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NAVAIR 00-80T-110

NATOPS AIR-TO-AIR REFUELING MANUAL NAVAIR 00-80T-110

**ISSUED BY AUTHORITY OF THE CHIEF OF NAVAL OPERATIONS
AND UNDER THE DIRECTION OF THE COMMANDER,
NAVAL AIR SYSTEMS COMMAND**

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NATEC ELECTRONIC MANUAL

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, D.C. 20350

1 October 1992

LETTER OF PROMULGATION

1. The Naval Air Training and Operating Procedures Standardization (NATOPS) Program is a positive approach toward improving combat readiness and achieving a substantial reduction in the aircraft mishap rate. Standardization, based on professional knowledge and experience, provides the basis for development of an efficient and sound operational procedure. The standardization program is not planned to stifle individual initiative, but rather to aid the commanding officer in increasing the unit's combat potential without reducing command prestige or responsibility.

2. This manual standardizes ground and flight procedures but does not include tactical doctrine. Compliance with the stipulated manual procedure is mandatory except as authorized herein. In order to remain effective, NATOPS must be dynamic and stimulate rather than suppress individual thinking. Since aviation is a continuing, progressive profession, it is both desirable and necessary that new ideas and new techniques be expeditiously evaluated and incorporated if proven to be sound. To this end, commanding officers of aviation units are authorized to modify procedures contained herein, in accordance with the waiver provisions established by OPNAVINST 3710.7, for the purpose of assessing new ideas prior to initiating recommendations for permanent changes. This manual is prepared and kept current by the users in order to achieve maximum readiness and safety in the most efficient and economical manner. Should conflict exist between the training and operating procedures found in this manual and those found in other publications, this manual will govern.

3. Checklists and other pertinent extracts from this publication necessary to normal operations and training should be made and carried for use in naval aircraft.

R.D. MIXSON
Rear Admiral, U.S. Navy
Director, Air Warfare Division

Air-to-Air Refueling NATOPS Manual

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LIST OF ILLUSTRATIONS

RECORD OF CHANGES

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INTERIM CHANGE SUMMARY

The following Interim Changes have been canceled or previously incorporated in this manual:

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE
1 thru 3	Previously incorporated.

The following Interim Changes have been incorporated in this Change/Revision:

INTERIM CHANGE NUMBER	REMARKS/PURPOSE

Interim Changes Outstanding - To be maintained by the custodian of this manual:

INTERIM CHANGE NUMBER	ORIGINATOR/DATE (or DATE/TIME GROUP)	PAGES AFFECTED	REMARKS/PURPOSE

SUMMARY OF APPLICABLE TECHNICAL DIRECTIVES

Information relating to the following recent technical directives has been incorperated in this manual

CHANGE NUMBER	DESCRIPTION	DATE INC. IN MANUAL	VISUAL IDENTIFICATION

Information relating to the following recent technical directives will be incorporated in a future change

CHANGE NUMBER	DESCRIPTION	VISUAL IDENTIFICATION

GLOSSARY

A

abnormal hose. An other-than-normal hose condition that could result from hydraulic, electrical, or mechanical malfunctions of the in-flight refueling system. Refueling from an abnormal hose shall only be accomplished in an emergency situation and at the discretion of the refueling area commander (RAC). If hose response is lost and a "dead hose" condition exists, extreme caution shall be exercised by receiver aircraft in attaining a minimum closure rate until contact is made.

abort point. The geographical point along the refueling track where fuel transfer must be in progress or else the receiver must abort and divert.

AEW. Airborne early warning. (AWACS, E-2C)

airborne standby tanker. An airborne tanker stationed at a given location, on or near course, to refuel those aircraft that may require additional fuel because of in-flight emergencies or terminal weather conditions.

air refueling (A/R). The refueling of an aircraft in flight by another aircraft.

air refueling airspeed. An airspeed or Mach number at which air refueling will be initiated.

air refueling cell. Two or more tankers and/or receivers.

air refueling control point (ARCP). The planned geographic point over which the receiver arrives in the observation position with the assigned tanker.

air refueling control time (ARCT). The planned time that the receiver and tanker will arrive over the ARCP.

air refueling element. One tanker and one or more receivers.

air refueling envelope. The area limits behind the tanker within which the receiver must fly to remain in contact with the tanker.

air refueling exit point (A/R EXIT PT). The designated geographic point at which the refueling track terminates.

air refueling initial point (ARIP) (fighter). A point located upstream from the ARCP (inbound to ARCP) where the receivers can get a positive fix using the navigational aids available. (Time over ARIP is used to confirm or correct the ETA to the ARCP.)

air refueling range (fixed-wing aircraft). A 60-foot range with the hose extended approximately 20 to 80 feet.

air refueling range (helicopter). A 20-foot range with the hose extended approximately 56 to 76 feet.

air refueling rendezvous. The procedures employed to enable the receiver(s) to reach the precontact position behind the assigned tanker(s) by electronic, radio, and/or visual means. The basic types of rendezvous procedures are the point parallel, on-course, and en route. All other rendezvous procedures are modifications of the basic types.

air refueling rendezvous (helicopter). The procedures employed to enable the tanker to reach a position one-half nm behind the receiver at refueling altitude.

air refueling time. The planned elapsed time from the air refueling control point to the completion point.

air refueling track. A track designated for air refueling.

alternate air refueling control point. The prebriefed point where tanker and receiver are planned to effect rendezvous in the event that the primary point cannot be used.

alternate air refueling control time. The planned time that the receiver and tanker will arrive over the alternate air refueling control point.

alternate air refueling track. That track designated for air refueling in the event the primary track cannot be used.

altitude differential. The difference between the receiver altitude and the tanker altitude.

anchor point. A designated geographical point on the downstream end of the inbound course of the anchor refueling pattern.

anchor/random rendezvous. The procedure normally employed by radar (CRC/GCI/AWACS) to vector.

ARCP (Helicopter). The planned geographic point where the tanker will assume the lead.

AREP (AR Exit Point). The designated geographic point at which the refueling track terminates.

ARIP. The geographical point at which the receiver aircraft enters the refueling track (anchor), initiates radio contact with the tankers, and begins maneuver to RV.

ATP-56. NATO publication that addresses modes, commonality, and standards for inflight refueling of multination aircraft.

B

base altitude. A reference altitude at which lead aircraft of a tanker formation (or single aircraft for individual air refueling) will fly at initial contact.

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

bingo fuel (fighter) (helicopter). A predetermined receiver fuel quantity at which the receiver, if delayed, will have fuel to complete the mission as planned.

bingo time (helicopter). That time at which an aircraft must depart an area to permit recovery at a landing site.

breakaway. The command used by either tanker or receiver flight crewmembers to indicate the need for emergency disconnect and/or separation of aircraft.

buddy cruise. When tanker(s) and receiver(s) cruise as an air refueling element/cell.

buddy join-up procedure. These procedures are utilized when the tanker(s) and receiver(s) approach the ARIP 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/cell.

C

clear contact. terminology used by tanker that authorizes receiver to engage hose.

clear disconnect. Terminology used by tanker that authorizes receiver to disconnect from hose.

contact. That configuration in which the tankers and receivers are physically engaged and, if applicable, their respective electrical systems indicate a contact made condition.

contact point. The geographical point along the planned air refueling track where fuel transfer should commence.

D

dead hose. A hose condition caused by electrical, hydraulic, or mechanical failure of the refueling pod. When this condition exists, hose slack will not be taken up when contact is made by receiver aircraft.

descent air refueling. Air refueling during a descending flightpath ("toboggan").

descent point/range. That distance from the tanker(s) at which the receiver(s) desires to initiate.

disconnect. When tanker and receiver separate from air refueling contact; also a command to separate, but not warranting a breakaway.

E

emission control. The following emission control options are listed for each individual to choose from:

1. Emission option 1 (USAF). Any and all emitters are authorized to ensure timely training/ feedback and maximum safety; emission 1 is used for initial qualification, requalification, category qualification, and difference training for tanker or receiver units.

2. Emission option 2 (USAF) (restricted communications). Radio silent formation except for rendezvous and air refueling conducted with only two radio exchanges. Fifty minutes prior to the rendezvous/ ARCT, the receivers(s) will advise the tanker of

call sign(s), changes in timing (if applicable), receiver altitude, and hot armament check (if applicable). Example: "Tank 32, 6 minutes late, FL 260." Tankers/receivers will use the adjusted ARCT established during the 15-minute call. If either the tanker or the receiver is not at the planned rendezvous altitude at the 15-minute call, an additional call is required as soon as the aircraft is at the altitude. An abbreviated precontact radio check is required as the receiver closes to precontact. At this time, the boom operator will transmit numerical call signs only (e.g., "25, 23" and the receiver will respond, "25"). If this check cannot be completed, refueling will not be accomplished unless mission priority or receiver emergency fuel status dictates. Receivers will not depart precontact until either this radio check is accomplished or visual signs direct approach to contact. Emission option 2 is the desired standard for daily air refueling operations. More restrictive procedures under emission option 2 will be fully coordinated between tanker and receiver units. In an emergency/abnormal condition (KC-10), the tanker/receiver may transmit over air refueling frequency.

3. Emission option 3 (communications out). Radio silent operations including formation, rendezvous, and refueling. The use of other emitters is authorized unless prohibited by supported operations, plans, etc.

4. Emission option 4 (emission out). No emitters will be used unless specifically authorized by the plan supported. This includes radios, Doppler, radio navigation transmitters, radar, radio altimeters, IFF, exterior lighting, etc. This option will not be practiced during peacetime operations unless specifically tasked by NAF or higher headquarters.

emitter. A piece of equipment that emits electromagnetic radiation (radio, radar, tacan, IFF Doppler, radio altimeter, etc.).

en route cell formation (KC-135/KC-10A). Two or more tankers in trail, 1-nm separation, and stacked up 500-foot intervals.

end of air refueling (ENDAR). The planned geographical point at which air refueling should be completed and at which the receiver should disengage from the tanker to continue its mission.

H

head-on rendezvous (KC-130/helicopters). The procedure normally used when the tanker aircraft approaches the receiver on the reciprocal of the refueling track and makes a procedure turn. No orbit is utilized.

J

join-up (helicopter). Those procedures employed to enable the tanker to assume formation lead and the receiver to assume observation position.

join-up altitude (helicopter). Using helicopter high procedures, a procedure 200 feet above refueling altitude. Using helicopter low procedures, a position 300 feet below refueling altitude. In a helicopter formation, the highest helicopter will be at least 200 feet below refueling altitude.

judy. A call made by the receiver to the tanker meaning the receiver has radar contact on the tanker.

M

mixed air refueling cell. Two or more tankers refueling two or more dissimilar types of aircraft simultaneously.

modified point parallel rendezvous. A rendezvous procedure optionally employed when the receiver aircraft is established on-station in command-and-control orbit or airspace patrol. The tanker enters the area, effects the rendezvous, and completes the refueling within the confines of receiver's assigned airspace.

movement control officer. A mission commander specifically designated to coordinate both tanker and receiver forces.

O

observation position

1. Helicopter. A position to the left or right of the tanker and outboard of the wingtip stand slightly above and behind the tanker horizontal stabilizer where the receivers fly while observing or awaiting air refueling.

2. Fighter. A position to the right and/or left and slightly behind the tanker wing with a minimum of one receiver wingspan clearance between tanker and receiver, weather permitting.

3. The observation position will be referred to as either "left observation" or "right observation" by the controlling agency and/or aircraft.

offload/onload. The amount of fuel transferred between tankers and receivers.

offset (track). The lateral distance the tanker is displaced from the ARIP to ARCP track to compensate for turn radius and drift.

overrun

1. Rendezvous. An overrun when the receiver passes the tanker prior to or during the tanker rendezvous turn.

2. Closure. An overrun when the receiver's closure rate prevents stabilizing in the precontact position or when forward movement of the receiver is considered excessive during contact on approach to contact.

overtaking point parallel rendezvous (C-130). Same as point parallel rendezvous except tanker plans to turn to refueling 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 1 mile in front of the receiver at air refueling airspeed.

P

positive control. The state of control of aircraft when two-way radio communication is established, radar contact is plotted, and the receivers are following orders from the controller. Safety of the aircraft is the responsibility of the controller, and receivers must be informed when control is less than positive.

point parallel rendezvous procedures. The procedure normally used when the tanker arrives in the refueling area ahead of the receiver (a tanker orbit is normally planned).

postair refueling procedures. The procedures employed by tankers and receivers after final disconnect and prior to establishing cruise.

practice separation. The term to be used by tanker and receiver aircrews when referring to a practice breakaway and prior to accomplishing the maneuver.

precontact (ready) position

1. Boom and receptacle. The position approximately 50 feet behind and slightly below the tanker boom nozzle where the receiver stabilizes before being cleared to the contact position.

2. Probe and drogue. The position where the probe is approximately 5 feet directly aft of the drogue.

3. Helicopter. A position behind the paradrogue and slightly below the tanker wing where the receiver stabilizes before attempting contact.

4. For aircraft with two refueling drogues such as the KC-130, the precontact position will be referred to as either "left precontact" or "right precontact" vice "port" or "starboard".

primary rendezvous. A point parallel rendezvous accomplished with the tanker maintaining an appropriate offset, the receiver flying the ARIP to ARCP track, and the tanker turning in front of the receiver at a computed range. Tanker offset is maintained with INS/DNS information and turn range is determined by A/A TACAN DME.

R

receiver force. The organization to be refueled in flight.

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 rendezvous by the tanker. This point is used during anchor refueling alternate procedures.

receiver observation position. A position to the right or left, above and behind the tanker formation, well clear of refueling operations. It is normally used as a loiter position when receiver aircraft outnumber refueling hoses available.

receiver reform area (fixed wing). An area to the left or right and slightly below the tanker formations where receiver aircraft reform upon completion of air refueling.

receiver reform area (helicopter). An area to the left and slightly above the tanker formation where receiver aircraft reform upon completion of air refueling.

receiver serial. The unit of receivers scheduled to arrive at the ARCP at a given time.

receiver/tanker route formation. Receivers positioned on the tanker with two or four receivers wingspan clearance.

refueling altitude. The tanker altitude during the join-up and fuel transfer stages.

refueling area commander (RAC). A tanker commander specifically designated to command the air refueling operation in a specified air refueling area.

refueling position (helicopter). A position directly aft of the tanker's wingtip jettison mast taken by the receiver after drogue engagement.

refueling heading. A magnetic/grid heading taken by the tanker and receivers to maintain ARCP-E and A/R TRACK.

rendezvous altitude. The tanker altitude during the rendezvous stage that is 1,000 feet above or below the receiver's join-up altitude.

rendezvous control time. A general term that applies to any control time utilized for accomplishing a rendezvous between tanker and receivers at a specific point (i.e., at the ARCP, RZ, RZIP, etc.).

rendezvous controller (RC). The agency designated to provide rendezvous control of air refueling in a specific air refueling area. Rendezvous control may be provided by a tanker with integral rendezvous capability or by other suitable means (e.g., GCI equipment or AEW aircraft).

rendezvous equipment. Electronic radio equipment installed in tankers and receivers for use in accomplishing a rendezvous.

rendezvous initial point (RZIP). A planned geographical point prior to ARCP at which join-up is initiated by starting descent at the scheduled rendezvous control time.

rendezvous point. A general term that applies to any planned geographical point where a join-up between two or more aircraft is accomplished (i.e., ARCP, RZIP, RZ, anchor point, etc.).

rendezvous rollout heading. A magnetic/grid heading taken by the tanker(s) on the final turn toward the rendezvous point (ARCP, RZ, etc.) to maintain the receiver's inbound track.

RZ. Identifier for geographic point at which join-up is initiated by starting descent at the scheduled rendezvous control time.

S

safe position (KC-10). The position during a partial or complete boom control system failure that it 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.

stabilized precontact position. See precontact position.

static refueling. Refueling performed as tankers maintain a prescribed pattern that is anchored to a geographical point or fix.

T

tactical air control system. This may be any CRC, GCI, or AWACS control system.

tactical stream. Two or more air refueling elements/cells preceding at a predetermined spacing along identical flightpaths.

tallyho. The word announced by the receiver or tanker pilot upon visual sighting of the other aircraft.

tanker cell. The unit of tankers at a given ARCP.

tanker force. The organization that provides tanker aircraft.

tanker orbit point. A geographical point along the planned air refueling track where the tanker will orbit.

toboggan. The word announced by a receiver pilot indicating to the tanker pilot to commence a predetermined rate of descent or to increase the rate of descent.

turn range. The distance used to determine the tanker start turnpoint and is measured directly from aircraft to aircraft.

U

universal aerial refueling receptacle slipway installation (UARRSI). A modular aerial refueling unit incorporating an aerial refueling receptacle and slipway to guide the tanker boom nozzle into the receptacle. (This system has boom interphone capability.)

LIST OF ABBREVIATIONS/ACRONYMS

A

ACP. Allied communication publication.

ADF. Automatic direction finder.

AEW. Airborne early warning.

AGL. Above ground level.

AI. Air intercept.

AR. Air refueling.

ARCP. Air refueling control point.

ARCT. Air refueling control time.

ARIP. Air refueling initial point.

ARTC. Air route traffic control.

ARTCC. Air route traffic control center.

D

DF. Direction finder(ing).

DME. Distance measuring equipment.

E

EMCON. Emission control.

ETA. Estimated time of arrival.

ETE. Estimated time en route.

F

FAA. Federal Aviation Administration.

fpm. Feet per minute.

G

GCI. Ground-controlled intercept.

gpm. Gallons per minute.

H

HF. High frequency.

I

ICAO. International Civil Aviation Organization.

IFF. Identification friend or foe.

IFR. In-flight refueling.

IMC. Instrument meteorological conditions.

ISA. Interservice support agreement.

J

JANAP. Joint Army, Navy, Air Force publication.

K

KCAS. Knots calibrated airspeed.

KIAS. Knots indicated airspeed.

N

nm. Nautical mile(s).

NORDO. No radio.

P

ppm. Pounds per minute.

psi. Pounds per square inch.

R

RAC. Refueling air commander.

RC. Rendezvous controller.

RZ. Rendezvous point.

S

SAR. Search and rescue.

SIF. Selective identification feature.

T

tacan. Tactical air navigation.

U

UHF. Ultrahigh frequency.

V

VFR. Visual flight rules.

VHF. Very high frequency.

VMC. Visual meteorological conditions.

W

WARPS. Wing aerial refueling pod system.

PREFACE

SCOPE

This NATOPS manual is issued by the authority of the Chief of Naval Operations and under the direction of Commander, Naval Air Systems Command in conjunction with the naval air training and operating procedures standardization (NATOPS) program. It provides the best available operating instructions for most circumstances, but no manual is a substitute for sound judgment. Multiple emergencies, adverse weather, or terrain may require modification of the procedures contained herein. When modifications are required to successfully, safely, and orderly complete the mission, the modifications shall be briefed. Read this manual from cover to cover. It's your responsibility to have complete knowledge of its contents.

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UPDATING THE MANUAL

To ensure that the manual contains the latest procedures and information, NATOPS review conferences are held in accordance with OPNAVINST 3710.7 series.

CHANGE RECOMMENDATIONS

Recommended changes to this manual or other NATOPS publications may be submitted by anyone in accordance with OPNAVINST 3710.7 series.

Routine change recommendations are submitted directly to the model manager on OPNAV Form 3710/6. The address of the model manager of this manual is:

Commanding Officer
Marine Aerial Refueler Transport
Squadron 352
MAG-11, 3d MAW, MARFORPAC
MCAS El Toro, Santa Ana, CA
92709-9008
Autovon: 997-6727

Change recommendations of an URGENT nature (safety of flight, etc.) should be submitted directly to the NATOPS advisory group member in the chain of command by priority message.

YOUR RESPONSIBILITY

NATOPS flight manuals are kept current through an active manual change program. Any corrections, additions, or constructive suggestions for improvement of its content should be submitted by routine or urgent change recommendations, as appropriate, at once.

NATOPS FLIGHT MANUAL INTERIM CHANGES

Flight manual interim changes are changes or corrections to the NATOPS flight manual promulgated by CNO or NAVAIRSYSCOM. Interim changes are issued either as printed pages or as a naval message. The interim change summary page is provided as a record of all interim changes. Upon receipt of a change or revision, the custodian of the manual should check the updated interim change summary to ascertain that all outstanding interim changes have been either incorporated or canceled; those not incorporated shall be recorded as outstanding in the section provided.

CHANGE SYMBOLS

Revised text is indicated by a black vertical line in either margin of the page, like the one printed next to this paragraph. The change symbol shows where there has been a change. The change might be material added or information restated. A change symbol in the margin by the chapter number and title indicates a new or completely revised chapter.

WARNINGS, CAUTIONS, AND NOTES

The following definitions apply to "WARNINGs," "CAUTIONs," and "Notes" found throughout the manual.

WARNING

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

CAUTION

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

Note

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

WORDING

The concept of word usage and intended meaning that has been adhered to in preparing this manual is as follows:

"Shall" has been used only when application of a procedure is mandatory.

"Should" has been used only when application of a procedure is recommended.

"May" and "need not" have been used only when application of a procedure is optional.

"Will" has been used only to indicate futurity, never to indicate any degree of requirement for application of a procedure.

NATOPS/TACTICAL CHANGE RECOMMENDATION
OPNAV 3710/6 (4-90) S/N 0107-LF-009-7900

DATE _____

TO BE FILLED IN BY ORIGINATOR AND FORWARDED TO MODEL MANAGER

FROM (originator)	Unit
TO (Model Manager)	Unit

Complete Name of Manual/Checklist	Revision Date	Change Date	Section/Chapter	Page	Paragraph

Recommendation (be specific)

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Justification

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(a) Your Change Recommendation Dated _____

☐ Your change recommendation dated _____ is acknowledged. It will be held for action of the review conference planned for _____ to be held at _____

☐ Your change recommendation is reclassified URGENT and forwarded for approval to _____ by my DTG _____

/S/_____ MODEL MANAGER | _____ AIRCRAFT

CHAPTER 1

General Information

1.1 INTRODUCTION

This manual provides receiver pilots, tanker pilots, and planning staffs with a description of the refueling systems of multidrogue, multiengine aircraft configured for probe/drogue refueling and of tactical aircraft capable of being utilized as buddy tankers. Standard procedures for aerial refueling are outlined; no attempt is made to prescribe specific model receiver techniques to accomplish refueling contact since these procedures properly belong in the applicable NATOPS flight manual. The procedures outlined in this manual are directive in nature and apply to all units participating in refueling operations.

Air refueling requires exact procedures and precise timing. It may be accomplished at altitudes within the common performance capabilities of both receiver and tanker aircraft; however, minimum altitudes are 500 feet above ground level (AGL) during the day and 1,500 feet AGL at night. The commander responsible for planning an air refueling operation should know both tanker and receiver capabilities involved. Each tanker and receiver air crewmember shall be familiar with the procedures contained in this manual.

Commanders of units at all echelons shall ensure compliance with these procedures.

1.2 POLICY

Tanker-receiver training should be conducted so as to ensure that refueling operations can be carried out at the altitude consistent with aircraft limitations and operational considerations.

WARNING

The minimum altitude for all tanker evolutions (assigned stations, formations, rendezvous, engagements/disengagements, and departures) shall be 500 feet AGL during the day and 1,500 feet AGL at night.

Aerial refueling over densely populated areas should be avoided whenever possible because of the possibility of fuel and/or other material falling from the aircraft during refueling operations.

1.3 TRAINING

Aerial refueling training will be conducted in accordance with this manual and the provisions of the applicable flight manual. Before refueling training flights are scheduled, receiver pilots will be thoroughly briefed on procedures, techniques, communications, and emergency provisions.

Close coordination between tanker and receiver units is necessary to ensure that proper fuel loads are aboard tanker aircraft. Both wet and dry sorties may be scheduled during any refueling period. An adequate number of receivers will be scheduled so as to achieve maximum utilization of the tanker on station. Receiver pilots shall be considered qualified in aerial refueling for transoceanic flights when the move from observation position to preconnect position is consistently accomplished in 5 minutes or less, and the move from the stabilized position to engagement with fuel flowing is completed in 5 minutes or less. These criteria are in addition to specific numbers of wet or dry engagements that may be required by this or other publications.

Transoceanic flights by mass receiver formations are closely timed. Accordingly, receiver units shall schedule their best qualified pilots for these flights and shall not utilize a transoceanic flight as a means of increasing levels of pilot skill in refueling or to attain other training goals.

1.4 QUALIFICATIONS

1.4.1 Fixed Wing. The following minimum initial qualification criteria shall be met by all fixed-wing pilots.

1. Day: A total of six plugs with a minimum of two initial approaches to the basket. An initial approach

is defined as commencing from the observation position on the tanker and making a successful contact and withdrawal from the basket.

2. Night: Same requirements as day. Day initial qualifications shall be completed before night qualifications are attempted.

After initial qualification, a pilot will be considered current for deployment involving refueling operations if he has completed a minimum of 2 day and 2 night plugs in the last 90 days. Night currency is not required for day-only operations. Applicable aircraft NATOPS flight manuals may set additional currency requirements.

1.4.2 Helicopter. The following minimum initial qualification criteria shall be met by all helicopter pilots:

1. Day: At least one rendezvous and join-up with a total of three day plugs.

2. Night: Same requirements as day. Day initial qualifications shall be completed before night qualifications are attempted.

After initial qualification, a pilot will be considered current for deployment involving refueling operations if he has completed a minimum of 2 day and 2 night plugs in the last 180 days. Night currency is not required for day-only operations. Applicable helicopter NATOPS flight manuals may set additional currency requirements.

1.4.3 USAF KC-135/KC-10 Tanker Qualification. The U.S. Navy/U.S. Air Force interservice support agreement (ISA), dated 24 October 1983, prescribes currency requirements for use of USAF tanker assets by Navy/Marine Corps aircraft as follows:

1. Case One: To refuel from a USAF tanker, a naval aviator shall be NATOPS, instrument, and air refueling qualified for type aircraft.

2. Case Two: To refuel from a USAF tanker for transoceanic missions, a pilot must meet the requirements of Case 1 and have at least 1 plug on a KC-10, a KC-135, or a KC-135 tanker within 90 days. If a transoceanic mission is to be conducted with a KC-135, a KC-135 must be used for qualification. If the mission is to be conducted with a KC-10, qualification on a KC-10, a KC-135, or a KC-130 is required within 90 days and qualification is required on a KC-10 within the last 12 months. If a transoceanic mission includes night refueling, a minimum of one night plug within 90 days on a KC-10, a KC-135, or a KC-130 is required. If a transoceanic mission includes night refueling from a KC-135, a KC-135 must be used for qualification. If the mission includes night refueling from a KC-10, a KC-135 or a KC-130 is required within 90 days, and qualification on a KC-10 is required within the last 12 months.

3. Case Three: To refuel from a USAF tanker for contingency operations, a pilot must meet the requirements of Case 1 and have at least 2 plugs with a USAF tanker within the last 12 months.

Revisions to the interservice support agreement may change USAF tanker qualification requirements.

1.4.4 KC-10 Wing Aerial Refueling Pod System (WARPS). The United States Air Force has developed a WARPS for KC-10 aircraft. In consideration of successful qualification testing with Navy receiver aircraft, all Navy and Marine Corps aircraft currently authorized to refuel from the KC-10 centerline hose reel system are now authorized to refuel from the KC-10 WARPS in accordance with existing air refueling limits and restrictions of this manual and receiver aircraft NATOPS.

1.4.5 NATO Aircraft in Aerial Refueling. The following NATO aircraft may participate in aerial refueling, provided the requisite conditions have been met:

*1. KC-130

*2. KA-6

*3. All aircraft with aerial refueling store (ARS)

**4. Tornado PA-200

**5. Mirage 200 B/C

**6. Jaguar A/E

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* Respective receiver NATO aircraft limits and restrictions apply.
Tanker aircraft with MA-3 coupling must have part number 60381-2 incorporated.
KA-6D tanker aircraft must have hose-end pressure regulator.
Prior to each NATO refueling procedures, capabilities, limitations, and restrictions shall be thoroughly briefed and understood by tanker and receiver aircrews.

** Authorized to provide up to maximum normally allowed aerial refueling load.

*** Authorized to provide up to 700 pounds less than maximum normally allowed aerial refueling load.

**7. Mirage F-1

***8. Mirage F-8

***9. Super Entendard.

1.4.6 Aerial Refueling. For aerial refueling operations conducted with NATO aircraft, procedures set forth in Allied Tactical Publication (ATP)-56 shall be followed. Terminology and procedural deviations exsist between this manual and the ATP-56.

CHAPTER 2

KC-130 Tanker Capabilities and Procedures

2.1 DESCRIPTION OF SYSTEM

To refuel in flight from the KC-130 in the shortest possible time as safely as possible, receiver pilots should have a general knowledge of the construction, configuration, and operation of certain components of the KC-130 aerial refueling (AR) system. The following description of the refueling operation is from the viewpoint of the receiver pilot as he closes on the paradrogue from the precontact position.

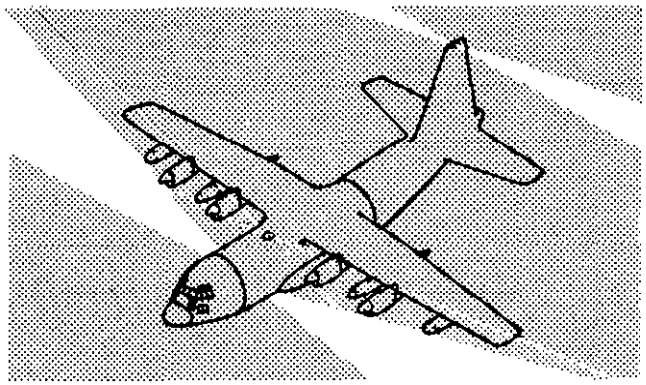
If all tanker refueling systems are functioning properly, the tanker will have two hoses extended. Each hose is 85 feet long; each 10 feet of hose length is marked by a white band. In some instances, the hose will be marked white on the first and last 5 feet for use in helicopter refueling. The heavy reception coupling at the end of the hose is kept aerodynamically stable by the circular canopy of the paradrogue assembly. The paradrogue assembly is attached to the reception coupling by interconnecting arms. Aerodynamic load inflates the canopy to a diameter of 27 inches. The inner sides of the attaching arms are painted with white luminous paint. The paradrogue is illuminated at night by six equally spaced radioactive buttons. In addition, pod and hose illumination lights are mounted on the forward outboard edge of the tanker's horizontal stabilizers for night use if greater illumination is required to improve receiver pilot visual references.

At the aft end of the refueling pod there are three lights: red, amber, and green. The red light, when illuminated, indicates HYDRAULIC PRESSURE OFF. Engaging the hose when this light is illuminated is an emergency procedure only. The amber light when illuminated indicates TANKER READY. The green light when illuminated indicates fuel is flowing. Normally, as the receiver approaches the tanker, the amber TANKER READY light will be illuminated. For planning purposes, Figure 2-1 contains additional exterior lighting available on the KC-130.

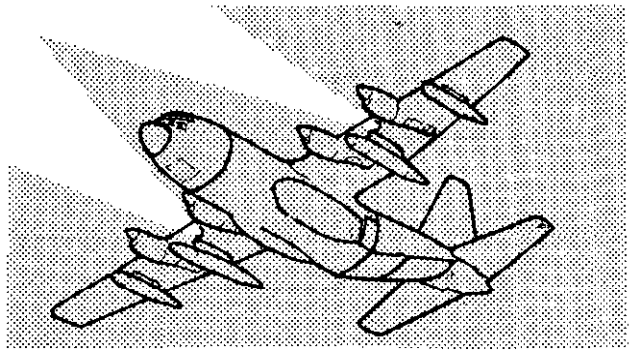
The interior of the reception coupling attached to the end of the hose is cone shaped to guide the entrance of the mating probe. The coupling has a locking mechanism consisting of three spring-loaded pistons connected to rollers extending through the interior of the reception coupling. When the probe enters the reception coupling, these rollers are forced back against the spring tension as they ride up the shallow angle of the sloping front surface of the probe head. After coupling is completed, the rollers drop down the steeply angled rear surfaces of the probe head. It requires approximately 140 foot-pounds of force to push the rollers back during the coupling action; thus a closure rate of 2 to 5 knots is necessary.

Before clearing the receiver to engage, the tanker crew shall check out the operation of all components of the tanker refueling system. The last step in this checkout procedure is to set the response of the hydraulic system. The TANKER READY light illuminates as the response set cycle is completed. The hydraulic system operates so that when response is set at refueling speed, the receiver engages and supplies 10 percent of the force necessary to push in the hose. The hydraulic system senses this push and supplies the other 90 percent of the force necessary to retract the hose. This action retracts the hose at approximately 15 feet per second as long as 10 percent push is supplied by the receiver. Slack is thus taken up and hose whip minimized. If the receiver stops pushing, the hose stops retracting.

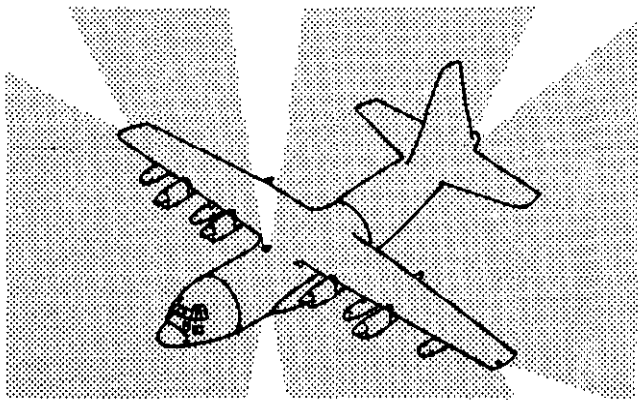
The tanker refueler system usually is set to start pumping fuel automatically when the hose is pushed 5 feet in from the fuel trail (85-foot position). As the hose is pushed in from the 80-foot mark, the amber TANKER READY light will go out and the green FUEL FLOWING light will illuminate. Fuel will continue to flow as long as the receiver maintains the hose extension between 20 and 80 feet. Exceeding either of these range limits will cause the FUEL FLOWING light to go out and fuel flow to be shut off. The amber TANKER READY light will also illuminate whenever



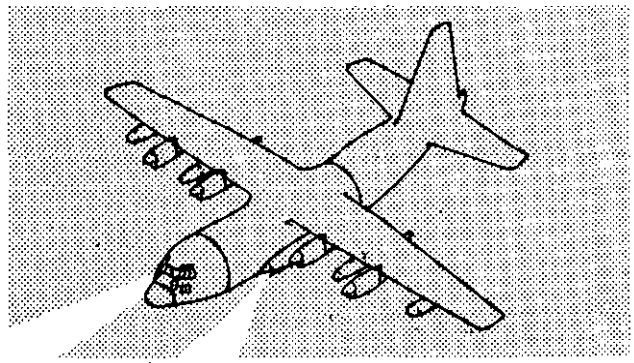
ANTI-COLLISION/STROBE LIGHTS



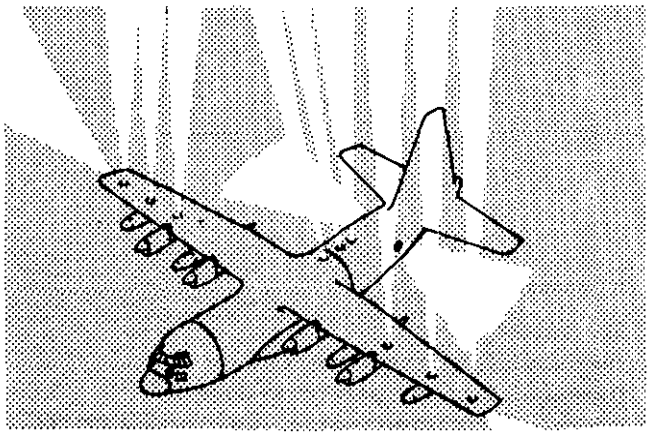
LANDING LIGHTS



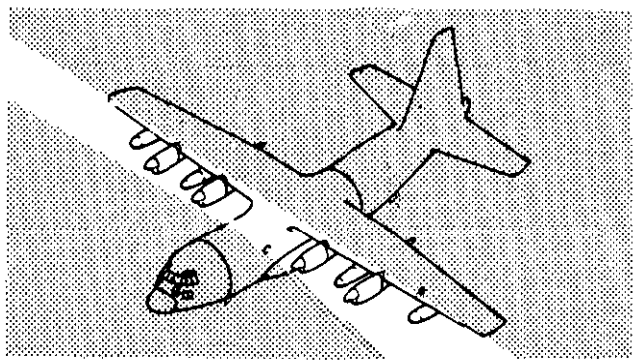
NAVIGATION LIGHTS



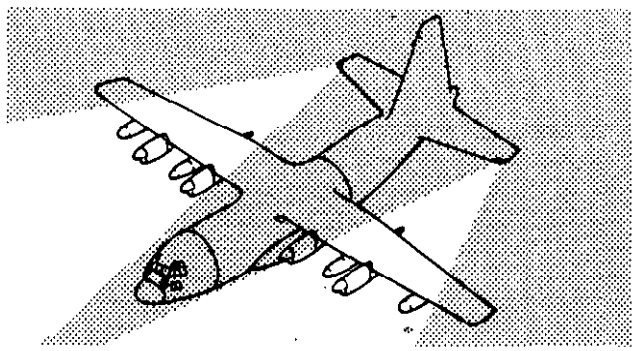
TAXI LIGHTS



FORMATION LIGHTS



LEADING EDGE LIGHTS



POD & HOSE ILLUMINATION LIGHTS

Note

KC-130F/R aircraft do not have ventral/dorsal navigation lights.

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Figure 2-1. Exterior Light Locations

either of these limits is exceeded. While the receiver is in the refueling range, fuel will continue to flow until the scheduled amount of fuel has been transferred or until the receiver is full, and intermittently thereafter as receiver fuel supply is constantly diminished by the operating engine in the receiver aircraft. Fuel flow during refueling may be controlled manually by the tanker flight engineer; however, little difference will be noted by the receiver pilot.

Rate of fuel transfer during the refueling operation is governed by several factors. One is the transfer rate capability of the receiver aircraft. Another is a function of tanker fuel system configuration and mode of tanker refueling system operation. If the tanker has the removable 3,600 gallon AR tank installed, and if both of the AR pumps mounted therein are used, fuel can be transferred at an approximate rate of 600 gallons per minute. One in-flight refueling pump will supply approximately 300 gallons per minute (gpm). In some cases, particularly after the receiver is initially filled and "riding the tanker," tanker cabin pressurization alone may be used to transfer enough fuel to keep the receiver full without subjecting it to high surge pressures. If the tanker is configured so that only wing store fuel is available, maximum transfer capability is 150 gallons per minute to each receiver and fuel transfer by pressurization is not possible. In any event, the tanker will normally use the lowest transfer fuel pressure consistent with accomplishment of fuel transfer in the allotted time.

While refueling is in progress, probe and drogue engagement is further ensured by the fuel pressure in the hose, which is admitted to the rear of the spring-loaded pistons in the reception coupling. This pressure locks the rollers behind the head of the probe. If coupling is accomplished at less than the required closure rate and with insufficient force to cause the probe to completely enter the reception coupling, the locking action will not occur. If the locking action does not occur and the pilot of the receiver aircraft adjusts his position rearward relative to the tanker, the hose and probe will separate and the hose will remain in position at the time of separation. Incomplete locking action could result in fuel spraying from the coupling.

It is possible that receiver aircraft, whose configuration is such that engine air intakes are directly behind the probe, may encounter auto-acceleration in cases where coupling is improperly completed. If fuel escapes between the reception coupling and the probe and enters the receiver intakes, a dangerous condition may result. Fuel can be transferred with incomplete coupling only while the receiver pushes in.

If proper coupling is accomplished and the locking action is completed by fuel pressure, the pull on the hose when the receiver backs out will be sensed by the tanker response system. The hose will extend at the same rate as the receiver moves to the rear. During refueling, the receiver should maintain a position on the hose so that the 50-foot marker is just at the pod tunnel entrance.

When refueling is completed, normal disengagement is accomplished by the receiver backing out smoothly to a full extension of the hose. Since fuel pressure will be off at full hose extension, the locking action described earlier will be released. Considerably more force will be required to disengage than was required to engage, because the locking rollers of the reception coupling must now travel up the steeply inclined rear surfaces of the probe head. Approximately 420 foot-pounds of force are required to disconnect a properly completed coupling.

It is possible that tanker hose response will need to be reset while refueling is in progress. Indications of this may be hose slack and whip after engagement for a dead hose feel to the receiver. When these conditions occur, as observed by the tanker observer or as reported by receiver pilots, the receiver will be instructed to disengage and to remain clear of the hose in question. The hose shall be cycled, the response set, the TANKER READY light will illuminate, and, when cleared, the receiver may reengage. If hose response is subsequently improper, the receiver should be directed to a spare hose. Refueling may be completed by the dead hose if the proper technique is employed and if extreme care is exercised. Under these conditions, minimum possible closure rate is necessary to avoid bending or breaking the receiver probe. Once engaged on a dead hose, receiver position must be precisely maintained to minimize hose slack and resultant whip. As previously mentioned, refueling from a dead hose is an emergency procedure and should be executed accordingly. Dead hose refueling may also be required if a tanker encounters partial electrical or utility hydraulic system failure. Complete utility hydraulic system failure will always be indicated by illumination of the red HYDRAULIC PRESSURE OFF light.

2.2 GENERAL OPERATION

A refueling area commander (RAC) and alternate commanders, as required by the mission, shall be designated for each refueling area. Commanders shall be highly experienced in air refueling operations as described in this manual. During operational missions, the RAC is in command of the air refueling operation

in the air refueling area and shall be responsible for making necessary decisions. He shall coordinate with the movement control officer and the receiver flight leader to assure the successful completion of the mission.

Any position in the flight may be assumed by the RAC, but for best observation, the rearmost tanker position is recommended.

The RAC shall assume control of the receiver forces when radio contact has been established. In the event of radio failure or when radio silence is required, the RAC shall assume command when visual contact is established. Receiver aircraft shall retain the responsibility of securing air route traffic control (ARTC) approval for any changes in their flight plan or altitude.

