and/or EPS is appropriate, and that provisions for inspection and servicing provide adequate clearance for all required maintenance activities.

Note that criteria 8.6.7.1-8.6.7.6 of MIL-HDBK-516C have been subsumed into this EMACC criterion.

Information Sources			
Comm'l Doc:	For b. above: ARP994, Tubing/Plumbing Routing - tubing and line support, routing and clearance requirements SAE AS50881A, Wiring,		

Information Sources			
	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: 14CFR references: 23.901, 23.1021, 25.901, 25.102123.901, 23.1021, 25.901, 25.1021	*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 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

Information Sources			
			CS-E 270 CS-E 340 CS-E 690

8.6.8 Flammable fluid ingestion/exhaust gas impingement.
APS and EPS inlets and exhausts hazards (including air flow velocities, temperatures, acoustics, and exhaust by-products) shall be acceptable.

Consideration should be given to:
a. Hazards to personnel, including ground crew, flight crew and passengers.
b. Hazards to aircraft systems and structure.

Considerations for preparation of AMC:
1. Functional Hazard Assessment (FHA) should identify the hazards associated with the APS and/or EPS inlets and outlets.
2. System Safety Assessment (SSA) should demonstrate that the hazards associated with the APS and/or EPS inlets and outlets are acceptable, and that appropriate controls and/or mitigations are in place to reduce the resulting risk for each hazard.
3. Rig, ground and flight testing should demonstrate that the hazards associated with inlets and exhausts of APS and/or EPS are acceptable.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 27.1091-1093, 27.1121-1123 CS 29.1091-1109, 29.1121-1125 CS-APU 230 CS-APU 260 CS-APU-80 CS-APU-470 CS-E 510

8.6.9 Merged with 8.6.14.

8.6.10 Merged with 8.6.3.

8.6.11 Merged with 8.6.4.

8.6.12 Operator interface.

Adequate controls and displays shall be available to notify the flight crew of the APS and EPS and its necessary functions to warn for hazardous conditions.

Consideration should be given to:
a. Clear presentation of relevant information to crew, including status indication, and warning, caution and advisory information.
b. All required APS and EPS functions and tracked parameters (e.g. voltage, current, pneumatic/hydraulic pressure, shaft speed, etc.);
c. The location of the sensors should be carefully considered so that true parameters will be indicated;
d. Ensuring all displays and controls meet the specified requirements (arrangement, location, type, size, guards etc.).

Considerations for preparation of AMC:
1. System Description Documents (SDD) should identify the controls and displays provided to crew. For controls, detail should be provided regarding the mode of operation and function of each control. For displays, detail should be provided regarding all information displayed to the crew, and where appropriate, the conditions that would lead to specific indications.
2. Rig, ground and flight testing should demonstrate that controls perform their intended function(s) and that displays provide accurate and useful information to the crew.

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 Component life/usage tracking.

APS and EPS life/usage parameters which affect the continuing airworthiness of the aircraft shall have appropriate means for tracking.

Consideration should be given to:

a. All life/usage parameters which may affect the continuing airworthiness of the aircraft, such as those arising from the adoption of 'Safe Life' or 'Damage Tolerant' design philosophies.
b. Appropriate means of tracking, taking into account the frequency of operation/usage of the aircraft and the installed APS/EPS. Such means may include automatic recording (e.g. an active Health and Usage Monitoring System (HUMS)), manual recording of aircraft parameters (flight hours, flight cycles, etc.), or manual means of recording APS/EPS specific parameters (e.g. number of Auxiliary Power Unit starts).

Considerations for preparation of AMC:
1. System Description Documents (SDD) should highlight APS and/or EPS lifing/usage parameters, including their means for tracking.
2. System Safety Assessments (SSA) should identify any specific controls or mitigations which rely on the management of APS and/or EPS lifing/usage parameters.
3. Maintenance Technical Publications should include means for the tracking and management of APS and/or EPS lifing/usage parameters, acceptable limits for each parameter, and procedures to follow in the event of reaching each lifing/usage parameter's associated limit.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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, A27.3 and A29.3 TSO C77b: 4.3; 4.4.1; 4.6.1; 5.7	*EASA CS Reference:*	CS 25 Appendix H 25.43 CS A27.3, A29.3 CS-APU 150 CS-APU 310 CS-E 515

8.6.14 Technical manuals.
Flight and maintenance manuals shall include normal, back-up and emergency operating procedures, limitations, restrictions, servicing, and maintenance information and other information necessary for safe operation of the APS and EPS.

Consideration should be given to:
a. The level of detail necessary to provide accurate technical information while remaining concise;
b. The information, at the appropriate level of detail, required to allow personnel to operate and maintain the aircraft as safely and effectively as possible at an acceptable workload.

Considerations for preparation of AMC:
1. Operational Technical Publications for the flight crew (Aircraft Flight Manual, Emergency Procedures, Checklists etc.) should clearly define all required normal, back-up and emergency operating procedures, limitations and restrictions.
2. Maintenance Technical Publications for ground crew (Aircraft Maintenance Manual, Master Minimum Equipment List, Maintenance Schedule, etc.) should clearly define all required servicing and maintenance information.
3. Flight Simulations, Ground Testing and/or Flight Testing should verify that all Operational Technical Publications are clear and unambiguous and can be followed by a flight crew through all flight phases and conditions without incurring excessive crew workload and serve their intended function.

4. Rig and/or Ground Testing should verify that all Maintenance Technical Publications are clear and unambiguous and can be followed by a competent maintenance engineer in a manner which ensures the continuing airworthiness of the aircraft.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.3.3; 3.6.2; 4.3.3	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.USAR 1581
FAA Doc:	14CFR reference: 23.1581 - 23.1585; G23.3 - G23.4; 23.1541; 25.1541; 25.1581 - 25.1585; H25.3 - H25.4	*EASA CS Reference:*	CS 25.1581 (a) (2) 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 CS-APU 30 CS-E 20 CS-E 30 CS-E 510

8.6.15 Merged with 8.6.2.1.

8.6.15 Merged with 8.6.2.1.

8.7. AIR-TO-AIR REFUELLING (AAR) SYSTEM.

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).

8.7.1 AAR operations.
AAR systems shall allow safe and successful AAR with the targeted tanker/receiver aircraft and its AAR system(s).

Consideration should be given to:
a. The role(s) that the aircraft will undertake in any AAR operations, which may include both dispense (tanker) and receipt roles.
b. The aircraft with which AAR operations may be conducted, which may include fixed wing and rotary types.
c. The AAR systems/equipment that may be utilised by the aircraft with which AAR operations will be conducted (flying boom, hose and drogue, etc.).
d. Dimensional, physical, electrical, and material compatibility between each AAR interface.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the AAR system(s) fitted to the aircraft.
2. SDD should detail the aircraft and AAR system types with which the aircraft can perform AAR operations.

3. Technical Publications should provide procedures for safe and successful AAR operations, for each tanker and/or receiver with which the aircraft is cleared to perform AAR operations.
4. Rig, ground and flight testing should demonstrate that the interfacing aircraft and their AAR systems are able to interface safely and successfully.

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 S3 3.5 00-970 P7 S2 L701/4
		STANAG Reference:	3447 3847 3971 7191
FAA Doc:		*EASA CS Reference:*	

8.7.1.1 Technical manuals.
Flight, operator, and maintenance manuals shall include normal, back-up and emergency operating procedures, limitations, restrictions, servicing, and maintenance information to support safe AAR operations.

Consideration should be given to:
a. The level of detail necessary to provide accurate technical information while remaining concise;
b. The information, at the appropriate level of detail, required to allow personnel to operate and maintain the aircraft as safely and effectively as possible at an acceptable workload.
c. Ensuring that all required operating procedures are defined, taking account of requirements for military operation (e.g. in-flight rectification).
d. Ensuring alignment and consistency between the aircraft's Technical Publications and the publications of the aircraft with which it will perform AAR operations.

Considerations for preparation of AMC:
1. Operational Technical Publications for the flight crew (Aircraft Flight Manual, Emergency Procedures, Checklists etc.) should clearly define all required normal, back-up and emergency operating procedures, limitations and restrictions.
2. Maintenance Technical Publications for ground crew (Aircraft Maintenance Manual, Master Minimum Equipment List, Maintenance Schedule, etc.) should clearly define all required servicing and maintenance information, including appropriate inspection criteria for wear/damage of each AAR component.
3. Flight Simulations, Ground Testing and/or Flight Testing should verify that all Operational Technical Publications are clear and unambiguous and can be followed by a flight crew through all flight phases and conditions without incurring excessive crew workload and serve their intended function.
4. Rig and/or Ground Testing should verify that all Maintenance Technical Publications are clear and unambiguous and can be followed by a competent maintenance engineer in a manner which ensures the continuing airworthiness of the aircraft."

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,	*Def-Stan 00-970 Reference:*	00-970 P13 S3 3.5 00-970 P13 S3 3.5.79

Information Sources			
	3.4.6.2.2		00-970 P1 7.5 00-970 P13 S4 L9 00-970 P7 S2 L1005 00-970 P7 S2 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)

8.7.1.1.1 Life-limited components.

A safe life shall be defined for all AAR components whose proper functioning is essential to maintain the flight safety of the aircraft and/or the safe usage of the AAR system.

Consideration should be given to:

a. All components directly installed as part of the AAR system, and any other aircraft components essential to maintain the flight safety of the aircraft and/or the safe usage of the system.

b. The maximum wear rates expected in service, taking into account frequency of AAR operation, rates of fuel dispense and/or receipt and environmental conditions.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the AAR components whose proper functioning is essential to maintain the flight safety of the aircraft and/or the safe usage of the AAR system, and the defined safe life for each component.
2. Rig, ground and flight testing should demonstrate that failure of essential components does not occur before the end of their defined safe life.
3. Technical Publications should define the safe life of each essential component, and procedures for their installation and removal.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.574

8.7.1.1.2 Merged with 8.7.1.1.1.

8.7.1.2 Merged with 8.7.1.

8.7.1.2.1 Probe obstructions.

The area around the AAR probe/ receptacle shall be free from obstructions that might cause damage to the aircraft, or become a hindrance to the AAR operation.

Consideration should be given to:

a. Ensuring that fastener heads are flush with the surrounding surface;

b. Ensuring that any structure and panels in the vicinity of the AAR Probe/Receptacle cannot snag or otherwise interfere with the AAR boom or drogue;
c. Any hose and suspension devices.

Considerations for preparation of AMC:
1. Rig, ground and flight testing should demonstrate that the AAR probe/receptacle and surrounding structure and panels does not snag dispensing AAR equipment (e.g. boom/drogue).

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 S3 3.5.5-3.5.6 00-970 P13 S3 3.5.14 00-970 P13 S4 L9
		STANAG Reference:	3447 3487 7191
FAA Doc:		*EASA CS Reference:*	

8.7.1.3 Loads at the refuelling interface.
The AAR system interface, its attachment to airframe structure, and the structure surrounding the interface shall withstand loads throughout the defined flight envelope and during normal and abnormal AAR operations (engagement, disengagement and fuel transfer) without the tanker/receiver interface(s) being damaged or creating FOD due to failure.

Consideration should be given to:
a. For boom and receptacle AAR 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 AAR 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 AAR coupling and the probe nozzle must be forcibly pulled out of the receptacle in all flight conditions.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the AAR equipment, its interface with the aircraft, and the structure through which AAR refuelling loads are reacted.
2. Structural analysis should demonstrate that the AAR refuelling equipment, its interface with the aircraft, and surrounding structure do not undergo excessive or permanent deformation.
3. Rig, ground and flight testing should demonstrate the accuracy of the performed structural analysis, and should demonstrate that AAR operation does not result in excessive or permanent deformation.

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 P13 S4 L9

Information Sources			
	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	*STANAG Reference:*	
FAA Doc:		*EASA CS Reference:*	CS 25.1435 CS 26.963

8.7.1.4 Crewmember/operator cues.
Cues (visual or equivalent) shall be provided to assist the receiver aircraft to accomplish the AAR process under all anticipated attitudes and environmental conditions.

Consideration should be given to:
1. Ensuring that the cues provide sufficiently detailed information to assist AAR operations without confusing operators.
2. Ensuring that the type(s) of cues provided are appropriate for the AAR operations anticipated.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the cues provided for receiver operators.
2. Technical Publications should detail procedures for AAR rendezvous, including the cues provided by the tanker aircraft for the receiver aircraft and their meaning.
3. Flight simulation and flight testing should demonstrate that AAR rendezvous can be accomplished successfully and safely under all expected AAR operating conditions.

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 Marking durability.
Visual cues used for AAR (e.g. markings and exterior lights) shall be compatible with their expected environmental conditions and fluid exposures (fuel, hydraulic fluid, cleaning solvents, etc.).

Consideration should be given to:

a. Compatibility of markings with existing surface finish scheme;
b. Degradation of the aircraft's 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.

Consideration for preparation of AMC:
1. Declarations of Design and Performance (DDP) should identify the environmental conditions for which the AAR visual cues are approved to operate within.
2. Qualification Test Reports (QTR) should demonstrate that AAR visual cues are compatible with their expected environment without degradation for the duration of the prescribed maintenance interval.

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 Exterior lighting.
Exterior lights shall be provided for the guidance of aircrew, operators and automated systems during AAR operation.

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. Lighting within drogues should not require power from the tanker for operation;
i. Need for compatibility with Night Vision Imaging Systems
j. Ground/Ship based lighting for HIFR.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the lighting provided to facilitate safe AAR operations.
2. Flight simulation and flight testing should demonstrate that the provided lighting facilitates safe AAR operations.

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 3.5.30-3.5.35 00-970 P13 S4 L9 00-970 P7 S12 L104 00-970 P7 S2 L1005
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.1.4.3 Merged with 8.7.1.4.2

8.7.1.4.4 Exterior lighting intensity.

The intensity of each exterior light or light group shall be variable to meet the needs of the interfacing tanker/receiver aircraft, and shall be Night Vision Device (NVD) compatible.

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.

Considerations fo preparation of AMC:
1. System Description Documents (SDD) should highlight the variability of AAR lighting and their NVD compatibility.
2. Flight simulation and flight testing should demonstrate that the variability of the AAR lighting, and its NVD compatibility allows for successful and safe AAR operations under all expected lighting conditions, both with and without the use of NVD.

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

8.7.1.4.5 Merged with 8.7.1.4.4.
8.7.1.4.6 Merged with 8.7.1.4.1

8.7.1.4.7 Viewing systems.
Viewing systems (if used) shall permit safe AAR operations.

Consideration should be given to:
a. Ensuring that failure of a viewing system is obvious to operators, and could not lead to the operators becoming unaware of an unsafe condition.
b. Preventing the obscuration or other degradation of viewing systems.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail any viewing systems incorporated for AAR.
2. Functional Hazard Assessment (SSA) should demonstrate that hazards associated with use of viewing systems for AAR operations are acceptable.
3. Failure Modes and Effects Analysis (FMEA) should demonstrate that hazards associated with the full or partial failure of viewing systems is acceptable for tanker and receiver aircraft.
4. System Safety Assessment (SSA) should demonstrate that hazards associated with the integration of viewing systems and their use during AAR operations are acceptable and appropriately controlled and mitigated.
5. Technical Publications should provide procedures for the use of viewing systems during AAR operations.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1301 CS 25.1301 CS 27.1301 CS 29.1301

8.7.1.5 Communication system.
Communication system(s), including data communication systems, shall be available to transmit data / information between tanker and receiver aircraft during the AAR operation 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.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the communication system(s) to be utilised during AAR operations.
2. Technical Publications should provide procedures for the conduct of AAR operations including communication between tanker and receiver aircraft.
3. Flight simulation and flight testing should demonstrate that AAR operations can be conducted effectively and safely, including effective communication between aircraft.

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 (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

8.7.1.6 Identification of fuels.
Permitted fuel types for AAR shall be defined.

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 aircraft;
d. Compatibility of different fuels with AAR system components;
e. Segregation of different types of fuel.
f. Adequate isolation between AAR fuel and aircraft fuel, when separation is required.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the types of fuel permitted for AAR operations, highlighting any restrictions applicable during carriage of any fuel type.
2. Technical Publications should detail the fuel types permitted for AAR operations and any restrictions applicable to each fuel type.
3. Rig, ground and flight testing should demonstrate that the aircraft and AAR system(s) can operate safely with any permitted fuel type.

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 aircraft is compatible with the aircraft 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 Delivery pressure and flow rate.
As a receiver, the aircraft (including AAR receipt subsystem) shall withstand the maximum pressure and flow-rate, including the effects of single failures and surge. As a tanker, the maximum dispense pressure and flow-rate shall be defined and constrained within the design limits of intended receivers, including the effects of single failures and surge.

Consideration should be given to:
a. Providing capability to regulate or limit dispense and receipt pressures and flow rates;
b. Ensuring adequate capacity and capability of the fuel vent system;
c. Effects of surge, including effects of pump start-up and shut-down, valve closures (in tanker and receiver aircraft), and disengagement AAR at maximum rate of flow.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the maximum permitted pressures and flow rates for AAR receipt, at the AAR inlet, and the maximum expected pressures and flow rates for AAR dispense at the AAR outlet. In each case, such detail should include the magnitude and frequency of any surge pressures.
2. Technical Publications should detail the procedures for AAR operations, including any detail necessary to limit the pressure and/or flow rates of AAR dispense/receipt, and/or prevention of surge pressures.
3. Analysis should demonstrate that during AAR operation at the maximum permitted flow rate and pressure, the various flow rates and pressures throughout the aircraft fuel system do not exceed their design allowables.
4. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis, and should demonstrate that AAR operations, including disengagement of AAR during AAR at the maximum flow rate does not result in permanent deformation of any part of the aircraft.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.4.7.2.1, 3.4.7.2.2 (Unverified)	*Def-Stan 00-970 Reference:*	00-970 P1 5.1.127 00-970 P1 5.2.3 00-970 P1 5.2.4

Information Sources			
			00-970 P1 S5 L4 00-970 P1 S5 L7 00-970 P13 S4 L9 1.3.3
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.1.8 Merged with 8.7.1.7

8.7.1.9 Fuel spray.

Fuel spillage/spray during AAR operations shall not prevent safe AAR operation.

Consideration should be given to:

a. AAR operation throughout the permitted flight envelope, including normal and abnormal conditions and attitudes;

b. Fuel spray dispersion pattern created during engagement and disengagement of the AAR interfaces;

c. Abnormal disengagements at full flow rates;

d. Effect on other aircraft in the vicinity;

e. Impact of single point failures including breakage of AAR probe/nozzle.

Considerations for preparation of AMC:

1. Rig and flight testing should demonstrate that any fuel spillage/spray during AAR operations is acceptable, and does not inhibit the safe flight of tanker or receiver aircraft.

2. System Safety Assessment (SSA) should demonstrate that the risk associated with fuel spray/spillage is appropriately controlled and mitigated.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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:*	

8.7.1.10 Flight stability and handling qualities.

The aircraft shall demonstrate satisfactory flight stability and handling characteristics throughout the aircraft's cleared AAR flight envelope at all permitted configurations in all permitted roles (tanker / receiver).

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. Variations in aircraft configurations;

d. Stability of tanker's hose, boom and probe.

Considerations for preparation of AMC:

1. Technical Publications should provide procedures for AAR operations including any restrictions/limitations on flight handling.
2. Flight simulation and flight testing should demonstrate the aircraft's ability to perform AAR operations successfully and safely throughout the aircraft's cleared AAR flight envelope at all permitted configurations.

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 23 Subpart B CS 25 Subpart B CS 25 Subpart G CS 27 Subpart B CS 29 Subpart B

8.7.1.11 Merged with Section 15.

8.7.1.12 Equipment safing.

It shall be possible to inhibit/disengage any aircraft system which could pose a hazard during AAR.

Consideration should be given to:
a. Ensuring that procedures are in place to control and/or mitigate hazards through the inhibition/disengagement of aircraft systems.
b. Ensuring that methods for inhibition/disengagement of hazardous aircraft systems is appropriate, which may include automating shut-down of hazardous systems on AAR rendezvous.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should highlight aircraft equipment/systems which pose a hazard to AAR operations, and their means of inhibition/disengagement.
2. Technical Publications should detail procedures for the inhibition/disengagement of aircraft systems prior to or during AAR operations.
3. System Safety Assessment (SSA) should demonstrate that hazards associated with aircraft systems and AAR operations are suitably controlled and mitigated.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1301 CS 25.1301 CS 27.1301 CS 29.1301

8.7.1.13 Spatial clearance between participating aircraft.
There shall be adequate clearance between AAR aircraft to allow for safe AAR operations.

Consideration should be given to:
a. The effect of performing AAR operations throughout all conditions for which AAR is permitted, including altitudes, weather conditions, flight rules, etc.
b. The effect of modifications to tanker and/or receiver aircraft which could reduce the available clearance.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the nominal and minimum clearance between tanker and receiver aircraft.
2. Technical Publications should provide procedures for safe AAR, including detail on achieving and maintaining adequate clearance between aircraft.
3. Flight simulations and flight testing should demonstrate that the clearance between aircraft during AAR operations (in receipt and/or tanker roles as applicable) is safe throughout the AAR operation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P13 S4 L9, 6.1
		STANAG Reference:	ATP 3.3.4.2(B)
FAA Doc:		*EASA CS Reference:*	

8.7.2 Safe installation and operation.
AAR operations, in receiver and/or tanker roles as applicable, shall meet an appropriate level of safety. In addition, no single failure shall result in loss of control or loss of the aircraft.

Consideration should be given to:
a. Defining an appropriate level of safety to be met, taking into account the type of the aircraft, its roles, and the frequency with which AAR operations will be conducted.
b. Effects of operation and failure of aircraft systems, and any subsequent effect on other aircraft systems.
c. Hazards associated with fuel, fuel systems, and potential leaks and subsequent ignition risks, and provision of adequate ventilation/drainage to prevent hazardous build-up.

Considerations for preparation of AMC:
1. The aircraft specification should detail the level of safety to be met for AAR.
2. Failure Modes and Effects Analysis (FMEA) should demonstrate that single failures in any aircraft system (including the AAR system) cannot not result in loss of control or loss of the aircraft.
3. System Safety Assessment (SSA) should demonstrate that hazards associated with the aircraft and AAR operations are suitably controlled and mitigated, and that the overall level of safety is acceptable.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	JSSG-2009: 3.2.7.4.4.1,	*Def-Stan 00-970*	00-970 P13 S3 3.5.39-3.5.41

Information Sources			
	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)	*Reference:*	00-970 P13 S4 L9
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.561, 23.1309 CS 25.561 CS 25.789 CS 25.1309 CS 27.561, 27.1309 CS 29.561, 29.1309

8.7.2.1 Minimization of hazards.

The AAR system shall be designed to minimise hazards from lightning, static electricity, fuel leaks, ignition sources and ground potential differences.

Consideration should be given to:

a. Ensuring that each hazard is identified and appropriately controlled and mitigated, to provide an acceptable level of safety.

b. Static electricity resulting from the potential difference between aircraft.

Considerations for preparation of AMC:

1. Functional Hazard Assessment (FHA) should identify the hazards associated with lightning, static electricity, fuel leaks, ignition sources and ground potential differences.
2. System Safety Assessment (SSA) should demonstrate that hazards associated with lightning, static electricity, fuel leaks, ignition sources and ground potential differences are appropriately controlled and mitigated.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 P1 4.27.36-4.27.39 00-970 P13 S3 3.5.16 00-970 P13 S3 3.5.18 00-970 P13 S3 3.5.26 00-970 P13 S3 3.5.39 00-970 P13 S4 L9 00-970 P1 S6 59-113 and 411 (for EMI/EMC)
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.581, 23.1316 CS 25.581 CS 25.954 CS 25.1316 CS 27.954, 27.1316 CS 29.954, 29.1316

8.7.2.1.1 Receptacle pressure box.

Receptacle installations shall have a fuel- and vapour-proof pressure box to collect any fuel spray that may occur during AAR. Probe compartments shall be fuel- and vapour-proof so that any fuel and vapour which may collect as a result of AAR operations is not able to migrate to other areas.

Consideration should be given to:

a. Venting and drainage of pressure box or probe compartments to prevent the build-up of hazardous quantities of fuel.

b. Isolation from potential ignition sources, including lightning.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the pressure box and/or probe compartment design, demonstrating that the pressure box collects fuel spray, and that the probe compartment prevents migration of fuel to other areas of the aircraft.

2. Functional Hazard Assessment (FHA) should demonstrate that the design of the pressure box and/or probe compartment provides adequate protection against ignition hazards.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 P13 S3 3.5.16 00-970 P13 S3 3.5.26 00-970 P13 S4 L9
		STANAG Reference:	3614
FAA Doc:		*EASA CS Reference:*	CS 25.954

8.7.2.1.2 Compartment drainage.

It shall be possible to drain the AAR compartments (receptacle pressure box, probe compartment, pod compartments, Hose Drogue Unit, etc.) without causing hazards to the aircraft, other aircraft or creating a potential hazard to personnel in all flight and ground conditions.

Consideration should be given to:

a. Ensuring that the capacity of the compartment is adequate to prevent over-flow.

b. Ensuring that the process for drainage of the compartment is easily achievable and safe.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the provisions for drainage of each AAR compartment.

2. Technical Publications should detail the procedures for safe drainage of each AAR compartment.

3. Rig, ground and flight testing should demonstrate that drainage of each AAR compartment is achievable in accordance with the defined procedures in ground and flight as applicable.

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

Information Sources			
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.975 CS 27.975 CS 29.975

8.7.2.1.3 Merged with 8.7.2.1.1.

8.7.2.1.4 Merged with 8.7.2.1.2.

8.7.2.1.5 Merged with 8.7.2.

8.7.2.1.6 Merged with 8.7.2.1.2.

8.7.2.1.7 Refuelling pump dry run capability.

Dry running of any AAR pump (i.e. the running of a pump not submerged in fuel) shall not create a potential ignition source.

Consideration should be given to:

a. The effect of failure of any safety device designed to prevent the dry running of AAR pumps.

b. The effect of running pumps when partially submerged and wholly unsubmerged.

Considerations for preparation of AMC:

1. Qualification Test Reports (QTR) should demonstrate that AAR pumps do not present a potential ignition source under prolonged dry run conditions.

2. Rig, ground and flight testing should demonstrate that the dry running of AAR pumps does not cause an unacceptable rise in temperature of the pump or any surrounding area.

3. System Safety Assessment (SSA) should demonstrate that the risk of ignition due to the dry running of any AAR pump is suitably controlled and mitigated.

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

8.7.2.1.8 Secondary barrier.

A secondary liquid and vapour-tight barrier shall be in place between the AAR fuel tanks and all identified fire and ignition hazard areas and inhabited areas.

Consideration should be given to:

a. Providing means to highlight the failure of the primary barrier.

Considerations for preparation of AMC:

1. Zonal Hazard Assessment (ZHA) should identify the fire and ignition hazard areas of the aircraft, and the inhabited areas of the aircraft.

2. System Description Documents (SDD) should detail the primary and secondary vapour-tight barriers in place between AAR tanks and fire and ignition hazard areas and inhabited areas.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 S3 3.5.26
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.2.1.9 Merged with 8.7.2.1.

8.7.2.1.10 Merged with 8.7.2.1.

8.7.2.2 Aircraft flight control/handling qualities.

Flight control/handling qualities of the aircraft shall not be unacceptably degraded when the AAR sub-system is installed or operating under normal AAR and single-failure conditions.

Consideration should be given to:

a. Normal installation and operating conditions the aircraft (in tanker and/or receiver role) in isolation, with the AAR sub-system in either stowed or deployed configuration

b. Ensuring that satisfactory flight stability and handling qualities are achievable for the tanker/receiver AAR interface within the specified AAR envelope.

Considerations for preparation of AMC:

1. Technical Publications should detail any flight handling limitations or restrictions with the AAR fitted, or when performing AAR operations.

2. Flight simulation and flight testing should demonstrate that the handling qualities of the aircraft are acceptable with AAR equipment fitted, and during AAR operations.

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:*	00-970 P13 Section 3.5
		STANAG Reference:	
FAA Doc:	14CFR reference: 23 Subpart B, 25 Subpart B, 27 Subpart B, 29 Subpart B	*EASA CS Reference:*	CS 23 Subpart B CS 25 Subpart B CS 25 Subpart G CS 27 Subpart B CS 29 Subpart B

8.7.2.2.1 Flight control/handling qualities degradation.

Failure of the AAR system preventing return to a fully stowed configuration shall not degrade flight handling qualities below safe limits, or prevent continued safe flight and landing.

Consideration should be given to:

a. Failure of both receipt and dispense subsystems in the extended positions.

b. The operation of jettison systems, and the result of failure of such systems.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail any design features incorporated to prevent degradation in flight handling qualities resulting from failure of AAR sub-systems.
2. System Safety Assessments (SSA) should demonstrate that the risk associated with failure of AAR retraction sub-systems is acceptable.
3. Flight simulation and flight testing should demonstrate that flight handling qualities are acceptable following failure of the AAR system preventing return to a fully stowed configuration, and during jettison of AAR equipment (if applicable).

Information Sources			
Comm'l Doc:	SAE ARP4761		
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:*	

8.7.2.2.2 Ram air turbine failure.
Ram Air Turbines (RAT) incorporated as part of the AAR system shall not unacceptably degrade flight control/handling qualities of the aircraft or prevent continued safe flight and landing.

Consideration should be given to:
a. Operation of the RAT in all flight phases.
b. Asymmetrical RAT operation.
c. Failure of the RAT in a deployed, stationary configuration.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should provide detail regarding any RAT(s) installed as part of the AAR system, and any associated safety devices.
2. Functional Hazard Assessment (FHA) should demonstrate that the hazards associated with the RAT cannot cause unacceptable system effects or flight handling qualities.
3. Failure Modes and Effects Analysis (FMEA) should demonstrate that the hazards associated with failure of the RAT are acceptable, and cannot prevent continued safe flight and landing.
4. Flight simulation and flight testing should demonstrate that installation, operation and failure of the RAT(s) does not prevent continued safe flight and landing.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 S3, 3.5.18
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.7.2.2.3 Jettison of stores/pods.

Jettison of AAR equipment shall not result in unacceptable flight handling qualities, or prevent continued safe flight or landing.

Consideration should be given to:

a. Defining an overall level of safety to be met, taking into account likely operational reasons for jettison of AAR equipment, and the frequency with which such jettison is expected.

b. Ensuring that the flight handling qualities of the aircraft following jettison of AAR equipment supports the expected aircraft missions following such jettison.

Considerations for preparation of AMC:

1. The aircraft specification should specify the requirement for jettison of AAR equipment if applicable.
2. System Description Documents (SDD) should detail provisions for jettison of AAR equipment (if required).
3. Functional Hazard Assessment (FHA) should demonstrate that hazards associated with jettison of AAR equipment are acceptably controlled and mitigated.
4. Rig, ground and flight testing should demonstrate that AAR equipment can be successfully and safely jettisoned.
5. Flight simulation and flight testing should demonstrate that flight handling qualities during and following jettison of AAR equipment are acceptable, and that jettison of AAR equipment does not prevent continued safe flight or landing.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

8.7.2.2.4 Hose jettison function.

It shall be possible to jettison any portion of AAR hose in a safe and timely manner without resulting in unsafe flight handling qualities, or preventing continued safe flight or landing.

Consideration should be given to:

a. Defining an overall level of safety to be met, taking into account likely operational reasons for jettison of AAR hose, and the frequency with which such jettison is expected.

b. Ensuring that the flight handling qualities of the aircraft following jettison of AAR hose supports the expected aircraft missions following such jettison.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail provisions for jettison of AAR hose.
2. Functional Hazard Assessment (FHA) should demonstrate that hazards associated with jettison of AAR hose are acceptably controlled and mitigated.
3. Rig, ground and flight testing should demonstrate that AAR hose can be successfully and safely jettisoned.

4. Flight simulation and flight testing should demonstrate that flight handling qualities during and following jettison of AAR hose are acceptable, and that jettison of AAR hose does not prevent continued safe flight or landing.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P13 S4 L9 00-970 P13 S3, 3.5.57
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

8.7.2.3 Egress with unstowed equipment.

The in-flight egress, ground emergency egress, and assisted egress of any crewmember of either tanker or receiver aircraft shall not be hindered when the AAR system interface cannot be returned to its fully stowed configuration.

Consideration should be given to:

a. All methods of egress, including ejection or use of any provided emergency escape.

b. Failure of AAR equipment in any combination of un-stowed configuration (for example more than 1 hose extended).

Considerations for preparation of AMC:

1. Functional Hazard Assessment (FHA) should demonstrate that hazards associated with emergency egress with AAR equipment in an un-stowed configuration are acceptable.
2. Technical Publications should provide procedures for emergency egress with AAR equipment fitted and in an un-stowed condition.
3. Rig, ground and flight testing should demonstrate that emergency egress is not hindered by the AAR equipment in an un-stowed condition.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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:*	00-970 P13 S4 L9 7.4.1
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 25.809 CS 23.1309 CS 25.1309 CS 27.1309 CS 29.809, 29.1309

8.7.2.4 Built-in-test and fault isolation.

AAR systems shall incorporate Built In Test (BIT) functions and fault isolation provisions to maximise the safety of AAR operations.

Consideration should be given to:
a. Ensuring that the use of BIT functions and fault isolation provisions is simple and can be utilised at all appropriate times (during ground maintenance, pre-flight checks, AAR rendezvous, etc.).

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail BIT functions and fault isolation provisions incorporated into the design of the AAR system.
2. Technical Publications should detail procedures for the use of AAR BIT functions and fault isolation provisions.
3. Rig, ground and flight testing should demonstrate that AAR BIT functions and fault isolation provisions function as intended.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: 3.2.9, 3.2.9.1, 4.2.9 00-970 P13 S4 L9 7.4.1	*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 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

8.7.3 Removal of AAR equipment.
The aircraft shall have acceptable handling qualities and safety of flight in all permitted configurations of the AAR equipment.

Consideration should be given to:
a. Removable hardware, which may include AAR pods, fuel tanks and AAR probe installations;
b. All permitted flight configurations (e.g. partial installation of the AAR system).

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the permitted flight configurations.
2. System Safety Assessment (SSA) should demonstrate that hazards associated with the AAR system in all allowable configurations of the AAR hardware are acceptable and appropriately controlled and mitigated.
3. Technical Publications should provide procedures for use of the AAR system and any flight handling limitations/restrictions, for all allowable configurations of the AAR system.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1301 CS 25.1301

Information Sources			
			CS 27.1301 CS 29.1301

8.7.3.1 Removal of AAR equipment effect on other-system interfaces
With AAR equipment removed, interfaces with other systems (e.g., electrical, hydraulic and fuel) shall be safe.

Consideration should be given to:
a. Electrical, hydraulic and fuel system components, leads, pipes and assemblies, ensuring that all interfaces are properly covered, sealed, isolated, etc.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the various configurations in which AAR equipment installation is permitted, and for each configuration, provisions for the isolation of system interfaces not in use.
2. Technical Publications should provide procedures for the isolation of system interfaces when not in use.
3. Rig, ground and flight tests should demonstrate that interface isolation is effective when all or part of the AAR system is removed.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009: F.3.4.6.1.5, F.4.4.6.1.5; G.3.4.7.3, G.4.4.7.3	*Def-Stan 00-970 Reference:*	00-970 P13
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

8.7.3.2 Merged with 8.7.3.

8.7.3.3 AAR equipment removal effect on operation of other systems.
Removal of AAR equipment shall not unacceptably degrade the operation of the other aircraft systems.

Consideration should be given to:
a. Electrical, hydraulic and fuel system components, leads, pipes and assemblies;
b. Impact of removal or the AAR equipment on the operation of the remaining aircraft systems.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the various configurations in which AAR equipment installation is permitted, and should highlight any degradation in any aircraft system due to partial installation or removal of the AAR system.
2. Technical Publications should detail any limitations/restrictions in place due to partial installation or removal of the AAR system.
3. Rig, ground and flight tests should demonstrate that all aircraft systems operate acceptably with the AAR system partially installed or removed.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.3.11.1.1-3.3.11.1.3 JSSG-2009: F3.4.6.1.5, F.4.4.6.1.5 MIL-STD-1797	*Def-Stan 00-970 Reference:*	00-970 Part 13 Section 3, 3.5
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

8.7.4 Merged with 8.7.1.

8.7.4.1 Exposure of components to proof pressure.

AAR system plumbing/components shall withstand exposure to the specified proof pressure without resulting in excessive or permanent deformation, fuel leakage and/or degradation of system performance.

Consideration should be given to:

a. Ensuring that appropriate proof pressures are defined, which should be greater than the maximum expected system pressure, including pressure transients (surges).

Considerations for preparation of AMC:

1. System Description Documents (SDD) should define the proof pressure of the AAR system.
2. Analysis should demonstrate that pressures in the AAR system do not exceed the defined proof pressure, including all expected operating conditions.
3. Analysis should demonstrate that AAR system components and their supports are able to withstand the defined proof pressure without excessive or permanent deformation, fuel leakage and/or degradation of system performance.
4. Rig, ground and flight testing should demonstrate the accuracy of the performed analysis, and should demonstrate that AAR system pressures do not exceed the defined proof pressure, and that the AAR system operates without excessive or permanent deformation, fuel leakage and/or degradation of system performance.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	ARSAG 00-03-01, "Pressure Defs & Terms, Mar '03.doc" 3.5 and 4.7 (unverified) 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:*	

8.7.4.2 Functional modes.

Critical operational functions and functional modes shall be provided in the AAR system to ensure the AAR operations 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. Emergency extensions or retractions of the AAR probe system.

Considerations for preparation of AMC:
1. Functional Hazard Assessment (FHA) should state the critical operational functions and functional modes and demonstrate that hazards associated with AAR operations are acceptable.
2. System Safety Assessment (SSA) should capture the hazards associated with critical operational functions and functional modes associated with AAR operations, and show that they are are acceptable and appropriately controlled and mitigated.
3. Ground and flight testing should demonstrate that the functional modes permitting AAR can be conducted without causing loss of aircraft or creating hazards to personnel.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 23.1301, 23.1309 CS 25.979 CS 25.1301 CS 25.1302 CS 25.1309 CS 27.1301, 27.1309 CS 29.979, 29.1301, 29.1309

8.7.4.3 AAR Operator Control
Adequate controls shall be provided and properly located for the appropriate crewmember(s)/operator(s) to activate and safely control the critical functions of the AAR system.

Consideration should be given to:
a. Critical functions.
b. Anthropometric ranges of AAR operators.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the controls provided to flight crew for the control of AAR functions.
2. System Safety Assessment (SSA) should demonstrate the crew member/operator(s) ability to carry out the critical AAR operational functions.
3. Functional Hazard Assessment (SSA) should demonstrate the crew member/operator(s) ability to carry out the critical operational functions and functional modes and demonstrate that hazards associated with AAR operations are acceptable.
4. Workload and Anthropometric assessment should demonstrate that the crewmember(s)/operator(s) can safely activate and control the various functions of the AAR system.
5. Flight simulation and flight testing should demonstrate that controls are suitably located and provide the crew with the ability to safely initiate and control AAR functions.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 23.771 CS 25.771 CS 25.1353 CS 27.771 CS 29.771, 29.1353

8.7.4.4 Display provisions.

Displays shall be provided and properly located to provide the appropriate crewmember(s)/operator(s) with the information necessary to safely perform AAR operations.

Consideration should be given to:

a. Display visibility, location, and background/ambient lighting conditions, taking into account day and night operation;

b. Clarity of displays and, if relevant, choice of colours and icons (consider international standards and interoperability requirements).

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the AAR displays provided, the various indications and other information that the displays provide to crew, and the situations/logic that will lead to each indication.
2. Technical Publications should provide procedures for safe AAR operations, including detail on the various indications that could be provided to aircrew, and the actions that aircrew should subsequently take.
3. Rig, ground and flight testing should demonstrate that displays function as expected, and that AAR operations can be conducted safely in accordance with the provided procedures, using the provided displays effectively.

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:*	CS 23.1321 CS 25.1321 CS 27.1321

Information Sources			
			CS 29.1321

8.7.4.5 Display lighting.

The intensity of displays shall be variable and compatible with Night Vision Devices (NVD) where such devices are permitted for use on the aircraft.

Consideration should be given to:

a. An appropriate range of intensity variation, taking into account the type and role of the aircraft, and the possibility for reducing intensity to the point that it may become difficult to discern the content of displays accurately.

b. The types of NVD with which the displays should be compatible.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the provisions for variation of AAR display intensity, and compatibility with NVD.

2. Flight simulation and flight testing should demonstrate that displays function as intended, providing adequate intensity variation, and NVD compatibility.

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 4.15.63 00-970 P1 4.15.48
		STANAG Reference:	3224 3800
FAA Doc:		*EASA CS Reference:*	

8.7.5 Compatibility with other systems.

Installation and operation of the AAR system shall not unacceptably degrade the operation, function, performance, or safety of other aircraft systems.

Consideration should be given to:

a. Aircraft systems with which the AAR system has direct interfaces, such as hydraulic, electrical, fuel, and avionics systems, including fuel management sub-systems.

b. Aircraft systems with which the AAR system does not have direct interfaces, but which it may otherwise affect, such as flying controls.

c. The effect of AAR pressures in aircraft fuel systems, and hazards associated with any resulting leaks in either (AAR or fuel) system.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the systems with which the AAR system has direct interfaces, and any other systems which the AAR system may affect.

2. Systems Interface Documents (SID) should detail the parameters at each interface between the AAR system and other systems.

3. Analysis should demonstrate, for each aircraft system, that the load induced by the AAR system does not result in unacceptable performance of the aircraft system, or any other power-operated system.

4. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that the performance of all aircraft systems remains acceptable throughout AAR operations.

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 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

8.7.5.1 Merged with 8.7.5.

8.7.5.2 Merged with 8.7.1.6.

8.7.5.3 Merged with 8.7.1.5.

8.7.5.4 Field of view.

The field of view of the crew member(s)/operator(s)/automated system(s) shall be adequate for AAR operations, and other aircraft operations.

Consideration should be given to:

a. Normal operation of the AAR system (i.e. probe or pod fitted / stowed / extended);

b. Failure of retractable elements to return to the fully stowed configuration;

c. Safety critical flight phases.

Considerations for preparation of AMC:

1. Analysis should demonstrate that any restriction in the field of view in any direction, caused by the installation or use of AAR equipment is acceptable.

2. Flight simulation and flight testing should demonstrate that the installation and use of AAR equipment does not cause unacceptable restriction in the available field of view, and cannot prevent continued safe flight or landing.

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:*	

8.7.5.5 Merged with 8.7.5.

8.7.5.6 Effects of electrical failure(s).

Electrical failures within the AAR system shall not prevent the continued safe function of the aircraft electrical system, or any other power-operated system.

Consideration should be given to:

a. Providing a means to electrically isolate the AAR system from the main electrical system in the event that a failure occurs.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail provisions for the electrical isolation of AAR equipment from the aircraft's electrical system.
2. Failure Modes and Effects Analysis (FMEA) should demonstrate that any electrical failure of the AAR system cannot lead to failure of the aircraft's electrical system, or prevent operation of any other power-operated system.
3. Technical Publications should provide procedures for the electrical isolation of the AAR system, and, where appropriate, its sub-elements.
4. Rig, ground and flight testing should demonstrate that the AAR system can be electrically isolated in accordance with defined procedures.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 3.5.18 00-970 P1 S6
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

8.7.5.7 Merged with 8.7.5.
8.7.5.8 Merged with 8.7.5.
8.7.5.9 Merged with 8.7.5.
8.7.5.10 Merged with 8.7.2.2.1.
8.7.5.11 Merged with 8.7.2.2.4.
8.7.5.12 Merged with 8.7.5.
8.7.5.13 Merged with 8.7.5.

8.8 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 aircraft 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.

8.8.1 Functionality.

Mechanisms shall perform their intended function(s) throughout all expected operating environments and conditions.

Consideration should be given to:

a. The failure of power supply systems, actuators, and linkages, and the resulting effect on aircraft functions.

b. The varying operating environments through which operation is expected, including temperatures, humidities, dust and sand, frosting and icing, and operation under load.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the mechanisms incorporated in the design of the aircraft, their source of power, and their function(s).
2. Failure Modes and Effects Analysis (FMEA) should demonstrate that the risk of failure of each mechanism is acceptable.
3. Rig, ground and flight testing should demonstrate that mechanisms operate as intended through all expected operating conditions.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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

Information Sources			
			CS 29.809 CS 29.1301 CS 29.1309

8.8.2 Effects of jams.

The jamming of mechanisms (e.g. due to inadvertent interference between parts) shall not result in damage or permanent deformation to any latch or support structure.

Consideration should be given to:

a. The various locations at which a mechanism could jam, and the resulting forces throughout the mechanism, and on any latches or support structure.

b. Preferred points of failure of the mechanism, taking into account its fail-safe design, maximisation of airworthiness, and provisions for access for maintenance.

Considerations for preparation of AMC:

1. Structural analysis (static, dynamic and kinematic) should identify the point(s) of failure of the mechanism and the loads through each mechanism component, latch and supporting structure through expected and possible ranges of movement.

2. Rig testing should demonstrate the accuracy of the performed analysis, and should demonstrate that the jamming of mechanisms cannot result in damage or permanent deformation of any latch or support structure.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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: 3.1.4.9; 3.1.5.9; 4.1.4.9; 4.1.5.9 - inactive for new design	*Def-Stan 00-970 Reference:*	00-970 P1 4.20.5 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

Information Sources			
			CS 29.1301 CS 29.1309

8.8.3 Failure effects.

Failure of any mechanism shall not cause the loss of control of the aircraft, or prevent continued safe flight and landing.

Consideration should be given to:

a. The varying modes through which each mechanism could fail, taking into account the loads through each mechanism at all points in their travel.

b. All possible effects of failure, including direct effects (e.g. the failure of actuated flight control surfaces) and indirect effects (damage to surrounding structure and equipment, severing of hydraulic lines, electrical cables, fuel lines, etc.).

c. The effective mitigation of failure, for example ensuring that the failure of a primary mechanism does not cause the failure of a secondary (back-up) mechanism.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail any design features which provide controls and/or mitigations for the failure of mechanisms.
2. Structural analysis (static, dynamic and kinematic) should identify the point(s) of failure of the mechanism, and the travel of the mechanism at each failure.
3. Failure Modes and Effects Analysis (FMEA) should demonstrate that the failure of any mechanism cannot cause the loss of control of the aircraft, or prevent continued safe flight and landing.
4. Rig, ground and flight testing should demonstrate that any controls and/or mitigations provided to reduce the risk of failure of any mechanism functions correctly.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 CS 23.1309 CS 25.601 CS 25.783 CS 25.1301 CS 25.1309 CS 27.601 CS 27.1301

Information Sources			
			CS 27.1309 CS 29.601 CS 29.783 CS 29.1301 CS 29.1309

8.8.4 Independence from flight controls.

Operation (commanded, inadvertent or uncommanded) of any non flight control system mechanism shall not restrict or prevent the correct operation of any flight control system mechanism.

Consideration should be given to:

a. All non flight control system mechanism, and any potential interference or other conflict that could arise with any flight control system mechanism.

b. Potential interference or other conflict at the pilot/crew interface, at the flight control surface, and at any point in between.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should demonstrate independence between flight control system mechanisms and mechanisms for other systems/functions.

2. Zonal Safety Assessment (ZSA) should confirm the independence between flight control system mechanisms and mechanisms for other systems/functions.

3. Flight simulation, ground and flight testing should demonstrate that operation of other controls does not restrict or prevent the correct operation of any flight control system mechanism.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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

Information Sources			
			CS 27.1301 CS 27.1309 CS 29.601 CS 29.607 CS 29.783 CS 29.1301 CS 29.1309

8.8.5 Fail-safe latching.
No single failure shall allow any latch to open inadvertently.

Consideration should be given to:
a. Failures of each latch, and other failures that could lead to the inadvertent opening of latches (e.g. failure of hinges that could cause excessive loads on latches).

Considerations for preparation of AMC:
1. Structural analysis should identify the point(s) of failure of latches and any other part that could directly cause the inadvertent opening of latches.
2. Failure Modes and Effects Analysis (FMEA) should demonstrate that the failure of latch or any other part does not cause the inadvertent opening of latches.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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

8.8.6 Interrelation of latching and locking systems.

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. The latching and locking sequence, and the effect of any latch not being in the fully secured position.

b. Ensuring that any locked indications are only provided when all latches are fully secured, and locked.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail any provision for the locking of latches, and means preventing the locking of latches in an unsecured position.

2. Failure Modes and Effects Analysis (FMEA) should demonstrate that the failure of any latch in an unsecured position cannot lead to the locking of latches or indication of a locked mechanism.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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: 4.1.5.7 - 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 4.23.10
		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

8.8.7 Door pressurisation interlock.

All aircraft doors, whose inadvertent opening would present a probable hazard to continued safe flight and landing, shall have provisions to prevent depressurisation or inadvertent pressurisation of the aircraft to an unsafe level when the doors are closed but not fully secured (closed, latched, and locked).

Consideration should be given to:

a. The levels of depressurisation and inadvertent pressurisation considered hazardous to the continued safe flight and landing of the aircraft.
b. Means for preventing the inadvertent opening of aircraft doors that are closed but not secured.
c. Means for preventing the depressurisation of the aircraft cabin when aircraft doors are closed but not secured.
d. Means for preventing the inadvertent pressurisation of the aircraft cabin when aircraft doors are closed but not secured.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the provided means to prevent the inadvertent opening of aircraft doors, and the depressurisation and inadvertent pressurisation when the aircraft doors are closed but not secured,
2. Rig, ground and flight testing should demonstrate that when any aircraft door that could affect continued safe flight and landing is closed but not secured:
a. The door cannot be inadvertently opened.
b. The aircraft cabin cannot depressurise.
c. The aircraft cabin cannot inadvertently pressurise.

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

8.8.8 Operator interface.
Adequate information shall be available to notify the flight crew of the status of aircraft door and mechanism security; i.e. that an unsafe indication is provided when a door/mechanism, latching, or locking system is unsecured, and that a safe indication is provided when aircraft doors and other mechanisms are secured

Consideration should be given to:

a. Clear presentation of relevant information to crew, including status indication, and warning, caution and advisory information.
b. Ensuring that changes in the aircraft door/mechanism status are highlighted to the crew in a clear and unambiguous manner.
c. Ensuring that any required pilot/crew input or intervention is clearly and unambiguously identified.
d. Ensuring that, where pilot/crew action is required in accordance with an emergency procedure, checklist or other Technical Publication, the relevant section of the Technical Publication is clearly defined such that the pilot/crew can intervene with minimal delay.
e. Ensuring that any credible combination of failures does not prevent the accurate notification of system operating conditions.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should identify the indications/displays provided to crew including where appropriate the conditions that would lead to specific indications.
2. System Description Documents (SDD) should clearly define the possible system operating conditions and the operating parameters that trigger each condition.
3. Analysis (e.g. System Simulations) should demonstrate that system status information and changes in system operating conditions are provided to the crew throughout all foreseeable aircraft operating conditions.
4. Rig and/or Ground Testing should verify the accuracy of the performed analysis, including the effect of system/equipment failures.
5. Flight Simulations, Ground Testing and/or Flight Testing should verify that the system status information and changes in operating conditions are displayed clearly and unambiguously, and that emergency procedures, checklists and other Technical Publications can be used effectively.

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

Information Sources			
			CS 29.1309

8.8.9 Merged with 9.1

8.8.10 Door seals.

All door seals shall prevent rain or water leakage into the aircraft during all flight and ground operations, and while the aircraft is parked and depressurised under storm conditions.

Consideration should be given to:

a. The effect of variation in aircraft attitude, and positions of moveable components.

b. The effect of reasonably expected deterioration of seals prior to their replacement.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail provisions for the prevention of water ingress.

2. Rig, ground and flight testing should demonstrate the effectiveness of seals or other devices, and should demonstrate that no water enters the cabin on the ground or in flight during 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 Canopies: 3.1.10.2; 4.1.10.2 - inactive for new design	*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 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

8.8.11 Merged with 8.8.1.

8.8.12 Locking of structural load path mechanisms.

Mechanisms that also provide a structural load path, shall be fail-safe. I.e. failure of the mechanism shall not result in failure of the structural load path.

Consideration should be given to:

a. Ensuring that mechanisms fail in a suitable position, for example with a flight control surface in a central position.
b. Ensuring that any locking required to secure a failed mechanism is either automatic or easily achievable by the pilot/crew and documented in necessary technical publications.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail fail-safe provisions for all mechanisms that also provide a structural load path, and the range of positions the mechanisms may fail in.
2. Structural analysis should confirm that failure of any mechanism that also provides a structural load path does not result in failure of that structural load path.
3. Aerodynamic analysis and/or testing should demonstrate that the failure of any mechanism in any possible position, but while still acting as a structural load path, does not result in loss of control or prevent the continued safe flight and landing of the aircraft.

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:*	

8.8.13 Merged with 8.8.8.

8.8.14 Utility actuation control.

Utility actuation mechanisms (those mechanisms provided for functions not critical to flight) shall permit controlled operation of normal and emergency functions and shall provide separate means for motion control and locking.

Consideration should be given to:
a. Ensuring adequate separation between motion control and locking, such that both actuation power and control for moving the mechanism to its commanded position are independent from the power and control used to hold the mechanism in a given state.
b. Preventing inadvertent actuation of mechanisms, including through controls (e.g. by the incorporation of guards) and through extraneous interference (e.g. electromagnetic interference).

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail any utility systems and their mechanisms, highlighting the separate controls for their actuation and their locking.
2. Failure Modes and Effects Analysis (FMEA) should demonstrate that failure of the actuation means or locking means of any utility system does not result in a hazardous effect that could prevent continued safe flight and landing.
3. Rig, ground and flight testing should demonstrate that the controls provided for utility systems allows for controlled actuation and locking of its mechanisms.

Information Sources	

Information Sources			
Comm'l Doc:	SAE ARP4761		
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:*	

8.8.15 Safety devices for manual operation.

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 and shall incorporate means of controlling deployment speed to a specified safe rate.

Consideration should be given to:

a. Preventing inadvertent mechanism operation (incorporation of mechanical locks, circuit breaker lock-out collars, manually operated valves, etc.);

b. Ensuring that manual system operation does not require personnel access near power-operated moving parts;

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail any provisions for manual operation of mechanisms and the safety devices provided to maximise the safety of its operator.
2. System Safety Assessment (SSA) should demonstrate that the risk of injury when operating any manually operated mechanism is acceptable.
3. Technical Publications should detail procedures for the operation of manually operated mechanisms, highlighting any parts of the procedure required to ensure the safety of personnel.
4. Rig and ground testing should demonstrate that manually operated mechanisms can be operated in accordance with the Technical Publications effectively and safely.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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

8.8.16 Utility actuation systems with ground power.

Utility actuation mechanisms (those mechanisms provided for functions not critical to flight) shall be capable of operating from ground power, and separately, from aircraft power.

Consideration should be given to:

a. Ensuring adequate system/mechanism performance for each and all sources of power, including transitions from one source of power to another.

b. Ensuring that system safety is unaffected by the source of power, including the control, indication and sequencing of mechanisms.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail any utility systems and their power supplies.
2. Rig, ground and flight testing should demonstrate the correct function of each utility system, and where possible during aircraft operation the concurrent operation of multiple utility systems using each and all sources of power, including transition from one power source to another.

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; 4.4.9.4.6	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.8.17 Actuation time.
All actuation subsystems shall:
a. Safely perform their specific functions within the specified times and number of cycles;
b. Repeatedly perform their specific functions within an acceptable interval; and,
c. Have an acceptable expected life, taking into account the performance and expected usage of the mechanism.

Consideration should be given to:
a. The actuation times and cycles for each subsystem;
b. Ensuring the time between successive operations of the same cycle is not degraded over time and can be consistently repeated, throughout 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 aircraft operational requirements;
e. Ensuring that common cycles between related systems that operate in conjunction with one another are taken into account.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the actuation time and/or number of actuation cycles required for each mechanism.
2. Equipment testing should demonstrate that actuators and mechanisms can withstand the required number of cycles without failure.
3. Technical Publications should define replacement intervals for mechanisms and their actuators.

