ATP-56(B)

AIR-TO-AIR REFUELLING

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AIR TO AIR REFUELLING

(ATP-56(B))

22 JANUARY 2010

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NORTH ATLANTIC TREATY ORGANISATION

NATO STANDARDIZATION AGENCY (NSA)

NATO LETTER OF PROMULGATION

22 January 2010

1. ATP-3.3.4.2(B) (ATP-56(B)) Change 2 - AIR TO AIR REFUELLING is a NATO Publication **RELEASABLE BY INTERNET.** The agreement of NATO nations to use this publication is recorded in STANAG 3971.

2. ATP-3.3.4.2(B) (ATP-56(B)) Change 2 is effective on 1st February 2010. It supersedes ATP-56(B) which shall be destroyed in accordance with the local procedure for the destruction of documents.

3. Part 5 of ATP-3.3.4.2(B) (ATP-56(B)) will be issued for the recording of factual and informative matters not subject to national ratification. Changes to this part will be incorporated as editorial changes, when required.

Juan A. MORENO
Vice Admiral ESP(N)
Director, NATO Standardization Agency

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ATP-56(B)

AIR TO AIR REFUELLING

Allied Tactical Publication – 56(B) - Air to Air Refuelling is

Published under authority of:
The Secretary of the Army
The Secretary of the Navy
The Secretary of the Air Force

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS PUBLICATION TO THE ATTENTION OF ALL PERSONNEL CLEARED FOR OPERATION OF AIRCRAFT UNDERTAKING AIR TO AIR REFUELLING.

AIR TO AIR REFUELLING (AAR) MANUAL

1. **Purpose**. The primary function of this manual is to provide aircrew with internationally standardised definitions, abbreviations and procedures to enable successful and safe AAR operations. For DoD aircraft with an in-flight refuelling capability, the relevant T.O.-1 series (USAF) or appropriate single service documents provide supplemental MDS-specific information on AAR orbit and rendezvous techniques used by crewmembers, and procedures and tactics concerning tanker/receiver formations. This manual offers information pertinent to refuelling from flying boom and drogue equipped tankers. Importantly, where appropriate, the USA national Annex offers placeholders for the KC-45 tanker. Additionally, the appropriate tanker National Annex provides information crucial to successful AAR from foreign and commercial tankers.

2. **Regulatory Nature of this Document**. USA aircrews are to consider the instructions in this document as regulatory.

3. Waiver Authority and Deviations.

USAF Waiver Authority.

1. The USAF waiver authority to procedures and restrictions published in Parts 1 through to 4 inclusive and Annex Z through to Annex ZF is as follows:
   a. **Operational Missions**. The COMMAFOR/NAF CC with OPCON for operational missions.
   b. **Training Missions**. The appropriate MAJCOM/A3 for training missions.
2. For an operational mission or training mission involving US only aircraft, before a waiver is granted the Lead Command A3V for the tanker (where appropriate) and/or (where appropriate) receiver must be consulted.
3. In the event that an engineering disposition is required, the Lead Command A3V for each platform will consult with the appropriate Systems Group (SG) engineers, or equivalent for activity involving USN/USMC or US Army.
4. For missions involving foreign platforms requiring an engineering disposition, the US SG must work with the engineering support authority of the foreign platform before offering a recommendation on waiver action.

Deviations.

Do not deviate from the restrictions published in Parts 1 through to 4 inclusive and Annex Z through to Annex ZF except when the situation demands immediate action to ensure safety. The Pilot in Command is vested with ultimate mission authority and is responsible for each course-of-action they choose to take. Report all deviations through the responsible MAJCOM Standardization/Evaluation (Stan/Eval) function.

USN/USMC Waiver Authority. Requests for waivers to Parts 1 through to 4 inclusive and Annex ZG should be submitted in accordance with the requirements of OPNAVINST 3710.7.

4. Notes, Warnings and Cautions. Part 1, Chapter 1, para 106 provides definitions for Notes, Warnings and Cautions.

5. NATO and USA Equivalent Terms. Where the NATO standard terms listed below are used in this document, USA users shall interpret them to mean the following:

NATO TERM	EQUIVALENT USA TERM	USA DEFINITION
IS TO, ARE TO, or MUST	SHALL or WILL	The instructions or procedures prefaced by "shall" or "will" are mandatory. "Will" is also used to indicate simple futurity, ie "Loss of hydraulic power will affect operations"
SHOULD	SHOULD	Normally used to indicate a preferred but non-mandatory method of accomplishment.
MAY	MAY	An acceptable or suggested but non-mandatory means of accomplishment

6. Carriage of ATP-56. USAF MAJCOMs, or appropriate equivalents in sister services, will direct which elements of ATP-56 should be carried by (or be accessible to) AAR qualified crews. As a minimum, all USA aircrew participating in AAR operations are to have access to the Preliminaries and Part 1. In addition, they must have access to the appropriate fixed wing (Part 2), rotary (Part 3) or tiltrotor (Part 4) section of the document together with the relevant elements of the USA National Annex. Importantly, USA receiver aircraft planning to conduct AAR with commercial tankers and tankers of another nation are to have access to a copy of the commercial or foreign tanker's National Annex.

7. Platform-Based Tranches. The following platform-based table offers a suggested list of tranches from ATP-56 that should be made available to aircrew. This table has been used to populate the bundled options for USA operators available from the USA ATP-56 Part 5 National Annex webpage (http://www.raf.mod.uk/downloads/usnational.cfm).

	MAIN DOCUMENT					PT 5 ANNEXES											
						ANNEX Z (UNITED STATES)											COMMERCIAL & OTHER NATION'S TANKERS
PLATFORM	PRELIMS – USA	PT 1	PT 2	PT 3	PT 4	PRELIMS – PT 5	Z	ZA	ZB	ZC	ZD	ZE	ZF	ZG	ZH	ZI	
KC-135	X	X	X			X	X	X				X			WHEN CONDUCTING AAR WITH NON-USA PLATFORMS	X	ONLY WHEN PLANNED TO RECEIVE FUEL FROM A COMMERCIAL TANKER OR A TANKER OF ANOTHER NATION
KC-135RT(1)	X	X	X			X	X	X	X	X		X	X			X	
KC-10	X	X	X			X	X	X	X	X		X	X			X	
KC-45	X	X	X			X	X	X	X	X		X	X			X	
HC-MC-130	X	X		X		X	X				X		X	X		X	
USN/USMC TANKERS	X	X	X	X		X	X				X					X	
FIXED WING RECEIVERS - USAF	X	X	X			X	X	X	X	X		X	X	X		X	
FIXED WING RECEIVERS – USN/USMC	X	X	X			X	X	X	X	X		X		X		X	
ROTARY RECEIVERS	X	X		X		X	X				X		X	X		X	
TILT ROTOR (*NOT YET ISSUED*)	X	X			X	X	X				X		X	X		X	
NOTE	1. FOR RECEIVER QUALIFIED CREWS ONLY																

8. Additional USA Tanker and Receiver Information. Refer to Annex Z and its sub-annexes for additional information about USA tankers and receivers.

9. Amendment Process. ATP-56 Main Body Pts 1, 2, 3 and 4 together with the USA National Annex are reviewed and updated every 6 months. To ensure that the document remains relevant, it is incumbent upon all operating personnel and those working with flight test and accident reports to ensure inclusion of the latest data in the manual. Importantly, an error in the main body cannot be rectified unless NATO is made aware of its existence. Similarly, errors in the USA National Annex can be rectified only if AMC or the USN/USMC (as appropriate) are informed about the problem. Therefore, it is essential that users play their part to provide comments, corrections, and queries regarding this manual. These should be submitted on an AF Form 847, or single Service equivalent, through channels established by higher headquarters, to HQ AMC/A3VK at ATP-56@scott.af.mil.

a. Critical Timelines. Endorsed proposals for amendments to either the Main Body or the USA National Annex must be submitted to AMC/A3VK for consideration, implementation or onward transmission to NATO. Whilst submissions can be made at any time, the table below identifies the last submission date for each amendment cycle.

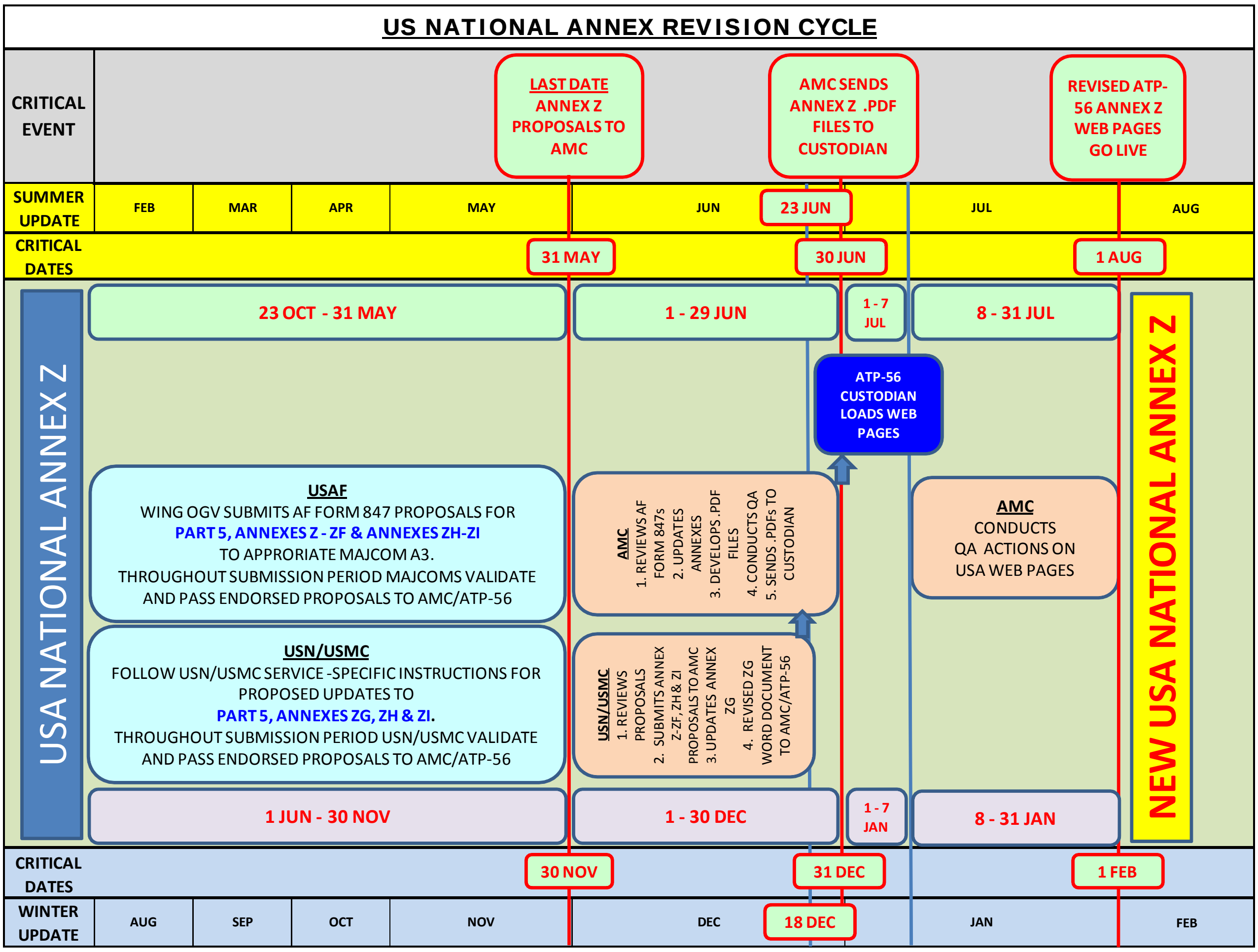
(1) AMC Units. For AMC units, only AF 847s endorsed and submitted by the unit OGV will be reviewed by AMC/A3VK.

(2) Other USAF MAJCOMs. Units must submit AF 847s to their MAJCOM A3 for consideration. Only proposals endorsed by a MAJCOM A3 and subsequently forwarded to AMC/A3VK will be considered for implementation.

(3) Sister Services. Units within the sister services must comply with appropriate service directives when submitting proposals for change. Only proposals endorsed at HQ level and subsequently forwarded to AMC/A3VK will be considered for implementation.

	LAST SUBMISSION DATE TO AMC	
EVENT	**SUMMER RELEASE**	**WINTER RELEASE**
Proposed Amendments to Parts 1, 2, 3 and/or 4	**31 MAY**	**30 NOV**
Proposed Amendments to Annex Z		

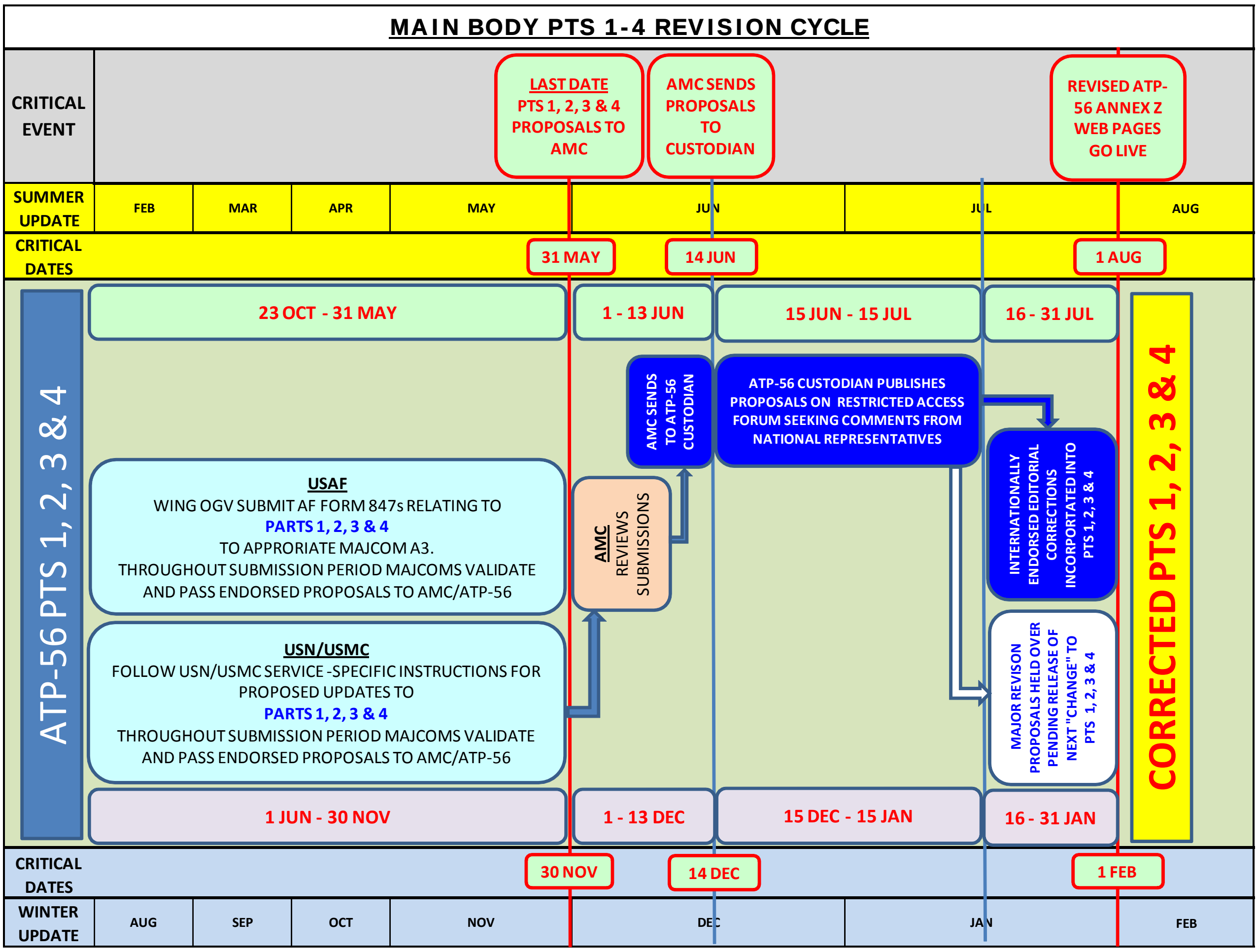
b. Staffing Timelines – USA National Annex. The following schematic illustrates the staffing process associated with the two six-monthly revision cycles for the USA National Annex.



c. Staffing Timelines – Main Body. Proposals for changes to the Main Body of ATP-56 (ie Parts 1, 2, 3 and 4) may be submitted at any time in accordance with the procedures published in para 9a. The schematic below illustrates the staffing process associated revisions to the Main Body; proposed changes normally fall into one of two categories, namely:

(1) Editorial Corrections. Proposals identifying grammatical, typographical and spelling errors only require "editorial" correction rather than co-ordination with all end users be that USA or other NATO nations. Such proposals will be forwarded by AMC/A3VK to the NATO Custodian for consideration/action.

(2) Changes to Procedures. Proposals emanating from USA end users that would significantly change internationally agreed AAR procedures published in Parts 1, 2, 3 or 4 need to be staffed nationally before being forwarded to NATO. The DoD Head of Delegation (HOD) to the NATO AAR Panel (see paras 11 and 12 below) will solicit agreement from MAJCOMs and other Services to ensure interagency consensus before seeking agreement to a change from other NATO nations.



10. Flight Safety. Every effort has been made to provide flight crews with the safest possible procedures and techniques for all phases of AAR activities. These procedures and techniques will be followed by all flight crews involved in AAR activity. If occasions or unusual situations arise that are not specifically covered in this manual, flight safety will be the prime consideration in determining a course of action.

RATIFICATION AND STAFFING - USA

11. International Military Agreements for Rationalisation, Standardisation, and Interoperability. On 8 February 2008 the Chairman of the Joint Chiefs of Staff issued an instruction entitled "International Military Agreements for Rationalization, Standardization, and Interoperability between the United States, its Allies, and other Friendly Nations (CJCSI 2700.01C)" available at http://www.dtic.mil/cjcs_directives/cdata/unlimit/2700_01.pdf . The instruction establishes policy, procedures, and responsibilities for achieving international military rationalisation, standardisation and interoperability (RSI) agreements with allies and other friendly nations in the areas of operations, doctrine, materiel, training, logistics and in-service equipment. Importantly, the instruction appoints the USAF as the national Lead Agent (LA) for AAR. Additionally, it details the staffing procedures that must be followed in order that the USA's position in AAR related matters can be established and correctly articulated to NATO.

a. USA - Air Force Lead Command Responsibility for AAR. Through AFPD 10-21 (Air Mobility Lead Command roles and responsibilities), the USAF has designated AMC as the lead command for the air mobility mission area, including AAR. Using this delegated authority, AMC is charged with managing and taking the lead in coordinating the processes that develop and maintain concepts, processes, and force structure to enable interoperability of forces, regardless of command.

(1) DoD HOD to the NATO AAR Panel. Each NATO nation nominates a national representative who is an action officer to NATO's AAR Panel (AARP). Using its Lead Command authority, AMC appoints the principal USA representative, commonly called the DoD "head of delegation (HOD)". His individual serves as the chief national spokesperson and decision maker at AARP meetings (see para 12e for additional information).

12. AAR Staffing and Ratification Process – USA. Updates to NATO Standardisation Agreements (STANAGS) must be supported by a quorum of NATO user nations. The staffing process to determine the USA position on STANAG 3971(the overarching directive for ATP-56) and other AAR related STANAGs, as well as the offices through which it is eventually communicated back to NATO, is illustrated in the diagram below. The key offices associated with the staffing process, together with their responsibilities, are identified as follows:

a. NATO Custodian. The ATP-56 Custodian is located within NATO's Joint Air Power Competence Centre (JAPCC). The Centre provides innovative and timely advice and subject matter expertise, both proactively and responsively, for the transformation of Joint Air and Space Power to the Alliance and Nations. As a Centre of Excellence, with a strategic and operational level focus, it offers independent thought, analysis and solutions. The purpose is to enable NATO´s effective and efficient use of Joint Air and Space Power.

b. NATO Standardisation Agency. The NATO Standardisation Agency (NSA) is a single part of the integrated structure of the Alliance and is, *inter alia*, responsible for coordination and support of all operational (doctrinal and procedural) standardisation efforts on behalf of the Military Committee (MC). The NSA coordinates military standardisation among all NATO bodies involved in standardisation and it administers all NATO-Terminology activities as well as standardisation efforts in the area of civil standards, which includes cooperation with civilian standard organisations.

c. USA Representative to NATO. The USA representative to the NATO Military Committee Air Standardisation Board (MCASB) is responsible for directing standardisation issues, including requests for ratification, to the appropriate offices within HQ Air Force. The MCASB reports directly to the NSA.

d. **AF International Standardization Office**. Upon receipt of requests for staffing action from the USA representative to the MCASB, the Air Force International Standardization Office (currently AF/A5XX) undertakes co-ordinating activities for the following:

(1) NATO STANAGs in the 3000 and 7000 series.

(2) NATO terminology series and Air Standardization Coordinating Committee (ASCC) Air Standards.

(3) NATO Allied Publications under purview of the NATO NSA.

(4) STANAGs in the 1000, 2000, 4000 series for the USAF.

(5) Army QSTAGs.

For ATP-56 (STANAG 3971), USAF staffing action is delegated to the DoD HOD to the NATO AARP.

e. **DoD HOD**. The DoD HOD will:

(1) Maintain contact with two networks, *viz*, international POCs and USA POCs as determined by their official statements of interest, ie USAF MAJCOMs and the USN/USMC.

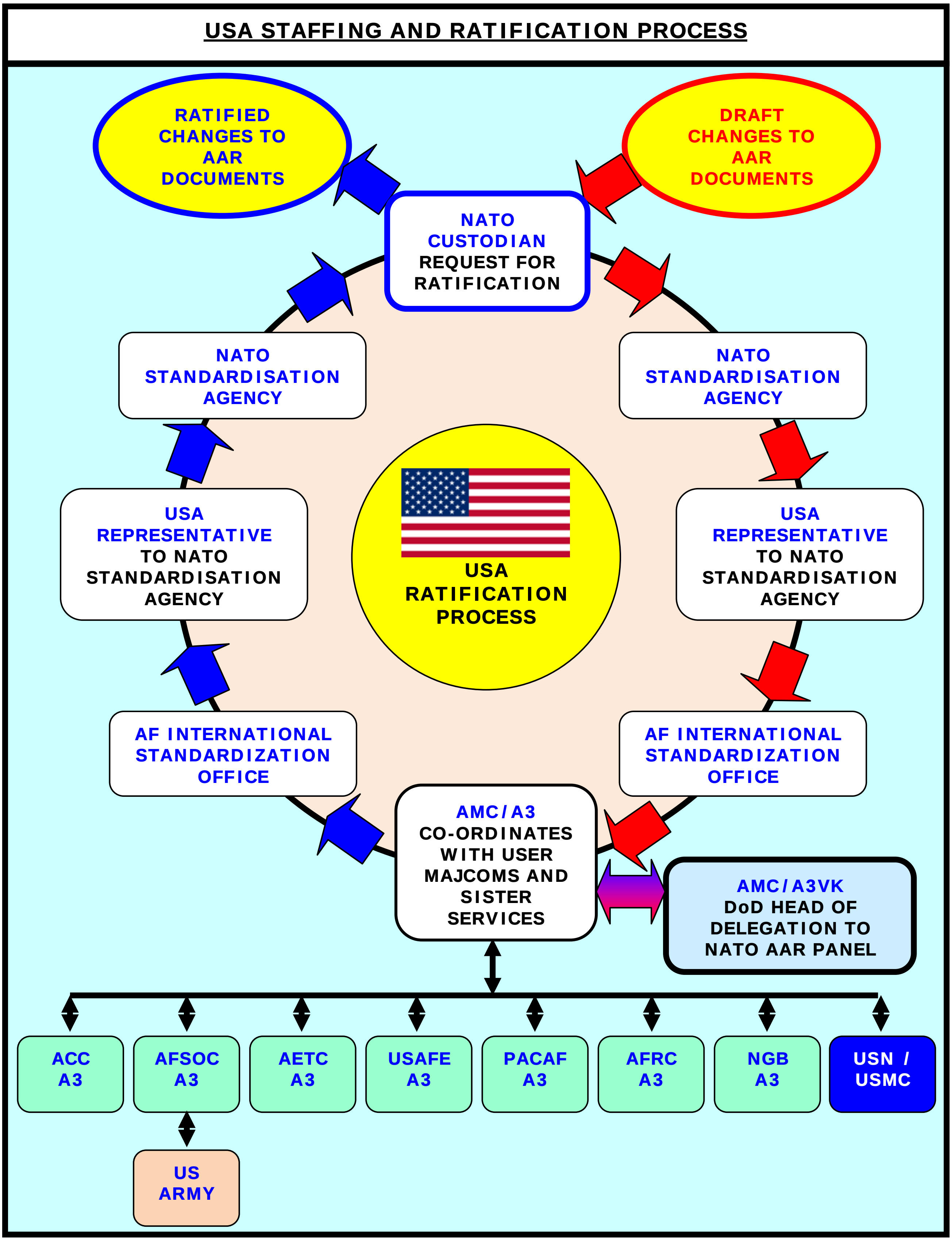
(2) Draft, coordinate, and issues USA decisions.

(3) Serve as the main USA link with other nations or organisations, eg NATO strategic commands, which participate in the activity.

(4) Have overriding authority over other USA delegates; the latter will be subordinate to the HOD. If a matter arises for which there is no USA position, the HOD will seek the consensus of the USA delegation. Short of consensus, the HOD may break the impasse to decide for the USA. However, such HOD decisions will be consistent with established USA policy, doctrine, and procedures. Alternately, the HOD may request deferral of the matter to the USA or abstain.

(5) Ensure that essential documents, decisions etc, are conveyed to fellow delegates and others as appropriate. Normally the chairman of the meeting will publish a record of decisions (ROD). If necessary, the HOD will coordinate with fellow USA delegates and submit USA comments, eg corrections, concerning the ROD. Internal USA reports of the meeting and necessary follow up action will be carried out as appropriate under the leadership of the HOD in coordination with fellow delegates (CJCSI 2700.01C dated 8 February 2008, Enclosure B provides amplifying information on this matter).

(6) Determine USA positions prior to international meetings. When developing the USA position, the HOD will consider all relevant information. Input from participating organisations will be solicited in the course of staffing positions. The HOD will collate all input and normally conduct working group meetings to review input and develop consensus for the USA position. The HOD should seek interagency consensus for the USA position. If consensus is not obtained, resolution will be decided per DOD 4120.24-M, March 2000, “Defense Standardization Program (DSP) Policies and Procedures” and Joint Staff Instruction 5711.01 series, “Action Processing”.


USA STAFFING AND RATIFICATION PROCESS
RATIFIED CHANGES TO AAR DOCUMENTS
DRAFT CHANGES TO AAR DOCUMENTS
NATO CUSTODIAN REQUEST FOR RATIFICATION
NATO STANDARDISATION AGENCY
NATO STANDARDISATION AGENCY
USA REPRESENTATIVE TO NATO STANDARDISATION AGENCY
USA RATIFICATION PROCESS
USA REPRESENTATIVE TO NATO STANDARDISATION AGENCY
AF INTERNATIONAL STANDARDIZATION OFFICE
AF INTERNATIONAL STANDARDIZATION OFFICE
AMC / A3 CO-ORDINATES WITH USER MAJCOMS AND SISTER SERVICES
AMC / A3VK DoD HEAD OF DELEGATION TO NATO AAR PANEL
ACC A3
AFSOC A3
AETC A3
USAFE A3
PACAF A3
AFRC A3
NGB A3
USN / USMC
US ARMY

RECORD OF RESERVATIONS BY NATIONS

Part No	**RECORD OF RESERVATIONS BY NATIONS**
1	None
2	USA
3	None
4	None
5	None

SPECIFIC NATIONAL RESERVATIONS

NATION	RESERVATION
USA	**Part 2 Annex 1B - RV Bravo and Part 2 Annex 1C - RV Charlie** will not be trained or executed by USAF aircraft. USA-USAF.

RECORD OF CHANGES

CHANGE	CHANGE DATE	DATE ENTERED	EFFECTIVE DATE	BY WHOM ENTERED
1	19 Nov 08	19 Nov 08	14 Dec 08	Custodian
2	22 Jan 10	22 Jan 10	01 Feb 10	Custodian

Summary of Change 1

1. ***Change 2 summarised below:***

Incorporates Part 3 – Rotary AAR Procedures.

ATP-56(B)

AIR TO AIR REFUELLING

TABLE OF CONTENTS

Subject	Page Or Paragraph

PART 2 – FIXED WING PROCEDURES

PART 4 – TILT ROTOR PROCEDURES

To Be Issued

PART 5 – NATIONAL AND ORGANISATIONAL ANNEXES

See Part 5 For Detailed List

LIST OF EFFECTIVE PAGES FOR PRELIMINARIES

PAGE NUMBERS	EFFECTIVE PAGES
Cover – Reverse Blank i to xxiv	Change 1 Change 2

PART 1 – GENERAL PROCEDURES

CHAPTER 1

Introduction

101 Origin. Many NATO air and maritime air forces have the capability to conduct air-to-air refuelling (AAR) operations. Although detailed procedures are dependent on aircraft type, mode of employment and national requirements, there is sufficient commonality for NATO Standard Procedures to be developed to enhance operational interoperability.

102 Aim. The aim of this publication is to provide a reference document covering procedures, national AAR equipment and AAR capable aircraft. This will:

a. Provide guidance for NATO and national commanders and staff in order to promote the effective employment of AAR in NATO air operations.

b. Lead to a better understanding of national AAR capabilities amongst NATO forces.

c. Promote mutual AAR support amongst suitably equipped NATO forces.

d. Promote the development of mutual AAR tactics and procedures.

103 Scope. This document will address the modes of employment of AAR, the commonality of equipment and identify areas where NATO standardization is practicable. Annexes covering specific national procedures have been incorporated where necessary.

104 Applicability of Limitations. Where limitations are specified in Part 1 to 4 of this document, these are to be considered the baseline for operations between tanker and receiver aircraft from different nations.

a. Tanker Restrictions. In all cases the appropriate National Annex for the participating nation's tanker is to be consulted to identify if more restrictive limitations apply for the tanker/receiver combination.

b. Receiver National Limitations. Receiver and/or tanker national limitations take precedence over less restrictive limitations published in Parts 1, 2, 3 or 4 of ATP-56 or the participating tanker's national annex. Additionally, when working with other nations, the most restrictive of the participant's national limits or those published in ATP-56 will apply. It is the responsibility of participants to bring such restrictions to the attention of the other party, either through pre-mission contact or verbally prior to commencing AAR.

c. Tanker/Receiver AAR from Same Nation. Nations may publish less restrictive criteria for their own aircraft when operating together.

105 Application. The planning for and employment of AAR should be based on the principles and procedures contained in this document.

106 Definitions, Terms and Phraseology. Definitions, terms and phraseology are listed in the ATP-56 Lexicon at Part 1 Annex 1A. Additional national terms and definitions are contained in the corresponding National Annex.

a. Warnings, Cautions and Notes. The following definitions and symbols apply to warnings, cautions and notes found throughout ATP-56.

WARNING

An operating procedure, practice or condition that may result in injury or death if not carefully observed or followed.

CAUTION

An operating procedure, practice or condition that may result in damage to equipment if not carefully observed or followed.

NOTE

An operating procedure, practice or condition that is essential to emphasise.

107 Additional Information. Additional information on the detailed employment of AAR is contained in:

a. ATP-34 - Tactical Air Support of Maritime Operations (TASMO) or Joint Maritime Operations.

b. AIRN Manual 80-6.

108 AAR Objectives. The objective of AAR operations is to enhance combat effectiveness by extending the range, payload or endurance of receiver aircraft. Successful AAR depends on 3 major factors:

a. Equipment Compatibility. It is essential that aircraft requiring AAR are fitted with probes/receptacles and fuel systems compatible with the characteristics of the tanker aircraft employed, eg drogue/boom system, fuel surge pressures, fuel type etc.

b. Performance Compatibility. It is essential for tanker and receiver aircraft performance to be compatible in terms of AAR speeds and altitudes.

c. Procedural Compatibility. It is essential for tankers and receivers to employ pre-planned and compatible procedures for rendezvous, making contact, fuel transfer and departure.

109 Combined AAR Operations. Within the constraints of national procedures and equipment characteristics, it is highly desirable that all NATO receivers are able to conduct AAR operations with all NATO tankers on both a pre-planned and/or opportunity basis.

PART 1 ANNEX 1A

Lexicon Part 1 – Acronyms and Abbreviations

The Lexicon contains abbreviations relevant to ATP-56 and is not meant to be exhaustive. The definitive and more comprehensive list is in AAP-15.

AAR	Air-to-Air Refuelling
AARA	AAR Area
AARC	AAR Controller
AREP	AAR Entry Point
ATO	Air Tasking Order
ATC	Air Traffic Control
ALTRV	Altitude Reservation
AOB	Angle of Bank
AVANA	Approval Void if Aircraft Not Airborne
BDA	Boom Drogue Adapter
EMCON	Emission Control
EUCARF	European Centralised Airspace Reservation Facility
HAAR	Helicopter Air-to-Air Refuelling
IDS	Independent Disconnect System
LOA	Letters of Agreement
MBL/EBL/OBL	Manual / Emergency / Override Boom Latching
MARSA	Military Assumes Responsibility for Separation of Aircraft
MPRS	Multi-Point Refuelling System
NAAR	Night AAR
QF	Quick Flow AAR
RV	Rendezvous
RVIP	RV Initial Point
RVCP	RV Control Point
RVCT	RV Control Time
SKE	Station Keeping Equipment
SPINS	Special Instructions
TMO	Tanker Manual Override
UARRSI	Universal AAR Receptacle Slipway Installation
WARP	Wing AAR Pods

Lexicon Part 2 – Terms and Definitions

AAR Abort Point
A planned point along the receiver track at which the receiver must divert, if he is not in contact receiving fuel.

AAR Airspeed
An airspeed or Mach number at which AAR will be conducted.

AAR Area (AARA)
A defined area encompassing both a racetrack shape AAR track and its protected airspace.

AAR Bracket
Designated segment of a route where AAR is planned. The bracket is defined by a refuelling start point and stop point.

AAR Control Point (ARCP)(HAAR ONLY)
Helicopter Receivers. Normally the earliest point the tanker can pass abeam the receiver during join-up.

AAR Control Time (ARCT)(HAAR ONLY)
Helicopter Receivers. The planned time that the receiver and tanker will arrive over the ARCP.

AAR Element
One tanker and one or more receivers.

AAR Entry Point (AREP)
A designated point at which the receiver enters the anchor area.

AAR Envelope
The area limits behind a boom equipped tanker within which a receiver must fly to remain in contact.

AAR Exit Point (A/R EXIT PT)
The designated geographic point at which the refuelling track terminates.

AAR Formation (Tanker/Receiver Formation)
Two or more tankers and/or receivers operating together with a designated formation leader (See Formation below.).

AAR RV
The procedures employed to enable the receiver(s) to reach the astern position behind the assigned tanker(s) (boom) or the observation position (drogue) by electronic, radio, and/or visual means.

AAR Stores
The refuelling pod, hose and drogue that connects onto the aircraft when configured in the tanker role.

AAR System Normal Operation
Both tanker and receiver using normal signal system.

AAR Time
Planned elapsed time from RVCP to completion point.

AAR Track
A track designated for AAR.

Air Tasking Order (ATO)
Formatted order detailing all information for the mission. Used to task and disseminate to components, subordinate units, and command and control agencies projected sorties, capabilities and/or forces to targets and specific missions.

Air Traffic Control (ATC)
A control system that ensures the safe operation of commercial and private aircraft, as well as military aircraft using the same airspace, by co-ordinating the movement of air traffic to ensure they remain a safe distance apart.

Alternate AAR Track
The track designated for AAR in the event that the primary track cannot be used.

Alternate RV
A RV achieved when primary means are not available. Alternate means may be radar beacon, common TACAN, Timing, DF Steer, ATC/GCI assistance etc, or any combination of these.

Altitude Differential
The difference between the receiver altitude and the tanker altitude.

Altitude Reservation (ALTRV)
An area of airspace reserved for AAR with the appropriate ATC authority. There are 2 types of ALTRV: moving and static. A moving ALTRV encompasses en route activities and advances coincident with the mission progress. A static ALTRV consists of a defined geographic area, specific altitude(s) and time period(s).

Amplifier Override
Procedure for using receiver override boom latching when receiver air refuelling system malfunctions. Also see Manual Boom Latching.

Anchor Point
A defined reference point upon which an anchor refuelling track is orientated.

Anchor Refuelling
AAR performed as the tanker(s) maintain a prescribed pattern which is anchored to a geographical point or fix (See RVs Alpha and Echo).

Anchor RV (RV Alpha)
The procedures normally employed by radar (CRC/GCI/AWACS) to vector the tanker(s) and receiver(s) for a visual join-up for refuelling.

Angels
A brevity code meaning aircraft altitude (in thousands of feet).

Approval Void if Aircraft Not Airborne (AVANA) by (time UTC)
ALTRV Approval Void for Aircraft Not Airborne by (time). In most cases the AVANA is one hour after the last planned take-off, after which time the ALTRV is automatically cancelled.

Astern Position

a. Probe and Drogue. The stabilized formation position behind the AAR equipment (approximately 5 ft directly aft of the drogue) with zero rate of closure.

b. Boom. The position approximately 50 ft behind and slightly below the tanker boom nozzle where the receiver stabilizes with zero rate of closure before being cleared to the contact position.

Awaiting AAR Position (non-SKE)

a. Probe and Drogue. The Awaiting AAR Position and the Observation Position are the same for fighter aircraft on a Probe and Drogue tanker, ie echelon on the left wing of the tanker.

b. Fighter Formations - Boom. The Awaiting AAR Position for fighter aircraft/elements on a boom tanker is a position 1 to 3 nm in trail and a minimum of 1000 ft below their tanker's altitude

Awaiting AAR Position (SKE and USAF Heavy Aircraft)
A 60º right echelon off the last tanker, 1 nm nose to nose spacing, stacked 500 ft above that tanker.

Base AAR Altitude
A reference altitude at which the lowest aircraft of a tanker formation (or a single aircraft for individual AAR) will fly. Ideally, this should be at least 2000 ft below receiver optimum altitude for refuelling.

Beacon RV
Use of an airborne radar or RV beacon to provide range and offset.

Bingo Fuel
A pre-determined quantity of fuel which requires the receiver or tanker to immediately return to home station or divert to an alternate.

Boom Cycling
A retraction and extension of the boom to relieve fuel pressure in the boom drogue adapter.

Boom Drogue Adapter (BDA) (KC-135)
Equipment used to convert the boom for use with probe equipped receivers.

Breakaway
An emergency in either the tanker or receiver may require an urgent cessation of refuelling; in such an event a radio call and/or appropriate visual signals will be given:

a. By the tanker when the receiver is judged to be flying erratically.

b. If the tanker has a malfunction.

c. By the boom operator or receiver if the receiver underruns the tanker.

The receiver(s) (and where appropriate, tanker) will immediately disconnect and take action as detailed in Part 2 Chapter 4. (HAAR detailed in Part 3 Chapter 4)

Brute Force Disconnect (Boom Only)
A disconnect which is the result of a receiver aircraft moving aft to full boom extension and overriding hydraulic pressure or a mechanical malfunction holding the receivers' toggles in the engaged position. A brute force disconnect may occur inadvertently or as part of a controlled tension disconnect procedure, coordinated between the boom operator and the receiver pilot.

Buddy Cruise
When tanker(s) and receiver(s) cruise as an AAR element/formation.

Buddy Join up Procedure (RV Foxtrot)
These procedures are utilized when the tanker(s) and receiver(s) approach the RVIP on a common track by taking off from the same base and joining up.

Buddy Takeoff/Departure
When tanker and receiver take off and climb as an element/formation.

Clear Astern
Radio call by the tanker clearing a receiver behind the left/centre/right assigned AAR equipment. The receiver moves to the astern position.

Clear Contact (Probe and Drogue and BDA Only)
The receiver is cleared to move forward from the astern position to engage the probe in the drogue.

Clear Contact Position (Boom Only)
The receiver is cleared to advance to the contact position.

Clear Join
Radio call by the tanker clearing the receiver to join in close formation in the observation position or astern position for boom operations.

Clear Leave
Radio call given by the tanker clearing the receiver to leave the tanker formation. This call is given only after the receiver has completed the move to the Post AAR Position.

Communications Out
Radio silent AAR RV operations. All other RV aids may be used.

Contact

a. **Probe and Drogue, and BDA.** A contact is made when the probe engages the drogue.

b. **Boom.** Called by the boom operator and the receiver when the boom is locked in the receptacle.

Contact Point
The geographical point along the planned AAR track where fuel transfer should commence.

Contact Position (Boom Only)
The stabilized position of the receiver within the AAR envelope where it is possible to make contact.

CONVEX
Flying conversion exercises performed to familiarise and qualify aircrew in a new skill set.

Crossover (HAAR Only)
A specific manoeuvre to reposition a receiver from one side of the tanker to the opposite side.

Dead Hose
See Hard Hose

Descent Range
The distance from the tanker at which the receiver desires to initiate letdown to the tanker.

Deployment
The relocation of forces and materiel to desired operational areas.

Disconnect

a. Action taken by receiver pilot or boom operator to disengage tanker and receiver refuelling systems.

b. Command given by the tanker to receiver, either verbally or by signal, instructing receiver to disengage from tanker refuelling equipment.

(1) Probe and Drogue, and BDA. The receiver moves smoothly back toward the astern position until the probe disconnects from the drogue.

(2) Boom. When the boom is seen to be clear of the receptacle, the receiver moves smoothly back to the astern position.

Dry Contact
AAR engagement for aircrew proficiency during which fuel is not transferred.

Electronic Contact (HAAR Only)
Electronic data on aircraft/formation location. Operational equipment that provides, at a minimum, range information.

Emergency/Override Boom Latching
Procedure for using receiver override boom latching when receiver air refuelling system malfunctions. Also see Manual Boom Latching.

Emission Control (EMCON) Procedures
The management of electromagnetic radiation to counter an enemy's capability to detect, identify, or locate friendly emitters for exploitation by hostile action For ease of tasking, the restrictions for both equipment emissions and radio transmissions are standardized into 4 Options. These options are detailed in the Communications Chapter.

Emitter
A piece of equipment that emits electromagnetic radiation (radios, radar, TACAN, IFF, Doppler, radio altimeter, etc).

End AAR
A planned point or the actual position within the confines of the AAR track at which all AAR operations/requirements are complete.

En route Formation (KC-135/KC-10A)
Two or more tankers in trail, 1 nm separation, and stacked up at 500 ft intervals.

En route RV (RV Golf)
Procedure used when join up is to be achieved en route to the AAR area at the RV position by making good a scheduled time. Timing may be accomplished by utilising an orbit delay or timing triangle.

En route RV HAAR (RV Golf)
An AAR RV conducted along the receivers' planned routing.

Force Extension
Tankers escorting fighters are force extended when they are refuelled en-route to their destination by other tankers which may or may not be part of the formation package.

Formation
Two or more aircraft with the same intended route or flight, maintaining station-keeping operations by either or both visual and electronic means. The formation will normally be flown with successive tankers in line astern, and stepped up or down behind the leader.

Go Reform Right/Left
Radio call given by the tanker which instructs a receiver to move from the astern position to the reform position after refuelling is complete. Omission of "right/left" means that the receivers are to reform on the right side of the tanker.

Ground Controlled Intercept (GCI)
A ground based radar system through which aircraft are controlled in order to achieve an airborne RV with other aircraft.

Hard Hose (Dead Hose)
A hose condition in which hose slack is not properly taken up on contact. Any resulting hose whip is likely to damage the receiver's probe.

Hot Armament
Forward firing ordnance that can be selected and fired by the receiver pilot or crew.

Inadvertent Disconnect (HAAR Only)
Unplanned disconnect. Receiver moves to astern position (or as briefed) to await further instructions from tanker.

Independent Disconnect System (IDS)(KC-10)
The Independent Disconnect System is an electrically controlled, pneumatically actuated system located in the nozzle assembly. It causes the sides of the KC-10 boom nozzle to collapse, allowing the boom to be retracted from the receiver aircraft while its toggles are in the latched extended position.

Join Up (HAAR Only)
Procedures used to transition the tanker from the RV phase of flight to a position abeam the receiver, ready to assume formation lead and the helicopter(s) ready to move to the observation position.

Join Up Altitude (HAAR Only)
A helicopter altitude that ensures tanker/receiver altitude separation during the join up.

Judy
Radio call made by the receiver when radar contact with the tanker and taking over responsibility for closing to within visual range.

Manual / Emergency / Override Boom Latching (MBL/EBL/OBL)
Procedure for using receiver boom latching when receiver AAR system malfunctions. Both tanker and receiver AAR systems in manual operation. Also known as Emergency/Override Boom Latching and Amplifier Override.

Mark
A request for the tanker to assist the receiver in achieving visual contact. Depending on type, the tanker may dump a small quantity of fuel, or fire a flare, or switch on/vary the high intensity lighting. Refer to National Annexes.

MARSA (FAA Only)
Military Assumes Responsibility for Separation of Aircraft - applies only to participating aircraft and FAA controlled formations.

Marshall Stack
A predetermined distance from an aircraft carrier in which aircraft hold to await an individual instrument approach to the deck. Marshall radials extend 20 to 45 nm from the carrier.

Minimum Safe Altitude (MSA)(HAAR Only)
A pre-briefed altitude that provides a vertical clearance from all obstacles within a defined range along a refuelling track. National restrictions determine the mission minimum.

Mixed AAR Formation
Any formation involving one or more tankers refuelling two or more dissimilar types of aircraft simultaneously.

Modified Point Parallel RV (RV Delta)
An RV procedure optionally employed when the receiver aircraft is established on-station in a command and control orbit or airspace patrol. The tanker enters the area, effects the RV, and completes the refuelling within the confines of the receiver's assigned airspace.

Multi-Point Refuelling System (MPRS) (KC 135)
Self-contained pods mounted on wing-tips of selected KC-135R aircraft that allow a single tanker to support both probe and drogue and boom AAR missions.

Night AAR (NAAR)
AAR operations that take place between official sunset and sunrise.

Normal Communications
Normal procedures as established in current AAR orders. All RV aids may be utilised as necessary.

Nose Cold
Radar selected to standby.

Observation Position (HAAR Only)
Helicopter – A position to the left or right of the tanker, outboard of the wingtip and slightly above and behind the tanker horizontal stabilizer. ***Note: Helicopter receivers should initially RV on the left side of the tanker unless previously briefed or mission dictates otherwise.***

Observation Position (Fixed Wing Only)
The initial formation position for a receiver joining a tanker. This is normally echelon left for all receivers.

a. Drogue Equipped Tanker

(1). Availability of Observers. Refer to the tanker's National Annex to determine if an observer is located in the rear of the aircraft.

(2). Without Refuelling Observers. Receivers should initially be co-altitude with the tanker, at least one receiver wingspan outboard of the tanker wingtip and well forward, to be observed and identified by the tanker pilots.

(3). With Refuelling Observers. The observation position for fixed wing aircraft is stepped down, aft of the tanker wingline and one receiver wingspan outboard of the tanker wing.

b. Boom Equipped Tanker. A position to the left and slightly behind the tanker wing with a minimum of one receiver wingspan clearance between tanker and receiver (weather permitting). This contrasts with the Awaiting AAR position (see above).

Off-load/On-load
The tanker fuel, normally established at the planning stage, assigned for off-load/on-load to receiver(s) during an AAR mission.

Offset (Track)
The lateral distance the tanker is displaced from the RVIP to RVCP track to compensate for turn radius and drift.

On-Call (Unplanned AAR)
An AAR that has not been planned before the mission, but becomes a requirement due to changing tactical situations.

On-Deck Position. (Quick Flow Procedure Only)
Left hand echelon formation on the receiver in the contact position.

Oral Communications (Boom Only)
The following terminology will be used by the boom operator when verbal instructions to the receiver are necessary:

Back	Move receiver backward
Down	Descend receiver.
Forward	Move receiver forward.
Left	Move receiver left.
Right	Move receiver right.
Stabilize	Hold receiver steady in present position
Up	Ascend receiver.
Slow Closure	Called when boom operator perceives an excessive closure rate. Receiver will reduce aircraft closure rate.
Return to astern	Receiver will manoeuvre aircraft to the astern position and stabilise

Orbit Departure Time
That time at which the tanker will depart the orbit point to effect the planned RV.

Orbit Pattern
The pattern flown by the tanker at the orbit point.

Orbit Point
A geographic point along the planned AAR track where the tanker will orbit.

Overrun
An overrun occurs when the receiver passes the tanker prior to or during the tanker RV turn.

Overtaking Point Parallel RV (RV Delta)
Same as Point Parallel RV except tanker plans to turn to refuelling track so as to roll out behind the receiver. The tanker then overtakes the receiver and begins a slowdown so as to position the tanker one mile in front of the receiver at AAR Airspeed.

Point Parallel RV Procedure (RV Delta)
The procedure normally used when the tanker arrives in the AAR area ahead of the receiver (A tanker orbit is normally planned).

Post AAR Position
The position to be maintained by receiver aircraft upon the completion of AAR.

a. **Fighters and Heavy Probe Receivers.** See Reform Area/Position.

b. **Heavy Boom Receivers.** Heavy boom receivers will maintain at least 1000 ft below and no less than 1/2 nm in trail behind the lead tanker (if unable to maintain visual contact, in trail distance is increased to 1 nm). This position will be maintained until clearance is received from Air Traffic Control.

c. **Heavy Aircraft Formation (SKE).** See Post AAR Position (SKE).

Note: In EMCON other than 3 or 4, tanker lead and receiver will verbally coordinate their respective separation manoeuvres prior to either aircraft departing formation.

Post AAR Position (SKE)
A 60º left echelon, 2 nm nose to nose separation, stacked down 1000 ft off the lead tanker.

Post AAR Procedures
The procedures employed by tankers and receivers after final disconnect and prior to establishing cruise.

Practice Emergency Separation
The term to be used by tanker and receiver aircrews when referring to a Practice Breakaway, prior to accomplishing the manoeuvre.

Quick Flow AAR (QF)
Visual formation procedures used to expedite AAR operations by minimising required refuelling time.

Radio Silent
No radio transmissions between tanker and receiver except in an emergency. For further details see Part 2 Chapter 5.

Receiver Holding Point
A point along the upstream end of the inbound course to the Anchor Point where the receiver(s) will hold until cleared for RV by the tanker. This point is used during Anchor Refuelling Alternate Procedures.

Reform Area/Position
An area to the right and level or slightly above the tanker formation, where receivers other than those moving to the Post AAR Position reform upon completion of AAR. This is normally echelon right for all participating receivers.

a. Drogue Equipped Tanker

(1) Availability of Observers. Refer to the tanker's National Annex to determine if an observer is located in the rear of the aircraft.

(2) No Refuelling Observers. Receivers should initially be co-altitude with the tanker, at least one receiver wingspan outboard of the right tanker wingtip and well forward, to be observed by the tanker pilots.

(3) With Refuelling Observers. The reform position for fixed wing aircraft is level or slightly above the tanker, aft of the tanker wingline and one receiver wingspan outboard of the right tanker wingtip.

b. Boom Equipped Tanker. A position to the right and slightly behind the tanker wing with a minimum of one receiver wingspan clearance between tanker and receiver (weather permitting).

Receiver/Tanker Route Formation (Fighter)
Receivers positioned on the tanker with two or four receivers' wingspan clearance.

Refuelling Altitude
The briefed AAR altitude that meets the performance and operational requirements of both the tanker and receiver aircraft.

Refuelling Heading
A true / magnetic / grid heading taken by the tanker(s) and receivers to maintain AAR track.

RV Control Point (RVCP)
The planned geographic point over which the receiver(s) arrive in the observation/astern position with respect to the assigned tanker.

RV Control Time (RVCT)
The planned time that the receiver and tanker will arrive over the RVCP.

RV Equipment
Electronic/radio equipment installed in tanker and receivers for use in achieving an RV.

RV FL/ Altitude/Height
The FL, altitude or height of the tanker during an RV procedure.

RV Initial Call
When the use of radio is authorized, the tanker is to confirm RV details before starting the RV procedure. The format of the call is in Part 2Annex 5B.

RV Initial Point (RVIP)
A planned geographic point prior to the RVCP to which tankers and receivers time independently to effect an arrival at the RV control time. If the tanker/receiver is not already at its assigned RV FL/ altitude, it commences a climb/descent to that FL/altitude. This point may be a designated position established at the planning or briefing stage, or as directed by the tanker/GCI/AEW controlling the RV.

RV Point
A designated point where tanker and receiver are planned to be joined in formation (RVCP, RVIP, etc).

RV Procedure
A procedure to join the receiver with the tanker.

RV Rollout Heading
A heading reference taken by the tanker(s) on the final turn towards the RV Point.

RV Speed

a. For RVs where the receiver flies the tanker speed plus 20 kts, the tanker speed (IAS) is known as the RV speed; this is usually the intended refuelling speed (normally optimised for best receiver AAR performance).

Note: If communications are not possible for any reason, and pre-briefing is not possible, the tanker will fly at the optimum speed for the receiver type as listed in Part 5 Annex BB, TANKER AAR CAPABILITIES.

b. For RVs where the receiver's speed is known to the tanker, RV Speed is the speed flown by the receiver when flying towards the tanker for the RV.

RV Track (Tanker Track)
The track flown by the tanker during the RV procedure. Receiver(s) track to the RV Point is dependent on planned route and RV procedure.

Reverse Flow AAR (boom only)
The transfer of fuel from receiver to tanker.

Rim
The probe strikes the rim or periphery of the drogue but does no damage.

Safe Position (KC/KDC-10)
The position during a partial or complete boom control system failure that is safe for the boom operator to initiate a disconnect. This position is when the receiver is approximately 0° roll and moving down and back.

Station Keeping Equipment (SKE)
An avionics based formation management system that allows a large number of aircraft operating on different frequency channels to fly fully instrumented formation in zero visibility. The system can also communicate navigation data and proximity warnings when a threat of collision exists. Participating aircraft can operate within a limited radius of a selected master system on the same frequency.

Single Hose Procedure
A change to the refuelling procedure which is effected when a tanker, which normally operates with 2 AAR stores, has one store unserviceable.

Soft Contact
The probe has not fully engaged in the drogue.

Special Instructions (SPINS)
Special Instructions which are attached to the ATO and detail operating procedures for all missions and tasks.

Spokes
The receiver has damaged the drogue.

Start Descent Point
A point where descent is initiated.

Start Point
A designated point on track where refuelling of the first receiver(s) is planned to start.

Stop Point
A designated point on track where refuelling of the last receiver(s) is planned to stop.

Switches Safe
All Weapons Switches selected to Safe/Off.

Tactical Air Control System
Any CRC, GCI, or AWACS command and control system.

Tactical Stream
Two or more AAR formations proceeding at a pre-determined spacing along identical flight paths.

Tanker Abeam (HAAR)
When receiver is aft of the tanker's 9 o'clock position during join-up.

Tanker Manual Override (TMO) (Boom Only)
Receiver AAR system in normal operation, tanker AAR system in manual operation.

Tanker Manual Override (TMO) without Tanker Disconnect Capability (Boom Only)
Mode of operation used when tanker AAR signal system malfunctions. Receiver AAR system will remain in normal operation. AAR will not be accomplished except during fuel emergencies or when operationally essential.

Terminate (Emergency Separation)
Call by tanker to cease breakaway manoeuvre.

Texaco (HAAR)
Brevity term to request a Helicopter Refuelling that can be accomplished on-call.

Toboggan
Request from receiver for the tanker to start a slow descent, maintaining the refuelling airspeed. The rate of descent is between 300 and 500 ft per min and this should be used unless tanker or receiver requests otherwise.

Track Offset
Used in RV Delta (Point Parallel), it is the lateral distance which the tanker is offset from the receiver track. The distance compensates for tanker turn radius and drift during the turn towards the ARCP.

Transferable Fuel
Tanker fuel available for passing to a receiver. This is the total fuel in the tanker, minus the fuel the tanker requires to recover to an airfield including any landing/diversion/weather reserves.

Transmit for DF
A 10 sec carrier wave transmission, unmodulated by speech, which allows relative positions of tanker and receiver to be determined using UHF/DF.

Turn Range
In some RV procedures, the distance measured between the tanker and receiver at which point the tanker initiates the turn for the RV.

Underrun
An underrun occurs when the receiver's closure rate prevents stabilising in the astern position, or when forward movement of the receiver is considered excessive during contact or approach to contact.

Universal AAR Receptacle Slipway Installation (UARRSI)
A modular AAR unit incorporating an AAR receptacle and slipway to guide the tanker boom nozzle into the receptacle. The UAARSI has a boom interphone capability.

Visual
Radio call from the receiver or tanker confirming visual contact with the other aircraft.

Visual Formation
Receiver(s) flying off tanker's wing.

Wave (of aircraft)
A series of aircraft formations departing from or arriving at an airfield or target, or passing a precise geographic location, with a specified interval between each formation.

Wet Contact
AAR engagement during which fuel is transferred.

Wing AAR Pods (WARP) (KC-10)
A set of 2 self-contained Flight Refuelling Ltd Mk32 refuelling pods mounted on selected KC-10 aircraft that allows simultaneous refuelling of 2 probe-equipped receivers.

PART 1 – GENERAL PROCEDURES

CHAPTER 2

Employment Considerations and Principles

201 Peacetime

a. Fundamental Principles. Normally, AAR operations require extensive pre-planning to ensure optimum effectiveness whilst maintaining safety and efficiency. This requires the identification of the best tanker type or types for the receiver, the selection of the optimum route for the operation, and suitable diversions for the aircraft types. If not tasked through a Combined Air Operation Centre (CAOC), it is essential that an efficient communications interface exist between tanker and receiver tasking organizations, to ensure the correct positioning and timing of the tanker to meet receiver demands.

b. Flight Safety. Formations undertaking AAR operations, or in transit, occupy a large volume of airspace and cannot manoeuvre easily. Thus, not only must aircrew be well aware of the increased collision risk during AAR but all control agencies must recognise the special requirements of formations undertaking AAR operations.

c. Airspace Reservations. Because of the large volume of airspace required, it is important to consult the relevant documents so that National and International Air Traffic procedures are strictly adhered to. In particular, some nations require AAR operations to be conducted in specific geographical areas. For flight safety considerations, it is normal to conduct AAR operations in reserved airspace. Such airspace can be divided into 2 broad categories:

(1) AAR Areas (AARAs)/Anchor Areas and AAR Tracks

(a) Peacetime AARAs/anchors areas and AAR tracks are areas of airspace established by the national authority for the conduct of routine AAR training. These areas can be either permanent or activated by NOTAM. Bookings for this airspace are usually made through the designated national scheduling unit, who are also responsible for liaison with the appropriate ATC authority for activation of the airspace and issue of NOTAMs. If suitably positioned, AARAs/anchor areas or AAR tracks may be used for AAR deployments.

(b) Exercise/operational AARAs/anchor areas and AAR tracks are temporary areas established by NOTAM for the duration of the exercise or operation and may be either permanent or time restricted as dictated by the nature of the task.

(c) Typical dimensions of AARAs/anchor areas and AAR tracks are in Part 2 Annex 1A.

(2) Altitude Reservations (ALTRVs) and Military Corridors. ALTRVs and military corridors are normally arranged with the appropriate national ATC authorities. For AAR purposes, moving ALTRVs are normally used to guarantee the required route and altitude(s) for an AAR supported deployment. Military corridors are activated by NOTAM and are essentially static ALTRVs.

(a) ALTRV Scheduling Facilities. To ease the scheduling difficulties of the civilian ATC authorities, the USAF operate 3 scheduling facilities which may be used by other nations by prior agreement. The facilities are responsible for prioritising military tasks and arranging the required ALTRV/corridor times with the appropriate ATC authority.

The areas of responsibility for the 3 USA and 2 Canadian facilities are:

(i) Central Airspace Reservation Function (CARF): Continental USA, New York and Oakland Oceanic FIRs (DSN 904-4426, Commercial: USA 703-904-4426).

(ii) European Central Airspace Reservation Facility (EUCARF): Europe, Santa Maria and Shanwick Oceanic FIRs (DSN 314-480-7346, Commercial: Germany 6371-47-7346).

(iii) Pacific Military Airspace Reservation Facility (PACMARF): Pacific and Indian Ocean (DSN 315-449-7286, Commercial: USA 808-449-7286).

(iv) Altitude Reservations East (ARE): Toronto, Montreal, Moncton and Gander FIRs and Gander Oceanic (Commercial: Canada 709-651-5243).

(v) Altitude Reservations West (ARW): Vancouver, Edmonton and Winnipeg FIRs (Commercial: Canada 780-890-4739).

(b) Additional Information. Amplifying information on the use of reserved FAA airspace can be found in FAA Order 7610.4K – Special Military Operations. This is an access controlled document but copies may be released to legitimate applicants (see http://www.faa.gov/airports_airtraffic/air_traffic/publications/spec_ops/ for access details).

(3) ALTRV Utilisation. There are significant differences between FAA and ICAO procedures when using ALTRVs. Fundamentally, ICAO acknowledges that ALTRVs can be established, but it does not recognise them in official publications.

(a) Pre-Flight Planning. Prior to flying a mission employing an ALTRV, aircrew must review their own nation's relevant National Instructions and/or regulations, together with appropriate airspace planning documents, to ensure compliance with all governing regulations for the airspace in which the ALTRV is established.

(b) ATC Clearance. In FAA Airspace, operations within an ALTRV permit the participating aircraft to manoeuvre freely within the vertical, lateral and longitudinal limits specified in the ALTRV message. In contrast, an ICAO ALTRV may or may not be an actual ATC clearance, depending on the region in which the formation is operating. For instance, Shanwick FIR (United Kingdom) requires aircraft to obtain ATC approval for all altitude changes. Importantly, aircraft transiting multiple airspace regions/countries need to be aware that ALTRV procedures may change when crossing FIR boundaries.

(i) US DoD European Operations. For US DoD aircraft operating in European airspace, letters of agreement (LOA) maintained at European Centralised Airspace Reservation Facility (EUCARF) explain ALTRV procedures and routings for individual countries. LOAs are coordinated on a one-to-one basis between EUCARF and each controlling agency/nation, not for the whole region. Crews must therefore consult paragraph "g" of the ALTRV message for country-specific information, pay close attention to comments therein and explicitly follow all instructions. If further clarification is required, contact the ALTRV planner first, followed by the appropriate altitude reservation facility.

(c) Formation - FAA. The FAA has specific definitions to describe a formation. These are:

(i) Standard Formation. A standard formation is one in which each wingman maintains a proximity of no more than 1 nm laterally or longitudinally and within 100 ft vertically from the flight leader.

(ii) Non-standard formation. Non-standard formations are those operating under any of the following conditions:

(A) When the flight leader has requested and ATC has approved other than standard formation dimensions.

(B) When operating within an authorized altitude reservation (ALTRV) or under the provisions of a letter of agreement.

(C) When the operations are conducted in airspace specifically designed for a special activity.

(d) Formation – ICAO. ICAO does not recognize the terms in para 201c(3)(c). However, Part 7 of NAT DOC 001, *Guidance and Information Material Concerning Air Navigation in the North Atlantic*, provides the following guidance:

(i) Definition of a Formation Flight. More than one aircraft, which, by prior arrangement between the pilots, operate as a single aircraft with regard to navigation and position reporting, are defined as a formation flight. Separation between aircraft within a formation flight remains the responsibility of the flight leader and the other pilots within it. This includes during transition periods when aircraft within the formation are manoeuvring to attain separation from each other in order to effect individual control, and during join-up and break-away.

(ii) Provisions

(A) Flight Plan. A formation shall file an appropriate ICAO flight plan for an operation although an ATC clearance will only be issued to the formation leader.

(B) Formation Dimensions – ICAO. All aircraft within a formation shall operate so that the wing aircraft maintain a distance of not more than one nm laterally or longitudinally and a vertical displacement of not greater than 30 m (100 ft), from the flight leader.

(C) Separation – Other Traffic. A formation flight will be considered as one aircraft by ATC for separation purposes. If at least one of the aircraft participating in the formation flight is MNPS approved, the entire formation flight is considered to be approved for operation in NAT MNPS Airspace. Formation flights will be considered as non-RVSM flights regardless of whether one or all aircraft in the formation are RVSM approved.

(D) Formation in RVSM Airspace. Formation flights operating within RVSM Airspace will only be approved by means of an airspace reservation.

(e) Formations – UK Airspace. In UK airspace, formations are considered as a single unit for separation purposes provided that:

(i) Formation Dimensions. The formation elements are contained within one nm both laterally and longitudinally, and are at the same level or altitude.

(ii) Controller Approved Formation. Exceptionally, at the controller's discretion, these limitations may be increased to 3 nm and/or 1000 ft vertically.

(iii) Co-ordinated Formation. The formation, although operating outside the parameters given above, has been the subject of a mission-specific airspace co-ordination and notification procedure.

(f) Formation – UK and European Airspace. Within congested UK and European airspace, unless otherwise approved, formation leaders must minimize formation spacing. Many controlling agencies (particularly civilian) only use secondary radar (IFF) to provide aircraft control. As such, unless agreed otherwise, they ‘see’ the formation as a one nautical mile ‘box’ based on the squawking aircraft and make separation allowances between other traffic based on that assumption. ATC is blind to aircraft in the formation outside the ‘box’. Therefore, rigid adherence to the approved formation dimensions is essential to ensure that the safety bubble between other traffic and the formation is not compromised.

(g) Large Formations. It is imperative that formation leads coordinate any additional dimensions with ATC if mission requirements dictate. If it is not possible to keep the formation within the limits previously mentioned, inform ATC and anticipate that aircraft greater than one mile from the lead aircraft may be considered as separate “speaking units” and receive separate controlling instructions.

202 Combat Operations. The employment of AAR in war or other hostile environments will depend on the capabilities of the aircraft types employed, local threat assessments and proximity to unsecured airspace. It is not appropriate in this document to detail AAR operations under combat conditions; however, tankers are vulnerable and high value assets and therefore, in general, they should be placed well clear of the combat zone or protected using fighter support. The procedures and principles of AAR described in this document should be applied whenever possible.

203 Tasking

a. AAR Requests. Units operating tanker aircraft respond to requests for AAR support from receiver units. Receiver aircraft units, or their command/tasking authority, are to identify those tasks that require AAR and raise the necessary request for AAR support.

b. Command and Control. The command and control structure must be clearly identified within the operation order or national instructions. Commanders must decide on the priorities to accord to individual requests and allocate forces accordingly.

c. AAR Tasking. AAR tasking is normally issued by an ATO or an AAR Combined Task Message (AARCTM). The format and structure of the AARCTM is contained in APP-8 - Allied Tactical Air Messages.

PART 1 – GENERAL PROCEDURES

CHAPTER 3

Refuelling Equipment

301 Introduction. This Chapter gives a general description of current AAR equipment. There are 2 different AAR systems in use: Probe and Drogue and the Flyable Boom. The 2 systems are not compatible. However, some booms can be adapted (on the ground) using a Boom Drogue Adapter (BDA) kit; this makes the boom compatible with probe equipped receivers. Some tankers (eg KC-10A) are equipped with both boom and hose/drogue systems and either may be used on the same flight.

302 Probe and Drogue. The tanker trails a hose; the free end of the hose terminates in a reception coupling and a conical shaped drogue. Receiver aircraft are fitted with an AAR probe which terminates in a fuel nozzle; the receiver aircraft is flown to engage the probe into the drogue:

a. System Description

(1) The tanker hose is carried on a power driven hose drum (or reel).

(2) To trail the hose, the hose drum brake is released and air drag on the drogue pulls the hose, at a controlled rate, into the airstream. When the hose is at full trail, a winding-in torque (response system) is applied to the drum; this counters the air drag of the drogue. The controlled balance between winding-in torque (response system) and air drag absorbs the impact of the receiver making contact; it also damps any tendency for the hose to whip as contact is made, provided excessive receiver closure rates are avoided.

(3) When contact is made the probe engages coupling latches, which grip the probe to make a fuel tight joint; fuel valves in the coupling and probe then open.

(4) The receiver continues to move forward, pushing the hose back onto the drum. When sufficient hose has rewound onto the drum, the main fuel valve in the AAR equipment opens and fuel can be pumped to the receiver.

(5) After making contact the forward movement required of the receiver to open the fuel valve is typically about 2 m (6 ft); however, the distance varies according to AAR equipment type, details are provided in National Annexes.

(6) Most systems afford a considerable range of fore and aft hose movement within which fuel will flow to an in-contact receiver. A range of movement from the valve open position to 7 m (20 ft) forward of this, is typical. On some equipment, the fuel valve closes if the hose is pushed in too far. Refer to National Annexes for specific recommended or permitted ranges of hose movement.

(7) When AAR is complete, the receiver pilot makes a small power reduction and drops back slowly to stabilize in the astern position. As the hose nears the full trail position, the AAR equipment fuel valve closes.

(8) When the hose reaches full trail, the probe begins to pull out of the reception coupling; the coupling and probe fuel valves close, then the coupling latches release the probe.

(9) If a Breakaway is commanded, the receiver drops back quickly. A sensor in the AAR equipment detects the high rate of hose movement and the hose drum brake is automatically applied; this achieves a swift, positive disconnect and occurs well before the hose reaches full trail.

(10) The Mk 17 hose remains in the braked position until it is manually reset but most hoses retrail automatically.

b. Tanker Installations. There are 2 general types of tanker AAR equipment: the podded store and the integral system.

(1) AAR pods are self-contained units requiring only fuel and low voltage electricity from the parent aircraft; the power source for fuel pumping and hose drum drive is usually a pod ram air turbine.

(2) AAR pods are widely used to give fast jet aircraft an alternate tanker capability; one pod is mounted on an under-wing or under-fuselage pylon; refer to National Annexes for specific installations.

(3) Pods are also carried by some large tankers; usually a pylon mounted pod is carried under each wing.

(4) Integral AAR systems may be carried on large tankers; normally these are installed within the main fuselage and the hose is trailed from a centreline fairing or tunnel. However, there are variations on this general principle; for example the FAF Transall AAR equipment is mounted within the left-hand fuselage undercarriage bay.

(5) Integral AAR systems use a variety of high powered aircraft supplies (pneumatic, hydraulic and electric) for fuel pumping and hose drum drive.

c. Hose Dimensions and Markings

(1) Generally pod hoses are shorter, lighter and have a narrower bore than integral system hoses. The lengths of pod hoses vary between 15 m (50 ft) and 27 m (90 ft) depending on the system and use; 24 m (80 ft) is typical of an integral system hose. National Annexes provide specific information.

(2) Most hoses are marked with coloured bands; there is a wide variety of colours and marking patterns, refer to National Annexes.

(3) However, most hoses have a series of bands or a block of colour to indicate the optimum receiver refuelling position; this is achieved when the hose is pushed in so that the markings enter the hose fairing or tunnel.

(4) On some hoses, the refuelling position marks are bounded by additional markings indicating the start and stop positions for fuel flow. Usually, there is a series of closely spaced bands at the tanker end of the hose; these provide cues for the receiver pilot to assess rates of fore and aft movement after making contact, or during disconnect.

d. Compatibility. Probe and drogue couplings are built to dimensions established by STANAG 3447; the aim of the STANAG is to ensure probe and drogue compatibility irrespective of the country of manufacture. However, the initial STANAG proved to be insufficiently precise in certain areas with the result that some British Flight Refuelling Limited (FRL) probes were incompatible with some US MA-3 and MA-4 couplings; there was a risk of the FRL probe becoming locked into the US couplings. STANAG 3447 has since been revised to eliminate this problem and all affected MA-3 and MA-4 couplings used within NATO have been modified to restore compatibility. Note that some MA-3 and MA-4 couplings supplied to other air forces outside NATO may still be unmodified. National Annexes list the type of couplings fitted to tankers.

e. Signal Lights. Associated with each tanker AAR installation is a set of rearward facing signal lights, using the colours red, amber and green; although some equipment may have only amber and green lights. On some systems, the signal lights are duplicated for redundancy. The lights provide indications of the operating status of the AAR equipment; on most installations, the lights can be controlled by the equipment operator to give radio silent commands.

(1) NATO Standard Lighting. The NATO standard light signals are:

(a) Red Light. A red light means Breakaway, or do not make contact.

(b) Amber Light. An amber light means clear contact.

(c) Green Light. A green light signifies fuel is flowing.

(2) National Differences. Variations on these principles are noted in National Annexes.

f. Drogue Lighting. Most drogues are illuminated to assist night AAR. Some drogues are lit internally by lights at the coupling; alternatively, the drogue periphery may be highlighted by a series of luminescent tritium light sources. On some tankers, reflective paint is applied to the inside of the drogue.

g. Probe Lights. Many receivers have a light which illuminates the probe. These lights should be used with caution, because they can dazzle the refuelling operator in the tanker; furthermore, their use may accentuate a tendency for receiver pilots to chase the drogue and therefore possibly overcontrol.

h. Drogue Tunnel/Serving Carriage Lights. The drogue tunnel or the serving carriage of most tanker AAR installations are lit from within. This is particularly useful for gauging the amount of hose pushed back onto the hose drum.

303 Boom. The tanker is fitted with a flyable, telescopic boom; the free end of the boom terminates in a probe-like fuel nozzle. Receiver aircraft are fitted with a reception coupling, or receptacle. The receiver flies a steady formation position whilst the boom operator manoeuvres and extends the boom to make contact with the receptacle. Some booms are equipped with a Boom Interphone system which permits direct communication with suitably equipped receivers during the period that the boom is in contact with the receiver. Full descriptions of the types of boom in service, and their operation, is provided in the appropriate National Annex.

a. Pilot Director Lights. To aid receiver positioning, the tanker aircraft is fitted with Pilot Director Lights (PDL); these consist of 2 parallel light arrays, set longitudinally on the undersurface of the fuselage between the nosewheel bay and the main landing gear. The PDLs give directions to a receiver informing it which way to attain and maintain the ideal refuelling position.

(1) One light array gives up and down commands and the other gives fore and aft commands.

(2) Coloured positioning bands on the telescoping portion of the boom correspond to the coloured segments of the fore and aft PDL.

(3) There are no lights for azimuth positioning.

(4) Only the PDL Elevation Background Lights will be used when the BDA is fitted.

(5) A full description of PDLs and boom markings is given in the appropriate National Annex.

b. AAR Equipment Lighting. Boom tankers are fitted with a rear-mounted floodlight, which illuminates the receiver, to assist the boom operator. The boom is fitted with a boom nozzle light to assist the operator in positioning the nozzle into the receptacle. Some receivers' receptacles are also internally lit; the UARRSI is usually lit, or highlighted by marker lights.

304 Boom Drogue Adapter

a. System Description

(1) The KC-135 and the C135FR boom can be modified to refuel some types of probe equipped aircraft by fitting a Boom Drogue Adapter (BDA); this consists of 3 m (9 ft) of hose attached to the end of the telescoping part of the boom. The hose terminates in a hard non-collapsible drogue.

(2) The PDLs should not be used with this system.

(3) The BDA does not have a hose response system; therefore receiver pilots should exercise caution during approach to contact.

(a) Excessive closure rates could result in a broken probe or hose.

(b) Attempts to disconnect which are not made down the correct withdrawal path could result in the probe binding in the reception coupling.

(i) For this reason, the USAF recommends the use of 'Flexitip' probes with the BDA. Flexitip probes have some internal bracings removed; this allows the probe mushroom valve tip some lateral movement within the probe structure and makes an off-centre disconnect easier.

(4) A full description of the BDA is given in the appropriate National Annex.

b. Tanker Installation. The BDA can only be fitted/removed on the ground.

305 Fuel Flow Rates and Pressures. Fuel flow rates vary widely according to AAR installation. In general terms, the boom system offers the highest rate of fuel flow up to 3650 kg/min (8000 lb/min), podded hose systems offer flow rates between 870 kg/min to 1000 kg/min (2800 lb/min to 3200 lb/min) and integral hose systems offer flow rates around 2300 kg/min (5000 lb/min). Fuel pressure is regulated in most systems not to exceed about 3.5 bars (50 psi) at the reception coupling. Fuel transfer rates will be affected by the SG of the fuel and the limitations of the receiver fuel system. See National Annexes for details.

NOTE

Some European aircraft have relatively poor on-load rates and consequently require lengthy AAR time; this may make their use incompatible with single-point tankers.

306 Tanker Reference Markings. Most tankers have some form of reference markings, providing enhanced cues for formation and/or AAR station keeping. These markings may be painted lines, fluorescent stripes, or electroluminescent panels. Boom tankers have a fluorescent yellow stripe on the bottom centreline of the fuselage to provide an azimuth reference. Some probe and drogue tankers have reference markings providing alignment cues for the approach to contact.

307 Tanker Lighting. Most tankers have floodlighting which make them readily visible to receivers. The lighting is designed to highlight parts of the tanker which may be used as formation visual references, to illuminate the AAR equipment and to light any reference markings provided for AAR. This lighting is usually dimmable. Some small combat aircraft with an alternate tanker role do not have floodlighting for AAR.

LIST OF EFFECTIVE PAGES FOR PART 1 ATP-56(B)

PAGE NUMBERS	EFFECTIVE PAGES
1-1 to 1-2	Change 1
1A-1 to 1A-14	Change 1
2-1 to 2-4	Change 1
3-1 to 3-4	Change 1
LEP-1 to LEP-2	Change 1

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PART 2 - FIXED WING PROCEDURES

CHAPTER 1

Rendezvous Procedures

101 Introduction. The purpose of a RV procedure is to achieve close visual contact between the tanker and a receiver section or element. For the purpose of this Chapter, each RV procedure is written for one tanker. However, all procedures can be adapted when tankers are flying in any formation. The RV is usually at the RVCP and at the RVCT. This Chapter outlines 7 standard types of RV. The type of RV utilised will be dictated by the mission requirements, available equipment, weather conditions and the EMCON option in force.

102 General Procedures

a. Altimeter Settings. Unless otherwise directed, an altimeter setting of 1013.2 mb (29.92 inches) is to be used for AAR operations at or above transition altitude, or when over water and operating in accordance with ICAO procedures. When not operating on standard pressure settings, tanker crews are to include the altimeter setting in the RV Initial Call. To minimise the chance of dissimilar pressure settings between receivers and tankers, the following terminology is to be used:

(1) Flight Level. When the tanker and receiver altimeters are set to the international pressure setting of 1013.2 mb (29.92 inches), vertical reference will be made using the term ‘flight level’.

(2) Altitude. When the tanker and receiver altimeters are set to QNH or a regional pressure setting, vertical reference will be made using the term ‘altitude’.

(3) Height. When the tanker and receiver altimeters are set to QFE, vertical reference will be made using the term ‘height’.

b. Vertical Separation. Receivers are normally to join from below and are to maintain a minimum of 1000 ft vertical separation, unless otherwise stated at the planning or briefing stage, until visual contact and positive identification have been made. If the planned flight levels/altitudes/heights are found to be unsuitable, the tanker commander may select other flight levels/altitudes/heights that will give the best possible chance of a successful RV. A change of flight levels/altitudes/heights is to be made only when all aircraft and radar units taking part in the procedure are aware of the proposed change and ATC has approved the use of the airspace.

c. Speeds

(1) Tanker. The tanker speed during a RV procedure is prescribed in the tanker’s flight manual and repeated in the applicable National Annex; this speed is normally optimised for best tanker performance. This is the speed that the tanker will fly if communication is not established with the receiver. If the tanker’s speed differs from that listed, the tanker should advise the receiver in the RV Initial Call.

(2) Receiver. The receiver should normally fly the speed prescribed in its flight manual and listed in appropriate tanker National Annex. For Option 1 of the RV Delta (Part 2 Chapter 1, Annex 1D, page 1D-1) where the tanker’s speed is known to the receiver, the receiver flies the tanker speed plus 20 kts.

d. Visibility . Receivers will maintain altitude separation of at least 1000 ft until 1 nm from the tanker.

(1) Visual With Tanker. Once the receiver(s) is visual with the tanker, receivers are clear to join and should initiate a progressive climb towards the tanker.

(2) Not Visual With Tanker. If receivers are not visual with the tanker, the subsequent actions will be in accordance with the capability of the receiver.

(a) Receivers Without Radar or with Weather Radar. Aircraft without radar or with only Weather Radar shall not proceed inside 1 nm unless the tanker is in sight.

(b) Basic Airborne Intercept Radar. Where receiver national limitations permit, aircraft with a basic airborne intercept radar (ie, target search available but lock capability not available) may climb to 500 ft below base AAR altitude, maintain this level and close to ½ nm.

(i) Loss of Radar Contact. If radar contact is lost inside of 1 nm without visual contact with the tanker, the receiver is to descend to 1000 ft below tanker altitude.

(c) Airborne Intercept (AI) Radar. Where receiver national limitations permit, as long as radar lock is maintained, aircraft equipped with an AI radar may continue closure at no more than 10 kts of overtake inside of ½ nm maintaining 500ft vertical separation to a minimum range of 1500 ft.

(i) Visual Contact Established. When visual contact is established with the tanker, a progressive climb may be initiated in order to join the tanker.

(ii) No Visual Contact by 1500 ft Range. If visual contact is not established by a range of 1500 ft, closure is to cease.

(iii) Loss of Radar Lock Inside ½ nm Range. If radar lock is subsequently lost, the receiver shall re-establish at least ½ nm range and maintain a minimum of 500 ft vertical separation.

