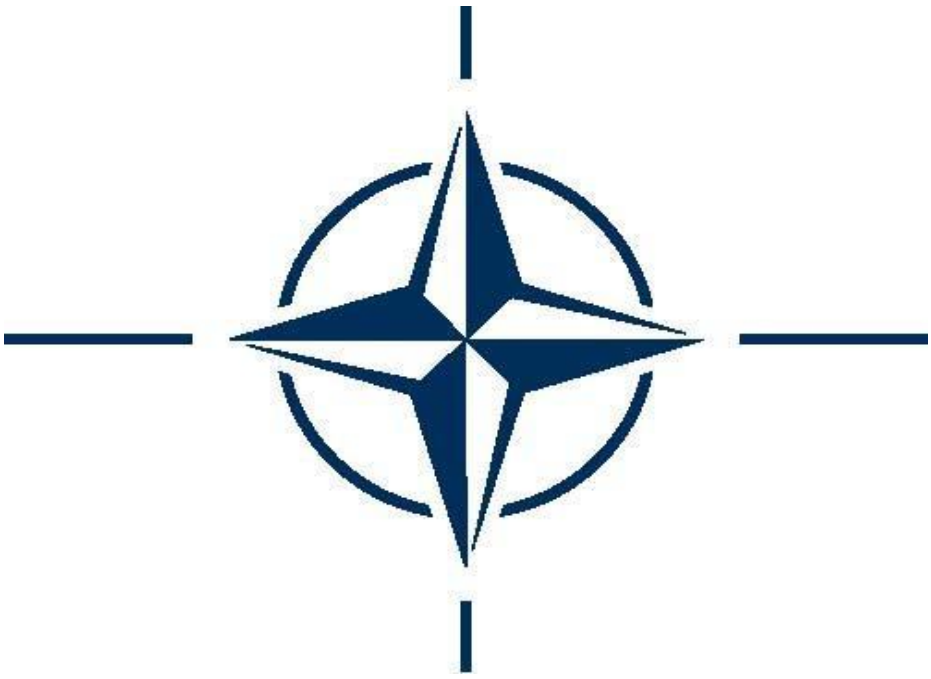
STANDARDS RELATED DOCUMENT

ATP-3.3.4.2.1

A GUIDE TO OBTAINING AIR-TO-AIR REFUELING CLEARANCES AND COMPATIBILITY ASSESSMENTS

Edition B Version 1

MARCH 2021



NORTH ATLANTIC TREATY ORGANIZATION

Published by the
NATO STANDARDIZATION OFFICE (NSO)

INTENTIONALLY BLANK

NORTH ATLANTIC TREATY ORGANIZATION (NATO)

NATO STANDARDIZATION OFFICE (NSO)

NATO LETTER OF PROMULGATION

25 March 2021

1. The enclosed Standards Related Document ATP-3.3.4.2.1, Edition B Version 1, A GUIDE TO OBTAINING AIR-TO-AIR REFUELING CLEARANCES AND COMPATIBILITY ASSESSMENTS, which has been approved in conjunction with ATP-3.3.4.2 by the nations in the Military Committee Air Standardization Board (MCASB), is promulgated herewith.

2. ATP-3.3.4.2.1, Edition B, Version 1 is effective upon receipt and supersedes ATP-3.3.4.2.1, Edition A, Version 1 which shall be destroyed in accordance with the local procedure for the destruction of documents.

3. This NATO standardization document is issued by NATO. In case of reproduction, NATO is to be acknowledged. NATO does not charge any fee for its standardization documents at any stage, which are not intended to be sold. They can be retrieved from the NATO Standardization Document Database ((https://nso.nato.int/nso/) or through your national standardization authorities.

4. This publication shall be handled in accordance with C-M(2002)60.

Zoltán GULYÁS
Brigadier General, HUNAF
Director, NATO Standardization Office

INTENTIONALLY BLANK

RESERVED FOR NATIONAL LETTER OF PROMULGATION

INTENTIONALLY BLANK

TABLE OF CONTENTS

INTENTIONALLY BLANK

CHAPTER 1 INTRODUCTION

NOTE

THE PROCEDURE CONTAINED WITHIN IS INTENDED AS A GUIDE FOR NATIONAL OR MULTI-NATIONAL AAR CLEARANCE STANDARDIZATION.

THE PROCESS IS NOT MANDATORY AND DOES NOT SUPERSEDE NATIONAL PROCEDURES.

1.1. INTRODUCTION

An Air-to-Air Refuelling (AAR) Clearance is the result of assessed risk determined to be acceptable for conducting AAR between tanker and receiver aircraft as well as legal, financial and political considerations. In AAR there are two types of risk to consider—technical and operational. Technical risk is assessed through a Technical Compatibility Assessment (TCA). A TCA is accomplished to determine the airworthiness and technical risk of a tanker and receiver pairing. This is further discussed in Chapter 3. Operational Risk is assessed through an Operational Compatibility Assessment (OCA) discussed in Chapter 4. An OCA is accomplished to determine individual and organizational qualification and operational risk in conducting AAR.

1.2. BACKGROUND

1. This Standards Related Document (SRD) explains an acceptable means of complying with the above assessments and presents general guidelines for nations and organizations/agencies to navigate these processes. It also provides standardized definitions and terms to ensure greater international interoperability. There are three AAR Clearance categories (1, 2, & 3). These clearance category numbers are based on a TCA. However, before aircraft are tasked, the TCA should be considered in conjunction with an OCA as well as the legal, financial considerations. For the purposes of this document, a completed clearance means that technical and operational considerations have been addressed and a Commander can then task their assets. A published AAR TCA for a specific tanker/receiver combination only verifies that the subject tanker and receiver are technically capable of conducting AAR. Importantly, a TCA does not constitute an authority or clearance to conduct AAR operations. That authority is ultimately a Commander’s decision which should take into account the results of TCAs and/or OCAs or any other considerations.

2. The national procedures for addressing all aspects of a clearance vary from nation to nation and specific procedures are not currently mandated by any NATO STANAG. Annexes to this SRD aim to supply nations with an acceptable means of complying with TCAs and OCAs. Ultimately, the conduct of AAR is the result of national and bi-lateral agreements.

1.3. AAR COMPATIBILITY REPOSITORY

1. In order to facilitate multi-national AAR operations, a repository of Compatibility Assessment documentation is required. The national and organizational SRDs to ATP-3.3.4.2 comprise the only common source where AAR compatibility details can be found. The AAR Compatibility and Clearance Matrix is a quick reference guide to the clearance and compatibility to what is reported by the nations in their SRDs.

The National/Organizational SRDs are the primary reference documentation and should always be referenced when planning or conducting AAR operations.

2. In order to ensure the most accurate clearance and compatibility information as is possible is available to commanders, planners and operators, nations and organizations should:

- Maintain accurate and complete SRDs in accordance with the template located at www.japcc.org/aar.
- Make SRDs available to their applicable crews.
- Submit their SRDs to the custodian of the AAR Compatibility and Clearance Matrix.

3. The matrix custodian will make SRDs available for international use and will update the above-mentioned matrix with updated clearance and compatibility information.

4. The AAR Compatibility and Clearance Matrix can be viewed at www.japcc.org/aar and its custodian can be reached at aar@japcc.org.

CHAPTER 2 AAR CLEARANCE CATEGORIES, REQUESTS AND DOCUMENTATION

2.1. AAR CLEARANCE CATEGORIES

There are three AAR Clearance categories. While clearances in total include the TCA, OCA and other considerations, the numerical assignment will be TCA-driven as further described in the paragraphs below. Ultimately, nations individually determine, through assessments, the clearance category of their own aircraft paired with another nation's aircraft. Therefore, a category assigned by the tanker or receiver nation when assessing their pairing can differ between the two nations.

2.1.1 Category 1

Definition. No requisite technical aspects regarding airworthiness/safety of flight for the targeted tanker/receiver pairing have been satisfied through acceptable means of compliance for the targeted scope specified by the nation requesting and/or conducting the analysis, beyond an in-principle form/fit desktop evaluation of available data.

Amplifying information. A level of safety as required by the agreed certification basis (set of criteria to be assessed by test, evaluation and certification community) cannot be assured for any portion of the scope of the AAR envelope. Mitigation of residual technical risk depends entirely on engineering judgement.

2.1.2 Category 2

Definition. Some of the requisite technical aspects regarding airworthiness/safety of flight for the targeted tanker/receiver pairing have been satisfied through acceptable means of compliance for the targeted scope specified by the nation requesting and/or conducting the analysis.

Amplifying information. A level of safety as required by the agreed certification basis (set of criteria to be assessed by test, evaluation and certification community) can be partially assured for the scope of the AAR envelope. Some aspects within the scope of the AAR envelope have not been evaluated, while the associated residual technical risk cannot be mitigated through limitations on the scope of the AAR envelope. For CAT 2 residual technical risks, the only mitigation resides in restricting the chance of exposure through limiting how long a clearance is valid.

2.1.3 Category 3

Definition. All requisite technical aspects regarding airworthiness/safety of flight for the targeted tanker/receiver pairing have been satisfied through acceptable means of compliance for the targeted scope specified by the nation requesting and/or conducting the analysis.

Amplifying information. The CAT 3 may be deliberately limited to any acceptable scope provided it has been completely evaluated for all required technical aspects within this scope. The full level of safety required by the pre-agreed certification basis can be assured, in accordance with applicable national requirements.

2.2 CONSIDERATIONS FOR ALL CATEGORIES

2.2.1 Risk

Each clearance category carries a different level, amount and type of risk. Broadly speaking, a CAT 1 has a higher level of risk than a CAT 2 which has a higher level of risk than a CAT 3. There are three owners of risk in terms of AAR—the tanker nation, the receiver nation, and the nation where the AAR event takes place, although, the location of the event may yet to be determined, thus, this risk is difficult to quantify. Risks to all three should be considered at the appropriate level. Lastly, nations should not be content to operate on CAT 1 clearances indefinitely unless the likelihood of the pairing conducting AAR Ops is remote. In such a case, the CAT 1 would be simply an indicator to planners, that the pairing is a possibility.

2.2.2 Duration of validity

Clearances can have an open-ended duration of validity, but are subject to review if there are changes impacting key elements of the AAR Clearance such as changes in tanker/receiver equipment, visual aids, refuelling/mission procedures and other specifications to be eventually discussed in future versions of the Standardized Technical Data Survey (STDS, Annex B). In addition, it is recommended that all AAR clearances be reviewed periodically to ensure currency.

2.2.3 Cost

The cost of obtaining clearances will be mutually agreed by the tanker and receiver nations or a third party who may be involved in the clearance process.

2.2.4 Certification and the categories

Since CAT 1 and CAT 2 clearances do not satisfy the full level of safety required by the pre-agreed certification basis can be assured, these clearances would typically not qualify for certification by relevant aviation authority. Therefore, operations under a CAT 1 or CAT 2 would be akin to operations under an exemption having been subject of technical risk management. In contrast, a CAT 3 having satisfied all relevant certification specifications would qualify for certification by the relevant aviation authority. It is understood that at this time not all nations conduct certification under an independent aviation authority and thus the organization they do use might have equivalent terms such as “qualification” / “approval” which essentially equate to “certification” as it applies to this paragraph.

2.3 FORMALIZED AAR CLEARANCE REQUEST

A formal request for an AAR Clearance can be initiated by a tanker or receiver or third party. National Standards Related Documents (SRD) to ATP 3.3.4.2 outline to whom the request should be sent and may include what additional information should be included. If National SRDs do not contain a formatted request template, Annex A contains a suggested template and a list of suggested information to include with the request.

2.4. AAR CLEARANCE/AUTHORIZATION DOCUMENTATION

The formal authorization to conduct AAR varies by nation and may be manifested in an Execution Order, Operations Order, Air Tasking Order, schedule, or other formalized bi-lateral agreement. Nations at a minimum should reflect (in chart, list or other form) the status of TCAs and OCAs in their National SRD and should also list completed clearances to the maximum extent possible.

INTENTIONALLY BLANK

CHAPTER 3 AAR TECHNICAL COMPATIBILITY ASSESSMENT

3.1 TECHNICAL COMPATIBILITY ASSESSMENT (TCA)

1. Safe, efficient AAR operations between two or more aircraft are dependent on their technical compatibility. NATO STANAGs provide standardized specifications for AAR equipment. The Technical Compatibility Assessment confirms that the aircraft are (or are not) able to mechanically couple, off-load or on-load fuel and then decouple without damaging either aircraft or creating an unsafe situation. The Technical Compatibility Assessment is conducted by the test and evaluation and engineering organizations of both tanker and receiver aircraft. There are multiple means of conducting a TCA which can include verification through analysis of flight, ground, or lab test data and/or validation through read-across using acceptable data collected previously or by third parties. Finally, even if all desired testing and data collection/analysis is completed, there may be some incompatibilities that are identified and limitations may need to be in place to negate this incompatibility.

2. Each nation should confirm via bi-lateral or multi-lateral agreements that the aircraft they operate complies with applicable agreed upon AAR design standards such as the following NATO standards: (Reference most current) NATO ATP-3.3.4.5 (STANAG 7191), NATO ATP-3.3.4.7 (STANAG 7215), NATO ATP-3.3.4.2 (STANAG 3971), and NATO ATP-3.3.4.6 (STANAG 3447).

3.1.1 TCA Content

A TCA should include all available detail and may include, but is not limited to, all/or some of the following not included in ATP 3.3.4.2, aircraft documentation, or the tanker or receiver National SRD:

a. The specific aircraft and nations for which the TCA is valid

b. Compatibility envelope for the specified aircraft.

c. Limitations. The limitations specific to either the tanker or the receiver aircraft for the purposes of mitigating risk during AAR.

d. Procedural requirements specific to the tanker and receiver pairing.

e. Cautions and Warnings. The warnings and cautions for both the tanker and receiver.

f. General Information. Any additional information with respect to the aircraft and procedures, relevant to AAR.

g. Associated References. Documentation relevant to the compatibility certification process including existing compatibility documentation or data.

h. Continued airworthiness. Any limitations or procedural changes affecting the aircraft maintenance program should be addressed and incorporated in the relevant aircraft documentation such as maintenance manuals.

Note: The specific decision to ignore a portion or all of the TCA will be considered addressing that aspect.

3.2. CONSIDERATIONS FOR A SUCCESSFUL TCA PROCESS:

A successful outcome will be enabled by:

a. An open and rapid exchange of information between all agencies through any manner including but not limited to meetings to involve technical, operational and identified test agencies as well as aircraft hardware manufacturers.

b. Ready availability and maximum use of applicable technical information including full access to accurate data from all equipment manufacturers. Nations and commercial operators that appoint either the OEM or another representative as the platform Engineering Authority should confirm that responsibility for engineering related communication has been transferred to that party.

c. Ready availability and use of a fully completed Standardized Technical Data Survey (STDS) for receiver and tanker aircraft specifying refuelling method to be used. See ANNEX B for details on the STDS.

d. Mutual agreement on the applicable Certifications Specifications and Acceptable Means of Compliance.

e. An early consensus on AAR requirements including, but not limited to factors such as where will the AAR be conducted, in what weather, whether or not the AAR clearance is required for day and/or night operations, and if night vision devices will be used.

3.3. ELEMENTS OF THE TCA PROCESS

In order to accomplish a TCA, nations will identify the agreed scope that such assessment should cover. This scope is submitted in a request (ANNEX A). Once a request is accepted, there will be a need for sharing of relevant data to identify whether or not a requested technical compatibility is in principle feasible. An STDS as described in ANNEX B of this SRD can aid nations/organizations in fulfilling this requirement. After determining the feasibility of technical AAR compatibility within

the agreed scope, the involved parties then must agree on the relevant criteria against which to perform the assessment. This is often referred to as a “certification basis” although it is acknowledged that some nations may refer to this as “qualification” or “approval”. Certification Specifications covering all conceivable relevant criteria for certification of a tanker/receiver pairing known to date should be developed. These Certification Specifications are used for developing the certification plan which can take different forms in varying organizations. Such a plan will identify acceptable means of compliance. Where these acceptable means of compliance are identified as requiring flight test, a test plan is developed with applicable flight test techniques. ANNEX C of this SRD contains the Certification Specifications (CS) and Acceptable Means of Compliance (AMC)/Guidance Material (GM) for Air-to-Air Refuelling Tanker/Receiver pairing Technical Compatibility Assessment, CS-AAR document. ANNEX D and ANNEX E contain generic test plan and Flight Test Technique (FTT) suggestions for Boom/Receptacle and Probe/Drogue pairings as required.

3.4. SCOPE

Nations may agree to restrict the targeted/requested AAR envelope for various reasons such as a limited resource of money, time, and asset or personnel availability. It should be noted that even in the case of such a voluntarily limited scope, a TCA that satisfactorily meets all applicable certification specifications will still be able to support a CAT 3 clearance.

3.5. READ-ACROSS

The TCA process will be greatly assisted, and potentially accelerated, by the provision of previous AAR Compatibility Assessments and/or Clearances between specified receiver aircraft and specified tankers (from a different nation). Further, if the receiver aircraft data is technically and operationally similar (e.g. a variant of another nation’s receiver), the depth and scope of the AAR Compatibility Assessment Process may be significantly reduced. This read-across of information may contain evidence from previous Compatibility Assessments, AAR envelope parameters, cautions, warnings and general information that is important to note. Furthermore, accreditation of the organizations/authorities involved with production of the relevant data in the TCA used for read-across reference, renders this as acceptable data thus removing the requirement for verification.

INTENTIONALLY BLANK

CHAPTER 4 AAR OPERATIONAL COMPATIBILITY ASSESSMENT

4.1 OPERATIONAL COMPATIBILITY ASSESSMENT

1. The Operational Compatibility Assessment (OAC) is a process which assesses the ability and risk of two aircraft, conducting AAR in accordance with operational considerations and procedures. This assessment considers operational aspects such as role, configuration, environment, procedures, crew training and currency.

2. ATP-3.3.4.2 details NATO AAR procedures with individual national SRDs covering data and procedures specific to AAR-capable countries, agencies and organizations. OCAs should be conducted by the command element that operates the aircraft being assessed. The applicable staff conducting an OCA should make every effort to brief their Commanders on the risk they will be accepting for the particular assessed pairing.