The following essential items shall be coordinated and published in a briefing and/or operation order prior to any refueling operations:

1. Type of refueling (on-course or static).

2. Air refueling area.

3. Air refueling control point(s) (ARCP).

4. Air refueling control time(s) (ARCT).

5. Air refueling altitude.

6. Air refueling course.

7. Air refueling speed.

8. Air refueling frequencies (primary and secondary).

9. Tanker and receiver call signs.

10. Tanker loiter time.

11. Total amount of fuel to be dispensed to each receiver.

12. Disengage point.

13. Reform area.

14. Provisions for emergency and/or spare tankers.

15. Refueling abort point (bingo).

16. Primary and alternate base for recovery aircraft in case of an air refueling abort.

17. Alternate air refueling control point and time.

18. Air route traffic control: This section of the operation order, will designate the organization responsible for obtaining required clearances.

Before takeoff, the RAC shall determine the necessity for radar and, if required, ensure that a minimum of one tanker aircraft has radar capable of identifying and decoding identification friend or foe (IFF). If radar becomes inoperative during the flight, the mission may be continued at the discretion of the RAC.

The tanker should be on station a minimum of 30 minutes before ARCT.

All participating tanker aircraft shall monitor the rendezvous frequency a minimum of 20 minutes before scheduled ARCT.

One airborne spare should normally be provided per four or less primary tankers.

Spare receiver aircraft scheduled to utilize a vacated position shall abort to the designated alternates unless otherwise provided for. Receiver aircraft shall be cleared to individual tanker aircraft by position number and shall refuel on the appropriate air refueling frequency.

Ground spare tankers should be provided, as necessary, to ensure that the required number of tankers is available to support the mission.

For planning purposes, the tanker fuel load shall be sufficient for the tanker to orbit 30 minutes, accomplish the planned air refueling, and return to a planned point of landing on all engines with the required fuel reserve.

In-flight checks of air refueling system and rendezvous equipment should be accomplished as soon as practicable after takeoff.

The RAC shall be responsible for all position reports for the entire force after tanker/receiver radio contact has been established.

2.3 RENDEZVOUS

2.3.1 Types

2.3.1.1 Static Rendezvous. The tanker establishes a left-hand racetrack pattern anchored on an orbit point with 25-nautical mile (nm) legs. All turns should be one-fourth standard rate. In this operation, the actual rendezvous can be made at any point around the orbit, with the refueling being accomplished in the pattern. The length of orbit legs can be adjusted as required (see Figure 2-2).

2.3.1.2 Head-on Rendezvous. The tanker aircraft approaches the receiver head-on and makes a procedure turn so as to roll out on the receiver course with the receiver approximately 1 mile in trail. The tables included in Figure 2-3 prescribe the proper distance for commencing the procedure turn. The method of accomplishing the procedure turn is also illustrated in this figure.

2.3.1.3 On-Course Rendezvous. The tanker force establishes either a left-hand or right-hand racetrack pattern. Upon commencing the rendezvous, the tanker force shall head toward the receiver force on a track approximately 13-nm offset from the on-course refueling track. When receivers reach a point 4 minutes prior to the ARCP, tankers will commence a one-fourth standard rate turn to roll out over the ARCP with receivers in the observation position (refer to Figure 2-4).

CAUTION

Utilize extreme caution when approaching tanker aircraft with multiple receivers in the refueling area. Altitude separation will maximize receiver deconfliction.

2.3.2 Rendezvous Procedures. A primary rendezvous controller (RC) shall be designated in the operation order for the mission. Airborne early warning (AEW) aircraft or ground-controlled intercept (GCI) facilities may be provided as backup/RC. These backup units shall check in on and guard then en route frequency, maintain radar surveillance of the operation, and be prepared to assume control at the request of the RAC. They shall otherwise maintain radio silence except to report a dangerous situation observed.

1. All participating formations shall monitor rendezvous frequency a minimum of 20 minutes prior to the scheduled ARCT.

2. When a frequency specifically designated for rendezvous control other than the en route frequency is employed, the rendezvous frequency shall be utilized for initial contact with the RC.

3. Dependent upon conditions, the standard altimeter setting 29.92 or local altimeter setting will be utilized.

Note

A hazardous condition exists if low altitude refueling using QNE and QNH is substantially less then QNE.

4. The receiver flight leader shall attempt to establish radio contact with the RAC at least 20 minutes prior to ARCT. On initial radio contact between tankers and receivers, the RAC shall assume control of the receiver force and direct the receiver flight leader to select a specific mode and code, shift air-to-air tacan, and give a short count for a basic direction finding (DF) steer.

a. All receivers shall squawk the requested mode and code.

b. All aircraft in the tanker force shall select the air-to-air tacan mode. Some KC-130 aircraft are equipped with an AN/ARN-139(V) rotating antenna tacan. Availability of tacan information is shown in Figure 2-5.

5. Receiver aircraft shall arrive at the ARCP at 1,000 feet higher than the tankers (weather permitting) to effect better radar contact, for better fuel economy, and to preclude the possibility of a long tail-chase.

6. Receiver aircraft upon reaching the letdown point shall commence a descent to an altitude and position assigned by the RAC. Speeds in descent shall be governed by the procedures outlined in the applicable NATOPS flight manual.

7. The letdown point should be computed by the receiver to ensure the termination of the letdown at the observation position behind the tanker formation. The following formula shall be used by computing the letdown point:

$$\frac{\text{Differential Altitude}}{\text{Rate of Descent}} \times \frac{\text{Differential Groundspeed}}{60} + 1 = \text{Letdown point in nm}$$

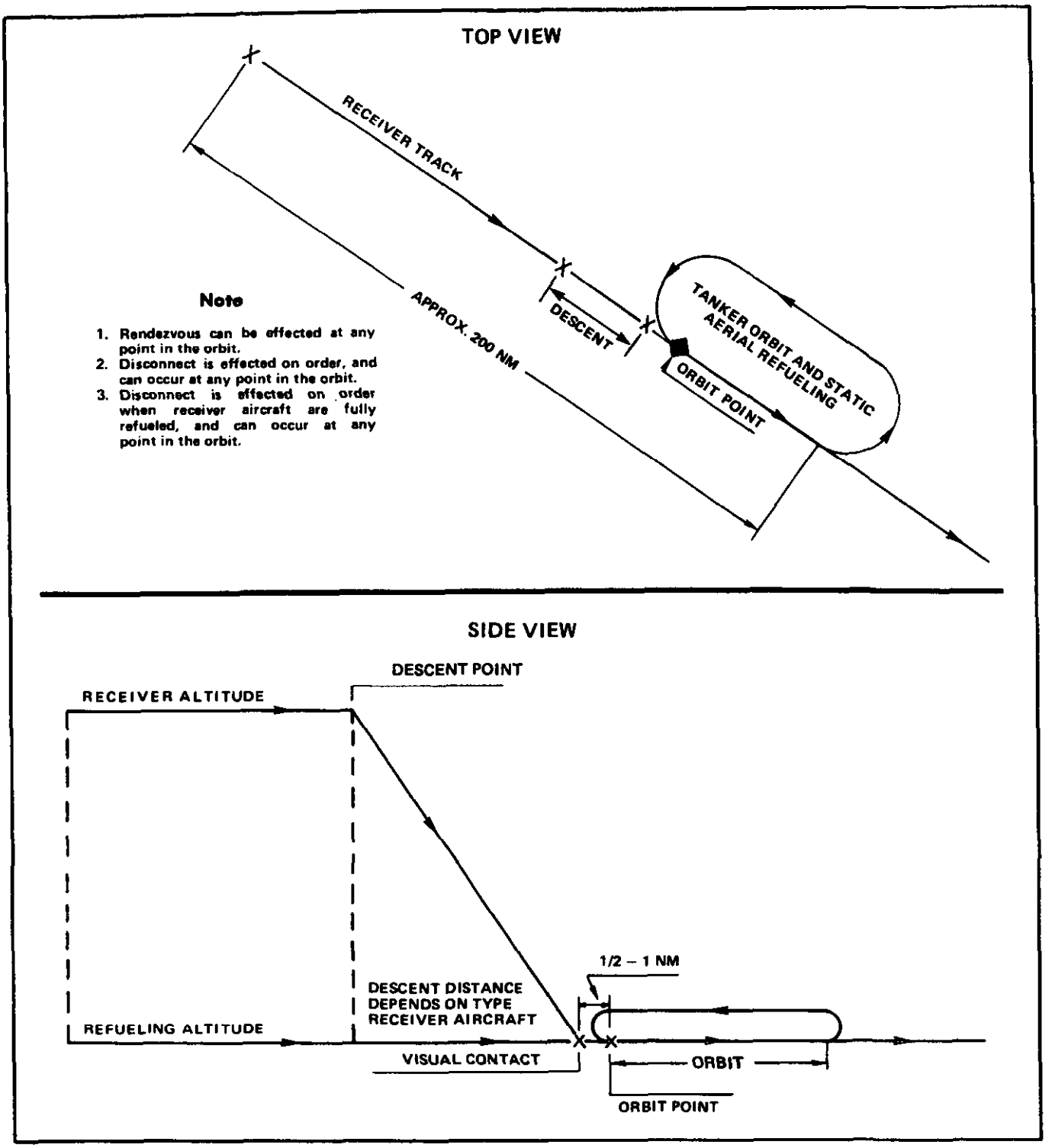
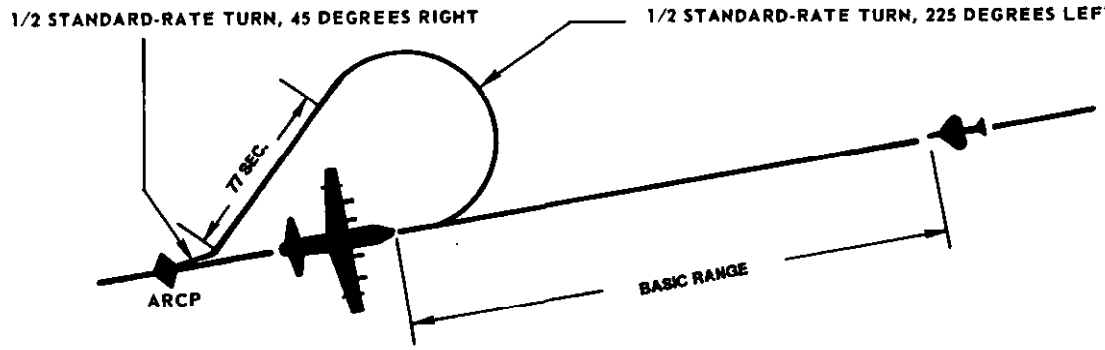


Figure 2-2. Static Refueling



TANKER TAS	RECEIVER TAS						
	280	320	360	400	440	480	520
200	13.9	16.7	19.6	22.4	25.2	28.1	30.9
220	13.3	16.1	19.0	21.8	24.6	27.5	30.3
240	12.7	15.5	18.4	21.2	24.0	26.9	29.7
260	12.0	15.0	17.8	20.6	23.4	26.2	29.2
280	11.4	14.4	17.2	20.0	22.8	25.6	28.6
300	10.8	13.8	16.6	19.4	22.2	25.0	28.0
320	10.2	13.2	16.0	18.8	21.6	24.4	27.4
340	9.6	12.6	15.4	18.2	21.0	23.8	26.8

Note

- The basic ranges from the table above are computed for both aircraft to arrive at the ARCP at the same time.
- The 77-second timing leg may be adjusted 1 second for each 10 knots of crosswind.
- Basic range may be adjusted for slant range.

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Figure 2-3. Head-On Rendezvous, One-Half Standard-Rate Turn

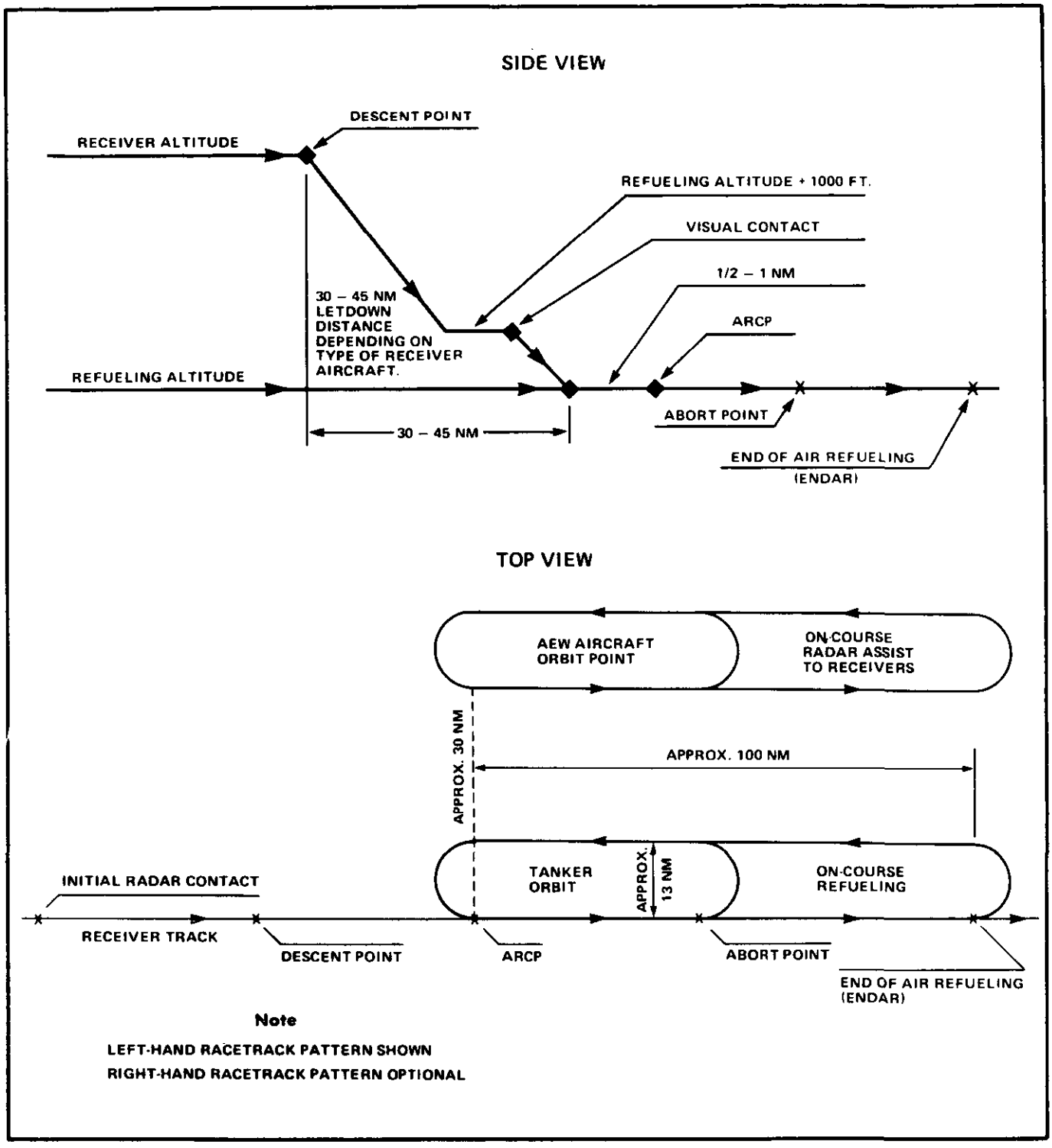

Figure 2-4. On-Course Rendezvous Refueling Operations

			TRANSMITTER									
			AN/ARN-118(V)		AN/ARN-139(V)							
		MODE	A/A REC	A/A T/R	A/A NORM NORMAL	A/A NORM EXTEND	A/A INV NORMAL	A/A INV EXTEND	BCN NORM NORMAL	BCN NORM EXTEND	BCN INV NORMAL	BCN INV EXTEND
RECEIVER	AN/ARN 118(V)	A/A REC									B	B
		A/A T/R		D	D	D	D	D	D	D	B/D	B/D
	AN/ARN 139 (V)	A/A NORM NORMAL		D	D	D	D	D	D	D	B/D	B/D
		A/A NORM EXTEND		D	D	D	D	D	D	D	D	D
		A/A INV NORMAL		D	D	D	D	D	B/D	B/D	D	D
		A/A INV EXTEND		D	D	D	D	D	D	D	D	D
		BCN NORM NORMAL		D	D	D	D	D	D	D	B/D	B/D
		BCN NORM EXTEND		D	D	D	D	D	D	D	D	D
		BCN INV NORMAL		D	D	D	D	D	B/D	B/D	D	D
		BCN INV EXTEND		D	D	D	D	D	D	D	D	D

	B	D	B/D
NO INFORMATION AVAILABLE	BEARING	DISTANCE	BEARING AND DISTANCE

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Figure 2-5. Tacan Air-to-Air Interaction

8. After initial contact, the receiver flight leader shall inform the RAC of the number and type of aircraft in the receiver serial and estimated time of arrival (ETA) at the ARCP.

9. Upon receipt of the receiver serial information, the RAC shall advise the receiver flight leader of the following:

a. Number of operational hoses available

b. Weather in the refueling area and at the receiver recovery base

c. Altimeter setting to be used in the refueling area

d. Indicated altitude of the highest tanker in the tanker force

e. Other pertinent information.

10. DF steers in magnetic course shall be transmitted in order to bring the receivers into the tanker force's 6 o'clock position over the ARCP and shall continue until radar or visual contact is established. Only one RC, designated by the RAC, shall give the steers.

11. The first RC who receives a probable receiver target on his radarscope shall advise the RAC of the possible receiver radar position. If the designated RC still does not have a receiver radar position plotted, the RAC may pass the rendezvous control to the RC who has this radar plot. When the designated RC has a positive radar plot of the receiver serial, the RAC may direct him to resume rendezvous control. When then the receivers are painted, the RC having initial control shall positively identify the receiver serial by directing the receivers to change modes or codes. This RC shall notify the receivers when they are in positive radar contact and shall have all receivers except the flight leader strangle the IFF. When this has been accomplished, the receivers shall be considered under positive control, at which time:

a. Each controller in the tanker force shall broadcast his call sign and the word "contact" upon initial radar contact.

b. The RC shall direct control of the receivers under positive control until "Tallyho" or "Judy" is transmitted by the receivers. At this time, the receiver flight leader shall assume complete directional control to intercept. Direction by the RC shall revert to information control and all information supplied to the receiver flight leader by the RC shall end with "out."

12. Receivers shall be provided with radar range and steer data at least every 20 nm. As receiver-to-tanker range decreases, this data should be given, when practical, at 10-nm intervals or less until "Tallyho." By this time, the steer problem should be one of refinement. If the receiver is air intercept (AI) radar equipped, the first receiver pilot to "paint" the tankers shall transmit "contact" and state his position from the tankers. The RC shall confirm this by stating, "That is your tanker," or "That is not your tanker," and then give the range and steer data. After a lock-on is obtained, the receiver flight leader may broadcast "Judy," which will be acknowledged by the RC, and may then complete the intercept, utilizing the receiver's air intercept (AI) radar.

13. If radio contact has not been established by 100 nm from the ARCP, the receiver pilot shall turn his IFF to the prebriefed mode and code. When an IFF signal is received prior to radio contact, the RC shall instruct the receiver pilot to change modes until the receiver complies, indicating one way communications are established. This procedure shall be utilized for rendezvous instructions until normal radio contact is established or until a successful rendezvous is completed.

14. If no radar contact or tacan lock-on is established between the receivers and tankers, the receivers shall commence their descent at the prebriefed position/time to an altitude 1,000 feet above the prebriefed altitude of the highest tanker.

15. If the tanker force does not have positive radar contact, the receiver flight leader shall transmit his position to the RAC at least every 10 nm until "Tallyho."

16. The RC shall direct the receivers until a positive "Tallyho" or "Judy" is established. When the flight leader transmits his contact report, he shall then assume the intercept to completion.

17. When AEW aircraft or GCI are used as rendezvous control, they shall be employed as follows:

a. AEW aircraft shall launch so as to arrive on station 30 minutes before ARCT. GCI units shall have all necessary equipment manned and operating 30 minutes before ARCT.

b. AEW aircraft shall orbit abeam of and 30 nm away from the ARCP. From this position, the aircraft shall effect tanker-to-receiver rendezvous.

c. The RC shall advise the receiver of his arrival at the descent point.

d. The RC shall advise the RAC when the tanker force has arrived at the ARCP, or, in the event the ARCP is missed on rendezvous, he shall advise the tanker leader of the bearing and distance to the ARCP.

18. As soon as the receivers report "Tallyho," the AEW aircraft shall depart on a track parallel to the receiver track toward the next receiver checkpoint. While on this track, he shall constantly monitor the position of the tanker aircraft in preparation for turning these aircraft to the ARCP for rendezvous with the next receiver serial.

19. Immediately upon receiver-tanker disconnect, the RAC will contact the receiver flight leader on the refueling frequency and provide dropoff point, time, no-wind magnetic heading to receiver's next reporting position, and fuel offload information. When a special retirement frequency is employed, the switchover to the retirement frequency shall be made when the receivers have reformed and have climbed well clear of the tankers.

20. AEW RCs may be called upon to :

a. Assist the receivers in reassembly after completion of refueling.

b. Provide navigational assistance to spare or aborting aircraft returning to the recovery base.

c. Render assistance to tanker aircraft to ensure that the tanker force does not pass the planned completion point on critical fuel-reserve missions.

21. Whenever possible, the AEW agency shall be contacted by the command planning the mission well in advance of the execution date to ensure a thorough understanding of the general plans and procedures, mission requirements, call signs, frequencies, etc.

22. In hours of darkness or poor visibility, the navigation and refueling lights shall be turned ON by all aircraft in the tanker force, 20 minutes before the scheduled ARCT. The last aircraft in the tanker formation shall turn ON the top rotating beacon light (anticollision) at the same time.

23. The tanker and receiver aircraft navigation and refueling lights shall be turned to DIM and STEADY. In the event of loss of communications or when air refueling is being conducted under radio silence conditions, the position lights on both the tanker and receiver shall be turned to DIM and STEADY when visual contact has been established.

24. Receiver formation integrity shall be rigidly maintained until RAC gives the order for each receiver to go to his respective tanker.

2.4 REFUELING PROCEDURES

The procedures contained in this manual combined with those in the applicable NATOPS flight manual of each receiver aircraft shall govern all phases of the air refueling operation.

1. The tankers shall adjust their orbit in order to ensure rendezvous with the receivers at the ARCP on schedule. All tankers shall monitor both the en route and refueling channels at this time.

2. When the receivers are in the observation position, the tanker force shall be at refueling airspeed, with drogues at trail and wet hoses (display identification lights, if used) and with the lower rotating beacon OFF. Retracted drogues indicate that the tanker is unable to transfer fuel from that position. (Tanker identification can be accomplished by the display of varied Aldis lamp colors from the stations.)

3. Air refueling altitudes shall be specified in the operations order. Tanker altitudes shall be stated for both the highest and the lowest tanker in the formation. The RAC shall advise the receiver flight leader prior to initiation of receiver letdown of any change in the briefed tanker altitudes.

4. Receiver aircraft should arrive at the ARCP at an altitude higher than the highest tanker (1,000 feet minimum, weather permitting) to better effect radar contact, safety, and fuel economy and to preclude the possibility of a long tail-chase.

5. Upon tanker receiver rendezvous, the receiver shall switch on order of the RAC to the refueling frequency and perform an in-flight refueling (IFR) check. In the case of tactical aircraft, a voice report shall be made stating, "Noses cold, switches safe,"

indicating the radar is in standby and the armament switches are off.

6. When approaching the observation position, receiver aircraft shall slow to the refueling airspeed and, when cleared by the RAC, will proceed to the precontact position of the assigned tanker in preparation to hookup. Additional receiver aircraft awaiting available drogues shall remain in the observation position.

WARNING

- Even normal closure rate (2 to 5 kts) on a known dead hose or abnormal hose (hose that has not been reset) can be considered excessive and can lead to large sine wave formation.
- Receiver aircraft must be aware of potential for sine wave formation and be prepared to react by immediately disengaging.

CAUTION

- Do not engage drogue with lower rotating beacon illuminated.
- Improper disengagement position or aircraft misalignment at disengagement may result in a moment producing a binding force between the probe and reception coupling, greatly increasing required disengagement force, and possibly resulting in structural failure of the probe or refueling hose.
- An excessive disengagement rate may also result in excessive loads on the probe and refueling hose.

7. When each receiver has been refueled, the receiver shall clear down and to the left of the tanker formation, switch to en route frequency, and continue the assigned mission.

8. Formation speed with the tanker at any compatible refueling altitude shall be 200 knots indicated airspeed (KIAS). Optimum air refueling speed for all altitudes below 21,000 feet should be 230 KIAS unless otherwise requested directly by the receiver. Tanker formation positions should not take precedence over the required altitude, speeds, and rates of descent needed for successful refueling.

9. When in the precontact position and cleared by the RAC, the receiver shall plug in. Immediately after a successful contact, each tanker shall transfer the scheduled token amount of fuel to the receivers to ensure that the air refueling systems are in operation. When tobogganing procedures are involved, refueling shall not commence until all receiver aircraft are hooked up.

10. Receiver aircraft shall be refueled with a prebriefed fuel load. Exceptions to this shall be only when an emergency has been declared by a receiver pilot.

2.4.1 Level Flight Refueling. Refueling at or below flight level 210 can normally be performed at a constant altitude and airspeed. As receiver aircraft approach maximum gross weight, a minimum of 215 KIAS is required for satisfactory receiver flight characteristics.

2.4.2 Descent-Type Refueling. Refueling above 21,000 feet may require use of the descent toboggan techniques. Normally, procedures to be used by receiver aircraft at or near maximum gross weight above 21,000 feet are contained in the performance data charts of the NATOPS flight manual.

After receiver hookup and fuel transfer is in progress, toboggan procedures, if necessary, will be initiated at the request of the receiver. Upon receiving the request to "Toboggan," the tanker(s) shall begin a 250- to 350-feet per minute (fpm) descent and gradually accelerate to a maximum of 250 KIAS as the receiver load increases.

WARNING

Initial contact with the tanker basket should normally be accomplished in level flight. Attempting to plug the basket while in a descent poses a hazard because reduced deceleration responses make it difficult to arrest closure. Once the basket is engaged, gentle climbs and descents can be made as required.

2.4.3 Refueling Systems Check. Each receiver, upon effecting a hookup, shall be given a scheduled token amount of fuel to ensure that the refueling systems are operating properly. If the receiver pilot fails to get a

positive indication, he shall immediately communicate with the RAC and request additional assistance.

WARNING

A momentary transfer of fuel shall be utilized for all A-4s. Upon completion, transfer shall be secured to allow the pilot to determine if proper coupling has been accomplished.

If no transmissions are heard for the receiver or if the receiver does not disengage, the tanker shall reinitiate fuel transfer.

WARNING

If, during the subsequent refueling, the A-4 pilot observes fuel escaping at the coupling, he should immediately reduce throttle to idle and extend speedbrakes.

CAUTION

- AV-8A aircraft should not be refueled using the IFR pumps. Use of transfer pump only is preferred since use of the IFR pumps may rupture a fuel cell on the AV-8A because of the higher pressure. One IFR pump may be turned on at the request of the AV-8A pilot.

- In the event of a lack of hose response, the pilot shall immediately reduce power and establish a smooth positive rate of disengagement from the drogue. The use of speedbrakes will only aggravate any hose sine wave motion.

2.4.3.1 Emission-Controlled (EMCON) Air Refueling Procedures. EMCON air refueling may be conducted using the signals in Figure 2-6.

2.4.4 Communications. Tanker aircraft shall maintain interplane communication on the briefed ultra high frequency (UHF)/very high frequency (VHF).

Radio (except in an emergency) contact between receiver and tanker aircraft should be accomplished by the RAC only. Individual tanker aircraft shall inform the RAC of the desired message to a specific receiver; the RAC shall contact and direct the receiver as required.

Primary means of communication between tanker and receiver aircraft shall be light signals. The following light signals may be used:

1. Steady amber (pod) ..... Ready tanker
2. Steady green (pod) ..... Fuel flowing
3. Blinking green (pod) ..... Intermittent fuel flow-receiver full or system malfunction
4. Red (before engagement) (pod) ..... Do not engage — tanker not ready
5. Red (after engagement) (pod) ..... Disengage — tanker malfunction
6. *Bottom rotating* beacon on or flashing Aldis lamp from observers ..... Emergency breakaway.

The voice report in Figure 2-7 shall be utilized, as required, for tanker/receiver operations. Training refueling operations shall not be conducted until satisfactory two-way radio communications are established between tanker and receiver pilots. Operational refueling may be accomplished without two-way communications if the situation warrants. In the event of receiver radio failure, communications shall be effected as follows:

Note

The following procedures also apply to (NORDO) no radio receivers requiring emergency refueling that have not been prebriefed.

1. The receiver flight leader shall notify the RAC of the NORDO aircraft and the extent of the radio failure.

2. The NORDO aircraft shall refuel on the prebriefed tanker and shall be programmed for the prebriefed amount of fuel.

SIGNAL	FROM	TO	MEANING	RESPONSE
1. Steady Aldis light	Observer	Receiver	Clear contact	Receiver engages drogue
2. Steady Aldis light	Observer	Receiver engaged with drogue	Receiver has pre-briefed amount of fuel	Receiver disengages drogue and awaits wingman at port observation
3. Flashing Aldis light	Observer	Receiver engaged with drogue	Tanker is experiencing problems with that hose	Receiver disengages and remains outboard of the hose
4. Hose partially/ fully retracted	Tanker	Receiver	Hose unsafe	Receiver does not engage drogue
5. Receiver disengages drogue and remains in precontact position outboard of the hose	Receiver	Tanker	Receiver not satisfied with hose response or fuel flow rate	Hose will be retracted, troubleshot and extended; receiver cleared to engage drogue
6. Receiver remains in contact after prebriefed giveaway and a steady light from observer	Receiver	Tanker	Receiver requires more fuel than prebriefed	Tanker will top off receiver or give in the following increments: F-4: 4,000 lb All other aircraft: 2,000 lb
7. Steady Aldis light after # 6 above	Observer	Receiver	Additional give-away unavailable	Receiver disengage and await wingman or join wingman at port observation

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Figure 2-6. EMCON Air Refueling Signals

3. With transmitter only failure, the NORDO aircraft shall follow the instructions of the RAC. In the event these instructions are not acceptable, the NORDO receiver shall move into a position to be seen by the observers and indicate by shaking his head left to right that he is unable to comply with the instructions. He shall convey his needs by standard hand signals.

4. With receiver only failure, he shall transmit his desired fuel and any deviation from the preflight briefing. After stabilizing and upon receiving an amber pod light, with the bottom rotating beacon OFF, the NORDO aircraft may effect an engagement and receive fuel.

5. With both transmitter and receiver failure, the NORDO aircraft shall refuel from the briefed tanker for the scheduled amount. The receiver flight leader or section leader shall convey to the NORDO aircraft, by means of a "thumbs up" hand signal that refueling will be conducted as briefed. In the event a change in tanker or drogue assignment is necessary, the NORDO aircraft shall be lead to the newly assigned drogue prior to the leader stabilizing on his assigned tanker.

6. If more fuel than the briefed amount is desired, the NORDO receiver shall fly his aircraft in a position to be observed by the observers, make a "thumb to mouth" refuel hand signal, and indicate by finger signal (each finger indicates 100 pounds; a full hand is 500 pounds) the amount of additional fuel desired.

REPORT	FROM	TO	MEANING
1. Tally-ho	Receiver leader	RAC	Visual contact
2. Judy	Receiver leader	RAC	Radar contact
3. Observation position	Individual receiver	RAC	Receiver aircraft in observation position
4. Cleared precontact	RAC	Individual receiver	Receiver aircraft is cleared to the precontact position
5. Cleared contact	RAC	Individual receiver	Receiver aircraft is cleared to engage hose
6. Fuel flow	RAC	Individual receiver	Aircraft is receiving fuel
7. Fuel flow complete	RAC	Individual receiver	Briefed fuel transfer
8. Cleared disconnect	RAC	Individual receiver	Disconnect and maintain precontact position
9. Cleared to port reform	RAC	Individual receiver	Reposition down and to the left
10. Fuel transferred _____ pounds	RAC	Receiver leader	Amount of fuel transferred to receivers
11. Breakaway	Individual tanker	Individual receiver	Emergency is in effect, disconnect immediately
12. Noses cold/switches safe	Each receiver	RAC	Radar OFF/armament SAFE

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Figure 2-7. Voice Reports, Tanker/Receiver Operations

7. The following procedures shall be used in peacetime to signal for an escort when a receiver must abort to recovery base and has lost communications.

2.4.4.1 *Night Operations*

1. The receiver requesting assistance shall fly in such a position as to be seen by his observer and shall change his navigation lights to BRIGHT and FLASH.

2. The observer shall relay to the RAC, who will contact the flight leader by radio, advising him of the location of the receiver in difficulty. The flight leader shall assign an escort.

3. The receiver requiring assistance shall remain in sight of the observer until his escort has joined on his wing. After breaking away from the tanker, the lead shall be changed and, with appropriate signals, the flight shall proceed to the recovery base.

If a receiver requiring assistance is alone on a tanker, he shall remain there until his escort has joined. In the event of total communication failure, daytime procedures shall apply.

2.4.4.2 Day Operations

1. The receiver requesting assistance shall fly in such a position as to be seen by his observer and shall rock his wing.

2. The observer shall relay to the RAC, who shall contact the flight leader by radio, advising him of

the location of the receiver in difficulty. The receiver flight leader shall then assign an escort.

3. The receiver requiring assistance shall remain in sight of the observer until his escort has joined on his wing after breaking away from the tanker. The lead shall be changed by appropriate hand signals and the flight shall proceed to the recovery base.

Observers shall maintain radio silence unless the receiver requests aid, an emergency occurs, of the hose fouls on the receiver. All directions from observers shall be standard terminology:

1. Hold your position..... Hold the aircraft steady in the present position
2. Forward..... Move the aircraft forward, holding azimuth and altitude
3. Back ..... Move the aircraft backward, holding azimuth and altitude
4. Down..... Descend the aircraft, holding azimuth and lateral position
5. Up ..... Ascent the aircraft, holding azimuth and lateral position
6. Right ..... Move the aircraft to the right, holding altitude
7. Left ..... Move the aircraft to the left, holding altitude.

2.4.5 Completion of Refueling. At the completion of mass refueling, each receiver shall maintain contact with the drogue and continue taking fuel until the RAC orders disengagement; at which time, all receivers should simultaneously disengage and clear down and to the left of the tankers to the reform area. When reform is accomplished, on order of the receiver flight leader, switch to the en route frequency and continue on the mission.

2.5 TRANSOCEANIC/TRANSCONTINENTAL SPECIFIC REFUELING PROCEDURES

1. Air Force tanker aircraft have assumed responsibility for providing en route aerial refueling for Marine tactical jet aircraft. However, in the event that the Air Force is unable to provide tanker support, refer to the appropriate Force Commander Order for policy, procedures, and related instructions concerning the transoceanic/transcontinental movement of Marine tactical jet aircraft utilizing Marine KC-130s.

2. *Trans-Pacific (TRANSPAC):* For TRANSPAC movement of Marine tactical jet aircraft refer to MARFORPac Order P3710.3_.

3. Trans-Atlantic (TRANSLANT): For TRANSLAN T movement of Marine tactical jet aircraft refer to Wg0 "P3710.34_" .. and Wg0 "3710.2_" .."

2.6 TANKER FORMATION

2.6.1 Tanker Formation Procedures. The following procedures are applicable either to mass refueling, which involves formations of two or more tankers, or to individual refueling, which involves a single tanker (where separation is listed as 250 feet, increase to 500 feet for night operation).

2.6.1.1 En Route Formation. En route formation shall be specified by the tanker force commander.

2.6.1.2 Tanker Orbit Formation Option 1. Tanker aircraft shall maintain a comfortable right echelon, stepped down, with separation of 250 feet vertically, 500 feet laterally, and 500 feet nose-to-tail, using a racetrack pattern. Free cruise may be utilized to maintain interval during the turns (see Figure 2-8).

2.6.1.3 Tanker Orbit Formation Option 2. Tanker aircraft shall maintain a trail position, stepped down, with separation of 500 feet vertically and up to one-half mile nose-to-tail, using a racetrack pattern. Radius of turn may be utilized to maintain interval and position during the turns. In utilizing this formation, all aircraft are already positioned for any en route weather penetration. At the flight lead's discretion, the individual aircraft may increase nose-to-tail separation to 1 mile (see Figure 2-9).

2.6.1.4 Tanker On-Course Refueling Formation. When the final turnout of the orbit pattern onto the refueling track has been completed, tanker aircraft shall form up into either formation option 1 or 2 (Figures 2-8 and 2-9) as briefed, crossing the ARCP at ARCT. It is imperative that tankers maintain formation during rendezvous to enable receivers to identify their respective tankers.

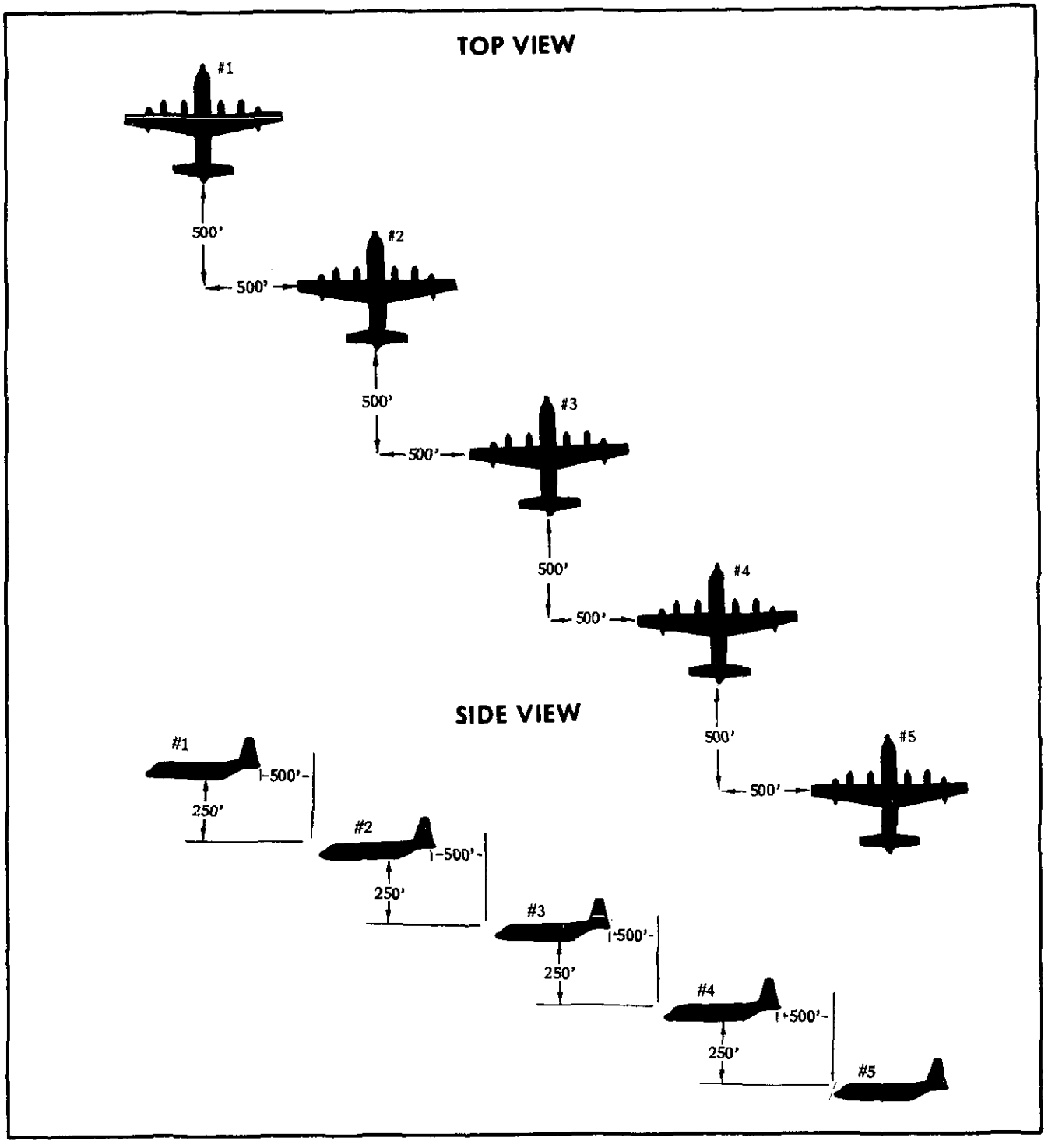

Figure 2-8. Static and On-Course Air Refueling Formation Option 1

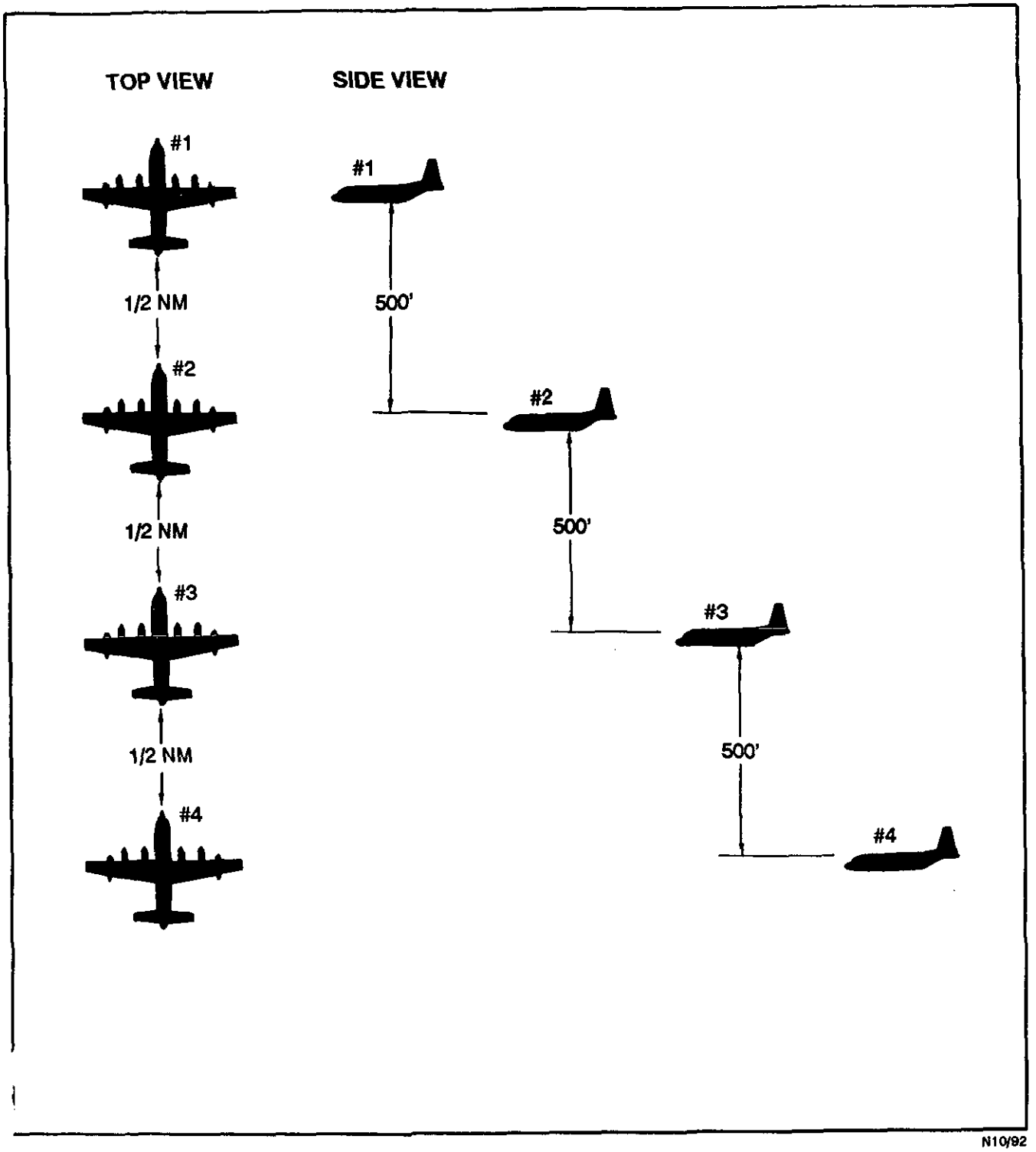

Figure 2-9. Static and On-Course Air Refueling Formation Option 2

2.6.1.5 En Route Weather Penetrations

1. When an outboard en route weather penetration is anticipated, the tanker force commander shall direct the tankers into a trail formation, stepped down with 1-mile interval between tankers, using air-to-air tacan and radar.