(3) Visual Contact Not Established. If visual contact is not achieved at the appropriate minimum closure range, the receiver(s) may:

(a) Stabilise at the appropriate minimum range and maintain it until the tanker manoeuvres into an area of improved visibility.

or

(b) Descend to 1000 ft below the tanker, drop back to 1 nm and either maintain this position until the tanker manoeuvres into an area of improved visibility or terminate the RV.

e. Termination of AAR Due to Visibility. AAR is to be discontinued when in-flight visibility is deemed insufficient for safe AAR operations.

f. Turning Angles of Bank (AOB) and Range. A planning assumption of 25° AOB is used by tankers for most RV procedural turns mentioned in this Chapter and its Annexes. This AOB should be flown whenever possible; most of the tanker Turn Ranges in RV procedures are based on this planning assumption. Additional sets of Turn Range tables are provided for some RV procedures; these tables are based on the planning assumption of the tanker using the AOB specified in the table.

Notes:

(1) *These tables assume that the tanker is actually established in the turn at the prescribed turning range.*

(2) *Figures 1B-2, 1B-3, 1C-2, 1D-3 and 1D-4 publish turn ranges that achieve a tanker roll out 1 nm ahead of the receiver.*

(3) *Figures 1D-6 and 1D-7 are used by the USAF to ensure that the tanker rolls out 3 nm ahead of the higher speed receiver(s), whilst, with slower receivers, the tanker will roll out either ½ nm behind or 1 nm in front of the receiver(s).*

g. Racetracks and Orbits. Whenever possible, the tanker should set up a racetrack in a suitable position ahead of the RV. The main purpose of this is to allow the tanker timing to be adjusted to meet the needs of the receiver. In the Annexes to this Chapter, racetracks are described in positions ahead of the RV, which are considered to be ideal; however, these are not inflexible and they may be planned elsewhere if necessary. An orbit by the tanker may be used as a tactical holding device during the course of a RV to allow a receiver to catch up, or to hold if visual contact is not made when expected. Unless otherwise briefed, or for ATC reasons, all racetracks and orbits are to be to the left to give the tanker pilot the best lookout.

h. Heading Reference. All headings are magnetic unless otherwise stated.

i. Base AAR Altitude. See definition in Lexicon.

103 Visual Acquisition of Tanker. To enhance visual acquisition of the tanker(s), the receiver or air/ground agency controlling the rendezvous may request the tanker to switch on/vary the high intensity lighting using the RT call:

"(Receiver Callsign) Mark"

Some tankers are capable of dumping a small quantity of fuel, or firing a flare in response to this call. This procedure should only be used if a receiver has a low fuel state or other similar circumstances that necessitate the RV to be expedited.

104 Rendezvous Overrun. When either the tanker or receiver detects that an overrun condition exists, or if the receiver(s) passes the tanker prior to or during the tanker rendezvous turn the following procedures will be employed:

a. Receiver(s). The receiver(s) will ensure positive vertical separation such that they pass at least 1000 ft below the tanker(s). The receiver(s) will also call:

"(Tanker Callsign) Execute Overrun"

and decelerate, maintaining AAR heading and assigned flight level/altitude.

b. Tanker(s). The tanker(s) will maintain flight level/altitude/height, accelerate to overrun speed (but to no more than drogue limiting speed if drogue(s) are trailed) and maintain AAR heading.

c. Terminate. When either the tanker or receiver deems that the overrun condition is no longer a factor, they will call:

"(Receiver Callsign) Terminate Overrun"

d. Rejoin. Once the overrun condition has been corrected and the receiver is below and behind the tanker, (ie tanker has positive electronic or visual contact ahead of the receiver(s)) the tanker(s) will slow to AAR airspeed and complete normal RV procedures. Receivers will not begin a climb to the RV altitude until it is evident that the tanker(s) will remain in front of the receiver for the entire closure to the astern position.

105 Joining - Probe and Drogue Tankers

a. Observatio n Position. The left-hand side of the tanker is allocated for joining aircraft, unless the lead tanker directs otherwise. The exact location of the observation position is dependent upon the availability of rearward facing observers or boom operators that can monitor the receivers; see the Tanker's Nation Annex for tanker configuration.

(1) Tankers Without Refuelling Observers. Where the tanker has no rearward facing observers, the receivers must move forward ahead of the wingline to the observation position in order to be seen and identified by the tanker pilots. See Figure 1-1.

(2) Tankers With Refuelling Observers. Where the tanker has rearward facing observers or boom operators, the observation position is behind the wingline of the tanker. See Figure 1-2.

b. Joining Multi-Tanker Formations. Multi-tanker formations are to be in echelon right formation during receiver joins. Receivers are normally to join on the left of a multi-tanker formation, or to the left of their assigned tanker once visual with the complete formation.

Figure 1-1. Diagram of Key Areas Around a Probe and Drogue Tanker Without an Aft Observer

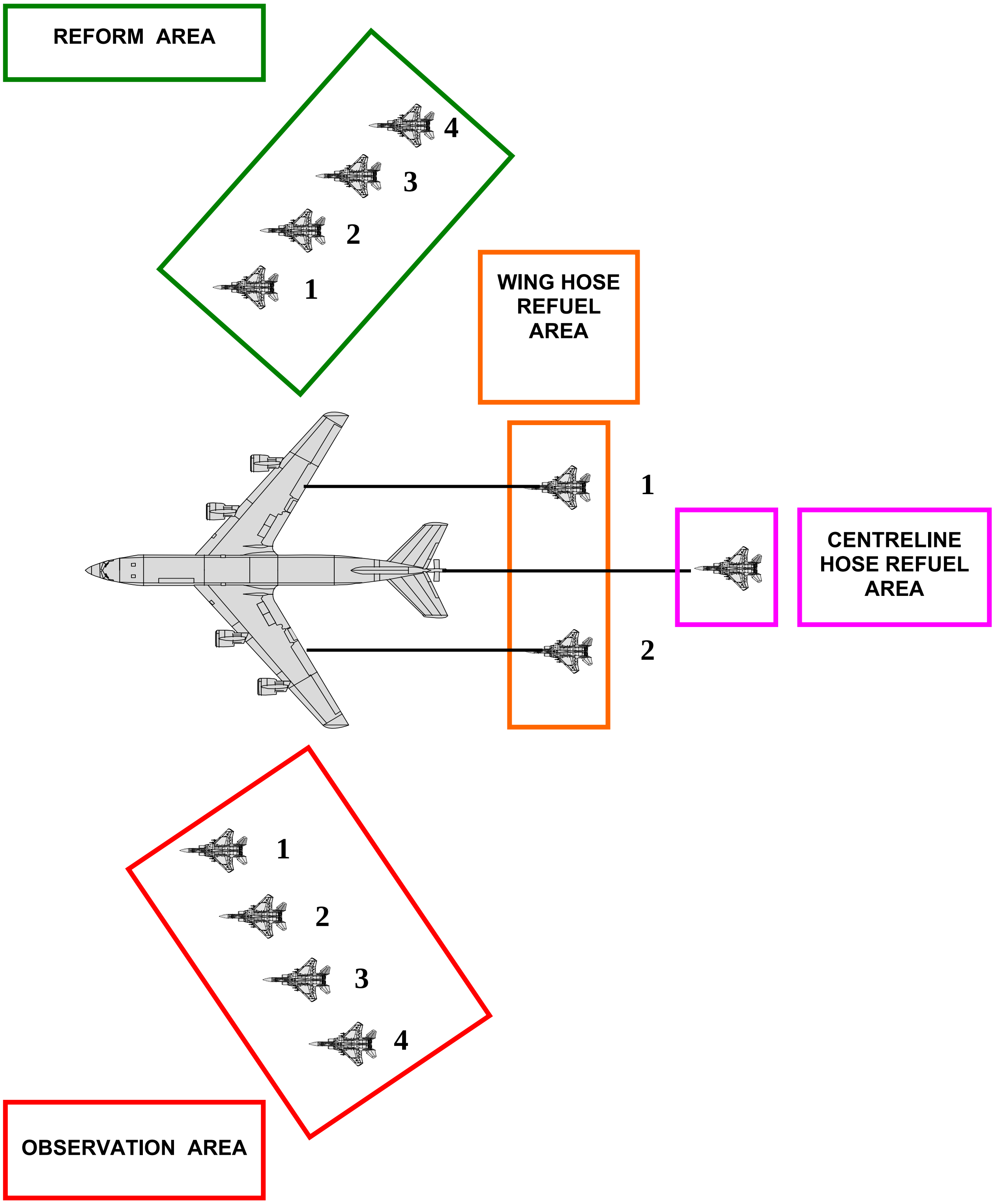
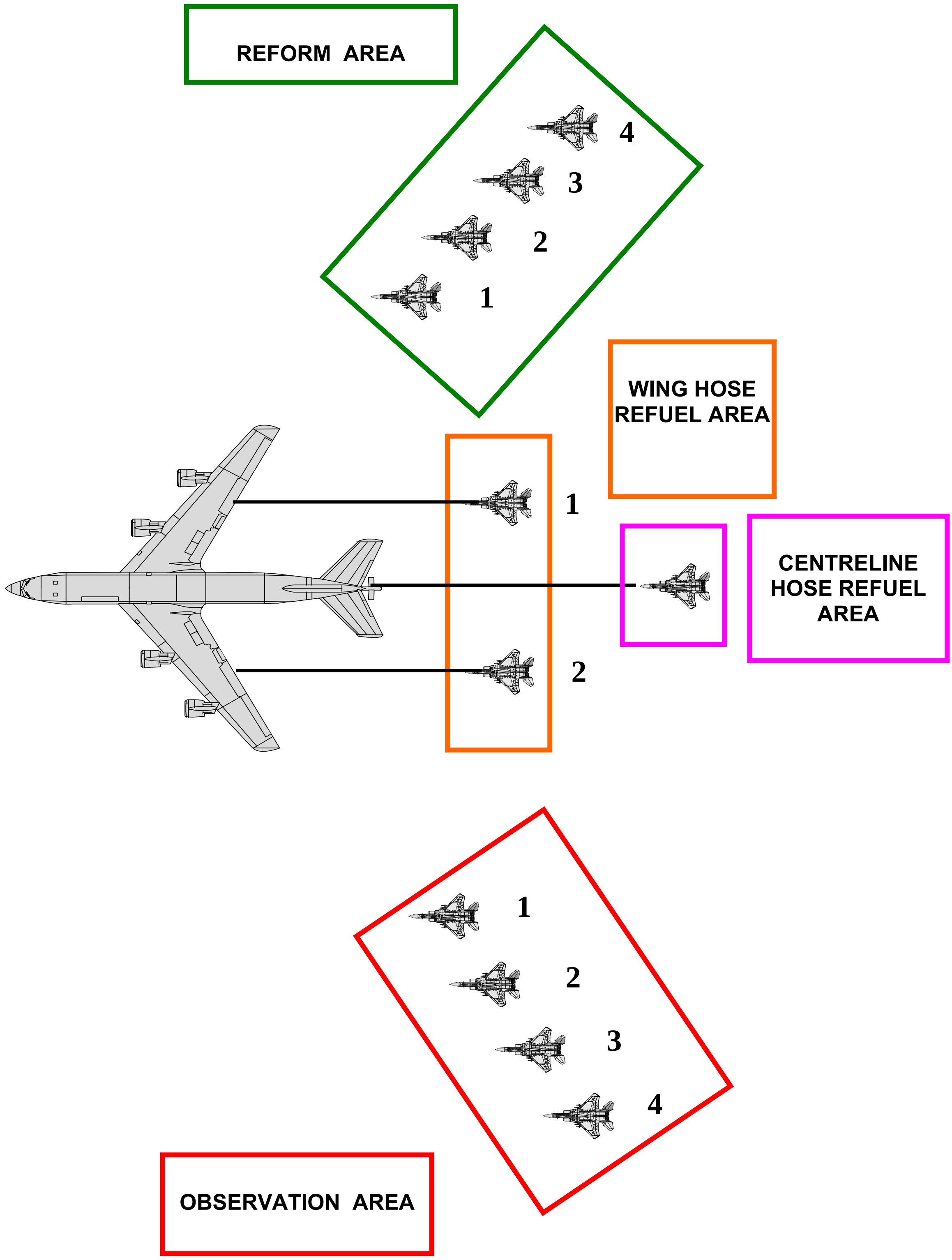


Figure 1-2. Diagram of Key Areas Around Tankers - Boom and Probe and Drogue with an Aft Observer



106 Refuelling – Probe and Drogue

a. Join – Observation Position. Receivers arrive from tanker's left side and form up in the observation position as described in para 105. See Figures 1-3A, 1-3B and Figure 1-2 as appropriate to the tanker.

b. Receiver Sequence. To ensure safe operations, the tanker will direct receivers to the formation position that they are to adopt. Furthermore, the tanker will direct when receiver aircraft are to reposition. Receiver aircraft are to move sequentially from echelon in the observation position to the astern position on command from the tanker; this command may be given by radio or by using the standard procedural signals in EMCON conditions. See Figure 1-3 for illustrations of controlled receiver flow around the tanker.

c. Simultaneous Movement of Receivers- Repositioning Receivers. Up to two receivers may be directed to move simultaneously from the observation position to behind the hoses. Similarly, both aircraft behind the hoses may be directed to move simultaneously from this position to the reform position. See Figure 1-3 for illustrations of controlled receiver flow around the tanker. Until directed by the tanker, all other aircraft should remain steady in their allocated formation position.

d. Collision Avoidance. Receivers are responsible for ensuring that the airspace they are moving into is clear of other aircraft. In addition, moving receivers are mutually responsible for ensuring that they do not collide with the other repositioning aircraft.

e. Receiver(s) on Tanker with 2 Wing Refuelling Stations

(1) One Receiver on Tanker with 2 Wing Refuelling Stations. When the tanker has 2 wing refuelling stations and both are available, the receiver moves to the right hand refuelling position

(2) Two Receivers on Tanker with 2 Wing Refuelling Stations. If there is more than one receiver and both refuelling stations are vacant, the first receiver moves behind the right hand hose into the astern position, and the second receiver moves in turn behind the left hand hose into the astern position. See Figures 1-3C and 1-3D.

(3) Receivers Waiting on the Tanker Wing. Until directed by the tanker, all other aircraft should remain steady in their allocated formation position.

f. Receiver(s) on Tanker with One Wing Refuelling Station or Centreline Station

(1) Movement of Receivers. When the tanker has one wing refuelling station or a single centreline hose, only one receiver will be directed to move in turn to cycle from the Observation Position to behind the available hose.

(2) Receivers Waiting on the Tanker Wing. Until directed by the tanker, all other aircraft should remain steady in their allocated formation position.

g. Clear for Contact and Remaining in Contact

(1) Individual Clearance to Contact. Normally, the tanker is only able to safely monitor one receiver at a time. Consequently, receivers will be cleared (verbally and/or by light signals) to make contact one at a time. Where the tanker is able to monitor both receivers, simultaneous contacts may be approved.

(2) Remaining in Contact. Because of the potential to cause the tanker to yaw slightly if one receiver disconnects from a wing hose, receivers should remain in contact until cleared to disconnect by the tanker. See Figure 1-3E.

h. Disconnect. Normally, when both wing hoses are occupied, the tanker will instruct receivers to disconnect simultaneously. However, the tanker may order individual disconnects either to maximise hose efficiency or because of disparate receiver fuel states.

(1) Other Considerations for Disconnecting. Refer to Part 2 Chapter 4 para 404e for other safety considerations associated with receiver disconnects.

i. Change Hose Procedure. It is important to move only one receiver at a time when cycling/changing the receivers behind hoses. To cycle 2 receivers between wing hoses, the tanker is to:

(1) Order one receiver to the observation or reform position.

(2) With this achieved, the second receiver may be cleared to the astern position behind the vacant hose.

(3) On completion of this manoeuvre, the first receiver may be cleared to the astern position behind its new hose.

j. Reforming. Once cleared from behind the hose, receivers will reform in echelon in the Reform Position. See Figure 1-3F.

k. Refuelling Subsequent Receiver(s). The next receiver waiting in the Observation Position will remain in that position until cleared by the tanker to move behind the hose. Before moving, the receiver(s) must also visually confirm that the previous receiver(s) have moved towards the Reform Position.

l. Other Receivers Joining. Receivers must exercise caution as other formations may be joining the tanker at the same time as they are reforming and departing. See Figure 1-3H.

m. Silent Procedures. During silent procedures, tankers will use visual signals to clear receivers to reposition. Receivers remain responsible for ensuring that the area into which they are moving has been vacated by the previous receiver.

107 Joining – Boom

a. Join - Single Tanker – Observation Position. Receivers arrive from tanker’s left side, unless the lead tanker directs otherwise, and form up in the observation position. The observation position is behind the wingline of the tanker. See Figure 1-4 and Figure 1-5A.

(1) First Boom Receiver. The boom operator has a good rear view of the receiver and is able to give detailed commentary and advice to both the receiver and the tanker. If cleared by the tanker, the first receiver of a formation may join directly behind the boom. The receiver visually must confirm that no AAR is in progress and that the boom is lowered. See Figures 1-5B.

(2) Remainder of Formation. All other members of the formation should form up in the observation position. See Figures 1-5A and B.

b. Joining Multi Tanker Formations. Multi-tanker formations are to be in echelon right formation during receiver joins. Receivers are normally to join on the left of a multi-tanker formation, or to the left of their assigned tanker once visual with the complete formation. See Figures 1-5A and 1-5B.

Figure 1-3. Diagram of Receiver Flow Around a Probe and Drogue Tanker

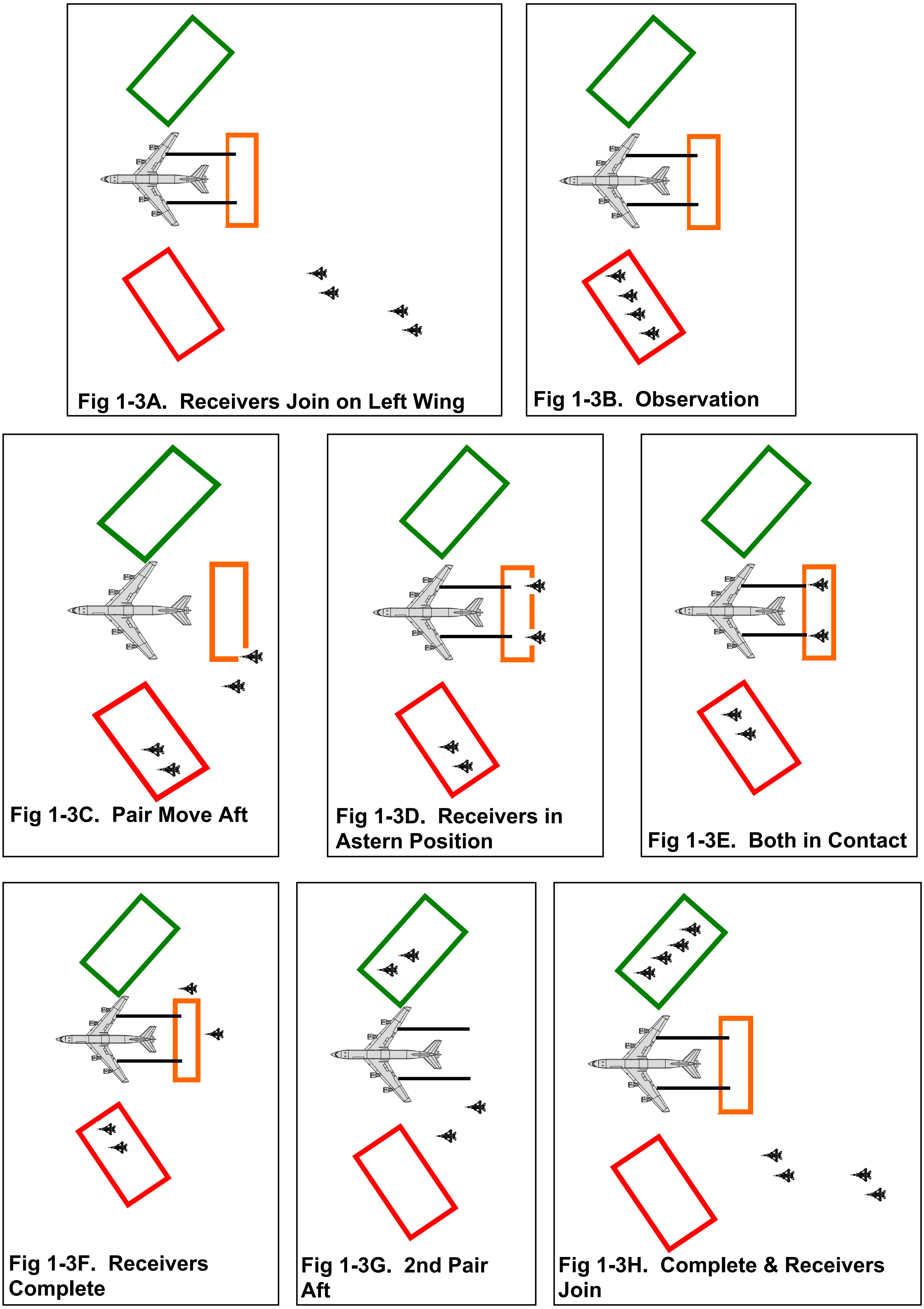


Fig 1-3A. Receivers Join on Left Wing

Fig 1-3B. Observation

Fig 1-3C. Pair Move Aft

Fig 1-3D. Receivers in Astern Position

Fig 1-3E. Both in Contact

Fig 1-3F. Receivers Complete

Fig 1-3G. 2nd Pair Aft

Fig 1-3H. Complete & Receivers Join

108 Joining – Boom Tankers

a. Join - Single Tanker – Observation Position. Receivers arrive from tanker's left side, unless the lead tanker directs otherwise, and form up in the observation position. The observation position is behind the wingline of the tanker. See Figure 1-4.

b. Receiver Sequence. To ensure safe operations, the tanker will direct receivers to the formation position that they are to adopt, ie the observation, refuelling or reform areas. Furthermore, the tanker will direct when receiver aircraft are to reposition, and then only one aircraft at a time is to be changing formation position; all other aircraft should remain steady in the formation position allocated by the tanker; this command may be given by radio or by using the standard procedural signals in EMCON conditions. See Figure 1-5 for illustrations of controlled receiver flow around the tanker.

c. Collision Avoidance. Receivers are responsible for ensuring that the airspace they are moving into is clear of other aircraft. In addition, moving receivers are mutually responsible for ensuring that they do not collide with other repositioning aircraft.

d. Boom Signals. The standard signal given by the boom operator to clear the receiver to the astern position is lowering the boom. Refer to Part 2 Chapter 5 Annex 5C Figure 5C-3.

e. Receiver Flow – Single Tanker

(1) One Tanker and One Receiver. The standard flow for boom AAR operations between one tanker and one receiver is for the receiver to join directly behind the boom, only if the receiver has visually confirmed that no AAR is in progress and that the boom is lowered.

(2) One Tanker and More Than One Receiver. With the exception of non-bomber heavy receivers that flow from right to left, for two or more receivers the standard flow is left to right. This standard may only be adjusted when airspace, ATO, or SPINS make flowing from left to right impossible.

f. Refuelling First Receiver. The first receiver is refuelled and, when complete moves to the reform position on the right wing. See Figures 1-5C and 1-5D.

(1) Receiver/Tanker Formation. Once in position, the receiver pilot flies close formation with the tanker, although this can be complicated by wake turbulence.

(2) Boom/Rece iver Mating. The boom is unlatched from its stowed position and "flown" towards the receiver by the boom operator using the attached wings. The telescoping section is then hydraulically extended until the nozzle fits into the receiver's receptacle.

(3) Fuel Flow. Following connection of the boom nozzle with the receiver's receptacle, an electrical signal is passed between the boom and receiver, hydraulically opening valves. At this point, the tanker activates pumps to drive fuel through the boom, and into the receiver.

(4) Indicator Lights. Once the two aircraft are mated, additional lights (pilot director lights (PDLs)) on the tanker, activated by sensing switches in the boom, illuminate if the receiver flies too low or too high, or too near or too far away.

g. Refuelling Complete. When fuelling is complete, the valves are closed and the boom is automatically or manually retracted.

h. Reforming. Once cleared from behind the boom, receivers will reform in echelon in the Reform Position. See Figure 1-5D.

i. Refuelling Subsequent Receivers. The next receiver(s) waiting in the Observation Position will remain in that position until cleared by the tanker to move. Once the refuelled receiver is clear of the boom and moving towards the reform position, the next receiver in the sequence will be directed to the astern position and then complete the refuelling sequence discussed above. Before moving, the receiver must also visually confirm that the previous receiver has moved towards the Reform Position. See Figure 1-5E.

j. Other Receivers Joining. Receivers must exercise caution as other formations may be joining the tanker at the same time as they are reforming and departing. See Figures 1-5F and 1-5G.

k. Silent Procedures. During silent procedures, tankers will use visual signals to clear receivers to reposition. See Part 2, Annex 5C, Figure 5C-3. Receivers should comply with the controlled formation changes detailed above.

109 Refuelling – Boom Drogue Adaptor (BDA). Part 1 Chapter 3, para 304 describes how the boom is modified through the BDA to allow probe receiver aircraft to take on fuel. In order to achieve a successful transfer of fuel, the tanker and receiver must comply with the following:

a. The tanker flies straight and level, and the drogue is allowed to trail out behind and below it.

b. Probe equipped receivers should adopt formation positions appropriate to a tanker with an observer in the rear of the tanker (Figures 1-2 and 1-4).

c. The drogue can be flown by the boom operator but the receiver must fly the probe directly into the basket to make contact.

d. The boom operator holds the BDA as motionless as possible.

e. The receiver must make contact with the drogue and then move forward and offset to one side.

f. After the receiver states "contact" the boom operator triggers contact which allows the tanker pilot to start the AAR pumps and offload fuel.

g. The receiver maintains position during refuelling, keeping an eye on the hose to make sure he remains in a suitable position.

h. When fuelling is complete, the receiver decelerates firmly enough to extract the probe out of the basket. The line of rearward movement should straighten the hose and place the probe along the same longitudinal access as the boom and hose, thereby minimising lateral loads on the probe.

Figure 1-4. Diagram of Key Areas Around a Boom Tanker

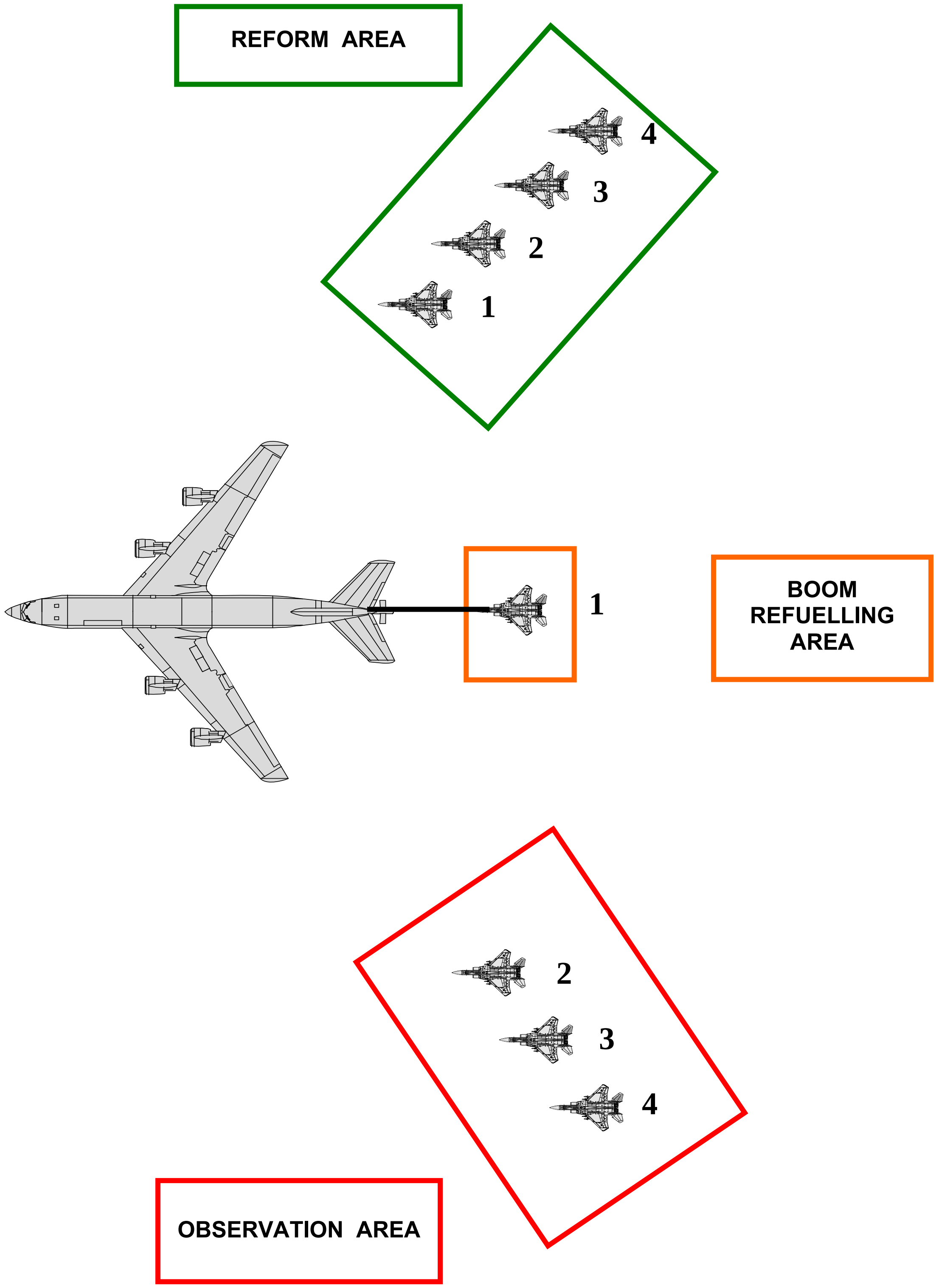
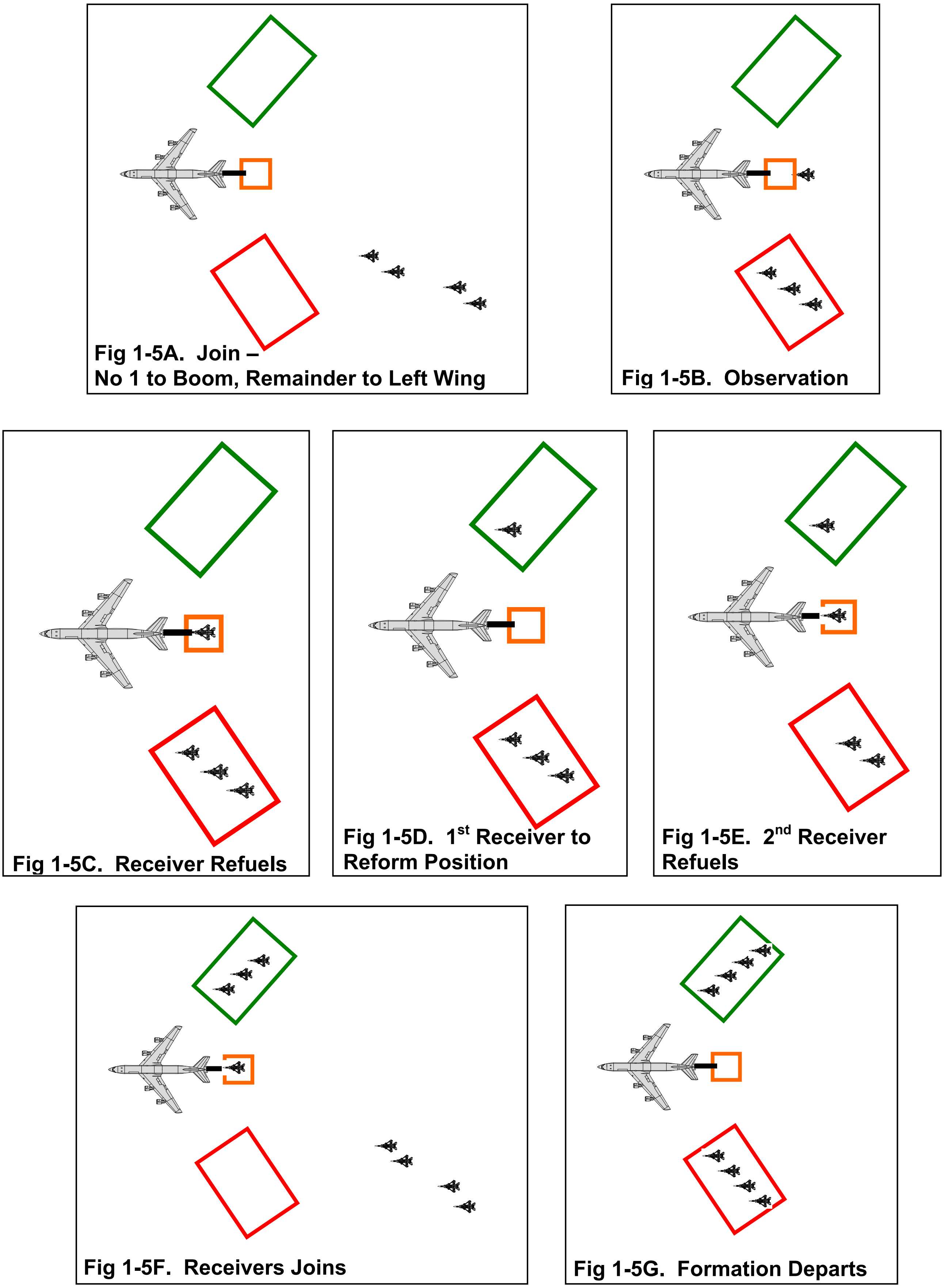


Figure 1-5. Diagram of Receiver Flow Around a Boom Tanker



110 Leaving

a. Boom Fighters and Probe and Drogue Receivers (Fighter and Heavy Aircraft). Once refuelling is complete, receivers will be cleared to the reform position. If there are two or more receivers, they should reform using echelon right formation, moving sequentially outboard of the tanker with the first receiver remaining closest to the tanker's wing. From this position, they leave the tanker either level with the tanker or climbing.

(1) Vertical Separation. Normally, receivers must not descend from a tanker formation unless co-ordinated with an ATC or other controlling unit as other receivers are likely to be joining the tanker from below.

b. Heavy Receivers - Boom. Normally, on completion of AAR, the tanker(s) will climb to the top of the AAR block and the receiver will descend to the bottom of the AAR block. While obtaining the tanker post AAR report, the receiver is to manoeuvre to a position that ensures safe separation from the tanker(s). Thereafter, the tanker is to return to the designated ATC or control frequency.

(1) Receivers Required to Climb. Where receiver(s) are required to accelerate and climb on the refuelling heading, the receiver(s) will manoeuvre either left or right (with minimum of 1 nm separation) of the tanker(s) prior to accelerating and climbing. This will preclude the departing receiver's jet wash from causing injury to personnel on or damage to the remaining tanker(s).

111 Types of RV

a. RV Alpha (Anchor RV). This is a procedure directed by a radar control station, whether ground based, seaborne, or airborne (AEW); details are at Part 2 Annex 1A.

b. RV Bravo. This is a heading based procedure which utilises air-to-air equipment of both tanker and receiver. The tanker controls the procedure; details are at Part 2 Annex 1B.

c. RV Charlie. This is a heading based procedure similar to the RV Bravo which allows receivers with an Airborne Intercept (AI) radar to control the procedure once positive AI radar contact is established; details are at Part 2 Annex 1C.

d. RV Delta (Point Parallel). This procedure requires the receiver to maintain an agreed track and the tanker to maintain the reciprocal track, offset a pre-determined distance; details are at Part 2 Annex 1D.

e. RV Echo (Timing). This procedure is intended for use in support of a combat air patrol (CAP); particularly during periods of EMCON constraints; details are at Part 2 Annex 1E

f. RV Foxtrot (Sequenced). This procedure is normally used when the tanker and receiver operate from the same base; details of the accompanied/buddy climb and tailchase departure are at Part 2 Annex 1F.

g. RV Golf (En-route). This procedure facilitates join up on a common track to make good a scheduled time. The receivers may have departed either from the same or different bases. There are a number of enroute RVs; details are at Part 2 Annex 1G.

112 Equipment Unserviceabilities. In the event of equipment unserviceabilities which prevent the implementation of a RV procedure according to plan, the tanker is to make good the pre-arranged time at the control point and orbit left until a join-up is achieved, or, at the tanker commander's discretion, the attempt to RV is abandoned.

PART 2 - ANNEX 1A

RV Alpha (Anchor RV)

101A Introduction. The RV Alpha (Anchor) procedure is a RV carried out under the control of a radar station on the ground, in the air or on-board ship. The RV Alpha is normally used to vector receivers to tankers operating on an AARA/anchor area but may be used as required in any situation. However, with the agreement of the tanker, the controller may give the tanker alterations of heading to effect a quicker join-up.

102A Procedure. The essential requirement for a RV Alpha is positive control by the radar controller to bring the receiver to an ideal position of 1 nm behind and 1000 ft below the tanker.

a. Track Requirements. The radar controller will either anchor the tanker or provide headings for it to fly.

b. Tanker Responsibilities. The tanker(s) is(are) to:

(1) Fly an anchor orbit unless directed otherwise by the radar controller.

(2) Be at the base AAR altitude.

(3) Normally, fly the turns at either 15 or 25 AOB.

c. Receiver Responsibilities. Receiver(s) are to:

(1) FL/Altitude/Height. When directed by the controlling agency, be established at 1,000 ft below the assigned base air refuelling altitude.

(2) Heading. Fly headings as directed by the controlling agency.

(3) Receiver Takes Control of RV. Complete the RV using organic AI radar once radar contact with the tanker is established and call:

"(Callsign) Judy"

(4) Receiver Visual with Tanker. When visual with the tanker and EMCON procedures permit the use of radios, the receiver calls:

"(Callsign) visual"

and is then cleared by the tanker to join (on the left unless directed otherwise by the tanker).

d. Communication Procedures. Whilst on station, the tanker will monitor the published AAR frequency. When the controlling agency initiates the receiver RV, it will ensure that the receiver(s) confirm their FL/altitude/height, A/A TACAN (channel), Mode 3 and armament state to the tanker.

(1) In EMCON 1, the receiver(s) should not close inside 1 nm until radio contact is established with the tanker.

(2) If either the tanker or receiver(s) is not at its briefed FL/altitude/height an additional radio call is to be made when established at its nominated FL/altitude/height.

(3) During EMCON 2, radio calls will not be made unless they are necessary to ensure safe vertical separation.

e. Vertical Separation. The RV vertical separation is to be maintained until 1nm from the tanker(s) and visual contact is established. The receiver(s) will then commence a gradual climb to the astern (boom) or observation position (drogue). If the tanker(s) is not acquired visually by 1 nm, use the procedures described in Part 2 Chapter 1, para 102d.

f. Navigation Responsibilities During AAR. Unless the controlling agency is vectoring the tanker, navigation is the tanker's responsibility from the astern position (boom) or observation position (drogue) until the receiver(s) depart the tanker. Nevertheless, receivers should monitor their navigation systems to ensure situational awareness.

103A Control. Where a radar station provides advisory information, as distinct from control, one of the other types of RV should be planned. In this case, the information passed by the radar station may be used to supplement the use of airborne aids.

104A Anchor Pattern

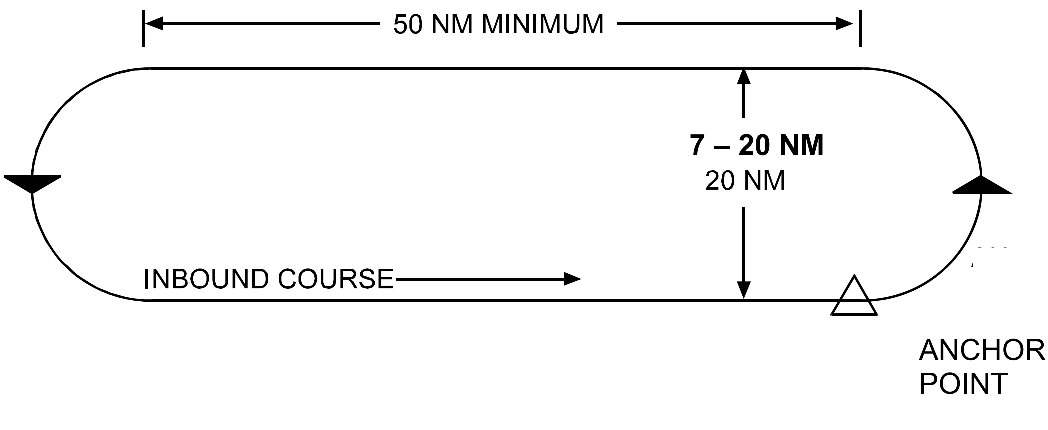
a. The refuelling anchor pattern is a left-hand racetrack with legs separated by as little as 7 nm for smaller, slower tankers such as the KC-130 and as much as 20 nm for larger, faster tankers. The standard leg length for this pattern is 50 nm, as shown in Figure 1A-1.

b. The location of the pattern is determined by the anchor point and the orientation of the inbound course.

c. Single tankers or tanker formations may be used in the anchor. Routinely, single tankers will be separated by 4000 ft; tanker formations will be separated by 4000 ft between the highest aircraft in the lower formation and the lead aircraft of the next higher formation. (The actual vertical separation between tanker formations will be briefed in the SPINS or pre-flight formation brief. Normally, 3000 ft should be considered the minimum for safe vertical separation between multiple tanker formations).

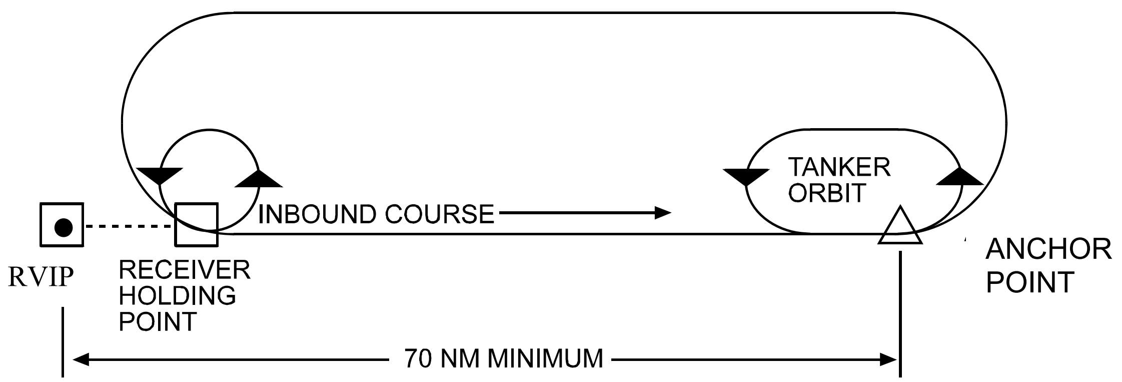
d. Anchor AAR tracks requiring frequent turns should be flown in trail or offset trail (approximately 20° echelon, as described in Part 2 Annex 2A).

Figure 1A-1. Anchor Pattern



105A Alternative Anchor Pattern. In the event that a radar control unit is not available to con trol an anchor RV, an alternative anchor pa ttern is to be flown. This pattern is shown at Figure 1A-2 and the RV procedure is described in Part 2 Annex 1D.

Figure 1A-2. Alternate Anchor Pattern



PART 2 - ANNEX 1B

RV Bravo

101B Introduction. The RV Bravo is a heading based procedure that utilises air to air equipment of both tanker and receiver; it is ideally suited for situations where accuracy of the navigation equipment of the tanker or receiver is in doubt or degraded. It has a further advantage in that it does not require a pre-briefed AAR track. However, for briefed tasks a RVIP, the receiver's inbound track and a RV control time are normally designated. This procedure caters for non-AI radar equipped receivers; it is also suitable for large or battle-damaged receivers, because the tanker performs all turns during the procedure. As this procedure is heading rather than track based, it may not be suited to a busy ATC environment.

102B Procedure

a. Track Requirements. A reciprocal head-on approach without lateral displacement is set up. To give sufficient time to correct any heading error, a minimum initial head-on separation of 100 nm is desirable. See Figure 1B-1.

b. Navigation to the RVIP. For maximum flexibility, the tanker should plan to have time in hand and a timing racetrack should be set up to the left at a convenient position up-track from the ARCP. Both aircraft navigate to make good the RVIP at the RVCT.

c. Receiver and Tanker Airspeeds

(1) The tanker flies at the indicated refuel speed for the receiver. This speed is available in the appropriate National Annex, through the SPINS or arranged between the tanker and receiver on the ground or in the air prior to AAR.

(2) The tanker translates the indicated refuel speed into TAS for the RV altitude (Part 2 Chapter 1, Annex D, Figures 1D-2 and 1D-3), applies it to the appropriate AOB table (Figure 1B-2) and calculates the turn range.

(3) The receiver should normally fly the procedure at the tanker's speed (KIAS) plus 20 kts.

d. Transmission for Direction Finding (DF)

(1) After the RV Initial Call has been made, the tanker crew is to call 'Transmit for DF' or use any other suitable equipment to ascertain relative positions.

(2) The tanker is to control the heading of the receiver to establish it on a reciprocal heading.

Example:

(a) *Tanker and receiver established on heading 090º and 270º respectively.*

(b) *The tanker pilot calls "Transmit for DF' and then establishes that the relative bearing of the receiver is 20º right of the tanker's nose.*

(c) *He then calls for the receiver aircraft to turn 10º right onto 280º and changes his own heading to 100º.*

(3) As the RV progresses, further 10 second carrier wave transmissions are to be requested to refine the head-on approach using the technique described in paras 102B.d (1) and (2).

e. Tanker Turn Range. When the appropriate turn range is reached, see para 102B.c, the tanker is to turn to the left through 225°.

f. Tanker Reversal onto Receiver's Track

(1) On roll-out, the tanker is to take a bearing on the receiver using DF or other suitable equipment, obtain a range using A/A TACAN and start a stop-watch.

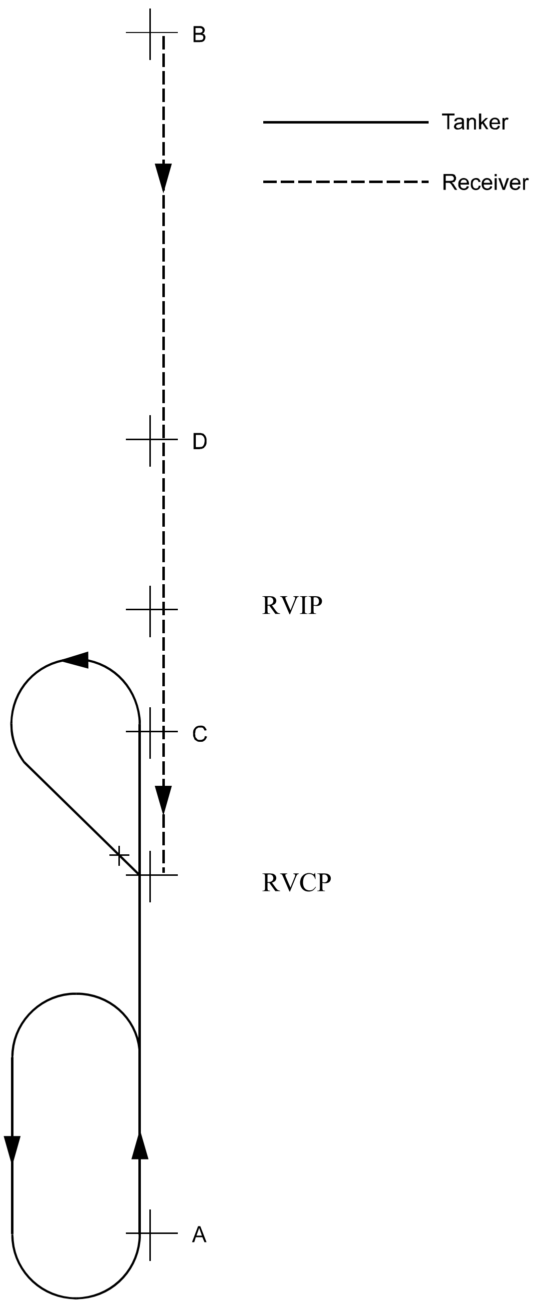
(2) These figures are plotted on the chart at Figure 1B-3 to obtain a time to run to the final turn onto the receiver's heading.

(a) Ideally, the receiver's relative bearing from the tanker should be 285° and adjustments to the tanker/receiver speeds are not required.

(b) However, if the bearing is other than 285°, using Figure 1B-3 the tanker must adjust speed to re-establish the ideal RV geometry.

103B Control. The RV Bravo is to be controlled throughout by the tanker unless, because of equipment unserviceabilities, the tanker makes a positive handover of control to the receiver. Should its equipment be unserviceable, the tanker, without relinquishing control, is to request the receiver to use its own equipment to establish the head-on approach. The receiver is to advise the tanker of all alterations of heading. Range information may be obtained from a ground radar unit.

Figure 1B-1. Diagram of RV Bravo



NOTES:

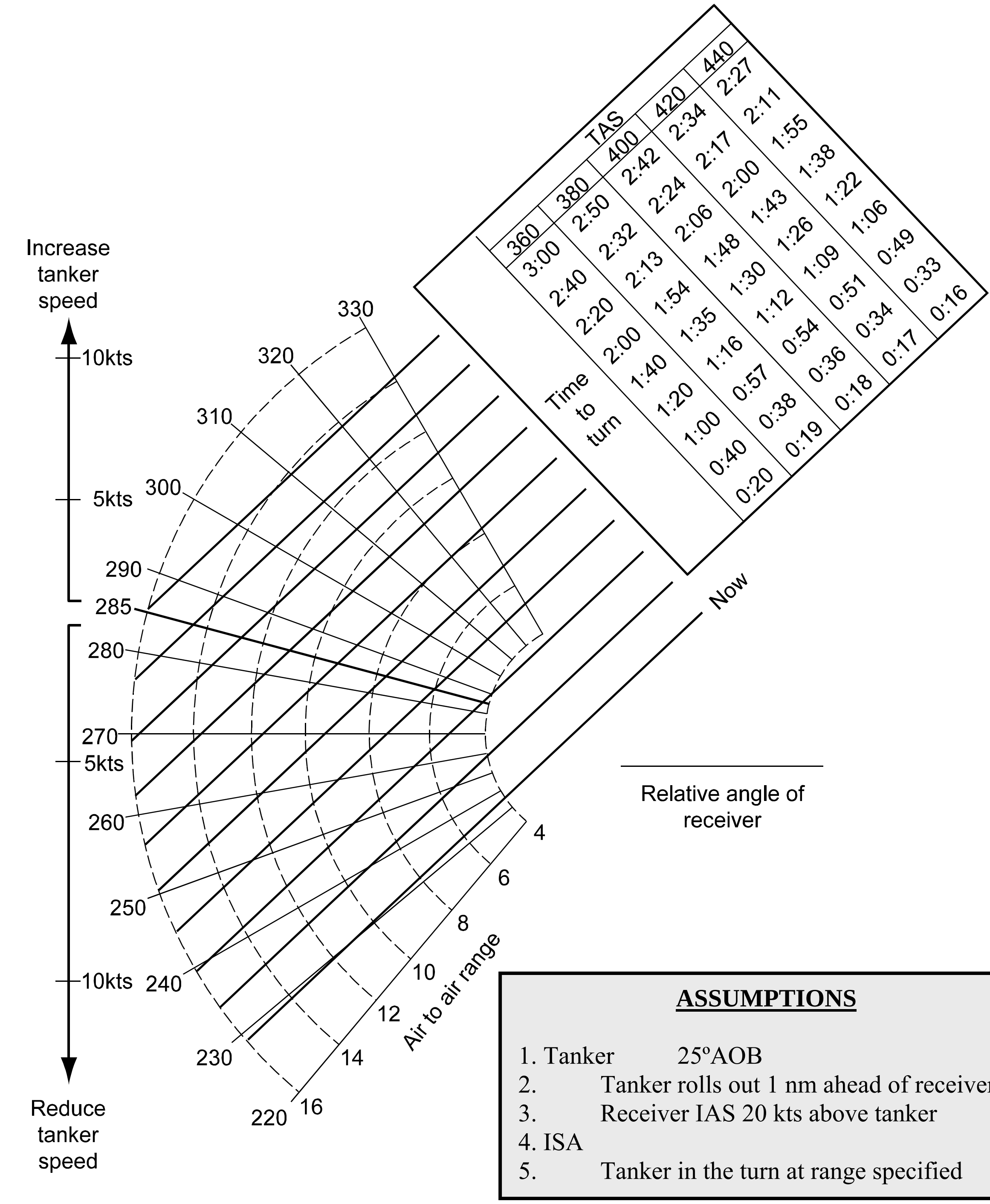
1. **A minimum initial head-on separation of 100 nm (A-B) should be planned.**
2. **C-D = turn range.**
3. **The tanker racetrack is shown in an ideal position but it may be planned elsewhere as required.**

Figure 1B-2. RV Bravo Turn Range

Tanker 25° AOB	
Tanker Speed (TAS)	**Turn Range (NM)**
230	8.4
240	9.0
250	9.6
260	10.3
270	11.0
280	11.7
290	12.4
300	13.2
310	14.0
320	14.8
330	15.6
340	16.5
350	17.3
360	18.2
370	19.2
380	20.1
390	21.1
400	22.1
410	23.1
420	24.2
430	25.2
440	26.3
450	27.5
460	28.6
470	29.8
480	31.0
490	32.2
500	33.4

Tanker 15° AOB	
Tanker Speed (TAS)	**Turn Range (NM)**
180	9.2
190	10.0
200	10.9
210	11.8
220	12.8
230	13.9
240	14.9
250	16.0
260	17.2
270	18.4
280	19.6
290	20.9
300	22.2

<u>Figure 1B-3. RV Bravo Correction Chart</u>



<u>ASSUMPTIONS</u>

1. Tanker 25ºAOB
2. Tanker rolls out 1 nm ahead of receiver
3. Receiver IAS 20 kts above tanker
4. ISA
5. Tanker in the turn at range specified

NOTES:

1. When tanker is on a heading of 45^{o} less than the receivers, obtain relative bearing and A/A TACAN range and start stop-watch.
2. Adjust tanker speed, based on left hand speed scale, if relative bearing is other than 285^{o}.
3. Plot receiver's position on chart and determine tanker's distance/time to the final turn.
4. Tanker turns onto receiver's heading at appropriate distance/time.
5. If A/A Tacan range decreases and then starts to increase again, <u>ignore timing and turn immediately on to receiver's heading</u> then carry out DF to resolve relative position.

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PART 2 - ANNEX 1C

RV Charlie

101C Introduction. The RV Charlie is a heading based procedure (similar to the RV Bravo) that allows receivers with an AI radar to control the RV once positive AI radar contact is established. It is thus ideally suited when accuracy of tanker navigation equipment is in doubt or degraded. It does not require a pre-briefed AAR track. However, for briefed tasks a RVIP, the receiver's inbound track and a RVCT are designated. It requires the receiver to use an AI radar to complete the RV. As this procedure is heading rather than track based, it may not be suited to a busy ATC environment.

102C Procedure

a. Track Requirements. A reciprocal head-on approach with no lateral displacement is set up. To give sufficient time to correct any heading error, a minimum initial head-on separation of 100 nm is desirable; see Figure 1C-1.

b. Navigation to the RVIP. For maximum flexibility, the tanker should plan to have time in hand; a left hand timing racetrack may be set up at a convenient position up-track from the RVIP, if required. Both aircraft navigate to make good the RVIP at the RVCT.

c. Receiver and Tanker Airspeeds

(1) The tanker flies at the indicated refuel speed for the receiver. This speed is available in the appropriate National Annex, through the SPINS or arranged between the tanker and receiver on the ground or in the air prior to AAR.

(2) The tanker translates the indicated refuel speed into TAS for the RV altitude (Part 2 Chapter 1, Annex D, Figures 1D-2 and 1D-3), applies it to the appropriate AOB table (Figure 1C-2) and calculates the turn range dependent on drift.

(3) The receiver should normally fly the procedure at the tanker's speed (KIAS) plus 20 kts.

d. Transmission for Direction Finding (DF)

(1) After the RV Initial Call has been made, the pilot in control is to call 'Transmit for DF' or use any other suitable equipment to ascertain relative positions.

(2) The controlling aircraft is to establish the other aircraft on a reciprocal heading.

Example:

(a) *Tanker and receiver established on heading 360º and 180º respectively.*

(b) *The pilot in control calls "Transmit for DF' and then establishes that the relative bearing of the tanker is 20º left of the receiver's nose.*

(c) *He then calls for the tanker to turn 10º left onto 350º and changes his own heading to 170º.*

(3) As the RV progresses, further 10 second carrier wave transmissions are to be requested to refine the head-on approach using the technique described in paras 102C.d(1) and (2).

(4) Separation between aircraft is to be measured using A/A TACAN or AI equipment.

(5) The turn range must be passed to and acknowledged by the receiver.

e. Tanker and Receiver Turn Range

(1) When the turn range is reached, see Figure 1C-2, the tanker is to turn left through 180^{o} and the receiver(s) is to turn right 45^{o} using 45^{o} AOB and roll out wings level.

(2) When required, the receiver(s) is to commence a left turn to roll-out onto the tanker's heading.

(3) If visual at anytime during the RV, the receiver(s) is to adjust flight path as necessary to expedite the RV.

103C Control

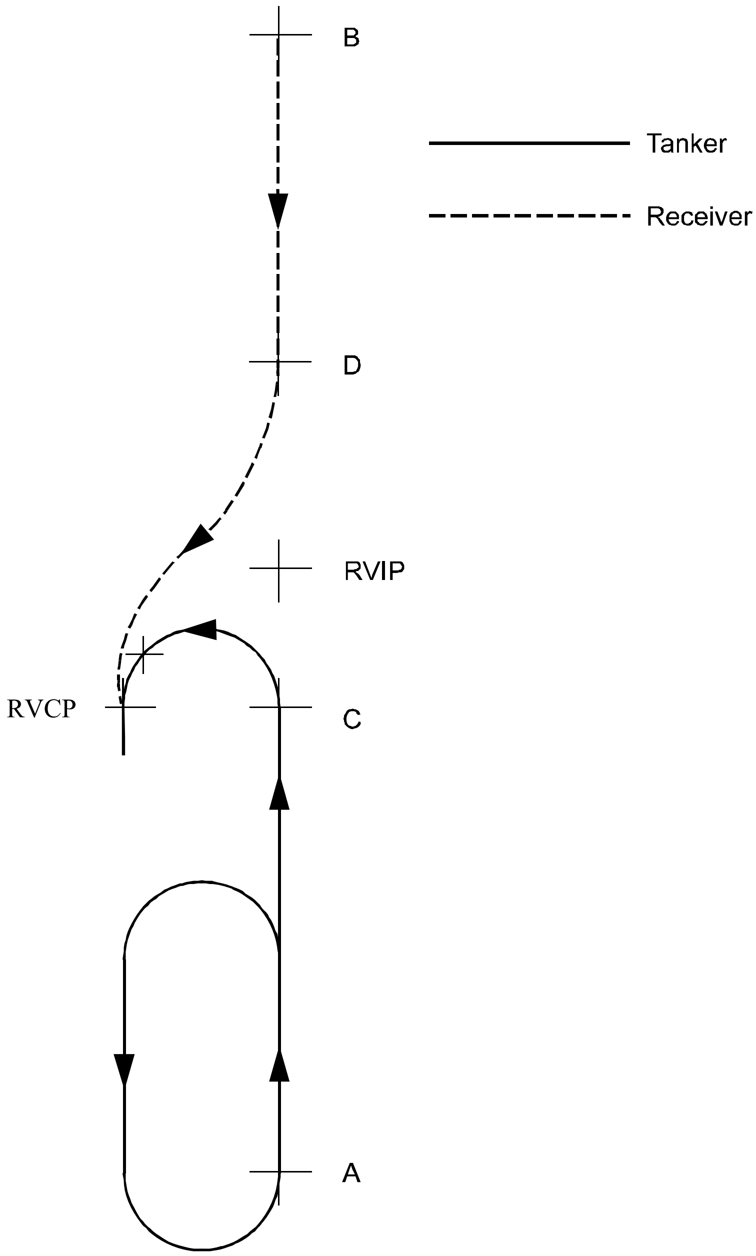
a. Initial Control. The initial control of RV Charlie (achieving and maintaining the head-on approach) is usually accomplished by the tanker.

b. Receiver Control. When the receiver has closed to effective AI range and is able to complete the procedure unassisted, the receiver is to call 'Judy' and then take control. On occasions it may be more appropriate for suitably equipped receivers to control the procedure throughout; however, it is important to establish clearly which aircraft is in control. Therefore, as a standard procedure, the tanker controls the RV, unless management for the whole RV is positively handed to the receiver.

c. Turn to ARCP. Each aircraft is to turn towards the RVCP at the turn range.

d. Failure to Achieve AI Contact. In the event of the receiver not gaining AI contact, this procedure can revert to an RV Bravo (Part 2 Chapter 1, Annex B) as long as there is adequate split range.

Figure 1C-1. Diagram of RV Charlie



NOTES:

1. **A minimum initial head-on separation of 100 nm (A-B) should be planned.**
2. **C-D = turn range.**
3. **The tanker racetrack is shown in an ideal position but it may be planned elsewhere as required.**

Figure 1C-2. RV Charlie Turn Range

TANKER 25° AOB RECEIVER 45° AOB	
TANKER SPEED (TAS)	**TURN RANGE (NM)**
230	5.4
240	5.8
250	6.2
260	6.6
270	7.0
280	7.4
290	7.9
300	8.3
310	8.8
320	9.3
330	9.8
340	10.3
350	10.9
360	11.4
370	12.0
380	12.5
390	13.1
400	13.7
410	14.4
420	15.0
430	15.6
440	16.2
450	16.9
460	17.6
470	18.3
480	19.0
490	19.7
500	20.5

TANKER 15° AOB RECEIVER 45° AOB	
TANKER SPEED (TAS)	**TURN RANGE (NM)**
180	6.0
190	6.5
200	7.0
210	7.6
220	8.2
230	8.8
240	9.5
250	10.2
260	10.9
270	11.6
280	12.4
290	13.2
300	14.0

PART 2 - ANNEX 1D

RV Delta (Point Parallel)

101D Introduction. The RV Delta (Point Parallel) procedure requires the receiver to maintain an agreed track and the tanker to maintain the reciprocal track, offset a pre-determined distance; see Figure 1D-1.

102D Procedure

a. Track Requirements. A common track of at least 70 nm is usually the minimum requirement for the RV and consists of a straight line between the RVIP and the RVCP.

b. Receiver and Tanker Airspeeds. Two methods exist to determine when the tanker initiates its final turn onto the receiver's heading.

(1) Option 1 - Tanker Airspeed Known to Receiver

(a) RV Speed - Tanker. The tanker flies at the indicated refuel speed for the receiver. This speed is available in the appropriate National Annex, through SPINS or pre-arranged between the tanker and receiver on the ground or in the air prior to AAR.

(b) Turn Range. The tanker translates the indicated refuel speed into TAS (Figure 1D-2 or Figure 1D-3), applies it to the appropriate AOB table (Figure 1D-4 or Figure 1D-5) and calculates the turn range dependent on drift.

(c) RV Speed – Receiver. The receiver should normally fly the procedure at the tanker's speed (KIAS) plus 20 kts.

(d) Turn Range and Offset Calculation. The worksheet at Figure 1D-6 provides a step by step approach to calculating the tanker turn range and offset.

(e) Receiver Roll Out Range. The data in Figure 1D-4 or Figure 1D-5 should result in the tanker rolling out with the receiver 1 nm behind the tanker.

(2) Option 2 - Receiver Airspeed Known to Tanker (Normal USAF Procedure)

(a) RV Speed – Receiver. The tanker extracts the receiver indicated RV speed from the appropriate National Annex, SPINS or as pre-arranged between the tanker and receiver on the ground or in the air prior to AAR.

(b) RV Closure Speed. The tanker translates the receiver's indicated refuel speed into TAS using the table at Figure 1D-2 or Figure 1D-3 and adds it to the tanker's TAS to calculate the RV closure speed.

(c) Turn Range. Entering the appropriate table in Figures 1D-7 or Figure 1D-9 with the RV closure speed will provide the tanker's turn range, dependent on AOB.

(d) Anchor Offset. The anchor offset, corrected for drift and tanker TAS is derived from Figure 1D-8 or Figure 1D-10, dependent on AOB.

(e) Back-Up Turn Time. Figure 1D-12 provides a backup time to turn based on a known hack range and closure speed.

(f) Turn Range and Offset Calculation. The worksheet at Figure 1D-13 provides a step by step approach to calculating the tanker turn range and offset.

(g) Receiver Roll Out Range. The data in Figure 1D-7 or Figure 1D-8 will result in the tanker rolling out with the receiver behind the tanker at 3 nm, ½ nm or 1 nm in front of the tanker, depending on the receiver AAR speed.

(h) Turn Range/Offset Correction - 3 NM Rollout. During an RV Delta execution, if the actual offset differs from that derived using the instructions in para 102D (2) (f), use Figure 1D-11 to calculate the corrected turn/offset parameters. Using the calculated turn range and offset pairing, enter the chart at column A. Move horizontally through columns B to G to find the actual offset. At the intersection of these variables, identify the revised turn range that will result in a 3 nm RV Delta tanker/receiver rollout.

***Example 1*:** *VC10 tanker at FL 230, Tornado F3 receiver at FL220, OAT at tanker altitude minus 35ºC with 15º right drift on the RVIP to RVCP leg.*

Tanker RV Speed. From UK National Annex VC10 tanker speed = 280 KIAS

Receiver RV Speed. Receiver flies tanker KIAS + 20 kts.

Using the above data and referencing the Figures identified in Column C of Figure 1D-6, the appropriate interpolated values extracted from the tables will provide both the anchor offset and tanker turn range.

A	B	C	D	E
	PARAMETER	**REFERENCE**	**TANKER**	**RECEIVER**
1	ALTITUDE	FL230		FL220
2	TANKER RV IAS	TANKER NATIONAL ANNEX	280	
3	RECEIVER RV IAS (=TANKER IAS +20 KTS)	300		
4	TANKER RV TAS	FIG 1D-2 or 3	386	
5	ACTUAL TEMP	-35		
6	STD TEMP	FIG 1D-2	-31	
7	**ACTUAL – STD (Row 4 – Row 5)** (<**STD** = REDUCE BY 1 kt / ºC) (>**STD** = INCREASE BY 1 kt / ºC)		- **4** +	
8	**CORRECTED TAS (Row 3±Row 6)**		382	
9	RVIP TO RVCP DRIFT		**15 ~~L~~/R**	
10	TURN RANGE	FIG 1D-4 ~~or 5~~	23.0	
11	OFFSET	FIG 1D-4 ~~or 5~~	13.4	

Example 2: *KC-10 Tanker at FL 230, F-16A receiver at FL220, OAT at tanker altitude minus 28ºC with 10º left drift on the RVIP to RVCP leg.*

Tanker RV Speed. KC-10 tanker speed (varies with aircraft weight) = 275 KIAS.

Receiver RV Speed. Figure ZE-4 to Annex ZE provides receiver RV speed of 345 KIAS.

Using the above data and referencing the Figures identified in Column C of Figure 1D-13, the appropriate interpolated values extracted from the tables will provide both the anchor offset and tanker turn range.

Using a few fixed range points and the closure TAS, a backup time to turn can be calculated. These times are extracted from Figure1D-12.

A	B	C	D	E	F
	PARAMETER	REFERENCE	TANKER		RECEIVER
1	ALTITUDE		FL230		FL220
2	RV IAS	TANKER NATIONAL ANNEX	275 345		
3	RV TAS	FIG 1D-2 or 3	380		467
4	ACTUAL TEMP	-28			
5	STD TEMP	FIG 1D-2		-31	
6	**ACTUAL – STD (Row 4 – Row 5)** (<**STD** = REDUCE BY 1 kt / ºC) (>**STD** = INCREASE BY 1 kt / ºC)			**-** + **3**	
7	**CORRECTED TAS (Row 3±Row 6)**		383		470
8	**CLOSURE TAS (RCVR + TNKR)**		853		
9	RVIP TO RVCP DRIFT	DERIVED FROM TANKER NAV SYSTEM		10 **L/~~R~~**	
10	TURN RANGE	FIG 1D-7 ~~or 9~~		21.2	
11	OFFSET	FIG 1D-8 ~~or 10~~		7	
12	50 MN TIMING BACKUP	FIG 1D-12		1:47	
13	30 NM TIMING BACKUP	FIG 1D-12		0:23	

c. Tanker Responsibilities. The tanker(s) is(are):

(1) Responsible for directing the rendezvous.

(2) To be at the base AAR altitude.

(3) May enter the refuelling holding orbit from any direction.

(4) To attempt to arrive at least 15 min before the RVCT and, normally, establish a left-hand holding pattern using the RVCP as an anchor point.

(5) Normally, to fly the straight legs for 2 min duration and fly the turns at either 15º or 25ºAOB.

d. Receiver Responsibilities. Receiver(s) will:

(1) Be established at 1000 ft below the assigned base AAR altitude when departing the RVIP.

(2) Enter the track via the RVIP and should aim to be at the RVCP at the RVCT (see Figure 1D-1).

(3) Depart from the RVIP and not deviate from the RVIP/RVCP centreline unless directed to do so by the tanker.

(4) Aid the RV, when so equipped, by remaining in electronic contact on radar, A/A TACAN, TCAS or other means as soon as possible, but no later than 50 nm range or the RVIP, whichever occurs first, until reaching the observation position (drogue) or astern position (boom).

e. Communication Procedures. Fifteen minutes prior to the RVCT the tanker and the receiver(s) are to confirm their FL/altitude/height, A/A TACAN (channel), Mode 3, armament state and timing. The receiver(s) should fly down track towards the RVCP with A/A TACAN and radar beacon on (if appropriate) at 1000 ft below the base AAR altitude.

(1) If radio contact between the tanker and receiver has not been established prior to the RVCT, the tanker will maintain orbit over the RVCP until 10 min after the RVCT, unless otherwise briefed.

(2) If either the tanker or receiver(s) is not at its briefed FL/altitude/height an additional radio call is to be made when established at its nominated FL/altitude/height.

(3) The tanker must not initiate the turn in front of the receiver(s) until the receivers confirm that they are level at their assigned FL/altitude/height.

(4) During EMCON 2, radio calls will not be made during the RV unless they are necessary to ensure safe vertical separation. However, an astern RT call is required to ensure two way contact between the tanker and receiver(s).

f. Initiation of RV by Tanker. The tanker will fly the outbound leg at the appropriate offset from the common track in a holding pattern, see Figures 1D-4, 1D-5, 1D-7 and 1D-8 as appropriate, until it is determined by A/A TACAN, AI equipment, radar beacon (if equipped) or radio call that the receiver(s) are at the RVIP. At that point, the tanker will either extend the outbound leg or, if inbound to the RVCP, turn to the reciprocal of the receiver's in-bound track to close with the receiver.

g. Initiation of Tanker's Final Turn. At the appropriate turn range (slant range), the tanker initiates a turn to return to the RVIP - RVCP track, inbound to the RVCP. If applicable, in EMCON 1, after turning through 90° the tanker is to call 'halfway round the turn'. This is the best time to determine if an overrun condition exists and the best time for visual acquisition. If an overrun condition exists, carry out the appropriate actions as described in Part 2 Chapter1, para 104.

h. Vertical Separation. The RV vertical separation is to be maintained until 1 nm of the tanker and visual contact is established. The receiver(s) will then commence a gradual climb to the astern (boom) or observation position (drogue).

i. Tanker/Receiver Rollout Range. At completion of the turn, receivers are normally 3 nm (US procedures) or 1 nm (other nations) in trail of the tanker(s).

j. Tanker Speed Adjustment. Tankers adjust to refuelling air speed when rolled out toward the RVCP.

k. Navigation Responsibilities During AAR. Navigation responsibility from the astern position (boom) or observation position (drogue) until the receiver(s) depart the tanker is primarily with the tanker, with receivers monitoring their navigation system to ensure situational awareness.

NOTE

Radio silence must be broken if the tanker or receiver determines that either the tanker or receiver will exceed ATC protected airspace while manoeuvring to attain the offset.

l. Late Arrival of Receivers. In the event that the receiver(s) is(are) delayed, the tanker is to normally maintains a left-hand holding orbit over the RVCP until 10 min after the RVCT, unless otherwise briefed.

m. RV with Correct Receiver. Tankers must ensure that they do not attempt to RV with the wrong receiver. Comparing the A/A TACAN DME and the TCAS target distance is an effective method of establishing positive identification. Additionally, to aid the receiver in identifying the tanker, if the tanker does not receive a communication from the receiver by RVCT minus 10 min, the tanker will transmit in the blind giving the information normally given during the RV. The tanker will cross the RVCP at the RVCT and at subsequent intervals of 8 min thereafter until the receiver has cancelled or the tanker must depart or is directed to proceed on its mission.

n. Missed RV Procedures. If contact is not established between the tanker and receiver, the tanker will arrive at the RVCP at the RVCT. When either aircraft arrives at the RVCP and does not have visual contact with the other, the aircraft will cross the RVCP at the appropriate altitude at the RVCT and at subsequent intervals of 8 min thereafter. While in the orbit, every attempt should be made to establish visual contact with the other aircraft. The length of the delay and the decision as to when to terminate radio silence should be determined during mission planning prior to flight.

103D Overtake RV Delta (Point Parallel). This procedure assumes that the tanker's normal cruising height and speed are higher than that of the receiver. It is similar to the RV Delta (Point Parallel) except the tanker plans to roll out 1 nm behind the receiver(s), see Figure 1D-7.

a. RVCP – Receiver. The receiver(s) plans to arrive at the RVCP on time, at the base altitude minus 1000 ft.

b. RVCP-Tanker. The tanker arrives at the RVCP one minute after the receiver at the base altitude.

c. Overtake - Tanker. The tanker then overtakes above the receiver(s) at the base altitude and slows down to position 1 nm in front of the receiver(s) at the refuelling speed.

d. Climb - Receiver. Once visual with the tanker, the receiver(s) climb(s) to the tanker's base altitude.

e. RV Control. The tanker maintains control of the overtake RV Delta (Point Parallel) throughout.

f. RT Call – Receiver. The receiver(s) must ensure that correct track, FL/altitude/height and speed are flown and, during EMCON 1, the tanker is to call 'turn' at the turn range.

g. EMCON 3. It is possible to fly this procedure in EMCON 3 but aircraft must be at the correct FL/altitude/height.

104D Modified RV Delta (Point Parallel) (EC-135, E-3, E-4, C-130). A modified point parallel RV is a procedure used to accomplish an RV with an EC-135/E-4 aircraft in a Post-Attack Command and Control System (PACCS) orbit, an E-3 on AWACS patrol, or a C-130 in a special on-station orbit; see Figure 1D-6. The following procedures will be used:

a. RVIP. The RVIP will be located at one of the turn points.

b. RVCP. The RVCP will be located at the turn point on the opposite direction track.

c. Descent – Receiver. If receiver requirements prevent early descent to RV altitude, the receiver may descend after passing the RVIP; however, the receiver must not descend until radio contact is established with the tanker and safe lateral separation is confirmed.

d. Orbit – Receiver. The receiver will establish a right-hand orbit 1000 ft below AAR altitude prior to the tanker's entry into the orbit area.

e. Orbit – Tanker. The tanker will be at refuelling altitude upon entering the orbit area and will establish a standard RV Delta (point parallel) orbit at the RVCP.

f. Departing RVIP – Receiver. The receiver will call departing the RVIP. The receiver will increase airspeed to closure airspeed during the last half of the turn toward the tanker. After the receiver rolls out from the turn toward the tanker, normal RV Delta (point parallel) procedures will be used.

g. Departing RVIP – Tanker. The tanker in the RVCP orbit will turn toward (if flying away from) or continue toward the RVCP when the receiver calls departing the RVIP.

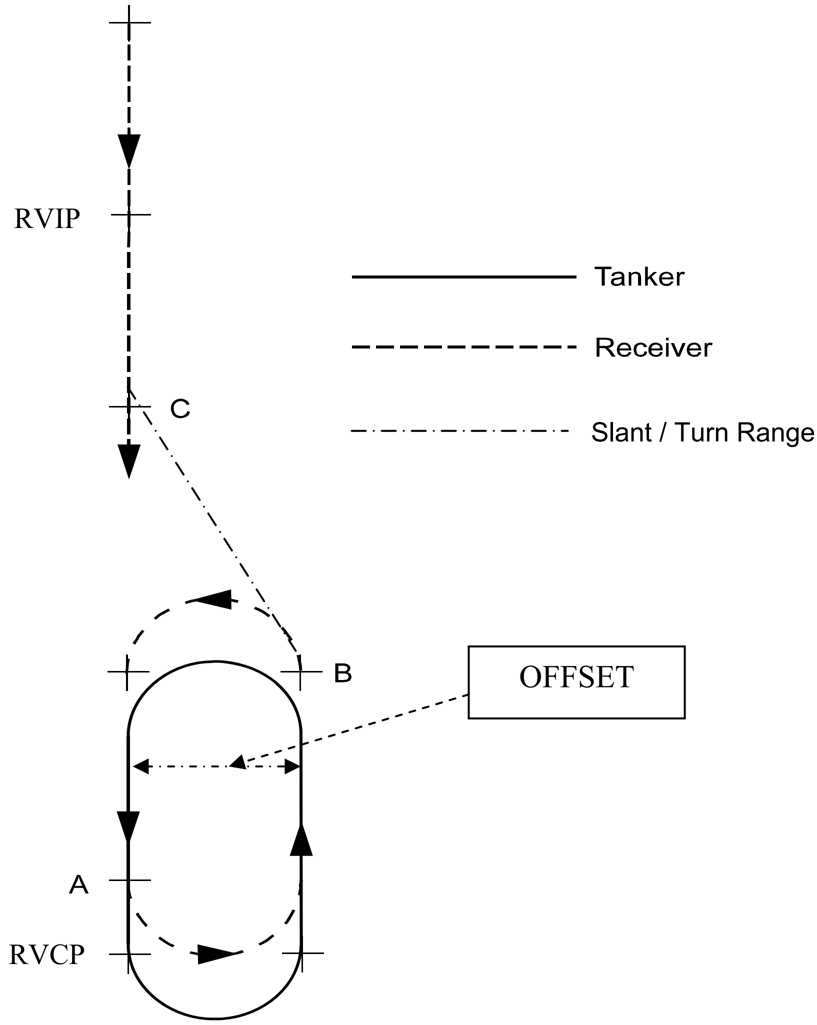
h. Turn Towards Receiver – Tanker. Two minutes after the receiver's RVIP call, the tanker will turn toward the receiver.

i. Final Turn – Tanker. At the appropriate turn range (Figures 1D-3, 1D-6 and 1D-7) the tanker will turn inbound to the RVCP and adjust to appropriate air refuelling speed (Refer to tanker's National Annex) when rolled out toward the RVCP.

j. Post RV Actions. Closure and contact will be normal after the RV. The refuelling track will follow the PACCS/ AWACS/Special Orbit Pattern, remaining within published/briefed orbit boundaries, using no more than 15º AOB during turns.

k. Departure – Tanker. Upon completion of refuelling, or when cleared by the receiver, the tanker will depart the area and the receiver will climb to assume normal on-station orbit.

Figure 1D-1. Diagram of RV Delta (Point Parallel)



NOTES:

1. The minimum distance between the RVIP and the RVCP should be 70 nm.
2. At the RVIP the receiver(s) call 'RVIP' and establish 1000 ft below the base altitude. If necessary, at the same time the tanker (A) turns on to the reciprocal of the receiver(s) inbound track and maintains the computed offset.
3. At the turn range (B-C), the tanker turns onto the receiver(s) inbound track.