4.2 CONSIDERATIONS FOR OPERATIONAL COMPATIBILITY ASSESSMENT

An OCA should consider and may include, but is not necessarily limited to, all/or some of the below aspects. These aspects may or may not be addressed in ATP 3.3.4.2, aircraft documentation, or the tanker or receiver National SRD.

a. The specific aircraft and nations for which the OCA is valid.

b. Crew compliment (or composition), qualification, training, currency, and experience. Nations should decide whether they are satisfied with the above standards or those of the nation with which they will be conducting AAR. Considering a nation's training/evaluation program does not necessarily require an audit. ATP 3.3.4.2.2 discusses some topics to consider with regard to training; however, each nation may have its own requirements for the applicable entity with whom they may be conducting AAR and these should be listed within their SRD.

c. Maintenance organization. For the purposes of the OCA, maintenance organization is considered to be how the maintenance units train and execute their maintenance programs. To address or consider maintenance organization for an OCA does not necessarily require an audit of such organizations.

d. Trust. Ultimately, an OCA, like a TCA and the entire compatibility and clearance process, relies heavily on trust and relationships between two nations.

e. Environment where AAR will be conducted to include threat, mission workload, and the use of Night Vision Devices.

f. Type of mission to be conducted before, during, or after the AAR by the receiver or tanker.

g. Operations tempo to include crew fatigue, duty cycles and circadian rhythm.

h. Operational necessity of a given pairing.

i. Political considerations and caveats.

Note: The specific decision to ignore a portion or all of the OCA is considered addressing that aspect.

To aid nations in completing an OCA, a document containing Operational Requirements (OR) and Acceptable Means of Compliance (AMC)/Guidance Material (GM) for Air-to-Air Refuelling Tanker/Receiver pairing Operational Compatibility Assessment, OR-AAR, has been included in ANNEX F.

CHAPTER 5 OTHER CONSIDERATIONS OF AAR

5.1 OTHER CONSIDERATIONS OF AAR

Legal and financial agreements, memorandums of understanding, or common framework that permits the multinational AAR activity. Fiscal and legal arrangements are a critical component of being able to conduct AAR operations. Although these items are typically bilateral in nature, or tied to a specific operation or theatre, it is recommended that they be addressed early in the AAR clearance process. Many of the required agreements can take months to years to formalize.

5.2 LEGAL CONSIDERATIONS

Some key legal issues relate to liability in the case of an accident or incident. Possible legal mechanisms that could satisfy agreements are: Status of Forces Agreements, bi-lateral or multi-lateral agreements, Special Instructions (SPINS) or operations plans for specific theatres of operation. Third-party liability should also be considered with regard to who owns the airspace in, or the land over, which the AAR will be conducted.

5.3 FISCAL CONSIDERATIONS

Some of the key fiscal issues relate to how payment for flight hours and fuel will be handled, and how will transit time or loiter time be paid for if conducting operations with numerous nations. Compensation for services can be done using multinational/bi-lateral agreements such as the Air Transport and Air to Air Refuelling and other Exchange of Services (ATARES) Agreement, cross servicing agreements, replacement in kind agreements, Foreign Military Sales agreements, or with cash transfers.

INTENTIONALLY BLANK

ANNEX A AIR-TO-AIR REFUELLING CLEARANCE REQUEST

ANNEX A contains a suggested template and a list of suggested information to include with the request.

TCA Category sought. (CAT1, CAT2, CAT3)

- Estimated magnitude of support. Location and timeline of support required.
- Operational Mission Requirements
- Type of refuelling system involved. (hose/drogue, boom/receptacle, BDA or all three)
- Type and mark of all aircraft requiring AAR. (Can be model i.e. F-16D, receiver flagged nation)
- Authority for direct contact with receiver and tanker aircraft manufacturers, AAR system manufacturers, OEM or others.
- POC of receiver and tanker aircraft and AAR system manufacturers, OEM or others.
- Previous AAR clearances between the designated receiver and other tankers.
- Fuel type required

INTENTIONALLY BLANK

ANNEX B STANDARDIZED TECHNICAL DATA SURVEYS

When Standardized Technical Data Survey (STDS) survey blanks involve units of measure, it is requested they be identified for each numbered response. United States units of measure or metric units should be consistent throughout the document to avoid confusion. When differences exist, they should be clearly identified.

- Use additional sheets when the form does not provide adequate space.
- Label attachments in accordance with the appropriate sections.
- Specify tanker and/or receiver aircraft which are equipped with both systems, those that are aerial refuelable or ground convertible and tankers which have multipoint capabilities. Also, include requirements and time to perform the conversion.
- When the available data is not easily transformed into the survey format, submit data in the as available format describing the data parameters.
- When required and/or available, it is required that 3-view drawings with airplane coordinates be provided for each receiver aircraft and 5-view drawings for the tanker aircraft. The two additional views of the tanker should include rear and bottom views. The data required by the survey for lighting, markings, aerial refuelling hardware location and envelope, aerial refuelling receptacle/slipway structural skin reinforcement, and pilot's eye position should be illustrated on the drawings when practical.
- Those completing this document should be knowledgeable fuel/AAR systems engineers, manufacturers of aircraft, aerial refuelling systems, subsystems and components and/or familiar with published/verified AAR technical interface data.
- When provided component data should include applicable aircraft identity.
- For those receiver aircraft that can be equipped with a portable tanker package (buddy store), the applicable portions of the tanker section should be completed.
- When the survey is not clear and/or does not specifically address a significant feature which you feel needs addressed, request you correct the form as required and fill in the information.

AAR Envelope Development. A chart depicting altitude and airspeed (equivalent) as a function of gross weight must be submitted and should be a part of the completed STDS. The AAR envelopes of the tanker and receiver aircraft can be overlaid and compared at this stage to assist in Compatibility Assessment. Any operational issues may require further assessment during the Operational Compatibility Assessment.

Standardized Technical Data Survey (STDS). In an attempt to standardize the AAR clearances process and provide a template that details AAR equipment data specific to AAR-capable aircraft, the Standardized Technical Data Survey (STDS) is included as ANNEX B of this SRD. A properly completed STDS will contain the necessary tanker/receiver data based on its use of boom/receptacle or probe/drogue AAR equipment for the Compatibility Assessment. In future, there could be a possibility for nations to decrease the necessity for data sharing for TCAs by accepting a reference to agreed technical standards as in the case of design specifications already in NATO standards referenced above.

- The questions in the STDS address critical factors involving AAR altitude/airspeed capabilities, hardware mating interfaces, structural loads, fuel line pressure capabilities, fuel pressure regulation capabilities, formation aids (lighting/marking, director lights and status lights, rendezvous equipment, including radios, radar, etc.), emergency procedures/engine out capability, redundancy and more.

- Even before data has been entered into the STDS, the STDS document can be effectively used as a comprehensive technical and operational tool. It provides the critical questions that must be answered in planning for an aerial refuelling mission. It provides an excellent starting point to support a dialog between tanker and receiver aircraft compatibility evaluators.

- Data from the following disciplines are required to complete this survey and are included to assist distribution:

Aerial Refuelling System
Fuel System
Structures
Aerodynamic/Performance
Stability and Control
Hydraulics/Pneumatics
Electrical/Electronic
Mechanical
Crew Stations
External Lighting/Marking
Avionics (Radio/Navigation Rendezvous Equipment)
Test (Lab/Ground/Flight)
Aircraft Configuration Control

- When completed, this questionnaire may require special access control and/or military classification. The company/organization and or country filling in the data should identify that control information to the recipients of the completed document.

ABBREVIATIONS

ADF	Automatic Direction Finder
AM	Amplitude Modulation
AR	Aerial Refueling
ARO	Aerial Refueling Operator
BL	Buttline
BO	Boom Operator
CG	Center of Gravity
DF	Direction Finder
FFP	Ferry Flight Performance
FLIR	Forward Looking Infra-Red
FM	Frequency Modulation
FS	Fuselage Station
GPM	Gallons Per Minute
GW	Gross Weight
HF	High Frequency
HM	Hot Mike
IFF	Identification Friend or Foe
KEAS	Knots Equivalent Air Speed
LORAN	Long Range Area Navigation
NVG	Night Vision Goggles
NVIS	Night Vision Imaging System
PTT	Push to Talk
PSI	Pounds per Square Inch
PSIG	Pounds per Square Inch Gauge
SIF	Selective Identification Feature
TACAN	Tactical Air Navigation System
UARRSI	Universal Aerial Refueling Receptacle Slipway Installation
UHF	Ultra High Frequency
VHF	Very High Frequency
WL	Waterline

INTENTIONALLY BLANK

ANNEX B1 STDS: TANKER AIRCRAFT BOOM EQUIPPED

TANKER AIRCRAFT (BOOM EQUIPPED)

For the most current version of references please visit http://www.arsaginc.com/

1. AIRCRAFT DESIGNATION

   a. Mission, Design, Series (Type, Model, Series) _____

   b. Familiar Name _____

   c. Primary Role/Mission _____

   d. Operating Country/Service _____

   e. Number in Inventory (Optional) _____

2. REFERENCES

   a. Flight Manual Designation _____

   b. Aerial Refuelling Operational Manual Designation _____

   c. Maintenance procedures (Optional)

   d. Identify any tanker interface document(s) attachment of documents (Optional)

	ATTACHED TO SURVEY	NOT AVAILABLE
3. NORMAL AERIAL REFUELING ENVELOPE Provide a chart depicting altitude and airspeed (equivalent) as a function of gross weight as illustrated in Attch 1.	☐	☐
4. ENGINE(S) OUT AERIAL REFUELING ENVELOPE Provide a chart depicting altitude and airspeed (equivalent) as a function of gross weight as illustrated in Attch 1 for minimum number of engines operating which will still permit aerial refuelling.	☐	☐
5. CRUISE PERFORMANCE (FERRY FLIGHT PERFORMANCE) Provide a chart depicting optimum altitude and optimum airspeed as a function of gross weight. Depict this performance curve on the AR envelopes required for survey questions 3 and 4 above.	☐	☐

6. FLIGHT RESTRICTIONS	ATTACHED TO SURVEY	NOT AVAILABLE
List operating restrictions/limitations involving or related to aerial refuelling operations.	☐	☐

7. FUEL AVAILABLE FOR TRANSFER TO RECEIVER AIRCRAFT

a. Provide a chart which depicts fuel available for transfer versus range and gross weight as illustrated in Attachment 2. ☐ ☐

b. Provide a similar chart which depicts fuel available for Transfer versus time with aircraft operating at maximum endurance during the aerial refuelling operations. (Optional)

c. Specify type of fuel (JP-4, JP-5, JP-8, etc.) used in constructing charts.

8. AUTHORIZED FUELS

List types of fuel and fuel additives approved for use and their limitations (i.e., see Attch 3) ☐ ☐

9. FUEL OFFLOAD FLOW RATE (at Boom Nozzle Inlet prior to nozzle/receptacle pressure drop)

a. Rate/Pressure/Distance (from nozzle tip) where measured _____GPM
See reference 2 for further information
_____PSIG
_____Inches

b. Provide a fuel flow versus pressure curve for all pumping configurations. ☐ ☐

10. PRESSURE REGULATION, SURGE SUPPRESSION AND REFUELING SYSTEMS DESIGN PRESSURES
See reference 2 for further information

a. Pressure Regulation (Nozzle Inlet)	Zero Flow	Normal Flow
– Normal System	____PSIG	____PSIG
– Failed Regulator (Single)	____PSIG	____PSIG
– Other Single Failure Conditions (Identify failure mode(s) evaluated i.e. Hydraulic Flow Controllers)	____PSIG	____PSIG

b. Other Delivery Pressure Relief Features, if present

– Type _____

– Cracking Pressure _____

– Flowing Pressure (GPM/PSI) _____

– Reseat Pressure _____

c. Surge Suppression Devices

– Type _____

– Capacity _____

– Precharge (Optional) _____

d. Refuelling System Design Pressures (PSIG) _____

– Operating *Defined in section 3.4 of reference 2* _____

– Limit (Proof) *Defined in section 3.5 of reference 2* _____

– Surge *Defined in section 3.6 of reference 2* _____

– Ultimate (Burst) *Discussed in section 3.7 of reference 2* _____

11. FUEL DUMP CAPABILITY (Optional)

a. Type system (i.e., wing dump mast, or through boom) _____

b. Maximum dump rate _____

	ATTACHED TO SURVEY	NOT AVAILABLE
12. CENTER OF GRAVITY (CG) MANAGEMENT		
Describe CG management method. Include restrictions in item 6.	☐	☐

13. MAXIMUM REVERSE FLOW DIRECTION REFUELING

Capable of reverse refuelling?	Yes	No

a. Rate _____GPM

b. Include restrictions in item 6.

14. FUSELAGE PITCH ANGLE DURING REFUELING

Provide angle of fuselage reference plane (waterline zero) to the ground at the following aerial refuelling airspeeds:
(+ indicates nose pitched up)

a. Maximum
_____Degrees

b. Minimum
_____Degrees

c. Nominal
_____Degrees

15. AERIAL REFUELING SIGNAL SYSTEM OVERRIDE CAPABILITY

a. Override capability exists YES _____ NO_____

b. Include restrictions in item 6 _____

16. BOOM INTERPHONE CAPABILITY TYPE

Identify the crewmembers who have the capability to talk over the boom interphone system.
Specify type push-to-talk (PTT) and or hot mike (HM).

Pilot_____
Co-Pilot_____
Navigator_____
Flight Eng _____
Boom Operator _____

17. INDEPENDENT DISCONNECT CAPABILITY

Does tanker have capability to disconnect from receiver with receptacle toggles in latched position (other than brute force)? YES____ NO_____

	ATTACHED TO SURVEY	NOT AVAILABLE
18. EXTERIOR LIGHTING	☐	☐

Provide illustration showing light locations, angular coverage, and areas illuminated for all exterior lights (i.e., see Attachment 4). for each light include type of light (incandescent, strobe, etc.), location in aircraft coordinates, lens colour, crew member having control, flashing or coding logic, intensity control/range (full rheostat dimming, step switch), NVG friendly, covert capability, etc. (Include Pilot Director Light operational coding in item 24).

19. EXTERIOR MARKING ☐ ☐

Provide illustration or description of tanker and boom markings which assist receiver formation positioning.

20. NVG COMPATIBILITY

a. Are the interior lights NVIS friendly? YES NO

b. Are the external lights NVIS friendly? YES NO

c. Do the external lights have a covert mode? YES NO
If yes describe basic mode (i.e. off vs. different spectrum)

21. RADIOS (Quantity, type, and frequency range)

a. HF Voice _____

b. VHF AM Voice _____

c. VHF FM Voice _____

d. VHF Navigation Receiver _____

e. UHF Voice _____

f. Satellite Communications _____

g. Other _____

h. Known EMI issues with any of the above YES NO
If yes, describe issues and restrictions below

_____

22. IFF/SIF

a. Transponder (quantity and type) _____

b. Interrogation Capability YES _____ NO _____

23. NAVIGATION AND RENDEVOUS EQUIPMENT (Quantity and type)

a. Inertial Navigation _____

b. Search Radar _____

c. Infrared (FLIR, etc.) _____

d. Electro-optical (television, etc.) _____

e. Rendezvous Radar Beacon _____

f. Doppler Radar _____

g. TACAN

Air-to-Air Mode _____

h. ADF _____

i. UHF DF _____

j. Celestial Navigation _____

k. LORAN (A or C) _____

l. Other _____

m. Known EMI issues with any of the above YES NO
If yes, describe issues and restrictions below

_____

24. BOOM PIVOT LOCATION (Optional)

a. Fuselage Station _____

b. Waterline _____

c. Buttline _____

25. BOOM LENGTH AND OPERATING ENVELOPE

	ATTACHED TO SURVEY	NOT AVAILABLE
Provide an illustration similar to Figure 3, AFGS 87166A (Attachments 5 and 6). Include the following:	☐	☐
a. Mechanical interference envelope	☐	☐
b. Refuelling disconnect envelope (Describe limits)	☐	☐
(1) Ground adjustment	YES ____	NO ____
(2) Flight adjustable by boom operator	YES ____	NO ____
	ATTACHED TO SURVEY	NOT AVAILABLE
c. Boom control envelope at maximum and minimum aerial refuelling airspeeds	☐	☐

d. Contact envelope ☐ ☐

e. Pilot Director Light coding ☐ ☐

f. Automatic load alleviation YES ____ NO ____

g. Describe automatic load alleviation limits ☐ ☐

26. BOOM STRENGTH Design Limit /Ultimate

a. Axial compression _____/_____

b. Axial Tension _____/_____

c. Radial _____/_____

d. Impact (compression) _____/_____

e. Telescoping tube extension/retraction force (Optional)

27. BOOM OPERATOR'S STATION WINDOW VISIBILITY ☐ ☐

Provide illustration showing field of view from design eye position and with normal head movement. Identify extensions to direct field of view obtained with mirrors, periscopes, television, etc. (See Attch 7)

28. AUTOPILOT AND STABILITY AUGMENTATION ☐ ☐

a. Identify type autopilot and stability augmentation systems.

b. Indicate considerations affecting aerial refuelling including whether normally used and impact on receiver if inoperative.

c. Include restrictions in item 6.