2. The tanker force commander shall assign individual tanker altitudes, using maximum separation compatible with block altitude assignments. Minimum vertical separation between tankers shall be 500 feet.

3. Individual tanker aircraft commanders shall acknowledge altitude assignments and report in position at assigned altitude.

4. The No. 1 tanker aircraft commander shall report all heading and true airspeed changes, and receive acknowledgment from individual tankers in the formation.

5. When an inbound weather penetration is anticipated, the tanker force commander shall direct the tanker force into a trail formation, stepped up, with 1-mile interval between tankers, using air-to-air tacan and radar and, following the procedure set forth in items 2, 3, and 4. A stepped-up trail formation is desirable when approaching destination to facilitate individual instrument approaches.

2.6.2 Emergency Weather Penetration During Refueling (While in Formation Option One). In-flight refueling shall not be conducted in IFR conditions. In the event the tanker formation encounters weather that requires penetration while conducting refueling, the RAC shall give a 2-minute warning before executing emergency weather penetration procedures (see Figure 2-10).

Upon receipt of the command of execution for weather penetration, the following shall be used:

1. All receiver aircraft shall remain engaged. If a disconnect occurs, the receiver shall maintain formation with his respective tanker.

2. The lead tanker shall initiate one-half standard-rate 60° turn to the left. This change in heading shall be held 2 minutes, then the original heading shall be resumed. The No. 5 tanker shall execute the same type of procedure except that the turn shall be to the right.

3. The No. 2 tanker shall delay 10 seconds, then execute a one-half standard-rate 30° turn to the left. This change in heading shall be held 1 minute, then the original heading shall be resumed. The No. 4 tanker shall execute the same type of procedure except that the turn shall be to the right.

4. The No. 3 tanker shall maintain a heading straight ahead.

5. Radar shall be utilized for station-keeping during the remainder of the weather penetration.

Depending on the various flight conditions, the receiver flight leader may elect not to accompany the tankers into adverse weather. In this event, the receiver flight leader shall notify the RAC to execute receiver disconnect. Upon disconnect, the receiver aircraft shall clear the tanker, remain on the refueling frequency, and climb straight ahead into visual flight rules (VFR) conditions. The RC shall, upon request, provide the necessary vectors to the receivers to establish them on a common tract. Range information shall be provided between sections with respect to the receiver flight leader. To accomplish this, the receiver aircraft (both aircraft in each section) shall set the assigned Mode 3 codes.

The RAC and the receiver flight may elect to execute a 180° turn prior to entering adverse weather, completing the refueling in a static orbit under VFR conditions.

2.7 NIGHT OPERATIONS

Night refueling is performed in essentially the same manner as during day refueling. All procedures will be in accordance with this manual and the current NAVAIR 01-75GAA-1 (KC-130F/C-130F) and current NAVAIR 01-75GAG-1 (KC-130R) series publications. Night vision goggle procedures for fixed-wing/rotary-wing operations shall consult the KC-130 Tactical Manual and MCO P3500.17/MCO P3500.5 for standard operating procedures.

2.8 EMERGENCY RESCUE CAPABILITIES

During transoceanic air refueling missions, the movement control officer will ensure that a search and air rescue (SAR) configured aircraft is available. Although the KC-130 is not configured for SAR missions, it can assist in locating a downed receiver and delivering a Mark VII raft.

The basic problem in rendering assistance to personnel down at sea is locating their position and then keeping them in sight during the required maneuvering of the KC-130 prior to making the drop of the Mark VII. The commander of the rescue aircraft should direct all off-duty crewmembers and as many passengers as may be available to maintain a lookout for the downed pilot. Once sighted, it is important that the person or persons discovering the position of the downed crew(s) maintain visual contact, giving verbal directions to effect the rendezvous. Abrupt movement of the rescue aircraft at this point may cause the lookout to lose sight of downed personnel. A suggested method for effecting rendezvous would be to follow the vectors given by the downed pilot, who would be using his survival radio. If after visual contact with the rescue aircraft the downed crew(s) for any reason suspect(s) that the rescue aircraft has lost sight of them, they should signal by any available means. A Mark VII raft shall be carried aboard the KC-130 when air refueling over water. A description of the Mark VII raft and its contents are covered in NAVAIR 13-1-6.1.

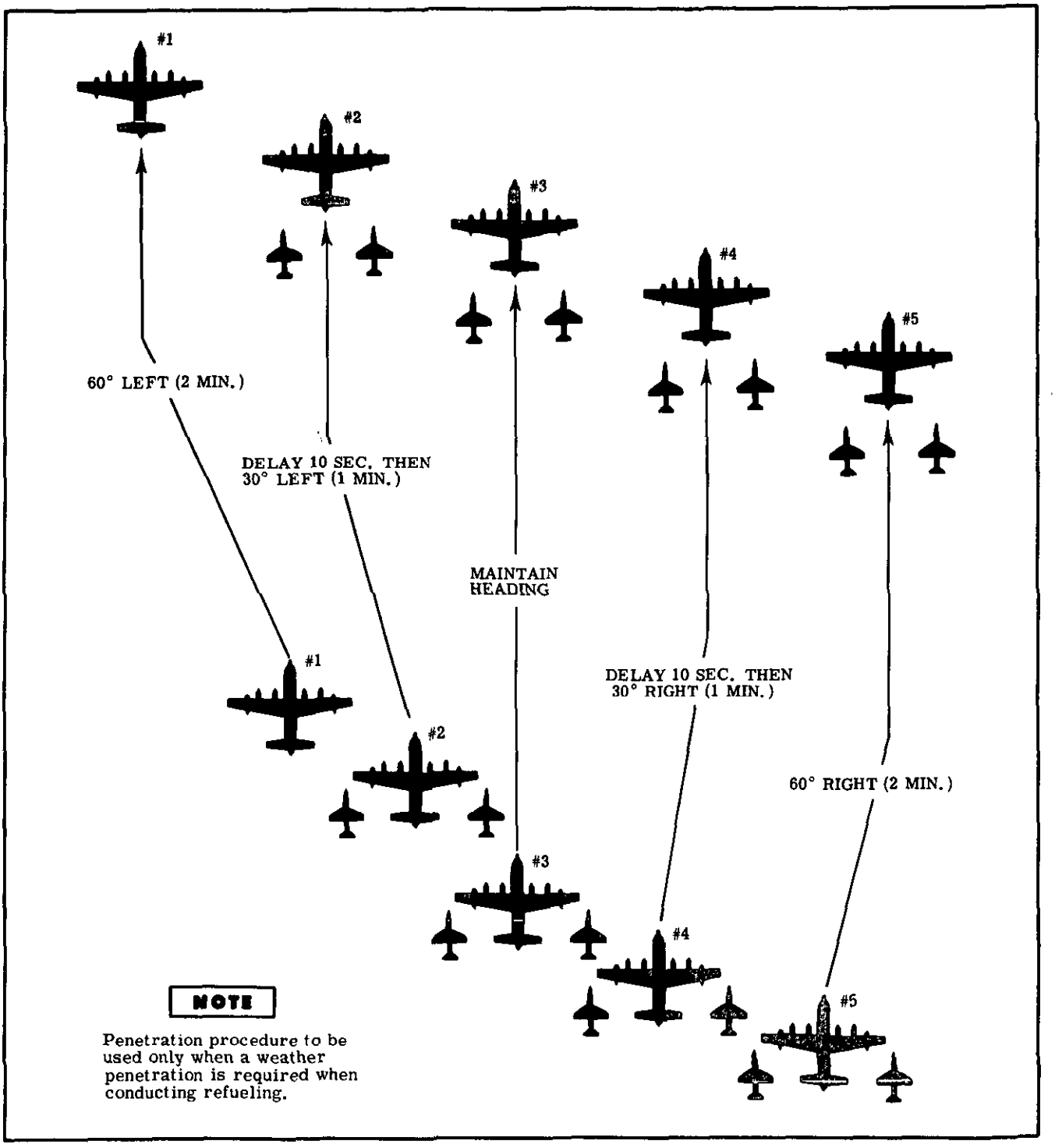

Figure 2-10. Emergency Weather Penetration Procedures (Formation Option 1)

CHAPTER 3

Tactical Tanker Capabilities and Procedures

3.1 GENERAL

The aerial refueling capability of tactical tankers is twofold: to refuel aircraft in an emergency situation and to extend the combat radius of strike aircraft. To utilize fully this capability, strike leaders and receiver pilots must be aware of and understand tanker aircraft limitations and operation. At the present time, there are three types of carrier aircraft capable of serving as tankers: the S-3, A-6, and A-7. This chapter will discuss the refueling components of these aircraft and the overall concept of refueling procedures.

Detailed tanker and receiver capabilities, flight characteristics, rendezvous techniques, and pilot techniques for drogue engagement/disengagement are promulgated in the appropriate aircraft NATOPS flight manual.

Basic carrier air refueling procedures are promulgated in the CV NATOPS Manual (NAVAIR 00-80T-105). Detailed procedures for individual carriers are promulgated in each carrier's air operations manual.

Shore-based air refueling procedures shall be in accordance with this manual and applicable directives of cognizant type and unit commanders.

3.2 EXTERNAL AERIAL REFUELING STORES

The externally carried D-704 aerial refueling store (Figure 3-1) enables the S-3 and A-6 aircraft to serve as tankers. The 700-pound (empty weight) store contains a 300-gallon fuel cell, a self-contained hydraulic system operated by a constant-speed ram-air turbine-driven hydraulic pump, a hydraulically driven fuel pump and hose reel assembly, and 50 feet of refueling hose, with an attached drogue measuring 2 feet in diameter. White rings mark the hose every 2 feet for the last 20 feet to be unreeled. The store transfers 180 gpm at a pressure of 35 to 55 pounds per square inch (psi). The operational envelope of the store with the drogue extended or extending is limited to 300 KIAS or 0.80 Mach, whichever is lower, at altitudes from sea level to 35,000 feet. Maximum speed for retracting the drogue is 250 KIAS. At the aft end of the refueling store are two lights: amber (left side) and green (right side). The amber light illuminates when the hose is extended, indicating that the receiver aircraft may now engage the drogue. After engagement, the receiver aircraft must move forward from 3 to 6 feet until the amber light goes out. Illumination of the green light indicates that fuel is flowing from the tanker to the receiver. The intensity of these lights can be controlled for day and night operations.

3.3 DESCRIPTION OF TACTICAL TANKER SYSTEMS

3.3.1 KA-6D Tanker. The KA-6D tanker can conduct refueling operations at altitudes up to 35,000 feet, at indicated airspeeds of 220 to 320 knots, with a desired airspeed of 250 to 270 KIAS. It is capable of transferring 23,300 pounds of fuel when carrying 5 external drop tanks.

The tanker package is located in the aft equipment compartment and consists of a drogue 26 inches in diameter and 55 feet of hose marked every 10 feet with a white band 1 foot in length. When retracted, the drogue is housed in a faired canister protruding from the lower portion of the fuselage. The store is capable of transferring up to approximately 350 gpm, depending upon the receiver aircraft's acceptance rate.

Lighting consists of normal navigation wingtip lights, fuselage formation lights, a white tail light, and a green anticollision light on the vertical stabilizer. In addition, there are two sets of red, amber, and green advisory lights (one set located on each side of the canister), a green anticollision light mounted under the nose, and one amber light mounted at the aft end of each outboard pylon as shown in Figure 3-2. The intensity of the advisory light can be controlled for day or night operation. Amber advisory lights indicate to

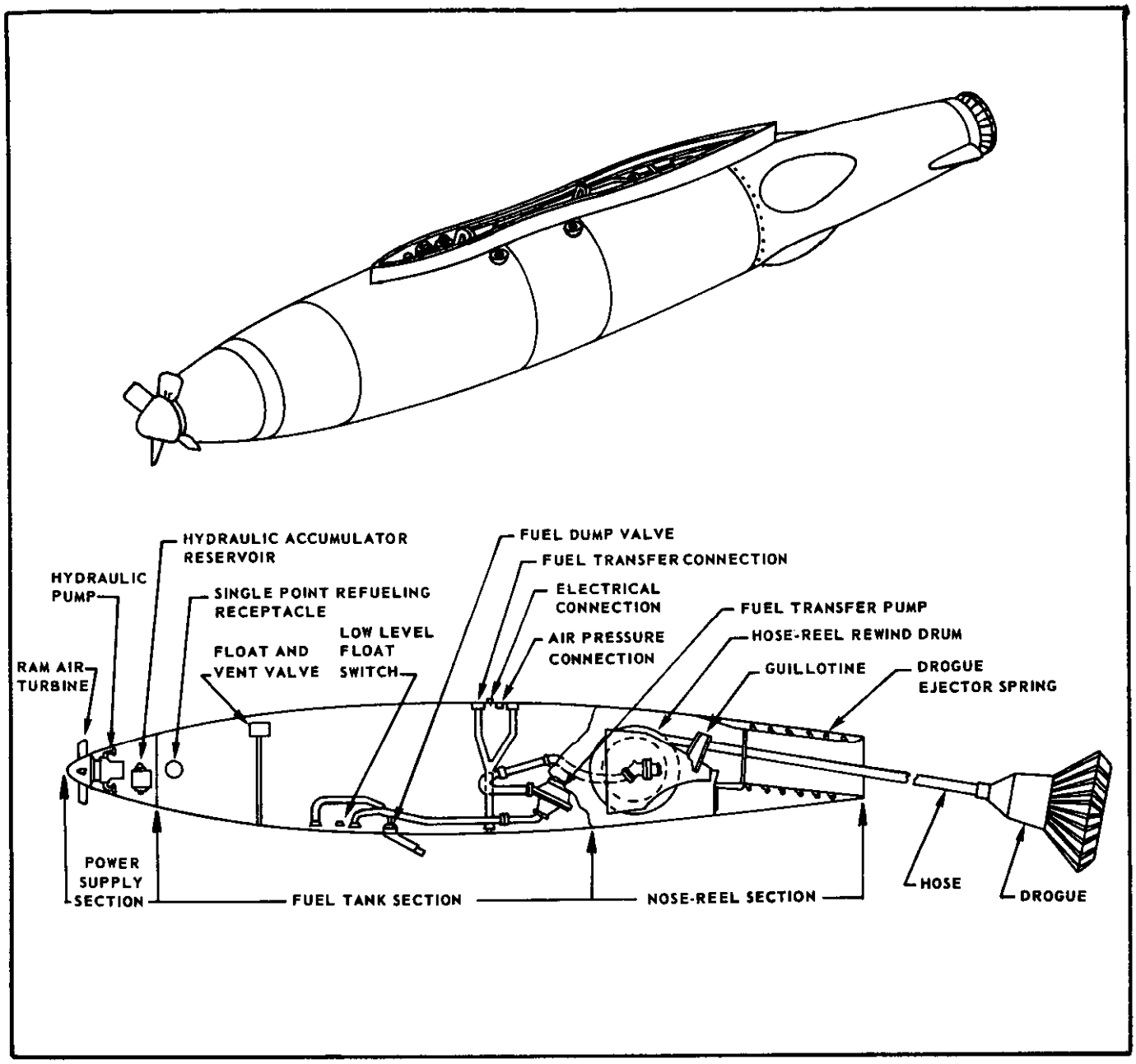

Figure 3-1. Aerial Refueling Store

the receiver pilot that the hose is extended to full trail and ready for engagement.

CAUTION

If refueling is attempted without the amber advisory lights illuminated or with a fuel transfer failure, ensure that the receiver aircraft engages and disengages the drogue only when cleared by the tanker pilot. Should the receiver aircraft attempt to disengage under these conditions without prior approval of the tanker pilot, damage to both aircraft is possible.

The amber light will go out when the receiver aircraft engages and commences pushing in the hose. The hose must be pushed in 5 feet to begin fuel transfer and will stop fuel transfer if the hose is pushed in more than 25 feet. The green advisory lights will illuminate when transfer begins and will go out when transfer stops.

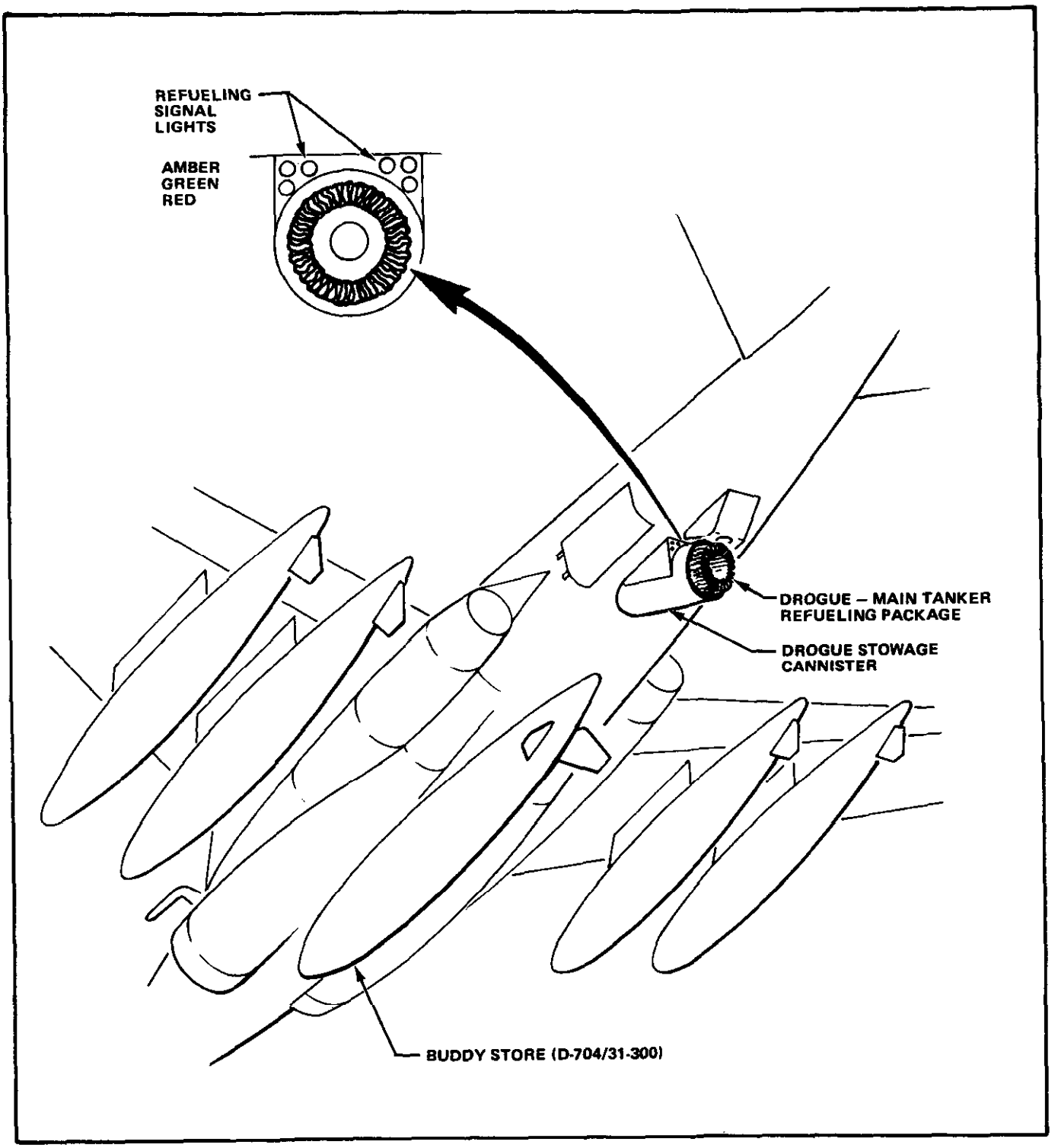

Figure 3-2. KA-6D Air Refueling System

CAUTION

If the red advisory lights illuminate or if fuel or hydraulic fluid is observed leaking from the aft refueling bay, immediately inform the tanker aircraft.

3.3.2 A-6 With External Refueling Stores. The A-6 may carry up to 16,000 pounds of fuel internally, 2,000 pounds in the refueling store, plus 2,000 pounds in each of 4 drop tanks, for a total of 26,000 pounds. All but 3,600 pounds may be transferred to receiver aircraft. The rate of transfer of fuel to the refueling store is sufficient to ensure uninterrupted fuel transfer during refueling operations. The refueling store is suspended from the centerline station of the tanker.

In addition to the standard formation and position lights, two pylon lights are available on the tanker, one in the aft end of each outboard pylon. The brilliance of these lights is controlled in conjunction with the refueling lights on the store.

3.3.3 S-3 With External Refueling Stores. The S-3 tanker may carry 13,100 pounds of fuel internally, 2,000 pounds in one store, plus 2,000 pounds in one external drop for a total of 17,100 pounds. Two thousand pounds is unavailable for transfer. Any fuel transferred from either the wings or the external drop tanks goes directly to the fuselage fuel cells and similarly becomes available. The rate of fuel transfer from the external drop tanks to the D-704 approximately equals the rate at which the D-704 can fuel receiver aircraft. The normal configuration is a buddy store on the left wing pylon and an external store on the right wing pylon.

A comparison of tanker capabilities is presented in Figure 3-3.

3.3.4 Lighting. All tactical tanker aircraft should display a green anticollision light.

3.4 AIR REFUELING BRIEFING

Prior to each mission, the following items shall be briefed (as applicable):

1. Type refueling (on course or static)
2. Tanker station
3. Tanker communications (frequencies and procedures)
4. Tanker and receiver call signs and modex
5. Tanker on station time
6. Rendezvous
7. Formation
8. Refueling procedures
9. Detaching procedures
10. Total amount of fuel available for transfer considering tanker recovery time
11. Receiver fuel requirements
12. Alternate refueling plans
13. Provisions for spare tanker.

3.5 RENDEZVOUS

There are three basic types of rendezvous: tacan circling, running, and geographic. Various aids are available to assist aircraft in locating the tanker: UHF/

MAX FUEL CARRIED (POUNDS)				FUEL NOT AVAIL FOR TRANSFER	STORE LOCATION
A/C	INT	EXT	STORE		
A-6	16,000	8,000	2,000	3,600	Centerline
KA-6D	16,000	10,000		2,700	Fuselage
S-3	13,100	2,000	2,000	2,000	Wing Station

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Figure 3-3. Tanker Capabilities

automatic direction finder (ADF), air-to-air tacan ranging, and surface and airborne radars.

3.5.1 Rendezvous Safety

1. Avoid area aft of tanker during rendezvous.

2. While rendezvousing on the tanker, pilots shall be alert for other aircraft in the vicinity of the tanker.

3.6 REFUELING OPERATIONS

3.6.1 Training and Refresher Refueling

3.6.1.1 Prior to Refueling (KA-6)

1. The receiver aircraft shall rendezvous in echelon abeam the tanker, ensuring that the area aft of the tanker is clear. Upon a signal from the flight leader, the tanker should stream the drogue.

2. After drogue extension, the flight leader should move the flight to a position abeam the drogue.

3. Recommended refueling speed range is 250 to 270 KIAS; however, type, gross weight, and configuration of receiver aircraft may govern the refueling speed. The flight leader should advise the tanker pilot if a change in speed is required.

3.6.1.2 Prior to Refueling (Buddy Store)

1. The receiver aircraft shall rendezvous in echelon abeam the tanker, ensuring that the area aft of the tanker is clear. The flight leader's position shall be abeam the tanker with at least 200 feet separation for safety in the event a turbine blade should fly off during unfeathering.

2. When the rendezvous is completed and the area aft of the tanker is cleared, the flight leader shall give the "drogue extend" signal. Upon receiving this signal, the tanker pilot should unfeather the turbine.

3. The flight leader shall indicate by a "thumbs-up" or "thumbs-down" whether or not the turbine is unfeathered. If the turbine does not unfeather, the tanker shall secure the store and not make further attempts to unfeather unless failure to provide fuel would place receiver aircraft in jeopardy.

4. If the turbine unfeathers on the first attempt, the tanker should respond to the thumbs-up signal of the flight leader by extending the drogue.

Note

After the turbine has been unfeathered and the drogue extended, the flight leader shall check the buddy store for evidence of hydraulic fluid leaks. If there is any evidence of hydraulic fluid leaking from the store, the drogue should be retracted immediately.

3.6.1.3 Refueling (All Tanker Aircraft)

1. The tanker pilot, as leader of the refueling formation, has the primary responsibility for maintaining a good lookout for other aircraft, although other members of the flight are responsible for assisting to the maximum extent possible.

2. Receiver pilots shall place any forward-looking radar on standby, lower helmet visor, and position necessary cockpit switches for receiving fuel.

3. The first receiver aircraft shall detach and move into position 10 to 20 feet behind and slightly below the drogue only after the lower rotating beacon has been turned off. Observe the amber light on the tanker, indicating that the drogue may be engaged. If the amber light is not on, advise the tanker pilot. Do not engage the drogue with the amber light out unless cleared to do so by the tanker pilot. Techniques for engaging the drogue are discussed in NATOPS flight manuals for applicable type aircraft.

4. Closure speed should be 3 to 5 knots. After engaging the drogue, continue to push the hose in until the amber light is out (about 5 to 8 feet). The green light on the tanker will illuminate only during fuel transfer.

5. The receiver should maintain a position so that if some opening between the tanker and the receiver occurs, transfer will not be interrupted. This position should also be along the natural trail position of the hose. The hose must be kept centered slightly above the lip of the fairing.

6. In the event sufficient fuel is transferred to deplete the auxiliary tank/buddy store of the tanker, the green transfer light will illuminate intermittently as fuel becomes available. If the receiver aircraft requires additional fuel, he may remain plugged in or back out, at his discretion, until the tanker is able to transfer more fuel into the refueling package.

3.6.1.4 Disengagement Procedures (All Tanker Aircraft)

1. To disengage from the drogue, the receiver pilot should return the drogue to the position at which it was first engaged and then establish a slow opening rate by reduction of power. The use of speedbrakes is not recommended. Backing out should be done slowly and directly aft of the natural drogue trail position with no vertical or lateral motion. A slight tug will be felt as the probe and drogue disengage. In the event the receiver aircraft is not in the proper position to disengage, the drogue may whip violently and damage either the receiver or tanker aircraft. The receiver probe may be bent or broken or the tanker drogue may be damaged by improper disengagement techniques. The receiver should not move away from the drogue until all members of the flight are sighted. To facilitate this, it is necessary that all flightmembers properly maintain their position in echelon. The call "Clear" shall be transmitted when the aircraft is well clear of the area behind the drogue.

2. In order to supervise the refueling, the flight leaders, after disengagement, should move to the side of the tanker opposite to that which was used for standby. After the flight leader is clear of the drogue, the No. 2 man in the flight will move into position and make his plug-in. Upon completion of refueling, he should disengage and join the leader in loose echelon.

3. Emergency breakaway action by the receiver aircraft may become necessary because of difficulties in either tanker or receiver aircraft. Emergency breakaway may be signaled by the transmission "breakaway-breakaway," or by illumination of the lower green anticollision lights. The receiver aircraft should make an expeditious return to the normal disconnect position and disengage without delay, using the normal disconnect procedures. If normal disconnect procedures are followed, the complicating results of damage to the tanker and/or receiver aircraft can be avoided. In an extreme situation, it may be necessary for the tanker to add power and accomplish the emergency breakaway by pulling ahead.

3.6.2 Mission Refueling. During fleet operations where refueling becomes a part of daily flight operations or in tactical situations where refueling becomes a necessity because of combat action, combat damage, or other such emergencies, routine briefings prior to refueling are not possible. The procedures and signals promulgated for training and refresher fueling may therefore be amended as required to enhance efficiency and to meet the requirements of the given situation. In these circumstances, the individual briefing items covered in paragraph 3.4, AIR REFUELING BRIEFING, should be standardized wherever possible. Periodic briefings covering all these items must be held often enough to ensure that all pilots understand and are thoroughly familiar with the established procedures. Any deviation from standardized procedures must be the subject of a briefing prior to the mission. Cognizant commanders should ensure that amendments and standardization of procedures do not compromise safety.

3.6.3 Night Refueling. Night refueling is performed in essentially the same manner as during the day. The tendency in night air refueling is for the receiver to start the approach too far aft. This compounds the already difficult problem of judging relative motion at night and contributes to the possibility of a high closure rate.

Light configurations shall be in accordance with NATOPS; however, the receiver pilot should request adjustment of the tanker lights whenever necessary to meet his requirements.

3.6.4 Aerial Refueling Hazards

1. Tanker or drogue streaming fuel or hydraulic fluid — An engagement should not be attempted and the tanker shall be informed by the receiver.

2. Oscillating drogue — Caused by ripped canopy on basket rim, usually tanker altitude, or air turbulence. Tanker can possibly change altitude/airspeed or cycle drogue to minimize effects.

3. Misaligned initial approach position requires radical corrections to effect engagement. Receiver aircraft may strike with drogue or hook the hose with refueling probe.

4. Excessive engagement speed — Last minute corrections have to be more abrupt, and the possibility exists that excessive hose whip upon engagement will break probe-drogue coupling connection.

5. Misaligned at high closure speeds — The drogue may contact radome, nose section, canopy, etc., and cause damage. If the rogue is missed, remain clear of the drogue and back straight out until the drogue is in sight. Avoid looking up and/or back for the drogue since this may cause inadvertent back pressure on the stick and result in a climb into the drogue or tanker aircraft. Instead, use the tanker as a reference until safely aft of the drogue.

CAUTION

It is necessary to back straight down to preclude aircraft and drogue contact or entanglement with aircraft protrusions.

6. Too slow an engagement speed — Induced drogue oscillations with immediate danger to receiver aircraft windscreen and canopy. Difficulty may be experienced in properly seating the probe in the drogue.

7. Excessive disengagement speed — Possible separation of hose and drogue assembly from the tanker.

8. Misalignment on disengagement will result in drogue whip and possible equipment damage.

3.6.5 Communication. The amount of active radio communications between aircraft engaged in aerial refueling is dependent upon the degree of training. A moderate number of radio transmissions may be required during initial training, but after training has progressed to a point where pilots are proficient, radio transmissions are unnecessary and undesirable. The voice transmissions required (if necessary) by receiver aircraft are "stabilize/precontact," "contact," "clear," and "breakaway." See Figure 3-4 for hand signals.

3.6.6 Completion of Refueling. When the last member of the receiver flight has completed refueling and has cleared the area aft of the tanker, the flight leader shall monitor the retraction and stowing of the drogue and feathering of the turbine of the buddy store. The flight leader shall signal the tanker pilot when he is cleared to retract the drogue, and signal when the store is secured.

Separation of the receiver flight and the tanker may be accomplished by either element commencing a turn away from the refueling course and either or both changing altitude. Both the flight leader and the tanker pilot must understand the procedures to be used, and a course and altitude differential should be obtained by each. During departure, a careful lookout should be maintained to avoid other tankers or flights.

DAY	NIGHT	MEANING
Closed fist, thumb moved to mouth plus hand signaled number.	Flash external lights once for each 1,000 pounds.	Receiver requests - - - - - - - - thousand pounds of fuel.
One-finger turnup.	Circular flashlight motion.	Unfeather D-7Ø4 prop.
Cone-shaped hand, fingers aft, moved aft.	Extend probe, probe light on.	Extend drogue.
Thumbs up.	Circular flashlight motion.	Cleared to tank.
Green light out, amber light on.	Same as day.	Programmed/requested fuel was delivered.
Lower anticollision lights coming on during tanking.	Same as day.	Emergency breakaway.
Cone-shaped hand, fingers forward, moved forward.	Stow probe, secure probe light.	Retract drogue.
Thumbs up.	Circular flashlight motion.	D-7Ø4 secured/drogue stowed.
Wave "bye-bye."	Anticollision lights on.	Cleared to detach.

Figure 3-4. Visual Signals

CHAPTER 4

Strategic Tanker Capabilities and Procedures

4.1 GENERAL

This chapter provides a description of the KC-135 and KC-10 refueling system, differences in U.S. Air Force (USAF) rendezvous procedures, and specific aerial refueling operational procedures. This chapter is extracted from current USAF publications; differences between standard formations, voice reports, or procedures established by other portions of this manual should be noted.

4.2 DESCRIPTIONS OF TANKER SYSTEMS

4.2.1 KC-135 Systems. The KC-135 is normally configured with a single flyable boom; however, this may be modified by the incorporation of a standard drogue.

4.2.1.1 KC-135 Boom System. The KC-135 flyable boom extends to preset limits that control receiver director lights.

4.2.1.1.1 Boom Envelope Limits. The air refueling boom envelope is the operational limits dictated by the aerodynamic control authority of the boom. As long as the receiver is positioned inside the limits, contact can be held despite rolling, yawing, or pitching. The envelope limits are set well within the mechanical limits of the boom so that disconnect will normally take place before any structural damage occurs (Figure 4-1).

CAUTION

Approaching boom limits at relatively high velocity can cause structural damage as a result of an inability to disconnect because of binding action of the boom nozzle.

Note

The boom operator will disconnect when 10° left or right azimuth is exceeded.

4.2.1.1.2 Receiver Director Lights. Receiver director lights (Figure 4-2) are on the bottom of the fuselage between the nose landing gear and the main landing gear. They consist of two rows of lights: the left row for elevation and the right row for telescoping. The triangular-shaped panels are for elevation and the rectangular-shaped panels are for forward and back movement. The elevation lights consist of five colored panels with a green stripe, green and red colors, and two illuminated letters "D" and "U" for down and up, respectively. Background lights are located behind the panels. The colored panels are illuminated by lights that are controlled by boom elevation during contact made. On the telescoping side, the colored panels are not illuminated by background lights. There is an illuminated white panel between each panel to serve as a reference. The letter "A" for aft and "F" for forward augment the colored panels on the telescope side. The receiver pilot director lights will remain illuminated and follow boom movements in both the contact made and disconnect conditions. There are no lights for azimuth position. A fluorescent yellow stripe on the bottom center of the tanker fuselage may be used as a centerline reference by the pilot. The director lights do not give true vertical and horizontal information. The up and down lights change because of angular movement of the boom; the fore and aft lights change because of in and out movements of the boom. The axis of the director light system is inclined at a 30° angle to the tanker fuselage. This angle causes an interaction in both lights when a true vertical or horizontal movement is made by the receiver. For example, flying straight forward while in contact will cause the boom to compress and also increase its angle with the tanker fuselage. The lights

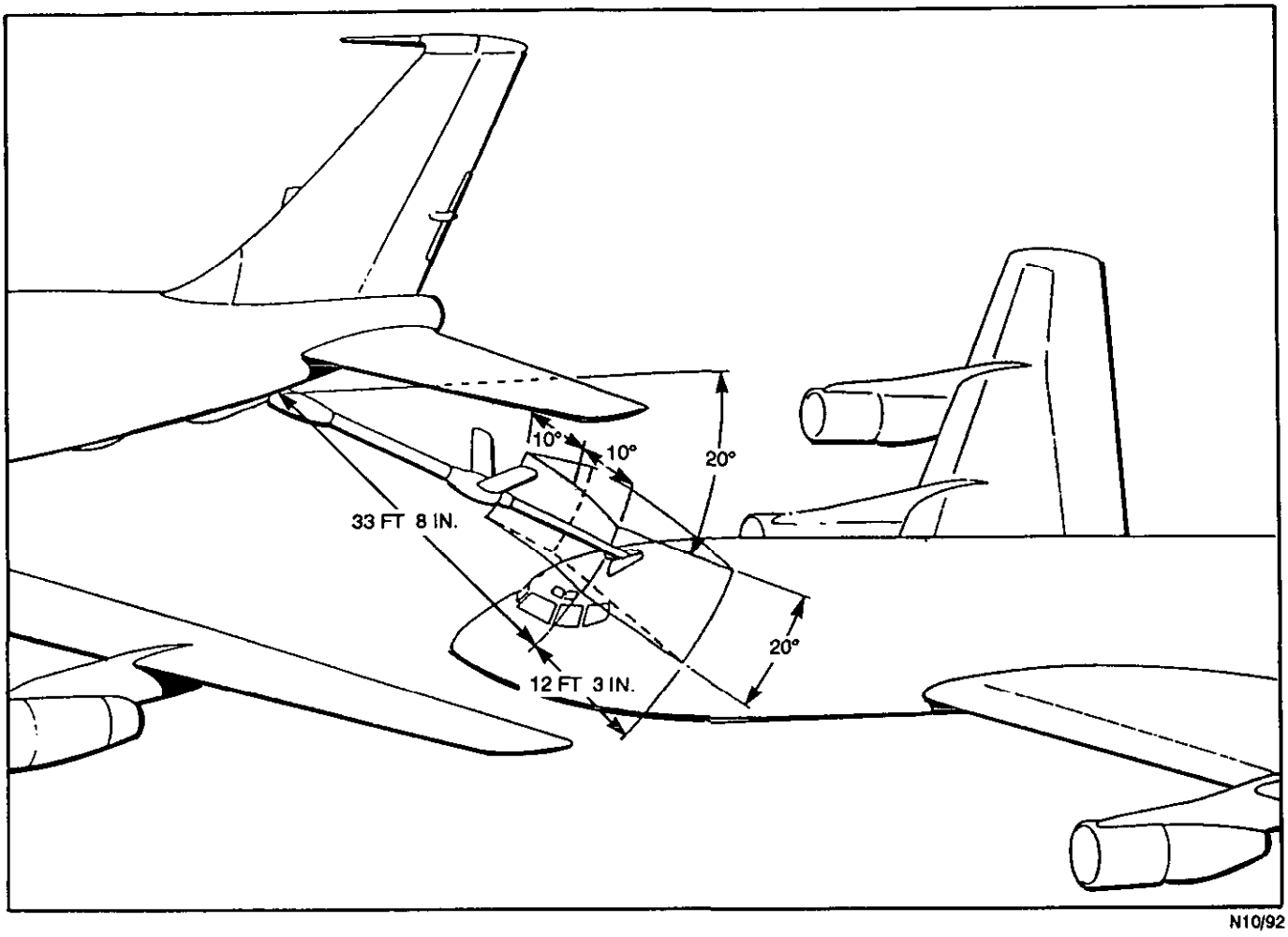

Figure 4-1. KC-135 Boom Envelope Limits

will show that the aircraft is flying forward and down. If a true up movement is made, the boom will compress and also decrease its angle with the tanker fuselage giving a combined up and forward indication from the lights. When this interaction between the lights is understood, it can be used to the receiver pilot's advantage in maintaining position. Small forward and aft corrections can be made with little or no power change by moving vertically. The receiver pilot director lights will remain illuminated and follow boom movements in both the contact made and disconnect conditions.

4.2.1.2 KC-135 Drogue System. The drogue kit uses a standard drogue/coupling attached to the telescoping portion of the boom via a 9-foot length of hose.

CAUTION

There is no hose response with this system. Receiver aircraft should exercise extreme caution during the engagement phase in order not to engage the hose at an excessive closure rate; to do so could result in a broken hose/probe condition.

The KC-135 will transfer fuel at the maximum rate possible. Actual transfer rates are governed by the fuel-flow capability of the receiver system.

Optimum altitudes and airspeeds for refueling operations should normally be those prescribed for optimum operation of receiver aircraft or aerodynamic load restrictions on the receiver probe.