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:	

Information Sources			
FAA Doc:		*EASA CS Reference:*	

8.8.18 Actuation without damage.
Utility actuation mechanisms shall 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. Environmental effects (such as wind, temperature and snow/ice).

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the design features incorporated to prevent utility actuation mechanisms from causing damage to movable surfaces during folding and unfolding operations.
2. Technical Publications should detail procedures to prevent damage to moveable surfaces during folding and unfolding operations.
3. Rig and ground testing should demonstrate that folding and unfolding operations can be performed in accordance with defined procedures without causing interference or damage between utility mechanisms and moveable surfaces.

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:*	

8.8.19 Actuation subsystem attachment location.
Actuation subsystem attachments shall not form an integral part of aircraft structure, such that failure of attachments does not cause failure of structure, and such that attachments are replaceable without the replacement of aircraft structure.

Consideration should be given to:
a. Ensuring that fastening means for securing attachments to structure allow for the replacement of attachments.
b. Providing frangible design features to ensure that attachment points fail before any excessive or permanent deformation of aircraft structure.
c. Providing adequate access to attachment points to allow for their installation and removal.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the attachment means for each mechanism, highlighting separation from aircraft structure.
2. Structural analysis should demonstrate that overload of a mechanism causing failure of the attachment point cannot result in excessive or permanent deformation of aircraft structure.

3. Technical Publications should detail the procedures for replacement of each mechanism attachment point.

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:*	

8.8.20 Mechanism clearances.

Sufficient clearance shall be maintained between mechanisms and other parts of the aircraft and the ground such that inadvertent interference/contact is impossible throughout the travel of the mechanisms in all ground and flight conditions.

Consideration should be given to:

a. Critical combinations of landing gear deflections (including flat tyres, compressed landing gear, etc.) and aircraft loading conditions.

b. Variation in mechanisms throughout the aircraft's life, including the effects of wear, adjustment of parts, and variation in part dimensions (i.e. tolerances).

c. Environmental effects (such as wind, temperature and snow/ice).

Considerations for preparation of AMC:

1. Structural analysis should demonstrate that inadvertent interference/contact is impossible throughout the travel of mechanisms in all ground and flight conditions.
2. Rig, ground and flight testing should verify the accuracy of analysis performed and should demonstrate that inadvertent interference/contact between mechanisms does not occur in critical ground and flight conditions.
3. Technical Publications should detail procedures for adjusting mechanisms to ensure that inadvertent interference/contact does not occur, taking into account the effects of flight conditions.

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:*	

8.8.21 Manual actuation provisions for ground operations.

Mechanisms used during ground operations or maintenance shall have manual means of operation to allow operation during power-off conditions.

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.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the means provided for manual operation of mechanisms used during ground operation, and the means provided for manual operation of other mechanisms used during maintenance.
2. Technical Publications should detail procedures for use of manual operation means for mechanisms to be used during ground operations, and those to be used during maintenance.

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:*	

8.8.22 Clear display of locked/unlocked status.
The locked-unlocked condition of mechanisms used during ground operations shall be visually displayed, externally, internally, or both if appropriate, by purely mechanical, non-electric means.

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 aircraft 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 position that a maintainer could be expected to be at during the actuation cycle.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the means provided to indicate the locked-unlocked condition of mechanisms to ground crew.
2. Technical Publications should detail procedures for working around mechanisms, highlighting the means for ensuring that mechanisms are secured, and the indications provided to ground crew.

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	4671.783

Information Sources			
		Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.783 CS 25.783 CS 29.783

8.8.23 Securing of aircraft doors on the ground.

For ground operation with power off, means shall be provided to hold the aircraft 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 which personnel can access safely. Subsequent power operation of the doors, with these means left in place, shall not result in damage.

Consideration should be given to:

a. Ensuring that the means for holding the doors in the open or closed position are either automatic, or that the procedure for their use is clearly displayed.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the design features incorporated to secure the aircraft doors in the open and closed positions.
2. Structural analysis should demonstrate that, with the doors secured in the open or closed positions, actuation of the doors does not result in excessive or permanent deformation of any part.
3. Technical Publications should detail procedures for the securing of the aircraft doors in their open and closed positions, and releasing such security to enable to opening or closing of the doors.

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 Reference:*	CS 23.783 CS 25.783 CS 29.783

8.8.24 Aborted and resumed operation of controls.

Door 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.

Consideration should be given to:

a. 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 hydraulic fluid bleeding down after hydraulic system power is shut off or loss of electrical power.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail controls provided for the operation of doors, and the effect of aborting and resuming door actuation.

2. Failure Modes and Effects Analysis (FMEA) should demonstrate that the effects of failure (e.g. loss of power) does not result in an unacceptable risk.
3. Rig, ground and flight testing should demonstrate that doors function as expected in ground and, where applicable, flight conditions.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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

8.8.25 Merged with 8.9.24

8.8.26 In-flight actuation prevention for ground only systems.

Actuation systems designed for ground-only operation shall incorporate means to prevent in-flight actuation. All mechanical and powered locks and actuators shall be designed to prevent undesired surface positioning in flight. In the case of flight critical surfaces, control of any fold sequence shall require two separate and deliberate actions.

Consideration should be given to:
a. Utilising a “weight-on-wheels” (WOW) switch to prevent operation of ground-only actuating subsystems.
b. Ensuring that the incorporated means of preventing actuation in flight provides adequate protection.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the means to prevent operation in flight for all ground-only systems and mechanisms.
2. SDD should detail the design features incorporated to prevent undesired surface positioning in flight.
3. SDD should detail the inputs requured to control flight-critical fold mechanisms, ensuring that at least two separate and deliberate actions are required.
4. Failure Modes and Effects Analysis (FMEA) should demonstrate that the risk of failure of any protection means for ground-only systems/mechanisms is acceptable.
5. System Safety Analysis (SSA) should demonstrate that the hazards associated with in-flight operation of ground-only systems/mechanisms, undesired surface positioning in flight, and inadvertent folding are adequately controlled and mitigated.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	JSSG-2009, Appendix I: I.3.4.9.4.2/I.4.4.9.4.2	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.8.27 Prevention of inadvertent actuation.

Actuation systems shall incorporate positive locking features which do not depend on any power source to remain engaged to prevent inadvertent actuation following the activation and subsequent relief of safety devices such as thermal switches, fuses etc.

Consideration should be given to:

a. Ensuring that the locking features provide adequate mitigation of risk of inadvertent actuation, taking into account the effect of such inadvertent actuation on flight safety.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the positive locking features which prevent inadvertent actuation following the activation and subsequent relief of safety devices.
2. System Safety Analysis (SSA) should demonstrate that the risk associated with inadvertent operation of mechanisms following the activation and subsequent relief of safety devices is adequately controlled and mitigated.
3. Rig, ground and flight testing should demonstrate that mechanisms cannot be inadvertently operated following the activation and subsequent relief of safety devices.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	JSSG-2009, Appendix I: I.3.4.9.4.2/I.4.4.9.4.2	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

8.8.28 Strength of removable devices for mechanism securing.

Removable devices fitted for the purpose of securing mechanisms and surfaces in any given position shall have strength equal to or exceeding that of the aircraft.

Consideration should be given to:

a. Removable surface securing devices used in lieu of integral locks;
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 aircraft 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 aircraft 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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail any provisions for removable devices for securing mechanisms or surfaces.
2. Structural analysis should demonstrate that the removable devices are stronger than the part(s) of the aircraft which they secure.

3. Technical Publications should detail the procedures for the installation and removal of removable devices and the maintenance activities that can take place with and without such removable devices installed.

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:*	

8.8.29 Performance of bearings.

Airframe bearing selection and installation shall permit safe mechanical operation / function in each application, and shall be capable of:

a. Joining mechanical elements;

b. Transmitting design loads through the full range of the system operating parameters;

c. Permitting rotation, misalignment, or both while maintaining a specified dimensional relationship between the joined elements;

d. Reducing friction and wear; with appropriate limits for deviation/tolerance.

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).

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the use of bearings, including their type and size.

2. Structural analysis should demonstrate that selected bearings are suitable for their application.

3. Rig, ground and flight testing should demonstrate that mechanisms function correctly, and that bearings do not fail or excessively wear.

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

Information Sources			
			CS 25.613 CS 25.657 CS 25.693 CS 27.603 CS 27.613 CS 29.603 CS 29.613

8.8.30 Life limit of bearings.

Each flight safety critical bearing shall have defined safe life limits which account for their operation in worst case environmental conditions.

Consideration should be given to:

a. Worst case operating conditions for each bearing, taking into account frequency of actuation, environmental effects, and effects of operation under load.

b. Ensuring that bearings are fail-safe, i.e. that failure of a bearing does not result in failure of a flight critical mechanism.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should highlight each flight critical bearing.

2. Technical Publications should include safe life limits for each flight safety critical bearing, and procedures for their replacement.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2009, Appendix I: I.3.4.9.2/I4.4.9.2 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

8.8.31 Endurance of mechanisms.

Safety of Flight critical mechanisms shall have sufficient endurance to preclude adverse safety effects throughout their service life.

Consideration should be given to:

a. Worst case operating conditions for each mechanism, taking into account frequency of actuation, environmental effects, and effects of operation under load.
b. Ensuring that mechanisms are fail-safe, i.e. that failure of a mechanism does not result in total failure of the subsystem.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should highlight each flight critical mechanism.
2. Fatigue analysis should demonstrate that mechanisms and their attachments points withstand the loads applied throughout their service life.
3. Technical Publications should include safe life limits for each flight safety critical mechanism, and procedures for their replacement.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P1 S4 4.5.4 00-970 P1 S4 4.12.27 00-970 P7 S2 Supplement 4 L407 Para 2.1
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.603 CS 23.619 CS 23.627 CS 25.603 CS 25.619 CS 27.603 CS 27.619 CS 29.603 CS 29.619

8.8.32 No binding or jamming of flight critical mechanisms.
Safety of flight critical mechanisms shall not cause binding or jamming with surrounding structure or any portion of the system under expected operating conditions.

Consideration should be given to:
a. Temperature effects;
b. Air loads;
c. Landing loads;
d. Structural deflections;
e. Tire condition;
f. Landing gear condition; and,
g. Critical combinations of manufacturing tolerances and/or wear.

Considerations for preparation of AMC:
1. Structural analysis (static, dynamic and kinematic) should demonstrate that the loads through each safety of flight critical mechanism component does not cause binding or jamming with surrounding structure or any portion of the system, through expected and possible ranges of movement.
2. Rig testing should demonstrate the accuracy of the performed analysis, and should demonstrate that safety of flight critical mechanisms do not jam under expected operating conditions.

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

8.9 CARGO HOOK SYSTEMS.

8.9.1 No adverse effects on safety.

Cargo Hook systems shall be safe for their intended use.

Consideration should be given to:

a. Usage parameters for the cargo hook equipment (weight limits, duration and frequency of use, aircraft and lifted item(s) accelerations, etc.);

b. Interfaces with the aircraft, and the effect of installation and use of the equipment on the aircraft, including effects on structures, crew workload, normal and emergency egress, flight handling qualities (including resonance and turbulence), operating procedures (normal and emergency), etc.;

c. The level of safety to be considered appropriate, taking into consideration the aircraft, its roles/missions, and the intended and expected operation of the cargo hook equipment.

Considerations for preparation of AMC:

1. Aircraft Specifications should identify the requirement for cargo hook equipment, including the required type(s) of equipment (sling mount, suspension mount, fixed, retractable, etc.), and the safety requirements to be met;
2. Systems Interface Documents (SID) should define the interfaces between the cargo hook equipment and the aircraft;
3. Technical Publications should provide procedures for use of cargo hook equipment, and should take account of effects of incorporation of such equipment (e.g. effects on flight handling, normal and emergency egress, operating procedures, maintenance procedures, etc.);
4. System Safety Assessment (SSA), and associated safety artefacts (Loss Models, Risk Registers, etc.) should demonstrate that the risk associated with incorporation of cargo hook equipment is acceptable;
5. Analysis should demonstrate that the cargo hook equipment and supporting aircraft structure is suitably strong for the equipment's expected use (see also Section 5);
6. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that the design of the cargo hook equipment, and its integration to the aircraft is acceptable.

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 S3 L1017
		STANAG Reference:	2445 2286

Information Sources			
FAA Doc:	14CFR reference Parts 27 and 29	*EASA CS Reference:*	CS 27.865 CS 29.865

8.9.2 Pilot/operator control of cargo hook system.

Adequate controls and displays shall be available to the pilot/operator to indicate the status of the cargo hook system to the required personnel (e.g. pilot and/or loadmaster), and controls shall be provided for the release of cargo in normal, automatic and emergency modes.

Consideration should be given to:

a. Clear presentation of relevant information to crew, including status indication, and warning, caution and advisory information;

b. Cargo hook status information appropriate to the aircraft's type, role and missions, in all weathers, operating environments, day and night;

c. The controls necessary to allow for the normal, emergency and automatic release of cargo, incorporating appropriate guards to prevent inadvertent release;

d. Ensuring that any required pilot input or intervention is clearly and unambiguously identified.

e. Ensuring that any credible combination of failures does not prevent the accurate notification of system operating conditions.

Considerations for preparation of AMC:

1. Aircraft Specifications should identify the requirement for cargo hook indications and controls;
2. Systems Interface Documents (SID) should define the interfaces between the cargo hook equipment and the aircraft;
3. System Description Documents (SDD) should identify the controls and displays provided to crew. For controls, detail should be provided regarding the mode of operation and function of each control. For displays, detail should be provided regarding all information displayed to the crew, and where appropriate, the conditions that would lead to specific indications.
4. Technical Publications should provide procedures for use of cargo hook equipment, and should take account of effects of incorporation of such equipment (e.g. effects on flight handling, normal and emergency egress, operating procedures, maintenance procedures, etc.);
5. System Safety Assessment (SSA), and associated safety artefacts (e.g. Failure Modes and Effects Analysis) should demonstrate that the effect of aircraft failures and any resulting cargo hook hazard is acceptable;
6. Rig ground and flight testing should demonstrate that controls perform their intended function(s) and that displays provide accurate and useful information to the crew and that the design of the cargo hook equipment, and its integration to the aircraft is acceptable.

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 L105 11.3 00-970 P7 S3.9 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	*EASA CS Reference:*	CS 27.865(b) CS 27.865(c) CS 29.865(b) CS 29.865(c)

Information Sources			
	Operations)		

8.9.3 Securing of cargo.

Processes for the securing of cargo to the cargo hook system shall be defined in the appropriate manual(s), and shall be safe.

Consideration should be given to:

a. Usage parameters for the cargo hook equipment (types of loads to be lifted, lifting procedures, etc.);

b. Incorporation of markings and placards on the aircraft;

c. The level of safety to be considered appropriate, taking into consideration ground and flight crew, the aircraft, its roles/missions, and the intended and expected operation of the cargo hook equipment;

d. The maximum and minimum loads for safe movement of cargo.

Considerations for preparation of AMC:

1. Aircraft Specifications should identify the requirement for cargo hook equipment, including the required type(s) of equipment (sling mount, suspension mount, fixed, retractable, etc.), and the safety requirements to be met;
2. Technical Publications should provide procedures for use of cargo hook equipment, and should take account of effects of incorporation of such equipment (e.g. effects on flight handling, normal and emergency egress, operating procedures, maintenance procedures, maximum and minimum loads for safe movement of cargo, etc.);
3. System Safety Assessment (SSA), and associated safety artefacts (Loss Models, Risk Registers, etc.) should demonstrate that the risk associated with incorporation of cargo hook equipment is acceptable;
4. Rig, ground and flight testing should demonstrate that the loads can be secured to the cargo hook system effectively and safely.

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 S3 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

8.9.4 Merged with Section 13.

8.9.5 Merged with Section 5.

8.9.6 Technical manuals.

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. The level of detail necessary to provide accurate technical information while remaining concise;
b. The information, at the appropriate level of detail, required to allow personnel to operate and maintain the aircraft as safely and effectively as possible at an acceptable workload.
c. Ensuring that all required operating procedures are defined, taking account of requirements for military operation (e.g. in-flight rectification).

Considerations for preparation of AMC:
1. Operational Technical Publications for the flight crew (Aircraft Flight Manual, Emergency Procedures, Checklists etc.) should clearly define all required normal, back-up and emergency operating procedures, limitations and restrictions, including the maximum and minimum safe loads for movement of cargo.
2. Maintenance Technical Publications for ground crew (Aircraft Maintenance Manual, Master Minimum Equipment List, Maintenance Schedule, etc.) should clearly define all required servicing and maintenance information.
3. Flight Simulations, Ground Testing and/or Flight Testing should verify that all Operational Technical Publications are clear and unambiguous and can be followed by a flight crew through all flight phases and conditions without incurring excessive crew workload and serve their intended function.
4. Rig and/or Ground Testing should verify that all Maintenance Technical Publications are clear and unambiguous and can be followed by a competent maintenance engineer in a manner which ensures the continuing airworthiness of the aircraft.

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

8.9.7 Merged with 8.9.1.

8.10 HOIST/WINCH SYSTEMS.

8.10.1 No adverse effects on safety.
Hoist/winch systems shall be safe for their intended use.

Consideration should be given to:
a. Usage parameters for the hoist/winch equipment (personnel and/or weight limits, duration and frequency of use, aircraft and hoisted/winched item(s) accelerations, etc.);

b. Interfaces with the aircraft, and the effect of installation and use of the equipment on the aircraft, including effects on structures, crew workload, normal and emergency egress, flight handling qualities, operating procedures (normal and emergency), etc.;
c. The level of safety to be considered appropriate, taking into consideration the aircraft, its roles/missions, and the intended and expected operation of hoist/winch equipment.

Considerations for preparation of AMC:
1. Aircraft Specifications should identify the requirement for hoist/winch equipment, including the required type(s) of equipment (rescue hoists, cargo winches, etc.), and the safety requirements to be met;
2. Systems Interface Documents (SID) should define the interfaces between the hoist/winch equipment and the aircraft;
3. Technical Publications should provide procedures for use of hoist/winch equipment, and should take account of effects of incorporation of such equipment (e.g. effects on flight handling, normal and emergency egress, operating procedures, maintenance procedures, etc.);
4. System Safety Assessment (SSA), and associated safety artefacts (Loss Models, Risk Registers, etc.) should demonstrate that the risk associated with incorporation of hoist/winch equipment is acceptable;
5. Analysis should demonstrate that the hoist/winch equipment and supporting aircraft structure is suitably strong for the equipment's expected use (see also Section 5);
6. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that the design of the hoist/winch equipment, and its integration to the aircraft is acceptable.

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 S3.9 L714 00-970 P7 S2 L723 00-970 P7 S3 L1017 00-970 P7 S3 L1017/1
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 27.1309 CS 29.1309

8.10.2 Operation under all load conditions.
Hoist/winch equipment shall operate correctly under all expected (including both normal and emergency) loading conditions.

Consideration should be given to:
a. The effect of varying loads on the extension and retraction of the hoist/winch, including loads above the maximum expected cable breaking strength.
b. Operation throughout the flight envelope (airspeeds, attitudes, aircraft weights and C of G positions, etc.) for which hoist/winch operation is permitted;
c. Effects on the aircraft (performance, flight handling, static and dynamic structural, electrical, hydraulic, pneumatic, etc.) from deployment at varying lengths, and from extension and retraction of the hoist/winch;
d. Ensuring that effect of operating the hoist/winch outside normal limits is acceptable (e.g. stoppage of the motor rather than failure of the cable).

Considerations for preparation of AMC:
1. Aircraft Specifications should identify the requirement for hoist/winch equipment, including performance and operational requirements to be met;

2. Systems Interface Documents (SID) should define the interfaces between the hoist/winch equipment and the aircraft;
3. Technical Publications should provide procedures for use of hoist/winch equipment, including performance and operating limitations;
5. Analysis should demonstrate that the hoist/winch equipment and supporting aircraft structure is suitably strong for the equipment's expected performance (see also Section 5);
6. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate the acceptable performance of the hoist/winch equipment and supporting systems and structure.

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 S3.9 L714 00-970 P7 S2 L723 00-970 P7 S3 L1017 00-970 P7 S3 L1017/1
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 27.1309 CS 29.1309

8.10.3 Merged with Section 13.

8.11 ABSEIL BOLSTER / FAST ROPE INSERTION/EXTRACTION SYSTEM (FRIES).

8.11.1 Insertion and extraction of personnel.
Equipment installed for the purpose of insertion and/or extraction of personnel using a stationary rope or similar arrangement (Abseil Bolsters, FRIES, etc.) shall be safe for its intended use.

Consideration should be given to:
a. Usage parameters for the insertion/extraction equipment (number of personnel, duration and frequency of use, aircraft and personnel accelerations, etc.);
b. Interfaces with the aircraft, and the effect of installation and use of the equipment on the aircraft, including effects on structures, crew workload, normal and emergency egress, flight handling qualities, operating procedures (normal and emergency), etc.;
c. The level of safety to be considered appropriate, taking into consideration the aircraft, its roles/missions, and the intended and expected operation of insertion/extraction equipment.
d. Ability of crewmembers to supervise and observe FRIES operation effectively
e. Ability of crewmembers to terminate FRIES or Abseil operations immediately, should safety be jeopardised

Considerations for preparation of AMC:
1. Aircraft Specifications should identify the requirement for insertion/extraction equipment, including the required type(s) of equipment (Abseil Bolster, FRIES, etc.), and the safety requirements to be met;
2. Systems Interface Documents (SID) should define the interfaces between the insertion/extraction equipment and the aircraft;
3. Technical Publications should provide procedures for use of insertion/extraction equipment, and should take account of effects of incorporation of such equipment (e.g. effects on flight handling, normal and emergency egress, operating procedures, maintenance procedures, etc.);

4. System Safety Assessment (SSA), and associated safety artefacts (Loss Models, Risk Registers, etc.) should demonstrate that the risk associated with incorporation of insertion/extraction equipment is acceptable;
5. Analysis should demonstrate that the insertion/extraction equipment and supporting aircraft structure is suitably strong for the equipment's expected use (see also Section 5);
6. Rig, ground and flight testing should demonstrate the accuracy of performed analysis, and should demonstrate that the design of the insertion/extraction equipment, and its integration to the aircraft is acceptable.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	US Army Publication: TC 21-24 – RAPPELLING – Issued 1/9/2008 US Marine Corps Handbook MCRP 3-11.4A (Helicopter Rope Suspension Techniques (HRST) Operations) dated August 2003	*Def-Stan 00-970 Reference:*	00-970 P7 S2 L205/1 00-970 P7 S2 L407/4 00-970 P7 S3.9 L714 (2.1.4) 00-970 P7 S3 L1017 00-970 P7 S3 L1017/1
		STANAG Reference:	2445
FAA Doc:		*EASA CS Reference:*	CS 27.865 CS 29.865

8.11.2 Merged with Section 5.

SECTION 9 - CREW SYSTEMS

The crew systems area consists of the following elements: pilot 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

9.1. ESCAPE AND EGRESS SYSTEM.

This section covers the provision of means whereby the occupant(s) can leave the aircraft 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 aircraft occupants;
- The anthropometric range and mass of the aircrew;
- Consistency of exit sign design.

9.1.1 Escape system safety compatibility.

The escape system, or means to effect emergency escape, shall allow safe operation and egress from the aircraft and/or control station ; and shall be integrated and compatible with the aircraft and/or control station

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 shall 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. Absence of rigid objects (i.e. canopies and hatches) are located in the ejection path.

b.. Arrangement of any movable objects which can enter the path are arranged so that they are moved out of the ejection path upon ejection.

c. All attitudes and speeds encountered in the flight envelope.

d. Loads and accelerations imposed to the body.

e. Environmental hazards on the escape path or due to the clearance mechanisms.

f. Failure of the escape path clearance system.

g. Escape path clearance interference with the crew tasks.

h. The anthropometric range and mass of the aircrew.

i. Inadvertent operation.

j. Location and design of emergency controls.

k. The use of command ejection system.

l. Escape path clearance independenance of any other system.

m. Ability to see outside the exit when exit is closed.

n. Ability to see the ground where the evacuee might land.

o. Engine(s) running at ground idle.

Considerations for preparation of AMC:

1. Rig and ground tests should demonstrate the escape system compatibility throughout the designated envelope with extreme permutations of crew anthropometry and mass properties.

2. Ground testing should demonstrate emergency egress with human subjects to verify he ability to safely operate required systems and egress the aircraft.

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:	*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

Information Sources			
	Unverified - no access to JSSG 2010 - 8, 9, 11, 13, 14) NATO Working Party 61		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 25.809 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 Escape system reliability.

Aircraft 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.
d. Specified system and subsystem reliability levels.
e. Specified confidence intervals.

Considerations for preparation of AMC:

1. Rig and ground tests should demonstrate the escape system reliability throughout the designated envelope with extreme permutations of crew anthropometry and mass properties.
2. Rig and ground tests should demonstrate emergency egress with human subjects to verify the ability to safely operate required systems and egress the aircraft.
3. System Description Documents (SDD) should verify integration and compatibility with the aircraft and other subsystems.

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:	

Information Sources			
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

9.1.2 Escape exits and routes.

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 aircraft occupants following landing / ditching of the aircraft . It shall be possible for all occupants to egress the aircraft , within specified time limits.

Consideration should be given to:

a. Size, type, number, location and ease of opening of exits.
b. Specified time limits for ground / ditching evacuation (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 aircraft being on fire, and at maximum seating capacity.
o. Engine(s) running at ground idle.
p. The impact of a lockable pilot compartment door.

Considerations for preparation of AMC:

1. Rig and ground tests should demonstrate the escape system throughout the designated envelope with extreme permutations of crew anthropometry and mass properties.
2. Rig and ground tests should demonstrate emergency egress with human subjects to verify the ability to safely operate equired systems and egress the aircraft.

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

Information Sources			
			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 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 Emergency exit markings.

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 aircraft from outside.

Consideration should be given to:

a. Ensuring the design of exit signs are consistent throughout the aircraft .
b. Ensuring the identity and location of each passenger emergency exit are recognisable from a distance.
c. Identification in different light conditions, i.e. darkness, dense smoke.
d. Colour of external and internal markings.
e. Colour contrast.
f. Reflectance.

Considerations for preparation of AMC:

1. Rig and ground tests should demonstrate emergency egress with human subjects to verify the ability to safely operate required systems and egress the aircraft.

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	*Def-Stan 00-970 Reference:*	00-970 P1 4.23.5
		STANAG	3230

Information Sources			
	2010 - 8, 9, 11, 13, 14)	*Reference:*	
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 Ground/ditching emergency egress devices.

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.
c. The operational environmental requirements.
d. Applicable physical and power integration requirements.
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.

Considerations for preparation of AMC:
1. Rig and ground tests should demonstrate emergency egress with human subjects to verify the ability to safely operate required systems and egress the aircraft.

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 Ground/ditching emergency processes and procedures.
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 enables 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.

Considerations for preparation of AMC:
1. Rig and ground tests should demonstrate emergency egress with human subjects to verify the ability to safely operate required systems and egress the aircraft.

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 CS 29.1585

9.1.6 Emergency egress/rescue equipment.
Egress equipment shall be provided to aid escape in the event exits are blocked, damaged, or when exit opening actuation fails.

Consideration should be given to:
a. Provision of onboard devices such as crash axe, canopy penetrator, etc.
b. Ground rescue tools such as fire rescue axe, powered saw.

Considerations for preparation of AMC:
1. Rig and ground tests should demonstrate emergency egress with human subjects to verify the ability to safely operate required systems or devices and egress the aircraft when exits are blocked, damaged, or when exit opening actuation fails.

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	

Information Sources			
		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 aircraft and crew station 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 aircraft i.e. commercial, fighter, attack, bomber, transporter, maritime reconnaissance;
- Mission activities/tasks including take-off, landing and aerial refuelling.

9.2.1 Crew station arrangement.
Controls and displays shall be arranged and located to provide convenient operation (functional and visible). Controls and displays shall be arranged and located to provide convenient operation (functional and visible).

Consideration should be given to:
a. The physiological aspects of design, including anthropometric range of occupants and/or operators.
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 aircraft .
c. Controls, which are in regular use in flight, should not be positioned aft of the pilot's shoulder line.
d. Location of the controls and pilot with respect to the plane of rotation of propellers.
e. Grouping and arrangement of flight instruments with respect to the pilot's forward vision.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail that the anthropometric requirements are met.
2. Rig and ground tests should demonstrate appropriate Human Machine Interface (HMI) with mission equipped human subjects representative of the intended anthropometric range.

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 Controls and display readability.

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. The physiological aspects of design, including varying operator's eye positions given the anthropometric range of occupants;

b. Readability of displays under all expected illumination conditions , including during NVG operations if required;

c. The effect of reflection on clarity of information;

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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail that the anthropometric requirements are met.

2. Rig and ground tests should demonstrate appropriate Human Machine Interface (HMI) with mission equipped human subjects representative of the intended anthropometric range.

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 25.777 CS 27.777(b) CS 29.777

9.2.1.2 Interior and exterior fields of view.

The aircraft shall provide the aircrew with sufficient interior and exterior fields of view to safely perform all flight and mission-critical functions and tasks, and avoid ground or flight obstacles. The flight crew shall have 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 aircraft class, type and operational role.

For UAVs, the design of the control station shall facilitate the command and control of the UAV by the UAV crew for safe operations.

Consideration should be given to:

a. External vision / rectilinear plot.

b. The zero reference in azimuth.

c. Different crew seating configurations i.e. single seater, tandem or side by side.

d. Type and role of aircraft , i.e. commercial, fighter, attack, bomber, transporter, maritime reconnaissance.

e. Mission activities/tasks including takeoff, landing and aerial refuelling.

f. Location of controls, consoles, instrument panels, headup display ancillary equipment and other structures where they do not critically restrict vision.

g. Seat adjustment to allow the pilot to place his eyes at the level of the aircraft design eye position.

h. Avoiding blind spots from posts, canopy bow, windshield frames, heads up display (HUD) supports, etc.

i. The physiological aspects of design, including anthropometric range of occupants and/or operators.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail that the anthropometric requirements are met.

2. Rig and ground tests should demonstrate appropriate Human Machine Interface (HMI) with mission equipped human subjects representative of the intended anthropometric range.

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 Controls and display usability.

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, aircraft attitudes and throughout the complete range of "g" force loads.

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.

Consideration should be given to:

a. The physiological aspects of design, including anthropometric range of occupants.

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 aircraft 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 aircraft attitudes.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail that the anthropometric requirements are met.

2. Rig and ground tests should demonstrate appropriate Human Machine Interface (HMI) with mission equipped human subjects representative o the intended anthropometric range.

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 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)	*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 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 Aircrew alerting systems.

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 30° cone of vision of the operator's normal line of sight as much as possible.

b. 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 aircraft.

Considerations for preparation of AMC:

1. Rig and ground tests should demonstrate appropriate Human Machine Interface (HMI) with mission equipped human subjects representative of the intended anthropometric range.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	FAA References: 14 CFR 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-	*EASA CS*	CS 23.1321

Information Sources			
	23.1322, 25.1321-25.1322	*Reference:*	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 markings.
Emergency action controls shall be appropriately marked, in accordance with the specified requirements.

Consideration should be given to:
a. Emergency controls to be included.
b. Outlining functional groups.
c. Ensuring no other controls are the same colour as emergency controls.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail that proper marking of emergency action controls has been verified by inspection and analysis of program documentation including cockpit, crew and operator station layout drawings or mockups, as well as inspection of hardware, manufacturing drawings and engineering drawings.

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

9.2.6 Interior finishes, components and equipment.
Materials (including finishes or decorative surfaces applied to the materials) used for aircraft interiors shall be at least flame resistant and non toxic.Consideration should be given to:
a. Interior compartments occupied by crew or passengers (including lavatories and galleys).
b. Areas that are not continuously occupied (including cargo and baggage compartments).

c. Flame propagation, burn-through and smoke limiting requirements.
d. Additional requirements for aircraft with passenger capacities of 20 or more.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the materials used in the aircraft's interior.

2. Coupon testing should demonstrate that the materials used in the aircraft's interior are flame resistant and non-toxic, meeting the appropriate flame propagation and burn-through resistance, toxicity and smoke limiting requirements.

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 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)	*Def-Stan 00-970 Reference:*	00-970 P1 4.26.16
		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 Communication systems.

A means of intercommunication shall be provided between the flight-deck, other aircrew, ground personnel and military and/or civilian airspace controllers.

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.
e. Incorporation of a passenger address system.

Considerations for preparation of AMC:
1. Flight and ground tests should demonstrate functionality of communication systems.

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 Speech intelligibility.
All audio communication systems shall have speech intelligibility of sufficient quality to ensure safe and effective aircraft operation.

Consideration should be given to:
a. The efficiency of communications needed and the type material to be transmitted.
b. Specified communications requirements (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.

Considerations for preparation of AMC:
1. Flight and ground tests should demonstrate communication systems have sufficient speech intelligibility in the worst case noise environments.

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. AIRCRAFT LIGHTING.

This section covers the provision, controllability and luminance of all internal and external aircraft light systems and illumination. Aircraft 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 Lighting system performance.

Aircraft 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. Normal ingress and emergency egress.
b. All compartments and areas.
c. Emergency lighting.
d. Chart, utility and worktable lighting.
e. Where applicable, provision of required lighting to perform troop jumps (i.e. three light system).
f. Cockpit floodlighting system, if fitted.
g. Aerial refuelling (See Section 8.7.1.4.2).
h. All illuminance requirements.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the photometric and radiometric performance requirements.
2. Rig and ground tests should demonstrate the adequacy of the lighting system, both internal and external to the cockpit, and control station and crew stations, through Lighting Mockup, System Integration Laboratory (SIL), and aircraft evaluations.

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:*	00-970 P1 4.15.54
		STANAG Reference:	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

Information Sources			
			CS 29.812 CS 29.1381 CS 29.1383

9.3.2 Lighting controllability and uniformity.

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.

Consideration should be given to:

a. Specified average luminance ratio (typically 2:1).

b. Minimising reflections from the canopy, windshields, and windows.

c. The possibility 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. Wing icing detection lights

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should detail the luminance and specular reflective performance requirements.

2. Rig and ground tests should demonstrate the adequacy of the lighting system, both internal and external to the cockpit, and control station and crew stations, through lighting mockup, System Integration Laboratory (SIL), and aircraft evaluations.

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 Exterior Lighting.

The aircraft 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 3ú2 km - 4.0 km) (at night under clear atmospheric conditions).

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the taxi and landing lights, navigation lights, riding (anchor) lights (where applicable) and an anti-collision light performance requirements.
2. Rig and ground tests should demonstrate the adequacy of the lighting system through lighting mockup, System Integration Laboratory (SIL), and aircraft evaluations.

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 Lighting for flight-critical tasks.
Aircraft 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).

Consideration should be given to:
a. Aircraft lighting luminance requirements.
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).
f. The physiological aspects of design, including anthropometric range of occupants.

Considerations for preparation of AMC:
1. Declaration of Design Performance (DDP) should detail that electronic and/or electro-optical displays meet the levels for luminance, chromaticity, and daylight contrast specified in the System Requirements Document (SRD).
2. Rig and ground tests should demonstrate the readability and discernibility of instruments through lighting mockup, System Integration Laboratory (SIL), and aircraft evaluations.

Information Sources			
Comm'l Doc:			

Information Sources			
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:*	00-970 P1 6.7.1
		STANAG Reference:	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 FACTORS

This section covers recognition of human factors engineering principles within the aircraft 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 Functional operations and workload.

Aircrew, operator and maintenance tasks and/or functional operations, and procedures and/or pilot / aircraft interfaces shall be demonstrably safe.

Consideration should be given 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;
d. Ensuring all tasks / procedures are defined and documented;
e. Operation over the anticipated range of environmental conditions.

Considerations for preparation of AMC:
1. Rig and ground tests should verify that trained personnel can perform the tasks in a safe manner, through function and task analysis using fully trained and qualified operators and maintainers.

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 Primary flight display suites.
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 aircraft 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 which 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.

Considerations for preparation of AMC:
1. Analysis of hardware, engineering design drawings and documents should demonstrate that Primary Flight Display design is appropriate.

Information Sources			
Comm'l Doc:			

Information Sources			
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) 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 maneuvering performance (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
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 Relevant documentation.

All aircraft documentation 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. All procedures or pilot/vehicle interfaces shall be accomplished within acceptable crew workload limits.

Consideration should be given to:

a. Ensuring all documentation is produced to the required standard.

b. Identifying and segregating approved parts of any documented instruction, procedure, limitation etc. from each unapproved part (if applicable).

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should verify emergency procedures are identified and documented and are compared to results from the subsystem integration testing, human use analysis, and failure and degraded modes analysis.

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-	*EASA CS*	CS 23.1581-23.1589

Information Sources			
	23.1589, 25.1581-25.1587	*Reference:*	CS 25.1581-25.1587 CS 27.1581-27.1589 CS 29.1581-29.1589

9.4.3 Merged with 9.2.1.2

9.4.4 Crew system interface.

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. The physiological aspects of design, including anthropometric range of occupants and/or operators.
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 inadvertent firing or release of weapons or countermeasures.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the crew system interface.
2. System Safety Assessment (SSA) should demonstrate adequate analysis of crew system interfaces.
3. Subsystem integration testing, human use analysis, failure and degraded modes analysis, and crew system simulation and documentation should demonstrate adequate crew system interfaces.

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

9.4.6 Exposure to sound.

Sound pressure exposure levels in areas of the aircraft 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 levels, typically not more than 85 dB(A)
b. Ensuring noise levels are controlled as required by human factors requirements.
c. Combined noise levels from the air conditioning system and all other sources, i.e. engine, are lower than the maximum acceptable levels.
d. Individual hearing protection.

Considerations for preparation of AMC:
1. Rig, ground and flight testing should demonstrate that internal noise levels do not exceed safe limits.

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 aircraft life support systems and personal protective equipment. Life support systems provide aircraft occupants with breathing and anti-g provisions, and natural, induced, and combat hazard protection for aircraft missions; during and after any in-flight emergency; and as appropriate after escape from the aircraft. 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 aircraft 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 Life support functionality.

Aircraft 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 and passengers throughout the operational envelope of the aircraft.

Consideration should be given to:
a. Hypoxia, toxic smoke and fumes.
b. Effect of high 'g' accelerations.
c. Effect of high altitude / depressurization.
d. Effect of foreign matter and irritants.
e. Ballistic threats.
f. Nuclear, Biological, Chemical and/or Laser environments.
g. Anthropometric range of occupants.

Considerations for preparation of AMC:
1. Rig and ground tests should demonstrate life support system integration and functionality, from the standpoint of the overall system performance and installation.

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 Life support physiology.

Aircraft life support systems and personal protective equipment shall include sufficient provisions and protection to satisfy the specified physiological requirements, in order to permit aircraft occupants to maintain control under all anticipated environmental conditions. The physiological needs of aircraft occupants shall be met in normal flight, as defined by the mission roles of the aircraft; during and after any in-flight emergency; and as appropriate after escape from the aircraft.

Consideration should be given to:
a. Specified physiological requirements.
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.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail physiological requirements.
2. Human testing in mockups, simulators and production representative systems should verify physiological requirements are met.

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 Life support interfaces.
Where aircraft life support systems interface with other aircraft subsystems, no operational mode of any life support system shall degrade other subsystems sufficiently to cause an unsafe condition; and no operational or failure mode of 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 subsystems.
b. The effect of a software/firmware failure to subsystems that interface with the oxygen subsystem such as built-in-test.

Considerations for preparation of AMC:
1. Rig and ground tests should demonstrate the life support system's interface with other subsystems. Demonstrations should include using mock-ups and simulations, and on-aircraft and/or control station system check-outs.
2. Failure Modes Effects and Criticality Analysis (FMECA) should identify potential failure mode causes, including those that could be induced by life support system or subsystem operations.

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 Emergency oxygen.

The oxygen system, which is used in the event of an emergency shall provide a supply of breathing gas to all aircraft 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.

b. The worst-case crewmember breathing scenario.

c. Whether the cabin is pressurised or depressurised.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the emergency oxygen system capabilities.
2. Rig and ground tests should demonstrate the emergency oxygen system capabilities.

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 Emergency oxygen-escape.

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.
b. The specified worst-case crewmember breathing scenario.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail emergency oxygen requirements.
2. Rig and ground tests should demonstrate oxygen requirements are met. Testing should consist of initial simulated human exposures to operational environments, followed by human testing in mockups and simulators.

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 Life raft operation.
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 aircraft 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.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should verify the existence of markings and instructions by aircraft and article inspections. Floatation accessibility is verified by mockup demonstrations and functional tests of floatation deployment and inflation systems.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-11: 3.11.7.3 (Unverified - no access to JSSG-2010-11)	*Def-Stan 00-970 Reference:*	00-970 P1 P1 6.8.18 00-970 P1 7.4.13 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

Information Sources			
			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 Life raft release.

Each life raft released automatically or by a crew member shall be attached to the aircraft by a static line to keep it alongside the aircraft . This line shall be sufficiently weak to break away from the aircraft to prevent submerging the raft when the aircraft becomes submerged.

Consideration should be given to:

a. Ensuring intergration with the aircraft is such that probability of inadvertant inflation during egress is minimised.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should verify the physical characteristics of the aircraft flotation system.

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

9.5.7 Firefighting equipment and protection

The aircraft shall be equipped with breathing and eye protection equipment, fire-fighting equipment, and fire extinguishers appropriate for the expected use.

Consideration should be given to:

a. Ensuring equipment is conveniently located and readily accessible by the crew.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should verify availability and accessibility of fire protection equipment by inspection of operator/crew equipment provisions and the aircraft system configuration.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	MIL-HDBK-516: 8.2, 8.4 and section 14 JSSG-2010: 3.7, 4.7 JSSG 2010-9: 3.9.3 FAA References: 14 CFR references: 25.851	*Def-Stan 00-970 Reference:*	00-970 Pt 13 Sec 1.4 00-970 Pt 13 Sec 1.6.12 00-970 Pt 13 Sec 1.6.13 to 1.6.13.2
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.851 CS 23.1197 CS 23.1439 CS 25.851 CS 25.1197 CS 25.1439 CS 29.851 CS 29.1197 CS 29.1439

9.6. TRANSPARENCY INTEGRATION.

This section covers the installation, integration, interface and operation of aircraft 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 Transparency system integration with the escape system.
Canopies, or other transparency systems, along with their associated support structure, actuation, latching, and locking mechanisms shall be compatible with the aircraft 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.

Considerations for preparation of AMC:
1. Flight tests, computer modeling and inspections of engineering drawings, should demonstrate transparency system compatibility with the escape system.

Information Sources			
Comm'l Doc:	For a new transparency in an existing aircraft, it is recommended that reference be made to the existing aircraft		

Information Sources			
	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 Transparency system survivability.
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.
c. Remote camera system susceptibility to bird strike.

Considerations for preparation of AMC:
1. Structural analysis should demonstrate that maximum stresses due to a bird strike are below material allowables.
2. Rig and ground tests of full scale bird strikes at worst case impact locations should demonstrate no transparency or backup structural failure is sufficient to cause loss of the aircraft, or crew member incapacitation, or loss of remote camera system functionality.

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 CS 29.631 CS 29.775

9.6.3 Transparency system structural/thermal capabilities.

The structural/thermal capability of the transparency system shall be adequate for all loads and flight conditions.

Consideration should be given to:

a. Structural impacts including impact loads from hail.

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.

Considerations for preparation of AMC:

1. Rig and ground tests should demonstrate the structural and thermal capabilities of the aircraft transparencies.

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 compatibility.

Transparency system shape shall be compatible, and not interfere, with crew-member and equipment positions and motions used during normal and emergency conditions.

Consideration should be given to:

a. Use of specialized cockpit equipment,.

b. Transferring equipment from one crew member to another.

c. Inertial reactions to accelerations.

Considerations for preparation of AMC:

1. Rig and ground tests should demonstrate the extent of any scratching or crazing as the result of any activities or positions that may cause contact.

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 Optical characteristics of the transparency system.

The optical characteristics of the transparencies (windshield, canopy, windows, and enclosures for flight critical remote camera systems and sensors, as applicable), 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. Optical characteristics such as transmissivity, angular deviation, optical distortion, haze, multiple imaging, binocular disparity, birefringence, and minor optical defects
b. Specialised coatings.

Considerations for preparation of AMC:
1. Rig and ground tests should demonstrate transparency system optical characteristics by optical test of coupon samples and representative first articles.
2. Rig and ground tests should demonstrate that the pilot and/or operator visibility is sufficient in all relevant operational lighting conditions (including NVIS lighting) to maintain vehicle control and perform critical tasks.

Information Sources			
Comm'l Doc:			
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 Canopy deployment power.

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 aircraft 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.

Considerations for preparation of AMC:
1. Rig and ground tests should demonstrate deployment power availability and manual capabilities.

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

Information Sources			
		STANAG Reference:	
FAA Doc:	14CFR references: 23.775, 25.775	*EASA CS Reference:*	

9.6.7 Transparency system integration with the environmental management system.
The environmental management system interface shall provide necessary defogging, pressurization, heating, cooling, humidity control, and ventilation of the transparency system under normal and emergency conditions.

Consideration should be given to:
a. Ensuring provisions are incorporated to sufficiently remove rain, snow, ice, and fog from transparencies.

Considerations for preparation of AMC:
1. Rig and ground tests should demonstrate the capability of removing fog, ice, snow, or rain from the transparency through system tests in simulated flight 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 CS 25.1438 CS 27.773 CS 29.773

9.6.8 Transparency system external degradation
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.

Considerations for preparation of AMC:

1. Rig and ground tests should demonstrate the capability of removing external debris and precipitation from the transparency through system tests in simulated flight conditions.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2010-14: 3.14, 4.14	*Def-Stan 00-970 Reference:*	00-970 P1 4.17.8-4.17.15 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 aircraft 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 aircraft occupants;
- Ensuring that body mass figures used are appropriate, and allow a sufficient margin for fully equipped troops;
- Type and role of aircraft;
- The ability of personnel to operate appropriate emergency devices while wearing personal protective equipment; this relates to aircrew and rescue crews.

9.7.1 Seating system load capabilities.

The seating system, or systems including stretchers, to be used on the aircraft shall be appropriate for their proposed use. 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.

Considerations for preparation of AMC:

1. Rig and ground tests should demonstrate that the seat and restraint system, with associated aircraft structure, meets the standard with a seated occupant.

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 Seating stroke clearance envelopes.

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.

e. The physiological aspects of design, including anthropometric range of occupants.

Considerations for preparation of AMC:

1. Rig and ground tests should demonstrate the stroke clearance envelope, indicating the occupied stroke volume for the design impact velocity of the aircraft and ensuring that volume exists and is unobstructed in the aircraft design.

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 Restraint systems loads.

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. Aircraft 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.

Considerations for preparation of AMC:

1. Rig and ground tests should demonstrate that the restraint system properly restrains the occupant.

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

Information Sources			
			CS 29.785

9.7.4 Occupant strike envelope.

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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail design crash loads.
2. Rig and ground tests should demonstrate that occupant body translation is determined for design crash loads and that no objects in the crew station that would cause major injury are within that translation volume. Analytical models of human body motion under crash load conditions should verify that no strike hazards exist.

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 Post crash operational exits.

The design crash loads for the aircraft shall be defined and it shall be shown that the designated emergency exits are operable up to, and including, these defined loads.

Considerations for preparation of AMC:

1. Rig and ground tests should demonstrate that all aircraft exits function following application of loads up to and including design crash loads.

Information Sources			
Comm'l Doc:			

Information Sources			
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 Items of mass.

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 aircraft .

Consideration should be given to:

a. Ultimate loads for structural installations for normal and emergency operations/conditions.

b. Installed equipment in passenger compartments.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the aircraft system level crash condition requirements.

2. Analyses and/or rig and ground tests should demonstrate that aircraft component installations do not pose a serious injury hazard.

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

Information Sources			
			CS 27.561 CS 27.787 CS 29.561 CS 29.787

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	14CFR references: 25.851	*EASA CS Reference:*	

9.7.7 Ditching provisions.

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.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should verify normal and emergency operations for all intended aircraft occupants through analyses and intergration testing from the standpoint of the overall system performance and installation.

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

Information Sources			
			CS 29.801 CS 29.1411 CS 29.1415

9.7.8 Pre-crash warning system.

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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the ability to convey a warning indication to all crew and passengers.
2. Technical Publications should detail the process to activate the warning system.
3. Rig and ground tests should demonstrate the operation of the warning system from seated positions.

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 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	*EASA CS Reference:*	CS 23.771 CS 25.819 CS 25.1307 CS 25.1423 CS 29.1307

9.7.9 Occupiable volume reduction in rotary wing aircraft.

For rotary wing aircraft, 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.

Consideration should be given to:

a. The mounting of engines, transmissions, fuel cells, rotor masts, and other high mass objects.

b. Impact conditions such as rollover about the aircraft's pitch or roll axes.

Considerations for preparation of AMC:

1. Structural test and analysis and crash load tests should verify that the design meets occupant volume requirements.

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

9.7.10 Emergency crew extraction mechanisms.

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.

Considerations for preparation of AMC:

1. Rig and ground tests should demonstrate the ability to operate required emergency egress and rescue mechanisms.

2. Technical Publications should detail the process to operate required emergency egress and rescue mechanisms.

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	3230

Information Sources			
		Reference:	
FAA Doc:	14CFR reference 25.811	*EASA CS Reference:*	CS 23.811 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. LAVATORIES, GALLEYS, AND AREAS NOT CONTINUOUSLY OCCUPIED.

This section covers aircraft 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.

9.8.1 Combustible material containment.

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.

Consideration should be given to:

a. Fire resistant material.

b. Minimising the use of openings for ventilation, entry, or other use in fire containment areas.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the fire retardant requirements for combustible materials containers.
2. Rig tests should demonstrate the ability of the disposal receptacle to contain fires under all probable conditions of wear, misalignment, and ventilation expected in service.

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

9.8.2 Smoke and fire detectors & extinguishers.

All aircraft and/or control station compartments shall have separate and approved smoke and/or fire detectors to alert the crew at the pilot, operator or flight engineer station for both in-flight and ground operations. Each aircraft and/or control station compartment shall have dedicated hand fire extinguishers, and if unoccupied cargo holds are present, fire protection and fire detection/suppression requirements shall be met.

Consideration should be given to:
a. Ensuring fire extinguishers are readily accessible for use.
b. Ensuring no extinguishing agent likely to enter personnel compartments will be hazardous to the occupants.
c. Built-in fire extinguishing systems.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the smoke detectors, fire extinguishers, and fire protection/detection/suppression systems installed throughout the aircraft and/or control station.

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

Information Sources			
			CS 27.855 CS 27.859 CS 29.855 CS 29.859

9.8.3 Intercom/ public address system.

The fire alarm and intercom/public address system shall be audible in all lavatories, galleys, and other compartments not continuously occupied.

Consideration should be given to:

a. Ensuring system volume is sufficient to be detected in all compartments, during all normal flight noise levels.

b. Capability to provide independance of alarm and intercom or PA systems from any required crewmember interphone system.

Considerations for preparation of AMC:

1. Rig and ground tests should demonstrate the fire alarm, intercom, and public address systems functionality under all approved operating configurations and conditions.

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

9.8.4 Safe operation under aircraft environmental exposures.

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.

Consideration should be given to:

a. Where locking mechanisms are installed, capability exists to be unlocked from the outside without the aid of special tools.

b. Ensuring enclosed spaces, such as lavatories and compartments, have emergency lighting to permit the occupants to perform flight safety critical functions and escape during a loss of electrical power.

c. Ensuring that lighting automatically operates upon loss of power.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail for requirements for functionality of areas not continuously occupied in all approved operating configurations and conditions.

2. Rig and ground tests should demonstrate the function and performance of emergency lighting during loss of electrical power.

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

9.8.5 Occupant entrapment.

It shall not be possible for occupants to become trapped in lavatories, galleys, or other compartments during emergency evacuation situations. Emergency lighting shall be available to aid egress.

Consideration should be given to:

a. Ensuring each enclosed cabin with passenger accommodations has adequate access to external doors.

Considerations for preparation of AMC:

1. Rig and ground tests should demonstrate availibility of emergency egress from lavatories, galleys, or other compartments.

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 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 aircraft diagnostics; and specifically the detection, isolation, and reporting of loss or degradation of system functions. Some diagnostic systems covered include, but are not limited to, built-in-tests (BIT), built-in-test-equipment (BITE) and health and usage monitoring systems (HUMS).

CERTIFICATION CRITERIA

10.1. FAILURE MODES.

10.1.1 Identification and detection.
Critical functional failure modes shall be identified, and provisions incorporated within the aircraft design for their detection.

Consideration should be given to:
a. Conducting a recognised System Safety Analysis (SSA);
b. Conducting Failure Modes, Effects & Criticality Analysis (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 aircraft and third parties, considering the stage of flight and operating conditions;
f. The air crew's capability of determining faults.

Considerations for preparation of AMC:
1. System Safety Analysis (SSA), supported by other safety artefacts as appropriate (e.g. FMECA) should identify all safety and mission critical failures including damage from external sources, probabilities of multiple failures and undetected faults, and the resulting effects on aircraft safety and airworthiness.

Information Sources			
Comm'l Doc:	SAE AIR 4845 details the FMECA process. SAE ARP4761		
DoD/MIL Doc:	JSSG-2000: 3.3.2 JSSG-2001: 3.3.7, 3.3.7.1 FAA References: 14 CFR references: 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351, 27.1309, 29.1309	*Def-Stan 00-970 Reference:*	00-970 P1 2.25.76 00-970 P1 4.12.8 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 CS 27.1309 CS 29.1309

10.1.2 Timely reporting.

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 that cautions and warnings are 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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the caution and warning functions and message indicators associated with each of the aircraft critical functional failures.

2. System Safety Analysis (SSA) should include caution and warning functions, including the effects of likely delays in corrective action (automatic or manual).

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	JSSG-2000: 3.3.2 JSSG-2001: 3.3.7, 3.3.7.1 FAA References: 14 CFR references: 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351, 27.1301, 27.1309, 27.1351, 29.1301, 29.1309, 29.1351	*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 23.1301 CS 23.1309 CS 23.1351 CS 25.1301 CS 25.1309 CS 25.1351 CS 27.1301 CS 27.1309 CS 27.1351 CS 29.1301 CS 29.1309 CS 29.1351

10.2. OPERATION.

10.2.1 Safety of flight parameters.

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 aircraft and ground diagnostic systems.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the diagnostic provisions for all SOF parameters, including their accuracy.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.6.2 FAA References: 14 CFR references: 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351, 27.1301, 27.1309, 27.1351, 29.1301, 29.1309, 29.1351 EASA CS 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351, 27.1301, 27.1309, 27.1351, 29.1301, 29.1309, 29.1351	*Def-Stan 00-970 Reference:*	00-970 P1 4.4.7 00-970 P9 USAR U1787
		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

10.2.1.1 Critical parameter calibration.
Diagnostic sensor operation and calibration procedures shall maintain 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.

Consideration for preparation of AMC:
1. System Description Documents (SDD) should detail the diagnostic sensors incorporated in the design of the aircraft and their tolerances and calibration procedures.
2. Technical Publications (e.g. Aircraft Maintenance Manual) should detail the procedures for calibration of each aircraft diagnostic sensor,

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.3.2 JSSG-2001: 3.3.7,3.3.7.1 FAA References: 14 CFR references: 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351, 27.1301, 27.1309, 27.1351, 29.1301, 29.1309,	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	

Information Sources			
	29.1351 EASA CS 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351, 27.1301, 27.1309, 27.1351, 29.1301, 29.1309, 29.1351		
FAA Doc:	14CFR references: 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351	*EASA CS Reference:*	

10.2.2 Diagnostics system safety.

Failure of the diagnostic system itself shall not adversely affect safety-of-flight (SOF), induce undetected failures, or otherwise damage the aircraft .