29. WAKE TURBULENCE ATTACHED TO SURVEY NOT AVAILABLE

Describe tanker flow field as a function of spanwise position and elevation relative to the tanker to a point 500 feet aft of the boom in terms of velocity and angle referenced to free stream for representative airspeeds, altitudes and gross weights. ☐ ☐

30. OTHER COMPATIBILITY INTERFACE DATA (Test + Design)

a. Identify non-compliance of refuelling boom and nozzle with military specifications and drawings. ☐ ☐

b. Include other information affecting aerial refuelling compatibility. ☐ ☐

c. Compliance with STANAG 7191

31. AERIAL REFUELING COMPATIBILITY INTERFACE DATA (TEST & DESIGN)

For tests conducted with receivers currently in the active inventory, provide the following: (Use additional sheets as necessary)

a. Agency conducting test _____

b. Test report number _____

c. Title of report _____

d. Date of report _____

e. Receiver aircraft (or test rig/simulator) utilized in test _____

f. Type test (rig, ground, mock-up, flight) _____

g. Type instrumentation _____

h. Report available from _____

i. Attach abstract or description of test _____

32. COMPONENT DATA (Optional)

a. Name of Component/Subsystem _____

b. Performance Criteria

(1) Weight (fully serviced hydraulic fluid) _____

(2) Airspeed/Altitude Limits _____

(3) Fuel Pressure Design Criteria (Operating/Proof/Surge/Ultimate {Burst}) _____

(4) Pressure drop at rated flow (i.e., 10 psig at 1200 gpm and nominal length) _____

(5) Component output performance (300 gpm at 80 psig) _____

(6) Pressure/Surge Relief — ATTACHED TO SURVEY ☐ NOT AVAILABLE ☐

Cracking Pressure _____

Flowing Pressure (Press/Flow) _____

Reseat Pressure _____

(7) Closure time vs. flow plot _____

c. Power Requirements (Examples only)

(1) Hydraulic (2000 psi at 19.5 gpm) _____

(2) Electrical Power (4.5 amps/28 volts) _____

(3) Pneumatic (dry air/nitrogen 300 psi) _____

d. Sketch with outline dimensions and interface details for mounting and power supply hookup ☐ ☐

e. Validation Criteria Report Number _____

f. Specification Number _____

33. DATA ORIGIN

a. Responding organization (government symbol or company name and department) _____

b. Point of contact _____

(1) Name _____

(2) Title or position _____

(3) Telephone Number _____

(4) Fax Number _____

(5) E-Mail address _____

(6) Mailing address _____

c. Data Sources _____

INTENTIONALLY BLANK

ANNEX B2 STDS: RECEIVER AIRCRAFT RECEPTACLE EQUIPPED

RECEIVER AIRCRAFT (RECEPTACLE EQUIPPED)

For the most current version of references please visit http://www.arsaginc.com/

1. AIRCRAFT DESIGNATION

   a. Mission, Design, Series (Type, Model, Series) _____

   b. Familiar Name _____

   c. Primary Role/Mission _____

   d. Operating Country/Service _____

   e. Number in Inventory (Optional) _____

2. REFERENCES

   a. Flight Manual Designation _____

   b. Aerial Refuelling Operational Manual Designation _____

   c. Maintenance procedures (Optional)

   d. Identify any tanker interface document(s) attachment of documents (Optional)

	ATTACHED TO SURVEY	NOT AVAILABLE
3. NORMAL AERIAL REFUELING ENVELOPE Provide a chart depicting altitude and airspeed (equivalent) as a function of gross weight as illustrated in Attch 1.	☐	☐
4. ENGINE(S) OUT AERIAL REFUELING ENVELOPE Provide a chart depicting altitude and airspeed (equivalent) as a function of gross weight as illustrated in Attch 1 for minimum number of engines operating which will still permit aerial refuelling.	☐	☐
5. CRUISE PERFORMANCE (FERRY FLIGHT PERFORMANCE) Provide a chart depicting optimum altitude and optimum airspeed as a function of gross weight. Depict this performance curve on the AR envelopes required for survey questions 3 and 4 above.	☐	☐

6. FLIGHT RESTRICTIONS — ATTACHED TO SURVEY ☐ — NOT AVAILABLE ☐

List operating restrictions/limitations involving or related to aerial refuelling operations.

7. USABLE FUEL CAPACITY

a. Internal _____

b. Max External _____

8. AUTHORIZED FUELS

List types of fuel approved for use and their limitations (i.e., see Attch 3) ☐ ☐

9. MAXIMUM FUEL ONLOAD RATE (WHERE MEASURED) _____GPM@____PSIG

Provide a fuel flow versus pressure curve for each tank and all tanks filling. ☐ ☐

10. MAXIMUM RATE OF FUEL DUMP (Optional) _____GPM

11. FUEL VENT CAPABILITY

Has the vent be certified capable to prevent overpressure in the event of a failed Level Control Valve (LCV) during aerial refuelling? YES NO

At what flow rate _____GPM
See reference 2 for further information

12. REFUELING SYSTEM DESIGN PRESSURES (PSIG)
For further information please see reference 2

a. Operation *Defined in section 3.4 of reference 2* _____

b. Limit (Proof) *Defined in section 3.5 of reference 2* _____

c. Ultimate (Burst) *Defined in section 3.6 of reference 2* _____

d. Surge *Discussed in section 3.7 of reference 2* _____

e. Tank Limit/Ultimate Pressure (DESIGN) _____
(Provide for each tank if different)

f. Failed Level Control Valve Tank Pressure (Measured)

(1) Maximum Tank Pressure(s) _____

(2) Inlet Pressure Conditions (specify location of Measurement, i.e. boom nozzle or receptacle manifold)

_____

	ATTACHED TO SURVEY	NOT AVAILABLE
13. CENTER OF GRAVITY (CG) MANAGEMENT		
Describe CG management method. Include restrictions in item 6.	☐	☐
14. REFUELING RECEPTACLE		

a. Type (UARRSI, Extendible, i.e., descriptive terms) _____

b. Location of boom nozzle ball joint with nozzle latched into receptacle.

(1) Fuselage Station _____

(2) Waterline _____

(3) Buttline _____

c. Slipway/Receptacle

(1) Door Configuration (Clam shell, drop door, etc.) _____

(2) Size (length, width, and depth) _____

(3) Layout with dimensions. Provide three view drawings with F.S.s, B.L.s, W.L.s. ☐ ☐

d. Angle between receptacle axis and aircraft waterline. _____

e. Markings (location and type, i.e. reflective tape/paint) _____

f. Weight (including installation structure) (Optional) _____

15. ABILITY TO BE TOWED BY AERIAL REFUELING BOOM include restrictions in item 6 YES ____ NO _____

16. PRESSURE DISCONNECT SETTING

Identify pressure settings that initiate an automatic disconnect and the response time.

a. Pressure _____PSIG

b. Response Time _____Seconds

17. RECEPTACLE STRENGTH Design Limit / Ultimate

a. Axial compression _____/_____

b. Axial Tension _____/_____

18. STRUCTURAL REINFORCEMENT FOR BOOM NOZZLE LOADS ATTACHED TO SURVEY NOT AVAILABLE

Define lateral, vertical, and impact loads (limit and ultimate) and describe area protected). ☐ ☐

a. Slipway/Receptacle

_____

_____

_____

b. Surrounding Area

_____

_____

_____

19. MAXIMUM REVERSE FLOW DIRECTION REFUELING

Capable of reverse refuelling? Yes No

a. Rate _____GPM
Include restrictions in item 6.

20. BOOM RECEPTACLE LATCHING/UNLATCHING MODES
Actuation Time Max/Min (Seconds)____

a. Signal/System Manual (pilot initiated) YES____ NO_____

b. Signal System Override (via control switch) YES ____ NO_____

21. BOOM INTERPHONE CAPABILITY TYPE

Identify the crewmembers who have the capability to talk over the boom interphone system.
Specify type push-to-talk (PTT) and or hot mike (HM).

Pilot_____
Co-Pilot_____
Navigator _____
Flight Eng _____
Other_____

22. EXTERIOR LIGHTING

Attached ☐ NA ☐

Provide illustration showing light locations, angular coverage, and areas illuminated for all exterior lights (i.e., see Attachment 4). for each light include type of light (incandescent, strobe, etc.), location in aircraft coordinates, lens colour/frosted, crewmember having control, flashing or coding logic, intensity control/range (full rheostat dimming, step switch), NVG friendly, covert, etc.

23. NVG COMPATIBILITY

a. Are the interior lights NVIS friendly? YES NO

b. Are the external lights NVIS friendly? YES NO

c. Do the external lights have a covert mode? YES NO
If yes describe basic mode (i.e. off vs. different spectrum)

24. RADIOS (Quantity, type, and frequency range)

a. HF Voice _____

b. VHF AM Voice _____

c. VHF FM Voice _____

d. VHF Navigation Receiver _____

e. UHF Voice _____

f. Satellite Communications _____

g. Other _____

h. Known EMI issues with any of the above YES NO
If yes, describe issues and restrictions below

_____

25. IFF/SIF

a. Transponder (quantity and type) _____

b. Interrogation Capability YES ____ NO ____

26. NAVIGATION AND RENDEVOUS EQUIPMENT (Quantity and type)

a. Inertial Navigation _____

b. Search Radar _____

c. Infrared (FLIR, etc.) _____

d. Electro-optical (television, etc.) _____

e. Rendezvous Radar Beacon _____

f. Doppler Radar _____

g. TACAN
Air-to-Air Mode _____

h. ADF _____

i. UHF DF _____

j. Celestial Navigation _____

k. LORAN (A or C) _____

l. Other _____

m. Known EMI issues with any of the above YES NO
If yes, describe issues and restrictions below

_____

27. FUSELAGE PITCH ANGLE DURING REFUELING (each configuration)

Provide angle of fuselage reference plane (waterline zero) to the ground at the following aerial refuelling airspeeds:
(+ indicates nose pitched up)

a. Maximum _____Degrees

b. Minimum _____Degrees

c. Nominal _____Degrees

28. CANOPY/WINDSCREEN VISIBILITY

	ATTACHED TO SURVEY	NOT AVAILABLE
a. Provide illustrations showing field of view from cockpit (pilot and copilot) include restrictions such as munitions and canopy bows.	☐	
b. Include conditions for design eye position(s) and normal head movement		

29. FORWARD FIRING ORDNANCE (Type)

_____

_____

_____

30. AUTOPILOT AND STABILITY AUGMENTATION ☐ ☐

a. Identify type autopilot and stability augmentation systems.

b. Indicate considerations affecting aerial refuelling including whether normally used and impact on receiver if inoperative.

c. Include restrictions in item 6.

31. DISCONNECT CAPABILITY ☐ ☐

Describe method of achieving disconnect in each of the following conditions and subsequent sequence of events. Include restrictions in item 6.

a. Signal system override_____
_____
_____

b. Tension disconnect (ex. 10 ft/sec @ -65°F)_____
_____
_____

c. Failure mode (torque shafts) (Failure Load)_____
_____
_____

32. REFUELING ENVELOPE LIMITS (RECEIVER AIRCRAFT ENVELOPE)

Indicate envelopes relative to individual tanker types (i.e. KC-10, KC-135)

a. Azimuth (Provide envelope measurements in feet in lieu of degrees) _____

b. Elevation (Provide envelope measurements in feet in lieu of degrees) _____

c. Telescoping _____

	ATTACHED TO SURVEY	NOT AVAILABLE
33. TANKER BOOM/RECEIVER CANOPY/ WINDSHIELD CLEARANCE	☐	☐

Provide boom to canopy clearance for the flying boom at the most critical telescoping position and receiver aircraft at maximum pitch angle. Assume 0° azimuth for aircraft with centreline/top fuselage/high wing mounted receptacles and 10° azimuth (disfavouring canopy clearance) for aircraft with low wing-mounted receptacles or off-centre fuselage

a. Clearance at 20° boom elevation _____Inches

b. Clearance at upper disconnect limit (____°)(if other than 20° boom elevation) _____Inches

c. Provide distance from centre of receptacle face (engaged nozzle ball joint) to the windshield or canopy glass _____Inches

34. OTHER AERIAL REFUELING COMPATIBILITY DATA (Describe)

	ATTACHED TO SURVEY	NOT AVAILABLE
a. Fuel tank level control system, type and control	☐	☐
b. Fuel pressure surge protection	☐	☐
c. Level control valve (pre-check methods ground/flight)	☐	☐

d. Compatibility of receptacle/slipway installation with requested boom nozzle(s) (Physical restrictions with hookup and disconnect) ☐ ☐

e. Areas of incompatibility with requested aircraft (Aerodynamic restrictions, instabilities, etc.) ☐

35. AERIAL REFUELING COMPATIBILITY / INTERFACE DATA (Test + Design) ☐ ☐

For tests conducted with tankers currently in the active inventory, provide the following: (Use additional sheets as necessary)

a. Agency conducting test _____

b. Test report number _____

c. Title of report _____

d. Date of report _____

e. Tanker aircraft (or test rig/simulator) utilized in test _____

f. Type test (rig, ground, mock-up, flight) _____

g. Type instrumentation _____

h. Report available from _____

i. Attach abstract or description of test _____

36. COMPONENT DATA (Optional)

a. Name of Component/Subsystem _____

b. Performance Criteria

(1) Weight (fully serviced hydraulic fluid) _____

(2) Airspeed/Altitude Limits _____

(3) Fuel Pressure Design Criteria (Operating/Proof/Surge/Ultimate {Burst}) _____

(4) Pressure drop at rated flow (i.e., 20 psig at 1200 gpm) _____

(5) Component output performance (300 gpm at 80 psig) _____

	ATTACHED TO SURVEY	NOT AVAILABLE
(6) Pressure/Surge Relief	☐	☐
Cracking Pressure	_____	
Flowing Pressure (Press/Flow)	_____	
Reseat Pressure	_____	
(7) Closure time vs. flow plot	_____	
c. Power Requirements		
(1) Hydraulic (2000 psi at 19.5 gpm)	_____	
(2) Electrical Power (4.5 amps/28 volts)	_____	
(3) Pneumatic (dry air/nitrogen 300 psi)	_____	
d. Sketch with outline dimensions and interface details for mounting and power supply hookup	☐	☐
e. Validation Criteria Report Number	_____	
f. Specification Number	_____	

37. DATA ORIGIN

a. Responding organization (government symbol or company name and department)	_____
b. Point of contact	_____
(1) Name	_____
(2) Title or position	_____
(3) Telephone Number	_____
(4) Fax Number	_____
(5) E-Mail address	_____
(6) Mailing address	_____

ANNEX B3 STDS: TANKER AIRCRAFT DROGUE EQUIPPED

TANKER AIRCRAFT (DROGUE EQUIPPED)

For the most current version of references please visit http://www.arsaginc.com/

1. AIRCRAFT DESIGNATION

   a. Mission, Design, Series (Type, Model, Series) _____

   b. Familiar Name _____

   c. Primary Role/Mission _____

   d. Operating Country/Service _____

   e. Number in Inventory (Optional) _____

2. REFERENCES

   a. Flight Manual Designation _____

   b. Aerial Refuelling Operational Manual Designation _____

   c. Maintenance procedures (Optional)

   d. Identify any tanker interface document(s) attachment of documents (Optional)

	ATTACHED TO SURVEY	NOT AVAILABLE
3. NORMAL AERIAL REFUELING ENVELOPE Provide a chart depicting altitude and airspeed (equivalent) as a function of gross weight as illustrated in Attch 1.	☐	☐
4. ENGINE(S) OUT AERIAL REFUELING ENVELOPE Provide a chart depicting altitude and airspeed (equivalent) as a function of gross weight as illustrated in Attch 1 for minimum number of engines operating which will still permit aerial refuelling.	☐	☐
5. CRUISE PERFORMANCE (FERRY FLIGHT PERFORMANCE) Provide a chart depicting optimum altitude and optimum airspeed as a function of gross weight. Depict this performance curve on the AR envelopes required for survey questions 3 and 4 above.	☐	☐

6. FLIGHT RESTRICTIONS	ATTACHED TO SURVEY	NOT AVAILABLE
List operating restrictions/limitations involving or related to aerial refuelling operations.	☐	☐

7. FUEL AVAILABLE FOR TRANSFER TO RECEIVER AIRCRAFT

a. Provide a chart which depicts fuel available for transfer versus range and gross weight as illustrated in Attachment 2 for the following cases: ☐ ☐

(1) Internal fuel only

(2) Maximum internal and external fuel

b. Provide a similar chart which depicts fuel available for Transfer versus time with aircraft operating at maximum endurance during the aerial refuelling operations. (Optional)

c. Specify type of fuel (JP-4, JP-5, JP-8, etc.) used in constructing charts.

8. AUTHORIZED FUELS

List types of fuel approved for use and their limitations (i.e., see Attch 3) ☐ ☐

9. FUEL OFFLOAD FLOW RATE

a. _____GPM at_____PSIG

b. Provide a fuel flow versus pressure curve for all pumping configurations. ☐ ☐

10. PRESSURE REGULATION, SURGE SUPPRESSION AND REFUELING SYSTEMS DESIGN PRESSURES
See reference 2 for further information

a. Pressure Regulation Coupling Regulated Outlet	Zero Flow	Normal Flow
– Normal System	____PSIG	____PSIG
– Failed Regulator (Single)	____PSIG	____PSIG
– Other Single Failure Conditions (Identify failure mode(s) evaluated i.e. Hydraulic Flow Controllers)	____PSIG	____PSIG

b. Surge Suppression Device

– Type _____

– Capacity _____

– Precharge (Optional) _____

c. Refuelling System Design Pressures (PSIG) _____

– Operating *Defined in section 3.4 of reference 2* _____

– Limit (Proof) *Defined in section 3.5 of reference 2* _____

– Surge *Defined in section 3.6 of reference 2* _____

– Ultimate (Burst) *Discussed in section 3.7 of reference 2*_____

11. FUEL DUMP CAPABILITY (Optional)

a. Type system (i.e., wing dump mast) _____

b. Maximum dump rate _____

	ATTACHED TO SURVEY	NOT AVAILABLE
12. CENTER OF GRAVITY (CG) MANAGEMENT		
Describe CG management method. Include restrictions in item 6.	☐	☐
13. DESCRIPTION AND LOCATION OF HOSE AND DROGUE MECHANISM	☐	☐

Provide illustration and indicate location in aircraft coordinates of drogue exit tunnel for internally mounted systems and/or external pods

a. AR System Weight _____

b. Installation/Structure Weight _____

c. Total Weight _____

14. REMOVABLE TANKER PACKAGE YES _____ NO_____

15. MAXIMUM NUMBER OF AIRCRAFT WHICH CAN BE REFUELED SIMULTANEOUSLY

    a. Indicate number of receivers which can be refuelled Simultaneously _____

    b. Include restrictions and/or limitations in item 6 _____

16. RADIOS (quantity, type, and range)

    a. HF Voice _____

    b. VHF AM Voice _____

    c. VHF FM Voice _____

    d. VHF Navigation _____

    e. UHF Voice _____

    f. Satellite Communications _____

    g. Other _____

    h. Known EMI issues with any of the above YES NO
    If yes, describe issues and restrictions below

17. IFF/SIF

    a. Transponder (quantity and type) _____

    b. Interrogation Capability YES____ NO____

18. NAVIGATION AND RENDEVOUS EQUIPMENT (Quantity and type)

    a. Inertial Navigation _____

    b. Search Radar _____

    c. Infrared (FLIR, etc.) _____

    d. Electro-optical (television, etc.) _____

    e. Rendezvous Radar Beacon _____

    f. Doppler Radar _____

g. TACAN
Air-to-Air Mode _____

h. ADF _____

i. UHF DF _____

j. Celestial Navigation _____

k. LORAN (A or C) _____

l. Other _____

m. Known EMI issues with any of the above YES NO
If yes, describe issues and restrictions below

	ATTACHED TO SURVEY	NOT AVAILABLE
19. EXTERIOR LIGHTING	☐	☐

Provide illustration showing light locations, angular coverage, and areas illuminated for all exterior lights (i.e., see Attachment 4). For each light include type of light (incandescent, strobe, etc.), location in aircraft coordinates, crew member having control, flashing or coding logic, intensity control/range (full rheostat dimming, step switch), lens colour/frosted, NVG friendly, covert capability etc.