4.2.2 KC-10 System. The KC-10 is a tanker/ cargo aircraft with both boom and two hose reel systems (Figure 4-3). A centerline hose reel system is permanently installed in a compartment on the starboard side of the boom operator viewing window. A wing aerial refueling pod system (WARPS) consists of pods that can be mounted to each wingtip. Total fuel offload capability of the aircraft is approximately 300,000 pounds.

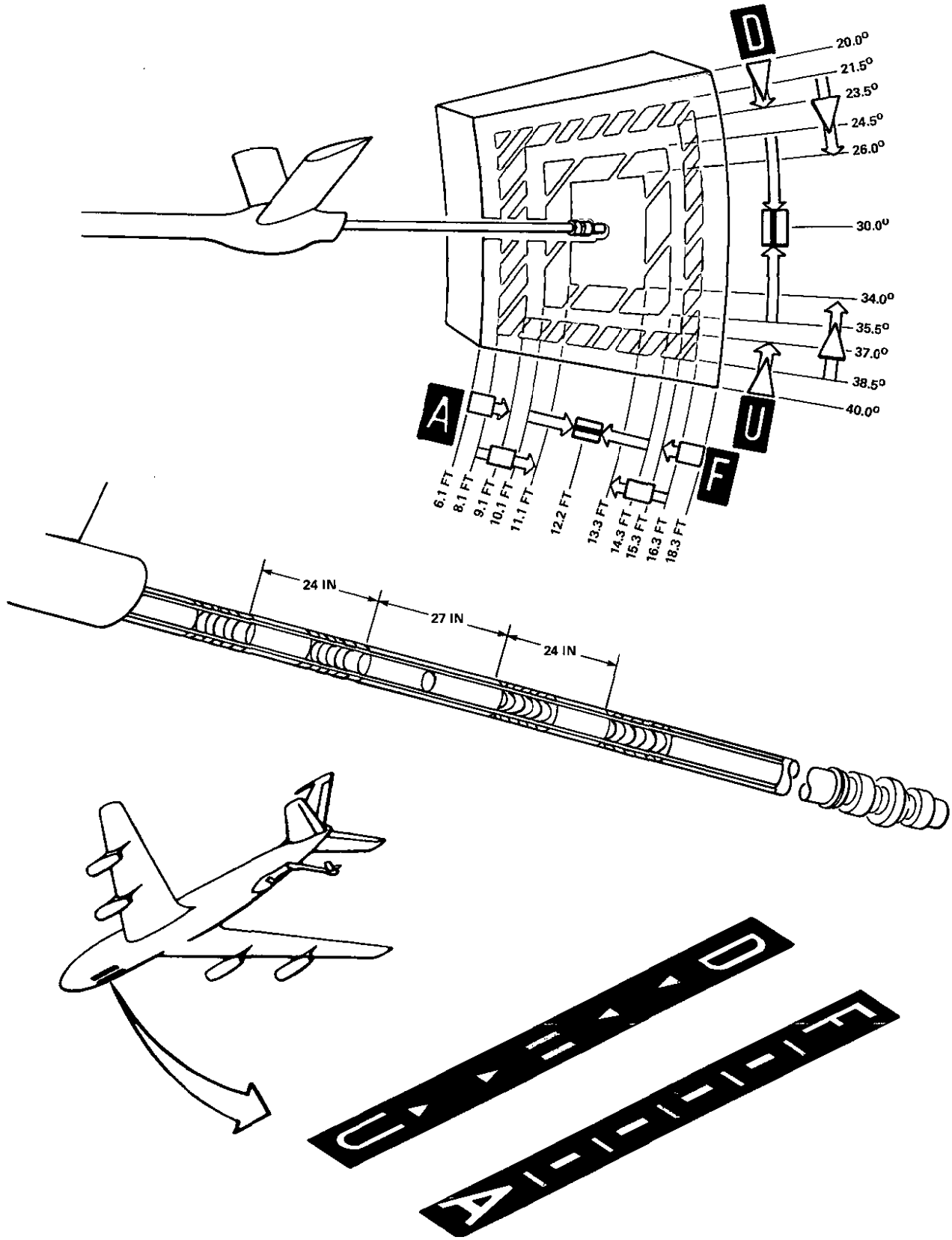

Figure 4-2. KC-135 Pilot Director Lights

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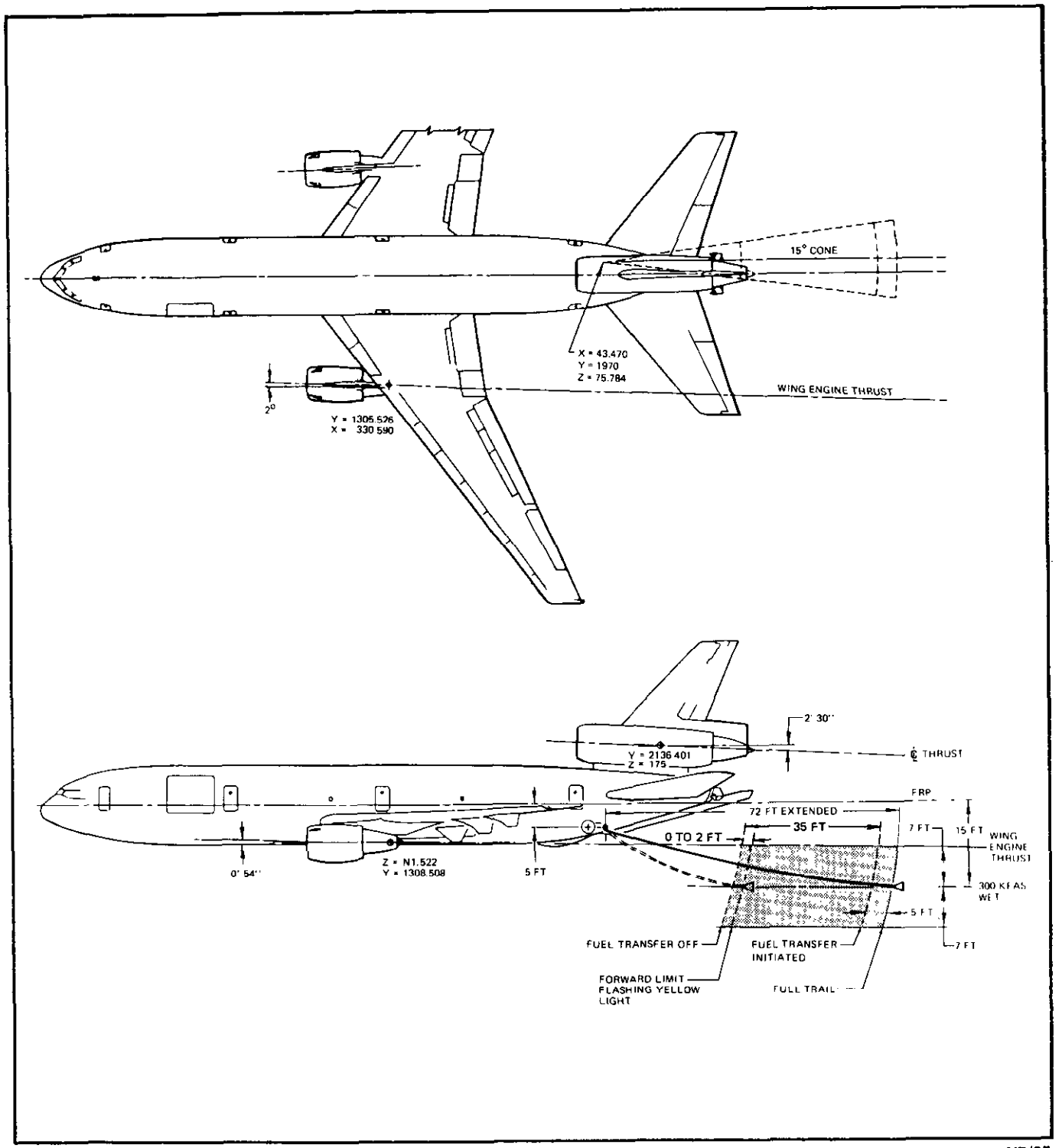

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Figure 4-3. KC-10 Centerline Drogue Refueling Envelope (Showing Engine Thrustlines)

4.2.2.1 KC-10 Boom System

4.2.2.1.1 Boom Envelope Limits. The KC-10 boom limits are shown in Figure 4-4.

a. Pilot Director Lights. The pilot director lights (Figure 4-5) consist of two rows of lights located forward of the wing root. Relative elevation position is provided by the left row; the right row provides telescoping position. The elevation row contains one green, two amber, and two red triangular panels and two white letters: "U" at the forward end for up and "D" at the aft end for down. The colored panels and letters are dimly illuminated by background lights. The telescoping row contains one green, two amber, two red, and four white rectangular panels and two white letters: "A" at the forward end for aft and "F" at the aft end for forward. The colored panels are not background lighted; however, the letter at each end of the row is dimly illuminated. Separation is provided by the white panels. The pilot director lights automatically adjust to the size of refueling envelope for each receiver and provide guidance during contact and disconnect.

To provide more response time, the appropriate panel and letter are illuminated in anticipation of receiver movement. The director lights provide commands based on both receiver position and rate of movement. With rapid motions of the receiver, the lights can show a correction required even though the receiver is in the center of the envelope. The red panel

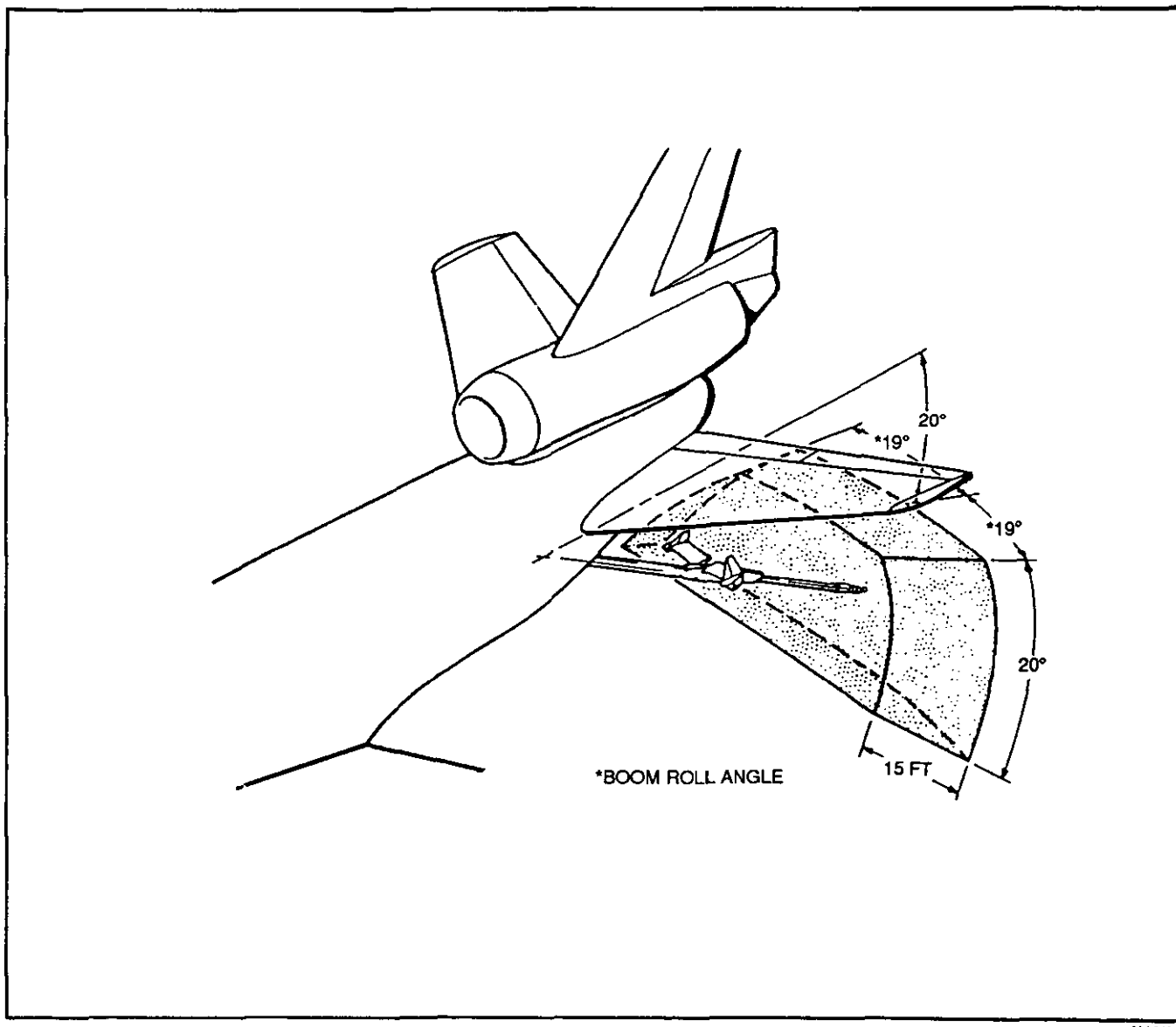

Figure 4-4. KC-10 Boom Envelope Limits

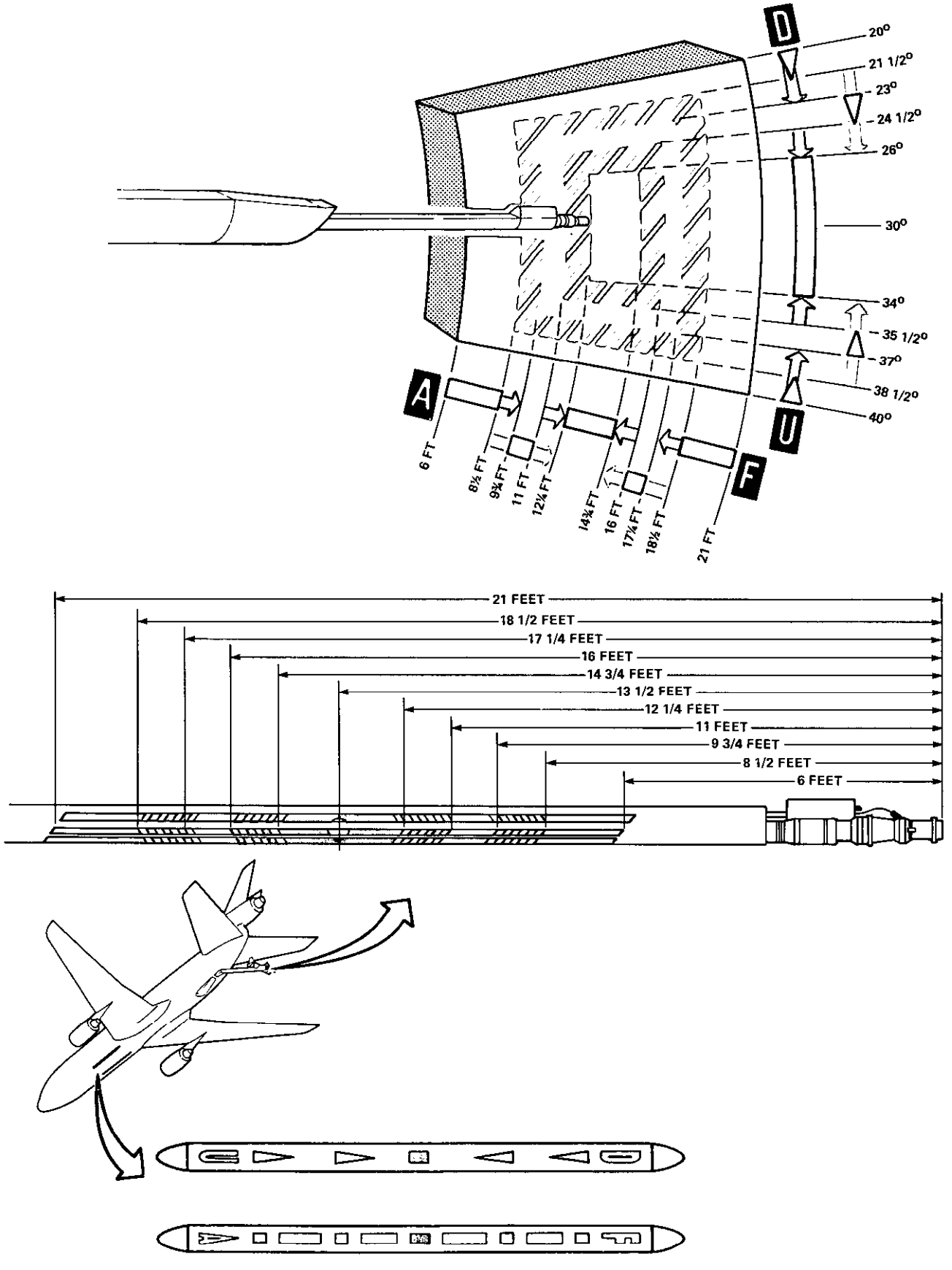

Figure 4-5. KC-10 Pilot Director Lights

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and letter at the ends of each row can be illuminated by the boom operator to aid the receiver in attaining the contact position.

b. Disconnect KC-10. The KC-10 aerial refueling boom is controlled by a digital fly-by-wire system. Certain failure conditions of this system may cause one or more axes of the boom control system to become inoperative. Should this occur, the boom operator may not be able to maneuver the boom to avoid striking the receiver aircraft. In this situation, the boom operator will issue instructions to direct the receiver to a position where a safe disconnect can be effected.

WARNING

When notified that a KC-10 boom flight control system failure has occurred, do not initiate a disconnect unless directed by the boom operator.

Follow explicitly the boom operator's instruction. To reduce the probability of the boom strike after disconnect, it may be necessary to remain in a stabilized position to allow for aerodynamic faring of the boom control surfaces.

Another feature of the KC-10 is the independent disconnect system. This system allows the KC-10 boom operator to obtain a disconnect even when the receiver's toggles remain in the latched position. This system should be used in lieu of the brute force disconnect.

4.2.2.2 Centerline System. The hose on the centerline system is 80 feet in length with approximately 70 feet of hose trailed. The hose is marked in 10-foot intervals with a 12-inch white band. The fuel flow area is marked by 12-inch white bands at 5-foot intervals. The fuel flow initiation position, the recommended refueling position, and the inner limit position are each marked by a 24-inch white stripe. The fueling range is approximately 5 feet from full trail for 35 feet. The drogue is 26 inches in diameter and has small lights for drogue illumination at night. There is also a hose floodlight that illuminates the hose exit area. Three signal lights (red, amber, green) that show the status of the reel system are located on the fuselage aft of the drogue stowage tube. A steady red light indicates that the hydraulic pressure is too low for hose reel operation. A flashing red light, controlled by the boom operator, is an emergency signal to the receiver to break away from the tanker. A steady amber light indicates the hose is in full trail position and the system is ready for contact. A flashing amber light indicates the hose has been pushed in past the inner fuel flow limit. A green signal light indicates that fuel is flowing (Figures 4-6 and 4-7). The centerline hose reel has the capability to transfer fuel at the rate of 600 gpm. See Figure 4-8 for drogue visual signals.

4.2.2.3 Wing Aerial Refueling Pod System (WARPS). The WARP system consists of one externally mounted hose and drogue pod located on the underside of each wing near the wingtip. The hose is 79 feet in length with approximately 74 feet trailed. The hose is white and is marked by black bands (Figure 4-9). The fuel flow initiation and the inner limit position are each marked by 24-inch black bands. The fueling range is approximately 5 feet from full trail for 18 feet. The first band is 24 inches wide and indicates the fuel flow initiation position. The next 3 bands are 4.5 feet apart and define the refueling envelope. The next band is 24 inches wide and signifies the inner limit. The rest of the markings are at 10-foot intervals as an aid to the boom operator. Three red guidelines are provided at each wingpod location to aid with alignment prior to contact. The drogue has small lights attached that illuminate it at night. A floodlight also illuminates the hose exit area. Red, amber, and green signal lights (Figure 4-10) are located on the underside of the aft tailcone fairing. A steady red light indicates that the pods are not ready for contact. If in contact, it indicates a malfunction with the pod. A flashing red light is an emergency signal to the receiver to break away from the tanker. A steady amber light indicates that the hose is in trail and is ready for contact. A flashing amber light indicates that the hose has been pushed in to 51 feet and that the inner limit (48 feet) is being approached.

CAUTION

When the hose is pushed in to approximately 46-foot trail, the takeup system stops and a "dead" hose will result. A loop could form that could strike the receiver aircraft.

A steady green light indicates that fuel is being transferred at a rate of 50 gpm or greater. The signal light goes out and fuel transfer is stopped if the hose is moved out of the refueling range. When the hose is returned to the fueling range, fuel transfer will resume and the green light will come back on. The pods have the capability to offload fuel at the rate of 400 gpm.

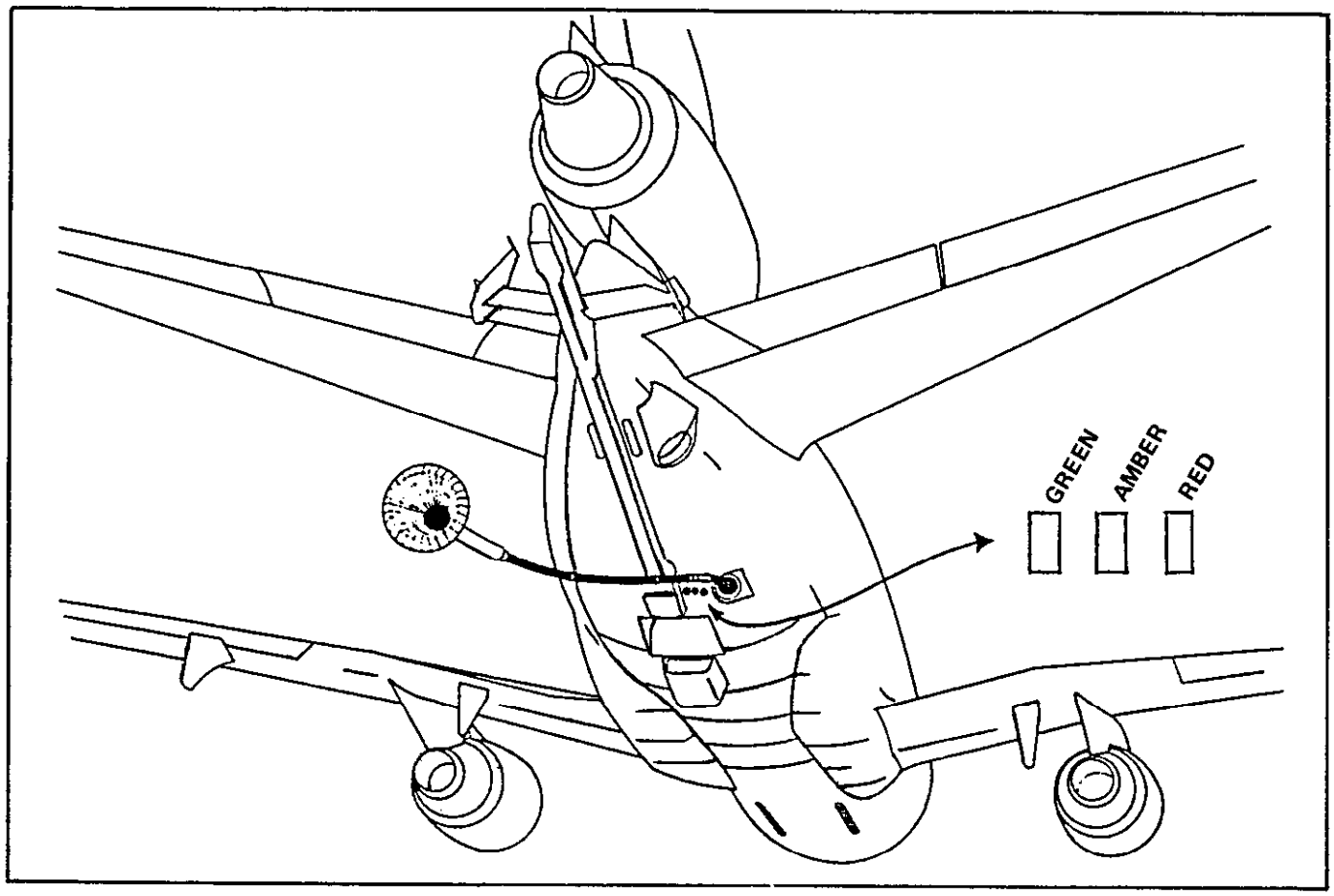


Figure 4-6. KC-10 Hose/Drogue Signal Lights

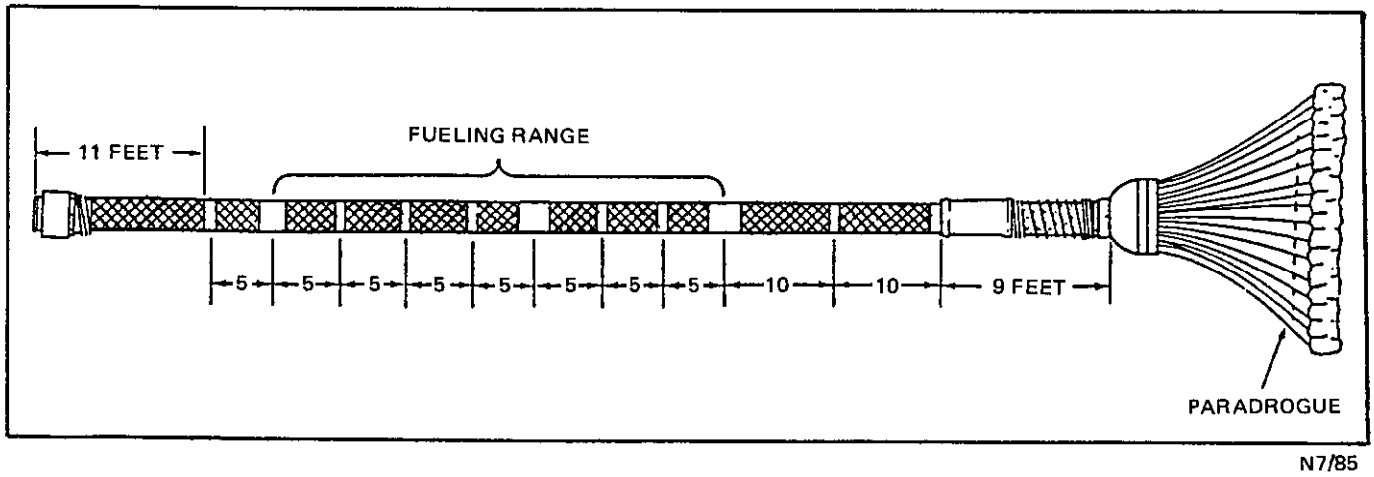


Figure 4-7. KC-10 Hose/Drogue Markings

MEANING	SIGNAL
1. Tanker ready for contact.*	Hose in trail with ready light on steady (amber).
2. Fuel offload complete.	Fuel flow light off (green).
3. Hose pushed in beyond fuel flow range (receiver probe tip beneath the refueling boom).	Flashing amber light.
4. Tanker aerial refueling system inoperative.	Drogue stowed, no lights.
5. Hydraulic pressure too low for hose reel operation.	Steady red signal light (hose might be either trailed or stowed).
6. Tanker request for disconnect. Receiver return to precontact position.	All three signal lights on. Green steady, amber and red flashing.
7. System malfunction. Receiver check air refueling systems.	Drogue stowed. All three signal lights on. Green steady, amber and red flashing.
8. Emergency breakaway.	Flashing red signal.
9. Receiver emergency fuel shortage exists.**	Receiver rocks wings or shows steady light.

*Receiver(s) in the observation position will move behind the drogue in their briefed sequence only after ensuring that the system ready light (amber) is on steady and the preceding receiver has cleared the tanker.

**If fuel shortage exists at times other than scheduled air refueling, the receiver should be positioned so the signal can be seen from the tanker cockpit.

Figure 4-8. KC-10 Drogue Visual Signals

4.3 WEATHER MINIMUMS

Rendezvous closure will not be continued inside 1-nm range unless visual contact is established with the tanker(s). Air refueling will not be continued when in-flight visibility is determined insufficient for safe air refueling operations.

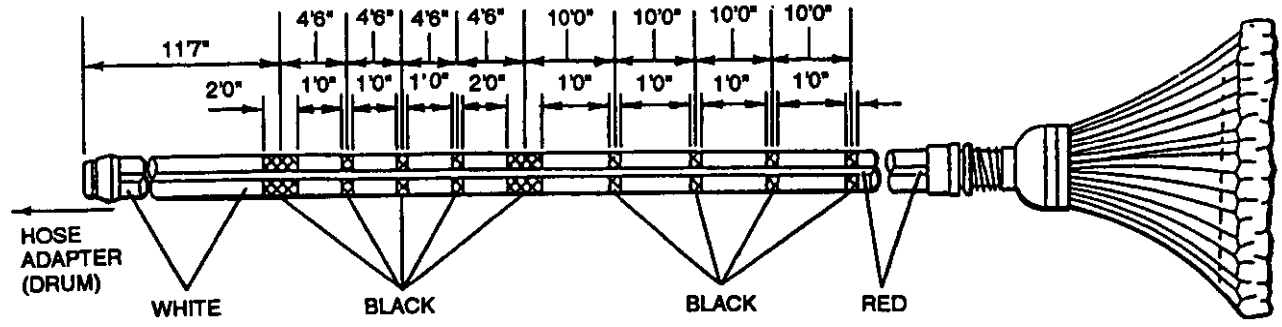
4.4 COMMUNICATIONS

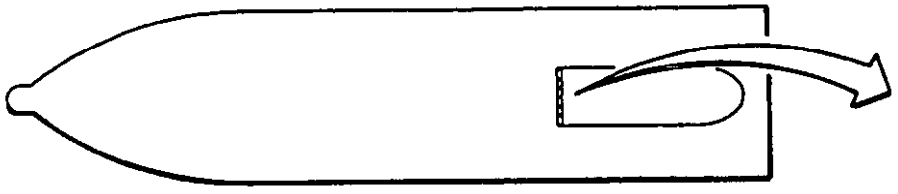
Emission option 2 will be used as the normal rendezvous and air refueling procedure. Emission option 2, 3, or 4 procedures do not preclude verbal communications for safety of flight situations or to ensure mission success. Radio calls are summarized in Figure 4-11.

Unless directed otherwise, communication capability between tankers and receivers will be maintained during all rendezvous and air refueling operations. Voice transmission, however, will be held to an absolute minimum in accordance with the emission option being used.

All crewmembers must be thoroughly familiar with all required oral, visual, and electronic means of communications. Strict radio discipline must be adhered to at all times. Calls will normally be prefaced with individual call signs. Tankers will begin monitoring designated frequencies and will have the radar/rendezvous beacon operating at least 30 minutes prior to the air refueling control time. The A/A tactical air navigation (tacan) will be tuned to the approximate channel 15 minutes prior to the air refueling control time unless required for navigational purposes. Receivers will call 15 minutes prior to the air refueling control time, advising the tanker(s) of call signs, any changes in ETA (minutes early or late), and altitude.

WING POD HOSE/DROGUE SIGNAL LIGHTS/MARKINGS





WING POD HOSE POSITION AT FULL TRAIL

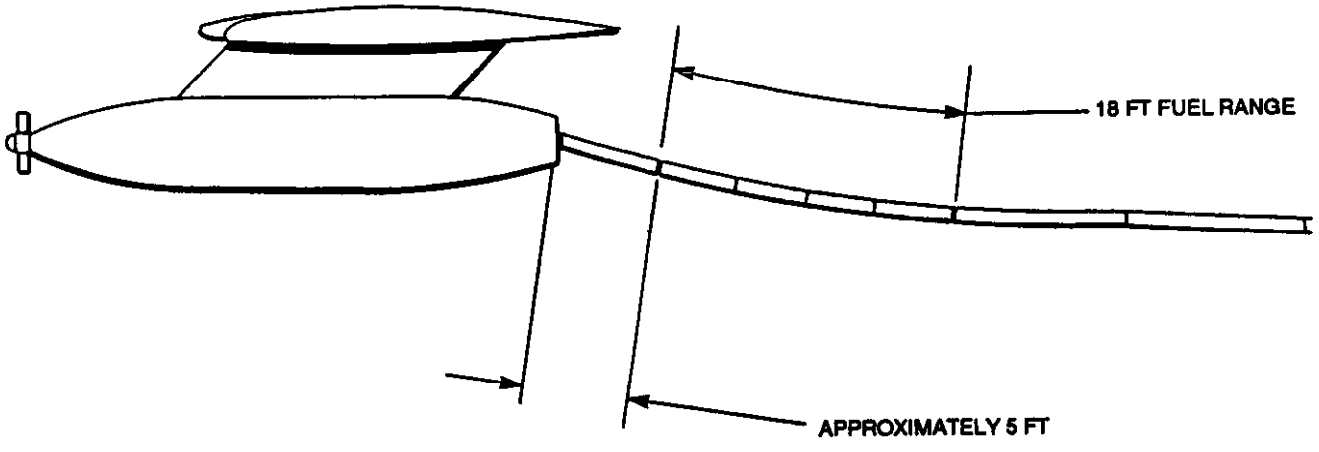


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Figure 4-9. Wingpod Apparatus

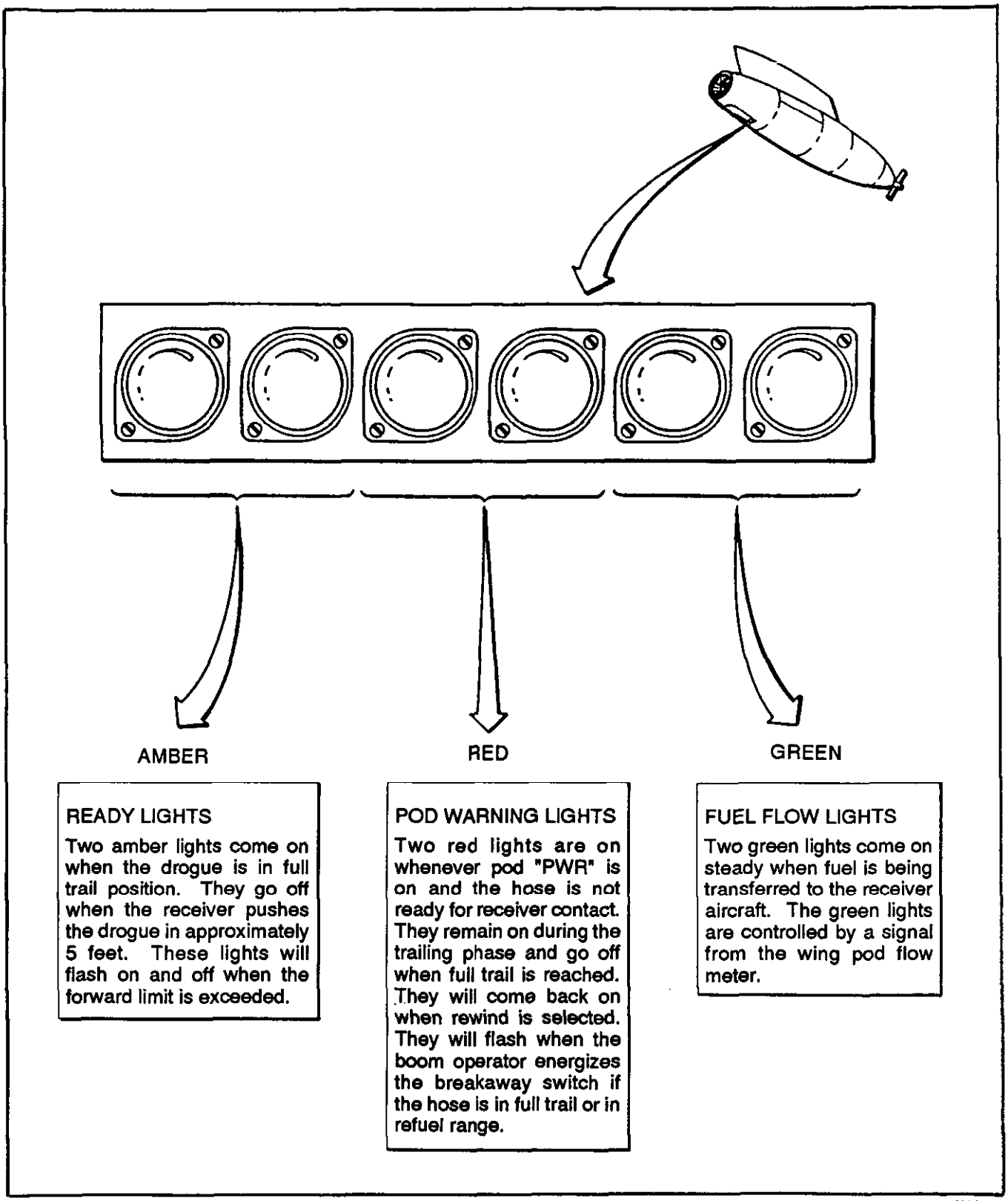

Figure 4-10. Wingpod Signal Lights

ITEM	ACTION	EMISSION OPTION 1	2	3	4
1	Radio set 30 minutes prior to ARCT (if dual radio capable)	X	X	1	2
2	15-minute call	X	X		
3	A/A tacan set 15 minutes prior to ARCT	X	X	3	
4	Beacon positive identification (if applicable)	X			
5	ADF check (if applicable)	X			
6	One-half through turn call (tanker)	X			
7	1 mile closure call (receiver)	X			
8	Mandatory boom operator calls				
	a. Precontact call	X	X		
	b. Clear receiver to contact	X			
	c. Acknowledge contact/disconnect	X			
	d. Verbal correction	X			
	e. Advise receiver(s) to return to precontact for checklist or equipment considerations	X			
9	Mandatory receiver calls after 15-minute call				
	a. Visual contact established/loss to include overrun	X			
	b. Precontact call	X	X		
	c. When contact or disconnect is made	X	4		
	d. Verbally notify boom operator prior to manual/emergency boom latching procedures	X	X		
10	Postair refueling report	X	X		

Note

Variation may be indicated by "EMCON 2. Item 8a/9b COMM N/A." This would mean normal emission option 2 procedures except the precontact call would be deleted.

1 Radio silent. Use of other emitters is authorized unless prohibited by supported operation plans.

2 No emission (radios, Doppler, navigation transmitters, radar, IFF, exterior lighting, etc.) unless authorized by air tasking order, rules of engagement, operation plans, safe passenger procedures, or other mission directive.

3 Point parallel only.

4 KC-135 drogue air refueling contacts only. N10/92

Figure 4-11. Emission Option Communications

Note

If tankers and receivers are in contact with a common facility providing rendezvous assistance, the radio contact between the tankers/receivers may be delayed to accomplish the rendezvous.

The tanker will advise the receiver(s) of their call sign, air refueling altitude and, if applicable, any change in tanker timing that would affect the rendezvous (in minutes early or late).

Tanker(s) and/or receiver(s) will make an additional radio call confirming level at the proper rendezvous altitude if they are not at the proper rendezvous altitude when the 15-minute prior to the rendezvous control time call is made.

For all rendezvous and air refueling operations, tankers and receivers will normally use their individual flight call signs unless directed otherwise in operational plans. When assured no other counit formation will be in range of or using the frequency and/or a discrete tactical frequency has been assigned to the formation, flight call signs may be abbreviated for clarity and brevity purposes (e.g., "RENO FLIGHT . . . GO ECHELON" (acknowledge) "TWO" "THREE").

4.4.1 Mandatory Receiver Radio Calls. See Figure 4-11 for mandatory receiver radio calls.

CAUTION

Except during an emergency fuel situation, air refueling operations will not be conducted when radio communications capability is lost between tanker and receiver. If radio communications are lost or unreadable between the boom operator and receiver pilot, contacts will not be attempted.

Note

The receiver pilot actually in control of the aircraft will position his radio controls to receive only interphone and the air refueling frequency during the rendezvous and air refueling. The receiver navigator accomplishing the rendezvous may limit monitoring to interphone and air refueling frequency if the other radios prove distracting. This will prevent transmissions on other frequencies from blocking pertinent refueling communications.

4.4.2 Oral Communications

Note

- With the exception of the breakaway calls, crewmembers may shorten individual flight call signs by using only the number (e.g., Tank 11 would be 11).

- Normally, the receiver leader will proceed to the precontact position. When the leader has completed refueling, subsequent receivers will move from the observation position as precoordinated.

The 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 feet from the contact position. Direction, if required, will precede distance for receiver to move and will be given until the receiver reaches the contact position (e.g., "Forward 50," "Up 4," "Back 2.").

For emission options 1 and 2, the boom operator will make a precontact radio check with receiver(s) and the receiver(s) will acknowledge. For example, tanker will say "25/57," the receiver will reply "25."

During receiver pilot demonstration of limits, when requested by the receiver pilot, the boom operator will give boom position in increments of two for the limit being demonstrated and will notify the receiver pilot when he is approaching the boom limits. Disconnect capability must be demonstrated prior to performing a limit demonstration.

Voice procedure for tanker manual and manual boom latching is as follows:

1. Receiver briefings

   a. Tanker manual operation briefing (required any time tanker does not have disconnect capability): "(Receiver call sign), the following contacts will be made in tanker manual operation. Receiver air refueling system will remain in normal and receiver pilot must initiate all disconnects. (Tanker call sign) ready." Receiver pilot acknowledges by stating, "(Receiver call sign) ready."

b. Manual boom latching briefing: "(Receiver call sign), the following contacts will be made in manual boom latching and receiver pilot must initiate all disconnects. (Tanker call sign) ready." Receiver pilot acknowledges by stating "(Receiver call sign) ready."

CAUTION

Tanker crew must be notified prior to performing manual boom latching. Manual boom latching will only be accomplished for actual fuel emergency or operational necessity.

4.4.3 Visual Signals. Visual signals are summarized in Figures 4-8 and 4-12. Radio silent air refueling can be conducted by use of visual signals provided the following precautions and procedures are observed.

The method, time, and place of rendezvous and amount of fuel to be transferred must be covered in the preflight briefing of each crew. The tanker will use the receiver director lights (red only) to aid in positioning the receiver. A steady red light indicates a large correction and a flashing red light indicates a small correction in the direction indicated. If the need for an emergency breakaway occurs during radio silent air refueling, oral breakaway procedures will be used with the visual signals in Figures 4-8 and 4-12.