Figure 1D-2. KCAS to TAS Conversion

TRUE AIRSPEED TABLE

PRESSURE ALTITUDE 1000 FT	STD DAY TEMP	KCAS 200	220	240	250	255	265	275	280	285	290	295
6	+3	215	238	259	272	277	288	299	304	309	314	319
8	-1	222	245	266	279	285	296	307	312	318	323	329
10	-3	230	253	274	287	293	304	315	321	327	332	338
12	-7	237	261	282	296	302	313	324	330	336	341	347
13	-11	240	264	286	300	306	318	329	335	341	346	352
14	-13	244	269	291	305	312	324	335	341	347	352	358
15	-15	248	273	295	310	317	329	340	347	353	358	364
16	-17	254	279	301	316	322	334	345	352	358	363	369
17	-19	258	283	305	319	327	339	350	357	363	368	374
18	-21	262	287	310	324	332	344	355	362	368	373	379
19	-23	266	293	316	330	336	349	361	367	373	378	384
20	-25	269	296	320	334	340	353	366	373	379	384	390
21	-27	273	300	324	338	345	359	372	378	385	391	398
22	-29	276	304	328	342	349	363	376	383	390	396	403
23	-31	280	310	335	349	354	367	380	386	393	400	406
24	-33	284	314	340	354	360	374	388	394	401	407	413
25	-35	289	319	346	361	368	382	396	402	409	415	422
26	-37	294	324	352	366	374	387	402	408	415	422	429
27	-38	301	332	360	374	381	395	410	417	424	431	438
28	-40	307	338	365	380	388	401	415	423	431	438	445
29	-42	313	344	373	388	396	408	423	431	439	446	452
30	-44	318	350	378	395	402	416	430	437	444	451	459
32	-48	330	362	392	407	415	429	443	452	460	469	476
34	-52	342	374	405	419	426	442	456	464	472	481	488
36	-56	352	384	418	432	442	458	472	478	485	494	502

PRESSURE ALTITUDE 1000 FT	STD DAY TEMP	KCAS 300	305	310	315	320	325	330	335	340	350	
6	+3	325	331	336	342	348	354	360	366	372	381	
8	-1	335	340	346	352	358	364	370	376	382	391	
10	-3	344	349	355	361	367	373	379	385	391	400	
12	-7	353	358	364	370	376	382	388	394	400	409	
13	-11	358	363	369	375	381	387	393	399	404	414	
14	-13	364	369	375	381	387	393	399	405	410	420	
15	-15	370	375	381	387	393	399	405	411	416	426	
16	-17	375	381	387	393	399	405	411	417	422	432	
17	-19	380	386	392	398	404	410	416	422	428	438	
18	-21	385	391	397	403	409	415	421	427	434	444	
19	-23	390	397	403	409	416	422	428	434	440	451	
20	-25	396	403	409	415	422	428	434	440	446	458	
21	-27	405	411	417	423	429	435	442	449	455	466	
22	-29	410	417	423	430	437	442	449	456	462	473	
23	-31	412	419	426	432	439	445	452	459	466	480	
24	-33	419	426	433	439	446	453	461	469	476	489	
25	-35	428	435	442	449	455	461	468	473	480	493	
26	-37	435	442	449	456	462	468	475	482	488	502	
27	-38	444	451	458	464	470	477	484	490	496	510	
28	-40	452	459	466	473	479	486	493	499	505	518	
29	-42	459	466	473	481	487	494	501	508	515	528	
30	-44	466	473	480	487	494	501	508	515	523	536	
32	-48	484	490	497	504	510	517	525	533	541	554	
34	-52	496	503	510	517	523	530	537	545	553	567	
36	-56	509	517	524	532	539	547	555	563	570	584	

NOTES:
1. **For each °C below std day temp subtract 1 knot from std day TAS**
2. **For each °C above std day temp add 1 knot to std day TAS**

Figure 1D-3. KIAS to TAS Conversion

TRUE AIRSPEED TABLE

PRESSURE ALTITUDE 1000 FT	KIAS												
	200	210	225	235	245	250	255	260	270	275	280	285	290
3	212	222	238	249	259	265	269	275	286	291	297	302	307
6	214	224	240	251	261	268	272	278	289	294	298	305	310
9	223	235	251	263	274	279	285	290	302	307	313	318	324
10	227	238	255	267	278	283	289	295	307	312	317	322	328
12	234	245	263	275	286	292	298	303	315	321	327	332	338
14	241	253	271	283	295	301	307	313	325	330	336	342	348
16	249	261	280	292	304	310	316	322	335	341	347	352	359
18	257	269	288	301	314	320	326	332	346	351	357	363	370
20	265	278	298	311	324	330	336	343	356	362	367	374	381
21	270	283	303	316	329	335	342	348	361	367	374	379	387
22	274	288	308	321	334	341	347	355	367	374	380	386	393
23	279	292	313	326	339	347	354	360	372	379	385	392	399
24	283	297	318	332	345	353	359	365	379	384	391	397	404
25	288	302	324	338	351	358	364	371	385	390	397	404	411
26	293	307	329	343	357	363	371	377	390	397	404	410	417
27	298	312	334	348	363	370	376	384	397	404	410	417	424
28	303	318	340	354	369	376	382	390	404	410	417	424	431
29	308	323	345	360	375	385	389	396	411	416	424	431	437
30	313	329	351	366	381	388	395	403	416	424	431	437	445
31	319	335	357	372	387	395	402	410	424	431	437	444	453
32	325	340	364	379	394	401	409	416	431	437	445	452	459
33	331	346	370	385	401	408	416	424	438	445	452	460	466
34	336	352	376	392	407	415	423	431	445	452	460	466	474
35	342	358	382	398	414	422	430	438	454	460	467	474	481

PRESSURE ALTITUDE 1000 FT	KIAS												
	300	305	310	315	320	325	330	335	340	345	350	355	360
3	318	323	328	334	339	344	350	355	360	366	371	376	381
6	321	326	331	337	342	347	352	358	364	369	374	379	385
9	335	340	346	351	357	362	368	373	379	385	390	395	401
10	340	345	351	356	362	367	373	378	384	390	395	401	406
12	349	355	361	367	372	378	384	390	395	400	406	412	418
14	360	366	372	377	383	389	395	401	407	412	418	424	430
16	371	372	383	389	395	401	407	412	418	424	430	436	442
18	382	388	394	400	407	413	419	425	431	437	443	449	455
20	394	400	406	412	419	425	431	437	444	450	456	462	469
21	400	406	413	418	425	431	438	444	450	456	463	469	475
22	406	413	419	425	432	438	445	452	457	463	470	476	483
23	411	417	425	431	437	444	451	457	464	470	477	483	490
24	417	424	431	437	444	451	458	464	471	477	484	490	497
25	424	431	437	444	450	458	465	472	478	485	491	497	504
26	431	437	444	450	458	465	472	479	486	492	499	505	512
27	437	445	451	459	466	472	479	486	493	500	506	513	520
28	445	452	459	466	474	480	487	494	501	507	514	521	528
29	452	459	466	474	482	488	494	501	508	515	522	529	536
30	459	466	474	482	490	496	502	509	516	523	530	537	544
31	466	474	481	489	497	503	510	517	524	531	538	545	552
32	474	481	489	496	504	511	518	525	532	539	546	553	560
33	481	489	496	504	512	519	526	533	540	547	554	561	568
34	489	497	504	512	520	527	534	541	549	556	563	570	577
35	497	504	512	521	529	535	542	550	558	564	571	578	585

Figure 1D-4. RV Delta (Point Parallel) Turn Range and Offset

Tanker 25^{o} AOB

Tanker Turn Range to Achieve a One NM Rollout of Receiver Behind Tanker														
Offset (nm)							25° AOB	Turn Range (nm)						
Drift on IP to CP Leg (°)							Tanker TAS	Drift on IP to CP Leg (°)						
15L	10L	5L	0	5R	10R	15R		15L	10L	5L	0	5R	10R	15R
2.0	2.5	2.9	3.3	3.8	4.3	4.8	230	6.1	6.5	7.0	7.5	8.0	8.5	9.0
2.2	2.7	3.1	3.6	4.1	4.7	5.3	240	6.5	7.0	7.5	8.0	8.6	9.1	9.7
2.4	**2.9**	**3.4**	**3.9**	**4.5**	**5.1**	**5.7**	**250**	**7.0**	**7.5**	**8.1**	**8.6**	**9.2**	**9.8**	**10.5**
2.6	3.1	3.7	4.3	4.9	5.5	6.2	260	7.5	8.0	8.6	9.2	9.9	10.5	11.2
2.8	3.4	4.0	4.6	5.2	5.9	6.7	270	8.0	8.6	9.2	9.9	10.6	11.3	12.0
3.0	3.6	4.3	4.9	5.6	6.4	7.2	280	8.5	9.1	9.8	10.5	11.3	12.0	12.9
3.3	3.9	4.6	5.3	6.0	6.8	7.7	290	9.0	9.7	10.4	11.2	12.0	12.8	13.7
3.5	**4.2**	**4.9**	**5.7**	**6.5**	**7.3**	**8.2**	**300**	**9.6**	**10.3**	**11.1**	**11.9**	**12.8**	**13.7**	**14.6**
3.7	4.5	5.2	6.0	6.9	7.8	8.8	310	10.1	10.9	11.8	12.6	13.6	14.5	15.5
4.0	4.8	5.6	6.4	7.3	8.3	9.4	320	10.7	11.6	12.5	13.4	14.4	15.4	16.5
4.2	5.1	5.9	6.7	7.8	8.9	10.0	330	11.3	12.2	13.2	14.2	15.2	16.3	17.4
4.5	5.4	6.3	7.3	8.3	9.4	10.6	340	11.9	12.9	13.9	15.0	16.1	17.2	18.4
4.7	**5.7**	**6.7**	**7.7**	**8.8**	**10.0**	**11.2**	**350**	**12.6**	**13.6**	**14.7**	**15.8**	**17.0**	**18.2**	**19.5**
5.0	6.0	7.1	8.1	9.3	10.5	11.9	360	13.2	14.3	15.5	16.6	17.9	19.2	20.5
5.3	6.4	7.5	8.6	9.8	11.1	12.5	370	13.9	15.1	16.3	17.5	18.8	20.2	21.6
5.6	6.7	7.9	9.1	10.4	11.7	13.2	380	14.6	15.8	17.1	18.4	19.8	21.2	22.8
5.9	7.1	8.3	9.6	10.9	12.4	13.9	390	15.3	16.6	17.9	19.3	20.8	22.3	23.9
6.2	**7.4**	**8.7**	**10.1**	**11.5**	**13.0**	**14.7**	**400**	**16.1**	**17.4**	**18.8**	**20.3**	**21.8**	**23.4**	**25.1**
6.5	7.8	9.2	10.6	12.1	13.7	15.4	410	16.8	18.2	19.7	21.2	22.8	24.5	26.3
6.8	8.2	9.6	11.1	12.7	14.3	16.2	420	17.6	19.1	20.6	22.2	23.9	25.7	27.5
7.2	8.6	10.1	11.6	13.3	15.0	16.9	430	18.4	19.9	21.5	23.2	25.0	26.8	28.8
7.5	9.0	10.5	12.2	13.9	15.7	17.7	440	19.2	20.8	22.5	24.3	26.1	28.0	30.1
7.8	**9.4**	**11.0**	**12.7**	**14.5**	**16.5**	**18.6**	**450**	**20.0**	**21.7**	**23.5**	**25.3**	**27.2**	**29.3**	**31.4**
8.2	9.8	11.5	13.3	15.2	17.2	19.4	460	20.8	22.6	24.5	26.4	28.4	30.5	32.8
8.5	10.3	12.0	13.9	15.9	18.0	20.2	470	21.7	23.6	25.5	27.5	29.6	31.8	34.2
8.9	10.7	12.6	14.5	16.5	18.7	21.1	480	22.6	24.5	26.5	28.6	30.8	33.1	35.6
9.3	11.2	13.1	15.1	17.2	19.5	22.0	490	23.5	25.5	27.6	29.8	32.1	34.5	37.0
9.7	**11.6**	**13.6**	**15.7**	**17.9**	**20.3**	**22.9**	**500**	**24.4**	**26.5**	**28.7**	**31.0**	**33.3**	**35.8**	**38.5**

Figure 1D-5. RV Delta (Point Parallel) Turn Range and Offset

Tanker 15° AOB

Tanker Turn Range to Achieve a One NM Rollout of Receiver Behind Tanker														
Offset (nm)							**15° AOB**	**Turn Range (nm)**						
Drift on IP to CP LEG (°)							**Tanker TAS**	**Drift on IP to CP LEG (°)**						
15L	**10L**	**5L**	**0**	**5R**	**10R**	**15R**		**15L**	**10L**	**5L**	**0**	**5R**	**10R**	**15R**
3.6	4.3	5.0	5.8	6.6	7.5	8.4	230	9.9	10.7	11.5	12.3	13.2	14.1	15.1
3.9	4.7	5.5	6.3	7.2	8.1	9.2	240	10.7	11.5	12.4	13.3	14.3	15.3	16.3
4.2	**5.1**	**5.9**	**6.8**	**7.8**	**8.8**	**10.0**	**250**	**11.5**	**12.4**	**13.3**	**14.3**	**15.4**	**16.5**	**17.6**
4.6	5.5	6.4	7.4	8.4	9.6	10.8	260	12.3	13.3	14.3	15.4	16.5	17.7	19.0
4.9	5.9	9.9	8.0	9.1	10.3	11.6	270	13.2	14.2	15.4	16.5	17.7	19.0	20.3
5.3	6.3	7.4	8.6	9.8	11.1	12.5	280	14.1	15.2	16.4	17.7	19.0	20.3	21.8
5.7	6.8	8.0	9.2	10.5	11.9	13.4	290	15.0	16.2	17.5	18.9	20.2	21.7	23.3
6.1	**7.3**	**8.5**	**9.8**	**11.2**	**12.7**	**14.3**	**300**	**15.9**	**17.3**	**18.7**	**20.1**	**21.6**	**23.1**	**24.8**
6.5	7.8	9.1	10.5	12.0	13.6	15.3	310	16.9	18.4	19.8	21.4	22.9	24.6	26.4
6.9	8.3	9.7	11.2	12.8	14.5	16.3	320	18.0	19.5	21.0	22.7	24.4	26.2	28.1
7.3	8.8	10.3	11.9	13.6	15.4	17.4	330	19.0	20.6	22.3	24.0	25.8	27.7	29.8
7.8	9.3	11.0	12.6	14.4	16.4	18.4	340	20.1	21.8	23.6	25.4	27.3	29.4	31.5
8.2	**9.9**	**11.6**	**13.4**	**15.3**	**17.3**	**19.5**	**350**	**21.2**	**23.0**	**24.9**	**26.8**	**28.9**	**31.0**	**33.3**
8.7	10.5	12.3	14.2	16.2	18.3	20.7	360	22.4	24.3	26.3	28.3	30.5	32.7	35.1
9.2	11.1	13.0	15.0	17.1	19.4	21.8	370	23.5	25.6	27.7	29.8	32.1	34.5	37.0
9.7	11.7	13.7	15.8	18.0	20.4	23.0	380	24.8	26.9	29.1	31.4	33.8	36.3	39.0
10.2	12.3	14.4	16.6	19.0	21.5	24.2	390	26.0	28.2	30.6	33.0	35.5	38.2	41.0
10.8	**12.9**	**15.2**	**17.5**	**20.0**	**22.6**	**25.5**	**400**	**27.3**	**29.6**	**32.1**	**34.6**	**37.3**	**40.1**	**43.1**
11.3	13.6	15.9	18.4	21.0	23.8	26.8	410	28.6	31.1	33.6	36.3	39.1	42.0	45.2
11.9	14.3	16.7	19.3	22.0	25.0	28.1	420	29.9	32.5	35.2	38.0	41.0	44.0	47.3
12.4	14.9	17.5	20.2	23.1	26.2	29.5	430	31.3	34.0	36.8	39.8	42.9	46.1	49.5
13.0	15.6	18.4	21.2	24.2	27.4	30.9	440	32.7	35.6	38.5	41.6	44.8	48.2	51.8
13.2	**16.4**	**19.2**	**22.2**	**25.3**	**28.6**	**32.3**	**450**	**34.1**	**37.1**	**40.2**	**43.4**	**46.8**	**50.3**	**54.1**
14.2	17.1	20.1	23.2	26.4	29.9	33.7	460	35.6	38.7	42.0	45.3	48.8	52.5	56.5
14.9	17.9	20.9	24.2	27.6	31.2	35.2	470	37.1	40.4	43.7	47.2	50.9	54.8	58.9
15.5	18.6	21.8	25.2	28.8	32.6	36.7	480	38.6	42.0	45.5	49.2	53.0	57.1	61.3
16.2	19.4	22.8	26.3	30.0	34.0	38.8	490	40.2	43.7	47.4	21.2	55.2	59.4	63.9
16.8	**20.2**	**23.7**	**27.4**	**31.2**	**35.4**	**39.9**	**500**	**41.8**	**45.5**	**49.3**	**53.3**	**57.4**	**61.8**	**66.4**

Figure 1D-6. Work Sheet - RV Delta (Point Parallel)

Turn Range and Offset – Receiver Flying Tanker Speed +20kts

A	B PARAMETER	C REFERENCE	D TANKER	E RECEIVER
1	ALTITUDE	FL230		FL220
2	TANKER RV IAS	TANKER NATIONAL ANNEX		
3	RECEIVER RV IAS (=TANKER IAS +20 KTS)			
4	TANKER RV TAS	FIG 1D-2 or 3		
5	ACTUAL TEMP			
6	STD TEMP	FIG 1D-2		
7	**ACTUAL – STD (Row 4 – Row 5)** (<**STD** = REDUCE BY 1 kt / ºC) (>**STD** = INCREASE BY 1 kt / ºC)		- +	
8	**CORRECTED TAS** **(Row 3±Row 6)**			
9	RVIP TO RVCP DRIFT		**L/R**	
10	TURN RANGE	FIG 1D-4 or 5		
11	OFFSET	FIG 1D-4 or 5		

Figure 1D-7. RV Delta (Point Parallel) Turn Range and Offset

Tanker 25º AOB

TURN RANGE - 25º AOB									
TAS RCVR - TNKR		RVIP TO RVCP DRIFT							NOTES
ORBIT LEFT		15L	10L	5L	0	5R	10R	15R	
		15R	*10R*	*5R*	*0*	*5L*	*10L*	*15L*	*ORBIT RIGHT*
CLOSURE RATE	1000 26		28 30		32	34 36	39		3 NM ROLLOUT RANGE
	975 25		27	28	30	32 34	36		
	950 24		26	27	29	31 33	35		
	925 23		24	29	28	29 31	33		
	900 22		23	25	27	28 30	32		
	875 21		23	24	26	27 29	31		
	850 20		21	23	24	26 27	29		
	825 19		20	21	23	24 26	27		
	800 18		19	21	22	23 25	26		
	775 17		18	19	21	22 23	25		
	750 16		17	18	20	21 22	24		
	725 15		16	17	18	20 21	22		
	700 15		15	16	17	18 19	20		
	675 12		13	14	15	15 16	17		
	650	11	12	13	14	15	15	17	1/2 NM ROLLOUT RANGE (A-10)
	625	10	11	12	13	14	15	16	
	600	9	10	11	12	13	14	15	
	575	9	10	10	11	12	13	14	
	550	8	9	9	10	11	12	12	
	525	7	8	8	9	10	11	11	
	500	7	7	8	8	9	10	11	
	475	6	7	7	8	8	9	10	
	575 8		9	10	11	11 12	13		1 NM ROLLOUT BEHIND C-130
	550 7		8 9		10	11 12	13		
	525 6		7 8		9	10 11	12		
	500 6		6 7		8 9		10	11	
	475 5		6 6		7	7 8 9			

NOTE: The turn range presented by some Flight Management Systems (FMS) may not agree with the values in the table. The FMS calculation accounts for additional variables and should be considered more accurate.

<u>Figure 1D-8. RV Delta (Point Parallel) Offset</u>

<u>Tanker 25º AOB</u>

OFFSET - 25º AOB									
		RVIP TO RVCP DRIFT							NOTES
ORBIT LEFT		15L	10L	5L 0		5R	10R	15R	
		15R	*10R*	*5R*	*0*	*5L*	*10L*	*15L*	*ORBIT RIGHT*
TANKER TAS	520	11 13		15	17	20	22	26	
	500 10		12	14	16	18	21	23	
	480 9		11	13	15 17		19	21	
	460 9		10	12	13 15		18	20	
	440 8		9	11	12 14		16	18	
	430 7.5		8.5	10.5	11.5	13.5 15.5 17.5			
	420 7		8	10	11	13 15 17			
	410 6.5		7.5	9.5	10.5 12.5		14	16	
	400 6		7 9		10	12 13 15			
	390 6		7	8.5	9.5	11.5 12.5 14.5			
	380 6		7 8		9	11 12 14			25° BANK
	370 5.5		6.5	7.5	8.5 10		11.5	13	
	360 5		6 7		8 9		11	12	
	350 5		5.5	6.5	7.5 8.5		10.5	11.5	
	340 5		5 6		7 8		10	11	
	320 4		5 6		6 7		9	10	
	300 4		4 5		6	7 8 9			
	280 3		4 4		5	6 7 8			
	260 3		3 4		4	5 6 7			
	240 2		3 3		4	5 5 6			
	220 2		3 3		4	4 5 5			

NOTE: Offsets in the top right shaded area may place the aircraft outside of the FAA protected airspace.

Figure 1D-9. RV Delta (Point Parallel) Turn Range

Tanker 30º AOB

TURN RANGE - 30º AOB									
TAS RCVR - TNKR		RVIP TO RVCP DRIFT							NOTES
ORBIT LEFT		15L	10L	5L	0	5R	10R	15R	
		15R	*10R*	*5R*	*0*	*5L*	*10L*	*15L*	*ORBIT RIGHT*
CLOSURE RATE	1000 22		23 25		26	28 30	32		3 NM ROLLOUT RANGE
	975 21		22	24	25	27 28	30		
	950 20		22	23	24	25 27	29		
	925 19		21	22	23	24 26	28		
	900 19		20	21	22	24 25	27		
	875 18		19	20	21	23 24	26		
	850 17		18	19	20	22 23	24		
	825 16		17	18	19	20 21	23		
	800 15		16	17	18	19 21	22		
	775 15		16	16	17	18 20	21		
	750 14		15	16	17	18 19	20		
	725 13		14	15	16	16 17	18		
	700 12		13	14	15	16 16	17		

Figure 1D-10. RV Delta (Point Parallel) Offset

Tanker 30º AOB

OFFSET - 30º AOB									
		RVIP TO RVCP DRIFT							NOTES
ORBIT LEFT		15L	10L	5L	0	5R	10R	15R	
		15R	*10R*	*5R*	*0*	*5L*	*10L*	*15L*	*ORBIT RIGHT*
TANKER TAS	460 7		8 9		11	12 14	16		30º BANK
	440 6		7 8		10	11 13	15		
	420 6		7 8		9	10 12	14		
	400 5		6 7		8 9		11	12	
	380 5		6 6		7 9		10	11	
	360 4		5 6		7 8		9	10	
	340 4		4 5		6	7 8 9			
	320 3		4 4		5	6 7 8			
	300 3		4 4		5	5 6 7			
	280 3		3 4		4	5 6 6			
	260 2		3 3		4	4 5 5			
	240 2		2 3		3	3 4 4			

Figure 1D-11. RV Delta (Point Parallel) Turn Range/Offset Correction – 3 NM Rollout

TURN RANGE ADJUSTMENT CHART 3 NM ROLLOUT RANGE							
A		B	C	B	E	F	G
PLANNED TURN		ACTUAL OFFSET (NM)					
RANGE	OFFSET	0	5	10	15	20	25
13	2	13	14	16	20	24	28
14	3	14	15	17	20	24	29
	4	13	14	17	20	24	28
15	4	15	15	18	21	25	29
16	4	16	16	18	22	25	29
	5	15	16	18	21	25	29
17	4	17	17	19	22	26	30
	5	16	17	19	22	26	30
	6	16	17	19	22	25	30
	7	16	16	18	22	25	29
18	5	17	18	20	23	26	30
	6	17	18	20	23	26	30
	7	17	17	19	22	26	30
	8	16	17	19	22	26	30
19	5	18	19	21	24	27	31
	6	18	19	21	23	27	31
	7	18	18	20	23	27	31
	8	17	18	20	23	26	30
	9	17	17	20	22	26	30
20	6	19	20	22	24	28	32
	7	19	19	21	24	27	31
	8	18	19	21	24	27	31
	9	18	19	21	23	27	31
	10	17	18	20	23	26	30
21	7	20	20	22	25	28	32
	8	19	20	22	25	28	32
	9	19	20	22	24	28	31
	10	18	19	21	24	27	31
	11	18	19	21	23	27	31
22	8	21	21	23	25	29	32
	9	20	21	23	25	28	32
	10	20	20	22	25	28	32
	11	19	20	22	24	28	32
	12	18	19	21	24	27	31
23	9	21	22	23	26	29	33
	10	21	21	23	26	29	33
	11	20	21	23	25	28	32
	12	20	20	22	25	28	32
24	10	22	22	24	27	30	33
	11	21	22	24	26	29	33
	12	21	21	23	26	29	33
	13	20	21	23	25	28	32
25	12	22	23	24	27	30	33
	13	21	22	24	26	29	33
26	13	23	23	25	27	30	34
	14	22	23	24	27	30	33
27	13	24	24	26	28	31	34
	14	23	24	25	28	31	34
28	15	24	24	28	28	31	34

This chart includes all the turn range/offset possibilities in the 400-480 TAS range.

1. Enter chart from left with the planned turn range/offset.
2. Enter from the top with the observed offset as it occurs during the RV.
3. The intersection of these entries is the new turn range at which to command the tanker's turn.

EXAMPLE:
With a planned 20/8 and actual 20 nm offset, the tanker's turn should occur at 27 nm.

NOTE
New turn ranges are rounded to the nearest nm.

Figure 1D-12. Timing Chart (Nil Wind)

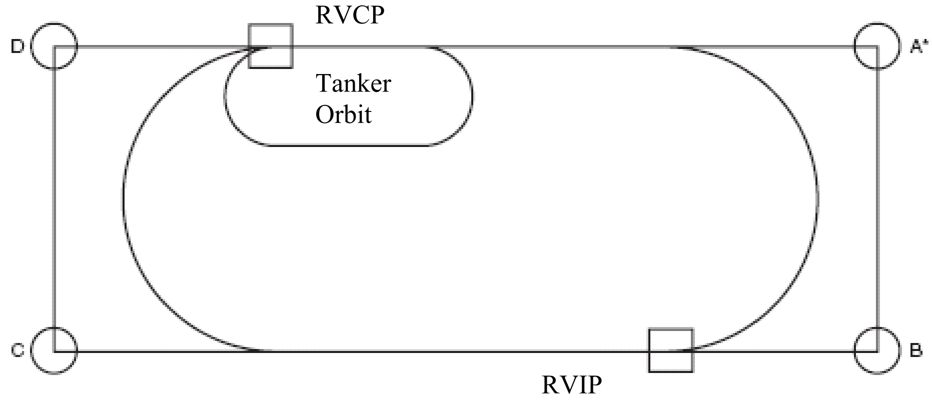
DISTANCE	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	TURN RANGE
CLOSURE SPEED																
460	3:05	3:44	4:22	5:02	5:41	6:20	6:59	7:38	8:17	8:56	9:36	10:15	10:54	11:33	12:12	6.4
480	2:51	3:28	4:06	4:43	5:21	5:58	6:36	7:13	7:51	8:28	9:06	9:43	10:21	10:58	11:36	7.2
500	2:38	3:14	3:50	4:26	5:02	5:38	6:14	6:50	7:26	8:02	8:38	9:14	9:50	10:26	11:02	8
520	2:27	3:01	3:36	4:10	4:45	5:19	5:54	6:29	7:03	7:38	8:12	8:47	9:22	9:56	10:31	8.8
540	2:16	2:49	3:22	3:56	4:29	5:02	5:36	6:09	6:42	7:16	7:49	8:22	8:56	9:29	10:02	9.6
560	2:06	2:38	3:10	3:42	4:14	4:46	5:18	5:51	6:23	6:55	7:27	7:59	8:31	9:03	9:36	10.4
580	1:57	2:27	2:58	3:30	4:00	4:31	5:02	5:33	6:04	6:36	7:07	7:38	8:09	8:40	9:11	11.2
600	1:48	2:18	2:48	3:18	3:48	4:18	4:48	5:18	5:48	6:18	6:48	7:18	7:48	8:18	8:48	12
620	1:39	2:09	2:37	3:06	3:36	4:05	4:34	5:03	5:32	6:01	6:30	6:59	7:28	7:57	8:26	12.8
640	1:32	2:00	2:28	2:56	3:24	3:52	4:21	4:49	5:17	5:45	6:13	6:41	7:09	7:37	8:06	13.6
660	1:25	1:52	2:19	2:46	3:14	3:41	4:08	4:36	5:03	5:30	5:57	6:25	6:52	7:19	7:46	14.4
680	1:18	1:44	2:11	2:37	3:04	3:30	3:57	4:23	4:50	5:16	5:43	6:09	6:36	7:02	7:28	15.2
700	1:07	1:33	1:58	2:24	2:50	3:15	3:41	4:06	4:32	4:58	5:24	5:49	6:15	6:41	7:06	17
720	1:00	1:25	1:50	2:15	2:40	3:05	3:30	3:55	4:20	4:45	5:10	5:35	6:00	6:25	6:50	18
740	:54	1:18	1:42	2:06	2:30	2:55	3:19	3:43	4:08	4:32	4:56	5:21	5:45	6:09	6:34	19
760	:47	1:11	1:35	1:58	2:21	2:45	3:09	3:33	3:56	4:20	4:44	5:07	5:31	5:55	6:18	20
780	:42	1:05	1:28	1:50	2:13	2:36	3:00	3:23	3:46	4:09	4:32	4:55	5:18	5:42	6:04	21
800	:36	:59	1:21	1:43	2:05	2:28	2:51	3:13	3:36	3:59	4:21	4:44	5:06	5:29	5:51	22
820	:31	:53	1:15	1:37	1:58	2:20	2:42	3:04	3:26	3:48	4:10	4:32	4:54	5:16	5:38	23
840	:26	:47	1:09	1:30	1:51	2:12	2:34	2:55	3:17	3:38	4:00	4:21	4:43	5:04	5:25	24
860	:21	:42	1:03	1:24	1:44	2:05	2:26	2:47	3:08	3:29	3:50	4:11	4:32	4:53	5:13	25
880	:16	:37	:57	1:18	1:38	1:58	2:19	2:39	3:00	3:20	3:40	4:01	4:21	4:42	5:02	26
900	:12	:32	:52	1:12	1:32	1:52	2:12	2:31	2:52	3:12	3:31	3:52	4:11	4:32	4:52	27
920	:08	:27	:47	1:07	1:26	1:46	2:05	2:24	2:44	3:04	3:23	3:43	4:02	4:22	4:41	28
940	:04	:23	:42	1:01	1:20	1:40	1:58	2:18	2:37	2:56	3:15	3:34	3:53	4:12	4:31	29
960	:00	:19	:38	:56	1:15	1:34	1:52	2:11	2:30	2:48	3:08	3:26	3:45	4:03	4:22	30
980	-	:15	:33	:51	1:10	1:28	1:46	2:04	2:23	2:41	3:00	3:18	3:36	3:55	4:13	31
1000	-	:11	:29	:47	1:05	1:23	1:41	1:59	2:17	2:35	2:53	3:11	3:29	3:47	4:05	32

Note: **The table provides a tanker time to turn to achieve a 3 nm roll out in front of the receiver.**

Figure 1D-13. Work Sheet - RV Delta (Point Parallel)
Turn Range and Offset– Tanker and Receiver Flying AAR RV Speeds

A	B	C	D	E	F
	PARAMETER	REFERENCE	TANKER		RECEIVER
1	ALTITUDE				
2	RV IAS	TANKER NATIONAL ANNEX			
3	RV TAS	FIG 1D-2 or 3			
4	ACTUAL TEMP				
5	STD TEMP	FIG 1D-2			
6	**ACTUAL – STD (Row 4 – Row 5)** (<**STD** = REDUCE BY 1 kt / ºC) (>**STD** = INCREASE BY 1 kt / ºC)			- +	
7	**CORRECTED TAS (Row 3±Row 6)**				
8	**CLOSURE TAS (RCVR- TNKR)**				
9	RVIP TO RVCP DRIFT	DERIVED FROM TANKER NAV SYSTEM		**L/R**	
10	TURN RANGE	FIG 1D-7 or 9			
11	OFFSET	FIG 1D-8 or 10			
12	50 MN TIMING BACKUP	FIG 1D-12			
13	30 NM TIMING BACKUP	FIG 1D-12			

Figure 1D-14. Diagram of a Modified RV Delta (Point Parallel)



PART 2 - ANNEX 1E

RV Echo (Timing)

101E Introduction. The RV Echo is a timing based anchor orbit and should be used in tactical situations where it is necessary to have a tanker available with which receivers can RV in a known area on an opportunity basis. The RV Echo is normally used to support Combat Air Patrols (CAPs) and is particularly appropriate when EMCON procedures are in force; see Figure 1E-1.

102E Procedure

a. Anchor Point. The position of the Anchor Point can be identified in 2 ways:

(1) Range and True Bearing. A range and true bearing from a reference point with the inbound track to the Anchor Point orientated at right angles and to the left of the radial from the reference point.

(2) Geographic Point and True Track. A geographic point and a true track which is to be flown towards the Anchor Point.

b. Anchor Duration

(1) Although the normal RV Echo duration is 15 min, to allow for limitations in airspace reservations or operational requirements, it may be defined as an RV Echo 10, 15, 20 etc.

(2) It is vital that the anchor duration is briefed prior to the mission, as the receiver will use the information to predict the approximate position of the tanker.

c. Tanker Passage Through Anchor Point. The tanker should aim to fly through the Anchor Point at the RV FL/altitude/height on the hour and then at intervals as dictated by the RV Echo duration.

d. Receiver Join on Tanker

(1) Each receiver homes independently onto the tanker using all available aids.

(2) The receiver is to join the pattern 1000 ft below the RV FL/altitude/height.

(3) Receivers with AI radar or visual contact may join at any suitable point along the anchor.

(4) Receivers without AI radar should aim to fly the inbound track to the Anchor Point and adjust their timing to arrive 30 sec after the tanker.

e. Impact of EMCON Procedures. EMCON procedures may be used in conjunction with the RV Echo. However, in such circumstances, the receivers should be aware that several other receivers/formations may be approaching the tanker from different directions. Therefore, it is essential that all receivers maintain a good lookout and strict adherence to AAR procedures.

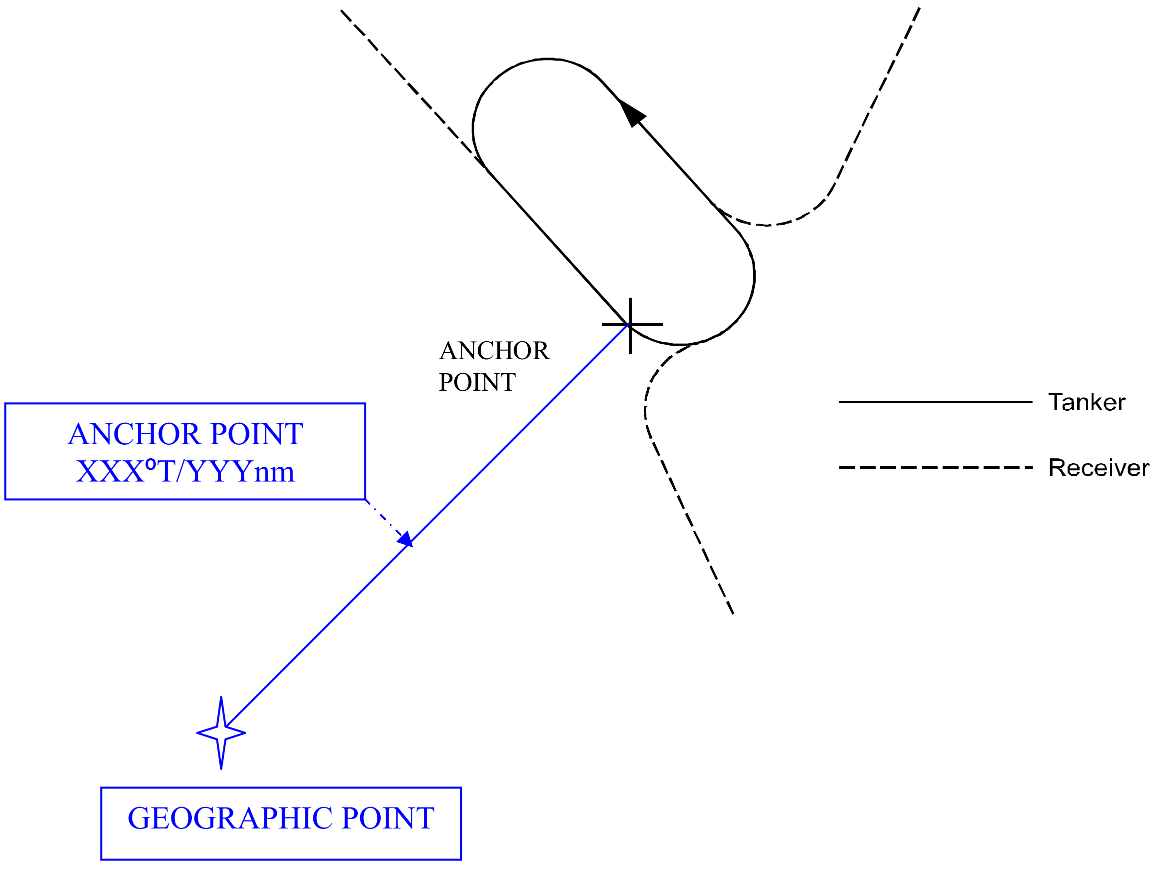
f. Tanker Actions to Ensure VMC. Within the limitations of the tactical situation, the tanker pilot is to adjust the FL/altitude/height and or position of the racetrack to maintain good VMC.

103E Aids Employed to RV. Subject to the EMCON policy in force, all available aids should be employed to achieve the RV. If available, A/A TACAN should be used as follows:

a. The tanker should select the A/A TACAN channel appropriate to the towline or as directed in the SPINS or tasking order throughout its time on station.

b. The tanker may select air to ground mode as necessary to obtain a position for a navigation fix.

Figure 1E-1. Diagram of RV Echo



NOTES:

1. Dotted lines show example tracks only; receivers may approach the tanker from any direction.
2. The RV FL/altitude/height, orientation (if necessary) and A/A TACAN channel should be specified in the SPINS or tasking order.

PART 2 ANNEX 1F

RV Foxtrot

101F Introduction. The RV Foxtrot is a sequenced departure normally used in VMC conditions when the tanker(s) and receiver(s) are operating from the same airfield. Tanker and receiver take-offs occur within a few minutes of each other, which eliminates the fuel and time consuming racetracks of the other RV procedures. The collocated procedures have the added advantage that it is usually possible for the tanker to delay its take-off until assured of the receiver's serviceability on start up. However, adverse climb out weather or ATC considerations may make these procedures impracticable. There are two methods of effecting a RV Foxtrot: the Accompanied Departure / Buddy Climb and the Tailchase.

102F Accompanied Departure / Buddy Climb. In this procedure, see Figure 1F-1, the receiver(s) takes off before the tanker and complete(s) a visual circuit of the airfield whilst the tanker takes off; the receiver(s) then joins formation with the tanker in the climb. This method has several advantages:

> **a. Wake Turbulence.** The receiver(s) is not exposed to wake turbulence caused by the heavy tanker.
>
> **b. Receiver Unserviceabilities.** Receiver(s) unserviceability immediately after take-off will be known before the tanker is airborne.

103F Accompanied Departure / Buddy Climb - Planning Considerations. This method has 2 significant factors that need to taken into consideration deciding whether or not to employ this RV rather than the Tailchase Departure described below.

> **a. Fuel Consumption.** The receiver(s) consumes extra fuel completing the visual circuit.
>
> **b. Ability to Join Up.** Weather conditions at the airfield need to be good enough for a visual circuit and join.

Therefore, during the planning phase, careful consideration of factors such as weather conditions and route of flight are required to ascertain the optimal procedure.

104F Accompanied Departure / Buddy Climb - Implementation. The method of implementing the Accompanied Departure / Buddy Climb is:

> **a. Receiver/Tanker Departure.** Because airspace reservations are usually based on the tanker flight plan, the tanker take-off time remains the critical planning factor. Therefore, the receiver(s) must take-off ahead of the tanker with sufficient time in hand to fly a visual circuit and still permit the tanker to achieve its Estimated Time of Departure (ETD).
>
> **b. Receiver Visual Circuit.** The receiver(s) flies a visual circuit and when the receiver is downwind the tanker then commences a take-off.
>
> **c. Tanker Departure.** The tanker carries out a standard departure; the receiver(s) continues the visual circuit adjusting speed and track to join the tanker in the climb.

105F Tailchase Departure. In this procedure, see Figure 1F-2, the tanker takes off before the receiver(s).

106F Tailchase Departure - Planning Considerations. As the tanker launches first, planning factors must take into consideration that, should one or more receivers fail to get airborne, the tanker will normally continue as planned accompanied by the reduced number of receivers.

107F Tailchase Departure – Establishing RVIP. The standard method for arranging this departure is to establish a RVIP after tanker top of climb; tanker and receiver take-offs are adjusted to make good the RVIP at the RV control time. The advantage of this method is that it is suitable when weather conditions are relatively poor at the airfield or during the initial stages of the climb. However, if weather conditions are good, the take-offs can be planned so that the receiver(s) join with the tanker in the climb.

108F Tailchase Departure - Implementation. Careful pre-flight briefing between tanker and receiver crews is essential.

a. RVIP. The tanker crew calculates their top of climb position and establishes the RVIP at one minute along track from the top of climb position. A direct climb-out from base is preferable but not essential.

b. RVCT. Knowing the time to height, the RVCT is calculated from the tanker take-off time.

c. Take-Off Time - Receiver. The receiver calculates its own time for take-off to make good the RVIP and compares that time with the tankers take-off time to ensure adequate separation to avoid the tanker's wake turbulence.

d. Vertical Separation - Receiver. As soon as practical after take-off, the receiver is to establish RT contact with the tanker. The receiver is to ensure that its passing FL/altitude/height is at least 1000 ft below that of the tanker until positive visual identification is made.

e. Rate of Climb. An agreed common rate of climb is to be pre-briefed as laid out in Part 2 Chapter 2 Annex 2C.

f. Height Calls - Tanker. Following the initial RT contact, the tanker is to call the FL/altitude/height level every 5000 ft until the receiver is in visual contact; this also assists the receiver in maintaining vertical separation. If IMC is encountered by either aircraft prior to the join-up, more frequent height comparisons are to be made to ensure the necessary vertical separation is maintained.

g. Navigation Aids. Usually, tanker and receiver(s) fly identical INS tracks and A/A TACAN is selected to give split ranges.

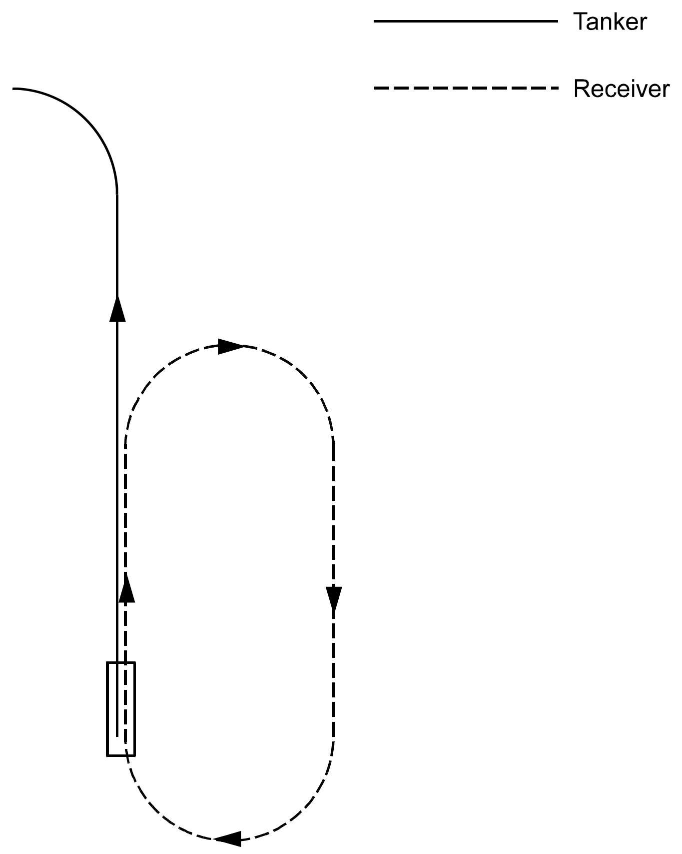
(1) If the departure procedures require the use of a ground base TACAN, then range and bearing comparison to this facility is to be made at every height check.

(2) If required, UHF Direction Finder (UDF) may be used to ascertain relative positions.

h. Orbiting – Tanker. If the receiver has not confirmed visual contact during the climb, the tanker is to make good the RVIP and, with ATC agreement, establish a left hand orbit until join up is complete.

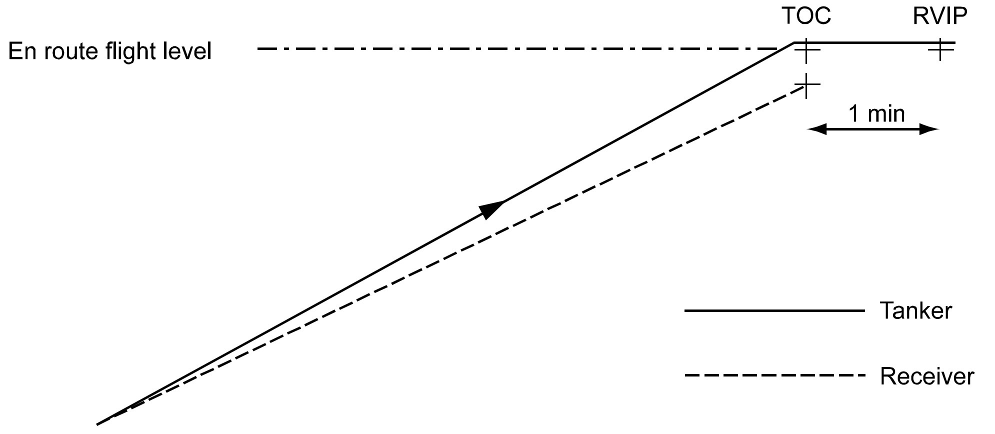
109F Receivers Depart Before Tanker. Sometimes, the receiver(s) may depart ahead of the tanker(s). In such cases, the procedures listed above remain valid, although the lead formation assumes responsibility for height calls. Once VMC, the formation will co-ordinate with ATC a 1000 ft separation between the receivers and tankers. Additionally, if the tanker is unable to accelerate and overtake the receivers, the formation should arrange with ATC for the receivers to orbit left in order to acquire the tanker.

Figure 1F-1. Diagram of RV Foxtrot –Accompanied Departure / Buddy Climb



NOTE: When receiver(s) is downwind, the tanker starts the take-off.

Figure 1F-2. Diagram of RV Foxtrot - Tailchase



NOTES:

1. The receiver takes off after the tanker to make good the RV control time.
2. The receiver is to remain at least 1000 ft below the tanker's climbing height/altitude/flight level until visual.

PART 2 - ANNEX 1G

RV Golf (En Route)

101G Introduction. The RV Golf facilitates a join up en-route on a common track to make good a scheduled time to join an ALTRV or other established military corridor; the tanker(s) and receiver(s) may have departed either from the same or different bases. See Figure 1G-1.

102G Basic Procedure

a. Arrival at RVIP. The tankers and receiver(s) navigate independently to arrive at the RVIP at a designated RVCT. To counter departure delays or receiver(s) arriving early, it may be necessary for the tanker to arrive approximately 10 min before the receiver(s) and establish an orbit prior to the RVIP.

b. Track Requirements. A common track length equivalent to 15 min flying time should be planned to allow for tanker descent to RV FL/altitude/height, visual acquisition and timing corrections.

c. Communication Procedures. Fifteen minutes prior to the RVCT the tanker and receiver(s) are to confirm their FL/altitude/height, A/A TACAN (channel), Mode 3, armament state and timing. The receiver(s) should fly towards the RVCP with A/A TACAN and radar beacon on (if appropriate) at 1000 ft below the base AAR altitude.

d. Visual Acquisition of Tanker(s)/Receiver(s). When established on the common track, tanker(s) and receiver(s) are to use all available locating aids (EMCON state permitting) to gain visual contact between the tanker(s) and the receiver(s).

103G Variations in EMCON 2 to Basic Procedure

a. During EMCON 2, if radio contact between the aircraft has not been established prior to the RV control time, or the adjusted RV control time, tanker(s) and receiver(s) are to maintain their assigned FL/altitude/height and depart the RV to cross the RVCP/RVIP at the RVCT.

b. Aircraft delaying at the RVCP will employ normal orbit procedures unless otherwise directed. If there is minimal separation between following aircraft or formations using the same track, orbits at the RVCP will require close coordination and thorough crew briefings to ensure vertical separation.

104G Specific Procedures in EMCON 4. If EMCON 4 procedures are in force, the tasking instructions should include control times for both the RVIP and the RVCP. There are 3 basic options for this procedure:

a. Procedure 1. This procedure should be used when the receiver(s) and tanker(s) have a similar transit speed and cruise height.

(1) Tanker. The tanker plans to arrive at the RVIP at the planned RV FL/altitude/height and RV control time at the AAR speed.

(2) Receiver. The receiver(s) arrive(s) at the RVIP 1000 ft below the tanker at the RV control time plus 30 sec and then adjusts KIAS to a 20 kts overtake on the tanker.

(3) Receiver Visual with Tanker. Once visual with the tanker and cleared by the tanker, the receiver(s) climbs to the observation position (drogue) / astern position (boom). A/A TACAN is used throughout to determine relative positions.

b. Procedure 2. This procedure is used when turboprop or jet receiver(s) have a considerable difference in cruising FL/altitude/height and speed to that of the tanker.

(1) Navigation Aids. A/A TACAN/range to the RVCP is used throughout the descent to monitor relative positions.

(2) Receiver. The receiver arrives at the RVIP at the RV control time and the RV FL/altitude/height minus 1000 ft.

(3) Tanker. The tanker arrives at the RVIP at the RV altitude and the RV control time plus 1 minute and commences to overtake the receiver, maintaining 1000 ft vertical separation, aiming to pass to overhead a boom receiver or at least 2 wingspans to the right of a probe and drogue receiver.

(4) Join

(a) Boom. On passing the receiver, the tanker is to reduce to AAR speed. Once visual with the tanker and cleared to join, the receiver is to commence a climb to the astern position.

(b) Probe and Drogue. Once the tanker and receiver are visual, the tanker descends to the RV FL/altitude/height minus 1000 ft. On the final approach to overtake, tanker speed is to be reduced to receiver speed + 5 kts and the tanker is to pass on the receiver's right-hand side with a displacement of at least 2 wingspans.

c. Procedure 3. This is a modification of the Procedure 2 and is normally used by Probe and Drogue tankers for jet receivers that have a considerable difference in cruising FL/altitude/height and speed to that of the tanker.

(1) Receiver. The receiver plans to arrive at the RVIP and RV FL/altitude/height minus 1000 ft at the RV control time.

(2) Tanker. The tanker arrives at the RVIP at a higher FL/altitude/height at the RV control time plus 30 seconds and then commences a descent to level off at the RV FL/altitude/height.

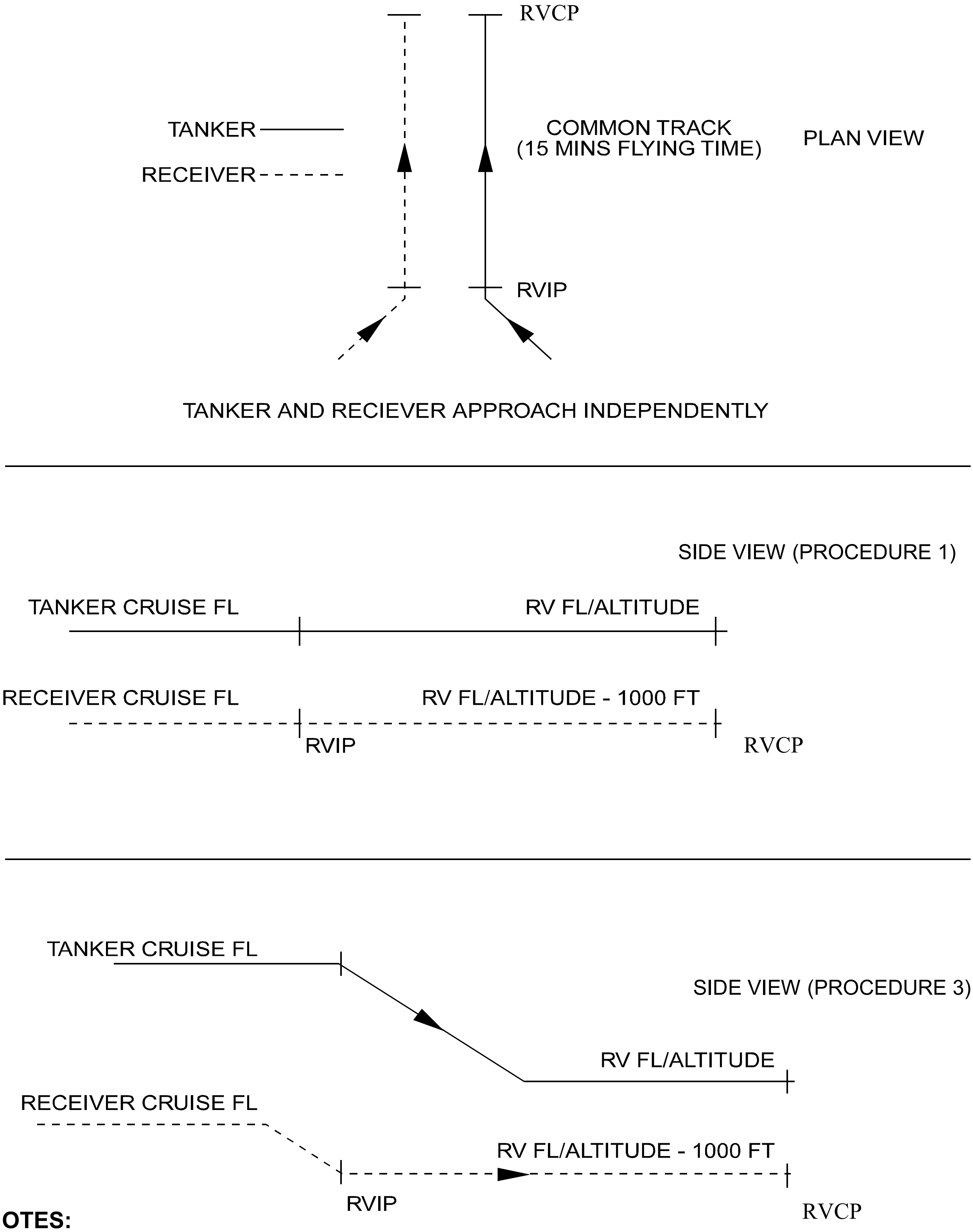
(3) Tanker Descent. During the descent, the tanker establishes a 20 kts overtake on the receiver and uses the A/A TACAN/range to the RVCP to monitor relative positions.

(4) Tanker Visual with Receiver. When visual with the receiver, the tanker speed is reduced to the receiver's speed + 5 kts and the receiver climbs to the RV FL/altitude/height and establishes in the observation position on the tanker's echelon left.

NOTE

This procedure may be used with the positions of the tanker and receiver reversed. In this case the procedure remains identical, except that the tanker, once joined with the receiver, overtakes the receiver as described in para 104G.b above.

Figure 1G-1. Diagram of RV Golf (En Route)



NOTES:

1. **The RVIP should be 15 minutes up track from the RVCP.**
2. **Tanker and receiver(s) compare ranges/time to go inbound to the RVIP from any direction to ensure that aircraft arrive in the correct order.**

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PART 2 – FIXED WING PROCEDURES

CHAPTER 2

Formation Procedures

201 Introduction. The procedures for safe rendezvous, joining, refuelling and leaving the tanker are detailed in Part 2 Chapter1 and Part 2 Chapters 4. This chapter describes factors that must be taken into account when a formation of receivers and/or tankers operates together.

202 Flight Safety. For flight safety reasons, it is important that these procedures are uncomplicated and unambiguous; furthermore, it is essential that there should be a high degree of commonality between tactical and strategic formation procedures. To minimise complications, these procedures are uniformly applicable by day and by night; these are essential prerequisites to making AAR practicable under EMCON.

203 Formation Control. The commander of the tanker (or lead tanker in multiple tanker formations) is responsible for the control and safe navigation of AAR formations.

204 Wingman/Receiver Responsibilities. To ensure safe operations and integrity of the formation, wingman are to:

a. Keep the leader in visual or electronic contact at all times.

b. Maintain briefed position at all times.

c. Anticipate corrections/changes and plan accordingly.

d. Monitor all aspects of formation operations and advise the receiver formation leader if an unsafe condition is identified.

205 Airspeeds and Altitudes. The optimum altitude and airspeed for AAR varies with the tanker/receiver combination. See tanker National Annex for appropriate details.

206 Weather/Visibility . Refer to Part 2 Chapter 1, para 102d.

207 Single Tanker Formations. Usually, tactical AAR involves receivers joining individually or in groups to refuel from one tanker and then depart. However, for training purposes, time with the tanker may be prolonged.

a. Visual Meteorological Conditions (VMC). For VMC, the tanker should brief a formation most suited to the AAR sequence, taking into consideration the formation preferences of the receiver leader. In most cases, aircraft that are not refuelling will be directed to remain in either the Observation or Reform position/area. Should the tanker clear receivers to maintain a loose formation, they are not to stray too far away from the tanker, otherwise they may conflict with other airspace users. Local ATC restrictions may stipulate more stringent requirements, but, generally, the formation frontage should not exceed 1 nm and receivers must stay within ±200 ft of the tanker’s height.

b. Instrument Meteorological Conditions (IMC). Whenever ATC and fuel considerations permit, tankers should avoid IMC by implementing track or height adjustments.

(1) Climb to VMC. Receiver performance capabilities (particularly for AAR at high weights) may be a limiting factor; nevertheless, tankers should consider climbing to achieve VMC for cruise and initial AAR contact and then toboggan as receiver weight increases.

(2) Unable to Avoid IMC. If IMC cannot be avoided, the receivers are to be ordered into the close formation which will give them the best opportunity to retain visual contact with the tanker.

(a) Receivers should be arranged so that movement around the tanker is minimised during AAR sequences.

(b) Extended echelon formations can be difficult and tiring to fly, particularly under prolonged IMC. Thus, receivers should be apportioned equally (as far as possible) to the left and right echelon positions on the tanker.

(c) The tanker is to exercise strict control of receiver movement around the tanker during formation changes for AAR brackets.

(d) Receiver Loss of Visual Contact. If the receivers lose visual contact with the tanker, they are to immediately implement the 'Lost Wingman" procedures laid out in Part 1, Chapter 4 and maintain the prescribed separation until visual contact is regained.

208 Detailed Formation Procedures

a. Multi-Tanker Formation Procedures. Part 2 Annex 2A provides information about multi-tanker formation procedures.

b. Force Extension Procedures. Part 2 Annex 2B provides information about force extension procedures.

c. Tanker Snake/Formation Climb. Part 2 Annex 2C provides a guide to tanker snake/formation climb procedures.

d. Alternative AAR Formation Procedures – Heavy Aircraft. Part 2 Annex 2D discusses alternative AAR formation procedures for heavy aircraft.

e. Receiver Station Keeping Equipment (SKE) - AAR Procedures. Part 2 Annex 2E provides guidance on the use of SKE when flying heavy aircraft in formation with tankers.

f. Quick Flow Procedures. Part 2 Annex 2F describes receiver actions when employing Quick Flow procedures.

PART 2 - ANNEX 2A

Multi-Tanker Formation Procedures

NOTE

The US and RNLAF do not fly multi-tanker echelon procedures as described in this Annex. US procedures are published in appropriate national documents and summarised in Part 2, Annex 2D.

201A Multi-Tanker Formation - Echelon Procedures. On occasions, tasking may require several tankers to be in formation during the RV and for refuelling. Tankers may fly in echelon right formation on the lead tanker.

a. Formation Turns. At the lead tanker's discretion, the other tankers may go to line astern formation for turns prior to and during a RV procedure; however, they must resume echelon right prior to the receivers joining formation.

b. Receivers Joining a Tanker Formation

(1) Fighter and Heavy Probe and Drogue Receivers. All fighter and heavy probe and drogue receivers joining a multi-tanker formation are to join on the left of the tanker formation.

(2) Heavy Boom Receivers. All heavy boom receivers will join either directly behind the boom or, if there is more than one heavy receiver, the second and subsequent receivers will join on the right of the tanker formation.

(3) Receivers and Assigned Tankers. At the appropriate time, receivers will be cleared to join their assigned tanker.

(a) Receivers are not to penetrate through the tanker formation to reach their tanker.

(b) Receivers are to drop back on the left of the tanker formation, then move across behind the formation, before moving forward to join their tanker.

202A Formation in Visual Meteorological Conditions (VMC)

a. After joining, the standard cruise formation is with the tankers in echelon formation on the right side of the lead tanker.

b. If the lead and the formation tanker(s) have concurrent AAR commitments, then the formation tanker(s) should establish a loose echelon position where the autopilot can be engaged to provide a steady AAR platform for the receivers.

c. Ideally, when more than 3 tankers are allocated to a wave, the fourth and subsequent tankers should be formed into a separate section 3 nm in trail from the leading section, using an A/A TACAN or TCAS range from the lead tanker; this eases the tankers' station keeping task and keeps the formation frontage within reasonable bounds.

(1) Where possible, the formation should remain clear of cloud.

(2) Provided sufficient visual cues remain, the formation may penetrate thin cloud.

(a) The No 2 tanker should be brought to close right echelon on the lead tanker and the receivers put into close left echelon on the lead tanker.

(b) If there is a third tanker, this should be placed in line astern behind the second tanker to ease the station keeping task.

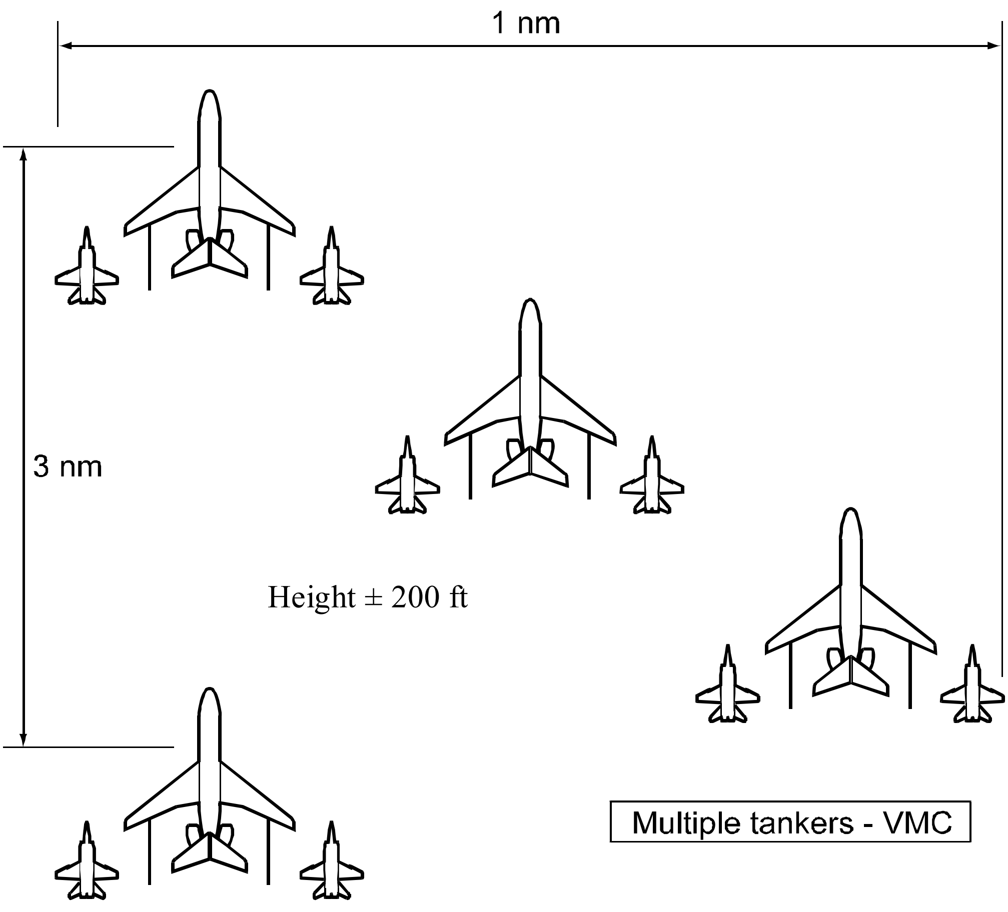
(c) If there is a second section, then this should remain 3 nm behind of the lead tanker.

(3) The lead tanker will be able to refuel its receivers if these conditions prevail during the brackets.

(4) At the conclusion of the lead tanker's AAR duties, the receivers will be able to take formation on the station keeping tankers, freeing the lead tanker to hand over the lead and leave the formation by a level turn to the left.

(5) If the AAR plan requires concurrent AAR from the other tanker(s), then it is not practicable for the tanker(s) to hold close formation and provide a steady AAR platform. In this event, tankers are to take up a Standard Separated Formation, with the receivers in a discrete formation around their allocated tanker.

Figure 2A-1. Diagram of VMC Multi-Tanker Formation



203A Formation in Instrument Meteorological Conditions (IMC) - Standard Separated Formation

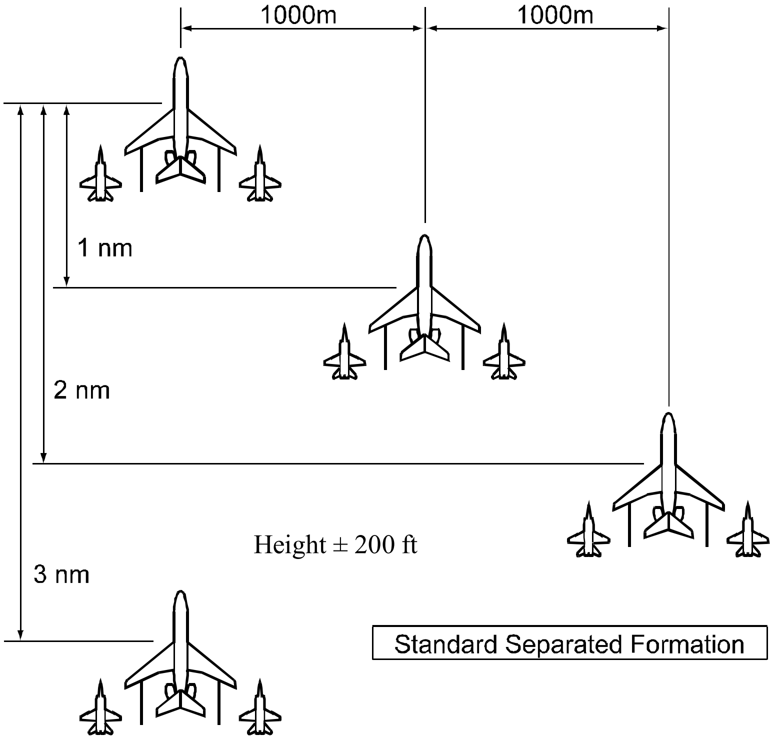
a. Tankers within each section are to be in right echelon, approximately 1000 m and 30° displaced from and 1 nm behind of the preceding tanker; radar, TCAS and A/A TACAN ranges are to be used to maintain the prescribed displacement.

b. If there is a second section of tankers, then tanker 4 is to maintain a range of 3 nm behind the lead tanker, and so on.

c. The lead tanker is to make frequent broadcasts of its heading and speed whilst IMC prevail.

d. If an aircraft cannot maintain the prescribed separation because of radar/TCAS/TACAN unserviceabilities, a safe height separation from the rest of the formation is to be achieved; the tanker leader is to be informed.

Figure 2A-2. Diagram of IMC Multi-Tanker Formation



204A Tanker Lead Change. There are several ways in which 2 tankers may change the lead when flying in visual contact. Provided good airmanship is applied, the lead change may be carried out in a manner suited to the particular circumstances. A maximum overtake speed of 10 kts is recommended. If a higher speed is used in poor visibility, it is possible that the new No 2 will lose sight of the leader before joining formation. For the same reason, lateral separation should not be more than about 200 m. A recommended procedure suitable for most circumstances is as follows:

a. The leader passes its datum heading and speed to the No 2 and orders him to overtake on the appropriate side.

b. No 2 accelerates to overtake the leader on a 5^{o} divergent heading, climbing 200 ft above the leader's level. No 2 should aim to put himself slightly high in the leader's 3/9 o'clock moving forward to the 2/10 o'clock position.

c. As soon as the leader has visual contact with the No 2, the leader formally hands over control and maintains echelon on the new leader until otherwise ordered.

d. If at any stage during the overtake the No 2 loses sight of the leader before the leader calls 'visual', the No 2 must immediately take collision avoidance and report its actions to the leader.

205A Multi-Tanker Formation Procedures. The formations described in this Annex are an alternative to close echelon formation and may be adopted at any stage in the cruise at the discretion of the lead tanker.

a. Pre-Flight Brief. Before a tanker formation is flown, a full and formal brief is to be given by the formation leader. The main briefing points to be covered for a snake/formation climb are outlined in Annex 2C.

b. Formation Considerations. The following is merely a guide to formation procedures and cannot cover all situations. Crews are to use their judgement when circumstances dictate, eg in conditions of reduced visibility.

(1) Formation Leaders. Formation leaders are responsible for their entire formation. Differing performance capabilities of other aircraft require additional considerations, particularly when dissimilar aircraft are mixed in a single formation.

(2) Formation Members. Formation members are to make every effort to maintain correct positioning and are to be prepared to provide assistance to the formation leader or to assume the formation lead if required.

(3) Standard Formation. The standard formation is flown with successive tankers in line astern and stepped up behind the leader.

(4) Formation Weather Limits – Non-AI Radar Aircraft. For non-AI equipped receivers or non-SKE equipped tankers, weather limits for formation are 1000 ft clear of cloud, one nm visibility plus one nm of visibility per tanker in the formation.

(5) Formation Weather Limits – AI Radar Aircraft. For AI equipped aircraft the weather limits are as prescribed for each nation.

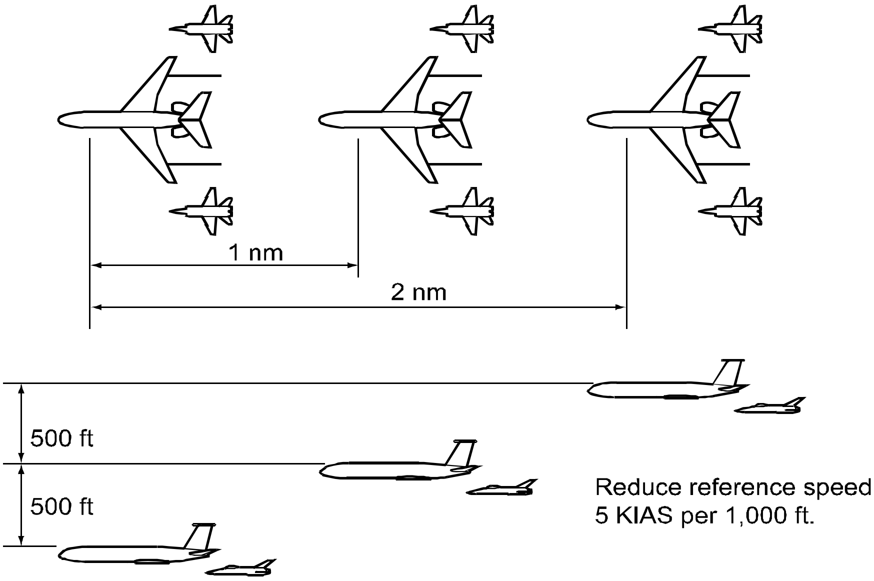
(6) Formation Size. Normally, the formation is to comprise a maximum of 3 tankers.

(a) In VMC, the normal separation between tankers is to be 500 ft and 1 nm but this may be reduced at the discretion of the formation leader in VMC to a minimum of 500 ft and ½ nm.

(b) In IMC the minimum separation is to be 1000 ft and 1 nm.

(7) Altitude Block. An altitude block is to be used whenever possible. If an altitude block is not available, each tanker is to have a separate IFR altitude assigned.

Figure 2A-3. Diagram Of Multi-Tanker Formation



c. Take-off. If receivers are part of the formation from take-off, they should normally take-off first. Take-off intervals or sequence may be varied as necessary depending on aircraft acceleration and performance, training requirements, weather, airfield conditions and mission requirements. All aircraft are to use the runway centreline for alignment. The effects of turbulence and vortex generation increase as the take-off roll progresses, reaching a maximum at unstick. The effects of turbulence may be decreased after take-off by turning slightly left or right as soon as possible after getting airborne to place the aircraft upwind (if possible) and out of the vortex of the preceding aircraft.

(1) Tanker Snake/Formation Climb Procedures. Usually, tankers will take-off from the same base in order to establish formation. Part 2 Annex 2C outlines the snake/formation climb procedures for all types of tankers. Dissimilar tanker types are to fly a pre-briefed speed and rate of climb until joined up. A full brief is to be given by the formation leader.

d. Establishing Formation. Normally, the briefed formation disposition is to be established after cruising altitude is reached; formation disposition may be established directly or from echelon. Each tanker is to call when ‘in position’. To establish formation disposition from echelon:

(1) VMC

(a) For 2 tankers, No 2 drops back and climbs into position maintaining visual contact with the lead.

(b) For 3 tankers, No 3 maintains formation on No 2 until No 2 is in position then drops back further and climbs into its own position.

(2) IMC

(a) For 2 tankers, No 2 first attains a ½ nm lateral spacing using the loss of visual contact procedure, then climbs to the appropriate altitude before dropping back into position directly behind the lead.

(b) For 3 tankers, No 3 is to move into its formation position first. When No 3 is in position, No 2 is then to establish its own formation position in turn.

e. Rendezvous. Turns in formation should be minimised to ease the station keeping task and tankers are not to exceed 25° AOB (if tanker national restrictions direct the use of AOB less than 25º, ATC should be informed). Aircraft joining the formation should join in the normal manner 1 nm and 1000 ft below the lead tanker.

(1) Tankers joining a formation are to be passed the formation position to be adopted and an individual formation callsign numbered sequentially with No 1 as the lead.

(2) Receivers joining a formation are to state 'visual with xx number of tankers' before the lead tanker instructs the receiver(s) to join a specific tanker (using the tanker's formation position, not callsign).

(3) Safety. Aircraft joining a formation are not to enter the formation until all aircraft in the formation have been visually identified.

f. Maintaining Formation. Maintaining correct formation positioning requires constant attention and effort. The lead tanker is to fly as stable a platform as possible and is to call all changes of heading, height or airspeed. Any deviation from the stated parameters will be magnified with each succeeding aircraft. Subsequent tankers should maintain position by reference to the lead tanker using A/A TACAN, radar, TCAS and visual references. If there is significant drift, aircraft will not fly 'nose to tail' but will fly crabbed relative to each other.

(1) Speeds. At medium cruising levels, due to differences in TAS, it will be necessary for following aircraft to fly about 5 KIAS slower for every 1000 ft they are above the lead. The lead tanker will fly the planned formation speed which will be dependent on tanker/receiver limitations and separately briefed. In some cases this may have to be increased so that the last tanker is not below the minimum speed for the receiver type.

(2) Turns. To maintain position, all aircraft must start the turn over the same geographical point. Succeeding tankers will therefore start the turn after an appropriate delay, which will depend on TAS and separation. The lead tanker should use 10° AOB for turns up to and including 20° and 25° AOB for turns of more than 20° (if tanker national restrictions direct the use of AOB less than 25º, ATC should be informed). Any necessary track adjustment due to wind in the AAR area is to be made on the straight legs; the bank angle is not to be increased during the turn.

NOTE

Some tankers with receiver(s) in contact, are restricted to 20° AOB. See National Annexes for details

(3) Climbs/Descents

(a) VMC. In VMC, the lead tanker may elect to climb or descend the formation as a formation.

(b) IMC. In IMC, climbs or descents as a formation are not permitted and are to be accomplished by tanker elements moving individually. All movements are to be controlled by the lead tanker.

(i) For a descent, the lead descends first.

(ii) When established, the lead calls its new level and instructs No 2 to descend to its new level.

(iii) When No 2 has called at its new level, the lead instructs No 3 to descend and so on.

(iv) For a climb, the reverse procedure is to be used with the rear tanker moving first and the lead tanker last.

(4) Autopilot Operation. The autopilot is to be used to reduce fatigue and aid in altitude separation. Consideration is to be given to placing an aircraft with an inoperative or malfunctioning autopilot in the last position in the formation for extended periods of formation.

(5) A/A TACAN. A/A TACAN should be used in the normal manner. If each tanker has 2 TACANs, a channel pairing should be specified between No 1 tanker and No 2 tanker, and a separate pairing should be specified between No 2 tanker and No 3 tankers (the aircraft in front selects the higher channel). The lead should use its second TACAN for range (and bearing) for the receivers as normal.

(6) Formation Position Changes. Formation position changes must be carried out in a prompt but formal manner. To change the lead, the lead tanker calls the datum heading, height and speed and instructs No 2 to overtake (normally on the right).

(a) VMC. No 2 descends towards the echelon position on the lead and carries out a standard lead change.

(b) IMC

(i) No 2 establishes ½ nm lateral separation from the lead tanker using loss of visual contact procedure, then increases speed by 10-15 KIAS and overtakes maintaining level.

(ii) When No 1 is able to maintain separation on No 2 (using A/A TACAN, TCAS and radar), No 1 hands over the lead.

(iii) No 2 takes the lead, reduces to formation speed, renumbers the formation if applicable, instructs the new No 2 to climb into position and descends into the lead position.

(iv) A similar procedure is to be used for other position changes within the formation.

(c) Radar and/or Visual Contact. Radar or visual contact must be maintained throughout the position change.

(i) If radar and visual contact is lost during a position change, maintain altitude and advise the formation leader that contact has been lost.

(ii) The formation member losing contact is to ensure positive separation by any means available and must not attempt to rejoin the formation until positive radar or visual contact is established.

(d) Renumbering of Formation Members. Aircraft changing position are to assume the callsign of their new position. When all aircraft are level at their new altitude and established in their new position, they are to acknowledge with their new formation callsign.

(7) Refuelling. During refuelling, the formation lead must fly precise airspeeds, altitudes and heading in order to maintain a stable platform for aircraft in the formation. Any deviation from these parameters requires corrections which increase in magnitude with each succeeding aircraft. Therefore, formation aircraft are to maintain their position relative to the lead aircraft. This prevents the ‘accordion’ effect during refuelling and possible conflict with other aircraft in the formation. Receivers with large onloads at high gross weight may require airspeeds to rise as onload increases. Maintaining formation in this scenario may be extremely difficult and the formation leader should plan for this eventuality and brief/co-ordinate actions accordingly.

(8) En Route / Straight Track. If necessary, the receivers can be towed to a drop off point, as specified in the ATO. When the formation is flying a long straight track (IMC or VMC), tankers can establish a 60° echelon on the tanker ahead:

(a) When the tanker to large receiver ratio is one to one or greater (ie 3 tankers and 2 receivers), 2 nm spacing stacked up 500 ft will normally be used.

(b) When the tanker to large receiver ratio is less than one to one (ie 2 tankers and 4 receivers), 2 nm spacing stacked up 1000 ft will normally be used.

(c) For all fighter type receivers, 1 nm spacing stacked up 500 ft will normally be used.

(9) Use of Radio. Formation management usually requires the use of full RT. This situation demands strict radio and intercom discipline from all aircraft in the formation.

(a) Cockpit intercom and RT are to be brief and, if possible, not made when the receiver is closing to or in the contact position.

(b) Boom operator RT is to be brief but adequate and include the entire Callsign identification.

(c) If RT silence is operationally essential, all aspects of formation disposition, particularly the RV and join, are to be specifically pre-briefed.

(d) In the normal case when full RT is available, refuelling should normally be conducted using Radio Silence to reduce RT and avoid possible confusion between receivers. However, if full RT is used for refuelling, callsigns should not be abbreviated.

(10) EMCON. EMCON is to be the minimum required for flight safety and will depend on prevailing weather conditions.

(11) Receivers

(a) Receivers are to join the formation at 1 nm and 1000 ft below the lead (lowest) tanker on the left and, when cleared by the tanker formation leader, move up to their assigned tanker.

(b) Preferably, there are not to be more than 4 receivers per tanker.

(c) Flow through the tanker is to be left to right.

(i) If receivers require topping up they are to resume left echelon after initial refuelling.

(d) Once refuelling is complete, all receivers are to establish right echelon and, if possible, climb 1000 ft above the formation before departing.

(e) Any receiver that loses visual contact with its tanker is to carry out the loss of visual contact procedure specified in Part 2 Chapter 4, para 406 or 407 as appropriate.

(i) The lead tanker is to co-ordinate the rejoin, as applicable.

(12) Breakaw ay. It is essential that a Breakaway transmission is prefaced by the appropriate tanker Callsign. Refer to Part 2 Chapter 4, para 408 for subsequent actions.

(13) Weather Radar. The lead tanker is to maintain weather watch for the whole formation.

(14) Loss of Contact - Multi-Tanker Formation. See Part 2 Chapter 4 para 407 for Loss of Visual Contact procedures.

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PART 2 - ANNEX 2B

Force Extension Procedures

201B AAR Deployments (Force Extension). AAR deployments, also known as Force Extension missions, utilise tankers to deploy receivers along a pre-prepared route which may be promulgated in an ATO or a route brief and which may include an ALTRV. Often, a considerable portion of the route is flown with the receiver and tanker in company. On occasions, at least a part of the route may include the presence of several tankers. The general procedures established for single or multi-tanker formations should apply, where possible. Options for deployment formation procedures are presented below and specific instructions are laid out in national instructions; as a general principle, the type of formation to be adopted should be decided and briefed before take-off.

202B Use of AAR for Force Extension. Where force extension procedures are employed, force extension tankers (also known as 'whirlers') provide AAR for tankers escorting fighters during deployment operations. Force Extension missions are often complex and demanding to all aircrew, especially in IMC. All facets of the mission, to include the RV, formation, air refuelling, VMC/IMC rejoin procedures, and formation break-up are to be briefed during mission planning and clearly understood by all participants.