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 directly or indirectly reduce SOF.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the interfaces between diagnostic systems and other aircraft systems.
2. System Safety Assessment (SSA) should demonstrate that failure of aircraft diagnostic systems does not reduce aircraft safety below the level of safety that would be met without a diagnostic system installed.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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:* *STANAG Reference:*	00-970 P1 2.25.76 4671.1309
FAA Doc:	14CFR references: 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351	*EASA CS Reference:*	CS 23.1301 CS 23.1309 CS 23.1351 CS 25.1301 CS 25.1309 CS 25.1351 CS 27.1301 CS 27.1309 CS 27.1351 CS 29.1301 CS 29.1309

Information Sources			
			CS 29.1351

10.2.3 Safety systems health reporting.

All critical safety systems shall be monitored to ensure they are fully functional throughout the aircraft flight envelope.

Consideration should be given to:
a. Use of Built-In-Test (BIT) and/or continuous health monitoring.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail provisions for the status monitoring of all critical safety systems and should confirm that system status is monitored throughout the flight envelope.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 23.1301 CS 23.1309 CS 23.1351 CS 25.1301 CS 25.1309 CS 25.1351 CS 27.1301 CS 27.1309 CS 27.1351 CS 29.1301 CS 29.1309 CS 29.1351

10.2.4 Operation and maintenance manuals.
Flight and maintenance manuals shall include normal, back-up and emergency operating procedures, limitations, restrictions, servicing, and maintenance information and other information necessary for safe operation of diagnostic systems.

Consideration should be given to:
a. The level of detail necessary to provide accurate technical information while remaining concise;
b. The information, at the appropriate level of detail, required to allow personnel to operate and maintain the aircraft as safely and effectively as possible at an acceptable workload.

Considerations for preparation of AMC:
1. Operational Technical Publications for the flight crew (Aircraft Flight Manual, Emergency Procedures, Checklists etc.) should clearly define all required normal, back-up and emergency operating procedures, limitations and restrictions.

2. Maintenance Technical Publications for ground crew (Aircraft Maintenance Manual, Master Minimum Equipment List, Maintenance Schedule, etc.) should clearly define all required servicing and maintenance information.
3. Flight Simulations, Ground Testing and/or Flight Testing should verify that all Operational Technical Publications are clear and unambiguous and can be followed by a flight crew through all flight phases and conditions without incurring excessive crew workload and serve their intended function.
4. Rig and/or Ground Testing should verify that all Maintenance Technical Publications are clear and unambiguous and can be followed by a competent maintenance engineer in a manner which ensures the continuing airworthiness of the aircraft.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	JSSG-2000: 3.6.2 FAA References: 14 CFR references: 23.1301, 23.1309, 23.1351, 25.1301, 25.1309, 25.1351, 27.1301, 27.1309, 27.1351, 29.1301, 29.1309, 29.1351	*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 23.1301 CS 23.1309 CS 23.1351 CS 25.1301 CS 25.1309 CS 25.1351 CS 27.1301 CS 27.1309 CS 27.1351 CS 29.1301 CS 29.1309 CS 29.1351 CS 29.1465

10.2.5 Flight Data Recorder / Cockpit Voice Recorder

Aircraft shall be equipped with Flight Data Recorders (FDR) and Cockpit Voice Recorders (CVR) where appropriate.

Consideration should be given to:

a. The essential parameters to be recorded as determined by the National Regulatory Authority.
b. Any potential security aspects associated with the required installation and parameters to be recorded.
c. Location of microphone for audio recordings.
d. Power supply to recording device.
e. Prevention of erasure, or over-writing, of recording after a crash impact.
f. Crash survivability of recording device.
g. Any conspicuity requirements, including underwater detection if required.
h. Ability for pre-flight checking of recorder to ensure correct functioning.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the provision of FDR and CVR.

2. Technical Publications (e.g. Aircraft Maintenance Manual) should detail the procedures for pre-flight checking of the recorders.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	14 CFR: 23.1457, 23.1459, 25.1457, 25.1459, 27.1457, 27.1459, 29.1457, 29.1459	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1457 CS 23.1459 CS 25.1457 CS 25.1459 CS 27.1457 CS 27.1459 CS 29.1457 CS 29.1459

SECTION 11 - AVIONICS

This section covers the design, installation, arrangement and compatibility of the complete aircraft avionics system.

CERTIFICATION CRITERIA

(Note: For subsystems that use computer resources, see section 15 for additional, specific criteria.)

11.1. AVIONICS ARCHITECTURE.

11.1.1 Avionics subsystems architecture.

Avionics Subsystems shall 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:

a. Air data systems, 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 aircraft or 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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the number and type of sensors, data processors, data buses, controls and displays, and communications devices which form part of the avionics subsystem(s).
2. Component qualification, application of appropriate HW and SW development standards, rig, ground and flight testing should demonstrate that the avionics subsystem(s) support the correct function of aircraft systems.

Information Sources			
Comm'l Doc:	For air data system: RTCA DO-236A, guidance on CNS/ATM related air data system requirements		

Information Sources			
	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 RTCA DO-178C RTCA DO-254	*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 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),	*EASA CS Reference:*	CS 23.1301 CS 25.1301 CS 27.1301 CS 29.1301

Information Sources			
	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: 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		

Information Sources			
	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 Redundancy.

Failure of any single sensor, connection, processor, or display unit with any credible combination of failures shall 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;

Considerations for preparation of AMC:

1. Failure Modes and Effects Analysis (FMEA),as part of the Safety Asessment should demonstrate that the failure of any single sensor, connection, processor, or display unit does not result in loss of safety-critical data or display of unsafe or misleading data.
2. Component qualification, application of appropriate HW and SW development standards, rig, ground and flight testing should demonstrate the accuracy of the performed analysis and should demonstrate that failure of any single sensor, connection, processor, or display unit does not result in loss of safety-critical data or display of unsafe or misleading data.

Information Sources			
Comm'l Doc:	SAE ARP4761 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 Data buses.

Data buses shall have sufficient redundancy, reliability, and integrity to meet system safety and flight-critical requirements, and shall preclude the loss of safety-critical functioning, the display of unsafe or misleading information to the operator or maintainer, and any undetected failure modes.

Consideration should be given to:

a. Normal, Emergency and Critical Failure Mode conditions;

b. Multiple, independent paths for critical signals.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail provisions for redundancy, reliability and integrity, and should demonstrate that such provisions meet system safety and flight-critical requirements.
2. Failure Modes and Effects Analysis (FMEA) as part of the Safety Asessment should demonstrate that data bus design precludes the loss of safety-critical functioning, the display of unsafe or misleading information to the operator or maintainer, and any undetected failure modes.
3. Component qualification, application of appropriate HW and SW development standards, rig, ground and flight testing should demonstrate that the avionics subsystem(s) support the correct function of aircraft systems.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 Deterministic operation.
The overall avionics system shall operate in a predictable, deterministic and bounded manner and limit latency of any time-critical data, including primary flight data, as needed to support all safety-critical functions.

Consideration should be given to:
a. Defining and achieving limits appropriate to the design of the avionics system such as latency limits, signal attenuation and/or data loss rates.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the identified design limits for each avionics system, and the likely causes and effects of operation outside of such limits.

2. Systems Interface Documents (SID) should define the avionics interface characteristics for each interfacing system, including relevant design limits and the likely effects of operation outside of such limits.
3. System Safety Assessment (SSA) should demonstrate that the avionics system operates in a predictable, deterministic or bounded manner supporting all safety-critical functions.
4. Component qualification, application of appropriate HW and SW development standards, rig, ground and flight testing should demonstrate that the avionics subsystem(s) support the correct function of aircraft systems.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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:* *STANAG Reference:*	00-970 P7 L725/2 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 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 23.1331 CS 25.1309 CS 25.1331 CS 27.1309 CS 29.1309 CS 29.1331

11.1.5 Modes of operation.

All modes of operation of the avionics system shall be safe, taking into account the effect of undetected failure modes, timing or latency anomalies, and failures of interfaces and interconnections.

Consideration should be given to:
a. All identified modes of operation, and resulting effects on system interfaces due to operation in back-up or emergency modes.
b. Ensuring that any degradation in function or reliability resulting from operation in back-up or emergency modes does not result in unacceptable degradation in flight handling qualities or airworthiness.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should define the various modes of operation of the avionics system, including any back-up or emergency modes, and the effects that such operation has on system interfaces.
2. System Safety Assessment (SSA) should demonstrate that all modes of operation of the avionics system are safe while specifically taking into account the effect of undetected failure modes, timing or latency anomalies, and failures of interfaces and interconnections.

3. Component qualification, application of appropriate HW and SW development standards, rig, ground and flight testing should demonstrate that the avionics subsystem(s) support the correct function of aircraft systems.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 Diagnostics.

Integrated avionics diagnostic systems shall provide fault coverage, low false alarm rates, fault isolation and fault detection such that bad data and failed components that would unacceptably degrade aircraft safety are detected.

Consideration should be given to:

a. Ensuring that incorporated diagnostic systems and functions are appropriate to the design of the avionics system and the systems with which it interfaces, taking into account the effect on flight safety of failure of the diagnostic system..

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the provision of diagnostic systems in the design of the avionics system, including the fault coverage, false alarm rates, fault isolation and fault detection capabilities of the diagnostic system.

2. System Safety Assessment (SSA) should demonstrate that avionics diagnostic systems adequately support aircraft safety.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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	4671.1787

Information Sources			
		Reference:	
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 Critical information.

Flight, status and warning information shall be 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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the flight, status and warning information provided to the crew.
2. Component qualification, application of appropriate HW and SW development standards, rig, ground and flight testing should demonstrate that the flight, status and warning information provided to the crew is provided in a timely, clear and unambiguous form.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	DoD/MIL Doc: AFI 11-202 Vol 3: 2.6, 2.6.1, 2.6.1.1, 2.6.1.2, and 2.6.1.2.1 MIL-HDBK-87213 section 3.1.1 JSSG-2005: 3.2.1.8, 4.2.1.8, 3.2.1.8.1, and 4.2.1.8.1	*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

Information Sources			
	MIL-HDBK-87213: 3.2.1.25.4.1 and App A JSSG-2005: 3.2.1.8.5, 4.2.1.8.5 MIL-HDBK-87213 MIL-STD-1787 section 4.2 MIL-STD-1787 Appendix A JSSG-2005: 3.2.1.3.2, 4.2.1.3.2 FAA Doc: AC-27-1 and AC-29-2 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 23.1311, 23.1323, 23.1325, 23.1326, 23.1327, 25.1323, 25.1325, 25.1326, 25.1327 23.1311, 23.1322, 25.1322 AC-1311-1A section 9 14CFR reference 23.1321, 23.1541, 25.1321, 25.1541 23.1309, 25.1309		3705
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,	*EASA CS Reference:*	CS 23.1309 CS 23.1321 CS 23.1322 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

Information Sources			
	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 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 Reliability/redundancy of controls.

Avionic controls, such as those for controlling avionic modes and system function, shall have adequate redundancy and/or reliability in order to maintain required control of safety critical functions.

Consideration should be given to:

a. Ensuring that provisions for redundancy and reliability of controls takes into account the criticality and effects of failure of such controls.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the avionic controls and incorporated provisions for redundancy and reliability.
2. System Safety Assessment (SSA) should demonstrate that the redundancy and reliability of avionic controls is appropriate, taking into account the effects of failure on the aircraft and its systems.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	JSSG-2005: 3.2.1.8.6, 4.2.1.8.6 FAA References: 14 CFR 23.1309, 25.1309	*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 Safety and flight critical control functions.

Safety and flight critical control functions shall ensure safety of flight integrity and continuity of service throughout all intended missions, and shall ensure that hazardously misleading information is identified and not displayed to the operator.

Consideration should be given to:

a. Appropriate integration of off-board system command and control.
b. Automatic and semi-automatic (man-in-the-loop) landing.
c. Formation flight.
d. Guidance.

e. Other control used for safety and flight critical functions.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should define all safety and flight critical control functions, and should identify provisions which ensure the integrity and continuity of service throughout all intended missions.
2. SDD should define provisions for the identification of hazardously misleading information, and the provisions used to prevent the display of such information to the operator.
3. System Safety Analysis (SSA) should demonstrate that the integrity and continuity of safety and flight critical control functions is sufficient to ensure SOF.
4. Component qualification, application of appropriate HW and SW development standards, rig, ground and flight testing should demonstrate that the avionics subsystem(s) support the correct function of aircraft systems.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 Operational environment.
The avionics system, including its subsystems and equipment, shall operate safely and effectively throughout the expected operational environment.

Consideration should be given to:
a. System, subsystems and equipment environmental qualification to the full aircraft operating envelope.
b. Ensuring that pre-existing qualification of Commercial/Military Off-The-Shelf (COTS/MOTS) equipment is adequate, and where appropriate performing additional qualification to account for the operating environment of the military aircraft such as high manoeuvre loads, high vibration and shock loads and operation at supersonic speeds.
c. Electromagnetic Compatibility (EMC), including operation in High Intensity Radiated Fields (HIRF).
d. Heating of external probes.

Consideration for preparation of AMC:
1. The Aircraft Specification should define the environments within which the aircraft will operate.
2. System Description Documents (SDD) should define the operating environment of the avionics system, including its subsystems and equipment throughout the aircraft through critical operating conditions.
3. Declaration of Design and Performance should demonstrate that avionics equipment operates safely and effectively in their given location and throughout all expected operating conditions.
4. Qualification Test Plans and associated Reports (QTR & QTP) should identify the environmental requirements for the avionics system, subsystems and equipment, and should demonstrate that the

system, subsystem and equipment operates safely and effectively in their given location and throughout all expected operating conditions.
5. Rig, ground and flight testing should demonstrate that the avionics system, subsystem and equipment operates safely and effectively in their given location and throughout all expected operating conditions.

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. FAA References: 14 CFR 23.1309, 25.1309, 27.1309 and 29.1309	*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 RTCA DO-160

11.2.5 Electrical power quality.
The avionics system shall operate safely throughout the range of expected power supply characteristics (see also criterion 12.1.4).

Consideration should be given to:
a. Power supply characteristics (voltage, frequency, impedance, current, etc.) through normal, back-up and failure operating conditions.
b. Prioritisation of SOF-critical avionics functions.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the power-supply of the avionics system, including any particular power-supply characteristics for the system, subsystems or equipment.
2. Systems Interface Documents (SID) should define the power-supply characteristics for the interface between the avionics system and its power supply/supplies.
3. Rig, ground and flight testing should demonstrate that the avionics system operates safely throughout the range of expected power supply characteristics.

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 RTCA DO-160

11.3. AVIONICS INSTALLATION.

11.3.1 Avionics installation.

The installation of the avionics system, including its arrangement and crashworthiness, shall support SOF.

Consideration should be given to:

a. Normal, Emergency and Critical Failure Mode conditions;

b. Independence of appropriate flight critical services such as separate flight crew stations.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the installation of avionics systems including the arrangement and crashworthiness of subsystems and equipment.
2. Structural analysis (static and/or dynamic) should demonstrate the appropriate arrangement and crashworthiness of the avionics system, including its subsystems and equipment.
3. System Safety Analysis (SSA) should demonstrate that the overall level of safety of the installation of the avionics system is acceptable, taking into account any particular risks associated with its design and installation.

Information Sources			
Comm'l Doc:	SAE ARP4761 RTCA DO-160		
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 Operation and maintenance manuals.

Flight and maintenance manuals shall include normal, back-up and emergency operating procedures, limitations, restrictions, servicing, and maintenance information and other information necessary for safe flight, including emergency operations.

Consideration should be given to:

a. The level of detail necessary to provide accurate technical information while remaining concise;

b. The information, at the appropriate level of detail, required to allow personnel to operate and maintain the aircraft as safely and effectively as possible at an acceptable workload.

Considerations for preparation of AMC:

1. Operational Technical Publications for the flight crew (Aircraft Flight Manual, Emergency Procedures, Checklists etc.) should clearly define all required normal, back-up and emergency operating procedures, limitations and restrictions.
2. Maintenance Technical Publications for ground crew (Aircraft Maintenance Manual, Master Minimum Equipment List, Maintenance Schedule, etc.) should clearly define all required servicing and maintenance information.
3. Flight Simulations, Ground Testing and/or Flight Testing should verify that all Operational Technical Publications are clear and unambiguous and can be followed by a flight crew through all flight phases and conditions without incurring excessive crew workload and serve their intended function.
4. Rig and/or Ground Testing should verify that all Maintenance Technical Publications are clear and unambiguous and can be followed by a competent maintenance engineer in a manner which ensures the continuing airworthiness of the aircraft.

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 Transport Category Rotorcraft	*EASA CS Reference:*	CS 23.1501 CS 25.1501 CS 27.1501 CS 29.1501

11.3.3 Antenna performance.

Aircraft antennae subsystems shall ensure that aircraft flight-critical functions are retained, that unsafe information is not displayed to the operator or maintainer, and that availability and continuity of service is adequate to support SOF.

Consideration should be given to:

a. Ensuring adequate gain and coverage for transmission and receiving functions.

b. Normal, emergency and failure conditions.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the design of antenna subsystems and should demonstrate provisions for retention of flight critical functions, prevention of display of unsafe information to operators/maintainers, and maintaining availability and continuity of service to support SOF.
2. Rig, ground and flight testing should demonstrate that antenna subsystems ensure that aircraft flight-critical functions are retained, that unsafe information is not displayed to the operator or maintainer, and that availability and continuity of service is adequate to support SOF.

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 aircraft 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.)

CERTIFICATION CRITERIA

12.1. ELECTRIC POWER GENERATION SYSTEM.

The electric power generating system includes electrical power sources, main power buses, transmission cables, and associated control, regulation and protective devices.
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 Power quantity.
Sufficient electrical power shall be available to meet the aircraft systems power requirements during all modes of operation and potential failure conditions, including operation from emergency back-up systems (e.g. batteries).

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.

Considerations for preparation of AMC:
1. Electrical Loads Analysis should demonstrate that sufficient power is available. This requires consideration of all sources, and includes evaluating battery rate(s) of discharge.

Information Sources			
Comm'l Doc:	For guidance/principles regarding aspects of assuring effective and proper electric power generation system design, integration and compatibility: SAE AS50881		

Information Sources			
	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-7080 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	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.2 00-970 P1 6.6.16 00-970 P1 6.6.18
		STANAG Reference:	
FAA Doc:	14CFR references: 23.1351 25.1351	*EASA CS Reference:*	CS 23.1351 CS 23.1353 CS 25.1310 CS 25.1351 CS 27.1351 CS 29.1351

12.1.1.1 Notification of battery discharge.

There shall be a means to notify the crew if an electrical malfunction is causing the continuous discharge of any safety of flight battery system.

Consideration should be given to:

a. Providing voltage and current information.

Considerations for preparation of AMC:

1. System Description Documents should detail the notifications provided to aircrew for electrical malfunctions.
2. Rig and ground testing should demonstrate that notifications provided to aircrew for electrical malfunctions are clear and unambiguous.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	00-970 P9/13 3
		STANAG Reference:	4671.1809
FAA Doc:		*EASA CS Reference:*	

12.1.2 Safe operation of generation system.
The operation of the electric power generation system and its component parts shall be safe.

Consideration should be given to:
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.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate, using Functional Hazard Assessment (FHA) and Failure Modes, Effects and Criticality Analysis (FMECA), that the system is safe.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 - 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 Safe operation of integrated electrical power system.
Operation of the integrated electrical power system for normal and emergency modes shall be 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.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate that operation of the integrated system during normal and emergency modes is safe.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 - 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 Power quality.
The required power quality shall be 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.

Considerations for preparation of AMC:

1. System Interface Documents (SID) should detail the power quality characteristics for each supplied system.
2. Electrical Loads Analysis should demonstrate that adequate power quality is maintained for all supplied systems through all operating conditions and load combinations.
3. Rig and ground testing should demonstrate that accuracy of Electrical Loads Analysis and should demonstrate that adequate power quality is maintained for Safety Of Flight (SOF) critical systems through critical operating conditions and load combinations.

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 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	*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
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

Information Sources			
			CS 25.1363 CS 27.1351 CS 27.1353 CS 29.1351 CS 29.1353 CS 29.1355 CS 29.1363

12.1.5 Uninterruptible power.

Independent, uninterruptable power sources shall be 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).

Consideration should be given to:

a. All Safety Of Flight (SOF) critical functions, including those on-aircraft and within Ground Control Stations (GCS).

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should demonstrate that adequate independence/redundancy is provided such that electric power is reliably delivered to essential systems and equipment under both normal and adverse operating conditions.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 H.3.4.8, H.4.4.8	*Def-Stan 00-970 Reference:* *STANAG 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 4671.1351 4671.1353
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 Battery charging.

Where batteries are employed to provide backup power for Safety Of Flight (SOF) functions, the installation shall be safe and the method for charging and checking shall be adequate.

Consideration should be given to:

a. Ensuring that no explosive or toxic gases emitted by any battery in normal operation, or as the result of any probable malfunction in the battery subsystem, accumulate in hazardous quantities within the aircraft.

b. Ensuring that safe battery cell temperatures and pressures are maintained during any probable charging and discharging conditions.

c. Ensuring battery charging systems are designed to automatically control the charging rate of the battery in order to prevent overheating.

d. Ensuring that, where lithium batteries are installed, adequate charging methods and checks are provided.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the incorporation of batteries in the design of the aircraft electrical power system, including details regarding charging methods and ongoing monitoring of all parameters that could affect Safety Of Flight (SOF) (e.g. temperature).

2. Rig, ground and flight testing should demonstrate that battery cell temperatures and pressures remain within safe limits through all expected operating conditions.

3. System Safety Assessment (SSA) should demonstrate, using Functional Hazard Assessment (FHA) and Failure Modes, Effects and Criticality Analysis (FMECA), that battery sub-systems are safe.

Information Sources			
Comm'l Doc:	SAE ARP4761 RTCA DO-277 RTCA DO-311 RTCA DO-347		
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

12.1.6.1 Merged with 12.1.6

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	14CFR references: 23.1351-23.1367; 25.1351-25.1363	*EASA CS Reference:*	

12.1.7 Technical manuals.

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. The level of detail necessary to provide accurate technical information while remaining concise;

b. The information, at the appropriate level of detail, required to allow personnel to operate and maintain the aircraft as safely and effectively as possible at an acceptable workload.

c. Ensuring that all required operating procedures are defined, taking account of requirements for military operation (e.g. in-flight rectification).

Considerations for preparation of AMC:

1. Operational Technical Publications for the flight crew (Aircraft Flight Manual, Emergency Procedures, Checklists etc.) should clearly define all required normal, back-up and emergency operating procedures, limitations and restrictions.

2. Maintenance Technical Publications for ground crew (Aircraft Maintenance Manual, Master Minimum Equipment List, Maintenance Schedule, etc.) should clearly define all required servicing and maintenance information.

3. Flight Simulations, Ground Testing and/or Flight Testing should verify that all Operational Technical Publications are clear and unambiguous and can be followed by a flight crew through all flight phases and conditions without incurring excessive crew workload and serve their intended function.

4. Rig and/or Ground Testing should verify that all Maintenance Technical Publications are clear and unambiguous and can be followed by a competent maintenance engineer in a manner which ensures the continuing airworthiness of the aircraft.

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

12.1.8 Merged with Line 12.1.7.

12.1.9 Start and reversion to safe state.

The system shall power up in a safe state and in circumstances involving a loss of power, power transients or fluctuations, the system shall remain or revert to a known safe state.

Consideration should be given to:

a. Continuous built-in-test (BIT), fault detection, indication, isolation capability, and fault alarm rates.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should verify that the system will operate properly.

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 aircraft and for UAV, the control station safety of flight-related wiring system. Databuses are excluded from the scope of this section and covered in Section 11.

12.2.1 Selection of components.

Appropriate electrical system wiring and components shall be suitable for the physical environment in each area on the aircraft where they are used. Electrical wiring system installation shall be 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.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the types of wiring used, and the general routing of wiring/looms through the aircraft.
2. Declarations of Design and Performance (DDP) should demonstrate that the electrical system wiring and components are suitable for the physical environment in each area on the aircraft where they are used.
3. System Safety Assessment (SSA) should demonstrate that wiring and components are safe, taking into account shock hazards.

Information Sources			
Comm'l Doc:	For guidance/principles regarding design of aircraft electrical wiring systems: ARINC Report 609 SAE AS50881 SAE ARP1870 SAE ARP4761 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:*	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
		STANAG Reference:	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

Information Sources			
			CS 25 Subpart H

12.2.2 Ampacity.

Wiring shall be 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.

Considerations for preparation of AMC:

1. Electrical Loads Analysis should demonstrate that wire sizing is sufficient for its associated voltage and current.
2. Rig testing should demonstrate the accuracy of the performed analysis and should demonstrate that safe limits are provided for current capacity and voltage drop.

Information Sources			
Comm'l Doc:			
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 Circuit protection.

Proper circuit protection shall be provided for wiring associated with power distribution throughout its entire run.

Consideration should be given to:

a. Circuits contained in or exiting from any electronic enclosures performing intermediate power switching or distribution functions.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should include details of circuit protection for aircraft power distribution systems.
2. Electrical Loads Analysis should demonstrate that the provided circuit protection devices provides adequate protection against unsafe electrical loads, whilst providing an appropriate margin above normal operating loads to ensure that such devices are not activated erroneously.

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 Circuit isolation.
Ensure that redundant circuits provided for safety are sufficiently isolated.

Consideration should be given to:
a. Potential for differing specifications for aircraft and ground mobile applications.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA), including Functional Hazard Assessment (FHA) and Failure Modes, Effects, and Criticality Analysis (FMECA) should demonstrate that there is sufficient isolation of redundant circuits.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Comm'l Doc: For guidance/principles regarding provision of isolation for aircraft electrical circuits: SAE AS50881	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1309 4671.1351

Information Sources			
	SAE ARP4761 NFPA 70 DoD/MIL Doc: JSSG-2009: Appendix H H.6.4.1* for guidance/principles regarding provision of isolation for aircraft electrical circuits		
FAA Doc:	14CFR references: 23.1301*, 23.1309*; 25.1301*, 25.1309*	*EASA CS Reference:*	CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

12.2.5 Avoidance of single point failures.
The electrical system design shall preclude single-point failures related to wiring.

Consideration should be given to:
a. Integrating redundant functions within an electronics enclosure.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should confirm the absence of single point failures.

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 SAE ARP4761 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:* *STANAG Reference:*	00-970 P1 6.6.2 00-970 P7 C706 2.4 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 Sufficiency of design.
The design of the wiring system installation, including connectors, shall be adequate for all expected 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.

Considerations for preparation of AMC:
1. Electrical Loads Analysis should demonstrate that the wiring system installation (including connector) is suitable for supplied electrical loads under all expected operating conditions.
2. System Safety Assessment (SSA), including Functional Hazard Assessment (FHA) and Failure Modes, Effects, and Criticality Analysis (FMECA) should demonstrate that the installation of the wiring system is safe, taking into account expected operating conditions, load combinations, and failures within the electrical distribution system.

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:*	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
		STANAG Reference:	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	*EASA CS Reference:*	CS 23.1351 CS 25.1351 CS 25.1703 CS 27.1351 CS 29.1351

Information Sources			
	System Fault Tolerance Evaluation Requirements AC 43.13-1B CHG 1 - Acceptable Methods, Techniques and Procedures - Aircraft Inspection and Repair		

12.2.6.1 Prevention of ignition.
Wiring in areas containing explosive vapours shall be protected to prevent potential ignition sources.

Consideration should be given to:
a. Electrical systems in close proximity to fuel systems;
b. Issues resulting from installation, operational environment, ageing and deterioration of the wiring.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should the protection provided for all wiring routed in areas containing explosive vapours.
2. Functional Hazard Assessment (FHA) should demonstrate that hazards associated with the routing of electrical wiring are acceptable.

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:*	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
		STANAG Reference:	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 CS 25.863 CS 25.1703 CS 25.1705 CS 25.1707 CS 25.1713

Information Sources			
			CS 25.1723 CS 27.863 CS 29.863

12.2.6.2 Faults in safety critical wiring.

Failure within a wiring harness that includes safety-critical wiring shall 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.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) and Failure Modes, Effects and Criticality Analysis (FMECA) should demonstrate that failure within any Safety Of Flight (SOF) critical wiring harness does not cause loss or unacceptable degradation of any SOF-critical functions

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 and minimization of loss of safety-critical functions.	*Def-Stan 00-970 Reference:*	00-970 P1 6.6.2 00-970 P1 6.6.3 00-970 P7 LC706 2.4
		STANAG Reference:	4671.1351
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 Wiring separation.

The wiring design and installation procedures shall maintain positive separation of wiring from all fluid or gas carrying lines, and from mechanical and electrical flight controls.

Consideration should be given to:

a. Dynamic G loading.

b. Mechanical system movement.

c. Cable flexing.

d. Thermal effects.
e. Vibration.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the provisions for separation of electrical distribution system wiring from fluid or gas carrying lines, and from mechanical and electrical flight controls.

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:*	00-970 P1 6.6.3 00-970 P1 6.6.90
		STANAG Reference:	4671.1351 4671.1365
FAA Doc:		*EASA CS Reference:*	CS 23.1351 CS 23.1365(d) CS 25.1707 CS 27.1351 CS 29.1351 CS 29.1353

12.2.6.4 Chafing.
The routeing design and installation procedures shall be 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.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail provisions for prevention of chafing of electrical distribution system wiring.

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:* *STANAG Reference:*	00-970 P1 6.6.64 00-970 P1 S6 L14 4.1.3 00-970 P7 C706 6.5.1 4671.1351
FAA Doc:		*EASA CS Reference:*	CS 23.1351 CS 23.1365(d) CS 25.1717 CS 27.1351

12.2.6.5 Wiring support.
Wiring design shall provide primary and secondary support for the wiring throughout the installation.

Consideration should be given to:
a. Possible differences between specifications for aircraft and ground control systems applications.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail provisions for wiring support.
2. Structural analysis should demonstrate that wiring supports can be subjected to the maximum loads that would be expected in service without excessive or permanent deformation, taking into account maximum wiring runs between supports, aircraft deflections under ground and flight loads, etc.

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;	*Def-Stan 00-970 Reference:* *STANAG 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 4671.1365

Information Sources			
	Appendix H H.6.4.1, H.6.4.2		
FAA Doc:		*EASA CS Reference:*	CS 23.1365(d)

12.2.6.6 Avoidance of damage.

Wiring design shall provide routing and installation to minimize the risk of damage to wiring by cargo, crew and maintenance personnel.

Consideration should be given to:

a. Possible differences between specifications for aircraft and ground control systems applications.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail provisions for the protection of wiring against damage by cargo, crew and maintenance personnel.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2001: 3.1.5 JSSG-2009: Appendix H.6.4.1 Wiring.	*Def-Stan 00-970 Reference:*	00-970 P7 C706 2.5
		STANAG Reference:	1365 USAR.1367
FAA Doc:		*EASA CS Reference:*	CS 23.685 CS 25.685 CS 27.685 CS 29.685

12.2.6.8 Bonding and grounding.

All equipment and equipment racks shall be designed for proper electrical bonding and grounding.

Consideration should be given to:

a. Appropriate limits for electrical resistance between local ground points and main ground points.

b. Clear ground markings.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail of provisions for electrical bonding and grounding.

2. Electrical Loads Analysis should demonstrate that the resistance of bonding and grounding points and any leads/straps is suitable for the electrical loads expected in service, taking into account reasonably expected failures.

Information Sources			
Comm'l Doc:	For guidance/principles leading toward maintainable design(s): SAE AS50881 NFPA 70		
DoD/MIL Doc:	Comm'l Doc: SAE ARP1870 for guidance/principles regarding the provision of proper	*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

Information Sources			
	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; Appendix G: G.3.4.7.2, G.3.4.7.6, G.4.4.7.6	*STANAG Reference:*	4671.867
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

12.2.6.9 Care in modification.

The addition of a modification into existing wiring installations shall not create cracking or conditions for chafing or other degradation of existing wiring insulation.

Consideration should be given to:

a. Possible differences between specifications for aircraft and ground control systems applications.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail provisions for the prevention of chafing or other wiring/harness degradations.
2. System Safety Assessment (SSA), including Functional Hazard Assessment (FHA) and Failure Modes, Effects and Criticality Analysis (FMECA) should demonstrate that modifications made to, and in the vicinity of wiring installations do not cause cracking, chafing or other unsafe degradation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Comm'l Doc: For guidance/principles regarding the prevention of wire/cable/harness chafing:	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.1351

Information Sources			
	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 Def-Stan 00-970: 00-970 6.6.64 00-970 S6 L14 4.1.3 P7 C706 6.5.1		
FAA Doc:		*EASA CS Reference:*	CS 23.1351 CS 23.1365(d) CS 25.1703 CS 25.1707 CS 27.1351

12.2.6.7 Maintainability.
Maintainability shall be a factor in the design and installation procedures for wiring and components.

Consideration should be given to:
a. Ensuring accessibility for inspection is considered in the design.
b. Ensuring all wiring and components are properly identified.
c. Ensuring identification means does not adversely affect the performance or life of the wiring or components.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail provisions for improving the maintainability of electrical wiring and components, including but not limited to accessibility and wiring/component identification.

Information Sources			
Comm'l Doc:	SAE ARP1870 for guidance/principles regarding the provision of proper electrical bonding		
DoD/MIL Doc:	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): 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 C706 2.5
		STANAG Reference:	

Information Sources			
FAA Doc:		*EASA CS Reference:*	

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.

CERTIFICATION CRITERIA

13.1. COMPONENT/SUBSYSTEM E3 QUALIFICATION.

13.1.1 Flight/safety critical equipment requirements.

All flight-critical and safety-critical equipment shall comply with all electromagnetic environmental effects requirements.

Consideration should be given to:

a. All electromagnetic environmental effects requirements, including lightning susceptibility, as appropriate for the particular equipment; this includes conducted and radiated emissions and susceptibility requirements.

b. Introduction of appropriate mitigations for those equipment that are not shown to be compliant.Considerations for preparation of AMC:

1. Safety Analysis to identify all parts of aircraft systems which are flight critical and/or safety critical.
2. System Description Documents (SDD) should specify the parts of aircraft systems which are flight critical and/or safety critical.
3. Demonstrating that all equipment have been included in the EMC/EMI test plan.
4. Demonstrating that all equipment, flight and/or safety critical aircraft systems have been appropiately tested up to aircraft level.

Information Sources			
Comm'l Doc:	RTCA DO-160 sections 18 through 22 SAE ARP5412, section 4		
DoD/MIL Doc:	RTCA DO-160 sections 18 through 22 SAE ARP5412B, section 4 SAE ARP 5414A, 5416A 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 4.27.1-4.27.40 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

Information Sources			
			4671.1431 4671.1605 4671.1717
FAA Doc:		*EASA CS Reference:*	CS 23.867 CS 23.1301 CS 23.1308 CS 23.1309 CS 23.1431 CS 25.581 CS 25.899 CS 25.1316 CS 25.1317 CS 25.1707 CS 23.1431 CS 27.610 CS 27.1317 CS 29.610 CS 29.1309 CS 29.1317 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:	RTCA DO-160 sections 18 through 22 SAE ARP 5412, section 4 MIL-STD-461, section 5 MIL-STD-464, section 5.47	*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 Reference:	4671.685(e) 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

Information Sources			
			CS 25.581 CS 25.899 CS 25.1316 CS 25.1431 CS 25.1707 CS 27.610 CS 27.865 CS 29.610 CS 29.865 CS 29.1309 CS 29.1431

13.1.3. Merged with 13.1.2

13.2. SYSTEM-LEVEL E3 QUALIFICATION.

13.2.1 Mutual electromagnetic compatibility of equipment and subsystems.
All systems and sub-systems shall be mutually electro-magnetically compatible.

Consideration should be given to:
a. Flight-critical and safety-critical systems.
b. Non flight-critical and non safety-critical systems.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should be provided for all systems.
2. Demonstrating that all systems and sub systems have been included in the EMC/EMI test plan.
3. The EMC/EMI test plan should take cognisance of all systems at a platform level.
4. The EMC/EMI test plan should account 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

Information Sources			
			CS 25.1431 CS 25.1707 CS 29.1309 CS 29.1431

13.2.2 Mutual compatibility of antenna-connected and other equipment.

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 affect 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. All antenna-connected systems ; includingbut not limited to: radios; radars including rad-alt, TFR, ECM and ECCM systems, and their various modes; GPS systems; navigation systems; surveillance systems.

b. Off-board equipment considered to have the potential to interact with on-board equipment ; including but not limited to: ATC systems; other aircraft transmitters; terrestrial radio and TV transmitters; military systems, and all equipment able to generate intended or spurious RF transmissions.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should identify all antenna-connected systems.
2. The EMC/EMI test plan should take cognisance of all antenna-connected systems.
3. The EMC/EMI test plan should take cognisance of all off-board equipment considered to have the potential to interact with on-board equipment.
5. The EMC/EMI test plan should account for all likely combinations of on and off-board equipment in 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 6.1.4 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 25.1431 CS 25.1707 CS 29.1309 CS 29.1431

13.2.3 Compatibility of aircraft with electromagnetic environment.
The intended external RF electro-magnetic environment for the aircraft shall be defined, and the aircraft shall be shown to be compatible with this environment.

Consideration should be given to:
a. Ground, sea and air based emitters;

Considerations for preparation of AMC:
1. The EMC/EMI test plan should define how compliance will be demonstrated and what the acceptance criteria are.
2. Testing, or demonstration of compliance, should be at aircraft level.

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 25.1431 CS 27.610 CS 27.865 CS 29.610 CS 29.865 CS 29.1309 CS 29.1431

13.2.4 Lightning effects.
All requirements for meeting lightning protection, both the direct (physical) and indirect (electro-magnetic) effects, shall be identified, agreed and verified by testing. Potential for ignition of fuel vapours shall be eliminated.

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. Fuel tank inerting.

Considerations for preparation of AMC:
1. The EMC/EMI test plan should define how compliance will be demonstrated and what the acceptance criteria are.
2. Testing, or demonstration of compliance, shall be at aircraft level.

Information Sources			
Comm'l Doc:	SAE ARP5412, section 4		
DoD/MIL Doc:	SAE ARP5412B, section 4 SAE ARP 5414A, 5416A MIL-STD-464, section 5.45	*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 25.1316 CS 25.1707 CS 27.610 CS 27.865 CS 29.610 CS 29.865 CS 29.954 CS 29.1309

13.2.5 EMP protection.
If protection from the effects of an electro-magnetic pulse is required, the appropriate level of protection and associated acceptance criteria shall 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. Whether any extra protection against EMI, over and above the base level, is required.
d. Any requirement for redundant systems for use after experiencing EMP.
Considerations for preparation of AMC:
1. Analysis of flight critical and/or safety critical equipment EMP susceptibility.
2. Demonstrating that any EMP requirements have been included in the EMC/EMI test plan.

3. Demonstrating that all equipment, flight and/or safety critical aircraft systems have been appropiately tested up to aircraft level.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-464,section 5.6 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 Electrostatic charge.

The aircraft 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.

Consideration should be given to:

a. Ordnance hazards;

b. Personnel shock hazards;

c. Control p-static interference or damage to electronics;

d. The static discharge spark.

Considerations for preparation of AMC:

1. Analysis of flight critical and/or safety critical equipment/systems susceptibility to electrostatic charge.
2. Demonstrating that any electrostatic charge requirements have been included in the EMC/EMI test plan.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-464, section 5.8	*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 CS 29.610

13.2.7 Hazards of electromagnetic radiation.

Sources of electromagnetic radiation shall pose no Hazard of Electromagnetic Radiation to Personnel (HERP), Hazard of Electromagnetic Radiation to Fuel (HERF), and Hazard of Electromagnetic Radiation to Ordnance (HERO), and the appropriate manuals shall include safety criteria regarding distance from on-board and off-board transmitters to personnel and fuel sources.

Consideration should be given to:
a. The radiation pattern of on-board emitters.
b. The minimum distance by which the air vehicle must stay away from external transmitters, both on the ground and in the air.
c. Other sources of high intensity radio frequency radiation.

Considerations for preparation of AMC:
1. Analysis of radiation pattern of on-board emitters.
2. Demonstrating by test that any electromagnetic safe distances are valid.

Information Sources			
Comm'l Doc:	SAE ARP5583, sections 5 and 7 SAE ARP5412, section 4		
DoD/MIL Doc:	SAE ARP5583, sections 5 and 7 MIL-STD-464, section 5.9 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 Electrical bonding.
The electrical bonding shall be adequate to ensure safe air vehicle operation.

Consideration should be given to:
a. Minimum impedance.
b. Maximum fault current.
c. Current return path.
d. Shock hazard.
e. RF potential.

Considerations for preparation of AMC:
1. Analysis of current return path.
2. Demonstration by test of bonding performance.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-464, section 5.11	*Def-Stan 00-970 Reference:*	00-970 P1 4.27 00-970 P7 L708
		STANAG Reference:	3659 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

Nil. This line has been deleted.

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:*	

13.2.9 Electromagnetic spectrum licensing and certification.
The system shall meet the electromagnetic spectrum licensing requirements in accordance with national and international regulations, and have received electromagnetic spectrum certification.

Considerations for preparation of AMC:
1. Analysis of radiation of on-board emitters.
2. Demonstration by test of bonding performance.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	DoDD 4650.1, Management and Use of the Radio Frequency Spectrum DD Form 1494, Application for Frequency Allocation Joint Service Publication (JSP) 602 Lflt 1038 National procedures	*Def-Stan 00-970 Reference:*	Joint Service Publication (JSP_ 602 Lflt 1038
		STANAG 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.

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 System safety process.

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.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should demonstrate that a system safety approach has been documented through inspection of technical and programmatic documents.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 14CFR references: system safety sections of Parts 23, 25,	*Def-Stan 00-970 Reference:*	00-970 P7 L732 3.3.1 00-56
		STANAG Reference:	4671.1309

Information Sources			
	27, 29 AC 23.1309-1E AC 25.1309-1A		
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 CS 25 AMC 25.1309 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.1.1.1 System safety requirements.

The system safety programme shall be integrated effectively into all aspects of the systems engineering lifecycle, throughout all acquisition phases, 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.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should demonstrate that a system safety approach has been documented through technical and programmatic documents.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	MIL-STD-882D: 4.1 14CFR references: system safety sections of Parts 23, 25, 27, 29 AC 23.1309-1E AC 25.1309-1A	*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:*	CS 25 AMC 25.1309 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

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:	Covered by 14.2.10	*Def-Stan 00-970 Reference:*	Covered by 14.2.10
		STANAG Reference:	Covered by 14.2.10

Information Sources			
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 Hazard/risk tracking and risk acceptance.

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.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should demonstrate that appropriate closed loop hazard tracking system and the risk acceptance processes are in place by inspection of safety program documentation.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	MIL-STD-882D: 4.1, 4.2, 4.3, 4.4, 4.5 14CFR references: system safety sections of Parts 23, 25, 27, 29 AC 23.1309-1E AC 25.1309-1A	*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:*	CS 25 AMC 25.1309 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.1.1.4 System safety program implementation.

The system safety programme shall be comprehensive, and as a minimum, shall address; 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, and 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.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) and supporting documentation should specifically address, where applicable; 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, and support equipment..

Information Sources			
Comm'l Doc:	For f. above: ANSI Z 136.1 for definitions of key laser safety design requirements SAE ARP4761		
DoD/MIL Doc:	MIL-STD-882D: 1.1, 4.1, 4.2, 4.3, 4.4, 4.5 14CFR references: system safety sections of Parts 23, 25, 27, 29 AC 23.1309-1E AC 25.1309-1A For f. above: ANSI Z 136.1 for definitions of key laser safety design requirements 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	*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 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 i. Materials j. Failure modes and effects testing and built-in-test k. Fail safe design	*EASA CS Reference:*	CS 25 AMC 25.1309 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

Information Sources			
	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 aircraft 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;
- Aircraft 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 Hazard identification/control/resolution process

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.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate that a hazard identification/control/resolution process is employed, by inspection of safety process documentation and review of safety analyses and system safety group proceedings.

Information Sources			
Comm'l Doc:	SAE ARP4761		

Information Sources			
DoD/MIL Doc:	MIL-STD-882D: 4.1, 4.2, 4.3, 4.4, 4.5, Appendix A 14CFR references: system safety sections of Parts 23, 25, 27, 29 AC 23.1309-1E AC 25.1309-1A MIL-STD-882E	*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	*EASA CS Reference:*	CS 25.1315 CS 25 AMC 25.1309 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.2.2 Mitigation of mishap risks.

All mishap risks associated with the aircraft 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.
e. Risk to 3rd parties.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should include a process to mitigate hazards with "unacceptable" mishap risk by detailing the system safety documents, technical documents, test documents, programmatic documents, safety hazard tracking database and the residual risk acceptance process.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 14CFR references: system safety sections of Parts 23, 25, 27, 29 AC 23.1309-1E AC 25.1309-1A	*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	*EASA CS Reference:*	CS25 AMC 25.1309 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.2.3 Single point failure assessment.
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 aircraft 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.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate that the risk of all single point failure hazards do not exceed the hazard baseline set for the program, and that the residual risk has been accepted. Verification methodology includes inspection of the safety analyses for single point failures and the relevant data in the closed loop hazard tracking system.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 14CFR references: system safety sections of Parts 23, 25, 27, 29 AC 23.1309-1E AC 25.1309-1A	*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 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 23.1309 CS 25.629(d) CS 25.933(a) CS 25.971(c) CS 25.1309

Information Sources			
			CS 27.1309 CS 29.1309

14.2.4 Subsystem protection.

Redundant aircraft 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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail how power sources, controls, and critical components of redundant subsystems are separated/shielded.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	MIL-STD-882D: 4, Appendix A 14CFR references: system safety sections of Parts 23, 25, 27, 29 AC 23.1309-1E AC 25.1309-1A	*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:*	CS 25.1707(k) CS 23 AMC 23.1309 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309 AMC 20-06 Rev. 2

14.2.5 Human factors.

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.

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

Considerations for preparation of AMC:

1. System Description Documents (SDD) should demonstrate that human factors requirements are incorporated into the design.

2. System Safety Assessment (SSA) should identify safety issues/risks related to human factors and reduce them to an acceptable level. This is achieved by inspection of safety documentation, safety analyses and program functional baselines.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	MIL-STD-882D: 4, Appendix A MIL-STD-1472 gives the human-factor design requirements 14CFR references: system safety sections of Parts 23, 25, 27, 29 AC 23.1309-1E AC 25.1309-1A	*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 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309 AMC 20-06 Rev. 2

14.2.6 Human error.

The risks from failures or hazards, created by human error during the operation and / or support of the aircraft , shall be minimised through system design, and reduced to an acceptable level.

Consideration should be given to:

a. The level of acceptable risk;

b. The use of safeguards to prevent inadvertent operations.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should demonstrate that design safeguards are in place to reduce the mishap risks associated with human error to acceptable levels, by inspection of safety documents and analyses and review of the closed loop hazard tracking system.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	MIL-STD-882D: 4, Appendix A 14CFR references: system safety sections of Parts 23, 25, 27, 29 AC 23.1309-1E AC 25.1309-1A	*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 CS 23.1309 CS.25.1309

Information Sources			
			CS 27.1309 CS 29.1309

14.2.7 Environmental conditions.

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.

c. Operation in, or in the vicinity of, for example, a volcanic ash cloud.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should demonstrate that the safety risk minimization process addresses effects of worst-case environmental conditions on the design, by review of safety analyses and environmental/climatic test results/reports.

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 14CFR references: system safety sections of Parts 23, 25, 27, 29 AC 23.1309-1E AC 25.1309-1A	*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 27.1309 CS 29.603(c)

Information Sources			
			CS 29.607(a) CS 29.1309

14.2.8 Assembly/installation hazards.
Risks to personnel, caused by exposure to hazards during the installation process, including those due to hazardous locations of systems in the aircraft , 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.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate procedural safety requirements acceptability by inspection and approval of maintenance process documentation.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	MIL-STD-882D: 4, Appendix A 14CFR references: system safety sections of Parts 23, 25, 27, 29 AC 23.1309-1E AC 25.1309-1A	*Def-Stan 00-970 Reference:*	00-970 P1 3.9.54 00-970 P1 6.1.21 00-970 P7 L203 8.2.1 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 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.2.9 Safety design process.
The aircraft 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.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate the standard to assure that hazardous substances, components and operations have been identified and corrective measures taken (e.g., separation, shielding, isolation), and/or risks reduced to an acceptable level for the program. Methods include review of safety analyses and program technical documentation.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	MIL-STD-882D: 4, Appendix A 14CFR references: system safety sections of Parts 23, 25, 27, 29 AC 23.1309-1E AC 25.1309-1A	*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 CS 23.967 CS 23.1121 CS 23.1309 CS 25.851 CS 25.967 CS 25.1121 CS 25.1309 AMC 25.1309 CS 27.1309 CS 29.1309

14.2.10 Analysis of changes or modifications.
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.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate that no changes/modifications to existing systems will cause an uncceptable level of mishap risk, by inspections of system safety analyses on changed or modified equipment or software.

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 AC 23.1309-1E AC 25.1309-1A MIL-STD-882D: 4	*Def-Stan 00-970 Reference:*	00-56
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.2.11 Assess safety of operational contingencies.

The system shall provide and implement operational contingencies in the event of catastrophic, critical and marginal failures or emergencies involving the system.

Consideration should be given to:

a. Pre-determined states and modes following a failure.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should demonstrate that operational contingencies have been approved by inspection of system safety documentation.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	AC 23.1309-1E AC 25.1309-1A	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671 USAR 1309
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.2.12 Safety assurance for special military modes of operation.

Special military modes of operation when inactive shall not reduce the aircraft below threshold safety levels.

Consideration should be given to:

a. Weapons or stores arming and release.

b. Operation of electromagnetic spectrum emitters.

c. Physical/functional separation between the special modes when inactive and the basic UAS.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should demonstrate that special military modes of operation of UAS when inactive meet probability of failure and design and development assurance requirements through inspections of programmatic, system safety and software safety documents.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	AC 23.1309-1E AC 25.1309-1A	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671.USAR.U19
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.2.13 Military requirements for cockpit & cabin design.

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;

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.

Considerations for preparation of AMC:

1. The aircraft specification should include all relevant requirements for physical protection measures for the flight deck, resistance to the effects of an explosive or incendiary device, survivability of systems, and the ease of searching the aircraft interior.

2. System Description Documents (SDD) should detail all design features incorporated to provide physical protection measures for the flight deck, resistance to the effects of an explosive or incendiary device, survivability of systems, and the ease of searching the aircraft interior.

3. Analysis should demonstrate that the design features provided meet the associated requirements of the aircraft specification.

4. Testing should demonstrate the accuracy of the performed analysis and should demonstrate that the required levels of protection, resistance, survivability and searchability have been met.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	AC 23.1309-1E AC 25.1309-1A	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	CS 23.1309 CS 25.795 CS 25.1309 CS 27.1309 CS 29.1309

14.3. SOFTWARE SAFETY PROGRAM.

This section covers 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 Levels;
- 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 also covered by Section 15.3

14.3.1 Comprehensive approach to software safety.

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 levels , typically in accordance with 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.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should demonstrate by inspection of program safety, software safety, and software documentation that the comprehensive software safety program has been integrated into the system safety program in a manner which meets the selected standard.

Information Sources			
Comm'l Doc:	DO-178B to establish software integrity levels for commercial		

Information Sources			
	aircraft SAE ARP4754A		
DoD/MIL Doc:	Joint Software System Safety Committee, Software System Safety Handbook: A Technical & Managerial Team Approach, Dec 1999 FAA Doc: 14CFR references: system safety sections of Parts 23, 25, 27, 29 AC 23.1309-1E AC 25.1309-1A	*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 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.3.2 Planning/accomplishing software safety analyses and assessments.

Appropriate software safety designated analyses shall be performed as part of the software development process, to satisfy the software safety programme.

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.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should demonstrate by inspection of system safety, software safety, and software documentation that the tailored set of analyses and assessments (or equivalent) required by this section (14.3) are planned for and accomplished.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	Joint Software System Safety Committee, Software System Safety Handbook: A Technical & Managerial Team Approach, Dec 1999 FAA Doc: 14CFR references: system safety sections of Parts 23, 25, 27, 29 AC 23.1309-1E AC 25.1309-1A	*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)

Information Sources			
FAA Doc:	14CFR references: system safety sections of Parts 23, 25, 27, 29	*EASA CS Reference:*	AMC 25.1309 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.3.2.1 Performance of software safety analyses.
The required software safety analyses preparation shall be accomplished.

Consideration should be given to:
a. Ensuring software safety analyses and assessments include the tailored documentation required by the references of this section (14.3).

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate by inspection that the delivered software safety analyses for the program have a complete systems view, including identification of software hazards, and associated software risks.

Information Sources			
Comm'l Doc:	SAE ARP4754A		
DoD/MIL Doc:	AC 23.1309-1E AC 25.1309-1A RTCA DO-178C	*Def-Stan 00-970 Reference:*	00-970 P1 6.2.63 00-55
		STANAG Reference:	4671 AMC.1309(b)
FAA Doc:		*EASA CS Reference:*	AMC 25.1309 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.3.2.2 Performance of software safety traceability analyses.
The required software safety traceability analyses shall be accomplished.

Consideration should be given to:
a. Bi-directional traceability to the identified hazard(s).
b. Ensuring software safety analyses and assessments include the tailored documentation required by the references of 14.3 (this document).

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate by inspection of system safety, software safety and program documentation that the bi-directional software safety traceability analyses amongst requirements, design, implementation, verification, and hazard have been accomplished.

Information Sources			
Comm'l Doc:	SAE ARP4754A		
DoD/MIL Doc:	AC 23.1309-1E AC 25.1309-1A RTCA DO-178C	*Def-Stan 00-970 Reference:*	00-970 P1 6.2.63 00-55
		STANAG	4671 AMC.1309(b)

Information Sources			
		Reference:	
FAA Doc:		*EASA CS Reference:*	AMC 25.1309 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.3.3 Evaluation of software for elimination of hazardous events.

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.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should demonstrate by inspection that the delivered software safety analyses for the program have a complete systems view, including identification of software hazards, and associated software risks.
2. Rig/simulation tests of software applications should demonstrate that systems respond as intended.

Information Sources			
Comm'l Doc:	DO-178B defines software integrity levels for safety critical functions SAE ARP4754A		
DoD/MIL Doc:	Joint Software System Safety Committee, Software System Safety Handbook: A Technical & Managerial Team Approach, Dec 1999 FAA Doc: 14CFR references: system safety sections of Parts 23, 25, 27, 29 AC 23.1309-1E AC 25.1309-1A	*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 00-55
		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 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.3.4 Commercial off-the-shelf software integrity level confirmation.

Commercial Off-the-Shelf (COTS) and reuse software (which includes application software and operating systems) shall be developed to the necessary software integrity level.

Consideration should be given to:
a. Defining the appropriate software integrity level at the software and/or safety planning stage.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate by inspection of program, system safety, software safety and software engineering documentation that COTS and reuse software is developed to the necessary software integrity level.

Information Sources			
Comm'l Doc:	SAE ARP4754A		
DoD/MIL Doc:	AC 23.1309-1E AC 25.1309-1A RTCA DO-178C	*Def-Stan 00-970 Reference:*	00-970 P1 6.2.63 00-055
		STANAG Reference:	4671 AMC.1309(b)
FAA Doc:		*EASA CS Reference:*	AMC 25.1309 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.3.5 Identification of safety designated/significant software.
Software elements that perform functions related to system hazards shall be identified and handled as safety related/critical software.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate by inspection of program, system safety and software safety documentation that the identified safety related software elements are handled (labeled, tracked, implemented, tested, etc.) as required by software/safety planning based on their safety criticality levels.

Information Sources			
Comm'l Doc:	SAE ARP4754A		
DoD/MIL Doc:	AC 23.1309-1E AC 25.1309-1A RTCA DO-178C	*Def-Stan 00-970 Reference:*	00-970 P1 6.2.63 00-055
		STANAG Reference:	4671 AMC.1309(b)
FAA Doc:		*EASA CS Reference:*	AMC 25.1309 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.3.5.1 Assignment of criticality levels.
Each safety designated software function shall be assigned an appropriate criticality level.