4.5 LIGHTING

4.5.1 KC-135 Lighting. While approaching the precontact/contact position, the boom operator can adjust tanker lighting as required by the receiver pilot.

Note

Tankers in a cell will display the appropriate color code until the receiver(s) is/are in the precontact position. To further aid in identification, tanker position lights will be placed on BRIGHT and FLASHING for Nos. 1, 3, and 5. Position for lights for Nos. 2 and 4 will be BRIGHT and STEADY. Position lights will be set prior to takeoff. After the receiver has established visual contact and has closed to one-half nm in trail, tankers will turn position lights to STEADY and DIM and turn lower beacon and rendezvous beacon lights OFF. When receivers reach the observation position, tankers will turn underwing, underbody, and nacelle illuminating lights to DIM. Exterior lights will then be adjusted as requested by the receiver pilot.

Refer to Figure 4-13A for KC-135 exterior lighting and identification lighting for tanker cells.

4.5.2 KC-10 Lighting. While accomplishing the rendezvous, the tanker will have specified exterior lights full bright to aid in visual sighting. The lights will be on at least 15 minutes prior to the rendezvous control time. After the receiver has established visual contact and has closed to one-half nm in trail, tankers will turn strobe light, fuselage lights, wing flood and horizontal stabilizer lights OFF and will set position lights to STEADY and DIM. When the receiver reaches the observation/precontact position, the tanker will adjust exterior lights as required or as requested by the receiver. The receiver will adjust his lights as requested by the boom operator.

Refer to Figure 4-13B for KC-10 exterior lighting and identification lighting for tanker cells.

4.6 EN ROUTE PROCEDURES

4.6.1 Taxi. After engine start, check in with the tanker on the predetermined frequency. When ready to taxi, each tanker will call "(Tanker call sign) — taxiing." A distance of 300 feet will be maintained between tankers and receivers. Tankers not scheduled to be used during the first air refueling will taxi and take off first. Spare tankers will taxi off last, if applicable.

4.6.2 Buddy Departure. A buddy departure is effected when the tanker(s) and receiver(s) take off from the same base and visual contact is maintained. Because of the requirement for a launch delay for receiver aircraft when following heavyweight tankers, receiver elements should launch ahead of the tanker(s). If the tanker is required to launch first for operational considerations, the receivers shall delay launch for appropriate wake turbulence considerations. Join-up may be effected in VRF conditions during climbout. If IFR conditions are anticipated, plan an en route rendezvous after level-off.

WARNING

During buddy takeoffs and join-ups, wake turbulences generated by preceding aircraft may create a hazard.

4.6.3 Aborts During Takeoff. An aborting aircraft will make an abort call on the prebriefed common

SIGNAL	BOOM AIR REFUELING
1. Boom in Trail	
a. Extend 10 feet — — — — — — — — — — — — — b. Fully extended	Ready for Contact[1] — — — — — — — — — — — — — 1. Tanker Manual Operation Without Tanker Disconnect Capability.
— — — — — — — — — — — — — c. Fully retracted	2. Acknowledge Receiver's MBL Signal. — — — — — — — — — — — — — Offload Complete.
2. Boom Stowed	
a. Fully retracted — — — — — — — — — — — — — b. Extended 5 feet	Tanker Air Refueling System Inoperative. — — — — — — — — — — — — — System Malfunction, Tanker and Receiver Check Air Refueling Systems.
3. Flashing Receiver Director Lights/Tanker Lower Rotating Beacon ON	Breakaway.
4. Receiver Director Lights Going OUT During Contact[3]	Tanker Request for Disconnect, Receiver Return to Precontact Position.
5. Receiver Closing and Opening Receptacle Door When in Precontact Position	1. Manual Boom Latch. 2. Acknowledge Tanker's Manual Operation Without Tanker Disconnect Capability Signal
6. Steady Light From Receiver or Rock Wings[2]	Emergency Fuel Shortage Exists.
7. Flashing Light From Receiver Cockpit Area	Initiate Toboggan Maneuver.

[1] Receivers(s) in the observation position will move to the precontact position in their briefed sequence only after ensuring that the boom is in the ready for contact position and the preceding receiver has cleared the tanker. The receiver will stabilize in the precontact position, then move to the contact position. The boom operator will not give the ready for contact signal until the preceding receiver has cleared the tanker.

[2] If fuel shortage occurs at times other than scheduled air refueling, the receiver should be positioned so the signal may be seen from the tanker cockpit.

[3] The receiver will advise the tanker of any pilot director light malfunctions/deficiencies.

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Figure 4-12. Boom Air Refueling Visual Signals and KC-135 Drogue Visual Signals

TANKER NUMBER	LIGHT COLOR	
	UPPER	LOWER
1	Red	Red
2	White	White
3	Red-White	Red-White
4*	White	Red

Single KC-135 tankers will display red and white.
*KC-135 only.

Figure 4-13. Tanker Exterior Lighting and Cell Identification Lighting

frequency as soon as possible. Frequency changes will not be made by tanker/receivers until all aircraft in the same element/cell are airborne.

4.6.4 Climb and Join-Up. Tanker climb airspeed schedule and cell join-up procedures will be briefed prior to departure.

If a ceiling is to be encountered prior to the completion of join-up, the tanker should level off below the cloud layer and maintain briefed climb airspeed.

The receiver join-up with the tanker will be accomplished on the outside of the turn or on the tanker's left wing during a straight-ahead join-up. After the receiver flight has stabilized in a formation position, the receiver leader will transmit the command for a crossover to place the wingman on the tanker's right wing.

4.6.5 Cruise Formation (See Figure 4-14)

Note

The air refueling formation may be changed from 60° right echelon, 1-nm separation, to 20° right echelon, 1-nm separation when maneuvering airspace or weather conditions so dictate. In those cases where 20° echelon formation is used, all participating aircrews will be briefed.

Receivers fly cruise formation position on the tanker. The leader will be on the tanker's right wing; with four receivers, Nos. 1 and 2 will form on the left wing with Nos. 3 and 4 on the right wing. Spacing may be closed up during IFR or night operations. When air refueling is required, the other receiver(s) will assume the observation position.

4.6.6 Lost Wingman Procedures. In the event a receiver becomes lost during refueling operations or buddy cruise, the following procedures apply:

1. Remain clear of the flight using briefed procedure.

2. Notify flight leader and tanker commander of the situation.

3. Attempt rejoin only after receiving clearance from the tanker and when within radar or VFR capability.

4.6.7 Air Abort Procedures. If a receiver aborts during an air refueling mission, the receiver leader will determine the course of action to be taken.

4.7 RENDEZVOUS GENERAL INFORMATION

The type of rendezvous will be dictated by mission requirements, weather conditions, etc.

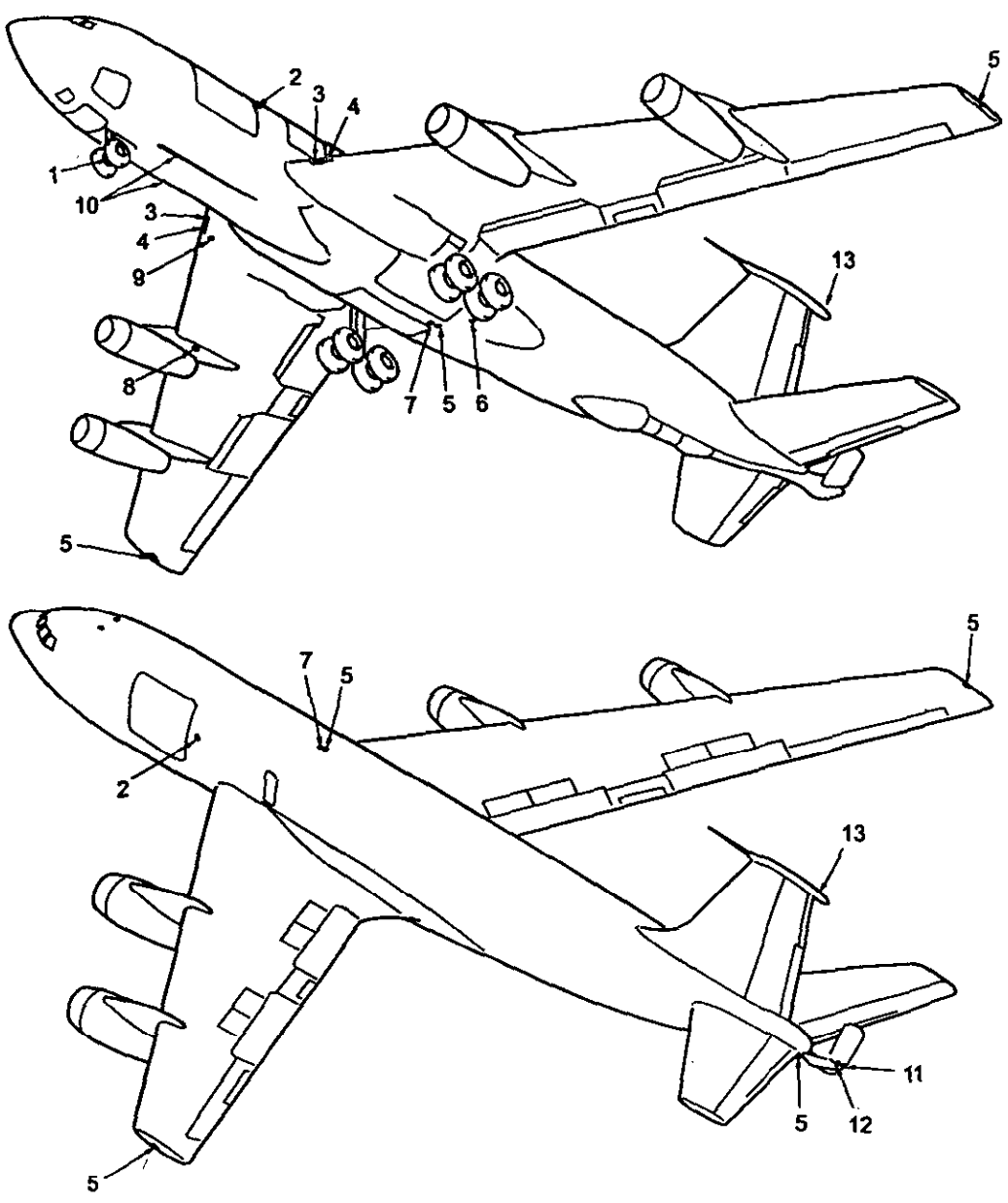
Note

- Receivers complete hot armament checks prior to initiating rendezvous.
- Initial visual contact between the receiver and tanker may be enhanced, in-flight weather conditions permitting, if the tanker jettisons fuel to increase its visual target. This procedure may be initiated/requested by the tanker, receiver, or the ground agency controlling the rendezvous. It should only be used if a receiver low fuel state or other similar circumstances require the rendezvous to be expedited.

4.7.1 Track. Receivers will pass over the air refueling initial point (ARIP), if applicable, and make good the planned inbound track and speed to the ARCP. If a deviation is required because of weather, etc., receivers will not attempt rendezvous or proceed to the ARCP until the deviation has been approved by the air route traffic control center (ARTCC) and coordinated with the tanker. If radio contact between the tankers and receivers is not established prior to the ARCT, the tankers will be over the ARCP at the ARCT.

Note

In most cases, entire refueling tracks/area will be controlled by a single ARTCC. Indirect communication between single-radio receivers and tankers through the ARTCC



1	Nose landing and taxi light	*8	Underbody illumination light (typical)
*2	Nacelle illumination light (typical) (2 places)	9	Terrain light (retractable)
3	Taxi light (2 places)	*10	Receiver pilot director light
4	Landing light (fixed) (2 places)	11	Boom marker lights (fluorescent)
*5	Navigation light (7 places)	*12	Boom nozzle light
*6	Underwing illumination light (typical)	13	AAR flood lights
7	Rotating beacon lights (2 places)		

*Designates Adjustable Lighting

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Figure 4-13A. KC 135 Exterior Lighting

KC10 EXTERIOR LIGHTING (1)

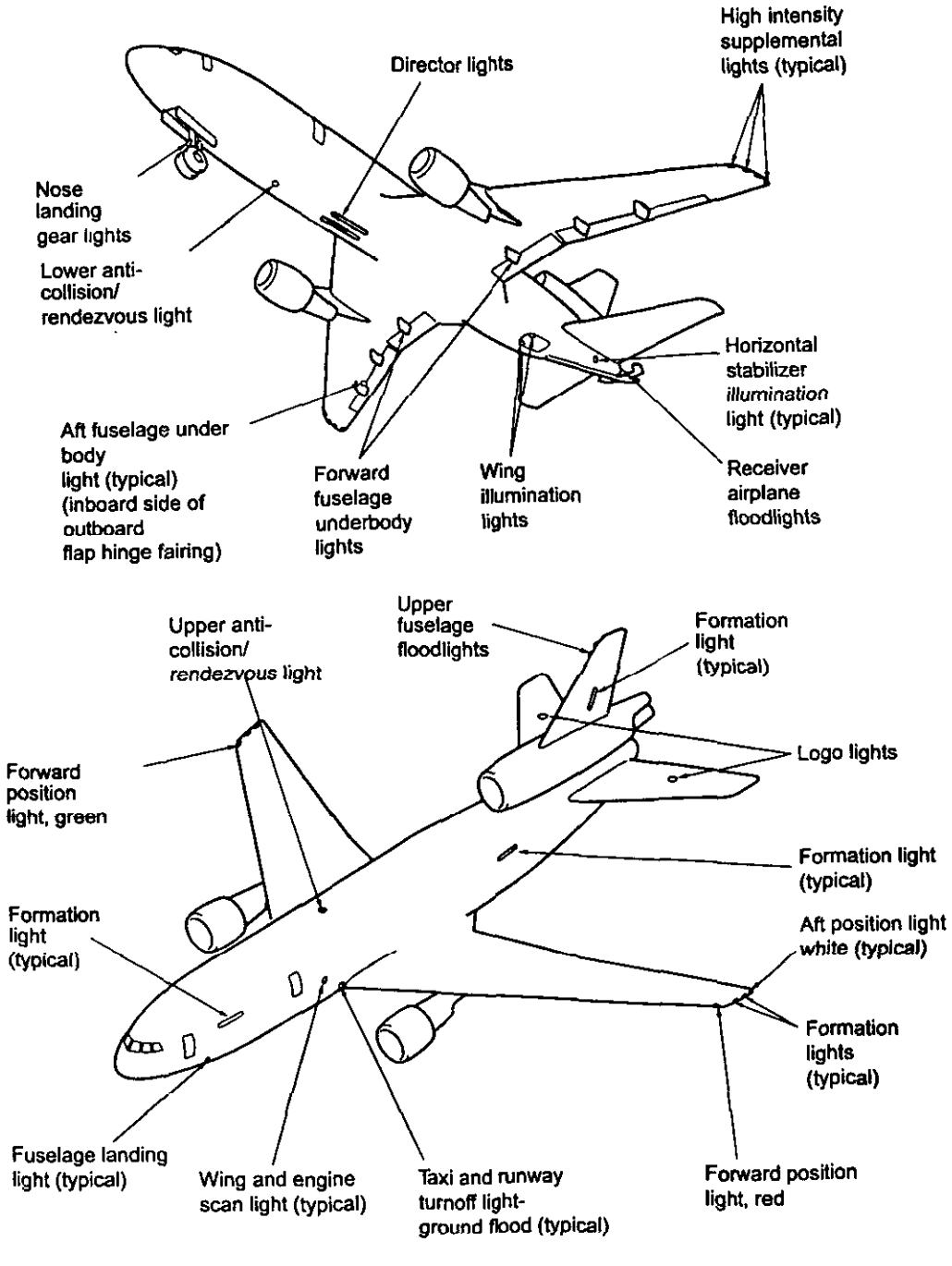

Figure 4-13B. KC10 Exterior Lighting

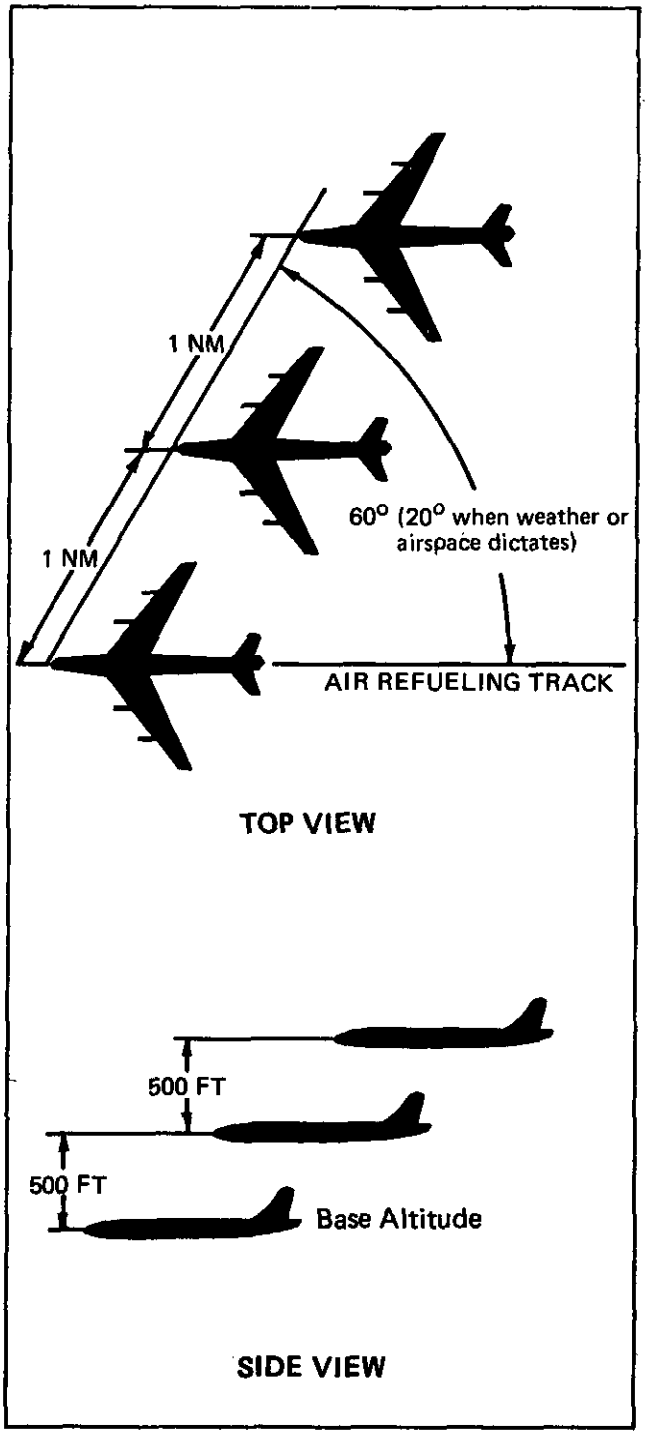

Figure 4-14. Tanker Cruise Air Refueling Formation

does not degrade rendezvous. In those cases where a second ARTCC controls ARIP airspace, single-radio receiver aircraft should effect transfer to the ARTCC controlling the tanker prior to departing the ARIP.

4.7.2 Altimeter Settings. Unless otherwise directed, an altimeter setting of 29.92 inches Hg will be used for air refueling operations at or above transition altitude or when over water and operating in accordance with International Civil Aviation Organization (ICAO) procedures.

4.7.3 Tanker Rendezvous Equipment

4.7.3.1 KC-135 Rendezvous Equipment The KC-135 rendezvous equipment consists of automatic direction finder AN/ARA-25, radar beacon AN/APN-69 (all), radar beacon AN/APN-134 (some), tacan A/A AN/ARN-118(V) (DME only), and search radar AN/APN- 59 skinpaint capability.

4.7.3.2 KC-10 Rendezvous Equipment. The KC-10 rendezvous equipment consists of automatic direction finders (Collins 514-7, DF-301E), radar beacons AN/APN-226 (J-band), AN/APX-78 (I-band), tacan A/A AN/ARN-118(V) (bearing and range are available to the receiver), Bendix RDR-1FB radar with I-band, and search radar skinpaint capability.

4.7.4 Receiver Formation During Rendezvous. Formation procedures after level-off or from the ARIP until join-up with the tankers will be as follows.

WARNING

- Joining flights of receivers should not close astern of the tanker for 1 to 3 nm at the same altitude to 1,000 feet lower than the tanker to avoid severe wake turbulence. Loss of aircraft control can occur if this wake turbulence is encountered.
- Because atmospheric conditions have varying effects on the wake turbulence, it is recommended that receiver aircraft remain clear of the tanker's tail from 1- to 5-nm trail distance, 200 feet above and 1,000 feet below in altitude, and one-half nm laterally.

Note

Formation lead changes and join-ups will normally be completed prior to departure from the ARIP. Should such maneuvers be

required subsequent to departure and prior to join-up on the tanker(s), the rendezvous will not be continued unless the flight leader is positive of his position in relation to the tanker(s) and the published air refueling track.

4.7.4.1 Day VFR (Visibility 5 Miles or Better). Flights will be in trail, offset to the right of the preceding flight. When all aircraft are in visual contact with the tankers, each aircraft/flight will join with his respective tanker as briefed.

4.7.4.2 IFR or Night. Flights of four aircraft will be in the briefed formation with succeeding flights positioned in a like formation, a maximum of 1,500 feet to the rear, and maintaining visual contact with the first flight. The flight/section leader will join on the last tanker while maintaining 1,000 feet below base altitude until visual contact is made. When the appropriate wingmen have visual contact and are within 1 nm of their tanker, the leader will drop them off and proceed to the next tanker. The receiver leader will continue as above until all wingmen are on their appropriate tankers, then join the lead tanker. When effecting this type of join-up, the section/flight leader will notify the tanker cell leader of his intentions and request that the last tanker in the cell provide UHF/DF steers and distance measuring equipment (DME) information as appropriate to effect join-up. Aircraft equipped with airborne radar should use this equipment as an aid in effecting the rendezvous.

4.7.5 Early Arrival at Tanker(s). While waiting for a preceding flight to complete their air refueling operations, the joining flight will join in a position 600 to 800 feet out (laterally) from the receivers presently in the observation position. The decision on which side to join will be based on the direction of the orbit of the tanker, departure intentions of the refueling flight, and the presence of additional holding flights.

WARNING

Joining flights of receivers should not close astern of a tanker that is conducting refueling operations with other receivers. The wake turbulence generated by these aircraft during departure/changing of positions, if encountered, can result in loss of aircraft control.

4.7.6 Early Arrival at ARCP. If the receiver aircraft arrive at the ARCP ahead of the tankers, receivers shall enter holding, ensuring a minimum 1,000-foot separation above or below the confines of the air refueling block altitude. The receivers shall remain in holding at the ARCP until cleared downtrack by the tanker. Awaiting the tanker aircraft, receivers shall remain aware of the possible necessity to divert and divert fuel criteria.

4.8 RENDEZVOUS PROCEDURES

4.8.1 Buddy Rendezvous

4.8.1.1 Departure and Climb. The receiver departure time will be adjusted to ensure arrival at altitude in trail of the tanker.

4.8.1.2 Rendezvous. The tanker will level off on course at the programmed cruise altitude and establish briefed airspeed to permit receiver overtake. The receiver will level off on course, 1,000 feet below the tanker's base altitude, and establish a closing airspeed.

Receivers will call "tallyho" when visual contact is established with the tanker. After visual contact is established, the receiver will request the tanker to accelerate/decelerate to cruise or air refueling airspeed.

Note

Receivers will establish radio contact with the tanker on the assigned cell frequency in accordance with desired EMCON option. Air or ground radar will be used to effect tanker/receiver closure until visual contact is made.

4.8.2 Point Parallel Rendezvous. A successful point parallel rendezvous requires the receiver to fly the specified rendezvous track and speed from the ARIP to the ARCP. Emission option 2 will be the normal rendezvous and air refueling procedure. The receiver will call 15 minutes prior to the ARCT and relay call sign, ETA (minutes early or late), and altitude. The tanker will then confirm his call sign, air refueling altitude, and timing (minutes early or late) if it will affect the rendezvous. If either the tanker or the receiver is not on the appropriate rendezvous altitude, an additional radio call will be made when the proper rendezvous altitudes are established.

The tanker is responsible for receiver navigation, regardless of the number of tankers or receivers, after rendezvous through completion of refueling operations except when under control of a tactical air controller while in an anchor area.

The receiver will proceed from the ARIP to the ARCP using all navigational aids necessary to arrive over the ARCP via the inbound track. Receivers will be level at rendezvous altitude at the ARIP. The receiver level-off altitudes will provide a separation of 1,000 feet between the highest receiver and tanker leader base altitude. Receiver will rendezvous at published closure speed or air refueling speed plus 45 knots if none is published.

WARNING

To help ensure safe separation of aircraft during descent when range to tanker is not known, descent will not be unnecessarily delayed. Additionally, tankers will not initiate final turn to refueling track unless receiver has confirmed level at rendezvous altitude.

The tanker INS will be the primary means of maintaining the offset and the A/A tacan will be primary for range information. To provide A/A tacan ranging, the tanker and receiver will set the assigned tacan channels 15 minutes prior to the ARCT. The receiver will set the numerically lower tacan channel and the tanker will set the numerically higher channel. The accuracy of the rendezvous equipment should be cross-checked with as many available aids as necessary.

When it is determined the receiver is at or inside the ARIP, the tanker will turn to or continue on the reciprocal of the receiver's inbound track and will establish and maintain the proper offset until reaching the planned turn range. The receiver will not deviate from the ARIP/ARCP centerline unless directed to do so by the tanker.

Range will be measured directly from aircraft to aircraft.

Note

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

Note

The exact turn range and track offset separation will be determined by the tanker using the appropriate chart from Figure 4-15A, which allows approximately 3 nm seperation at tanker rollout.

The tanker will turn inbound to the ARCP at the turn range and adjust to appropriate air refueling speed when rolled out toward the ARCP.

The tanker will note the receiver's distance when halfway through the turn back to the ARCP. This is the best time to determine if an overrun condition exists and the best time for visual sighting. If an overrun condition exists, appropriate action should be taken.

With suitably equipped receivers, the last tanker in a cell will turn the radar/rendezvous beacon to operate (single code) on rollout to rendezvous/refueling heading.

Interphone range calls will be made at 15-nm, 10-nm, and 5-nm forward ranges. Radar skinpaint should be attempted as soon as practical to ensure accurate range calls. If skinpaint is not possible, continue rendezvous using the beacon mode. Once behind the tanker, the receiver is responsible for making course corrections to ensure completion of rendezvous. The 3-, 2-, 1-, 1/2-nm range calls will be given over interphone to the pilot. The rendezvous altitude separation will be maintained until 1 nm from the tanker and visual contact is established. A gradual climb will then be initiated, with a minimum altitude separation of 500 feet at the 1/2-nm trail, to arrive at the precontact position.

4.8.3 En Route Rendezvous. An en route rendezvous may be used when tanker(s) and receiver(s) fly individual flight plans to a common rendezvous point (RZ) where join-up is accomplished.

For training missions, the ARIP or ARCP may be designated as RZ. In this case, air refueling will start as soon as practicable after rendezvous.

Tanker(s) and receivers will join up at the RZ by controlling timing to arrive at the RZ at the same time. Timing may be adjusted using differential airspeed, orbit delays, or timing triangles. Assigned altitudes must provide ar least 1,000 feet separation between tanker(s) and receiver(s). If join-up for cruise is prior to air refueling, receiver(s) may be higher. If immediate refueling is planned, the receiver(s) will be lower.

Communication will be in accordance with specified emission option. If radio or visual contact is not established by RZ contact time, maintain altitude and depart RZ to cross the ARCP at the ARCT.

4.8.4 Alternate Rendezvous Means. When primary means are not available or are lost, alternate means will be utilized to perform the rendezvous. When using alternate means, the tankers and receivers will fly the

same profiles as described in the previous paragraph entitled RENDEZVOUS PROCEDURES. The following are some suggested alternate means for conducting the rendezvous. The various alternate means should be used in conjunction with each other when equipment availability permits and, when practical, to ensure a successful rendezvous (i.e., AN/ARA-25 UHF/DF, common VORTAC/tacan DME, radar beacon, and Federal Aviation Administration (FAA)/GCI advisories, etc.).

FAA/GCI facilities, when available, may be used for vector and separation advisories.

DME/radial information from a common tacan/VORTAC may be exchanged with the final to refueling track being accomplished when the DME difference equals proper turn range.

When adequate navigational checkpoints are available, the tanker may adjust the final orbit pattern to depart over the ARCP on the refueling heading on the receiver's ETA to the ARCP.

ARA-25 UHF/DF means may be utilized providing the tanker is so advised prior to the receiver reaching a point 40 nm upstream of the rendezvous point. As soon as reliable radio contact has been established between aircraft, DME/radial information from a common tacan/VORTAC station will be exchanged, if available. When the receivers call departing the ARIP, the tanker(s) will turn to or continue to fly the reciprocal of the receiver's inbound track. For DF steers, receivers will use the mike switch without talking. The receiver will transmit on the air refueling frequency approximately 10 seconds out of every 20-second period, ending each transmission with the receiver's call sign. When the receiver's bearing shows 26° left (NO WIND) of the tanker, the lead tanker will notify the receiver starting turn to the refueling track. The homing signal will be transmitted until visual sighting is made.

4.8.4.1 Radar/Rendezvous Beacons. The receiver/tanker beacons may be used for range and offset information with suitably equipped aircraft. Depending on equipment capability, one aircraft should maintain the planned outbound or inbound track while the other aircraft maneuvers to establish the planned offset. The tanker will clearly establish which aircraft will be maneuvering.

4.8.4.2 INS/DNS Distance. When tanker and receiver have a reliable INS or navigation equipment of comparable accuracy, the ARCP or any other common point may be entered as a waypoint to help determine range.

Timing should be used as a backup for all other rendezvous means, if feasible; however, it should only be used as a last resort as the primary means of rendezvous. Timing begins or is updated when reliable nose-to-nose separation is obtained with tanker on reciprocal heading.

Note

If radar skinpaint can be obtained during the final phase of an alternate rendezvous, the receiver/tanker will be notified and final closure will be accomplished utilizing skinpaint.

4.8.5 Point Parallel Rendezvous With Tanker Escort. The receivers will join on the escorting tanker in the briefed sequence. The escorting tanker is responsible for effecting the rendezvous with the orbiting cell.

4.8.6 Anchor Refueling Procedures. An air refueling anchor is a left-hand racetrack pattern with legs separated by 20 nm and a minimum leg length of 50 nm (Figure 4-15). Tankers will adjust from en route cell formation to the air refueling formation of 20° right echelon, 1-nm nose-to-nose separation, stacked up at 500-foot intervals during the final turn to the air refueling track.

When the receivers are inbound, the rendezvous will be directed by ground control units (CRC/GCI). It will be the CRC/GCI controller's decision on the type rendezvous to be made. The tanker will adjust to refueling airspeed when directed by the receiver leader. Receivers will rendezvous 1,000 feet below refueling base altitude until visual contact is established.

4.8.7 Alternate Anchor Refueling Procedures. In the event CRC or GCI radar is not available to control anchor refueling operations, the following alternate procedure will be used. The tanker will establish a normal point parallel rendezvous at the anchor point. Receiver flights will proceed to an ARIP a minimum of 70 nm upstream from the anchor point. Receivers will rendezvous 1,000 feet below the refueling base altitude until visual contact is established. Normal point parallel rendezvous procedures will be used for the rendezvous.

Note

Unless otherwise directed by the tanker, the receiver flight will accomplish a 360° left turn at the receiver holding point to enable the tanker to turn toward the receiver flight for the rendezvous (Figure 4-15).

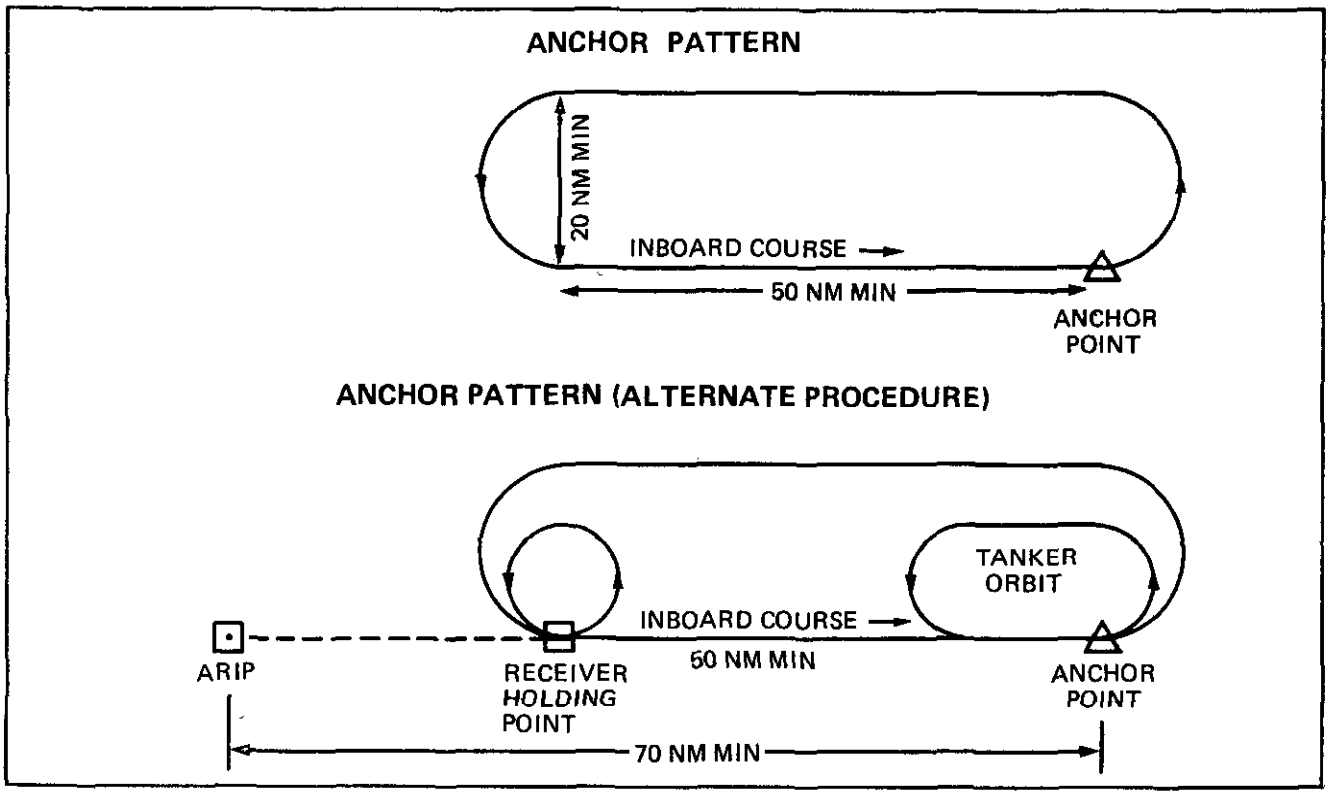

Figure 4-15. Anchor Patterns

After the receiver flight is joined up with the tanker, the anchor pattern will be used for refueling. Additional receiver flights to be refueled normally will not depart the ARIP until the previous receiver flight has departed the anchor pattern and the tanker is reestablished in orbit at the anchor point. However, if cleared by the tanker commander, subsequent receiver flights may depart the ARIP if the receivers have the capability to assure safe aircraft separation and they can join on the tanker using onboard equipment.

4.8.8 Rendezvous Overrun

Note

- When a rendezvous overrun occurs, the tanker or receiver pilot will immediately transmit a warning to all members of the flight and initiate RENDEZVOUS OVERRUN procedures.

- When positive visual contact can be maintained, the tanker may direct the receiver to maneuver in order to decrease closure time.

In the event of an overrun, the receiver(s) will pass 1,000 feet below the tanker to ensure positive vertical separation. The receiver will decelerate to air refueling overrun speed (255 KIAS recommended) and maintain air refueling heading. The tanker will increase airspeed to 310 KIAS/305 KIAS. Maintain air refueling altitude and track as required and overtake the receiver. After overtaking the receiver, the tanker will decelerate to air refueling airspeed, and normal closure procedures will be employed.

4.9 NAVIGATION AND POSITION REPORTING

When rendezvous is completed, tankers will be responsible for all navigation, weather avoidance, and position reporting. The tanker pilot will, once each hour, advise the receiver pilots of the cell geographic position, heading, distance, and estimated time en route (ETE) to the next checkpoint or destination, as applicable. If the receiver pilot has not completed his onload upon reaching his geographic air refueling abort point, the tanker pilot will so advise.

Note

During refueling operations conducted within a preplanned orbit pattern, the tanker is not required to provide the above information unless required by the receiver leader.

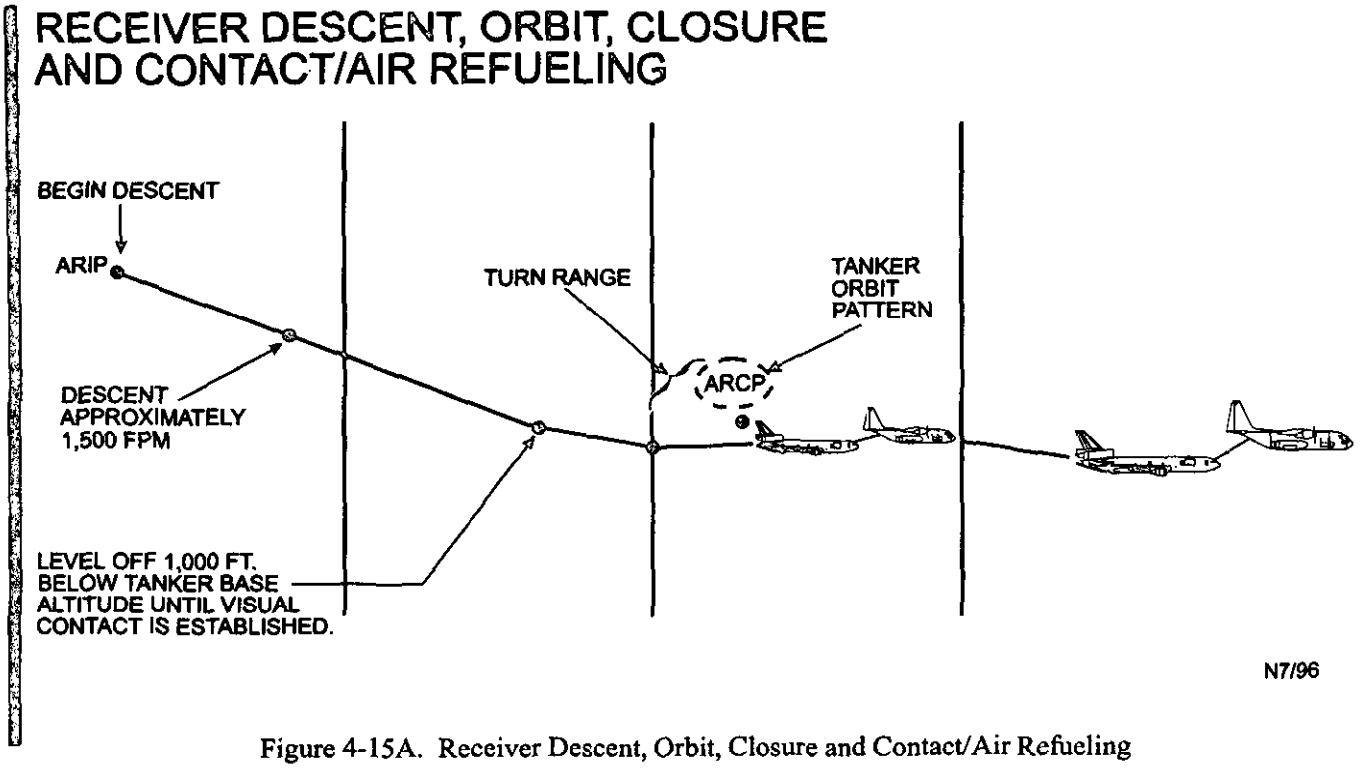

Figure 4-15A. Receiver Descent, Orbit, Closure and Contact/Air Refueling

4.10 REFUELING PROCEDURES

The KC-135 boom and KC-10 boom and hose are controlled by the boom operator while the fuel transfer is controlled by the tanker crew from the pilot compartments.

4.10.1 Boom Air Refueling Procedures

4.10.1.1 Closure

During rendezvous the receiver will establish Mach .76 or 310 KIAS, whichever is lower, at 1,000 feet below AR altitude to a point 2 nm from the tanker. This level-off altitude will be maintained until 1 nm from the tanker and visual contact has been established, at which time a gradual climb to precontact position will be initiated, arriving at one-half nm in trail with a minimum altitude separation of 500 feet. The receiver will maintain 310 KIAS until the following ranges versus airspeed schedules apply.

WARNING

Tankers will maintain applicable contact air refueling airspeed during closure. If within 1-nm closure, the tanker is off airspeed by more than 10 knots and required to decelerate or accelerate to obtain contact airspeed; the receiver pilot will be informed prior to tanker airspeed changes.

Note

If the receiver is more than 4 nm in trail with the tanker, the airspeed may be increased to 330 KIAS for closure. The normal speed schedule will be resumed at 3 nm in trial.

3 NM — Mach 0.76 or 310 KIAS, whichever is lower.

2 NM — Mach 0.76 or 310 KIAS, whichever is lower.

1 NM — Mach 0.72 or 290 KIAS, whichever is lower.

1/2 NM — Mach 0.69 or 285 KIAS, whichever is lower.

Contact — Mach 0.66 or 275 KIAS, whichever is lower.

During deceleration, it is imperative that the airspeed schedule be maintained. The receiver navigator will pass the range calls to the receiver pilot at 3, 2, 1, and 1/2 nm.

Note

Level-off altitude will be maintained until it is ascertained overrunning will not occur.

The receiver pilot will establish a rate of deceleration in sufficient time to allow a zero rate of closure at the precontact position.

