DEF STAN 00-970 NOTICE OF PROPOSED AMENDMENT (Def Stan 00-970-NPA)

TITLE OF PROPOSAL:
Move of AAR requirements to Part 13, Section 3.

Stage of Amendment:	Issue 1

Def Stan 00-970 NPA Serial No:	*2012-012*		
Unsatisfactory Report Serial No:			
MAA Originator:	C2/Grade	R A Bennett-Jones	MAA-Cert-ADS1a

Affected Part: (including paragraphs)	Part 1, Section 2.18 + Leaflet 33 Part 1, Section 4.19, Table 25 + Leaflet 61 Part 1 Section 5.2
Cross-reference to other relevant amendment proposals or documents:	
Proposed Issue Date	Jan 14

Weblink of where this document can be accessed

ADS Point of Contact details		
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Part 1 (for issue to Regulated Community)
INTRODUCTION *(Not more than 250 words)*
The new text will be clearly identifiable within Annex A. Move of requirement. 1. With the development of a new Part 5 Large Aircraft rather than copy the AAR requirements into part 5 it would make sense to move the AAR requirements into Part 13 Section 3 and refer out from Parts 1, 5 and 7. 2. Future work will be required to amend Part 7 to align with this NPA. 3. The proposed changes are at annex A.

SUMMARY OF PROPOSED AMENDMENT

Change: *See Annex A*

Impact Assessment:

Objective: Clarification of the requirement

Risk Assessment: The impact of not incorporating the recommended changes is the possibility of misinterpretation of the requirement

Courses of Action.

1. ***Do nothing.*** The option to do nothing is not desirable for the following reason. Not incorporating the changes will result in increasing duplication of the requirement, leading to possible divergence of the requirement and lack of full compliance.
2. ***Partial Amendment –*** Due to the nature of the change partial amendment is not considered.
3. ***Full Amendment.*** There is no reason that full implementation of all the changes should not be completely feasible. The changes will remove possible divergence from within 00-970.It is highly likely that the clarified requirements will be complied with in full. Retrospective mandation would not be considered necessary.

Preferred Course of Action. Amendment

Benefits and Costs:

1. ***Do nothing.*** There is little benefit of this option and could result in increased divergence, confusion and non compliance with Def Stan 00-970.
2. ***Partial Amendment – No benefit.***
3. ***Full Amendment.*** Full amendment will clarify the Def Stan 00-970 Parts 1 and 13 reference to AAR, resulting in improved overall compliance with the document. The changes proposed here and would have no or little economic impact.

Post Implementation Review: *Timing of post-implementation review.*

The author will establish the impact of the implementation of the change and consider lessons learned from this implementation.

Consultation period ends: 04 Oct 2013

The consultation period for this proposed amendment ends on the stated date. Please send your feedback via email to MAA-Cert-ADSGroup@mod.uk.

Part 2 (for MAA internal use)

Log of Comments (to be completed once the consultation period has ended).

Comment reference	Date	From (name)	Post	Précis or Topic of Comment	MAA Response

Recap of Proposal: *A short summary of the proposal amendment including what changes were incorporated following the consultation period.*

Recommendation. *This section will be completed once all the comments have been received. The recommendation is for the relevant Head of Division to approve the proposal.*

Approval. *This section will detail exactly what has been approved and by whom, and confirm the date for the amendment to be incorporated as well as the date the NPA should be reviewed to determine what the effects of the amendment were in terms of meeting the objective of the change, if there were any unintended consequences and establishing whether the estimated costs were correct.*

Accepted changes will be authorised at the following levels:

- Changes requiring retrospective mandation: 2 *
- Changes not requiring retrospective mandation but having a significant engineering impact: 1*
- Changes not requiring retrospective mandation but having a minor engineering impact: Head of ADS.
- Changes deemed as administrational only: C1 or Equivalent.

Approved by:

Signature	
Name	
Rank/Grade	
Post	
Date signed	
Date for amendment to be incorporated	
Date for NPA review to take place	

Part 3 - NOTIFICATION OF AUTHORIZED AMENDMENT (Def Stan 00-970 NAA)

Document Part:		Sub-Part	

Unsatisfactory Report Reference		NPA Reference	

Originator		Date	

Amendment to be Incorporated on	**XX/XXX/XX**

INTRODUCTION

AUTHORIZED AMENDMENT

FURTHER ACTION

APPROVAL

This Def Stan 00-970 NPA has been approved by the xxxx on behalf of DG MAA

INCORPORATION

The amendment will be incorporated in….

Signed (IAW with part 2).

for DG MAA

Annex A.

Existing Text.

20120730-Original_P
art-1_Requirements.(

20120730-Original_P
art-13_Requirements

Proposed Text.

3.5 IN-FLIGHT REFUELLING

INTRODUCTION

3.5.1 This Clause sets out the design requirements for the installation of 'in-flight refuelling' equipment in both Tanker and Receiver Aircraft.

Symbol/ Abbreviation	Meaning
RR	air-to-air refuelling (receiver)
RT	air-to-air refuelling (tanker) (see Part 1 Section 2 Leaflet 1, Para 3.1 and Table 2)

REQUIREMENT	COMPLIANCE	GUIDANCE
BASIC OPERATIONAL REQUIREMENTS		
3.5.2 When the Aircraft Specification calls for refuelling in flight, it will lay down the rate of flow, the range of fuels to be used, and limits of speed and height at which the operation is to be carried out.	Unless otherwise specified, the Probe and Drogue system shall be used and the transfer system assembly shall be in 'package' form.	
3.5.3 For Aircraft which have an alternative role, the time to change the Aircraft from this role to that of a Tanker or Receiver shall be as short as possible.	Compliance with this requirement shall be proved by demonstration.	
3.5.4 Opening of the refuelling valves in the Receiver shall be selected by the crew of the Receiver Aircraft.		
REQUIREMENTS FOR DESIGN		
DIMENSIONS		

REQUIREMENT	COMPLIANCE	GUIDANCE
3.5.5 The mating dimensions of the reception coupling and the nozzle/probe mast shall conform to STANAG 3447.		
3.5.6 A clearance space shall be provided around the nozzle/probe mast installation in accordance with STANAG 3447.		
COCKPIT CONTROLS AND DISPLAYS		See Part 1, Section 4, Clause 4.19
IN-FLIGHT REFUELLING COCKPIT CONTROLS AND DISPLAYS		
3.5.7 The following controls and displays shall be provided for in - flight refuelling operations in receiver Aircraft: (a) Controls (See Leaflet 9 Para 6.5.1): (1)Air refuel selector, (2)Reset button (where applicable), (3)Disconnect button (where applicable). (b) Display: (1)Tanks full indication, (2)Disconnect indication (Master caution) (where applicable).		
PRESSURES		
3.5.8 The system shall be designed to transfer fuel		See STANAG 3447.

REQUIREMENT	COMPLIANCE	GUIDANCE
at a static pressure (gauge) not exceeding 55 lbf/in^2 (380kPa) at the coupling, without damage to the fuel system or tanks; in either the Tanker or Receiver. The refuelling pressure shall be capable of being regulated at all values of Tanker delivery flow-rate.		
3.5.9 The system shall be so designed that any surge pressures developing at any stage during refuelling operations are limited to 517kPa, except in multi-tank systems, where simultaneous closure of any combination of tank valves can occur, the surge pressure shall not exceed 827kPa. The strength requirements of Part 1, Section 5, Clauses 5.2.202 & 203.		Note: If the design of the system limits the surge pressure to a value lower than the maximum quoted above, then the lower value can be used for design purposes.
3.5.10 Ample inward venting shall be provided in the tanks of the Tanker to prevent any risk of tanks collapsing Outwards venting in both the Tanker and Receiver shall be sufficient to cater for the failure of any one fuel cut-off valve without endangering the fuel tank or surrounding structure. Provision shall also be made to prevent the build-up of excessive pressure in any pipeline.		See Leaflet 9.
3.5.11 The requirements of Clauses 3.5.8 to 3.5.10 inclusive apply also to the tanks of a refuelling package installation.		
3.5.12 It shall be possible to transfer fuel at not less than half of the specification flow rate in the event of failure of any main transfer pump or		

REQUIREMENT	COMPLIANCE	GUIDANCE
equipment associated with the flight-refuelling package.		
FIRE PRECAUTIONS		
3.5.13 The installation of associated electrical equipment shall comply with the requirements of Part 1, Section 4, Clauses 4.26 & 4.27 and Part 1, Section 6, Clause 6.6.		
3.5.14 Electrical connection (to discharge static) shall be established between the Tanker and Receiver before fuel is transferred.		
3.5.15 There shall be no leakage from the Tanker installation when the hose is stowed or trailed. There shall be the minimum possible spillage when the Receiver makes contact, no leakage at all whilst in contact, and a minimum leakage on disconnect. Leakage at disconnect shall be held to this minimum both under normal or emergency break-away conditions even with the most adverse offset of the probe from the drogue.		
3.5.16 Fuel pipes shall not run through: (a) passenger, (b) crew, (c) cargo, or (d) baggage;	Such protection would involve the use of a design that contains the fuel in the event of leakage from the fuel pipes, however caused, and subsequently vents the fuel into a suitable drain system. Typical examples of such a design are double-skinned/walled, jacketed or shrouded. Whenever lagging is used in compartments in which pipes, tanks or equipment containing	The aim of this requirement is to minimise the risk of fire or explosion following leakage from the fuel pipes. A suitable drain system should be capable of accepting the system's maximum flow rate and any resulting increase in pressure. The drain system should also enable detection and identification of the general location of any leakage.