	ATTACHED TO SURVEY	NOT AVAILABLE
20. EXTERIOR MARKING	☐	☐

Provide illustration or description of tanker and drogue markings which assist receiver formation positioning.

21. AUTOPILOT AND STABILITY AUGMENTATION	☐	☐

a. Identify type autopilot and stability augmentation systems.

b. Indicate considerations affecting aerial refuelling including whether normally used and impact on receiver if inoperative.

c. Include restrictions in item 6.

22. NVG COMPATIBILITY

a. Are the interior lights NVIS friendly? YES NO

b. Are the external lights NVIS friendly? Yes No

c. Do the external lights have a covert mode? Yes No
If yes describe basic mode (i.e. off vs. different spectrum)

23. COUPLING DISCONNECT FORCE SETTINGS _____
(include tolerance)

24. DROGUE REFUELING ENVELOPE

	ATTACHED TO SURVEY	NOT AVAILABLE
Provide 3-view drawing illustrating the drogue refuelling envelope based on the optimum aerial refuelling envelope. Include, as a minimum:	☐	☐
a. Drogue exit tunnel in aircraft coordinates (Optional)	☐	☐
b. Drogue location at full trail, outer fuel transfer limit, and inner fuel transfer limit.	☐	☐
c. Off centre disconnect limits	☐	☐
d. Indicate horizontal, vertical, and lateral distances from hose/drogue to nearest aircraft structure	☐	☐

25. HOSE REEL PERFORMANCE

a. Maximum Response _____FPS

b. Minimum Response _____FPS

c. Extend Time _____Sec

d. Rewind Time _____Sec

26. WAKE TURBULENCE	ATTACHED TO SURVEY	NOT AVAILABLE
Describe tanker flow field as a function of spanwise position and elevation relative to the tanker to a point 500 feet aft of the drogue in terms of velocity and angle referenced to free stream for representative airspeeds, altitudes and gross weights.	☐	☐

27. OTHER COMPATIBILITY DATA

a. Identify deviations of aerial refuelling system from NATO STANAG 3447 and AFGS 87166 (Guide Doc.).	☐	☐
b. Include other information affecting aerial refuelling compatibility.	☐	☐
c. Fuel pressure surge protection	☐	☐
d. Provide physical dimensions of drogue (if not IAW STANAG 3447 and AFGS 87166A) (Guide Doc)	☐	☐

28. AERIAL REFUELING COMPATIBILITY INTERFACE DATA (Test + Design) ☐ ☐

(See ARSAG Website Doc. Reference #3) Attach #2 Here.
For tests conducted with receivers currently in the active inventory, provide the following: (Use additional sheets as necessary)
For further information see reference 3

a. Agency conducting test _____

b. Test report number _____

c. Title of report _____

d. Date of report _____

e. Receiver aircraft (or test rig/simulator) utilized in test _____

f. Type test (rig, ground, mock-up, flight) _____

g. Type instrumentation _____

h. Report available from _____

i. Attach abstract or description of test _____

29. COMPONENT (VENDOR) DATA

a. Name of Component/Subsystem _____

b. Performance Criteria

(1) Weight (fully serviced hydraulic fluid) _____

(2) Airspeed/Altitude Limits _____

(3) Fuel Pressure Design Criteria (Operating/Proof/Surge/Ultimate {Burst}) _____

(4) Pressure drop at rated flow (i.e., 10 psig at 1200 gpm and nominal length) _____

(5) Component output performance (300 gpm at 80 psig) _____

(6) Pressure/Surge Relief

	ATTACHED TO SURVEY	NOT AVAILABLE
	☐	☐

Cracking Pressure _____

Flowing Pressure (Press/Flow) _____

Reseat Pressure _____

(7) Closure time vs. flow plot _____

c. Power Requirements

(1) Hydraulic (2000 psi at 19.5 gpm) _____

(2) Electrical Power (4.5 amps/28 volts) _____

(3) Pneumatic (dry air/nitrogen 300 psi) _____

d. Sketch with outline dimensions and interface details for mounting and power supply hookup

	ATTACHED TO SURVEY	NOT AVAILABLE
	☐	☐

e. Validation Criteria Report Number _____

f. Specification Number _____

30. DATA ORIGIN

a. Responding organization (government symbol or company name and department) _____

b. Point of contact _____

(1) Name _____

(2) Title or position _____

(3) Telephone Number _____

(4) Fax Number _____

(5) E-Mail address _____

(6) Mailing address _____

INTENTIONALLY BLANK

ANNEX B4 STDS: RECEIVER AIRCRAFT PROBE EQUIPPED

RECEIVER AIRCRAFT (PROBE EQUIPPED)

For the most current version please visit http://www.arsaginc.com/

1. AIRCRAFT DESIGNATION

   a. Mission, Design, Series (Type, Model, Series) _____

   b. Familiar Name _____

   c. Primary Role/Mission _____

   d. Operating Country/Service _____

   e. Approximate Number in Inventory (Optional) _____

2. REFERENCES

   a. Flight Manual Designation _____

   b. Aerial Refuelling Operational Manual Designation _____

   c. Maintenance procedures (Attachment of documents Optional)

   d. Identify any tanker interface document(s) (Attachment of documents Optional)

3. NORMAL AERIAL REFUELING ENVELOPE	ATTACHED TO SURVEY	NOT AVAILABLE
Provide a chart depicting altitude and airspeed (equivalent) as a function of gross weight as illustrated in Attch 1.	☐	☐
4. ENGINE(S) OUT AERIAL REFUELING ENVELOPE	☐	☐

Provide a chart depicting altitude and airspeed (equivalent) as a function of gross weight as illustrated in Attch 1 for minimum number of engines operating which will still permit aerial refuelling.

5. CRUISE PERFORMANCE (FERRY FLIGHT PERFORMANCE) ☐ ☐

Provide a chart depicting optimum altitude and optimum airspeed as a function of gross weight. This shall include both a clean aircraft and/or with maximum external fuel. Depict this performance curve on the AR envelopes required for survey questions 3 and 4 above.

6. FLIGHT RESTRICTIONS	ATTACHED TO SURVEY	NOT AVAILABLE
List operating restrictions/limitations involving or related to aerial refuelling operations.	☐	☐

a. Maximum airspeed and/or mach restriction with probe extended. _____

b. Internal/external tanks which cannot be refuelled in flight. _____

7. USABLE FUEL CAPACITY

a. Internal _____

b. Max External _____

8. AUTHORIZED FUELS

List types of fuel approved for use and their limitations (i.e., see Attch 3) ☐ ☐

9. MAXIMUM FUEL ONLOAD RATE (WHERE MEASURED) ____GPM @____PSIG

(Provide a fuel flow versus pressure curve for each tank and all tanks filling.) ☐ ☐

10. MAXIMUM RATE OF FUEL DUMP (Optional) _____GPM

11. REFUELING SYSTEM DESIGN PRESSURES (PSIG)
For further information please see reference 2

a. Operation *Defined in section 3.4 of reference 2* _____

b. Limit (Proof) *Defined in section 3.5 of reference 2* _____

c. Ultimate (Burst) *Defined in section 3.6 of reference 2* _____

d. Surge *Discussed in section 3.7 of reference 2* _____

e. Tank Limit/Ultimate Pressure (DESIGN) _____
(Provide for each tank if different)

f. Failed Level Control Valve Tank Pressure (Measured)

(1) Maximum Tank Pressure(s) (Specify tank) _____

_____

_____

(2) Inlet Pressure Conditions _____
(specify location of measurement, i.e. coupling or probe nozzle/mast)

	ATTACHED TO SURVEY	NOT AVAILABLE
12. CENTER OF GRAVITY (CG) MANAGEMENT		
Describe CG management method. Include restrictions in item 6.	☐	☐

13. REFUELING PROBE NOZZLE

a. Fixed, removable, telescoping, or retractable (specify envelope if different than STANAG 3447). _____
See ARSAG website for latest version of STANAG 3447

b. Does the probe mast flex to alleviate loads? Yes No

c. Type nozzle (manufacture/part number) specify dimensions if different than STANAG 3447 and/or MS 24356. _____

d. Does the nozzle have a flexible tip? Yes No

e. Location of nozzle tip with probe mast in refuelling position.

(1) Fuselage Station _____

(2) Waterline Location _____

(3) Buttline Location _____

(4) Fuselage Clearance _____

f. Weight of probe mast. _____

g. Installation weight _____

h. Total weight _____

14. PROBE STRENGTH Design Limit / Ultimate

a. Axial Compression _____/_____

b. Axial Tension _____/_____

c. Radial _____/_____

d. Impact Compression _____/_____

e. Bending moment about the probe hinge point or probe attachment point. _____/_____

15. LOCATION OF PROBE HINGE OR PROBE ATTACH POINT

a. Fuselage Station _____

b. Waterline Location _____

c. Buttline Location _____

	ATTACHED TO SURVEY	NOT AVAILABLE
16. EXTERIOR LIGHTING	☐	☐

Provide illustration showing light locations, angular coverage, and areas illuminated for all exterior lights (i.e., see Attachment 4). for each light include type of light (incandescent, strobe, etc.), location in aircraft coordinates, lens colour/frosted, crewmember having control, flashing or coding logic, intensity control/range (full rheostat dimming, step switch),NVG friendly, covert capability, etc.

17. RADIOS (Quantity, type, and frequency range)

a. HF Voice _____

b. VHF AM Voice _____

c. VHF FM Voice _____

d. VHF Navigation Receiver _____

e. UHF Voice _____

f. Satellite Communications _____

g. Other _____

h. Known EMI issues with any of the above YES NO
If yes, describe issues and restrictions below

_____

18. IFF/SIF

a. Transponder (quantity and type) _____

b. Interrogation Capability YES ____ NO ____

19. NAVIGATION AND RENDEVOUS EQUIPMENT (Quantity and type)

a. Inertial Navigation _____

b. Search Radar _____

c. Infrared (FLIR, etc.) _____

d. Electro-optical (television, etc.) _____

e. Rendezvous Radar Beacon _____

f. Doppler Radar _____

g. TACAN
Air-to-Air Mode _____

h. ADF _____

i. UHF DF _____

j. Celestial Navigation _____

k. LORAN (A or C) _____

l. Other _____

m. Known EMI issues with any of the above YES NO
If yes, describe issues and restrictions below

---

20. FUSELAGE PITCH ANGLE DURING REFUELING (each configuration)

Provide angle of fuselage reference plane (waterline zero) to the ground at the following aerial refuelling airspeeds:
(+ indicates nose pitched up)

a. Maximum _____Degrees

b. Minimum _____Degrees

c. Nominal _____Degrees

21. CANOPY/WINDSCREEN VISIBILITY

	ATTACHED TO SURVEY	NOT AVAILABLE
a. Provide illustrations showing field of view from cockpit (pilot and copilot) include restrictions such as munitions and canopy bows.	☐	
b. Include conditions for design eye position(s) and normal head movement	☐	☐

22. FORWARD FIRING ORDNANCE (Type)

_____

_____

_____

	ATTACHED TO SURVEY	NOT AVAILABLE
23. AUTOPILOT AND STABILITY AUGMENTATION		
a. Identify type autopilot and stability augmentation systems.	☐	☐
b. Indicate considerations affecting aerial refuelling including whether normally used and impact on receiver if inoperative.	☐	☐
c. Include restrictions in item 6.	☐	☐

24. OTHER AERIAL REFUELING COMPATIBILITY INTERFACE DATA (Test + Design) (Describe)

a. Fuel tank level control system, type and control	☐	☐
b. Fuel pressure surge protection	☐	☐
c. Level control valve (pre-check methods ground/flight)	☐	☐
d. Identify deviations of aerial refuelling system from NATO STANAG 3447 and AFGS 87166AB. _____		
e. Include other information affecting aerial refuelling	☐	☐

compatibility.

25. AERIAL REFUELING COMPATIBILITY INTERFACE DATA (Test and Design)

For further information see reference 3 ☐ ☐
For tests conducted with tankers currently in the active inventory, provide the following: (Use additional sheets as necessary)

a. Agency conducting test _____

b. Test report number _____

c. Title of report _____

d. Date of report _____

e. Tanker aircraft (or test rig/simulator) utilized in test _____

f. Type test (rig, ground, mock-up, flight) _____

g. Type instrumentation _____

h. Report available from _____

i. Attach abstract or description of test _____

26. COMPONENT DATA (Optional)

a. Name of Component/Subsystem _____

b. Performance Criteria

(1) Weight (fully serviced hydraulic fluid) _____

(2) Airspeed/Altitude Limits _____

(3) Fuel Pressure Design Criteria (Operating/Proof/Surge/Ultimate {Burst}) _____

(4) Pressure drop at rated flow (i.e., 10 psig at 1200 gpm) _____

(5) Component output performance (300 gpm at 80 psig) _____

(6) Pressure/Surge Relief

	ATTACHED TO SURVEY	NOT AVAILABLE
	☐	☐
Cracking Pressure	_____	
Flowing Pressure (Press/Flow)	_____	
Reseat Pressure	_____	

(7) Closure time vs. flow plot _____

c. Power Requirements

(1) Hydraulic (2000 psi at 19.5 gpm) _____

(2) Electrical Power (4.5 amps/28 volts) _____

(3) Pneumatic (dry air/nitrogen 300 psi) _____

d. Sketch with outline dimensions and interface details for mounting and power supply hookup

ATTACHED TO SURVEY	NOT AVAILABLE
☐	☐

e. Validation Criteria Report Number _____

f. Specification Number _____

27. DATA ORIGIN

a. Responding organization (government symbol or company name and department) _____

b. Point of contact _____

(1) Name _____

(2) Title or position _____

(3) Telephone Number _____

(4) Fax Number _____

(5) E-Mail address _____

(6) Mailing address _____

ANNEX C CERTIFICATION SPECIFICATIONS (CS)

Certification Specifications (CS) and Acceptable Means of Compliance (AMC)/Guidance Material (GM) for Air-to-Air Refuelling Tanker/Receiver pairing Technical Compatibility Assessment (CS-AAR)

INTRODUCTION

While this annex presents guidance in support of ATP 3.3.4.2.1, “Guide to obtaining Air-to-Air Refuelling Clearances and Compatibility Certification”, it is also useful as a standalone reference for the Certification Basis for technical certification of a tanker/receiver pairing when required.

The document adopts the internationally recognized format of presenting Certification Specifications (CS) in one chapter, with referenced accompanying Acceptable Means of Compliance (AMC) and/or Guidance Materiel (GM) in separate chapter following the same structure.

The document content is originally based on and incorporates accepted documentation such as but not limited to EMACC, MIL-HDBK-516, INTA General Instruction and CS-25. Reference is available in a separate document. Adopting the combined reference materiel in one single accepted document will enhance efficiency in execution of tanker/receiver Technical Compatibility Assessment.

This document provides for a common set of Certification Specifications from both tanker as well as receiver perspective. From this set of Certification Specifications an agreed Certification Basis can be derived to support any tanker/receiver Technical Compatibility Assessment.
Whereas existing (reference) documentation provides for criteria regarding the certification of individual aircraft, it is recognized that close proximity of and ultimately contact between two aircraft can influence Airworthiness aspects and or Safety of Flight of either own ship, targeted tanker/receiver or both.
Therefore, the Certification Specifications herein are intended to support certification of the Airworthiness and Safety of Flight of a tanker/receiver pair, regarded as a whole.

The document content assumes that both tanker as well as receiver are already individually certified aircraft according their applicable rules and regulations, which qualify as tanker and receiver respectively and are mutually accepted by the appropriate authorities. Furthermore, the CS presented here assume that all tanker/receiver systems, disciplines and capabilities affected under the scope of each CS shall be previously certified or cleared to perform Air-to-Air Refuelling operations within the respective tanker/receiver individual AAR envelope. It is not the aim of this document to challenge the existing individual certification of tankers or receivers.

The CS contained in this document are intended to be equally applicable to Air-to-Air Refuelling operations under normal conditions as well as failure conditions under which continued Air-to-Air Refuelling operations are certified for the individual tanker/receiver and which are desired to be included under the scope of this pairing (degraded conditions). Therefore, it is not the intent that System Safety Assessments (SSAs) will be performed again. In case safety hazards are identified that fall beyond those covered in the tanker’s/receiver’s individual certification basis this should be addressed with the Original Equipment Manufacturer (OEM) or the scope should be revised.

The Acceptable Means of Compliance (AMC)/Guidance Material (GM) is not required to satisfy the same acceptable level of safety under failure conditions as opposed to under normal conditions in order to comply with the CS.

Individual Operators' desired operational requirements for a tanker/receiver pairing are not covered and need to be addressed separately by such Operator.