WARNING

- The receiver will stabilize in the precontact position with a zero rate of closure. If the receiver fails to attain stabilized position or it becomes apparent that a closure overrun will occur, a breakaway will be initiated. Failure to initiate a breakaway under a closure overrun condition can result in a midair collision.

- Because of the magnitude of interrelated aerodynamic effects, flying two aircraft in close vertical proximity is not safe. Upwash and downwash effects may occur drawing the aircraft together. Low pressure areas created by an overrunning receiver flying under the tanker will effect static ports, causing possible erroneous airspeed and altitude indications to both aircraft. The tanker autopilot altitude hold function may sense the low pressure as a climbing indication and initiate a descent into the receiver aircraft.

4.10.1.3 Contact. Once the precontact position is attained, the receiver pilot should make the necessary corrections to align the aircraft with the tanker's fuselage centerline and dampen all relative lateral movement of the receiver aircraft. Closure from precontact to the contact position should be made very slowly to enable both the tanker pilot/autopilot and the receiver pilot to compensate for the required trim changes. Cross-check the receiver director light signals and use the boom operator's directions as necessary to judge the location of the aircraft in the envelope. Anytime lateral movement, pitch oscillations, or rate of closure become excessive, reduce power and drop back into precontact position and stabilize the aircraft. As the receiver reaches the contact position, the receiver pilot should hold a steady platform until the boom is in the slipway.

CAUTION

- If the receiver director lights fail to illuminate when contact is established, the receiver pilot will inform the boom operator if he wishes to continue refueling operations. If refueling is continued, verbal corrections from the boom operator may be requested.

- Attempts to effect a contact during loss of any air refueling lighting that results in less than desired illumination will be at the discretion of the boom operator.

The air refueling boom envelope (Figures 4-1 and 4-4) is the operational limits dictated by the aerodynamic control authority of the boom. Rough usage of controls on the part of either the receiver or tanker pilot will cause a chain reaction with progressively larger corrections required to maintain position. The envelope limits are set well within the mechanical limits of the boom so that a disconnect will normally take place soon enough to allow ample time for separation. Extreme azimuth disconnects should be avoided at all times.

CAUTION

- Approaching boom limits at relatively high velocity can cause structural damage as a result of an inability to disconnect because of binding action of the boom nozzle.

- If the boom is released at an extreme azimuth limit, slipstream forces attempt to streamline the boom to the trail position. Possible damage to the slipway doors or slipway lights may occur if the boom operator cannot elevate the boom prior to it striking the doors.

The receiver director lights are used in conjunction with visual references to maintain the optimum position. The receiver pilot must be familiar with operation of the receiver director lights and the fact that they do not give true vertical and horizontal information. See paragraph 4.2.1.1, RECEIVER DIRECTOR LIGHTS.

Turns and banks may be made during contact without disconnects provided no large or abrupt motions or throttle movements are made by either tanker or receiver.

4.10.1.4 Disconnect. There are two major classifications of disconnects: planned and inadvertent. Planned disconnects may be initiated by either the receiver pilot, copilot, or tanker boom operator activating his disconnect switch. Disconnects may be initiated by the receiver if less than a full load is required, if a malfunction is suspected, or for training purposes. If a prearranged quantity of fuel is to be transferred, the disconnect will be initiated by the tanker boom operator after the planned amount of fuel is transferred and the receiver pilot is notified. Inadvertent disconnects may be caused by exceeding the air refueling boom envelope limits. A pressure disconnect switch in the receiver air refueling system will cause a disconnect if excessive pressure surges occur either from transfer pressure or when the selected tanks become full and the high level float switches close.

To disconnect in an emergency, the receiver pilot and copilot must be prepared at all times to press the autopilot/air refueling boom release buttons.

CAUTION

Unless a serious emergency arises, every effort should be made to stay in contact position until certain that the boom nozzle is clear of the air refueling receptacle. Remain stabilized in the contact position until the boom operator or pilot not flying the aircraft visually confirms a disconnect has been made. This will prevent damage to the boom and/or receptacle through a brute force disconnect.

Note

In the event of failure to obtain a contact and after each disconnect, the receiver will move aft and stabilize in a position in trail of the boom or in precontact position, reset air refueling system and await boom operator signal to return to the contact position.

4.10.1.5 Fuel Transfer Rate. The fuel transfer rate normally will be 6,600 pounds, reducing to 5,000 pounds per minute (PPM) with all four tanker air refueling pumps operating.

4.10.2 KC-135 Drogue Refueling Procedure. The KC-135 boom/drogue and KC-10 hose is controlled by the boom operator while the fuel transfer is controlled by the tanker crew from the flight deck.

4.10.2.1 Refueling Sequence

4.10.2.1.1 Formation. Normally, the leader will proceed to the precontact position. No. 2 will proceed to the observation position for the remainder of the flight. Refueling sequence will be determined by the receiver. After refueling is completed, each receiver will rejoin the formation.

4.10.2.1.2 Stabilized Precontact. All precontact air refueling checks will be completed in the observation position.

The boom will be trailed fully extended as follows:		
TYPE RECEIVER	DEGREE AZIMUTH	DEGREE ELEVATION
A-4	0	30°
E/A-6	0	30°
F/A-18	0	30°
S-3A	0	30°
F-14	6R	38°

Figure 4-16. KC-135 Boom Position (Drogue Air Refueling)

WARNING

Attain a zero rate of closure at the stabilized precontact position. If the receiver fails to attain stabilized position or it becomes apparent that a closure overrun will occur, a breakaway will be initiated. Failure to initiate a breakaway under closure overrun conditions can result in a midair collision.

Upwash and downwash effects may occur, drawing the aircraft together. Low pressure areas created by an overrunning receiver flying under the tanker will affect static ports, causing possible erroneous airspeed and altitude indications to both aircraft. On KC-135 aircraft, the tanker autopilot altitude hold function may sense the low pressure as a climbing indication and initiate a descent into the lower aircraft.

4.10.2.2 KC-135 Boom/Drogue Procedures

1. Upon receiving clearance, move up to the precontact position with probe approximately 5 feet directly aft of the drogue. The boom will be trailed as specified in Figure 4-16.

2. Allow the drogue to stabilize and select a formation reference point on the tanker. Using this reference, peripheral vision will include the drogue. The drogue should not be used as a primary reference since drogue oscillation will invariably result in overcontrol.

3. Add sufficient power to establish a closure rate not to exceed 2 knots. A combination of formation reference and peripheral vision will assist in moving straight forward toward the drogue.

CAUTION

No attempt should be made to chase the drogue in pitch. Disregard small oscillations of the drogue while closing for contract. Contrasts from closure rates higher than 2 knots are likely to cause the hose to whip, possible damaging the probe, drogue, or receiver.

Note

Slow closure rates may not firmly seat the probe for fuel transfer. Closing slowly on the drogue tends to cause the pilot to chase the drogue and make contact less likely.

4. If the probe misses or hits the edge of the drogue, retard the throttle and move slowly straight back until the probe is approximately 5 feet aft of the drogue.

5. After each unsuccessful attempt at contact, back off and closely analyze the error that caused the miss.

6. After contact is effected, position the drogue as shown in Figure 4-17. The hose is approximately 9 feet long and allows for approximately 5 feet of forward and aft movement without becoming disconnected or damaging the hose. During all contacts, the boom operator will hold the boom as motionless as possible. All contacts will be effected by the receiver.

CAUTION

- Special precautions must be taken to prevent the hose from looping around the probe while in contact. Looping can be avoided by restricting the probe-to-boom closure distance to less than one-half the hose length. If looping occurs, however, stabilize in the contact position and coordinate with the boom operator on the action necessary to correct the situation. Disconnects made with the hose looped around the probe may result in damage to the receiver aircraft or the tanker drogue assembly.

- Should contact result in the hose loop lying on the aircraft nose, fuel may be transferred with the hose in this position if fuel requirement is critical, or a disconnect may be affected to reposition the hose. No attempt should be made to swing the hose loop from one side to the other without first fully extending the hose or disconnecting. Air refueling will be terminated when a crimp and/or fuel leak is observed in the hose except in case of emergency or when continuance of refueling is indicated by operational necessity.

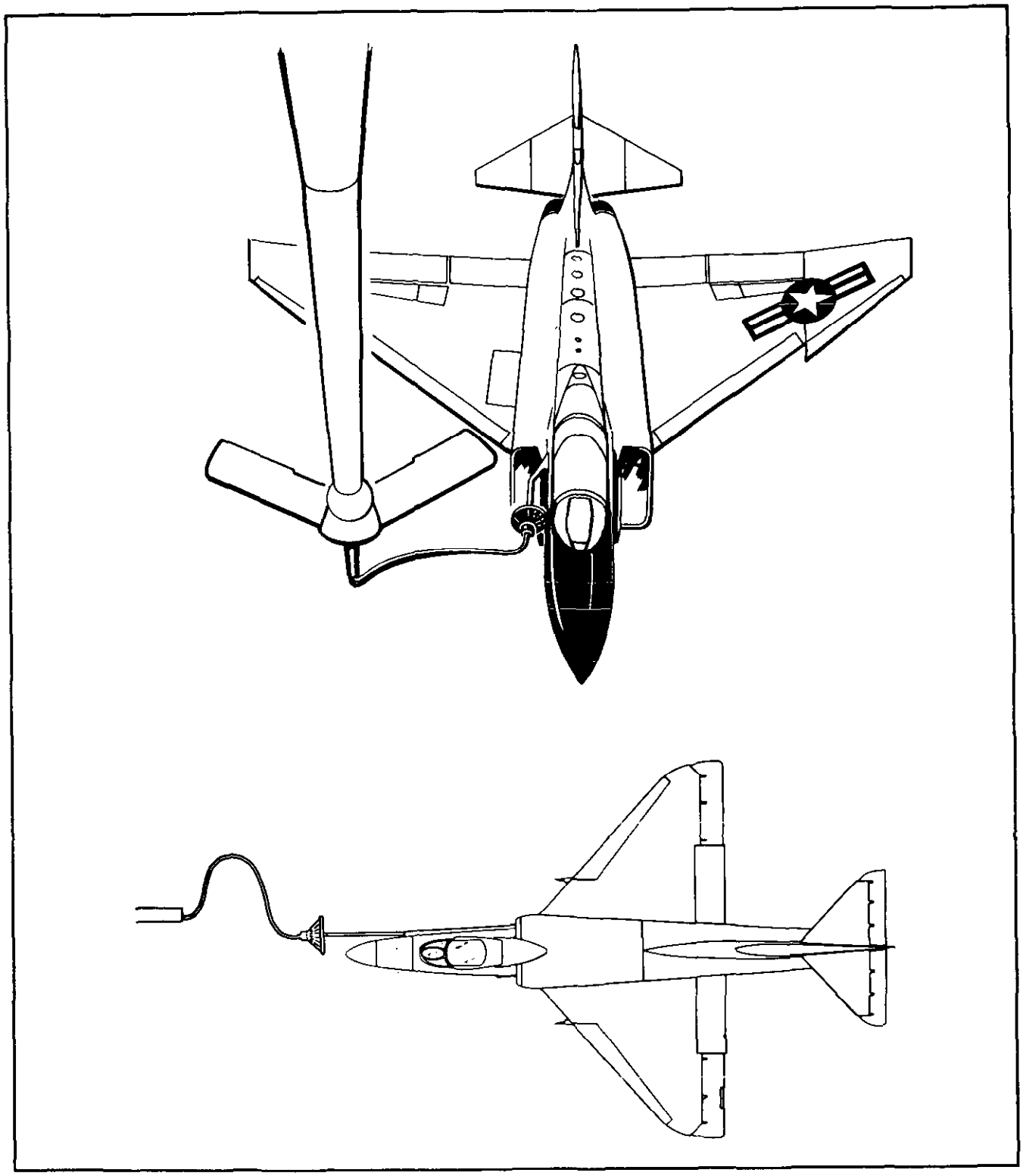

Figure 4-17. Probe and Drogue Air Refueling With KC-135

Note

Because of the boom operator's limited visibility of the drogue, it is possible for contact or disconnect to be accomplished without the boom operator's knowledge.

7. As soon as contact is made, the receiver pilot will state "(Receiver call sign) contact" (EMCON 1). The tanker copilot/flight engineer will turn on the air refueling pumps momentarily to transfer a few gallons and to pressurize the air refueling system. If no fuel leakage is observed, normal transfer will commence.

8. If for any reason fuel is not transferring or is transferring at a less than normal rate, the tanker will advise the receiver. Disconnect and clear the area aft of the drogue to permit the boom operator to cycle the boom.

9. When a disconnect occurs, state "(Receiver call sign) disconnect," and the boom operator will acknowledge with "(Tanker call sign) disconnect" (EMCON 1). If an inadvertent disconnect occurs, move to a stabilized position a minimum of 5 feet behind the drogue while the boom operator recycles the boom to prepare for another contact.

10. After air refueling is completed, disconnect should be made directly aft and level with the drogue aligned to the free trail position. To prevent excessive side forces damaging the probe or the aircraft, disconnect must be flown with the same care as contact.

CAUTION

The boom operator will not retract the boom to effect a disconnect except in an emergency. The drogue whips back and forth over its trail position very rapidly when breaking contact and if the receiver is to the left or right of the prescribed trail position, the drogue could cause excessive damage to the receiver.

Note

The tanker will turn AR pumps off 5 seconds prior to disconnect to reduce the possibility of fuel spray and reduced receiver visibility. If receiver pilots experience fuel spray on the windshield during disconnect, forward visibility may be temporarily reduced depending on the amount of fuel spray (up to 30 seconds). The fuel spray may also cause fumes in the cockpit because of the engine ingesting the fuel spray and transmitting the fumes through the cockpit air-conditioning and pressurization system. The fuel spraying is greatly reduced on a coordinated disconnect since the tanker fuel pumps are turned off prior to disconnect.

4.10.2.3 KC-10 Hose/Reel Procedures

1. After each receiver reports "Stabilized precontact" (EMCON 1), the boom operator will clear the receiver to contact. Once cleared to contact, the boom operator will generally provide no further comments unless hose reel response reset is required. The receiver will accomplish the contacts and refueling, utilizing the signal system light information.

2. From the stabilized precontact position , a steady closure rate should be maintained until the probe is contacted. The closure rate for the KC-10 reel system is 2 to 3 knots.

CAUTION

- Closure/contact rates above 5 knots may exceed the hose reel response and cause hose oscillation, which may result in severe damage to the receiver aircraft.

- Do not contact drogue when red signal light is on steady or flashing. The receiver aircraft should not be directly behind the hose anytime the red signal light is on.

Note

- As airspeed is increased, the drogue becomes a stiffer target. This is a factor when refueling above 275 KIAS since latchups are improbable when hitting the drogue off center. The drogue will yaw but not slip on the probe like it does at lower airspeeds. If this occurs, the receiver should back away and attempt an on-center contact. Above 275 KIAS, turbulence from drogue is more pronounced.

- Receivers may feel the high energy airstream from the KC-10 impinging on their vertical stabilizer(s). This may require additional pilot compensation when attempting to contact the drogue.

3. If the probe misses or hits the edge of the drogue, retard the throttle and move slowly straight back until the probe is approximately 5 feet aft of the drogue.

4. After each unsuccessful attempt at contact, back off and closely analyze the error that caused the miss.

5. Upon contact, the hose must be moved in approximately 5 feet to start fuel flow. At this point, the steady amber light will go out and the green fuel flow light will come on when the fuel flow starts. The receiver should move at least an additional 10 feet of hose into the fuel flow range to minimize the possibility of inadvertent disconnect. Since the hose exit area on the KC-10 is approximately 4 feet to the right of the fuselage centerline, some small lateral force may be required to hold the receiver aircraft directly in line with the drogue tunnel. When in contact, the receiver aircraft should attempt to maintain the hose aligned with the hose tunnel. Pushing the hose beyond the inner fuel flow range (indicated by a 2-foot stripe) will cause the amber light to be in flashing mode and, at this point, the receiver probe tip will be beneath the KC-10 refueling boom.

6. It is possible that receiver aircraft whose configuration is such that engine intakes are directly behind the probe may encounter autoacceleration in cases where coupling is improperly completed. If fuel escapes between the reception coupling and the probe and enters the receiver intakes, a dangerous condition may result. Fuel can be transferred with incomplete coupling only while the receiver pushes in.

CAUTION

Air refueling will be terminated if a crimp and/or fuel leak is observed in the nose except in case of emergency or operational necessity.

Note

On the KC-10 tanker, the green fuel flow status light may illuminate with the amber light when engaged. During this condition, the receiver may receive up to 200 pounds of fuel uncommanded because of gravity feed. This is a normal characteristic of the system.

7. During night refueling, the strobes, wingtip, aft position, and wing and horizontal stabilizer lights should be OFF. The dimmable lights should be at the intensity that is determined to be optimum at the time of refueling.

8. Upon completion of refueling, the receiver should have the probe in the vertical plane of the normal hose trail position. The receiver should reduce power and back out so as to keep the hose aligned with the base tunnel to cause minimal drogue movement upon disconnect. The receiver should continue straight back after disconnect and then assume the assigned postrefueling formation position.

Note

Receiver pilots may experience fuel spray on the windshield during disconnect. Forward visibility is temporarily reduced depending on the amount of fuel spray (up to 30 seconds). This fuel spray may also cause fumes in the cockpit because of the engine ingesting the fuel spray and transmitting the fumes through the cockpit air-conditioning and pressurization system.

4.10.2.4 Toboggan. When altitude and atmospheric conditions result in thrust requirements that exceed the receiver's available thrust, a toboggan may be necessary. The toboggan technique is a coordinated effort between the tanker pilot and the receiver pilot.

1. Call for a toboggan before reaching full military power.

2. The tanker pilot will very gently reduce power and initiate a rate of descent of approximately 300 fpm while maintaining air refueling airspeed throughout the toboggan maneuver.

3. If the receiver power requirements continue to exceed the thrust capability, an increased rate of descent may be required.

WARNING

Initial contact with the tanker basket should normally be accomplished in level flight. Attempting to contact while in a descent poses a hazard because reduced deceleration response makes it difficult to arrest closure. Once in contact, gentle climbs and descents can be made as required.

4.10.2.5 Weather Abort Procedures. Receivers must take every feasible action to enhance the possibility of completing air refueling. Such actions include altitude and course deviations necessary to avoid severe weather. Deviations, when required, must be made judiciously. When the receiver leader determines that weather conditions are such as to make refueling hazardous, he may abort the cell. When the cell is to be aborted, the receiver leader will instruct the tanker leader to clear the refueling track. Normal end refueling procedures will apply.

4.11 EMERGENCY AIR REFUELING PROCEDURES

4.11.1 Breakaway Procedures. When a crewmember aboard either the tanker or the receiver determines that an emergency exists, he will transmit on air-refueling frequency the tanker call sign and the word "breakaway" three times. When "breakaway" is called, the upper and lower rotating beacons will be turned on.

Note

The upper rotating beacon will normally already be on. Also, the navigation lights will be turned to full bright and the high intensity lights, if applicable, will be turned on. The KC-10 boom operator will also signal breakaway by flashing the red hose reel status signal light. The "breakaway" call is used to notify the tanker and receiver of any condition that would require an immediate vertical and horizontal separation of the aircraft. This would include but not be limited to excessive rate of closure overrun and engine failure. The aircraft do not necessarily have to be in contact to call a breakaway.

The following action will be taken simultaneously by the indicated crewmembers.

1. Tanker pilot — Increase power to obtain forward separation. When notified by the boom operator that the receiver is well clear, the breakaway may be terminated. The receiver will be notified and acknowledgment received prior to any power reduction to reestablish refueling speed. If notified by the boom operator that a climb is required, disengage autopilot and climb straight ahead with wings level. If in a turn, maintain the established bank angle until the receiver is well clear. In either case, establish a definite rate of climb and do not decrease airspeed below that indicated at start of climb.

2. Receiver pilot — Actuate autopilot/boom disconnect switch. Retard throttles and establish a definite rate of descent, and use speedbrakes and landing gear if necessary to assure safe separation. If possible, drop aft of tanker until the entire tanker is in sight and monitor flight instruments.

3. Receiver copilot (if in two pilot aircraft) — Actuate autopilot/boom disconnect switch, maintain visual contact with the tanker, and turn on anticollision lights until clear and standby for instructions from the pilot.

Note

- If a breakaway is called prior to any receiver reaching the observation position, the entire receiver flight will execute the breakaway procedure. If a breakaway is called after receivers have reached the observation position, only the receiver in contact or precontact position will execute the breakaway procedure. The receiver in the observation position will maintain formation on the tanker.

- With certain gross weights and aircraft configurations, the tanker rate of acceleration on a breakaway may exceed the rate of acceleration for the receiver aircraft in the observation position.

4.11.2 System Malfunctions. When any system malfunction or condition exists that could jeopardize safety, air refueling will not be accomplished except during fuel emergencies or when continuance of refueling is dictated by operational necessity. At any time fuel siphoning is noticed, fuel transfer will be stopped and receiver notified. The requirements to continue fuel transfer will be at the discretion of the receiver pilot.

WARNING

- After an A-4 receiver aircraft contacts the drogue, the tanker shall transfer a few gallons, then cease transfer to ensure that fuel is not leaking from the drogue. If no fuel leakage is reported, continue normal transfer.

- If during subsequent refueling, the A-4 pilot observes fuel escaping at the coupling, he shall immediately break away.

CAUTION

- In the event of a lack of KC-10 hose response, the receiver pilot shall immediately reduce power and establish a smooth, positive rate of disengagement. The use of speedbrakes will only aggravate any hose since wave motion.

- Tanker crew must be notified prior to performing manual boom latching. Manual boom latching will only be accomplished for actual fuel emergency or operational necessity.

Note

A small amount of fuel spray may be present upon drogue contact/disconnect. No fuel spray should be evident during fuel transfer. Air refueling operations may be continued or discontinued at the receiver's discretion.

4.11.3 Crash Landing, Ditching, or Bailout. If an emergency occurs that necessitates a crash landing, ditching, or bailout, an aircraft designated by the mission commander will accompany the disabled aircraft or will cover personnel at a safe distance above the surface. The designated aircraft will render all assistance possible, orbiting the area until aid arrives or until fuel supply requires leaving the area.

4.12 POSTAERIAL REFUELING

Upon completion of air refueling, the receivers should descend to the bottom of the assigned altitude block while awaiting postair refueling report and further ARTC clearance. Tanker leader is responsible for directing positive vertical separation during refueling formation breakup/separation. All tankers and receivers shall use means available to monitor the position of all aircraft in the formation during all position changes, reforming, or departure from the flight.

WARNING

Receivers will ensure a safe clearance from the tanker(s) as they proceed on their assigned missions. Receiver(s) required to accelerate past the tanker(s) and climb on the refueling heading will maneuver either left or right (a minimum of 1 nm) of track to preclude climbing directly in front of the tanker(s)/remaining receiver(s). Tanker(s)/remaining receiver(s) flying through departing receiver jet wash may experience damage to the aircraft and injury to personnel.

Note

Any aircraft maneuvers executed prior to the termination of MARSA should be coordinated between the involved refueling aircraft. This may include verbal radio clearance between aircraft depending on emission control procedures and operational constraints. Otherwise, positive visual clearance is imperative.

4.12.1 Separation/Termination Procedures. Following completion of air refueling, maneuver to the prescribed formation position, obtain tanker postair refueling report, and return to the primary refueling frequency (if applicable). After the receivers have reformed, the tanker leader will provide the receiver or receiver leader with present position in relation to the planned completion point.

Additional information will be provided if requested (i.e., weather information, nearest abort bases, etc.). The receiver or receiver leader will request the no-wind heading and distance to the next checkpoint unless he has a positive fix from which to navigate.

4.12.2 Separation

4.12.2.1 One Tanker/One Receiver. Upon completion of air refueling, the tanker will normally climb to the top and the receiver will descend to the bottom of the air refueling block. The receiver will maintain a safe clearance from the tanker and proceed on assigned mission. The tanker will give postair refueling information to the receiver as required.

Upon termination of air refueling, all exterior lights will be set as required.

4.12.2.2 Multiple Tankers and/or Receivers. The tankers and receiver leader will coordinate on the method of separation. Normally, after the receiver flight has reformed, they will clear the tanker by descending or as directed by the controlling agency. After receiving clearance from the tanker leader and the appropriate controlling agency, the receivers will proceed on their assigned mission, maintaining safe clearance from the tanker formation.

4.12.3 Receiver Rejoin Procedures (IFR). If the receiver elements are not in visual contact with each other at the completion of cell termination, the following procedures should be initiated:

1. Each receiver element should maintain their respective altitude.

2. The receiver formation leader should maintain heading and each of the following receiver elements should simultaneously turn left 10⊃ on the formation leader's command.

3. Nos. 2, 3, and 4 elements should maintain this heading for 1, 1-1/2, and 2 minutes, respectively, and then resume original heading.

4. Elements should join up in sequence.

4.12.4 Cell Termination at Terminal Approach Fix. Because of the many possible combinations of tanker/receiver formations, terminal destination weather, and terminal airfield penetration facilities, it is impractical to designate one optimum method for penetration at the destination. The following methods may be used, as applicable, if prebriefed and coordinated.

1. From the final air refueling point, tankers and receivers can be scheduled at their individual optimum airspeeds to provide spacing for the penetration.

2. After the receivers have a positive tacan lock-on, they will normally depart the tankers and proceed to destination as directed by the appropriate controlling agency.

3. When available, radar approach control (RAPCON) should be used with en route descents to obtain aircraft separation.

4.12.5 Cell/Element Penetration. If conditions exist which necessitate a more expeditious recovery (fuel shortage, emergency, etc.), a cell/element penetration (e.g., one tanker/two receivers) may be made. Penetration airspeed and descent rate will be coordinated between the tanker and receiver leader. When VFR, the receiver will break off and enter initial for a VFR landing. Weather minimums for this type approach are 2,500 feet and 3 nm.

4.13 RECEIVER MISSION PLANNING

4.13.1 General. Figure 4-18 provides basic in-flight data used by the USAF to plan air refueling missions. The data is based on an air refueling movement in which the tankers accompany the receivers to destination (buddy movement); however, the air refueling data is applicable to anchor-type refueling. The data is applicable for both KC-135 and KC-10 tankers and is a compromise between optimum and Air Force tanker performance during buddy cruise and air refueling cruise.

4.13.2 Receiver Configuration. The receiver configurations indicated have been determined by receiver NATOPS model managers as a standard ferry/transoceanic configuration and was based on a transoceanic movement in excess of 2,000 miles. The in-flight data is predicated on the configuration indicated and will be utilized by the Air Force for a movement with such configuration. The in-flight data may be used for other configurations not indicated; however, the resulting cruising and air refueling profiles may result in less than optimum receiver performance.

4.13.3 Buddy Cruise. Buddy cruise is the formation flight of tanker(s) and receivers (i.e., cell/element) not air refueling. The in-flight data for buddy cruise provides the most efficient altitudes and true airspeed for tankers and receivers under cruise conditions during a buddy movement.

Note

S-3 in-flight data under buddy cruise is based on no tanker escorts and is the optimum cruise altitude and airspeed for the receiver only. This is due to the extensive range, communication, and navigation capabilities of both aircraft eliminating buddy movements.

4.13.4 Air Refueling Cruise. Air refueling cruise is the formation flight of tankers and receivers (i.e.,

cell/element) undergoing air refueling operations. The in-flight data for air refueling cruise provides the most efficient and effective altitude and calibrated airspeed to accomplish the following:

1. Maintain receiver airspeed below KC-10 maximum drogue contact airspeed of 300 knots calibrated airspeed (KCAS).

2. Maintain receiver airspeed below KC-135 maximum probe limit Mach.

3. Provide altitude and airspeed that gives a stable receiver platform and is compatible with the performance range of the tankers.

4. Provide highest altitude possible for transition to buddy cruise so as to preclude a step-climb when possible.

4.13.5 KC-135 Probe Limit Mach. The probe limit Mach is the maximum allowable Mach during KC-135 air refueling from contact to disconnect. The probe limit Mach is based on the strength and rigidity of the receiver probe system and the associated side level forces applied by the KC-135 drogue to the receiver probe that increases with an increase in airspeed/Mach.

ACFT	CONFIG	BUDDY CRUISE FL/TAS/MACH/CAS/IAS	A/R CRUISE FL/TAS/MACH/CAS/IAS	KC-135 PROBE LIMIT MACH	TRANSFER RATE/NO PUMPS KC-135	KC-10	PROBE LIMIT (IAS) OPERATE/CRUISE	NOTE
F-14A	2-TKS (A)	270/460/.77/310/310	250/400/.67/280/285	.68	1500/1	2500/2	400/400	
F/A-18	3-TKS (B)	300/460/.78/295/295	300/440/.75/280/285	.80	2000/1	2300/2	300/400	
A-4M	3-TKS (C)	270/440/.74/295/298	270/365/.61/242/245	.61	1000/1	1600/2	N/A	
A-6E KA-6D EA-6A	3-TKS (D)	260/420/.70/285/290	260/405/.65/265/270	.68	1000/1	2500/2	FIXED	
A-6E	4-TKS (E)	260/420/.70/285/290	260/405/.67/275/280	.68	1000/1	2500/2	FIXED	
EA-6B	4-TKS (F)	250/390/.68/270/275	250/390/.68/270/275	.68	1000/1	2500/2	FIXED	
AV-8B	4-TKS (G)	290/445/.75/290/290	290/425/.72/275/275	N/A		1100/1	300/300	KC-10 ONLY
S-3A/B	2-TKS (H)	300/305/.54/230/235	200/305/.50/230/235	.62	1800/1	1800/2	300/300	
E-6A	7-TKS (I)	.74	250/390/.66/270/275	N/A	6000/4	6000/4	N/A	BOOM ONLY

CONFIGURATION NOTES:

(A) 2/280g WT, 2/PYLONS
(B) 2/330g WT, 1/315g CLT, 2/LAU-7, 2/PYLONS
(C) 2/300G WT, 1/400g CLT
(D) 2/300G WT, 1/300g CLT
(E) 4/300g WT, With/Without Travel Pods
(F) 4/300g WT
(G) 4/300g WT
(H) 2/300g WT
(I) 2/440g, 2/2350g, 2/4070g WT, 1/10, 200g CTR

N7/96

Figure 4-18. Air Refueling Mission Planning, Ferry Configuration, and Flight Data

CHAPTER 5

Helicopter Air Refueling

5.1 MISSION PLANNING GENERAL

The air refueling operation requires precise and detailed planning to ensure success. Consideration must be given to each factor resulting from various receiver/tanker capabilities and limitations. The most efficient performance and procedures may not be the optimum for either the receiver or tanker; however, it must be within the operating limitations of each. Crewmembers must be thoroughly familiar with all the planning factors used in determining how the mission is to be flown.

A KC-130 Pilot RAC shall be designated for each refueling area. During AR missions, the RAC is in command of the refueling operation in the refueling area and shall be responsible for making necessary decisions. He shall ensure coordination with the receiver flight lead has been accomplished so that the refueling mission will be successfully completed. The RAC shall assume control of the receivers when radio contact is established or, in the case of EMCOM/communications-out refueling, when visual contact is established. The helicopter flight lead maintains lead responsibility for his flight and maneuvers his flight as briefed/required or as directed by the RAC. During the join-up stage, the helicopter flight lead will pass the lead for his flight to the RAC.

Crewmembers will be briefed and become thoroughly familiar with the weather forecast for the air refueling area so that alternate plans can be utilized when the primary track or area is unsuitable. Tanker crews will become familiar with the receiver's route of flight/flight plan and mission requirements. In addition, both tanker and receiver crews must be thoroughly familiar with the following in order to adequately plan for a mission. When possible all items will be briefed prior to flight. Otherwise items will be briefed in flight prior to rendezvous.

Note

When ARCPs are located beyond the navigational capability of the receivers, appropriate escort should be considered.

1. Tanker and receiver call signs
2. Number of receivers/tankers
   a. Option 1 (primary tanker with spare)
   b. Option 2 (separate refueling elements)
3. Type of refueling (on course or static)
4. Air refueling initial point (ARIP) and alternate ARIPs
5. Air refueling control point (ARCP) and alternate ARCPs
6. Air refueling control time (ARCT) and alternate ARCTs
7. Air refueling track/course
8. Air refueling altitudes(s) and airspeed
9. Type of rendezvous (RV)/join-up
10. Air refueling frequencies (both primary and secondary) and beacon/IFF settings.
11. Fuel transfer requirements
12. End air refueling point/ENDAR/disengage point
13. Air refueling abort point (bingo) and procedures to follow after abort point is reached
14. Cell or individual tactics
15. Tanker/receiver lighting configuration and NVD considerations
16. Receiver flow to tanker
17. Simultaneous air refueling

18. Reform area

19. Tanker loiter time

20. Lost contact procedures and signals

21. Communications-out / EMCON procedures

22. Inadvertent IMC procedures

23. Standby tanker requirements

24. Helicopter procedures if tanker does not show at ARCP or down track

25. Tanker procedures if helicopter does not show at ARCP or down track

26. Alternate track if weather becomes a factor

27. Air traffic control clearance limits

28. Emergency bases

29. Weather (destination and emergency bases).

To ensure that required briefing items are addressed in a standardized format Figure 5-1 is available to both the tanker and receiver crews. A thorough understanding of the procedures contained in this chapter is required to make good use of this card.

5.2 CONTROL OF TANKER/RECEIVER FORCES

The control of the tanker/receiver forces will be as specified in the mission operations plans/orders.

5.3 OPERATIONAL PLANS

Appropriate operations plans/orders should be published to cover all operational missions. The controlling agency directing the mission will be responsible for obtaining en route and air refueling clearances for all missions in accordance with existing procedures. All defined points, such as ARIP and ARCP, should be located over easily recognizable terrain when operationally feasible. Operations plans will contain specific instructions on the items that follow:

5.3.1 Helicopter Air Refueling Initial Point (ARIP). The ARIP is a point established a minimum of 8 miles prior to the ARCP. This point is part of the AR track and aids in identifying the receiver and determining their heading. Where operationally feasible, collocate-tanker and receiver ARIPs. Receivers should be at the ARIP 3 minutes prior to ARCT, inbound to the ARCP, at approximately 120 KIAS. This will assist in placing both aircraft in a position for rendezvous at the ARCP. If unable to collocate tanker and receiver ARIPs, each crew should select an ARIP that will place their aircraft on course at the ARCP at the ARCT. Receiver aircraft shall be established at the join-up altitude at the ARIP. Receiver aircraft shall maintain the join-up altitude until cleared by the RAC, either by voice or visual signal, to the observation position.

5.3.2 Helicopter Air Refueling Control Point (ARCP). The ARCP is the planned geographic point or coordinates over which the tanker arrives abeam the receiver and assumes formation lead. The ARCP is normally the earliest point the tanker can pass abeam the receiver, not when fuel is flowing from the tanker to the receiver. Receiver aircraft shall be at the join-up altitude at the ARCP. Receiver aircraft shall maintain the join-up altitude until cleared by the RAC, either by voice or visual signal, to the observation position.

5.3.3 Helicopter Air Refueling Turn Point (ARTP). ARTPs are planned turn points along the refueling route. ARTPs may be used on both a static track and along an enroute refueling track.

5.3.4 Helicopter Air Refueling Control Time (ARCT). The ARCT will be a specified time coordinated between the tanker and the receivers, Greenwich Mean Time preferred, or a prebriefed time after receiver launch. The receiver and the tanker should plan to arrive at the ARCP at the ARCT.

5.3.5 Helicopter End Air Refueling (ENDAR). A previously coordinated geographic point will be designated as the ENDAR point for fuel transfer on all enroute refueling.

5.3.6 Abort Points. The abort point is the point at which a receiver divert is directed if fuel transfer has not been initiated. Provisions for wind-adjusted abort points will be provided for all refueling tracks when required.

5.3.7 Receiver Flight Plan/Route of Flight. The receiver's route of flight will be specified. When grid procedures are required crews will be briefed and coordination assured between tanker and receiver crews as to grid configuration requirements and heading reference to be used. The tanker navigator will ensure the receiver grid heading is reset as required.

5.3.8 Communications. Communications will be as prescribed in ICAO procedures, enroute publications, regulations, ACEOIs and other existing instructions, unless specific instructions to the contrary are in the

KC-130 AERIAL REFUELING BRIEFING								
TYPE RENDEZVOUS	HEAD-ON/ HEAD-ON OFFSET			RANDOM/ TANKER ORBIT	EN ROUTE/ CONVERGING- RENDEZVOUS			
RECEIVER	HI/LOW			ARCT				
JOINUP ALT				AR ALT				
ALT SET	10 MIN PRIOR			AIRSPEED	110	115	220	240
LIGHTING CONFIGURATION		NVG		MIN	FAA			
TANKER C/S				RECV'R C/S				
AR FREQ PRI/SEC/TER								
IFF MODE 1/2/3A								
A/A TAC (T/R)	Y/X				Y/X			
COMM	FULL			EMCON				
ON-LOAD								
TNKR OPTION	1	2	SPARE	SIMULTANEOUS	YES		NO	
ARIP	N/S				W/E			
ARCP	N/S				W/E			
AR TP#1	N/S				W/E			
AR TP#2	N/S				W/E			
BINGO/ABORT	N/S				W/E			
ENDAR	N/S				W/E			
TRACK HEADING								
INV IMC PROCEDURES/NOTES:								

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Figure 5-1. AR Briefing Card

operations orders. Call signs, cell number, rendezvous and refueling frequencies, IFF/SIF modes and codes, control channels, and recognition and authentication procedures will be specified in this section.

5.3.9 Alternate Plans. If alternate refueling routes and tracks are applicable, they will be planned with the same detail required for the primary route.

5.3.10 Standby and Spare Tanker Requirements. Spare tankers will be provided, as necessary, to insure the required number of tankers are available to support the mission

5.3.11 Offload/Onload Requirements. Based upon the appropriate charts, the fuel transfer requirements will be computed against the profile as specified in the operations plans. Air refueling rate is normally 1,000 pounds per minute.

5.4 AIR REFUELING AIRSPEED AND ALTITUDES

To determine the indicated airspeed and altitude to be used for a specific air refueling operation, the performance capability of the helicopter must be determined and then compared with the KC-130 airspeed capability. All other factors being compatible, normal air refueling airspeed will be 110 KIAS. All airspeeds are indicated airspeeds. Determine the minimum airspeed for the gross weight at which the tanker may refuel.

When conducting low-altitude refueling with a "receiver low" join-up, the join-up altitude will remain 300 feet below the refueling altitude. The highest helicopter in the element should be no higher than 200 feet below the refueling altitude.

The aircraft responsible for the rendezvous does not leave this altitude (normally 1,000 feet above or below the A/R altitude) until visual contact is made with the other aircraft.

WARNING

- Airspeeds of less than 105 KIAS will cause the paradrogue to droop, resulting in a loss of helicopter rotor to tanker tail clearance that creates a high potential for midair collision.

- While configured for helicopter AR, the tanker has a small margin for safety above power-off stall speed. Abrupt power reduction at high gross weights may result in a stall with no stall warning. The refueling altitude should always be chosen with consideration of the threat. Refueling may be conducted from 500 to 15,000 feet AGL. 500 feet should be added to the refueling altitude for each tanker involved in multiple tanker evolutions to allow maneuvering and recycling of tankers on the AR track.

Note

Refueling below 1,000 feet AGL at night is not allowed by T&R Volume I unless the entire tanker crew is aided.

5.5 COMMUNICATIONS

UHF/VHF will normally be used for interplane communications. Identical UHF/VHF frequencies will not be assigned to any two air refueling operations being conducted in a proximity that would cause a communications overlap. Each cell will be assigned a frequency for the entire air refueling operation. All crews must be thoroughly familiar with all required verbal, visual, and electronic means of communication. All tanker and receiver aircraft shall monitor the air refueling frequency during the entire refueling evolution, regardless of EMCON/ communications-out conditions, for safety of flight considerations. The entire refueling evolution is defined as the beginning of the rendezvous to the clearance from the RAC to the detach and depart the refueling area.

CAUTION

Air refueling training will not be accomplished unless interplane communications capability is maintained between tanker(s) and receiver (s) during the air refueling operation.

Note

- During escort operations, the inbound tanker will rendezvous with the escorting tanker on a UHF/VHF frequency other than the primary tanker and receiver(s). During air refueling operations, communications between tanker and receiver aircrews must be a highly coordinated effort. Lengthy and improper call signs often cause confusion / block essential radio transmission.

- For air refueling operations, tankers and receivers will use their assigned call signs. Spare tankers will use assigned call signs suffixed by the words "callsign spare". Example, "Draft 51 spare".

Unless otherwise directed, communication between tankers and receivers will be maintained during all normal rendezvous, join-up, and fuel transfer operations. Voice transmissions, however, will be IAW the EMCON/ communications-out level of the evolution. Normally this will be held to the absolute minimum required and will be conducted between the tanker and receiver pilots. Any tanker or receiver crewmember noting an emergency or hazardous situation may initiate breakaway procedures. Tankers and receivers will begin monitoring designated radio frequencies and should have electronic rendezvous equipment operating at no less than 20 minutes prior to the ARCT. Rendezvous equipment signal identification and reliability must be known to both crews, together with range information, as soon as possible.

Note

AEW airplanes, or GCI/FAA facilities, when available, will be used for backup control for rendezvous, communication purposes and to confirm positive tanker/receiver identification. Strict radio discipline

must be adhered to at all times. All calls will be prefaced with individual call signs.

5.5.1 Radio Silence. Communications-out air refueling may be conducted for tactical training and operational missions provided the following precautions and procedures are observed:

1. The air refueling prerendezvous briefing requirements will be covered in the premission briefing.

2. Radio equipment on both aircraft must be operative and crews on both airplanes must monitor the same frequency and GUARD (243.0) during all air refueling procedures.

3. The following communications-out signals will be used in day or night tactical missions:

5.5.1.1 Helicopter Light Signals for Communications-Out Day/Night. (See Figure 5-2.)

Note

All EMCON signals are given from the observer located on board the tanker in the paratroop doors. Lights on the tankers AR pods are an indication of the hydraulic and fuel flow status of the AR pod to the receiver and are not used for EMCON communication between the tanker and receiver.