203B Force Extension Procedures. When deploying packages of aircraft, particularly fighters, force extension (or trail) procedures may be employed. The procedures detailed below are the standard for force extension tankers providing AAR to escort tankers. Any deviations to these procedures are to be co-ordinated between all tankers (escorting and force extension), receivers, and the mission commander. If a pre-departure briefing is not conducted due to geographically separated departure locations, the escorting tanker will coordinate changes in flight to the force extension tanker upon initial contact, prior to the AAR RV.

a. Basic Join Principles. The RV Delta (Basic Point Parallel) or RV Golf (En route Rendezvous) usually offer the most convenient process to gather the tanker and receiver aircraft.

b. Transit Formation. Once together, multi-ship tanker formation should plan to fly 60º echelon, 2 nm spacing unless otherwise directed.

c. Formation in IMC. Missions that encounter IMC conditions during air refuelling may increase air refuelling echelon formation spacing from 2 nm to 3 nm.

d. Join with Force Extension Tanker(s). If a mid transit tanker (or 'whirler') RV is planned, the escorting tanker will attempt to contact the force extension (or 'whirler') tanker and exchange information that will assist the AAR join. In-flight visibility will be the determining factor in utilising VMC versus IMC procedures to conduct air refuelling.

NOTE

For the purpose of these procedures, the USAF defines VMC as visibility equal to or greater than 2 nm. Similarly, they define IMC as visibility less than 2 nm.)

e. Join Force Extension Tanker - VMC. When cleared by the escorting tanker pilot, receivers will join on the force extension tanker in the observation position or as directed by the force extension tanker. Once all receivers have joined the force extension tanker, the escorting tanker will be cleared for refuelling. Receivers should fly a loose wing formation and, with the exception of receivers behind the boom or drogues executing the manoeuvre, remain with their force extension tanker in the event that a breakaway is called.

f. AAR Speeds. The tanker will inform receivers the speed to be used as the refuelling airspeed for the formation (normally, for large aircraft tankers, this will be in the range 290-310 KIAS). The lead force extending tanker will determine air refuelling airspeed based on receiver/tanker aircraft types, altitude, weight, weapons load, etc.

g. Join Force Extension Tanker - IMC or Night. Air-to-air radar equipped fighters, when cleared by the escorting tanker pilot, should adopt one of the following formation positions:

(1) Close Formation with Force Extension Tanker. With the agreement of the Force Extension tanker, position in close formation on both wings of the Force Extension Tanker.

(2) Trail. If close formation is not practical, the receiver formation should position 1.5 to 2 nm in trail (6 o'clock position) of the escorting tanker, 2000 ft (or as briefed) below their assigned tanker whilst it is being refuelled by the force extension tanker.

(a) AI radar or other electronic means should be used to confirm longitudinal separation.

h. Post Refuelling Procedures

(1) Once all AAR is complete, the escorting tanker(s) will descend 1000 ft below the force extension tanker, offset slightly to the right, and then move to a position 1 nm in front of the force extension tanker(s).

(2) Once the escorting tanker(s) is stabilized in this position, it will assume lead for the formation after a positive verbal lead change.

(3) The escorting tanker will then clear the fighters forward to rejoin.

(4) Non-air-to-air radar equipped fighters and other aircraft will rejoin visually with their respective escorting tanker.

(5) If required, air-to-air radar equipped fighters will rejoin using radar guidance.

i. Rejoin in IMC. If IMC prevails and poor visibility precludes visual rejoins, some nations may permit the force extension tanker(s) to momentarily reduce separation to 1/2 nm and 500 ft vertical separation to facilitate the rejoin. See Part 2 Chapter 1, para 102d.

j. Inability to Rejoin by End of Track. If the formation reaches the end of the AAR track and visual rejoins are not possible, fuel permitting, force extension tankers will continue along the receiver's route of flight until visual rejoins are possible. If the force extension tanker(s) reaches BINGO FUEL at, or after the end of the AAR track and the fighters/receivers have not rejoined with the escorting tanker(s), the entire formation will abort to a suitable alternate airfield.

k. Formation Deconfliction Prior to Separation. The tanker radar should be used for position monitoring throughout the manoeuvre. It is the force extension tanker's responsibility to inform the entire formation of current heading and airspeed until relieved of that responsibility by a lead change.

(1) The force extension tanker/formation will reform at the top of the air refuelling block.

(2) Once the fighters have rejoined on their respective escorting tankers, the escorting tanker/ formation will reform at the bottom of the block.

(3) Formation separation will be accomplished by the force extension or escorting tanker formation increasing/decreasing airspeed as determined by mission requirements and/or the permission brief.

(4) Force extension or escorting tankers will not make any climbing or descending turns to depart the stream until the tankers are identified visually or by radar, are well clear, and verbal co-ordination is made between tanker formation leaders. All aircrews must clear aggressively and be cognizant of potential converging headings or conflicts.

(5) When simultaneous refuelling of fighters and escorting tankers is required. The lead force extending tanker will determine air refuelling airspeed based on aircraft type, altitude, weight, weapons load, etc.

NOTE

For KC-10 receivers, use 310 KCAS and for KC-135 receivers use 295 KIAS.

l. Departure – Force Extension Tanker. Once all fighters/receivers have rejoined on their respective escorting tanker, the force extension tanker(s) will depart the stream from the rear of the formation.

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PART 2 - ANNEX 2C

Tanker Snake/Formation Climb Guide

<table>
<tr><th>Item
(a)</th><th>Lead Aircraft
(b)</th><th>Subsequent Aircraft
(c)</th></tr>
<tr><td>Pre-flight Briefing</td><td colspan="2"><u>Brief should include, but is not restricted to, the following points</u>:

1. Weather for T/O, en route, AAR, destinations and alternates.
2. ATC callsigns, individual formation callsigns, T/O time and R/T check in times (1).
3. Aircraft, parking locations, POB, fuel for each aircraft.
4. 1.35g buffet (VC10), buffet boundary (TriStar), 1.5 V_{mm} (KC-10) for each aircraft.
5. Differences in aircraft performance/dissimilar types (2).
6. COMMS/EMCON plan and allowable emitters, A/A TACAN channels and R/T channels/frequencies and inter-aircraft frequencies.
7. Taxi plan/sequence.
8. T/O and departure routeing, covering abort and emergencies plan and wake turbulence.
9. Flap retraction height/point (VC10), flap retract schedule (TriStar), Acceleration Height (KC-10/KC-135). Standard flap retract height for all aircraft in a formation climb with dissimilar tankers is 1500 ft (unless noise abatement procedures dictate otherwise).
10. Power settings.
11. Climb/cruise speeds and rate of climb/vertical speeds (below and above 10,000 ft). Intermediate level offs, turns and bank angles.
12. Transition altitude.
13. VMC/IMC procedures.
14. Formation join up, altitude block, airspeed (indicated/true/mach) and minimum manoeuvre airspeed. RV join procedure, RVCT and position in formation.
15. Any formation position changes.
16. AAR plan, receiver callsigns and assigned tanker, off/on loads, sequence, base altitude, track, type of RV.
17. Safety - Loss of Visual Contact procedures.
18. Formation break up and base recovery.
19. Tanker lighting (KC-10/KC-135).</td></tr>
<tr><td>T/O-40</td><td>Call for 'RT CHECK'.
A/A TACAN ON, CHECKED, as reqd.</td><td>RT check with leader.
A/A TACAN ON, CHECKED, as reqd.</td></tr>
<tr><td>T/O-20</td><td>Call for 'START CLEARANCE' for all aircraft. Start engines.</td><td>Start engines.
Call 'READY' when ready to taxi.</td></tr>
<tr><td>T/O-10</td><td>Call 'TAXI' for all aircraft.</td><td>Taxi in turn.</td></tr>
<tr><td>CLNC</td><td>Obtain ATC clearance for all aircraft.</td><td>Acknowledge ATC clearance.</td></tr>
</table>

Item (a)	Lead Aircraft (b)	Subsequent Aircraft (c)
Holding Point	- Brief on A/A frequency: 'VMC/IMC SNAKE CLIMB AS BRIEFED. CLEARED TO FL__ (-1000 ft for each ac)'. Or, if block levels allocated 'MY FL ___, YOUR FL____' Brief any changes.	Call 'READY'. Acknowledge: 'VMC/IMC SNAKE CLIMB AS BRIEFED TO FL ___' Or, if applicable, 'MY FL ___'
T/O	Call 'READY FOR DEPARTURE' for all aircraft. A/A TACAN ON. One aircraft on runway at a time. FTOT/FULL PWR (VC10), DERATE (TriStar, KC-10, KC-135) as reqd. Call all turns **(3)**. Use $20^{o}/25^{o}$ AOB as reqd.	Stream T/O: 30 sec VMC (VC10), 45 sec VMC (KC-135) and IMC (VC10, KC-135), 60 sec (TriStar, KC-10). A/A TACAN ON. FTOT/FULL PWR (VC10), DERATE (TriStar, KC-10, KC-135) as reqd. Start turns at appropriate interval after lead's call.
CLIMB IMC	Climb at 250 kts and briefed rate of climb, V_{mm} (KC-10) **(4)**. Call passing every 5000 ft VMC or 2000 ft IMC **(5)**. At FL100/10,000 ft increase to 290 kts and briefed rate of climb, 93% (VC10) or speed for weight (TriStar, KC-10) **(4)(6)**. Call levelling at cruise FL.	Climb at lead's speed and rate of climb. In the climb minimum separation from aircraft ahead 2 nm/1000 ft until visual. Acknowledge height calls by calling passing level. At FL100/10,000 ft increase to lead's speed and rate of climb. Call when level.
TOC/ CRUISE IMC	Speed 290 kts (if subsequent aircraft is VC10) or 300 kts (if subsequent aircraft is TriStar, KC-10, KC-135). Maintain until following aircraft are in trail formation then as reqd **(6)**.	Speed 20 kts above lead until in trail formation then as lead. When level minimum separation from aircraft ahead 1 nm/1000 ft until visual.
VMC	Visual join procedures may be adopted at any stage when sustained VMC is achieved.	
	Reduce speed (within buffet limits) and power to assist join as reqd **(6)**. Max $20^{o}/25^{o}$ AOB as reqd with large receivers joining or in echelon.	Call 'VISUAL'. Complete visual join. Max overtake 30 kts within 2 nm of aircraft ahead. When joined call 'ECHELON LEFT/ RIGHT'.

NOTES:

1 Timings for RT checks, start and taxi should be stated by the lead tanker. Standard timings are: RT check at T/O-40, start at T/O-20, taxi at T/O-10 (or when all ac 'READY'). These timings may be varied to take account of local conditions.

2 If a VC10 and TriStar/KC-10 carry out a snake/formation climb, even if the TriStar/KC-10 is subsequently to lead the formation, the VC10 should lead the snake/formation climb. This will reduce problems of wake turbulence during the take-off and allow the TriStar/KC-10 to use its climb performance to best advantage. A KC-135 can be either lead or a subsequent aircraft. Any lead change should be carried out after join up. The following must be considered at the briefing stage:

a. Differences in rates of climb if there are large AUW or performance differences between aircraft.

b. IAS discrepancies caused by PEC differences.

3 Call all turns using the format 'C/S TURNING LEFT/RIGHT XXX (hdg) NOW' and commence the turn on executive word 'NOW', except for turns on a published SID which need not be called.

4 Details of the different climb parameters for each tanker are as follows:

a. The VC10 and KC-135 snake/formation climb speeds are 250 kts to FL100, then 290/0.82M (VC10K) or 290/0.84M (VC10C) or 280/0.78M (KC-135). However, a heavy VC10 may require a higher speed up to FL100 (1.35g buffet speed at FL100 at max AUW with aileron upset applied is 279 kts for a K2 and 268 kts for a K3/K4). If 250 kts is to be exceeded below FL100, ATC should be informed.

b. The recommended climb schedule for a TriStar is 250/300/0.80 if below 185,000 kg AUW and 250/320/0.82 if at or above 185,000 kg AUW. TriStar should have CLIMB 1 selected on the FMS when leading or following with TM engaged and CLIMB 3 displayed if following and using manual throttles.

c. Climb speeds for the KC-10 are normally 250/330/0.82M for aircraft less than 430,000 lbs Gross Wt. Above 430,000 lbs, the KC-10 climbs at Vmm to 10,000 ft then 330 KIAS/0.82M. For mixed KC-10/KC-135 formations, climb speeds are 285 KIAS with KC-10s less than 500,000 lbs and 310 KIAS for KC-10s equal to or greater than 500,000 lbs, unless a slower speed is required for an aircraft with more limiting performance.

5 In VMC, call height passing at least every 5000 ft until subsequent aircraft are visual. More frequent height calls should be given if there are large AUW or performance differences between aircraft, or if there are more than 2 aircraft in the snake climb. In IMC, call height passing every 2000 ft.

6 Call all speed changes.

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PART 2 - ANNEX 2D

AAR Formation Procedures – Heavy Aircraft

201D AAR Formation Procedures – Heavy Aircraft

a. Departure. For formation departure and join-up prior to air refuelling, comply with applicable national formation directives.

NOTE

Normally, tankers will maintain en-route formation while in the orbit pattern (see figure 2D-1).

b. En-Route Formation. During the final turn to AAR track, tankers will adjust from en-route formation to 60^{o} right echelon with 2 nm nose-to-nose separation (1 nm for fighters) and stack up at 500-ft intervals (see figures 2D-2). Unless otherwise briefed, this formation will be used during the air refuelling operation. Pilots will use their radar scopes, A/A TACAN and TCAS to maintain the formation position.

Figure 2D-1. Diagram of En-Route Formation

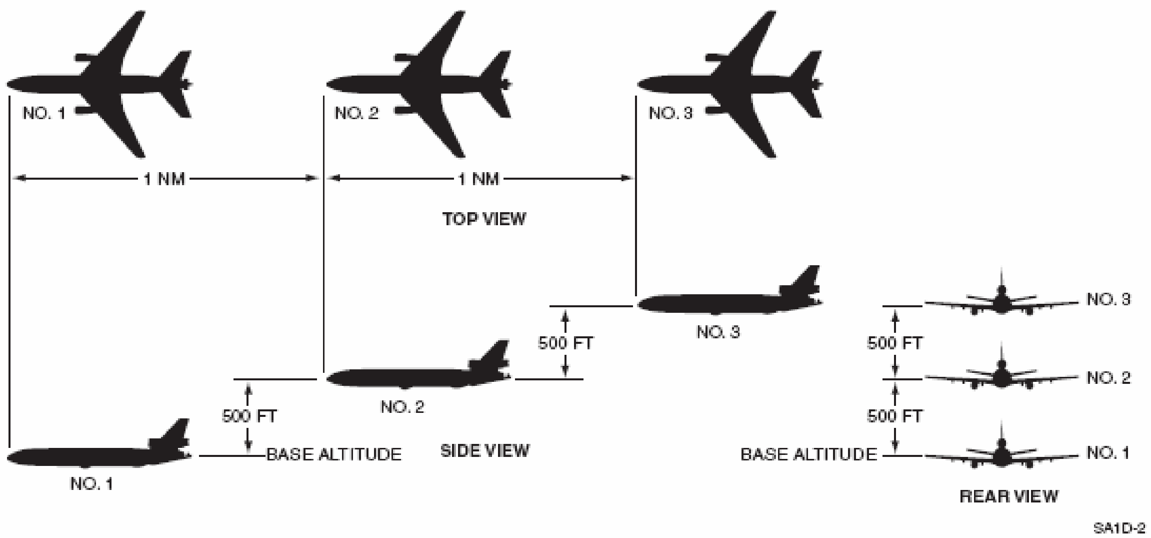
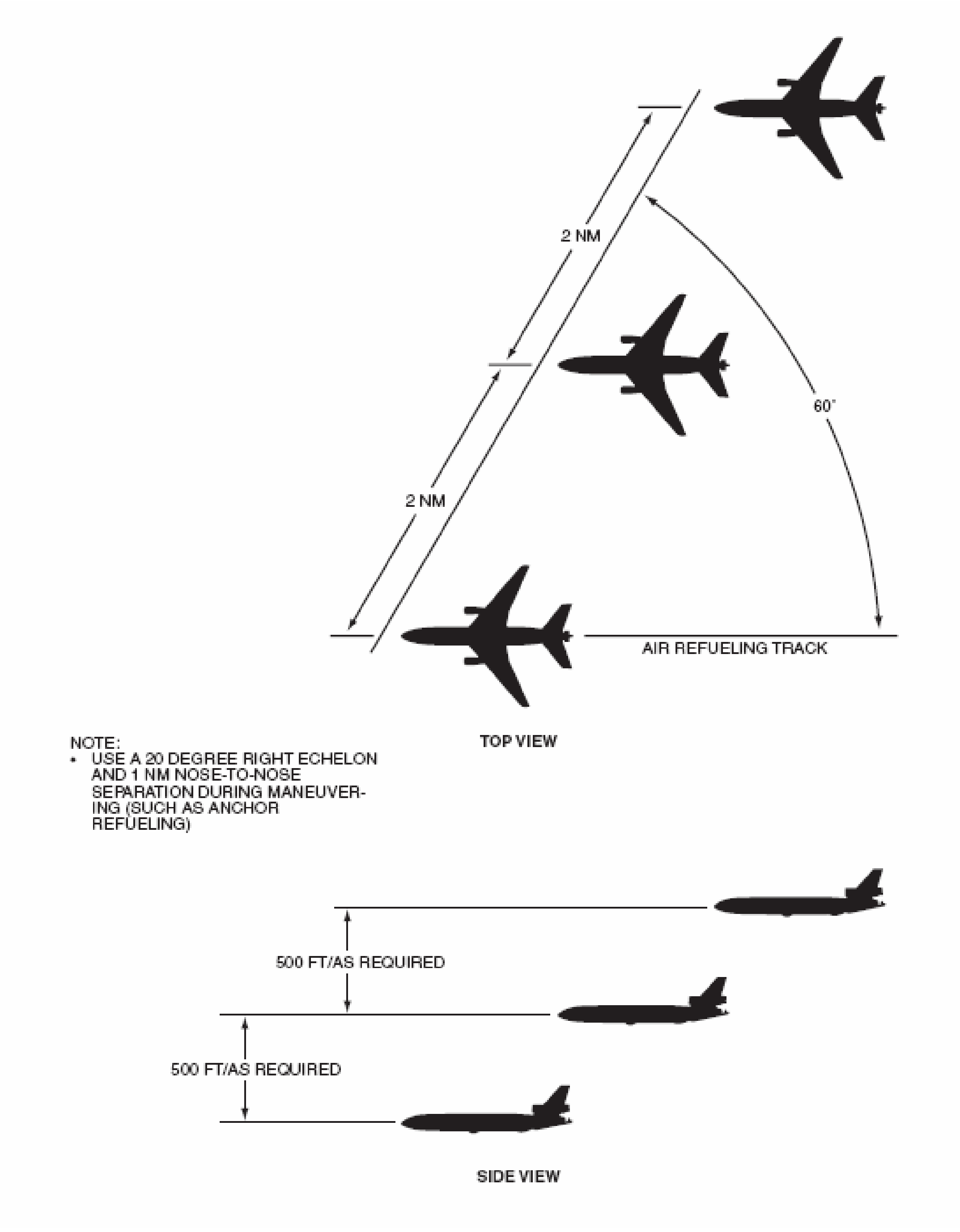


Figure 2D-2. AAR Formation



NOTES

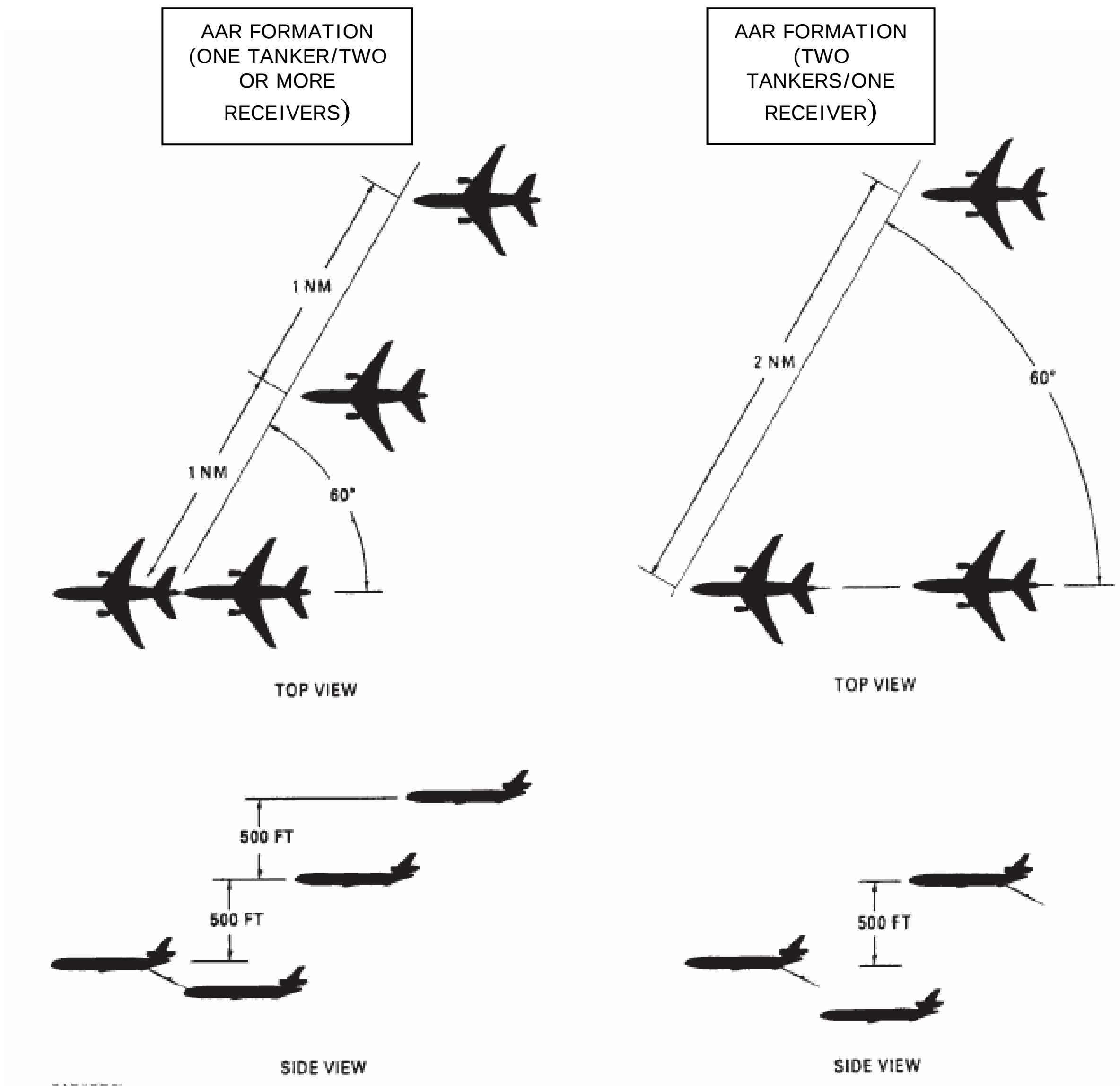
- **For an AAR formation of two tankers / four multi-engine receivers or three tankers / six multi-engine receivers, the tankers will stack up at 1000 ft intervals instead of 500 ft intervals.**

- **Echelon should be maintained throughout the refuelling except where conditions require turns into echelon formation greater than 30°, in which case the formation will be directed by the leader to assume 1 nm in trail formation until the turn is complete.**

202D AAR Formation Procedures To Be Used By USAF Heavy Receivers

a. General. The receiver formation will move into AAR formation upon completion of the RV or as prebriefed. AAR formation is defined as 60° right echelon stacked up at 500 ft intervals with 1 nm nose-to-nose separation (see figure 2D-3). Nose to nose separation may be increased to match tanker air refuelling formations.

Figure 2D-3. AAR Formations – Heavy Receivers



a. One Tanker/One Receiver

(1) Upon completion of AAR, the receiver will move aft and descend to a position at least 1000 ft below the tanker, and at least 1/2 nm in-trail.

(2) If unable to maintain visual contact with the tanker, increase spacing to 1 nm. This position will be maintained until air refuelling is terminated and clearance is received from ARTCC.

(3) Prior to either aircraft departing the AAR formation, clearance from ARTCC (US airspace) or ATC must be received and the tanker and receiver must coordinate their respective separation manoeuvres (verbal coordination not applicable during EMCON 3 and EMCON 4).

b. One Tanker/Two Receivers

(1) Receiver number 2 will maintain the AAR formation position (60^{o} right echelon stacked up 500 ft from the tanker) until refuelling is complete for the lead receiver.

(2) At that time, the lead receiver will descend 1500 ft, move aft and left to assume a 60^{o} left echelon, 2 nm nose-to-nose separation from the refuelling element, stacked down at 1500 ft.

(3) Once receiver lead is established in this post AAR position and calls "established in post AAR", receiver number 2 will establish radio contact with the tanker and close by descending, then moving left (10^{o} or less of heading change), until established in a position 500 ft below and 1/2 nm in trail of the tanker.

(4) After receiver number 2 has completed refuelling, it will manoeuvre directly aft while descending 1000 ft below the tanker (500 ft above receiver lead) call level at their altitude, decelerate, and rejoin on receiver lead (verbal coordination not applicable during EMCON 3 and EMCON 4).

(5) If needed, the tanker will then climb (or the receiver element may descend) to an altitude which provides a minimum of 1000 ft between the tanker and the highest receiver.

(6) Prior to any aircraft departing the AAR formation, 1000 ft of altitude separation between the tanker and highest receiver should be established (500 minimum required), clearance from ARTCC (US only) or ATC must be received, and the tanker and receivers must coordinate their respective separation manoeuvres (verbal coordination not applicable during EMCON 3 and EMCON 4).

c. Two or More Tankers/One Receiver

(1) During final turn to the AAR track, the tanker formation will move into echelon formation on the right of the tanker leader, stacked up at 500 ft intervals with 2 nm nose-to-nose separation measured along the 60^{o} echelon (see figure 2D-3).

(2) The receiver will rendezvous with the lead tanker. When reaching 2 nm from the last tanker, and visual contact is established, the receiver will manoeuvre to refuel from the last tanker.

(3) After completion of this refuelling, the receiver will descend, then manoeuvre left (10^{o} or less of heading change), until established in a position 500 ft below and 1/2 nm in trail of the next tanker (as necessary).

(4) Upon completion of this air refuelling, the receiver will move aft and descend to a position at least 1000 ft below the lead tanker, and at least 1/2 nm in-trail.

(5) If unable to maintain visual contact with the lead tanker, increase spacing to 1 nm.

(6) This position will be maintained until air refuelling is terminated and clearance is received from ARTCC (US only) or ATC.

(7) Prior to any aircraft departing the air refuelling formation, 1000 ft of altitude separation between the lowest tanker and the receiver should be established (500 ft minimum required), clearance from ARTCC must be received, and all tankers and receivers must coordinate their respective separation manoeuvres (verbal coordination not applicable during EMCON 3 and EMCON 4).

d. Three Tankers/Two Receivers

(1) A minimum of 4 successive altitudes (3000 ft) is required for this procedure.

(2) Planned fuel onload figures may vary depending on the mission.

(3) For three tankers/two receivers, the receiver leader will refuel from tanker number 2 first, receiving 1/3 of the scheduled onload.

(4) The receiver leader will then descend and then move left to refuel off the lead tanker, receiving the other 2/3 onload.

(5) Receiver number 2 will refuel from tanker number 3 first, receiving 2/3 of the scheduled onload.

(6) Receiver number 2 will then descend and then move left to refuel off tanker number 2, receiving the 1/3 of the scheduled onload (after the lead receiver has cleared tanker number 2).

(7) When the lead receiver has completed refuelling, it will clear the lead tanker by descending, moving aft and left to assume a 60^{o} left echelon, 2 nm nose-to-nose separation from the refuelling element, stacked down 1500 ft.

(8) Once the lead receiver is established in this post AAR position, the crew will call "Established in Post A/R."

(9) After receiver number 2 has completed refuelling, it will descend, move directly aft while descending 1500 ft below tanker number 2 (500 ft above receiver lead), call level at their altitude, decelerate, and rejoin on receiver lead (verbal coordination not applicable during EMCON 3 and EMCON 4).

(10) If needed, the tankers will then climb (or the receiver element may descend) to an altitude which provides a minimum of 1000 ft between the lowest tanker and the highest receiver.

(11) Prior to any aircraft departing the air refuelling formation, 1000 ft of altitude separation between the lowest tanker and highest receiver should be established (500 ft minimum required), clearance from ARTCC (US only) or ATC must be received, and all tankers and receivers must coordinate their respective separation manoeuvres (verbal coordination not applicable during EMCON 3 and EMCON 4).

e. Two Tankers/Three Receivers

(1) A minimum of 4 successive altitudes (3000 ft) is required for this procedure.

(2) Planned fuel onload figures may vary depending on the mission.

(3) The receiver leader will receive the total scheduled onload from the lead tanker.

(4) Receiver number 2 will receive 1/2 the scheduled onload from tanker number 2 and 1/2 the scheduled onload from the lead tanker.

(5) Receiver number 3 will receive the total scheduled offload from tanker number 2. Receiver number 3 will maintain the air refuelling formation (60° right echelon stacked up 500 ft from the number 2 tanker) until receiver number 2 has completed refuelling with tanker number 2.

(6) After completing the onload, receiver lead will descend, move aft and left, and assume a 60° left echelon, 2 nm nose-to-nose separation from the lead tanker, stacked down 2000 ft.

(7) Once the lead receiver is established in this post AAR position, they will call "Established in Post A/R."

(8) Receiver number 2 will refuel from tanker number 2 first, receiving 1/2 of the scheduled onload.

(9) Receiver number 2 will then descend and move left to refuel off the lead tanker, receiving 1/2 of the onload (after the lead receiver has cleared the lead tanker).

(10) After receiver number 2 has completed refuelling with the lead tanker receiver number 2 will descend 1500 ft below the lead tanker (500 ft above the receiver lead), call level at their altitude, decelerate, and rejoin on the lead receiver (verbal coordination not required during EMCON 3 and EMCON 4).

(11) Once receiver number 3 has completed refuelling with tanker number 2, they will descend 1000 ft below the lead tanker (500 ft above the number 2 receiver), call level at their altitude, decelerate, and rejoin on the receiver element (verbal coordination not required during EMCON 3 and EMCON 4).

(12) If needed, the tankers will then climb (or the receiver element may descend) to an altitude which provides a minimum of 1000 ft between the lowest tanker and the highest receiver.

(13) Prior to any aircraft departing the air refuelling formation, 1000 ft of altitude separation between the lowest tanker and highest receiver should be established (500 ft minimum required), clearance from ARTCC (US only) or ATC must be received, and all tankers and receivers must coordinate their respective separation manoeuvres (verbal coordination not applicable during EMCON 3 and EMCON 4).

f. Post AAR Position. The post AAR position is defined as the 60° left echelon position, 2 nm nose-to-nose separation from the lead tanker, stacked down with a minimum of 1000 ft separation between the lowest tanker and the highest receiver.

PART 2 - ANNEX 2E

Receiver Station Keeping Equipment (SKE) – AAR Procedures

201E Introduction. This annex provides amplified guidance for aircraft employing Station Keeping Equipment (SKE) to maintain separation.

202E Pre-Flight Briefing. Tanker aircrews will contact their respective SKE formation receiver aircrews prior to flight to ensure full understanding of the formation air refuelling procedures to be used.

203E Formation Size and Dimensions

a. Normal Formation. The normal SKE formation consists of elements of three aircraft which fly co-altitude, 4000 ft in-trail from each other, 500 ft right for the number two aircraft, 500 ft left for the number three aircraft (Figure 2E-1).

b. Maximum Formation Size. Formations may consist of up to ten elements of three aircraft. Each element will stack-up 100 ft above the preceding element. Tanker formations conducting refuelling operations with SKE formations will fly 60^{o} right echelon, 1 nm spacing, stacked up 500 ft (Figure 2E-1).

204E Rendezvous. Plan normal rendezvous procedures (en-route or point parallel). The following detailed tactics will be used when refuelling large formations of receiver aircraft utilising SKE:

a. Receiver formations utilising SKE procedures will use normal AAR Formation Procedures with minor modifications.

b. At the completion of the rendezvous, receiver formations will transition to a right 60^{o} echelon refuelling formation.

c. Receivers awaiting an open tanker will maintain the Awaiting AAR Position. (Exception: The number three receiver when operating with a single tanker will remain inline with the number two receiver until the number two receiver transitions to the precontact position).

d. Awaiting AAR Position. The Awaiting AAR Position is defined as right 60^{o} echelon off the last tanker, 1 nm nose to nose spacing, stacked 500 ft above that tanker. Receivers in the Awaiting AAR Position will be cleared to their tanker after the preceding receiver calls "RECEIVER (NUMBER) ESTABLISHED IN POST AAR."

e. Change in Formation Constitution. Procedures, including spacing to be used, will be briefed to tanker and receiver crews prior to flight. If the formation ratio changes (loss of a tanker or receiver through unserviceability, add-on tanker or receiver, etc.), in-flight coordination is required prior to the rendezvous.

205E Positive Separation. It is the responsibility of all formation members (both tanker and receiver) to ensure positive separation throughout refuelling operations. Formation members shall know and understand where all formation members are at all times. Question any manoeuvre or position which you do not understand.

206E Unplanned Turns. If an unplanned turn must be accomplished (i.e. weather), tankers must coordinate with receivers well in advance of the turn. Lead tanker will announce turn direction and approximate roll out heading on AAR primary. All receivers must acknowledge before the turn may commence. Receiver acknowledgement indicates there is proper separation (see definition below) between all receivers and tankers and proper separation will be maintained throughout the turn. If a receiver cannot maintain proper separation, he will call:

"RECEIVER (NUMBER), STANDBY TURN"

Tankers will maintain current heading until Receiver (number) can maintain proper separation and calls:

"RECEIVER (NUMBER), READY FOR TURN"

207E Separation Criteria. Proper separation is defined as one of the following:

a. Established in post-AAR.

b. Established in awaiting-AAR.

c. Established or approaching (within 0.5 nm) the astern or contact position.

d. 500 ft altitude separation and 0.5 nm lateral separation being attained and maintained from each tanker and receiver.

208E Turns Greater than 90 Degrees. Before executing turns greater than 90^{o}, tankers must be in trail formation and receivers must be in a SKE in-line formation at least 1000 ft below the lowest tanker. Awaiting AAR receivers will not depart the Awaiting AAR Position toward the contact position until the:

"RECEIVER (NUMBER) ESTABLISHED IN POST AAR"

call is received. Before moving from the Awaiting AAR Position, that receiver will verify the previous receiver is clear of the intended flight path to the previous receiver calls:

"RECEIVER (NUMBER) CLEAR"

the receiver in the Awaiting AAR Position will establish radio contact with his respective tanker, and be cleared to precontact position using normal closure procedures.

209E Formation Irregularities. Any crewmember noting a formation position irregularity which may involve conflicting flight paths will immediately notify the pilot flying who will take action to prevent such conflict (roll out of closure heading, cease climb or descent, etc.) and establish radio contact with the other aircraft to de-conflict the situation.

210E Tanker Echelon. Tankers will maintain a precise 60^{o} right echelon formation position when refuelling with SKE formations. Precise formation position is more important than maintaining a smooth platform.

NOTE

When refuelling SKE formations, crewmembers should shorten individual tactical call signs. Tanker lead is "TANKER 1", Receiver lead is "RECEIVER 1" and so on.

211E Conditions for 180 Degree Turns On Track. Tanker/SKE Receiver formations may execute 180^{o} turns on tracks if all the following conditions are met (no later than 2 min prior to the turn):

a. Tankers are in-line formation.

b. Receivers have rejoined in an in-line SKE formation and are maintaining a position 2 nm in trail of the lead tanker around the turn.

c. The highest receiver is at least 1000 ft below the lowest tanker.

212E Formation Post Roll-Out. Upon roll-out on new base course, if further formation refuelling is desired, the receiver formation will transition to normal AAR formation refuelling position. Receivers may elect to use a SKE Box Pattern. If this option is used, tanker(s) will proceed to the RVCP and prepare for a second rendezvous (point parallel). Prior coordination is essential.

NOTES

- **SKE Box Pattern is a series of turns, 90° or less, initiated at the air refuelling exit point designed to position the SKE formation for a point parallel rendezvous in the opposite direction.**

- **EXCEPTION: For 2 or 3 receivers on 1 tanker only; the receiver in the contact/astern position may remain in the contact/astern position during the turn. The other receiver(s) will move to the in-trail position for the duration of the 180° turn. In-trail aircraft will return to awaiting A/R or post A/R, whichever is appropriate, after the refuelling formation is re-established on track (after the turn). The receiver in the contact/astern position will remain in the contact/astern position until the other receiver(s) is re-established in the awaiting A/R or post A/R position.**

213E Post SKE AAR. At the completion of AAR, receiver aircraft will move to the Post AAR position to accomplish their rejoin. The Post AAR position is defined as 60° left echelon, 2 nm nose to nose separation, stacked down 1000 ft off the lead tanker. For large formations, this may require several receivers to cross behind the tanker formation prior to the tankers' transition to en-route formation (see Figure 2E-3 and 2E-5).

NOTE

For post AAR, to transition back to SKE formation, consideration must be given to the amount of time required to accomplish this transition. THIS MAY TAKE UP TO 15 MINUTES. Once the receiver formation is confirmed in their respective SKE positions, the SKE formation leader will confirm position with tanker leader. Upon confirmation, the tanker formation can move to the in-trail formation, stacked up 500 ft.

214E Breakaw ay. In the event of a breakaway, SKE receiver aircraft are limited to an altitude 500 ft below their respective tanker.

215E Typical SKE Formations. Figures 2E-1 through 2E-8 depict typical receiver AAR formations when using SKE equipment.

Figure 2E-1. SKE Formation

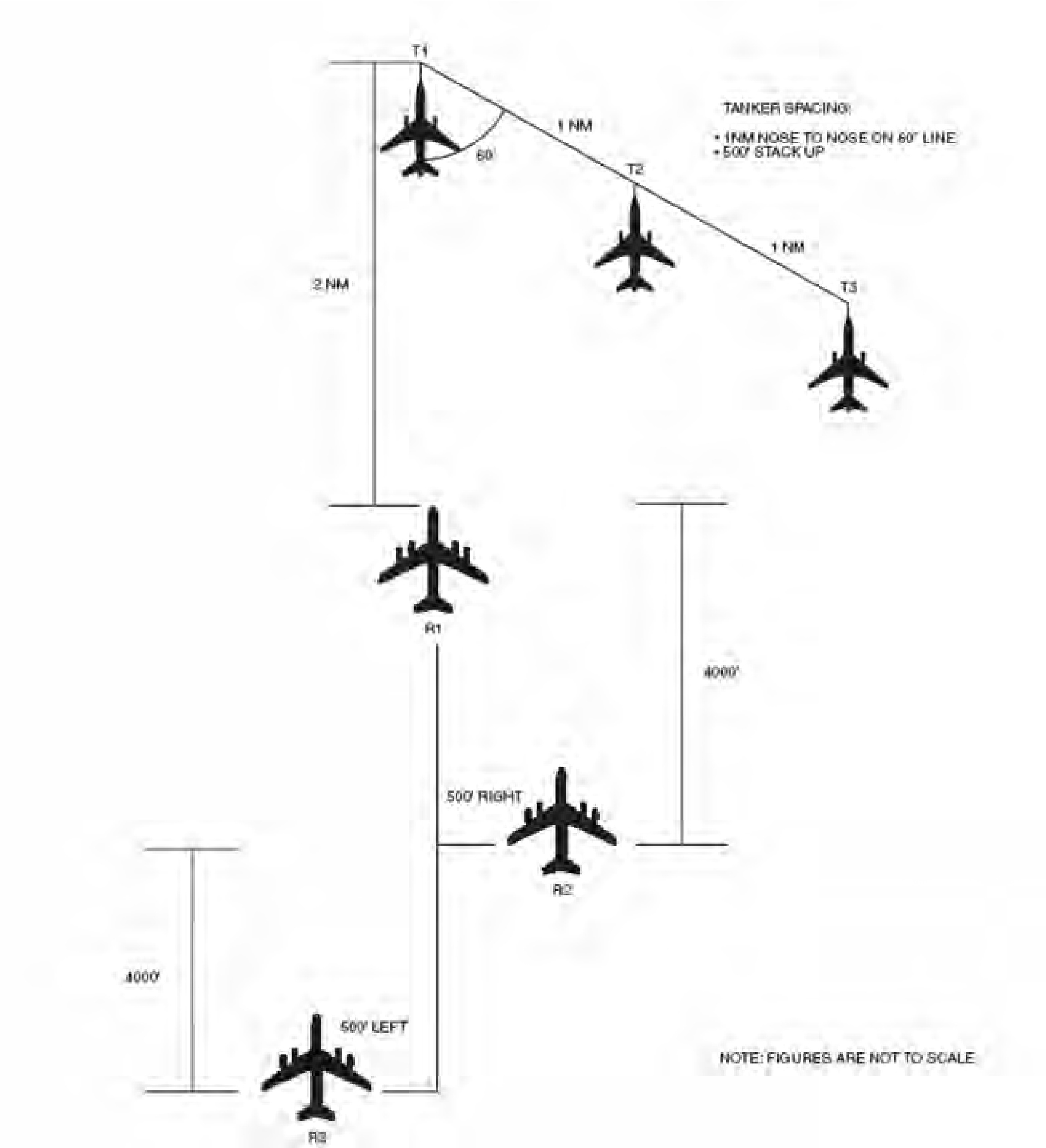


Figure 2E-2. AAR Procedures (3 Receivers (or 2) on 1 Tanker)

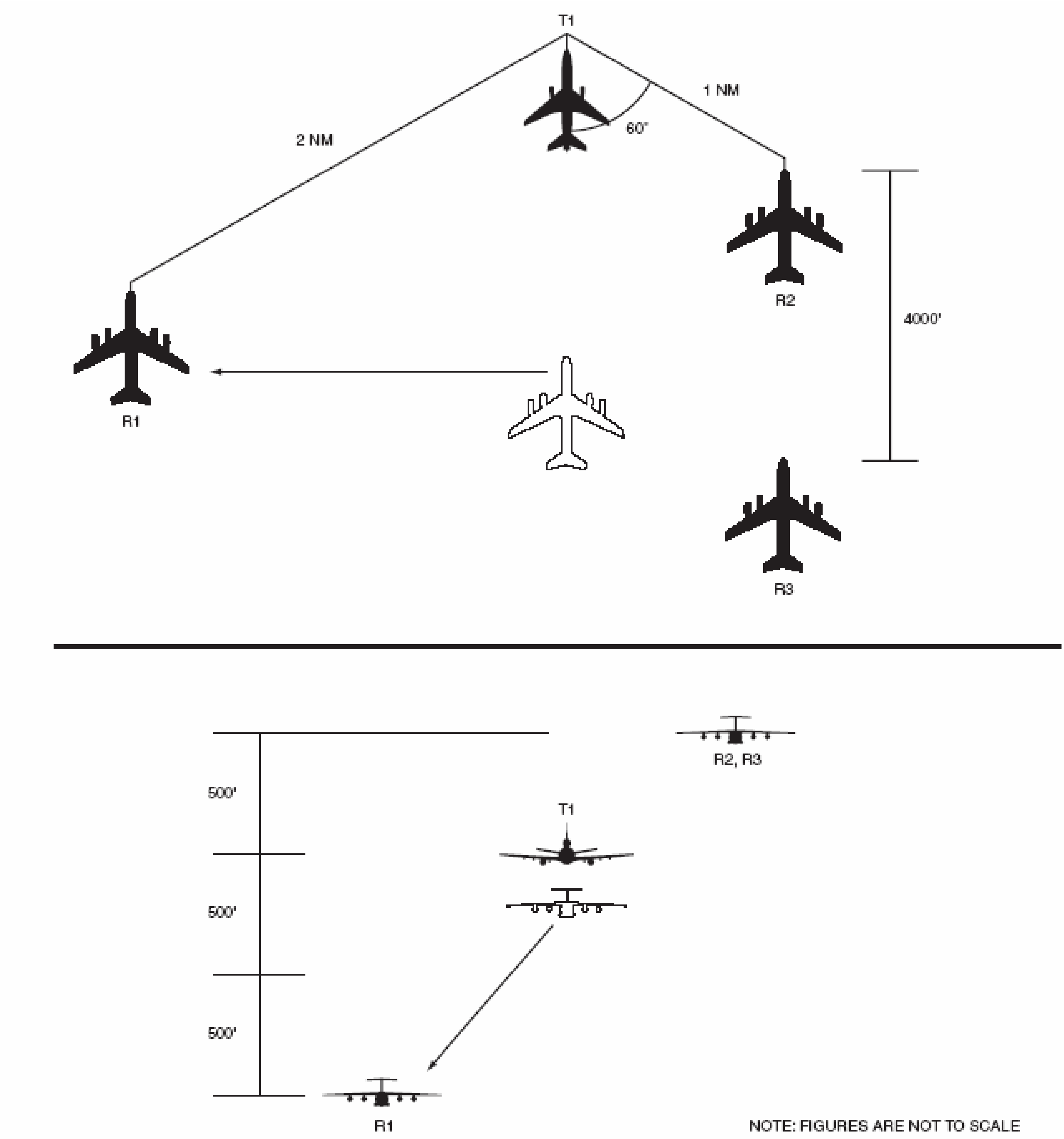


Figure 2E-3. Post AAR Procedures 3 Receivers (or 2) on 1 Tanker

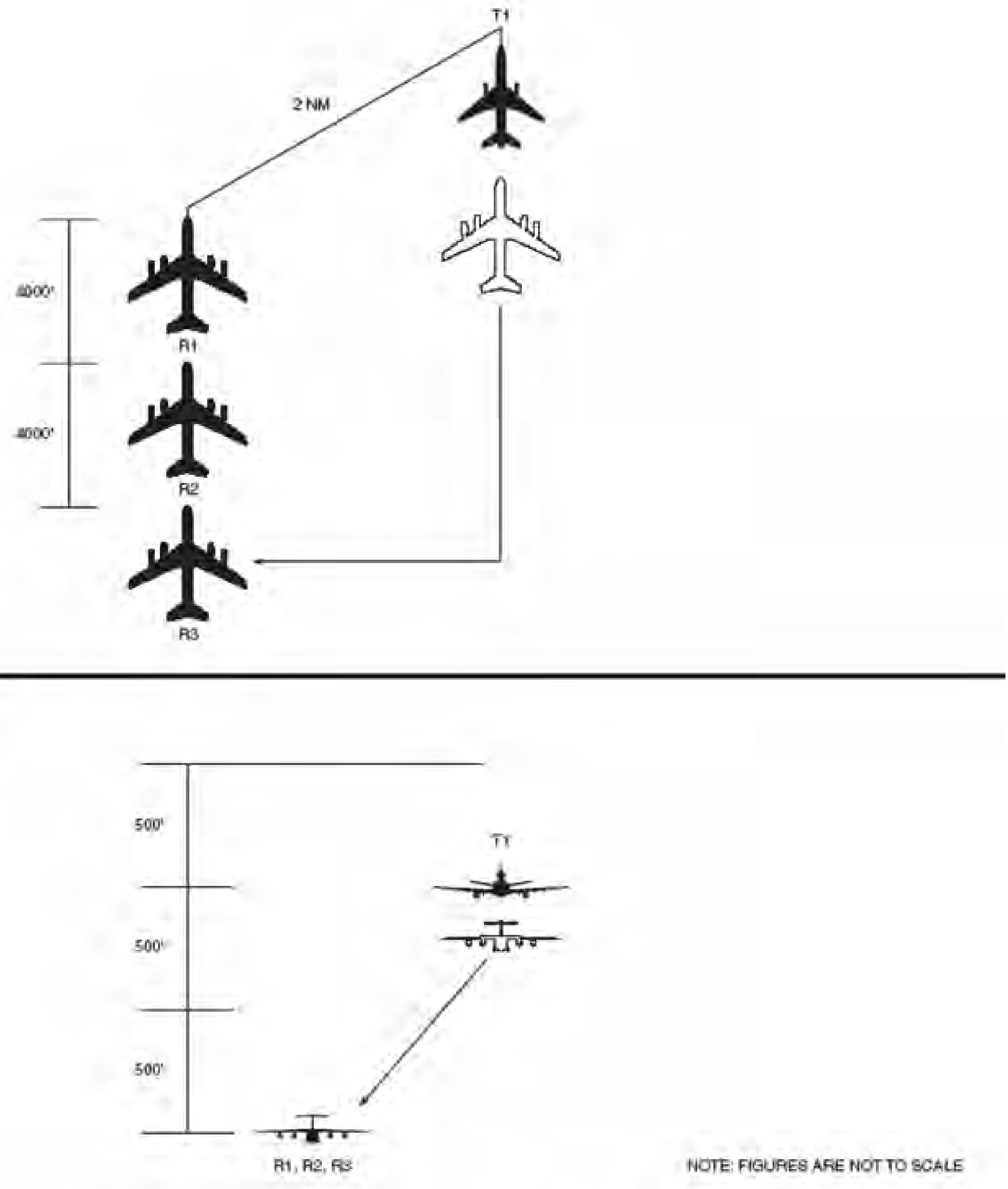


Figure 2E-4. AAR Procedures (3 Receivers on 2 Tanker)

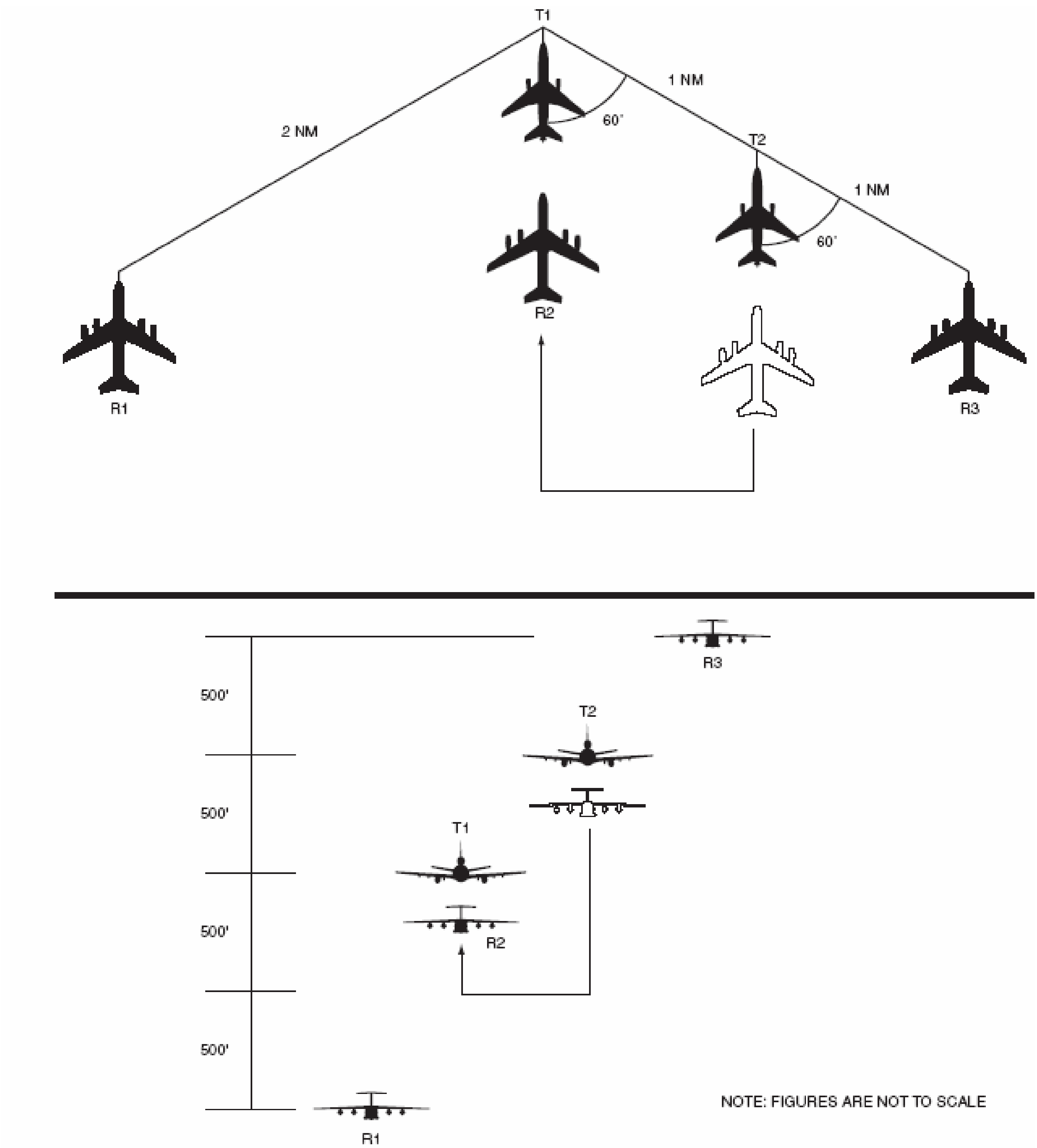


Figure 2E-5. Post AAR Procedures (3 Receivers on 2 Tankers)

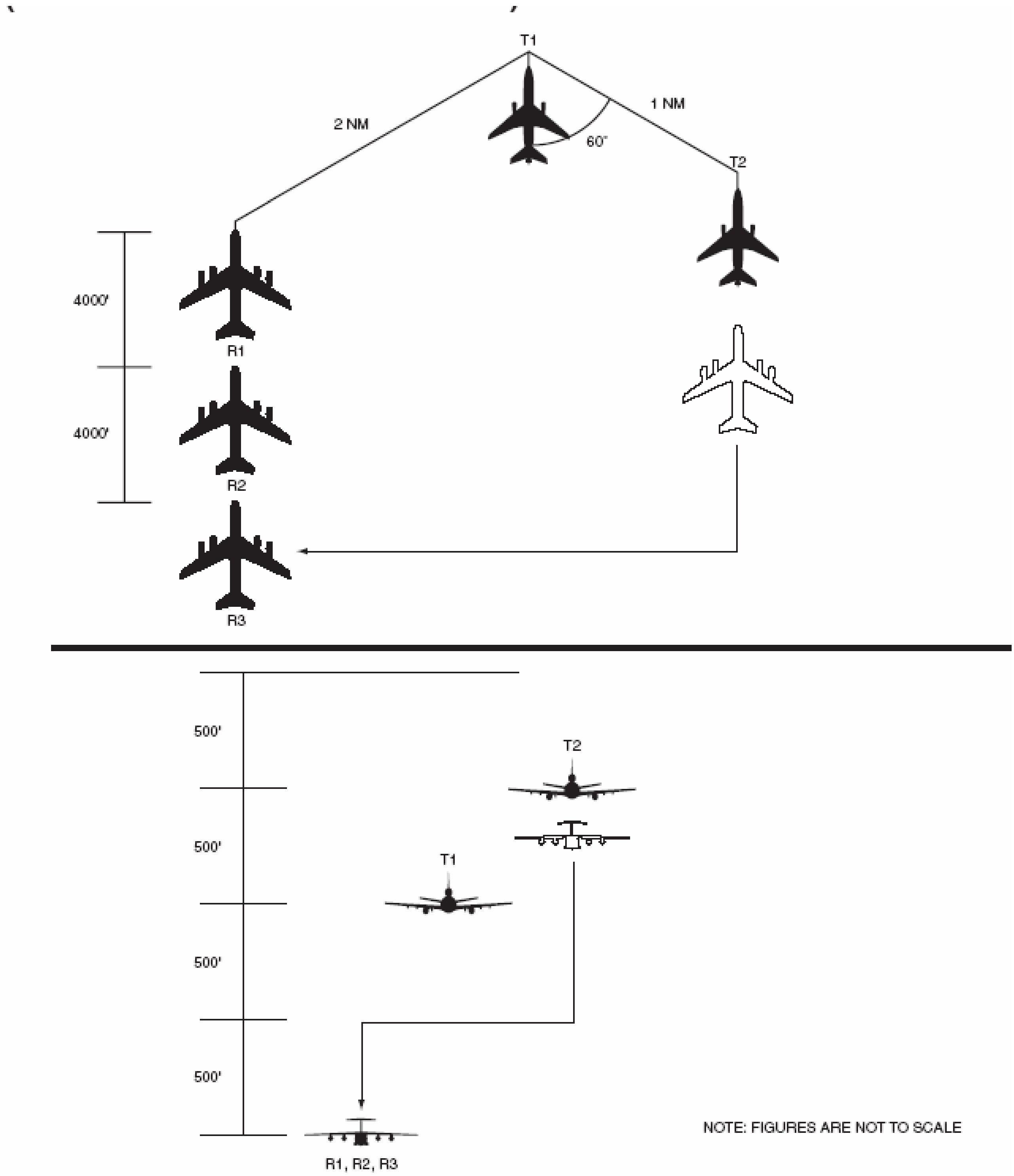


Figure 2E-6. AAR Procedures (X Receivers on X Tankers)

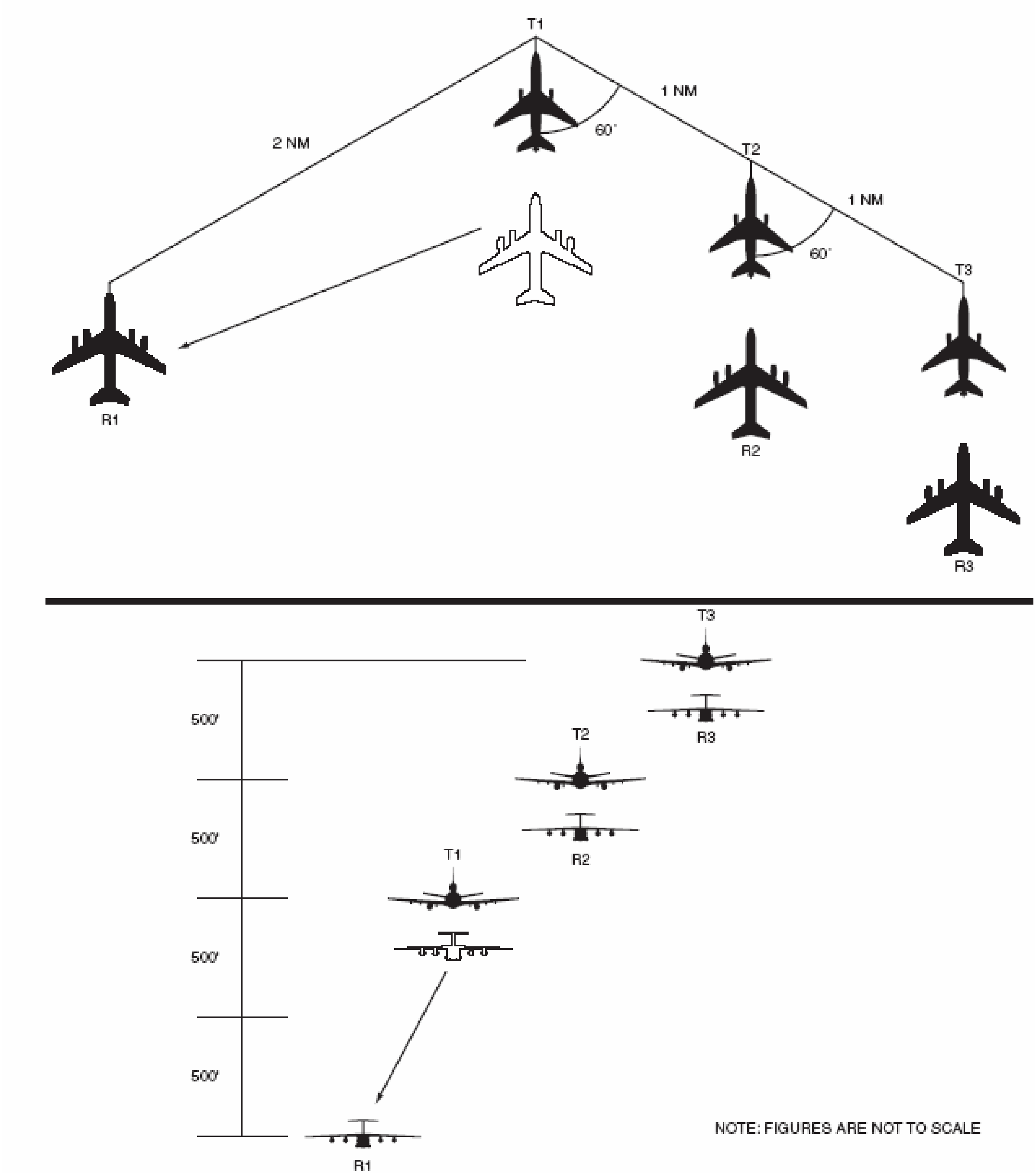


Figure 2E-7. Post AAR Procedures (X Receivers on X Tankers)

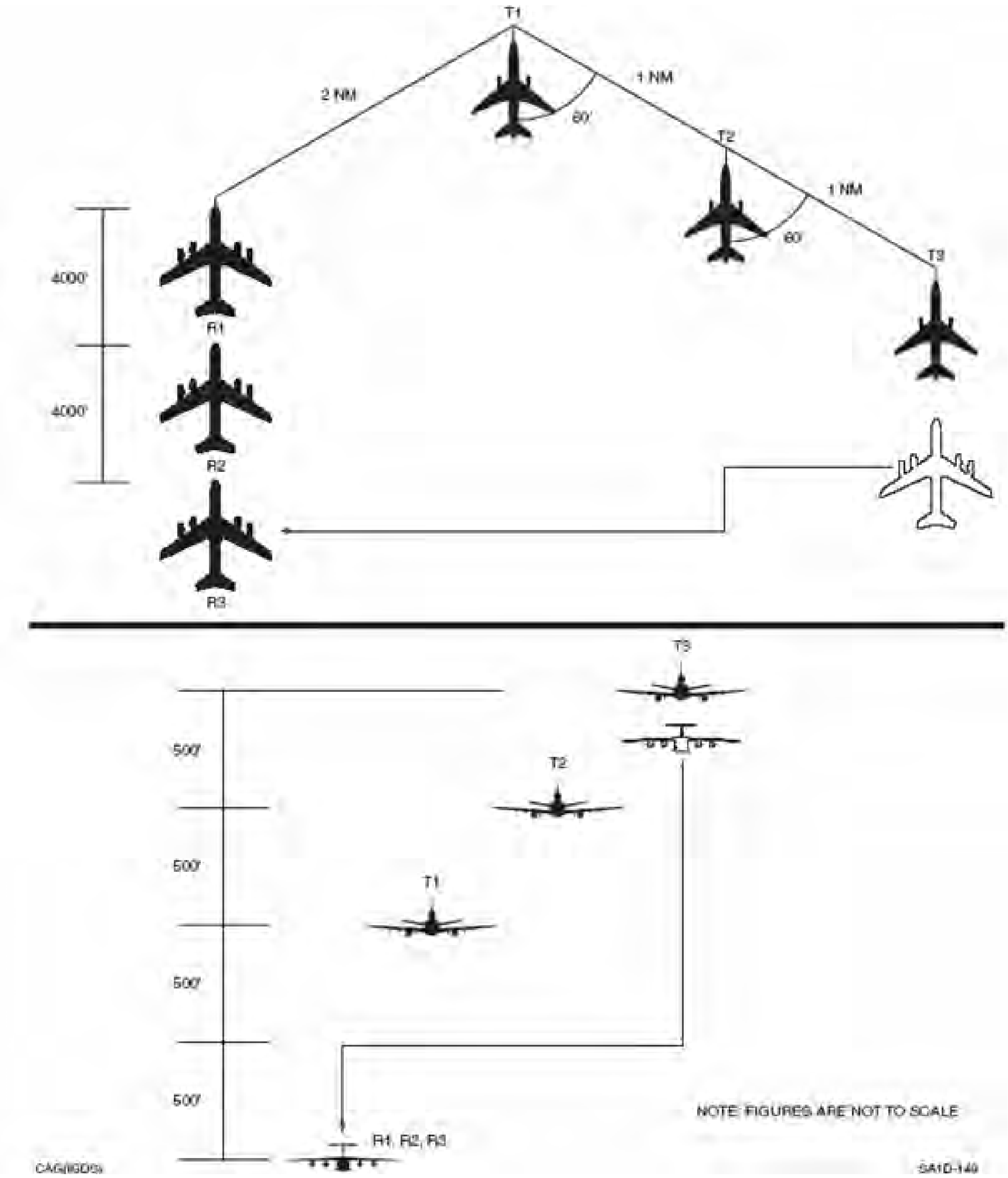
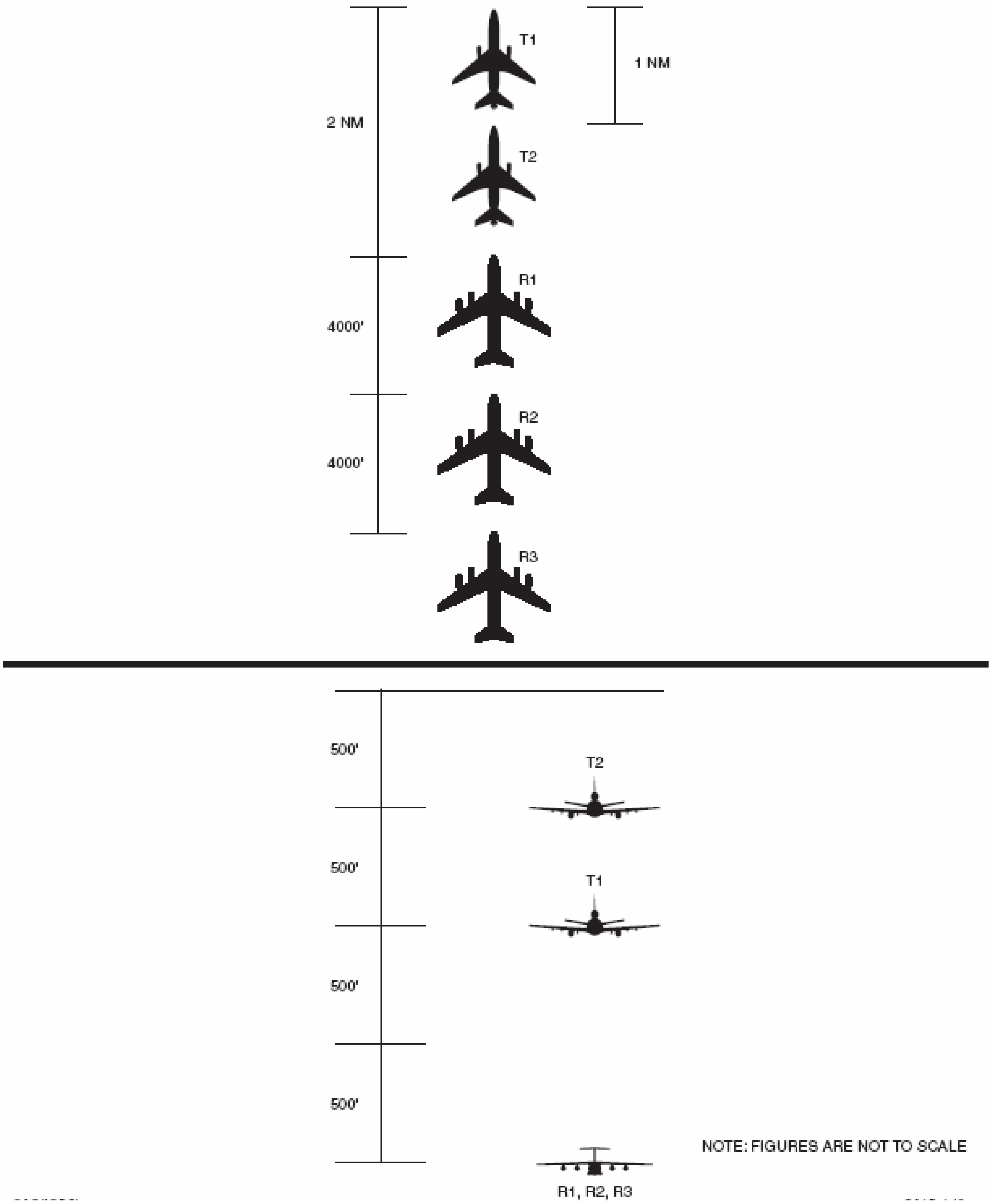


Figure 2E-8. Post AAR Turns at End of Track



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PART 2 - ANNEX 2F

Quick Flow Procedures

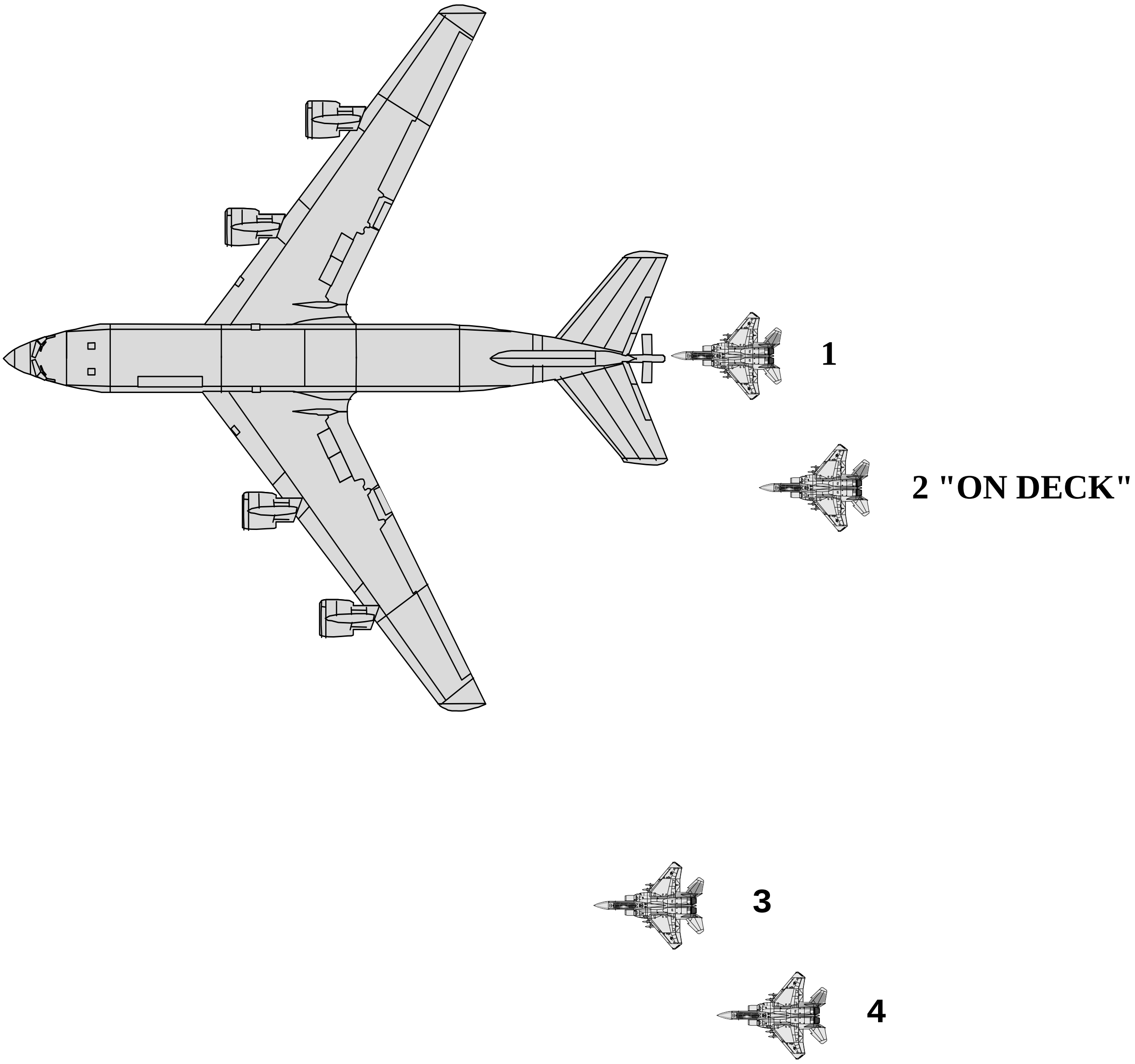
201F Quick Flow Procedure (QF) (Boom Only)

a. General. Fighter type receivers may use QF procedures to expedite AAR operations. QF allows receivers to minimize refuelling time with maximum fuel, but may be employed only during DAY or NIGHT under VMC conditions. If it appears that flight may result in penetration of adverse weather conditions, standard IMC procedures will be used. Co-ordination between tanker(s) and receivers is required prior to initiating QF procedures. Air tasking guidance, direct communication with the tanker unit or adding the term "Quick Flow" to the initial radio call will satisfy those co-ordination requirements. The Tanker lead is the final authority prior to initiating and during QF operations. Left echelon formation is normally used for QF; however, variations are authorized with prior tanker lead approval and flight lead co-ordination.

b. QF Procedures. Normally, the receiver flight will join on the tanker with the flight lead moving to the astern position. Remaining aircraft will proceed to the left observation, visual position. Once the flight lead commences refuelling, the second aircraft in the air refuelling sequence will move to the "On-Deck Position" (Figure 2F-1). The "On-Deck Position" is echelon formation on the receiver in the contact position. When the flight lead completes refuelling, that aircraft moves to an observation position on the tanker's right wing. The second receiver moves from the "On-Deck Position" to the astern and contact position. If three or more receivers are part of the fighter formation, the third receiver moves to the "On Deck" position. The left to right flow continues until all fighters have refuelled. When AAR is complete, the aircraft will depart the tanker or remain in echelon formation on the tanker's right wing for additional AAR. If further refuelling is required, reverse the above procedures with a right to left flow. The second receiver can assume a right "On Deck Position" and Quick Flow will continue in order. If additional receivers arrive prior to the first flights completion, they will remain in trail position until cleared by the tanker or observe the first flight departing the tanker.

c. Breakaw ay Procedures. In the event of a breakaway, the "On-Deck" receiver follows the receiver on the boom. Any receivers on the wing will remain with the tanker. In the event a breakaway is initiated while a receiver is transitioning from the observation position to the "On-Deck" position, that receiver will follow the receiver on the boom.

Figure 2F-1. Quickflow Air Refuelling



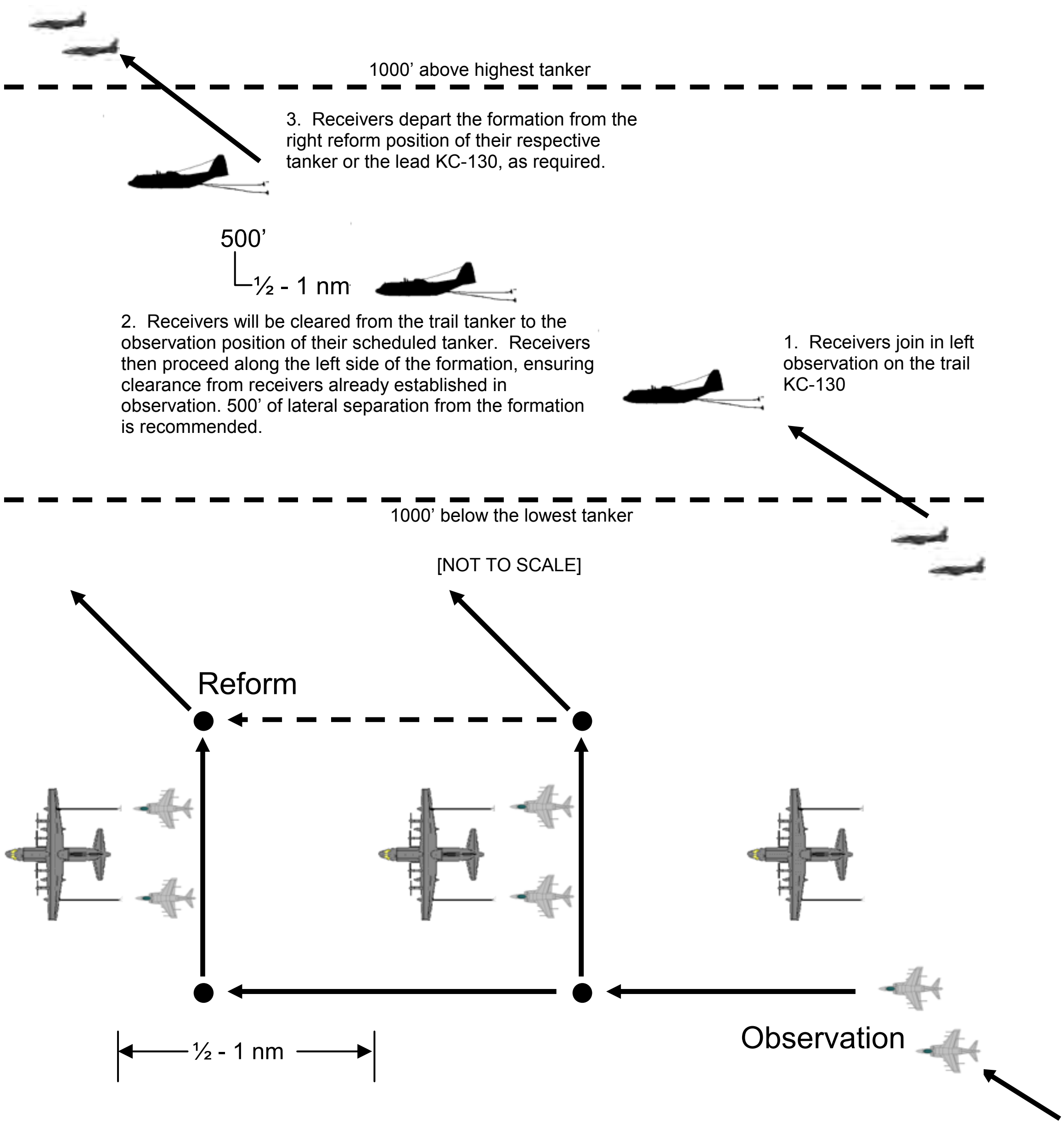
PART 2 - ANNEX 2G

KC-130 AAR Formation Procedures

201G Introduction. The USMC typically employs multiple tankers in a trail formation. This formation is similar to the cell formation commonly used by other tanker aircraft; however, tankers are stepped down vice stepped up and longitudinal separation between tankers may be as little as ½ nm. The stepped down formation and reduced separation together permit the Refuelling Area Commander (RAC), located in the last tanker, to monitor and control all refuelling operations. The RAC directs all receiver movement around the tanker formation. This formation is routinely used during multi-tanker operations on a static orbit and may also be used during force extension operations.

202G Multi-Tanker Rendezvous Procedures. The RVs employed by USMC KC-130s are the same as those for other tanker formations. RVs Alpha or Echo are used during static-orbit operations whilst, during force extension operations, the RV-Delta (Point Parallel) is the most common RV.

Figure 2G-1. USMC KC-130 Formation



203G Multi-Tanker Formation Procedures

a. Receiver Join. Receivers joining a multi-tanker formation are to join in the left observation position on the last tanker in the formation. Upon completion of the join, the receiver cruise formation is echelon in the observation position. The tankers remain in the trail formation for all phases of refuelling.

(1) Receiver Tanker Assignment. When appropriate, receivers will be cleared by the RAC to join their assigned tanker in the observation position. Receivers should anticipate receiving this clearance prior to stabilizing on the trail tanker.

(2) Receiver Joining Assigned Tanker. Once cleared, receivers move along the left side of the tanker formation to the observation position of their assigned tanker. During this manoeuvre, receivers shall exercise caution and remain clear of other receivers already established in an observation position. A lateral separation of 500 ft from the tanker formation is recommended during this procedure.

b. Receiver Refuelling Flow

(1) Astern Position. Once receivers are established in the observation position, the RAC will clear them to the astern position on the appropriate hose. Receivers should anticipate being directed to the right hose first, if available.

(a) Normally, receivers will not be directed behind an aircraft already in contact with a refuelling hose.

(b) Aircraft that are complete with refuelling on the left hose will be directed to disconnect and remain in the contact position until the receiver in the right hose has disconnected.

(2) Clearance to Contact. Once established in the astern position, receivers will be cleared to contact.

(3) Reform Position. Once receivers are refuelling complete, they will be directed to disconnect and manoeuvre to the reform position to the right of their respective tanker. With clearance from the RAC, the receiver flight lead may reform his entire flight in the reform position on the lead tanker. Receiver aircraft are to exercise caution and remain clear of other receivers already established in a reform position when manoeuvring along the right side of the tanker formation.

(4) Leaving. When cleared to leave, receiver aircraft depart the tanker formation either level or climbing.

204G Communication Procedures. The terminology used during RT-controlled evolutions is standard. Receivers should be aware that the RAC, vice individual aircraft commanders, controls all receivers in the formation. During evolutions employing min-com or radio silent procedures, observers located in the paratroop doors of the KC-130 control receiver movement via aldis-lamp signals per Part 2 Chapter 5 Figure 5C-2.

205G Procedures During IMC. The stepped-down formation employed by the USMC poses a unique problem when receiver aircraft experience a "loss of visual contact". In Part 1 Chapter 4, receivers in contact that lose sight of the tanker are instructed to initially descend 500 ft and reduce airspeed by 10 KIAS. Executing this procedure with a stepped-down formation creates a conflict between the receiver and the trailing tanker. To mitigate this hazard, the KC-130 formation should increase nose-to-tail separation to at least 1 nm. Additionally, receivers in contact that lose visual contact should climb 500 ft, vice descend 500 ft.

PART 2 – FIXED WING PROCEDURES

CHAPTER 3

Accompanied Let Down Procedures

301 General. It may occasionally be necessary for a tanker to accompany receiver aircraft from cruising level through a joint descent to a height of 500 ft AGL on the approach to a runway. The accompanied let down procedure provides a standard method of making a formation descent to a point from which a final approach and landing can be completed.