REQUIREMENT	COMPLIANCE	GUIDANCE
compartments, nor in hazardous proximity to: (e) hot air ducts, (f) electrical wiring and (g) electrically operated equipment contained in bays; unless they are without couplings and adequately protected against potential sources of ignition and damage. Any space between a pipe and its protection shall be adequately vented and drained. See also Part 1, Section 4, Clause 4.26.82.	flammable fluids are installed, suitable precautions shall be taken to prevent the wetting of the lagging by flammable fluids as a result of normal operation, damage, failures of the equipment or leakages from joints or unions.	
3.5.17 No fuel shall be left in the refuelling pipelines after completion of the operation, if it could constitute a fire hazard.		
SAFETY CONSIDERATIONS		
3.5.18 No single failure in the Receiver or in the Tanker refuelling package or the installation of it in the Aircraft shall endanger the safety of either Aircraft, and no fuel/vapour shall be released into the cockpit or cabin.		
3.5.19 The equipment in both the Tanker and Receiver shall be installed in such a position that, with hose stowed, there is no appreciable adverse aerodynamic effect on either Aircraft.		
3.5.20 The accelerating capability of the hose drum unit shall be such that the hose will not		

REQUIREMENT	COMPLIANCE	GUIDANCE
"whip" when the Receiver makes contact at any closing speed up to 2.44 m per second. The probe shall be provided with a weak link so that the nozzle will break away in the event of excessive loads occurring due to instability of the hose or of failure of the nozzle and coupling to release under normal operating conditions. It shall also be provided with a non-return valve so that, in the event of such breakage, fuel spillage will not endanger the Receiver.		
3.5.21 Consideration shall be given to locating the refuelling probe so as to minimise the risk of spilled fuel obscuring the windscreen, entering the air intakes or otherwise interfering with the safe and efficient functioning of the Aircraft or its equipment.		
3.5.22 The probe shall be so installed that the pilot of the Receiver has an adequate view, to achieve accurate alignment and engagement with the drogue. The nozzle shall normally be aligned with the flight path of the Receiver at the refuelling speed.	.	
3.5.23 The system shall be installed so that the centre of gravity of both Tanker and Receiver does not move outside authorised limits before, during and after transfer of fuel.		
3.5.24 In the event of failure of the re-winding gear, it shall be possible to jettison the hose from		

REQUIREMENT	COMPLIANCE	GUIDANCE
the refuelling package. Otherwise it shall be impossible for the hose to leave the Tanker. If the equipment is of the "pod" type it shall be possible, in combat Aircraft, to jettison the complete assembly. To guard against inadvertent jettisoning, the operation, if electrical, shall be by a double pole swatch which is effectively guarded, and if mechanical or hydraulic, the system shall be duplicated.		
3.5.25 When the refuelling package incorporates a fuel tank, the fuel in the tank shall be available for use by the Tanker if required.		
3.5.26 Where fuel tanks are installed within the Aircraft pressure cabin, these tanks shall be vented to atmosphere, and they shall be contained in structural enclosures. Means of detecting leaks into the enclosure shall be provided, and the enclosure shall be drainable overboard.		
3.5.27 A system safety assessment shall be carried out demonstrating compliance with the specification safety requirements.		
3.5.28 Radio equipment and aerial positions shall be capable of providing safe and effective communications between the Tanker and Receiver Aircraft, with the Receiver in the refuelling position and in proximity to the Tanker.		
INDICATORS AND LIGHTS		
3.5.29 Means shall be provided in the Tanker		For signal lights see Clauses 3.5.33 to 3.5.35.

REQUIREMENT	COMPLIANCE	GUIDANCE
to indicate: (a) the amount of fuel available for transfer, (b) when fuel is flowing and the rate of flow, (c) the amount of fuel (in kgs) which has been transferred to the Receiver Aircraft, (d) the length of the hose that is trailing (for centre-line units) and, (e) whether pressure has built up in the hose such as to prevent successful contact being established.		
3.5.30 When night refuelling is specified, it shall be possible to illuminate the probe and the drogue and to floodlight the wings of the Tanker so as to provide a datum for the pilot of the Receiver.		
3.5.31 The "root end" length of the hose, which it is necessary to wind in after engagement before fuel transfer can be initiated, shall be marked so as to be clearly distinguishable to the Receiver pilot.		
3.5.32 On refuelling packages which incorporate a fuel tank, an indicator, to show the		

REQUIREMENT	COMPLIANCE	GUIDANCE
range full to empty shall be fitted in such a position that it can readily be seen by ground personnel during servicing. If the package is in the form of a pod carried on the folding portion of the wing, the indication shall be given whether the wings are folded or spread.		
SIGNAL LIGHTS		
3.5.33 Signal lamp systems shall be duplicated such that no single failure will result in the inability of the Receiver Aircraft to monitor the Tanker Aircraft signals.		
3.5.34 A system of red, amber and green signal lights shall be provided at the following positions in the Tanker: (a) on the control panel from which the refuelling operation is controlled, and (b) externally in a position readily visible to the pilot, or appropriate crewmember, of the Receiver.	The lights shall operate in the following order: (a) red, when the master switch is switched on to start the refuelling operation, (b) amber, when the hose has reached the full trail position, (c) green, when successful contact has been made and partial wind-in of the hose under the thrust of the Receiver's probe has opened the valves permitting fuel flow, (d) amber, when fuel flow ceases, and (e) red, when winding in of the hose has started.	

REQUIREMENT	COMPLIANCE	GUIDANCE
3.5.35 It shall be possible, at any stage, to flash the red lamps to warn the Receiver pilot to disengage or stand-off.		

AIR-TO-AIR REFUELLING - FLIGHT

3.5.36 The object of the tests of this Clause is to demonstrate that the handling characteristics of Aircraft are satisfactory.

(a) When operating in the air-to-air tanker role.

(b) When operating in the air-to-air receiver role.

3.5.37 The Clause is divided into two parts:

(a) Part A describes the tests to be made to assess the flying qualities of Aircraft when operating as Air-to-Air Refuelling (AAR) tankers.

(b) Part B describes the tests to be made to assess the flying qualities of Aircraft when engaged in AAR operations as receivers.

REQUIREMENT	COMPLIANCE	GUIDANCE
TANKERS		
3.5.38 The installation of AAR equipment in the tanker Aircraft will normally either take the form of a pod for external attachment to a wing pylon, or a hose Drum Unit (HDU) installation in the rear fuselage, or be a combination of such systems in a multi-point tanker.		
3.5.39 When an Aircraft is developed as a tanker, or converted to the tanker role, a full programme of tests will be carried out to assess the handling characteristics over its operating envelope.	The tests shall normally include the following: (a) Stability and control of the Aircraft with the hose trailed, and when the hose is being extended or retracted. Stability of the	The test methods to be used are described in Part 1 Section 2 Clauses 2.2 to 2.17 (as appropriate). Some further tests, specific to the tanker role, will be required, and this part deals with these tests.

	hose and drogue when extended. All these tests shall be made with the Aircraft under manual and, where applicable, automatic control. (b) Night lighting of the Aircraft and AAR equipment and line-up markings. (c) Failure cases: e.g., handling at low speed with the hose extended. (d) Cockpit layout: AAR controls and indicators.	
3.5.40 Any testing relating to the 'hose' shall include where relevant configuration of any one, any combination or all of the hoses on a multi-point tanker.		
RECEIVERS		
3.5.41 Tests of receiver Aircraft shall consist of assessments of stability and control when approaching to make contact, in contact, and withdrawing from contact with the tanker. Failure cases, such as the effect of engine failures shall be considered. Night lighting shall also be assessed.		

PART A - TANKERS

APPLICABILITY

3.5.42 These tests are applicable to all classes of Aircraft (when operating in the AAR tanker role) as defined by Part 1 Section 2 Clauses 2.1.13 to 16, and to all types of control system as defined by Part 1 Section 2 Leaflet 6 Para 2.