Consideration should be given to:
a. Ensuring that, if a software function contains multiple software elements, the function is assigned a criticality level equal to the criticality level of the highest element.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate by analysis and inspection of documentation, that the appropriate level of criticality is assigned to each software function.

Information Sources			
Comm'l Doc:	SAE ARP4754A		
DoD/MIL Doc:	AC 23.1309-1E AC 25.1309-1A RTCA DO-178C	*Def-Stan 00-970 Reference:*	00-970 P1 6.2.63 00-055
		STANAG Reference:	4671 AMC.1309(b)
FAA Doc:		*EASA CS Reference:*	AMC 25.1309 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.3.5.2 Testing to criticality levels.
Each safety designated software function shall be developed and tested commensurate with its assigned criticality level.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate by inspection of documentation, that the appropriate level of development and testing for designated safety software has been performed and required results were achieved.

Information Sources			
Comm'l Doc:	SAE ARP4754A		
DoD/MIL Doc:	AC 23.1309-1E AC 25.1309-1A RTCA DO-178C	*Def-Stan 00-970 Reference:*	00-970 P1 6.2.63 00-055
		STANAG Reference:	4671 AMC.1309(b)
FAA Doc:		*EASA CS Reference:*	AMC 25.1309 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.3.6 Software safety test analyses.
The appropriate software safety test analyses shall be planned and performed.

Consideration should be given to:
a. Ensuring that results are recorded using formal procedures and are kept under configuration control.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate by inspection of the safety plans that software safety testing and test analyses have been adequately planned, performed and documented.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	AC 23.1309-1E AC 25.1309-1A RTCA DO-178C	*Def-Stan 00-970 Reference:*	00-970 P1 6.2.63 00-055
		STANAG Reference:	4671 AMC.1309(b)
FAA Doc:		*EASA CS Reference:*	AMC 25.1309 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

14.3.7 Structural coverage analysis.

Structural Coverage Analysis shall be planned and executed.

Consideration should be given to:

a. Ensuring that results are recorded using formal procedures and are kept under configuration control.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should demonstrate by inspection of the test plans that adequate structural coverage analysis is planned and documented.
2. Test/simulation should demonstrate that adequate structural coverage is in place.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	AC 23.1309-1E AC 25.1309-1A RTCA DO-178C	*Def-Stan 00-970 Reference:*	00-970 P1 6.2.63 00-055
		STANAG Reference:	4671 AMC.1309(b)
FAA Doc:		*EASA CS Reference:*	AMC 25.1309 CS 23.1309 CS.25.1309 CS 27.1309 CS 29.1309

SECTION 15 - COMPUTER SYSTEMS AND SOFTWARE

This section covers the design, installation, arrangement and compatibility of the complete aircraft computer resources. This includes manned aircraft avionics, as well as airborne and ground segment avionics for UAVs.

CERTIFICATION CRITERIA

15.1. AIRCRAFT PROCESSING ARCHITECTURE

15.1.1 Safety critical functions (SCFs).
Safety critical functions (SCFs) shall be identified and documented for each aircraft system.

Consideration should be given to:
a. Allocation of an integrity level for each system.
b. Identifying all associated system hardware and software.
c. Ensuring that the required safety level has been associated with each of the hardware and software functions.

Considerations for preparation of AMC:
1. System Safety Analysis (SSA) should identify each safety critical function.

Information Sources			
Comm'l Doc:	RTCA DO-178B, RTCA DO-254 SAE ARP4761 SAE ARP4754A		
DoD/MIL Doc:	RTCA DO-178C, RTCA DO-254 JSSG-2008: 3.1.12, 3.3.1 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	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		STANAG Reference:	4671.1301 4671.1309

Information Sources			
	to 10E-7 hazard rates depending on flight phase) AC 20-115C		
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 AMC 20-115C

15.1.2 SPA requirements.
System Processing Architecture (SPA) safety requirements shall be fully defined and documented.

Consideration should be given to:
a. Attributes such as functional requirements, processing demands, timing criticalities, data flow, interfacing elements, redundancy and fault tolerance.
b. Federated and integrated elements of the SPA.

Considerations for preparation of AMC:
1. System Safety Assessment should document that all technical and safety SPA risks are appropriately mitigated/captured.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	RTCA DO-178C, RTCA DO-254 JSSG-2008: 3.3.1 JSSG-2008 Appendix A: 3.1.7, 3.1.12, 3.3.1 for further guidance concerning redundancy, system and processing architectures 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 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:		*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 AMC 20-115C

15.1.10 Physical and functional separation.

Physical and functional separation between SSEs and non-SSEs shall be accounted for in the SPA.

Consideration should be given to:

1. Clearly identifying all SSE of the architecture.
2. Ensuring that non-SSE of the architecture do not share either hardware or software resources.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) shall demonstrate physical and functional separation of SSEs and non-SSEs.

Information Sources			
Comm'l Doc:	RTCA DO-178B SAE ARP4761		
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 JSSG-2008: 3.1.7.1 JSSG-2008 Appendix A: 3.1.7.1 provides for basic partitioning of the architecture (hardware and software); 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 AC 20-115C	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P0 S4 00-970 P13 1.7 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 AMC 20-115C

15.1.11 Notification of loss of critical processing.
The operator shall be notified upon the loss of flight critical processing capability or redundancy in flight critical processing.

Consideration should be given to:
a. Built-In-Test (BIT) detection of loss of redundant processing capabilities for flight critical systems.
b. Prioritization of loss or degraded processing annunciations.
c. Latency time from detection to annunciation for flight critical alerts

Considerations for preparation of AMC:
1. System Description Documents (SDD) should include details of operator notification due to the loss of flight critical processing capability or redundancy in flight critical processing.
2. Rig and ground testing should demonstrate that operator notifications (due to the loss of flight critical processing capability or redundancy in flight critical processing) are displayed correctly.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:		*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 AMC 20-115C

15.1.7 Computer System Integrity Levels (CSILs).
All SCFs shall be fully allocated to elements within the SPA and each element assigned a Computer System Integrity Level (CSIL) based on the criticality of support that it provides to the SCF.

Consideration should be given to:
a. Identifying both the hardware and software components relating to SCFs.
b. Dissimilar systems within redundant SPAs.

Considerations for preparation of AMC:
1. System Safety Analysis (SSA) should demonstrate that each of the identified SCFs have been allocated.
2. SSA should include analysis of SPA criticality.

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254 SAE ARP4761 SAE ARP4754A		

Information Sources			
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 JSSG-2008: 3.1.16 MIL-STD-882D Appendix A: A.4.4.2 establishes hardware and software analysis in the hazard identification process AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		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 AMC 20-115C

15.5.8 Unsafe techniques.

SSSEs shall not utilize or include unsafe techniques or attributes (e.g., patches, de-activated code, lab test functionality).

Consideration should be given to :

a. Configuration control methods.

Considerations for preparation of AMC:

1. Rig testing should demonstrate code coverage.
2. Inspection of the delivered software should demonstrate that no unsafe techniques or attributes are included in software design.
3. Software release and change control records should detail all changes made to the software, and reviews should not find any details of unsafe techniques or attributes.

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254 SAE ARP4761		
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 JSSG-2008: 3.3.7 contains guidance on Software Change Control AC 20-115C Functional design integration of processing elements.	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		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

Information Sources			
			CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309 AMC 20-115C

15.1.5 Probability of loss of control and hazard mitigations.

. The SPA shall be designed to meet Probability of Loss of Control (PLOC), Probability of Loss of Aircraft (PLOA), SCF processing, hazard mitigations, and reliability requirements.

Consideration should be given to:

a. Identifying and recording the quantitative safety targets for the PLOC and PLOA as well as the requirements of SCF processing, hazard mitigations and reliability.

b. Identifying and recording the fault tolerance requirements for the architecture.

c. Documenting the redundancy scheme based on the requirements.

4d. Documenting the voting mechanism for the architecture.

Considerations for preparation of AMC:

1. System Safety Assessment (SSA) should demonstrate that SPA are designed to meet Probability of Loss of Control (PLOC), Probability of Loss of Aircraft (PLOA), SCF processing, hazard mitigations, and reliability requirements

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254 SAE ARP4761 SAE ARP4754A		
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 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 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	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		STANAG Reference:	4671.1301 4671.1309

Information Sources			
	of proper levels of redundancy AC 20-115C		
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 AMC 20-115C

15.1.6 SPA interfaces.

All SSEs of the SPA that interface (physically or functionally) with other processing elements (SSEs or non-SSEs) shall continue safe operation in the event there is a data channel failure or data corruption with the interfacing elements.

Consideration should be given to:

a. Ensuring data/calculation/system-timing dependencies do not impede system performance in any operational mode or degrade architectural safety coverage.

Considerations for preparation of AMC:

1. Rig, ground and flight testing should demonstrate the robustness of the architecture regarding data channel failure or data corruption with the interfacing elements.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:		*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 AMC 20-115C

15.1.12 Uninterruptable power.

Electrical power quantity and quality for the SPA(s) shall be sufficient to maintain continuous operation.

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.

Considerations for preparation of AMC:
1. Systems Interface Documents (SID) should include relevant details for electrical power quantity and quality for SPAs.
2. Rig, ground, and flight testing should demonstrate that electrical power quantity and quality remains within defined limits, sufficient to maintain continuous operation, through all expected operating conditions.

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254		
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 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 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		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 CS 29.1351 CS 29.1355 AMC 20-115C

15.1.3 SPA redundancy.
The SPA shall employ redundancy to preclude the loss of safety critical processing in the event of a single failure or data channel loss and support fault tolerance requirements.

Consideration should be given to:
a. Provision of mitigations for any failure modes identified

Considerations for preparation of AMC:
1. A full system failure analysis (e.g. FMECA) should determine potential single points of failure.

Information Sources			
Comm'l Doc:	RTCA DO-178B		

Information Sources			
	RTCA DO-254 SAE ARP4761		
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 JSSG-2008: 3.3.1 JSSG-2008 Appendix A: 3.1.7, 3.1.12, 3.3.1 for further guidance concerning redundancy, system and processing architectures 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 AC 20-115C	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P0 S4 00-970 P13 1.7 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 AMC 20-115C

15.1.4 SCF threads.

All SPA supported Safety Critical Function (SCF) threads shall be identified, documented and completely traced, and all Safety Supporting Elements (SSEs) of the SPA shall be identified.

Consideration should be given to:

a. Identifying Safety Supporting Hardware Elements (SSHEs) relevant to the SCF thread.

b. Identifying non-SSEs relevant to the SCF thread.

Considerations for preparation of AMC:

1. System Description Documents (SSD) for software should include details of functional thread analysis for each SCF from the SPA to the SSEs, Safety Supporting Software Elements (SSSEs), SSHEs, and components.

2. System Description Documents (SSD) for software should include details of automation of the SCF thread tracing capability to allow repeatability and expansion of analysis.

Information Sources			
Comm'l Doc:			

Information Sources			
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:		*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 AMC 20-115C

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 SAE ARP4761 SAE ARP4754A		
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 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 VCMS systems with non-safety critical processing elements AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		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

Information Sources			
			CS 29.1309 AMC 20-115C

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:	RTCA DO-178C RTCA DO-254 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 AC 20-115C	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P0 S4 00-970 P13 1.7 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 AMC 20-115C

15.2 DESIGN AND FUNCTIONAL INTEGRATION OF SPA ELEMENTS.

15.2.1 Functional coupling.

SSEs shall avoid unnecessary coupling.

Consideration should be given to:

a. All parameters coupled to SSE threads should be recorded and justified to prevent unnecessary coupling.

Considerations for preparation of AMC:
1. System Safety Analysis (SSA) should include analysis of the processing elements to ensure that all parameters are defined and recorded in the appropriate software documentation.
2. System Safety Analysis (SSA) should include analysis of safety critical functional threads, to record processing element inter-dependencies.
3. Rig and ground testing should demonstrate that SSEs are not unnecessarily coupled.

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254 SAE ARP4761		
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 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 I AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		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 AMC 20-115C

15.2.2 Functional autonomy and critical data sources.
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.

Considerations for preparation of AMC:
1. Rig and ground testing should demonstrate 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:	RTCA DO-178C RTCA DO-254 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 AC 20-115C	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P0 S4 00-970 P13 1.7 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 AMC 20-115C

15.2.3 Integration methodology.
The integration methodology used for the SPA SSEs shall be defined and documented, and shall provide complete verification coverage of SCFs at all levels, for each flight configuration release.

Consideration should be given to:
a. An established and proven process to record 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. Integration of each element into the complete system.
d. Integration of the complete system into the air vehicle.

Considerations for preparation of AMC:
1. System Safety Analysis (SSA) should define and document the integration methodology used for the SPA SSEs.
2. Rig, ground and flight testing should demonstrate correct function for all SCFs.

Information Sources			
Comm'l Doc:	RTCA DO 178B RTCA DO-254		

Information Sources			
	SAE ARP4761		
DoD/MIL Doc:	RTCA DO 178C RTCA DO-254 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 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		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 AMC 20-115C

15.3 PROCESSING HARDWARE/ELECTRONICS.

15.3.1 Merged with 15.1.7, 15.1.5 and 15.1.10

15.5 Software architecture and design.

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254		
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	AC 20-115B	*EASA CS Reference:*	

15.5.1 Software architecture.

The software architecture and design shall be defined, shall properly implement the system/software requirements, and be safe.

Consideration should be given to:

a. Allocation of system level requirements to the subsystem and software requirements.

b. Software functions that ensure system integrity (e.g., partition schemes).

c. Software architecture compatibility with the target hardware architecture.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should define the software architecture and design.
2. Rig and ground testing should demonstrate that system/software requirements are properly implemented.
3. System Safety Analysis (SSA) should demonstrate that the software architecture and design, and implementation of system/software requirements is safe.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:		*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 AMC 20-115C

15.3.2 Merged with 15.1.10

15.5.2 Software control structure and execution rates.
For each SSSE, the execution rates provided by the executive/control structure (considering priority assignments and interrupt design) shall be consistently obtainable and sufficient to safely provide the required performance for all SCFs supported.

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 SSE requirements are met despite priority task assignments and interrupts.

Considerations for preparation of AMC:
1. Rig and ground testing should demonstrate that allowable data latencies are not exceeded and that SSE requirements are met, while taking into account system loading, interrupts, and worst case timing scenarios.

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254		
DoD/MIL Doc:	RTCA DO-178C	*Def-Stan 00-970*	00-970 P0 S4

Information Sources			
	JSSG-2008: 3.3.4 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 AC 20-115C	*Reference:* *STANAG Reference:*	00-970 P13 1.7 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 AMC 20-115C

15.5.3 Software architecture attributes and performance.

The software architecture and design, including the initialization, synchronization, timing, data flow, control flow, interrupt structure, and data structures for all SSSEs shall be safe and sufficient to support the required processing performance for all SCFs supported.

Consideration should be given to:

a. Sub-system/system integration, and identification of potential failure modes;

Considerations for preparation of AMC:

1. System Safety Analysis (SSA) should demonstrate that the software architecture and design is safe, taking into account the initialization, synchronization, timing, data flow, control flow, interrupt structure, worst case execution time, stack analysis, and data structures for all SSSEs.

2. Rig, ground and flight testing should demonstrate that software meets the required execution rates under worst case timing conditions.

Information Sources			
Comm'l Doc:	RTCA DO-178B RTCA DO-254 SAE ARP4761		
DoD/MIL Doc:	RTCA DO-178C JSSG-2001: 3.3.3.1 provides guidance for establishing adequate computer hardware reserve capacity JSSG-2008: 3.3 JSSG-2008 Appendix A: 3.3.4 addresses synchronization, deterministic execution and frame rate issues; 3.1.7 gives	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P0 S4 00-970 P13 1.7 4671.1301 4671.1309

Information Sources			
	overall architecture design guidance along with specific data latency discussions in Lessons Learned subparagraph I; 3.1.5.1 gives guidance on data latency issues AC 20-115C		
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 AMC 20-115C

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	
FAA Doc:	AC 20-115B	*EASA CS Reference:*	

15.5.4 Dynamic operation.

The following shall be designed to safely operate under all dynamic conditions anticipated: mode inputs, operational flight modes, failure monitoring and detection techniques, failure management functions, redundancy management, voting schemes, self-checks, built-in-tests, safety interlock mechanizations, SSSE interfaces supporting SCFs, health status interfaces, reconfiguration capabilities, and switchover of command and control data links.

Consideration should be given to:

a. Transient effects of mode switching and condition changes.

b. Loss of control due to switchover of command and control data links.

c. Isolation of flight test features and software hooks for laboratory testing to prevent inadvertent activation in flight.

d. The techniques for assessing self-health.

e. Integration, including sub-system/system integration and system/system integration for all normal and failure states under all dynamic conditions.

Considerations for preparation of AMC:

1. Rig and ground testing, including system/subsystem integration tests, and FMET at various levels, should demonstrate safe system operation taking into account all expected dynamic conditions and modes throughout the design envelope.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:		*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 AMC 20-115C

15.6.2 Full qualification of software.
All SSSEs released for flight shall be fully qualified.

Considerations for preparation of AMC:
1. System Requirements Documents (SRD) should include all software requirements, which should be traceable through to the software programme.
2. SRD should include SOF requirements.
3. System Development Plan (SDP) should document the rigorous and approved software development methodology, 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:	IEEE STD 12207 provides industry best practice software development guidance. RTCA DO-178C JSSG-2008: 3.3.6	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		STANAG Reference:	4671.1301 4671.1309

Information Sources			
	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 AC 20-115C		
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 AMC 20-115C

15.5.7 Restart and reset capabilities.

The SSSE designs shall have the necessary provisions to restart and/or reset the system safely while 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.

Considerations for preparation of AMC:

1. Rig, ground and flight testing should demonstrate in flight SSSE reset and/or restart capability.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 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	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		STANAG Reference:	4671.1301 4671.1309

Information Sources			
	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 AC 20-115C		
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 AMC 20-115C

15.6.5 Software load process.
The software loading and load verification processes for all software shall be safe and correct.

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.Considerations for preparation of AMC:1. Technical publications should detail software loading and load verification processes for all software.
2. Rig and ground testing should demonstrate that software can be loaded safely and correctly when following the defined loading procedure.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	RTCA DO-178C JSSG-2008: 3.1.16 JSSG-2008 Appendix A: 3.3.2 gives guidance for single point 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 AC 20-115C	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P0 S4 00-970 P13 1.7 4671.1301 4671.1309

Information Sources			
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 AMC 20-115C

15.5.6 Digital system failures.

To preclude SOF issues, the SSSEs 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 should 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.

Considerations for preparation of AMC:

1. Rig and ground testing should demonstrate that SSSEs 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.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 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 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		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

Information Sources			
			CS 29.1301 CS 29.1309 AMC 20-115C

15.5.9 Resource capacity.

There shall be capacity and design margin for all processors, data channels (I/O, buses, etc.), and data storage devices.

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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should include details of excess capacity and design margin for all processors, data channels (I/O, buses, etc.), and data storage devices.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 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 AC 20-115C	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P0 S4 00-970 P13 1.7 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 AMC 20-115C

15.5.10 Safety Supporting Software Elements (SSSE) performance.

All SSSEs shall provide acceptable performance and safety.

Consideration should be given to:

a. Ensuring software requirements and interfaces are accurate, consistent, unambiguous, stated in quantifiable terms with tolerances, sufficiently detailed, and verifiable.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate the safety of all SSSEs.
2. Rig, ground and flight testing should demonstrate the adequate performance of all functions of SSSEs.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	RTCA DO-178C AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:		*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 AMC 20-115C

15.6 Software qualification and installation.

15.6.1 Software test methodology.

Each SSSE shall be tested and integrated in a multi-level approach from the software component level to the integrated system level and there shall be adequate test coverage at each level of testing.

Consideration should be given to:
a. Test coverage at all levels. Levels include:
- Unit testing.
- Component testing.
- Computer Software Configuration Items (CSCI) testing on target hardware.
- CSCI integration testing.
- Subsystems testing.
- Systems integration testing, including operator-in-the-loop testing.
- SCF Thread Testing.
- Iron bird testing.
- Flying test bed testing.
- Aircraft level testing.
- Ground testing.
- Flight testing.

Considerations for preparation of AMC:

a. A test plan should assess requirements coverage, failure condition testing (out-of-bounds, off-nominal and robustness) and regression testing, and should document the required testing at each appropriate level.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	RTCA DO-178C AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:		*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 AMC 20-115C

15.6.3 Software build process.
The software build process for SSSEs shall be safe.

Consideration should be given to:
a. Integration of each element into the complete system.
b. Integration of the complete system into the air vehicle.

Considerations for preparation of AMC:
1. System Development Plan (SDP) should document the established and proven methodology to be used to record all aspects of the Operational Flight Profile (OFP) life cycle, including but not limited to: requirements, design, build, integration, and testing.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	RTCA DO-178C JSSG-2008: 3.3.6	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
	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	*STANAG Reference:*	4671.1301 4671.1309

Information Sources			
	integrated architecture design AC 20-115C		
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 AMC 20-115C

15.3.3 Merged with 15.1.7, 15.1.5 and 15.1.10

15.3.4 Environmental qualification.

All hardware processing elements shall be capable of safely operating within planned operational environments.

Consideration should be given to:

a. Natural and induced environmental conditions expected for air system locations/envelopes/operational environments.

Considerations for preparation of AMC:

1. Rig, ground, and flight testing should demonstrate that processing elements are qualified to defined environmental requirements.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 RTCA DO-160G1 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:		*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 AMC 20-115C

15.4 Software development processes.

15.4.1 Software processes.

The software development process for Safety Supporting Software Elements (SSSEs) shall be fully documented (e.g., Software Development Plan (SDP), Software Safety Plan (SSP)), followed, and sufficiently suitable to produce software supporting SCFs.

Consideration should be given to:

a. Production of a rigorous SSSE development process which is suitable, comprehensive, well defined, documented and consistently applied.
b. Identifying activities to support the SSSE requirements, design, code, integration, test and release of products.

Considerations for preparation of AMC:
1. System Safety Analysis (SSA) and appropriate supporting documentation (e.g., Software Development Plan (SDP), Software Safety Plan (SSP)) should document the development process for SSSEs, and should demonstrate that the SSSEs are sufficiently suitable to produce software supporting SCFs.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P13 1.7
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	AMC 20-115C

15.4.2 Traceability.
Each SSSE shall have sufficient bidirectional traceability established for requirements (performance and interface), design, source code, and test data.

Consideration should be given to:
a. SCF bidirectional traceability both vertically (system level to the lowest software level) and horizontally (across the system/software).

Considerations for preparation of AMC:
1. System Requirements Documents (SRD) and associated Validation/Verification plans should demonstrate that bidirectional traceability for requirements and functions are coupled to all levels of testing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P13 1.7
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	AMC 20-115C

15.4.3 Configuration management.
The configuration/change control management process shall be fully documented, followed, and sufficiently suitable to control software supporting SCFs.

Consideration should be given to:
a. Definition of hardware and software configuration items.
b. Identification of each configuration item's criticality to supported SCFs.

Considerations for preparation of AMC:
1. System Development Plans (SDP) or other appropriate artefact should document configuration management/change control processes, and should demonstrate that the processes maintain the integrity of hardware and software configurations.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P13 1.7
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	AMC 20-115C

15.5.5 Failure management and redundancy management.
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.

Considerations for preparation of AMC:
1. Rig and ground testing should demonstrate that BIT and redundancy/failure management algorithms operate correctly.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	RTCA DO-178C JSSG-2008: 3.3.6.2 JSSG-2008 Appendix A: 3.3.6.2 establishes guidance 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 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		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 25.1701 CS 25.1707 CS 25.1709 CS 27.1301 CS 27.1309 CS 29.1301 CS 29.1309 AMC 20-115C

15.2.4 Critical discrepancies.
Safety critical hardware and software discrepancies identified shall be safely 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. All interfaces should be well documented and compatible (hardware/hardware, hardware/software, and software/software).
d. Use of a peer review audit system comprising independent reviewers.

Considerations for preparation of AMC:
1. System Safety Analysis (SSA) should detail any identified safety critical hardware and software discrepancies, and should demonstrate that any such discrepancies have been safely corrected or mitigated.

Information Sources			
Comm'l Doc:	RTCA DO-178B SAE ARP4761		
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 JSSG-2008: 3.3.7 JSSG-2008 Appendix A: 3.3.8 provides guidance under lessons learned for tracking and mitigating software discrepancies AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		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

Information Sources			
			CS 29.1301 CS 29.1309 AMC 20-115C

15.2.5 Simulations, models and tools.

Simulators, models, and tools used in the development, integration, and testing of software and hardware supporting SCFs shall be appropriately qualified and validated.

Consideration should be given to:

a. Identification of source, i.e.: off-the-shelf (commercial or government), modified, or developed for the application.

Considerations for preparation of AMC:

1. A test plan including analysis of the effectiveness (accuracy and fidelity) of the output performance for all simulators, models, and tools.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:		*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 AMC 20-115C

15.2.6 Safety interlocks.

Interlocks shall provide safe engagement and disengagement of system modes for flight and ground operations.

Consideration should be given to:

a. Specifics of how each safety interlock is used by each SSE.

b. safety interlocks required for engagement, switching, and disengagement, of single or multiple modes.

c. Safely control mode (enable/prevent) engagement based on ground or flight parameters and to prevent engagement of incompatible modes.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should provide details of interlocks which provide safe engagement and disengagement of air system modes for flight and ground operations.

2. Rig and ground testing should demonstrate the correct function of safety interlocks.

Information Sources	

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:		*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 AMC 20-115C

15.2.7 Single event upset (SEU) susceptibility.
The SPA shall be designed to ensure that SEUs do not cause unsafe conditions.

Consideration should be given to:
a. Identification of areas of the flight envelope susceptible to SEU effects.
b. Detection, correction, and prevention techniques to mitigate hazards and the loss of SCFs.

Considerations for preparation of AMC:
1. System Safety Analysis (SSA) should include assessment of hazards associated with SEUs.
2. Rig and ground testing should demonstrate correct system function throughout any expected SEU.

Information Sources			
Comm'l Doc:	SAE ARP4761		
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 AC 20-115C	*Def-Stan 00-970 Reference:*	00-970 P0 S4 00-970 P13 1.7
		STANAG Reference:	4671.1301 4671.1309
FAA Doc:		*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 AMC 20-115C

15.6.4 Software load compatibility.
Adequate configuration management controls shall be in place to ensure proper/ functionally compatible software loading for the intended use on the aircraft .

Consideration should be given to:

a. A matrix of allowable hardware/software versions ; which should encompass all allowable inter and intra system loads;
b. A robust configuration control process , which should 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, which should be carefully controlled to prevent inappropriate versions or combinations being loaded onto the aircraft .

Considerations for preparation of AMC:
1. System Development Plans (SDP) or other appropriate artefact should document configuration management/change control processes, and should demonstrate that the processes maintain the proper/ functionally compatible software loading for the intended use on the aircraft.

Information Sources			
Comm'l Doc:	RTCA DO-178B		
DoD/MIL Doc:	RTCA DO-178C JSSG-2008: 3.1.16 JSSG-2008 Appendix A: 3.1.16 provides guidance regarding OFP version control and integrity AC 20-115C	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P0 S4 00-970 P13 1.7 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 AMC 20-115C

15.2.8 Security techniques.
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 SSE functionality.
d. Physical security means.

Considerations for preparation of AMC:
1. System Safety Assessment (SSA) should demonstrate that security techniques used in the SPA are implemented safely.

Information Sources			
Comm'l Doc:	RTCA DO-178B		

Information Sources			
	SAE ARP4761		
DoD/MIL Doc:	RTCA DO-178C RTCA DO-254 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 tampering with components; 3.3.7 establishes a place for traceable security requirements AFPam 63-1701 provides guidance for implementation of Systems Security Engineering AC 20-115C	*Def-Stan 00-970 Reference:* *STANAG Reference:*	00-970 P0 S4 00-970 P13 1.7 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 AMC 20-115C

SECTION 16 - MAINTENANCE

This section includes criteria for servicing and maintenance activity and oversight.
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

16.1. MAINTENANCE MANUALS/CHECKLISTS.

16.1.1 Servicing instructions.
Servicing instructions shall be provided for all systems that require servicing.
Consideration should be given to:
a. All aircraft systems, including fuel, engine oil, hydraulic systems, landing gear struts, tyres, oxygen, escape system, etc.

Considerations for preparation of AMC:
1. Instructions for Continued Airworthiness should include requirements for servicing of aircraft systems, and the procedures for carrying out such servicing.

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

Information Sources			
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

16.1.2 Cautions and warnings.

Cautions and warnings shall be included in maintenance manuals, aircrew checklists, and ground crew checklists.

Consideration should be given to:

a. Ensuring the cautions and warnings and associated technical information maximises the safety of personnel by providing clear and unambiguous instructions for preventative or remedial actions.

Considerations for preparation of AMC:

1. Instructions for Continued Airworthiness should include clear and unambiguous warnings and cautions. All associated technical information should inform personnel of the preventative or remedial action that should be taken.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	14CFR: 23.1501, 23.1529, 25.1501, 25.1503-25.1533, 25.1529, 25.1541, 25.1543, 25.1557, 25.1563	*Def-Stan 00-970 Reference:*	00-970 P1 4.4.25
		STANAG Reference:	4671.1501 4671.1529 4671.1541 4671.1581 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 23.1501 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

Information Sources			
			CS 27.1589 CS 27 Appendix A CS 29.1501 CS 29.1529 CS 29.1581 CS 29.1589 CS 29 Appendix A

16.1.3 Maintenance checklists.
Maintenance checklists shall be available for critical maintenance tasks.

Consideration should be given to:
a. Procedures for replenishments such as fuel and oxygen;
b. Towing procedures including restrictions;
c. Jacking and trestling procedures;
d. Engine operation during maintenance (engine running guards and tie down etc.);
e. Flight servicing.

Considerations for preparation of AMC:
1. Instructions for Continued Airworthiness should include checklists for all critical maintenance tasks.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.6.1, 3.6.2 JSSG-2001: 3.1.5 14CFR: 23.1501, 23.1529, 25.1501, 25.1503-25.1533, 25.1529, 25.1541, 25.1543, 25.1557, 25.1563	*Def-Stan 00-970 Reference:*	
		STANAG Reference:	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

16.1.4 Support equipment.
Support equipment shall not adversely affect the safety of the aircraft.

Consideration should be given to:
a. Equipment or vehicles which are directly connected to the aircraft vehicle or used in close proximity to it, including but not limited to:
i. Towing arms
ii. Towing vehicles
iii. Ground power sets (electrical, hydraulic, or pneumatic)
iv. Special to type test equipment or rigs

v. Replenishment equipment
vi. Weapon loading vehicles and equipment
vii. Cargo handling vehicles and equipment
b. Authorisation of all support equipment required to support the air vehicle with any limitations documented;
c. Clear identification of any maintenance requirements for the support equipment and appropriate record keeping;
d. Abnormal operation of special to type test equipment (STTE).

Considerations for preparation of AMC:
1. Instructions for Continued Airworthiness should include details of all support equipment approved for use on the aircraft, including any procedures and limitations associated with their use.
2. Rig and ground testing should demonstrate that all approved support equipment can be used without adversely affecting the safety of the aircraft, when operated in accordance with defined procedures and limitations.

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

16.1.5 Removal procedures.
Maintenance manuals shall incorporate procedures for system/component removal.

Consideration should be given to:
a. Specifying the tooling required for component removal.
b. Including any additional procedures to take account of any removable equipment that might be fitted to the aircraft (weapons, role equipment, etc.) that may need to be removed prior to the removal of a component.

Considerations for preparation of AMC:
1. Aircraft Maintenance Manuals (AMM) should include procedures for system/component removal.
2. Analysis should demonstrate that the AMM includes all necessary procedures for the safe installation and removal of systems and components, including but not limited to all procedures which support the safety of the aircraft as documented in System Safety Assessments (SSA).

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:	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

16.1.6 Operational testing.
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 required after disturbing systems, e.g. as a means of accessing other areas of the aircraft .
c. Any inter-system testing that may be required.
d. Any requirement for testing after changing a software load.

Considerations for preparation of AMC:
1. Aircraft Maintenance Manuals (AMM) should include procedures for operational testing of normal/emergency systems after removal/replacements of parts.

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

16.1.7 Troubleshooting procedures.
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.

Considerations for preparation of AMC:
1. Aircraft Maintenance Manuals (AMM) should include troubleshooting procedures to diagnose and allow correction of expected system/component failures.

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

16.1.8 Non-destructive inspections.
In-service, non-destructive inspection techniques, inspection intervals, damage limits and detailed repair procedures shall be included in appropriate technical publications.

Consideration should be given to:
a. Use of non-destructive testing methods, such as eddy-current, magnetic-particle, liquid penetrant, radiographic, and ultrasonic testing.
b. Use of other non-destructive inspection methods such as visual and tactile inspection.
c. Ensuring that inspection intervals and damage limits are appropriate to the type of inspection carried out.

Considerations for preparation of AMC:
1. Instructions for Continued Airworthiness should include non-destructive inspection techniques, inspection intervals, damage limits and detailed repair procedures.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:		*Def-Stan 00-970 Reference:*	
		STANAG Reference:	4671 G.3
FAA Doc:		*EASA CS*	CS23 G23.3

Information Sources			
		Reference:	CS25 H25.3 CS27 A27.3 CS29 A29.3

16.2. INSPECTION REQUIREMENTS.

16.2.1 Special inspection procedures.
Special inspection procedures shall be available for unusual or specified conditions.

Consideration should be given to:
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.

Considerations for preparation of AMC:
1. Instructions for Continued Airworthiness should include inspection procedures for all unusual or specified conditions as listed in this criterion.

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:		*EASA CS Reference:*	CS 23.1501 CS 23.1529 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 Life-limited parts.
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. Ensuring that items are fitted with elapsed time indicators, magnetic chip detectors etc. where possible to record operational usage;
d. Defining a programme of in-service monitoring to ensure that the assigned predicted life is appropriate (not too long or too short).

Considerations for preparation of AMC:
1. Instructions for Continued Airworthiness should include details of life-limited items and replacement intervals, which should be based on relevant test and development data.

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 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

16.2.3 Inspections and intervals.
All required inspection intervals shall be identified using relevant operational and development (i.e. test) data.

Consideration should be given to:
a. Ensuring the inspection periodicity has been justified;

Considerations for preparation of AMC:
1. Instructions for Continued Airworthiness (recognised through the Maintenance Planning Documents) should include details of life-limited items and replacement intervals, which should be based on relevant test and development data.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.6.1, 3.6.2 JSSG-2001: 3.1.5 MIL-PRF-5096: 3.2.1.1.1 gives guidance regarding frequency of maintenance items	*Def-Stan 00-970 Reference:*	00-970 Pt 1 3.2.17 00-970 Pt 1 3.2.18 00-970 Pt 1 3.2.19 00-970 Pt 1 4.4.6
		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

16.3 INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

16.3.1 Preparation of Instructions for Continued Airworthiness
Instructions for Continued Airworthiness shall be prepared.

Consideration should be given to:
a. Ensuring that Instructions for Continued Airworthiness contain a section titled Airworthiness Limitations that is segregated and clearly distinguishable from the rest of the document.

Considerations for preparation of AMC:
1. Instructions for Continued Airworthiness should include all relevant information, drawings and processes for maintaining the continued airworthiness of the aircraft.

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

SECTION 17 - ARMAMENT/STORES INTEGRATION

This section covers the installation, integration, interface and operation of the aircraft armament system, including guns/rockets, stores and in particular laser systems.

Included within the scope of this section are:

- Fixed and free guns/rockets.
- Stores - A store is any device intended for internal or external carriage, mounted on aircraft suspension and release equipment, which may or may not be intended to be for in-flight separation from the aircraft. 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 aircraft.
- aircraft and personnel protection from third party laser systems.
- Specific safety interlock systems to prevent inadvertent operation of the aircraft armament system.

Where necessary specific aircraft 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 aircraft equipment and systems, as well as the overall aircraft 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 Gun/rocket induced environments.

The installation and integration of guns/rockets shall not adversely affect the operational function or safety of the aircraft. 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 shall be given to the location of such installations:
a. The effect of flammable gas as a hazard to the aircraft.
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 aircraft aerodynamics and the safety of the aircraft, crew or maintenance personnel.
d. The installation purging system.
e. The temperature conditions in the gun and ammunition compartments shall permit the aircraft 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.

Considerations for preparation of AMC:
1. Verification is accomplished by initial installation testing, qualification testing, physical fit checks, static ground fire testing, safety analysis, safe separation testing, and live fire testing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-516B 17.1.1 MIL-HDBK-244: 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 (unverifed- 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 Gas and plume hazards.
Gun/rocket gases and plume shall not adversely affect the safety of the aircraft, 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 aircraft 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 aircraft 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 shall 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.

Considerations for preparation of AMC:
1. Verification is accomplished by initial installation testing, qualification testing, physical fit checks, static ground fire testing, safety analysis, safe separation testing, and live fire testing.

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

Information Sources			
			00-970 P11 S4.5 *(unverified- NL516)
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

17.1.2.1 Sensor hazards.
Munitions gases and plume shall not create an unsafe condition by obscuring primary sensor or weapons designation systems (e.g., laser, radar, etc.) when employing munitions.

Consideration should be given to:
a. Effects on weapons designation system caused by blast effects, debris and weapons rate of fire.

Considerations for preparation of AMC:
1. Verification is accomplished by initial installation testing, qualification testing, physical fit checks, static ground fire testing, safety analysis, safe separation test certification, and live fire testing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-HDBK-244	*Def-Stan 00-970 Reference:*	00-970 P13 3 00-970 P9 UK587c
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

17.1.3 Merged with 17.1.2

17.1.4 Merged with 17.1.2

17.2 STORES INTEGRATION.

17.2.1 Store clearance.
The installation, integration and interface of the aircraft 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 are to be made when designing stores installations and the location of store 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 aircraft. The use of differently sized/oriented connectors to avoid misconnection.
d. The installation of stores shall allow for their safe jettison, or deactivation if required, in order to protect the aircraft or for operational/safety reasons following a malfunction.
e. The possibility to release mechanically any store and/or its jettisonable carrier without entering the cockpit (Particularly for Rotorcraft);

f. The store shall not become armed until it has successfully separated from its release unit or launcher.
g. The environment induced by the stores on the aircraft, and by the aircraft on the store during carriage and launch/separation/jettison.
h. The effect of high temperature efflux from engines, rockets or missiles impinging on the store or its release system.
i. Contamination of stores and release systems by engine exhaust, fuels, oil or any substance which could adversely affect the armament system.
j. Unacceptable aircraft flying qualities result from the release of stores.

Considerations for preparation of AMC:
1. Stores/aircraft interface is verified by test.
2. Stores loading/unloading procedures are verified by demonstration using the stores loading manual.

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-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 MIL-STD-8591 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 Safe separation.
Both internal and external stores shall separate safely from the aircraft throughout the aircraft 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)

Considerations for preparation of AMC:
1. Safe separation is verified by Computational Fluid Dynamics (CFD) models, wind-tunnel testing, safe separation flight testing.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	MIL-STD-1289 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) 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	*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 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 Store, suspension and release equipment structural integrity.
The aircraft, store and release equipment installations shall meet the strength and stiffness requirements for operating safely within the aircraft/Store carriage flight envelope.

Consideration should be given to:
a. Taxiing with stores.
b. Carriage.

c. Operation.
d. Release.
e. Landing with stores.

Considerations for preparation of AMC:
1. Store and suspension/release equipment structural integrity are verified by Finite Element Models (FEM), Computational Fluid Dynamics (CFD) models, wind-tunnel testing, captive carriage flight testing and ejection/jettison testing.

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.
Electrical interfaces in the armament system shall not cause unsafe stores operation, including uncommanded jettison, or unsafe interactions with the aircraft in all possible stores configurations.

Consideration should be given to:
a. It shall not be possible to make incorrect mechanical or electrical connections.
b. Failure to make any connection properly shall not create a situation where damage to the aircraft can occur during carriage or after release of the store.
c. Static lines, umbilicals, 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.

Considerations for preparation of AMC:
1. Aircraft electrical/logical interfaces are verified by System Integration Laboratory test, EMI/EMC test, Hazards of Electromagnetic Radiation to Ordnance (HERO) test and flight test.

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*

Information Sources			
			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

17.2.6 Safe store operations.

The combination of stores fitted to the aircraft 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 effects on stability, handling and rolling characteristics.

Considerations for preparation of AMC:

1. Verification is accomplished by physical fit and function, loading/installation procedures, aeroelastic ground vibration test, wind tunnel tests, effects of aircraft on captive stores/suspension equipment, effects of stores/suspension equipment on aircraft, environmental vibration tests, aeroacoustic test, HERO test, EMI/EMC, ballistic tables, temperature extremes and thermal test, and SIL.

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*

Information Sources			
			*(unverified- NL516)
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

17.2.7 Store configurations.

All cleared stores configurations for the aircraft shall be documented in the aircraft document set.

Consideration should be given to:

a. Safe release envelopes and flight limits

b. Proper loading procedures

c. Appropriate store checklists

d. Correct employment data for operational employment planning.

Considerations for preparation of AMC:

1. Validation/Verification of technical publications (e.g., flight manuals, maintenance manuals) accomplished by maintainers to ensure proper loading/unloading procedures.

2. Round testing to verify all store configurations.

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:*	00-970 P1 7.1.7* 00-970 P1 7.5.3 *(unverified- NL516)
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

17.2.8 Merged with 17.2.1

17.2.9 Lost link.

A lost-link condition during a weapons engagement shall be considered and hazards minimized and/or mitigated.

Consideration should be given to:

a. Ensuring that weapon system transitions to a predetermined state and mode in the event of loss or corruption of the command and control link.

Considerations for preparation of AMC:
1. Verification is accomplished by analysis (e.g., fault tree analysis, system safety analysis), avionics tests, and ground and flight demonstrations and tests.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	ADS-44-HDBK	*Def-Stan 00-970 Reference:*	00-970 P9 USAR U1613
		STANAG Reference:	4671 USAR.U1613
FAA Doc:		*EASA CS Reference:*	

17.3 LASER INTEGRATION AND INTERFACE.

17.3.1 Crew exposure.
Crew and maintenance personnel shall be protected from laser radiation (direct and reflected).

Consideration should be given to:
a. The level of laser protection shall ensure exposure is below the limits, which shall be defined and proved.
b. For UAVs, this shall include 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.

Considerations for preparation of AMC:
1. Minimum crew and maintenance personnel exposure to laser radiation is verified by analyses (e.g., laser safety analysis), laser characteristics tests, laser control system (e.g., power on, weight on wheels) inspection/demonstration, accessibility checks, wire verification, ground test equipment checks, loading procedures checks, identification of safety equipment and inspection of training procedures.

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. MIL-HDBK-828 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 Induced environment.

The installation, integration and operation of all lasers shall not adversely affect the safety of the aircraft.

Consideration should be given to:

a. The environment induced by laser operations with respect to the aircraft's limitations for vibroacoustics, thermal loads, and structural loads of the aircraft.

b. The effects from both the laser chemical and any resultant exhaust gases

Considerations for preparation of AMC:

1. Laser operation compatibility is verified by analyses (e.g., structural, stress, mechanical load, electrical load, acoustical), explosive environment test and ground and flight demonstrations/tests.

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:*	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

17.3.4 Operation and direction.

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 shall 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 energized, etc.)

b. Providing means to ensure lasers do not adversely affect safety following the loss a UAS control link.

Considerations for preparation of AMC:

1. Laser boresighted alignment, pointing accuracy and display are verified by installation tests, SIL testing, and ground and flight demonstrations/tests.

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	*Def-Stan 00-970 Reference:*	

Information Sources			
	laser systems MIL-HDBK-828 AFOSH STD 48-139, Laser Radiation Protection Program RCC 316-98, Laser Range Safety	*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

17.3.6 Airframe contact.

The installation of the laser shall prevent the beam from contacting any part of the aircraft.

Consideration should be given to:

a. Laser software and/or hardware inhibitors

b. Ensuring laser energy is not reflected back into the eyes of the pilot, operator, crew, or personnel.

c. Peripherals (i.e., stores, sensors etc.).

Consideration to AMC:

1. Verification is accomplished by initial installation tests, SIL testing, ground and flight test, and laser operating procedures.

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

17.3.7 Ground lasing.

The installation of the laser shall prevent inadvertent lasing when the aircraft is on the ground.

Consideration should be given to:

a. Procedures for ground crew.

b. Redundant hardware (e.g., interlocks, interlock switches/weight on wheels), and software (e.g., armament, sensor).

For UAS, consideration shall 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 energized, etc.)

Considerations for preparation of AMC:

1. Verification is accomplished by initial installation tests, SIL testing, ground and flight test, and laser maintenance and operating procedures.

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.
Appropriate design measures shall be in place to prevent the unsafe operation of stores.

Consideration should be given to:
a. Prevention of armament release whilst the aircraft is on the ground;
b. The use of switch guards and system interlocks;

Considerations for preparation of AMC:
1. Verification is accomplished by initial installation testing, qualification testing, physical fit checks, static ground fire testing, safety analysis and safe separation test certification,

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 MIL-STD-1425 ADS-62-SP ADS-65-HDBK	*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.

CERTIFICATION CRITERIA

18.1. SURVIVABILITY OF PASSENGERS.

18.1.1 Passenger seating and restraint systems.

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.

h. Maximum expected loads in each direction during emergency landings.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail that the seating restraint system meets crash load requirements and that there are seat and restraint systems for all passengers.

2. Rig and ground tests should demonstrate that Static and dynamic loads do not exceed appropriate limits, taking into account the comfort of passengers.

3. Declaration of Design Performance (DDP) should detail the maximum allowed occupant weight.

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,	*EASA CS*	CS 23.562

Information Sources			
	23.2, 23.562, 23.785, 25.562	*Reference:*	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

18.1.3 Stowage compartment structure.

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.

b. The type and classification of the aircraft ;

c. The maximum allowed baggage or cargo weight for the compartment.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail all aircraft stowage compartments, the maximum weight of their contents and the means provided to prevent their contents becoming a hazard due to shifting.
2. Rig and ground testing and analysis with simulated landing and in-flight load conditions verify that contents do not cause injury or other passenger hazards.

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 CS 25.787 CS 25.789 CS 27.561 CS 27.787 CS 29.561 CS 29.787

18.1.4 External doors.

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.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail all aircraft doors, highlighting that each passenger compartment with a seat and restraint system has an external exit with a door that can be opened internally and externally, and that there is clear indication of a locked or unlocked condition.
2. Rig and ground tests should demonstrate the ability to operate doors internally and externally.

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 Exit locking mechanisms.
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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail exit locking mechanisms, highlighting that all exits in passenger areas are lockable by aircrew, simple to open without training, and will stay locked in flight when not opened for mission need.
2. Rig and ground tests should demonstrate the expected passenger population's abilities to operate exits.

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 Provisions for passenger evacuation.

Each non-over-wing emergency exit more than 1.8 m (6 feet) from the ground (with the aircraft 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.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail passenger evacuation routes, highlighting the exits which are more than 1.8 m (6 feet) above the ground and any non-over-wing exits of that set which have a means for passenger descent.
2. Rig and ground tests should demonstrate emergency egress using non-trained passengers, representative of the expected passenger population, to verify the ability to safely exit and descend to the ground.

Information Sources	

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 Exit weight and actuation.

The weight of each removable passenger exit, and its means of opening shall be conspicuously marked.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should show that each hatch door is clearly marked with its means of opening and weight.

Information Sources			
Comm'l Doc:			
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 Emergency lighting system.

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).

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the positioning of the lighting system, both internal and external to the cockpit/crewstations as well as the duration of the emergency lighting.

2. Rig and ground test should demonstrate effective emergency egress and should include evaluation of the aircraft in night time lighting conditions.

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 Emergency exit signs.

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 of 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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the location and type/size of emergency exit signs, and the operating configurations and conditions under which emergency exit signs must be functional.

2. Rig and ground tests should demonstrate that emergency exit signs are appropriate for all operating configurations and conditions.

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

Information Sources			
			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 Public address system power.

If required for the category of aircraft, 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.

Consideration should be given to:

a. Ensuring the public address system works as required for all approved operating configurations and conditions.

b. Ensuring 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.

c. Ensuring 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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the type of public address system installed, and the operating configurations and conditions under which the system must be functional.
2. Rig and ground tests should demonstrate that the public address system is appropriate for all 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 Public address system accessibility.

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.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail provisions for operation of the public address system by each member of the aircew.
2. Rig and ground tests should demonstrate that the public address system is appropriate for all operating configurations and conditions.

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 Marking of safety equipment controls.
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.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should include details of the markings provided for controls of safety equipment.
2. Rig and ground tests should demonstrate that the marking of safety equipment is appropriate for all intended passengers.

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

Information Sources			
		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 Marking of safety equipment storage.

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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the markings indicating stowage locations of life saving equipment.
2. Rig and ground tests demonstrate the ability of passengers to discern markings identifying and instructing methods of removal for safety 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 Flotation devices.

At least one approved, individual flotation device / means (such as removable seat flotation cushions or under seat life preservers) shall be provided for each occupant, for aircraft 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 flotation devices, and the ability to deploy, inflate or provide buoyancy.

b. The ability of each passenger to access a flotation device during emergency evacuation.

c. Whether or not the aircraft is certified for ditching.

d. Provision of life lines if required.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the availability and stowage provisions of approved flotation devices.

2. Rig and ground tests demonstrate the ability of passengers to access flotation devices. Emergency egress demonstrations should verify the ability of each passenger to access a flotation device during emergency evacuation.

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 Emergency equipment.
The aircraft 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 aircraft.
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.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail emergency equipment provisions.
2. Rig and ground tests should demonstrate the functional capabilities of equipment, showing that they are appropriate for their intended purpose.

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	

Information Sources			
		Reference:	
FAA Doc:	14CFR references: 121.309, 121.310	*EASA CS Reference:*	

18.1.16 Signs and placards in passenger compartments.
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.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail the signs and placards provided in each passenger compartment.

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 Ignition source isolation.
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.

Considerations for preparation of AMC:
1. System Description Documents (SDD) should detail sources, locations, and configurations of possible ignition sources.
2. Rig and ground tests should demonstrate the inability of components and systems to ignite flammable materials, and therefore preclude ignition of an explosive atmosphere.

3. System Safety Assessments (SSA) should detail cargo clearances and preventive means of contacting ignition sources.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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 installation.

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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the location and routing of oxygen lines for criteria compliance.
2. Rig and ground tests should demonstrate that adequate heat protection is provided for oxygen equipment.
3. System Safety Assessments (SSA) should show identification and acceptability of ignition/explosive hazards through Failure Mode and Effects Criticality Analysis and a System Safety Hazard Analysis.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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

Information Sources			
		STANAG Reference:	
FAA Doc:	14CFR references: 25.869	*EASA CS Reference:*	CS 23.1451 CS 25.869

18.3. PHYSIOLOGY REQUIREMENTS OF OCCUPANTS.

This section covers equipment and systems specific to the physiological requirements of crew and passengers during flight.

18.3.1 Oxygen.

Aircraft 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 aircraft , or from a stand-alone system.

b. Minimum mass flow requirements for different cabin pressure altitudes.

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.

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the supplemental oxygen system and the quantity of oxygen available to each passenger.
2. Rig and ground tests should demonstrate the ability of the supplemental oxygen system to provide necessary oxygen quantities, duration, and flow rates.
3. System Safety Assessments (SSA) should show the integrity of the oxygen system by identification of hazards through Failure Mode and Effects Criticality Analysis and a System Safety Hazard Analysis.

Information Sources			
Comm'l Doc:	SAE ARP4761		
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

Information Sources			
			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 First aid.

Approved emergency medical kit(s) shall be installed in the aircraft; 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).

Considerations for preparation of AMC:

1. System Description Documents (SDD) should detail the installation and availability of emergency medical kits.

2. Rig and ground tests should demonstrate the accessibility of medical kits.

3. System Safety Assessments (SSA) should show that any emergency medical kits have been have been assessed as appropriate for the aircaft role(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 aircraft structure, aircraft 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. Nondestructive 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 Material property evaluation.

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 aircraft;

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 property certification.

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	4671.603

Information Sources			
		Reference:	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 27.613 ESDU 00932

19.1.3 Material design value.

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.

Consideration should be given to:

a. The effects of:

- Product shape and form;
- Production representative processing and manufacturing variability;
- Effects of defects;
- Final assembly interfaces;
- Environmental conditions, such as temperature, humidity, UV, chemical, solvent, fuel, electromagnetic radiation, and airborne particulates expected in service;
- Repair.

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 specification properties.

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
		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 Environmental effects.

The durability of the aircraft 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 become 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

Information Sources			
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 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 process capability.

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

19.1.8 Damage repair.

The aircraft 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 aircraft;

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 Material failure modes.

Insidious failure modes (e.g., hydrogen embrittlement, crack bifurcation) shall be understood and accounted for, such that all parts of the aircraft 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 Corrosion prevention and control practices.

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, stress corrosion cracking, and microbially induced corrosion;

b. Preventing water leaking into, or being driven into, any part of the aircraft;

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.
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	4671.571

Information Sources			
		Reference:	4671.609
FAA Doc:		*EASA CS Reference:*	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

19.2.3 Non-metallic corrosion control.
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 Protective finishes.
Finish systems shall provide adequate corrosion protection for the airframe and its components, in order to maintain the specified operational capability of the aircraft, and ensure it is not degraded because of 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.

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 MIL-HDBK-1568 MIL-STD-7179 MIL-STD-889	*Def-Stan 00-970 Reference:*	00-970 P1 4.3.77 00-970 P7 407
		STANAG Reference:	4671.609
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 NONDESTRUCTIVE INSPECTION.

19.3.1 Defect characterization and detection.
Prior to conducting non-destructive testing and inspection (NDT/I), the nature of those defects which are critical to material integrity shall be characterized, and any effects 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 NDI assessment criteria.
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 NDI manuals.

Non-destructive inspection (NDI) manuals shall be developed to accompany the aircraft, in order to provide an audit trail of the adequacy, thoroughness, and completeness of NDT/I 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 NDT/I methods and their application.

Consideration should be given to:

a. NDT manuals, which 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 Inspection intervals.

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 aircraft some disassembly of structure, e.g. de-riveting 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

Information Sources			
			CS 29.573

19.4 WEAR AND EROSION.

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, fibres, 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.

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 AIR TRANSPORTABILITY AND AIRDROP.

Air transport and airdrop are aircraft capabilities that enable an aircraft to perform cargo transport as a prime mission. Cargo includes transported and airdroppable objects and personnel (e.g., passengers and parachutists). These capabilities involve primary and secondary aircraft structure, size and shape of the cargo carrying compartment, and aircraft interactions with the cargo mass and weight, especially if cargo is airdropped during flight.

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 aircraft 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 aircraft;
• The largest, and heaviest load combinations;
• Different shapes of cargo;
• Air transportation of hazardous materials.

20.1.1 Aircraft structure.
It shall be shown that the aircraft 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 aircraft;
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.

Considerations for preparation of AMC:
Analysis and structural testing of subsystems or complete structures should be performed. Structural testing should verify analytical results such that an acceptable margin of safety is attained for the design condition.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2000: 3.1.7.2 JSSG-2001B: 3.4.5 JSSG-2001B: 3.4.6.2 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

20.1.2 Clearances.

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.

Considerations for preparation of AMC:

Acceptable clearance should exist for aircrew and support personnel access during ground operations and flight of all required cargo items. Acceptable clearance should exist for passenger egress on flights required to carry passengers. NOTE: Passenger egress clearances may be different from aircrew and support personnel access clearances.

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 00-970 P1 1.1.2 00-970 P1 4.26.56 00-970 P1 4.22 00-970 P7 L100 1.1 00-970 P7 L307 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 CS 29.813 CS 29.815

20.1.3 Cargo loading limits.

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 aircraft 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	*Def-Stan 00-970 Reference:*	
		STANAG	

Information Sources			
	aircraft loading manuals include cargo loading limits in the desired formats.	*Reference:*	
FAA Doc:		*EASA CS Reference:*	

20.1.3.1 Restraint system structure.

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.