302 Criteria. When considering the use of an accompanied let down, the following criteria should be used:

a. The procedure must be fully pre-briefed with particular regard to formation procedures, speeds, angles of bank and weather minima.

b. Aircraft limiting speeds for gear and flaps must not be exceeded.

c. Single frequency approaches should be used whenever possible.

303 Considerations. In addition to the criteria at para 302 above, the following aspects should be considered:

a. The effect of wake turbulence, especially in strong crosswind conditions.

b. At night or in IMC, reduced visibility may make formation flying difficult.

c. Most receivers are sensitive to power changes, thus all tanker changes in speed or power must be called early to prevent an overtake.

d. Calls must be made when selecting services, on commencing descent or go-around and for heading changes.

e. Primary considerations for the tanker pilot must be smooth flying, accurate airspeeds and the avoidance of rapid applications of bank. Bank angle is a particular consideration bearing in mind the long moment of the wing tip from the centreline. If the tanker autopilot is in use, it is advisable to disconnect it (if possible) from automatic lateral steering and height control facilities, to avoid unexpected and rapid deviations from a steady formation lead condition.

304 Standard Accompanied Let Down. Procedures unique to specific combinations of tanker and receiver types are covered in national instructions. However, on occasion a receiver(s) may require a let down led by a tanker from another NATO nation and in circumstances where pre-briefing or in-flight briefing is not possible. The following NATO Standard Accompanied Let Down should be used in these circumstances:

a. The tanker assumes responsibility for radio communication with the ground on behalf of the whole formation. The tanker navigates to the destination airfield or responds to ground directions.

b. When appropriate, the formation descends to FL100/10,000 ft at the refuelling airspeed, avoiding high rates of descent.

c. During the descent from FL100/10,000 ft to the runway instrument pattern height, the formation progressively reduces speed to 200 KIAS.

d. The tanker should request a runway instrument approach with, if possible, a straight-in approach.

e. At 3 nm or 500 ft AGL the tanker adopts the go around/overshoot procedure, the receiver reduces to landing speed and lands.

NOTE

Consider progressive speed reduction to be at 250 KIAS by 10,000 ft (for FAA and Canadian Regs).

PART 2 – FIXED WING PROCEDURES

CHAPTER 4

Safety Procedures

401 Introduction. The foundation for the safe conduct of AAR by national or multi-national forces is standard, simple and unambiguous procedures. With these criteria established, multi-national AAR is practicable by day and night, and during periods of EMCON constraint.

402 Rendezvous

a. Vertical Separation. Regardless of the method used to achieve a RV, it is vital to minimize collision risks by establishing a vertical separation between tanker and receiver; this vertical separation should be maintained until the receiver commences a visual join with the tanker.

b. Receiver Joining Tanker from Below. In some scenarios, prior to the start of the RV procedure, the receiver may be cruising above the level of the tanker. Nevertheless, unless otherwise directed, and to achieve a commonality of practice, the receiver should descend and establish itself at least 1000 ft below the tanker before commencing the RV procedure. The cockpit view for receivers is usually better looking forward and upwards; moreover, a join from below allows the receiver greater freedom for manoeuvre with less risk of losing visual contact with the tanker.

c. Ultra Low Level AAR. In some circumstances (eg ultra low-level AAR), a join from below may not be possible, in which case the tanker is to specify the exact nature of the join. If an RV is planned with a non-standard vertical separation, this should be specified in the tasking message, SPINS or at the briefing stage.

403 Joining - Safety Considerations

a. Probe and Drogue Refuelling

(1) To complete a safe join, the receiver should achieve a stable formation position (ie zero rate of closure) on the tanker before manoeuvring to the astern position. Stable formation must be achieved in a position where an error of judgement in the join does not lead to a collision risk with the tanker.

(2) Longitudinal distance from the tanker and rate of closure from behind are the most difficult features to assess, particularly at night; therefore, a direct join to a position behind the tanker should <u>not</u> be attempted.

(3) Accordingly, all joins should be made to a loose echelon position in the observation position; thus errors in line and overtake speed can be corrected clear of the tanker.

b. Boom. Although receiver may join directly behind the boom, the considerations described in para 403a(1) applies equally to receivers joining a boom equipped tanker.

404 Refuelling

a. Standardization. To achieve safe refuelling the standardised radio terms in Part 2 Chapter 5 Annex 5B are to be used. A procedure for light signals to achieve safe radio silent AAR is at Part 2 Chapter 5 Annex 5C. However, it is recognised that not all NATO aircraft carry the necessary lights to fully implement these procedures at this time; national variations to light signals are contained in National Annexes at Part 5.

b. Probe and Drogue AAR Over Land. AAR involves a small risk of parts of the tanker's/receiver's AAR equipment detaching in-flight; broken probe nozzles are the most common occurrence and not all nozzles are retained in the tanker's drogue coupling. Furthermore, on a few occasions, a tanker hose has separated from the aircraft. The civil population (and their property) should not be exposed to avoidable hazards; therefore routine AAR (including hose trail and wind) is not normally to take place over populated areas.

c. Trailing Hoses – Inadvertent Separation. If the tanker has not trailed refuelling hoses before receiver join, the tanker will direct receivers to remain clear of the below and aft position of the refuelling hoses whilst the hoses are trailed. The majority of inadvertent hose departures (separation from the aircraft) from tankers occur during trailing or rewinding of refuelling hoses.

d. Trailing and Winding Hoses. If a tanker hose is trailed or wound when the aircraft is not steady in straight and level flight, the hose may not feed correctly off or onto the hose drum; this could cause the hose to jam. The risk is small but can be easily avoided without significant operational penalties; therefore hoses:

(1) Are not to be moved during aircraft attitude changes.

(2) Should only be wound during turns in cases of operational necessity.

(3) May be trailed and wound in a steady climb or descent.

(4) May be trailed during a steady turn.

e. Probe and Drogue Contacts and Disconnects. The rear viewing system of most multi-point tankers can only monitor the approach path to one wing hose at a time. Therefore, unless the tanker approves simultaneous receiver contact, the following guidelines should be adopted:

(1) Simultaneous AAR. For simultaneous AAR, one receiver is to be in contact (with fuel flowing if wet) before the second receiver is cleared for contact.

(2) Simultaneous Disconnect. Normally, receivers will be cleared to disconnect simultaneously.

(3) Individual Receiver Disconnect. Receivers may be cleared to disconnect individually if disparate fuel transfers exist. An individual disconnect may disturb the hose for the receiver remaining in contact; therefore, during receiver CONVEX, tankers may only order individual disconnects with the approval of the receiver leader or in the event of a spokes contact.

(4) Contacts/Disconnects – Straight and Level. There is considerable potential for receiver pilot disorientation during AAR, particularly at night or when horizons are ill defined; this can be exacerbated by the wing anhedral/dihedral of some tankers giving false horizontal cues. Ideally, all contacts and disconnects should occur in straight and level flight, although by day experienced pilots may make contacts/disconnects in steady turns, climbs and descents providing the formation is clear of cloud and the drogues are stable.

(5) Prohibited Contacts/Disconnects. Contacts/disconnects are not to be permitted during tanker attitude changes.

(6) Contacts/Disconnects – CONVEX. Some nations require that, during receiver CONVEX, tankers will order all contacts/disconnects in straight and level flight unless the receiver supervisory pilot requests otherwise for training purposes.

(7) Contacts/Disconnects – Night. By night, extra caution is needed to guard against disorientation. Therefore, with due regard to prevailing visual conditions, the tanker may permit contacts and disconnects at night whilst in a steady turn/climb/descent. Where a receiver pilot subsequently elects to make contact or disconnect only in straight and level flight, they should, if possible, inform the tanker. Some nations will not permit night contacts or disconnects in a steady turn/climb/descent unless operationally necessary.

f. Damaged Spokes. A receiver pilot damaging the spokes is to call 'spokes'. If the probe has penetrated the drogue structure, the receiver pilot is to hold a stabilized in-contact position; the tanker is to order the receiver to 'maintain position'. This will allow a controlled sequence of actions to minimize further damage to the tanker and receiver(s). When conducting multi-point simultaneous AAR, the tanker is then to order the unaffected receiver to disconnect and move to an echelon position. The affected receiver is then to be ordered to disconnect; the receiver is to disconnect in accordance with advice given in its own aircraft manual.

(1) Subsequent Actions - Tanker. Damaged spokes will impair the structural integrity of the drogue so it is not to be used for further AAR. Before, a multi-point tanker continues AAR with its serviceable hose, tanker crews will follow tanker-specific procedures for the damaged hose.

(2) Subsequent Actions – Receiver. When spokes damage occurs, the drogue may shed debris; and there is a significant probability of the receiver's engine(s) ingesting the debris. When clear of the tanker, receiver pilots are to check engine instruments to assess possible damage, and if practical, have an airborne inspection to check for airframe damage. Receiver pilots are then to proceed as follows:

(a) Operational Sorties. Where operational considerations are paramount, the sortie may be continued if there are no signs of engine or airframe damage. The receiver pilot is to advise the tanker accordingly.

(b) AAR Deployments. Where there are no signs of damage, it may be preferable to continue with the deployment rather than embark on a long diversion to a foreign airfield where the aircraft may be grounded awaiting technical assistance. The receiver leader is to advise the tanker of the preferred course of action. The tanker is to assess the effect of the receivers' wishes upon the safety of the formation; in particular, the implications of single hose AAR upon the overall plan are to be considered. The final decision on whether to continue or divert the formation (or part of it) rests with the tanker.

(c) Training/CONVEX Sorties. Experience shows that even though there may be no indication to the receiver pilot of malfunction, engines sustain damage caused by ingestion of pieces of the drogue on 25% of all spokes contacts. Unless there are overriding reasons to continue the sortie, the safest course of action is to divert to the nearest suitable airfield.

(3) After Landing. In all cases, the engine(s) of a receiver aircraft that has had a spokes contact is to be inspected after landing for possible damage.

g. Locked Receiver Nozzle. Exceptionally, it is possible that the receiver probe nozzle may jam in the drogue reception coupling.

(1) If difficulty is experienced in disconnecting, the receiver pilot is to maintain a stabilized in-contact position; the tanker is to be informed so that the receiver on the other hose (if any) can be order to disconnect.

(2) When ordered by the tanker to disconnect, the receiver with the jammed nozzle is to withdraw down the natural line of the hose; throttles may have to be fully retarded to achieve separation.

(3) Upon disconnect, the receiver is to immediately go to an echelon position; parts of the probe and/or drogue may separate from the receiver and the tanker.

(4) The affected hose is not to be used for further AAR.

(5) The receiver pilot is to proceed in accordance with the instructions given in his aircraft manual.

h. Boom. The following warnings, cautions and notes are specific to boom AAR:

WARNING

The receiver will stabilize with zero rate of closure in the astern position. If the receiver fails to attain stabilized position or it becomes apparent that a closure underrun will occur, breakaway procedures will be initiated. Failure to do so can result in a mid-air collision. Furthermore, the majority of damaged booms result from receivers closing too fast and exceeding the AAR envelope (inner limit). It is critical for receivers to stabilize with a zero rate of closure prior to the boom/AAR systems operator clearing the receiver to contact.

CAUTION

- **A receiver approaching the boom limits at relatively high velocity can cause structural damage as a result of an inability to disconnect due to binding action of the boom nozzle.**
- **Disconnect or breakaway procedures will be initiated any time the receiver becomes erratic within the AAR envelope or damage to either aircraft appears imminent.**
- **Receiver pilots should not attempt to push the boom in during boom telescope failure**

NOTE

If radio communication between the boom operator and the receiver pilot is lost or unreliable, contacts are not permitted unless operationally necessary.

405 Options to Reduce the Likelihood of Employing Loss of Visual Contact (Lost Wingman) Procedures

a. Maximum Number of Receivers – VMC. In day VMC, the number of receivers assigned to a tanker will be limited only by boom or hose cycle time, receiver bingo fuel requirements, or the tanker's offload capability.

b. Avoidance of Weather. If a tanker or receiver identifies flight conditions ahead of the formation (visually, using radar, reports from aircraft ahead or from ATC) that could result in one or more formation members losing visual contact with other formation members, the tanker should avoid the area using navigational turns and co-ordination with ATC.

c. Formation Entering Weather. In the event that the formation enters an area of reduced visibility, the tanker should endeavour to maintain straight and level flight. If turns are necessary, they should be made using 10º AOB and called over the radio. In addition, the tanker will state the approximate roll out heading.

Tanker call: "HAPPY 25, turning right, rollout heading 250."

Tanker executes turn.

d. Formation Management

(1) Actions to Mitigate Risk of Loss of Visual Contact (Lost Wingman). When in-flight conditions are likely to impede safe operations of large formations on the wing of the tanker, the tanker and/or receiver formation lead should consider re-distributing receivers around the tanker. Such actions as restricting the number of receivers on a wing or moving some or all receivers into radar trail (provided that the lead receiver in each element is suitably equipped with a serviceable radar) should be considered.

(2) Large Receiver Formations. Nations have different definitions of a "standard formation". For instance, within the UK, a formation:

> "is considered as a single unit for separation purposes provided that the formation elements are contained within one mile laterally and longitudinally and are at the same level."

This contrasts with FAA regulations where:

> "a "standard formation" is one in which a proximity of no more than 1 mile laterally or longitudinally and within 100 ft vertically from the flight leader is maintained by each wingman."

In all cases, the formation leader is responsible for separation between units comprising the formation. This is known as MARSA – Military Accepts Responsibility for Separation of Aircraft. Also, whenever a tanker/receiver formation transits a nation's airspace, the tanker (as the formation lead) must be aware of the formation regulations that govern that airspace and brief the receivers accordingly. Importantly, if the formation occupies or plans to occupy a volume of airspace (ie. vertically, horizontally or longitudinally) in excess of that defined by the Aeronautical Information Publications appropriate to the airspace, it is imperative that approval for using the additional airspace is obtained from the authority responsible for controlling the airspace.

(a) Formation Size – Night/IMC. During night and/or IMC, the tanker/receiver formation lead should limit the size of the formation operating on the tanker. In such situations, normally, no more than 12 receivers will be in formation with a single tanker, with no more than 3 receivers in close formation on each wing (see para 405d(2)(b)).

(b) Receivers on Tanker's Wing – Night/IMC. Normally, during night and/or IMC, the tanker should restrict the number of receivers in close formation with the tanker to a maximum of 6. These aircraft can be distributed with a maximum of 3 on each wing. Importantly, when a receiver is positioned astern of, or in contact with, a fuel transfer system, a wing position must be left vacant for each such receiver to accommodate the receiver(s) when refuelling is complete.

(c) Receivers in Trail. When the wing positions are full (to include those positions reserved for receivers astern of, or in contact with, the fuel delivery system), other aircraft/elements should be directed to assume a trail position. The first element should be 1 to 1½ nm behind the tanker and stepped down 1000 ft below their tanker's altitude. The second trail element should be 1 to 1½ nm behind the first element and stepped down 1000 ft below the first element's altitude, but see para 405d(2) for ATC considerations.

(d) Large Formation – Receiver Distribution. During pre-mission briefing for large formations, the tanker and formation lead should agree on a distribution plan for the receivers around the tanker in the event of night/IMC. Whilst numerous factors will help determine the most appropriate plan for a specific mission, Figure 1-1 illustrates one possible formation suitable for both boom and centreline hose receivers. Figure 1-2 offers a suggested formation for twin probe and drogue operations. In both cases, receivers are shown in the astern position; normally when not refuelling, these receivers will be positioned on the tanker's wing.

(e) Receivers – Tanker Formations. For formations of tankers, only the last tanker will have receivers in trail.

(3) Additional Receivers – Joining (Night/IMC). In night and/or /IMC conditions, additional receivers should not be cleared to join the tanker when 3 receivers are already in both the observation and reform positions. Where less than 3 receivers are on a wing, additional receivers may be cleared to join that wing so long as they:

(a) Remain visual with the tanker and all receivers during the join.

(b) Join on the outside of the formation already on the wing.

(c) The total number of receivers on a wing does not exceed 3.

(4) Tanker Management of Receivers. A large formation of up to 12 receivers against one tanker requires extensive coordination between the tanker and receiver formation lead. This is because there will be almost continuous receiver manoeuvring as receiver elements completing refuelling move aft and trailing elements move forward to the tanker's wing. To expedite this movement, the tanker should use the following procedures when directing the receiver aircraft.

(a) Tanker. The tanker should be in straight and level flight.

(b) Tanker Manoeuvring for Weather. For tanker actions when approaching weather see paras 405b and 405c.

(c) Manoeuvring of Receiver Elements

(i) Element Moving Aft. The receiver element moving to trail from the observation or reform position is to reposition first by moving aft and then down 500 ft.

(ii) Elements Moving Forward. The trailing elements are not to move forward until lateral and vertical separation with the tanker and other receiver elements is confirmed using visual, radar, TCAS, A/A TACAN or other means.

(iii) Elements Leaving In-Trail Altitude. Elements moving forward may only leave their in-trail altitude when:

(A) Visual with both the tanker and any receiver elements between them and the tanker and able to remain clear of such elements when manoeuvring.

OR

(B) Each in-trail element has confirmed and deconflicted its longitudinal and vertical position with respect to the tanker and other receiver elements using visual, radar, TCAS, A/A TACAN or other means.

(iv) Element Closest to Tanker. Once paras 405d(4)(c)(ii) and (iii) are satisfied, the element closest to the tanker may close to radar lock-on limits, or visual limits (as stipulated in Part 2, Chapter 1) if radar is not working/fitted. Once visual with the tanker, the tanker may clear the element to close to the wing and/or boom as appropriate.

(v) Subsequent Trailing Element. Once the element closest to the tanker has vacated its in-trail position, the next trailing element will move forward to 1nm to 1½ nm in trail of the tanker. Only when it has fulfilled the criteria paras 405d(4)(c)(ii) and (iii), will the element climb to 1000 ft below the tanker's altitude.

(vi) Descent of Element Moving Aft. The receiver element moving to the trail position will continue to move aft to the last in-trail position at 500 ft below the tanker. Once the first and second elements have moved forward and are confirmed to be ahead of the element moving aft using visual, radar, TCAS, A/A TACAN or other means, the latter may descend to the appropriate in-trail altitude (1000 ft below the tanker if there is only one trail element or 2000 ft below the tanker if there are two trail elements).

(d) Tanker to Tanker RVs. During tanker-to-tanker RVs, the tanker escorting the fighters should be at the lower altitude. If the escorting tanker is at the higher altitude, additional altitude separation between formations will be required.

Figure 1-1. Night/IMC Formation Suitable for Both Boom and Centreline Hose Receivers

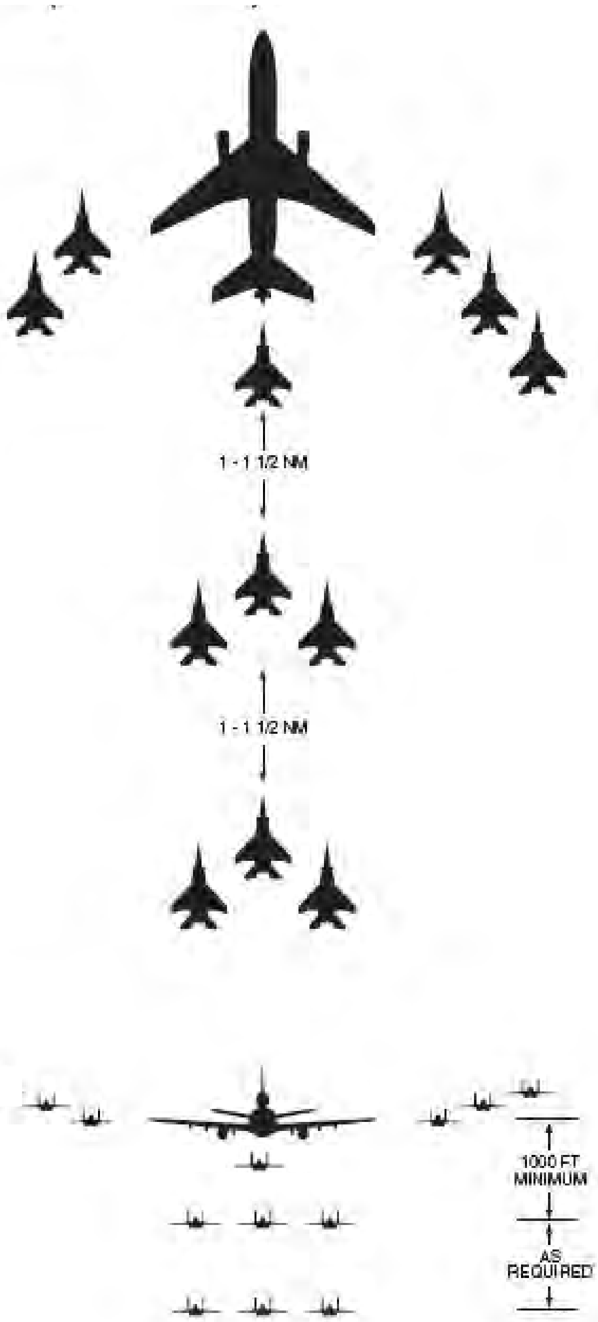
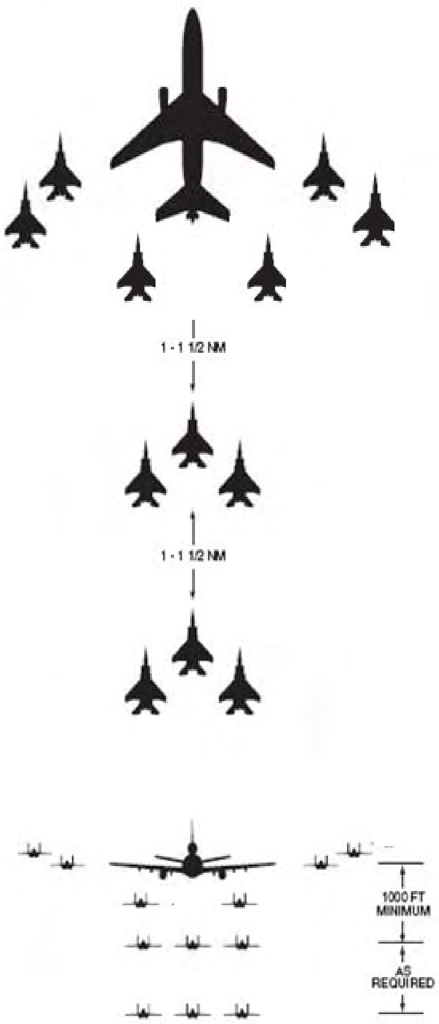
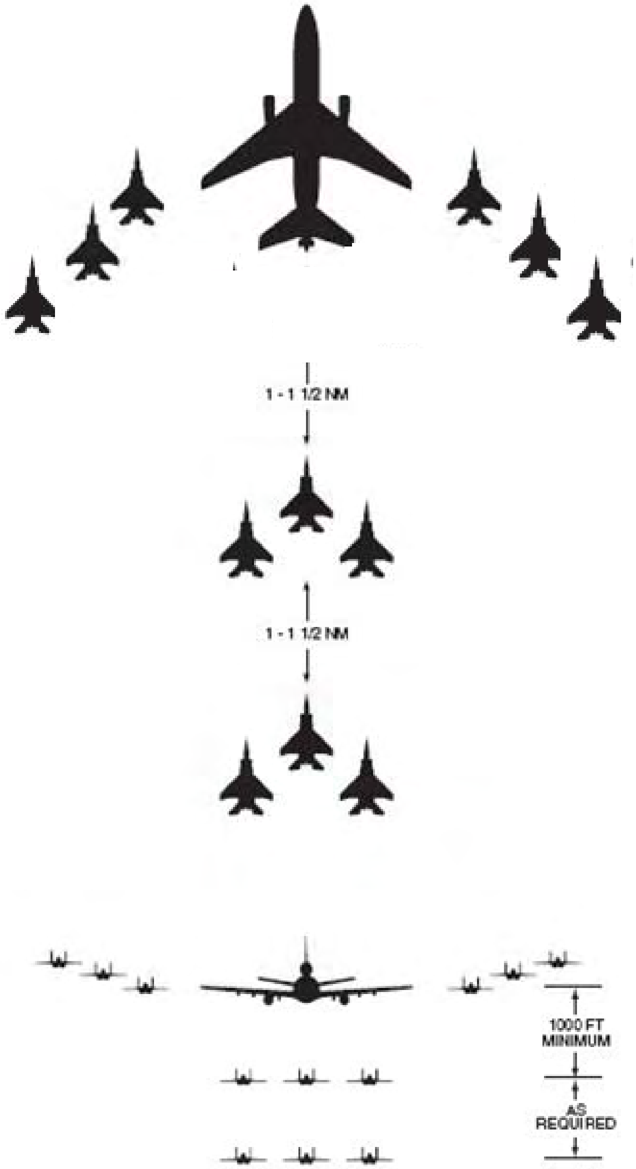


Figure 1-2. Night/IMC Formations Suitable for Dual Probe and Drogue Receivers



or



406 Loss of Visual Contact (Lost Wingman) – Receivers on Tanker Wing in Single Tanker Formation

a. Immediate Actions upon Loss of Visual Contact. Any aircraft in close formation that loses visual contact with the tanker or the receiver upon which it is formating is to take immediate action to achieve safe separation from the tanker, and if necessary, other receivers. This will be achieved by executing Loss of Visual Contact (Lost Wingman) Procedures whilst simultaneously transitioning to flight instruments. The receiver is to call:

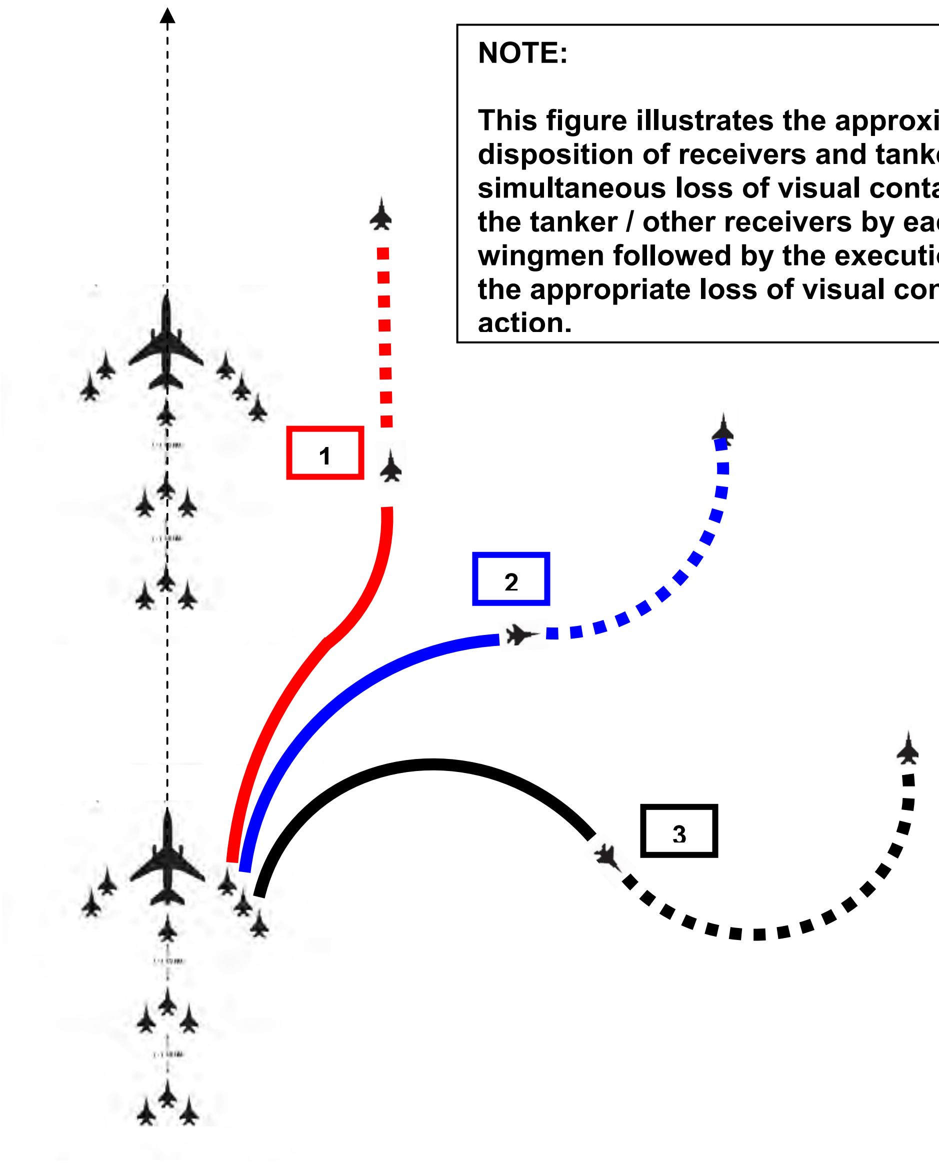
• '(Callsign) loss of visual contact
or
• '(Callsign) lost wingman'.

b. Specific Tanker and Receiver Actions

TANKER ACTIONS				
(1) Assume Steady Heading		**(2) Subsequent R/T Calls**		**(3) Navigation Aids**
If turning, the tanker is to call: **a.** • '(Callsign) Rolling out heading XXX°' Thereafter, the tanker is to roll wings level.		The tanker is to transmit the following on the AAR frequency: • Its heading (stating °T or °M). (If rolling out of a turn, the tanker will give the heading it intends to maintain after rollout.) • Its FL/altitude/height. • Its speed. • The receiver A/A TACAN channel.		The tanker will: • Select the tanker A/A TACAN channel. • Attempt to establish receiver position(s) by all available means (Radar, TCAS, ATC, DATA LINK etc).

<table>
<tr><th colspan="3">RECEIVER ACTIONS</th></tr>
<tr><td colspan="3">Receivers(s) Astern or Contact. Receiver(s) astern or in contact losing visual contact with the tanker will execute the procedures described in para 409.</td></tr>
<tr><td colspan="3">Receivers on Tanker's Wing. Upon losing sight of the element upon which it is formating, or if unable to maintain formation due to spatial disorientation (SD), the receiver will simultaneously execute the applicable loss of visual contact (lost wingman) procedures described below while transitioning to instruments.</td></tr>
<tr><th colspan="3">Tanker Straight and Level (Figure 1-3)</th></tr>
<tr><th>Receiver Closest to Tanker Wing (No 1)</th><th>Receiver on Wing of No 1 (No 2)</th><th>Receiver on Wing of No 2 (No 3)</th></tr>
<tr><td></td><td>• Attempt to remain in formation with the No 1.</td><td>• Attempt to remain in formation with the No 2.</td></tr>
<tr><td></td><td>If visual contact cannot be maintained, the second in echelon will:</td><td>If visual contact cannot be maintained, the third in echelon will:</td></tr>
<tr><td>• Turn away from the tanker's heading using 15° AOB for 15 sec (15:15).</td><td>• Turn away from the tanker's heading using 30° AOB for 30 sec (30:30).</td><td>• Turn away from the tanker's heading using 45° AOB for 30 sec (45:30).</td></tr>
<tr><td>• Resume the tanker's heading to parallel track</td><td>• Resume the tanker's heading to parallel track.</td><td>• Resume the tanker's heading to parallel track.</td></tr>
<tr><th colspan="3">Tanker Turning - Receiver on Outside of Turn (Figure 1-4)</th></tr>
<tr><th>Receiver Closest to Tanker Wing (No 1)</th><th>Receiver on Wing of No 1 (No 2)</th><th>Receiver on Wing of No 2 (No 3)</th></tr>
<tr><td></td><td>• Attempt to remain in formation with the No 1.</td><td>• Attempt to remain in formation with the No 2.</td></tr>
<tr><td></td><td>If visual contact cannot be maintained, the second in echelon will:</td><td>If visual contact cannot be maintained, the third in echelon will:</td></tr>
<tr><td>• Turn away from the tanker by rolling through wings level to achieve 15° AOB in the opposite direction.</td><td>• Turn away from the tanker by rolling through wings level to achieve 30° AOB in the opposite direction.</td><td>• Turn away from the tanker by rolling through wings level to achieve 45° AOB in the opposite direction.</td></tr>
<tr><td>• Maintains this turn for 15 sec (15:15).</td><td>• Maintain this turn for 30 sec (30:30).</td><td>• Maintain this turn for 30 sec (45:30).</td></tr>
<tr><td colspan="3">• Resume the tanker's heading to parallel track.</td></tr>
<tr><th colspan="3">Tanker Turning - Receiver on Inside of Turn (Figure 1-5)</th></tr>
<tr><th>Receiver Closest to Tanker Wing (No 1)</th><th>Receiver on Wing of No 1 (No 2)</th><th>Receiver on Wing of No 2 (No 3)</th></tr>
<tr><td></td><td>• Attempt to remain in formation with the No 1.</td><td>• Attempt to remain in formation with the No 2.</td></tr>
<tr><td></td><td>If visual contact cannot be maintained, the second in echelon will:</td><td>If visual contact cannot be maintained, the third in echelon will:</td></tr>
<tr><td colspan="3">• Momentarily reduce power to ensure nose-tail separation.</td></tr>
<tr><td>• Roll into turn to achieve 15° AOB.</td><td>• Roll into turn to achieve 30° AOB.</td><td>• Roll into turn to achieve 45° AOB.</td></tr>
<tr><td>• Maintains this turn for 15 sec (15:15).</td><td>• Maintain this turn for 30 sec (30:30).</td><td>• Maintain this turn for 30 sec (45:30).</td></tr>
<tr><td colspan="3">• Resume the tanker's heading to parallel track.</td></tr>
</table>

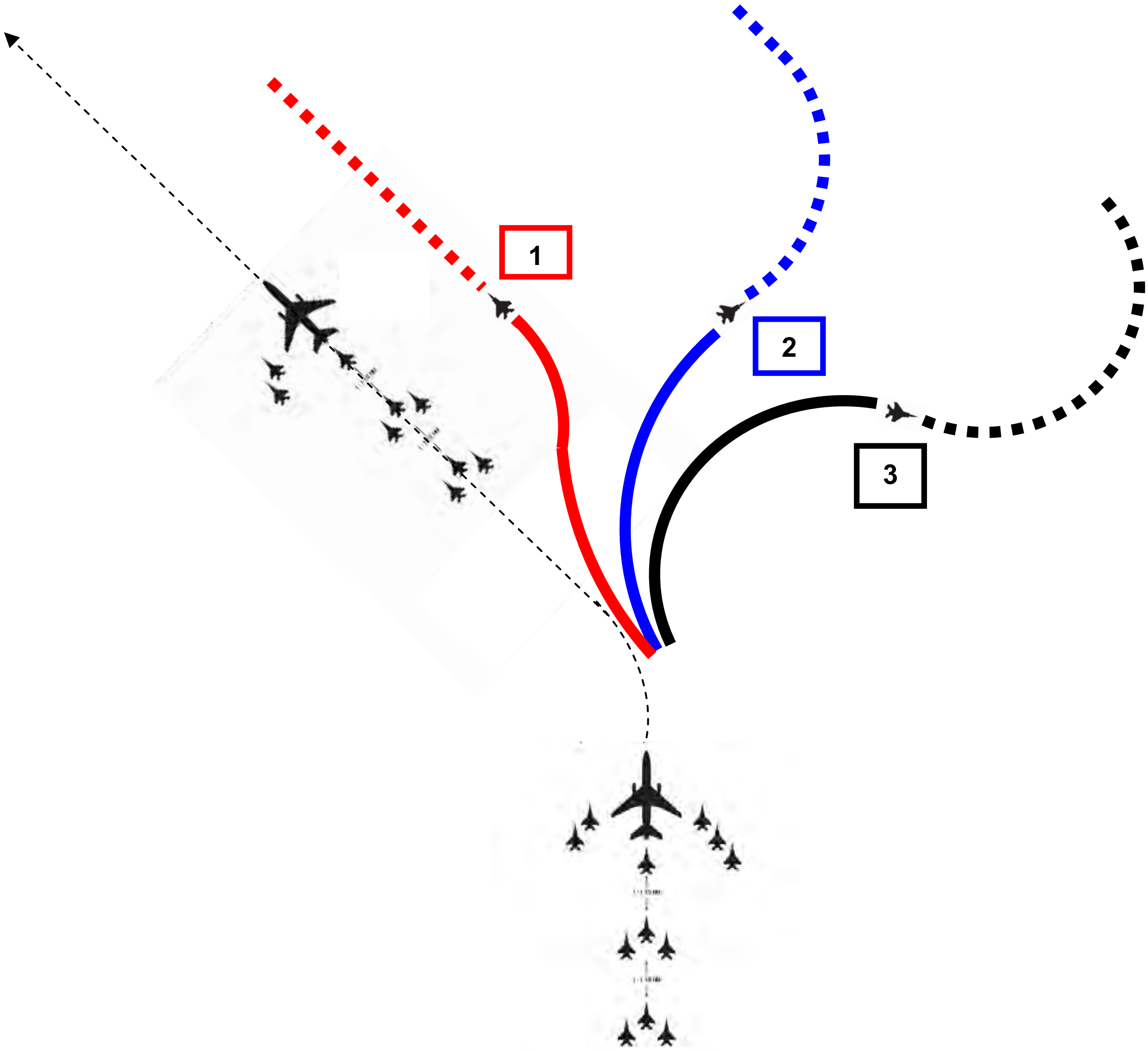
Figure 1-3. Loss of Wingman – Tanker Straight and Level



NOTE:

This figure illustrates the approximate disposition of receivers and tanker after simultaneous loss of visual contact of the tanker / other receivers by each of 3 wingmen followed by the execution of the appropriate loss of visual contact action.

Figure 1-4. Loss of Wingman – Receivers on Outside of Turn



NOTE:

This figure illustrates the approximate disposition of receivers and tanker after simultaneous loss of visual contact of the tanker / other receivers by each of 3 wingmen followed by the execution of the appropriate loss of visual contact action. The tanker has rolled wings level on the first call of:

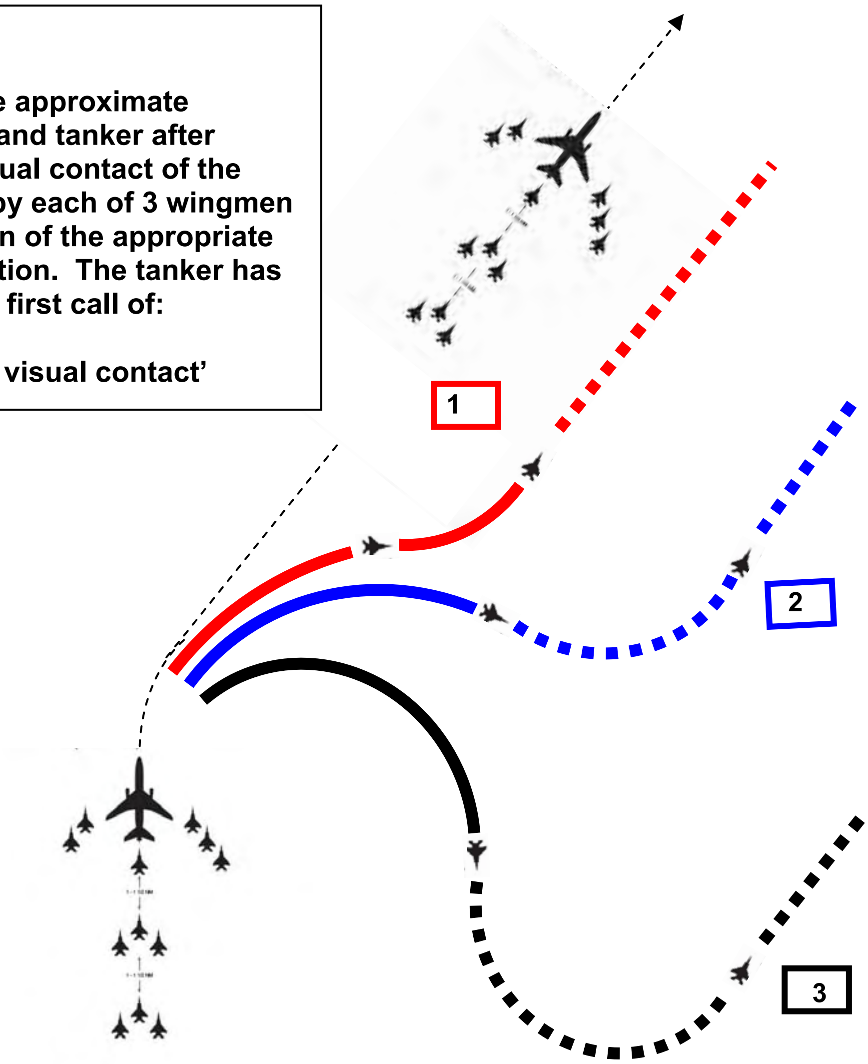
'(Callsign) loss of visual contact'.

Figure 1-5. Loss of Wingman – Receivers on Inside of Turn

NOTE:

This figure illustrates the approximate disposition of receivers and tanker after simultaneous loss of visual contact of the tanker / other receivers by each of 3 wingmen followed by the execution of the appropriate loss of visual contact action. The tanker has rolled wings level on the first call of:

'(Callsign) loss of visual contact'



c. Tanker Failure to Acknowledge. In either turning case, if the tanker does not acknowledge the loss of visual contact call, the receiver is also to achieve an immediate vertical separation of 500 ft below tanker FL/altitude/height.

d. Tanker Climbing/Descending - Receivers. In addition to the actions described in paras 406b above, when the tanker is climbing or descending, and where proximity to terrain is not a factor, the receiver(s) should level off whilst the tanker continues the climb/descent to the ATC cleared FL/altitude/height. The receiver must inform ATC of its level off FL/altitude/height either directly or through the tanker (see para 406f).

e. Lost Wingman with Fuel Transfer Complete. When a receiver executes Loss of Visual Contact (Lost Wingman) procedures and fuel transfer is complete, it may decide to leave the tanker rather than execute a rejoin. In such circumstances the procedures outlined in Part 2, Chapter 1, para 110 should be modified as appropriate to the situation.

f. Informing ATC

(1) Receiver. If the receiver executing loss of visual contact (lost wingman) procedure is working the ATC frequency, they are to inform ATC about their actions and seek an ATC service to rejoin the tanker/other receivers or depart.

(2) Tanker. Where the receiver is not working the ATC frequency, the tanker is to relay the necessary safety information detailed in para 406 f (1) above.

g. Rejoin

(1) Vertical Separation. When initial lateral separation is achieved, the receiver(s) is/are to achieve a vertical separation.

(2) Longitudinal Separation. Separated receiver(s) is/are to use radar/A/A TACAN/TCAS or other means to position 1 nm behind the last in-trail receiver element, so long as this does not conflict with the position of the next tanker in trail.

(3) Parameters to Rejoin Formation. Receivers will only attempt to rejoin the formation when they can achieve the parameters described in Part 2 Chapter 1, para 102d.

NOTES

- **National Annexes may stipulate different criteria from the above procedure (e.g. 20:20).**
- **If mission requirements dictate, tanker and receiver crews must agree differences to above procedures prior to flight.**

407 Loss of Visual Contact (Lost Wingman) - Multi-Tanker Formation. Depending on national policy, tankers will fly in both close and separated formation (e.g. echelon or trail). In the latter, the tankers will use a combination of visual positioning, electronic aids, radio transmissions and vertical separation to maintain the relative position between formation members.

a. Loss of Visual Contact – Tankers in Close Formation. For those nations that permit tankers to fly in close formation (see Figure 1-6), when visual contact is lost the Loss of Visual Contact Procedures ("Lost Wingman Procedures") described in para 406 is to be actioned, substituting tanker where reference is made to receiver(s).

Figure 1-6 – Tanker Close Formation

b. Loss of both Visual Contact and Situational Awareness – Separated Formation. Normally, in addition to visual monitoring, tankers in separated formation, both swept or trail, have many ways of maintaining situational awareness between all participating tankers. This includes air-to-air TACAN, weather radar, TCAS, radios, and vertical separation. If both visual contact and situational awareness are lost, the following procedures should be employed:

(1) Immediate Action by Tanker Losing Situational Awareness. The tanker losing both visual and situational awareness will transmit:

(a) "Callsign, Lost Contact"

(2) Achieving Vertical Separation. The tanker losing both visual and situational awareness will coordinate with other tankers in the formation to ensure that vertical separation is achieved.

NOTE

It is not possible to cover every situation; therefore, procedures for the more complex formations should be pre-briefed and based on the principles outlined above.

408 Breakaway. Whenever a 'Breakaway' call is made, the receiver and tanker will perform the following actions:

TANKER ACTIONS		
Initial Actions. The tanker is to maintain heading or established AOB and assigned FL/altitude/height and		
Subsequent Actions.		
Drogue Tankers	**Boom/BDA**	**Post Breakaway – All Tankers**
• Some nation's tankers will accelerate up to the drogue limiting speed for probe and drogue AAR operations	• The tanker is to increase power and accelerate	• To regroup the formation, when the situation permits, consider rolling wings level • Calling the roll-out heading on R/T
	• If the Boom Operator calls "clear to climb", the tanker will begin a slow climb maintaining established AOB. It is imperative that the airspeed is not allowed to decrease below that indicated at the start of climb	

RECEIVER ACTIONS		
(1) Immediately disconnect. **(2)** Move back and go to a safe position clear of the tanker and the refuelling equipment.		
Probe and Drogue – Wing	**Probe and Drogue – Centreline**	**Boom**
For probe and drogue tankers, the safe position is clear of the area directly behind the tanker and outboard of the tanker's wing.		
• **Left Wing**. The receiver on the left hose moves to the left wing	• **Centreline**. A receiver on the centreline hose should move outboard to whichever wing has room to accommodate the aircraft.	• The receiver will commence an immediate descent to achieve vertical separation
• **Right Wing**. The receiver on the right hose moving to the right wing		• If possible, drop aft of the tanker until the entire tanker is in sight
		• In the event that the receiver loses visual contact with the tanker during the breakaway: • **Fighters:** Descend at least 500 ft below the tanker • **Heavy Receivers:** Descend at least 1000 ft below the tanker
Breakaway Terminated. Once the breakaway is terminated, the receiver may either arrange with the tanker for a further closure or to depart.		
SAFETY NOTES: **(1) Receivers waiting in echelon should remain in formation on the tanker.** **(2) Receivers waiting in echelon, as well as those executing a breakaway manoeuvre, are to exercise good lookout to prevent a receiver/receiver collision.**		

409 Loss of Visual Contact – Receiver(s) in Contact or Astern, or Astern Following a Breakaway

<table>
<tr><th colspan="5">RECEIVER(S)</th></tr>
<tr><td colspan="5">Immediate Receiver Actions upon Loss of Visual Contact
Upon losing sight of the tanker, or if unable to maintain formation due to spatial disorientation (SD),a receiver(s) in contact or astern or following a breakaway will simultaneously:
(1) Immediately disconnect (if appropriate).
(2) Execute the applicable loss of visual contact (lost wingman) procedures described below while transitioning to instruments.
(3) Make a call of:
• '(Callsign) loss of visual contact'
(4) Slow down 10kts</td></tr>
<tr><th colspan="5">TANKER ACTIONS</th></tr>
<tr><td colspan="5">Initial Actions. The tanker is to maintain heading or established AOB and assigned FL/altitude/height and</td></tr>
<tr><th colspan="5">Subsequent Actions</th></tr>
<tr><th>Drogue Tankers</th><th></th><th>Boom/BDA</th><th></th><th>Post Breakaway – All Tankers</th></tr>
<tr><td>• Some nation's tankers will accelerate up to the drogue limiting speed for probe and drogue AAR operations</td><td></td><td>• The tanker is to increase power and accelerate</td><td></td><td>• To regroup the formation, when the situation permits, consider rolling wings level and calling the roll-out heading on R/T</td></tr>
<tr><td></td><td></td><td>• If the Boom Operator calls "clear to climb", the tanker will begin a slow climb maintaining established AOB. It is imperative that the airspeed is not allowed to decrease below that indicated at the start of climb</td><td></td><td></td></tr>
</table>

<table>
<tr><th colspan="5">SUBSEQUENT RECEIVER ACTIONS</th></tr>
<tr><th colspan="5">Tanker Straight and Level</th></tr>
<tr><th>Wing Pod Receiver(s)</th><th></th><th>Centreline Probe Receiver – Fighter and Heavy Receivers</th><th></th><th>Boom Receiver – Fighter & Heavy</th></tr>
<tr><td>When one or two receivers on the wing pod(s) lose visual contact, they are to:</td><td></td><td>A centreline receiver is to:</td><td></td><td>A boom receiver is to:</td></tr>
<tr><td colspan="5">• Perform Immediate Receiver Action as described above, plus
• Hold tanker heading</td></tr>
<tr><td>• Descend 500 ft/1000 ft (left/right receiver)</td><td></td><td>• Descend 500 ft or until visual with the tanker</td><td></td><td>• Fighters:
Descend at least 500 ft below the tanker</td></tr>
<tr><td colspan="4"></td><td>• Heavy Receivers:
Descend at least 1000 ft below the tanker</td></tr>
<tr><td colspan="5">• After 30 sec, resume normal airspeed</td></tr>
<tr><td colspan="3">• Wing Pod and Centreline Probe and Drogue. Once visual with tanker, position to left or right of the tanker centreline either as directed by the tanker or where there is a space within the formation on the tanker's wings. Do NOT remain directly behind the tanker as debris or the hose may fall from the tanker.</td><td></td><td></td></tr>
</table>

<table>
<tr><th colspan="3">SUBSEQUENT RECEIVER ACTIONS</th></tr>
<tr><th colspan="3">Tanker Turning</th></tr>
<tr><td colspan="3">• Perform Immediate Receiver Action as described above, plus</td></tr>
<tr><th>Wing Pod Receiver - Outside of Turn</th><th>Centreline Probe Receiver – Fighter and Heavy Receivers</th><th>Boom Receiver – Fighter & Heavy</th></tr>
<tr><td>When one or two receivers on the wing pod(s) lose visual contact, they are to:</td><td>A centreline receiver is to:</td><td>A boom receiver is to:</td></tr>
<tr><td>• Roll through wings level, to achieve 15° AOB in the opposite direction</td><td colspan="2">• Roll wings level</td></tr>
<tr><td>• Descend 500 ft/1000 ft (left/right receiver)</td><td>• Descend 500 ft or until visual with the tanker</td><td>• Fighters: Descend at least 500 ft below the tanker</td></tr>
<tr><td></td><td></td><td>• Heavy Receivers: Descend at least 1000 ft below the tanker</td></tr>
<tr><td>• Establish a heading 15° away from the tanker’s heading</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>• Hold new heading for 15 sec</td></tr>
<tr><td>• Resume the tanker’s heading to parallel track (15:15:15)</td><td colspan="2">• When stable, turn on to tanker’s heading</td></tr>
<tr><td colspan="3">• After 30 sec, resume normal airspeed</td></tr>
<tr><th>Wing Pod Receiver - Inside of Turn</th><td colspan="2" rowspan="8"></td></tr>
<tr><td>• Call “loss of visual contact”</td></tr>
<tr><td>• Simultaneously slow down 10 kts and</td></tr>
<tr><td>Maintain the turn until heading 15° away from the tanker’s heading</td></tr>
<tr><td>• Descend 500 ft/1000 ft (left/right receiver)</td></tr>
<tr><td>• Hold new heading for 15 sec</td></tr>
<tr><td>• Resume the tanker’s heading to parallel track (15:15:15)</td></tr>
<tr><td>• After 30 sec, resume normal airspeed</td></tr>
<tr><td colspan="2">• Wing Pod and Centreline Probe and Drogue. Once visual with tanker, position to left or right of the tanker centreline either as directed by the tanker or where there is a space within the formation on the tanker’s wings. Do NOT remain directly behind the tanker as debris or the hose may fall from the tanker.</td><td></td></tr>
<tr><td colspan="3">Breakaway Terminated. Once the breakaway is terminated, the receiver may either arrange with the tanker for a further closure or to depart.</td></tr>
<tr><td colspan="3">SAFETY NOTES:

1. Receivers waiting in echelon should remain in formation on the tanker.
2. Receivers waiting in echelon, as well as those executing a breakaway manoeuvre, are to exercise good lookout to prevent a receiver/receiver collision.</td></tr>
</table>

410 Leaving. See Part 2 Chapter 1 para 110.

411 Aircraft Malfunction

a. A tanker or receiver emergency may require an urgent cessation of refuelling; in this event the radio call:

- "(Tanker Callsign), Breakaway, Breakaway, Breakaway"

and/or signal light command is to be given, see Part 2 Chapter 5 Annexes 5B and 5C.

b. The receiver is required to disconnect immediately and move clear of the tanker, see para 408 and 409. The responsibility of achieving safe separation is placed on the receiver.

c. The tanker is to maintain heading. Also, the tanker is to maintain FL/altitude/height or climb as required by national breakaway procedures. Additionally, some nation's tankers will accelerate up to the drogue limiting speed for drogue AAR operation.

d. For boom/BDA operations, the tanker is to increase power and accelerate.

412 Wake Turbulence. Wake turbulence caused by wide-bodied (heavy) jets can affect a considerable area and precautions are necessary to ensure that AAR formations are not subject to disturbance whilst refuelling is in progress. If a contact is reported by radar or sighted visually, whose track will coincide with or cross within 10 nm of the track of an AAR formation and whose vertical position is within the 2000 ft band above the formation, the following action is to be taken:

a. Attempt to identify if the contact is 'heavy'.

b. If 'heavy' or if identity cannot be established.

c. Order any receivers in contact to disconnect.

d. Do not bring receivers into contact until affected track area has been traversed.

NOTE

Multi-tanker formations that include TriStar/KC-10 should be particularly aware of wake turbulence, especially if the TriStar/KC-10 is leading or takes the lead.

413 Fuel Dump. On occasions, a tanker may have to dump fuel. The tanker pilot is to inform the national ATC agency that a 'fuel dump' is necessary and is to obtain permission from the ATC agency prior to dumping fuel. Many nations have designated fuel dump areas and, if possible, the tanker is to fly to this area before dumping fuel.

414 Hose Jettison. If at all possible, hoses are to be jettisoned over the open sea, at least 20 nm from the coast. Some nations have reserved ordnance jettison areas; therefore, the tanker pilot is to advise the ATC agency of the need to jettison a hose and is to operate in accordance with the national ATC agency directions. Additionally, the tanker crew is to use all available means to ensure the area below the tanker is clear. This is best achieved by carrying out a visual search of the area below, if weather conditions and fuel reserves permit. If weather conditions and/or fuel reserves do not permit a visual search, then the hose may be jettisoned, under the directions of the national ATC agency, from the normal cruising FL/altitude/height. In this case, the tanker's radar is to be used to check that the area is clear and the ATC agency is to confirm that the airspace beneath the tanker is clear of other aircraft. The position and time of release is to be logged and reported using an appropriate national Air Incident Report. Only in an emergency is the hose to be jettisoned over land. If the hose fails to jettison, the aircraft is to recover to land avoiding built up areas.

415 Radar and Weapons. It is the responsibility of the receiver aircraft commander to ensure that the aircraft radar is not radiating. Normally, the radar should be set to standby once the receiver is visual with the Tanker. Similarly, the receiver aircraft commander is to ensure that weapons are safe prior to commencing an RV with a tanker. During conditions of EMCON constraint (EMCONs 3 and 4), radio calls between tanker and receiver to check on radar and/or armament states are both inappropriate and impractical.

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PART 2 – GENERAL PROCEDURES

CHAPTER 5

Communications

501 Security . It can be assumed that all AAR frequencies will be subject to regular monitoring by potentially hostile agencies. Message originators are to ensure that classified information is not passed in an unclassified form. In particular, messages concerning airframe numbers, linkage of squadrons and locations, order of battle and associations of personnel with units are not to be transmitted. Tanker transmissions are liable to be intercepted, thus giving hostile forces knowledge of tanker positions and procedures; therefore, transmissions must be kept to a minimum. It will also be necessary on occasion to restrict the use of some or all aircraft electronic transmitting equipment.

NOTE

Depending on the EMCON conditions, some tanker nations may permit or mandate the transmission of aircraft airframe numbers in order to track fuel transfer. Receiver national guidance must be followed before complying with such requests.

502 Communications in Multi-Tanker Formations. The lead tanker crew is responsible for the formation communications. If special circumstances require, specific tasks may be delegated to other tankers in the formation.

503 HF Transmission Restrictions

a. Facilitating Join-up. HF radio communications during AAR is limited to situations when either the tanker/receiver combination is beyond UHF range or to facilitate join up for AAR if unable to make UHF contact.

b. Use of HF During AAR. No HF transmissions are to be made from a tanker or receiver when a receiver is in contact or about to make contact and all HF equipment must be switched to STANDBY/MONITOR where possible.

NOTE

Some receiver aircraft have flight control systems which are susceptible to HF transmissions. Therefore, they may require a greater separation from the tanker before HF transmissions are made (eg Tornado aircraft require 1000 m / ½ nm separation before tanker HF is used).

504 IFF/SIF. IFF/SIF is to be operated on all exercises/operations in accordance with the tasking order. If it is necessary to switch IFF to standby, the controlling unit is to be informed.

505 Search and Rescue (SAR) Aircraft. On some Oceanic AAR flights, maritime patrol aircraft may be tasked to provide airborne SAR cover for a deployment. SAR aircraft should listen out on the briefed AAR frequency and monitor normal Oceanic frequencies for regular position reports. Where applicable, individual Mode 1 IFF settings should be allocated to all tankers and receivers to aid the SAR aircraft to track the formation(s).

506 AAR Radio Procedures

a. General. Control of receivers during routine AAR is achieved by radio commands given by the tanker. To assist interoperability, these commands are standardized, although mission/operation-specific requirements may be detailed in the tasking order. Importantly, to avoid uncertainty, normally, all RT calls will be prefaced with the speaking unit's individual callsigns. Outside of the training arena, normal operations are conducted using EMCON 2 procedures. Therefore, radio communications should be kept to a minimum consistent with safety and the published EMCON option; excessive radio traffic is distracting to the receiver pilot and is a potential source of confusion. Regardless of the type of AAR equipment in use, only a basic set of commands is required to accomplish refuelling. These basic commands are listed at Part 2 Annex 5B.

b. Probe and Drogue. In general terms, the probe and drogue system places the responsibility of positioning for refuelling on the receiver, after the tanker has cleared the receiver astern the refuelling equipment.

c. Boom. The boom system places more reliance on the tanker giving positioning commands to the receiver and the boom interphone should be used rather than RT whenever possible.

d. Air-to-Air (A/A) TACAN

(1) To provide A/A TACAN ranging, the tanker and the receiver (one aircraft per receiver and tanker formation) should tune the assigned A/A TACAN channels 15 min before the RVCT. The two designated channels will be 63 channels apart with the receiver setting the lower channel and the tanker the higher channel. The majority of receivers use the Y- channel but some only have X-channel capability.

(2) A/A TACAN should be left in the A/A setting until the receiver reaches astern (boom) or the observation position (drogue).

e. Monitoring Guard. During AAR , where radio equipment permits, tanker crews must maintain a listening watch on 243.00 MHz; this provides a guard frequency for receivers that need to join a tanker but do not know the AAR control frequency. Furthermore, 243.00 MHz provides a guard frequency in the event of loss of radio contact between tanker and receiver.

f. Loss of RT Communication. Loss of radio communication between tankers and receivers could prove hazardous, particularly during boom AAR. Receiver and tanker crews are to be aware of any national restrictions on the conduct of AAR when communications have been lost and are to operate in accordance with such instructions.

507 Verbal Communication – Boom AAR Only. Communication requirements should be established prior to the flight. Normally, boom visual signals will be used exclusively; however, if required or requested by the receiver, the boom operator will begin communications when the receiver reaches approximately 50 ft from the contact position. Direction, if required, will precede distance (in ft) for the receiver to move and will be given until the receiver reaches the contact position; example:

"Forward 50", "Up 4", "Back 2"

When contact is established the tanker will state:

"(Tanker Callsign) contact"

For Emission Options 1 and 2, the boom operator will make a astern radio check with the receiver(s) and the receiver(s) will acknowledge; example:

Tanker will say:

"25/57"

The receiver will reply:

"25"

508 Boom Envelope Demonstrations. During receiver pilot demonstration of AAR envelope limits, the boom operator will state the limit and give the boom position for the limit being demonstrated in increments of "2" for roll/azimuth and elevation, and "1" for telescoping (These are "degrees" and "feet" respectively but the dimensions are not normally included in R/T transmissions). When tankers are not equipped with an Independent Disconnect System, prior to receivers demonstrating envelope limits, the boom operator is required to confirm that a boom operator-initiated disconnect occurred. In this instance, receivers shall not request an envelope limits demonstration on the first contact.

509 Manual and Emergency Boom Latching. During tanker manual operation (without tanker disconnect capability) and emergency boom latching the following receiver briefings will be accomplished:

a. Tanker Manual Operation (TMO) Briefing (Without Tanker Disconnect Capability). During the briefing for tanker manual operation where there is no tanker disconnect capability, the boom operator will state:

"(Receiver Callsign), the following contacts will be made in tanker manual operation without tanker disconnect capability. Receiver air refuelling system will remain in normal and receiver pilot must initiate all disconnects."

"(Tanker Callsign), ready"

Receiver pilot acknowledges by stating:

"(Receiver Callsign) ready"

b. Emergency Boom Latching/Override Operation Briefing. During the briefing for emergency boom latching/override operation, the boom operator will state:

"(Tanker Callsign), ready"

Receiver pilot will acknowledge by stating:

"(Receiver Callsign), ready"

Tanker boom operator will state

"(Receiver Callsign), the following contacts will be made in manual boom latching. The receiver must initiate all disconnects"

The receiver will acknowledge by stating:

"(Receiver Callsign) astern ready"

Tanker boom operator acknowledges by stating:

"(Tanker Callsign), ready"

510 Fuel Transferred. At a convenient time between the receiver disconnecting and leaving the formation, the tanker should inform each receiver of the amount of fuel transferred. For boom interphone equipped tankers, the offload report may be made prior to disconnect. Whenever possible, the fuel quantity should be expressed in the units of measurement used by the receiver's fuel system.

511 Loss of Radio Contact. If radio contact is lost between tanker and receiver on the allocated AAR frequency:

a. Attempts are to be made to re-establish contact on the secondary AAR frequency.

b. If contact is not established on the secondary frequency or one is not allocated, both tanker and receiver are to establish contact on 243.00 MHz (121.50 MHz for some receivers).

c. Continued routine communication should not take place on the distress frequency; therefore tanker and receiver should attempt to continue AAR communication on another mutually acceptable frequency.

d. Some receivers have only one main radio and a standby radio pre-tuned to the distress frequency. If the loss of radio contact was caused by the failure of the receiver's main radio, then AAR communication on the distress frequency will be necessary; nevertheless, this should be minimized and radio silent procedures should be adopted if possible.

512 Emission Control Procedures. There may be a need to conduct AAR exercises/operations in electronic silence. The controlling authority will promulgate the emission control (EMCON) procedure in force for the exercise/operation. The use of electronic emitters will vary according to the assessed threat. The definition of each EMCON option is given in Part 2 Annex 5A. Also, EMCON options and acceptable communications for each option are shown in Part 2 Annex 5A. This describes 4 levels of restriction on the use of electronic emissions and provides for further refined selection of transmitters.

513 Radio Silent Procedures. There will be occasions when AAR is conducted using agreed procedures and signalling facilities without the use of radio. For pre-planned operational and training missions, the method, time and place of rendezvous, together with the amount of fuel to be transferred, must be covered in the pre-flight briefing of both the tanker and receiver crews. Radio silent procedures and visual boom signals are detailed in Part 2 Annex 5C. The occasions requiring silent procedures are:

a. When called for by the EMCON policy in force.

b. When deemed tactically necessary by the tanker or for training purposes agreed between tanker and receiver. In these cases, the tanker commander initiates the procedures by stating at the briefing stage or on radio at any time 'silent procedures'.

c. In the event of radio failure. Refuelling following total radio failure should only be undertaken when refuelling is essential due to the critical nature of the mission.

d. In the event that a receiver requires fuel but does not know the tanker's operating frequency.

514 Breakaway During Silent Procedures. If the situation calls for a breakaway during radio silent AAR, verbal breakaway procedures will be used in conjunction with the visual signal detailed in Part 2 Annex 5C.

PART 2 - ANNEX 5A

Emission Control

Figure 5A-1. Emission Control (EMCON) Options – Communications Criteria

EMCON	Criteria
Emission Option 1	Any and all emitters are authorized, ie full RT for training purposes adding any timing that would affect the RV. *(Note: This option is normally used for all Qualification/Certification Training.)*
Emission Option 2 (Restricted R/T Communications)	Routine EMCON. a. Emission Option 2 is the desired standard for day to day AAR. General. b. Radio silent formation except for RV and AAR which is conducted with limited radio exchange. c. All other emitters are authorized. d. Essential radio transmissions for flight safety may be made. e. At initial contact, receivers and tankers will exchange callsigns, RV (type), FL/altitude/height, A/A TACAN, Mode 3, altimeter setting and any changes in tanker timing that would affect the RV (in minutes early or late). f. Altimeter setting and hot armament check will also be co-ordinated, if applicable. g. If not at the planned RV FL/altitude/height, an additional call is required when reaching that FL/altitude/height. Boom Operations. h. For boom operations, an abbreviated astern radio check is required when the receiver reaches the astern position. i. The boom operator will transmit numerical callsigns only, eg '25,57', and the receiver will respond '25'. If this check cannot be completed, refuelling will not commence unless a mission priority or receiver fuel emergency has been declared. j. Receivers will not depart the astern position until either this radio check is achieved or visual signals direct approach to contact. k. Tanker boom operators will give verbal corrections when required to ensure receiver aircraft maintains proper envelope position. Restrictions under EMCON 2. l. More restrictive procedures under emission Option 2 will be fully coordinated between tanker and receiver units. In an emergency or abnormal condition, the tanker/receiver may transmit over an AAR frequency.
Emission Option 3 (Silent R/T)	Radio silent operations including formation, RV and AAR. The use of other emitters is authorized unless specifically prohibited.
Emission Option 4 (Emission Out)	No emitters will be used unless specifically authorised by the plan that the AAR is supporting (ATO, SPINS, Rules of Engagement (ROE), Operations plan, Safe Passage procedures, or other mission directive).

Figure 5A-2. Emission Control (EMCON) Options - Communications

Item	Action	Emission Option (1) (2) (3)			
		1	2	3	4
1	Tanker radio set 30 min prior to RVCT/RV (if dual radio capable).	X	X	(4)	(5)
2	15 min call (if applicable).	X	X		
3	A/A TACAN set 15 min prior to RVCT/RV.	X	X	X (6)	
4	Beacon positive identification (if applicable).	X			
5	RVIP call (if applicable).	X	X(7)		
6	ADF check (if applicable).	X			
7	Halfway through the turn call (tanker) - (if applicable).	X			
8	Mandatory tanker/boom operator calls:				
	a. Astern call.	X	X		
	b. Clear receiver to contact.	X			
	c. Acknowledge contact/disconnect.	X			
	d. Verbal corrections.	X			
	e. Advise receiver(s) to return to astern for check list or equipm ent considerations.	X			
9	Mandatory receiver calls after 15 min call:				
	a. Visual contact established/lost to include overrun.	X			
	b. Astern call (acknowledgement).	X	X		
	c. When contact or disconnect is made.	X			
	d. Boom - verbally notify boom operator prior to Manual/emergency boom latching procedures.	X	X		
10	Post AAR	X	X		

NOTES:

1. **When using EMCON Options 2 - 4, boom interphone should be used when receiver compatible. Tanker and receiver planners will co-ordinate and crews are to be thoroughly briefed on: RV type, RV point and time, tanker and receiver FL/altitudes/heights, cell procedures and break up arrangements, and missed RV procedures (including refuelling area departure time and back up communication procedures). If different EMCON options are to be used during different phases of the route, this must be included in the briefing.**
2. **Variations may be co-ordinated, eg: 'EMCON 2, ITEM 9a COMMS N/A' would mean normal EMCON Option 2 procedures except the astern call would be deleted.**
3. **EMCON Options 1 and 2 only are used when the FAF C135-FR is conducting pod refuelling.**
4. **Radio silent procedures. Use of other emitters is authorized unless prohibited by supported operations plans.**
5. **No emissions (radios, doppler, navigation transmissions, radar, IFF, exterior lighting, etc) unless authorized by the ATO, Rules of Engagement (ROE), operations plans, safe passage procedures or other mission directives.**
6. **RV Bravo, Charlie, Delta (Point Parallel) and Echo.**
7. **Modified RV Delta (Point Parallel) procedure.**

Figure 5A-3. EMCON Options – Emitters

Item	Equipment	Emission Option			
		1	2	3	4
1	Radar	On	On	As required	Off
2	Doppler	On	On	As required	Off
3	Beacon	On	On	As required	Off
4	Radio Altimeter	On	On	As required	Off
5	TACAN/DME	On	On	As required	Off
6	IFF	On	On	As required	Off
7	UHF/VHF	On	On	Monitor	Monitor
8	HF	On	On	Monitor	Monitor
9	Lighting	On	On	As appropriate / briefed	As appropriate / briefed
10	TCAS	On	On	As required	Off

NOTE: Variations may be co-ordinated, eg: 'EMCON 2, ITEM 1 EMITTERS OFF' would mean normal EMCON Option 2 procedures except the radar would be off.

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PART 2 - ANNEX 5B

Communication Procedures

Serial (a)	Situation (b)	Tanker RT (c)	Receiver RT (d)
1	15 min prior to RV	a. Set Radar/Rendezvous Beacon (where fitted) b. Set Air to Air TACAN to appropriate channel (ensure Y- or X- channel set appropriate to receiver capability)	a. Set Radar/Rendezvous Beacon (where fitted) b. Set Air to Air TACAN to appropriate channel (unless required for navigation) c. Transmit receiver IFF
2	RV Initial Call – made following ATC clearance to call (may be as much as 15 min prior to RVCT)	“(Receiver Callsign), (tanker callsign) for RV (type). My FL/altitude/height, when cleared, your FL/altitude/height, set A/A TACAN (channel), Mode 3, (timing if required), (and altimeter setting if not 1013.2mb (29.92 inches Hg))” **(1)**	“(Tanker Callsign), (receiver callsign), when cleared, my FL/altitude/height, TACAN (channel), Mode 3, (timing, if required), (and altimeter setting if not 1013.2mb (29.92 inches Hg)), (*if appropriate*, nose cold, switches safe)” **(1)**
3	Receiver has radar contact and takes responsibility for closing to visual range	-	“(Callsign) Judy”
4	Receiver has visual contact approaching tanker	-	“(Callsign) Visual”
5	Receiver cleared to join tanker	“(Callsign) Clear join”	Acknowledge **(2) (3)**
6	Receiver in the Observation Position	-	“(Callsign) Observation” **(4)**
7	Tanker AAR equipment deployed (hose trailed, boom lowered)	“(Callsign) Clear astern left/centre/right” **(4)**	Acknowledge **(4) (5) (6)**
8	Receiver astern left/centre/right	-	“(Callsign) Astern left/centre/right **(4) (6)**
9	Tanker AAR equipment ready to pass fuel	“(Callsign) Clear contact (specify left/ right if a multi-point tanker)” **(4) (7)**	Acknowledge **(8)**
10	Closing to boom contact	“Stabilize, Forward, Back, Up, Down, Right, Left, Return to astern” **(4)**	Acknowledge **(4)**
11	Receiver to disconnect	“(Callsign) Disconnect” **(4)**	Acknowledge **(4) (9)**
12	Receiver astern left/centre/right	-	“(Callsign) Astern left/centre/right”
13	Receiver to effect Emergency Separation	“(Callsign), Breakaway, Breakaway, Breakaway” **(10)**	Disconnect **(11)**
14	Practice Emergency Separation **(12)**	“(Callsign), Breakaway, Breakaway, Breakaway” **(10)**	Disconnect **(11)**
15	Terminate Emergency Separation	“(Callsign) Terminate Emergency Separation”	Acknowledge **(4)**

Serial (a)	Situation (b)	Tanker RT (c)	Receiver RT (d)
16	Receiver strikes drogue and suspects damage to ribs or canopy of drogue	-	"(Callsign) Spokes" **(13)**
17	Receiver to move from astern to Reform Position	"(Callsign) Go reform" **(14)**	Acknowledge **(4)**
18	Receiver echelon Observation/Reform	-	"(Callsign) Observation/Reform **(14)**
19	Receiver cleared to leave the tanker	"(Callsign) Clear to leave"	Acknowledge

Communication Procedures

NOTES:

1. In some national airspace, ATC controllers permit receiver(s) to contact the tanker to discuss the RV whilst the receiver(s) is(are) still under ATC control. The tanker's "when cleared" statement warns the receiver(s) that the RV information is not to be acted upon until ATC either releases the receiver(s) (eg MARSA) or approves changes in the receiver(s) flight parameters such as FL/altitude/height.

2. For Probe and Drogue/BDA operations, receivers form echelon in the observation position.

3. For boom operations, the first receiver may join directly to astern position, all others form echelon in the observation position.

4. Only required during EMCON Option 1.

5. Receiver moves behind the assigned AAR equipment and stabilizes in the astern position.

6. Boom operations need not designate centre.

7. During EMCON Option 2, the boom operator and lead receiver will accomplish an abbreviated radio check prior to boom contact, eg tanker: '36 Alpha, 42', receiver: '36 Alpha'. If more than one receiver formation is on the AAR frequency, tanker will use the full receiver callsign. After contact, use the boom interphone to maximum extent possible.

8. Receiver advances to engage probe with drogue or moves to the boom contact position.

9. Receiver makes a routine disconnect and drops back to the astern position.

10. To avoid confusion with multiple tankers on the same frequency, the specific tanker callsign must preface the breakaway call.

11. See Part 2 Chap 4, para 408.

12. Prior to a practice breakaway, in-flight co-ordination between the tanker crew and receiver pilot is mandatory.

13. After a spokes, tanker and receiver consult to assess damage to AAR equipment and establish feasibility of continuing AAR.

14. Tanker passes to receiver the amount of fuel transferred (Note: When known, use the unit of measurement of the receiver's fuel system, otherwise use the tanker's unit of fuel measurement.)

PART 2 - ANNEX 5C

Radio Silent Procedures

Figure 5C-1. Radio Silent Procedures - Probe and Drogue

Serial (a)	Situation (b)	Tanker Actions (c)	Receiver Actions (d)
1	Receiver requires fuel	-	Receiver joins on tanker's left side at the observation position, and extends probe **(See notes 1 and 2)**
2	Tanker acknowledges receiver presence, has understood and has fuel available	Trails hose	-
3	Tanker acknowledges but has no fuel available	Tanker's hose remains stowed or retracted	Receiver diverts or attempts to find another tanker **(See note 4)**
4	Tanker AAR equipment ready, receiver clear astern	Switch off all red anti-collision beacons/strobes. All on again when receiver seen to move behind the tanker	Receiver goes to the astern position behind the AAR equipment (right hose as first choice on multi-point tankers, if available)
5	Fuel transfer	Light sequence as in National Annex **(See note 4)**	Receiver reacts to lights/visual signals
6	Receiver leaves formation	-	Receiver pulls forward on right side in visual contact then turns away
7	Receiver to breakaway	a. Tanker AAR equipment red signal light on or flash. b. Some tankers will turn strobes lights on and navigation lights to bright. c. For tankers not fitted with AAR equipment red signal lights (1) Any other specified red light on (eg anti-collision, hand held lamp). (2) Refer to Tanker National Annex for other variations.	Receiver makes emergency disconnect, moves back and then goes to a safe position clear of the tanker and the refuelling equipment, usually to echelon

NOTES:

1. For tankers where the crew is only on the flight deck (see appropriate Tanker National Annex), receivers should pull well forward to attract the pilot's attention.

2. For tankers with observers stationed in the rear of the aircraft (see appropriate Tanker National Annex), receivers should not move forward of the tanker's wing leading edge.

3. Receivers should depart the tanker using the prescribed procedures for refuelling (e.g. – from the right side of the tanker, level or climbing).

4. It is not yet possible to propose standardized signals to indicate clearance for receivers to commence and disconnect refuelling because AAR light signalling equipment is not fitted on NATO aircraft to a common STANAG.

Figure 5C-2. Radio Silent Procedures – Aldis-Equipped Probe and Drogue

Serial (a)	Situation (b)	Tanker Actions (c)	Receiver Actions (d)
1	Receiver requires fuel	-	Receiver joins on tanker's left side at the observation position **(See notes 1 and 2)**
2	Tanker acknowledges receiver presence, has understood and has fuel available	Trails hose	Proceed to astern position on respective hose(s). (Right hose as first choice on multi-point tankers, if available)
3	Tanker acknowledges but has no fuel available	Tanker's hose remains stowed or retracted	Receiver diverts or attempts to find another tanker **(See note 3)**
4	Receiver is cleared to contact hose.	One steady Aldis signal from respective side of aircraft.	Receiver engages drogue
5	Fuel transfer	Light sequence as in National Annex **(See note 5).**	Receiver reacts to lights/visual signals
6	Receiver has briefed amount of fuel, or tanker has no additional give remaining.	One steady Aldis signal to receiver engaged in drogue.	Receiver disconnects and proceeds to the right reform.
7	Receiver has briefed amount of fuel, but request additional offload.	Tanker provides additional fuel in briefed increments, unless there is no additional offload (refer to item 6)	Receiver remains engaged in drogue after receiving steady Aldis signal.
8	Receiver is not satisfied with hose response or fuel flow rate.	Tanker resets hose response once receiver is clear of the hose.	Receiver disconnects, moves aft and outboard of hose, and awaits further signal from tanker.
9	Hose is unsafe	Tanker retracts hose	Receiver proceeds to open hose or departs tanker/tanker cell.
10	Tanker has a malfunction that requires receiver to momentarily disconnect	Flashing Aldis signal from the observer	Receiver disconnects, moves aft and outboard of hose, and awaits further signal from tanker.
11	Emergency requiring a breakaway exists	Tanker turns on lower anti-collision light	Receiver expeditiously disconnects from hose, moves aft and outboard, and awaits further signal from tanker. **(See note 4)**

NOTES:

1. **For tankers where the crew is only on the flight deck (see appropriate Tanker National Annex), receivers should pull well forward to attract the pilot's attention.**
2. **For tankers with observers stationed in the rear of the aircraft (see appropriate Tanker National Annex), receivers should not move forward of the tanker's wing leading edge.**
3. **Receivers should depart the tanker using the prescribed procedures for refuelling (e.g. – from the right side of the tanker, level or climbing).**
4. **When a breakaway is signalled for an emergency situation, receivers should avoid exacerbating the situation with an excessively rapid disconnect from the hose.**
5. **It is not yet possible to propose standardized signals to indicate clearance for receivers to commence and disconnect refuelling because AAR light signalling equipment is not fitted on NATO aircraft to a common STANAG.**

Figure 5C-3. - Radio Silent Procedures - Boom

Serial (a)	Boom/Receiver AAR Signal (b)	BDA/Receiver AAR Signal (c)	Meaning (d)
1	Receiver may join directly to astern position		Receiver requires fuel/training
2	Boom extended in trail.		Tanker ready for contact **(See Note 1)**
3	Boom in trail (fully extended)		Tanker manual operation without disconnect capability or Tanker acknowledgement of receiver's manual boom latching signal
		Boom in trail (fully extended)	Tanker ready for contact
4	Boom in trail (fully retracted)	Boom in trail (fully retracted)	Fuel offload complete
5	Same receiver returns to astern with receptacle door open (DAY): Pilot signals closed fist, thumb to mouth plus hand signalling number equating to one finger for every 1000lb of fuel required. (NIGHT): Same receiver returns to astern with receptacle door open, ready for contact. **(See note 2)**		Additional fuel required – EMCON 2-4
6	Boom stowed (fully retracted)	Boom stowed (fully retracted)	Tanker AAR system inoperative
7	Boom 0° elevation, extended 5 ft		System malfunction. Tanker and receiver check AAR systems
8	Flashing pilot director lights (push emergency breakaway switch). Tanker lower rotating beacon on (Beacon light master switch to Both)	Flashing pilot director lights (push emergency breakaway switch). Tanker lower rotating beacon on (Beacon light master switch to Both)	Breakaway
9	Turn pilot's director lights off during contact. Push disconnect signal switch **(See note 3)**	Turn pilot's director lights off during contact. Push disconnect signal switch **(See note 3)**	Tanker request for disconnect, receiver return to astern position

10	Receiver closing and opening receptacle door when in astern position		Receiver request manual boom latching or Receiver acknowledgement of tanker's manual operation signal without tanker's disconnect capability signal
11	Receiver rocks wings or shows a steady light	Receiver rocks wings or shows a steady light	Receiver emergency fuel shortage exists **(See note 4)**
12	Flashing light from receiver cockpit area	Flashing light from receiver cockpit area	Initiate toboggan manoeuvre

NOTES:

1. **When more than one receiver is being refuelled, the boom operator will not give the ready for contact signal until the preceding receiver has cleared the tanker.**
2. **Additional fuel offload for each subsequent contact will be 5000 lb for large receiver aircraft and 2000 lb for small receiver aircraft.**
3. **The receiver(s) will advise the tanker of any pilot director light malfunction.**
4. **If fuel shortage occurs at times other than scheduled AAR, the receiver should be positioned so that the signal may be seen from the tanker cockpit.**

LIST OF EFFECTIVE PAGES TO PART 2 ATP-56(B)

PAGE NUMBERS	EFFECTIVE PAGES
1-1 to 1-14	Change 1
1A-1 to 1A-2	Change 1
1B-1 to 1B-6	Change 1
1C-1 to 1C-4	Change 1
1D-1 to 1D-18	Change 1
1E-1 to 1E-2	Change 1
1F-1 to 1F-4	Change 1
1G-1 to 1G-4	Change 1
2-1 to 2-2	Change 1
2A-1 to 2A-10	Change 1
2B-1 to 2B-4	Change 1
2C-1 to 2C-4	Change 1
2D-1 to 2D-6	Change 1
2E-1 to 2E-12	Change 1
2F-1 to 2F-2	Change 1
2G-1 to 2G-2	Change 1
3-1 to 3-2	Change 1
4-1 to 4-22	Change 1
5-1 to 5-4	Change 1
5A-1 to 5A-4	Change 1
5B-1 to 5B-2	Change 1
5C-1 to 5C-4	Change 1
LEP-1 to LEP-2	Change 1

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ATP-56(B)

PART 5 - NATIONAL AND ORGANISATIONAL PROCEDURES

TABLE OF CONTENTS

Information on the Annexes of Part 5

101 Introduction. The Annexes to Part 5 are provided by each nation or AAR organisation to assist AAR interoperability. The information provided gives tanker capabilities and characteristics relevant to AAR, and includes which receivers are cleared to refuel from its tankers. Each nation or organisation has its own instructions relating to AAR planning, AAR deployments and peacetime training constraints; the Annexes list the source document for this information. The Annexes also list the national POCs, and any national or organisational reservations or amendments to the standard procedures of this ATP-56(B). Annex BA outlines the suggested procedure for obtaining AAR Clearances. Annex BB summarizes the national tanker capabilities in tabular format. Annex BC is a matrix of tanker/receiver clearances.