REQUIREMENT	COMPLIANCE	GUIDANCE
EQUIPMENT		
COCKPIT INSTRUMENTS		
3.5.44 The test Aircraft shall be fitted with a normal accelerometer and angle of attack gauge. The Airspeed Indicator shall have been recently calibrated.		
TEST INSTRUMENTATION		
3.5.45 The parameters which should be recorded during these tests are listed in Leaflet 9 Para 9.		
LOADING		
3.5.46 The tests are to be made at loadings such that all forward and aft c of g load conditions of Part 1 Section 2 Table 1 are covered.		
GENERAL TEST CONDITIONS		
ALTITUDE		
3.5.47 The tests shall be made at low, medium and high altitudes appropriate to the flight phase of the Aircraft under test.		
AIRCRAFT CONFIGURATIONS AND SPEED RANGES REQUIRED FOR THE TESTS		

3.5.48 The tests shall be made over the speed ranges indicated in Table 1, and with the lift devices (i.e., slats, flaps etc.,) in the position(s) most appropriate to the flight phase categories (Part 1 Section 2 Clauses 2.1.17 and 18) given in Table 1. Any other intermediate positions shall also be considered if these are likely to be used. Combinations of flaps down/slats in, or vice versa shall only be considered if these are likely to be used, or if they result from single failures.		
TESTS		
PRELIMINARY TESTS		
3.5.49 Some preliminary tests can be carried out on the ground to assess the suitability of the controls and indicators relating to the AAR tanker role at the pilots' stations and the refuelling control panel. An initial assessment of the night lighting, signal lighting system and visual references may also be made on the ground before flight trials are undertaken.		
HOSE AND DROGUE STABILITY TESTS		
3.5.50 The tests of Clauses 3.5.51 to 55 shall be made with the hose both empty and full, over the specified maximum AAR envelope.		
3.5.51 Straight and Level Flight - For these trials a chase or receiver Aircraft equipped with a video or cine camera shall be provided.	The chase or receiver Aircraft is to be positioned slightly behind the drogue, a few feet from the refuelling position. At each test speed and altitude, with the tanker under manual control, the behaviour of the hose and drogue shall be	

	recorded, and any vertical or lateral oscillations which occur shall be noted. The tests shall be repeated with the tanker under autopilot control. In some instances, particularly with a large receiver Aircraft, the proximity of the nose of the receiver may cause a disturbance in the airflow round the drogue, with consequent irregular or oscillatory hose behaviour. If this tendency is noted, a separate chase Aircraft shall be employed to record, using video or cine camera, the hose behaviour during AAR approaches and contacts.	
3.5.52 Banked Turns - Gentle turns of up to 30° bank are to be initiated with the tanker under (a) manual and (b) autopilot control, and the behaviour of the hose and drogue assembly shall be recorded at the initiation of, during and on recovery from turns.		
3.5.53 Descents - The behaviour of the hose and drogue shall be recorded on initiation of, during and on recovery from descents made with up to 500 ft/min rate of descents.		
3.5.54 Longitudinal Trimming - The effect of small adjustments to the longitudinal trim of the Aircraft under manual and autopilot control shall be assessed by recording the hose and drogue behaviour during and after the trim changes. Any long period phugoid tendencies of the Aircraft shall be noted and recorded.		
3.5.55 Induced Hose Oscillations - Oscillations		

in pitch shall be initiated by inducing 'doublet' inputs in the pitch control. The behaviour of the hose and drogue shall be recorded.		
NIGHT LIGHTING, VISUAL REFERENCES AND LINE-UP MARKINGS		
3.5.56 Chase or receiver Aircraft shall be used in making assessments of the night lighting and line-up markings of the tanker.	The suitability of the lighting and the ability to vary its intensity to cover a range of light conditions shall be assessed. The presence of any unwanted reflections in the receivers' canopies shall be noted. The adequacy and position of visual references and suitability of the line-up and hose markings shall be evaluated over a range of day and night ambient conditions. The suitability of the signal lights shall be investigated.	
FAILURE CASES		
3.5.57 Hose Jettison Tests - These tests shall be made in association with Engineering Division and shall be undertaken over a specified dropping zone with a chase Aircraft in attendance.	Video or cine films shall be taken to provide a record of the trajectory of the hose, following jettison. Wind-tunnel tests or predictions shall precede the tests to provide guidance on the preferred jettison speed, and the initial flight tests shall be made suitably close to this speed.	If failure to re-wind the hose can result from a single malfunction, hose jettison tests may be necessary.
3.5.58 AAR Operations With Engine Failed - Tests shall be made to assess the feasibility of undertaking AAR operations with an engine of the tanker failed, and to explore the flight envelope in which fuel transfer is possible under these conditions.	The most critical engine shall be shut down and the hose and drogue deployed at an altitude at which a satisfactory cruising speed (within the normal AAR limits) can be maintained. A receiver shall then attempt to make a dry contact. If contact can be made and held, fuel is to be transferred. A practical AAR envelope in terms of speed and altitude for this condition can then be explored, and the tests are to include gentle turns	

	of up to 30° bank and descents of up to 500 feet/min rate of descent whilst in contact. The refuelling tests shall be made with the tanker under manual and autopilot control.	
COCKPIT LAYOUT, CONTROLS AND INDICATORS		
3.5.59 All controls and indicators relating to the AAR tanker role at the pilots' stations and the refuelling control panel shall be evaluated, and any shortcomings or deficiencies noted.		Accurate knowledge of the fuel contents and distribution is essential to enable the tanker's mass and c of g position to be readily determined.

PART B - RECEIVERS

APPLICABILITY

3.5.60 These tests are applicable to all classes of Aircraft (when operating in the AAR receiver role) as defined by Part 1 Section 2 Clauses 2.1.13 to 16, and to all types of control system as defined by Part 1 Section 2 Leaflet 6 Para 2.

REQUIREMENT	COMPLIANCE	GUIDANCE
EQUIPMENT		
COCKPIT INSTRUMENTS		
3.5.61 The Airspeed Indicator shall have been recently calibrated.		
TEST INSTRUMENTATION		
3.5.62 The parameter(s) which should be recorded during these tests are listed in Leaflet 9 Para 9.		
3.5.63 In addition to the handling instrumentation specified in Clause 3.5.62, some structural instrumentation may also be required to monitor fatigue aspects.		See Part 1 Section 1 Clause 1.2.9 Guidance.
LOADING		
3.5.64 The tests shall be made at loadings such that all forward and aft c of g load conditions of Part 1 Section 2 Table 1 are covered.	If the Aircraft is capable of carrying external stores, these loadings shall include the most adverse combinations of the stores in relation to: (a) highest mass.	

	(b) lowest lateral and directional stability. (c) highest pitch inertia. (d) The most aerodynamically destabilising configuration.	
GENERAL TEST CONDITIONS		
ALTITUDE		
3.5.65 The tests shall be made at selected altitudes over the intended AAR envelope, up to the maximum practical AAR altitude.		
AIRCRAFT CONFIGURATIONS AND SPEED RANGES REQUIRED FOR THE TESTS		
3.5.66 The tests shall be made over the speed ranges indicated in Table 2, and with the high lift devices (i.e., slats, flaps etc.,) in the position(s) most appropriate to the flight phase categories (Part 1 Section 2 Clauses 2.1.17 and 18) given in Table 2. Any other intermediate positions shall also be considered if these are likely to be used. Combinations of flaps down/slats in, or vice versa shall only be considered if these are likely to be used, or if they result from single failures. High lift devices will normally only be used if essential for the tanker speed range to be matched.		
3.5.67 For Aircraft which possess variable wingsweep, the sweep angle to be used is that most appropriate to the flight phase category, but at least one other wingsweep angle shall be evaluated as well.		