Consideration should be given to:

a. Ensuring strength levels equal to or in excess of the tiedown devices and are capable of withstanding specified loads.

b. Ensuring repair of tiedown rings is included in the maintenance manuals.

Considerations for preparation of AMC:

1. The attachment hardware, pan assemblies, and supporting airframe structure should be verified to withstand pulling forces greater than the rated capacities of the restraint system.

2. Ring assemblies should be tested in vertical up, lateral, and longitudinal directions plus other directions as dictated by the analysis.

Information Sources			
Comm'l Doc:			
DoD/MIL Doc:	JSSG-2006	*Def-Stan 00-970 Reference:*	00-970 P1 4 00-970 P5 UK25.301a 00-970 P5 UK25.301b 00-970 P7 L200
		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

20.1.4 Aircraft weight and balance limits.

Correctly positioned cargo shall meet the weight and balance requirements of the aircraft 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 aircraft, 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.

Considerations for preparation of AMC:
Aircraft weight and balance limits should be verified by analysis, simulation, flight testing and any combination of methods, conducted at critical and extreme points of the aircraft gross weight, cargo locations and operating envelope.

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 00-970 P5 UK25.143b 00-970 P7 L600 3.3.1
		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

20.1.5 Restraint system function during aerial delivery operations.
With the exception of items designated for airdrop, properly loaded and restrained cargo shall not change the position of the aircraft's CofG during flight.

Consideration should be given to:
a. Ensuring cargo items are secured against movement in all directions.
b. Secure cargo for crash and other severe flight conditions.

Considerations for preparation of AMC:
1. Restraints should be verified by structural analysis and test of restraining systems
2. Restraint devices and other applicable cargo delivery systems should be verified for use with the pallets/platforms that will be used in the loading of cargo.

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 P1 4 00-970 P5 UK25.143b 00-970 P7 L600 3.3.1
		STANAG Reference:	3400 4761.787
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

20.1.6 Capacity and quantity of cargo restraint provisions.
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/acceleration in all directions;
c. Aircraft with crew, passengers and cargo located in the same cabin or on the same deck.

Considerations for preparation of AMC:
Through analysis and demonstration, the quantity of restraint devices should be shown to be sufficient to restrain various mass quantities of cargo items. The strength of the restraints should be of a standard or otherwise approved value.

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	*Def-Stan 00-970 Reference:*	00-970 P1 4.22.49 00-970 P1 4.22.50 00-970 P5 UK25.301a 00-970 P5 UK25.301b 00-970 P7 L200
		STANAG	STANAG 3400

Information Sources			
	restraint devices	*Reference:*	
FAA Doc:		*EASA CS Reference:*	CS 23.787 CS 25.787 CS 25.789 CS 27.787 CS 29.787

20.1.7 Manuals.

All the operator and maintenance manuals (e.g. T.O.'s) shall be accurate, consistent with the aircraft data, and provide the cargo preparation, handling, carriage, and normal and emergency 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.

Considerations for preparation of AMC:

It should be demonstrated that draft copies of the operator, maintenance and loading manuals can be be successfully used by properly trained crewmembers to perform necessary functions.

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:*	CS 23.1583 CS 23.1589 CS 25.1583 CS 27.1583 CS 27.1589 CS 29.1583 CS 29.1589

20.1.8 Cargo compartment dimensions.

The aircraft shall be designed to allow enough room to load, transport, and, where required, 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.

Considerations for preparation of AMC:

Selected cargo loading demonstrations and analysis of loaded cargo via drawings should indicate that the clearance envelope is maintained throughout the loading and flight activities.

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 1.1.2 00-970 P7 L100 1.1
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

20.1.9 Cargo or CG movement in flight.

The aircraft shall be loaded with cargo ready for air-dropping without damage to the airframe; and aircraft flight safety 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 aircraft from settling on its tail while being loaded;

b. The maximum mass to be carried, and its location within or on the aircraft, 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.

Considerations for preparation of AMC:

Analysis and test should verify flight safety during airdrop of the designated payload weight at required airspeeds. Stability and control analyses and testing performed in Section 6 should demonstrate the ability to maintain safe flight during the exit of the heaviest payloads. Loading demonstrations should verify that the aircraft has sufficient stability in ground mode to present a stable platform for loading operations.

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

Information Sources			
			CS 25.23 CS 25.25 CS 25.27 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

20.1.10 Personnel airdrop system structure.

The aircraft 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 aircraft.

Considerations for preparation of AMC:

Analysis of structural loads verified with instrumented results from flight testing should demonstrate that the aircraft structure and subsystems are not adversely affected by personnel airdrop and retrieval operations under a worst case scenario.

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:*	

20.1.11 Towed jumper retrieval capability.

The aircraft shall provide the capability to safely recover a paratrooper who has jumped but not separated from the aircraft.

Consideration should be given to:

a. The required force to retract the static line, taking account of:

i. The weight of the paratrooper and their equipment,
ii. The weight and number of Static Lines and Deployment Bags already attached to the retrieval system,
iii. The aerodynamic forces acting on the parachutist and Static Lines and Deployment Bag.
b. The amount of time required to recover the paratrooper.
c. Storage and availability of retrieval equipment.
d. Risk to paratroopers introduced by equipment and other protrusions both inside and on the exterior of the aircraft.

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:*	

20.1.12 Personnel airdrop operations.
For airdrop operations the aircraft's aerodynamics shall be designed to ensure that the risk to paratroopers is minimised, including paratrooper collision, adverse vortex interaction and adverse multi-ship formation effects.

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 aircraft proximities during multi-ship formation air-drops;
d. Ensuring that National rules and regulations, or operational procedures, reflect any required safety limitations.

Considerations for preparation of AMC:
1. Verification means may include design documentation, risk assessment and computational modelling of aircraft vortex interaction.

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:*	

20.1.13 Cargo jettison capability.
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 aircraft 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.

Considerations for preparation of AMC:
1. The capability to airdrop the specified types and sizes of cargo should be defined and substantiated through analysis and flight testing.
2. The ability to jettison items of palletized cargo should be demonstrated and documented.
3. Extensive flight testing should define the range of hardware items and the required parameters necessary to perform preplanned airdrop and unplanned jettisoning of cargo loads.
4. The range of testing should include maximum and minimum weights, locations, airspeeds, and other limitations as needed for technical input into the operational manuals.

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 1.1.28 00-970 P1 1.1.29 00-970 P1 1.1.30 00-970 P1 2.17.1 00-970 P1 2.17.6 00-970 P1 2.17.8 00-970 P1 2.17.32 00-970 P1 2.24.19 00-970 P5 UK25.3.1.1 00-970 P7 L100 16
		STANAG Reference:	
FAA Doc:		*EASA CS Reference:*	

20.1.14 In-flight movement
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 aircraft. See Line 9.8.4 for details;

d. Transported items, if moved, must remain within the designated cargo volume of the aircraft 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 aircraft 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 aircraft. 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.

Considerations for preparation of AMC:
1. Analysis and testing should verify that operation or movement of equipment does not put the aircraft out of established balance limits if it is relocated or used anywhere within operational possibilities.
2. Transported equipment which, in a dynamic situation, could impose risks to personnel should only be moved in a manner that affords control of the object at all times.
3. Items with components or materials that could pose a hazard should be drop tested to verify safety of possible post drop configurations and any release of hazardous materials.

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:*	

20.1.15 Mission-specific equipment installation.
In-flight operation of mission-specific equipment shall not adversely affect the safety of the aircraft 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 lifing 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.

Considerations for preparation of AMC:
1. Hazard analysis and/or test data to verify that no additional safety hazards to the aircraft are induced by the installation and function of mission specific equipment.

Information Sources			
Comm'l Doc:			

Information Sources			
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 CS 23.1309 CS 25.1309 CS 27.1309 CS 29.1309

20.2 MISSION/TEST EQUIPMENT OPERATIONS AND INSTALLATION.

20.2.1 In-flight operations.

The following items shall not adversely affect the primary SOF functionality of the aircraft:

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 aircraft 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 aircraft power supply (i.e spikes etc)

iii. EMC and EMI effects.

iv. Impact or changes to aircraft 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'.

Considerations for preparation of AMC:

1. Hazard analysis and/or test data is to verify that no additional safety hazards to the aircraft are induced by the installation and function of non-SOF equipment.

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

Information Sources			
		Reference:	
		STANAG Reference:	4671.1481
FAA Doc:		*EASA CS Reference:*	

20.2.2 Installation safety.
Carriage of cargo or payload shall not adversely affect safety of the aircraft 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 aircraft 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'.

Considerations for preparation of AMC:
1. Hazard analysis and/or test data verifies that no additional safety hazards to the aircraft are induced by the installation and function of cargo and/or payload.

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 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.	*EASA CS Reference:*	CS 23.685 CS 23.787 CS 25.685 CS 25.787 CS 27.685 CS 27.787 CS 29.685 CS 29.787

20.3 PAN-PLATFORM CRITERIA.

20.3.1 Volcanic Ash.

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:
a. Engine abrasion corrosion;
b. Blockage of engine cooling ducts/vents or paths;
c. Aircraft skin and transparency abrasion;
d. Damage to systems from ingestion of particles (air conditioning, electronic cooling, contamination of surfaces or fluids, etc.)
e. 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

20.3.2 ETOPS.

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

20.3.3 Level ground position.

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

AER(EP).P-516

ANNEX B

IN FLIGHT REFUELLING

B1. SCOPE

The purpose of this Annex to P.T. AER(EP).P-516 is to define the general approach for "qualifying" a receiver aircraft from a specific tanker aircraft (and vice versa) for performing In Flight Refueling (IFR) activities in compliance with DAAA processes.
In particular, two different starting points will be given:

- Aircraft that need to be modified to acquire receiver (or tanker) capability;
- Aircraft that are delivered from production with receiver (or tanker) capability.

Furthermore, two working hypotheses will be developed:

- Aircraft without any receiver qualifications from tanker aircraft (and vice versa)
- Aircraft already qualified receiver for some tanker aircraft (and vice versa).

B2. GENERAL APPROACH TO IFR CERTIFICATION FOR A RECEIVER

Annex A in Section 8.7, "Aerial Refueling System," establishes airworthiness criteria that, adjusted for each individual "type" of receiver, define the airworthiness requirements to be demonstrated for IFR capability.

B2.1 IFR clearance for an aircraft modified for receiver (or tanker) capability

For an aircraft that needs to be modified post introduction to service to acquire receiver (or tanker) capability, the basis for certification is determined by tailoring the airworthiness criteria in paragraph 8.7 of ***Annex A***.

In addition, there is a need to supplement the above requirements also with those derived from AGARD 300 Vol.11 "The Testing of Fixed Wing Tanker and Receiver Aircraft to establish their Air-to-Air refueling capabilities."

The table in ***Annex B - Appendix 1*** also shows the possible demonstration methods required for the finalization of certification activities, including the demonstration of the aircraft's capabilities to operate safely under conditions other than free-stream flight and, in particular, under turbulent flow conditions.

B2.2 IFR clearance for a new aircraft whose design includes receiver (or tanker) capability

Aircraft under Qualification as a receiver (or tanker) already show in the certification basis the inherent airworthiness requirements, derived from EMACC or an equivalent standard.

These requirements, including those pertaining to the macro areas identified by the AGARD publication in ***Annex B - Appendix 1***, shall be demonstrated by the

Manufacturer during the aircraft type certification process, using the Means of Compliance - MOC agreed upon in the Certification Plan.

The certification basis of such aircraft -Technical Specification and Airworthiness Basis - may also directly contain the “integration” requirements of a specific tanker which will be directly reported in the contents of the Aircraft Type Certificate of the receiver aircraft.

B2.3 IFR clearance for an already receiver-certified domestic or foreign aircraft versus a new domestic or foreign tanker

An aircraft already certified to IFR operations is authorized to operate with a list of tankers normally identified in applicable technical operational publications.

In order to add a tanker aircraft to the aforementioned list, DAAA, through the activities conducted by the *1st Office of the Technical Vice Directorate* (VDT) for the release of a Technical Compatibility Assessment (TCA), in accordance with the provisions of the NATO Standard Related Document (SRD) - ATP-3.3.4.2.1.

The purpose of such a TCA is to ensure, following the appropriate technical-engineering analyses and evaluations, the proper pairing between receiver and a tanker already certified for IFR operations, excluding any potential risk in the conduct of training and operational activities.

Initiation Process:

To initiate the process, the request for issuance of a TCA for a new IFR clearance should be forwarded by the 3° Reparto dello Stato Maggiore Aeronautica (SMA 3) to the DAAA *1st Office* VDT, along with all available evidence in support to the feasibility of the task. The DAAA *1st Office* VDT, having evaluated the documentation, will determine whether to issue a TCA through:

- read - across, i.e. through similarity,

or, if necessary:

- through involvement of the *Reparto Sperimentale di Volo* (Italian Flight Test Center, RSV) for technical support for analysis and/or conducting ground and/or flight tests.

The read - across is a methodology used to formalize a new pairing based on already available data.

This methodology aims to verify several critical aspects, including:

- ***Absence of Buffet (Flutter) Phenomena:***

  Buffet phenomenon refers to structural vibrations caused by aerodynamic turbulence. Flutter is a specific type of aeroelastic vibration that can lead to catastrophic instabilities. Similarity analysis will help determine whether the new pairing tanker/receiver could be subject to phenomena of this nature.

- ***Changes in aerodynamic loads on the structure:***

  Aerodynamic loads significantly affect the structural integrity of the aircraft. It will be evaluated whether the new IFR tanker receiver, coupling introduces changes in loads that could alter the distribution of forces on the respective structures by comparing the data with those of already certified tankers/receivers (for pairing).

- ***Impact on the fatigue life of the cell:***

  Airframe fatigue life refers to the durability of the main body of the aircraft under repeated cycles of stress.

- ***Impacts on thruster life (propellers and flow distortion in air intake):***

  This item examines the potential impacts of the new pairing on operation and engine life, including propellers and inlet airflow efficiency. Any airflow distortions and their impact on engine performance will be analyzed.

- ***Differences in plant performance (pressures and flows):***

  The performance of the plant systems following the new tanker/receiver pairing will be evaluated. This comparison will seek to identify any differences from what was verified for the already certified tanker/receivers. Through the read-across approach, certification time and costs are likely to be reduced while providing a solid basis for preliminary safety and performance assessments.

In light of these reviews, the impacts on the existing airworthiness basis will be assessed with subsequent “reopening of some requirements”, where necessary.

Typically, the disciplines most affected are:

- Fuel system;
- Human Machine Interface;
- Visual cues;
- E3;
- Environment;
- Air Data System;
- FCS & HQ;
- Propulsion;
- Structure.

As for the technical-engineering analysis allocated to the Italian Flight Test Center, it is mainly based on the following incremental steps:

Verification Process:

This phase consists of the following steps:

- ***Verification, first on the ground and then in flight, of the mechanical probe-drogue and functional compatibility of the fuel systems, ensuring the fluid dynamic parameters (flow rates and pressures) of the tanker are within the limits for which the receiver trim has already been qualified***.

  Upon demonstration that the nominal pressures and delivery capacities are within the already qualified envelope, the functional verification per similarity of the receiver's fuel system is directly demonstrated.The amount of embarked fuel can be deduced with sufficient accuracy from on-board instrumentation and tanker data, without the need for dedicated instrumentation. Even if the aircraft fuel system has already been qualified for in-flight refueling, test instrumentation may be necessary to monitor the pressures registered at the interface between the receiver IFR system and the basal fuel system (typically before and after refueling valve) and at the point of insertion of the IFR line into the basal system.

- ***Verification of wake effects on the receiver aircraft propulsion system, a particularly significant aspect for turbo-prop aircraft;***

  Verification of wake effects on the behavior of the receiver thruster, particularly the effect of flow distortion - with regard to structural strength and rotor stall margins, as well as increased operating temperatures with regard to fatigue life - may be carried out without dedicated instrumentation when there are obvious performance similarities between the new tanker and those already reported (and thus already certified) in the contents of the applicable receiver manuals. For turboprop-based propulsion systems, the absence of propeller stall flutter phenomena will also need to be verified. This verification will be possible by similarity and thus without dedicated instrumentation when test evidence collected with tanker aircraft of similar characteristics is available.

- ***Aeromechanical evaluation:***

  Evaluation of handling qualities and pilot workload under various flight conditions and aircraft configurations, with special attention to tanker wake effects on the receiver aircraft at various positions during IFR operations and the effect of receiver aerodynamics on drogue behavior (bow-wave effect). Verification of wake effects on the aeromechanical behavior of the aircraft, particularly the assessment of the flight qualities of the receiver during the various phases (astern, pre-contact, contact, refueling, disconnect, turn, toboggan), may be carried out with standard flight testing techniques using data already available on the aircraft (onboard instrumentation or data from the avionics bus), without the aid of dedicated instrumentation.

- ***Verification of Wake Effects on the Air Data System:***

  Verification of wake effects due to drogues and related tubes on the aircraft air data system, particularly significant for Fly By Wire (FBW) aircraft. The impact of the tanker wake on the receiver for structural aspects should consider:
  - Magnitude of the phenomenon: The wake generated by an aircraft consists of a central part with descending velocity, evolving at the sides into two zones where the wingtip vortex first cancels the vertical component and then makes it positive (ascending). The phenomenon is maximum near the aircraft generating it and evolves by widening and thinning. The values of the velocities of the overall perturbation are a function of the aerodynamic lift of the aircraft generating the wake.
  - A representative maximum value is about 6-7 m/s downhill.

  Calculations based on contrails derived from wind tunnel data or Computational Fluid Dynamics (CFD) can be used for risk mitigation in clearance issuance, with which to then proceed to flight testing. The approach is experimental.

- ***Verification and Formalization Process:***

  Upon completion of the relevant evidence verification process, DAAA will formalize the TCA as per the form in Annex B - Appendix 2, which will then be transmitted via dedicated letter to SMA3 and for information to:
  - SMA4
  - Comando Logistico AM – Stato Maggiore
  - Divisione Aerea Sperimentazione Aeronautica e Spaziale.

  SMA 3, in accordance with NATO SRD - ATP-3.3.4.2.1, will issue an Operational Compatibility Assessment (OCA) and proceed to approve the new clearance, resulting in an updated national SRD. In the case of a clearance to a foreign tanker/receiver, SMA 3 will notify the foreign counterpart that the clearance issuance process has been completed. For simplicity, a schematic of the process of issuing the so-called TCA document is shown below - **Figure 1.**

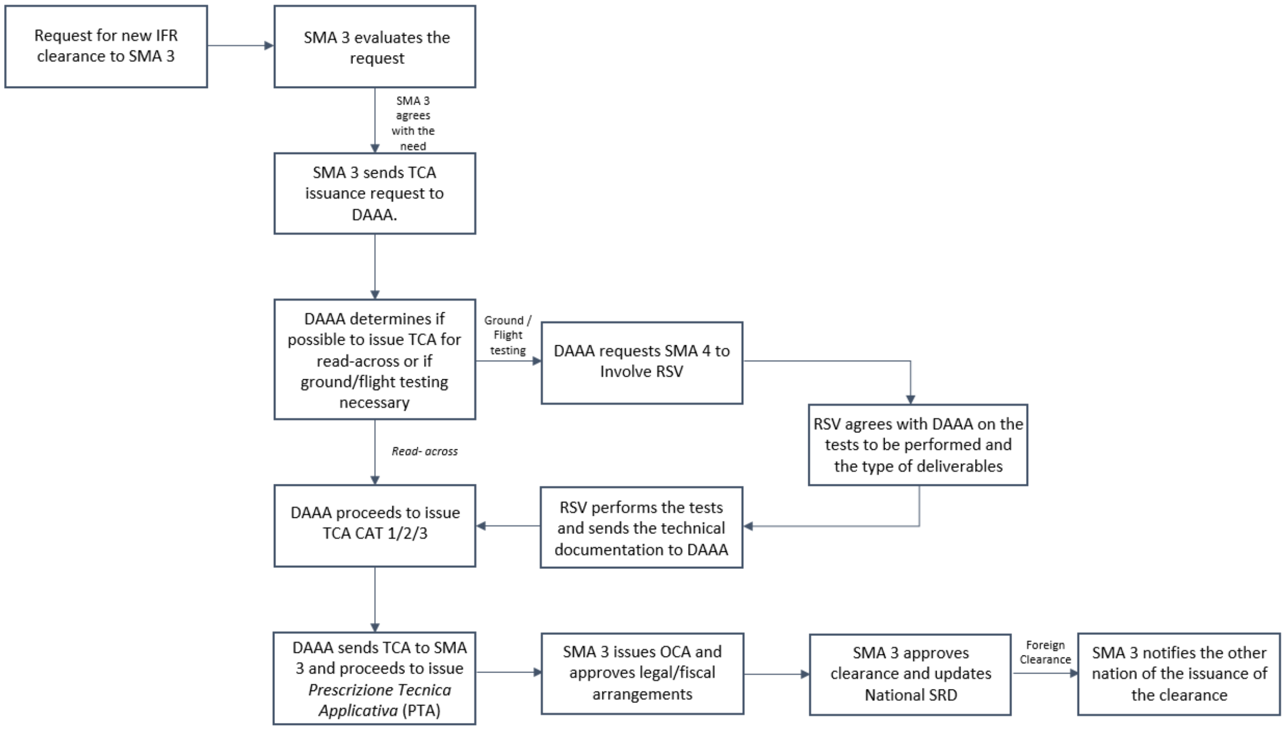


Figure 1: TCA request and formalization process

B3. UTILIZATION OF PREVIOUS TECHNICAL OPERATIONAL CERTIFICATION

If an urgent operational need arises for a new tanker/receiver pairing, the *Ufficio Certificazione del Comando Logistico A.M*. may activate a F.A. Technical Operational Certification (CTO) based on the activities carried out by the RSV, as per regulation AER(EP).P-9.

Typically, this process provides evidence for a clearance in a reduced envelope, duration and with limited conditions with respect to the tanker's performance characteristics.

The conversion of the CTO into a regulat Certification released by the DAAA, the RSV will submit to the DAAA an Approval Plan and the necessary MoCs, based on the criteria and requirements defined in the preceding paragraphs and on the processes defined in ***ANNEX B.***

There may be an instance where an aircraft flying under a CTO is required to achieve an IFR clearance. Such clearance can alternatively be obtained as a further implementation of the CTO scope and contents, or through the afore-described process, with the the direct involvement of DAAA. This activity is possible only under the assumption that the systems/subsystems modified by the CTO are not involved by the IFR functions. Such evaluation shall be preemptively carried out by DAAA with the support of RSV.

EXTRACT FROM AGARD 300 VOL.11
"*THE TESTING OF FIXED WING TANKER AND RECEIVER AIRCRAFT TO ESTABLISH THEIR AIR-TO-AIR REFUELING CAPABILITIES*"

Macro areas for identifying in-flight refueling activities.

Area	Description	Evidence
Fuel System Compatibility	Verification of the ability to transfer fuel in a safe and controlled manner within the CG limits of the aircraft. Verification of reliability of receiver air refueling subsystem and related failure management. Verification of interface compatibility with tanker air refueling systems. Structural verification of the receiver air refueling subsystem. (References HDBK 516, JSSG 2009)	– Design – Analysis – Ground Test with dedicated instrumentation – Flight Test with dedicated instrumentation. – Similarity of subsystem with already certified system.
Physical Hazards	Verification of possible mechanical intereference between drogue and receiver aircraft in case of failure to dock. (References JSSG 2009, MIL-A-87166)	– Design – Analysis – Flight Test
Airflow disturbance & Airframe/Engine Integrity	Verification of consequences of disturbed aerodynamic flow generated by the tanker on the safety of receiver aircraft operations. For example: – Pitot sensor and static pressure, influence on air data accuracy with consequence on FCS: – Flow distortion in engine air intake with possible compressor stall or surge; – Structual loads on probe/boom; – Pitch oscillations resulting in excursions in Nz and influence on fatigue life; – Loads on tail planes; – Loads on propellers (in case of transport turbopropt A/Cs) due to wing vortices generated by the tanker; – Tanker engine exhaust gas ingestion by the receiver engine; – Receiver engine problems due to disturbed flow caused by tanker exaust plume; – Power profile of receiver engine operation with life cycle impacts.	– Analysis – Flight Test – Simulation – Similarity

Area	Description	Evidence
Cockpit Layout & Control Charactheristics	Evaluation HMI issues related to air refueling mission: seating, visibility, hand on operations, dedicated cockpit instrumentation	− Ground Test − Flight Test
Flying qualities	Permanence of flight qualities sufficient to ensure safe operations even under emergency or failure conditions: - Emergency breakaway; - FCS mode operations; - Engine failure operations.	− Design − Analysis − Flight Test − Similarità
Flight envelope	Definition of a minimum flight envelope such as to ensure safe operations during in-flight refueling.	− Design − Analysis − Flight test

MINISTRY OF DEFENCE
SECRETARIAT GENERAL OF DEFENCE AND NATIONAL ARMAMENTS DIRECTORATE
DIRECTORATE OF AIR ARMAMENTS AND AIRWORTHINESS

<table>
<tr><th colspan="4">AERIAL REFUELING - TECHNICAL COMPATIBILITY ASSESSMENT</th></tr>
<tr><td colspan="2">1. Tanker:</td><td>2. Receiver:</td><td>3. Category:</td></tr>
<tr><td colspan="4">4. Aircraft configurations:</td></tr>
<tr><td colspan="4">5. Background:</td></tr>
<tr><td colspan="4">6. Substantiations:</td></tr>
<tr><td colspan="4">7. Recommendation:
[…] in accordance with the configuration above listed and the specific AAR Restrictions/Limitations listed in Annex 1, […]</td></tr>
<tr><td colspan="4">8. Terms and Conditions:</td></tr>
<tr><td colspan="4">9. References:
See Annex 2.</td></tr>
<tr><td>10. Date of Issue</td><td colspan="2">11. Approved by
ITA MILITARY AIRWOTHINESS AUTHORITY
THE DEPUTY DIRECTOR, TECHNICAL</td><td>12. Office Symbol</td></tr>
</table>

AAR RESTRICTIONS/LIMITATIONS

REFERENCES

AER(EP).P-516

ANNEX C

SEMI-PREPARED RUNWAYS

C1. INTRODUCTION

The System Design Responsible Company shall identify in the Technical Specification the aircraft requirements to consent safe takeoff and landing on semi-prepared runways.

The prepared runways are paved by a rigid or flexible material and are covered by tarmac. The parameters necessary to define a prepared runway are captured in the ICAO Annex 14.

The semi-prepared runways are unpaved and generally composed by different layers of soil: the bottom layer, the intermediate under-the-surface and the base superficial layer. The semi-prepared runways may lack of the intermediate and/or the superficial layers, if lesser bottom layers are deemed sufficient to withstand the aircraft operations.

The main features identifying the semi-prepared runways are hereby described:

- <u>the bearing</u>, expressed by the parameter CBR (California Bearing Ratio).
  This feature represents the capability to sustain a certain number of takeoff and landing (transits) performed by aircraft with a determined Maximum TakeOff Weight (MTOW), a certain number of wheels, landing gear type and tire pressure;
- <u>the roughness</u>, defined as the quantity and depth of the depressions present on the entire runway; the maximum allowed roughness depends on the aircraft type and can change during the relevant employment with a rate linked to the bearing and the number of transits.

Additional parameters are the paths, aerial and land, enabling takeoff and landing, such as:

- “Runway End Clear Zone” ,
- horizontal and vertical ”Imaginery Surface” (minimum takeoff and landing trajectory slopes), so to consent a safe obstacle overcome.

These characteristics determine whether a runway is identified as semi-prepared and impose specific design constraints into the aircraft in terms of sizing and siting of the wheels and the corresponding tire pressure.

C2. TECHNICAL SPECIFICATION REQUIREMENTS

The operational requirement shall define the requirements pertaining to the semi-prepared runways (length, width, CBR, initial and pre-refurbishment/maintenance roughness, minimum number of transits before the next scheduled maintenance, paths). Therefore the expected characteristics of the semi-prepared runways shall be included in the Technical Specification, in line with the operational requirements set by the Armed Forces.

As part of the activity to achieve Type Certification and Qualification, the System Design Responsible Company shall therefore demonstrate the aircraft capability of taking off and landing on the above-described semi-prepared runway, up to a set number of transits.

The Company shall design the aircraft so to comply with this requirement, with particular care to the following items:

- landing gear geometry (number of wheels, front and rear gear design, inherent distance from the aircraft center of gravity);

- allowable tolerance (longitudinal and transversal) for the center of gravity;
- tire pressure;
- MTOW.

JSSG-2001 provides general guidelines for the wording to capture in the Technical Specification:

3.1.1.2 Ground performance

The air vehicle, including external stores, shall not contact the ground or shipboard deck surfaces except for __(1)__during all nonemergency landings and ground operations on runways, taxiways, ships from which the air vehicle must operate, including surface imperfections not greater than six inches, and __(2)__. The air vehicle shall be capable of turns with not greater than __(3)__ lateral acceleration without tipback or tipover. The air vehicle shall be capable of reverse braking on a __(4)__ slope for all c.g. and loading conditions. The air vehicle shall be capable of 180-degree turns without stopping, backing, or differential braking on a __(5)__ foot wide runway/taxiway. The air vehicle shall be capable of ground operations for up to __(6)__ passes over California bearing ratio (CBR) __(7)__ soft field conditions, and shall be capable of unlimited ground operations on a runway facility of load classification number (LCN) __(8)__ or greater. The air vehicle shall be able to traverse, take off, and land on repaired runways including __(9)__ runway bomb crater repair bumps.

REQUIREMENT RATIONALE (3.1.1.2)

Consistent ground performance is expected to occur collaterally with consistent flight performance. The air vehicle and all stores carried (including fuel tanks, armament, sensors) should not strike the ground or deck during normal operation and operation with failures which induce asymmetric loadings. In order to be effective, the air vehicle should be capable of rapid and efficient movement while on various runway types.

REQUIREMENT GUIDANCE (3.1.1.2)

Blank 1. Include those parts of the air vehicle such as tires, landing skids, tail skids, or arresting hook that would normally be expected to touch the ground or deck during normal operations.

Blank 2. Identify the deck edge wheel stop height associated with the ships from which the air vehicle is required to operate. For CV/CVN class ships, a value of six inches is recommended. For all other class ships, a value of twelve inches is recommended.

Blank 3. Identify the lateral acceleration during turns that the air vehicle should withstand without tipback or turnover. Assure all conditions are addressed to assure safe and efficient turns. The recommended value for blank 3 is 0.5g.

Blank 4. Identify the maximum slope to which the air vehicle will be exposed and with which it will be required to use self-braking. The typical value to insert in blank 4 for land-based air vehicles is “not greater than 3 degrees,” but the value selected may be dependent on air vehicle anticipated basing. Ship-based air vehicles would require a greater anticipated deck angle pitch or roll.

Blank 5. Identify the minimum width of the runway or taxiway on which the air vehicle will be required to turn 180 degrees. This width may or may not be the minimum width of all the runways/taxiways on which the air vehicle will operate. Select the most practicable width for design based on runway/taxiway anticipated usage and air vehicle cost. The typical value used for design is 50 feet.

Blank 6. Identify the maximum number of air vehicle landings required on CBR soft field conditions. For fixed wing, manned, tactical air vehicles, the typical design number of landings for CBR 9 soft field conditions is 50.

Blank 7. Identify the worst-case CBR landing field required with which the air vehicle should be compatible. The typical CBR value used for fixed wing air vehicles is 9.

Blank 8. Identify the load classification number (LCN) for the airfield type that the air vehicle will use most of the time. The typical LCN used for fixed wing air vehicles is 28.

Blank 9. Identify the worst-case crater type in which the air vehicle will be required to taxi. The typical design value for fixed wing air vehicles is E-type.

REQUIREMENT LESSONS LEARNED (3.1.1.2)

The ground performance disclosed in MIL-STD-3013 (for fixed wing air vehicles) and in Appendixes D (for rotary wing air vehicles) needs to be augmented to assure ground performance expectations are achieved. The 6-inch minimum deck clearance requirement for CV/CVN class ships with either armament or fuel tanks installed has been difficult to achieve. However, it needs to be stipulated early in the design process. This requirement is a safety issue and is significant during the air vehicle launch and landing cycle. During air vehicle takeoff or arrestment, any contact with the catapult or the deck can be catastrophic.

Ground or deck clearances for all parts of the air vehicle, such as propeller(s), anti-torque tail rotor, structure (exclusive of tail bumper, wheel or skid structure, arresting hook in extended position), fairings, control surfaces, flaps, speed brakes, external stores, antennae, hatches and open weapon bay doors in their most critical configurations should be considered. Clearances for failure states, such as flat tire(s), over or under-extended wheel struts, etc., should be considered. Dynamic conditions such as those experienced during ground maneuvers, particularly onboard a moving ship, must be considered.

The roughness characteristics are reporter in the MIL-A-8862A and MIL-A-8863C.

In addition, in accordance with JSSG-2001, the Technical Specification is required to include a paragraph dedicated to the semi-prepared runways, as hereby exemplified:

"*Requirements for semi-prepared runways*

- *CBR (California Bearing Ratio)*
- *Roughness (Rugosità)*
- *Runway*
- *Taxiway*
- *Aprons*
- *Overruns*
- *Runway End Clear Zone*
- *Imaginery Surfaces*
- *APZ (Accident Potential Zone) and Areas of exclusion*
- *all aircraft data necessary to guarantee operations on this runway type*"

Further details about these runways are included in the following publications, collected at the First Office of the Vice-Technical Directorate:

- *AEP-46(B) NATO Aircraft Classification Numbers (ACN)/Pavement Classification Number (PCN), 16 June 2008, NATO STANAG 7131*
- *UFC (Unified Facilities Criteria) 3-260-1,"Airfield and Heliport Planning and Design ", DoD 17 November 2008*
- *Regulationan S. Currey, "Aircraft Landing Gear Design Principles and Practices", Lockheed Aeronautical Systems Company, Marietta, Georgia, 1988*
- *Donald H. Gray, Donald E. Williams, "Evaluation of Aircraft Landing Gear Ground Flotation Characteristics for Operation from unsurfaced soil airfield", Technical Report ASD-TR-68-34.*
- *"Runway roughness measurement, quantification and application – The Boeing Method" edito dalla Boeing Airport Technology Organization.*

AER(EP).P-516

ANNEX D

GUIDELINES FOR NECK LOAD EVALUATION IN THE CONTEXT OF MILITARY TYPE CERTIFICATION

D1. FOREWORD AND SCOPE

This document reports the evolution of the standards and the guidelines regulating the evaluation of the Neck Load, in the context of Military Type Certification and Qualification.
In the aeronautical context, the Neck Load rappresents the value of the load sustainable by the neck structure, when subject to critical phases like in the case of ejection.
This constitutes, therefore, a sensible aspect during the evaluation of the Crew Escape features, because strictly tied to the risk of accidents or injuries to the neck.

D2. APPLICABLE REGULATION

D2.1 MIL-S-18471G

MIL-S-18471G, "*SYSTEM, AIRCREW AUTOMATED ESCAPE, EJECTION SEAT TYPE: GENERAL SPECIFICATION FOR",* al par. 3.1.9 "*environmental requirements"* clarifies that the limits for acceleration, shock and vibration, and the inherent analytical methodologies shall be defined in accordance with the Technical Specifications applicable to each aircraft.
Paragraph 3.2.1.6 *("Design strength")* prescribes that the *"Ejection seat assembly, attachment fittings and supporting structure"* shall be designed to withstand the loads registered during an ejection at 27g (parallel to the rails), topped with the loads derived by the aerodynamic pressure at the maximum aircraft speed (at least 600 KEAS).
MIL-S-18471G does not directly establish a bespoke evaluation for the Neck Load.

D2.2 DEF-STN-00970 , CHAPTER 102 (EMERGENCY ESCAPE), LEAFLET 102/3

This standard, although not pinpointing a specific Neck Load limit, provides elements for a first estimation.
The following text can be extracted:
"5.2 The ground test called for in chapter 102, para 9, must be carried out finally to ensure that a safe ejection can be made. Impact gauges, approved by A & AEE, should be used in this test to assess the injury to be expected from any blow on the occupant's head, shoulders or knees. The significance of the results of these tests should be discussed with IAM (RAF) before clearance us given."
The standard recalls, as applicable reference, the results of the study carried by the "*Institute of Aviation Medicine" (IAM)* of the "*Royal Air Force" (RAF)*, where for first time a methodology for the Neck Load evaluation is presented.

The accelerations and derived values to which the ejectee would be subjected will be monitored to ensure compliance with the requirements of AD4 and AD6. The ATD's neck load in the Z-axis shall be reported and plotted against time. The criteria against which the loads imposed on aircrew members during the canopy ejections are assessed are in AD3 which states:

> *"Impact gauges should be used to assess the injury to be expected from any blow on the occupant's head, shoulder or knees. Present recommendations by the Institute of Aviation Medicine suggest that the bruising sustained would be acceptable provided the reading of the gauge did not exceed 1500 units…"*

The study reports that the Neck Load value, albeit only relative to the z-axis, shall be plotter across time, and it defines **1500 lbf** as acceptable limit load.
Therefore, the standard links the effects to the physical structure (spinal cord and neck) to the sole point vertical load upon ejection.
Following this approach, the Advisory Group for Aerospace Research & Development (AGARD) recommends in the report AGARD-AR-330 a limit load of **900 lbf**, clarifying that *"a load higher than the suggested one doesn't necessarily imply that a person would be injured if exposed to the collision since the load suggested is not injury thresholds".*
In this context, the M-346 programme for the Italian and Royal Singapore Air Forces adopted the DEF-STN-00970 approach for what regarded the use of helmets HGU-55G and HGU-55P.
More details on the AGARD are provided in the next paragraphs.

D2.3 AGARD-AR-330 (ANTHROPOMORPHIC DUMMIES FOR CRASH AND ESCAPE SYSTEM TESTING)

AGARD ADVISORY REPORT 330 describes:

- an historical re-visitation of the mannequins developed in the context of NATO programmes;
- the human bio-mechanics aspects of the adult mannequins;
- the anthropometrics of the adult mannequins;
- the acceptance criteria as a consequence of an impact (injury tolerance);
- the new generation mannequins;
- the mathematical models, as human surrogates;

The report includes recommendations for the evaluation of the aspects relevant to:

- effectiveness of the test systems for the evaluation of injuries;
- representativeness of the mannequins with respect to the aircrew population;
- instrumentation installed on the mannequins and data acquisition systems;
- validation and enhancement of the mathematical models.

The study of the injuries provoked by a crash (automotive) or ejection (aeronautics) is jointly treated, with continuous overlapping of information/evidence emerged from the two sectors.

The following mannequin models have been adopted.

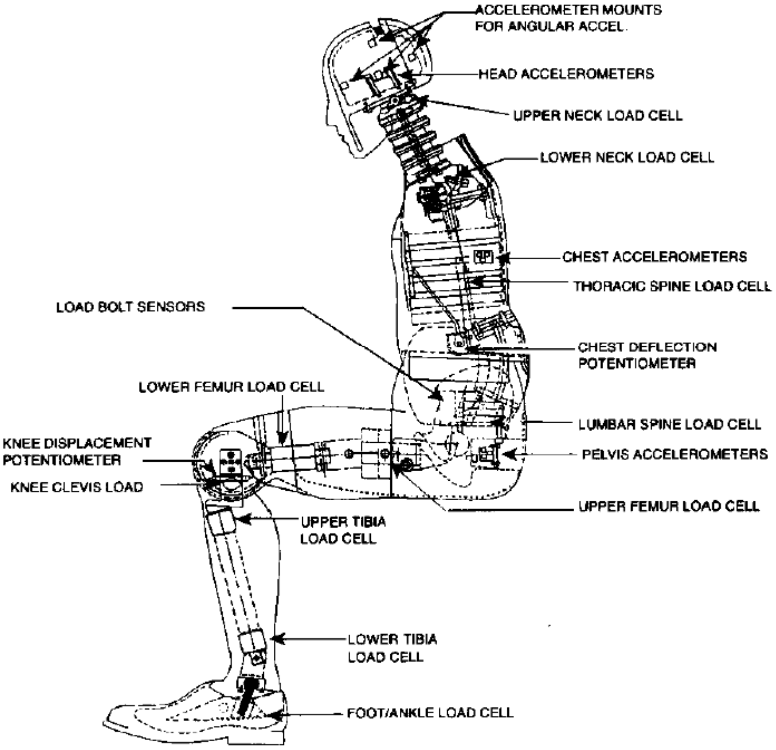
General Body Dimensions (m)

Dummy Type	Mass (kg)	Stature	Sitting Height	Buttock to Knee Length	Knee Height Sitting	Shoulder Height Sitting	Reference Population	Data Source
GARD/CG								
CG-5	60.1	1.656	0.858	0.556	0.510	0.542	[4.3]	
CG-50	73.4	1.755	0.914	0.599	0.551	0.592	[4.3]	
CG-95	91.1	1.856	0.966	0.645	0.592	0.638	[4.3]	
Hybrid II								
50th Male	74.4	n/a[k]	0.907	0.592	0.544	0.599	Civilian male[d] [4.2]	[4.4]
Hybrid III								
5th Female	48.7	n/a[k]	0.790	0.521	0.457	0.442[b]	Civilian female [4.5]	[4.6]
50th Male	78.2	n/a[k]	0.884	0.592	0.493[g]	0.513[b]	Civilian male[d] [4.2 & 4.7]	[4.8]
95th Male	101.1	n/a[k]	0.935	0.633	0.594	0.549[b]	Civilian male [4.5]	[4.6]
Aerospace								
5th Female	49.0	1.483	0.800	0.544	0.465	0.508	Military female[c]	
5th Male	71.7	1.650	0.879	0.559	0.518	0.536	USAF flying personnel [4.9]	
50th Male	85.7	1.697	0.886	0.591	0.544	0.599	Civilian male[d] [4.2]	[4.4]
95th Male	98.0	1.864	0.991	0.688	0.635		Military male[c]	
ADAM								
Small	64.2[a]	1.683	0.876	0.564	0.538	0.597	Small male aviator [4.1]	[4.10]
Large	98.3[a]	1.886	0.953	0.654	0.603	0.663	Large male aviator [4.1]	[4.10]
SID								
50th Male	76.5	n/a[k]	0.899	0.592	0.544	n/a	Civilian male [4.5]	[4.4]
BIOSID								
50th Male	76.2	n/a[k]	0.884	0.592	0.493[g]	0.513	Civilian male [4.5]	[4.11]
EUROSID 1								
50th Male	72.0	n/a[k]	0.904	0.610	0.544	0.557[b]	Civilian male [4.5]	[4.12]

a - Mass with on-board data acquisition system
b - Shoulder pivot height sitting
c - SAE J963 [4.4] modified by military service data
d - Military data adjusted to represent civilian population
g - Knee pivot height
k - Standard dummies have pelvis molded in a seated position and cannot stand. Standing versions of Hybrid II and Hybrid III are available as a special order

The possibility of collecting evidence of the Neck Loads (and the relevant flexional moment arms) applied to the 3 axes depends, therefore, on the adopted mannequin type.

In literature, it is suggested to use the mannequin model “**Hybrid III**”, which consents measurements of XYZ loads on different neck section.



The severity of the injuries (initially associated to car accidents) is classified in accordance with the *“Abbreviated Injury Scale (IAS)”,* developed by the *“Association for Advancement of Automotive Medicine”:*

Abbreviated Injury Scale (AIS) [5.4]

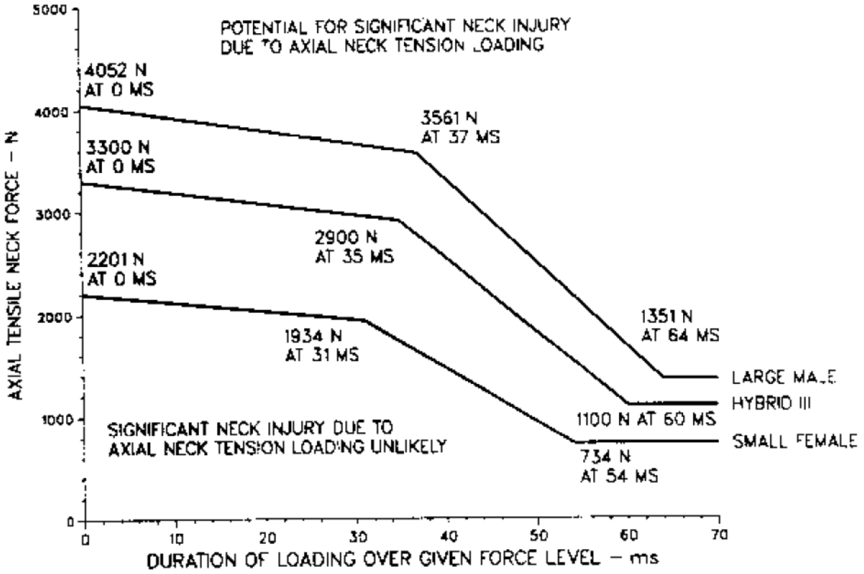
AIS	Severity of Injury
0	Not Injured
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
6	Maximum
7	Injured but Severity Not Known

Most of the injuries regards the head/face, the inferior limbs and the chest.
For the aeronautical sector, a first holistic analysis of the biomechanical data used to establish the acceptance criteria of the "Escape" is reported in the study carried by Raddin; this study documents a statistical analysis of the ejections from different US Air Force aircraft between 1975 and 1991.
In 1984 the “General Motors Corporation (GM)” published a set of ***“Injury Assessment Reference Values (IARVs)”***, used as guideline for the evaluation of the potential injuries and derived from measures performed on type “Hybrid III” mannequins at the 50th percentile adult male.
Each IARV refers to *“a human response level below which a specified significant injury is considered unlikely to occur for a given individual”.*

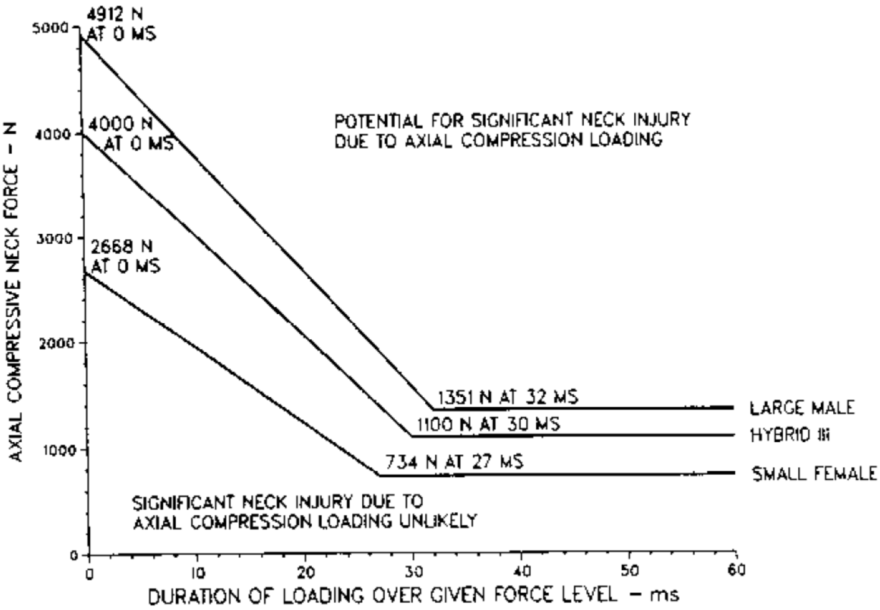
Therefore, keeping a level below IARVs limits does not assure 100% prevention from significant injuries; on the other hand, overcoming IARVs limits does not necessarily imply an injury, as the e IARVs index is not tied to a sort of injury risk threshold.
Having said that, the AGARD reports the following IARVs risk index table and supporting graphs:

Injury Assessment Reference Values for (IARVs) Hybrid III Type Adult Dummies [5.7]

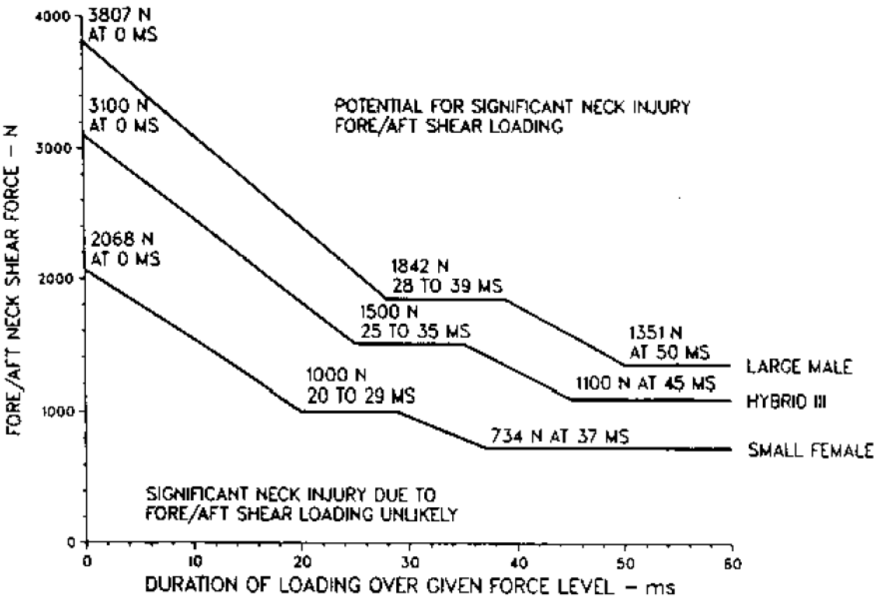
Body Region / **Injury Assessment Criteria**	**Small Female**	**Mid-Size Male**	**Large Male**
Head			
HIC; $(t_2 - t_1) \leq 15$ ms	1113	1000	957
Head/Neck Interface			
Flexion Bending Moment (Nm)	104	190	258
Extension Bending Moment (Nm)	31	57	78
Axial Tension (N)	Fig. 5.5	Fig. 5.5	Fig. 5.5
Axial Compression (N)	Fig. 5.6	Fig. 5.6	Fig. 5.6
Fore/Aft Shear (N)	Fig. 5.7	Fig. 5.7	Fig. 5.7
Chest			
Spinal Acceleration (G)	73	60	54
Sternal Deflection due to:			
Shoulder Belt (mm)	41	50	55
Air Bag & Steering Wheel Hub (mm)	53	65	72
Viscous Criterion (V*C) (m/s)	1	1	1
Femur			
Axial Compression (N)	Fig. 5.8	Fig. 5.8	Fig. 5.8
Knee			
Tibia-to-Femur Translation (mm)	12	15	17
Med./Lat. Clevis Compression (N)	2552	4000	4920
Tibia			
Axial Compression (N)	5104	8000	9840
Tibia Index, $TI = M/M_c + F/F_c$	1	1	1
where,			
M_c - Critical Bending Moment (Nm)	115	225	307
F_c - Critical Comp. Force (kN)	22.9	35.9	44.2



Injury Assessment Curves for Axial Neck Tension Measured with Hybrid III Type Adult Dummies



Injury Assessment Curves for Axial Neck Compression Measured with Hybrid III Type Adult Dummies



Injury Assessment Curves for Fore-and-Aft Sheer Forces Measured at the Head/Neck Interface of Hybrid III Type Adult Dummies [5 71

The *"Head Injury Criteria" (HIC)* can be calculated with the following formula:

$$HIC = (A_{avg})^{2.5} (t_2 - t_1)$$

where:

- A_{avg} = mid acceleration of the head center of gravity, expressed in "g", in the time interval (t_2- t_1) where the HIC reaches its max value
- (t2- t1) = 15 ms.

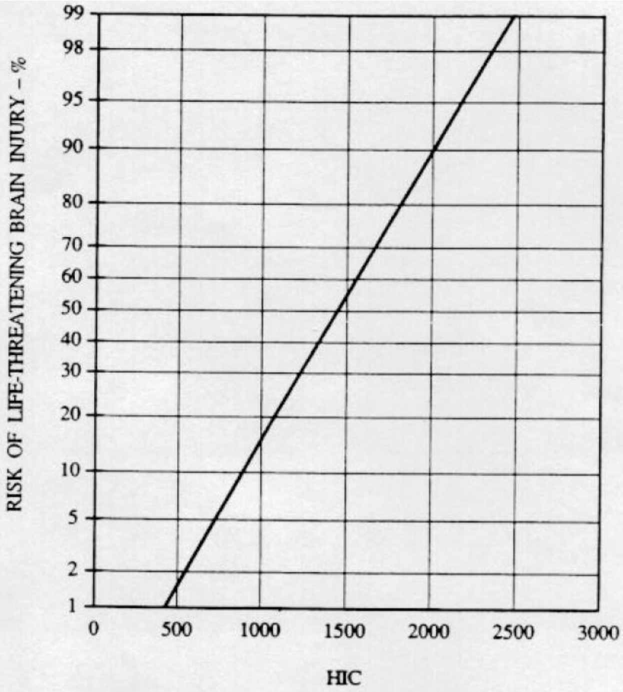
D2.4 JSSG-2010

The contents of JSSG-2010 are mostly in line with what reported in AGARD-AR-330. JSSG-2010 sets the following limits:

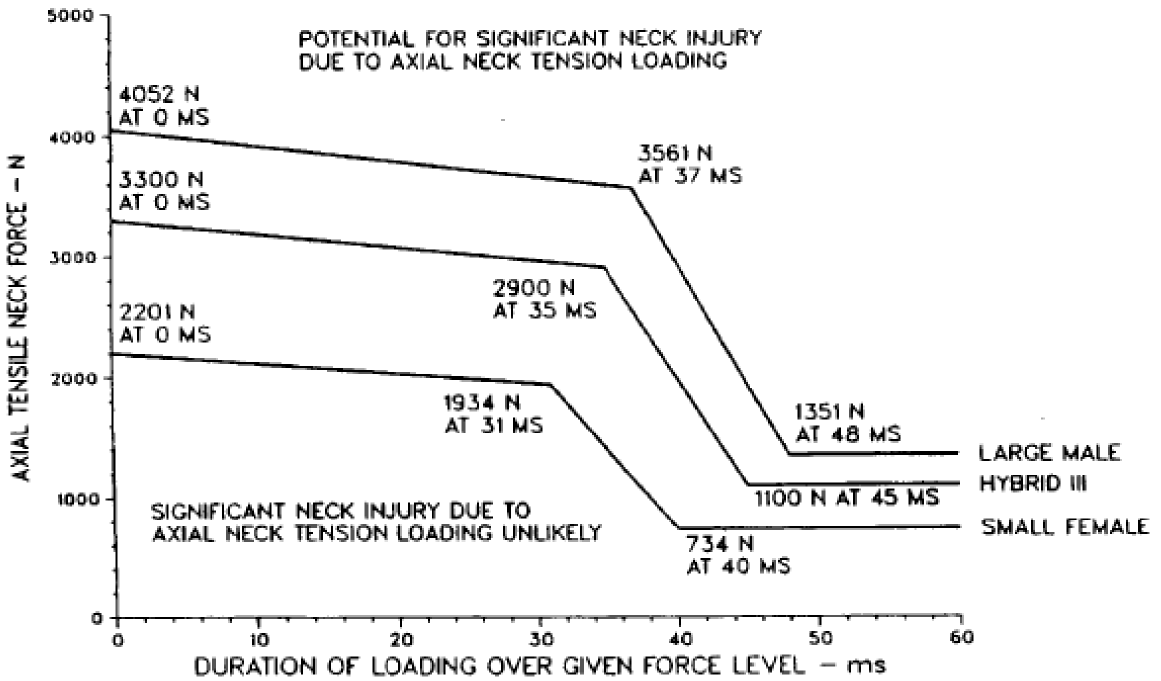
Injury assessment reference values for Hybrid III–type adult dummies.[32–35,37]

Body region Injury-assessment criteria[a]	Small female	Midsize male	Large male
Head			
HIC; $(t_2 - t_1) \leq 15$ ms	1,113	1,000[b]	957
Head/neck interface			
Flexion bending moment (Nm)	104	190	258
Extension bending moment (Nm)	31	57	78
Axial tension (N)	Fig. 4.A2	Fig. 4.A2	Fig. 4.A2
Axial compression (N)	Fig. 4.A3	Fig. 4.A3	Fig. 4.A3
Fore/aft shear (N)	Fig. 4.A4	Fig. 4.A4	Fig. 4.A4
Chest			
Spine box acc.; (3 ms, G)	73	60	54
Sternal deflection due to:			
— Shoulder belt (mm)	41	50	55
— Air-bag & steering-wheel hub (mm)	53	65	72
Viscous criterion (m/s)	1	1	1
Femur			
Axial compression (N)	Fig. 4.A5	Fig. 4.A5	Fig. 4.A5
Knee			
Tibia-to-femur translation (mm)	12	15	17
Med./lat. clevis compression (N)	2,552	4,000	4,920
Tibia			
Axial compression (N)	5,104	8,000	9,840
Tibia index, $TI = M/M_c + F/F_c$	1	1	1
Where,			
M_c—critical bending moment (Nm)	115	225	307
F_c—critical comp. force (kN)	22.9	35.9	44.2

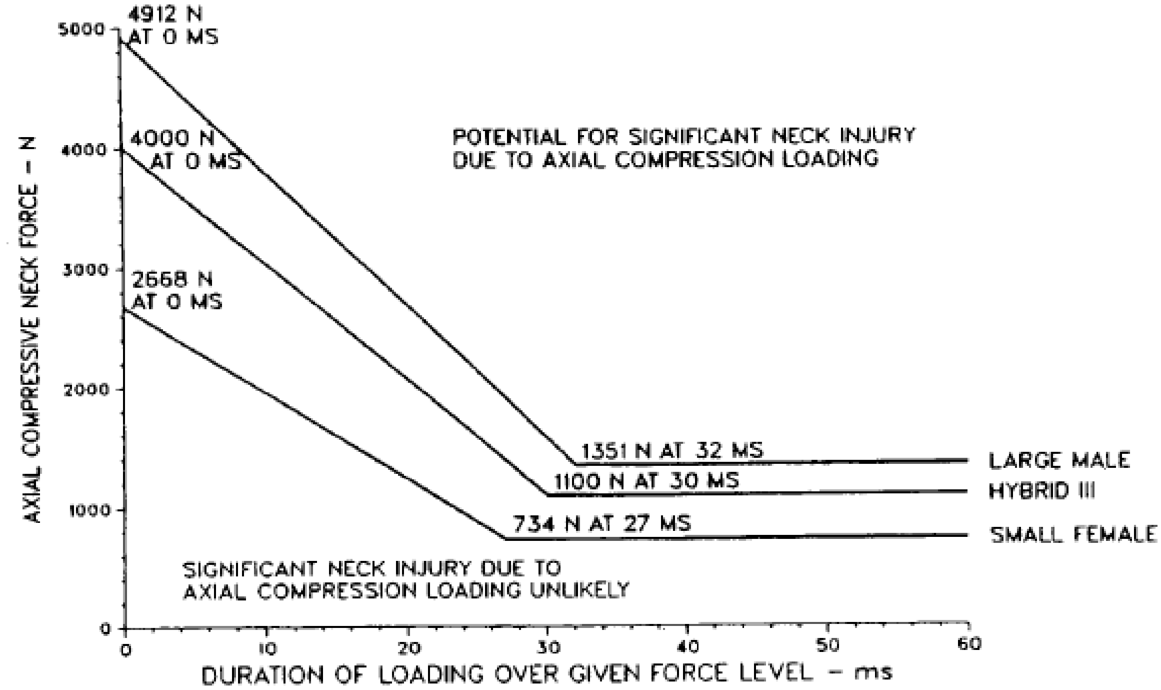
[a] Units are SI notation.[77]
[b] See Fig. 4.A1 for injury risk curve.