All aspects requiring consideration in the Technical Compatibility Assessment for certification of a tanker/receiver pairing known at the time of writing are addressed herein. By nature of evolving technology certain Certification Specifications at any given time may warrant alteration or additional Certification Specifications may need to be added. Thus by its very nature this document is a living document the content of which will be subject to change.
Each user is therefore encouraged to remain critical and submit suggestions for improvement, observed shortcomings, errors, obsolescence or other to the document custodian.

Note: This document is considered mature for use in certifications of manned tankers with manned receivers without automated AAR systems. References to other systems are considered not sufficiently mature and/or comprehensive in this revision.

ABBREVIATIONS

Abbreviation	Explanation
A3R	Automated Air-to-Air Refuelling
AAR	Air-to-Air Refuelling
AFM	Aircraft Flight Manual
AGARD	Advisory Group for Aerospace Research & Development
AIO	Aerial Refuelling Operator Induced Oscillations
AMC	Acceptable/Accepted (EASA/FAA) Means of Compliance
AOM	Aircraft Operating Manual
ARO	Aerial Refuelling Operator
ARSAG	Aerial Refuelling Systems Advisory Group
ATP	Allied Tactical Publication
AVO	Air Vehicle Operator
CHR	Cooper Harper Rating
CNS	Communication, Navigation and Surveillance
CS	Certification Specification
DOD	Department of Defence
EASA	European Aviation Safety Agency
EMAR	European Military Aviation Requirements
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
FAA	Federal Aviation Administration
FCOM	Flight Crew Operating Manual
GM	Guidance Material
ICA	Instructions for Continued Airworthiness
INTA	Instituto Nacional Técnica Aerospacial
MACC	Modified Airworthiness Certification Criteria
MCRI	Military Certification Review Item
MEL	Minimum Equipment List
MoC	Means/Method (EASA/FAA) of Compliance
NATO	North Atlantic Treaty Organization
PIO	Pilot Induced Oscillations
SME	Special Mission Equipment
SRD	Standard Related Document
SSRA	System Safety Risk Assessment
TAA	Technical Airworthiness Authority
TDS	Technical Data Survey
UAS	Unmanned Aircraft System

DEFINITIONS

Acceptable/Accepted (EASA/FAA) Means of Compliance
Acceptable means of Compliance are non-binding standards adopted by the National Military Aviation Authorities which may be used by persons to demonstrate compliance with regulations and its implementing rules; when acceptable means of compliance are complied with the related requirements or Certification Specification of the implementing rules are met.

Air-to-Air Refuelling
The process of transferring aviation fuel from one aircraft (tanker) to another (receiver) during flight.

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

Aircraft Operating Manual (AOM)
Aircraft Operating Manual (AOM) includes equivalent documentation such as, Flight Crew Operating Manual (FCOM), Checklists, ATP.

Certification basis
The complete (necessary and sufficient), documented set of airworthiness criteria, standards and methods of compliance utilized to assess the airworthiness and safety of flight of a specific system design.

Certification Specifications
Certification Specifications are a standard means to demonstrate compliance of a tanker/receiver pair with the relevant airworthiness/safety of flight requirements as adopted by the National Military Aviation Authorities. Such specifications shall be sufficiently detailed and specific to indicate to applicants the conditions under which certificates will be issued, amended or supplemented.

Guidance Material
Guidance Material is non-binding material developed by the National Military Aviation Authorities which helps to illustrate the meaning of a requirement or specification and is used to support the interpretation of regulation, its implementing rules, Certification Specifications, Acceptable Means of Compliance as well as provide guidance regarding Means/Method of Compliance.

Air-to-Air Refuelling Device
The conduit for transferring/delivering fuel from a tanker's Air-to-Air Refuelling fuel system to a receiver i.e. aerial refuelling boom or hose/drogue.

Covert Air-to-Air Refuelling Operations
Air-to-Air Refuelling operations with both tanker and receiver in night vision systems compatible lighting configuration.

Degraded Conditions
A manageable/acceptable reduction in functionality in the presence of a failure under which sustainment of air vehicle/system control, aircrew workload and situational awareness, possibly under certain limitations, still allow for Air-to-Air Refuelling operations to an acceptable level of safety.

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

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

Means/Method (EASA/FAA) of Compliance
The techniques that will be used to demonstrate compliance of the tanker/receiver pair against each certification requirement identified in the Certification Basis. Examples include test, analyses and inspections. (Ref EMAR/EASA AMC 21.A.20(b) Example Means of Compliance)

Operating pressure
The maximum steady state pressure (no-flow as well as flowing conditions) that the fuel system can continually sustain throughout the life of the air vehicle without any leakage, fatigue, failures or malfunctions.

Pilot Induced Oscillations
Oscillations of aircraft movement caused or exacerbated by pilot input.

Proof pressure
The minimum or maximum pressure at which the fuel system will continue to function satisfactorily including pressure transients (surges) which the air vehicle can continually sustain throughout its life without leakage, failures, malfunctions or permanent deformation

Removable Air-to-Air Refuelling hardware
Removable Air-to-Air Refuelling hardware includes, but is not limited to, removable aerial refuelling stores/pods, palletized aerial refuelling systems, removable aerial refuelling fuel tanks, boom-to-drogue adapters, and non-permanent probe installations. (Group B Mil-HDBK-516C).

Store
A store is any device intended for internal or external carriage, mounted on air vehicle suspension and release equipment, which may or may not be intended to be for in-flight separation from the air vehicle.

Tanker/Receiver pairing certification
Recognition that a tanker/receiver pairing complies with the applicable airworthiness requirements followed by a declaration of compliance.

Transparency
The element that provides aircrew and/or operators with exterior vision capability in accordance with system requirements. I.e. a flat transparency window, a windscreen, enclosures for flight critical remote camera systems and sensors and/or a canopy system.

1 CERTIFICATION SPECIFICATIONS

1.1 General

CS-AAR.100 Scope (see GM CS-AAR.100)

Each applicable requirement of this CS shall be met:

(a) for the intended use or kind of operations for the tanker/receiver pair,

(b) at each appropriate combination of configuration, state (both normal and degraded conditions), weight and centre of gravity for which certification is requested for the tanker/receiver pair, to ensure safe Air-to-Air Refuelling Operations (see GM CS-AAR.100).

CS-AAR.101 Proof of compliance (see AMC/GM CS-AAR.101)

(a) Meeting the requirements of this CS for the tanker/receiver pair whilst complying with CS-AAR.100 shall be shown by (see AMC/GM CS-AAR.101(a)):

(1) Engineering Evaluation and/or
(2) Tests and/or,
(3) Inspection and/or,
(4) Equipment Certification/Qualification

(b) Parameters critical for tests being conducted must be maintained within acceptable tolerances of the critical values during the testing (see AMC CS-AAR.101(b)).

1.2 Air-to-Air Refuelling Envelope

CS-AAR.200 Flight Envelope Compatibility (see AMC/GM CS-AAR.200)

The Air-to-Air Refuelling flight envelope in terms of altitude and airspeed shall be defined for the tanker/receiver pair.

CS-AAR.201 Weight and Centre of Gravity Envelope Compatibility (see AMC/GM CS-AAR.201)

(Individual) Weight and centre of gravity envelopes associated with Air-to-Air Refuelling shall be defined for the tanker/receiver pair.

CS-AAR.202 Induced Environment Compatibility (see AMC/GM CS-AAR.202)

(a) Aerodynamic Conditions

Aerodynamic effects shall not cause adverse effects on either tanker or receiver (see GM CS-AAR.202(a)).

(b) Fuel Spray

Fuel spray resultant from the Air-to-Air Refuelling process or due to fuel venting shall not negatively affect the safe operation of the receiver (see AMC/GM CS-AAR.202(b)).

(c) Electro Static Discharge

The electro static build-up of the tanker/receiver pair shall remain under the mutually acceptable threshold (see GM CS-AAR.202(c)).

(d) Exhaust Plume

Tanker exhaust plume shall not cause adverse effects on the receiver (see GM CS-AAR.202(d)).

(1) Tanker exhaust plume effects on the receiver Air Data Systems shall allow for safe Air-to-Air Refuelling operations.

(2) Receiver propulsion system and auxiliary/emergency power systems remain stable and compatible during Air-to-Air Refuelling operations.

(3) Receiver environmental control systems shall not be adversely effected by the tanker exhaust plume.

(e) Noise

Regarding personnel exposure to aircraft noise, compatibility with and/or adequate compensation for the new/induced sound environment of the tanker/receiver pair during Air-to-Air Refuelling operations shall be assured *(see AMC/GM CS-AAR.202(e))*.

(f) Vibration

Safe Air-to-Air Refuelling operations in any intended environmental condition shall be assured for the tanker/receiver pair for the aeroacoustic loads and vibrations induced by its aeroacoustic environment *(see AMC/GM CS-AAR.202(f))*.

1.3 Geometric Compatibility

CS-AAR.300 (see GM CS-AAR.300)

Boom/receptacle and probe/drogue geometrically compatible envelope shall be identified and ensure safe Air-to-Air Refuelling for the tanker/receiver pair.

(a) *Interface/air vehicle spatial clearance*

Boom/hose/drogue clearance to any receiver surface during engagement/contact/disengagement shall be adequate for safe Air-to-Air Refuelling operations. For boom/receptacle this shall be verified throughout the identified boom/receptacle geometrically compatible envelope (see GM-AAR.300(a)).

(b) *Air vehicle/air vehicle spatial clearance*

Spatial clearance between all engaged air vehicles shall be adequate to ensure safe Air-to-Air Refuelling operations for the tanker/receiver pairing (see GM CS-AAR.300(b)).

1.4 Loads Compatibility

CS-AAR.400 (see AMC/GM CS-AAR.400)

The tanker/receiver Air-to-Air Refuelling system interfaces, their conduit and attachment to airframe structure, and the structure surrounding the interfaces shall not experience loads exceeding individually certified/approved design service loads during Air-to-Air Refuelling operations.

(a) AAR Interfaces Loads

Compatibility of Air-to-Air Refuelling design loads at the interfaces shall be assured.

(1) It shall be demonstrated that the loads experienced at the probe/nozzle do not exceed the certified/approved design service loads during Air-to-Air Refuelling operations.

(2) It shall be demonstrated that the probe/nozzle weak link shall fail beyond the certified/approved design service loads and before exceeding any tanker/receiver structure and/or Air-to-Air Refuelling system limit load.

1.5 System Compatibility

CS-AAR.500 Visual References/Lights and Markings (see AMC/GM CS-AAR.500)

(a) Visible spectrum

References, including aircraft lights, Air-to-Air Refuelling lighting, light signalling and aircraft markings shall be adequate to ensure safe Air-to-Air Refuelling operations throughout all flight conditions as agreed per CS-AAR.100.

(b) Covert

References, including aircraft lights, Air-to-Air Refuelling lighting, light signalling and aircraft markings shall be adequate to ensure safe Air-to-Air Refuelling operations throughout all flight conditions as agreed per CS-AAR.100.

CS-AAR.501 Electromagnetic Environmental Effects (see GM CS-AAR.501)

Safe Air-to-Air Refuelling operations in any intended electromagnetic environmental condition shall be assured for the tanker/receiver pair and crews within the scope of CS-AAR.100.

CS-AAR.502 Fuel and Air-to-Air Refuelling Systems Compatibility

(see AMC/GM CS-AAR.502)

(a) Air-to-Air Refuelling Interfaces compatibility

Air-to-Air Refuelling interfaces of tanker and receiver shall be compatible. Compatibility refers to dimensional, physical, mechanical, electrical, geometrical, data and communication signals compatibility.

(1) Air-to-Air Refuelling interfaces during engagement/refuelling/disengagement shall provide satisfactory latching/unlatching for safe Air-to-Air Refuelling operations.

(2) Air-to-Air Refuelling interface loads shall be compatible. Reference CS-AAR.400.

(3) No measurable leakage shall be assured when in contact (see GM CS-AAR.502(a)(3)).

(b) Identification of Fuels (see AMC/GM CS-AAR.502(b))

Primary, alternate/restricted and emergency types of fuels suitable for both tanker/receiver to be transferred/received and limitations and/or any allowed deviations shall be identified.

(c) Maximum fuel transfer rate (see AMC/GM CS-AAR.502(c))

Maximum allowable fuel transfer rate shall be determined based on individual tanker/receiver maximum design fuel offload/onload rate and shall never exceed the most restrictive one.
Fuel delivery/receipt up to this fuel transfer rate shall not adversely affect the tanker/receiver fuel and Air-to-Air Refuelling systems.

(d) Steady state pressure (see AMC CS-AAR.502(d))

The tanker regulated fuel pressure, under flowing and zero-flow conditions, shall not exceed the receiver operating pressure.
NOTE:
Operating pressure is defined as the maximum steady state pressure (no-flow as well as flowing conditions) that the fuel system can continually sustain throughout the life of the air vehicle without any leakage, fatigue, failures or malfunctions.

(e) Pressure transients (see AMC/GM CS-AAR.502(e))

Surge pressures generated during the Air-to-Air Refuelling process shall not exceed proof pressure limits for the Air-to-Air Refuelling systems of the tanker/receiver.

NOTE:
Proof pressure is defined as the minimum or maximum pressure at which the fuel system will continue to function satisfactorily including pressure transients (surges) which the air vehicle can continually sustain throughout its life without leakage, failures, malfunctions or permanent deformation.

CS-AAR.503 Communication, Navigation and Surveillance (see GM CS-AAR.503)

Communication, Navigation and Surveillance (CNS) systems shall be provided which permit the timely and intelligible exchange of all necessary data/information between crewmember(s)/operator(s)/ automated system(s) of the air vehicle and crewmember(s)/operator(s)/ automated system(s) of the targeted tanker/receiver to ensure safe Air-to-Air Refuelling operations.

CS-AAR.504 Defensive Aids Compatibility (see GM CS-AAR.504)

Defensive Aids systems shall not pose any hazard to tanker/receiver, its crewmember(s) and/or operator(s) during Air-to-Air Refuelling operations.

1.6 Handling Qualities

CS-AAR.600 (see AMC/GM CS-AAR.600)

(a) Tanker/Receiver Handling Qualities

The Tanker and Receiver shall be safely controllable and manoeuvrable during Air-to-Air Refuelling operation within the scope of CS-AAR.100, CS-AAR.200, CS-AAR.201 and CS-AAR.202 (see AMC CS-AAR.600(a)).

(b) Air-to-Air Refuelling Device Handling Qualities

The piloted Air-to-Air Refuelling Device (i.e. Flyable Boom System) shall be safely controllable and manoeuvrable during Air-to-Air Refuelling operation within the scope of CS-AAR.100, CS-AAR.200, CS-AAR.201 and CS-AAR.202 (see AMC CS-AAR.600(b)).

1.7 Human Factors and Flight Deck Interface/Air Refuelling Operator Station Interface

CS-AAR.700 (see AMC/GM CS-AAR.700)

The individually tanker/receiver certified acceptable levels of work/task load, situational awareness and personal protection shall not be exceeded during Air-to-Air Refuelling operations with the tanker/receiver pair.

1.8 Operating Limitations and Information

Each operating limitation and other information necessary for safe Air-to-Air Refuelling shall be established.
The operating limitations and other information necessary for safe Air-to-Air Refuelling shall be made available to the crew members.

CS-AAR.800 Instructions for Continued Airworthiness (see GM CS-AAR.800)

If an impact to the Air Refuelling Systems and/or associated sub-systems is identified due to the tanker/receiver pairing, a revision of the Tanker and/or Receiver's Instructions for Continued Airworthiness shall be investigated and implemented as required. (see GM-AAR.800)

CS-AAR.801 Aircraft Operating Manual (see AMC/GM CS-AAR.801)

The Tanker/Receiver Aircraft Operating Manual (AOM), includes equivalent documentation such as, Flight Crew Operating Manual (FCOM), Checklists, ATP and shall contain any limitations, procedures, or other information established as a condition of compliance with safe Air-to-Air Refuelling Operations:

(a) Air-to-Air Refuelling Airspeed limitations

The following airspeed limitations and any other airspeed limitations necessary for safe Air-to-Air Refuelling operation between the tanker/receiver pair shall be furnished (see AMC CS-AAR.801(a)):

(1) $V_{AR\ Max}$ /$M_{AR\ Max}$ and $V_{AR\ Min}$/$M_{AR\ Min}$.

(b) Powerplant limitations

Any limitations on the powerplant associated with Air-to-Air refuelling for the tanker/receiver pair shall be included in the AOM.

(c) Weight and Centre-of-Gravity Limits.

Any limitations on aeroplane weight and centre-of-gravity associated with Air-to-Air Refuelling for the tanker/receiver pair shall be included in the AOM (see AMC CS-AAR.801(c)).

(d) Kinds of operations

Any limitations associated with Air-to-Air refuelling between the tanker/receiver pair that infringe on the certified limitations for the kinds of operations and environmental conditions for the individual aeroplane shall be included in the AOM.

(e) Air-to-Air Refuelling Altitudes

Any altitude limitations to the individually certified Air-to-Air Refuelling envelope for the respective tanker/receiver aircraft shall be included in the AOM (see AMC CS-AAR.801(e)).

(f) Fuel limitations

Identified types of acceptable fuel for the tanker/receiver pair conform CS-AAR.502 shall be furnished (see AMC CS-AAR.801(f)).

(g) Boom Envelope

Boom envelope limitations for the tanker/receiver pair shall be included in the AOM (see AMC CS-AAR.801(g)).

(h) Hose and drogue

Hose and drogue limitations for the tanker/receiver pair shall be included in the AOM.

(i) Air-to-Air Refuelling Lights

Optimum, limit and acceptable degraded light configurations and their settings for the tanker/receiver pair as established conform CS-AAR.500 shall be furnished in accordance with CS-AAR.100 for Air-to-Air Refuelling operations (see AMC CS-AAR.801(i)).

(j) EMI/EMC

Any limitation on the operation of electrical and electronic systems during Air-to-Air Refuelling for the tanker/receiver pair as established conform CS-AAR.501 shall be furnished (see AMC CS-AAR.801(j)).