TESTS		
GENERAL		
3.5.68 If any significant changes have been made to the Aircraft in converting it to the air-to-air Receiver role, a brief assessment shall be made to ensure that the Aircraft and/or engine handling characteristics have not been significantly changed by the conversion.		e.g., engine handling tests with an AAR probe extended, if in front of an engine intake.
3.5.69 Except where otherwise stated, the tests of Clauses 3.5.66 to 68 shall be made over the specified AAR envelope.		
PREPARATION		
3.5.70 Some preliminary tests can be carried out on the ground to assess the suitability of the controls and indicators relating to the AAR receiver role at the pilots' stations.		
INITIAL FLIGHT TESTS		
3.5.71 The flight programme shall commence with an initial exploration of the receiver behaviour when flying in representative positions behind the tanker with the tanker hose wound in. This should be done at moderate speed, altitude and weight, where the receiver will have plenty of power and manoeuvre capability in hand. In addition to exploring the positions likely to be encountered during a good approach and contact, the receiver pilot shall also ensure that the handling remains acceptable when displaced from the correct position. The tanker will then extend the hose and	(a) After making contact with the drogue, the optimum refuelling position shall be achieved, and the flying qualities assessed. (b) The receiver shall be displaced from the optimum position (with the hose still attached). The handling shall be explored within a 'cone' of about 15° (if possible) around the optimum position. (c) The receiver shall be moved closer to the tanker, and the handling assessed at the closest	

the receiver will make the first contacts with the drogue. At each speed and altitude the assessments listed under Compliance shall be made.	position that is likely to be encountered. (d) In the optimum refuelling position left and right hand turns shall be made by the tanker and receiver. Bank angles up to about 30° shall be assessed if possible. (e) The tanker shall be followed into descents at rates of up to 500 ft/min to cover the "toboggan" technique. (f) Contact shall be broken in the normal way by gently backing off from the tanker until, at full extension, the hose disconnects. (g) Contact shall be broken by emergency breaks. The use of airbrakes shall be assessed during this manoeuvre. (h) When confidence in the handling aspects has been gained, further contacts shall be made and fuel transferred.	
EXTENSION AND EXPLORATION OF THE AAR ENVELOPE		
3.5.72 (a) Handling assessments shall be made at the maximum practical speeds, Mach No's and altitudes. (b) If any handling problems arise as a	(a) With both Aircraft at light weight. (b) With both Aircraft at high weight. (c) With the receiver at the extremes of its c of	Normally the objective of the flight trials programme is to clear as wide an AAR envelope for the tanker and receiver combination as possible.

result of unusual behaviour of the hose/drogue when making or holding contact, the tests shall be repeated with video or cine camera coverage from a chase Aircraft.	g envelope.	
3.5.73 In addition to the general handling considerations covered in Clauses 3.5.71 and 3.5.72 above, the following particular aspects shall be investigated: (a) Airframe Buffet. (b) Engine Handling. (c) Lateral Control Power.	(a) Buffet levels shall be assessed with the receiver at the normal refuelling position and at high, low, left and right positions within the 15° cone, and any marked variation in buffet level shall be noted. (b) AAR operations can demand large engine power variations to make and then maintain contact with the tanker. Engine behaviour in response to normal throttle variations within the 15° cone shall be noted, and any tendency of the engine(s) to surge shall be recorded. At the lower altitudes and speeds, and where appropriate, the use of airbrakes to increase the drag, so that the engine(s) can be operated at a higher power setting, with faster response characteristics, shall be investigated. (c) The ability to trim out or counteract by use of lateral controls any tendency to roll towards the	

	tanker's fuselage when approaching wing stations, shall be confirmed.	
(d) Lateral and Directional Behaviour.	(d) The full AAR envelope shall be explored to ensure that no unacceptable lateral or directional oscillations occur, and that lateral and directional control can be maintained at all flight conditions.	
(e) Longitudinal Characteristics.	(e) The longitudinal handling characteristics shall be assessed over the full intended AAR envelope, to confirm that the longitudinal control is satisfactory, no unacceptable changes of trim in pitch are experienced, re-trimming can be effected without difficulty and no excessive short period pitching oscillations occur.	See Part 1 Section 2 Clause 2.21.29
NIGHT LIGHTING		
3.5.74 If any features of the tanker lighting are unsuitable for the particular receiver Aircraft, this shall be noted. Also the lighting of the receiver's cockpit shall be assessed whilst making and holding contact to ensure that there are no undesirable reflections or unsuitable lighting conditions.		
FAILURE CASES		
3.5.75 Asymmetric Thrust.	(a) No significant handling problems are generally experienced with asymmetric thrust following engine failure of a receiver. However, the loss of thrust will result in a marked reduction of the available AAR envelope, and this shall be defined.	

	(b) For Aircraft in which Part Throttle Reheat (PTR) is not available, it may be necessary to operate with fixed reheat thrust following engine failure, and in this case it may be necessary to vary the drag by airbrake operation to maintain station. In these cases tests shall be undertaken to ensure that adequate control can be maintained.	
3.5.76 Failure of Autostabilisation.	Where appropriate, tests are required to assess the feasibility of making AAR contacts when either the tanker or receiver has sustained a failure prior to making contact. The malfunction may be either a full or partial autostabiliser failure, depending on the type of Aircraft involved. Where necessary, a more restrictive AAR envelope in the presence of such failures shall be recommended. Where appropriate, any related effects of partial loss of control power on the tanker or receiver shall also be considered.	
FUEL SPILLAGE		
3.5.77 (a) If any fuel spillage occurs on disconnection from the hose, it is necessary to confirm that sufficient visibility can be retained to enable the receiver to break off safely, and that no fuel ingestion problems arise. (b) If any handling problems arise as a		

result of unusual behaviour of the hose/drogue when making or holding contact, the tests shall be repeated with video or cine camera coverage from a chase Aircraft.		
COMBINATIONS OF FAILURES OF THE TANKER AND RECEIVER		
3.5.78 If failure studies show that in the case of a particular combination of tanker and receiver, there is a high probability of a failure (or failures) being present on the tanker, and an unrelated failure (or failures) being present on the receiver, the effect of these failure combinations shall be investigated with the aim of permitting the operational use of some of these, and identifying associated limitations or techniques.		
FLIGHT TRIALS		
AIR-TO-AIR REFUELLING		
3.5.79 (a) Aircraft which have a capability of receiving fuel during air-to-air refuelling shall be tested to demonstrate: (1) Compatibility with in-service UK and allied tanker aircraft. (2) That the Aircraft C of G is not moved significantly due to the uneven distribution of fuel entering the tanks. (3) That the surge pressures resulting		

from refuelling valve closure are within the design limits. (4) That the venting system is adequate to prevent an excessive build-up of pressure in the fuel tanks. (5) That on separation of the probe from the drogue the fuel spilt does not either cause a significant deterioration in the pilot's view by obscuring the windscreens or enter the engine intakes in sufficient quantities to cause the engine(s) to surge or enter any other parts of the Aircraft where loading fuel could become a hazard. (b) Aircraft which have the capability to dispense fuel during air-to-air refuelling shall be tested to demonstrate: (1) Compatibility with in-service UK and allied receiver Aircraft. (2) That the Aircraft C of G is not moved significantly due to the uneven distribution of the fuel dispensed from the individual Aircraft tanks, or that suitable operating procedures will prevent unacceptable movement of the Aircraft C		

of G. (3) That the surge pressure which may result from an emergency receiver disconnect, receiver refuelling valves cycling or more than one receiver Aircraft disengaging at the same time are within design limits. (4) That the venting system is adequate to prevent an excessive negative pressure differential across the walls of the fuel tanks.		

TABLE 1 - AIRCRAFT CONFIGURATIONS AND SPEED RANGES - (Tankers)

Aircraft Configuration					
Ref	**Lift Devices**	**Under-carriage**	**Airbrake**	**Flight Phase Category Applicable**	**Speed Range**
3.5.48	Cruise	Up	In	B	As defined in Specification for AAR
3.5.48	Manoeuvre	Up	In	B	As defined in Specification for AAR
3.5.48	Approach	Down	In and Out	C	Min approach to max permissible
3.5.48	Landing	Down	In and Out	C	Min approach to max permissible

TABLE 2 - AIRCRAFT CONFIGURATIONS AND SPEED RANGES – (Receivers)

Aircraft Configuration					
Ref	**Lift Devices**	**Under-carriage**	**Airbrake**	**Flight Phase Category Applicable**	**Speed Range**
3.5.66	Cruise	Up	In & Out	A	Specified speed range for AAR, or max range achievable in relation to tanker’s performance
3.5.66	Manoeuvre	Up	In and Out	A	

LEAFLET 9

IN-FLIGHT REFUELLING SYSTEMS

GENERAL RECOMMENDATIONS

INTRODUCTION

NOMENCLATURE

1.0.1 Nomenclature and legends for use on controls, panels, and displays in aircrew stations:

Air to Air Refuelling	AAR
	A/R

SCOPE

1.1.1 This Leaflet sets out the design requirements for the installation of air to air refuelling equipment in both tanker and receiver aircraft which are additional to those given in Part 1, Section 5, clause 5.2.

PROBE AND DROGUE SYSTEM

1.2.1 Unless otherwise specified in the aircraft specification the probe and drogue system shall be used whenever the aircraft requires (AAR) capability.

GENERAL REQUIREMENTS FOR TANKER INSTALLATION

1.3.1 The tanker (AAR) system may take the form of one or a combination of the following types:

- Fuselage centreline station single or twin power source derived from tanker hydraulic electrical or pneumatic system.
- Wing pylon mounted dry pod power source derived from tanker system or ram air turbine containing integral fuel storage.
- Fuselage pylon mounted wet pod power source derived from tanker system or ram air turbine containing integral fuel storage (buddy buddy system).
- Fuselage pylon mounted dry pod power source derived from tanker system or ram air turbine.