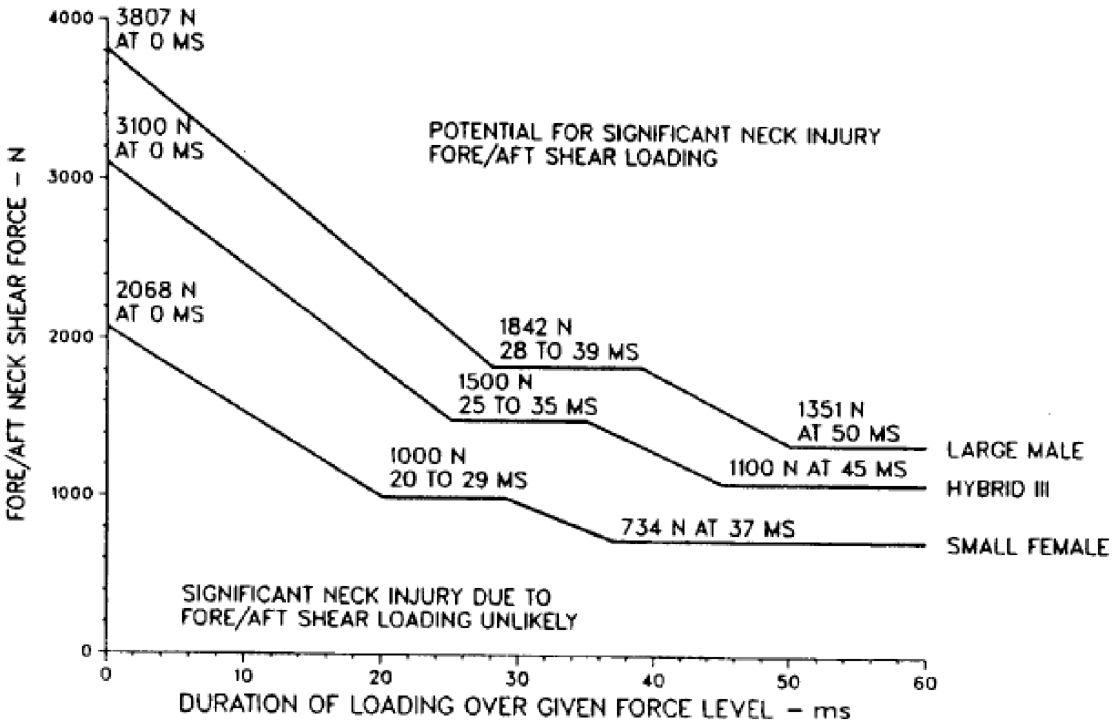
Injury risk curve for HIC for $t_2 - t_1 \leq 15\,ms$.[32]



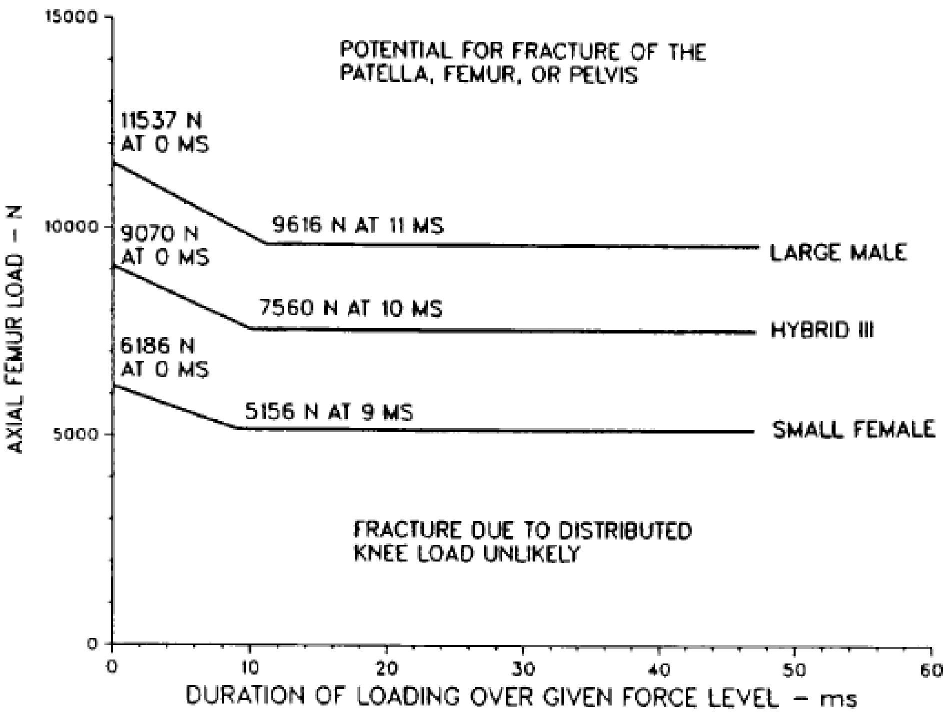
Injury-assessment curves for axial neck tension measured with Hybrid III–type adult dummies.[32,37]



njury-assessment curves for axial neck compression measured with Hybrid III–type adult



Injury-assessment curves for fore and aft shear forces measured at the head/neck interface of Hybrid III–type adult dummies.[32,37]



Injury-assessment curves for axial compressive femur force measured with Hybrid III–type adult dummies.[32,37]

The value of HIC is calculated as follows:

$$HIC = \left[(t_2 - t_1) \left[1/(t_2 - t_1) \int_{t_1}^{t_2} a(t)\, dt \right]^{2.5} \right]$$

D2.5 JSF APPROACH

The approach followed for the JSF-F34 certification, at the date of publication of this AER(EP).P-516 Annex, can be considered the state of the art in terms of evaluation of the effects (injuries) potentially caused by excessive values registered at the Neck Load.

To note, the JSF was the first programme formally introducing in the contract Technical Specification requirements specifically dedicated to the Neck Load, conversely defining the means for the corresponding analytical evaluation.

The peculiarity of the JSF programme was the articulated approach, from the measurement of the input loads and flexional moments on the 3 axes to the definition of bespoke "Neck Injury Criteria". This methodology encompassed all possible points of application of the loads and established the level of acceptability of the relevant tests.

The admissible values of Neck Load (requirement) are defined as a function of the relevant type.

- Maximum tension and relevant duration, measured at the "occipital condyles" (C0-C1) and "cervical vertebrae" (C7-T1):

Small Female Hybrid III Type Manikin (103 to 118 lbs)		Mid-Size Male Hybrid III Type Manikin		Large Male Hybrid III Type Manikin (200 to 245 lbs)	
Duration (ms)	Tension at C0-C1 & C7-T1 (lbs)	Duration (ms)	Tension at C0-C1 & C7-T1 (lbs)	Duration (ms)	Tension at C0-C1 & C7-T1 (lbs)
5	414	5	618	5	761
31	414	35	618	37	761
40	200	45	320	48	450
80	200	80	320	80	450

- Maximum compression and shear, and relevant duration:

Small Female Hybrid III Type Manikin (103 to 118 lbs)		Mid-Size Male Hybrid III Type Manikin		Large Male Hybrid III Type Manikin (200 to 245 lbs)	
Duration (ms)	**Compression at C0-C1 & C7-T1 (lbs)**	**Duration (ms)**	**Compression at C0-C1 & C7-T1 (lbs)**	**Duration (ms)**	**Compression at C0-C1 & C7-T1 (lbs)**
5	519	5	790	5	979
27	200	30	320	32	450
80	200	80	320	80	450
Duration (ms)	**Resultant Shear at C0-C1 (lbs)**	**Duration (ms)**	**Resultant Shear at C0-C1 (lbs)**	**Duration (ms)**	**Resultant Shear at C0-C1 (lbs)**
5	405	5	625	5	777
20	225	25	337	28	414
29	225	35	337	39	414
37	165	45	247	50	304
80	165	80	247	80	304
Duration (ms)	**Resultant Shear at C7-T1 (lbs)**	**Duration (ms)**	**Resultant Shear at C7-T1 (lbs)**	**Duration (ms)**	**Resultant Shear at C7-T1 (lbs)**
5	810	5	1250	5	1554
20	450	25	674	28	828
29	450	35	674	39	828
37	330	45	494	50	608
80	330	80	494	80	608

- Maximum combined effect of Force (Fz) and Moment (My), expressed as Nij index:

The maximum combined-cervical-force-and-moment limit, expressed as Neck Injury Criteria (Nij), is 0.5, as measured at the occipital condyles (C0-C1). The maximum Nij as measured at the cervical vertebrae (C7-T1) is 1.5.
Nij is not applied for pure tension or compression. Nij is calculated from the following equation:

$$N_{ij} = \frac{F_z}{F_{\text{int}}} + \frac{M_y}{M_{\text{int}}}$$

where:
Fz is the axial tension/compression load.
Fint is the critical intercept load (defined in Table 1.1.3).
My is the flexion/extension bending moment.
Mint is the critical intercept moment (defined in Table 1.1.3)

	Small Female Hybrid III Type Manikin (103 to 118 lbs)	Mid-Size Male Hybrid III Type Manikin	Large Male Hybrid III Type Manikin (200 to 245 lbs)
Tension (lb) (+F_z)	964	1530	1847
Compression (lb) (-F_z)	872	1385	1673
Flexion (in-lb) (+My)	1372	2744	3673
Extension (in-lb) (-My)	593	1195	1584

- Maximum combined effect of the Moments (Mx, My) , expressed as NMIx, NMIy index:

  To evaluate neck lateral bending (Mx) and rotation (Mz), the Neck Moment Index (NMI) will be calculated.
  The maximum allowable NMIx, is 0.5, as measured at the occipital condyles (C0-C1) and 1.5 as measured at the cervical vertebrae (C7-T1). The maximum allowable NMIz, is 0.5, as measured at the occipital condyles (C0-C1) and 1.0 as measured at the cervical vertebrae (C7-T1).
  NMI is calculated using the following equation:

$$NMI_i = \frac{M_i}{M_{iLIM}}$$

where:
NMIi is NMIx or NMIz
Mi is Mx or Mz
MiLIM is the Mx or Mz limit (defined in Table 1.1.4)

	Small Female Hybrid III Type Manikin (103 to 118 lbs)	Mid-Size Male Hybrid III Type Manikin	Large Male Hybrid III Type Manikin (200 to 245 lbs)
Lateral Bending (in-lb) (+/- Mx)	593	1195	1584
Rotation (in-lb) (+/- Mz)	593	1195	1584

The JSF approach, with a dedicated algorithm, managed any exceedance of the afore-defined limits, through the evaluation of the parameter *“Multi-Plane Neck Injury Index (MPNI):*

$$\sqrt{\left(\frac{F_z}{Fz_{crit}}\right)^2+\left(\frac{F_{xy}}{Fxy_{crit}}\right)^2+\left(\frac{Mx}{Mx_{crit}}\right)^2+\left(\frac{My}{My_{crit}}\right)^2+\left(\frac{Mz}{Mz_{crit}}\right)^2}$$

which, associated with the levels of occurrences (probability), consented the definition of the “Hazard Risk Index (HRI) matrix.

AER(EP).P-516

ANNEX E

SAFE EJECTION IN THE CERTIFICATION CONTEXT

E1. SCOPE

Scope of the present Annex is to illustrate the airworthiness requirements pertaining to the Crew Escape System with the aim of providing a clear definition and understanding of the concept "safe ejection", in accordance with the terms and the prescriptions derived from AER(EP).P-516.

The word "safe ejection" can carry different connotations as a function of the context of its use: for instance, in terms of operational requirement, a safe ejection may result more stringent, if associated to the aircrew survivability in hostile environments after the ejection.

In order to provide a clear understanding of the term "safe ejection" in the specific context of the aircraft Military Type Certification, the acceptable level of aircrew physiological damage will be defined.

More specifically, such damage will be estimated and evaluated in the assumption that the Crew Escape System has already achieved compliance with the applicable certification criteria adopted by DAAA.

E2. CERTIFICATION CRITERIA

Crew Escape System can be considered a “*safe system*” in the following condition:

"*Escape system functionality, including operation of escape path clearance systems, does not induce a probability of incapacitating major injury greater than 5% throughout the required performance envelope... Applied and inertial forces during escape do not exceed a 5% human incapacitating injury probability for speeds up to at least 350 KEAS for legacy aircraft and 450 KEAS for aircraft in development unless otherwise specified or limited by air vehicle speed capability".*

From what above, derives that the ejection System is deemed “*safe”* when inducing an “*incapacitating major injury”* with a probability below 5%.

To guarantee compliance with this requirement and with the probability of occurrence of a set physiological damage, it is necessary to comply with all the requirements included in JSSG-2010-3, JSSG-2010-7 and JSSG-2010-10.

Moreover, the following definition “injury" can be adopted for the determination of the physiological damage associated with the concept of *“incapacitating major injury”* (*U.S. Department of Transportation, National Highway Traffic Safety Administration* in the *Fatality Analysis Reporting System):*

“An incapacitating injury is any injury, other than a fatal injury, which prevents the injured person from walking, driving or normally continuing the activities the person was capable of performing before the injury occurred.

This includes: severe lacerations, broken or distorted limbs, skull or chest injuries, abdominal injuries, unconsciousness at or when taken from the accident scene, and unable to leave the accident scene without assistance.

This does not include momentary unconsciousness”.

Such definition is based on a 4-level classification:

- Code 1 (Possible Injury).
- Code 2 (Non-incapacitating Evident Injury)[1].

[1] To better understand the different with "incapacitating injury", the definition of “n*on-incapacitating Evident Injury”* is hereby presented*: A non-incapacitating evident injury is any injury, other than a fatal injury or an incapacitating injury,*

- Code 3 (Incapacitating Injury).
- Code 4 (Fatal Injury).

With respect to this definition, JSSG 2010-7 - CREW SYSTEMS CRASH PROTECTION HANDBOOK provides additional details.
JSSG 2010-7 at §3.7.2 provides further details about the classification of the physiological damage types (injury classification) and relevant severity (injury scales).
In particular, the regulation mentions the *Abbreviated Injury Scale (AIS*), developed by the *Association for the Advancement of Automotive Medicine*. The AIS is a method based on 6 different levels of severity:

- Minor
- Moderate
- Severe
- Serious
- Critical
- Maximum (virtually non-survivable).

These levels are tailored and applied to 9 specific body parts:

- Head
- Face
- Neck
- Torace
- Abdomen
- Spine
- Superior limbs
- Inferior limbs
- Other regions and external area.

This scale is a viable reference for determining a possible correlation between the MIL HNBK 516 requirement and the corresponding physiological damage.
Table 1, extracted from JSSG 210-7, shows a few examples of damage classification for the head and the spine, whereas Table 2 defines the probability of death as directed by the values assumed by the AIS, with a further expansion of the related possible physiological damages.

---

which is evident to observers at the scene of the accident in which the injury occurred. This includes: lump on head, abrasions, bruises and minor lacerations. This does not include limping (the injury cannot be seen).

Abbreviated injury scale (AIS) and sample injury types for two body regions.

AIS	SEVERITY	HEAD	SPINE
0	NONE	----	----
1	MINOR	Headache or dizziness	Acute strain (no fracture or dislocation)
2	MODERATE	Unconscious less than 1 hr., linear fracture	Minor fracture without any cord involvement
3	SERIOUS	Unconscious 1-6 hrs., depressed fracture	Ruptured disc with nerve root damage
4	SEVERE	Unconscious 6-24 hrs., open fracture	Incomplete cervical cord syndrome
5	CRITICAL	Unconscious more than 24 hrs., large hematoma (100cc)	C4 or below cervical complete cord syndrome
6	MAXIMUM INJURY (virtually non-survivable)	Crush of skull	C3 or above complete chord syndrome

Table 1 AIS scale example

AIS-Code	Injury	Example	AIS % prob. of death
1	Minor	superficial laceration	0
2	Moderate	fractured sternum	1 – 2
3	Serious	open fracture of humerus	8 – 10
4	Severe	perforated trachea	5 – 50
5	Critical	ruptured liver with tissue loss	5 - 50
6	Maximum	total severance of aorta	100

Table 2 Probability of death associated with AIS scale

From a confrontation between the severity levels defined in the Fatality Analysis Reporting System manual redacted by the U.S. Department of Transportation, National Highway Traffic Safety Administration and those described in the AIS, it is possible to derive a more comprehensive understanding of the safe ejection requirement.
In particular, the definition of “incapacitating injury”, as included in the “Fatality Analysis Reporting System”, can be correlated to the AIS level 3 (serious damage).
Considering the definition of “safe ejection” as the acceptance of a damage provoking an "incapacitating major injury" with a probability below 5%, it is possible to provide a quantitative interpretation of this requirement:

an ejection is defined “safe" when inducing a physiological damage "serious", as described in the AIS scale, with a probability of occurrence below 5%.

The choice to exclusively adopt the AIS scale finds further validation in other types of injury scales proposed in JSSG 2010-7 para §3.7.2 [2].
To note, a safe ejection in the context of certification still allows and tolerates the occurrence of a certain level of damage (serious) to the aircrew, albeit with a probability below 5%. In case a lower level of damage is sought for operational reasons, it is recommended, when redacting the Technical Specification, to provide adequate details in terms of maximum allowable load for the Crew Escape System.

[2] Examples of Indicated Assessment Reference Values, reported in figures 9, 10 and 11 of JSSG 2010-7 are associated to a "Potential for Significant Neck Injury", correlated to a quantitative definition of damage linkable to AIS scale level 3 "Serious".

AER(EP).P-516

ANNEX F

CERTIFICATION REQUIREMENTS TETHERED GAS BALLOONS (TGB)

F1. AIM

The aim of this Annex “F” is to introduce in DAAA regulation the EASA “*Certification Specification and Means of Compliance for Tethered Gas Balloon*” (CS-31TGB) as it is in adherence of para 1.3 introduction 1, adding specific military requirements to cover peculiar military capability as for Parachutists Training (PT). To facilitate the application, the aforementioned integration are highlight in bold fonts.

F2. APPLICABILITY

This Annex is applicable to non-free flying manned Tethered Gas Balloons for that operate up to a maximum altitude of 500 m above the surface and that derive their lift from non-flammable gas being lighter than air.

TGB are military aircraft registered in the RAM (Registro degli Aeromobili Militari), hence are to be managed in accordance with DAAA regulations for initial, continued and continuing airworthiness.

F3. DEFINITIONS AND ACRONYMS

All the terms and acronyms used in this Annex are in compliance with CS31T supplemented by ones listed below:

- **Tethered Gas Balloon**

Tethered Gas Balloons is a TGB designed and built, composed by an Air Segment (AS) and a Ground Control System (GCS), with the provisions for Parachutists Training if required.

- **Air Segment (AS)**

Air Segment (AS) is composed by the Envelope and the Gondola in which is installed the Control Panel housed, including all the instruments and switches necessary for monitoring and control of the AS. In the AS are installed the provisions designed for parachuting activities, if required.

- **Ground Control System (GCS)**

Ground Control System (GCS) controls the AS during the ascent/descent phases and for winching the AS on the landing platform at the end of the cycle, using Ground Control Station located on the Ground Cab in continuous contact with AS.

- **Maximum lift**

It is the sum of the maximum static lift from the lifting gas volume and the maximum dynamic lift, at sea level, in International Standard Atmosphere conditions;

- **Maximum dynamic lift**

It is the highest lift force at the chosen maximum operating wind condition at sea level, in International Standard Atmosphere conditions;

- **Maximum stress force**

It is the sum of maximum static lift, maximum dynamic lift and maximum dynamic drag;

- **Movable platform**

It is a constraint at which the Tethered Ground Balloon System is anchored during taxing phase.

F4. MILITARY REQUIREMENTS FOR TGB-PT

F4.1 INTEGRATION OF CS 31TGB.20 PARA (b)

The continuing controllability of the balloon or other mitigations are provided to give each occupants, and/or parachutist (on board and/or overflown) when used for parachuting training**,** every reasonable chance of escaping serious injury in the following emergency condition. (See AMC1 31TGB.20 (b)):

- potential or unintended free flight;
- terminating operation in wind conditions exceeding the operating limitations by 50%;
- tether system failure that prevents descent from the maximum operating height or any other height if considered more critical.

F4.2 INTEGRATION OF CS 31TGB.22

The strength requirements include consideration of the applicable in-service load cases such as:

- inflation;
- flight; and
- mooring;
- parachuting troop separation;
- gondola balance for parachuting troop launch.

The loads are determined and the parts and components under particular stress designed in accordance with their designated use and dimensioned such as not to fail under recurrent loads.

F4.3 INTEGRATION OF CS 31TGB.31

The suitability of each design detail or part that bears on safety is established by analysis **and**/or tests.

F4.4 INTEGRATION OF CS 31TGB.51

The Envelope has a means allowing rapid deflation of balloon, taking into due regard the effect of the maximum vertical speed permitted to be applied to a parachutist of an average weight of 120kg.

F4.5 INTEGRATION OF CS 31TGB.53

- The suitability, durability, and reliability of the tether system is established for all phases of operating (see AMC1 31TGB.53(a)).
- In operation and mooring the balloon is securely and reliably anchored to the ground or, if applicable, to a movable platform.
- Precautions are to be taken to mitigate the risks due to the effect of wind exceeding the maximum wind speed stated in the Flight Manual on the balloon when moored to the ground. (See AMC 31TGB.53(c))

F4.6 INTEGRATION OF CS 31TGB.59

- The gondola may not rotate independently of the envelope unless safe operation is assured.
- Projecting object in the gondola, that could cause injury to the occupants, are avoided or padded.
- A holding grip is provided for each occupant.
- Reasonable space is provided for all occupants, with regard to both comfort during the flight and to safety during the parachuting operations and landing.
- Occupants and items in the gondola are prevented from falling from the gondola.
- The gondola occupant securing devices (e.g. doors or harnesses) comply with the following requirements:
- The device is closed and locked during flight.
- The device is protected against unintentional opening by persons or opening as the result of a mechanical failure during flight.
- The device can be opened by occupants and crew.
- Operation of the device shall be simple and obvious.
- The device has a visual indication that it is properly closed and locked.
- If the TGB is required for parachuting training, the gondola is designed and produced taking into account the parachuting operations, in particular the design considers:
    - Structural loads and forces distribution deriving from separation of parachutists.
    - Structural loads deriving from parachute securing devices linked to the gondola.
    - Structural loads deriving from emergency due to recover the personnel in case of parachuting operation abortion/failure.
    - Proper passage/clearances/opening to allow the parachutists to leave safely the gondola and ensuring the clearance area for a safe separation.
- If the TGB is required for parachuting training, the gondola security devices for parachuting activities, complies with the following requirements:

- Parachutists keep their level of safety not disconnecting the security devices.
- Unintentional falling of the parachuting personnel is avoided by suitable systems.
- During parachuting operations, safe separation of parachuting personnel from AS shall be assured.

F4.7 INTEGRATION OF CS 31TGB.67

If an on-board power unit is used to provide electrical power during operation, the system is designed and installed so as not to create a fire hazard or cause an electrical shock to the occupants.

In order to prevent the occurrence of potential differences between components of the power unit and other electrically conductive parts of the balloon system which cannot be ignored on account of their mass, such conductive parts are conductively interconnected.

In case of lightning, the system shall resist to the potential differences and discharge to the ground, with no severe injuries to the on-board and on-ground personnel.

F4.8 INTEGRATION OF CS 31TGB.71

- Equipment is:
  - of a kind and design appropriate to its intended function;
  - labelled as to its identification, function, or operating limitations, or any applicable combination of these factors; and
  - installed according to limitations specified for that equipment.
  - Instruments and other equipment do not in themselves, or by their effect upon the balloon, constitute a hazard to safe operation.
- The following instruments are installed if required to monitor the operating limitations. (see AMC1 31TGB.71(c)):
  - An envelope pressure gauge which displays the limits of permissible internal pressure. The operator is warned by an unambiguous signal if the limit of airborne operating pressure is exceeded.
  - A temperature measuring device mounted at a point of the envelope that provides a measurement of the operational limitation.
  - A wind velocity measuring device mounted at the most appropriate point of the envelope.
  - A load cell at the most appropriate place in order to monitor the tensile force in the tether cable in service.
  - Device(s) to provide the operational or design limitations information to the operator.
- Systems and equipment that need to function properly for safe operation are identified in the operational instructions. (See AMC1 31TGB.71(d)).
- Systems and equipment for communication is provided in VHF frequency aeronautical band allowing:
- The communication between the crew, on board and on ground.
- The communication between the AS crew and the Air Traffic Control (ATC).

- A Transponder shall be provided, to allow the Air Traffic Control to identify the current position of the TGB, even in emergency conditions.

AER(EP).P-516

ANNEX G

CYBER SECURITY FOR AIRCRAFT SYSTEMS INTENTIONAL UNAUTHORISED ELECTRONIC INTERACTION

G1. INTRODUCTION

G1.1 PURPOSE

The purpose of this Annex is to provide a general approach for the certification of any aircraft system in the field of the "*Security for Safety*". This means to avoid that any Intentional Unauthorised Electronic Interaction (IUEI) could have an impact on the aircraft *airworthiness*.

G1.2 APPLICABILITY

This Annex shall be applied to any aircraft system certification.

This Annex is also fully applicable for the technical evaluation of the continued airworthiness of an aircraft system whose initial certification was done on the basis of this Annex.

In the case the "*Security for Safety*" has to be evaluated for an aircraft system whose initial certification was not done on the basis of this Annex (or equivalent civil standard), an initial agreement between the applicant and the Airworthiness Authority has to be reached about the applicability of the activities detailed in this Annex.

G1.3 DEFINITIONS

- **Aircraft System**

Aircraft plus any linked ground system that:
- could have an impact on the aircraft airworthiness and/or
- it is a support system as for the technical specifications.

- **Intentional Unauthorised Electronic Interaction (IUEI)**

Any circumstance/event that could have an impact on the aircraft airworthiness and that has been caused by an intentional unauthorised action. This action could lead to an unauthorised access, improper use, inaccessibility, modification and/or destruction of data at aircraft level and/or at the level of the ground support system linked to the aircraft. Any attempt to use a vulnerability to modify Confidentiality, Integrity and Availability (CIA) of an aircraft system could be considered an IUEI.

G1.4 ACRONYMS

AMC	Acceptable Means of Compliance
CIA	Confidentiality, Integrity and Availability
EASA	European Union Aviation Safety Agency
EUROCAE	European Organisation for Civil Aviation Equipment
IUEI	Intentional Unauthorised Electronic Interaction
RTCA	Radio Technical Commission for Aeronautics

TP Technical Publication

G1.5 REFERENCE DOCUMENT

[1] AMC-20 Amendment 18, AMC 20-42: Airworthiness information security risk assessment

[2] EUROCAE ED-202A, Airworthiness Security Process Specification, dated June 2014 / RTCA DO-326A, dated August 2014

[3] EUROCAE ED-203A, Airworthiness Security Methods and Considerations, dated June 2018 / RTCA DO-356, dated June 2018

[4] EUROCAE ED-204, Information Security Guidance for Continuing Airworthiness, dated June 2014 / RTCA DO-355, dated June 2014

G2. PROCEDURE DESCRIPTION

G2.1 ACCEPTABLE MEANS OF COMPLIANCE

The emerging problem of the Security for Safety has already been evaluated by EASA. EASA, as for AMC 20-42, recognises as an acceptable means of compliance the following European Organisation for Civil Aviation Equipment (EUROCAE) and Radio Technical Commission for Aeronautics (RTCA) documents:

- EUROCAE ED-202A "*Airworthiness Security Process Specification*", dated June 2014 / RTCA DO-326A, dated August 2014;
- EUROCAE ED-203A "*Airworthiness Security Methods and Considerations*", dated June 2018 / RTCA DO-356, dated June 2018;
- EUROCAE ED-204 "*Information Security Guidance for Continuing Airworthiness*", dated June 2014 / RTCA DO-355, dated June 2014.

DAAA fully endorses this approach. Any use of previous versions of EUROCAE ED/RTCA DO documents or different approaches shall be discussed with and accepted by DAAA.
DAAA in any cases reserves the right to request further evaluation for specific items that could have a particular military interest.

G2.2 REPORTING

The occurence knowledge of a security for safety breach requires the Type Certificate holder to perform an impact analysis. If this impact analysis identifies the potential for an unsafe condition, the Type Certificate holder shall report it to DAAA in a timely manner and identify any possible corrective actions.

G3. ENDORSEMENT OF CIVIL CERTIFICATION

This Annex is based on the AMC accepted by EASA. For this reason any Certification issued by EASA in the field of the Security for Safety could be endorsed by DAAA after a general evaluation of the documentation presented by the applicant.

AER(EP).P-516

ANNEX H

INTENTIONAL ELECTROMAGNETIC INTERFERENCE

H1. INTRODUCTION

H1.1 PURPOSE

The purpose of this Annex to Technical Publication (TP) AER(EP).P-516 is to provide a general approach (define criteria and guidelines) for the certification that any aircraft system (aircraft plus any linked ground system) can stand against Intentional ElectroMagnetic Interference (IEMI) that could have impact on the *airworthiness*. EMACC Issue 3.0 provides considerations for the definition of Acceptable Means of Compliance (AMC) with respect to the Electromagnetic Environment Effect and Lightening Susceptibility. In general, any test about the electromagnetic compatibility and interference is already part of the development of Aircraft System. This is also true for the Hazard of Electromagnetic Radiation to Personnel (HERP), Hazard of Electromagnetic Radiation to Fuel (HERF) e Hazard of Electromagnetic Radiation to Ordnance (HERO). This ANNEX of the AER(EP).P-516 is just an addendum to the EMACC with the aim to consider further elements in the evaluation of the IEMI as a possible source of a safety problem.

H1.2 APPLICABILITY

This Annex shall be applied to any aircraft system certification.

H1.3 DEFINITIONS

- **Aircraft System (AS)**

Aircraft plus any linked ground system that:
- could have an impact on the aircraft airworthiness and/or;
- it is a support system as for the technical specifications.

- **Intentional Electromagnetic Interference (IEMI)**

Intentional malicious generation of electromagnetic energy introducing noise or signals into electric and electronic systems, thus disrupting, confusing or damaging these systems for terrorist or criminal purposes (IEC - International Electrotechnical Committee).

- **Threat**

In this document a threat is an Intentional ElectroMagnetic Interference (IEMI).

H1.4 ACRONYMS

AES	Advanced Encryption Standard
AMC	Acceptable Means of Compliance
EASA	European Union Aviation Safety Agency
ECC	Elliptic Curve Cryptography
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EUROCAE	European Organisation for Civil Aviation Equipment
FAA	Federal Aviation Authority
IEMI	Intentional Electromagnetic Interference
HEMP	High Altitude Electromagnetic Pulse
HERF	Hazard of Electromagnetic Radiation to Fuel
HERO	Hazard of Electromagnetic Radiation to Ordnance
HERP	Hazard of Electromagnetic Radiation to Personnel
HIRF	High Intensity Radiated Fields
HPM	High Power Microwave
LEMP	Lightening Electromagnetic Pulse
NEMP	Nuclear Electromagnetic Pulse
RSA	Rivest–Shamir–Adleman
RTCA	Radio Technical Commission for Aeronautics
TP	Technical Publication
UWB	Ultra WideBand

H1.5 REFERENCE DOCUMENT

[1] Notice of Proposed Amendment NPA 2014-16 “High-intensity radiated fields (HIRF)

[2] AC 20-158A “*The Certification of Aircraft Electrical and Electronic Systems for Operation in the High-intensity Radiated Fields (HIRF) Environment*"

[3] SAE ARP 5583A “*Guide to Certification of Aircraft in a High-Intensity Radiated Field (HIRF)*”

[4] IEC 61000-4-36 ed1.0 “*Electromagnetic compatibility (EMC) – Part 4-36: Testing and measurement techniques – IEMI immunity test methods for equipment and systems*”

H2. IEMI

H2.1 SAFETY IMPACT

In any environment in which there are potential intentional activities based on the use ElectroMagnetic spectrum, it is important to perform a safety analysis of the aircraft system that includes also the IEMI. The IEMI have to be seen as a potential risk for two reasons:

- the increasing availabily of low cost technlogy able to create electromagnetic energy capable to interfere with aircraft systems;
- the increasing presence of fly by wire control systems and sensor that are susceptible to electromagnetic fields.

The IEMI risks have to be evaluated and mitigated in order to be inside the acceptability range of the airworthiness regulations related to the specific aircraft.

H2.2 CATEGORIES

Any aircraft certification process take under due regard the impact of electromagnetic fields on the aircraft system. In particular, the following:

- LEMP (Lightening Electromagnetic Pulse);
- EMC (Electromagnetic Compatibility);
- EMI (Electromagnetic Interference);
- NEMP (Nuclear Electromagnetic Pulse) for Nuclear explosions (only if included in requirements)
- HEMP (High Altitude Electromagnetic Pulse) for Nuclear explosions at high altitude (only if included in requirements);
- HIRF (High Intensity Radiated Fields) mainly for radar emissions.

As for Figure 1, the IEMI include high power pulse at a frequency greater than 10 MHz. The main differences between EMI and IEMI are:

- the intentionality of the interference;
- the features of the emission source that is not known;
- the use of unusual entry points to interfere with the aircraft system.

In order to analyse the IEMI impacts, it is necessary to evaluate the features of the electromagnetic pulse and in particular:

- waveform (narrowband or wideband);
- how the waveform reaches the system (radiated or conducted);
- any possible interaction with a traditional cyber threat.

On the basis of the waveform, the IEMI can be categorised as:

- Narrowband threat: also known as HPM (High Power Microwave) or HIRF, they usually have a frequency greater than 1 GHz (0,2-5 GHz is the range of frequencies considered for a threat). They are made by a pulse on a single frequency with a duration of microseconds. The frequency could be modified and the signal could be modulated.
- Wideband threat: they are made by a pulse with a very short rise time and short duration (for instance, for the ultra wideband (UWB) the rise time is less than 100 picoseconds and the duration about few nanoseconds+).

The main difference between narrowband and wideband threat is that:

- the narrowband impacts on one frequency at time with very high peak of power;

- the wideband impacts on many frequencies at the same time but the power peak is not so high.

As the greatest system suscettibility is at the resonance frequency, if the narrowband are radiated at the resonance frequency, they can damage the system. On the contrary, the wideband are able to interfere with the system with a single pulse.

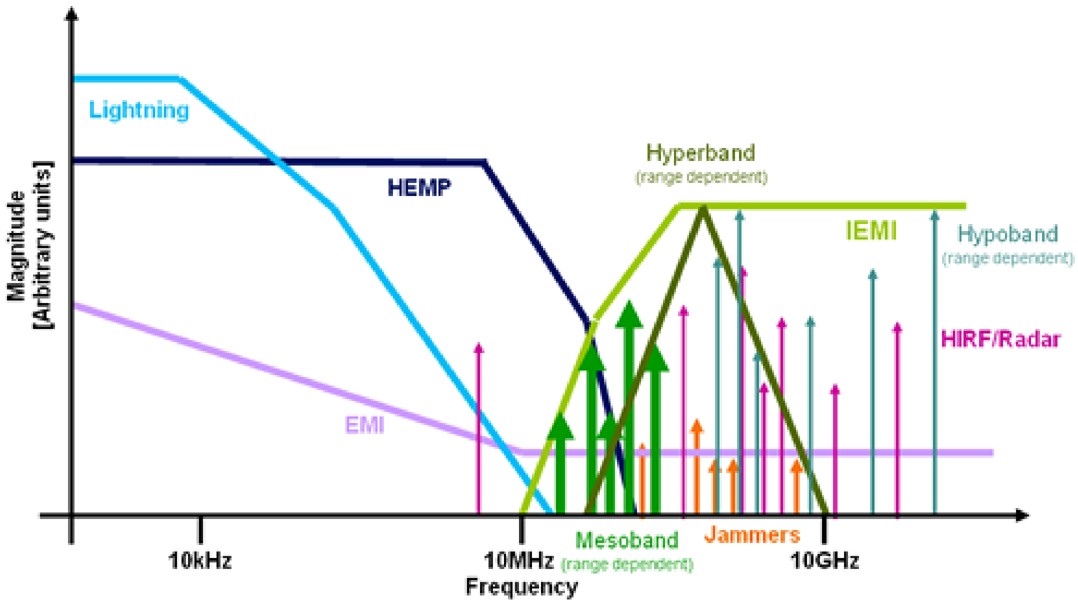


Figure 1 - IEMI

The waveform can transmitted to the target in two different ways: radiated and conducted. In anyway, on the basis of coupling and electrical safety, they can cause malfunctions and/or permanent damage.
Finally, these waveforms can transmit signal able to stimulate digital signal converters and data acquisition system software and so able to create, if associated with malecious software, unexpected conditions that could compromise the correct behaviour of the system and the integrity of the information.

H2.3 ATTACK TYPES

Leaving out the attacks aiming to a generic disturbances, jamming or the equipment destruction due to HIRP/HPM, the most common attacks are the "*Fault attacks through EM Injection*" able to generate functional errors using electromagnetic fields.

There are different types of fault attacks:

- the ones able to invalidate cryptographic algorithm (for istance, the ECC (Elliptic Curve Cryptography), AES (Advanced Encryption Standard), RSA (Rivest–Shamir–Adleman)) also using the Differential Fault Analysis technique (errors insertion to alterate the cryptographic algorithm behaviour and possibility to decipher using the differential analysis);
- the ones able to invalidate the regulational software execution (tampering with program flow) using the introduction of errors.

In general, it is possible to obtain the following effects: single bit flips, selected bit alterations, data corruptions, circuit rewiring, clock alteration and instruction swaps effects.
For this type of attack, it is mandatory to know the features of the target (i.e. microcontroller operating frequency, memory type, instruction execution) in order to define the relevant electromagnetic parameters of the attacker (i.e. where and how apply the pulse, direction and elevation of the source, pulse duration and amplitude).

H3. PROTECTION CRITERIA

The aim of this paragraph is to provide:

- certification criteria to grant that an aircraft system remains airworthy even in the case of IEMI;
- a guideline for the development of new aircraft systems.

H3.1 APPROACH

As already stated, any aircraft certification process take under due regard the impact of electromagnetic fields on the aircraft system. In the field of the IEMI, the following documents are relevant:

- The EASA *Notice of Proposed Amendment* NPA 2014-16 (reference [1]) defines new limits in terms of frequency spectrum, peak and mean values of the electromagnetic field.
- The FAA AC 20-158A (reference [2]) provides a *“general acceptable means of compliance and guidance material for the protection of electrical and electronic systems from the effect of HIRF*” mainly referring to the SAE ARP 5583A (reference [3]).

SAE ARP 5583A is based on the processes reported in Figure 2 and Figure 3 but they consider only the HIRF emissions. To completely evaluate the IEMI, it is necessary to modify the safety analysis adding some criteria (it has to be kept in mind that, currently, many of the attacks reported in paragraph H2.3 are not applicable for the small exposure time of the aircraft and for the distance from the source of the electromagnetic field).
The processes reported in Figure 2 and Figure 3 could be modified in order to expand the aircraft/system protection analysis including the IEMI waveforms. This means to add at the very beginning of the process a further activity called *“Define Aircraft and System IEMI Protection”*. The features of these waveforms could be provided by the *intelligence* and it has to be reported in the aircraft system specifications.

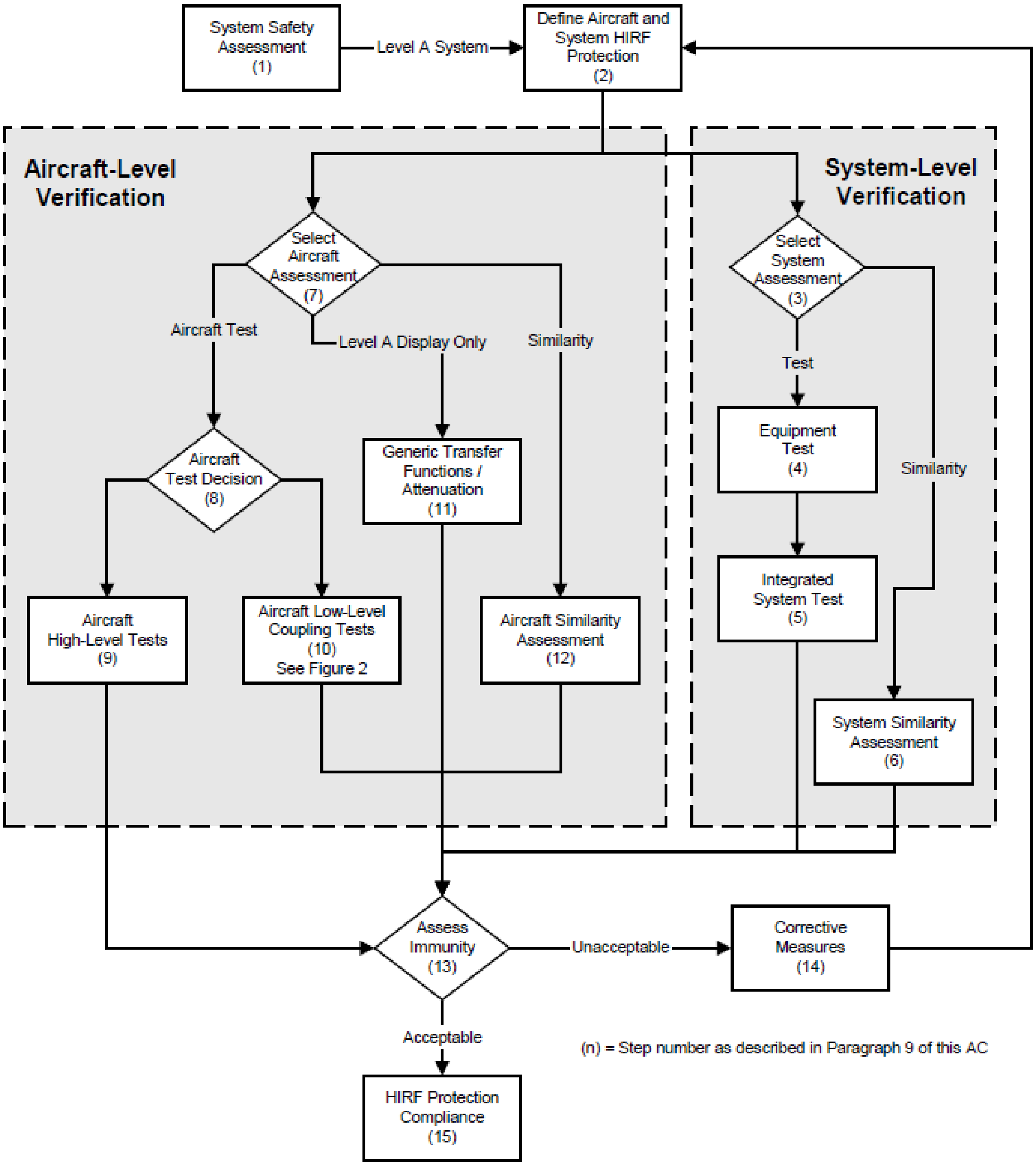


Figure 2 - HIRF Protecion Process (see reference [3])

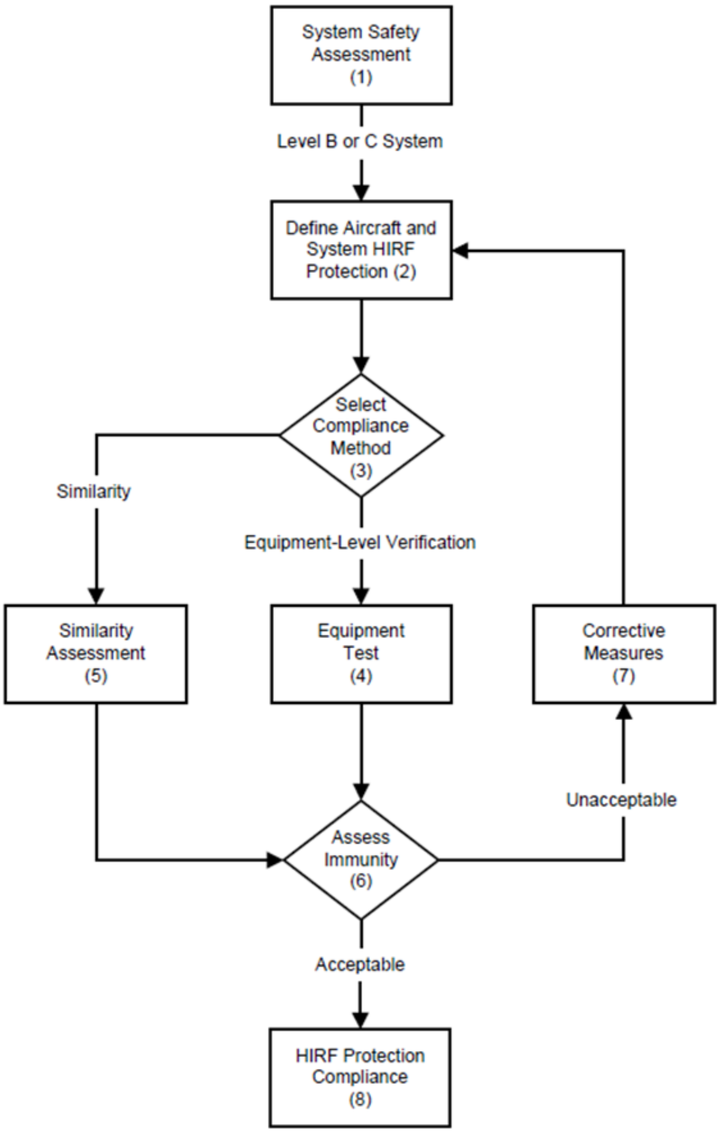


Figure 3 - HIRF Protecion Process (see reference [3])

H3.2 VERIFICATION

For the verification, in addition to SAE ARP 5583A (reference [3]), another reference for the IEMI could be the IEC 61000-4-36 ed1 (reference [4]).

The power levels and the frequencies range, in the case a deep knowledge of the threat is not available (and so it is not available an evaluation of the attenuation of the radiated power with distance from the radiation source), they can be considered applicable the values defined in AC-20-158 (reference [2]) that are currently accepted in the HIRF regulations.

AER(EP).P-516

ANNEX I

INTEGRITY ASSESSMENT CHECKLIST

I1. AIM

The aim of this Annex is to introduce in DAAA regulation a new certification approach for Mini and Micro Unmanned Aircraft Systems (UAS with Maximum Take-Off Weight - MTOW < 25 Kg).

The fast technological development of UAS's in the low weight category is posing challenging critical questions to the Airworthiness Authority in charge of regulating their operations. In particular, the standards developed by NATO for light UAS (MTOW < 150 kg), for fixed-wing UAS (ref.[1]) and for rotary wing UAS (ref.[2]), still require a significant certification effort, and in many cases for Micro UAS this may be too demanding.

Nowadays, UAS's technological growth and their wide usage over the last few years are showing that micro UAS's are increasing their reliability. This trend can be confirmed by thousands of flight hours flown by these Systems.

Therefore, a new certification approach has been developed by DAAA that takes into account system integrity as a main driver of the overall risk to third parties together with geometrical and crash energy characteristics. Where the system design integrity cannot be demonstrated through the compliance to applicable standards, documented service history is taken into account.

The main characteristics of the developed approach is to allow a much faster process to audit design integrity than regulational certification process, in order to quickly understand whether certain operations may be considered low risk, medium risk or high risk and establish in case proper limitations (population density to be overflown, safety buffer area, etc.).

I2. APPLICABILITY

This Annex is applicable to UAS with MTOW less than 25 kg (Micro and Mini).

I3. DEFINITIONS AND ACRONYMS

All the terms and acronyms used in this Annex are in compliance with AER.Q-2010 and EMAD 1.

I4. APPLICABLE DOCUMENTS

[1] STANAG 4703 / AEP-83 “*Light Unmanned Aircraft Systems Airworthiness Requirements*”

[2] AEP-89 “*Unmanned Aerial Vehicle (UAV) Systems Airworthiness Requirements (USAR) for Light Vertical Take Off and Landing (VTOL) Aircraft*”

[3] AER(EP).P-2 Supplement A, dated 17/11/2023, “*Omologazione, Certificazione e Qualificazione di Tipo Militare, Idoneità alla Installazione*”

[4] AER(EP).P-6 dated 19/03/2012 “*Istruzioni per la Compilazione dei Capitolati Tecnici per Aeromobili Militari*”

[5] AER(EP).P-22 dated 30/11/2023 “*Certification of Military Remotely Piloted Aircraft Systems*”

[6] AER(EP).P-7 dated 30/11/2023 “*Regulation for recording and maintaining the Military Aircraft Register*”

I5. CERTIFICATION APPROACH FOR UAS

Military Type Certification of UAS is conducted in accordance with the regulation AER(EP).P-XX (ref.[5]).

A set of basic airworthiness requirements is provided with the Integrity Assessment Checklist (IAC) developed by DAAA, which is described in the next paragraph and reported in the Appendix 1.

I5.1 INTEGRITY ASSESSMENT CHECKLIST (IAC)

IAC (Appendix 1) has been developed through a short set of open questions addressing multiple aspects that experience with military UAS has highlighted to be the most meaningful to quantify overall UAS safety.

Organization	Design and Production Organization processes are considered important for the final UAS integrity level. Poor Quality Management Systems may influence negatively product integrity. Configuration Management is considered fundamental.
Adopted Design Standards	The use of established design criteria and aerospace standards/practices is addressed.
Tested Usage Spectrum	Flight Test experience in all the usage spectrum, as well as an effecting reporting system, constitutes a credit for UAS integrity.
Stability and Control / Navigational Accuracy / Emergency Conditions	A set of questions has been developed to address Stability and Control in all operational modes, automatic protections, degraded and emergency modes, navigation, data-link, etc. As requested by ref. [3], reference is made also to mid-air collisions avoidance systems or strategies.

Ground Control Station / Control Box	Questions refer to human-machine interface, workload, etc.
Structural Integrity	Questions address structural strength characteristics, composite material design precautions, etc.
Propulsion and feeding systems	Several questions developed to address engine integrity for electrical specific features. Emergency conditions are also addressed.
Systems and equipment integrity	Questions refer to equipment qualification (e.g. E3), means for fault detection / fault isolation / fault management, electrical loads, etc.
Safety demonstration	System architecture is addressed. Typical System safety analysis demonstration would contribute to a more precise quantification of overall risk.
Software Integrity	Software life cycle assurance processes and data for critical functions are addressed.
Continued/Continuing Airworthiness and Operational Suitability Data	Questions address standard and emergency operating procedures; issue of comprehensive continuing airworthiness information; training aspects, technical occurrences collection systems, etc.
Cyber Security	Questions address security aspects, referring to C2 Link encryption, UCS authorisation and secured data storage.

Questions are open and explanatory, and for some of them a minimum requirement is established because deemed mandatory.

The Applicant must substantiate its answers providing evidence of compliance with applicable standards (i.e. STANAGs), or analysis based on documented service history. In addition, operating manuals can be in some cases taken into account by DAAA as means of evidence (MoE).