(k) Additional Systems and Equipment Limitation

Any limitations to systems and equipment that are considered necessary for safe Air-to-Air Refuelling operations between the tanker/receiver pair shall be furnished (see AMC CS-AAR.801(k)).

(l) Miscellaneous Limitations

Any information associated with Air-to-Air Refuelling between the tanker/receiver pair not specified under the preceding headings but necessary, as a limitation, to ensure safe Air-to-Air Refuelling operation shall be furnished (see AMC CS-AAR.801(l)).

CS-AAR.802 Operating Procedures (see AMC/GM CS-AAR.802)

(a) Air-to-Air Refuelling Operating procedures shall be furnished for:

(1) Normal Air-to-Air Refuelling procedures peculiar to the target Tanker/Receiver pairing;
(2) Non-normal Air-to-Air Refuelling procedures for malfunction cases and failure conditions in Tanker and/or Receiver involving the use of alternate procedures, special systems and/or the alternative use of regular systems.
(3) Emergency procedures for foreseeable but unusual situations during Air-to-Air Refuelling operations in which immediate and precise action by the crew may be expected to substantially reduce the risk of catastrophe.

(b) Processes shall be in place to identify and document normal and emergency procedures, limitations, restrictions, warnings, cautions and notes.

(c) AAR tanker-receiver envelope, operational procedures and limitations resulting from the demonstration of the requirements previously defined shall be gathered in the tanker/receiver AOM or equivalent Authority Approved Data.

2 ACCEPTABLE MEANS OF COMPLIANCE/GUIDANCE MATERIAL

2.1 General

GM CS-AAR.100 Scope

The scope includes coverage of intended use and/or kinds of operation and environmental conditions which have to be clearly determined and adequately defined.
Regarding Air-to-Air Refuelling operations the extent of approved operations should be clearly determined and defined including consideration for mission-driven unique Air-to-Air Refuelling operations. Air-to-Air Refuelling operations considerations include but are not necessarily limited to:

- Day operations
- Un-aided night operations
- Covert night operations
- One receiver at a time
- Simultaneous refuelling
- Deviations from standard ATP 3.3.4.2 procedures
- Training operations (dry hose, no fuel transfers)
- Hot weapons/active defence systems
- Reverse refuelling
- Communications out operations and other EMCON states
- Special external configurations (e.g. helicopter sling loads)
- Unique active emitters
- Cargo or payload possibly adversely affecting safety of the Air-to-Air Refuelling process (e.g. cargo, medevac configuration on receiver being an EMI source to the targeted tanker and vice versa)
- Stores jettisoned/employed during Air-to-Air Refuelling operations between the tanker/receiver pair. Example of such configurations include but are not necessarily limited to:
    - dispensed countermeasures, i.e. Chaff, Flare
    - externally slung loads

Tanker and receiver systems which affect or are relevant to performing Air-to-Air Refuelling Operations with the tanker/receiver pair should be clearly identified and relevant variations within these systems should be defined.
Such systems include but are not necessarily limited to boom, receptacle, drogue, and probe Air-to-Air Refuelling systems, including the interfaces with other tanker/receiver systems. Also included are those tanker/receiver systems/components, along with the Air-to-Air Refuelling system(s)/components, which are involved in the Air-to-Air Refuelling process.

Variations in Tanker/Receiver configuration and/or state include but are not necessarily limited to:

- flap settings,
- software configuration
- part numbers
- air vehicle skin properties
- external stores configurations (including asymmetric configurations)
- removable Air-to-Air Refuelling hardware
- flight augmentation systems (i.e. Load Alleviation System, yaw damper system, automatic trim)
- Autopilot (AP) OFF, Auto Throttle (AT) system OFF, both AP and AT OFF.
- failure conditions.

Degraded conditions

If the intended use or kind of operations for the tanker/receiver pair includes Air-to-Air Refuelling operations under approved degraded conditions, those conditions should be clearly defined for individual tanker and/or receiver.
Once selected, the degraded conditions to be cleared for Air-to-Air Refuelling operations, should be assessed following the same approach as for normal conditions and the relevant limitations/procedures should be defined to ensure safe Air-to-Air Refuelling operations.

Approved/acceptable degraded conditions typically can include but are not necessarily limited to:

- Emergency/secondary/back-up/degraded electrical or hydraulic power system(s)
- Engine inoperative (regarding Air-to-Air Refuelling and/or towing)
- Engine thrust/power under backup control mode
- Failure conditions in exterior lighting
- Failure conditions in remote vision system
- Failure conditions in flight control system
- Failure conditions in boom control system
- Failure conditions in fuel and Air-to-Air Refuelling systems e.g. failure conditions in fuel delivery regulation (flow/pressure)
- Stiff boom
- Air-to-Air Refuelling flight control logic failure
- Non-fully extended probe
- Dead hose/drogue

Hazard identification and considerations

Any particular tanker/receiver characteristics that introduce safety hazards for the pairing not considered in the individual tanker/receiver certification should be identified

and assessed for both the tanker and receiver to ensure safe Air-to-Air Refuelling operations. Identification of such a specific safety hazard may be satisfied through a qualitative assessment. Relevant failure condition identification and assessment should account for tanker/receiver pair specifics that may significantly increase the severity of the consequences of tanker failure affecting the receiver and vice versa during Air-to-Air Refuelling operations. Those consequences may have been insufficiently covered by the individual design assumptions which support the individual tanker/receiver certification. In case safety hazards have not been adequately addressed for the individual tanker/receiver certification, the scope of the tanker/receiver pairing at hand may have to be revised. .

Failure conditions to consider include but are not necessarily limited to:

- Failure of any propulsion system or component thereof
- Any single failure in either tanker or receiver Air-to-Air Refuelling system, i.e.:
    - single failure in the tanker/receiver system's pressure regulation/surge suppression feature(s)
    - failed open fuel control valve during Air-to-Air Refuelling
    - separation of an Air-to-Air Refuelling line within a tank
    - inability of the fuel vent system to maintain internal tank pressure within structural limits during Air-to-Air Refuelling operations under single failure conditions
    - Fuel spillage

- Inadvertent Defensive Aids system activation
- Uncommanded hose jettison affecting the receiver, i.e. consider multi-engine versus single-engine
- Boom system failures that may induce uncommanded boom movements in the vicinity of the receiver. Depending on the receiver type, size and geometry the risk associated with these failures may exceed the identified and accepted level of risk in the individual tanker certification for Air-to-Air Refuelling
- Uncontrolled hose whipping after contact
- Tanker High Frequency (HF) emitters inadvertent transmission
- Boom receptacle failure cases. Depending on the tanker type (and associated design precautions such as an Independent Disconnect functionality), the severity of this scenario (boom receptacle failing to unlatch) may be different from the tanker considered in the individual receiver certification for Air-to-Air Refuelling
- Receiver RADAR or other emitters inadvertent transmission

Considerations of such failure conditions is qualitative, using engineering and operational judgement and relies on the fact that both the tanker and receiver are individually certified for Air-to-Air Refuelling operation.

For those failures which are covered by the individual Tanker/Receiver certification for Air-to-Air Refuelling operations and for which their assessment may be considered as not Tanker/Receiver dependant, reassessment of risk is not necessary.

AMC CS-AAR.101 Proof of Compliance

AMC CS-AAR.101(a)

A description of the kind of operations, certification specifications, special conditions, equivalent safety findings as well as the description on how compliance is demonstrated, with selected means of compliance and any associated guidance material must be furnished. The description of the means of compliance should be sufficient to determine that all necessary data was collected and compliance was demonstrated. Identification of relevant personnel making decisions affecting airworthiness and operational suitability shall be furnished.

AMC CS-AAR.101(b)

Where variation of the parameter on which a tolerance is permitted will have an appreciable effect on the test, the result should be repeated or corrected to the specified value of the parameter; otherwise no correction is necessary.

GM CS-AAR.101 Proof of Compliance

GM CS-AAR.101(a)

In case modelling, simulation, analysis tools and/or databases are used for evaluating adequate safety for Air-to-Air refuelling operations appropriate fidelity, application and accurate representation of the new/modified tanker/receiver pair has to be ensured. Processes are in place to ensure that all modelling, simulation, analysis tools and databases are of appropriate accuracy and fidelity, are validated for the intended applications, and are configuration controlled. Requirements definition/traceability, design and performance analysis tools, prediction methods, models and simulations are applied appropriately, and exhibit accuracy commensurate with their applications.

Modelling and simulation data, databases and tools used to satisfy Air-to Air Refuelling flying qualities criteria are validated to ensure predictions of tanker/receiver stability and control, flying and handling qualities characteristics correctly and accurately represent tanker/receiver for trim, dynamic manoeuvres and failures across the intended Air-to-Air Refuelling envelope and configurations during Air-to-Air Refuelling operations between the new/modified tanker/receiver pair.

Modelling, simulation, analysis tools and databases which are utilized for evaluating adequate safety of Air-to-Air Refuelling operations with the new/modified tanker/receiver pair across the intended Air-to-Air Refuelling envelope, for all intended

certified centre-of gravity ranges, mass properties and configurations in the intended environmental conditions are verified and validated to be of sufficient fidelity and accuracy.

A suitable verification, validation and accreditation process is established (including flight test if necessary).

Configuration control across modelling, simulation, analysis tools and databases is established to assure currency and traceability.

Review of modelling, simulation, analysis tools and database documentation verifies and validates that predicted data, as well as offline and piloted simulation results, are generated by the most appropriate and accurate tools and processes. Review of the documentation verifies and validates that the frequency and time domain based analysis tools, models, simulations and all the databases/components thereof (e.g., aerodynamics, flight control system and flight control laws, sensors, actuators) are of sufficient fidelity and pedigree to support the Technical Compatibility Assessment of the new/modified tanker/receiver pair, having incorporated updates as a result of component testing, ground testing and flight testing, as appropriate.

Verify that the environment introduced by the new/modified tanker/receiver pair to perform Air-to-Air refuelling operations in used for simulation falls within the previously approved environment.

Simulation functional and physical fidelity (or degree of realism) requirements will typically depend on the configurations, functions, tasks, and equipment.

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.

Review of documentation verifies that the analytically predicted data is generated by validated and verified tools and processes. Review of the documentation validates and verifies the frequency and time domain based tools, models and components of models and simulations completed. Usable flight test data, possibly from various sources, is used in the validation process. Validation occurs across the intended environment conditions, centre-of-gravity and inertial properties, flight control modes and configurations.

2.2 Air-to-Air Refuelling Envelope

AMC CS-AAR.200 Flight Envelope Compatibility

The Air-to-Air Refuelling flight envelope should be defined based on the specific individual Air-to-Air Refuelling envelopes from Tanker and Receiver and must always

respect the most limiting one. Additional limitations to this Air-to-Air Refuelling flight envelope may be imposed coming from a desktop compatibility analysis or results from flight tests. To determine the Air-to-Air Refuelling flight envelope, the tanker Air-to-Air Refuelling flight envelope should be overlaid onto the receiver Air-to-Air Refuelling flight envelope, and the common area defines the in principle achievable Air-to-Air Refuelling flight envelope. If a smaller subset is all that is desired, then that Air-to-Air Refuelling flight envelope can be defined as such.

GM CS-AAR.200 Flight Envelope Compatibility

ATP 3.3.4.2.1 furnishes the Standardized Technical Data Survey (STDS) which can serve as guidance for the required data to accomplish an Air-to-Air Refuelling flight envelope comparison for the Tanker/Receiver pair.

AMC CS-AAR.201 Weight and Centre of Gravity Envelope Compatibility

Verify that weight and centre of gravity margins are properly defined to handle aerodynamic, centre of gravity, and inertia changes resulting from fuel on-load, off-load, and/or asymmetric fuel loading during Air-to-Air Refuelling for the tanker/receiver pairing.

GM CS-AAR.201 Weight and Centre of Gravity Envelope Compatibility

Aircraft weight and centre of gravity margins as approved for the aircraft certified flight envelope might prove to be not restrictive enough for Air-to-Air Refuelling operations.

Consider receiver accepting fuel from tanker that has higher fuel off-load capability then the certified on-load flow rate of the receiver. If maximum fuel flow rate from the targeted tanker is more than the maximum flow rate from the currently approved tankers for the receiver centre of gravity management capability might be exceeded.

When applicable consider analysis and/or flight test to verify that receiver has sufficient stability margins to conduct Air-to-Air Refuelling operations under cargo loading configurations that can cause wandering centre of gravity. An example of such a case would be the requirement carrying sling cargo or cargo jettison during Air-to-Air Refuelling operations.

AMC CS-AAR.202 Induced Environment Compatibility

Safe Air-to-Air Refuelling operations in any intended environmental condition should be assured for the tanker/receiver pair for all aspects identified as affected for that environmental condition within the individual certification/qualification of the tanker/receiver.

Safe Air-to-Air Refuelling operations in any intended environmental condition should be assured for the tanker/receiver pair for any additional aspects affected for that environmental condition that were not previously identified as affected within the individual certification/qualification of the tanker/receiver.

Verification methods include analysis, demonstration and/or test to verify that system elements and components provide required function and performance within the intended new induced environment for the tanker/receiver pair without imposing a safety of flight risk.

AMC CS-AAR.202(b) Fuel Spray

Analysis of system design and review of flight test data for the tanker/receiver pair gives evidence no hazards are caused by fuel spray resultant of the Air-to-Air Refuelling operation or fuel venting.

AMC CS-AAR.202(e) Noise

The following compliances are applicable in addressing the standards:

- Predictions of internal acoustic levels based on internal noise sources and the near field aeroacoustic predictions during Air-to-Air Refuelling operations between the tanker/receiver pair.
- Measurements at personnel stations of internal acoustic levels during Air-to-Air Refuelling operations between the tanker/receiver pair.

AMC CS-AAR.202(f) Vibration

The following compliances are applicable in addressing the standards:

- Analysis of the predicted vibration environment.
- Ground and flight vibration tests which identify the response characteristics of the tanker/receiver aircraft to forced vibrations and impulses encountered during Air-to-Air Refuelling operations between the tanker/receiver pair.

GM CS-AAR.202 Induced Environment Compatibility

Tanker/receiver should be individually certified/qualified to perform Air-to-Air Refuelling operations in the environmental conditions falling within the intended scope of the tanker/receiver pair.

Aspects to consider include but are not necessarily limited to:

- Comparison of the individual tanker/receiver assumed environment to the new induced environment expected with the tanker/receiver pairing assures validity

of the design criteria. The required level of safety throughout the intended Air-to-Air Refuelling envelope for the tanker/receiver pair should be assured for all system elements and components. Regarding Vehicle Control Function flight critical components warrant specific attention. For rotorcraft sufficient collective, pedal, and cyclic functionality and performance.

- The boom control and tanker/receiver Air-to-Air Refuelling control components adequacy of design to withstand the full range of induced environment created during Air-to Air Refuelling operations between the tanker/receiver pair should be considered.

- The receiver transparency system does not fail when exposed to maximum thermal and structural load stresses that may be experienced during Air-to-Air Refuelling operations with the tanker.

- Air-to-Air Refuelling operations with the tanker/receiver pair do not induce any kind of unsafe oscillatory effects. Structural oscillations of tanker, boom control, and receiver that may occur in Air-to Air Refuelling operations between the tanker/receiver pair do not impact completion of Air-to-Air Refuelling operation, compromise safety, or cause crew or passenger dangerous conditions. Air-to-Air Refuelling operation does not impact or degrade flying qualities of the tanker, flyable Air Refuelling system and the receiver beyond established limits in current Aeroplane Flight Manual. Air-to-Air Refuelling operation includes all applicable tanker/receiver/ Air Refuelling system control modes (i.e. autopilot, manual, normal, alternate, emergency/backup modes) within the intended scope of the tanker/receiver pair.

- Verify that the maximum required control surface positions can be obtained without mechanical interference or jamming situations from the structure or surrounding devices under the most adverse environmental conditions for the tanker/receiver pair.

- For UAS that use sensors to provide feedback to either a remote operator or autonomous control system for flight safety and mission critical aspects, verify that environmental effects do not degrade the sensor capabilities. Provisions are incorporated as necessary to protect such sensors against various environmental effects to include but not limited to obscuration, temperature, vibration, laser threats.

GM CS-AAR.202(a) Aerodynamic Conditions

Bow wave or tanker wake effects on tanker/receiver air data systems should allow for safe Air-to-Air Refuelling operations. Tanker/receiver air data tolerance to bow wave respectively tanker wake effects during Air-to-Air Refuelling operations between the tanker/receiver pair shows evidence that safe flying- and handling-qualities are assured. Receiver bow wave and tanker downwash and wake effects on air data systems include but are not necessarily limited to:

- redundancy management miscompares
- erroneous altitude indications/inputs
- erroneous airspeed indications/inputs
- erroneous angle of attack indications/inputs

Bow wave or tanker wake should not cause adverse effects to aerodynamically induced structural loads for the tanker/receiver. Absence of flutter, excessive buffeting or structural design limit exceedances should be assured.
Receiver bow wave and tanker downwash and wake effects on aerodynamic loading affects but is not necessarily limited to the following tanker/receiver structures and/or equipment:

- flight control surfaces
- propellers or rotors
- equipment and structure behind and near vents and louvers

It should be assured that controlled flight can be maintained for all symmetric as well as asymmetric conditions including fail states (see CS-AAR.100) throughout the Air-to-Air Refuelling Flight Envelope. Sufficient flight control power as well as the ability to trim control forces to acceptable levels should be assured.

Tanker/receiver propulsion system and auxiliary/emergency power systems remain stable and compatible during Air-to-Air Refuelling operations. Engine performance stays within certified individual tanker/receiver limitations. Consideration should be given to changes/disturbances in air flow from the tanker which can lead to engine and/or auxiliary/emergency power systems inlet pressure distortion and engine and/or auxiliary/emergency power systems instability for the receiver. Consideration regarding disturbance in air flow to the inlet of receiver auxiliary/emergency power systems is only applicable if the receiver has the capability to run such systems during Air-to-Air Refuelling operations.