1.3.2 The aircraft specification for a tanker aircraft will indicate whether the AAR equipment is to be in package form for use as role equipment. In such cases the installation and removal time of the equipment shall be minimised (actual time to be as agreed with the Project Team Leader). Loose equipment associated with the role change shall be kept to a minimum.

1.3.3 The aircraft specification for a tanker aircraft will also:

- Define the number of refuelling stations to be installed the range of fuels to be used and the rates of flow required from each station.
- define the speed and altitude envelope in which the dispensing of fuel and the hose trail and rewind operation must be possible
- Indicate whether the tanker is required to be equipped as a receiver and whether the tanker crew should be provided with a means of monitoring the receiver aircraft L (e.g. periscope or close circuit television).
- Indicate if the tanker requires to be provided with sufficient illumination to enable the receiver pilot to carry out AAR at night with safety.
- Indicate whether or not the signal and tunnel lights need to be compatible with a night vision goggles equipped receiver aircraft.
- Indicate whether there is a requirement for covert air to air refuelling and provide details as appropriate.

GENERAL REQUIREMENTS FOR RECEIVER INSTALLATION

1.4.1 The aircraft specification for the receiver aircraft will:

- Define the form of probe to be used - fixed retractable or removable. The interface with the aircraft systems will be defined in the systems structural specification.
- Indicate whether emergency probe extension is required.
- Indicate whether the receiver aircraft will be required to receive fuel from a tanker aircraft fitted with a boom to drogue adaptor.
- Define the tanker type and the speed altitude envelope from which the aircraft is to receive fuel.
- Indicate if there is a requirement for probe lighting ant requirement for probe lighting any requirement for brightness central being stated.

OPERATIONAL REQUIREMENTS

2.1 Flight envelopes appropriate to carriage hose trail fuel transfer and hose rewind shall be established in accordance with the aircraft specification.

2.2 Carriage if the AAR system or any aspect of the refuelling operation shall not degrade the safety of the aircraft’s Consideration shall be given to the effect if dumping fuel or jettison of any part of the AAR system with regard to fire hazard or impact damage to the tanker.

2.3 The system shall permit repeated dry contacts (e.g. fir training) without degradation of any system capability.

AERODYNAMIC FLYING QUALITIES

3.1 The aerodynamic and flying qualities of tanker and or receiver aircraft shall be examined in accordance with Section 3 Clauses 3.5.36 - 78.

SYSTEM PERFORMANCE

AERODYNAMIC PERFORMANCE

4.1.1 In non turbulent conditions the fully trailed hose and drogue shall present a sufficiently stable target to the receiver to maximise the probability of successful receiver contacts.

4.1.2 The hose and drogue shall recover from any instability induced by non damaging external influences once those external influences have ceased.

HOSE DRUM UNIT PERFORMANCE

4.2.1 Trail and rewind operation. The hose trail and rewind speed shall be controlled to minimise instability of the hose and drogue at any point during trail or rewind throughout the AAR envelope. In particular there shall be no contact between the hose and drogue and the tanker airframe during the trail and rewind operation such as to be a flight safety hazard or cause damage to either the airframe or hose drogue.

4.2.2 Hose response:

- Engagement. The response system shall be capable of accelerating the hose in the rewind direction to prevent hose whip, looping, oscillation or excessive slackness at receiver closing speeds of up to 3 m/sec. The response system shall also allow engagement at closing speeds as low as 0.6m/sec.
- Disengagement. The maximum relative speed at which the receiver can withdraw without inadvertent disengagement occurring shall be 1.2 m/sec. In addition the trail response action shall preclude hose oscillation whilst the receiver is in contact.
- Response. During engagement contact and disengagement any hose oscillation or heave whether created be aerodynamic or, mechanical effect shall be minimal shall not overload any part of the tanker or receiver aircraft and shall naturally damp out.

4.2.3 Arrest of motion. The motion of the hose drum and hose assembly shall be safety arrested at both full trail and full rewind.

FUEL SYSTEM PERFORMANCE

4.3.1 Pressure at coupling. The fuel transfer system shall regulate the static pressure at the coupling to 345 kPa ± 35 kPa throughout the range of flow. The system shall not subject the reception coupling to pressure other than that due to static head during normal engagement and disengagement. Note: The control pressure of 345 ± 35 kPa shall not be exceeded except for short duration surge peak pressures in accordance with 4.3.2 In cases where the AAR system is at its maximum flow rate capability and the receiver back pressure is not sufficient to generate the control pressure them lower pressures are acceptable.

4.3.2 Surge Pressures. The system shall be designed so that surge pressures do not exceed the proof pressure of the systems (receiver, tanker, pod or hose drum unit as defined in Part 1, Section 5, clause 5.2. Possible sources of pressure surge are:

- Valve closure in the tanker refuelling system.
- Valve closure in the receiver refuelling system.
- Receiver disengagement at any flow rate up to and including the system maximum.

CONSIDERATION SHALL BE GIVEN TO THE RATE OF CLOSURE OF REFUELLING VALVES TO MINIMISE THE SURGE PRESSURE EFFECT.

4.4.1 NOTE: For access (hose drum performance) and (fuel system performance) above, instantaneous peak surge pressures in the hose and reception coupling may exceed the steady state proof pressure but shall not cause permanent deformation, nor limit hose or coupling life.

4.4.2 With tanker single failure conditions the tanker refuelling system shall not generate drogue probe interface pressures greater than the proof pressure or 828 kPa.

4.4.3 Stall pressures. The fuel transfer system shall be designed so that any stall pressure experienced by the receiver aircraft is no greater than 414 kPa.

ENVIRONMENTAL CONDITIONS

GENERAL

5.1.1 Unless allowed by the aircraft specification, the installation of AAR capability shall not restrict the environmental conditions in which the basic aircraft can operate when the AAR equipment is in the stowed condition.

ELECTROMAGNETIC COMPATIBILITY

5.2.1 Installation of AAR equipment shall not compromise the electromagnetic compatibility of the aircraft, nor shall the operation of the AAR equipment be adversely affected by the existing airframe environment.

5.2.2 The system shall be designed so that it can withstand the effects of lightning strike, such that with or without the hose trailed fuel vapour ignition will be prevented and no physical damage will occur such as to cause a hazardous situation. Consideration shall be given to maintaining the AAR unit in an operational condition following a lightning strike.

SYSTEM DESIGN

INSTALLATION REQUIREMENTS

6.1.1 When installed, AAR equipment shall not interfere with satisfactory operation of parent aircraft equipment (e.g. slats, flaps, undercarriage doors etc). Further, the AAR equipment shall retain adequate clearance with the ground during take off and landing including emergency cases (e.g. with oleo and tyre collapsed).

6.1.2 The location of each AAR system and the trailed position of the hose and drogue shall be such that:

- Adequate clearance is maintained between the tanker and receiver and between each receiver on the approach to and during contact over 30º included angle cone centred on the hose normal trail position.
- The hose and drogue are clear of any significant destabilising effects due to aerodynamic wake, jet efflux or propeller slipstream.
- Any destabilising effects influencing the receiver handling or positioning on the approach to and during contact are minimised.
- The mating dimensions of the reception coupling shall conform to STANAG 3447.

6.1.3 The design dimensions of the probe installation should be such that:

- The mating dimensions of the nozzle probe mast shall conform to STANAG 3447.
- A clearance space shall be provided around the nozzle probe mast installation in accordance with STANAG 3447.
- The probe itself shall be located so that its nozzle is adequately within the receiver pilot’s vision when the pilot views the tanker aircraft and the trailed drogue during closure to contact. The probe location shall be such that the effect of airflow around the receiver in drogue stability just prior to contact is minimised. Interaction of tanker wake and receiver bow wave shall also bi taken into account. In addition the probe shall be located so as to minimise any adverse aircraft handling effect or any effect in engine air intakes.

6.1.4 Ground Handling and Ground Support Equipment:

- It shall be possible to gain easy access to the AAR equipment to allow pre and post flight checks and maintenance without removal of the equipment from the aircraft.
- Ground test procedures shall be adequate, simple and brief.

- The requirement for use of special to type ground equipment shall be minimised.
- The equipment shall have provision for hoisting, loading and transportation.

STRUCTURAL DESIGN

6.2.1 The strength of the AAR installation and the associated aircraft structure shall be designed in accordance with Part 1, Section 3, Clauses 3.1 and 3.2 and be capable of withstanding all loads generated by the system and applied to the system throughout the defined flight envelope for carriage and refuelling operations. See Para 1.3.1. above.