102 Format of Part 5 Annexes. The Annexes are to be laid out in the following format. Nations with multiple tanker types may use sub-Annexes and Appendices.

1 Introduction

2 Tanker Aircraft Type. All tanker types are listed and the following information is given for each type:

a. AAR Equipment. Type of AAR equipment (boom or drogue) and location of the equipment. This includes diagrams/photographs of hose and drogue markings and dimensions.

b. Refuelling Heights and Speeds. Refuelling height and speed envelope, of the tanker.

c. Maximum Transferable Fuel

d. Fuel transfer rate

e. Regulated Fuel Pressure

f. Fuel Types Available for AAR:

(1) Primary/usual type of fuel.

(2) Alternate types of fuel that may be carried on occasion.

g. Receiver Clearances

(1) Receiver Aircraft Permanently Certified. These clearances are based on the mechanical compatibility between the tanker and receiver aircraft. The receivers in this sub para should not be subject to any mechanical restrictions. Those receivers with restrictions should be listed under subsequent sub paras.

(2) Receiver Aircraft Certified for Approved Operations/Exercises. This section lists those receivers where the clearance is limited to contingency operations and certain approved exercises. In these cases, national approval from both tanker and receiver nation may be required.

h. Lighting. This section should detail the AAR equipment signal lights, night floodlighting and electroluminescent markings.

i. Mark facilities

j. Dimensions. This section should include a drawing with the physical dimension of the tanker aircraft, together with the location of the AAR store.

k. RV aids

3 Receiver Qualification and Currency. This section should cover receiver qualification, currency requirements.

4 Source Documents

5 POC for National Annex. The office responsible for the content of the National Annex. Each nation or organisation is responsible for reviewing/updating their National Annex regularly and informing the Editor of any changes. Ideally, this review/ update should be conducted at least annually to maintain the currency and credibility of the National Annex.

6 POC for Tanker/Receiver Clearances. The initial point of contact for all matters concerning tanker and receiver clearances. If available, details of the normal clearance process, including any standard questionnaire.

7 POC for STANEVAL. The initial point of contact for all international AAR and STANEVAL matters.

NOTE

POC information to include job title, full postal address, telephone number, Fax number, and email address. An office email address is preferred.

8 National Annex Last Updated. Date of last change.

9 National Reservations. Any national reservations or amendments to the standard ATP-56(B) procedures.

103 Procedure for Making Changes to Part 5 Annexes

a. The Annexes in Part 5 contain only factual information, and therefore, are not subject to the normal ratification process.

b. Changes will be included as near as possible to the following release dates: 1st February and 1st August. Inputs for change should be sent to the Custodian by either email or via the NSA AAR Panel Forum (http://nsa.nato.int/), at least 4 weeks prior to the above release dates. However, changes of an urgent nature will be included immediately on request from national annex POC. Notification of urgent changes will be by email to the National POC and via the NSA AAR Panel Forum

c. All amendments to the national annexes will be electronic and posted on the NSA https://nsa.nato.int/protected/ and the RAF http://www.raf.mod.uk/downloads/airtoair56b.cfm.

d. Users of annexes are strongly advised to refer to the web copy to ensure that they have the latest amendment to the relevant annex. If in doubt, contact the Annex POC.

104 POC for Editor of ATP-56(B)

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PART 5 – ANNEX Z

National Annex - United States of America

1Z Introduction. The USA has 6 main tanker types in service with the USAF, USMC, USN and the Coast Guard as well as a new type due to enter service in the coming years (a placeholder annex is included in anticipation of the arrival of this platform). Within some of these types there are different AAR equipment fits for Pod Status Lights; details of these variations are provided in the appropriate tanker annex.

2Z Tanker Aircraft Types.

a. KC-135 Stratotanker. See Annex ZA for full details of the KC-135 Stratotanker.

b. KC-10 Extender. See Annex ZB for full details of the KC-10 Extender.

c. KC-45 Tanker. Annex ZC is reserved for the KC-45.

d. HC/MC-130 Tanker (USAF). See Annex ZD for full details of the HC/MC-130 Tankers.

e. KC-130/130J Tanker (USMC). See Annex ZG, Appendix 2, for full details of the KC-130/130J Tankers.

f. S-3B Tanker. See Annex ZG, Appendix 3, for full details of the S-3B Tanker.

g. F/A-18E/F Tanker. See Annex ZG, Appendix 4, for full details of the F/A-18E/F Tanker.

3Z Receiver Qualification and Currency – Non-USA Receivers. See Annex ZI for details.

4Z Source Documents. See appropriate tanker annex for details of source documents.

5Z POCs for National Annex.

Service	Contact Address	Commercial	DSN
USAF	HQ AMC/A3VK 402 Scott Drive. Unit 3A1 Scott AFB, IL 62225-5302 e-mail: ATP-56@scott.af.mil	(+1) 618 229 2771 (Tel) (+1) 618 256 5692 (Fax)	779 7848 (Tel) 576 5692 (Fax)
USN/USMC	Commanding Officer Attn: KC-130 Division MAWTS-1 Yuma AZ 85369-9200 e-mail: USMC_USN_AAR@usmc.mil	(+1) 928 369 3547 (Tel) (+1) 928 269 6154 (Fax)	269 3547 (Tel) 269 6154 (Fax)
US Army	160th Special Operations Aviation Regiment (Airborne) AOAV-5C (Flt Stds Office) 7277 Nightstalker Way Fort Campbell, KY 42223 e-mail:	(+1) 270 798 1393 (Tel) (+1) 270 798 1917 (Fax)	

6Z Tanker/Receiver Technical Compatibility and POCs.

a. Tanker/Receiver Technical Compatibility. See Annex ZH for details.

b. POC for Tanker/Receiver Technical Compatibility Reviews.

Service	Contact Address	Commercial	DSN
DoD (Fixed Wing, Tilt Rotor and Rotary)	USTC J3-SR 508 Scott Drive Scott AFB IL 62225-5357 e-mail: ustcj3-s_arcell@ustranscom.mil	(+1) 618 229 1810 (Tel) (+1) 618 229 1809 (Tel) (+1) 618 229 7896 (Tel) (+1) 618 229 4527 (Fax)	779 1810 (Tel) 779 1809 (Tel) 779 7896 (Tel) 779 4527 (Fax)

7Z POCs for STAN/EVAL.

Service	Contact Address	Commercial	DSN
USAF (Fixed Wing)	HQ AMC/A3VK 402 Scott Drive. Unit 3A1 Scott AFB, IL 62225-5302 e-mail: ATP-56@scott.af.mil	(+1) 618 229 2771 (Tel) (+1) 618 256 5692 (Fax)	779 7848 (Tel) 576 5692 (Fax)
USAF (Tilt-Rotor)	HQ AFSOC/A3V 100 Bartley St Ste 141W Hurlburt Field FL 32544-5273 e-mail: AFSOC.A3V@hurlburt.af.mil	(+1) 850-884-4874 (Tel) (+1) 850-884-4027	579-4874 (Tel) 579-4027 (Fax)
USAF (Rotary-wing)	HQ ACC/A3TV 205 Dodd Blvd, Suite 101 Langley AFB, Virginia 23665 e-mail: acc.dotvsrtb@langley.af.mil	(+1) 757-764-7713(Tel) (+1) 757-764-8675	574-7713 (Tel) 574-8675 (Fax)
USN	Commander (N3A3) Naval Air Forces NAS North Island San Diego CA 92135-7051 e-mail:	(+1) 619-545-2779 (Tel)	735-2779 (Tel)
USMC	Commanding Officer Attn: KC-130 Division MAWTS-1 Box 99200 MCAS Yuma AZ 85369-9200 e-mail: USMC_USN_AAR@usmc.mil	(+1) 928 369 3547 (Tel) (+1) 928 269 6154 (Fax)	269 3547 (Tel) 269 6154 (Fax)
US Army	160th Special Operations Aviation Regiment (Airborne) AOAV-5C (Flt Standards Office) 7277 Nightstalker Way Fort Campbell, KY 42223 e-mail:	(+1) 270 798 1393 (Tel) (+1) 270 798 1917 (Fax)	

8Z National Annex Last Updated. 17 January 2010.

9Z National Reservations.

a. **USA.** USA forces do not participate in the European Airlift Centre (EAC) described in Part 5, Annex AE.

(1) **USAF.** For Reservations see USA Preliminaries, pages xv and xvi.
(2) **USN.** None.
(3) **USMC.** None.
(4) **US Army.** TBD

10Z List of Annexes and Appendices.

LIST OF EFFECTIVE PAGES TO PART 5, ANNEX Z, ATP-56(B)

PAGE NUMBERS	EFFECTIVE PAGES
Z-1 to Z-4	Feb 10
LEP-5-Z-1 to LEP-5-Z-2	Feb 10

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PART 5 – NATIONAL ANNEX

ANNEX ZA - USA

KC-135 STRATOTANKER

1ZA Introduction. The USAF has a large fleet of KC-135 Stratotankers with several variants in service; the main differences are in fuel capacity and engine fit. A small number of KC-135s are fitted with a receptacle to receive fuel from boom equipped tankers.

2ZA Receiver Types Certified. Details of receiver technical clearances together with AAR speeds and altitudes are published at Annex ZE. In addition, Annex ZE provides boom operators with receiver information essential to achieving safe AAR operations. For non-US receiver aircraft, the publishing of information in Annex ZE does not constitute an automatic authority to undertake refueling. However, see Annex ZH, paragraph 3ZH for details about authority to conduct AAR.

3ZA AAR Equipment. There is one centreline mounted flyable boom for boom-type refuelling. The boom can be modified to refuel probe-equipped aircraft by fitting a Boom Drogue Adapter (BDA); the BDA can only be fitted/removed on the ground. Approximately twenty aircraft have the capability to be fitted with two FRL Mk32B-753 wingtip mounted Multi-Point Refuelling System (MPRS) AAR pods.

a. AAR Equipment - Boom

(1) Description. The boom is approximately 8.5m (28 ft) long with an additional 5.6 m (18.5 ft) of inner fuel tube which can be extended or retracted by the boom operator. The boom is equipped with a Boom Interphone System which permits direct communication with suitably equipped receivers.

(2) Basic Operation

(a) When ready to refuel, the boom is lowered from its stowed position and about 3 m (10 ft) of the retractable portion is extended by the boom operator.

(b) When cleared, the receiver moves from a stabilised (zero rate of closure) astern position to a steady boom contact position.

(c) Closure to contact will be slow and stable (approximately 1 foot per second) with the receiver stabilising in the contact position.

(d) When this is achieved, the boom operator flies the boom to the receiver aircraft's receptacle and extends the boom to make contact. Locking toggles in the receptacle operate to hold the boom nozzle in contact.

(e) The receiver then maintains its position within the boom operating envelope.

WARNING

- The receiver will stabilise in the astern position and attain a zero rate of closure. If the receiver fails to attain a stabilised position, or it becomes apparent that a closure overrun will occur, breakaway procedures will be initiated. Failure to do so could result in a mid-air collision.

- Excessive closure rate could cause the tanker to descend into the path of the receiver. The tanker pilot must be prepared to disconnect the autopilot to prevent altitude deviations. Initiate a breakaway at the first indication of a closure overrun.

(3) Automatic Disconnect. Provided the receiver remains within the envelope, contact is maintained; however, if the receiver moves beyond the limits, a disconnect will automatically occur provided the tankers system is operating in normal.

CAUTION

- Approaching boom limits at relatively high velocity can cause structural damage as a result of an inability to disconnect due to binding action of the boom nozzle.

NOTE

- When the tankers air refueling system is in override, boom limit switches are inactive, the boom operator must initiate disconnects before the receiver exceeds limits.

(4) Boom Envelope. The envelope is defined by automatic limit switches connected to the boom; the envelope permits a limited amount of fore and aft movement and some freedom of manoeuvre in the pitching, rolling and yawing planes. The envelope limits are set well within the mechanical limitations of the boom; therefore, provided the envelope limits are not exceeded too rapidly, disconnect will occur before the boom is damaged. The full boom envelope is illustrated in Figures ZA-1-1 and 2 in Appendix 1 to this Annex; however, the freedom of manoeuvre in boom elevation is reduced for some receiver aircraft because of their receptacle characteristics.

(5) Normal Disconnect. To make a normal disconnect, the receiver releases the receptacle toggles (this may also be effected remotely by the boom operator) and remains stabilized in the contact position until the boom operator confirms a disconnect has been achieved; the receiver then moves to the astern position.

(6) Brute Force Disconnect. There are two types of brute force disconnect, inadvertent, and controlled tension (coordinated).

(a) Inadvertent Brute Force Disconnect. An inadvertent brute force disconnect is defined as any unplanned disconnect which is the result of one of the following:

(i) The receiver aircraft moves rapidly to the aft limit, causing mechanical tanker/receiver separation.

(ii) Boom pullout occurs at 38 degrees elevation or below.

CAUTION

- Following an inadvertent brute force disconnect, AAR will be terminated except during fuel emergencies or when continuation of AAR is dictated by operational necessity.

(b) Controlled Tension Brute Force Disconnect. A controlled tension brute force disconnect is defined as an intentional coordinated disconnect occurring above 38 degrees elevation, accomplished by gradual aft movement of the receiver aircraft (approximately 1 foot per second) until the boom is fully extended, and ending with a controlled tension boom pullout. Coordination between the receiver pilot and boom operator is required to ensure as smooth a disconnect as possible. Following a controlled tension disconnect, AAR may be continued with other receivers, provided the results of the following checks are satisfactory:

(i) Operational check of the boom for binding or uncontrollability.

(ii) Test of the tanker signal coil.

CAUTION

- A controlled tension brute force disconnect will be accomplished only as a last resort, after all other normal and emergency methods of disconnect have failed.
- AAR for the receiver that required a controlled tension disconnect will be terminated except during fuel emergencies or when continuation of AAR is dictated by operational necessity. If the receiver requires further AAR, the following actions must be accomplished before attempting another contact:

(i) Visual inspection of the receiver receptacle area and AAR boom.

(ii) Operational check of the boom for binding or uncontrollability.

(iii) Test of the tanker signal coil.

(7) AAR Boom Lighting

(a) Description. Pilot Director Lights (PDL) provide positioning information to receiver pilots during boom type refuelling. The PDLs are located on the bottom of the fuselage, aft of the nose landing gear; they consist of 2 panels of lights. The left panel gives boom elevation information and the right panel gives boom telescoping information. See Appendix 1, Figure ZA-1-1.

(b) Basic Operation. The lights are controlled by movement of the boom in elevation and by the in and out movement of the telescoping portion. These lights indicate the position of the boom in relation to the boom operating envelope and command the direction of receiver movement required to bring the boom to the ideal refuelling position.

(c) Receiver Actions

(i) Elevation. At one end of the elevation panel is the illuminated letter U (for up); at the other end is the illuminated letter D (for down); see Appendix 1 to this Annex. Adjacent to the letters are red arrowheads. If a receiver is in contact with the boom near the upward elevation limit, the red arrowhead next to the D will be illuminated; this indicates a downward movement is required. As the receiver moves down, the red light extinguishes and a green arrowhead illuminates, indicating the boom is approaching the ideal elevation. When the ideal elevation is reached, the green light extinguishes and 2 parallel green bars illuminate.

(ii) Longitudinal Position. Longitudinal position is verified using similar indications to those described above for the vertical position. The right-hand telescoping panel is similar in function, although the display is slightly different. The ends of the panel have the illuminated letters F and A (forward and aft); see Appendix 1 to this Annex. The position information and movement commands are given by illuminated horizontal bars with red leading into green, with the ideal position shown by 2 parallel green bars illuminating. The command indications are separated by illuminated vertical white bars to give contrast. The telescoping part of the boom is in colored segments, which duplicate PDL indications; at night these segments are illuminated by boom marker lights. Lights are not provided for azimuth positioning; however, a fluorescent yellow stripe on the undersurface of the tanker fuselage is provided for centerline reference. .See Appendix 5.

(iii) Visual References - Heavy Receivers. Heavy receivers should refer to Appendix 5 for illustrations and descriptions of tanker visual references.

(d) Radio Silent Procedures. During radio silence, the PDLs can be used to give positioning commands to direct a receiver into the boom contact position. A steady red PDLs commands a large movement in the direction indicated, and a flashing red light commands a small correction. The PDLs can also be extinguished to signal a request for disconnect.

(e) Failure of PDLs to Illuminate

(i) PDLs Fail to Illuminate When Making Contact. If the PDLs do not illuminate when a receiver makes contact, the receiver pilot will inform the boom operator if refuelling will continue. If refuelling is continued, verbal corrections from the boom operator may be requested.

(ii) PDLs Fail During Contact. If the PDLs go out during contact, the receiver will initiate a disconnect and return to the astern position. Subsequently, if refueling is continued, verbal corrections from the boom operator may be requested.

(f) Flashing PDLs. Flashing PDLs and the tanker lower strobe light on command a breakaway. Receivers will follow procedures in Part 2, Chapter 4, Para 408.

(g) Other Illumination. During night AAR, the AAR floodlight, and boom nozzle light will also be used to illuminate the boom and receiver receptacle.

b. AAR Equipment – Boom Drogue Adapter (BDA)

(1) Description. The BDA is 2.74 m (9 ft) of hose attached to the end of the telescoping part of the boom by a swiveling coupling; the hose terminates in a hard, non-collapsible drogue.

The telescoping part of the boom is kept fully extended whilst the BDA is in use. The boom will be trailed at the pre-determined boom elevation and azimuth settings for that particular receiver type.

(2) Basic Operation. The boom operator will hold the boom as motionless as possible, at the proper trail position, from the time the receiver reaches astern until completion of refuelling. The ideal astern position for the receiver is to be stabilized 1.52 m (5 ft) behind the drogue. When cleared, the receiver moves forward to make contact; slight oscillations of the drogue are normal, and can be expected in even ideal weather conditions. The boom operator will not move the boom except to avoid striking the receiver airplane (the drogue is never “Locked down”).

WARNING

- Simultaneous refueling from the centerline BDA and wingtip mounted MPRS AAR pod(s) is prohibited due to inadequate refuelling envelope clearance between receiver aircraft.

(3) Receiver Actions Extreme caution is required when operating on the BDA because, unlike hose drum systems, hose slack is not wound in. Contacts made with closure rates greater than about 2 kts will cause the hose to whip, with a consequently high probability of probe damage. Care must be taken to prevent the hose from looping around the probe, or touching the receiver’s fuselage; this can be avoided by the receiver approaching no closer than one half hose length. See Appendix 2.

(4) Fuel Transfer When the receiver has made contact, the tanker will transfer a small quantity of fuel to check the integrity of the system; if there are no fuel leaks, normal fuel transfer will continue. If possible, the tanker air refuelling pumps will be switched off 5 seconds before the scheduled disconnect; this is to minimize fuel spray on disconnect.

(5) Fuel Transfer Failure If fuel does not transfer, the receiver will be instructed to disconnect; the receiver should drop back to the astern position and check that the correct fuel system selections have been made. The boom operator will cycle the boom system by retracting the boom to approximately 6.5 m (15 ft) extension and then fully re-extend it. The receiver will then be re-cleared for a further contact.

(6) Normal Disconnect When cleared, the receiver should disconnect by backing, remaining aligned with the boom and aim to separate leaving the drogue aligned to its free trail position. The boom operator does not retract the boom for a normal disconnect. To avoid the drogue striking the aircraft, the receiver pilot must not stray away from the correct lateral alignment.

NOTE

- As soon as the receiver is in a safe position, the boom operator will cycle the boom by retracting to approximately 6.5 m (15 ft), then fully extending to signal "Ready for contact". Failure to cycle the boom could prevent subsequent contacts.

(7) Emergency Disconnect In an emergency the boom operator may retract the boom, in which event the drogue will whip violently as contact is broken.

(8) AAR Equipment Lighting - BDA

(a) Description. The elevation background lights and letters (PDLs described above in Para 3ZA a (7)) will be on during BDA AAR, but will not be used to direct receiver positioning; the PDLs do not provide correct positioning information during BDA operations. During night AAR, the AAR floodlight, boom nozzle light, and boom marker lights will also be used to illuminate the boom and BDA.

(b) Radio Silent Procedures and Breakaway. The elevation background lights and letters are used during radio silence to signal a routine disconnect (lights going out), or command a breakaway (flashing lights and tanker lower strobe light on).

c. AAR Equipment - Wingtip Mounted MPRS AAR Pods

(1) Description. When installed, the pods trail a 22.5 m (74 ft) retractable hose with MA-4 coupling and collapsible paradrogue. The black hose is marked with a series of 0.3 m (1 ft) long white markings and two 0.6 m (2 ft) wide orange bands. The range between the orange bands corresponds with the green pod status lights indicating the fuel transfer position. Appendix 3 provides a visual description of the pod status lights and relates this to hose position.

(2) Basic Operation. To start fuel flowing, the hose must be pushed in at least 1.5 m (5 ft), indicated by the first orange band, whereupon a green pod status lights coming on.

(3) Receiver Actions. Receiver pilots should remain within the ideal refuelling position; this is with the hose extended between the two orange bands. The inner limit is 16.4 m (54 ft) and the outer limit 21 m (69 ft). This provides a fore and aft range of movement of 4.6 m (15 ft). See Appendix 3, Figure ZA-3-2 and Figure ZA-3-3.

(4) Receiver Too Close. If the hose is pushed in too far, the amber pod status lights flash, fuel ceases after the hose is pushed in to less than 15.2 m (50 ft). Fuel flow will start again as the hose is pulled back out past 15.8 m (52 ft). Thus the receiver has a fore and aft range of movement of 5.8 m (19 ft) during which fuel will flow. See Appendix 3.

WARNING

- The system can be used to refuel two receivers simultaneously if the receiver wingspan is less than 68 ft. However, the boom operator will only clear one receiver at a time to move from astern to the contact position.
- Simultaneous refuelling from the centreline BDA and wingtip mounted MPRS AAR pod(s) is prohibited due to inadequate refuelling envelope clearance between receiver aircraft.

(5) AAR Equipment Lighting - Wingtip Mounted MPRS AAR Pods

(a) Description. Drogue lighting is provided by lights attached to four drogue ribs. Reflective tape is also affixed to both sides of each drogue rib and the outer ring. In addition to the drogue lighting, the following lights will be set by the boom operator; the receiver pilot can request intensity adjustments to lights as desired.

(i) Day AAR. For day AAR, the pod status lights and pod floodlights should be turned on full bright.

(ii) Night AAR. In addition to the day AAR lights, the underbody, underwing, nacelle illumination lights, pod illumination, horizontal stabilizer, and outboard nacelle illumination lights will be set to on/full bright for night AAR; they may be adjusted as requested by the receiver pilot. The AAR floodlight may also be used as desired. (Also see details of aircraft lighting in Para 4ZA d.)

d. Pod Status Lights. Three pairs of the lights (red, amber, and green) are located on opposite sides of the rear fairing of each pod. These lights inform the receiver pilot of the current mode/status of the pod. The lighting sequence is listed in, Appendix 3 Figure 2A-3-3.

e. Aircraft Lighting. Aircraft undersurfaces are illuminated by a comprehensive array of lights, many of which are adjustable for brilliance upon request (see Appendix 4, Figure ZA-4-1). The initial setting for underbody and underwing lights will be on/full bright during all types of refuelling day or night. The nacelle lights will be on during all types of refuelling, but during night AAR, will be dimmed prior to receivers reaching the observation position.

4ZA Refuelling Heights and Speeds

a. AAR RV Speed. The standard KC-135 tanker orbit speed is 275 KIAS or 0.78M, whichever is lower.

(1) The tanker will normally adjust to AAR speed when rolled out towards the RVCP.

(2) In the case of the A-10, fly orbit at 220 KIAS or the tanker's charted holding speed, whichever is the higher, and plan to roll out ½ NM in front of the receiver.

b. Boom and BDA AAR. Boom and BDA AAR height band is sea level to heights in excess of 30,000 ft; speed range is 200 to 320 KIAS.

c. MPRS AAR. Wingtip mounted MPRS AAR pods height band for AAR is 5,000 to 35,000 ft; speed range is 220 to 300 KIAS

5ZA Maximum Transferable Fuel. Total fuel load varies from 84,870 kg (187,000 lb) for the KC-135E to 92,060 kg (203,000 lb) for the KC-135R (CFM 56 engines). Maximum fuel available for offload on a four hour sortie is approximately 54,430 kg (120,000 lb) for a KC-135E or 61,280 kg (135,000 lb) for a KC-135R.

6ZA Fuel Transfer Rate. The tanker can transfer fuel at the following rates:

a. Boom. Exceeding 2722 kg/min (6000 lb/min) through the boom.

b. BDA. Exceeding 1270 kg/min (2800 lb/min) through the BDA.

c. MPRS. Exceeding1216 kg/min (2680 lb/min) through the wingtip mounted MPRS AAR pods.

7ZA Regulated Fuel Pressure. Fuel is delivered to the receiver at the regulated pressure of 3.5 ± 0.35 bars (50 ± 5 psi).

8ZA Fuel Types Available for AAR

a. Primary Fuel. The primary fuel is F34 (JP-8).

b. Alternate Fuels. The alternative fuels are F35 (Jet A-1), F40 (JP-4) and F44 (JP-5).

9ZA Mark Facilities. In response to a receiver request to "Mark" the tanker can dump fuel from the boom. "Mark" should only be used if a receiver low fuel state or other similar circumstance requires the rendezvous be expedited. If required, the tanker will dump fuel in 500 to 1000 pound increments until positive visual contact can be maintained.

10ZA Tanker Dimensions. The KC-135 is 39 m (128 ft) long with a wingspan of 40 m (130 ft).

11ZA RV Aids. The KC-135 has the following radio, navigation and RV aids:

a. UHF, VHF, HF, and SATCOM (some aircraft) radios.

b. VOR, TACAN, INS, GPS, and search/weather radar.

c. A/A TACAN (DME only), TCAS, IFF.

12ZA List of Source Documents

T.O. 1C-135(K)-1
T.O. 1C-135(K)E(I)-1
T.O. 1C-135(K)R(I)-1
T.O. 1C-135(K)(I)-1
T.O. 1C-135(K)R(II)-1

List of Appendices

Appendix	Subject
Appendix ZA-1	Boom
Appendix ZA-2	BDA
Appendix ZA-3	MPRS
Appendix ZA-4	Exterior Lighting
Appendix ZA-5	Refuelling - Visual References

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PART 5 – NATIONAL ANNEX

ANNEX ZA, APPENDIX 1 - USA

KC-135 STRATOTANKER - BOOM

Figure ZA-1-1 - KC-135 Pilot Director Lights Illumination Profile and Boom Limits

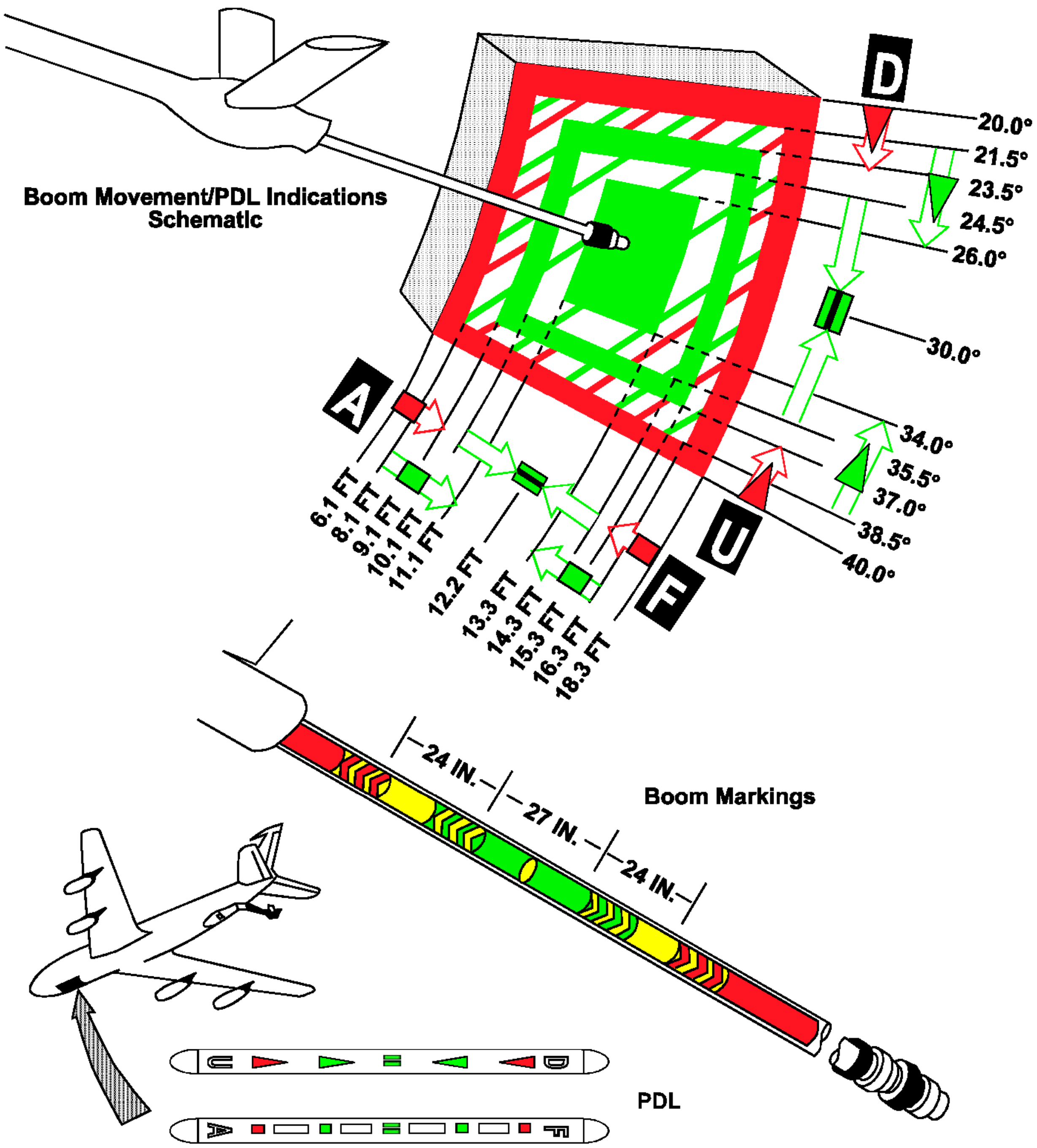
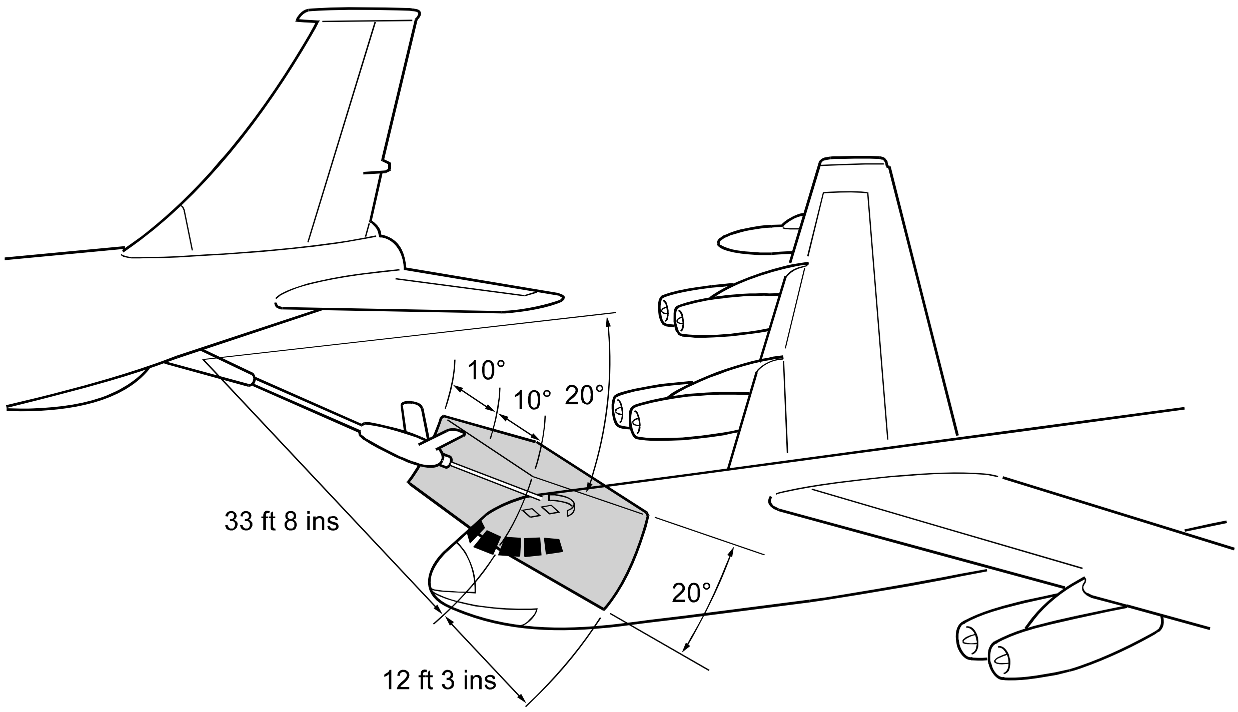


Figure ZA-1-2 - KC-135 Boom Limits



PART 5 – NATIONAL ANNEX

ANNEX ZA, APPENDIX 2 - USA

KC-135 STRATOTANKER - BOOM DROGUE ADAPTER (BDA)

Figure ZA-2-1 – BDA

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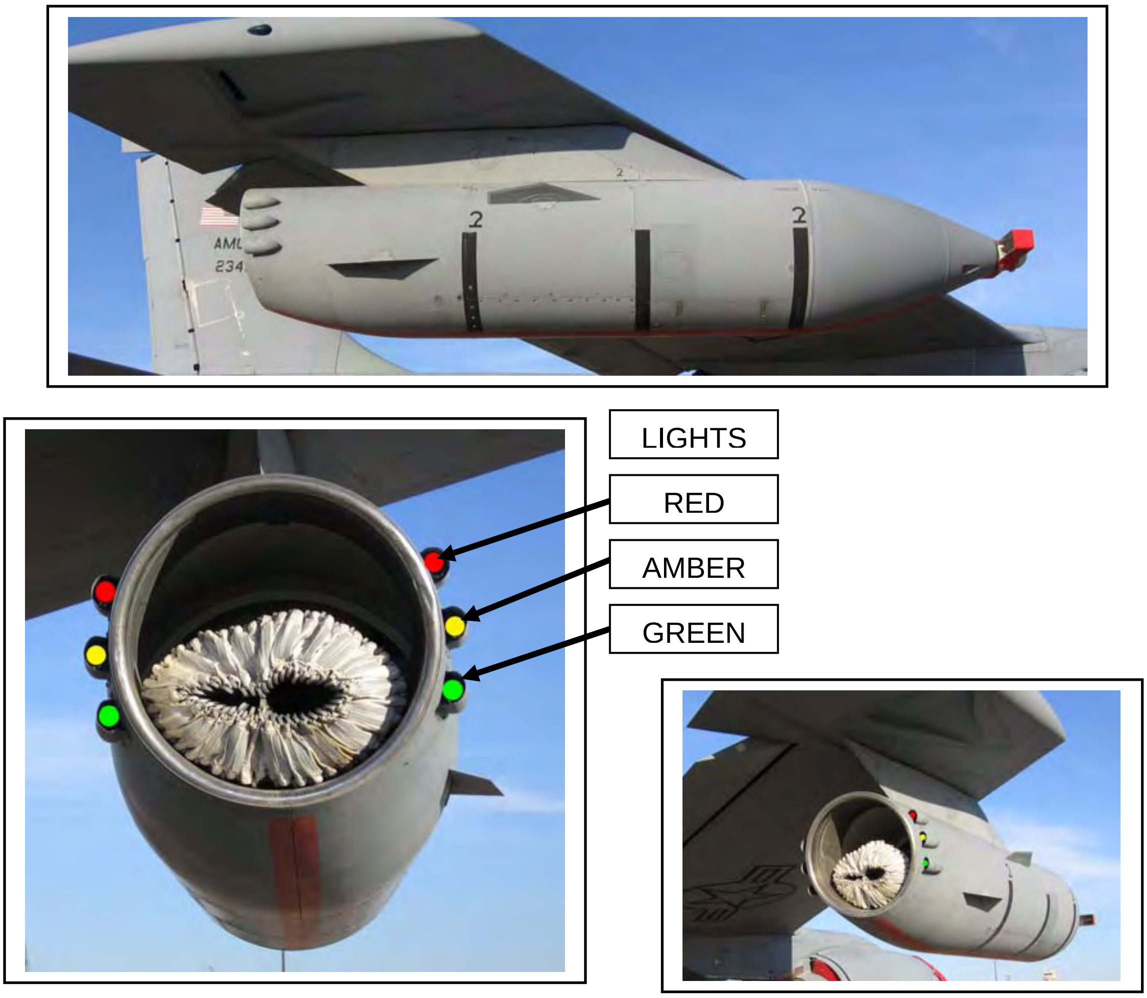
PART 5 – NATIONAL ANNEX

ANNEX ZA, APPENDIX 3 - USA

KC-135 MPRS POD STATUS LIGHTS

Figure ZA-3-1 – KC-135 MPRS Pod Status Lights



LIGHTS	FUNCTION
RED (2)	Light is on steady when power is on and hose is stowed and when the hose is deploying or being rewound using the REWIND/TRAIL switch on the pod control panel. Steady red light indicates to receiver the pod system is not ready to transfer fuel. Flashing indicates the need to immediate disconnect and separation. Comes on flashing when emergency breakaway switch on boom telescope lever is pressed; goes off after approximately 10 seconds or if emergency breakaway switch is pressed while lights are flashing.
AMBER (2)	When light is on steady, indicates to receiver that hose is fully extended and refueling system is ready for contact. Light flashes when hose is pushed in so deployed hose length is less than 51 feet and goes off when deployed hose length is more than 54 feet, when hose is pulled-out. Light is also on flashing when supplemental hose response is active.
GREEN (2)	Indicates to receiver that fuel transfer (greater than 50 gpm) is occurring. Lights are on when hose is deployed greater than 52 ft (but less than 69 ft), when the hose is pulled out. Lights are off when hose is pushed-in and less than 50 ft of hose is deployed or while supplemental hose response is active.

Figure ZA-3-2 – KC-135 MPRS Hose Markings/Pod Status Lights

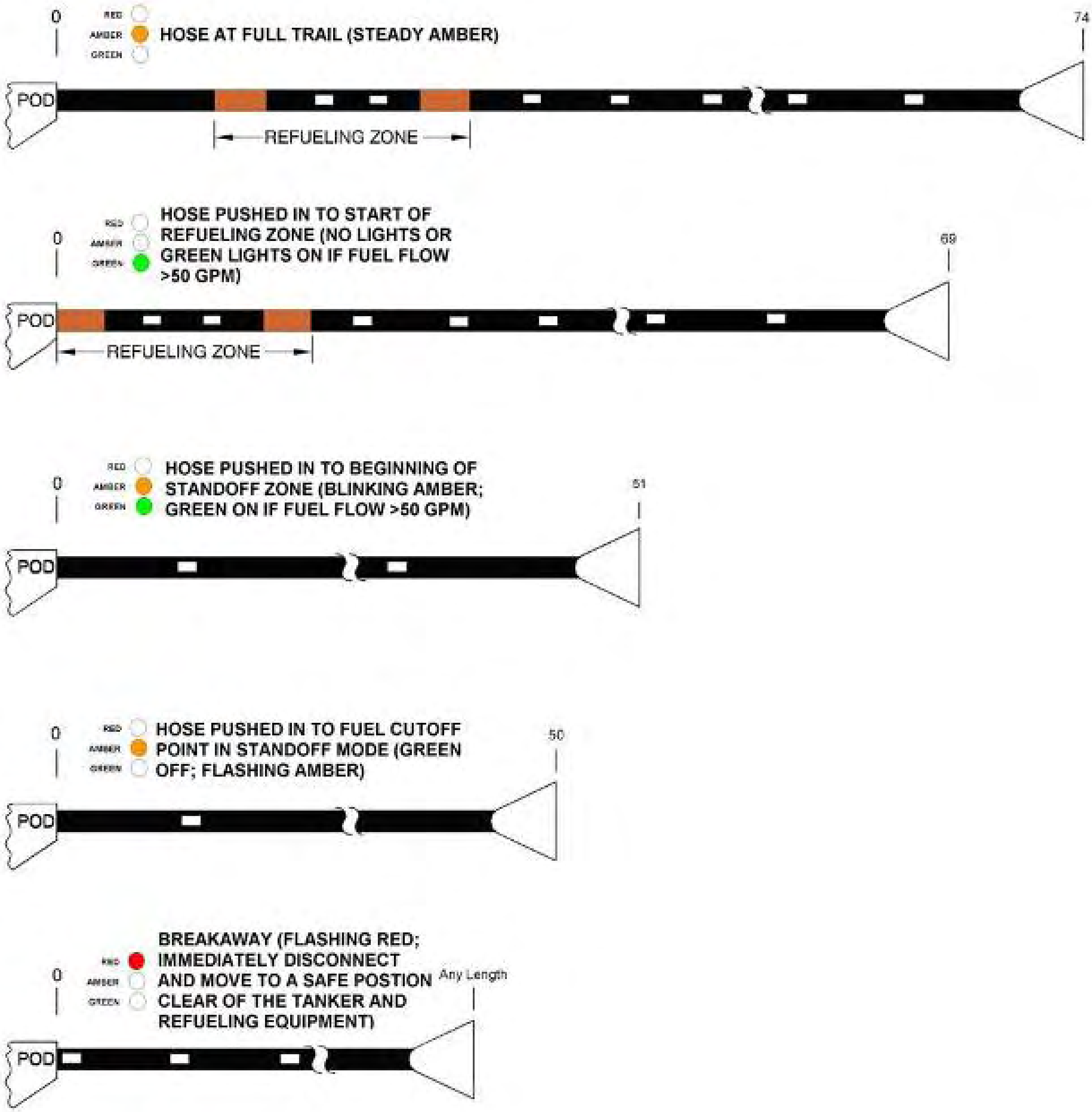


Figure ZA-3-3 – KC-135 MPRS Pod Status Lights

BEFORE CONTACT

STEADY RED	STEADY AMBER
Pod **NOT** ready. Do **NOT** make contact.	Ready for contact
	

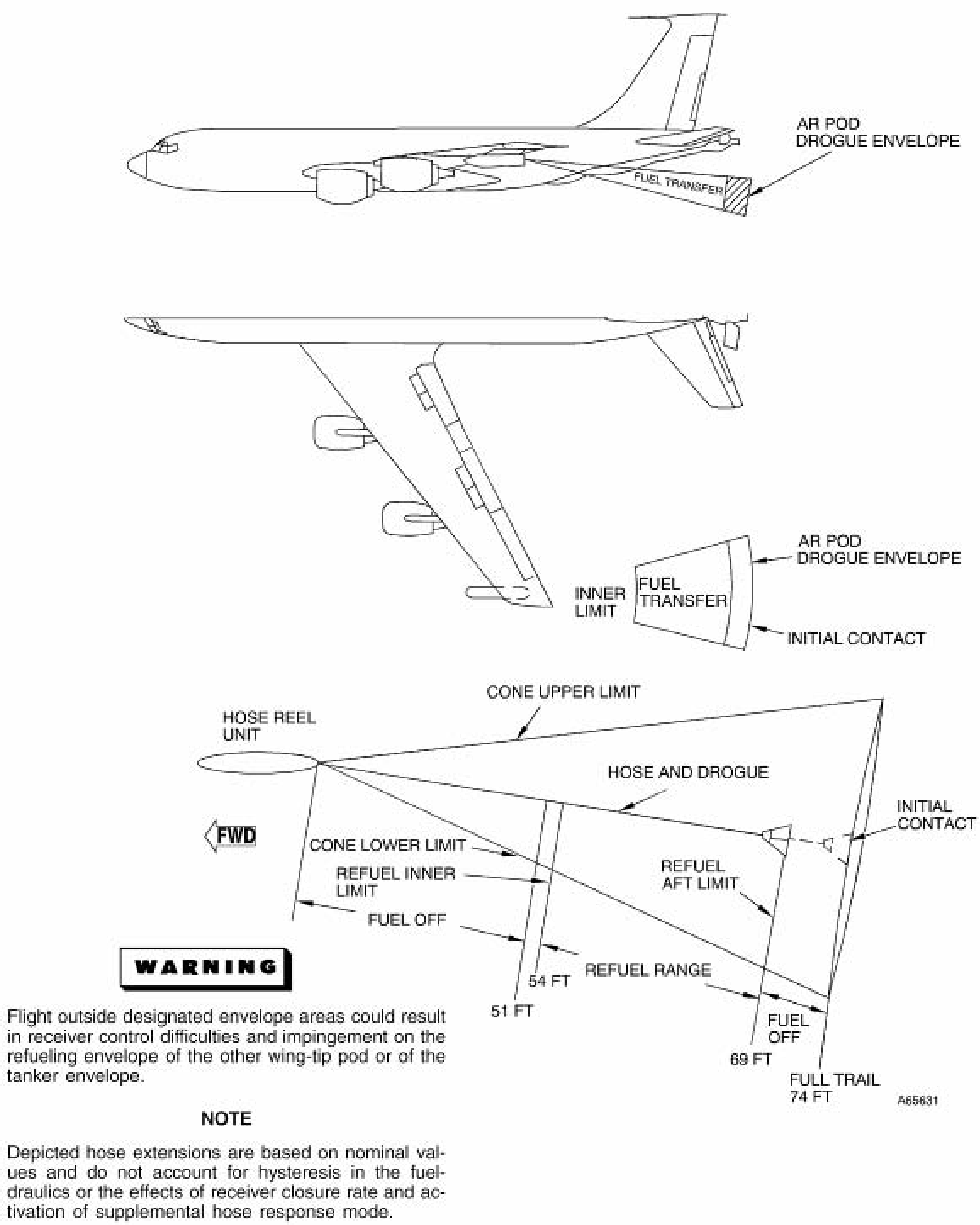
IN CONTACT

STEADY GREEN	ALL LIGHTS OUT (Receiver in Fuel Transfer Position)	FLASHING AMBER	STEADY AMBER
Fuel flows	Offload complete/ dry contact	Forward limit, drawback	Aft limit
			

ANYTIME

ALL 3 LIGHTS OUT	FLASHING RED
Disconnect	**BREAKAWAY**
	

<u>Figure ZA-3-4 – KC-135 Hose and Drogue – In-Flight Positioning</u>

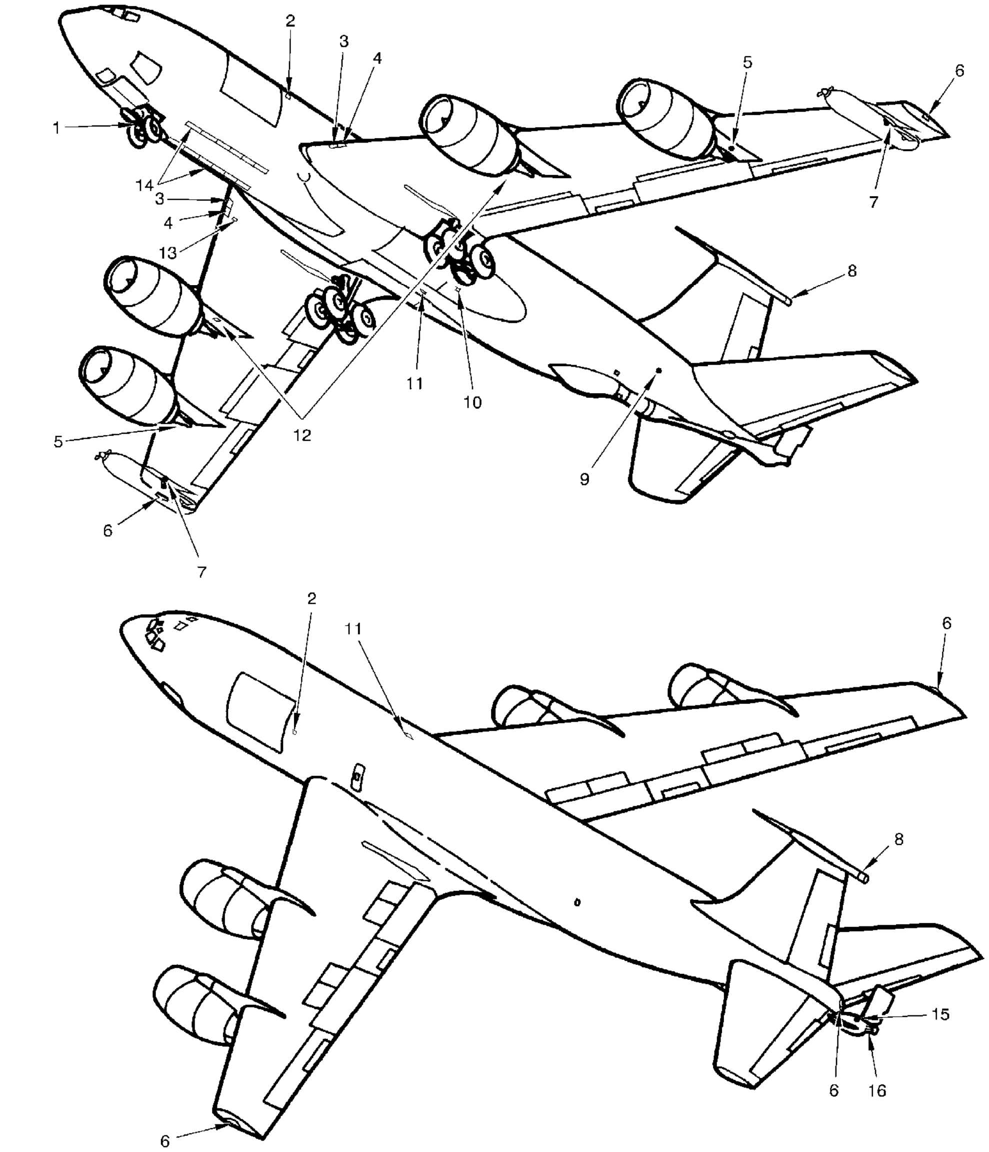


PART 5 – NATIONAL ANNEX

ANNEX ZA, APPENDIX 4 - USA

<u>KC-135 STRATOTANKER - EXTERIOR LIGHTING</u>

<u>Figure ZA-4-1 – KC-135 Exterior Lighting</u>



1	NOSE LANDING AND TAXI LIGHT (WHITE)
*2	NACELLE ILLUMINATION LIGHT (TYPICAL) (WHITE
3	TAXI LIGHT (WHITE)
4	LANDING LIGHT (FIXED) (WHITE)
*5	***[MPRS]*** POD ILLUMINATION LIGHTS (2) (WHITE)
*6	NAVIGATION LIGHT (LEFT-RED, RIGHT-GREEN, REAR - RED AND WHITE)
*7	***[MPRS]*** OUTBOARD NACELLE ILLUMINATION LIGHTS (2) (WHITE)
*8	FIN TIP AERIAL REFUELING FLOODLIGHT (WHITE)
*9	***[MPRS]*** HORIZONTAL STABILIZER ILLUMINATION LIGHTS (2) (WHITE)
*10	UNDERWING ILLUMINATION LIGHT (TYPICAL) (WHITE)
11	STROBE LIGHTS (2) (RED OR WHITE)
*12	UNDERBODY ILLUMINATION LIGHT (TYPICAL) (WHITE)
13	TERRAIN LIGHT (RETRACTABLE) (WHITE)
*14	RECEIVER PILOT DIRECTOR LIGHTS (WHITE, RED, GREEN)
15	BOOM MARKER LIGHTS (FLUORESCENT)
*16	BOOM NOZZLE LIGHT(S) (WHITE)

* Designates Adjustable Lighting

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PART 5 – NATIONAL ANNEX

ANNEX ZA, APPENDIX 5 - USA

KC-135 STRATOTANKER AAR - VISUAL REFERENCES

1ZA-5 Refuelling Position - Visual References When moving forward from the astern position to the contact position, the visual references used by heavy aircraft receiver pilots permit them to position their aircraft so that they remain within the tanker's AAR envelop. The following paragraphs provide guidance to help pilots achieve the correct position.

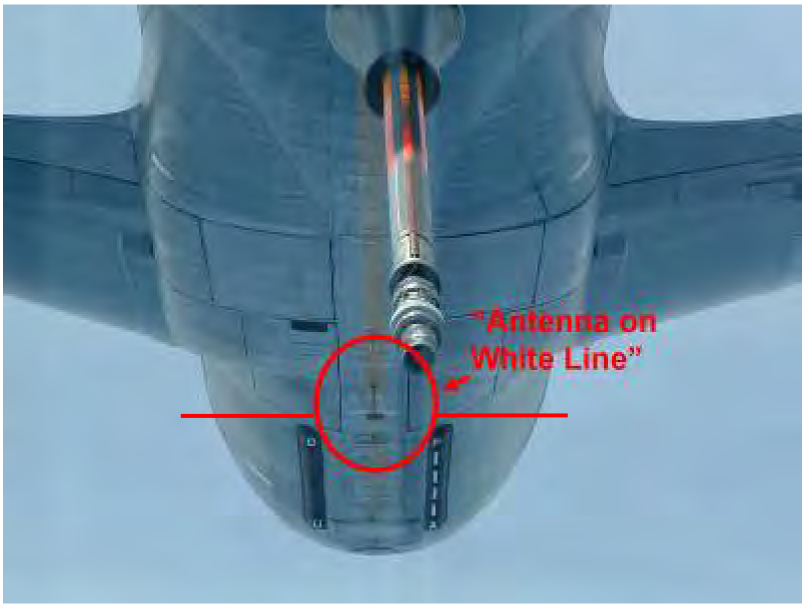
2ZA-5 Position - Elevation Determination of correct elevation is best achieved by comparing the alignment of the lower UHF antenna with the white line painted on the lower fuselage of the tanker. This antenna is easily seen on Block 30 KC-135 aircraft, but may be hidden by the significantly larger Block 40 VHF Data Link (VDL) antenna installed between the UHF antenna and the white line.

a. Vertical Visual References – Heavy Aircraft Receivers

(1) Upper Limit The upper limit is reached when the UHF antenna moves through the white line changing the inverted "T" to a "t". In addition, there will be more sky visible above the tanker's wing to the top of the receiver pilot's window.

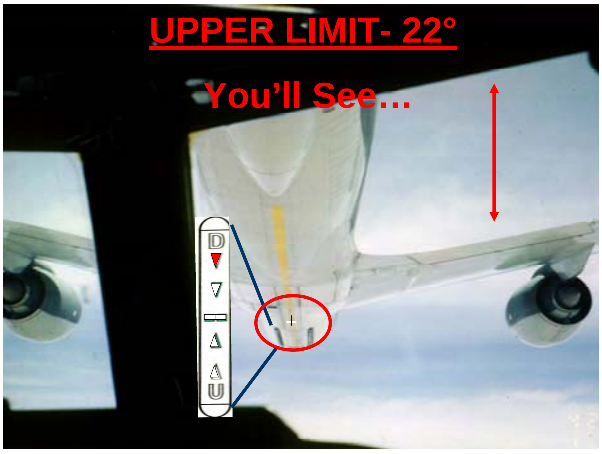
(2) Lower Limit When the lower limit is reached, there will be gap between the white line and the tip of the UHF antenna. This gap will be approximate one third of the length of the antenna.

Figure ZA-5-1. Lower UHF Vertical Visual Reference



Contact Position – Pre-Block 40 - Lower UHF Inverted T

Figure ZA-5-2. Upper and Lower Limits - Lower UHF Reference



Upper Limit

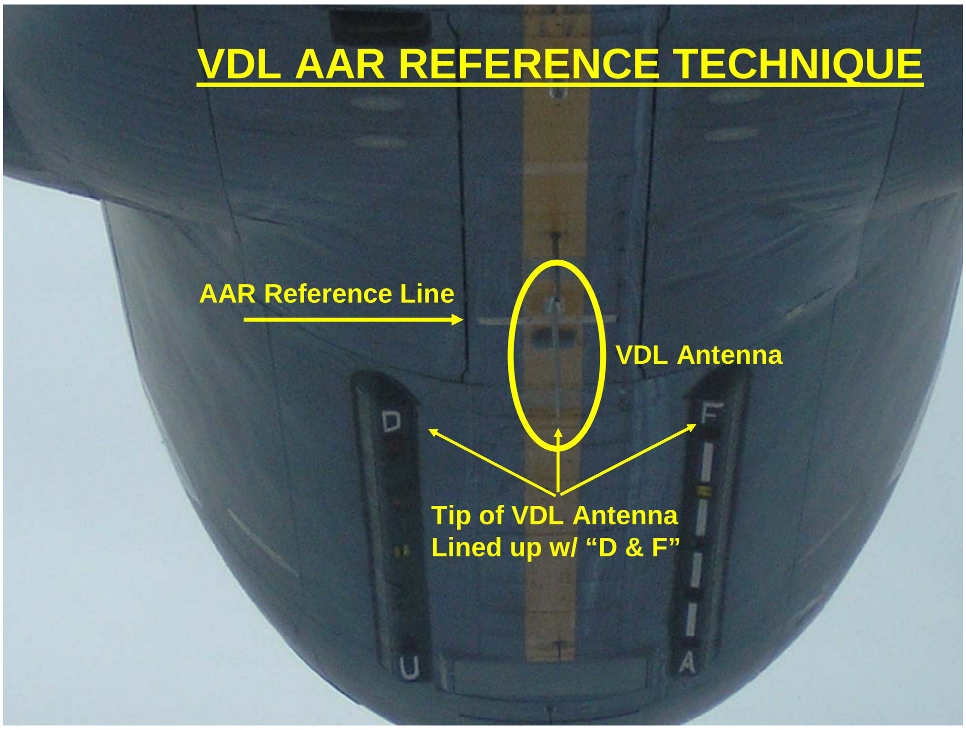
Lower Limit

b. Vertical Visual Reference (Block 40) – Heavy Aircraft Receivers

(1) Lower UHF Antenna When receiving fuel from Block 40 aircraft, receiver pilots must exercise caution to ensure that they do not mistakenly attempt to create an inverted "T" using the VDL antenna instead of the UHF antenna. Moving two degrees left or right will allow the receiver pilot to distinguish the lower UHF antenna, and use normal references.

(2) Alternative Reference – VDL Antenna When AAR position is determined by reference to the VDL antenna, the correct vertical position is achieved when the receiver pilot aligns the tip of the VDL antenna with an imaginary line drawn between the top of "D" and the top of the "F" of the Pilot Director Lights.

Figure ZA-5-3. Block 40 Vertical Visual Reference



Block 40 - Contact

LIST OF EFFECTIVE PAGES TO PART 5, ANNEX ZA, ATP-56(B)

PAGE NUMBERS	EFFECTIVE PAGES
ZA-1	May 08
ZA-2 to ZA-10	Feb 10
ZA-1-1 to ZA-1-2	May 08
ZA-2-1 to ZA-2-2	May 08
ZA-3-1 to ZA-3-2	May 08
ZA-3-3	Feb 10
ZA-3-4	May 08
ZA-4-1 to ZA-4-2	May 08
ZA-5-1 to ZA-5-2	May 08
LEP-5-ZA-1 to LEP-5-ZA-2	Feb 10

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PART 5 – NATIONAL ANNEX

ANNEX ZB - USA

KC-10 EXTENDER

1ZB Introduction. The USAF has 59 KC-10 Extenders in service. All KC-10s are equipped with an AAR boom and centreline drogue; many are fitted for Wing Air Refuelling Pods (WARP). The aircraft has a receptacle for receiving fuel from boom-equipped tankers, and has a reverse fuel pumping capability.

2ZB Receiver Types Certified. Details of receiver technical clearances together with AAR speeds and altitudes are published at Annex ZE. In addition, Annex ZE provides boom operators with receiver information essential to achieving safe AAR operations. For non-US receiver aircraft, the publishing of information in Annex ZE does not constitute an automatic authority to undertake AAR. However, see Annex ZH paragraph 3ZH for details about authority to conduct AAR.

3ZB AAR Equipment. There is one centreline flyable boom for boom-type refueling. Additionally, a Sargeant Fletcher fuselage mounted hose drum unit is fitted for probe and drogue operation. Approximately twent aircraft have the capability to be fitted with two Flight Refuelling Ltd Mk32B wing mounted AAR pods; these are known as Wing Aerial Refuelling Pods (WARPs).

a. AAR Equipment - Boom

(1) Description. The boom is approximately 11 m (36 ft 9 in) long with an additional 7 m (22 ft) of telescoping inner fuel tube. When the boom is fully extended it has a total length of 58 ft 3 in. All KC-10 booms are equipped with a Boom Interphone System which permits direct communication with suitably equipped receivers.

(2) Basic Operation. Procedures for refuelling from the boom are identical to those used with the KC-135 boom; however, the boom has a more sophisticated control system which provides a number of additional operating facilities.

(a) When ready to refuel, the boom is lowered from its stowed position and about 3.6 m (12 ft) of the retractable portion is extended by the boom operator.

(b) When cleared, the receiver moves from a stabilised (zero rate of closure) astern position to a steady boom contact position.

(c) Closure to contact will be slow and stable (approximately 1 foot per second) with the receiver stabilising in the contact position.

(d) When this is achieved, the boom operator flies the boom to the receiver aircraft's receptacle and extends the boom to make contact. Locking toggles in the receptacle operate to hold the boom nozzle in contact.

(e) The receiver then maintains its position within the boom operating envelope.

(f) The digital fly-by-wire control system has an Automatic Load Alleviation System (ALAS). The ALAS reduces and maintains constant radial forces on the nozzle and receptacle; this permits a larger AAR envelope without nozzle binding.

WARNING

- The receiver will stabilise in the astern position and attain a zero rate of closure. If the receiver fails to attain stabilised position, or it becomes apparent that a closure overrun will occur, breakaway procedures will be initiated. Failure to do so could result in a mid-air collision.

- Excessive closure rate could cause the tanker to descend into the path of the receiver. The tanker pilot must be prepared to disconnect the autopilot to prevent altitude deviations. Initiate a breakaway at the first indication of a closure overrun.

CAUTION

- Binding of the boom nozzle in the receiver's receptacle is possible, even with a disconnect signal. While nozzle binding can occur in most disconnect positions, it is most likely at high receiver roll and low boom elevation. If nozzle binding occurs or is suspected, neutralise boom flight control inputs. Avoid abrupt boom flight control inputs.

(3) Independent Disconnect System. The boom has an Independent Disconnect System (IDS). In the event of the receptacle toggles failing to unlatch from the boom using the normal electrical signalling system, the IDS can be used. The IDS employs compressed air to retract the toggle latches on either side of the boom nozzle; this obviates the requirement for brute force disconnects.

(4) Boom Envelope. The envelope is defined by automatic limit switches connected to the boom; the envelope permits a limited amount of fore and aft movement and some freedom of manoeuvre in the pitching, rolling and yawing planes. The envelope limits are set well within the mechanical limitations of the boom; therefore, provided the envelope limits are not approached too rapidly, the automatic disconnect will occur before the boom is damaged. The full boom envelope is illustrated in Appendix 1; however, the freedom of manoeuvre in the upper boom elevation is reduced for some receiver aircraft because of their receptacle characteristics.

(5) Failure of the Boom Flight Control System. Should the boom fly-by-wire control system suffer certain failures, the boom operator may not be able to control the boom in one or more axis of movement; coordinated action between the boom operator and the receiver pilot will then be required to prevent the boom from striking the receiver. The receiver pilot must remain in contact and follow the boom operator's instructions explicitly; the boom operator will direct the receiver to a safe disconnect position. This may be preceded by a period when the receiver pilot is required to maintain a stabilised in-contact position to allow the boom control surfaces to free stream to a neutral position. The safe position is defined as the position during a partial or complete boom control system failure that it is safe for the boom operator or receiver to initiate a disconnect. During one of these system failures, the boom operator will direct the receiver to this safe position, which is achieved when the receiver is approximately zero degrees roll and moving down and back.

(6) AAR Boom Lighting

(a) Description. Pilot Director Lights (PDL) provide positioning information to receiver pilots during boom type AAR. The PDLs are located on the bottom of the fuselage, aft of the nose landing gear; they consist of 2 panels of lights. The left panel gives boom elevation information and the right panel gives boom telescoping information. Appendix 1, Figure ZB-1-1.

(b) Basic Operation. The lights are controlled by movement of the boom in elevation and by the in and out movement of the telescoping portion. These lights provide positional trending information about the boom in relation to the boom operating envelope and command the direction of receiver movement required to bring the boom to the ideal refuelling position.

(c) Receiver Actions

(i) Elevation. At one end of the elevation panel is the illuminated letter U (for up); at the other end is the illuminated letter D (for down). Adjacent to the letters are red arrowheads. If a receiver is in contact with the boom near the upward elevation limit, the red arrowhead next to the D will be illuminated; this indicates a downward movement is required. As the receiver moves down, the red light extinguishes and a yellow arrowhead illuminates, indicating the boom is approaching the ideal elevation. When the ideal elevation is reached, the green light extinguishes and two parallel green bars illuminate

(ii) Forward/Aft. Forward/Aft position is verified using similar indications to those described above for the vertical position. The right-hand telescoping panel is similar in function, although the display is slightly different. The ends of the panel have the illuminated letters F and A (forward and aft). The position information and movement commands are given by illuminated horizontal bars with red leading into yellow, with the ideal position shown by two parallel green bars illuminating. The command indications are separated by illuminated vertical white bars to give contrast. The telescoping part of the boom is in coloured segments, which duplicate PDL indications; at night these segments are illuminated by boom marker lights. Lateral position lights are not provided for roll positioning; however, a fluorescent yellow stripe on the undersurface of the tanker fuselage is provided for centreline reference.

(d) Radio Silent Procedures. During radio silence, the PDLs can be used to give positioning commands to direct a receiver into the boom contact position. A steady red PDL light commands a large movement in the direction indicated, and a flashing red light commands a small correction.

(e) Failure of PDLs to Illuminate

(i) PDLs Fail to Illuminate When Making Contact. If the PDLs do not illuminate when a receiver makes contact, the receiver pilot will inform the boom operator if AAR will continue. Subsequently, if refueling is continued, verbal corrections from the boom operator may be requested.

(ii) PDLs Fail During Contact. If the PDLs go out during contact, the receiver is to initiate a disconnect and return to the astern position. If AAR is continued, verbal corrections from the boom operator may be requested.

(f) Flashing PDLs. Flashing PDLs and tanker lower strobe light on command a breakaway; the receiver will disconnect immediately and move back and down to clear the tanker.

(g) Other Illumination. During night AAR, the tail mounted floodlight (TMF), and the boom nozzle lights will also be used to illuminate the boom.

b. AAR Equipment - Centreline Hose

(1) Description. A single fuselage mounted hose drum unit fitted within the lower rear fuselage offers a hose which exits from a tunnel offset by about 1.2 m (4 ft) to the right of the aircraft centreline. The hose is 24 m (80 ft) long, of which 21 m (70 ft) trails from the tunnel; the hose is marked by a series of 0.3 m (1 ft) and 0.6 m (2 ft) wide white bands, see Appendix 2, Figure ZB-2-2. The hose terminates in a US MA-3/4 coupling and 0.7 m (26 in) diameter collapsible drogue.

(2) Basic Operation

(a) Before the centreline hose can be used for AAR, a series of checks need to be conducted by the tanker; these involve trailing the hose and performing a system test. Receivers are therefore to remain in the observation position until cleared astern the tanker; do not assume that the hose is primed and ready just because it is trailed.

(b) When cleared to contact, the receiver should move forward to make contact at the designed closure speed of 2 – 3 kts; overtake speeds approaching 5 kts will almost certainly produce a sine wave whipping action, possibly leading to probe or drogue separation.

(c) The hose must be pushed in at least 1.5 m (5 ft), indicated by the first of the 0.6 m (2 ft) white bands, to start fuel flowing.

WARNING

- Simultaneous AAR from the centreline drogue and wingtip mounted WARP pod(s) is prohibited due to inadequate refuelling envelope clearance between receiver aircraft.

- Except in an emergency, centreline drogue AAR will not be conducted while tobogganing.

CAUTION

- The centerline drogue reel response system will be reset after establishing/changing altitude, attitude, or airspeed.

(3) Receiver Actions

(a) The ideal AAR position is reached when a further 6 m (20 ft) of hose is pushed in; this is indicated by the second of the 0.6 m (2 ft) white bands. The receiver can push in a further 4.6 m (15 ft) of hose and remain within the refuelling range of the hose; the inner limit is marked by the third 0.6 m (2 ft) white band.

(b) When in contact, the receiver should maintain the hose aligned with the hose tunnel; this may impose some lateral control loads because of the offset tunnel.

(c) Wake turbulence from the tanker may be felt on rear control empennages and may cause some control surface loading.

(d) Above 275 KIAS, good contacts are more likely if the probe contacts the centre of the drogue; off-centre contacts may be ‘soft’.

(e) Fuel spray may enter the engine intake and result in engine malfunctions/compressor stalls.

(f) The hose drum unit has a winding in torque (response system) applied to counter drogue air drag and thus provide a balanced hose; if tanker airspeed, altitude or attitude is changed, the hose response system will have to be reset.

(g) Receivers will be directed clear of the hose whilst hose reset is accomplished.

(4) Receiver Too Close. If the inner limit is exceeded, fuel flow ceases and the amber signal light flashes. The receiver has a fore and aft range of movement of 11 m (35 ft) during which fuel will flow.

(5) AAR Equipment Lighting - Centeline Hose

(a) Description. Hose signal lights are mounted on the fuselage in a horizontal row to the left of the fuselage hose tunnel and beneath the pod mouth for the wing stations. The lights are coloured red, green and amber.

(b) Centreline Hose Status Lights See Appendix 2, Figure ZB-2-4 for details about the Centreline Hose Status Lights.

c. AAR Equipment - Wing AAR Pods (WARP)

(1) Description. When installed, the hose length is 24 m (79 ft) of which 22.5 m (74 ft) trails from the pod. The hose is black and is marked by a series of 0.3 m (1 ft) wide white bands and two 0.6 m (2 ft) wide orange bands. The hose terminates in a US MA-4 coupling and collapsible drogue.

(2) Basic Operation. The hose must be pushed in at least 1.5 m (5 ft), indicated by the first 0.6 m (2 ft) wide orange band, to start the fuel flowing.

WARNING

- The wingtip mounted WARP pod(s) can be used to refuel two receivers simultaneously if the receiver wingspan is less than 68 ft. However, the boom operator will only clear one receiver at a time to move from astern to the contact position.

- Simultaneous AAR from the centreline drogue and wingtip mounted WARP pod(s) is prohibited due to inadequate AAR envelope clearance between receiver aircraft.

- Except in an emergency, WARP drogue AAR will not be conducted while tobogganing.

(3) Receiver Actions. The ideal refuelling position is between the two 0.6 m (2 ft) wide orange bands which mark the inner limit of 17.4 m (57 ft) and the outer limit of 21 m (69 ft) of the AAR range, thus providing a fore and aft range of movement of 3.7 m (12 ft).

(4) Receiver Too Close. If the inner AAR limit is exceeded, the amber light flashes (see para 4ZE c (2) for a description of signal lights) indicating the inner response limit is being approached, fuel flow ceases after the hose is pushed in to 14.6 m (47 ft). Fuel flow will start again as the hose is pulled back out past 14.9 m (48 ft). Thus the receiver has a fore and aft range of movement of 6.4 m (20 ft) during which fuel will flow. Hose reel response is only effective from approximately 14 m (46 ft) to full trail. If the receiver pushes the hose inside this inner response limit, a 'dead hose' will result. A loop will form that could cause damage to the receiver aircraft.

(5) AAR Equipment Lighting – WARP

(a) Description

(i) Day AAR. Red, amber, and green signal lights are located on the underside of the aft pod tailcone fairing. See Annex ZB, Appendix 3, Figure ZB-3-1. They are set up in pairs for redundancy and are clearly visible to the receiver pilot. The red (WARNING) signal lights are illuminated whenever the WARP power switch is on and the pods are not ready for receiver contact. The red lights also flash if the hose is at full trail or in AAR range to signal breakaway. Both left and right pods and the centreline hose/drogue signal red signal lights are controlled from a common breakaway switch on the centreline hose/drogue control panel, and alternately by the breakaway switch on the boom controller. The pods will enter a passive mode when either breakaway switch is activated.

(ii) Night AAR. The intensity of the green and amber lights can be adjusted from BRIGHT for day operations to DIM for night operations. The red lights are always bright.

(b) Pod Status Lights. See Appendix 3 for details about the WARP Status Lights.

(c) Pod Markings. Three red guide lines are provided at each wing pod location to aid the receiver pilot with alignment prior to contact with the drogue. One line is painted on each side of each wing pod on the underside of the wings several feet away from the pods. A third line is located on the bottom of each wing pod and is used as a centre for receiver aircraft alignment.

d. Aircraft Lighting. The aircraft has an extensive array of floodlights, which are adjustable for brilliance; formation keeping lights are also provided. See Appendix 4, Figure ZB-4-1.

4ZB AAR Heights and Speeds

a. AAR RV Speed

(1) The standard tanker orbit pattern airspeed is 275 KIAS or Mach 0.78, whichever is lower, but not below AAR orbit speed.

(2) The standard tanker orbit pattern airspeed for A-10 AAR is 255 KIAS to facilitate the rendezvous slowdown to the A-10 AAR speed.

b. Boom. Boom AAR height band is sea level to 37,000 ft; speed range is 180 to 350 KIAS.

c. Centreline Hose. Centreline hose AAR height band is sea level to 35,000 ft; speed range is 200 to 280 KIAS.

d. WARP AAR. Wing pod AAR height band is sea level to 35,000 ft; speed range is 230 to 300 KIAS.

5ZB Maximum Transferable Fuel. Total fuel load is 154,240 kg (340,000 lb). Transferable fuel is dependent on sortie duration; about 113,330 kg (250,000 lb) is available for transfer during a 4 hour flight, assuming a fuel burn rate of 8170 kg/hr (18,000 lb/hr).

6ZB Fuel Transfer Rate

a. Boom. 3630 kg/min (8000 lb/min) through the boom.

b. Centreline Hose. 1820 kg/min (4000 lb/min) through the centreline hose.

c. WARP. 11 kg/min (2400 lb/min) through the wing hoses.

7ZB Regulated Fuel Pressure. Fuel is delivered to the receiver at the regulated pressure of 3.5 ± 0.35 bar (50 ± 5 psi).

8ZB Fuel Types Available for AAR

a. Primary Fuel. The primary fuel is F34 (JP-8).

b. Alternate Fuels. The alternative fuels are F35, F40 and F44.

9ZB Mark Facilities. In response to a receiver request to "Mark" the tanker can dump fuel and/or switch on High Intensity Lighting. "Mark" should only be used if a receiver low fuel state or other similar circumstance requires the rendezvous be expedited. If required, the tanker will dump fuel in 500 to 1000 pound increments until positive visual contact can be maintained.

10ZB Tanker Dimensions. The KC-10 is 55 m (180 ft) long and has a wingspan of 50 m (165 ft).

11ZB RV Aids. The KC-10 has the following radio, navigation and RV aids:

a. VHF, UHF and HF radios.

b. VOR, TACAN, INS, GPS, and search/weather radar.

c. UDF, A/A TACAN (bearing and DME), TCAS, radar transponder and radar beacon mode.