The tanker/receiver pair should not exhibit any aeroservoelastic instability resulting from the interactions of air vehicle systems involved in Air-to-Air Refuelling operations such as aerodynamics, commanded or uncommanded control systems coupling with the airframe, rotor systems and/or external slung loads, as appropriate. Boom and receptacle-equipped receiver control system feedback loops during Air-to-Air Refuelling operations have adequate stability margins for coupled flight within the Air-to-Air Refuelling envelope for the tanker/receiver pair.

GM CS-AAR.202(b) Fuel Spray

The effects of fuel spray from the Air-to-Air Refuelling devices or fuel venting onto the receiver should be assessed. Fuel spray is typically created during the engagement and disengagement of the Air-to-Air Refuelling interfaces but i.e. drainage from refuelling pods can be a possible source as well. Areas to consider include but are not necessarily limited to:

- receiver's engine intake position(s)
- receiver's environmental systems
- air data systems
- ventilation inlets/outlets
- low observable coatings/material
- ignition sources
- obstruction of required pilot field of view
- lights, optical windows/enclosures, antennae, canopy or any other sensitive devices/mission equipment

Equipment specifications should be considered in terms of appreciation of the possibility of fuel spray, drainage, leakage or spillage during Air-to-Air Refuelling flight-test activity from technical perspective, e.g.:

- MIL-C-25162 (Coupling Type MA2)
- MIL-X-81975 (Couplings Type MA3-MA4-MA5)
- MIL-N-25161 (Nozzle Type MA-2)
- STANAG 3447 Air-to-Air Refuelling Equipment : Probe-Drogue Interface Characteristics
- STANAG 7191 (Air-to-Air (Aerial) Refuelling Equipment: Boom Receptacle System and Interface Requirements)

This appreciation should bare no relevance to the acceptability of any fuel spray where it relates to safety of flight, reference the considerations listed in this GM.
The most adverse offset conditions for probe/nozzle from drogue/receptacle should be considered.

GM CS-AAR.202(c) Electro Static Discharge

It should be verified that each Air-to-Air Refuelling system can withstand the static discharge typically encountered during the engagement of tanker and receiver interfaces. Each Air-to-Air Refuelling system involved in an engagement is designed to accommodate/dissipate the static discharge resultant of the electrical potential difference between the specific tanker/receiver pair.

GM CS-AAR.202(d) Exhaust Plume

Receiver engine cooling and thermal management systems should continue to safely remove excess heat from the engine and its subsystems under the induced

environmental conditions. Evaluation of the specific tanker/receiver paring should confirm that receiver air vehicle and engine thermal management systems continue to ensure that cooling performance remains adequate and there are no conditions that result in exceedance of established loss of aircraft (LOA) rates.

Exhaust plume(s) (considering engine(s), APU, laser, chemicals and exhaust gases) from the tanker do(es) not impinge on receiver aircraft structure, canopy/windshields, air intakes, fluid drains and equipment to the extent that maximum allowable temperatures are exceeded.

Chemicals or exhaust gases produced by laser operation should not exceed the concentration or temperature defined as safe minimum values in any part of the tanker/receiver pair.

- Tanker exhaust: Chemicals or exhaust gases should not adversely affect receiver airframe or any of its subsystems. An induced laser exhaust hazard for the tanker is not created during Air-to-Air Refuelling operations with the receiver.

- Receiver exhaust: Chemicals or exhaust gases should not adversely affect the tanker, its Air-to-Air Refuelling interfaces or any of its subsystems during Air-to-Air Refuelling operations. An induced laser exhaust hazard for the receiver is not created during Air-to-Air Refuelling operations with the tanker.

GM CS-AAR.202(e) Noise

New/modified sound sources for the tanker/receiver pair should be identified.

GM CS-AAR.202(f) Vibration

New/modified vibratory sources for the tanker/receiver pair should be identified. Aeroacoustic loads and vibrations induced by the aeroacoustic environment can lead to sonic fatigue and/or excessive vibration of the airframe structure and/or components that could result in cracking or impaired functionality of the air vehicle or components of the air vehicle systems. Design of all components and associated cabling/wiring continues to ensure that their natural frequencies remain outside the induced vibratory environment or have adequate damping provisions to prevent resonances, chafing, damage, inadequate stores clearance and failure conditions. Engine vibration should not exceed engine limits within the receiver aircraft when Air-to-Air Refuelling behind the new/modified tanker.
Areas to consider include but are not necessarily limited to:

- Airframe structure (including cavities)
- Equipment, i.e., chaff/flare, towed decoy, laser, sensors
- Equipment provisions
- External stores, including suspension and release equipment
- Fuel tanks, fuel tubing
- Structural Mode Interaction

2.3 Geometric Compatibility

GM CS-AAR.300

Air-to-Air Refuelling interface geometric compatibility should conform to acceptable standards, e.g.:

- NATO STANAG 3447, ATP 3.3.4.6.
- NATO STANAG 7191, ATP 3.3.4.5.

GM CS-AAR.300(a) Interface/air vehicle spatial clearance

Aspects to consider typically can include but are not necessarily limited to:

- Canopy
- Engine intake lips
- Antennas
- Wing leading edges
- Canards
- Vertically raised surfaces, i.e. Air-to-Air Refuelling receptacle doors
- Conformal tanks
- Hose versus rotor blades

GM CS-AAR.300(b) Air vehicle/air vehicle spatial clearance

Consideration should be given to multiple receivers simultaneously engaged in Air-to-Air Refuelling with the same tanker. Adequate distance should be identified to ensure safe Air-to-Air Refuelling operations between the engaged air vehicles for the most critical spatial positions.

For boom/receptacle systems, evaluation should consider tanker/receiver and receiver/receiver (if applicable) clearance at each boom system's initial contact, fuel transfer, and inner limit positions. Evaluations should consider contact with the receiver positioned at the boom system's disconnect limits (elevation, lateral, and extension).

For probe/drogue systems, evaluation should consider the clearances between the tanker and each receiver, and between receivers (if multipoint refuelling) at each drogue system’s contact (full trail), fuel transfer, and inner limit positions. Evaluation should consider contact (full trail) positions with the hose empty and the hose full of fuel throughout the AR envelope. The evaluation, particularly with rotary-wing receivers, should also consider the position(s) procedurally taken by the receiver once successfully connected to the drogue system.
The evaluation should consider the motion of the drogue/coupling/hose upon disconnect and how that motion impacts the clearance between the receiver and the drogue/coupling/hose.

2.4 Loads Compatibility

AMC CS-AAR.400

The Air-to-Air Refuelling loads experienced by the tanker/receiver should be verified. Correlated loads evaluation containing details of magnitudes and distribution of all experienced loads should be performed for multiple and most critical tanker/receiver configurations and manoeuvres within the intended scope (reference CS-AAR.100), throughout the Air-to-Air Refuelling envelope.

GM CS-AAR.400

Air-to-Air Refuelling loads should not adversely affect operation/controllability of the tanker/receiver. Aspects to consider typically can include but are not necessarily limited to:

- control systems' interference
- control surface/air vehicle structure interference

There are different loads associated with the method and/or conditions of Air-to-Air Refuelling. Specific loads to be considered include:

- For boom/receptacle Air-to-Air Refuelling systems, 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 at Air-to-Air Refuelling flight conditions, loads due to inadvertent boom strikes, and acoustic/vibration loads (reference CS-AAR.202(f)) experienced when the Air-to-Air Refuelling system is in the "closed", "transition", or "open" positions.

- For probe/drogue Air-to-Air Refuelling systems, loads expected during normal engagements/disengagements at the most severe receiver closure/fall-back rates, those experienced due to inadvertent off-centre engagements/disengagements, those experienced when a single failure occurs in the latching mechanism of the Air-to-Air Refuelling coupling and the probe nozzle must be forcibly pulled out of the coupling at Air-to-Air Refuelling flight conditions, loads experienced due to a failed/degraded hose reel response at the most severe receiver closure/fall-back rates, and acoustic/vibration loads (reference CS-AAR.202(f)) experienced when the Air-to-Air Refuelling system is in the "closed", "transition", or "open" positions.

Air-to-Air Refuelling structural loads aspects to consider typically can include but are not necessarily limited to:

- Boom/receptacle engagement and contact
- Probe/drogue engagement and coupling
- Disconnect and disengagement
- Nozzle binding
- Tension disconnects
- Towing

Evaluation of all above mentioned aspects should take most critical/failure conditions into account. Aspects to consider, reference identified scope (CS-AAR.100), typically can include but are not necessarily limited to:

- Asymmetric configurations
    - External stores
    - Fuel
    - Payload

- Adverse trim conditions
- Backup control systems
- Load alleviation systems

2.5 System Compatibility

AMC CS-AAR.500 Visual References/Lights and Markings

The evaluation of visual references, lights and markings is for the most extent a qualitative and subjective process. Therefore appropriate test crew questionnaires and rating scales can prove to be useful. Multiple crew surveys should be gathered per crew position while ideally the test crew represents a spread in experience level.

GM CS-AAR.500 Visual References/Lights and Markings

The vision envelope for the appropriate tanker/receiver aircrew during Air-to-Air Refuelling operations can be verified by inspection of engineering drawings (including vision plots), a review of computer vision analyses, and flight test.

Aspects to evaluate, both from tanker as well as receiver perspective, can include but are not necessarily limited to:

- Lights intensity (consider adequate variability)
- Beacon lights
- Navigation lights
- Formation lights
- Flood lights and Air-to-Air Refuelling flood lights
- Air-to-Air Refuelling boom lights
- Director lights/signals

- Receptacle/slipway lights
- Wing Pod lights
- Centre-line/Fuselage Refuelling System/Unit lights
- Probe lights
- Probe asymmetry
- Drogue illumination, hose exit tunnel illumination, wing pod illumination, drogue subsystem status lights
- Positioning markings
- Aerial refuelling boom markings showing inner/outer receiver contact limit and inner/outer fuel transfer limit positions
- Hose markings showing full trail, inner and outer fuel transfer range
- Boom lead-in markings in front of the receptacle
- Distance and relative movement indicators (including lighting of) such as: antennae, wing leading edge, engine nacelle, canopy, horizontal/vertical stabilizers, etc.
- Automated Air-to-Air Refuelling (A3R) references (i.e. automated boom systems, unmanned receivers)
- Diverse backgrounds (snow, ocean, desert, populated city lights, foliage dominant, etc.);
- In, above, and below clouds
- Influence of paint scheme/properties
- Laser eye protection devices

Many of the above aspects are also associated with aspects considered under GM CS-AAR.700.

GM CS-AAR.500(a) Visible spectrum

Phenomena to consider include but are not necessarily limited to:

- Obscuration
- Excessive reflections, dazzling effect on air crew
- Glare/blooming including effects on remote vision systems (i.e. over- exposure versus aperture closure)
- Shadowing
- Sun in and out of field of view

GM CS-AAR.500(b) Covert

Phenomena to consider include but are not necessarily limited to:

- Obscuration (blind spots)
- IR lights compatibility with Night Vision Imaging System (NVIS) (i.e. IR floodlights, director lights, beacon lights, navigation lights, formation lights)
- Blooming effects on NVIS
- Twilight (cross-over effects)

- Ambient moon lighting (waxing/waning) in/out of field of view

GM CS-AAR.501 Electromagnetic Environmental Effects

Electro Magnetic Interference (EMI)/Electro Magnetic Compatibility (EMC) should be evaluated considering all active emitters, receivers, electrical and electronic systems during Air-to-Air Refuelling operations, according to scope CS-AAR.100 and conform to acceptable standards, e.g.:

- MIL-STD-464.

Electromagnetic Environmental Effects (E_3) aspects to consider typically can include but are not necessarily limited to:

- Electro Magnetic Compatibility (EMC) between active emitters and flight control, electrical and electronic systems and/or their interfaces of the targeted tanker(s)/receivers(s)
- Evaluation of antenna performance, i.e. continued adequate gain and coverage to ensure sufficient integrity, availability and continuity of required information. Identification of blanking
- Data bit error rates
- Link margins
- Instrumentation telemetry
- Hazard of Electromagnetic Radiation to Personnel (HERP): Personnel are protected from electromagnetic radiation emitting from the tanker/receiver during Air-to-Air Refuelling operations.
- Hazard of Electromagnetic Radiation to Fuel (HERF): Fuel cannot be inadvertently ignited by radiated electromagnetic fields from tanker/receiver emitters during Air-to-Air Refuelling operations.
- Hazard of Electromagnetic Radiation to Ordnance (HERO): Electrically initiated devices (EID's) used in ordnance and other parts and equipment of the tanker/receiver cannot be inadvertently actuated during, or experience performance degraded characteristics after, exposure to the radiated electromagnetic fields from tanker/receiver emitters.

AMC CS-AAR.502 Fuel and Air-to-Air Refuelling Systems Compatibility

AMC CS-AAR.502(a) AAR Interfaces Compatibility

Limitations regarding interfacing properties should be identified based on the specific individual tanker/receiver Air-to-Air Refuelling system design limitations and must always respect the most restrictive ones. It should be demonstrated that the Air-to-Air Refuelling system interfacing functions are adequate to permit safe Air-to-Air Refuelling operations.

AMC CS-AAR.502(b) Identification of Fuels

Verification should confirm mutually compatible fuel types based on the specific individual tanker/receiver certified fuel, limitations and/or any allowed deviations for both tanker/receiver. Aerial refuelling system compatibility and performance with all identified mutually compatible fuels to be transferred/received, under all specified flight and environmental conditions, are verified using analyses and/or review of individual tanker/receiver documentation.

AMC CS-AAR.502(c) Maximum fuel transfer rate

Limitations regarding flow rate should be identified based on the specific individual tanker/receiver Air-to-Air Refuelling system design limitations and must always respect the most restrictive ones. It should be demonstrated that fuel transfer control is adequate to permit safe Air-to-Air Refuelling operations. The actual flow rate of the transferred (delivered/received) fuel should be identified and within all applicable design limits for the tanker/receiver pair.

AMC CS-AAR.502(d) Steady state pressure

Limitations regarding fuel pressure should be identified based on the specific individual tanker/receiver Air-to-Air Refuelling system design limitations. It should be demonstrated that fuel pressure regulation is adequate to permit safe Air-to-Air Refuelling operations. The actual steady state pressure of transferred (delivered/received) fuel should be identified and within all applicable design limits for the tanker/receiver pair.

AMC CS-AAR.502(e) Pressure transients

Limitations regarding fuel pressure transients should be identified based on the specific individual tanker/receiver Air-to-Air Refuelling system design limitations. It should be demonstrated that fuel pressure regulation is adequate to permit safe Air-to-Air Refuelling operations. The actual transient pressure of transferred (delivered/received) fuel should be identified and within all applicable design limits for the tanker/receiver pair.

GM CS-AAR.502 Fuel and Air-to-Air Refuelling Systems Compatibility

Consideration should be given to critical operational functions and functional modes used in the Air-to-Air Refuelling system to conduct the Air-to-Air Refuelling process for not affecting the individual tanker/receiver loss of aircraft rate or otherwise creating hazards to personnel.

Adequate Test instrumentation should be fitted on the tanker and receiver in order to gather the data needed to show compliance with the Fuel Systems/Air-to-Air Refuelling systems requirements.

Typical Air-to-Air Refuelling system measurement aspects to consider can include but are not necessarily limited to:

- fuel pressure/flow in: nozzle/receptacle/probe/coupling, fuel pump, fuel lines, tanks, fuel vent systems
- sequence and quantity of scheduled transfer of (dispensed/received) fuel
- fuel temperature, density
- equipment status, transitions & operational modes (e.g. pumps, valves On/Off, Open/Close scheduling)
- probe/nozzle loads

GM CS-AAR.502(a) Interfaces Compatibility

Aspects to consider typically can include but are not necessarily limited to:

- receptacle subsystems disconnect function, normal and override/back-up operational modes and “through the boom” communication capability.
- probe subsystems probe disconnect function.
- boom subsystems boom control and manual/automatic disconnect functions, “through the boom” communication, load alleviation and independent disconnect capability
- drogue subsystems hose response capability
- tanker dispensing modes
- Air-to-Air Refuelling envelope “Green Zone” exceedances
- top-off
- bracket refuelling. Once receiver has been filled to full and remains in contact. As fuel is consumed, the receiver AAR shut-off valves open and close.

GM CS-AAR.502(a)(3) Interfaces Compatibility

No measurable fuel leakage should conform to acceptable standards, e.g.:

- STANAG 3447 Air-to-Air Refuelling Equipment : Probe-Drogue Interface Characteristics
- STANAG 7191 (Air-to-Air (Aerial) Refuelling Equipment: Boom Receptacle System and Interface Requirements)

GM CS-AAR.502(b) Identification of Fuels

Consideration should be given to:

- Fuel specifications and tolerances including permitted deviations;
- The use of additives;
- The need to transport, pump and transfer different types of fuel including those not useable by the host air vehicle;
- Compatibility of different fuels with Air-to-Air Refuelling system components;

- Segregation of different types or blends of fuel.

Reference documentation can include but is not limited to Aircraft Operating Manual (AOM) and Aircraft Maintenance Manual.

GM CS-AAR.502(c) Maximum fuel transfer rate

Aspects to consider include but are not necessarily limited to:

- maximum flow capability of the vent and fuel system
- flow induced static build-up
- simultaneous receiver refuelling
- number of Air-to-Air Refuelling pumps used
- delivery pressure regulation

GM CS-AAR.502(e) Pressure transients

Aspects to consider include but are not necessarily limited to:

- single fail states, reference CS-AAR.100
- pump start-up surges (no flow to receiver)
- all possible single/multiple receiver valve closures (manually or automatically activated) which could terminate flow into the receiver
- top-off
- flowing disconnects
- single receiver and simultaneous receiver refuelling scenarios
- reverse Air-to-Air Refuelling scenarios
- all possible tanker valve activations during fuel transfer
- negative pressures
- frequency of pressure perturbations/pulses outside design assumptions for fatigue of tubing and components (valves, pumps, etc....)