6.2.2 Probe.

- Refuelling probes may be fixes, removable or retractable. The probe shall be able to be locked in the extended position. Telescoping proves shall not permit fuel to enter between the inner and outer tubes. The probe installation shall not degrade the performance of the aircraft outside that required by the aircraft specification.
- The probe shall be provided with a weak link so that the nozzle will break away to prevent any abnormal condition resulting in loads in excess of the maximum design loading being applied to the robe. Loads which should be considered during the design of the weak link should include but need not e limited to; axial, radial, and moment breakaway loads for the disconnection loads between the nozzle and the reception coupling, and the effects of fuel pressure on such loads.
- In all cases the design of probe fairings, doors and mechanisms shall be such that the drogue cannot be caught upon them. It is therefore desirable that doors be closed after the probe is deployed.

6.2.3 The design of the drogue and coupling shall be such that:

- Those parts likely to contact the receiver shall be resistant to damage, or detachment, and shall not cause significant damage to the receiver.
- The failure of any single part of the drogue which may result from the drogue striking the receiver , or the receiver ‘spoking’ the drogue ribs shall not cause the total detachment of any part of the drogue.

FUEL SYSTEM DESIGN

6.3.1 Fuel tanks and vents. All aircraft fuel tanks, including those added as part of the tanker conversion shall be provided with sufficient inward venting so as to prevent the possibility of inward collapse. Similarly the receiver vent system shall be capable if venting fuel, should a failure of a fuel cut off valve build up in the fuel tanks. Where fuel tanks are installed within an aircraft pressure cabin, they shall be vented to atmosphere and shall be contained within structural enclosures. Means if detecting leaks into the enclosure shall be provided and the enclosure shall incorporate overboard drains. Care shall be taken to provide vents of sufficient size to cope with the worst conditions of operation and to eliminate the risk if the vents being blocked due to icing or foreign matter. (Part 1, Section 5, clause 5.2 refers).

6.3.2 Receiver valves. Unless otherwise specified, a valve shall be incorporated into the probe such that if the nozzle breaks off at the weak link the valve shall be retained in the nozzle and shall close to seal off the reception coupling so that fuel be given to providing protection of the receiver aircraft system in the event of nozzle breakage.

6.3.3 Fuel pipes.

- Fuel pipes shall not run through passenger, crew, cargo or baggage compartments nor in hazardous proximity to hot air ducts, electrical wiring and electrically operated equipment contained in bays unless they are without couplings and adequately protected against potential sources of ignition and damage. Any space between a pipe and its protection shall be adequately vented and drained. See also Part 13. Sect 3.5, Requirement 3.5.16.
- Consideration shall be given to the need for purging fuel pipes associated with the AAR equipment following completion of the operation, if the residual fuel could constitute a fire hazard.

6.3.4 Fuel System Integration.

- Fuel storage included as part of the AAR equipment shall be available for use by the tanker when required, except where the fuel type carried by the tanker for transfer to a receiver is unsuitable for use by the tanker itself. In this case the 2 types of fuel shall be segregated so that it is impossible for the fuels to be mixed or for the fuel transfer system or the tanker engine(s) to be fed with the wrong type of fuel.
- The tanker system shall be capable of supplying the AAR equipment at sufficient rate to meet the tanker refuelling requirement specification without compromising the tanker engine fuel feed.
- The effect of a single failure in the AAR equipment supply system on maximum transfer rate shall be minimised. Failure of the main transfer pump shall not prevent fuel transfer. However, reduced rates of flow will be acceptable.
- Devices for relief of surge pressure shall not require spillage of fuel outside of the fuel system.
- There shall be no leakage from any part of the system prior to contact, during contact or post contact. Leakage during the act of contact or breakaway, whether normal or emergency, shall be minimised even at the most adverse condition of probe coupling engagement.
- In addition to the requirements of Para 6.2.1 above the probe location shall take into account the risks associated with fuel spillage on to the windscreen and with fuel entry into engine air intakes or any other intake.
- There shall be no requirement for fuel to be supplied by the aircraft to the AAR package once refuelling is complete (e.g. to lubricate bearings etc) which significantly increases the aircraft’s minimum landing fuel.

ELECTRICAL/ ELECTRONIC SYSTEM DESIGN

6.4.1 Electrical equipment. Installation of associated electrical equipment shall comply with the requirements of Part 1, Section 4, Clauses 4.26 and 4.27 and Part 1 Section 6 Clause 6.6.

6.4.2 Static electricity. Electrical connection (to discharge static) shall be established between the tanker and receiver before fuel is transferred.

6.4.3 Bonding.

- Full electrical bonding of AAR equipment shall be provided.
- Following contact, equipotential of tanker and receiver aircraft shall be maintained via a conductive hose and drogue.

6.4.4 Radio communications. It shall be possible to conduct the refuelling operation safely without use of radio communications between tanker and receiver. However, when radio communication is used the equipment and aerial installation shall be safe and shall enable effective communication with the receiver in formation with, in close proximity to, and on contact with the tanker. It may be acceptable to prohibit specific air to air or air to ground communications such as HF during AAR operations. The Project Team Leader shall be notified of any such restrictions.

COCKPIT CONTROLS AND INDICATORS

6.5.1 In addition to the requirements of Part 1, Section 4, clause 4.19, the following minimum controls and indicators shall be provided in the tanker and receiver:

Tanker Controls.

- Signal light brightness.
- Hose jettison control.
- Fuel valve control.
- Emergency signal control.
- Hose trail and rewind control.
- ON/OFF master switch.

Tanker indicators:

- Fuel flow indicator.
- Fuel transferred.
- Hose stowed indicator.
- Hose position or movement indicator.
- Fuel valve position.
- Drogue at full trail and ready for engagement.
- Signal repeater indicators.

Receiver controls:

- Refuel valve control.
- Probe position (for retractable probes).
- Probe lighting controls (if fitted).

Receiver indicators:

- Probe position (for retractable probes).
- It shall be possible to assess the fuel contents available for transfer either by reference to existing indicators or by provision of additional indicators. Unless otherwise specified, fuel amount transferred shall be measured in kg and the fuel flow indicator gauged in kg/ min.

FUEL SYSTEM CONTROLS

1	IN-FLIGHT REFUELLING CONTROLS	
	(a) Selection/Reset Controls	In single or tandem seat Aircraft operated by the left hand. In multi-seat Aircraft near to and operated by the second crew member or flight engineer.
	(b) Disconnect Control	In single or tandem seat Aircraft on the control column and operated with the right hand. In multi-seat Aircraft on the control column and operated by the pilot.

6.6 INDICATORS AND MARKINGS

6.6.1 Signal lights.

- Signal lights shall be included to provide the receiver with an indication of the status of the air to air refuelling equipment. These lights shall be mounted adjacent to each other in a position that is clearly visible to the pilot of the receiver aircraft when astern of the tanker in pre contact positions.
- Where the tanker is fitted with multiple independent refuelling stations, separate light systems shall be fitted for each station.
- These lights shall be duplicated to allow redundancy and shall be capable of being dimmed for night operation.
- The following lights shall be used and operated in the given order.

6.6.2 RED - When the master switch is on and when the hose is stowed, trailing, rewinding or otherwise unsafe for receiver contact. It shall be possible to operate this light manually when required.

6.6.3 AMBER - When the AAR system is ready for receiver contact.

6.6.4 GREEN - When the hose has been pushed into the refuelling range (nominally 1.5 m from the full trail position) and the AAR system fuel valve has opened.

- Refer to Section 3 clause 3.5 for signal sequence and response.

6.6.5 Hose lights. Lights shall be provided to illuminate the refuelling hose markings (see Para 6.6.3) can be seen at night. The colour of the light shall be white. The light shall be installed or shielded in such a manner as to prevent the light from being a source of direct or reflected glare to the tanker crew or receiver pilot. Consideration shall be given to varying the intensity of this light to cater for ambient light conditions and to minimise the tanker signature.

6.6.6 Hose markings. The hose shall be marked to provide the receiver pilot with indications of the inner and outer limits of the hose refuelling range, the optimum position within that refuelling range and the position when disconnection at full trail is imminent. Refer to Fig 3 for recommended pattern of hose markings.

6.6.7 Drogue lighting. The drogue shall be illuminated for night operation. The lighting shall be self contained within the drogue and shall not require power from the tanker for operation.

6.6.8 Tanker markings. Markings shall be applied to the tanker which are clearly visible to the receiver pilot and give guidance as to the correct positioning and movement of the receiver for the refuelling operation. The markings shall be effective by both day and night. Refer to Fig 1 and Fig 2 for recommended patterns of tanker markings.

SAFETY CONSIDERATIONS

SAFETY REQUIREMENTS

7.1.1 in addition to the requirements defined elsewhere in this Clause, the equipment shall be designed so that no single failure on the tanker or the receiver shall cause fuel or fuel vapour to be released into the cockpit or cabin of either aircraft it in any other way endanger their safety.

7.1.2 A safety assessment and a zonal analysis shall be made of the AAR system and of its interface with the tanker aircraft own fuel system. Reference shall also be made to Part 1, Section 5, Clause 5.2.