APPENDIX 1

Integrity Assessment Checklist (IAC)

DESIGN INTEGRITY ASSESSMENT		APPLICANT
	ORGANIZATION	
1.1	Are the UAS design and production organizations certified as per AS/EN 9100? Consideration should be given to the following: – the documented statement of the quality policy explicitly includes system safety as one of the main objectives; – a safety culture is demonstrated; – safety management processes are implemented and safety-related work is undertaken by competent individuals (trained and qualified), in adequate facilities, with adequate tools, material, procedures and data. <u>As a minimum, it is mandatory that the design and production organizations are certified as per AS/EN 9001.</u>	
1.2	Have the design and production organization adequately characterized the materials and manufacturing processes used in the construction of the UAS? Consideration should be given in particular to the following aspects: – the suitability and durability of materials used is established on the basis of experience or tests; – materials conform to approved specifications; – manufacturing processes conform to recognized standards – etc.	
1.3	Are adequate criteria implemented to control materials, parts and components before/during and/or after manufacturing?	
1.4	Is configuration management performed correctly and effectively by the design organization? Is the operator educated by the design organization about the criticality of configuration management processes for the UAS? <u>As a minimum, the Organization must establish, document and maintain processes to define the UAS configuration(s) and manage design changes and to communicate these to the Operators.</u>	

DESIGN INTEGRITY ASSESSMENT		APPLICANT
	ADOPTED DESIGN STANDARDS	
2.1	Does the design organization of the UAS operate in accordance with identified design criteria, aerospace standards and practices used to design RPA structure, engine, propeller and UAS systems and equipment?	
	TESTED USAGE SPECTRUM	
3.1	Is the design usage spectrum as the set of all the foreseen operational conditions of the UAS well identified? Is the whole usage spectrum demonstrated by laboratory/ground and flight test? Is the flight test and/or in-service experience accumulated sufficient? Is the flight test experience representative of the configuration flown? Has flight test experience and/or in-service experience demonstrated that the design is free from unsafe features in the complete operational spectrum? Is there a system to track problem reports from development and qualification tests? Are problem reports all closed? If not are appropriate limitations in place and specified in the operating manual? Consideration should be given in particular to the following aspects: – typical design missions; – in-flight operation conditions; – on-ground operation conditions; – operational modes (automatic, speed-hold, altitude hold, direct manual, etc.); – take-off / launch / ramp conditions; – landing / recovery conditions; – locations and platforms (e.g. land vehicle, water vessel, aircraft, building, etc.) from which launch, command and control, and recovery operations will be performed (e.g., land, littoral/maritime, air, etc.); – number of air vehicles to be operated simultaneously; – handover; – transport conditions (define the transportation and storage environment of the UAS like bag, package, truck or whatever is required); – operating environmental conditions: o natural climate (altitude, temperature, pressure, humidity, wind, rainfall rate, lightning, ice, salt fog, fungus, hail, bird strike, sand and dust, etc.); o electromagnetic environmental effects (electromagnetic environment among all sub-systems and equipment, electromagnetic effects caused by external	

DESIGN INTEGRITY ASSESSMENT		APPLICANT
	environment, electromagnetic interference among more than one UAS operated in proximity); o lighting conditions (e.g., day, night, dawn, dusk, mixed, etc.); – all possible mass configurations, including all possible combinations of payload, fuel, minimum and maximum flying weight, CG, etc.	
	STABILITY AND CONTROL / NAVIGATIONAL ACCURACY / EMERGENCY CONDITIONS	
4.1	Is there a demonstration that the UA is stable and controllable in all sequences of flight and on-ground (as applicable), in all operational modes, throughout the full operational envelope (including wind conditions as applicable)? Are take-off/launch and landing/recovery phases and corresponding operational procedures sufficiently safe in the worst environmental condition (including wind) in accordance with the design usage spectrum? <u>Minimum level of demonstration of stability and control characteristics is always mandatory.</u>	
4.2	Is the Flight Control System protecting the UAS from stall, speed exceedance, over-load, dangerous oscillations, spinning and any other unsafe conditions? Are the UAS features such that the effects of the operator mistakes are minimized in all operational modes (including direct piloting and semi-automatic modes as applicable)?	
4.3	Is the UAS still stable and controllable (even in degraded mode) after failure of sensors and primary aerodynamic control surface actuation (eg jamming or free-play)?	
4.4	Is the navigation system accuracy (in nominal and degraded conditions) demonstrated to be adequate for the type of operations of the UAS throughout the full operational envelope (including adverse conditions like wind and turbulence as applicable)? Consideration should be given to failure conditions as well. <u>Minimum level of navigation system accuracy demonstration is always mandatory and navigational precision tolerances must be provided in the operational manual.</u>	

	DESIGN INTEGRITY ASSESSMENT	**APPLICANT**
4.5	Is there a demonstration that the datalink performance is adequate for the type of operations, ranges, environment of the UAS? Is there a means to monitor and indicate the UAS (including datalink) health status to the Designated UAS Operator? Is the command and control link protected from inadvertent jamming risks (e.g. operations in proximity of other systems)? <u>Minimum level of demonstration of datalink performance is always mandatory and minimum datalink information must be provided to the operator.</u>	
4.6	Is a safe datalink loss strategy established and demonstrated to be effective?	
4.7	Is the UAS provided with subsystems to avoid mid-air collisions, such as navigation and anti-collision lights, transponder, communication with ATC?	
	REMOTE CONTROL STATION / CONTROL BOX	
5.1	Are Human-Machine Interface and operator workload aspects considered? Is the information provided to the operator sufficient, clear, unambiguous, readable in the worst light conditions? Are all warning strategy (prioritization, actions and monitoring, etc...) and cues adequate? Is information about limit exceedances and unsafe conditions of the UA provided to the operator?	
	STRUCTURAL INTEGRITY	
6.1	Are the maximum operating loads determined for all the conditions (flight, ground, launch, recovery, transportation, handling, etc.)? Is there a demonstration that the UAS withstands, without rupture, the maximum operational loads multiplied by an adequate factor of safety, at each critical combination of parameters? Is there a demonstration that the metallic parts do not yield at the maximum operational loads? Alternative means of compliance could be evaluated on a case-by-case basis.	

DESIGN INTEGRITY ASSESSMENT		**APPLICANT**
6.2	Is the structural design taking into account fatigue and/or damage tolerance (BVID aspects for composites)? Is the pre-flight checklist prescribing composite parts inspections? Are damage acceptability threshold specified? Are inspection intervals, ease of inspection and techniques adequate to assure structural integrity throughout the UAS service life? Alternative means of compliance could be evaluated on a case-by-case basis.	

	ELECTRIC PROPULSION AND FEEDING SYSTEM INTEGRITY	
7.1	Has the entire propulsion system been subjected to an endurance test (or a very large operational experience in the worst case conditions), followed by tear down inspection, according to a duration and a cycle related to the design usage spectrum? Is operational experience confirming adequate engine reliability?	
7.2	Is there any substantiation (by tests, analysis or a combination thereof) that the Engine Control System (including propeller pitch control when applicable) performs the intended functions in all its control modes throughout the full operational envelope? <u>Minimum level of demonstration of engine control system performance is mandatory, if safety critical.</u>	
7.3	Is there evidence that the battery (considering tolerance for possible degradation of battery performance) is able to provide the necessary voltage and current required by the engine and electrical equipment throughout the operational envelope?	
7.4	Is there a means to minimize the risk of battery overheating/explosion (e.g. cooling, temperature sensor, active battery management system)?	
7.5	Is there a provision to alert the UA operator that the battery has discharged to a level which requires immediate UA recovery actions? Is the information about battery charge level provided to the operator?	
7.6	Are engine failures effects mitigated? Is a safe strategy to manage loss of engine power/thrust implemented in the full envelope? Is the engine failure mitigation strategy implemented automatically or by operator's action? Is the increased workload on the operator compatible with his qualification and training? Is the flight manual properly addressing the engine failure condition? For rotary wing UAS’s, are maneuverability and controllability demonstrated after power loss? Is the remote operator reaction time taken into account in defining engine inoperative emergency procedures?	

	SYSTEMS AND EQUIPMENT INTEGRITY	
8.1	Is all safety critical equipment (including Commercial-Off-The-Shelf) qualified for worst expected case environmental conditions in accordance with the design spectrum? Are environmental tests adequately performed for safety critical equipment? Is there evidence that the installation provisions, environment and the intended usage of all equipment meet all performance, operating and safety limitations to which the equipment is qualified? Alternative means of compliance could be evaluated on a case-by-case basis.	
8.2	Are Environmental Electromagnetic Effects (E3) considered in the design and demonstrated to be safe for the UAS system (including ground station, datalink equipment, air vehicle, etc.) and any required limitations are promulgated?	
8.3	Is the electrical system adequate (electrical loads were determined in the worst condition, wires are adequately sized, electrical generation and battery capacity are adequate, electrical bonding is guaranteed, etc.)? Is back-up electrical capacity (when implemented as per Section 9) adequate to manage primary generation system failures for the required duration (as defined in the Flight Manual) to enable UAS recovery and/or safe flight termination?	
8.4	Is the UAS designed to incorporate means for fault detection / fault isolation / fault management? Is the UAS design incorporating a sufficient set of Built-In-Tests (BIT) (e.g. power-up self-test; computers check-sum; GPS receiver failure indication from power-up, self-test or background BIT; motherboard under-voltage detection, temperature monitoring)? Are procedures established to mitigate the effects of detected faults?	
	SAFETY DEMONSTRATION	
9.1	Are Functional Hazard Analysis and a Failure Mode Effect and Criticality Analysis performed for the UAS (including all contributions coming from air segment, ground segment, datalink and any other equipment necessary to operate the UAS)? Are all failure modes identified and mitigations established? Consideration could be given to Emergency Recovery Systems (including Flight Termination Systems). Alternative means of compliance could be evaluated on a case-by-case basis.	

9.2	Is the Fault Tree Analysis (FTA) performed and a cumulative probability of an uncontrolled flight or of a crash potentially leading to fatalities (P_cum_cat) = 1E-4/fh demonstrated? Consideration could be given to to Emergency Recovery Systems and Flight Termination Systems (FTS), in particular considering that: – the FTS should be able to reduce the impact energy below the lethality threshold of 66J; – the FTS should be independent from the failure that caused the uncontrolled flight/crash. Alternative means of compliance could be evaluated on a case-by-case basis.	
9.3	Are all flight critical systems designed with fail-safe architecture? For example, is the Flight Control System (including sensors, computers, actuators) architecture redundant and fail-safe? Is the electrical power source redundant? Is safety critical equipment power source independent from a secondary power source feeding non-safety-critical equipment? Are overload protection devices used? Have fuel filters been equipped with a by-pass?	
	SOFTWARE INTEGRITY	
10.1	Are the life cycle assurance processes and data identified for the UAS critical functions (in accordance with the safety assessment)? For Software Items consideration should be given to: – requirements for software items are developed; – plans and Accomplishment Summaries to show software integrity are produced by the design organization; – an adequate number of tests is planned, performed and results are recorded; – software problem reports are available and shown to be closed; – configuration management processes for software are established and followed; – in-field experience as applicable. NOTE: DO-178 objectives may be used to measure software integrity. Alternative means of compliance could be evaluated on a case-by-case basis.	
	CONTINUED / CONTINUING AIRWORTHINESS AND OPERATIONAL SUITABILITY DATA	
11.1	The Operating Manual provided to the UAS operator must be clear and unambiguous. It must define all the regulational and emergency procedures, limitations and performance information (including as applicable take-off, launch, climb, descent, glide, flight in all operating modes, landing, recovery, handover, autorotation, link-loss procedures, etc.).	

11.2	The following instructions for continuing airworthiness must always be provided to the Operator: – maintenance procedures; – life limited parts; – equipment inspection intervals and techniques; – corrosion prevention; – repair procedures. All UAS systems and sub-systems must be included, such as but not limited to the propulsion system, airframe, electrical system, batteries, fuel system, lubrication system, avionics, sensors calibration, actuators, communication system, ground station, transport and handling information. Airframe inspection intervals and techniques must be reported adequately in the operational manuals. Airframe standard repairs must be specified. For safety critical systems, there must be a means (equipment and/or procedures) for health tracking/monitoring. Information concerning safe storage conditions must be specified. Corrosion related inspections must be properly identified.	
11.3	Are adequate checklists available for all aspects of operation? Is there a pre-flight and post-flight checklist?	
11.4	Is an operator training syllabus specified? Are the training requirements adequate to the complexity of the UAS system and its flight management system?	
11.5	Is it clear what type of organization and qualification is necessary for each type of inspection, maintenance and repair required under 11.2? Are the maintainer training requirements/syllabus defined?	
11.6	Is information concerning battery storage, operation, handling, maintenance, safety limitations and battery health conditions provided in the applicable manuals?	
11.7	Has the design organization in place a method to track technical occurrences (that have been reported) affecting safety throughout the life of the program? Is the design organization following a process to implement preventive and corrective actions as necessary to continuously improve airworthiness?	
	CYBERSECURITY	
12.1	Are information exchanged between the UCS and the UA via the C2 Link secured to prevent unauthorized interference with the UA? Is the UA capable to ensure unambiguously that it is controlled by an authorized UCS? Is data storage managed in such a way to ensure that data are protected in case of system loss?	

AER(EP).P-516

ANNEX J

CERTIFICATION REQUIREMENTS FOR LOITERING MUNITIONS

J1. AIM

The aim of this Annex is to define the criteria for the preemptive certification of Loitering Munitions (LM) before their actual integration onboard an aircraft.

These criteria will complement:

- the performance requirements set by the qualification basis;
- if necessary and required in the relevant contract, the integration activities (including fitness for installation) onto an aircraft, as directed in the dedicated section of the EMACC Handbook (Attachment A of the present regulation).

J2. APPLICABILITY

This annex is applicable to Loitering Munitions.

J3. DEFINITION AND ACRONYMS

All the terms and acronyms used in this Annex are in compliance with AER.Q-2010 and EMAD 1.

In addition, consider the following definition.

- **Loitering Munitions**

Weapons designed to find a target and crash into it.

Once airborne, loitering munitions can hunt for a target by a human-driven process from a control station, autonomous flight with authority to strike designated targets, or a combination of these methods.

Even if a munition is generally assumed expended once launched, there are options for recovering some Loitering Munitions that do not engage target.

The acronyms used in this Annex are defined as follows.

DAAA	Direzione Armamenti Aeronautici e per l'Aeronavigabilità
DEF-STAN	Defence standard
EMACC	European Military Airworthiness Cerification Criteria
EMAD	European Military Airworthiness Document
EMC	Elecromagnetic compatibility
EMI	Elecromagnetic interference
EME	Elecromagnetic environment
EMP	Electromagnetic pulse
EMRADHAZ	Electromagnetic radiation hazards
ER	Essential requirement
ESD	Electrostatic Discharge
HERP	Hazards of electromagnetic radiation to personnel
HIRF	High Intensity Radio Frequency

ICNIRP	International Commission on Non-Ionizing Radiation Protection
LM	Loitering Munitions
MIL-HDBK	Military Handbook
MIL-STD	Military Standard
NATO	North Atlantic Treaty Organization
RTCA	Radio Technical Commission for Aeronautics
LMCS	LM Control Station

J4. CERTIFICATION CRITERIA FOR LM

The following paragraphs define the criteria for the certification of the LM, with a particular focus on the airworthiness and safety aspects.

For each set of requirement, the applicable information source is presented.

Most of the requirements are extracted from STANAG 4703, whereas other, weaponry-specific, have been generated after a holistic review of the available armament system specifications.

J4.1 SYSTEM INTEGRITY

System integrity shall be assured for all anticipated flight conditions and ground operations for the operational life of the LM (source STANAG 4703, ER.1).

J4.1.1 STRUCTURES AND MATERIALS

The integrity of the structure shall be ensured throughout the operational envelope for the LM, and by a defined margin beyond, including its propulsion system, and maintained for the operational life of the LM (source STANAG 4703, ER.1).

J4.2 PROPULSION AND ELECTRICAL POWER

The integrity of the propulsion system (i.e. engine and, where appropriate, propeller) and electrical power system shall be demonstrated throughout, and by a defined margin beyond, the operational envelope of the propulsion and electrical power system (source STANAG 4703, ER.1.2).

J4.2.1 FUEL AND ELECTRICAL POWER SYSTEM

The engine shall be safely fed by the quantity of fuel required to perform the LM missions it is certified for (source STANAG 4703, ER.1.2.5, UL.19, UL.20).

The electrical power system shall safely provide the electrical power required to perform the LM missions it is certified for (source STANAG 4703, ER.1.2.5, UL.19, UL.20).

J4.3 SYSTEM AND EQUIPMENT

Each sub-system and equipment of the LM, LMCS, Data-Link, Launch/Recovery equipment (where applicable) shall function as intended (source STANAG 4703, UL.25).

- Identify all functions of each sub-system;
- Characterize the operational environment of each sub-system;
- Perform all necessary functional tests at sub-system level;
- Perform all necessary environmental tests (e.g. vibration, humidity, EMC/HIRF, etc.).

J4.3.1 ENVIRONMENTAL

Any LM equipment (including redundant equipment) performing functions whose failure could lead to loss of functions or misleading data with hazardous or catastrophic effects on safety, shall pass appropriate environmental tests. RTCA-DO-

160 or MIL-STD-810 should be used as reference material for LM equipment environmental tests (source STANAG 4703, UL.25, UL.35.2).

J4.3.2 EMI/EMC[1]

- EMI: Individual subsystems and equipment of the LM shall meet the interference control requirements and test methods of MIL-STD-461: RE102, CE102, CE106, RS103, CS101, CS114, CS115 and CS 116 .
- EMC: The LM shall be able to meet performance requirements in its intended electromagnetic environment including friendly and hostile emitters. (Inter-system EMC).
- ESD: MIL-STD-464
- EME: the Weapon in an unpowered state shall remain safe and serviceable when subjected to the EM environment defined in STANAG 1307 Edition: 1 Maximum NATO Naval Operational Electromagnetic Environment Produced by Radio and Radar, except for power levels as defined in classified Appendix_10 2304377.
- EMP: The Weapon shall survive the effects of the Nuclear Effects Environment Electromagnetic Pulse per Def Stan 08-4.

J4.4 SOFTWARE

The software life cycle assurance process agreed with the Certifying Authority should be demonstrated with the approach defined in RTCA DO-178/AMC 20-115, for the process objectives and outputs by assurance level. If equivalent standards are provided, a Plan for Software Airworthiness shall be provided and agreed with the Certifying Authority in order to present how the quoted standards will be applied.

The minimum software life-cycle data to be submitted to the Certifying Authority are:
- Software / Hardware architecture and DAL allocation;
- Plan for Software Aspects of Certification;
- Software Configuration Index;
- Software Accomplishment Summary.

J4.5 FIRMWARE/COMPLEX HARDWARE

The firmware and complex hardware life cycle assurance process agreed with the Certifying Authority should be demonstrated with the approach defined in RTCA DO-254 / AMC 20-152, for the process objectives and outputs by assurance level. If equivalent standards are provided, a Plan for Hardware Airworthiness shall be provided and agreed with the Certifying Authority in order to present how the quoted standards will be applied.

The minimum life-cycle data to be submitted to the Certifying Authority are:
- Software / Hardware architecture and DAL allocation;
- Plan for Hardware Aspects of Certification;
- Hardware Configuration Index;
- Hardware Accomplishment Summary.

J4.6 MULTICORE

Any multicore implemented in the design should be demonstrated against the objectives defined in the AMC 20-193, according to the allocated DAL.
If equivalent standards are provided, a bespoke Plan shall be provided and agreed

[1] source MIL-STD-461, MIL-STD-464, Def Stan 08-4; STANAG 4703, UL.25, UL26.1, 1307

with the Certifying Authority in order to present how the quoted standards will be applied.

J4.7 SAFETY

A System Safety Assessment shall be performed for the LM and submitted to the Certifying Authority.

Protection system in order to prevent and avoid inadvertent firing/detonation in both training and operational activities shall be demonstrated (source MIL-STD-882, MIL-STD-1316, SAE ARP 4761; STANAG 4703, UL.30).

J4.8 ELECTROMAGNETIC RADIATION HAZARDS (EMRADHAZ)

The system design shall protect personnel, fuels (where applicable), and ordnance (where applicable) from hazardous effects of electromagnetic radiation. MIL-STD-464A may be used as a reference (source MIL-STD-464; STANAG 4703, UL.30, UL.36).

- Hazards of electromagnetic radiation to personnel (HERP): personnel shall not be exposed to an electromagnetic field whose energy exceeds the permissible exposure limits specified in approved current standards (e.g. US-DoD policy 6055.11, EU- ICNIRP).

- A minimum safe distance from the data link antenna shall be established and the value provided to the LM operator (mandatory information shall be given in the flight manual; safe distance should be labelled on the antenna apparatus, where possible).

The kinds of operation for which the LM is approved shall be established and limitations and information necessary for safe operation, including environmental limitations and performance, shall be established.

J4.9 AIRWORTHINESS ASPECTS OF SYSTEM OPERATION

Procedures for regulational operations, failure and emergency conditions shall be established.
Warnings, cautions, notes or other forms of advices intended to prevent exceeding the regulational flight envelope, shall be provided (source STANAG 4703, ER.2.1.5, ER.2.1.6).

J4.10 LM HANDOVER

(where applicable)
Where the LM is designed for LM handover between two LMCS (STANAG 4703, ER.3.3, UL.66):

- The in-control LMCS shall be clearly identified to all LM operators;
- Positive control shall be maintained during handover;
- The command and control functions that are transferred during handover shall be approved by the Certifying Authority and defined in the LM Operating Manual;
- Handover between two LMCS shall not lead to unsafe conditions;
- The in-control LMCS shall have the required functionality to accommodate emergency situations.

J4.11 MULTIPLE LM OPERATIONS

(where applicable)
Where a LMCS is designed to command and control multiple LM (source STANAG 4703, ER.3.3, UL.67, UL.68, UL.69):

- The minimum number of LM operator(s) shall be established so that it is sufficient for safe operation of each LM and emergency condition.
- The LM data shall be displayed in the LMCS in a manner that prevents confusion and inadvertent operation.
- The LM controls shall be available to the LM operator(s) for each LM of which it has command and control, in a manner that prevents confusion and inadvertent operation.
- All indicators and warnings shall be available to the LM operator(s) for each LM, in a manner that prevents confusion and inadvertent operation.
- Where the LMCS is designed to monitor multiple LM, there shall be a means to clearly indicate to the LM operator(s) the LM over which it has command and control.

AER(EP).P-516

ANNEX K

AIRSPACE TRAFFIC INTEGRATION

K1. INTRODUCTION

K1.1 PURPOSE

The purpose of this Annex is to define DAAA avionics requirements and relevant applicability to Military Aircraft in the field of the Aircraft Traffic Integration (ATI).

It is important to highlight that:

- As for ref. [1] "*<u>only</u> National Aeronautical Information Publications (AIPs) and Aeronautical Information Circulars (AICs) contain formal and liable information concerning avionics requirements applicable to State aircraft*".
- As for ref. [2], "*A reference to compliance with the relevant section(s) of CS-ACNS in the aircraft flight manual (AFM) or other approved document may be used <u>by operators to demonstrate compliance with the applicable airspace rules</u>*".
- DAAA, as Airworthiness Authority, is responsible for the verification of the aircraft system compliance with the airworthiness requirements. Any deviation is reported on the aircraft system Technical Data Sheet.
- AVIAMM, as Italian Aviation Authority, is responsible for the verification of the aircraft system compliance with any airspace rules on the basis of the aircraft available equipment;
- The Armed Force/Armed State Corp originator of the operational requirement is responsible of identifying and formalizing to DAAA and AVIAMM any ATI requirement.

On this extent, for DAAA, this Annex is a guideline for the evaluation of the airworthiness requirements related with ATI providing possible Acceptable Means of Compliance (AMC).

K1.2 APPLICABILITY

This Annex is applicable to all the military aircraft required by the relevant Armed Force/Armed State Corp to be integrated into the civil airspace.

K1.3 DEFINITIONS

For the purposes of this Annex, all acronyms, words and phrases present in the P.T. AER.Q-2010 are still applicable.

The following integrations apply:

- **Aircraft Traffic Integration (ATI)**

Aircraft system compliance with any airspace rules on the basis of the aircraft available equipment.

- **Competent Authority / Operational Authority**

In the ATI documentation, AVIAMM is generally referred to as Competent Authority / Operational Authority.

- **Crew**

Personnel responsible for the operation of the Military Aircraft from takeoff to landing.

- **Operator**

Armed Force/State Corp that operate the Military Aircraft.

- **State Aircraft**

Aircraft used in military, customs, and police services shall be deemed to be state aircraft (Reference - ICAO Convention on International Civil Aviation, Article 3 (b)).

- **Technical Authority**

In the ATI documentation, DAAA is generally referred to as Technical Authority.

K1.4 ACRONYMS

ABAS	Aircraft Based Augmentation System
ACAS	Airborne Collision Avoidance System
ADS-B	Automatic Dependent Surveillance - Broadcast
AIC	Aeronautical Information Circulars
AIP	Aeronautical Information Publications
AMC	Acceptable Means of Compliance
APCH	APproaCH
ATI	Aircraft Traffic Integration
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
CIA	Confidentiality, Integrity and Availability
CNS	Communication, Navigation, Surveillance
CPDLC	Controller-Pilot Data Link Communications
CS-ACNS	Certification Specification for Airborne Communications, Navigation and Surveillance
DME	Distance Measuring Equipment
EASA	European Union Aviation Safety Agency
EGPWS	Enhanced Ground Proximity Warning System
EHS	Enhanced Surveillance
ELS	Elementary Surveillance
EUROCAE	European Organisation for Civil Aviation Equipment
GAT	General Air Traffic
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing System
INS	Inertial Navigation System
LNAV	Lateral NAVigation
MCTM	Maximum Certificated Take-off Mass
MEL	Minimum Equipment List
MLS	Microwave Landing System
MMEL	Master MEL
NGIFF	New Generation Identification Friend or Foe
OAT	Operational Air Traffic
OBPMA	On Board Performance Monitoring and Alerting
PBN	Performance Based Navigation

RAIM	Receiver Autonomous Integrity Monitoring
RNAV	aRea NAVigation
RNP	Required Navigation Performance
RTCA	Radio Technical Commission for Aeronautics
RVSM	Reduced Vertical Separation Minima
SBAS	Satellite Based Augmentation System
SESAR	Single European Sky ATM Research
SPI IR	Surveillance Performance and Interoperability Implementing Rule
SSR	Secondary Surveillance Radar
TAWS	Terrain Awareness Warning System
TCAS	Traffic Alert and Collision Avoidance System
TP	Technical Publication
VDL	VHF Data Link
VFR	Visual Flight Rules
VNAV	Vertical NAVigation
VOR	VHF Omnidirectional Range

K1.5 REFERENCE DOCUMENTS

[1] EUROCONTROL “*Avionics requirements for State aircraft*” Edition February 2021

[2] EASA “*Certification Specifications and Acceptable Means of Compliance for Airborne Communications, Navigation and Surveillance* (CS-ACNS)” Issue 4, 05 April 2022

[3] NATO Standard Agreement “*Technical Characteristics of IFF of Mk XA and Mk XII Interrogators and Transponders*” 4193 Ed 3

[4] EUROCONTROL “*Guidelines for the Certification and Operation of State Aircraft in European RVSM Airspace*” Edition 4.0

[5] EUROCONTROL “*Handbook for Civil-Military Interoperability in Performance-Based Navigation Implementation*” Edition 1.0, 23 March 2022

[6] NATO Standard AEP-101 “*Guidance on Sense and Avoid for Unmanned Aircraft Systems*” Edition A Version 1 February 2018

[7] NATO Standard AEP-107 “*Sense and Avoid System Performance Based Standard*” Edition A Version 1 December 2018

[8] EASA “Easy Access Rules for Standardised European Rules of the Air (SERA)”

[9] EASA “Easy Access Rules for Air Operations”

[10] EASA “Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Annex VII Non-commercial air operations with other-than-complex motor-powered aircraft [Part-NCO]”

K2. ATI REQUIREMENTS

This Annex represents a guideline and an integration of what already included in the EMACC criterion 11.1.1.d/e/f[1] and EMACC ed. 3.0 criterion 11.1.1.d/e/f[2]).

The main reference for each single equipment certification is the CS-ACNS at ref. [2].
The following tables provide a summary of the avionics requirements, their applicability to Military/State aircraft and possible AMC:

- Communications Requirements (see Table 1);
- Navigation Requirements (see Table 2);
- Surveillance Requirements (see Table 3);
- Safety Assurance and Sense and Avoid Requirements (see Table 4);
- Reduced Vertical Separation Minima requirements (see Table 5).

DAAA reserves the right to request further evaluation for specific items that could have a particular military interest. Likewise, Alternative Acceptable Means of Compliance can be proposed by the System Design Responsible, discussed and concurred with DAAA, provided that an acceptable equivalent performance is achieved and demonstrated[3].

Upon completion of the above-prescribed certification activities, the minimum equipment required to perform ATI flight missions shall be included within the aircraft Master Minimum Equipment List (MMEL) prepared by the System Design Responsible and approved by DAAA.

---

[1] "*d. An installed interoperable **communications subsystem** capable of supporting SOF operations with the required integrity and continuity of service throughout the intended missions.*
*e. A **navigation subsystem** capable of meeting SOF 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 SOF performance, integrity, and continuity of service requirements for identification, relative positioning, trajectory, timing, and intent.*"

[2] "*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;*"

[3] for instance, as implemented onto the Typhoon:

- As also caputred in the handbook at refernce [5], RNP compliance may be achieved by maintaining the extant mlitary-GPS-based navigation solution, augmented and cross-monitored with a validated, civil-TSO GPS signal
- RVSM compliance may be achieved by introduing a highly reliable altitude monitoring system, acting on top of the single-sourced altitude measuring system, in lieu of fitting the aircraft with two completely independent altitude measuring systems

Capability	Civil Requirements	Mandate Status	Military/State Aircraft equipage considerations
8.33 kHz VHF Voice	VHF Transceivers with 8.33 KHZ channel spacing More details in the 8.33 FAQ (Question 17): http://www.eurocontrol.int/sites/default/files/article/content/documents/nm/833/2015-04-28-8%2033-faqs-1.1-final.pdf	Mandatory carriage above FL195 from 15 March 2007. Below FL195: the European Commission published the new voice channels spacing implementing rule in the Official Journal of the EU on the 16 November 2012 as Regulation (EU) No 1079/2012. It applies to all State aircraft with transition arrangements for technical and procurement constraints including handling on VHF 25 kHz or UHF by ANSPs	There is no specific equipage definition for military aircraft. The AGVCS regulation encourages implementation of EUROCAE ED-23C standard, if possible, which has improved performance over ED-23B. EC regulation 1079/2012 (Article 9) contains arrangements for State aircraft: • Above FL 195 non-transport type State aircraft when justified by procurement constraints are to equip by 31 December 2015 at the latest • All State aircraft entering into service (or suffering major mid-life upgrades) after 01 January 2014 to be equipped (Forward Fit) • Retrofit all State aircraft by 31 December 2018 Transition Arrangements are possible due to procurement constraints with communication to the Commission by 30 June 2018 and equipage by 31 December 2020 at the latest. State aircraft that cannot be equipped with compelling technical or budgetary constraints are exempted (no defined end date). A list of these aircraft should have been communicated to the Commission by 30 June 2018. Exempted: All State aircraft that that will be withdrawn from operational service/go out of service by 31 December 2025 ATS providers are to accommodate non-equipped State Aircraft on UHF or VHF 25 kHz, provided safety ensured. Publication in national aeronautical information publication (AIP) of applicable procedures is also required.
VHF FM Immunity	All VHF Com and ILS and VOR receivers to be protected against interference from VHF broadcast. FM immune VHF equipment is to be used.	Mandated for en-route and airports as specified in national AIPs	Exemptions for State a/c may still be negotiated on a bilateral basis. See JAA TGL 16 and national AIPs.
Controller-Pilot Data Link Communications (CPDLC) ATN/VDL Mode 2	CPDLC application over ATN/VDL Mode 2 (or other communication protocols). Equipage details: (see civil tables): 3rd VHF Digital Radio, also either: Communications Management Unit (CMU) and Multi-function Control Display Unit (MCDU), or Air Traffic Service Unit (ATSU) and Dedicated Control and Display Unit (DCDU) or Integrated solution (e.g. Boeing FANS2) or Electronic Flight Bag solution (TBD)	EC regulation 310/2015 amending EC implementing regulation (IR) 29/2009 requires implementation by ATS providers of data link services for above FL285: • Airborne implementation date (civil aircraft) 5 February 2020 (no distinction between forward- and retro-fit) • Airborne implementation date (new transport type State aircraft if decided to equip with civil capability) 1 January 2019 (forward-fit only) • Ground implementation date 5 February 2018 • “Old aircraft” (civil) dates changed by 5 years to 2003 / 2022 The multi frequency environment has been deployed.	The EC regulation 29/2009 includes provisions on State aircraft. Member States which decide to equip new transport type State aircraft entering into service from 01 January 2019 with data link capability relying upon standards which are not specific to military operational requirements, shall ensure that those aircraft have the capability to operate the data link services defined in Annex II of the IR (with ATN/VDL Mode 2 data link or other communications protocol). Technical guidance see EASA CS ACNS, EASA AMC 20-11 and EUROCAE ED92C. EASA issued an SIB (EASA SIB No.: 2019-13) to clarify that the multi-frequency capability of the airborne datalink installation (over Very High Frequency Data Link Mode 2), constitutes a key minimum feature needed to provide the required levels of data link service to support CPDLC. Deployment guidance see SESAR Deployment Manager DLS Recovery Plan and operators of CPDLC aircraft conducting flights wholly or partly in the airspace where ATN B1 CPDLC is required for which the aircraft has been granted an exemption either automatic or by EC Decision, should include the letter Z in Item 10a and the indicator DAT/CPDLCX in Item 18 of the flight plan. Such proposal to reflect the CPDLC exemptions status in the flight plan stems from the Global Operation Data Link (GOLD) Manual.

Table 1: Communications Requirements (modified wrt ref. [1])

Capability	Civil Requirements	Mandate Status	Military/State Aircraft equipage considerations
ILS	ILS receiver		Available as part of Multi-Mode Receiver (MMR)
MLS	MLS receiver (EU OPS 1.865)		Available as part of Multi-Mode Receiver (MMR)
RNAV5 (previously named B-RNAV)	Navigation specifications detailed in ICAO PBN manual (doc 9613) RNAV systems (VOR/DME, DME/DME, GNSS or INS/IRU) capable of ± 5 NM accuracy. See **ref. [2]**	Commission Implementing Regulation (EU) 2018/1048.	The availability and continuity of VOR and DME coverage have been calculated for most of Europe and they are considered to be capable of meeting the requirements of the en-route phase of operations. Transitional measures and contingency measures are advocated in Article 4 and Article 6, respectively, of Commission Implementing Regulation (EU) 2018/1048. See **ref. [5]**
RNAV1	Navigation specifications detailed in ICAO PBN manual (doc 9613) RNAV systems (GNSS, DME/DME or DME/DME/IRU) capable of ± 1 NM accuracy. See EASA CS-ACNS	Commission Implementing Regulation (EU) 2018/1048	Transitional measures and contingency measures are advocated in Article 4 and Article 6, respectively, of Commission Implementing Regulation (EU) 2018/1048. See **ref. [5]**
RVSM	ICAO Min. Aircraft System Performance Standard (MASPS) The RVSM MASPS include: 1. Two independent, cross-coupled altitude measurement systems; 2. One automatic altitude control system (±65'); 3. One altitude alert system (±300'/±50'); 4. One SSR altitude reporting transponder (5) RVSM compliant avionics configuration. See EC 965/2012, EASA Part SPA and **ref. [2]**	Mandated from FL290 to FL410	State aircraft can be accommodated in RVSM airspace: Military aircraft operating as GAT which are non MASPS RVSM compliant are allowed in RVSM airspace but are subject to 2000ft vertical separation from all other aircraft. However, States are requested to adapt their State aircraft for RVSM approval, to the extent possible, and especially those aircraft used for General Air Traffic (GAT). There is no exemption for State aircraft to operate as GAT within RVSM airspace (FL 290 to FL 410) with a 1000 ft vertical separation minimum without an RVSM approval. The absence of such approval does not mean that State aircraft cannot access RVSM-designated airspace, but it does require a separation of 2000 ft to be observed. The EUROCONTROL Guidelines for Certification and Operation of State Aircraft in European RVSM Airspace can be found on https://www.eurocontrol.int/service/european-regional-monitoring-agency **See ref. [4]**
RNP APCH (flown to LNAV minima)	Navigation specifications detailed in ICAO PBN manual (doc 9613) See **ref. [2]**	Commission Implementing Regulation (EU) 2018/1048	Transitional measures and contingency measures are advocated in Article 4 and Article 6, respectively of Commission Implementing Regulation (EU) 2018/1048. See **ref. [5]**
RNP APCH (to LNAV/VNAV minima) also called APV Baro/VNAV	See **ref. [2]**	Commission Implementing Regulation (EU) 2018/1048	Transitional measures and contingency measures are advocated in Article 4 and Article 6, respectively, of Commission Implementing Regulation (EU) 2018/1048. SBAS supports RNAV Approach operations to LPV minima. RNP APCH operations approval may be required by national authorities in the State of the intended operations. See **ref. [5]**

Capability	Civil Requirements	Mandate Status	Military/State Aircraft equipage considerations
SBAS APV (to LPV minima) also referred to as APV SBAS	Requirements for SBAS receivers are contained in ICAO annex 10 Volume 1. See **ref. [2]**	Commission Implementing Regulation (EU) 2018/1048	Transitional measures and contingency measures are advocated in Article 4 and Article 6, respectively, of Commission Implementing Regulation (EU) 2018/1048. SBAS supports RNAV Approach operations to LPV minima. RNP APCH operations approval may be required by national authorities in the State of the intended operations.
RNP AR APCH (Authorisation Required)	Navigation specifications detailed in ICAO PBN manual (doc 9613) Enabling System: GNSS See **ref. [2]**	Commission Implementing Regulation (EU) 2018/1048	Relies on GNSS and flight crew performance. Specific authorisation required per procedure and the aircraft equipment eligibility includes aircraft qualification, maintenance procedures and minimum equipment list revisions. Approach specification for challenging environments. See **ref. [5]**
GLS CAT I and GBAS CAT II/III	Approaches based on GBAS equipment GBAS SARPS contained in ICAO Annex 10 Volume 1 GBAS performance specification is contained in RTCA DO 253D LAAS receiver MOPS	In operation at selected airports (CAT I operations). Deployment status and plans available at www.flygls.net Operational approval not required for CAT I (ILS look-alike) and under development for CAT II/III	GBAS SARPS for CAT I became applicable in Nov 2001 (refer to ICAO SARPS annex 10 volume 1). GBAS SARPS for CAT II/III published as baseline development standards. Specific applicability to State aircraft not defined.
A-RNP (Advanced RNP)	RNP operations where the RNP is scalable from 2 NM down to 0.3 NM to all phases of flight. RF required and options for higher continuity, FRT, Baro-VNAV and scalability. **ref. [2]** provides airworthiness material.	No current requirement or mandate.	Provide a means of a single aircraft qualification being applicable to a broader range of applications. Specific applicability to State aircraft not defined. See **ref. [5]**

Table 2: Navigation Requirements (modified wrt ref. [1])

Capability	Civil Requirements	Mandate Status	Military/State Aircraft equipage considerations
SSR Mode A+C	Mode A/C airborne transponder (ICAO Annex 10, Volume IV, Chapter 2) See: • **EASA ETSO C74d** • **RTCA DO-144**	Mandated for IFR/GAT and for VFR/OAT in 'designated airspace' However note Mode S requirement below	
SSR Mode S Elementary Surveillance (ELS) and Enhanced Surveillance (EHS)	**Elementary Surveillance (ELS)** "Basic Functionality" required: • Automatic reporting of Aircraft Identity • Transponder capability report • Altitude reporting in 25 ft intervals • Flight status • SI Code capability **Enhanced Surveillance (EHS**) EHS provides, in addition, 8 more downlinked aircraft parameters: • Magnetic Heading • Air Speed • Selected Altitude • Vertical Rate • Track Angle Rate • Roll Angle • Ground Speed • True Track Angle The ground acquisition of such specific aircraft-derived parameters enables the ATC Controllers ability to increase their efficiency in tactically separating aircraft. See: • **ref. [2]** • **EASA ETSO C112e** • **EUROCAE ED-73E / RTCA DO-181E**	The performance and interoperability requirements related with the carriage of Mode S (ELS and EHS) and ADS-B OUT in European Union airspace, for flights under GAT/IFR status, are regulated by the Commission Regulation (EU) No 1207/2011 (SPI IR[4]) amended by EU1028/2014, EU2017/386 and EU2020/5872[5]. Article 8 of the SPI IR covers State aircraft[6] and defines the cases for exemptions. Non-EU State aircraft are not covered by the SPI IR. For non-EU State aircraft, dispensations from Mode S and ADS-B obligations may be granted by the competent National Authority. EUROCONTROL does not make any SES regulatory interpretations. Consequently, any legal questions related with regulatory provisions must be submitted to the European Commission. For further information regarding the Regulations, and possible exemption mechanisms, please contact DG Move at the European Commission via 'move-infos@ec.europa.eu' The EASA Certification Specification for Airborne Communications, Navigation and Surveillance (CS-ACNS), issue 2 published April 2019, provides the avionics certification documentation in line with Commission Implementing Rule EU1207/2011. (See https://www.easa.europa.eu/sites/default/files/dfu/Annex%20I%20to%20ED%20Decision%202019-011-R%20-%20CS%20ACNS%20Issue%202.pdf)	**National Context** Prior to the publication of the SPI IR, several European States mandated Mode S carriage for State aircraft within each State's jurisdiction in the national context. The published obligations affect State aircraft when operating GAT (IFR and VFR) and, in certain cases, OAT. This was done "nationally" and consequently, State aircraft operators are strongly advised to consult national AIPs/AICs when planning flights conducted by State aircraft in European airspace to determine the procedures to submit the required waivers. A related Compendium on the Management of Flights by Mode S and ADS-B OUT Non-Equipped State Aircraft is available here: https://www.eurocontrol.int/service/handling-non-equipped-mode-s-and-ads-b-state-aircraft **European Context** Article 8 of the SPI IR mandates, from 07 December 2020, the carriage of Mode S ELS for all State aircraft and Mode S EHS and ADS-B OUT for Transport type State aircraft[7,8] when operating as GAT/IFR. Article 8 applies only to EU State aircraft, thus non-EU State aircraft are not covered by that Article 8 (nor by the SPI IR). For EU State aircraft, Member States had until 1 January 2019 to communicate to the European Commission which State aircraft cannot be equipped with the Mode S or ADS-B OUT capabilities as per Article 8.3 of the SPI IR. Such exemptions were limited to three reasons justifying non-equipage, in Article 8(3) of Regulation (EU) No 1207/2011. Non-EU State aircraft not equipped with Mode S or ADS-B OUT capability can be authorised to conduct flights in European airspace under GAT. Non-EU State aircraft operators that plan to conduct flights with non-Mode S or non-ADS-B OUT transport type State aircraft in European airspace shall consult the National AIPs of the States to be overflown, and submit case by case requests for dispensation/waivers for such particular flights in line with arrangements and procedures published therein. A related Compendium on the Management of Flights by Mode S and ADS-B OUT Non-Equipped State Aircraft is available here: https://www.eurocontrol.int/service/handling-non-equipped-mode-s-and-ads-b-state-aircraft

[4] SPI IR – Surveillance Performance and Interoperability Implementing Rule
[5] The precise text of the SPI IR can be found here: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32011R1207
[6] 'State aircraft' means any aircraft used for military, customs and police purposes as defined by SPI IR
[7] State aircraft with a maximum certified take-off mass exceeding 5 700 kg or having a maximum cruising true airspeed capability greater than 250 knots. It applies for aircraft with an individual certificate of airworthiness first issued on or after 7 June 1995.
[8] As per SPI IR, transport-type state aircraft means, "Fixed wing State aircraft that are designed for the purpose of transporting persons and/or cargo."

Capability	Civil Requirements	Mandate Status	Military/State Aircraft equipage considerations
Automatic Dependant Surveillance Broadcast (ADS-B)	ADS-B Out Transmit System: • **EASA ETSO C166b** • **EUROCAE ED-102A / RTCA DO-260B** ICAO Annex 10 Doc. 9871 Ed.2 ADS-B Out Horizontal Position Source: • EASA ETSO C129a (plus specific **ref. [2]** qualifications) • ETSO-C196 • ETSO-C145 / ETSO-C146.	The performance and interoperability requirements related with the carriage of Mode S (ELS and EHS) and ADS-B OUT in European Union airspace, for flights under GAT/IFR status, are regulated by the Commission Regulation (EU) No 1207/2011 (SPI IR) amended by EU1028/2014, EU2017/386 and EU2020/587 . Article 8 of the SPI IR covers State aircraft and defines the cases for exemptions. Non-EU State aircraft are not covered by the SPI IR. For non-EU State aircraft, dispensations from Mode S and ADS-B obligations may be granted by the competent National Authority. EUROCONTROL does not make any SES regulatory interpretations. Consequently, any legal questions related with regulatory provisions must be submitted to the European Commission. For further information regarding the Regulations, and possible exemption mechanisms, please contact DG Move at the European Commission via 'move-infos@ec.europa.eu' The EASA Certification Specification for Airborne Communications, Navigation and Surveillance (CS-ACNS), issue 2 published April 2019, provides the avionics certification documentation in line with Commission Implementing Rule EU1207/2011. (See https://www.easa.europa.eu/sites/default/files/dfu/Annex%20I%20to%20ED%20Decision%202019-011-R%20-%20CS%20ACNS%20Issue%202.pdf)	**National Context** Prior to the publication of the SPI IR, several European States mandated Mode S carriage for State aircraft within each State's jurisdiction in the national context. The published obligations affect State aircraft when operating GAT (IFR and VFR) and, in certain cases, OAT. This was done "nationally" and consequently, State aircraft operators are strongly advised to consult national AIPs/AICs when planning flights conducted by State aircraft in European airspace to determine the procedures to submit the required waivers. A related Compendium on the Management of Flights by Mode S and ADS-B OUT Non-Equipped State Aircraft is available here: https://www.eurocontrol.int/service/handling-non-equipped-mode-s-and-ads-b-state-aircraft **European Context** Article 8 of the SPI IR mandates, from 07 December 2020, the carriage of Mode S ELS for all State aircraft and Mode S EHS and ADS-B OUT for Transport type State aircraft when operating as GAT/IFR. Article 8 applies only to EU State aircraft, thus non-EU State aircraft are not covered by that Article 8 (nor by the SPI IR). For EU State aircraft, Member States had until 1 January 2019 to communicate to the European Commission which State aircraft cannot be equipped with the Mode S or ADS-B OUT capabilities as per Article 8.3 of the SPI IR. Such exemptions were limited to three reasons justifying non-equipage, in Article 8(3) of Regulation (EU) No 1207/2011. Non-EU State aircraft not equipped with Mode S or ADS-B OUT capability can be authorised to conduct flights in European airspace under GAT. Non-EU State aircraft operators that plan to conduct flights with non-Mode S or non-ADS-B OUT transport type State aircraft in European airspace shall consult the National AIPs of the States to be overflown, and submit case by case requests for dispensation/waivers for such particular flights in line with arrangements and procedures published therein. A related Compendium on the Management of Flights by Mode S and ADS-B OUT Non-Equipped State Aircraft is available here: https://www.eurocontrol.int/service/handling-non-equipped-mode-s-and-ads-b-state-aircraft
SSR Mode 1, 2, 3, 5	N/A	N/A	**STANAG 4193 Ed.3** "*Technical Characteristics of IFF Mk XIIA Interrogators and Transponder*" (**ref. [3]**): • Mode 1 iaw STANAG 4193 Ed.3 – Annex B • Mode 2 iaw STANAG 4193 Ed.3 – Annex B • Mode 3/A&C iaw STANAG 4193 Ed.3 – Annex B • Mode 4 iaw STANAG 4193 Ed.3 – Annex C (Mode 4 not anymore in use) • Mode S iaw STANAG 4193 Ed.3 – Part I, Annex D • Mode 5 iaw STANAG 4193 Ed.3 – Annex E and F For ASID see **STANAG 4722 Ed.2** "*Technical Characteristics of Reverse IFF using Mode 5 Waveform*"

Table 3: Surveillance Requirements (modified wrt main ref. [1])

<table>
<tr><th>Capability</th><th>Civil Requirements</th><th>Mandate Status</th><th>Military/State Aircraft equipage considerations</th></tr>
<tr><td>ACAS II</td><td>TCAS II Software Version 7.1 (adjacent column)

ICAO Annex 10 vol.4,
PANS OPS Doc 8168,
PANS ATM Doc 4444,
ICAO Doc 7030,
ICAO Doc 9863 (ACAS Manual)

ICAO Annex 6, Operation of Aircraft, Part 1 – International Commercial Air Transport – Aeroplane

European Commission Regulation No. 1332/2011, subsequently amended by Regulation No. 2016/583</td><td>ACAS mandate applies only to civil aircraft.</td><td>REVISED ACAS POLICY FOR MILITARY AIRCRAFT (Dated 28 September 2016)

Background
On the 21st April 2016 at the 48th meeting of the Civil-Military Interface Standing Committee (CMIC), the Military Authorities have agreed on a Revised ACAS Policy for Military Aircraft.

Policy Statement
<u>Background</u>
On 21 April 2016, the CIMIC Member States have commonly agreed to review the 2004 ACAS Policy for Military Aircraft to align with provisions for civil aircraft in Commission Regulation (EU) No 1332/2011 of 16 December 2011 subsequently amended by Regulation 583/2016 laying down common airspace usage requirements and operating procedures for airborne collision avoidance.

<u>Military Transport Type Aircraft</u>
Military Authorities of the CMIC Member States adopt TCAS II version 7.1 as the minimum for voluntary forward fit implementation for new military transport type aircraft (MTTA) entering into service or undergoing major mid-life modernisation.
It must be applicable to fixed-wing turbine engine aircraft having a maximum certificated take-off mass exceeding 15,000 kgs, or a maximum approved passenger seating configuration of more than 30, were required to be equipped with ACAS.

Situation in German airspace
German AIC IFR 13 dated 20 MAR 2003 states: “With effect from 1 January 2005, all fixed-wing turbine-engine aircraft, including military transport aircraft, having a maximum take-off mass exceeding 5700kg, or a maximum approved passenger seating configuration of more than 19 will be required to be equipped with, and operate ACAS II”.
For more details consult: https://www.eurocontrol.int/publication/revised-acas-policy-military-aircraft
See ref. [6] and [7]</td></tr>
<tr><td>Enhanced Ground Proximity Warning System (EGPWS) / Terrain Awareness Warning system (TAWS)</td><td>Applicable to aircraft with:
1. MCTM>5700kg or a more than 30seats and a C of A issued after 1/1/2001;
2. same MCTM and if 9 seats or more and C of A issued after 1/1/2004;
3. same MCTM and 9 seats or more and already equipped with GPWS - no TAWS required</td><td>Mandated from JAN 2003

Note:
• If MCTM>15000kg or passengers >30 the date is 01 JAN 2005
• If MCTM>5700kg or passengers > 9 the date is 01 JAN 2007</td><td>Applicability to State aircraft not defined.
This is not an ATM/CNS Requirement as stated in ICAO Annex 6 Part 1. Paras 6.15.5 to 6.15.7</td></tr>
<tr><td>Flight Data Monitoring</td><td>-</td><td>Under consideration for civil aircraft at EASA level</td><td>Applicability to State aircraft not defined.</td></tr>
</table>

Table 4: Safety Assurance and Sense and Avoid Requirements (modified wrt main ref. [1])

Capability	Civil Requirements	Mandate Status	Military/State Aircraft equipage considerations
RVSM	The RVSM system includes: (a) two independent altitude measurement systems. Each system is composed of the following elements: (1) Cross-coupled static source/system, with ice protection if located in areas subject to ice accretion; (2) Equipment for measuring static pressure sensed by the static source, converting it to pressure altitude; (3) Equipment for providing a digitally encoded signal corresponding to the displayed pressure altitude, for automatic altitude reporting purposes; (4) Static source error correction (SSEC), as required to meet the performance criteria as specified in CS ACNS.E.RVSM.035; and (5) Signals referenced to a pilot selected altitude for automatic control and alerting derived from one altitude measurement system. (b) an altitude alerting system; (c) an automatic altitude control system; and (d) a secondary surveillance radar (SSR) transponder with altitude reporting system that can be connected to the altitude measurement system in use for altitude keeping.	-	Applicability to Military/State aircraft not defined. Military/State aircraft are requested to comply with the RVSM requirements only if flying with an RVSM flight plan.

Table 5: RVSM Requirements (ref. [1])

K3. ADDITIONAL CONSIDERATIONS – IFR MINIMUM EQUIPMENT

IFR is a form of flight rule inherited from the civil world and also applicable to miltiary/state aircraft.

In order to fly IFR, the military aircraft shall be equipped with a minimum set of instruments, whose integration onboard shall be demonstrated and confirmed by the System Design Responsible, for the relevant verification by DAAA.

As for the rest of ATI disciplines, the presence onboard of such equipment exclusively fulfils the technical apportionment of the complete requirement, since access and authorization to fly IFR also requires of the operational and aircrew flight rating evaluations carried by AVIAMM.

The main reference for the definition of such list is represented by civil regulation at references [8], [9] and [10].

More specifically, references [9] and [10] define a full list of equipment and requirements for what regards the Non-Commercial Operations with and/or without complex motor-powered aircraft. However, alternative fittings, solutions and configurations may be proposed by the Applicant, provided that requirement SERA5015a at reference [8] “Aircraft shall be equipped with suitable instruments and with navigation equipment appropriate to the route to be flown and in accordance with the applicable air operations legislation” is fulfilled.

AER(EP).P-516

ANNEX L

CERTIFICATION REQUIREMENTS FOR ELECTRONIC FLIGHT BAGS

L1. AIM

Aim of this Annex is to adopt, in the Italian regulatory framework, a standard process to authorize the utilization of portable Electronic Flight Bag (EFB) on military aircraft, determining responsibility at each step. In order to determine the peculiarity of any potential EFB authorization, some differences are identified, in particular:

- EFB operations with no effect on safety;
- EFB operations with effect on safety not higher than minor;
- EFB operations with effect on safety higher than minor.

L2. APPLICABILITY

The instructions contained in this Annex apply to portable EFBs, containing NON-CLASSIFIED information, and to any accessories (leg, cover, power cable, mobile anchoring devices, etc.), which are intended to be used on Military Aircraft registered in the Register of Military Aircraft (RAM).

For what regards the authorization for use requested for an aircraft equipped with an Experimental Marking, it will be dealt with directly as part of the verification activities conducted in accordance with AER(EP).P-7 and, where applicable, to AER(EP).P-21, taking into account the technical aspects foreseen for EFBs in this Annex.

Fixed EFBs are not the subject of this Annex, as they shall be treated as part of the aircraft.

Similarly, proposals for the introduction of EFB in configuration by a System Responsible Company (DRS) or in possession of a Military Design Organization Approval (MDOA) will be treated at the pursuant to AER(EP).P-2, AER(EP).P-21 or AER(EP).00-00-5.

L3. DEFINITIONS

For the purposes of this technical publication, all acronyms, words and phrases present in the P.T. AER.Q-2010 are still applicable.

The following integrations apply:

- **Electronic Flight Bag (EFB):** electronic system (consisting of hardware, firmware, software applications and data) that allows the crew to access aeronautical and cartographic products (traditionally paper) in digital format. This information is obtained through software applications that allow the storage, updating, provision, display and/or calculation of digital data to support flight operations/activities.

  An EFB can include various accessories such as, for example:

  - Anchoring device to the aircraft (fixed or mobile);
  - Stringer;
  - Cover;

- Power cord.

An EFB can be fixed or portable. This standard is applicable only to portable EFBs.

- **Fixed EFB**: EFB that is part of the aircraft configuration and, as such, is included in the Aircraft Type Certification and managed according to the DAAA regulation and standard for initial/continued airworthiness.
- **Portable EFB**: EFB that is not part of the aircraft configuration and which is not operated according to the DAAA regulation for initial/continued airworthiness. Therefore, this Annex and AER(EP).P-14 apply in this case. Its installation/removal (even if positioned on a special anchoring system provided and forming part of the aircraft configuration) does not require any specialist maintenance procedure, carried out by an aeronautical maintenance technician. Therefore, it can be performed by the crew.
- **Anchoring device**: hardware device that allows the positioning of the portable EFB on board the aircraft. This device can be fixed or mobile. In the first case it will be considered part of the aircraft configuration and therefore certified/managed according to AER(EP).P-2, AER(EP).P-21 or AER(EP).00-00-5 standards. In the second case, it will be managed according to this Annex and AER(EP).P-14.
- **EFB platform**: the hardware (including any mobile anchoring device) in which the firmware (e.g. operating system) and computational capabilities reside.
- **EFB application**: a software application installed on an EFB platform to provide specific functionality.
- **Software Version:** identifier of a software component configuration.