5.5.2 Emission Control 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 restriction of electronic emissions are standardized into four NATO options. (See Figure 5-3).

1. Emission Option 1 — Any and all emitters are authorized.

2. Emission Option 2 — Radio silent formation except for RV and air fueling is conducted with limited radio exchange. All other emitters are authorized. Essential radio transmissions for flight safety may be made. At initial contact, receivers and tankers will exchange the RV initial call, adding any timing that would affect the RV (in minutes early or late). Receivers will not depart the precontact position until either this radio check or visual signals direct approach to contact. Emission option 2 is the desired standard for day-to-day air refueling.

3. Emission Option 3 — Radio silent operations including formation, RV and AR. The use of other emitters is authorized unless prohibited by supported operations, plan, etc.

4. Emission Option 4 — No emitters will be used unless specifically authorized by the plan which the AR is supporting (ATO, ROE, operations plan, safe passage procedures, or other mission directive). Doppler navigation systems may be used as required for mission accomplishment.

Note

A piece of equipment that emits electromagnetic radiation (radios, radar, tacan, IFF, doppler, radio altimeter, etc.).

5.6 LIGHTING WITH RECEIVERS AIDED (NVG)

The tactical/training situation will dictate the use of aircraft lighting for air refueling. Receivers/tankers will have lighting configured prior to rendezvous. During NVG air refueling rendezvous, the tanker(s) and receiver(s) will have their lighting configured IAW the training/operational scenario. Both the lead and trail receiver will utilize a strobe light during the rendezvous. A single tanker will utilize a rotating beacon until abeam the lead receiver. For multiple tankers, the lead tanker will have beacon OFF for the rendezvous. The spare tanker will utilize the beacon for the formation until required to assume primary tanker duties.

Note

- NVG air refueling requires the receiver pilots to wear NVDs. The tanker crew, or only the refueling observers, may also be aided. The aided capability of both the tankers and receivers should be contained in the premission brief.

- The tanker beacon causes excessive glare during NVG join-ups. After join-up, the trailing receiver or spare tanker (if tanker available) will carry the strobe for the formation. In the case of equal numbers of receivers on each side of the tanker, the trailing receiver on the right hose will carry the strobe.

SIGNAL	FROM	TO	MEANING	RESPONSE
1. RECEIVER LEAD LEAD ANTICOLLISION OFF	TANKER	RECEIVER	PASSES LEAD	NONE
2. TOP ANTICOLLISION OFF	TANKER	RECEIVER	TANKER ACCEPTS LEAD	RECEIVER MOVES TO OBSERVATION
3. HOSES OUT	TANKER	RECEIVER	CLEARED TO PRECONTACT POSITION	MOVE TO PRECONTACT POSITION
4. FLASHING LIGHT FROM A FLASHLIGHT OR OTHER SIGNALING DEVICE	RECEIVER	TANKER	REQUEST TO CROSS OVER	AS REQUIRED
5. MOMENTARY FLASH OF TOP ANTICOLLISION LIGHT	TANKER	RECEIVER	CROSSOVER	RECEIVER EXECUTE CROSSOVER
6. STEADY LIGHT	OBSERVER	RECEIVER	CLEAR CONTACT	RECEIVER ENGAGES DROGUE
7. STEADY LIGHT	OBSERVER	RECEIVER IN CONTACT	RECEIVER HAS PREBRIEFED AMOUNT OF FUEL	RECEIVER DISENGAGES
8. FLASHING LIGHT	OBSERVER	RECEIVER IN CONTACT	TANKER IS EXPERIENCING PROBLEMS WITH THAT HOSE	RECEIVER DISENGAGES AND REMAINS OUTBOARD OF HOSE
9. NOSE PARTIALLY/FULLY RETRACTED	TANKER	RECEIVER	HOSE UNSAFE	RECEIVER DOES NOT CONTACT THAT DROGUE
10. RECEIVER DISENGAGES AND REMAINS IN PRECONTACT POSITION OUTBOARD OF HOSE	RECEIVER	TANKER	RECEIVER NOT SATISFIED WITH HOSE RESPONSE OR FLOW RATE	HOSE WILL BE RETRACTED, TROUBLESHOT AND EXTENDED; RECEIVER CLEARED CONTACT
11. RECEIVER REMAINS IN CONTACT AFTER PREBRIEFED GIVE AND STEADY LIGHT FROM OBSERVER	RECEIVER	TANKER	RECEIVER REQUIRES MORE FUEL THAN PREBRIEFED	TANKER WILL OFFLOAD ADDITIONAL FUEL IN 500-LB INCREMENTS
12. STEADY LIGHT AFTER # 11 ABOVE	OBSERVER	RECEIVER	ADDITIONAL GIVE UNAVAILABLE	RECEIVER DISENGAGES
13. LOWER ANTICOLLISION LIGHT ON	TANKER	RECEIVER	EMERGENCY EXISTS	RECEIVER DISENGAGES
14. STEADY LIGHT MOVED UP AND DOWN	OBSERVER	RECEIVER	GO TO SPARE TANKER	RECEIVER TO SPARE TANKER'S OBSERVATION POINT

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Figure 5-2. Helicopter Light Signals for Communications-Out Day/Night

ITEM	EQUIPMENT	EMISSION OPTION			
		1	2 (USMC ZIPLIP 3)	3 (USMC ZIPLIP 2)	4 (USMC ZIPLIP 1)
1	RADAR	ON	ON	AS REQUIRED	OFF
2	DOPPLER	ON	ON	AS REQUIRED	OFF
3	RADIO ALTIMETER	ON	ON	AS REQUIRED	OFF
4	TACAN/DME	ON	ON	AS REQUIRED	OFF
5	IFF	ON	ON	AS REQUIRED	OFF
6	UHF/VHF	ON	ON	MONITOR	MONITOR
7	HF	ON	ON	MONITOR	MONITOR
8	LIGHTING	ON	ON	AS REQUIRED	OFF

NOTE

VARIATIONS MAY BE COORDINATED (EXAMPLE "EMCON 2, ITEM 1 EMITTERS OFF"). THIS WOULD MEAN NORMAL EMCON OPTION 2 PROCEDURES EXCEPT THE RADAR WOULD BE OFF.

(ZIPLIP CONDITIONS FOR USMC)

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Figure 5-3. Emission Option Emitter (Sheet 1 of 3)

ITEM	ACTION	EMISSION OPTION			
		1	2 USMC ZIPLIP 3	3 USMC ZIPLIP 2	4 USMC ZIPLIP 1
1	RADIO SET 30 MINUTES PRIOR TO ARCT (IF DUAL-RADIO CAPABLE)	X	X	(3)	(4)
2	15-MINUTE CALL	X	X		
3	A/A TACAN SET 15 MINUTES PRIOR TO ARCT	X	X	X (5)	
4	BEACON POSITIVE IDENTIFICATION (IF APPLICABLE)	X			
5	INITIAL CALL (IF APPLICABLE)	X	X		

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Figure 5-3. Emission Option Emitters (Sheet 2 of 3)

ITEM	ACTION	EMISSION OPTION			
		1	2 USMC ZIPLIP 3	3 USMC ZIPLIP 2	4 USMC ZIPLIP 1
6	ADF CHECK (IF APPLICABLE)	X			
7	1/2 WAY THROUGH THE TURN CALL (TANKER)	X			
8	1-NM CLOSURE CALL (RECEIVER)	X			
9	MANDATORY BOOM OPERATOR CALLS: A. PRECONTACT CALL B. CLEAR RECEIVER TO CONTACT C. ACKNOWLEDGE CONTACT/ DISCONNECT D. VERBAL CORRECTIONS E. ADVISE RECEIVER(S) TO RETURN TO PRECONTACT FOR CHECKLIST OR EQUIPMENT CONSIDERATIONS	 X X X X X	 X		
10	MANDATORY RECEIVER CALLS AFTER 15-MINUTE CALL: A. VISUAL CONTACT ESTABLISHED/ LOST TO INCLUDE OVERRUN B. PRECONTACT CALL C. WHEN CONTACT OR DISCONNECT IS MADE D. VERBALLY NOTIFY BOOM OPERATOR PRIOR TO MANUAL/ EMERGENCY BOOM LATCHING PROCEDURES	 X X X X	 X X		

Figure 5-3. Emission Option Emitters (Sheet 3 of 3) N7/96

Note

During single-receiver or two ship simultaneous AR training, in conditions of low illumination (no Moon or stars), the Loadmaster may be unable to perform his duties when the receiver is required to carry a strobe. Anytime safety is compromised, the tanker aircraft commander will terminate simultaneous portion of AR for two-ship operations.

5.6.1 Exterior Lighting. The following exterior lighting Figure 5-4, should be used by the tanker:

5.7 STAGES OF AIR REFUELING

Air refueling may be divided into four stages of operation: Rendezvous (intercept/escort), join-up, contact/ fuel transfer, and post air refueling.

5.8 GENERAL RENDEZVOUS PROCEDURES

During the initial stage of rendezvous standard intercept procedures will be employed to place the tanker on an intercept course with the receiver. The tanker will be established at rendezvous altitude, in sufficient time to allow an orderly accomplishment of the selected rendezvous procedure.

LIGHTS	JOIN-UP POSITION	REFUELING POSITION
1. Anticollision		
a. Upper	ON	OFF
b. Lower	OFF	OFF
2. Leading Edge	OFF	OFF
3. Navigation		
a. Flash/Off/Steady	STEADY	STEADY
b. Wing	DIM	DIM
c. Tail	OFF	OFF
d. Fuselage	OFF	OFF
4. Formation		
a. Colored Wing-Fus/Both	BOTH	BOTH
b. Rheostat	20%	20%
5. Pod and Hose Illum	OFF	OFF
6. Pod	Dim	Dim

Note: Refueling pod lights should be prepared before flight using green ordnance/duct tape. Either the pod lens should be taped by removing the "bird cage" or the "bird cage" should be taped. Two or three layers of tape should be used in order to prevent noncompatible light from escaping from the pod.

7. IR Beacon NVIS Modified (External) Aircraft		
a. Upper	ON	OFF
b. Lower	OFF	OFF

Note: Unless planned otherwise, the anticollision light will be illuminated until passing abeam of the receivers and assuming formation lead. The IR beacon may be used as well, and in some situations in place of the anticollision light. The IR beacon has selectable intensity. Intensity 5 is brightest to the aided viewer and should be used only during acquisition and in the distant portions of the rendezvous. The intensity of the IR beacon should be decreased as the distance between tanker and receiver decreases.

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Figure 5-4. Exterior Lighting

The receiver and tanker will monitor rendezvous UHF/VHF/HF frequencies and attempt to establish radio contact a minimum of 10 minutes prior to ARCT. If communications out procedures are used, both tanker and receiver crews shall monitor the frequencies and not attempt contact.

Prior to rendezvous the participating crews will confirm any changes to the premission briefing. Additionally, the following information will be determined/ reconfirmed by the tanker pilot if not previously addressed:

a. Refueling altitude

b. Altimeter setting

c. Time of bingo fuel.

After initial radio contact has been established between the tanker and receiver, the tanker will assume radio control of the rendezvous and clear the receiver(s) to the join-up altitude. Depending upon tanker capability, the tanker pilot will request the receiver to:

1. transmit a specific IFF code

2. transmit for a DF steer.

Positive radar identification may be made by having the receiver turn the IFF to STANDBY. The tanker will notify the receiver when radar contact is established. Receiver(s) may be provided with avail-

able range information every 10 nm, until the range decreases to 10 nm. When the IFF signal is received before radio contact has been established, the receiver may be instructed to squawk STANDBY for 10 seconds and return to NORMAL. When he complies, this indicates receipt of instructions.

5.8.1 Visibility/Weather. Minimum weather for a VMC rendezvous is visibility of 5 miles and a ceiling of 5,000 feet. Minimum visibility for radar rendezvous is 1 nm. Flight through clouds after contact is not recommended. The agency having overall control will make the go/no-go decisions based on weather. It is important that a close-weather watch be maintained throughout the operation to aid in making recalls, diversion, etc.

5.8.2 Altimeter Setting. Altimeter setting used will be the nearest station altimeter, prebriefed minimum altimeter from the weather brief, or the standard altimeter setting 29.92 inches Hg when authorized.

5.9 HOT ARMAMENT PROCEDURES

To prevent inadvertent weapons firing during refueling operations, positive checks will be made by the receiver prior to rendezvous.

Note

- Compliance with appropriate, checklist will provide required checks for receivers.
- With radio communications receiver(s) will complete hot armament checks prior to arriving in the precontact position with the tanker. If the receivers are a formation, hot armament checks should be completed and reported to the receiver flight lead. When requested, these checks will be reported complete to the tanker/RAC.

5.10 RENDEZVOUS PROCEDURES.

The tanker will normally accomplish all required maneuvering during rendezvous. The exception to this is using the "tanker orbit" rendezvous procedures. Rendezvous procedures provide the tanker a means of transition from escort/intercept conditions to a position one-half nm in trail of the receiver ready to begin the join-up. Join-up procedures enable the tanker to proceed from one-half nm in trail to the lead position, establish refueling configuration (hoses extended, flaps 70-percent, air speed below 120 KIAS for normal operation). In an effort to expedite the AR evolution, the tanker crew should allow time prior to the rendezvous to accomplish hose checks. Because of the requirement for reduced airspeeds with low-speed drogues extended, mission planning should use either reduced en route airspeeds to the ARIP/ARCP, or a planned en route delay to the ARIP/ARCP to allow hose checks to be conducted.

CAUTION

The maximum allowable extension/retraction airspeed on the low speed paradrogue is 120 KIAS. Do not exceed this speed during the extension or retraction of the paradrogue. Maximum airspeed after full extension of the paradrogue is 130 KIAS.

Note

A minimum vertical separation of 1,000 ft will be maintained between tanker and receiver during rendezvous until positive visual contact has been established. The aircraft conducting the rendezvous, normally the tanker, is responsible for this separation.

5.11 RANDOM RENDEZVOUS

Random rendezvous should be used during VMC as a method to facilitate rendezvous without losing visual contact with receiver(s). The tanker pilot should position his aircraft so as to maintain visual contact and:

1. If arriving from above the receiver, reach rendezvous altitude at least 5 nm from receiver(s).

2. Confirm receiver(s) is at join-up altitude.

3. Descend/climb to refueling altitude and maneuver to one-half nm in trail. Proceed with join-up procedures.

Note

This procedure is designed to expedite rendezvous, to maintain visual contact once established and to allow the tanker pilot to maneuver the tanker as required to accomplish a successful rendezvous.

5.12 HEAD-ON OFFSET RENDEZVOUS

The head-on offset rendezvous is the most frequently used procedure and is only utilized during VMC conditions. Tanker(s) and receiver(s) approach

from opposite directions on 180° reciprocal headings with the tanker at least 1,000 feet above or below the receiver's altitude. (See Figure 5-5.)

The head-on offset rendezvous may be done electronically using radar and IFF range and bearing information or air to air tacan (minimum visibility of 1 nm). It may be done visually by flying to a point 3 nm abeam the ARIP/ARCP (minimum visibility of 5 nm). The tanker will plan to be abeam the ARCP on a reciprocal track heading, at rendezvous altitude, at en route airspeed approximately 5 minutes prior to the ARCT. At this time, the receiver will be 2 minutes prior to the ARIP. The tanker should plan to make a standard rate turn back toward the AR track 3 minutes prior to the ARCT or passing the receiver's 10/2 o'clock position. This turn should occur with tanker abeam the ARIP and the receiver at the ARIP.

Note

- Minimum trail distance may be as little as 2 nm for this rendezvous.
- If the turn back to track is based on receiver(s) position, en route timing may end abeam the ARCP or ARIP.
- Arrive abeam the ARCP/ARIP 1 minute earlier for AR formation options and rendezvous.
- Winds parallel to the AR track heading can disrupt timing to the ARIP/ARCT.

Receivers must maintain the prebriefed ground track and airspeed between the ARIP and the ARCP in order for the tanker to complete its rendezvous in an expeditious manner.

Timing correction may be required by either the tanker or the receiver in order to arrive at ARIP and ARCP as planned. If required, these timing corrections should be done prior to arrival at the ARIP. In no situation should the receiver hold at the ARIP. Maintain 240 KIAS until commencing the rendezvous turn. With a visual on the receiver(s), the tanker will clear the receiver(s) to the join-up altitude. Tanker will confirm altimeter setting, airspeed, and heading. Ensure lateral offset is between 2 to 5 nm with 3 nm being the optimum distance. As the receivers approach the tankers 10/2 o'clock position heading in the opposite direction, the tanker will commence a climbing or descending/decelerating left/right hand turn to arrive at a position one-half nm in trail of the receiver(s) and 180/155 KIAS flaps 50 percent. As the tanker(s) approach the last receiver's 5 o'clock position in the formation, the tanker should reduce power, lower flaps to 70 percent and extend hoses at 120 KIAS, providing the receivers are in the observation position.

5.13 TANKER ORBIT RENDEZVOUS (VMC ONLY)

This is the only rendezvous in which the receiver maneuvers his helicopter to effect the rendezvous and join-up. The receiver is responsible for maintaining the required 1,000-ft. vertical separation from the tanker until visual contact is established. Tanker maintains an orbit, at the refueling altitude, at a specified location. The tanker will not attempt to arrive at ARCP at ARCT. The tanker will only maintain the prebriefed orbit pattern and allow the receivers to maneuver for rendezvous. This prebriefed orbit may be established on a portion of a static AR track, normally anchored just past the ARCP, or prior to the beginning of an on-course refueling track. Prior to join-up and at least 5 minutes prior to ARCT, tanker slows to refueling airspeed and establishes at the refueling altitude. The receiver will join up on the tanker. The join-up is complete with the receivers established in the observation position. Once the join-up is complete the tanker will assume the formation lead and continue to track along the static track or along the enroute refueling track.

Note

The tanker orbit is recommended for Marine CH-53Es that have limited navigational equipment.

5.14 HEAD-ON RENDEZVOUS

The tanker aircraft approaches the receiver on the reciprocal of the refueling track and makes a procedure turn. One of the following procedures will be employed, depending upon the rendezvous equipment available:

1. With radar/IFF range and bearing equipment Figure 5-6:

   a. The tanker navigator computes the turning point range Figure 5-7 and subtracts the desired trail distance, a minimum of 3 nm, to determine the initial turn short of the intercept point.

   b. When the turning point distance is reached, the navigator advises the pilot to make a 45° half standard rate (1 1/2° per second) turn to the right.

   c. Hold the new heading for 1 minute and 15 seconds.

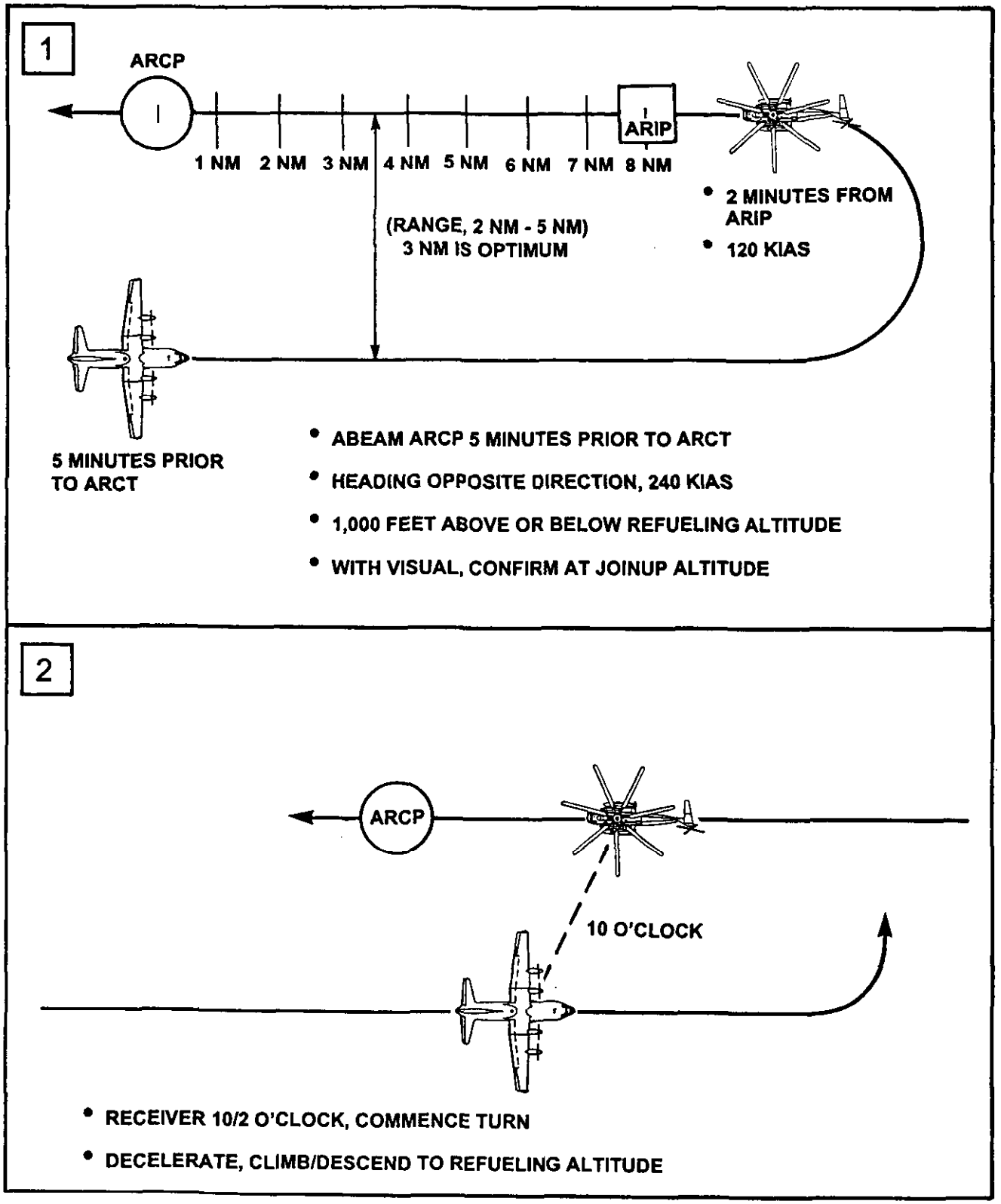

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Figure 5-5. Head-On Rendezvous (Sheet 1 of 2)

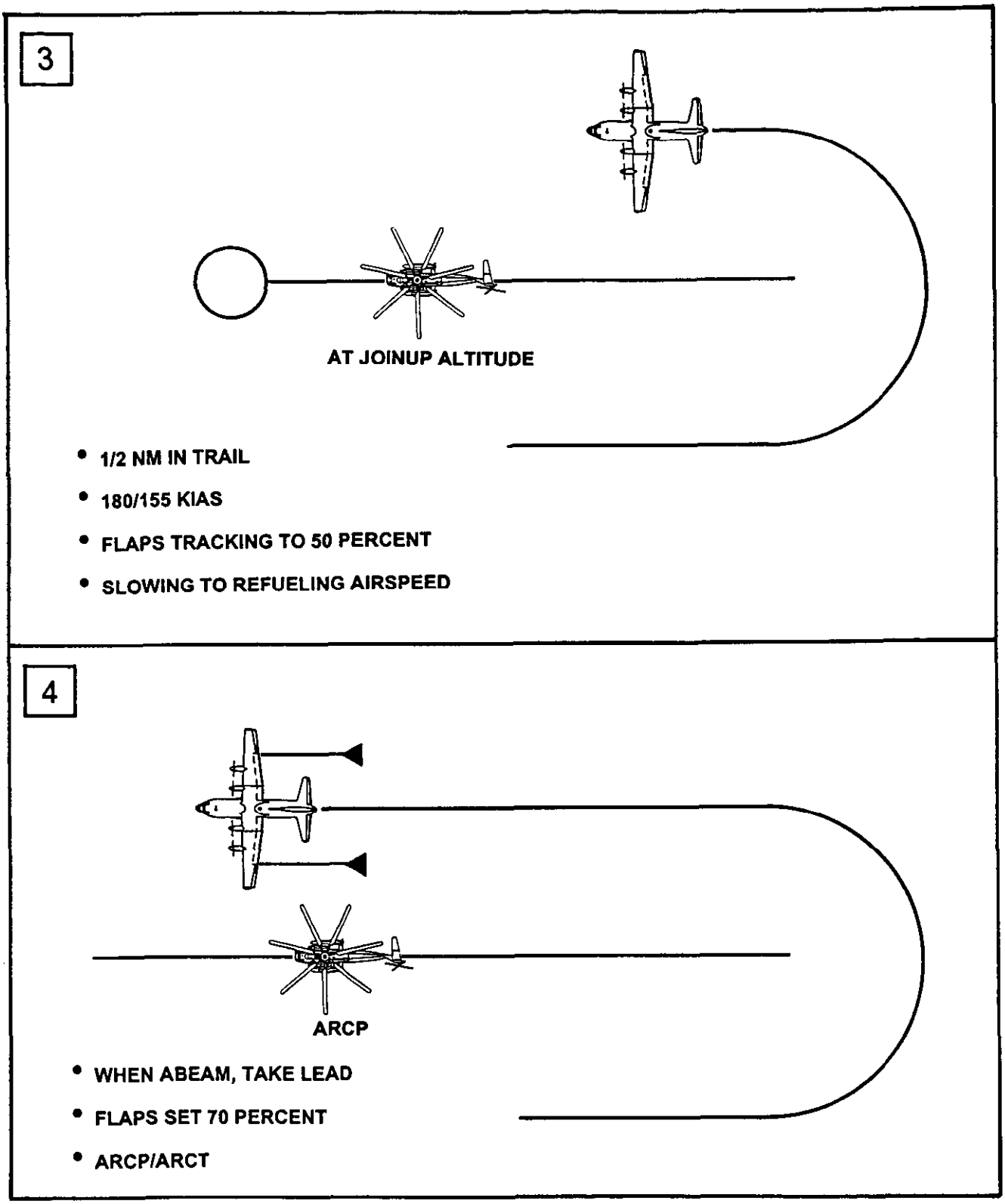

Figure 5-5. Head-On Rendezvous (Sheet 2 of 2)

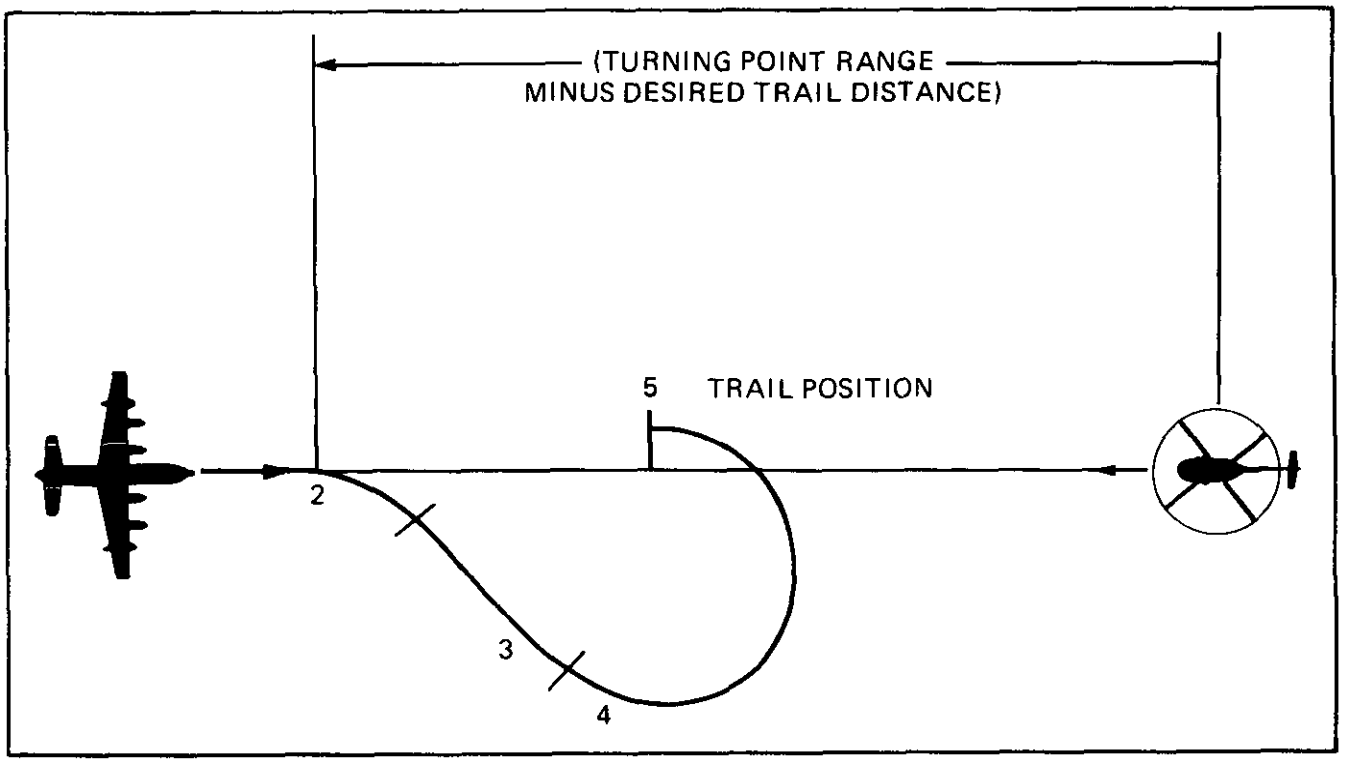

Figure 5-6. Head-On Rendezvous (Radar/IFF Range and Bearing Equipment)

KC-130 TAS	Helicopter TAS 80	90	100	110	120	130	140	150
160	10.4	11.1	11.8	12.5	13.2	13.9	14.6	15.3
170	10.7	11.4	12.1	12.8	13.5	14.2	14.9	15.6
180	11.0	11.7	12.4	13.1	13.8	14.5	15.2	15.9
190	11.3	12.0	12.7	13.4	14.1	14.8	15.5	16.2
200	11.6	12.3	13.0	13.7	14.4	15.1	15.8	16.5
210	11.9	12.6	13.3	14.0	14.7	15.4	16.1	16.8
220	12.2	12.9	13.6	14.3	15.0	15.7	16.4	17.1
230	12.5	13.2	13.9	14.6	15.3	16.0	16.7	17.4
240	12.8	13.5	14.2	14.9	15.6	16.3	17.0	17.7
250	13.1	13.8	14.5	15.2	15.9	16.6	17.3	18.0
260	13.4	14.1	14.8	15.5	16.2	16.9	17.6	18.3
270	13.7	14.4	15.1	15.8	16.5	17.2	17.9	18.6
280	14.0	14.7	15.4	16.1	16.8	17.5	18.2	18.9

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Figure 5-7. Turning Point Range —One-Half Standard Rate (1-1/2 Per Second)

d. Then, make a 225° one-half standard rate turn to the left.

e. After starting the turn, slow to 180 KIAS, lower flaps to 50-percent, request confirmation that receiver(s) are at join-up altitude and commence descent to reach refueling altitude a minimum of one mile behind the receivers. At the completion of the turn, the tanker will be on the receiver's heading.

f. If it is desired to use a standard rate turn for this procedure, divide the turning point range by two prior to subtracting desired in-trail distance. Hold the 45° outbound leg for 38 seconds then make a 225° standard rate turn to the left.

2. With bearing equipment only Figure 5-8:

a. The tanker navigator advises the pilot when approximately 5 miles from receiver. Tanker airspeed is reduced to 180 KIAS.

b. As the receiver passes the left wing, the tanker pilot executes a level 210° standard rate left turn, maintaining 180 KIAS and rendezvous altitude until visual contact is reestablished.

c. When visual contact is reestablished, lower flaps to 50 percent, request confirmation that the receivers have climbed to join-up altitude, descend to refueling altitude.

5.15 EN ROUTE (OVERTAKING) RENDEZVOUS

The tanker aircraft approaches the receiver from the rear utilizing either range and bearing information or bearing information only. (See Figure 5-9.)

1. With radar/IFF range and bearing equipment available, the tanker pilot will request confirmation that the receiver(s) have climbed/descended to join-up altitude and climb/letdown to reach refueling altitude a minimum of one mile behind the receiver(s).

2. With bearing equipment only, the tanker plans letdown to reach rendezvous altitude a minimum of 5 miles (based on navigator's computations) behind the receiver. When in visual contact with the receiver, the tanker pilot requests confirmation that receiver(s) have climbed/descended to join-up altitude and then descends/climbs to refueling altitude.

5.16 JOIN-UP

Rendezvous procedures position the tanker for join-up. Join-up from all types of rendezvous is the same. The tanker must maintain a positive rate of closure to avoid delaying refueling operations; however, caution must be exercised to avoid over running the receiver.

The join-up altitude is dependent upon the type join-up to be conducted. With a "receiver low" join-up the receiver's join-up altitude is 300 feet below the refueling altitude. With a "receiver high" join-up, the receiver's join-up altitude is 200 feet above the refueling altitude. The receivers shall be established at the join-up altitude at the ARIP.

At close range (one-half nm) tanker may advise the receiver(s) "one-half nm in trail" and reduces airspeed to 180 to 155 KIAS and lowers flaps to 50 percent. The hoses will not be extended until airspeed is below 120 KIAS and the receivers are in the observation position. As the tanker passes abeam, the receiver will respond "tallyho, you have the lead." The tanker advises the receiver "tanker has the lead" and establishes refueling airspeed. When cleared by the RAC, the receiver will report established in the observation position.

5.17 MULTIPLE RENDEZVOUS/JOIN-UPS (TRAINING) VMC ONLY

Standard rendezvous/join-up procedures apply. After the join-up is completed and the tanker is stabilized in formation lead, the tanker pilot will clear the receiver back to join-up altitude. Once the receiver is at join-up altitude the tanker pilot will climb or descend 1,000 feet prior to executing a 180° level turn away from the receiver. With approximately 8 nm of separation the tanker will direct the receiver to reverse course while executing a 180° level turn toward the receiver. When visual contact is acquired with the receiver, the tanker will follow standard join-up procedures.

After the join-up is completed and the tanker is stabilized in formation lead, the tanker pilot will clear the receiver back to join-up altitude. Once the receiver is at join-up altitude the tanker pilot will execute a 360° level turn away from the receiver. When visual contact is acquired with the receiver, the tanker will follow standard join-up procedures.

Note

If the tanker cannot establish visual contact by the time he has rolled out on the receiver

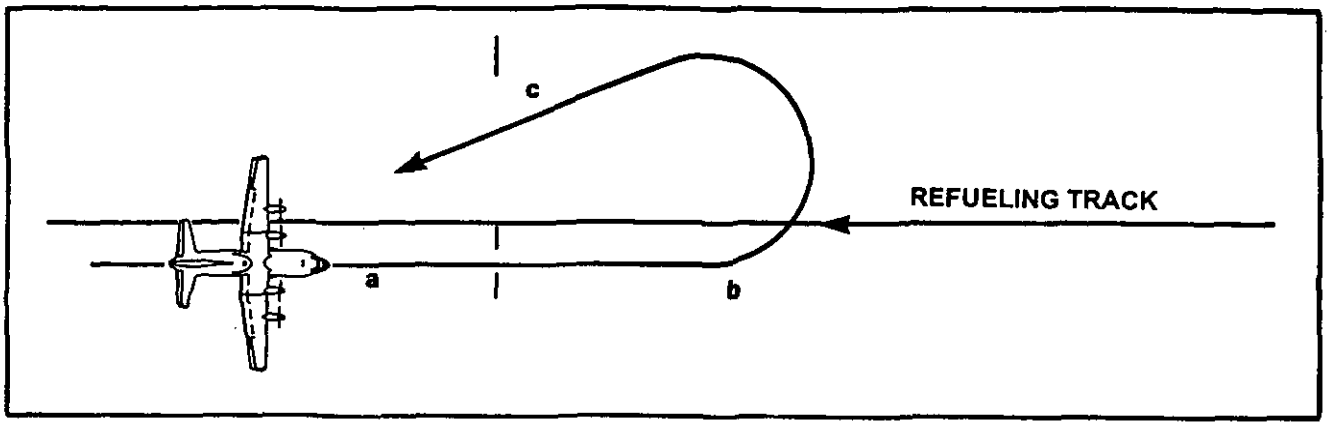

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Figure 5-8. Head-On Rendezvous (Bearing Equipment Only)

heading, the tanker will immediately execute LOST CONTACT PROCEDURES.

5.18 CONTACT/FUEL TRANSFER

This paragraph contains information to be used from the receiver's arrival in the observation position until the completion of fuel transfer. The left side refueling position will be primary; however, either side may be used.

WARNING

- Receivers will not attempt an engagement while in a turn at night. Engagements in a turn during the day are acceptable but at night the possibility of spatial disorientation exists when the receiver pilot divides his attention between the drogue and coordinating a turn while having less visual reference at night. Once engaged, turns are permitted because the pilot's reference is solidly on the tanker.

- Helicopters shall not attempt to refuel from a KC-130 configured with a high-speed drogue.

- The helicopter air refueling range is limited to 20 feet, approximately 56 to 76 feet of hose extension, to ensure safe aircraft separation during fuel transfer.

- Contacting a hose with no hydraulic pressure, as indicated by a red pod light illuminated, is an emergency procedure only.

- Excessively hard contact between probe and drogue can damage the refueling nozzle.

- Wing/prop turbulence can cause uncontrolled settling. If settling occurs while engaged in the drogue, disconnect immediately. Failure to disconnect may result in damage to the probe and possible blade-to-drogue contact.

- An excessive rate of disconnect will only aggravate any hose sine wave motion.

- Offcenter disconnects can damage the refueling nozzle.

5.19 MULTIPLE DRY CONTACTS (TRAINING)

Standard procedures will be used to accomplish the rendezvous, join-up, and initial contact. The receiver will request dry contacts by stating, "request multiple dry contacts on the left (or right) drogue." The tanker will approve multiple dry contacts by stating, "cleared for multiple dry contacts on the left (or right) drogue."

This series of maneuvers, contacts and disconnects, may be continued at the discretion of the receiver pilot until the clearance for multiple dry contacts is canceled or the receiver requests clearance to the observation position.

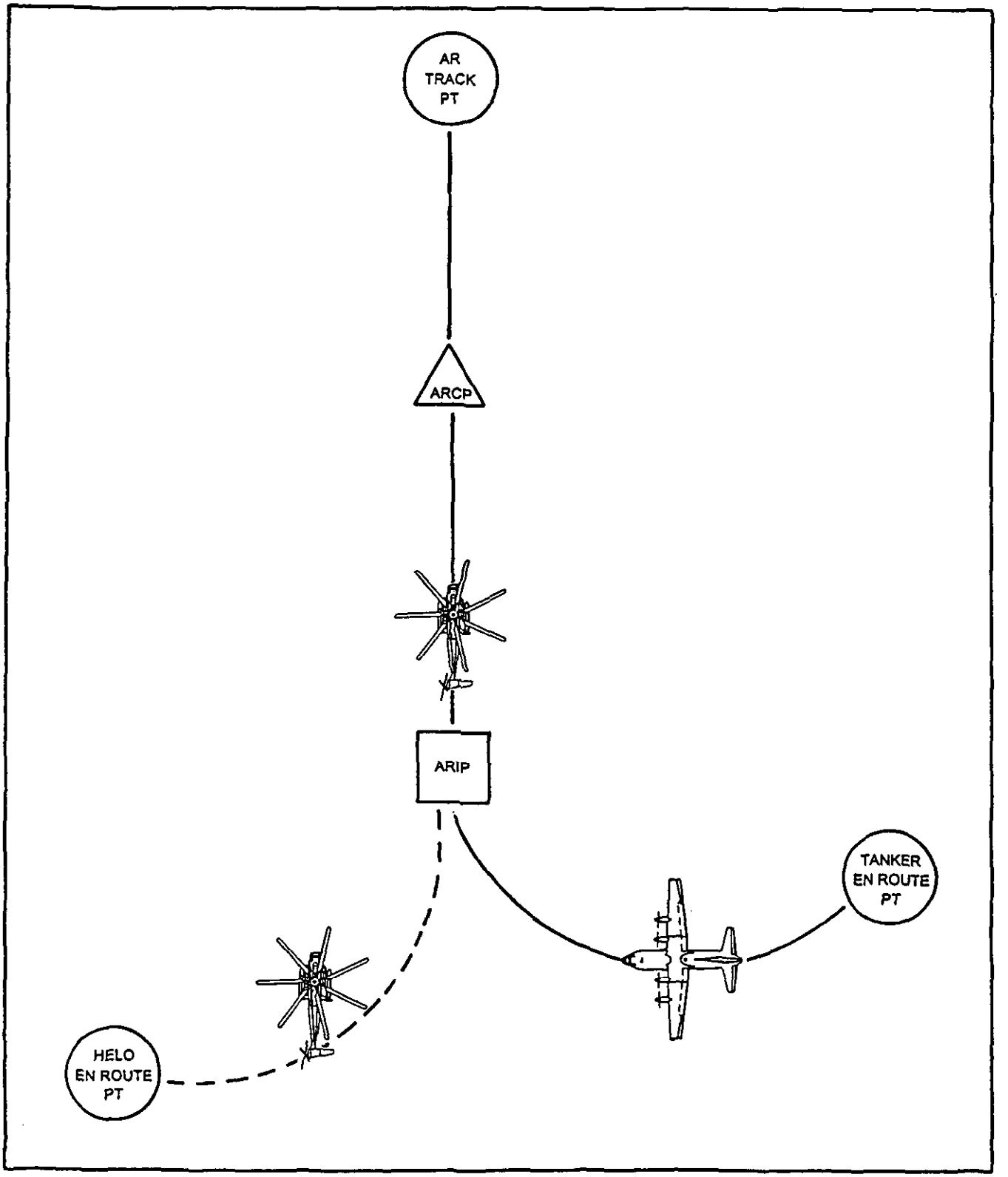

Figure 5-9. En Route (Overtaking) Rendezvous

5.20 CROSSOVER

If a crossover is required, the receiver pilot will move to the outside of the tanker wingtip, 100 feet aft of the horizontal stabilizer, and increase altitude to a minimum of 50 feet above the tanker's vertical stabilizer. A crossover will then be made by altering the receiver's heading. During crossover, the receiver aircraft should be flown to a position outboard of the opposite wingtip aft of the horizontal stabilizer before descending into the opposite observation position. This procedure will eliminate the possibility of the receiver passing through the area of extreme turbulence directly behind and slightly to the right of the tanker.