7.1.3 The AAR installation shall be so designed that a single failure subjects the receiver aircraft to minimal foreign object damage. Internally mounted AAR units shall be adequately isolated

from crew, passenger and freight compartments so that the operation of the AAR units does not endanger personnel nor compromise the usage of such compartments.

7.1.4 Where the AAR installation uses any of the tanker aircrafts vital systems i.e. fuel or power supplies, safeguards shall be taken to protect the tanker from the consequences of malfunction of the AAR units. It shall be possible to isolate the AAR unit from the aircrafts systems.

EXPLOSION PROOFING (also see Section 3 clause 3.5)

7.2.1 The system shall be designed to minimise the fuel vapour within the init as well as preclude ignition of any vapour that does exist. This requirement may be satisfied by a combination of:

- Design (e.g. incorporation of flame traps in electrical boxes),
- Test,
- Air purging if pod interiors HDU compartments. This operation shall not require the tanker to de pressurise.

JETTISON AND DUMPING SYSTEM

7.3.1 Where the aircraft specification requires the capability for package or hose jettison, or package fuel dumping, the jettison dumping systems shall operate satisfactorily throughout a separately defined jettison dumping envelope.

7.3.2 The jettison dumping systems shall be powered independently of the normal package systems.

7.3.3 In the case of package jettison or hose jettison, pyrotechnic devices shall not be used, unless permitted be either the tanker aircrafts or equipment specification.

7.3.4 The jettison dumping operation e.g. guarded or locked toggle. Double pole switches are preferred.

7.3.5 The hose drum outlet shall be sealed at the point if hose separation. The seal shall withstand system pressure.

OTHER EMERGENCY SYSTEMS

7.4.1 Where emergency systems such as emergency hose trail and or rewind or emergency probe extension are required by the aircraft specification these systems shall not compromise the reliability of the basic system. Where they are of the “one shot” type, they shall not degrade the safety of the aircraft once they have been operated. These systems shall be powered independently of the normal package systems.

DE ICING AND ANTI ICING

7.5.1 De icing arrangements for the nozzle and coupling are not required.

7.5.2 Consideration shall be given to the possible need for providing anti icing techniques for the AAR unit. In such an event provision of AAR unit temperature monitoring, heating control and attendant cockpit indicators will be required.

TESTS REQUIRED

GROUND TESTS

8.1.1 Ground tests shall be conducted to demonstrate compliance with the requirements if the aircraft specification for the following aspects:

- role change.
- Fuel capacity of tanker AAR package (usable and total).
- Proof pressure test.
- Fuel transfer tests.
- Surge pressure tests (normal and emergency breaks and receiver cut off).
- Mechanical and electrical function.
- structural requirements.
- environmental requirements.
- emergency system operation and failure cases.
- EMC requirements.
- Drainage.

FLIGHT TEST

8.2.1 Flight testing shall be conducted in accordance with Part 1, Section 2 – Flight.

SECTION 4

AIR-TO-AIR REFUELLING TEST EQUIPMENT

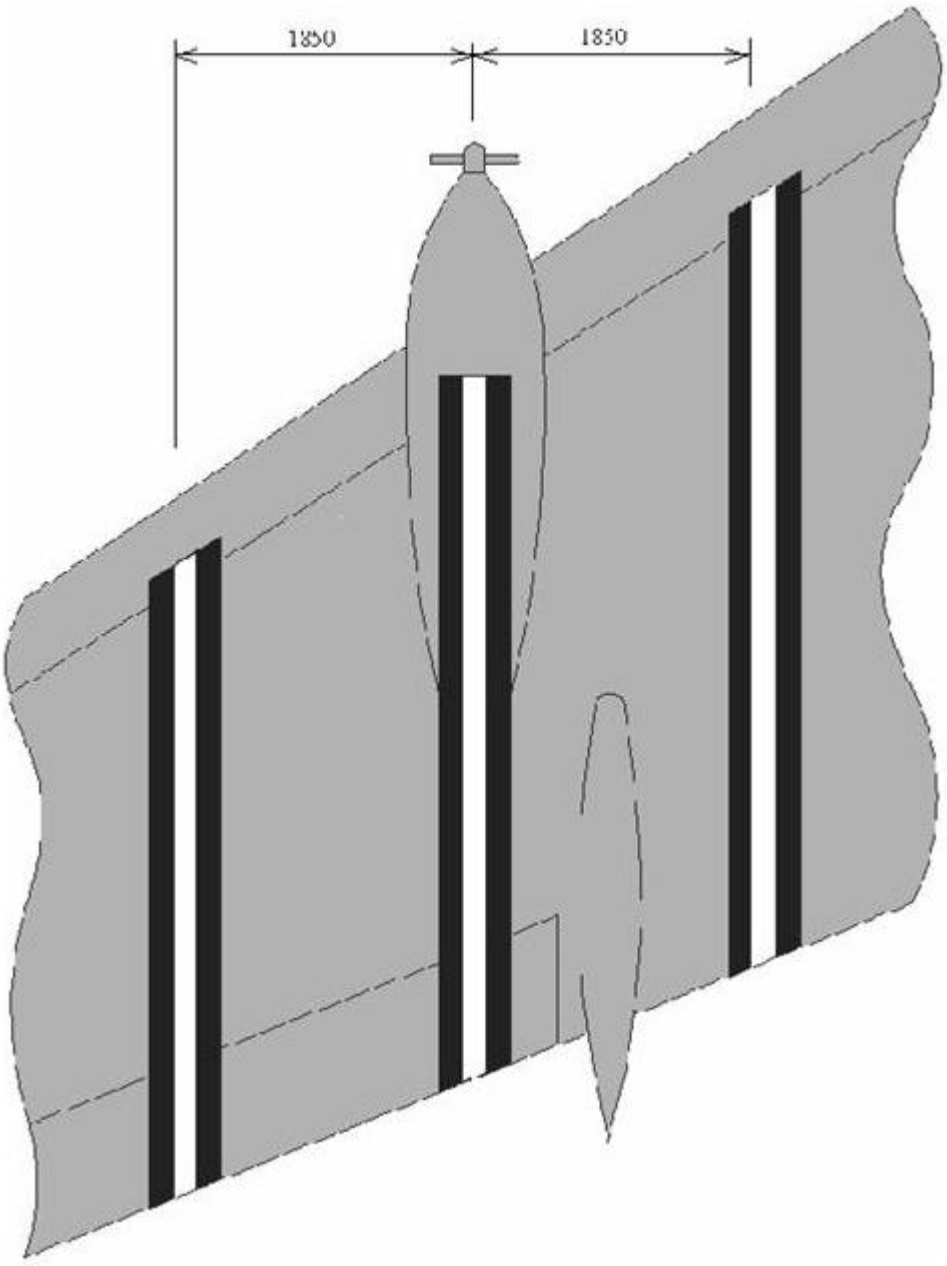
9 INSTRUMENTATION

9.1 Details of the parameter ranges, accuracies and resolutions are given in Part 1 Section 2 Leaflet 10, Table 1.

9.2 The following parameters should be recorded for the tests detailed in Section 3, Clauses 3.5.36 - 78, for both tanker and receiver Aircraft, or a lesser selection determined as appropriate and agreed by the Project Team Leader.

Item	Parameter
1	Time base
2	Manual event marker
3	Crew speech
4	Indicated airspeed
5	Altitude (pressure)
7	Total temperature
8	Angle of attack
9	Pitch attitude
10	Bank angle
11	Sideslip angle
12	Heading
13	Pitch rate
14	Roll rate
15	Yaw rate
16	Longitudinal acceleration
17	Lateral acceleration
18	Normal acceleration
19	Flap/slat setting
20A	Wing sweep position
21	Airbrake position
22	Failure state
24	Fuel contents
25	Pitch inceptor position
26	Roll inceptor position
27	Yaw inceptor position
28	Pitch inceptor force
29	Roll inceptor force
30	Yaw inceptor force
31	Pitch trim position
32	Roll trim position
33	Yaw trim position
34	Pitch motivator position
35	Roll motivator position
36	Yaw motivator position
44	Throttle position(s)
45	Rotational speed(s)

9.3 For the tests described in Clauses 3.5.50 to 58 and 3.5.71(b), chase or receiver Aircraft equipped with video or cine camera should be provided.