L4. REFERENCE REGULATIONS

D.Lgs. 15/03/2010, n. 66	Codice dell'Ordinamento Militare, Art.153
AER(EP).P-2	Homologation, Type Certification and Type Qualification for military aircraft, Approval of Installation Suitability
AER(EP).P-21	Certification of Military Aircraft and related Products, Parts and Appliances and Design and Production Organizations
AER(EP).0-0-2	Definizione e Regolamentazione del Sistema delle PP.TT. Della Direzione Generale degli Armamenti Aeronautici (ARMAEREO)
AER(EP).P-14	Idoneità all'impiego degli equipaggiamenti di: salvataggio, sicurezza, sopravvivenza e supporto alla missione utilizzabili sugli aeromobili militari delle Forze Armate e Corpi dello Stato

AER(EP).P-170	Definizione dei Requisiti Generali delle Pubblicazioni Tecniche Elettroniche Interattive (IETP) di competenza di Armaereo
AER(EP).P-175	Definizione dei requisiti generali per la fruizione remota delle pubblicazioni tecniche elettroniche interattive (IETP) di competenza della D.A.A.A.
AER(EP).00-00-5	Configuration control. Process for the elaboration, evaluation and authorization of changes to introduce on materials under DAAA competency
AER(EP).P-7	Resitration and keeping of Military Aircraft Register (R.A.M.)
AER(EP).00-01-6	Istruzioni per la compilazione, l'inoltro e la gestione delle Segnalazioni Inconvenienti relative al materiale aeronautico
AER.Q-2010	Definitions of Abbreviations, Terms and Expressions used in DAAA
MIL-STD-464	Electromagnetic Environmental Effects, Requirements for Systems
Regulation (EU) n. 965/2012	Technical requirements and administrative procedure related to Air Operations
EASA AMC 20-25A	Airworthiness Consideration For Electronic Flight Bags (EFB)
FAA AC120-76d	Authorization for use of Electronic Flight Bags

L5. AUTHORIZATION FOR EFB EMPLOYMENT

In accordance with the definitions in paragraph L.3, the portable EFB is composed of an EFB platform and the applications installed on it. Similarly, the process for authorizing the use of an EFB on board an aircraft distinctly concerns its platform and the related applications installed on it.

The process for authorizing the use of portable EFBs will therefore follow the following steps, described in detail later in this document:

- Request for employment of the EFB (para L.5.1);
- Definition of evaluation activities (para L.5.2);
- Reporting (para L.5.3);
- Definition of EFB management procedures (para L.5.4);
- EFB Authorization to use (para L.5.5);
- Familiarization (para L.5.6).

The DAAA will establish the possible need for familiarization activities on the EFB and will determine any methods of use in order to comply with the applicable regulations.

L5.1 REQUEST FOR EMPLOYMENT OF THE EFB

Following receipt of the specific requirements, the articulation originator of the operational requirement (Armed Force, State Corp, FA/CdS) will present the relevant request for technical authorization for employment to the DAAA VDT - 1st Office.

This request shall clearly indicate the configuration of the portable EFB and any accessories (leg strap, cover, power cable, mobile anchoring devices, etc.), through a coding assigned by the FA/CdS which uniquely identifies the type of EFB at a macroscopic level (intended as a system), battery and any accessories, in accordance with what is defined in AER(EP).P-14.

If necessary, upon receipt of the request, the VDT - 1st Office will activate the DASAS[1], defining the support necessary to complete the requested authorization.

L5.2 DEFINITION OF EVALUATION ACTIVITY

DASAS will produce a Test Plan in which the activities envisaged to allow authorization for the use of the EFB on board will be defined, and in particular:

- EFB platform Stand-alone qualification (para L.0);
- Application risk assessment (para. L.0);
- EFB vs Aircraft compatibility evaluation (para L.0).

L5.2.1 EFB PLATFORM STAND-ALONE QUALIFICATION

The technical evaluation process will begin with the verification of the compliance of the EFB platform with the minimum requirements identified for a stand-alone qualification, and in particular:

- Battery qualification

  Batteries shall be qualified according to one of the following international standards or equivalent:
  - *United Nations (UN) Transportation Regulations. UN ST/SG/AC.10/11/Rev.5-2009, Recommendations on the Transport of Dangerous Goods-Manual of Tests and Criteria;*
  - *Underwriters Laboratory (UL). UL 1642, Lithium Batteries; UL 2054*[2]*, Household and Commercial Batteries; and UL 60950-1, Information Technology Equipment - Safety.*
  - *International Electrotechnical Commission (IEC). International Standard IEC 62133, Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for portable sealed secondary cells and for batteries made from them, for use in portable applications;*
  - *RTCA/DO-311*[3]*, Minimum Operational Performance Standards for Rechargeable Lithium Battery Systems.*

[1] As required by SMA-LOG-028

[2] Compliance with UL 2054 indicates compliance with UL 1642

[3] An appropriate airworthiness testing standard such as RTCA/DO-311 can be used to address concerns regarding overcharging, over-discharging, and the flammability of cell components. RTCA/DO-311 is intended to test permanently installed equipment; however, these tests are applicable and sufficient to test EFB rechargeable lithium-type batteries

- Environmental qualification
  The EFB platform shall be qualified, according to the MIL-STD-810 standard or equivalent, to the following environmental requirements:
  - *Rapid decompression (if the intended use relates to pressurized aircraft);*
  - *Environmental characteristics related to the risk of fire/smoke on board (operating temperature limits, explosive atmosphere, flammability, etc.);*
  - *Crashworthiness.*
- Electromagnetic qualification
  The EFB platform, including any accessories to be used on board, shall be qualified according to the MIL-STD-461 standard or equivalent.

All data collected at the end of the stand alone qualification activities will be assumed as Means of Evidence (MoE) and used as part of the EFB/Aircraft platform compatibility assessment activities carried out by DASAS.
Where an EFB platform is already equipped with such evidence, it will be reported as a reference in DASAS Technical Report.

L5.2.2 APPLICATION RISK ASSESSMENT

DASAS, supported by the requesting FA/CdS, will provide a safety analysis, carried out according to the aeronautical regulations normally recognized by DAAA, which provides evidence regarding:

- Risk associated with the loss or malfunction of the software application required to perform the intended function;
- Risk associated with the loss or malfunction of the EFB system, following a malfunction whose cause can be related to the new software application.

This analysis, possibly based on the risk analysis produced by the company that developed the application, shall refer to the specific type of aircraft and consider its use by the FA/CdS body that presented the need.

This analysis will mainly serve to determine the classification of the severity of any functional risks and any limitations/mitigations/crew actions to be recommended, identifying three types of applications, as described in the following paragraphs.

However, the DAAA remains entitled, at its sole discretion, to incorporate relevant evidence of applications already in possession of authorization for use issued by other recognized military or civil aeronautical authorities, requesting any additional assessments.

L5.2.2.1 APPLICATION TYPE A

<u>Any malfunction or improper use (due to poor design) of the application associated with the requested functionality has no impact on safety (no fault condition has a criticality higher than "no safety effect") in all phases of flight.</u>
Examples of Type A applications are: consultation of mapping data, meteorological information, route information, tactical information, etc.
In these cases, the application can be added to the list of those already authorized in that configuration and managed by the Aviation Authority. Any software or

versioning updates of the application that do not involve additional functions will not require further authorization from the DAAA.

L5.2.2.2 APPLICATION TYPE B

Any malfunction or improper use (due to poor design) of the application associated with the requested functionality has "minor" effect on safety in at least one flight phase.

Examples of Type B applications are: consultation of digital operational Technical Publications, approved by the DAAA in accordance with the AER(EP).0-0-2 standard.

In these cases, the application may be added to the list of those authorized by the DAAA, following an analysis of any limitations/mitigations resulting from the safety assessment and will be managed by the DAAA, as Airworthiness Authority, in compliance with existing regulations for the management of aeronautical Technical Publications.

L5.2.2.3 APPLICATION TYPE C

Any malfunction or improper use (due to poor design) of the application associated with the requested functionality has a greater than "minor" effect on safety in one or more flight phases.

Examples of Type C applications are: in-flight performance calculations for determining take-off and landing distances, power setting indications, mass and balance calculations, etc.

In these cases, this application shall be treated like any avionics software and, therefore, shall satisfy the same safety requirements of the certification basis and managed by the DAAA, as Airworthiness Authority, in compliance with the current regulation. In case that it is impossible to provide an adequate Design Assurance Level[4], the FA/CdS, through DASAS, will have to provide the evidence produced by the Design Company for the Application to justify an Equivalent Level of Safety (ELOS) of the software[5].

L5.2.3 EFB VS AIRCRAFT COMPATIBILITY EVALUATION

The DAAA, supported by DASAS, will define case-by-case[6] what requirements of the aircraft certification basis could be impacted by the introduction of the EFB requiring the production of additional evidence. This will allow to verify that the introduction of the EFB platform does not affect the compliance of the aircraft with

[4] As required by the applicable certification basis

[5] For example, where it is a software for determining the take-off and landing distance, it will be necessary to explain whether these measurements are provided through a table, whether this table has been validated, whether and how a configuration control is maintained between the table of the software and the applicable manuals, what the resolution of the table and the interpolation/extrapolation method are, whether the measurements are the result of an algorithm and therefore how the validation of the algorithm was carried out, whether safety netting tools exist for the 'application in question etc.

[6] Depending on the type, class and/or Design Usage Spectrum of the aircraft Type

the relevant certification basis, nor that it determines a negative impact on other systems already authorized on board (e.g. other EFB platforms).

Furthermore, it will also be necessary to verify the correct functioning of the EFB in the "aircraft environment" and its compliance with the required operational requirement, determining its usability on the aircraft in question[7].

The Test Plan produced by DASAS will include activities to demonstrate the compatibility requirements between the aircraft, the system and any accessories (leg, cover, power cable, mobile anchoring devices, etc.) and will be shared with VDT - 1st Office.

A minimum set of compatibility requirements to meet is the one provided below, as a guideline:

- <u>Electromagnetic compatibility</u>
  Verification of electromagnetic compatibility (EMC between aircraft and EFB platform, HERO, etc.), in accordance with MIL-STD-464 or equivalent.
- <u>Environmental compatibility</u>
  Verification that EFB platform environmental limits are compatible with the aircraft environment (operating temperature, operating altitude, relative humidity), such as to guarantee compliance with the aircraft certification basis.
- <u>Human Machine Interface (HMI)</u>
  The use of the EFB platform shall not degrade:
  - cabin environment: the position inside the cabin shall not interfere with the crew operation in regulational and emergency conditions and shall allow the correct display of information on the EFB platform throughout the flight envelope and conditions;
  - lights and NVG: the EFB platform shall not affect the cabin lighting even in NVG operation, and the cabin lighting shall allow the correct display of the data on the EFB platform screen, even during NVG operation.
  - <u>Escape System</u>
    EFB platform operations shall not impact the procedures of:
  - emergency egress: the EFB platform shall not hinder emergency evacuation procedures;
  - ejection: the EFB platform shall not hinder the ejection sequence, i.e. it shall not damage in any way the devices that guarantee pilot survivability.
- <u>Electric system</u>
  The electrical characteristics of the EFB (in case of on-board battery charging requirement) shall be compatible with the predisposition of the aircraft in terms of power, consumption, voltage and frequency.

Particular attention shall be given to any requirements related to data exchange with the aircraft's avionics and to data connection activation during the flight phases. By default, these operations are considered not authorized. In case of explicit user requirements, dedicated activity shall be carried out.

[7] This requirement is also requested by AER(EP).P-14, therefore the results will be used also in a second phase of updating the AER(EP).P-14 regulation.

The evaluation activity carried out by DASAS can also be used to define the operational procedures to be adopted by the end user.

L5.3 REPORTING

Following the execution of the planned activities, DASAS will provide DAAA VDT – 1st Office with the activity Technical Report, which will have the value of Means of Evidence.

Following verification of compliance with the agreed requirements, the DAAA will express its opinion on the evaluation of the EFB platform/aircraft compatibility, based on the evidence produced by the DASAS.

Any permanent anchoring devices, falling within the aircraft configuration, will be managed in accordance with the relevant regulations (AER(EP).P-2, AER(EP).P-21 and/or AER(EP).00- 00-5).

L5.4 DEFINITION OF EFB MANAGEMENT PROCEDURES

The FA/CdS will define in a specific document the EFB management procedures to be applied to the specif EFB on the specific type of aircraft. The document, "EFB Management System Procedure", will be submitted to the DAAA (VDT – 1st Office and Aircraft Technical Division).

The document shall:

- detail the type/model of the EFB platform, the operating system, the application(s) and the type of aircraft (MDS Code);
- report any limitations/instructions and related mitigations that emerged during the evaluation activities;
- define the roles, responsibilities and procedures for the management (updates, maintenance, data loading, assignment monitoring, etc.) of the platform, applications and data contained;
- where the EFB is used for viewing Technical Publications, define the management procedure (data loading/updating), considering the following:
  - Technical Publications and related updates can be uploaded, only if approved by the DAAA in accordance with AER(EP).0-0-2;
  - Technical Publications shall be resident in the memory of the EFB.

L5.5 EFB AUTHORIZATION TO USE

Following the evaluation of the provided documentation, DAAA will issue the technical authorization[8] to use on the Type, with a letter signed by the Deputy Technical Director, prepared by VDT - 1st Office, in coordination with the Aircraft Techcnical Division.

The authorization will be used as input to update the AER(EP).P-14.

[8] The technical authorization will be in line with all the information contained in the “EFB Management System” document, in terms of aircraft type, operating system, applications, etc.

L5.6 FAMILIARIZATION

DAAA will evaluate, on a case-by-case basis, the need to establish a period to allow the end user to familiarize with EFB on the specific aircraft type before issuing a unlimited authorization[9].

At the end of this period, the FA/CdS will provide DAAA with a familiarization report. DAAA, in case of positive evaluation, will issue a revision of the employment authorization by eliminating the previous limitation.

L5.7 OCCURRENCE REPORT

The management of any occurrence related to the EFB shall be pre-emptively agreed between the Applicant and the Authority.

[9] For example, in case of EFB used to consult Technical Publications, the authorization could be issued exclusively for familiarization purposes, requiring the simultaneous presence on board of the Technical Publications “on paper” approved by DAAA as primary source of information.

L6. EFB UPDATE MANAGEMENT

EFB updates will be managed depending on the requested change.

In case of a change to the hardware platform, a new evaluation will need to be carried out regarding:

- Stand alone qualification of the hardware platform;
- Risk Assessment.

L7. TRANSITIONING PERIOD

This standard is valid from the date of approval.

EFB platform registrations already reported in AER(EP).P-14 and any previous authorization remains valid.

The related updates/occurrence report will follow what is established in this Annex.

AER(EP).P-516

ANNEX M

SAFETY REQUIREMENTS

M1. AIM

Aim of this Annex is to complement the safety requirements defined in EMACC Section 14 and to tailor certain aspects of system safety.

In particular, this Annex mainly provides elements to determine the quantitative requirements for the cumulative probability of catastrophic event (P_Cum_Cat) per flight hour and per aircraft class, as computed by exclusively taking into consideration technical faults. The potential impacts to the P_Cum_Cat of human errors (during flight, ground, installation operations, as declined in EMACC Sections 14.2.6 and 14.2.8) are treated separately in a bespoke paragraph at the end of this Annex.

It is also important to highlight that the P_Cum_Cat also constitutes a performance requirement, linked to the expected aircraft attrition rate (non-combat loss rate) set by the Armed Force/State Corp originator of the operational requirement; on this regard, the airworthiness/safety thresholds established in this Annex will stay unaffected, even in the case (remote, but possible) where the performance allocated in the aircraft Technical Specification aim at lower probabilities.

Finally, it is here remarked that, within the classic system/subsystem V-shaped development lifecycle (as per ARP4761 or MIL-STD-882), this Annex covers the tasks occurring at the beginning of the process, at the so-called “left-hand side of the V”, during the design and airworthiness/safety requirement definition.

M2. APPLICABILITY

The requirements contained in this Annex apply to all Military Aircraft, and relevant lower level configuration items, flying under the jurisdiction and authority of DAAA. For brevity, in the rest of the document they will be referred to as “military aircraft”.

M3. REFERENCE REGULATIONS

MIL-STD-882	System Safety
ARP4754	Guidelines for development of civil aircraft and systems
ARP4761	Guidelines for Conducting the Safety Assessment Process on Civil Aircraft, Systems, and Equipment
EUR-Lex - 32019R0947	COMMISSION IMPLEMENTING REGULATION (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft
STANAG 4671	Unmanned Aircraft Systems Airworthiness Requirements (USAR)
STANAG 4703	Light Unmanned Aircraft Systems Airworthiness Requirements

M4. DEFINITIONS

For the purposes of this regulation, all acronyms, words and phrases present in the AER.Q-2010 are still applicable.

The following integrations apply:

- **Applicant**: see AER(EP).P-2, AER(EP).P-7, AER(EP).P-21 and AER(EP.P-22. It is identified with the Industrial or Governmental Organization requesting the issue of a certification product and/or an authorization and subsequent entry into the Military Aircraft Registry. This includes, for instance, a request to the DAAA for the issue of an Experimental Marking as per AER(EP).P-7, an Operational Military Permit to Fly as per AER(EP).P-22 or a Military Type Certificate as per AER(EP).P-21.
- **First party**: personnel identified with the flight crew of a (Remotely) Piloted Aircraft System.
- **Second party**: persons who are participating in the (Remotely) Piloted Aircraft System operation[1] and who are aware of the relevant instructions and safety precautions.
- **Third party**: persons who are not participating in the (Remotely) Piloted Aircraft System operation or who are not aware of the relevant instructions and safety precautions.

The following paragraphs establish a set of definitions for the fault/hazard/failure condition severities and inherent qualitative/quantitative probabilities. This information, coupled with the particular aircraft categories, are propaedeutic to build the risk assessment matrix and its relevant level of acceptability during the design phase.

M4.1. SEVERITY

Category	Piloted Aircraft System	Remotely Piloted Aircraft System (RPAS)
Catastrophic	Fault conditions which may provoke the loss of aircraft or one or more fatalities (first, second and third party).[2]	Fault conditions expected to lead to uncontrolled flight conditions (including flying outside of the planned flight areas/profile) and/or uncontrolled crash. OR Fault conditions which could lead to one or more fatalities (first, second and third party).

[1] As defined in the Aircraft Concept of Operation, if avaialble, and/or the applicable technical publications
[2] From this definition derives that the loss of an aircraft part (store, fairing, etc.) is not considered, per se, a catastrophic event, unless for its effect on third party

Category	Piloted Aircraft System	Remotely Piloted Aircraft System (RPAS)
Critical	Fault condition which could cause serious damage to one or more of the aircraft's systems or serious injury or harm to one or more persons (first, second and third party). This condition may include a significant reduction in the safety margins or functional capacities. This condition may cause physical distress and/or increased workload for the crew such as to compromise their ability to completely and accurately perform their flight tasks.	Fault conditions which, either individually or combined to a crew workload increase, are expected to induce a flight termination with a controlled trajectory or a forced landing, potentially leading to loss of the RPAS, in which it can be reasonably expected that no loss of life will occur. OR Fault conditions which can reasonably be expected not to cause any fatalities (first, second and third party).
Major	Fault condition which could cause light damage to one or more of the aircraft's systems or minor injury or harm to one or more persons (first, second and third party). This condition may include a significant reduction in the safety margins (e.g. identifiable loss of redundancy) or functional capacities. This condition could lead to a significant increase in crew workload.	Fault conditions which, either individually or combined to a crew workload increase, are expected to lead to an emergency landing in a predetermined site, where it can reasonably be expected that no serious injury will occur. OR Fault conditions which could potentially lead to any injury (first, second and third party).
Minor	Fault conditions which do not cause significant damage to the safety of any aircraft system or any injury/indisposition to persons (intended as first, second and third party). This condition may include a slight reduction in the safety margins or functional capacities. This condition could lead to a slight increase in crew workload.	Fault conditions which do not significantly reduce the safety of the RPAS and require crew mitigating actions falling within their abilities without difficulty. These conditions may include a slight reduction in the safety margins or functional capacities. These conditions could lead to a slight increase in crew workload.
NO Safety Effect	Fault conditions which do not cause damage to the safety of any aircraft system or any injury/indisposition to persons (intended as first, second and third party).	Fault conditions which do not reduce the safety of the RPAS and require crew mitigating actions falling within their abilities without difficulty.

Table M-1: Severity definitions (derived from MIL-STD-882E and STANAG 4671 ed.2 AMC.1309)

M4.2 PROBABILITY

QUALITATIVE PROBABILITY LEVELS			
Description	**Level**	**Specific individual Item**	**Fleet or inventory**
Frequent	**A**	Likely to occur often in the life of an item	Continuously experienced
Probable	**B**	Will occur several times in the life of an item	Will occur frequently
Occasional	**C**	Likely to occur sometime in the life of an item	Will occur several times
Remote	**D**	Unlikely, but possible to occur in the life of an item.	Unlikely but can reasonably be expected to occur
Improbable	**E**	So unlikely, it can be assumed occurrence may not be experienced in the life of an item	Unlikely to occur, but possible
Eliminated	**F**	Incapable of occurence. This level is used when potential hazards are identified and later eliminated	

Table M–2: Qualitative probability levels (derived from MIL-STD-882E)

M4.3 AIRCRAFT CATEGORIES

Aircraft category	Description
S1	Airplanes belonging to the categories “Regulational”, “Utility” and “Aerobatic”, with single reciprocating engine and weight < 6000 lb
S2	• Airplanes belonging to the categories “Regulational”, “Utility” and “Aerobatic”, with more than one reciprocating engine or with one single rotary engine, and weight < 6000 lb • Helicopters with weight ≤ 20000 lb and number of passengers < 10
S3	Airplanes belonging to the categories “Regulational”, “Utility” and “Aerobatic”, weight ≥ 6000 lb
S4	• Airplanes belonging to the category “Commuters” • Airplanes belonging to the category “Large aircraft” • Helicopters belonging to the category “Large rotorcraft”, weight > 20000 lb and any number of passengers, or weight ≤ 20000 lb and number of passengers ≥10
S5	Aircraft belonging to the category “troops transportation and rescue”, “recognition”, “maritime patrol”, providing “air-to-air refueling”, carrying “Air Warfare missions”, etc.
S6	Aircraft belonging to the category “Combat”, “Trainers”, etc.
S7	RPAS with maximum take off weight ≤ 2 Kg (Micro RPAS)
S8	RPAS with maximum take off weight >2 Kg and ≤25 Kg (Mini RPAS)
S9	RPAS with maximum take off weight >25 Kg and ≤150 Kg (Light RPAS)
S10	RPAS with maximum take off weight >150 Kg and ≤500 Kg (Tactical RPAS)
S11	RPAS with maximum take off weight between > 500 Kg (Strategic RPAS)

Table M-3: Aircraft Categories

M5. SAFETY REQUIREMENTS

M5.1 GENERAL

In addition to what prescribed in EMACC Section 14, the Applicant shall demonstrate compliance with the additional requirements and inherent tailoring hereby described.

- The aircraft P_Cum_Cat shall be less than the minimum values identified in this Annex, in accordance with the particular aircraft category.
- The aircraft shall fulfil a "failsafe" design, i.e.: *"the aircraft systems, considered separately and in relation to the other systems, shall be designed in such a way that no single failure would lead to a catastrophic event"*. This requirement is not obligatory for RPASs with Maximum Take Off Weight (MTOW) below and equal 150 kg; nonetheless, in this cases, the DAAA reserves the right to request its application whenever necessary.
- Notwithstanding the intrinsically systematic nature of any Programmable Element (PE, software/firmware) fault, which is not modelled by a quantitative probability, whether by adopting RTCA-DO-178, RTCA-DO-254, NATO AOP-52 or other approved alternative standard, the Applicant shall establish the SW/FW life-cycle design requirements on the basis of their impact on Safety (criticality), in accordance with the severity definitions as per table M-1.
  - For each PE, further de-scoping of the original criticality is possible, depending on appropriate architectural choices (redundancy, partitioning, monitoring, dissimilarity, independence etc.) and pending DAAA approval. ARP4754 may be used as guideline.
  - Stricter PE criticalities than those determined on the basis of the safety analysis may be requested for maintenance reasons or to fulfil a specific performance/operational/mission suitability requirement.
  - For RPASs with an MTOW below and equal 150kg, less strict PE criticalities may be established, taking into consideration the minimum requirements of STANAG-4703.
- Common Cause Analysis, Zonal Hazard Analysis and Particular Risk analysis, as prescribed in MIL-STD-882, should be carried by the Applicant.

M5.2 SPECIFIC REQUIREMENTS

M5.2.1 P_CUM_CAT

The cumulative probability of a catastrophic event per hour of flight shall not be greater than the following maximum values:

Aircraft category[3]	Cumulative probability of a catastrophic event / flight hour[4]
S1	≤ $1x10^{-5}$ (5
S2	≤ $1x10^{-6}$ (5)
S3	≤ $5x10^{-7}$ (5)
S4	≤ $1x10^{-7}$ (5)
S5	≤ $1x10^{-6}$
S6	≤ $1x10^{-6}$
S7	≤ $1x10^{-4}$ (6)
S8	≤ 0.0015/MTOW (6)
S9	≤ 0.0015/MTOW (6)
S10	≤ $0.0813/MTOW^{-1.36}$ (6)
S11	≤ $1x10^{-6}$ (6)

Table M-4: P_Cum_Cat/fh for certification activities

The values set for the RPAS categories have been empirically calculated by estimating the total energy at the impact with the ground. In particular, it is assumed that the risk to overflown population produced by an RPAS is proportional to the total energy of the system in flight (which determines the seriousness of the impact on the ground) and to the quantity of fuel on board (which determines the risk of a potential explosion and fire on the ground). The following two charts show this empirical correlation for systems with MTOW not below 150kg.

[3]Refer to the corresponding EASA standards for defining the classes of aircraft derived from civil models

[4] For experimental activities, whereas the aircraft configuration is yet to be frozen, a case-by-case evaluation can be carried with the concurrency of DAAA, in order to tailor these P_Cum_Cat requirements, for instance by building a narrative based on the time at risk, the flight over a test range, regulated by a NOTAM, ownership of the test aircraft (and relevant economic impact in case of crash), etc.

[5] Any mitigating factor which degrades the level of reliability of the aircraft in its civil Type Approval Certificate configuration may be considered in order to take into account the hazards introduced by the military configuration items. The value of the mitigating factor depends substantially on the extent of the differences between the civil and military configurations. It should also be remembered that for single engine aircraft, these values may be further mitigated, as the civil process does not take this contribution into account

[6] The compliance with this requirement will not result in any density limitation to the overflown population

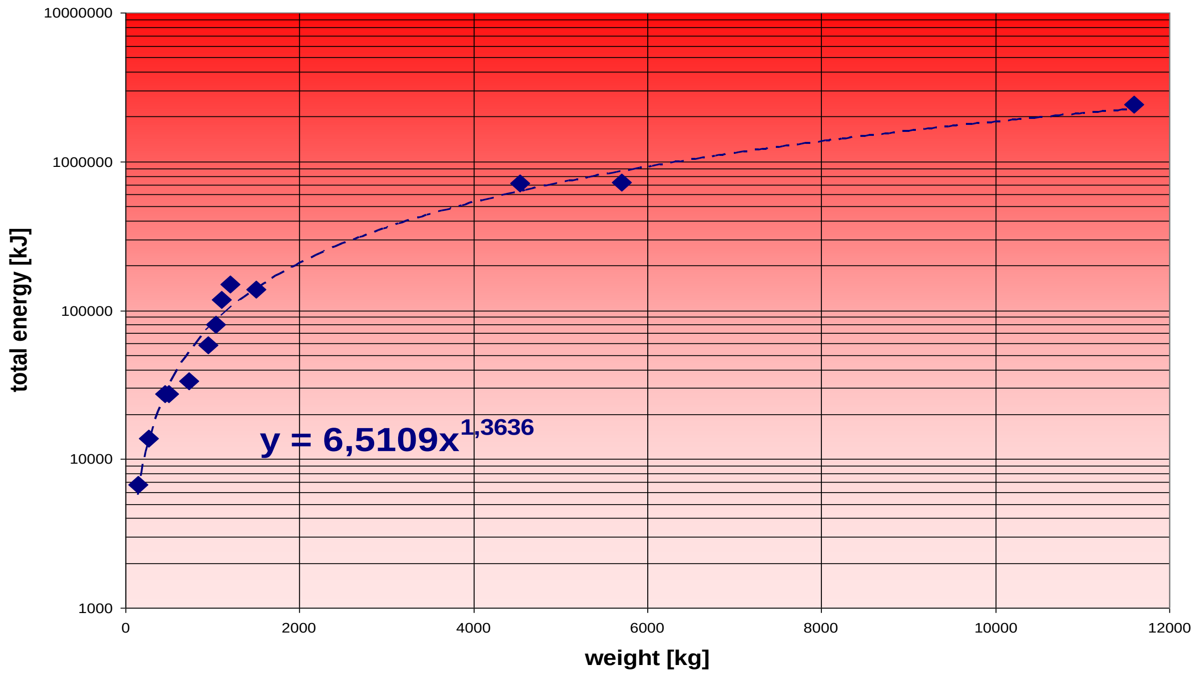


Figure M-1: Empirical correlation between RPAS MTOW and total energy (MTOW not below 150 Kg)

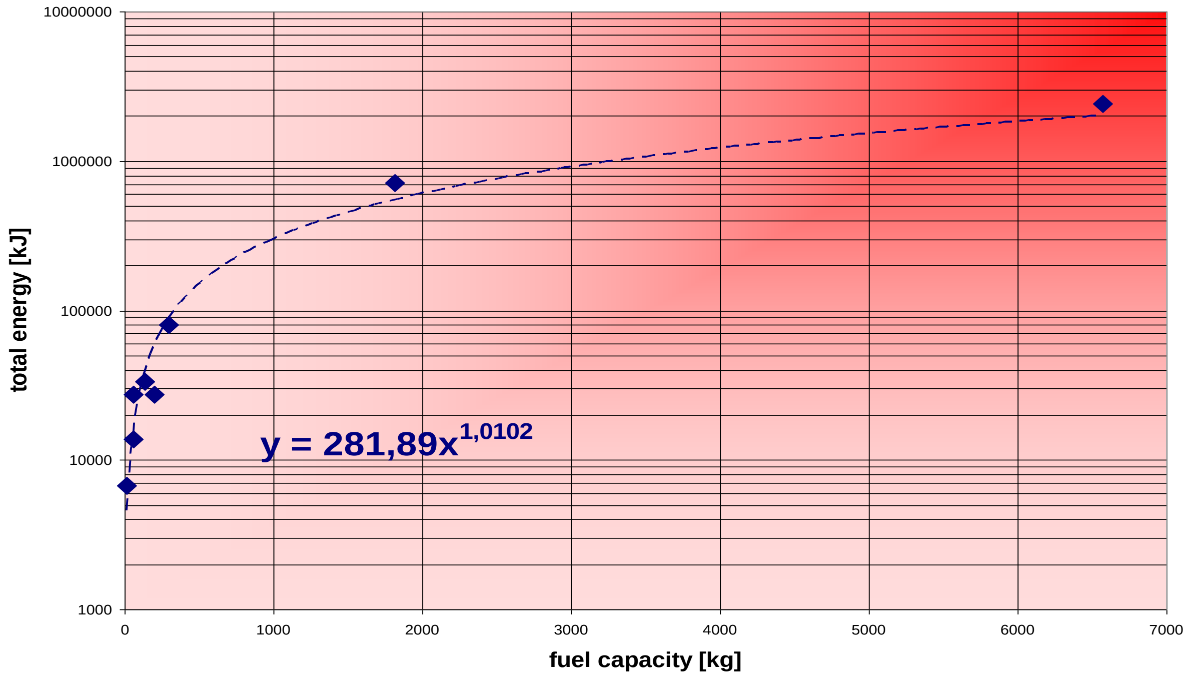


Figure M-2: Empirical correlation between RPAS fuel and total energy (MTOW not below 150 Kg)

For RPASs with MTOW not below 150kg, as the fuel capacity is approximately linear with the total energy of the system, and as the total energy of the system correlates with weight raised to the power of 1.36, it was concluded that the risk to overflown population depends on the weight raised to the power of 1.36, and that the safety requirement varies with weight raised to the (-1.36).

For RPASs with MTOW below and equal 150kg, as the total energy of the system is directly proportional to its weight, the safety requirement is inversely proportional to the weight (figure M-3).

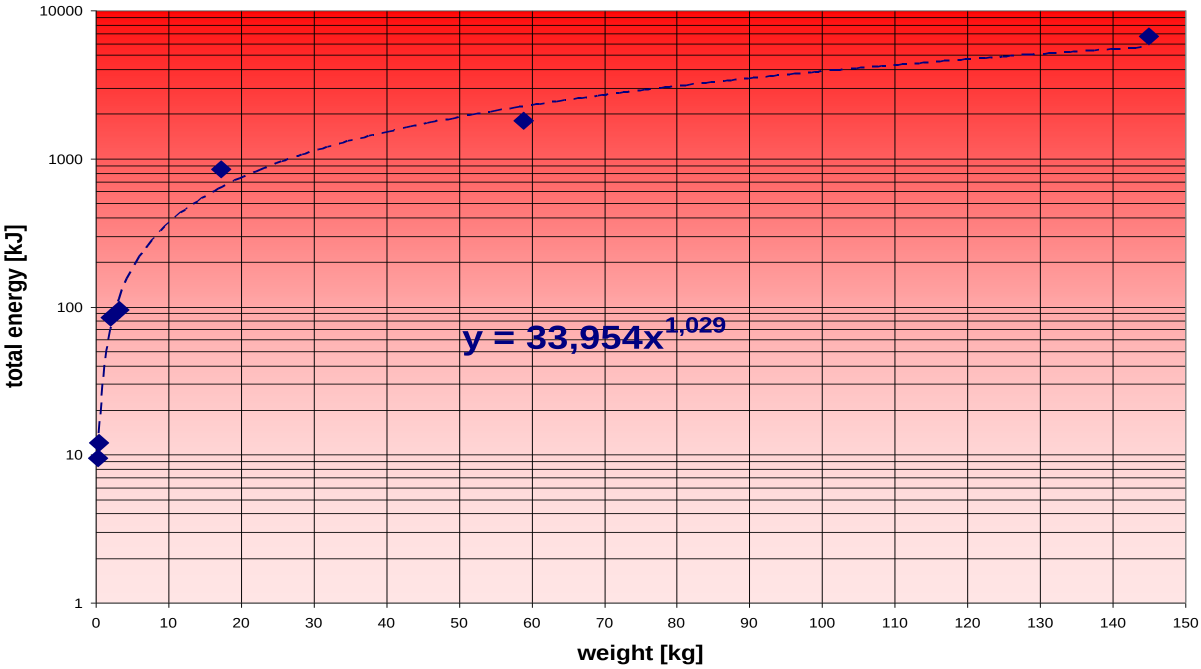


Figure M-3: Empirical correlation between RPAS MTOW and total energy (MTOW below and equal 150 Kg)

As such, the P_Cum_Cat for RPASs is required to satisfy the cumulative graph shown in figure M-4, in order to operate the system without any limitation to population density.

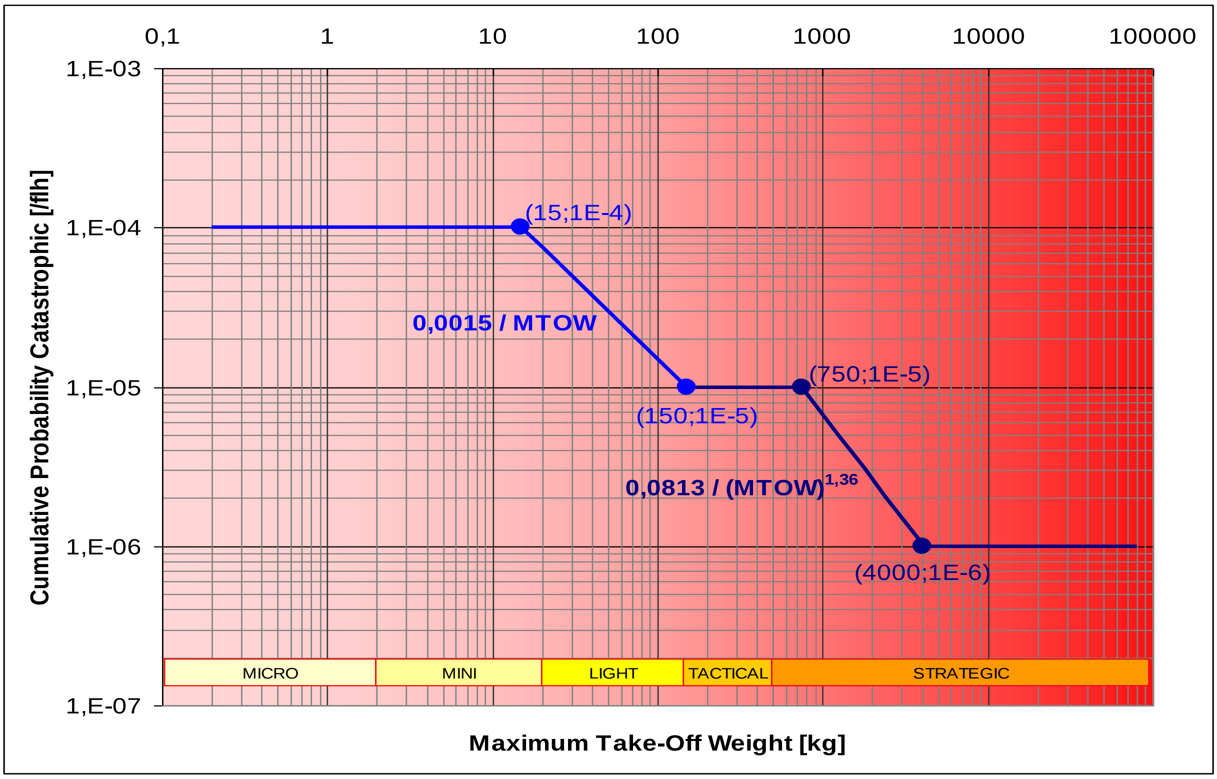


Figure M-4: Empirical correlation between RPAS MTOW and P_Cum_Cat with no limitations to the population density

Should an RPAS not satisfy the P_Cum_Cat requirement, the DAAA will establish a limitation on the density of the overflown population, using the methodology specified in the regulation AER(EP).P-22.

With the application of the population density mitigation, the P_Cum_Cat shall not be greater than the minimum acceptable safety values determined in table M-5 and figure M-5:

RPAS MTOW [kg]	**P_Cum_Cat** (minimum acceptable values implying population density limitations during certification tasks)
(S7, S8 and S9) MTOW ⩽ 150 kg	⩽ $1x10^{-4}$
(S10, S11) 150 kg < MTOW ⩽ 5670 kg	⩽ $1x10^{-5}$
(S11) MTOW > 5670 kg	⩽ $1x10^{-6}$

Table M-5: Minimum RPAS P-Cum_Cat/fh for certification activities with population density mitigations

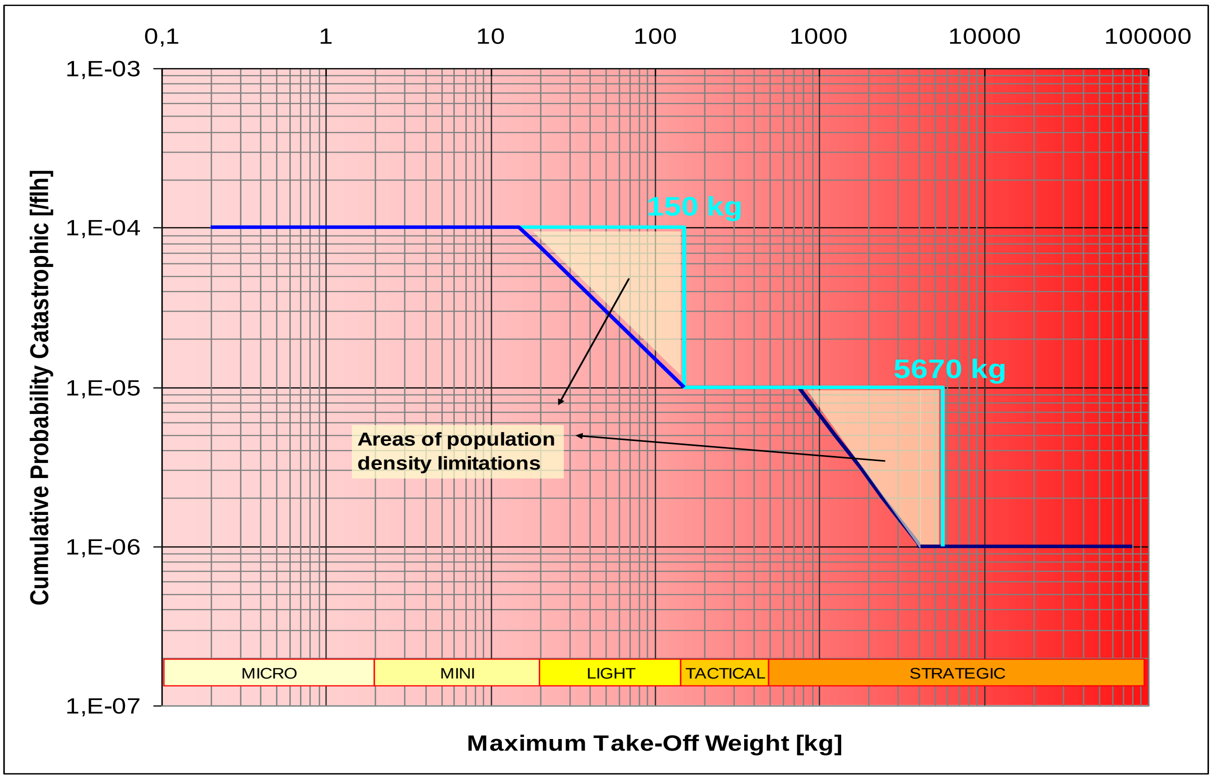


Figure M-5: Empirical correlation between RPAS MTOW and P_Cum_Cat with population density mitigations

M5.2.2 HAZARD RISK MATRIX

A Hazard Risk Index Matrix shall be created and populated by adopting a layout as per table M-6 and the indications provided in this paragraph; the matrix shall combine, for each fault condition, the severity categories and levels of probability with an inverse relationship between the probability of a certain fault condition and the severity of its effects.

Hazard Risk Index (HRI)	**(1) CATASTROPHIC**	**(2) CRITICAL**	**(3) MAJOR**	**(4) MINOR**
(A) FREQUENT	1A	2A	3A	4A
(B) PROBABLE	1B	2B	3B	4B
(C) OCCASIONAL	1C	2C	3C	4C
(D) REMOTE	1D	2D	3D	4D
(E) IMPROBABLE	1E	2E	3E	4E
(F) ELIMINATED	1F	2F	3F	4F

Table M-6: Hazard Risk Index Matrix template

Each fault condition shall be individually compliant with the requirements defined in the matrix in terms of expected severity and estimated qualitative and/or quantitative frequency. In particular, the quantitative frequency thresholds should be determined by adopting the guidelines shown in the following table.

Level of probability	FREQUENT (A)	PROBABLE (B)	OCCASIONAL (C)	REMOTE (D)	IMPROBABLE (E)
S1	$P > P_B$	$P_B = 10 \cdot P_C$ $P_C < P \le P_B$	$P_C = 10 \cdot P_D$ $P_D < P \le P_C$	$P_D = 10 \cdot P_E$ $P_E < P \le P_D$	$P_E = P_{CUM\text{-}CAT} / N_{EC}$ $P \le P_E$
S2	$P > P_B$	$P_B = 100 \cdot P_C$ $P_C < P \le P_B$	$P_C = 10 \cdot P_D$ $P_D < P \le P_C$	$P_D = 10 \cdot P_E$ $P_E < P \le P_D$	$P_E = P_{CUM\text{-}CAT} / N_{EC}$ $P \le P_E$
S3	$P > P_B$	$P_B = 100 \cdot P_C$ $P_C < P \le P_B$	$P_C = 100 \cdot P_D$ $P_D < P \le P_C$	$P_D = 10 \cdot P_E$ $P_E < P \le P_D$	$P_E = P_{CUM\text{-}CAT} / N_{EC}$ $P \le P_E$
S4	$P > P_B$	$P_B = 100 \cdot P_C$ $P_C < P \le P_B$	$P_C = 100 \cdot P_D$ $P_D < P \le P_C$	$P_D = 100 \cdot P_E$ $P_E < P \le P_D$	$P_E = P_{CUM\text{-}CAT} / N_{EC}$ $P \le P_E$
S5	$P > P_B$	$P_B = 100 \cdot P_C$ $P_C < P \le P_B$	$P_C = 100 \cdot P_D$ $P_D < P \le P_C$	$P_D = 10 \cdot P_E$ $P_E < P \le P_D$	$P_E = P_{CUM\text{-}CAT} / N_{EC}$ $P \le P_E$
S6	$P > P_B$	$P_B = 100 \cdot P_C$ $P_C < P \le P_B$	$P_C = 100 \cdot P_D$ $P_D < P \le P_C$	$P_D = 10 \cdot P_E$ $P_E < P \le P_D$	$P_E = P_{CUM\text{-}CAT} / N_{EC}$ $P \le P_E$
S7	$P > P_B$	$P_B = 10 \cdot P_C$ $P_C < P \le P_B$	$P_C = 10 \cdot P_D$ $P_D < P \le P_C$	$P_D = 10 \cdot P_E$ $P_E < P \le P_D$	$P_E = P_{CUM\text{-}CAT} / N_{EC}$ $P \le P_E$
S8	$P > P_B$	$P_B = 10 \cdot P_C$ $P_C < P \le P_B$	$P_C = 10 \cdot P_D$ $P_D < P \le P_C$	$P_D = 10 \cdot P_E$ $P_E < P \le P_D$	$P_E = P_{CUM\text{-}CAT} / N_{EC}$ $P \le P_E$
S9	$P > P_B$	$P_B = 10 \cdot P_C$ $P_C < P \le P_B$	$P_C = 10 \cdot P_D$ $P_D < P \le P_C$	$P_D = 10 \cdot P_E$ $P_E < P \le P_D$	$P_E = P_{CUM\text{-}CAT} / N_{EC}$ $P \le P_E$
S10	$P > P_B$	$P_B = 100 \cdot P_C$ $P_C < P \le P_B$	$P_C = 10 \cdot P_D$ $P_D < P \le P_C$	$P_D = 10 \cdot P_E$ $P_E < P \le P_D$	$P_E = P_{CUM\text{-}CAT} / N_{EC}$ $P \le P_E$
S11 (MTOW≤5670 Kg)	$P > P_B$	$P_B = 100 \cdot P_C$ $P_C < P \le P_B$	$P_C = 10 \cdot P_D$ $P_D < P \le P_C$	$P_D = 10 \cdot P_E$ $P_E < P \le P_D$	$P_E = P_{CUM\text{-}CAT} / N_{EC}$ $P \le P_E$
S11 (MTOW>5670 Kg)	$P > P_B$	$P_B = 100 \cdot P_C$ $P_C < P \le P_B$	$P_C = 100 \cdot P_D$ $P_D < P \le P_C$	$P_D = 10 \cdot P_E$ $P_E < P \le P_D$	$P_E = P_{CUM\text{-}CAT} / N_{EC}$ $P \le P_E$

Table M-7: Hazard Risk Matrix – template structure for quantitative probabilities

In the absence of technical rationale allowing a preliminary determination of the number of catastrophic events (N_{EC}), the following values should be used:

Aircraft category	**N_{EC} assumed**
S1	10
S2	10
S3	50
S4	100
S5	100
S6	100
S7	10
S8	10
S9	10
S10	50
S11 (MTOW≤5670 Kg)	50
S11 (MTOW>5670 Kg)	100

Table M-8: Hazard Risk Matrix – expected number of catastrophic events per aircraft category

The Hazard Risk Matrix requirements for each aircraft category, to be applied during the design phase, are shown in the following figures. Such requirements will be subject to verification and residual risk identification/acceptance at the end of the development process, at the so-called “right-hand side of the V-cycle”.

Aircraft Category: S1 – S2 – S3 – S4					
	Severity category				
Probability level	(1) CAT	(2) CRIT	(3) MAJOR	(4) MINOR	(5) NO SAFETY EFF.
(A) FREQUENT	1A	2A	3A	4A	5A
(B) PROBABLE	1B	2B	3B	4B	5B
(C) OCCASIONAL	1C	2C	3C	4C	5C
(D) REMOTE	1D	2D	3D	4D	5D
(E) IMPROBABLE	1E	2E	3E	4E	5E
(F) ELIMINATED	1F	2F	3F	4F	5F

Aircraft Category: S5					
	Severity category				
Probability level	(1) CAT	(2) CRIT	(3) MAJOR	(4) MINOR	(5) NO SAFETY EFF.
(A) FREQUENT	1A	2A	3A	4A	5A
(B) PROBABLE	1B	2B	3B	4B	5B
(C) OCCASIONAL	1C	2C	3C	4C	5C
(D) REMOTE	1D	2D	3D	4D	5D
(E) IMPROBABLE	1E	2E	3E	4E	5E
(F) ELIMINATED	1F	2F	3F	4F	5F

Aircraft Category: S6					
	Severity category				
Probability level	(1) CAT	(2) CRIT	(3) MAJOR	(4) MINOR	(5) NO SAFETY EFF.
(A) FREQUENT	1A	2A	3A	4A	5A
(B) PROBABLE	1B	2B	3B	4B	5B
(C) OCCASIONAL	1C	2C	3C	4C	5C
(D) REMOTE	1D	2D	3D	4D	5D
(E) IMPROBABLE	1E	2E	3E	4E	5E
(F) ELIMINATED	1F	2F	3F	4F	5F

Aircraft Category: S7 – S8					
	Severity category				
Probability level	(1) CAT	(2) CRIT	(3) MAJOR	(4) MINOR	(5) NO SAFETY EFF.
(A) FREQUENT	1A	2A	3A	4A	5A
(B) PROBABLE	1B	2B	3B	4B	5B
(C) OCCASIONAL	1C	2C	3C	4C	5C
(D) REMOTE	1D	2D	3D	4D	5D
(E) IMPROBABLE	1E	2E	3E	4E	5E
(F) ELIMINATED	1F	2F	3F	4F	5F

Aircraft Category: S9					
	Severity category				
Probability level	(1) CAT	(2) CRIT	(3) MAJOR	(4) MINOR	(5) NO SAFETY EFF.
(A) FREQUENT	1A	2A	3A	4A	5A
(B) PROBABLE	1B	2B	3B	4B	5B
(C) OCCASIONAL	1C	2C	3C	4C	5C
(D) REMOTE	1D	2D	3D	4D	5D
(E) IMPROBABLE	1E	2E	3E	4E	5E
(F) ELIMINATED	1F	2F	3F	4F	5F

Aircraft Category: S10					
	Severity category				
Probability level	(1) CAT	(2) CRIT	(3) MAJOR	(4) MINOR	(5) NO SAFETY EFF.
(A) FREQUENT	1A	2A	3A	4A	5A
(B) PROBABLE	1B	2B	3B	4B	5B
(C) OCCASIONAL	1C	2C	3C	4C	5C
(D) REMOTE	1D	2D	3D	4D	5D
(E) IMPROBABLE	1E	2E	3E	4E	5E
(F) ELIMINATED	1F	2F	3F	4F	5F

Aircraft Category: S11					
	Severity category				
Probability level	(1) CAT	(2) CRIT	(3) MAJOR	(4) MINOR	(5) NO SAFETY EFF.
(A) FREQUENT	1A	2A	3A	4A	5A
(B) PROBABLE	1B	2B	3B	4B	5B
(C) OCCASIONAL	1C	2C	3C	4C	5C
(D) REMOTE	1D	2D	3D	4D	5D
(E) IMPROBABLE	1E	2E	3E	4E	5E
(F) ELIMINATED	1F	2F	3F	4F	5F

HIGH	SERIOUS	MEDIUM	LOW	NO RISK

Figure M-9: Hazard Risk Index matrixes and relevant acceptability – safety requirements – design phase

Based on the colour coding allocated for each combination of aircraft category, hazard frequency and probability, the Applicant should design to aim the green and blue areas.

M5.3 SPECIAL CONDITIONS AND RISKS

Sometimes, for particular military operating requirements, some fault conditions identified during the design phase could be characterized by an unacceptable risk index due to technical limits.

For these conditions, the Applicant shall assess the possibility of establishing corrective provisions to reduce the risk, for example: redesign, introduction of safety devices, introduction of reliable monitoring and warning devices, appropriate, reliable and consolidated procedures for managing the risk via crew actions, inspection and maintenance actions. The procedure to pre-emptively assess and accept airworthiness and safety risks identified during the entire development life-cycle is described in AER(EP).P-23.

In addition, Special Conditions may be established and concurred with DAAA, with the scope of tailoring a particular safety requirement[7]. The Special Conditions related to the safety requirements should be limited in number (not exceeding 10% of the total of catastrophic events) and be justified with reasons purely technical in nature (for example, no feasible alternative solutions, reaching the technical limits inherent in the state of the art, lack of maturity of alternative technologies, etc.).

M5.4 READ ACROSS FROM OTHER AUTHORITIES

The military aircraft procured and derived from a civil design normally carries an original civil Type Certificate, on top of which a Military Type Certificate is built to cater for the specific military requirements.

In these cases, the "green version" of the aircraft results compliant with the civil regulation and its descending safety ecosystem, which may deviate from the quantitative and qualitative requirements set in this Annex. For instance, the severity definition for catastrophic events, established in the civil regulation ARP4761 admit a number of fatalities which are instead not tolerated in the military construct. This misalignment may yield to a different decomposition of the fault conditions, a diverted value of the P_Cum_Cat and a challengeable level of risk acceptance.

For what above, when the aircraft derives from a civil design, the Applicant should produce a comprehensive safety analysis, which embraces not only the bespoke military requirements and design changes, but also the effects of the original civil ecosystem in the military context. As a minimum, such potential misalignment should be identified as a risk, and assessed and accepted as per AER(EP).P-23.

[7] For instance, for single engine-aircraft, the technological limitations associated with the design of the engine may lead to a non-compliance with respect to the safety requirement allocated to the condition of unrecoverable loss of thrust. A tailored safety requirement may be needed and concurred with the DAAA.

This requirement is irrespective of any Mutual Recognition established between DAAA and the Civil Airworthiness Authority releasing the original civil Type Certificate.

Similar verification of the original safety requirements should also apply when inheriting an aircraft already certified by a different/foreign Military Airworthiness Authority.

M6. HUMAN ERRORS

Human errors are excluded from the P_Cum_Cat computation and HRI, however the Applicant should model the human contributions (air/ground crew throughout piloting and maintenance/installation tasks, without allocating a particular failure rate) as basic events in the Fault Tree Analysis and as potential conditioning/contributing/alleviating factors within the Functional Failure Analysis, with the purpose of identifying potential failure modes triggered/intensified by human contributions which otherwise would have been overlooked.

M7. SAFETY MAINTENANCE

After the release of a Military Type Certificate, the aircraft design continues to evolve in order to cater for new/additional requirements or to fix identified issues/non-compliances (Continued Airworthiness).

These aircraft configuration changes and the in-service use of the system, including reliability data, may also imply a re-visitation of the original failure rates used in the Fault Tree Analysis, the closure of legacy fault conditions and/or introduction of new ones, etc.

For what above, the Applicant should establish a method and a procedure to maintain the safety analysis and notify the DAAA whenever significant changes[8] occur.

M8. LEGACY PROGRAMMES

This Annex is valid from the date of approval.

Any analysis, activity and artefact produced in support of the extant/running/legacy programmes remain valid, unless a major significant/substantial change[9] occurs to the aircraft type design, which may require, with DAAA concurrence, the re-visitation of the certification basis, the applicable codes and/or the safety standards, tasks, objectives and outcomes.

The Applicant shall therefore concur with DAAA the strategy for the entry into use of the present Annex into the extant/running/legacy programmes.

[8] Refer to AER(EP).P-21 for the classification of the changes
[9] Refer to AER(EP).P-21 for the classification of the changes