GM CS-AAR.503 Communication, Navigation and Surveillance

Required data/information exchange systems to consider typically include but are not necessarily limited to:

- Systems used for relative positioning (i.e. A/A TACAN, relative GPS, IFF, Mode S, (E)TCAS, image processing, optical cues)
- U/VHF voice communications
- Data link communications between tanker and receiver
- Data link communications between tanker/receiver and remote Air Vehicle Operator (AVO)
- Visual cues, reference CS-AAR.500

Communications intelligibility requirements can be evaluated using guidance according to i.e. Phonetically Balanced word test, Modified Rhyme Test, Minimum Articulation Index, Speech Transmission Index and Speech Intelligibility Index. Other guidance may be used as long as it provides an equivalent level of compliance demonstration.

E.g. STANAG 4586 and STANAG 4660 provide guidance for data link communications.

AMC CS-AAR.504 Defensive Aids Compatibility

Defensive Aids systems' design and/or procedures adequately preclude Defensive Aids activation. If Defensive Aids systems activation cannot be adequately prevented or these systems are active conform scope (CS-AAR.100), it should be assured that the tanker/receiver(s) acceptable Loss of Aircraft (LOA) rate is not exceeded and aircrew exposure stays within permissible limits.

GM CS-AAR.504 Defensive Aids Compatibility

Defensive Aids systems to consider include but are not necessarily limited to:

- Chaff defensive countermeasures
- Infrared defensive countermeasures (i.e. directed laser, flare)
- Electronic defensive countermeasures (i.e. jamming)

In case of employment of directed laser technology tanker/receiver(s) aircrew should not be exposed to levels of laser radiation, direct or reflected, in excess of the maximum permissible exposure limit.

2.6 Handling Qualities

AMC CS-AAR.600

AMC CS-AAR.600(a) Tanker/Receiver Handling Qualities

It should be possible to perform any Air-to-Air Refuelling manoeuvre without excessive pilot compensation, exceptional piloting skills, alertness, or strength, and without danger of exceeding the aircraft under any probable operating conditions.

There should be no tendency for Pilot Induced Oscillations (PIO), that is, sustained or uncontrollable oscillations resulting from efforts of the pilot to control the aircraft for Tanker and Receiver that could compromise safety or task performance.

AMC CS-AAR.600(b) Air-to-Air Refuelling Device Handling Qualities

It should be possible to perform any Air-to-Air Refuelling Device manoeuvring without excessive Aerial Refuelling Operator (ARO) compensation, exceptional Aerial Refuelling Operator skills, alertness, or strength, and without danger of exceeding Air-to-Air Refuelling Device limits under any probable operating conditions.

There should be no tendency for Aerial Refuelling Operator Induced Oscillations (AIO), that is, sustained or uncontrollable oscillations resulting from efforts of the Aerial Refuelling Operator to control the Air-to-Air Refuelling Device that could compromise safety or task performance.

GM CS-AAR.600

Evaluation of tanker, receiver and piloted Air-to-Air Refuelling Device handling qualities in performing Air-to-Air Refuelling tasks is predominantly a qualitative process.

MIL-STD-1797, ADS-33-PRF and rating scales (Cooper-Harper, PIO) therein furnish guidance for how compliance demonstration could be achieved. Other guidance and scales may be used as long as it provides an equivalent level of compliance demonstration.

According MIL-STD-1797 or ADS-33-PRF, Level 1 Handling Qualities (HQ) and Pilot Induced Oscillation (PIO) tendency are considered compliant. In case Level 1 for either cannot be demonstrated acceptability of the observed HQ and/or PIO tendency needs specific substantiation.

Under single failure conditions accepting Level 2/Cooper-Harper 5 Handling Qualities (HQ) as minimum requirement can be considered provided Loss of Aircraft (LoA) rate is not affected.

This guidance equally applies to Air-to-Air Refuelling Device HQ and Aerial Refuelling Operator Induced Oscillation (AIO).

If at any point PIO/AIO tendency is identified during Air-to-Air Refuelling operations, it should be rated and further analysed.

Aspects to consider for evaluation of tanker, receiver and piloted Air-to-Air Refuelling Device Handling Qualities and PIO/AIO tendencies include but are not necessarily limited to:

- Air-to-Air Refuelling flight phases: formation flight in echelon, approaching astern, astern, contact, contact maintenance, disconnect, break-away and leaving formation
- Air-to-Air Refuelling manoeuvres: straight and level flight, turns up to maximum allowed bank angle, climb, descent and toboggans

- Tanker flight modes (i.e. auto-pilot, auto-throttle on versus off) to assess the influence on the receiver handling qualities
- Receiver Bow Wave effect on Tanker and Air-to-Air Refuelling devices throughout each relevant refuelling point
- Boom/Receptacle
    - ARO and A3R
    - Full contact envelope evaluation
    - Full disconnect envelope evaluation

- Probe/Drogue:
    - Full drogue spatial and refuelling envelope evaluation
    - Dry/wet contacts
    - Receiver closure rates
    - Disconnects throughout tankers drogue contact envelope

- Receiver piloted from the intended seat positions in accordance with CS-AAR.100
- Transient motions due to i.e. in-flight configuration changes, flight mode changes
- Trim response/capability (manual, automatic)
- Particular attention to most critical points in the Air-to-Air Refuelling flight envelope regarding phase and gain margins

2.7 Human Factors and Flight Deck Interface/Air Refuelling Operator Station Interface

AMC CS-AAR.700

It should be demonstrated that workload, situational awareness and personal protection is adequate to permit safe Air-to-Air Refuelling operations. Qualitative and/or quantitative evaluation results should identify that individually tanker/receiver certified acceptable levels are met for the tanker/receiver pair.

GM CS-AAR.700

Aircrew/operator tasks during Air-to-Air Refuelling operations conform to the intended use and all expected scenarios, as defined under CS-AAR.100 Scope should allow to be accomplished within the capabilities of the personnel without undue risk of injury.

Key human factors that deviate from the assumptions underpinning the individual tanker/receiver certification basis should be identified for the tanker/receiver pair. Systems, components, and features that are affected should be considered.
Aspects to consider include but are not necessarily limited to:

- Use of rating scales
    - aircrew should provide ratings to describe their appreciation of measurants regarding e.g. perception, required attention, processing/understanding, deciding and actioning related to performance of required tasks.
    - generally accepted rating scales are Bedford, Modified Cooper Harper, Task Load Index or equivalent rating scales and methodologies.

- The receiver fire alarm, intercom and/or public address system is intelligible at all passenger seats, lavatories, and flight attendant seats and work stations during Air-to-Air Refuelling operations. System volume is sufficient to be detected in all compartments during Air-to-Air Refuelling operations.

- Tanker/receiver crew station arrangements:
    - controls, displays, geometry, and human interfaces regarding the physical attributes, body dimensions, and capabilities of the intended user population for Air-to-Air Refuelling operations between the tanker/receiver pair. Critical information can be obtained, and control inputs can be made to safely conduct Air-to-Air Refuelling operations
    - examples of key human factors to consider for the tanker/receiver pair include but are not necessarily limited to:
        - No unsafe blind spots exist from e.g. posts, canopy bow, windshield frames and/or head up display (HUD) supports
        - Adequacy of transparency systems (e.g. canopy, windshield and windows) optical characteristics
        - Aircrew visual warnings/cautions are located within the certified prime visual signal area during Air-to-Air Refuelling operations with the tanker/receiver pair, and are of sufficient prominence to ensure rapid detection
        - Visibility on receptacle subsystems refuelling status indicators and/or functional modes, e.g. ready, open/closed, contact/disconnect and normal/override
        - Visibility on probe subsystems refuelling status indicators
        - Visibility on boom subsystems status indicators and/or functional modes, e.g. fuel transfer rates, delivery pressures, boom position, load alleviation status, boom flight control system mode, boom nozzle load, functional mode (normal/override/back-up) and system status (ready, contact/disconnect)
        - Visibility on drogue subsystems refuelling status indicators, e.g. operational status (on/off, extend, trail, rewind, stowed), fuel transfer rates, delivery pressures, ram air turbine speed, fuel temperature and hydraulic pressure
    - The geometry, design, and layout of controls, displays, and seating compatibility with human perception capabilities. These aspects should not induce sufficient fatigue, distraction, or discomfort to induce control errors during Air-to-Air Refuelling operations.

- Viewing systems adequacy to permit safe Air-to-Air Refuelling operations. Associated aspects to consider include, but are not necessarily limited to:
    - field of view, latency, depth perception, recognition of relative rates of motion and distances (overrun/underrun) in relation to tanker to receiver monitoring and guidance, recognition of surface contours around the Air-to-Air Refuelling interface and hose stability/response, clarity, background impacts, thermal signatures of tanker/receiver, blooming and glare effects, failure response, solar effects and overlay behaviour.
    - Transparency systems optical characteristics (e.g. enclosures for Air-to-Air Refuelling remote camera and sensor systems)
    - Helmet Mounted Display (HMD), Optical Helmet Mounted Display (OHMD), Head-Up Display (HUD) and Night Vision Device (NVD) are examples of vision systems that may introduce unique optical characteristics or can be adversely affected by the tanker/receiver pair. Typical issues can include but are not necessarily limited to conflicting frames of reference, head tracking shortcomings, head orientation concerns, dark adaptation, visual obscurations, binocular rivalry, field of view limitation and/or parallax.
    - Data transmission performance in support of system latency requirements. Integrity of transmitted data supports safe Air-to-Air Refuelling operations. Failure conditions cannot remain undetected for such duration to become a hazard (e.g. freeze frame). Reference CS-AAR.100 Scope.

- Personal protection associated aspects to consider include, but are not necessarily limited to:
    - Ocular protection (e.g. if tanker/receiver laser threats and/or counter measures during Air-to-Air Refuelling operations are considered, reference CS-AAR.100 Scope).
    - Hearing protection (for induced acoustic environment).

2.8 Operating Limitations and Information

The limitations and information established in accordance with paragraph 1.8 should be only those which are within the competence of the flight crew to observe, and should relate only to those situations (including pre- and post-flight) with which a flight crew member might reasonably be concerned.

GM CS-AAR.800 Instructions for Continued Airworthiness

Review/update relevant technical manuals (i.e. Aircraft Maintenance Program and Aircraft Maintenance Manual(s) or equivalent documentation) and verify adequacy of existing Instructions for Continued Airworthiness (ICA) for the tanker and/or receiver.

The relevant technical manuals should identify limited-life system components that must function properly to maintain the flight safety of the tanker/receiver and/or the

safe usage of the aerial refuelling system during aerial refuelling operations. Appropriate inspection intervals and/or life monitoring techniques should be implemented.

The relevant technical manuals should identify appropriate system components for inspections and their associated inspection criteria. The acceptable inspection intervals and levels for wear/damage on these system components should be furnished. Wear/damage inspection criteria are provided for, but not limited to, receptacle doors, boom nozzles, probe nozzles, drogue struts/canopy, fuel reception couplings, aerial refuelling hoses, and inadvertent boom strike structure surrounding receptacle installation.

AMC CS-AAR.801 Aircraft Operating Manual

The Aircraft Operating Manual (AOM) of the tanker and receiver should provide information to safely operate the respective aeroplane within the environment of the tanker/receiver pair under normal, abnormal and emergency conditions. The AOM should contain the operating limitations and operating procedures for the respective aeroplane's Air-to-Air Refuelling procedures for the tanker/receiver pair to include appropriate restrictions, cautions, warnings and notes.

The Limitations Section should present those operating limitations appropriate to the new induced environment for the tanker/receiver pair as established in the course of the Technical Compatibility Assessment in determining compliance with the applicable certification requirements. Limitations to all certified tanker/receiver configurations (i.e. stores, flap settings, pods) for Air-to-Air refuelling operations should be furnished.
Limitations prescribed by operating rules (i.e. ATP 3.3.4.2) may be incorporated as appropriate.

The extremes of the operational Air-to-Air Refuelling variables, including any appropriate descriptions for which compliance with the certification requirements has been shown and for which the AOM data have been approved, should be listed with respect to the following:

AMC CS-AAR.801(a) Air-to-Air Refuelling Airspeed limitations

Any limitations on the airspeed and Mach number associated with Air-to-Air refuelling between the tanker/receiver pair should be included in the relevant documents such as but not limited to AOM, ATP 3.4.4.2, for all certified configurations.
Limitations data should be included for at least the following:

(1) Maximum and minimum Air-to-Air Refuelling operating limit speed, $V_{AR\ Min}/M_{AR\ Min}$ and $V_{AR\ Max}/M_{AR\ Max}$.

(2) Air-to-Air Refuelling limiting speeds associated with possible variations in aeroplane configuration must be clearly identified and included as applicable (e.g. flaps extension, slats extension, external stores, etc.).

AMC CS-AAR.801(c) Weight and Centre-of-Gravity Limits

Tables or graphs to indicate the centre of gravity (CG) limits for Air-to-Air Refuelling for the tanker/receiver pair.
As appropriate, data should be provided for a range of weights between the maximum Taxi weight and the minimum in-flight weight. The data should be shown with the appropriate aeroplane configurations.

AMC CS-AAR.801(e) Air-to-Air Refuelling Altitudes

Minimum and maximum pressure altitude to which Air-to-Air Refuelling operation is limited for the tanker/receiver pair. Altitude limitations caused by mutual effects on structure, powerplant, equipment characteristics or flight characteristics (to include fail states for which continued Air-to-Air Refuelling operation is certified) should be provided.

AMC CS-AAR.801(f) Fuel Limitations

Operating limitations due to fuel related considerations (e.g. fuel type, fuel management, fuel pressure, fuel flow).

AMC CS-AAR.801(g) Boom Envelope

Azimuth/elevation and extension limitations for the tanker/receiver pair.

AMC CS-AAR.801(i) Air-to-Air Refuelling Lights

All relevant lights and their settings in relation to an acceptable light configuration for Air-to-Air refuelling operations as determined conform CS-AAR.500.

These lights can include but are not necessarily limited to:

- Hose light
- Wing mounted pod light
- Centre fuselage line lights,
- Probe light,
- Receptacle light,
- Centreline Refuelling Station light
- Flyable Boom System light
- Flood lights
- Covert lights

AMC CS-AAR.801(j) EMI/EMC

All electrical and electronic systems that are limited in their mode of operation during Air-to-Air refuelling operations as determined conform CS-AAR.501.

AMC CS-AAR.801(k) Additional Systems and Equipment Limitations

Limitations for appropriate systems and equipment installations such as but not necessarily limited to, electrical, hydraulic, pneumatic, autopilot, auto throttle, flight management system, self-protection systems (i.e. laser, flares), armament, radar, offensive countermeasures, pod jettisoning and aerial refuelling hose jettisoning systems, specialized test instrumentation.

AMC CS-AAR.801(l) Miscellaneous Limitations

Any information associated with Air-to-Air Refuelling between the tanker/receiver pair not specified under the preceding headings but necessary, as a limitation, to ensure safe Air-to-Air Refuelling operation.

GM CS-AAR.801 Aircraft Operating Manual

Operating Limitations address all applicable factors involved in Air-to-Air Refuelling operation including, but not limited to:

- day versus night
- with and without NVG
- approved airspeed/altitude envelopes for tanker/receiver contacts
- receiver contact/closure rate limits (probe-drogue systems only) and receiver closure/fall back rate limits once engaged
- for boom systems, envelopes (elevation, roll/azimuth, extension) for receiver contact, receiver disconnect, and boom control limits
- fuel transfer restrictions (e.g., flow rates/delivery pressures)
- reverse aerial refuelling
- operational restrictions

AMC CS-AAR.802 Operating Procedures

The operating procedures section of the AOM should present, as a minimum, the essential information, peculiar to Air-to-Air Refuelling operations for the tanker/receiver pair, that is needed for safe operation under normal and other-than-normal conditions.

Procedures not under control of the flight crew, should not be included in the AOM.

Procedures not directly related to airworthiness, but posing limitations to Air-to-Air refuelling procedures prescribed by operating rules (i.e. ATP 3.3.4.2) should be incorporated.

GM CS-AAR.802 Operating Procedures

Aspects to consider include, but are not necessarily limited to:

- Procedures Development. Prior to certification of Air-to-Air Refuelling between the tanker/receiver pair, it is essential to verify that proposed procedures per TCA are valid and operationally practicable. It is recognised that such procedures may have had only limited operational exposure at the time of TCA and may need to be revised based on service experience.

- Procedures Content. Classifying an Air-to-Air Refuelling operating procedure as normal or as non-normal is potentially not only dependent on whether the own aeroplane's systems are functioning normally. Air-to-Air Refuelling procedures for the tanker/receiver pair that are affected by the status of the other aeroplane's systems and therefore classified as non-normal should be incorporated.

- Procedures effectiveness. When an unsafe condition is detected and/or annunciated, the AOM and/or relevant manual has clear, precise and unambiguous corrective procedures for handling the failure without an excessive increase in workload and minimizing the failure impact.

- Operating Procedures address all applicable factors involved in Air-to-Air Refuelling operation in accordance with CS-AAR.100.

ANNEX D BOOM/RECEPTACLE TEST PLAN

NOTE: ANNEX D, currently blank, will be updated upon receipt of ARSAG documentation when this new document is agreed upon. This work is currently ongoing.

ANNEX E HOSE/DROGUE TEST PLAN

NOTE: ANNEX E, currently blank, will be updated upon receipt of ARSAG documentation when this new document is agreed upon. This work is currently ongoing.

ANNEX F OPERATIONAL REQUIREMENTS (OR) AND ACCEPTABLE MEANS OF COMPLIANCE (AMC)/GUIDANCE MATERIAL (GM) FOR AIR-TO-AIR REFUELLING TANKER/RECEIVER PAIRING OPERATIONAL COMPATIBILITY ASSESSMENT

NOTE: ANNEX F, currently blank, awaiting the Operational Requirements (OR) and Acceptable Means of Compliance (AMC)/Guidance Material (GM) for Air-to-Air Refuelling Tanker/Receiver pairing Operational Compatibility Assessment document from ARSAG. This ANNEX will be updated upon receipt of ARSAG documentation when this new document is agreed upon. This work is currently ongoing.

ATP-3.3.4.2.1(B)(1)

Edition B Version 1