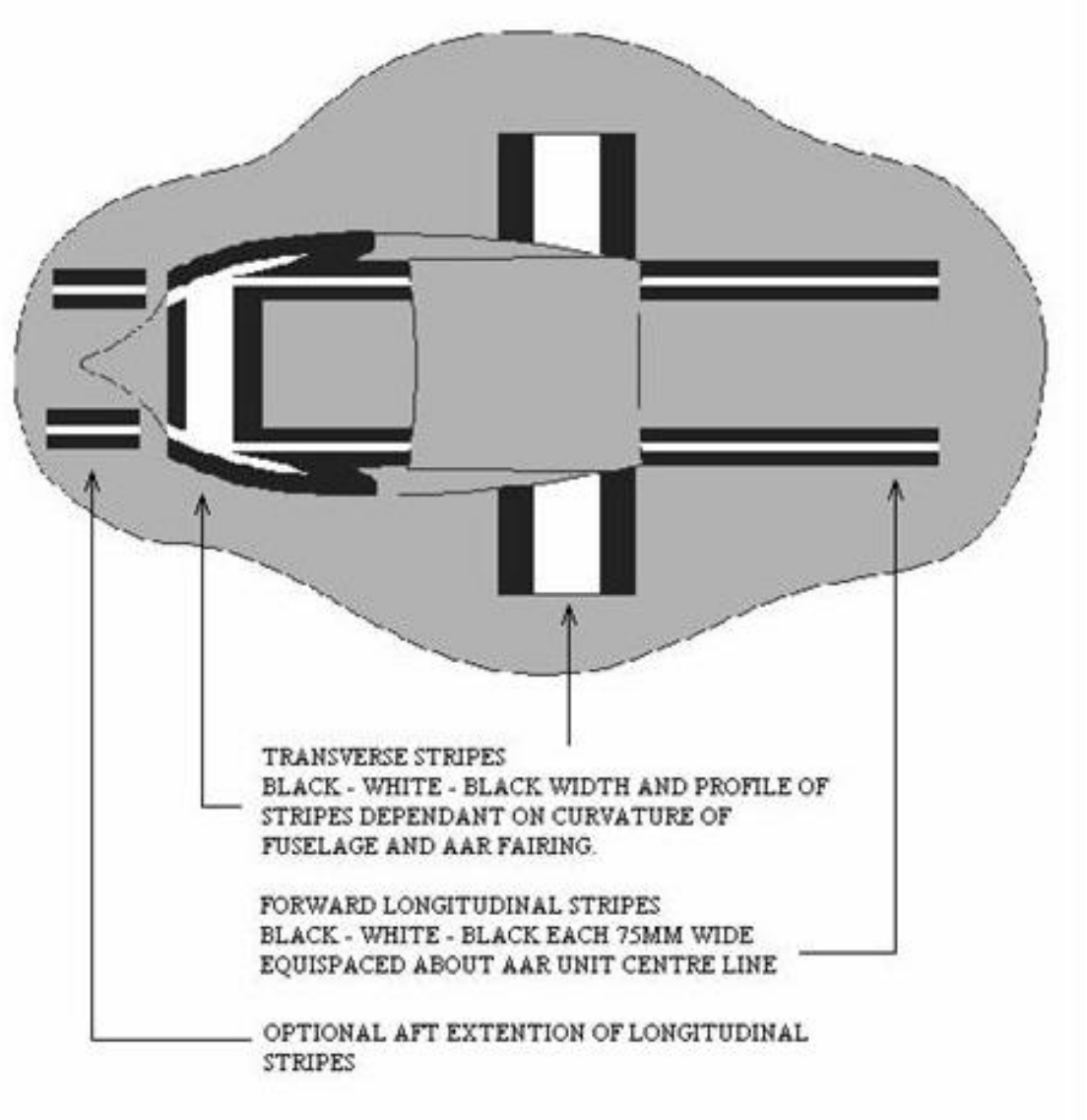


Black and white stripes 75 mm typically wide
Dimensions in mm
NOT TO SCALE

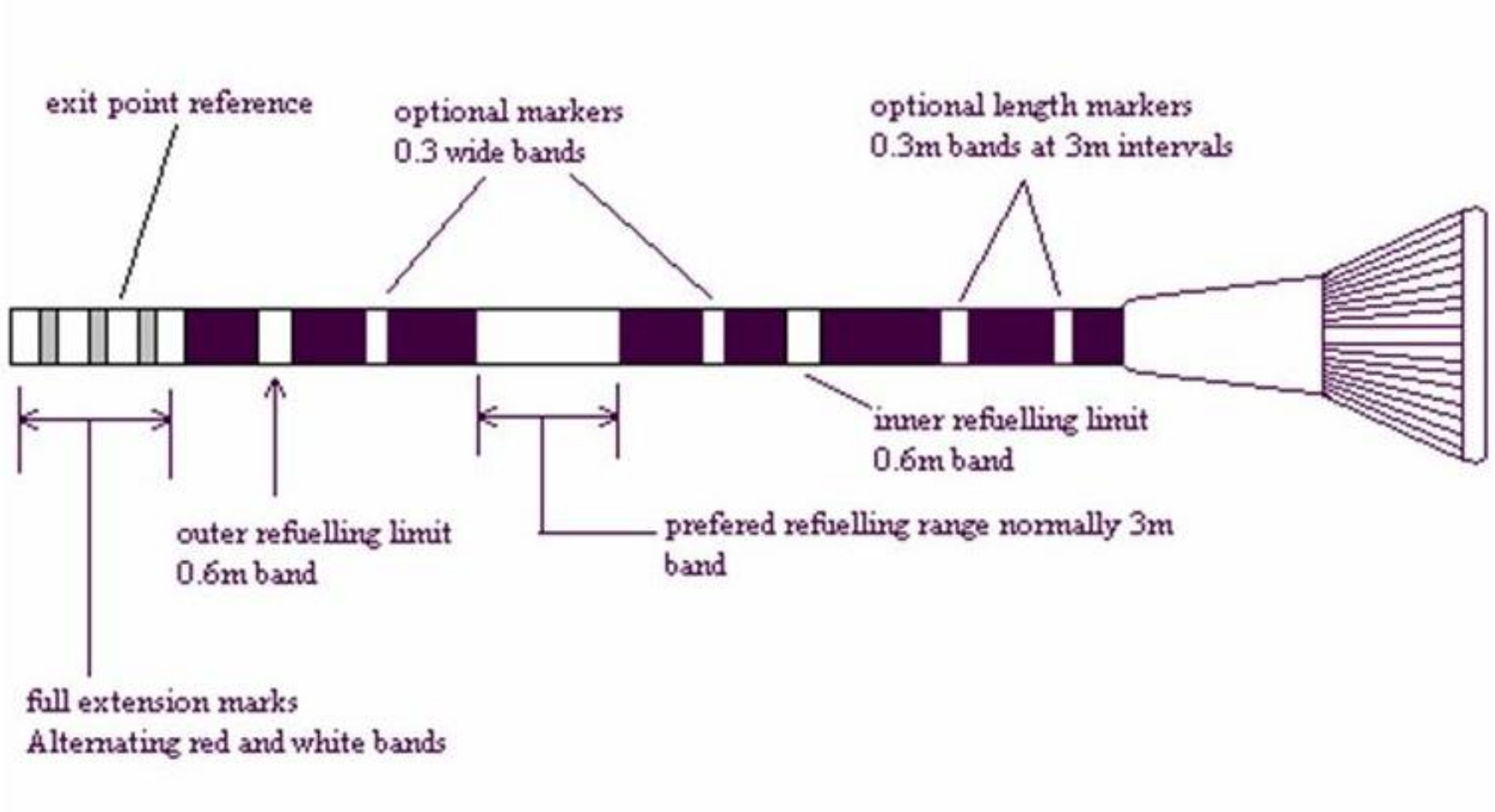
Suggested Under Wing Air to Air refuelling Pod Alignment Markings

Fig 1

FORWARD



Suggested Tanker Underfuselage Alignment Markings
Receiver Aircraft View
Fig 2



Typical Hose Identification Markings

Fig 3

SECTION 4

Amendments to other Parts.

Part 1 Section 2

2.18 AIR-TO-AIR REFUELLING

2.18.1 The content of this Clause has been moved to Part 13, Section 3, Clause 3.5.

Tables 12 and 13 – Table content moved to Part 13, Section 3.5.

Leaflet 33 – Leaflet content moved to Part 13 Section 4 Leaflet 9.

Part 1 Section 4

4.19.41 The content of this Clause has been moved to Part 13, Section 3, Clause 3.5.7.

Table 25 Line item 9 deleted.

Part 1 Section 5

FUEL SYSTEMS - GENERAL FLIGHT TEST REQUIREMENTS

OBJECT

5.2.207 The object of the tests of this clause is to demonstrate that the fuel system installed in the aircraft is suitable for service use and has satisfactorily provision for:

(a) Ground refuelling and defuelling.

(b) Supply of fuel to engine(s), and auxiliary device(s) where applicable.

(c) Jettison of fuel and fuel tanks where applicable.

(d) Air-to-Air Refuelling (where applicable) in accordance with design requirements (See Part 13 Section 3.5).

5.2.218 The content of this Clause has been moved to Part 13, Section 3, Clause 3.5.79.