12ZB Source Documents

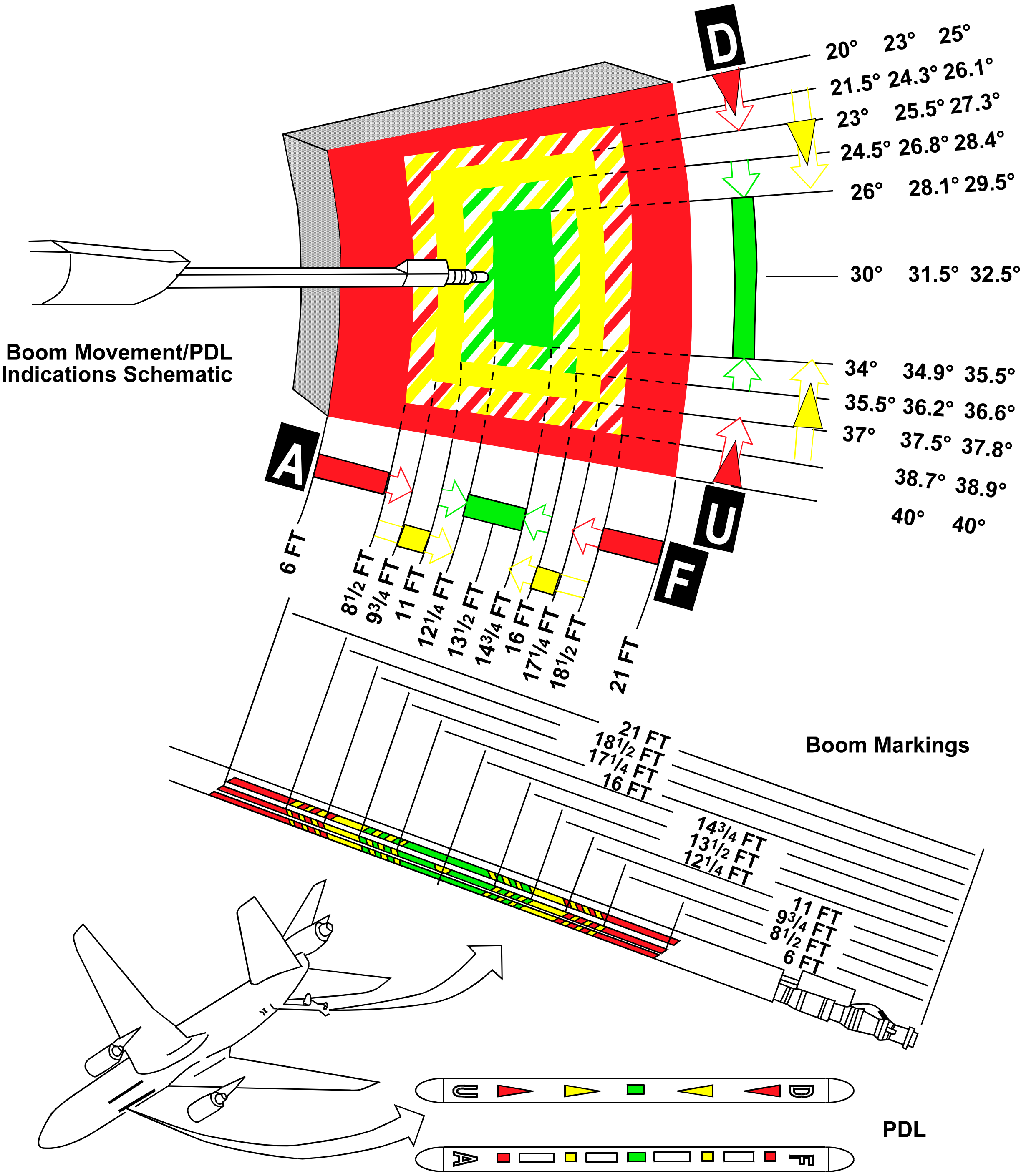
T.O. 1C-10(K)A-1

PART 5 – NATIONAL ANNEX

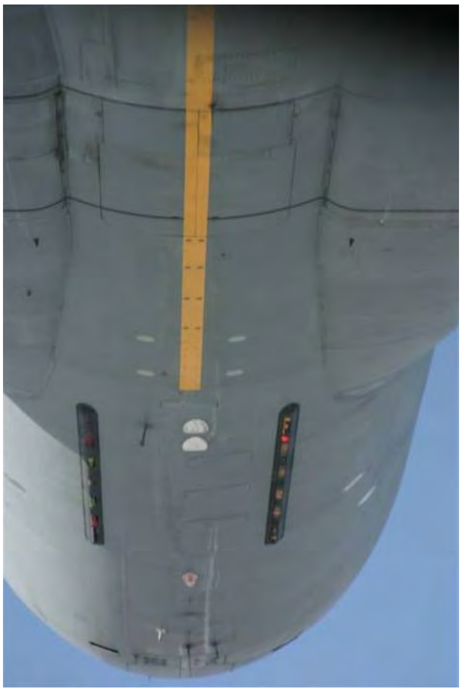
ANNEX ZB, APPENDIX 1 - USA

KC-10 EXTENDER - BOOM

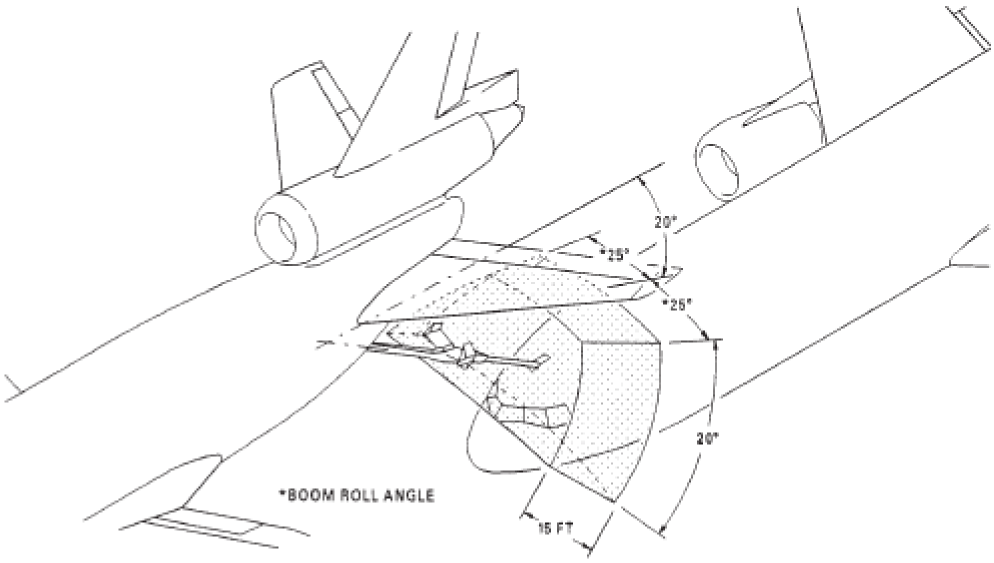
Figure ZB-1-1 - KC-10 Pilot Director Lights Illumination Profile



<u>Figure ZB-1-2 – KC-10 Pilot Director Lights</u>



<u>Figure ZB-1-3 - KC-10 Boom Limits</u>



PART 5 – NATIONAL ANNEX

ANNEX ZB, APPENDIX 2 - USA

KC-10 EXTENDER - CENTRELINE HOSE

Figure ZB-2-1 – KC-10 Centreline Hose/Drogue Signal Lights

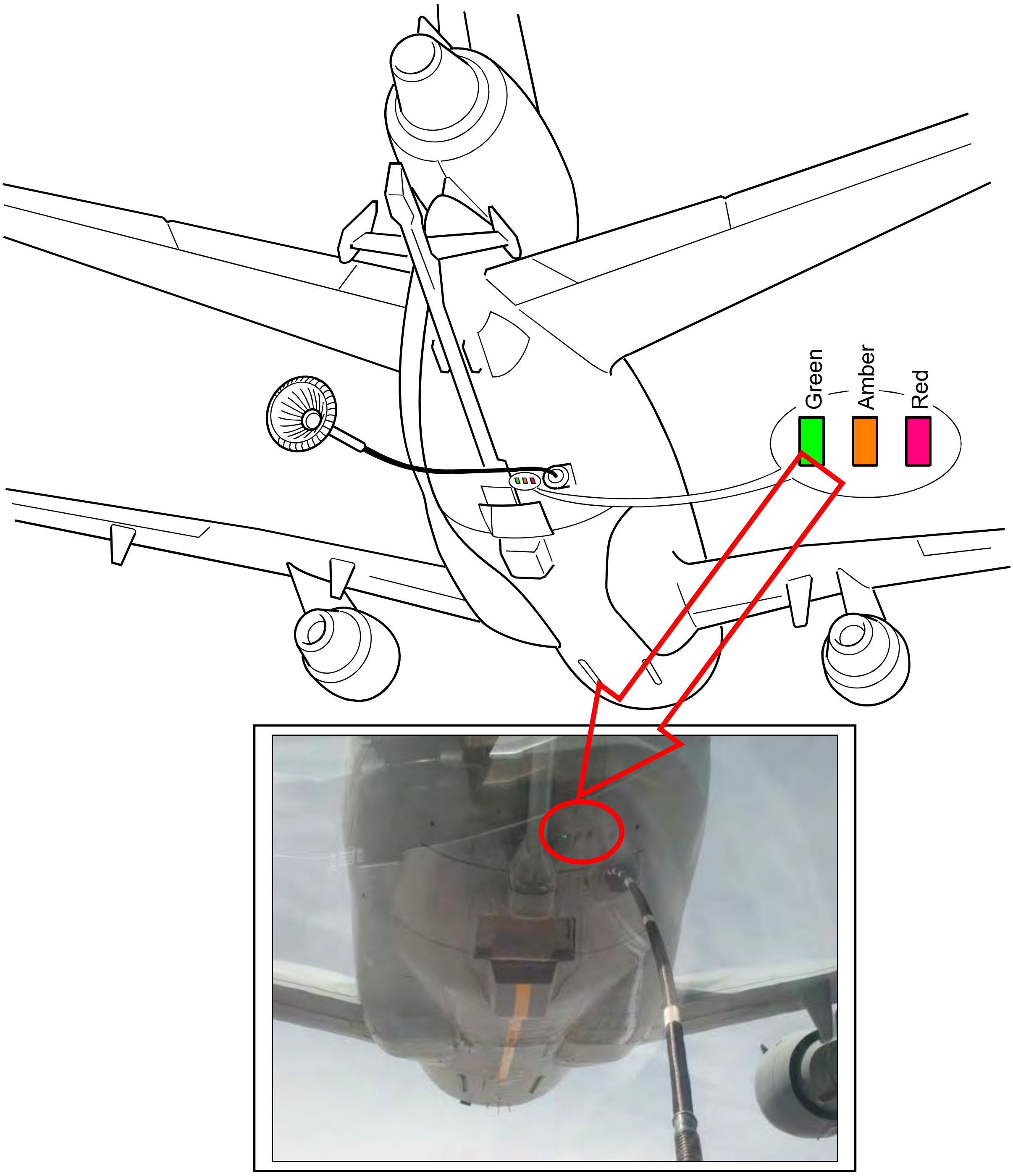
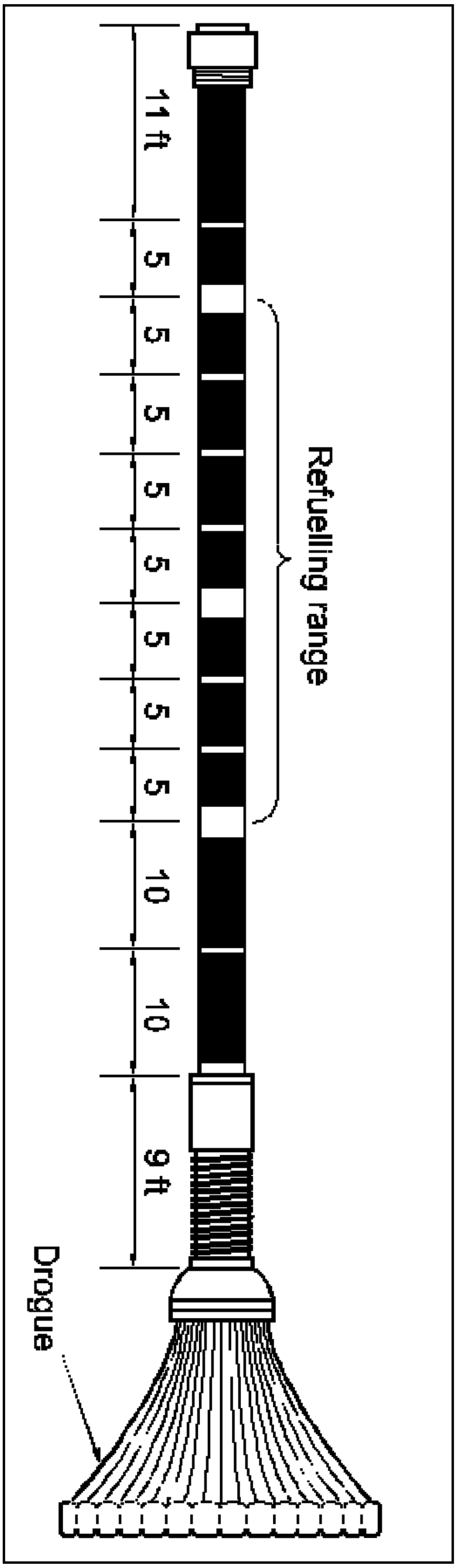


Figure ZB-2-2 – KC-10 Centreline Hose



<u>Figure ZB-2-3 – KC-10 Centreline Hose Markings/Pod Status Lights</u>

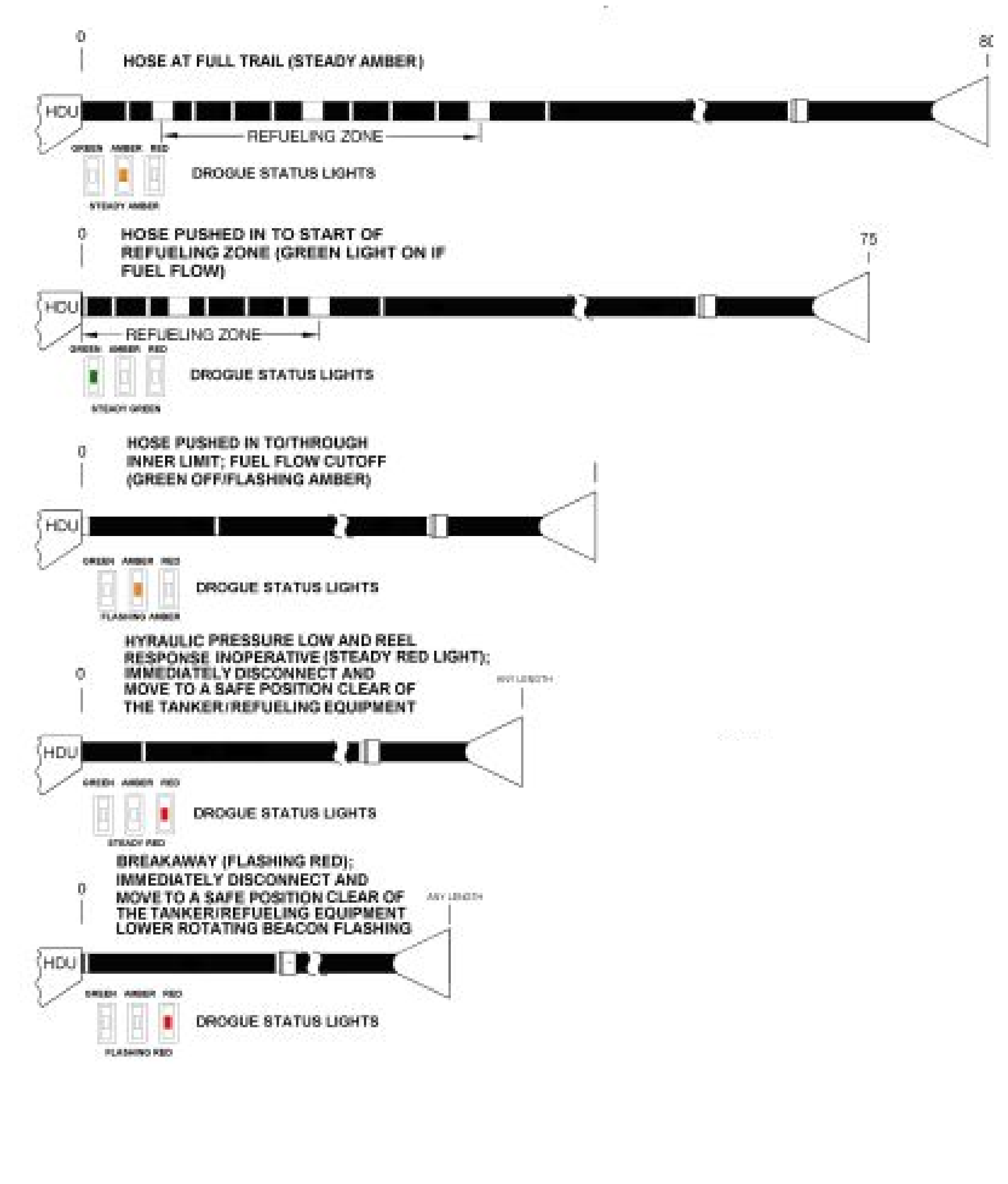
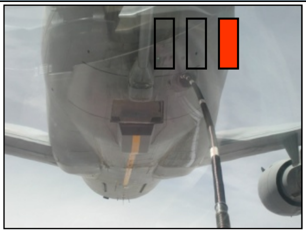
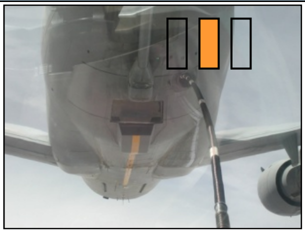
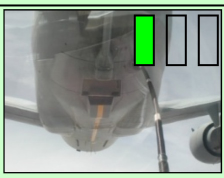
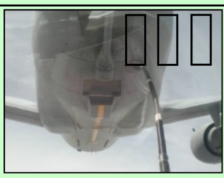
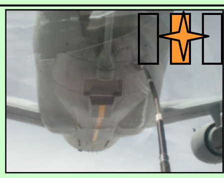
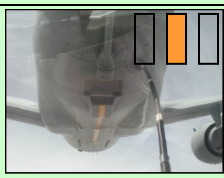
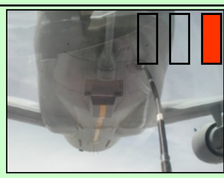


Figure ZB-2-4 - Centreline Hose Status Lights

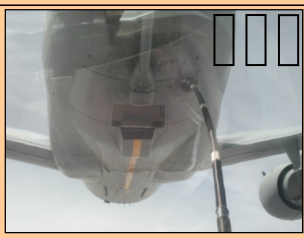
BEFORE CONTACT

STEADY RED	STEADY AMBER
NOT ready. Do **NOT** make contact.	Ready for contact
	

IN CONTACT

STEADY GREEN	GREEN EXTINGUISHES	FLASHING AMBER	STEADY AMBER	STEADY RED
Fuel flows	Offload complete	Hose is pushed back too far, drawback	Aft Limit	Disconnect, drogue malfunction
				

ANYTIME

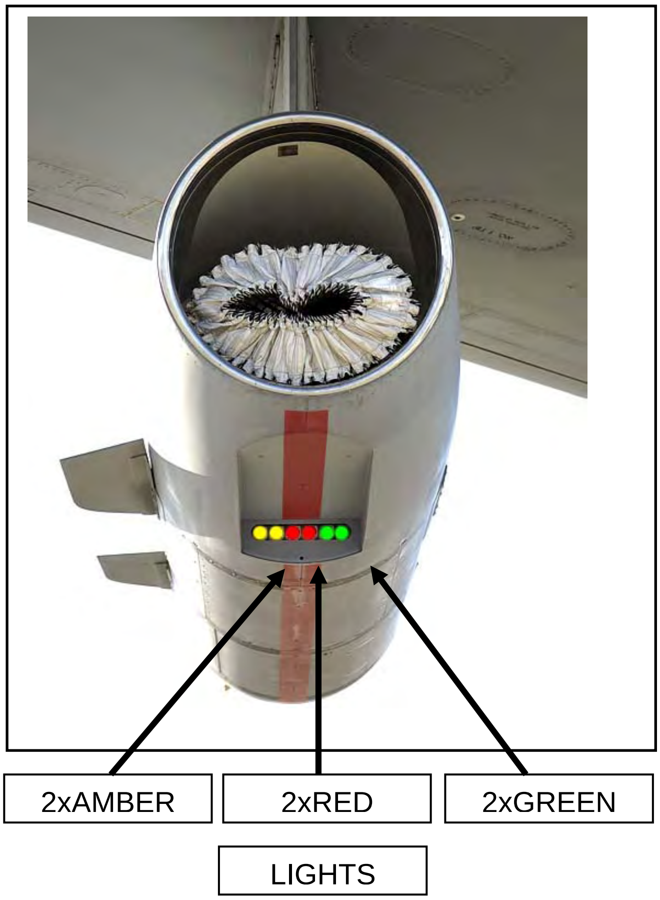
ALL 3 LIGHTS ON (Green-Steady, Amber/Red-Flashing)	**ALL 3 LIGHTS OUT**	**FLASHING RED** (Tanker lower strobe on)
Disconnect Return to Astern	Disconnect	**BREAKAWAY**
		

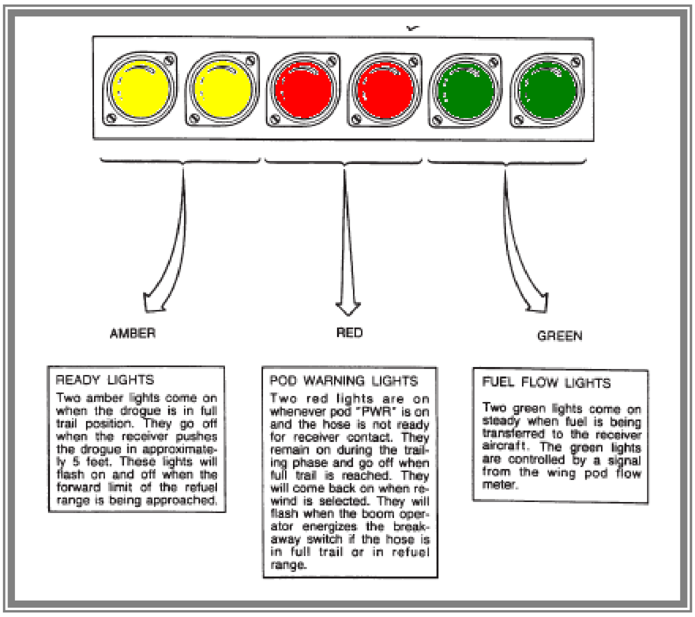
PART 5 – NATIONAL ANNEX

ANNEX ZB, APPENDIX 3 - USA

KC-10 WING AIR REFUELLING POD (WARP)

Figure ZB-3-1 – KC-10 WARP Status Lights





<u>Figure ZB-3-2 – KC-10 Wing Hose</u>

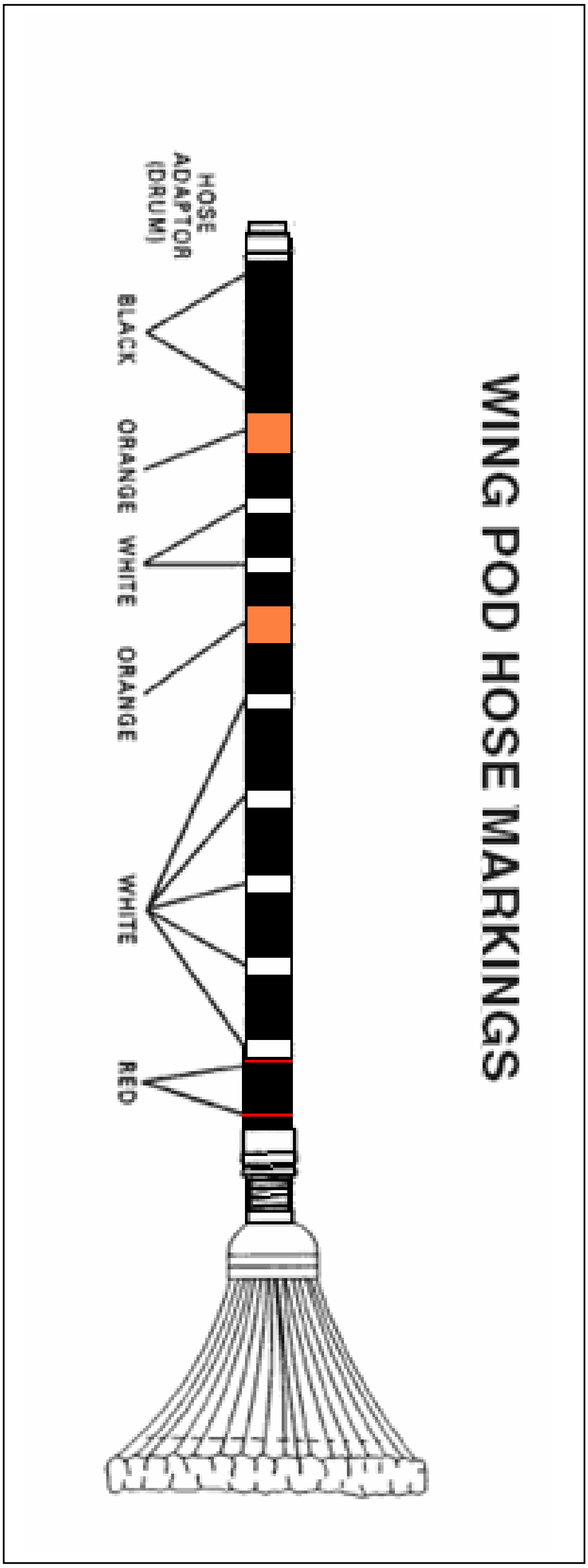
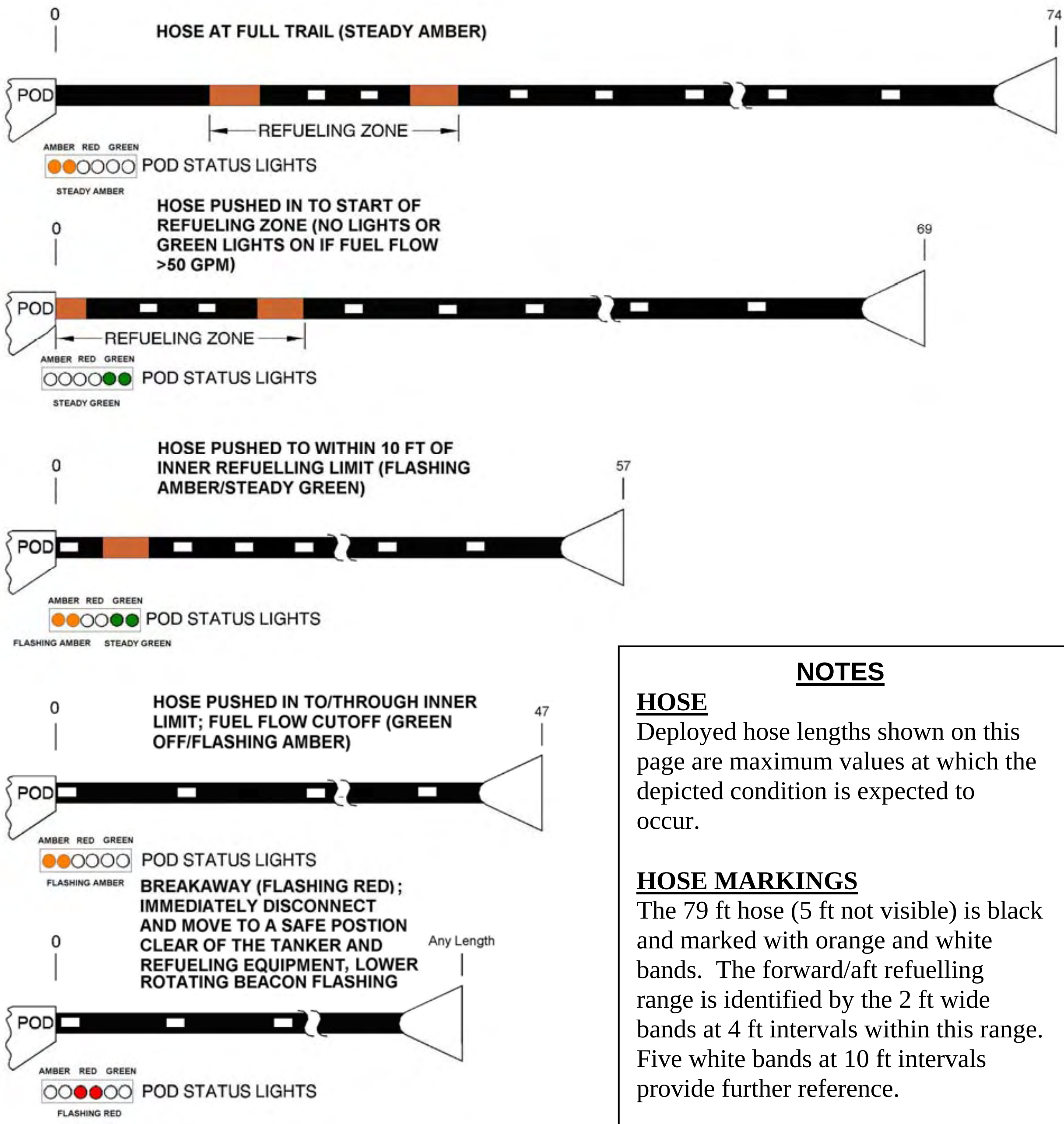


Figure ZB-3-3 – KC-10 WARP Hose Markings/Status Lights



NOTES

HOSE

Deployed hose lengths shown on this page are maximum values at which the depicted condition is expected to occur.

HOSE MARKINGS

The 79 ft hose (5 ft not visible) is black and marked with orange and white bands. The forward/aft refuelling range is identified by the 2 ft wide bands at 4 ft intervals within this range. Five white bands at 10 ft intervals provide further reference.

Figure ZB-3-4 - Pod Status Lights

BEFORE CONTACT

STEADY RED	STEADY AMBER
Pod **NOT** ready. Do **NOT** make contact.	Ready for contact
	

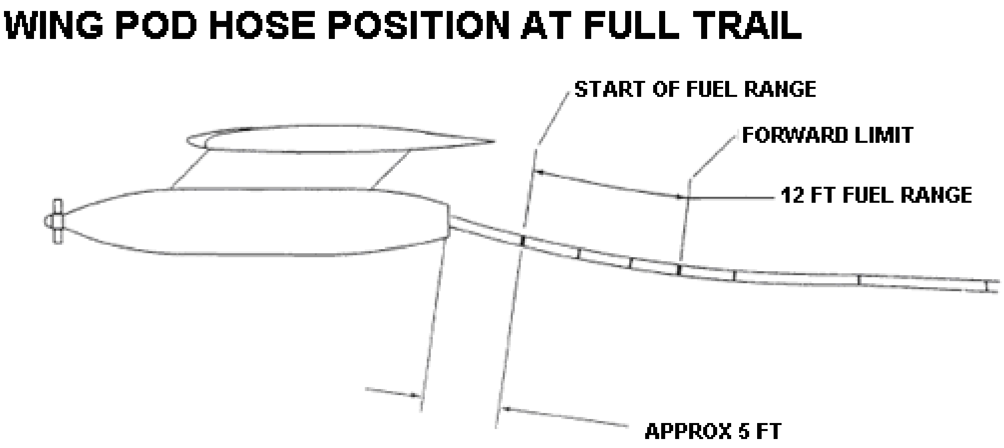
IN CONTACT

STEADY GREEN	GREEN EXTINGUISHES	FLASHING AMBER	STEADY RED
Fuel flows	Offload complete/ Fuel flow ceased	Hose is pushed back too far, drawback	Disconnect
			

ANYTIME

ALL 3 LIGHTS OUT	FLASHING RED (Tanker lower strobe on)
Disconnect	**BREAKAWAY**
	

Figure ZB-3-5 – WARP Hose



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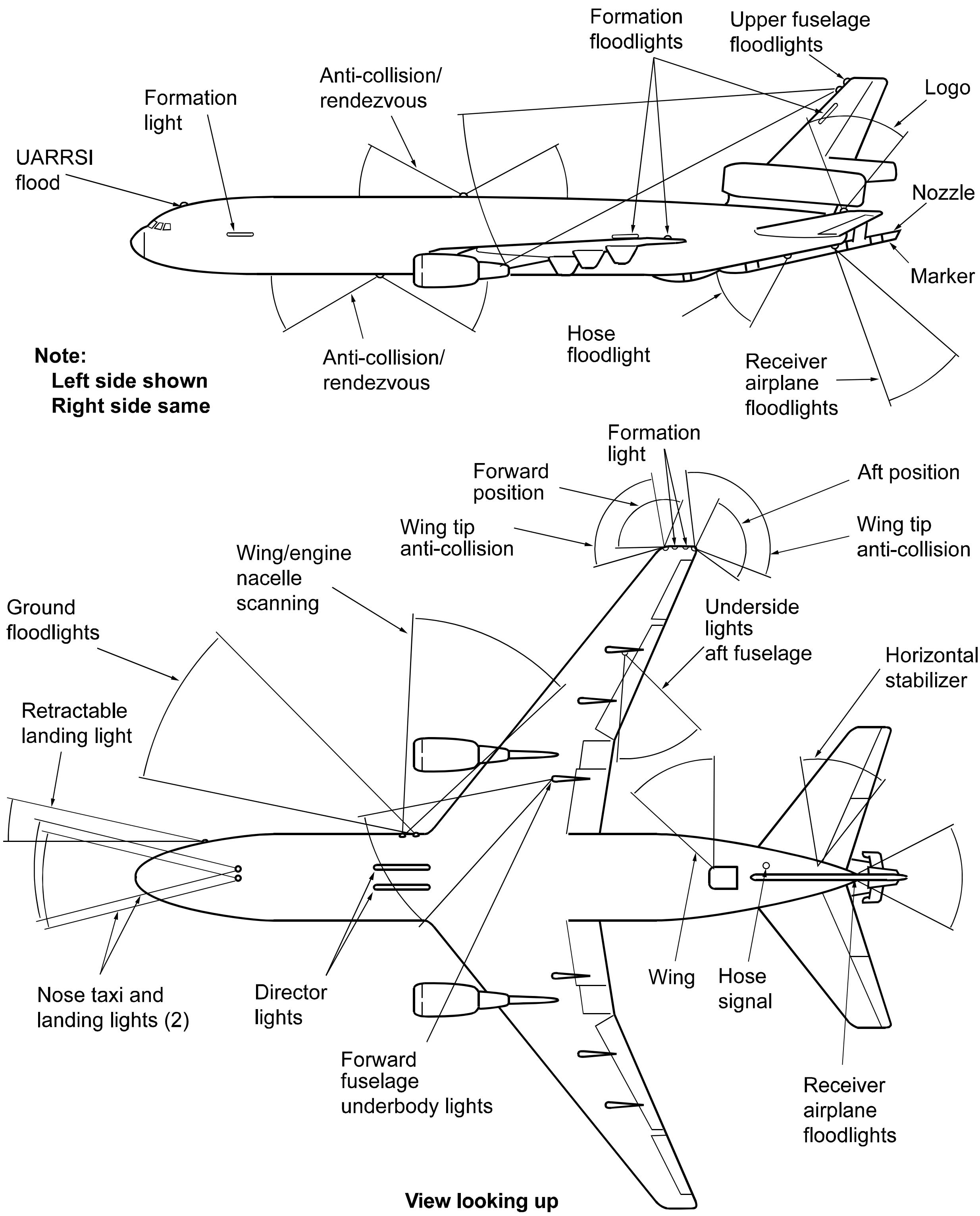
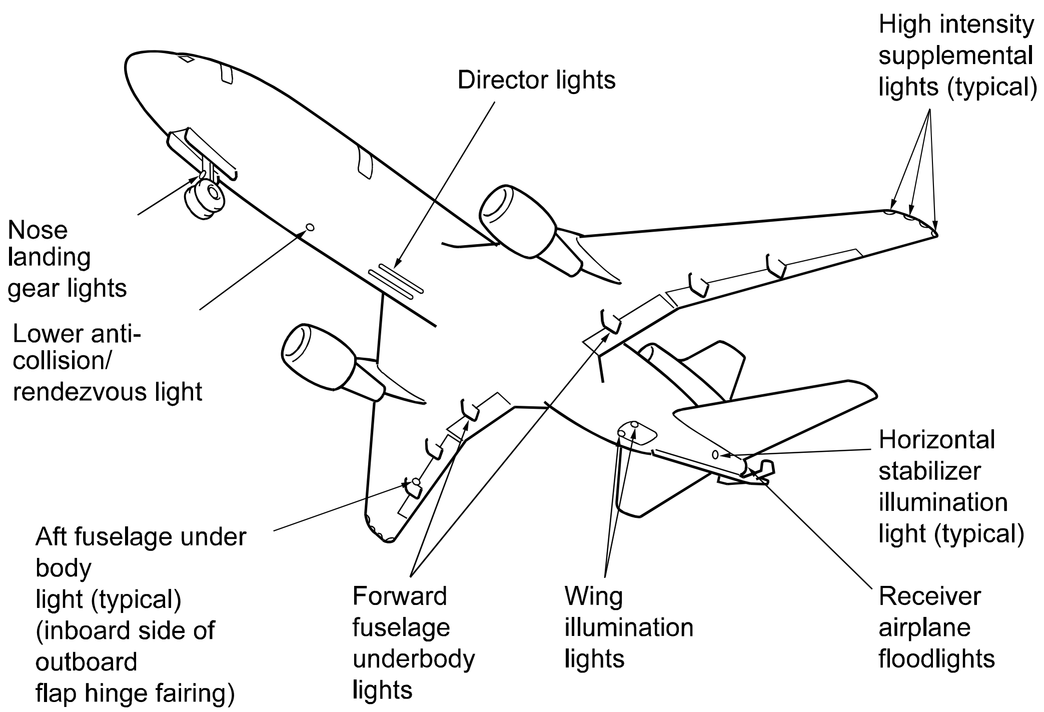
PART 5 – NATIONAL ANNEX

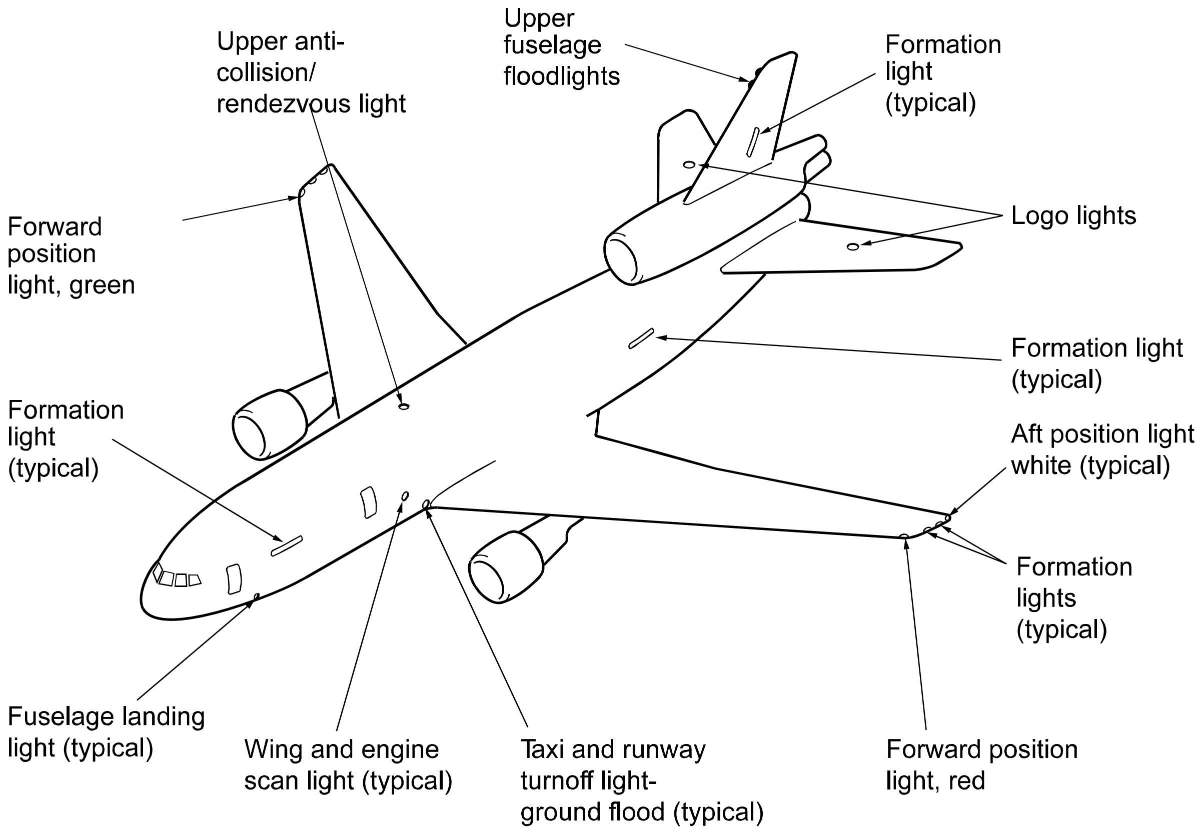
ANNEX ZB, APPENDIX 4 - USA

KC-10 EXTENDER - EXTERIOR LIGHTING

Figure ZB-4-1 – KC-10 Exterior Lighting




Director lights
High intensity supplemental lights (typical)
Nose landing gear lights
Lower anti-collision/ rendezvous light
Horizontal stabilizer illumination light (typical)
Aft fuselage under body light (typical) (inboard side of outboard flap hinge fairing)
Forward fuselage underbody lights
Wing illumination lights
Receiver airplane floodlights


Upper anti-collision/ rendezvous light
Upper fuselage floodlights
Formation light (typical)
Forward position light, green
Logo lights
Formation light (typical)
Formation light (typical)
Aft position light white (typical)
Formation lights (typical)
Fuselage landing light (typical)
Wing and engine scan light (typical)
Taxi and runway turnoff light- ground flood (typical)
Forward position light, red

PART 5 – NATIONAL ANNEX

ANNEX ZB, APPENDIX 5 - USA

KC-10 REFUELLING - VISUAL REFERENCES

1ZB-5 AAR Position - Visual References When moving forward from the astern position to the contact position, the visual references used by receiver aircraft pilots permit them to position their aircraft so that they remain within the tanker's AAR envelope. The following paragraphs provide guidance to assist pilots achieve the correct position.

2ZB-5 Boom - Elevation

a. Vertical Visual References – Heavy Aircraft Receivers

(1) Upper Limit

(a) Boom window and pivot in view
(b) Flap hinge below wing leading edge
(c) 1/2 UHF/VHF antenna below fuselage

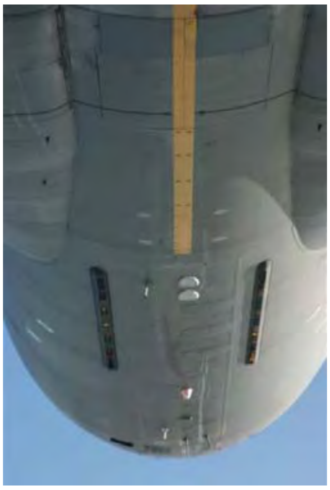
(2) Lower Limit

(a) Boom window out of view
(b) Flap hinge inside slat inner edge
(c) 1/2 length of UHF/VHF antenna above fuselage

Figure ZB-5-1

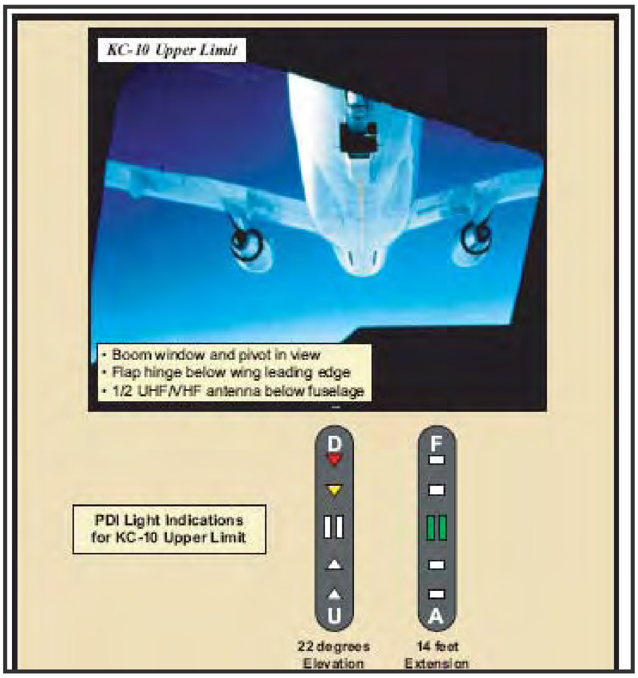
Closing to Astern Position

Astern Position

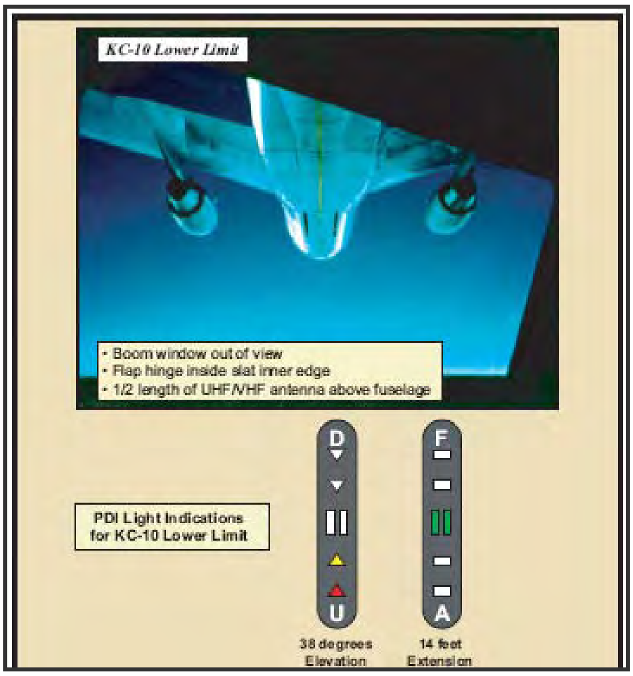


Contact Position

<u>Figure ZB-5-2 Upper and Lower Limits</u>

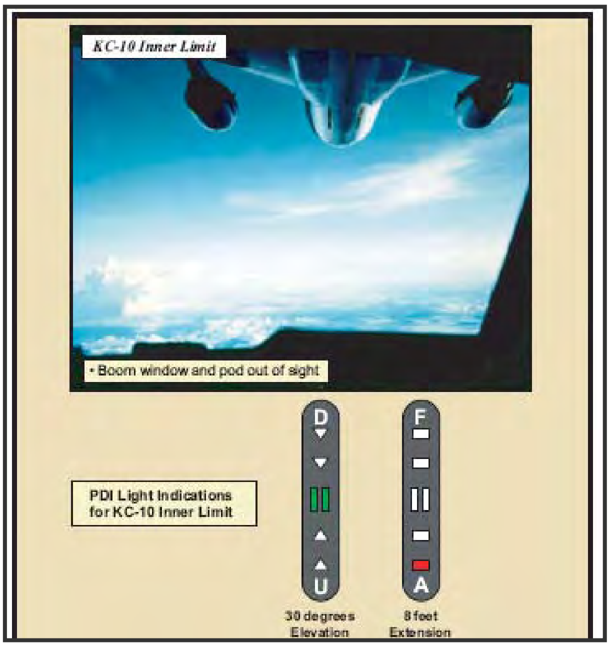


Upper Limit



Lower Limit

Figure ZB-5-3 Inner and Aft Limits



Inner Limit

Aft Limit

Figure ZB-5-4 Left and Right Limits

Left Limit

Right Limit

3ZB-5 Centreline Hose Visual References The picture below shows the first white band just about to enter the hose drum unit tunnel; this is the beginning of the AAR zone (see Annex ZB, Appendix 2). The lateral position is achieved through reference to the broad yellow line painted along the fuselage centreline.

Figure ZB-5-5. Receiver Position on Centreline Hose

Receiver with probe on right side correctly aligned along tanker centreline

4ZB-5 WARP Visual References Three red guide lines are provided at each wing pod location to aid the receiver pilot with alignment prior to contact with the drogue. One line is painted on each side of each wing pod on the underside of the wings several feet away from the pods. A third line is located on the bottom of each wing pod and is used as a center for receiver aircraft alignment.

Figure ZB-5-6. WARP Visual References

WARP Alignment Markings

LIST OF EFFECTIVE PAGES TO PART 5, ANNEX ZB, ATP-56(B)

PAGE NUMBERS	EFFECTIVE PAGES
ZB-1 to ZB-2	Feb 10
ZB-3 to ZB-6	May 08
ZB-7 to ZB-8	Feb 10
ZB-1-1 to ZB-1-2	May 08
ZB-2-1 to ZB-2-2	May 08
ZB-2-3 to ZB-2-4	Feb 10
ZB-3-1 to ZB-3-3	May 08
ZB-3-4 to ZB-3-6	Feb 10
ZB-4-1 to ZB-4-2	May 08
ZB-5-1 to ZB-5-4	May 08
LEP-5-ZB-1 to LEP-5-ZB-2	Feb 10

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PART 5 – NATIONAL ANNEX

ANNEX ZC - USA

<u>KC-45 TANKER</u>

1ZC Introduction TBD

LIST OF EFFECTIVE PAGES TO PART 5, ANNEX ZC, ATP-56(B)

PAGE NUMBERS	EFFECTIVE PAGES
ZC-1	May 08
LEP-5-ZC-1	Nov 08

PART 5 – NATIONAL ANNEX

ANNEX ZE - USA

RECEIVER DATA – JET TANKERS (BOOM/BDA/DROGUE)

1ZE Introduction. This Annex provides data essential for safe boom and drogue AAR operations between USAF heavy jet tanker and appropriately equipped receiver aircraft. Importantly, for boom AAR, as well as offering information about the location of the UARRSI, it lists receiver aircraft equipment in close proximity to the receiver receptacle that must be avoided to prevent damage during AAR operations.

2ZE USAF Heavy Jet Tanker/AAR Receiver Data. Tanker-specific receiver data is published in the following Appendices:

a. KC-135 Stratotanker – AAR Receiver Information. Appendix 1 to this Annex contains data necessary to effect KC-135 AAR operations.

b. KC-10 Extender – AAR Receiver Information. Appendix 2 to this Annex contains data necessary to effect KC-10 AAR operations.

c. KC-45 – AAR Receiver Information. Appendix 3 to this Annex contains data necessary to effect KC-45 AAR operations.

3ZE Common Warnings, Cautions and Notes. Warnings, Cautions and Notes that are common to all USAF tankers are published in Appendix 4 to this Annex. The definitions for each of these labels is published in Part 1, Chapter 1 to this document.

4ZE Receiver-Specific AAR Information. Where receiver-specific information is necessary to enhance the safety of AAR activity, it is promulgated in Appendix 5 to this Annex. Importantly, users of this Appendix must also consult Appendix 5 to ensure that they garner a full understanding of areas that must be considered before conducting AAR.

5ZE Commercial and Foreign Military AAR Receivers Technically Compatible with USAF Heavy Jet Tankers. All AAR participants, whether a tanker or receiver, must be reviewed to ensure that they are technically compatible with the other participant. Confirmation that a technical compatibility assessment has been conducted and found to be satisfactory is published by the appropriate tanker technical authority and incorporated into Appendix 6 to this Annex.

6ZE List of Appendices.

PART 5 – NATIONAL ANNEX

ANNEX ZE, APPENDIX 1 - USA

KC-135 STRATOTANKER – AAR RECEIVER INFORMATION

1ZE-1 AAR Mission Planning and Inflight Data. This Appendix publishes AAR planning data for all receiver aircraft with an AAR technical compatibility assessment has been conducted and a letter issued permitting operations with the KC-135Stratotanker. Dependent upon the fuel transfer mechanism in use, the appropriate tanker/receiver data contained in the following figures:

a. **Figure ZE-1-1 KC-135 AAR Mission Planning and Inflight Data (Boom).**
b. **Figure ZE-1-2 KC-135 AAR Mission Planning and Inflight Data (BDA).**
c. **Figure ZE-1-3 KC-135 AAR Mission Planning and Inflight Data (MPRS).**

Figure ZE-1-1 KC-135 AAR Mission Planning and Inflight Data (Boom)

KC-135 AAR MISSION PLANNING AND INFLIGHT DATA (BOOM)

NOTE: For foreign national receivers, before planning/conducting AAR activity, see Annex ZH, para 3ZH and Annex ZE, Appendix 6, Figure ZE-6-1.

CURRENT AS AT: FEB 10

TYPE RCVR	BUDDY CRUISE IAS/ MACH	OPTIMUM AAR ALT/IAS/MACH	RCVR RV SPEED IAS	OVERRUN IAS/MACH	PPM / # PUMPS	RENDEZVOUS UHF	VHF	HF	A/A TAC X	A/A TAC Y	RV VIS SINGLE / MULTI	BOOM INTERPHONE	BOOM TRIM SETTING	FLOOD LIGHT SETTING	REVERSE A/R CAPABLE	LIMITS L - R / U - D
A-10A/C	245	150/ 220 / 0.48 (0.6 AOA MAX)	220	250 / 0.55	2400 / 2	X	X		X	X	1NM/ 1NM	X	0	4-6		10 - 10 20 - 40
B-1B	320	210 / 320 / 0.70	350	355 / 0.90	7000 / 4	X	X	X	X	X	½ NM/ 1NM	X	1	7-10	X	10 - 10 20 - 40
B-2A	- / 0.76	250 / the lower of 260 / 0.75	450 KTAS	300 KCAS	5200 / 4 (12)	X	X	X	X	X	½ NM/ 1NM	X	3	7-9		10 - 10 25 - 40 (1)
B-52H	444 KTAS	300 / 275 / 0.80	310	310	6500 / 4	X		X	X	X	1NM/ 2NM		2	7-9	X	10 - 10 20 - 40
C-5A-C/M	440 KTAS	250 / 255 / 0.62	300	310	6800 / 4	X	X	X	X	X	1NM/ 2NM		5	7-9	X	10 - 10 20 - 40 (2)
C-17A		120 – 310 / 265/-	310	310	6800 / 4	X	X	X	X	X	1NM/ 2NM	X	5	10	X (13)	10 - 10 25 - 40 (3)
C-32B		250 / 275 / 0.66	310	310 / 0.88	6000 / 4	X	X	X	X	X	1NM	X	4	7-9		10 - 10 20 - 40 (4)
C-130E/H/P/U EC-130J		080 / 200 / - (5) (0.6 AOA MAX)	215	200	3800 / 2 (7)	X	X	X	X	X	1NM	X	0	7-9		10 - 10 20 - 40
KC-135R/T OC-135B RC-135S/U/V TC-135S/W WC-135W	450 KTAS	250 / 275 / 0.66	310	310	5000 / 4	X	X	X	X	X	1NM	X (6)	1	8-10	X	10 - 10 20 - 40
E-3A-D/F E-6B E-8C CT-49A (NTCA)	- / 0.74	250 / 275 / 0.66	310	310	6600 / 4 (8) (9)	X	X	X	X	X	1NM	X (6)	1	8-10		10 - 10 20 - 40
E-4B / VC-25A	335 / 0.78	250 / 275 / 0.80	310	310	6500 – 8000 / 4	X	X	X	X	X	1NM/ 2NM	X	1	5-9	X	10 - 10 20 - 40
F-4E/F	315	300 / 315 / 0.83	335	335 / 0.90	3400 / 2	X		X	X	X	RDR LOCK		0	7-10		10 - 10 25 - 40
F-15A-E/I/J/DJ/S/SG	315	300 / 315 / 0.82	335	335 / 0.90	3400 / 2	X			X	X	RDR LOCK		0	7-10		10 - 10 25 - 40
F-16A-F/I	315	300 / 315 / 0.81	335	335 / 0.90	2000 / 2 (10)	X	X		X	X	RDR LOCK	X	0	7-10		10 - 10 25 - 40
F-22A	315	250 / 310 /-	335	335	3000 / 2 (11)	X	X		X	X	RDR LOCK	X	0	8-10		10 - 10 25 - 40
F/RF-111C	320	220 / 320 / 0.84	355	355 / 0.90	5500 / 4	X		X	X	X	1NM		0	7-10		10 - 10 25 - 40
KC-10A	- / 0.80	250 / 295 / 0.82	325	335 / 0.90	6500 / 4	X	X	X	X	X	1NM/ 2NM	X	0	7-9	X	10 - 10 20 - 35

NOTES:

(1) B-2 FWD limit is 10, AFT limit is 18. Extend boom to 12 feet for astern.

(2) < 5 units of trim the elevation limits are 20 UP and 35 LOWER.

(3) < 5 units of trim the elevation limits are 25 UP and 35 LOWER.

(4) < 4 units of trim the elevation limits are 20 UP and 35 LOWER.

(5) EC-130J AAR airspeed envelope is 190 - 230 KIAS from 0 to 20,000 feet MSL. Adjust A/R airspeed as requested by receiver.

(6) RC/WC-135, E-8 and USAF E-3 receivers are equipped with boom interphone system.

(7) At the first indication of reduced fuel flow during AAR, reduce to one A/R pump.

(8) E-3D/F - Use a maximum of two A/R pumps.

(9) (CT-49A Only) Do not actuate the A/R pumps while in contact. After five dry contacts, have the receiver move to the astern position, and wet down the boom.

(10) Use one A/R pump with receivers configured with external tanks.

(11) The receiver may request to decrease to one A/R pump during fuel transfer or after a pressure disconnect.

(12) To minimize pressure disconnects, reduce the number of A/R pumps to two at the first indication of reduced fuel transfer rate.

(13) Reverse flow AAR is only accomplished in an actual fuel emergency.

Figure ZE-1-2 KC-135 AAR Mission Planning and Inflight Data (BDA)

KC-135 AAR MISSION PLANNING AND INFLIGHT DATA (BDA)

NOTE: For foreign national receivers, before planning/conducting AAR activity, see Annex ZH, para 3ZH and Annex ZE, Appendix 6, Figure ZE-6-1.

CORRECT AS AT: FEB 10			OVERRUN IAS	CLOSURE RATE	PROBE LIMIT MACH (3)	PPM / # PUMPS	RENDEZVOUS					BOOM TRAIL POSITION	
TYPE RCVR	BUDDY CRUISE ALT/IAS/MACH	OPTIMUM AAR ALT/IAS/MACH					UHF	VHF	HF	A/A TAC X	A/A TAC Y	AZ	ELV
TA/A-4AR (2)	270/440/0.74	270/245/0.61	310	1-2 FPS	0.61	1000/1	X			X	X	0	30
AMX		150/250/ -		1-2 FPS		- / 1	X	X		X	X	0	30
EA-6B	250/390/0.68	250/275/0.68	310		0.68	1000/1	X	X	X	X		0	30
CF-5 (4)	300/ - /0.80	300/305/0.80	335			1600/1	X			X	X	4L	34
CF-18 EA-18G EF-18A/B F/A-18A-G	300/460/0.78	300/275/0.80	335	1-2 FPS	0.80	2000/1	X	X		X	X	4R	30
JAGUAR-B		- / 250-280 / -		1-4 FPS		- / 1						4R	30
JAGUAR-S (1)		- / 250 – 275 / -		1-4 FPS		- / 1						4R	30
MIRAGE F-1		- / 250-290 / -		1-4 FPS		- / 1						0	30
MIRAGE 2000		- / 250-260 / -		1-4 FPS		- / 1						0	30
RAFALE		200-310/275 +5 KIAS		1-4 FPS		- / 1						4R	30
S-3B (5)	300/305/0.54	200/235/0.50	310		0.62	1800/1	X			X		0	30
TORNADO F-3 ADV (2) GR4/4A IDS/ECR PA-200	- / 320 / 0.70	260 MAX/270/0.59	310		0.87	2400/2	X			X	X	4R (6)	30

NOTES:

(1) Due to probe weakness, attempt contact at lower airspeed/closure rate. If required, increase airspeed in 5-knot increments, closure rate as necessary, up to indicated limits.

(2) Daylight AAR under VFR conditions only.

(3) Probe limit MACH is based upon the aerodynamic loads on the receiver's probe while in contact.

(4) No AAR operations shall be conducted with the F-5's Stability Augmentation System inoperative unless an emergency fuel quantity condition exists in the receiver.

(5) Turn range is 15 NM or 18 degrees ADF.

(6) Boom trail position for Tornado F-3 ADV is 4L

Figure ZE-1-3 KC-135 AAR Mission Planning and Inflight Data (MPRS)

KC-135 AAR MSN PLANNING AND INFLIGHT DATA (MPRS)

NOTE: For foreign national receivers, before planning/conducting AAR activity, see Annex ZH, para 3ZH and Annex ZE, Appendix 6, Figure ZE-6-1.

CORRECT AS AT: FEB 10			OVERRUN IAS	CLOSURE RATE	PROBE LIMIT MACH ❷	RENDEZVOUS				
TYPE RCVR	BUDDY CRUISE IAS/MACH	OPTIMUM AAR ALT/IAS/MACH				UHF	VHF	HF	A/A TAC X	A/A TAC Y
AMX		150/250/ -		2-4 FPS		X	X		X	X
AV-8B GR-7 (HARRIER)	300/0.80	150-200/275/0.66	310		0.80	X	X	X	X	X
EA-6B ❸	250/0.68	250/275/0.66	335		0.68	X	X	X	X	
CF-18 EA-18G EF-18A/B F/A-18A-G	300/0.78	250 / 275-285 /	335	1-2 FPS	0.86	X	X		X	X
GRIPEN		230/280/ -		1-3 FPS						
HAWK ❶		- / 220-250 / -		1-2 FPS						
JAGUAR-B		- / 250-280 / -		1-4 FPS						
JAGUAR-S ❷		- / 250-275 / -		1-4 FPS						
MIRAGE F-1		- / 280-320 / -		1-4 FPS						
MIRAGE 2000		- / 250-260 / -		1-4 FPS						
RAFALE		200-310/275 +5 KIAS		1-4 FPS						
S-3B ❹❺	300/.054	150/235/ -	310		0.62	X		X	X	
TORNADO F-3 ADV ❷ GR4/4A IDS/ECR PA-200		260 MAX/270/0.59	310	3-4 FPS		X			X	X

NOTES:

❶ Daylight AAR only.

❷ Due to probe weakness, attempt contact at lower airspeeds/closure rate; if required, increase airspeed in 5 knot increments, closure rate as necessary, up to indicated limits.

❸ Use only one pod and one AR pump. Simultaneous AAR is prohibited. Inform the receiver of any observed fuel venting; continuation of AAR will be at the discretion of the receiver pilot.

❹ Wingspan exceeds 68 feet; simultaneous refueling is prohibited.

❺ Turn range is 15 NM or 18 degrees ADF.

PART 5 – NATIONAL ANNEX

ANNEX ZE, APPENDIX 2 - USA

KC-10 EXTENDER – AAR RECEIVER INFORMATION

1ZE-2 AAR Mission Planning and Inflight Data. This Appendix publishes AAR planning data for all receiver aircraft with an AAR technical compatibility assessment has been conducted and a letter issued permitting operations with the KC-10 Extender tanker. Dependent upon the fuel transfer mechanism in use, the appropriate tanker/receiver data contained in the following figures:

a. **Figure ZE-2-1 KC-10 AAR Mission Planning and Inflight Data (Boom).**
b. **Figure ZE-2-2 KC-10 AAR Mission Planning and Inflight Data (Drogue).**

Figure ZE-2-1 KC-10 AAR Mission Planning and Inflight Data (Boom)

KC-10 AAR MISSION PLANNING AND INFLIGHT DATA (BOOM)

NOTE: For foreign national receivers, before planning/conducting AAR activity, see Annex ZH, para 3ZH and Annex ZE, Appendix 6, Figure ZE-6-1.

CORRECT AS AT: FEB 10						RENDEZVOUS									DISCONNECT	
TYPE RCVR	BUDDY CRUISE	OPTIMUM AAR ALT/CAS/MACH	RCVR RV SPD CAS	OVERRUN CAS/MACH	PPM/ PUMP	UHF	VHF	HF	A/A TAC X	A/A TAC Y	VISUAL SINGLE/ MULTIPLE	BOOM INTERPHONE	REVERSE AR	FLOOD LIGHT	DISC DELAY	LIMITS L R / U D
A-10A/C (1)	210	190/210/-	240	250	3000/2	X	X		X	X	1NM	X		5-7	.75	19 - 19 20 - 40
B-1B	320/.70	210/320/.70	350	350/.88	7000/6	X	X	X	X	X	½ NM /1NM	X	X	5-9	.50	25 - 25 20 - 40
B-2A	- / .76	250/275/.75	450 KTAS	300	5200/4	X	X	X	X	X	½ NM /1NM	X		6-10	.75	17 - 17 20 - 40
B-52H	275/.80	300/275/.80	310	310/.88	7300/6	X		X	X	X	1NM / 2NM		X	6-9	.25	19 - 19 20 - 40
C-5A-C/M (2)	300/.77	250/275/.66	300	310	7300/6	X	X	X	X	X	1NM / 2NM		X	6-9	.50	21 - 21 20 - 40
C-17A	310/.77	120 – 310 /285	310	310	8400/6	X	X	X	X	X	1NM / 2NM	X		7-9	.75	19 - 19 25 - 40
C-32B (8)	310/.77	250/275/.66	310	310/.77	6000/4	X	X	X	X	X	1NM	X		7-9	.75	25 - 25 20 - 40
C-130E/H/P/U EC-130J	N/A	(6) 080/200 (7)	215	240	3000/2	X	X	X	X	X	1NM	X		6-9	.50	15 - 15 20 - 40
KC-135R/T OC-135B RC-135S/U/V TC-135S/W WC-135W	- / .80	250/275/.80	310	310	6000/4	X	X	X	X	X	1NM / 2NM	X (3)	X	6-9	.75	19 - 19 20 - 40
E-3A-D/F E-6B E-8C CT-49A (NTCA)	- / .74	250/275/.66	310	310/.73	6000/4	X	X	X	X	X	1NM	X (3)		6-9	.50	19 - 19 20 - 40
E-4B VC-25A	- / .82	250/275/.82	310	310	7800/6	X	X	X	X	X	1NM / 2NM	X	X	5-7	.75	21 - 21 20 - 40
F-4E/F (5)	310/.82	300/310/.82	345	350/.88	3200/2	X			X	X	RDR LOCK			5-7	1.0	23 - 23 25 - 40
F-15A- E/I/J/DJ/S/SG (4)	310/.82	300/310/.82	345	350/.88	4000/2	X			X	X	RDR LOCK			6-10	1.0	15 - 21 25 - 40
F-16A-F/I (4)	310/.82	300/310/.82	345	350/.88	3000/2	X	X		X	X	RDR LOCK	X		5-10	.50	23 - 23 25 - 40
F-22A	310	250/310/-		335/.88	3000/2	X	X		X	X	RDR LOCK	X	X	5-7	.75	15 - 15 25 - 40
F/RF-111C	300/.74	220/300/.74	335	350/.88	4500/2	X			X	X	½ NM /1NM			6-10	.75	21 - 25 25 - 40
KC-10A	- / .82	250/290/.82	325	335/.88	7800/6	X	X	X	X	X	1NM / 2NM	X	X	5-9	.75	25 - 25 20 - 40

NOTES:

(1) A-10 with 2 external tanks and 2 ECM PODS use A/R altitude of 15,000 FT.

(2) When topping off C-5, use only 4 pumps.

(3) RC/WC-135, E-8 and USAF E-3 aircraft equipped with boom interphone.

(4) E-3, F-15, F-16 can interrogate IFF/SIF.

(5) F-4E/F with 3 external tanks use A/R altitude of 25,000 FT. Only RF-4 has HF.

(6) AC-130H optimum AAR speed CAS is 190 KTS.

(7) EC-130J aircraft AAR envelope is 190 to 230 KIAS at 0 – 20,000 FT MSL. Optimum is 210 KIAS/10,000 FT MSL.

(8) The C-32B can refuel at altitudes between FL200 and FL310. Speeds can vary between 250 – 300 KIAS.

Figure ZE-2-2 KC-10 AAR Mission Planning and Inflight Data (Drogue)

KC-10 AAR MISSION PLANNING AND INFLIGHT DATA (DROGUE) ❼

NOTE: For foreign national receivers, before planning/conducting AAR activity, see Annex ZH, para 3ZH and Annex ZE, Appendix 6, Figure ZE-6-1.

CURRENT AS AT: FEB 10			RCVR RV SPEED	OVERRUN CAS/MACH	PPM/ # PUMPS ❶ ❷	RENDEZVOUS				
TYPE RCVR	BUDDY CRUISE ALT/TAS/MACH	OPTIMUM AAR ALT/IAS/MACH				UHF	VHF	HF	A/A TAC X	A/A TAC Y
AMX	290/400/.67	150/250/.45		300/.75	2200/1	X	X		X	X
AV-8B/GR-7 (HARRIER)	290/445/.75	290/275/.72	300	325/.87	1100/1	X	X	X	X	X
EA-6B	290/400/.67	250/250/.60		300/.75	2500/2	X	X	X	X	
CF-18 EA-18G EF-18A/B F/A-18A-G	300/460/.78	300/275–285/.80 ❸	320	330/.88	2300/2	X	X		X	X
CF-5 F-5E/F ❽	300/460/.78	300/280/.75		330/.88	2200/1	X			X	X
GRIPEN		240/250/ -			- / 1					
HAWK ❹ ❺	220-250 KIAS				- / 1					
JAGUAR ❻		/250-275/			- / 1					
MIRAGE 2000	250-270 KIAS	- /250-260/ -			- / 1					
MIRAGE F-1	280-320 KIAS				- / 1					
RAFALE		150-310/ 250-300/ -			- / 1					
S-3B ❾	300/305/.54	200/230/.50		275/.65	1800/2	X		X	X	
SUPER ETENDARD		- /250-280/ -			- / 1					
TORNADO F-3 ADV ❷ GR4/4A IDS/ECR PA-200	200/430/.70	300 MAX/270/.64	310	320/.69	2200/2	X			X	X

NOTES:

❶ Applicable to Centreline Drogue only.

❷ For WARP AAR a minimum of two AR pumps will be used for each WARP Pod in use. When using both pods at the same time, a minimum of four AR Pumps will be used.

❸ For Centreline Drogue use 275 KIAS or .80 MACH, whichever is less. For WARP the maximum AAR speed is 300 KIAS or .86 MACH, whichever is less.

❹ Night AAR with the HAWK shall not be conducted.

❺ Due to unknown structural strength of the HAWK probe mast, closure rate is restricted to 1-2 FPS.

❻ Due to design weakness of the JAGUAR-S probe, contact should first be attempted at the lower airspeeds and closure rates. If necessary, increase speeds (5 knot increments) and slowly increase closure rate (up to 4 FPS authorized).

❼ (ALL) Concurrent AAR with the WARP and Centreline Drogue will not be conducted.

❽ No AAR operations shall be conducted with the Stability Augmentation System inoperative unless an emergency fuel quantity condition exists in the receiver.

❾ S-3B can interrogate IFF/SIF.

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PART 5 – NATIONAL ANNEX

ANNEX ZE, APPENDIX 3 - USA

KC-45 – RECEIVER INFORMATION

1ZE-3 AAR Mission Planning and Inflight Data. This Appendix publishes AAR planning data for all receiver aircraft with an AAR technical compatibility assessment has been conducted and a letter issued permitting operations with the KC-45 tanker. Dependent upon the fuel transfer mechanism in use, the appropriate tanker/receiver data contained in the following figures:

a. **Figure ZE-3-1 KC-45 AAR Mission Planning and Inflight Data (Boom).**
b. **Figure ZE-3-2 KC-45 AAR Mission Planning and Inflight Data (Drogue).**

Figure ZE-3-1 KC-45 AAR Mission Planning and Inflight Data (Boom)

KC-45 AAR MISSION PLANNING AND INFLIGHT DATA (BOOM)

NOTE: For foreign national receivers, before planning/conducting AAR activity, see Annex ZH, para 3ZH and Annex ZE, Appendix 6, Figure ZE-6-1.

CORRECT AS AT:			RCVR RV SPD CAS	OVERRUN CAS/MACH	PPM/ PUMP	RENDEZVOUS					VISUAL SINGLE/ MULTIPLE	BOOM INTERPHONE	REVERSE AR	FLOOD LIGHT	DISCONNECT	
TYPE RCVR	BUDDY CRUISE	OPTIMUM AAR ALT/CAS/MACH				UHF	VHF	HF	A/A TAC						DISC DELAY	LIMITS
									X	Y						L U R D
A-10A/C																
B-1B																
B-2A																
B-52H																
C-5A-C/M																
C-17A																
C-32B																
C-130E/H/P/U EC-130J																
KC-135R/T OC-135B RC-135S/U/V TC-135S/W WC-135W	PLACE HOLDER PENDING DATA RELEASE															
E-3A-D/F E-6B E-8C CT-49A (NTCA)																
E-4B VC-25A																
F-4E/F																
F-15A-E/I/J/DJ/S																
F-16A-F/I																
F-22A																
F/RF-111C																
KC-10A																

NOTES:

Figure ZE-3-2 KC-45 AAR Mission Planning and Inflight Data (Drogue)

KC-45 AAR MISSION PLANNING AND INFLIGHT DATA (DROGUE)

NOTE: For foreign national receivers, before planning/conducting AAR activity, see Annex ZH, para 3ZH and Annex ZE, Appendix 6, Figure ZE-6-1.

CURRENT AS AT:			RCVR RV SPEED	OVERRUN CAS/MACH	PPM/ # PUMPS	RENDEZVOUS				
TYPE RCVR	BUDDY CRUISE ALT/TAS/MACH	OPTIMUM AAR ALT/IAS/MACH				UHF	VHF	HF	A/A TAC X	A/A TAC Y
AMX										
AV-8B/GR-7 (HARRIER)										
EA-6B										
CF-18 EA-18G EF-18A/B F/A-18A-G										
CF-5 F-5E/F										
GRIPEN										
HAWK										
JAGUAR										
MIRAGE 2000										
MIRAGE F-1										
RAFALE										
S-3B										
SUPER ETENDARD										
TORNADO F-3 ADV GR4/4A IDS/ECR PA-200										

PLACE HOLDER PENDING DATA RELEASE

NOTES:

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PART 5 – NATIONAL ANNEX

ANNEX ZE, APPENDIX 4 - USA

COMMON WARNINGS, CAUTIONS AND NOTES

1ZE-4 WARNINGS, CAUTIONS, and NOTES. The following WARNINGS, CAUTIONS and NOTES are common to all receiver aircraft and must be read in conjunction with the receiver-specific information published in the appropriate paragraph below.

WARNING

- **(ALL)** For all foreign aircraft AARs, do not transmit on the HF radio when the receiver is within 1/2 NM; this includes datalink.
- **(ALL)** For all U.S. boom receiver AARs, do not transmit on HF radio when receiver is in close proximity or in contact with the AAR boom, unless otherwise specified.
- **(ALL)** Tanker airspeed and altitude changes must be made smoothly and cautiously while the receiver is in or near the contact position. Any airspeed or altitude adjustments required by the tanker due to aerodynamic effect of receiver closure should be accomplished after the receiver is stabilised in the contact position.
- **(ALL)** The boom operator must be constantly aware of the receiver's position and rate of movement. The receiver's rate of movement toward an envelope limit will dictate the need to initiate a disconnect. If the movement is toward the inner limit, boom operators will exercise sound judgment in initiating a disconnect or breakaway prior to the receiver exceeding the limit or overrunning the tanker.

CAUTION

- **(ALL)** For all fighter and C-130 aircraft, the telescope-at-disconnect switch will be in manual during AAR operations.
- **(ALL)** For all fighter aircraft, avoid excessive retraction rates to prevent pulling the receiver forward if a boom release is not obtained.
- **(ALL)** Contact will not be attempted until the fighter type receiver has stabilized 2 to 3 feet from the contact position.
- **(ALL)** For UARRSI and all fighter receptacles, to minimize nozzle cocking when making contact with the receiver, the boom nozzle should be inserted straight into the receptacle without aid of the slipway; using the slipway may cause the nozzle to cock, preventing contact.
- **(ALL)** During AAR operations, exercise caution to avoid striking any antenna in the vicinity of the AAR receptacle.
- **(ALL)** Attempts to affect a contact during loss of any AAR lighting that results in less than desired illumination will be at the discretion of the boom operator.
- **(ALL)** All foreign receiver pilots shall be AAR qualified and current in accordance with USAF procedures for all AAR operations.

NOTE

- **(ALL)** Receiver photography is prohibited while conducting flight operations in the Edwards Flight Test Centre complex.

- **(ALL)** The boom flight controls may block the view of the receptacle as the receiver moves in from approximately 30 feet, especially if the receiver is high in the envelope (Receivers equipped with a nose mounted UARRSI, A-10, B-1, E-4 and VC-25).

- **(ALL)** Except when security would be compromised, a verbal hot armament check will be accomplished between the tanker and receivers carrying forward firing ordnance during the 15 minutes prior to ARCT call. The verbal hot armament check accomplished between the Tactical Air Controller and the receiver during anchor rendezvous will satisfy this requirement.

- **(ALL)** Night is defined as the period of time when the boom nozzle is not clearly visible without the aid of the nozzle light(s) or tail mounted flood light(s).

PART 5 – NATIONAL ANNEX

ANNEX ZE, APPENDIX 5 - USA

RECEIVER-SPECIFIC AAR INFORMATION

A-10A/C

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

1ZE-5 AAR Data A-10A/C

A-10 close-up on KC-10 **A-10 on KC-135**

a. General Information

(1) The A-10 has a UARRSI receptacle located 26 inches AFT of the nose on centreline, and is 32 inches in front of the pilot's windscreen. Receptacle slipway lights are rheostat controlled.

b. AAR of Deployment Configured A-10s

(1) For AAR of deployment configured A-10's (two external tanks and two ECM pods) use the following guidelines.

(a) AAR altitude: 15,000 MSL (Max).

(b) Buddy cruise altitude: 20,000 MSL (Max).

(c) AAR airspeed: 210 KCAS (Min).

(d) Buddy cruise airspeed: 230 KCAS (Max).

A-10A/C

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

c. (KC-135) Rendezvous Procedures

(1) Modified Overtaking RV Delta (Point Parallel Rendezvous) When used, the KC-135 will follow procedures for RV Delta (point parallel rendezvous) (Part 2, Annex 1D), fly orbit at 220 KIAS or charted holding speed, whichever is higher, and plan to roll out ½ NM in front of the receiver.

(a) Tanker Speed Reduction The tanker then slows to AAR airspeed.

(b) Overrun If an overrun occurs, maintain overrun airspeed until reaching ½ NM in front of the receiver or until directed by the receiver pilot, whichever occurs first.

(2) RV Golf (Enroute Overtaking) Rendezvous

(a) An RV Golf (enroute overtaking) rendezvous is used when tanker(s) and receiver(s) arrive from the same general direction.

(b) Each airplane will fly individual flight plans to a common RVIP/RV and join-up enroute to the RVCP.

(c) The receiver(s) will plan to arrive at the RVIP/RV one minute prior to the RVCT.

(d) This procedure makes use of the tanker's increased overtake ability to compensate for the A-10's lower airspeed.

(e) To be effective, tanker(s) and receiver(s) must arrive at the RVIP/RV at their respective times.

(f) Tanker(s) and receiver(s) will adjust enroute airspeed/flight path to make the rendezvous control time.

(g) Tanker(s) and receiver(s) should communicate as soon as possible (in no case later than 15 minutes prior to the rendezvous control time) to update ETAs.

(h) Receiver(s) and tanker(s) must be at their assigned altitude prior to reaching the RVIP/RV.

(i) These altitudes will provide at least 1000 feet separation between the highest receiver and the lowest tanker with the receiver always at the lower altitude.

(j) The receivers will not depart their designated altitude until the tanker has passed abeam the receivers.

(k) The receiver will proceed down track from the RVIP/RV at 220 KIAS, and the tanker will overtake the receiver at 275 KIAS.

(l) Once visual/radar contact is established with the receiver, the tanker will manoeuver to pass overhead the receiver.

(m) The pilot not flying will call when the tanker passes overhead the receiver.

A-10A/C

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

(n) After the receiver passes under the tanker glare shield (1/2 NM on TCAS), the tanker will maintain 275 KIAS for another 30 seconds, decelerate to stabilise on AAR airspeed with the receiver(s) approximately 1/2 NM in trail.

d. (KC-10) Rendezvous Procedures

(1) KC-10 orbit speed for rendezvous with A-10 receivers is 255 KIAS, but not below A-10 AAR orbit speed.

(2) During the rendezvous manoeuver, consideration should be given to adjusting to minimum maneuver speed halfway through the rendezvous turn.

(3) Maintain at least minimum maneuver speed until less than 15 degrees of bank.

(4) Slow to AAR speed when rolling out on AAR heading.

e. KC-10/KC-135 Restrictions

(1) **Tanker Gross Weight** The tanker's gross weight at the beginning of AAR operations will not be greater than:

(a) **KC-10** 540,000 pounds (deployment configured A-10 with two external tanks and two ECM pods).

(b) **KC-135** 250,000 pounds.

(2) **Bank Angle** The tanker's angle of bank during AAR will be limited to 15 degrees.

(3) **Tanker Aircraft Response - Low Airspeed** Airspeed must be monitored closely, as aircraft response to power adjustment for lost airspeed is slower than normal.

(4) **Power Control** Judicious power control is critical at the relatively low airspeeds required during AAR.

(5) **Fuel Spray** The boom operator is to immediately notify the receiver pilot of any fuel spray from the boom nozzle or receiver receptacle during contact.

(6) **(KC-135) Fuel Configuration** Consider establishing the fuel configuration prior to slowing to AAR airspeed.

(7) **(KC-135) Fuel Drain** Draining fuel from the centre wing tank to the forward body tank with certain fuel loads may be slower than normal.

CAUTION

- **(ALL)** During boom retraction, the receiver slipway door forward area may be damaged by the boom nozzle catching on a gap in the forward end of the slipway. Retract the boom slowly and raise it to clear the door area.

A-10A/C

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

CAUTION

- **(KC-135)** During AAR, do not allow the airspeed to decrease below 190 KIAS or .6 AOA, whichever is higher, due to decreased boom control at lower airspeeds.

- **(KC-135)** During any AAR which requires the indicated airspeed to be less than 220 KIAS, keep the A/R line valve closed for dry contacts to preclude fuel siphoning from the forward body tank and causing unexpected CG changes.

- **(KC-135)** Turn the line valve to the closed position approximately 15 seconds prior to planned disconnect; this is to prevent fuel spray from impairing the vision of the receiver pilot

- **(KC-135)** At the discretion of the boom operator, night AAR may be accomplished if either the boom nozzle light or TMF is inoperative, so long as the receiver receptacle lights are operative. If the receiver receptacle lights are inoperative, both the boom nozzle light and TMF must be operative.

NOTE

- **(ALL)** With certain gross weights and aircraft configuration, the tanker rate of acceleration on a break-away may exceed the rate of acceleration for the receiver aircraft in the observation position.

- **(KC-10)** The KC-10 will require slats extended until the gross weight reaches approximately 420,000 pounds, standard day conditions. This gross weight and below will allow the KC-10 to maintain clean the 210 KCAS AAR speed at 15,000 MSL and 230 KCAS at 20,000 MSL during cruise.

- **(KC-10)** The 540,000 pound KC-10 maximum gross weight is limiting only so far as the A-10 is power-limited and unable to break through the KC-10 bow wave under these conditions. The only way possible for the A-10 to effect a hookup above 540,000 pounds KC-10 gross weight may be for the KC-10 to toboggan for each receiver. This should be done only as a last resort.

f. Enroute Formation Join-Up When join-up involves one tanker with one or more receivers, the tanker will level off at the highest altitude in the formation with receivers stacked down at 500 feet intervals with 1 NM in trail separation. Airspeeds at level-off will be adjusted as necessary to close the formation.

g. RV Procedures The AAR formation will be 30 degrees right echelon, 2 NM separation, stacked up at 500 foot intervals. Adjust to AAR speed when rolled out toward the RVCP.

B-1B

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

2ZE-5 AAR Data B-1B

B-1B close-up on KC-10

B-1B on KC-10

a. General Information

(1) The B-1 has a UARRSI receptacle located 8 feet from the nose of the aircraft and 18 inches in front of the crew compartment windshield.

NOTE

- **(ALL)** The nozzle tip may hang-up on the leading edge of the drop-down receptacle door. To assure successful contact, precise positioning of the boom straight into the receptacle is required.

b. Rendezvous Procedures

(1) The AAR formation will be 30 degrees right echelon, 2 NM separation, stacked up at 500 foot intervals.

(2) Adjust to AAR speed when rolled out toward the RVCP

c. KC-10/KC-135 Restrictions

(1) **(KC-135) Bank Angle** Limit the bank angle to 15 degrees for turns while in contact unless the receiver requests otherwise.

(2) **(KC-135) A/R Pumps** Four A/R pumps may be used for offload; however, if a pressure disconnect occurs, two pumps should be used.

B-1B

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

(3) Boom Handling Exercise extreme caution while flying and extending the boom into the receptacle prior to contact and at disconnect.

CAUTION

- **(ALL)** The B-1 centerline split windshield is located 18 inches directly aft of the air refueling receptacle. Exercise utmost caution while flying and extending the boom into the receptacle prior to contact and at disconnect.

- **(KC-135)** Night AAR is permitted if either the boom nozzle lights or tail-mounted floodlight are inoperative, so long as the receiver's receptacle lights are operative; if the receiver's receptacle lights are inoperative, both the nozzle lights and floodlight must be operative.

- **(KC-135)** Close the line valve approximately 15 seconds prior to planned disconnects; this reduces fuel spray which impairs the receiver pilot's vision.

B-2A

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

3ZE-5 AAR Data B-2A

B-2 on KC-10

B-2 Receptacle Close-up

B-2A

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

a. General Information

(1) The B-2 AAR receptacle is located 24 ½ feet aft of the nose, 16 feet aft of the crew compartment windshield.

(2) The receptacle rotates along the aircraft centreline

(3) Slipway lights are inside the receptacle.

(4) AAR lead-in lights are in front of the receptacle at 12, 9, and 6 feet.

(5) The area aft of the AAR receptacle is lit by three floodlights.

(6) Slipway lights and flood lights are rheostat controlled.

(7) B-2 performance data is estimated.

WARNING

- **(ALL)** Boom Operators must aggressively advise the receiver to slow the closure rate to 1 foot per second. An excessive closure rate could cause the tanker to descend into the receiver. The pilot must be prepared to disconnect the autopilot and prevent altitude deviations. Initiate a breakaway at the first indication of a closure overrun.

- **(ALL)** Tanker airspeed and altitude adjustments shall be made smoothly and slowly when the B-2 is in or near the contact position. Adjustments required by the tanker to compensate for receiver closure should be accomplished after the receiver is in the contact position

CAUTION

- **(ALL)** At true air temperatures colder than approximately -45 degrees C, the boom latching toggles may take up to 1 second to engage and 2 seconds to release.

- **(ALL)** For night AAR, the TMF (s) and boom nozzle light (s) shall be operational.

- **(ALL)** Contact with the surface outside of the receptacle must be avoided. The receiver pilot will be informed of boom contacts outside the receptacle.

NOTE

- **(ALL)** The absence of direct lighting from the aft AAR lead-in light to the AAR receptacle (6 feet) may cause errors in depth perception during night AAR.

b. Rendezvous Procedures

(1) The type of rendezvous will be a Modified Overtaking RV Delta (point parallel) or RV Golf (enroute).

(2) Receiver closure shall not continue inside 1/2-NM range (1 NM for multiple tanker formations and 2 NM for multiple receiver formations) unless visual contact is established with the tanker.

B-2A

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

c. AAR Procedures

(1) Closure Procedures

(a) The receiver initiates descent to 1000 feet below assigned AAR base altitude at the RVIP.

(b) The receiver descends at approximately 2000 to 3000 FPM at 0.76 Mach.

(c) The receiver maintains 450 KTAS (0.80 Mach maximum) after level off until rendezvous is complete.

(d) If the receiver is more than 3 NM in trail from the tanker after completion of descent and closure, the receiver airspeed may be increased up to 0.80 Mach to expedite join-up.

(2) Receiver Visual Closure

(a) The receiver maintains 1000 feet below AAR base altitude until 1 NM in trail and visual contact is established.

(b) The receiver does not exceed 30 KCAS above AAR airspeed inside of 1 NM from the tanker.

(c) After safe closure is ensured, receiver airspeed is reduced as necessary to AAR airspeed.

(d) If a closure overrun occurs and visual contact is lost, the receiver establishes a positive rate of descent to 1000 feet below AAR base altitude.

(3) Receiver Radar Closure

(a) If visual contact is not established by 1 NM, the receiver slows to AAR airspeed and maintains 1 NM.

(b) Once established on AAR airspeed, the receiver climbs to 500 feet below the AAR base altitude, closing to 1/2 NM while maintaining radar contact with the tanker.

(c) The receiver does not exceed 20 KCAS above AAR airspeed when closing from 1 NM to 1/2 NM without visual contact.

(d) If radar contact is lost without visual contact inside of 1 NM, the receiver descends to 1000 feet below AAR base altitude.

(e) The receiver does not close inside of 1/2 NM without tanker visual contact.

(4) Overrun

(a) If a rendezvous overrun occurs, the receiver reduces airspeed to no less than 230 KCAS, as required, and maintains track and altitude.

(b) The tanker increases airspeed to 300 KCAS, maintains AAR base altitude, adjusts track as required, and overtakes the receiver.

B-2A

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

(c) After passing the receiver, the tanker reduces AAR airspeed.

(d) If positive position of the receiver is established, the tanker may direct the receiver to manoeuvre to decrease closure time.

(5) Buddy Join-up

(a) See part 2, Annex 1F, para 106F.

(b) Lead holds 325 KCAS until reaching 0.75 Mach and maintains 0.75 Mach until level at assigned altitude.

(c) Lead should limit bank angle to 25 degrees during departure to allow wingmen to use cutoff as required.

(d) At final altitude, formation lead slows to 0.71 Mach to expedite closure. Following aircraft close at 0.75 Mach to join up.

(e) After join up, the formation accelerates to 0.76 Mach or maintains briefed airspeeds and altitudes until reaching the RVIP or a point 100 NM from the RVCP.

(f) Lead shall level off at the lowest altitude in the formation with the trailing aircraft stacked up at 500- foot intervals with 1-NM separation.

(6) (KC-10) Abnormal Procedures

(a) There is a slight bow-wave effect from the B-2 on the tanker during closure to the contact position.

(b) The effect could cause the tanker to experience trim changes depending on the rate of receiver movement.

(c) The B-2 should use a slow closure rate of approximately 1 foot per second.

(d) Rapid closure adversely affects the pitch trim of both aircraft

(e) The slow closure rate permits smaller adjustments to stabilise in the proper AAR position.

(f) The bow-wave effect increases as receiver gross weight increases, tanker gross weight decreases, and during approach to the upper limit of the boom envelope.

(g) If inadvertent disconnects occur due to a tanker malfunctioning signal amplifier or receiver system malfunction, AAR can be completed by receiver override operation.

(h) Boom operators shall vigorously advise the receiver to slow the closure rate to 1 foot per second, if required.

(i) Tanker airspeed and altitude adjustments shall be made smoothly and slowly when the B-2 is in or near the contact position.

(j) Adjustments required by the tanker to compensate for receiver closure should be accomplished after the receiver is in the contact position.

B-2A

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

(7) (KC-135) Abnormal Procedures

(a) Because of the restrictive inner boom envelope limit, the boom will be extended to 12 feet for the astern position.

(b) There is considerable bow-wave effect from the receiver during closure to the contact position.

(c) The effect has a steeper gradient and is similar in magnitude to a C-5 receiver.

(d) Up to 3 units of boom trim may be used.

(e) The bow-wave effect increases as receiver gross weight increases; as tanker gross weight decreases, and during approach to the upper limit of the boom envelope. The effect causes the tanker to experience large trim changes, depending on the rate of receiver movement.

(f) Rapid closure adversely affects the pitch trim of both aircraft; a slow closure rate permits smaller adjustments to stabilise in the proper AAR position.

(g) The receiver should use a slow closure rate of approximately 1 foot per second.

(h) When the tanker CG is 30% MAC or greater, the autopilot pitch control may become unstable, causing slow oscillations and resulting in altitude deviations of approximately 100 to 200 feet.

(i) B-2 receivers have manual boom latching capability.

B-52H

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

4ZE-5 AAR Data B-52H

B-52 in contact with KC-10

B-52 close-up on KC-10

a. General Information

(1) The receptacle doors on the B-52 rotate up, forming a large slipway 2.5 feet long and located 14.5 feet AFT of the nose and 7.5 feet behind the centre windows on fuselage centreline.

(2) Lead-in stripes are located in front of the receptacle at 5, 4 and 3 foot intervals.

(3) Receptacle lights are located on the inside of each door illuminating the slipway and receptacle and are rheostat controlled.

(4) During night AAR, the floodlight may cause a momentary reflection from the receiver's centre windscreen as the receiver moves from astern to the contact position.

C-5A-C/M

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

5ZE-5 AAR Data C-5A-C/M

C-5 on KC-135

C-5 on KC-10

C-5 close-up on KC-10

a. General Information

(1) The receptacle on a C-5 has a drop-down door which forms a small slipway 2.5 feet long.

(2) The receptacle is located 36.5 feet AFT of the nose slightly to the right of centreline. The distance from cockpit windows is approximately 12 feet.

C-5A-C/M

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

(3) Lead-in stripes are located in front of the receptacle at 5, 4 and 3 foot intervals.

(4) Receptacle lights are located inside the slipway on both sides of the receptacle and are rheostat controlled by the pilot.

(5) There is also an override if the lights fail to come on normally.

b. AAR Procedures

(1) (ALL) AAR Procedures Receiver closure rate from astern position must be made smoothly and slowly (approximately 1 foot per second).

WARNING

- **(ALL)** Tanker airspeed and altitude changes must be made smoothly and cautiously while the receiver is in or near the contact position. Any airspeed or altitude adjustments required by the tanker due to aerodynamic effect of receiver closure should be accomplished after the receiver is stabilised in the contact position.

- **(ALL)** The boom operator must be constantly aware of the receiver's position and rate of movement. The receiver's rate of movement toward an envelope limit will dictate the point to initiate a disconnect. If the movement is toward the inner limit, boom operators will exercise sound judgment in initiating a disconnect or breakaway prior to the receiver exceeding the limit or overrunning the tanker.

- **(ALL)** The boom operator must aggressively advise the receiver to slow the rate of closure to approximately 1 foot per second.

(2) (KC-10) AAR Procedures

(a) There is a slight bow wave affect on the boom elevators when the C-5 reaches approximately 10 to 20 feet, depending on receiver closure rate.

(b) The faster the closure rate, the greater the affect of the bow wave.

(c) Too rapid a closure rate could adversely affect the pitch trim of both aircraft.

(d) The boom operator will advise the receiver to slow its rate of closure if required.

CAUTION

- **(KC-10)** Fuel flow shall be monitored closely when refuelling a C-5 to full tanks. The C-5 manifold does not contain a fuel pressure disconnect switch and over-pressurisation could occur. When fuel flow starts to decrease, reduce the number of AR pumps in use to a maximum of four. Turn AR pumps off when fuel stops or briefed offload is completed.

NOTE

- **(KC-10)** The C-5 minimum AAR speed will be 252 KCAS/0.62, and 300 KCAS/0.77 will be the maximum AAR speed.

C-5A-C/M

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

NOTE

- **(KC-10)** The KC-10 tanker minimum AAR speed and maximum altitude will be determined from the cruise buffet-onset boundary (slats retracted) chart.
- **(KC-10)** Slats will not be extended to lower minimum AAR speed to 252 KCAS.
- **(KC-10)** During AAR with a C-5, the receiver's nozzle position switch will not be activated when the nozzle is inserted into the receptacle, and the receiver's disconnect light will remain illuminated throughout AAR.

(3) (KC-135) AAR Procedures

(a) There is considerable bow-wave effect on the ruddervators when the C-5 reaches approximately 10 to 20 feet depending on receiver closure rate.

(b) The faster the closure rate, the greater the effect of the bow-wave.

(c) Too rapid a closure rate adversely affects the pitch trim of both airplanes and can cause pitch trim forces in excess of autopilot capability.

(d) If boom instability is experienced while attempting contact, the boom should be moved out of the bow wave and allowed to stabilise prior to re-attempting contact.

(e) The Boom Operator will hold sufficient down pressure on the ruddervator control stick during contact to ensure the nozzle will clear the receptacle when a disconnect occurs.

(f) When accomplishing the astern call during EMCON 1 or EMCON 2, advise the receiver of the boom trim setting and subsequent lower elevation limitation; also notify the receiver when changing the trim setting if it affects the elevation limits.

(g) During EMCON 3 and above, use 5 units of trim to maximise the AAR envelope.

(h) Five units of boom trim is the preferred setting for the C-5 because it expands the lower envelope limit to 40 degrees and affords the boom operator or receiver a greater chance of effecting a disconnect before boom nozzle binding or the boom envelope limit is reached.

(i) As the receiver approaches the contact position, a slight amount of upward control stick force is required to maintain the boom at 30 degrees elevation.

(j) When the boom nozzle reaches approximately 20 feet from the receptacle, the bow-wave begins to neutralise the stick force; complete neutralization occurs as the nozzle reaches approximately 10 feet from the receptacle.

(k) As ruddervator trim increments are increased, upper elevation boom travel will be reduced proportionally.

(l) Upper elevation control improves as the receiver's bow-wave effect increases.

C-5A-C/M

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

WARNING

- **(KC-135)** Excessive closure rate could cause the tanker to descend into the path of the receiver. The pilot must be prepared to disconnect the autopilot to prevent altitude deviations. Initiate a breakaway at the first indication of a closure overrun.

- **(KC-135)** Pilots must be aware that situations that induce sudden large out-of trim conditions (large thrust or airspeed changes, rapid movement of large receiver aircraft etc) may exceed aircraft trim capability. In these situations, the "fail passive" design of the digital autopilot may result in large variation in aircraft attitude/altitudes prior to automatic disengagement of the autopilot. Pilots must be prepared to assume aircraft control immediately and should expect significant out of trim control forces to exist following manual/automatic autopilot disengagement.

CAUTION

- **(KC-135)** The tanker must closely monitor the fuel flow when refuelling to full tanks, as the C-5 does not contain a pressure disconnect switch. When fuel flow stops or when the briefed offload has been transferred, turn the A/R pumps OFF.

- **(KC-135)** Due to adverse trim changes on both the tanker and receiver, Mach/airspeed during contact shall in no case be more than 0.64M or 265 KCAS, whichever is lower.

- **(KC-135)** Night AAR is permitted if either the boom nozzle light or TMF are inoperative, so long as the receiver's receptacle lights are operative; if the receiver's receptacle lights are inoperative, both the nozzle light and TMF must be operative.

C-17A

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

6ZE-5 AAR Data C-17A

C-17 on KC-10

C-17 close-up on KC-135

a. General Information

(1) The C-17 has a UARRSI receptacle, located 15 feet AFT of the nose, and 10 feet AFT of the centre windows, on the fuselage centreline.

(2) Lead-in stripes are located in front of the receptacle at 1 foot intervals.

(3) The receptacle is illuminated by lead-in perimeter lights and slipway lighting.

(4) There is a 6 inch tall blade type antenna located approximately 6 feet aft of the UARRSI on the aircraft centreline.

(5) Except when mission requirements dictate, do not attempt contacts at night with the receiver lead-in perimeter lights and the tanker TMF failed, or with the receiver slipway light and tanker boom nozzle light failed

(6) A formation of C-17's will use SKE procedures during AAR.

b. AAR Procedures

(1) (ALL) AAR Procedures

WARNING

- **(ALL)** Excessive closure rate may cause the tanker to descend into the path of the receiver. The pilot must be prepared to disconnect the autopilot to prevent altitude deviations. Initiate a breakaway at the first indication of a closure overrun.
- **(ALL)** Tanker airspeed and altitude changes must be made smoothly and cautiously while the receiver is in or near the contact position. Any airspeed or altitude adjustment required by the tanker due to aerodynamic effects of the receiver should be accomplished after the receiver is stabilised in the contact position.

C-17A

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

WARNING

- **(ALL)** Boom operators must be alert to the receiver's capability of rapid movement in both pitch and roll axes within the AAR envelope. Monitor the receiver's rate of movement and use sound judgment in determining when to initiate a disconnect, to ensure that the nozzle disconnects from the receptacle prior to getting into a position where nozzle binding can occur. If receiver movement is toward the inner limit, boom operators will exercise sound judgment in initiating a disconnect or breakaway prior to the receiver exceeding the limit or overrunning the tanker.
- **(ALL)** The boom operator must aggressively advise the receiver to slow the rate of closure to approximately 1 foot per second.

(2) (KC-10) AAR Procedures

(a) When initiating fuel transfer to the C-17, arm at least one A/R pump prior to contact.

(b) If positive fuel pressure does not occur within 15 seconds after a boom contact made signal, initiate a disconnect.

(c) Select an alternate pump prior to re-accomplishing contact.

(d) All six A/R pumps may be used.

NOTE

- **(KC-10)** It is normal for fuel transfer to indicate zero flow for up to 15 seconds after the first pump is selected.

(e) Reverse AAR with the C-17 is prohibited.

(f) Unless mission requirements dictate, do not attempt contacts at night with the loss of the following lighting: C-17 lead-in perimeter lights and both TMFs failed, or with the C-17A slipway lights and both boom nozzle lights failed.

(g) Boom operators must be alert to the C-17's capability of rapid movement in both pitch and roll axes within the AAR envelope.

(3) (KC-135) AAR Procedures

NOTE

- **(KC-135)** Do not accomplish reverse flow AAR except in an actual fuel emergency.

(a) The receiver bow wave effect is more pronounced than the C-5 due to the rapid movements that the receiver is capable of performing.

(b) Bow wave effects are accentuated when the receiver is above 25 degrees elevation.

(c) During receiver closure from, or backing out to, approximately 40 feet, pilots must anticipate elevator trim changes of approximately ±2 units.

(d) Pilots should monitor the elevator trim wheel for excessive trim cycling.

C-17A

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

(e) Autopilot elevator trim authority may be exceeded.

WARNING

- **(KC-135)** Pilots must be aware that situations that induce sudden large out-of-trim conditions (large power or airspeed changes, rapid movement of the receiver aircraft, etc.) may exceed aircraft trim capability. In these situations, the fail-passive design of the autopilot may result in a large variation of aircraft attitude/altitudes prior to automatic disengagement of the autopilot. Pilots must be prepared to assume aircraft control immediately, and should expect significant out of trim control forces to exist following manual/automatic autopilot disengagement.

(f) Due to the ability of the C-17 to move rapidly within the AAR envelope, consider setting the telescope-at-disconnect switch to AUTO.

(g) The optimum boom trim setting is 5 units; this setting expands the lower envelope to 40 degrees, and affords the boom operator and receiver a greater chance of effecting a disconnect before boom nozzle binding occurs or the boom envelope limit is reached.

(h) As the amount of boom trim is decreased, boom control authority is significantly degraded to the point that 0 units of boom trim may not allow boom control authority below 35 degrees elevation, regardless of boom operator input.

(i) During EMCON 1 or EMCON 2 AAR operations, when accomplishing the astern call, advise the receiver of the boom trim setting and subsequent lower elevation limitation; also notify the receiver when changing the trim setting if it affects the elevation limits.

(j) During EMCON 3 and above, use 5 units of trim to maximise the AAR envelope.

(k) As the receiver approaches the contact position, a slight amount of upward control stick force may be required to maintain the boom at 30 degrees elevation.

(l) During approach to contact, a bow wave similar to, but more intense than that encountered with the C-5, becomes evident the last 10 to 20 feet prior to contact.

(m) The boom operator must ensure that the receiver has stabilised at the astern position (zero rate of closure) before clearing the receiver to the contact position.

(n) The C-17 rate of closure from the astern position must be made smoothly and slowly (approximately 1 foot per second).

(o) If the rate of forward movement is excessive or continues past the contact position, the boom operator will exercise sound judgment in initiating a breakaway prior to the receiver overrunning the tanker.

(p) Contact should not be attempted until the receiver has stabilised in the contact position.

(q) When initiating fuel transfer, the aft pump in the forward body tank or the forward pump in the aft body tank must be energised on and providing positive fuel pressure within five seconds following a boom contact made signal.

(r) If either of these pumps cannot be energised in that time frame, perform a disconnect and re-accomplish a contact.

C-17A

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

(s) It is normal for fuel transfer to indicate zero flow for up to fifteen seconds after the first pump is energised.

(t) Additional A/R pumps may be energised following fifteen seconds of stabilised fuel flow to the receiver.

(u) A maximum of 4 A/R transfer pumps may be used.

C-32B

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

7ZE-5 AAR Data C-32B

C-32B on KC-10

a. General Information

(1) The C-32 has a UARRSI receptacle located approximately 15 feet aft of the nose and 9 feet behind the cockpit windows on the aircraft's centreline.

(2) There are no external floodlights to illuminate the receptacle area but the receptacle has adjustable integral lighting.

NOTE

- **(ALL)** The C-32 does not have lead-in stripes or receptacle markings on top of the aircraft. During night AAR, the nose section of the aircraft appears to be a flat surface while in reality it is raised. This illusion may cause depth perception errors prior to making contact.

- **(ALL)** Prior to AAR with the C-32 at night, the boom operator should refuel the C-32 during daylight to become familiar with the C- 32 UARRSI.

- **(ALL)** During night AAR missions, both tanker and receiver aircraft will use all available external lighting. As a minimum, one of the following external light conditions must be met:

Boom Nozzle Lt (BNL) – INOP/Off	BNL - On	BNL – INOP/Off
Tail Mounted Floodlight (TMF)- On	TMF – On	TMF – INOP/Off
Receptacle Lts – On	Receptacle Lts –INOP/Off	Receptacle Lts - On

- **(ALL)** Except for emergency conditions, AAR operations should not be conducted when other single and dual failure combinations associated with these lights exist. During AAR with less than optimal lighting, extreme care should be taken due to reduced depth perception and lack of visual cues on the C-32 aircraft.

(3) **(KC-135)** Four units of boom trim are preferred, as it expands the lower envelope. During EMCON 1 or 2, notify the receiver of the boom trim setting and lower elevation limit. Notify the receiver any time boom trim settings are changed. During EMCON 3 and above, use 4 units of boom trim

AC/EC/MC/C-130E/H/J/P/U

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

8ZE-5 AAR Data AC/EC/MC/C-130E/H/J/P/U

EC-130 on KC-10

MC-130 close-up on KC-10

a. General Information

(1) The C-130 has a UARRSI receptacle located 12 feet AFT of the nose and 5.5 feet behind centre window on fuselage centreline.

(2) Distance lead-in stripes are located in front of the receptacle at 1-foot intervals.

(3) Approximately 17 inches forward of the receptacle is a set of lights offset on both sides to illuminate the area around the receptacle.

(4) There is additional lighting in the slipway area.

b. Rendezvous Procedures

(1) En-Route Overtaking Rendezvous

(a) An overtaking enroute rendezvous will be normally used for all C-130 operations.

(b) When executing an overtaking rendezvous with more than one tanker, delay adjusting airspeed, lowering the flaps, or manoeuvering to AAR formation until all aircraft are established on the AAR heading.

AC/EC/MC/C-130E/H/J/P/U

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

(c) Tanker(s) and receiver(s) arrive from the same general direction; each aircraft will fly individual flight plans to a common RVIP/RV and join-up enroute to the RVCP.

(d) The receiver(s) will plan to arrive at the RVIP/RV 1 minute prior to RVCT.

(e) This procedure makes use of the tanker's increased overtake ability to compensate for the receiver's lower airspeed.

(f) To be effective, tanker(s) and receiver(s) must arrive at the RVIP/RV at their respective times.

(g) Tanker(s) and receiver(s) will adjust enroute airspeed/flight path to make the rendezvous control time.

(h) Tanker(s) and receiver(s) should communicate as soon as possible (in no case later than 15 minutes prior to the rendezvous control time) to update ETAs.

(i) Receiver(s) and tanker(s) will be at their assigned altitude prior to reaching the RVIP/RV.

(j) These altitudes will provide at least 1000 feet separation between the highest receiver and the lowest tanker with the receiver always at the lower altitude.

(k) The receiver will proceed down track from the RVIP/RV at 215 KIAS, and the tanker will overtake the receiver at 275 KIAS.

(l) Once visual/radar contact is established with the receiver, the tanker will maneuver to pass overhead the receiver.

(m) The pilot not flying will call when the tanker passes overhead the receiver.

(n) After the receiver passes under the tanker glare shield **(1/2 NM on TCAS/1/3 NM on radar for KC-10)**, the tanker will maintain 275 KIAS for another 30 seconds (15 seconds for KC-10), then reduce power to idle and begin slowing to 200 KIAS (190 KIAS for AC130H).

(o) **(KC-135) Flaps**

(i) Weight 210K lbs or Less AAR may be accomplished with either flaps up or flaps 20 degrees at gross weights up to 210,000 lbs.

(ii) Weight Greater than 210K lbs At gross weights above 210,000 Ibs, AAR must be accomplished with flaps 20 degrees.

(iii) Extending Flaps If AAR is to be accomplished with flaps 20 degrees, then extend the flaps when passing through 220 KIAS.

(iv) Pitch Change Be prepared for a pitch change and continue to slow to 200 KIAS for AAR.

(v) Autopilot Axis Altitude Hold With airspeed stabilised at 200 KIAS, the autopilot elevator axis altitude hold may be engaged if desired.

AC/EC/MC/C-130E/H/J/P/U

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

NOTE

- **(ALL)** Due to engine spool-up time and rapid airplane deceleration when flaps are lowered to 20 degrees, pilots must be prepared to advance throttles simultaneously with extension of flaps.

(p) **Failure to make R/T Contact** If radio communications between airplanes have not been established by the rendezvous control time, airplanes will depart the RVIP/RV to make good the ARCT at the RVCP.

(q) **Delaying at RVCP** Use normal orbit procedures when delaying at the RVCP.

(r) **Formation Procedures** Once join-up has been accomplished, normal formation procedures apply.

(s) **Overrun** If the tanker has overrun the receiver during the final phase of the rendezvous, the following procedures are recommended:

(i) The tanker will reduce airspeed to 200 KIAS (0.6 AOA minimum) with flaps set for AAR and maintain track at the assigned AAR altitude.

(ii) The receiver will adjust airspeed, maintain an altitude 1000 feet below assigned base AAR altitude, adjust track as required, and close on the tanker.

(2) Overtaking RV Delta (Point Parallel Rendezvous)

(a) The overtaking RV Delta (point parallel rendezvous) uses normal RV Delta procedures except the tanker plans to roll out behind the receiver.

(b) The tanker than overtakes the receiver using the speed schedule and procedures outlined in the Enroute Overtaking Rendezvous.

(c) For formation operations, the tanker will adjust to AAR formation (stacked up 500 feet, 1 NM nose-to-nose, 60 degrees echelon) after completing the turn to the AAR heading.

(3) Overtaking Modified Point Parallel Rendezvous

(a) The modeled point parallel rendezvous with C-130 receivers is standard with the exception that the tanker will utilise overtaking procedures.

NOTE

- **(KC-10)** When executing tanker overtaking rendezvous with one or more tankers, delay adjusting airspeed, extending slats, or manoeuvering to AAR cell formation until all aircraft are established on AAR heading.
- **(KC-10)** If the tanker has overrun the receiver during the final phase of the rendezvous, the following procedures are recommended. The tanker will reduce airspeed to 200 KCAS with slats extended and maintain track at the assigned AAR altitude. The receiver will increase airspeed, maintain an altitude 1000 feet below assigned base AAR altitude, adjust track as required, and close on the tanker.

AC/EC/MC/C-130E/H/J/P/U

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

c. Closure Procedures

(1) The receiver will maintain 215 KIAS until 1/2 NM in trail, then slow during closure to reach the astern position at 200 KIAS.

d. AAR Procedures

(1) (ALL) AAR Procedures

CAUTION

- **(ALL)** Boom nozzle position shall be monitored closely prior to contact and following disconnect as receptacle to propeller line distance is only 15.5 feet.

NOTE

- **(ALL)** The MC-130H Combat Talon II (CTII) has an elongated tear shaped antenna located approximately 5 feet in front of the receptacle, protruding out from the front of the receptacle and aircraft.
- **(ALL)** EC-130J aircraft AAR envelope is 190 to 230 KIAS at 0 to 20,000 feet MSL. Optimum is 210 KIAS/10,000 feet MSL.
- **(ALL)** On EC-130J aircraft, fuel may be seen swirling within the UARRSI pressure box during AAR.
- **(ALL)** Bank angle during AAR with C-130 receivers will be limited to 15 degrees

(2) (KC-10) AAR Procedures

WARNING

- **(KC-10)** Do not raise or lower slats/flaps while the receiver is closer than the astern position because of the resultant pitch change of the tanker.

(3) (KC-135) AAR Procedures

(a) For formation operations, aircraft will be stacked up at 500 foot intervals from the leader with 1 NM nose-to-nose separation along the 60-degree echelon line.

(b) Consider establishing the fuel configuration prior to slowing to AAR airspeed; draining fuel from the centre wing to the forward body tank with certain fuel loads may be slower than normal.

(c) Power control is critical at the relatively low airspeeds required by the receiver.

(d) Airspeed must be monitored closely as the airplane response to power adjustments for lost airspeed is slower than normal, especially at gross weights approaching 250,000 pounds.

(e) Boom operators must be aware of changes in boom flight characteristics during AAR with the C-130 at slower airspeed in combination with tanker flap setting of 20 degrees.

AC/EC/MC/C-130E/H/J/P/U

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

(f) Control of the boom becomes heavier and the boom tends to trail at 35 to 37 degrees when flaps are lowered to 20 degrees.

(g) When the receiver stabilises in the astern position, the boom operator will hold required up pressure on the ruddervator control stick to maintain a 30-degrees trail position.

(h) Increased force is required to fly the boom to effect contact and to maintain boom-to-receptacle alignment.

(i) To minimise nozzle cocking when making contact below 33 degrees elevation, the boom must be inserted straight into the receptacle without aid of the slipway; using the slipway may cause nozzle to cock, preventing contact.

(j) For night AAR, if the receiver's nose section cannot be seen or the boom operator is having depth perception problems, fly the boom around the receiver's fuselage nose section as the receiver approaches the contact position.

(k) This procedure will also avoid directing the boom nozzle light into the eyes of the receiver pilot.

WARNING

- **(KC-135)** Do not raise or lower flaps while the receiver is closer than the astern position because of the resultant pitch change of the tanker
- **(KC-135)** During an actual/practice emergency separation, do not raise or lower the flaps until the receiver is well clear.
- **(KC-135)** If in a turn when a breakaway is initiated, maintain the established bank angle while adding power. Do not roll wings level and do not raise or lower flaps until the receiver is well clear.
- **(KC-135)** The maximum tanker gross weight beginning AAR operation with C-130 receivers will not be greater than 250,000 pounds.
- **(KC-135)** During AAR, do not to allow the airspeed to decrease below 190 KIAS or 0.6 AOA, whichever is higher, because of decreased boom control at lower airspeeds.
- **(KC-135)** During AAR with the flaps extended, exercise extreme caution to ensure that the flap placard speed is not exceeded.
- **(KC-135)** During any AAR which requires the indicated airspeed to be less than 220 KIAS, keep the A/R line valve closed for dry contacts to preclude fuel siphoning from the forward body tank and causing unexpected CG changes.

KC/OC/RC/TC/WC-135B/R/T/S/U/V/W

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

9ZE-5 AAR Data KC/OC/RC/TC/WC-135B/R/T/S/U/V/W

RC-135 on KC-10

a. General Information

(1) The receptacle doors on all models of -135's rotate up forming a large slipway 2.5 feet long.

(2) Location distance from radome to receptacle will vary depending on aircraft model.

(3) From centre windows to receptacle is approximately 7 feet.

(4) Receptacle lights are on the inside of each door illuminating the slipway and receptacle area and are rheostat controlled.

NOTE

- **(ALL)** Reverse flow AAR can only be accomplished with aircraft not restricted for reverse flow AAR.

E-3A-D/F/E-6B/CT-49A (NTCA) /E-8C

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

10ZE-5 AAR DATA E-3A-D/F/E-6B/CT-49A (NTCA) /E-8C

E-3 on KC-10

E-3D/F on KC-135

E-3A-D/F/E-6B/CT-49A (NTCA) /E-8C

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

E-6 on KC-10

E-8 on KC-135

a. General Information

(1) The receptacle doors on the E-3 rotate up forming a large slipway 2.5 feet long and are located approximately 15 feet aft of the nose section and 7 feet behind the centre windows on aircraft centreline.

(2) Receptacle lights, located on the inside of each door illuminating the slipway and receptacle area are rheostat controlled.

NOTE

- **(ALL)** Provide E-3 receivers with type of fuel to be offloaded. If JP-4 (NATO F-40) or Jet B (NATO F-45) fuel is being offloaded inform E-3 receiver of fuel temperature. E-3 fuel boost pumps are not certified for flights using JP-4 or Jet B fuel with fuel temperatures exceeding 85°C. Any fuel mixture containing more than 0.1% JP-4/ Jet B is to be considered JP-4.

b. E-3D/F

(1) The United Kingdom's E-3D and French E-3F are identical to the U.S. E-3B/C aircraft except for the installation of high bypass fan engines and a AAR probe located 30 inches forward and 3 feet to the left of the receptacle as seen from the boom operator's position.

(2) The probe is approximately 10 feet in length and has electroluminescent outline lighting, except for the last 1.5 feet of the probe tip. E-3F may or may not be equipped with AAR probe.

CAUTION

- **(ALL)** The boom may block the probe from view during approach to contact if the receiver is offset approximately 5 degrees to the left.

E-3A-D/F/E-6B/CT-49A (NTCA) /E-8C

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

CAUTION

- **(ALL)** Night AAR with E-3D/F receivers will not be attempted if the probe electro-luminescent lighting, boom nozzle light (s), and TMF (s) are inoperative.
- **(ALL)** The E-3D/F aircraft is cleared for boom AAR only. Probe/Drogue AAR is not permitted
- **(ALL)** Reverse flow AAR is prohibited

c. E-6B Data

(1) The Navy E-6B is a B-707 airframe with CFM-56 engines and a standard -135 AAR receiver receptacle.

(2) The AAR functions are essentially the same as the E-3.

(3) All data remains the same except the E-6B does not have mission radar and IFF rendezvous equipment.

d. CT-49A NATO Trainer/Cargo Aircraft (NTCA)

(1) The NATO Trainer/Cargo Aircraft (TCA) is equipped with a UARRSI receptacle that has boom interphone capability.

(2) The NTCA provides dry contacts only for NATO E-3 pilot training.

(3) It is approved for dry contacts only (day and night).

(4) (KC-135) To drain trapped fuel from the boom, ensure the A/R line valve is closed and accomplish the boom draining steps (except stowing the boom) contained in the FUEL DUMPING checklist of the applicable flight manual.

(5) (KC-135) When boom draining is complete, close the boom marker and nozzle lights circuit breakers.

NOTE

- **(ALL)** Only dry contacts will be accomplished. Do not pressurize the AR manifold with boom valve.

e. E-8C

(1) The E-8 is a B-707 airframe with a UARRSI receptacle located approximately 15 feet aft of the nose section and 7 feet behind the centre windows on the aircraft centreline.
(2) A blade antenna is located 18 inches aft of the receptacle.

CAUTION

- **(KC-135)** Night AAR will not be attempted if the receiver's receptacle lights are inoperative or the tanker does not have either an operable boom nozzle light or TMF.
- **(KC-10)** Night AAR can be safely accomplished with failed receiver receptacle lights provided that at least one TMF is operational.

E-4B/VC-25A

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

11ZE-5 AAR Data E-4B/VC-25A

E-4 on KC-135

Close-up of E-4

E-4 on KC-10

a. General Information

(1) The E-4 has a UARRSI receptacle which is located on the nose section 8 feet aft of the radome.

(2) The aircraft is provided with a receptacle "spoiler", 1 foot high and 2 feet across, located just aft of the AAR receptacle. It is designed to reduce/normalise receiver pilot pitch control problems.

(3) With the spoiler retracted, receiver pilot workload is greatly increased to control E-4 pitch oscillations encountered when closing from 10 to 2 feet and when contact is made.

NOTE

- **(ALL)** During night AAR, the nose section of the aircraft appears to be a flat surface while in reality, it is raised. The illusion may cause depth perception errors prior to making contact.

E-4B/VC-25A

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

b. Rendezvous

(1) Radar/beacon will be the primary rendezvous means.

(2) Differential DME from a common ground TACAN may be used during EMCON 1 or alternate rendezvous.

c. VC-25 Data

(1) The VC-25A AAR installation is externally exactly like the E-4 except for the lack of reference markings in front of the receptacle/slipway and the nose, upper fuselage (including the AAR receptacle, slipway and spoilers being painted with a glossy blue paint.)

(2) All data remains the same.

(3) **(KC-135)** Normal autopilot trim changes occur when the receiver closes from the astern position.

CAUTION

- **(KC-135)** AAR with the receiver's A/R spoiler retracted shall only be accomplished with a minimum of the tanker autopilot elevator axis and altitude hold engaged, and the yaw damper on.

- **(KC-135)** Night AAR is permitted if either the boom nozzle lights or tail-mounted floodlight are inoperative, so long as the receiver's receptacle lights are operative; if the receiver's receptacle lights are inoperative, both the nozzle lights and floodlight must be operative.

- **(KC-10)** The VC-25 can be refueled by the KC-10 with any two lighting failures (slipway, spoiler, fairing, wing) provided that the at least one KC-10 tail mounted floodlight (TMF) and one boom nozzle light are operational.

F-4E/F

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

12ZE-5 AAR Data F-4E/F

F-4 on KC-10 in Contact

F-4 on KC-10 Just Prior to Contact

a. General Information

(1) All models of the F-4 have a small receptacle with no slipway that is located on the fuselage centreline 2.5 feet behind the AFT canopy.

(2) Depending on the model, the receptacle is approximately 25 feet from the nose of the aircraft.

(3) There is a 3 inch high antenna located 1.5 feet forward of the receptacle approximately on fuselage centreline.

(4) Depending on the model, additional antennas may be located AFT of the receptacle.

(5) For night AAR, lights are located in the receptacle.

(6) The receiver pilot has the capability to position the lights to bright or dim only.

(7) When using the TMF, a momentary reflection from the receiver's windscreen may occur as the receiver moves in from astern position.

b. AAR Procedures

CAUTION

- **(KC-135)** For night AAR, if the boom nozzle light fails but the TMF is operative, attempts to effect a contact will be at the discretion of the boom operator. Should the receiver's receptacle light become inoperative, the boom operator may request the receiver pilot to turn on the anti-collision light.

NOTE

- **(ALL)** Some models of the F-4 do not have manual boom latching (MBL) capability.

F-15A-E/I/J/DJ/S/SG

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

13ZE-5 AAR Data F-15A-E/I/J/DJ/S/SG

F-15 on KC-10

F-15E on KC-135

F-15 close-up on KC-10

a. General Information

(1) The receptacle on the F-15 has a fold down door which forms a small slipway. It is located 30 feet from the nose and 3 feet left of centreline in the aircraft wing root area.

(2) Lights for the slipway are in the receptacle and on the aft portion of the canopy which illuminates the area around the receptacle.

F-15A-E/I/J/DJ/S/SG

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

b. AAR Procedures

CAUTION

- **(ALL)** Do not attempt contact if the forward AAR door is vibrating. Contact with the boom may cause loss of the AAR door.

NOTE

- **(ALL)** To assure successful contact, precise positioning of the boom straight into the receptacle is required. The nozzle tip may hang-up on a gap in the forward end of the receptacle slipway. The tip may also hang-up on the receptacle forward rollers if attempting contact from either side of the slipway.

c. F-15E Data

(1) To aid in determining the approximate deck angle and closure rate, a tail floodlight has been added.

NOTE

- **(ALL)** During night AAR, exercise extreme care due to reduced depth perception and lack of visual cues on the F-15E darker paint scheme.

F-16A-F/I

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

14ZE-5 AAR Data F-16A-F/I

F-16 on KC-10

Singapore AF F-16 W/ Raised Receptacle

F-16 With Conformal Tanks on KC-135

F-16A-F/I

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

F-16C on KC-135

F-16D close-up on KC-10

a. General Information

(1) The F-16 has a UARRSI receptacle which is located 27 feet from the nose on aircraft centreline, 6.5 feet aft of the canopy.

(2) The F-16B/D/F/I model (two-seater) receptacle is slightly closer to the canopy.

(3) There is a 2-inch high antenna on the upper fuselage centreline, 3 feet forward of the receptacle.

(4) On F-16B/D/F/I models, the antenna is 8 inches higher due to being mounted on the aft portion of the raised panels that blend the canopy to the fuselage.

(5) F-16C/D/F/I (single-/two-seater) models are modified with a tapering fillet at the base of the vertical stabiliser approximately 9 inches aft of the UARRSI.

(6) A single antenna on the fillet is approximately 2 feet aft of the receptacle.

(7) On F-16B/D/F/I models, the area forward and aft of the receptacle is reduced.

(8) Lighting for the receptacle is of fixed intensity.

(9) The floodlight on the upper fuselage, which illuminates the AAR markings around the receptacle, can be varied in intensity.

(10) The receivers may be equipped with conformal fuel tanks (CFTs); receivers with CFTs will be refuelled using standard F-16 procedures with the following exceptions:

(a) The AAR altitude is restricted to 15,000 to 30,000 feet MSL with optimum altitude being 20,000 feet MSL.

(b) Tanker A/R airspeed is 310 ± 10 KCAS (no slower than 300 KCAS)

F-16A-F/I

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

(11) On airplanes with CFTs installed, the top of the CFT is above the level of the AAR receptacle; the tanks are especially high toward the forward end.

(12) Airplanes with CFTs may have a green receptacle light that is visible during night AAR.

(13) CFT configured aircraft are limited to gross weights of 48,000 lbs.

b. AAR Procedures

WARNING

- **(ALL)** During AAR with an airplane with CFTs, immediately inform the receiver of any fuel venting in the area of the engine exhaust; there is a possibility that vented fuel could be ignited during afterburner operation.

CAUTION

- **(ALL)** F-16B/D model - Avoid striking the panels that blend the aft portion of the canopy with the fuselage during contact and after disconnect. These panels are approximately 18 inches from slipway doors.

- **(ALL)** During AAR with an airplane with CFTs, do not allow the boom to contact the CFT; a boom strike on either CFT could lead to tank failure and a catastrophic fuel leak. Immediately inform the receiver of any strike to a CFT.

- **(ALL)** Some F-16B/D/F/I (two-seater) models are modified with a raised avionic hump on the spine of the aircraft which raises the receptacle approximately 1 foot.

NOTE

- **(ALL)** F-16's do not have MBL capability.

- **(KC-135)** During F-16 AAR, be aware that pressure disconnects may occur.

F-22A

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

15ZE-5 AAR Data F-22A

F-22 on KC-135

F-22 on KC-10

F-22 Close on KC-135

a. General Information

(1) The F-22 has a UARRSI receptacle located 33.5 feet from the nose of the aircraft, 14.8 feet aft of the canopy, on centreline.

(2) The receptacle is flanked by doors that articulate outward and lay flat against the top of the fuselage.

(3) The door hinges are protected by a metal shroud that presents a possibility of the boom nozzle catching and damaging the door assembly.

(4) For visibility, the hinge covers are painted with red and white stripes.

b. Rendezvous

(1) Expect a receiver turn on rendezvous. Normally the tanker will orbit at 275 KIAS and wait for a receiver directed "push it up" call.

(2) The F-22 may or may not have an A/A TACAN.

(3) Normally test crews will not coordinate an A/A TACAN for rendezvous, however in-flight coordination can be done.

F-22A

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

c. AAR Procedures

WARNING

- **(ALL)** Receivers with special instrumentation are cleared for daylight operations only, using VFR conditions and VFR cloud cover. Test airplanes are not IFR capable and have not undergone icing tests; the special instrumentation could be damaged.

CAUTION

- **(ALL)** When cleared to contact position, ensure the receiver maintains centreline to minimize potential for damage to receptacle area.
- **(ALL)** Contact with the surface outside of the receptacle must be avoided. The receiver pilot will be informed of boom contacts outside the receptacle or damage to the receptacle door hinge covers.
- **(ALL)** At night, the forward edge of the receiver's receptacle may not be visible, increasing the chance of boom strikes outside the receptacle; to improve visibility, have the receiver decrease the intensity of the receptacle light.
- **(ALL)** When the tanker TMF (s) are inoperative, the receiver nose and engine inlets may not be visible. Closely monitor the receiver's elevation during closure to ensure adequate boom clearance. Visibility of the boom and boom nozzle will improve in the vicinity of the receiver's external spotlight located behind the canopy.
- **(KC-10)** If both nozzle lights fail, the receiver's receptacle light, spotlight and the KC-10 TMFs must be operative, unless operational mission, over-water deployed or fuel emergency dictates. If both the receiver's receptacle light and spotlight are inoperative, AAR will not be conducted unless operational mission, over-water deployment or fuel emergency dictates.
- **(KC-10)** The maximum floodlight setting is 7 to prevent distracting the receiver pilot while closing to the contact position.
- **(KC-135)** If any tanker lighting fails, but the receiver external spotlight is operative, contact will be at the discretion of the boom operator.

NOTE

- **(ALL)** F-22's do not have MBL capability.
- **(ALL)** With two pumps, the F-22 may experience a pressure disconnect when fuel quantity is within 1,500 pounds of full tanks. The receiver may ask to decrease to one pump during fuel transfer or after an inadvertent disconnect.
- **(KC-10)** For night AAR, the boom operator will notify the receiver if the boom nozzle lights are inoperative.
- **(KC-135)** For night AAR, the boom operator will notify the receiver if either the TMF or boom nozzle light is inoperative.

F-22A

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

d. Airspeed / Altitude/External Stores

(1) The Maximum Bank angle during AAR is 30 Degrees.

(2) F-22 aircraft configured with two external tanks in the inboard positions is the only external tank configuration certified for AAR. No other external tank configurations are permissible

CAUTION

- **(ALL)** F-22 aircraft configured with a mix of external tanks and external armament are not cleared for AAR.

F/RF-111C

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

16ZE-5 AAR Data F/RF-111C


F-111s on KC-10 (RAAF only receiver)

a. General Information

(1) The receptacle on the F-111's is a pop-up type receptacle which forms a small target. It is located 8 feet from the canopy 18 inches off centreline to the left.

(2) From the nose to the receptacle is 33 feet.

(3) Lights in the receptacle illuminate the area.

(4) There is an antenna located 2 feet AFT of the canopy on centreline 8 inches high.

NOTE

- **(ALL)** F-111's may require holding slight extend pressure momentarily to allow toggles to engage.

KC-10A

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

17ZE-5 AAR Data KC-10A

KC-10 on KC-10

KC-10 close-up on KC-10

KC-10 on KC-135

a. General Information

(1) The KC-10 has a UARRSI receptacle located 12 feet aft of the nose and 6 feet behind cockpit windows on aircraft centreline.

(2) AAR receptacle floodlights are located on both sides and just forward of the leading edge of the receptacle. Black lead-in stripes in front of the receptacle are 4 inches wide and 1 foot apart.

(3) The AAR area is outlined with a 4 inch wide black stripe. The black stripe directly around the receiver door is 2 inches wide

(4) Modified aircraft have electroluminescent (EL) light strips that replace the red lead-in stripes. Each light strip is 3 inches wide.

(5) The EL light strips form a forward perimeter, lead-in stripes, and aft left and right perimeters.

KC-10A

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

(6) During AAR with less than optimum lighting, extreme care should be exercised due to reduced depth perception and lack of visual cues on the camouflaged aircraft.

(7) **(KC-135)** The aerodynamic effects on the tanker aircraft during AAR are similar, but to a lesser degree, than those experienced with the C-5 receiver. The effects are particularly noticeable during rapid receiver separations.

WARNING

- **(KC-135)** Pilots must be aware that situations that induce sudden large out-of-trim conditions (large thrust or airspeed changes, rapid movement of large receiver aircraft, etc) may exceed aircraft trim capability. In these situations, the "fail passive" design of the digital autopilot may result in large variation in aircraft attitude/altitudes prior to automatic disengagement of the autopilot. Pilots must be prepared to assume aircraft control immediately and should expect significant out of trim control forces to exist following manual/automatic autopilot disengagement.

CAUTION

- **(ALL)** AAR receptacle flood light doors are located on both sides and just forward of the leading edge of the receptacle. If AAR receptacle flood lights are turned on, caution must be exercised to prevent striking the doors.

NOTE

- **(ALL)** During night AAR, the nose section of the aircraft appears to be a flat surface while in reality, it is raised. The illusion may cause depth perception errors prior to making contact.

- **(KC-10)** During night training missions, both tanker and receiver aircraft will use all available external lighting. As a minimum, either one TMF, or one nozzle light with override capability will be operable. During AAR with less than optimum lighting, extreme care should be exercised due to reduced depth perception and lack of visual cues. AAR will be at the discretion of the boom operator.

- **(KC-135)** For night AAR, if the boom nozzle light, TMF, or receiver's receptacle lighting fails, attempts to effect contact will be at the discretion of the boom operator.

TA/A-4AR; AM-X; JAGUAR B/S; MIRAGE 2000/F-1

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

18ZE-5 AAR Data TA/A-4AR; AMX; JAGUAR B/S; MIRAGE 2000/F-1

Mirage on Boom/Drogue Adapter

Mirage on KC-10

a. General Information

(1) The tanker pressure regulation system and MA-3/4 coupling pressure regulators will be fully functional. The Mirage F-1 should be equipped with a flex-tip probe nozzle. If the Mirage F-1 is not equipped with a flex-tip probe nozzle, then the F-1 pilot will be advised to avoid off center disconnects when conducting AAR from the BDA.

(2) During AAR with Jaguar B/S airplanes, a ground-fit check of the probe and drogue is required.

(3) Night AAR with the AM-X, Mirage and Jaguar S is prohibited unless the receiver is equipped with a probe nozzle light. For KC-135 night AAR, the AM-X is restricted to using the BDA. The tanker must have all AAR lights, including tail mounted floodlight when using the BDA, operable in addition to the AM-X and Mirage 2000 probe nozzle light.

b. AAR Operations

(1) AAR shall not occur in turbulence greater than light with the Mirage 2000/ F-1 and AM-X.

(2) The receiver pilot shall be informed by the tanker of the type fuel being transferred.

(3) The maximum capacity that the receiver shall be refuelled to is 90 percent. No receiver valve closures are permitted which would terminate fuel flow to the receiver.

WARNING

- **(ALL)** Do not AAR with AM-X receivers having a degraded electronic flight control system unless dictated by a fuel emergency; if a fuel emergency exists, WARP/MPRS is the preferred method of AAR because it ensures maximum tanker/receiver separation.
- **(KC-135 BDA)** After an A-4 receiver aircraft engages the drogue, the tanker shall transfer 300 pounds, and then cease transfer to ensure that fuel is not leaking from the drogue. If no leakage is reported, continue normal transfer. If during subsequent refueling the A-4 pilot or boom operator observes fuel escaping at the coupling, a breakaway will be called.
- **(KC-135)** AAR from the BDA is prohibited whenever the electronic flight control system (EFCS) is degraded. Whenever asymmetric wing loading configurations exist, even with EFCS functioning properly, AAR shall be performed on the MPRS only.

AV-8B, GR-7 (Harrier)

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

19ZE-5 AAR Data AV-8B, GR-7 (Harrier)

AV-8 on KC-10

a. General Information

(1) The tanker pressure regulation system and MA-3/4 coupling pressure regulators will be fully functional.

b. AAR Operations

(1) The receiver pilot shall be informed by the tanker of the type fuel being transferred.

GRIPEN (JAS 39C/D)

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

20ZE-5 AAR Data GRIPEN

a. General Information

(1) The tanker pressure regulation system and MA-3/4 coupling pressure regulators will be fully functional.

(2) Night AAR shall be prohibited until night evaluation flight testing has been completed

b. AAR Operations

(1) AAR shall not occur in turbulence greater than light.

(2) The receiver pilot shall be informed by the tanker of the type fuel being transferred.

(3) Maximum receiver closure rate shall be no greater than 3 ft/sec

(4) The maximum capacity that the receiver shall be refuelled to is 90 percent. No receiver valve closures are permitted which would terminate fuel flow to the receiver.

(5) All electronic stores, radar, and electronic counter measures must be turned off prior to AAR.

(6) The Gripen probe mast contains a pin which may be a “snag” point during coupling engagements and disengagements with the probe nozzle. This pin could damage the drogue canopy which could adversely affect the drag force of the drogue, resulting in instability during extension and rewind operations.

WARNING

- **(ALL)** Simultaneous AAR with other Gripen aircraft is prohibited.
- **(KC-135)** AAR using the Boom Drogue Adaptor is prohibited.

GRIPEN (JAS 39C/D)

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

NOTE

- **(ALL)** After an AAR mission with the Gripen, maintenance will inspect the drogue assembly of the appropriate hose system(s) for canopy tears and other damage. This is due to the location of the Gripen's probe pin. Annotate "Drogue assembly inspection required" in aircraft 781A.

Tornado (F-3 ADV, GR-4/-4A, IDS/ECR/PA-200)

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

21ZE-5 AAR Data Tornado (F-3 ADV, GR-4/-4A, IDS/ECR/PA-200)

Tornado on Boom/Drogue Adapter

Tornado on KC-10

a. General Information

(1) Only Tornado IDS/ECR/PA-200 airplanes equipped with the J.C. Carter flexible-tipped nozzle or an Aeronautical Systems Division (ASD)-approved alternate nozzle will be refuelled with the boom drogue adapter (BDA).

(2) The Tornado is equipped with a retractable probe mast located on the right side of the cockpit for GR-4, GR-4A, IDS, ECR, PA200 types, and on the left side for E-3 and ADV types.

(3) Per Tornado technical orders, no AAR operations are to be conducted with the receiver aircraft in degraded Command and Stability Augmentation System modes.

b. AAR Operations

(1) Limit the bank angle to 15 degrees for turns while in contact unless the receiver pilot requests different angles.

(2) The receiver pilot shall be informed by the tanker of the type fuel being transferred.

(3) **(KC-135)** AAR using the Boom Drogue Adaptor is restricted to day only with all Tornado variants.

RAFALE

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

22ZE-5 AAR Data Rafale

Rafale on Boom/Drogue Adapter

a. General Information

NOTE

- **(KC-10)** The Rafale is cleared to AAR on KC-10 tankers for OEF/OIF/ISAF missions only.

(1) This information applies to USAF tankers only.

(2) Night AAR with the Rafale is prohibited unless the tanker has all AAR lights, including tail mounted floodlight when using the BDA, operable.

(3) The KC-10A tanker pressure regulation system and the MA-4 coupling pressure regulators shall be fully functional.

b. AAR Operations

(1) AAR shall not occur in turbulence greater than light.

(2) The KC-10A aircraft shall be restricted to the use of only one AAR pump for HDU and two AAR pumps for WARP during fuel transfer to the receiver.

WARNING

- **(KC-10)** No AAR operations shall be conducted with the Rafale having a degraded Electronic Flight Control System unless there is an emergency fuel condition within the receiver. If such a condition exists, the preferred system to AAR with is the centreline drogue system.

(3) The maximum capacity that the receiver shall be refueled to is 90 percent. The receiver pilot shall terminate fuel flow by disconnecting when the 90 percent capacity has been attained.

(4) All electronic stores, radar, and electronic counter measures must be turned off prior to AAR.

(5) The receiver pilot shall be informed by the tanker of the type fuel being transferred.

SUPER ETENDARD

IMPORTANT: Read in conjunction with Appendix 4 – Common Warnings, Cautions and Notes and Appendix 6 - Foreign AAR Receivers Technically Compatible with USAF Heavy Jet Tankers

23ZE-5 AAR Data Super Etendard


Super Etendard on Centreline Drogue

a. General Information

NOTE

- **(KC-10)** The Super Etendard is cleared to AAR on KC-10 tankers for OEF/OIF missions only

(1) Night AAR shall be prohibited.

(2) Each Super Etendard receiver aircraft shall be equipped with a DoD Mil-N-25161 MA-2 probe nozzle.

b. AAR Operations

(1) Due to the unknown structural strength of the receiver probe mast, the receiver aircraft overtake speed at contact to the drogue basket/coupling shall be restricted to 1-2 feet per second closure rate.

(2) Due to unknown proof pressure capability of the receiver lines and fuel surge pressures generated during fuel transfer, each receiver's fuel system shall not be filled to top-off. AAR shall be limited to not exceeding 80 percent of maximum fuel capacity. No receiver valve closures shall be permitted which would terminate fuel flow to the receiver.

(3) Fuel transfer from the KC-10 shall be limited to one AAR pump operation and the pump shall be turned off the tanker crew when the receiver crew indicates that they have reached 80 percent of maximum fuel capacity. For wing aerial refuelling pod (WARP) operation, one AAR pump and one transfer pump shall be used.

(4) A ground fit check of the KC-10's centreline system's drogue basket/coupling with the French probe should be successfully completed prior to AAR operations. This fit check will verify that the engagement of the receiver's probe with the KC-10's drogue basket/couplings can be accomplished and made cleanly whilst in flight.

(5) The receiver pilot shall be informed by the tanker of the type fuel being transferred.

PART 5 – NATIONAL ANNEX

ANNEX ZE, APPENDIX 6 - USA

COMMERCIALLY AND FOREIGN MILITARY OPERATED AAR RECEIVERS TECHNICALLY COMPATIBLE WITH USAF HEAVY JET TANKERS

1ZE-6 Requirement for an AAR Compatibility Review. All AAR participants, whether a tanker or receiver, must be reviewed by a competent technical authority to ensure that they are technically compatible with the other participant. Importantly, commercial and foreign military receivers that are derivatives of an in-use US platform still require the issue of a technical compatibility letter; the absence of such a letter means that an AAR technical risk review has not been conducted and AAR should not be undertaken.

2ZE-6 AAR Compatibility Criteria. Compatibility reviews include, but are not limited to: an assessment of the impact that each platform has on the fuel system of the other (fuel flow rates, backpressures, safety features etc) as well as other features that impact AAR (eg aircraft lighting/markings, addition or removal of aircraft aerials (antennas), use of aircraft communication, especially HF and Satellite Phones).

3ZE-6 Request for AAR Compatibility Review. Receiver operators requesting an AAR compatibility review should comply with the instructions in ATP-56, Part 5, Annex ZH.

4ZE-6 Publication of Information Resulting from an AAR Compatibility Review. Confirmation that a technical compatibility assessment has been conducted and found to be satisfactory is published by the appropriate USAF tanker technical authority and incorporated into Figure ZE-6-1. Through this, the technical authority confirms that the combination of a commercially or foreign military operated receiver platform and a USAF tanker has been reviewed, including any receiver modification significant to AAR, and, where necessary, recommends procedural or technique changes that are necessary to ensure safe AA. The relevant information is incorporated into the receiver-specific data published in Annex ZE, Appendix 5. Additionally, Annex 5 provides information about the date of the review and the technical authority that conducted the review.

Figure ZE-6-1 AAR Compatible Commercial and Foreign Military Receivers

QUINQUENNIEL REVIEW

NON-USA RECEIVER TECHNICAL COMPATIBILITY APPROVALS PUBLISHED IN THIS FIGURE WILL AUTOMATICALLY LAPSE WITH THE SUMMER 2011 RELEASE OF ANNEX ZE

TO UPDATE A RECEIVER'S TECHNICAL COMPATIBILITY, RECEIVER NATIONS MUST COMPLY WITH THE INSTRUCTIONS DETAILED IN ANNEX ZH, PARAS 15ZH THRU 19ZH

AAR COMPATIBLE COMMERCIAL AND FOREIGN MILITARY RECEIVERS KC-10, KC-135, AND KC-45 TANKERS

NOTE: AAR compatibility for a non-US receiver listed in this table **ONLY** confirms that that the tanker and receiver are **TECHNICALLY** capable of pairing up and transferring fuel. See Annex ZH, para 3ZH for information about the **AUTHORITY** to conduct AAR.

KEY:
NONE = Compatibility Assessment Has Not Been Undertaken
UNSAT = Compatibility Assessment Deems Pairing is Hazardous or Impossible

CORRECT AS AT: FEB 10

COUNTRY	AIRCRAFT	KC-10 TECHNICAL COMPATIBILITY LETTERS	BOOM	CENTERLINE	WARP	KC-135 TECHNICAL COMPATIBILITY LETTERS	BOOM	BDA	MPRS	KC-45 TECHNICAL COMPATIBILITY LETTERS	BOOM	TBD	TBD
ARGENTINA	TA/A-4AR	NONE				ASC/ENFA 28 OCT 05		X					
AUSTRIA	Eurofighter/ Typhoon	NONE				NONE							
AUSTRALIA	F/A-18A/B	ASC/ENFA 2 APR 02		X	X	ASC/ENFA 2 APR 02		X	X				
	F/RF-111C	ASC/ENFA 11 JUL 02	X			ASC/ENFA 11 JUL 02	X						
	C-17A	NONE				NONE							
	E-737	NONE				NONE							
	KC-30A	NONE				NONE							
BAHRAIN	F-16E/F	ASC/ENFA 12 AUG 02	X			ASC/ENFA 12 AUG 02	X						
BELGIUM	F-16A/B	AMC 21 JAN 03	X			AMC 21 JAN 03	X						
BRAZIL	F-5E/F	ASC/ENFA 12 OCT 07		X	X	NONE							
	Mirage 2000	NONE				NONE							
	AMX	NONE				NONE							
	TA/A-4KU	NONE				NONE							
CANADA	CF-18	ASC/ENFA 15 JUN 09		X	X	ASC/ENFA 15 JUN 09		X	X				
	C-17	NONE				NONE							
CHILE	F-16C/D	ASC/ENFA 17 MAR 08	X			ASC/ENFA 17 MAR 08	X						
	F-16AM	NONE				NONE							
	CF-5	ASC/ENFA 15 SEP 05		X	X	ASC/ENFA 15 SEP 05		X					
CZECH REPUBLIC	Gripen	NONE				NONE							
DENMARK	F-16A/B	AMC 4 APR 03	X			AMC 4 APR 03	X						
EGYPT	F-16A-D	ASC/ENFA 28 AUG 97	X			ASC/ENFA 28 AUG 07	X						
	F-4E	ASC/ENFA 28 AUG 97	X			ASC/ENFA 28 AUG 97	X						
	Mirage 2000	ASC/ENFA 12 SEP 07		X	X	ASC/ENFA 12 SEP 07		X	X				
FINLAND	F/A-18C/D	ASC/ENFA 1 MAY 08		X	X	ASC/ENFA 1 MAY 08		X	X				
FRANCE	E-3F	ASC/ENFA 28 APR 05	X			ASD/ENFEF 3 May 90	X						
	Mirage F1	ASC/ENFA 13 AUG 09		X	X	ASC/ENFA 13 AUG 09		X	X				
	Mirage 2000	ASC/ENFA 12 SEP 07		X	X	ASC/ENFA 12 SEP 07		X	X				
	Rafale	ASC/ENFA 28 JAN 08		X	X	ASC/ENFA 10 FEB 07		X	X				
	Super Entendard	ASC/ENFA 10 JAN 02		X	X	NONE							

QUINQUENNIEL REVIEW

NON-USA RECEIVER TECHNICAL COMPATIBILITY APPROVALS PUBLISHED IN THIS FIGURE WILL AUTOMATICALLY LAPSE WITH THE SUMMER 2011 RELEASE OF ANNEX ZE

TO UPDATE A RECEIVER'S TECHNICAL COMPATIBILITY, RECEIVER NATIONS MUST COMPLY WITH THE INSTRUCTIONS DETAILED IN ANNEX ZH, PARAS 15ZH THRU 19ZH

AAR COMPATIBLE COMMERCIAL AND FOREIGN MILITARY RECEIVERS KC-10, KC-135, AND KC-45 TANKERS

NOTE: AAR compatibility for a non-US receiver listed in this table **ONLY** confirms that that the tanker and receiver are **TECHNICALLY** capable of pairing up and transferring fuel. See Annex ZH, para 3ZH for information about the **AUTHORITY** to conduct AAR.

KEY:
NONE = Compatibility Assessment Has Not Been Undertaken
UNSAT = Compatibility Assessment Deems Pairing is Hazardous or Impossible

CORRECT AS AT: FEB 10

COUNTRY	AIRCRAFT	KC-10 TECHNICAL COMPATIBILITY LETTERS	BOOM	CENTERLINE	WARP	KC-135 TECHNICAL COMPATIBILITY LETTERS	BOOM	BDA	MPRS	KC-45 TECHNICAL COMPATIBILITY LETTERS	BOOM	TBD	TBD
GERMANY	F-4F	ASC/ENFA 4 OCT 07	X			ASC/ENFA 4 OCT 07	X						
	Tornado IDS/ECR	ASC/ENFA 3 NOV 97		X		ASC/ENFA 3 NOV 97		X	X				
	Eurofighter/ Typhoon	NONE				NONE							
GREECE	RF/F-4E	NONE				NONE							
	F-16C/D	ASC/ENFA 24 AUG 07	X			ASC/ENFA 24 AUG 07	X						
HUNGARY	Gripen	ASC/ENFA 13 APR 09		X	X	ASC/ENFA 13 APR 09			X				
INDIA	Jaguar	NONE				NONE							
ISRAEL	F-16A /B/C/D/I	ASC/ENFA 6 SEP 90	X			ASC/ENFA 6 SEP 90	X						
	F-15D/I	ASC/ENFA 19 AUG 04	X			ASC/ENFA 19 AUG 04	X						
	A-4H/N	NONE				NONE							
ITALY	Tornado IDS/ECR	ASC/ENFA 7 JAN 91		X		ASC/ENFA 7 JAN 91		X	X				
	F-16A/B	ASC/ENFA 22 SEP 05	X			ASC/ENFA 22 SEP 05	X						
	AMX	ASC/ENFA 15 JUN 09		X	X	ASC/ENFA 15 JUN 09		X	X				
	AV-8B	ASC/ENFA 6 Dec 07		X	X	ASC/ENFA 6 Dec 07			X				
	Eurofighter/ Typhoon	NONE				NONE							
	KC-767A	NONE				NONE							
JAPAN	F-15J/DJ	ASC/ENFA 9 APR 03	X			ASC/ENFA 9 APR 03	X						
	E-767	NONE				NONE							
	K-767	NONE				NONE							
	F-2	NONE				UNSAT							
	RF/F-4EJ	NONE				NONE							
Jordan	F-16A/B	ASC/ENFA 31 AUG 09	X			ASC/ENFA 31 AUG 09	X						
KOREA	F-4E	NONE				NONE							
	F-15K	NONE				NONE							
	F-16C/D	NONE				NONE							
	E-737	NONE				NONE							
KUWAIT	F/A-18C/D	12 MAY 09		X	X	12 MAY 09		X	X				
NATO	E-3A	ASC/ENFA 12 DEC 08	X			ASC/ENFA 12 DEC 08	X						
	C-49A (NTCA)	ASD/ENFA 1 JUL 91	X			ASD/ENFA 1 JUL 91	X						
	C-17A	ASC/ENFA 12 JUN 09	X			ASC/ENFA 12 JUN 09	X						
NETHERLANDS	F-16A/C	ASC/ENFA 21 JAN 03	X			ASC/ENFA 21 JAN 03	X						

QUINQUENNIEL REVIEW

NON-USA RECEIVER TECHNICAL COMPATIBILITY APPROVALS PUBLISHED IN THIS FIGURE WILL AUTOMATICALLY LAPSE WITH THE SUMMER 2011 RELEASE OF ANNEX ZE

TO UPDATE A RECEIVER'S TECHNICAL COMPATIBILITY, RECEIVER NATIONS MUST COMPLY WITH THE INSTRUCTIONS DETAILED IN ANNEX ZH, PARAS 15ZH THRU 19ZH

AAR COMPATIBLE COMMERCIAL AND FOREIGN MILITARY RECEIVERS KC-10, KC-135, AND KC-45 TANKERS

NOTE: AAR compatibility for a non-US receiver listed in this table **ONLY** confirms that that the tanker and receiver are **TECHNICALLY** capable of pairing up and transferring fuel. See Annex ZH, para 3ZH for information about the **AUTHORITY** to conduct AAR.

KEY:
NONE = Compatibility Assessment Has Not Been Undertaken
UNSAT = Compatibility Assessment Deems Pairing is Hazardous or Impossible

CORRECT AS AT: FEB 10

COUNTRY	AIRCRAFT	KC-10 TECHNICAL COMPATIBILITY LETTERS	BOOM	CENTERLINE	WARP	KC-135 TECHNICAL COMPATIBILITY LETTERS	BOOM	BDA	MPRS	KC-45 TECHNICAL COMPATIBILITY LETTERS	BOOM	TBD	TBD
NORWAY	F-16A/B	ASC/ENFA 18 AUG 04	X			ASC/ENFA 18 AUG 04	X						
OMAN	Hawk	ASC/ENFA 25 MAR 97			X	NONE							
	Jaguar	ASC/ENFA 2 MAR 98		X	X	ASC/ENFA 2 MAR 98		X	X				
	F-16C/D	NONE				NONE							
PAKISTAN	F-16A/B	ASC/ENFA 9 NOV 09	X			ASC/ENFA 9 NOV 09	X						
POLAND	F-16C/D	ASC/ENFA 20 FEB 07	X			ASC/ENFA 20 FEB 07	X						
PORTUGAL	F-16A/B	ASC/ENFA 12 JUL 04	X			ASC/ENFA 12 JUL 04	X						
SAUDI ARABIA	F-15S	ASC/ENFA 28 NOV 05	X			ASC/ENFA 28 NOV 05	X						
	KE-3	NONE				NONE							
	Eurofighter/ Typhoon	NONE				NONE							
	KC-30B	NONE				NONE							
SINGAPORE	F-15SG	ASC/ENFA 16 JUN 09	X			ASC/ENFA 16 JUN 09	X						
	F-16A/B	ASC/ENFA 12 JAN 91	X			ASC/ENFA 12 JAN 91	X						
SOUTH AFRICA	Gripen	NONE				NONE							
SPAIN	EF-18A/B	ASC/ENFA 29 JUL 02		X	X	ASC/ENFA 29 JUL 02		X	X				
	AV-8B	ASC/ENFA 6 Dec 07		X	X	ASC/ENFA 6 Dec 07			X				
	Eurofighter/ Typhoon	NONE				NONE							
SWEDEN	Gripen	ASC/ENFA 13 APR 09		X	X	ASC/ENFA 13 APR 09			X				
THAILAND	F-16A/B	ASC/ENFA 16 JAN 03	X			ASC/ENFA 16 JAN 03	X						
	AV-8A	NONE				NONE							
TURKEY	F-16C/D	ASC/ENFA 21 MAR 03	X			ASC/ENFA 21 MAR 03	X						
	F-4E	NONE				NONE							
	E-737	NONE				NONE							
UAE	Mirage 2000	ASC/ENFA 12 SEP 07		X	X	ASC/ENFA 12 SEP 07		X	X				
	F-16E/F	ASC/ENFA 24 JAN 08	X			ASC/ENFA 24 JAN 08	X						
	KC-30A	NONE				NONE							
UK	Tornado F3 ADV, GR-4	ASC/ENFA 7 NOV 08		X	X	ASC/ENFA 7 NOV 08		X	X				
	E-3D	ASC/ENFA 22 MAR 05	X			ASC/ENFA 3 MAY 90	X						
	RAF Harrier (GR-7)	NASC 28 MAR 00		X	X	NASC 28 MAR 00			X				
	Eurofighter/ Typhoon	NONE				NONE							
	C-17A	NONE				NONE							

LIST OF EFFECTIVE PAGES TO PART 5, ANNEX ZE, ATP-56(B)

PAGE NUMBERS	EFFECTIVE PAGES
ZE-1 to ZE-1-1	Nov 08
ZE-1-2 to ZE-1-4	Feb 10
ZE-2-1	Nov 08
ZE-2-2 to ZE-2-3	Feb 10
ZE-2-4 to ZE-3-1	Nov 08
ZE-3-2 to ZE-3-3	Feb 10
ZE-3-4	Nov 08
ZE-4-1	Jul 09
ZE-4-2 to ZE-5-5	Nov 08
ZE 5-6 to ZE-5-7	Jul 09
ZE-5-8 to ZE-5-31	Nov 08
ZE-5-32 to ZE-5-33	Feb 10
ZE-5-34 to ZE-5-41	Nov 08
ZE-5-42	Jul 09
ZE-5-43 to ZE-5-45	Nov 08
ZE-5-46	Aug 09
ZE-5-47	Nov 08
ZE-5-48 to ZE-5-49	Jul 09
ZE-5-50 to ZE-5-52	Nov 08
ZE-6-1 to ZE-6-4	Feb 10
LEP-5-ZE-1	Feb 10
LEP-5-ZE-2	Nov 08

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PART 5 – NATIONAL ANNEX

ANNEX ZF - USA

COMMERCIALLY AND FOREIGN MILITARY OPERATED TANKERS TECHNICALLY COMPATIBLE WITH USAF AAR RECEIVERS

1ZF Requirement for an AAR Compatibility Review. Before participating in AAR activity with a commercial or foreign military tanker, both the tanker and receiver platforms must be reviewed by a competent technical authority to ensure that they are technically compatible with the other participant. Importantly, commercial and foreign military tankers that are derivatives of in-use US tankers still require a technical compatibility review by the USAF receiver's technical authority and the subsequent publication by the latter of a certifying letter. The absence of such a letter indicates that an AAR technical compatibility review has not been conducted and therefore AAR between the USAF receiver and the commercial or foreign military tanker should not be undertaken.

2ZF AAR Compatibility Criteria. Compatibility reviews include, but are not limited to: an assessment of the impact that the tanker has on the receiver's fuel system (fuel flow rates, backpressures, safety features etc) as well as other features that impact AAR (eg tanker lighting/markings and the addition or removal of aircraft aerials (antennas).

3ZF Request for AAR Compatibility Review – Commercial and Foreign Military Tankers.
Receiver operators requesting an AAR compatibility review should comply with the instructions in ATP-56, Part 5, Annex ZH

4ZF Publication of Information Resulting from an AAR Compatibility Review. Confirmation that a technical compatibility assessment has been conducted and found to be satisfactory by the appropriate USAF receiver technical authority is published in Figures ZF-1 (USAF boom receivers) and Figure ZF-2 (USAF and USA probe and drogue receivers). Through this, the technical authority confirms that the combination of commercial or foreign military tanker and USAF receiver has been reviewed and deemed compatible, this includes any tanker modification significant to AAR. Where necessary, recommended procedural or technique changes necessary to ensure safe AAR are included in the tables. Additionally, information is provided on the date of the review and the technical authority that conducted the review.

5ZF Receiver Crew – AAR Currency. Prior to undertaking AAR with a commercial or foreign military tanker, USAF crews must be qualified and current in accordance with the most restrictive of either the USAF requirements or the requirements of the tanker operator. Normally, tanker operators publish their receiver currency requirements in the appropriate National Annex to ATP-56. When this information is not published, receiver crews are responsible to liaising with the tanker crews to ascertain the tanker operator's requirements.

Figure ZF-1 Commercial and Foreign Military Tankers Technically Compatible with USAF AAR Receivers - Boom

AAR COMPATIBLE COMMERCIAL AND FOREIGN MILITARY BOOM TANKERS

NOTE: AAR compatibility for a non-US tanker listed in this table **ONLY** confirms that that the tanker and receiver are **TECHNICALLY** capable of pairing up and transferring fuel.
See Annex ZH, para 3ZH for information about the **AUTHORITY** to conduct AAR.

KEY:
NONE = Compatibility Assessment Has Not Been Undertaken
UNSAT = Compatibility Assessment Deems Pairing is Hazardous or Impossible

CORRECT AS AT: JUL 09	COUNTRY	AUSTRALIA	FRANCE	ITALY	JAPAN	NETHERLANDS	SAUDI ARABIA	SINGAPORE	TURKEY	UAE
	AIRCRAFT	KC-30	C-135R	KC-767	KC-767	KDC-10	KC-30	KC-135 ❶	KC-135	KC-30
MOBILITY AIR FORCE	C-5	NONE	NONE	NONE	NONE	NONE	NONE	ASC/ENFA 4 Feb 09	NONE	NONE
	C-17	NONE	NONE	NONE	NONE	NONE	NONE	ASC/ENFA 4 Feb 09	NONE	NONE
	KC-10	NONE	NONE	NONE	NONE	ASC/ENFA 16 Apr 02 OEF ONLY	NONE	ASC/ENFA 4 Feb 09	NONE	NONE
	KC-45	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	KC-135	NONE	NONE	NONE	NONE	NONE	NONE	ASC/ENFA 4 Feb 09	NONE	NONE
	VC-25	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
COMBAT AIR FORCE	A-10	NONE	ASC/ENFA 8 Jun 05	NONE	NONE	NONE	NONE	ASC/ENFA 22 Jun 09	NONE	NONE
	B-1B	NONE	NONE	NONE	NONE	NONE	NONE	ASC/ENFA 22 Jun 09	NONE	NONE
	B-2A	NONE	NONE	NONE	NONE	NONE	NONE	ASC/ENFA 22 Jun 09	NONE	NONE
	B-52	NONE	NONE	NONE	NONE	NONE	NONE	ASC/ENFA 22 Jun 09	NONE	NONE
	E-3/ E-8	NONE	NONE	NONE	NONE	NONE	NONE	ASC/ENFA 22 Jun 09	NONE	NONE
	F-15	NONE	NONE	NONE	NONE	NONE	NONE	ASC/ENFA 16 Mar 09	NONE	NONE
	F-16	NONE	NONE	NONE	NONE	NONE	NONE	ASC/ENFA 16 Mar 09	NONE	NONE
	F-22	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	HC-130	NONE	NONE	NONE	NONE	NONE	NONE	ASC/ENFA 16 Mar 09	NONE	NONE
AFSOC	AC-130H/U	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	MC-130	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE

NOTES:
❶ Equipped only with IFF Mode 1,2, 3/A, C, and S capability.

IMPORTANT
Ensure that the Foreign Tanker is still cleared to deliver fuel to the US receiver by consulting the appropriate tanker National Annex (see http://www.raf.mod.uk/downloads/atp56bpart5.cfm)

Figure ZF-2 Commercial and Foreign Military Tankers Technically Compatible with US AAR Receivers - Probe and Drogue

AAR COMPATIBLE COMMERCIAL AND FOREIGN MILITARY DROGUE TANKERS

NOTE: An AAR clearance for a non-US tanker listed in this table **ONLY** confirms that that the tanker and receiver are **TECHNICALLY** capable of pairing up and transferring fuel.
See Annex ZH, para 3ZH for information about the **AUTHORITY** to conduct AAR.

KEY:
NONE = Compatibility Assessment Has Not Been Undertaken
UNSAT = Compatibility Assessment Deems Pairing is Hazardous or Impossible

CORRECT AS AT: OCT 08	COUNTRY	AUSTRALIA	CANADA	FRANCE	GERMANY	ITALY	ITALY	SPAIN	SWEDEN	UNITED KINGDOM	UNITED KINGDOM
	AIRCRAFT	KC-30B	CC-150 POLARIS	C-160 TRANSALL	AIRBUS A310 MRTT	KC-767A	C-130J	KC130H	TP 84T (C-130E)	TRISTAR	VC-10K3 & K4
COMBAT AIR FORCE	MH-60G	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
AFSOC	CV-22	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
US ARMY	MH-60K	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	MH-60L	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE

IMPORTANT
Ensure that the Foreign Tanker is still cleared to deliver fuel to the US receiver by consulting the appropriate tanker National Annex (see http://www.raf.mod.uk/downloads/atp56bpart5.cfm)

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LIST OF EFFECTIVE PAGES TO PART 5, ANNEX ZF, ATP-56(B)

PAGE NUMBERS	EFFECTIVE PAGES
ZF-1 to ZF-3	Feb 10
ZF-4	Nov 08
LEP-5-ZF-1	Feb 10
LEP-5-ZF-2	Nov 08

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PART 5 – NATIONAL ANNEX

ANNEX ZI - USA

AAR QUALIFICATION AND CURRENCY – NON-USA AIRCREW AGAINST USA PLATFORMS

1ZI Introduction. Normally, before attempting to undertake AAR with a USA tanker, non-USA national aircrew must be receiver qualified and current within their own military. Additionally, the receiver aircrew must have been briefed by a USA tanker qualified instructor on Boom/BDA/Drogue operations as applicable. As a minimum, this briefing will include: closure limitations, lighting schemes, procedures, possible difficulties and emergency actions. For AAR activity with USAF platforms, exceptions to this requirement will be addressed by Air Force A3O-AT at afa3oat.workflow@pentagon.af.mil.

2ZI Obtaining *Ab-Initio* AAR Receiver Qualification using USA Tankers - Non-USA National Aircrew. *Ab initio* training (ie training for a first ever AAR qualification) for AAR receiver qualifications using USAF tankers can only be undertaken following the completion of a Foreign Military Sales (FMS) case.

3ZI Maintaining AAR Currency using USA Tankers – Non-USA National Aircrew. For non-USA national aircrew wishing to maintain AAR receiver currency using USA tankers, the following requirements apply:

a. USAF Tankers. Details will be made available on a case by case basis either as prescribed in the appropriate nation to nation Implementing Arrangement, published in theatre SPINS or other formal agreement between the participating nations.

b. USN/USMC Tankers.

(1) Fixed Wing. After initial qualification, a pilot will be considered current for AAR activity if they have completed a minimum of 2 day and 2 night contacts in the last 90 days. Contacts may be against a drogue equipped tanker from any nation. Night currency is not required for day-only operations. Applicable aircraft/country flight manuals may set additional currency requirements.

(2) Helicopters. After initial qualification, a pilot will be considered current for AAR activity if they have completed a minimum of 2 day and 2 night contacts in the last 180 days. Night currency is not required for day-only operations. Applicable helicopter flight manuals may set additional currency requirements.

4ZI Re-Currency if AAR Currency has Lapsed. A qualified instructor (who may be in another aircraft) must monitor at least one re-qualifying flight to regain currency if AAR receiver currency of non-USA national aircrew has lapsed. The re-qualifying flight must be flown in a dual control aircraft (where the aircraft type has such a capability) with a qualified instructor on board if the receiver pilot has not had a contact in the previous 6 months.

LIST OF EFFECTIVE PAGES TO PART 5, ANNEX ZI, ATP-56(B)

PAGE NUMBERS	EFFECTIVE PAGES
ZI-1 to ZI-2 LEP-5-ZI-1 to LEP-5-ZI-2	Feb 10 Feb 10

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