WARNING

Blade stall and uncontrolled settling may be encountered if the area directly behind and to the right of the tanker is entered. During demonstrations of wake turbulence for pilots receiving initial air refueling qualification, the instructor should use caution not to enter the area of extreme turbulence.

5.21 NAVIGATION AND POSITION REPORTING

When the rendezvous is complete, tankers will be responsible for all navigation, weather avoidance and position reporting.

5.22 EN ROUTE/ESCORT PROCEDURES

Some conditions may warrant using the tanker as an escort for the helicopter flight. Examples of this may be long range flights over water or desolate terrain where the onboard systems of the tanker may aid in navigation or communication. Although specific conditions will dictate the method in which escort will be accomplished, the following options should be considered:

1. Option 1 — Air refueling low altitude position for the tanker will be 1,000 feet above or below the helicopter flight and 1 to 2 miles in trail.

2. Option 2 — If tanker weight and/or receiver airspeed prohibit maintaining a position in trail of the helicopters, the tanker will maintain vertical separation and fly a procedure turn, variable dogleg, or progressive racetrack escort.

3. Option 3 — If the situation warrants, because of weather or other concerns, the tanker may fly as the formation lead with the receiver flight joined on the tanker.

The receivers cruise altitude will be the same as the refueling altitude unless the situation dictates otherwise.

5.23 AIR REFUELING WITH ONE TANKER/TWO OR MORE RECEIVERS

In the event more than one receiver is to be refueled by a tanker, the join-up will be performed as described in para.5.7 with the receivers in left echelon formation as shown in Figure 5-10. When number one receiver moves into the refueling position, the other receivers will maintain a position 200 feet behind and 200 feet to the left of tanker. When the first receiver completes refueling and is cleared by the RAC, he will make a normal disconnect and move aft and clear of the tanker and rejoin the helicopter formation outside of the echelon in the last (most rearward) position. The procedure will be repeated until all receivers have been refueled. Using this procedure, the first receiver to be refueled will again be in the lead position when all the receivers have completed refueling.

5.24 LOST CONTACT PROCEDURES

5.24.1 Prior To Tanker Assuming Formation Lead. If visual contact is not established by 1 nm, but electronic contact (radar/IFF range and bearing) is maintained the tanker will immediately turn 45° right of the receiver's heading. Lower wing flaps to 70 percent, slow to refueling airspeed, and call "no visual contact." After 30 seconds turn left and resume receiver's heading. Maintain electronic contact and a position 1 to 2 nm behind receivers.) If visual and electronic contact is lost after the tanker is within 5 nm of the receiver, the tanker will immediately turn 45 ° right of the receiver's heading, maintain existing altitude and call "Contact lost". After 30 seconds, initiate a climb/descent to rendezvous altitude. Maneuver for another rendezvous or proceed as briefed.

During no visual contact or contact lost, the spare tanker will stay with the lead tanker. If the spare tanker loses sight of lead, the spare will turn right 10° or more from the lead tanker's heading and follow the rest of the no visual contact or contact lost procedures.

5.24.2 After Tanker Assumes Formation Lead

1. Nonmountainous:

a. If the receivers lose sight of each other or the lead aircraft (tanker), maintain radio contact to confirm intentions. The receiver(s) will call "Lost visual contact" and simultaneously turn to lost contact heading to establish separation. The tanker will respond with "Execute" followed by base heading and the MSA. The tanker will accelerate to cruise airspeed and climb to MSA. The spare tanker will turn right 10°, accelerate to cruise airspeed and climb to MSA plus 500 feet. The first receiver (#2 in the formation) alters 20° (2xl0) away from the tanker's heading, climbs 400 feet (2x200) above MSA and, after 30 seconds, returns to the tanker heading. The second receiver (#3 in the formation) alters 30° (3xl0) away from the tanker heading, climbs 600 feet (3x200) above MSA and, after 30 seconds, returns to the tanker heading. Timing starts when you reach your altitude. Each receiver will call out the heading to which aircraft is turning and the altitude to which aircraft is climbing to preclude any possible misinterpretation. (See Figure 5-11)

b. For simultaneous refueling operations Figure 5-11, make the following changes to the procedures in (a.): After "Lost visual contact" is called, the first receiver on each side of the tanker (each is in the #2 position in the formation) will turn 20° (left or right respectively) away from the tanker heading, and climb 400 above MSA, and after 30 seconds, turns to resume the tanker heading. The second receiver on each side of the tanker (each is in the #3 position in the formation) will turn in the appropriate direction, 30° away from the tanker heading, and climb 600 feet above MSA and, after 30 seconds, returns to the tanker heading. Timing starts when you reach your altitude.

2. Mountainous:

a. If the receiver(s) lose sight of each other or the lead aircraft (tanker), the receivers will call "Lost visual contact". The tanker will respond with "Execute," followed by the base heading and the MSA. The tanker will then accelerate to cruise airspeed and climb to MSA to allow the receiver formation maneuvering room. The spare tanker will turn right 10°, accelerate and climb to MSA plus 500 feet. The first receiver (#2 in the formation) will maintain refueling airspeed and climb to MSA plus 200 feet. The second receiver (#3 in the formation) will adjust airspeed to air refueling airspeed minus 10 KIAS and climb to MSA plus 400 feet. The third receiver (#4 in the formation) will adjust airspeed to air refueling airspeed minus 20 KIAS and climb to MSA plus 600 feet. The fourth receiver (#5 in the formation) will reduce airspeed to air refueling airspeed minus 30 KIAS and climb to MSA plus 800 feet. All receivers will maintain heading as relayed by the tanker and hold their adjusted airspeed for 3 minutes after reaching their altitude. After 3 minutes, accelerate to base airspeed. See Figure 5-12.

b. For simultaneous refueling operations, make the following changes to the procedures in (a.) above: After "Lost visual contact" is called, the first receiver on the left side of the tanker will maintain air refueling airspeed and climb to MSA. The first receiver on the right side of the tanker will adjust airspeed to air refueling airspeed minus 10 KIAS and climb to MSA plus 200 feet. The second receiver on the left side of the tanker will adjust airspeed to air refueling airspeed minus 20 KIAS and climb to MSA plus 400 feet. The second receiver on the right side of the tanker will adjust airspeed to air refueling airspeed minus 30 KIAS and climb to MSA plus 600 feet. All receivers will maintain heading as relayed by the tanker and hold their adjusted airspeed for 3 minutes after reaching their altitude. After 3 minutes, accelerate to base airspeed. (See Figure 5-13.)

c. Option 2 — All aircraft in element 1, 2 or both are expected to execute the procedures per paragraph (b.) "After tanker assumes formation lead" or as briefed.

WARNING

The second element aircraft must be aware of possible midair potential with the first element receiver.

CAUTION

Lost visual contact in a mountainous environment, especially at low level, is a critical situation. The tactical environment, existing weather conditions, and terrain may require deviations to the above procedures. Therefore, it is extremely important that these factors be thoroughly briefed during mission planning. (See Figure 5-14.)

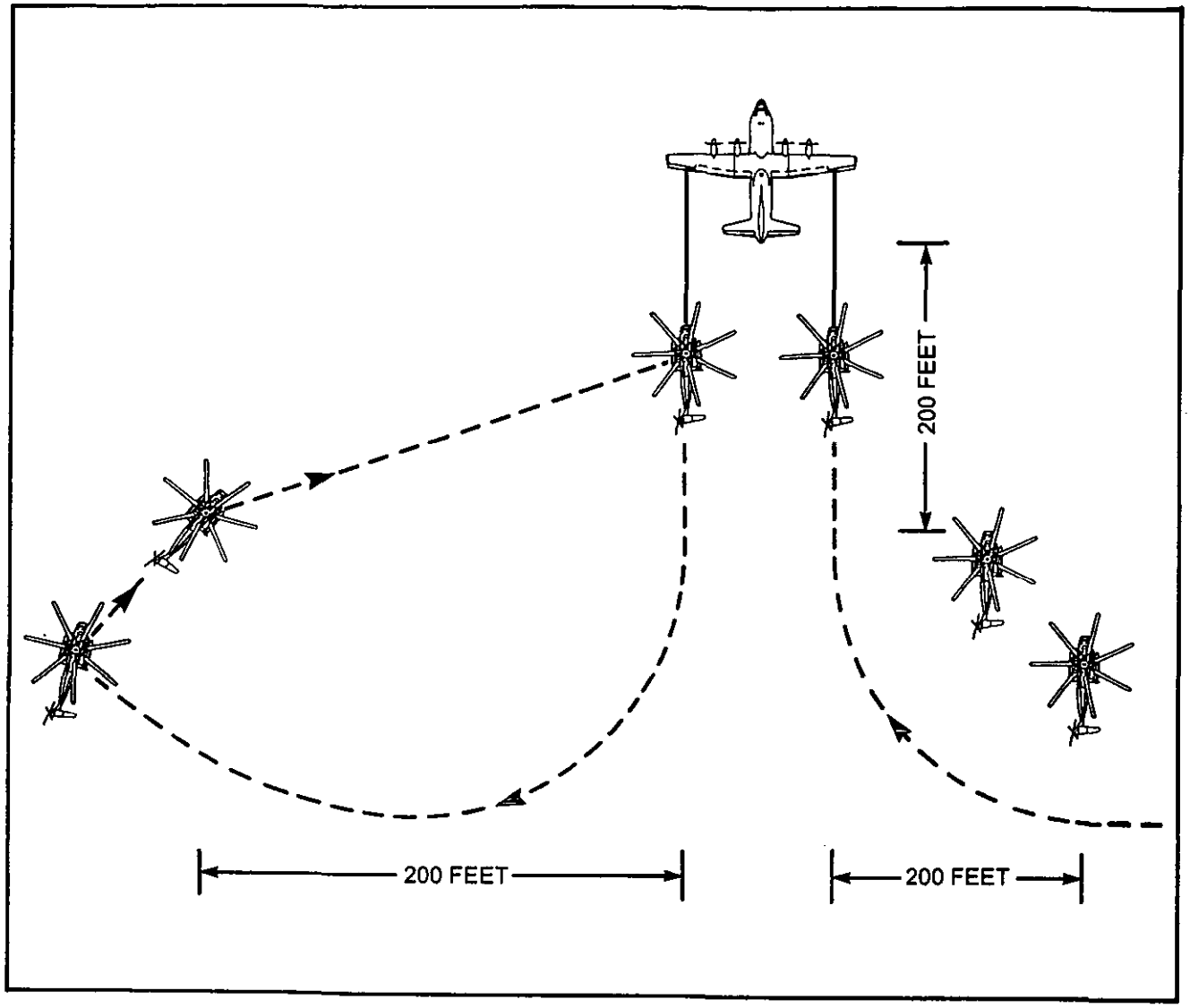

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Figure 5-10. One Tanker/Two or More Receivers

5.25 NO-SHOWS

1. Receiver no-shows:

If the receivers are not acquired by the ARIP, the tankers will slow to 180 KIAS between ARIP and ARCP, and proceed down track at the AR altitude plus 1,000 feet separation (airspeed as required) to ensure that the receivers have not passed by unobserved and to clear the track for the next refueling element. If after proceeding to the "end air refueling point" or to the track's turn point, the receivers have not been located, the tankers will execute the appropriate alternate plan. If the environment allows, the tankers may reverse track and maneuver near the ARCP for a prebriefed time and in a prebriefed manner prior to proceeding with the mission profile. Alternate ARCPs should be planned and coordinated in advance should operational requirements preclude the receivers from making the original ARCP/ARCT. Tanker orbits because of receiver no-shows should not be planned to take place at the ARIP or ARCP.

Note

Tankers who are ahead of schedule are expected to maneuver prior to arriving at the refueling track (ARIP) so as to make good their ARCT. At the ARCP, the tankers will be on time to 2 minutes late and the receivers will be 2 minutes early to on time.

2. Tanker no-shows:

Receivers shall ensure that they are established at ARCP at ARCT and at the join-up altitude. If no contact, voice or visual, is established between the

REFUELING IN NONMOUNTAINOUS TERRAIN

No. 1 receiver maintains refueling speed, turns 20° left/right away from the formation and climbs to the safety altitude plus 400 feet. After 30 seconds, the receiver resumes the tanker heading.

No. 2 receiver maintains refueling speed, turns 30° left/right away from the formation and climbs to the safety altitude plus 600 feet. After 30 seconds, the receiver resumes the tanker heading.

No. 3 receiver maintains refueling speed, turns 40° left/right away from the formation and climbs to the safety altitude plus 800 feet. After 30 seconds, the receiver resumes the tanker heading.

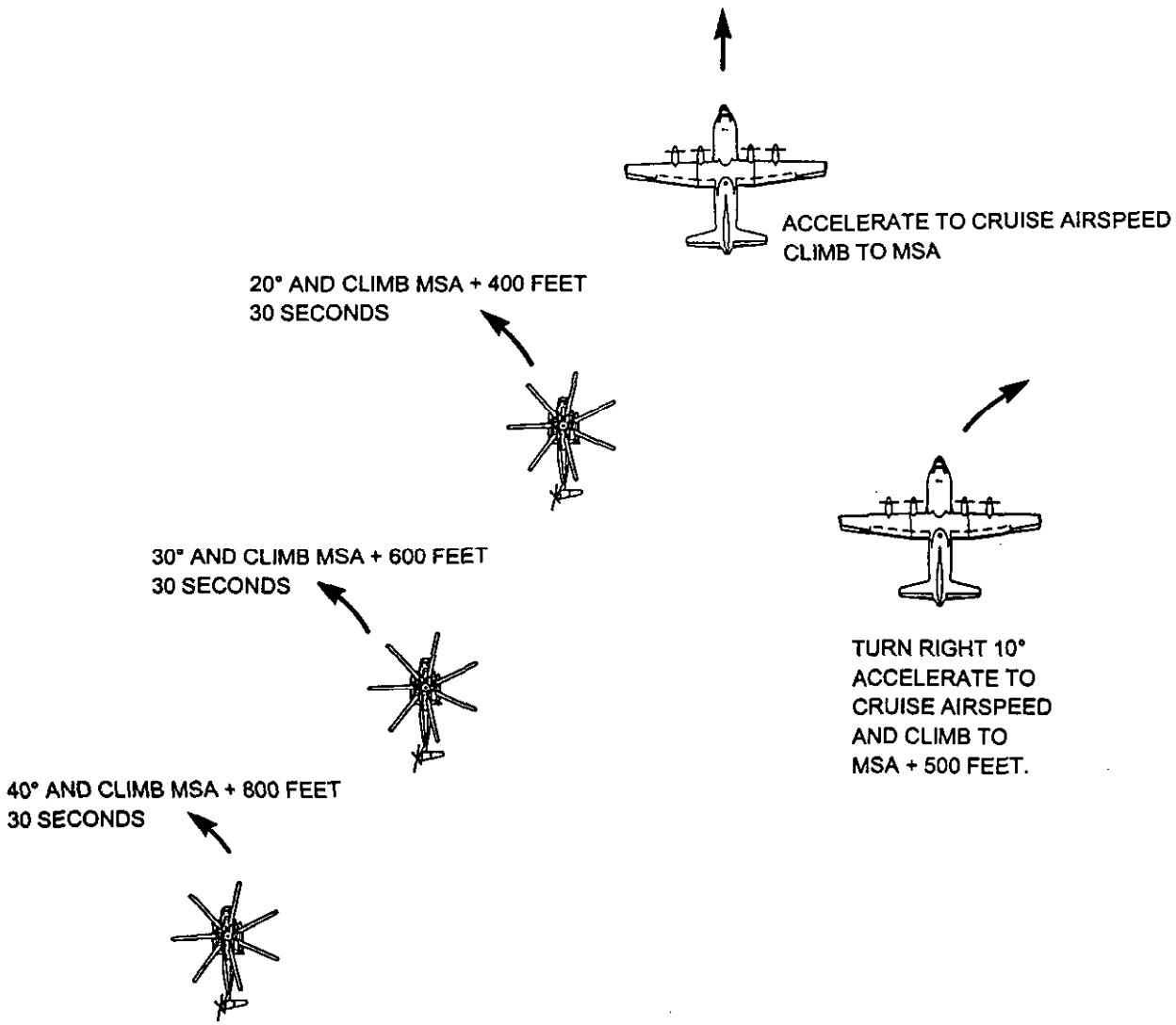

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Figure 5-11. Loss of Visual Contact (Nonmountainous Terrain) (Sheet 1 of 2)

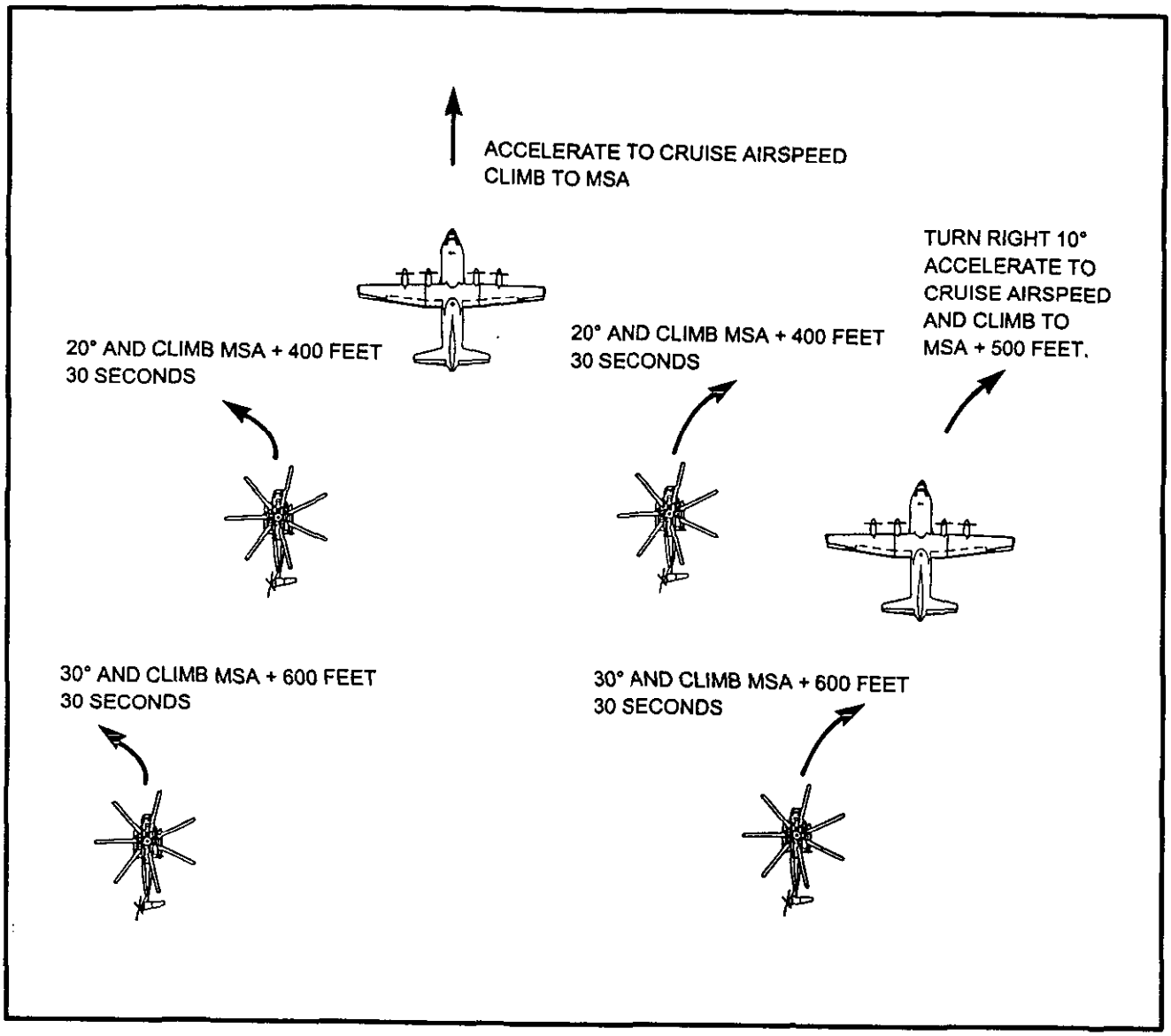

Figure 5-11. Loss of Visual Contact (Nonmountainous Terrain) (Sheet 2 of 2) N7/96

receiver and the tanker at the ARCP, the receiver shall continue along the refueling track at the join-up altitude until reaching the abort point or, in the case of a static track, the turn point. Further actions will be mission dependent and should be briefed to both the tanker and receiver crews.

Note

Receivers who are ahead of schedule are expected to maneuver prior to arriving at the refueling track (ARIP) so as to make good their ARCT. At the ARCP, the receivers will be 2 minutes early to on time and the tankers will be on time to 2 minutes late.

5.26 AIR REFUELING FORMATION OPTIONS

The following refueling formations will be used for AR missions requiring multiple tankers. Both tanker and receiver crew must be well versed in the air refueling formation procedures. Any variation from these procedures shall be coordinated with all participants. All of these formation options begin with tankers in the trail position. Consideration should be given to launching two tankers to support multiple helicopters. When five receivers or more are involved in the refueling operation, consideration should be given to dividing the helicopters into smaller elements with each element having a primary tanker.

1. Option 1 (Figure 5-13). This consists of two tankers (one primary and one spare), up to four re-

REFUELING IN MOUNTAINOUS TERRAIN

No. 1 receiver accelerates to refuel airspeed and climbs to the safety altitude. Note: The receiver should hold this airspeed for 3 minutes, then reestablish to the refueling base airspeed.

No. 2 receiver decelerates to refuel airspeed minus 10 KIAS and climbs to the safety altitude plus 400 feet. See note above.

No. 3 receiver decelerates to refuel airspeed minus 20 KIAS and climbs to the safety altitude plus 600 feet. See note above.

No. 4 receiver decelerates to refuel airspeed minus 30 KIAS and climbs to the safety altitude plus 800 feet. See note above.

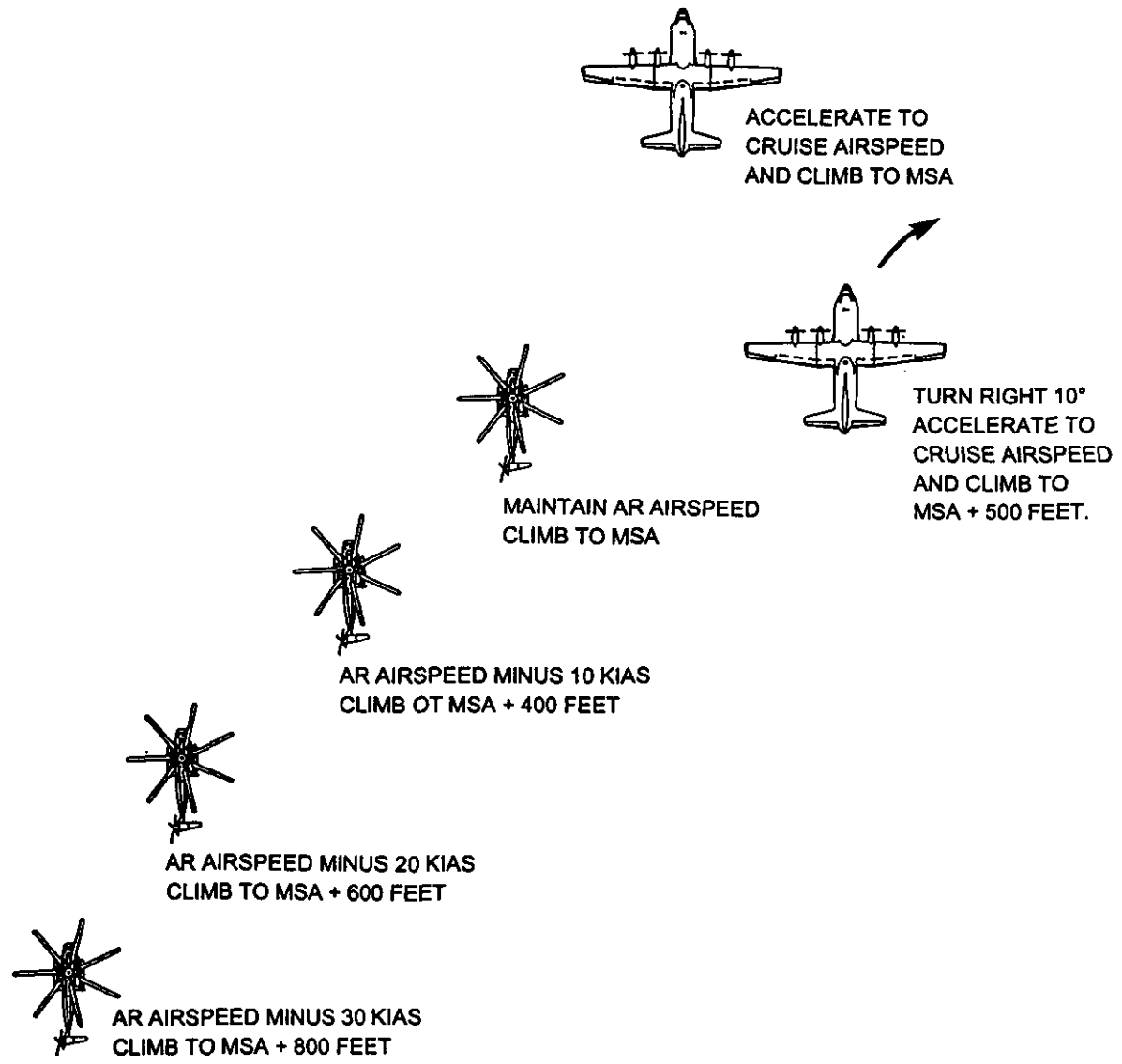

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Figure 5-12. Loss of Visual Contact (Mountainous Terrain) Simultaneous Refueling (Sheet 1 of 2)

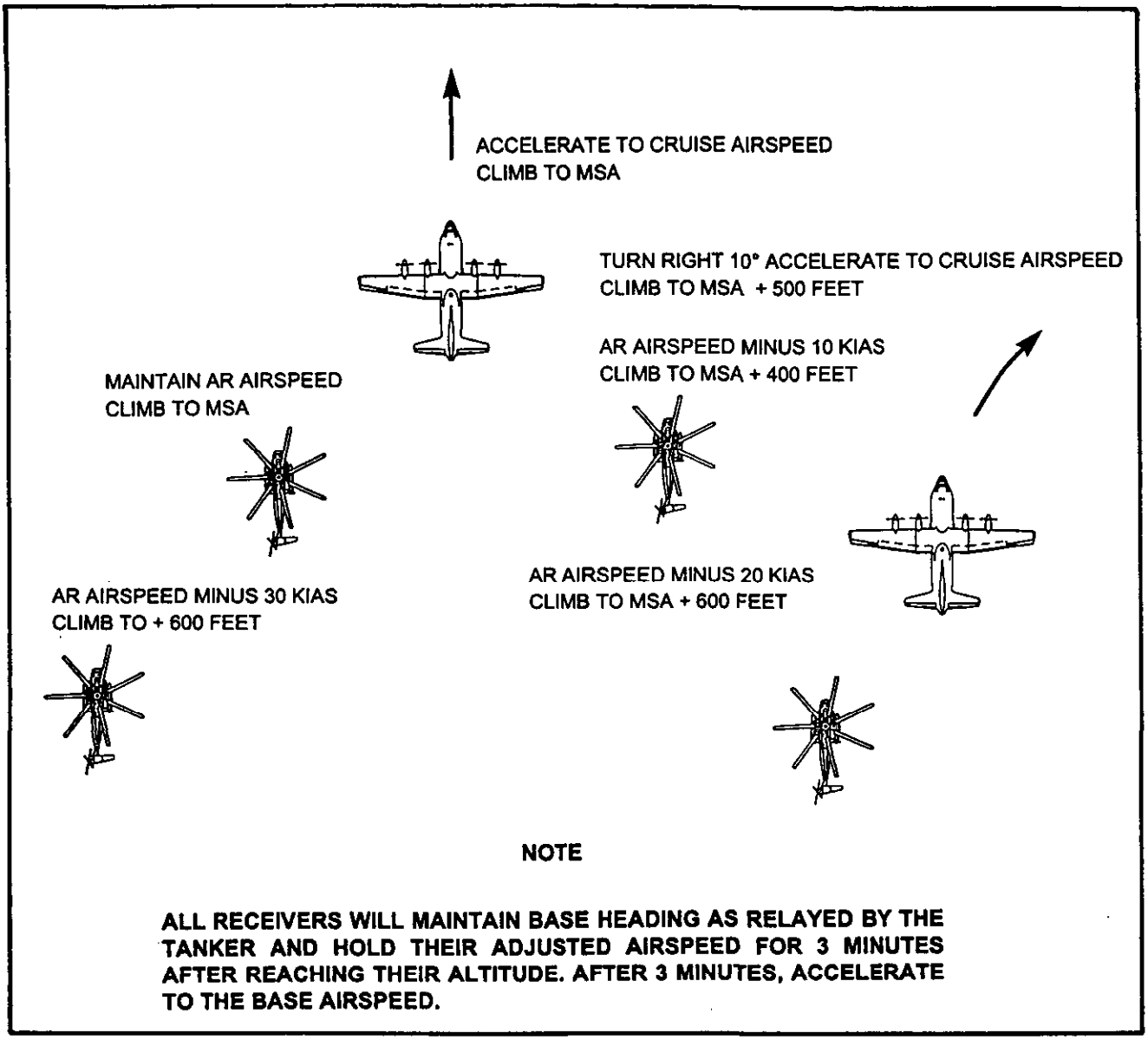

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Figure 5-12. Loss of Visual Contact (Mountaneous Terrain) Simultaneous Refueling (Sheet 2 of 2)

ceivers (normally), and, in some circumstances, several nonreceivers. All receivers will refuel from the primary tanker. Prior to join-up, the spare tanker will assume a position slightly behind and approximately 500 to 2,000 feet to the right of lead. The transition to this spare position should be done early enough to allow the lead tanker latitude in maneuvering and airspeed changes during rendezvous. The spare tanker will configure its hoses at the same time as the lead tanker. After refueling is complete, the lead aircraft will maintain refueling airspeed until the spare is rejoined in a right echelon. The formation will then proceed as briefed. If the primary tanker is unable to fuel, as indicated by the "go to spare tanker" signal it will accelerate straight ahead, climb 500 feet when clear, and turn to rejoin into a spare position. The spare tanker will maintain position and configuration while the receivers move to the observation position. Refueling will then proceed with the spare assuming lead duties.

2. Option 2 (Figure 5-14). The helicopter flight will split into two trail elements prior to the ARIP. The tanker formation will rendezvous with the helicopter elements as they proceed down the refueling track. The spacing between elements will be approximately 2 nm, based on mission requirements, such as, type and number of receivers in each element. The ARCT is the control time for arrival of the lead helicopter elements at the ARCP.

CAUTION

After the join-up, the second cell should consider establishing a vertical and or horizontal separation to avoid possible turbulence from the lead cell.

a. The tankers will rendezvous with the helicopter elements from a close trail formation. As the tanker formation approaches the second helicopter element (the trailing element), the second primary tanker will drop out of formation and complete a join-up on the second helicopter element. The first tanker will continue forward to rendezvous and join-up on the lead helicopter element. When the second element has completed refueling, the second tanker will accelerate and join in right echelon on the lead tanker.

b. If a spare (third) tanker is available and used in the option 2 formation, it will be positioned as #3 in trail. As the tanker formation approaches the trailing helicopter element, the #2 and #3 tankers drop out of formation as an element and complete rendezvous and join-up. Leadtankercontinuesforwardtojoinontheleadhelicopterelement. As the #2 tanker slows, the #3 tanker will assume a spare position slightly behind and 500 to 2,000 feet to the right. The transition to the spare position should be done early enough to allow the #2 tanker latitude in maneuvering and airspeed changes during the rendezvous. The spare will configure at the same time as #2. When #2 signals "fuel flowing," the spare will retract hoses and accelerate ahead to the lead element to spare the lead tanker. When refueling is complete, lead will maintain refueling air speed until all tankers are rejoined to right echelon. The #2 tanker will join up to the right of #3 tanker, which is in spare position on lead. If a primary tanker is unable to refuel, as indicated by a "proceed to spare tanker" light signal, it will accelerate, climb 500 feet when clear of the formation and rejoin at the end of the formation in the spare position. The spare will maintain position and assume primary tanker duties as the receivers move to the observation position.

c. If it is desired to use a fourth tanker in option 2 refueling, two spares will be used, in two elements of two tankers each, following general procedures above in Figure 5-17.

When simultaneous refueling by two receivers is required, the join-up will be performed in the same manner as prescribed in paragraph 5.16 with the receivers initially in left echelon. When the lead receiver is in the left observation position, the receivers designated to refuel on the tanker's right side (second element) will cross over to the right observation position. If the tanker is ready to begin refueling operations, the receivers on the left side may be cleared for contacts prior to the second element crossing over to the right observation position. When both receiver elements have completed air refueling operations the helicopter formation rejoin can be executed, prior to or after tanker departure, as prebriefed.

WARNING

Under normal circumstances two receivers will not disconnect simultaneously or fly in the precontact position at the same time. This is because of the difficulty of maintaining lateral separation during disconnect and the distraction caused by a second helicopter in the precontact position, especially at night.

Note

- Qualified observers will be at each paratroop door/window for simultaneous air refueling contacts.
- The helicopter(s) designated to refuel on the right hose may cross over individually, in sequential order, or may cross over simultaneously as a formation element.

5.27 POST AIR REFUELING

5.27.1 Disengagement. When fuel transfer is completed, the RAC will clear the receiver to disengage. The receiver will proceed to the disengagement position and effect a normal disengagement.

5.27.2 Formation Breakup. When the receiver(s) call clear of the tanker, the tanker will retract the hoses and smoothly accelerate away from the receiver flight. The tanker will climb 1,000 feet prior to initiating any turns.

5.27.3 Navigational Assistance. When the receiver force has completed fuel transfer, the RAC will

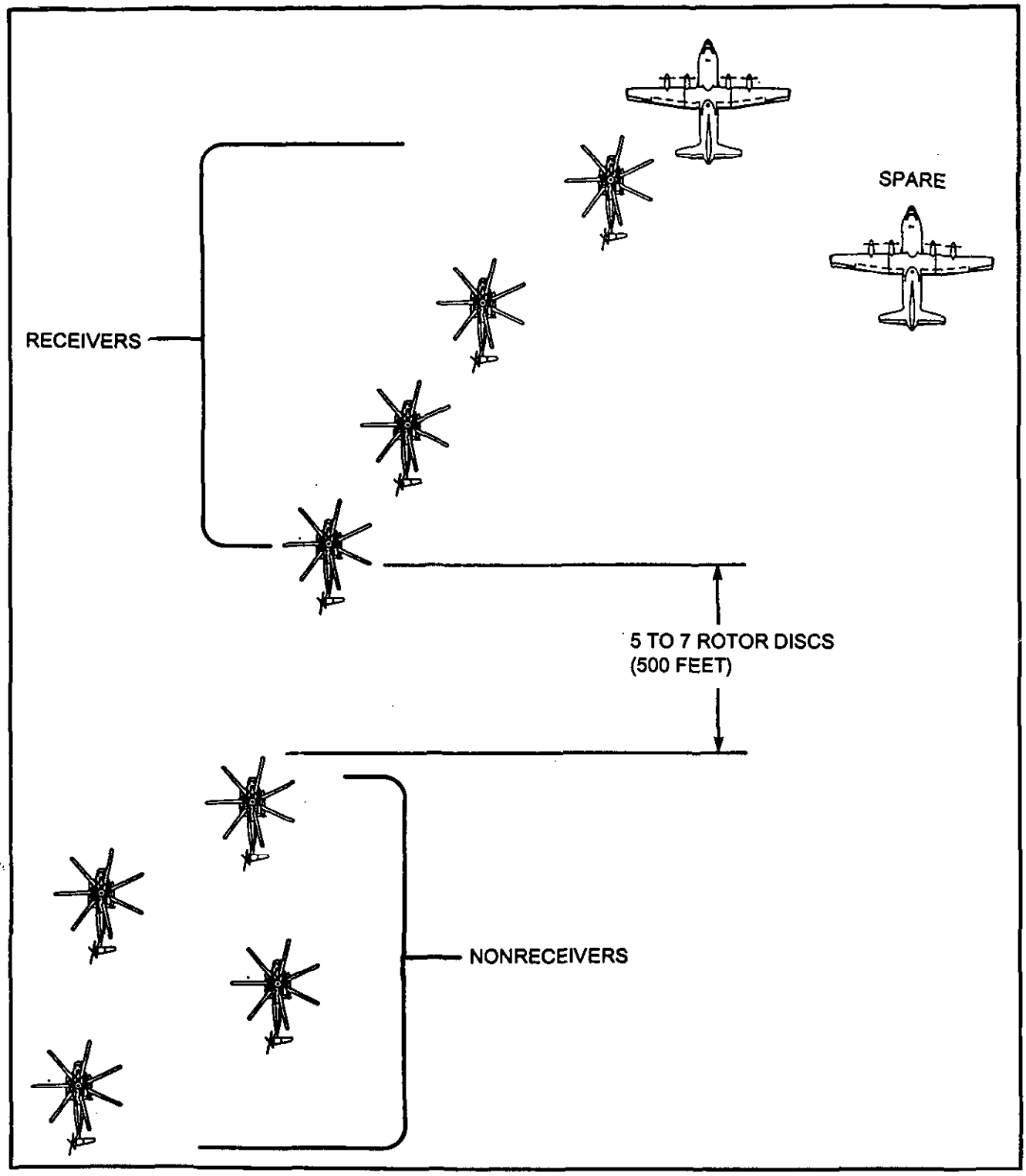

Figure 5-13. Air Refueling Formation Option 1

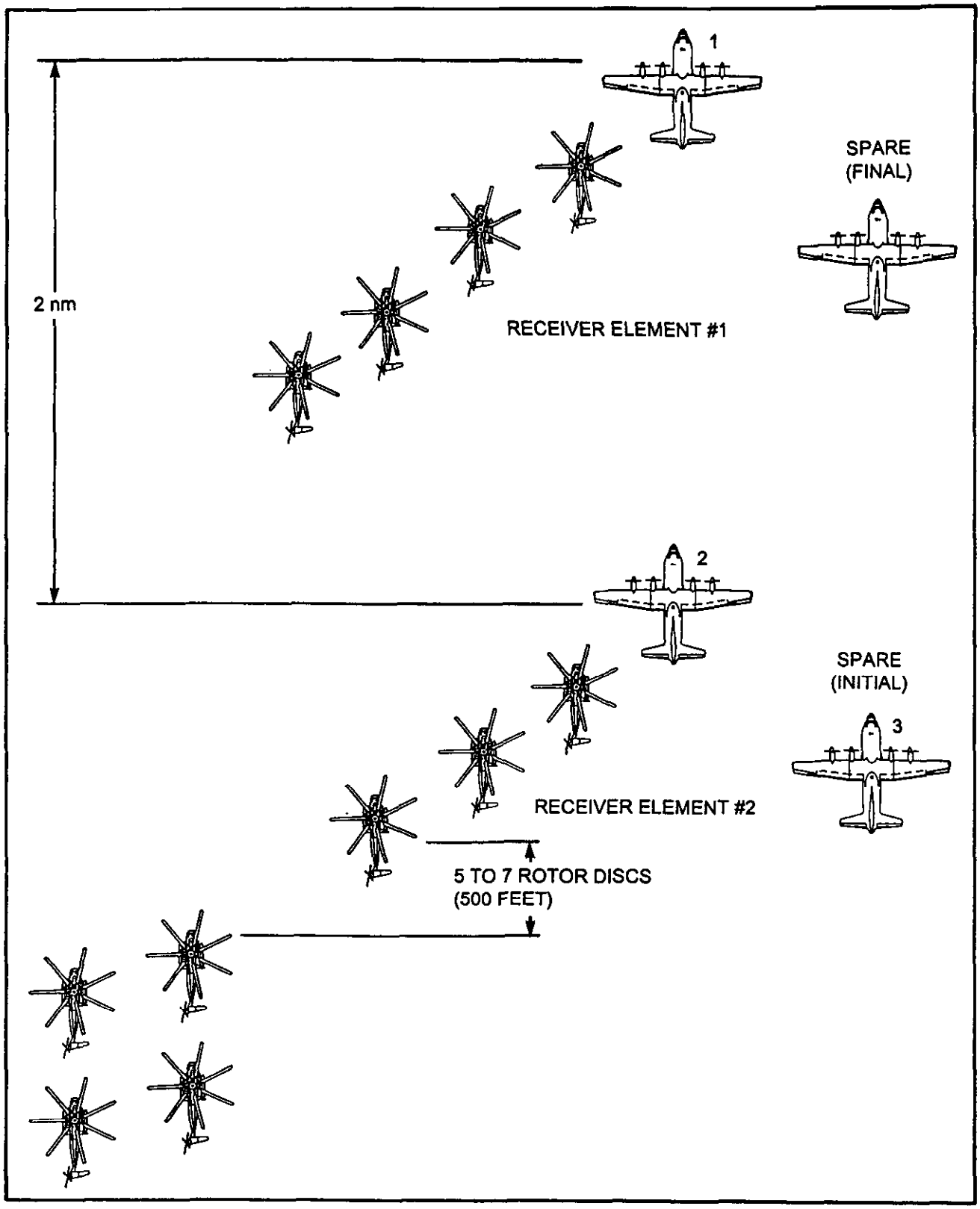

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Figure 5-14. Air Refueling Formation Option 2 With Three Tankers

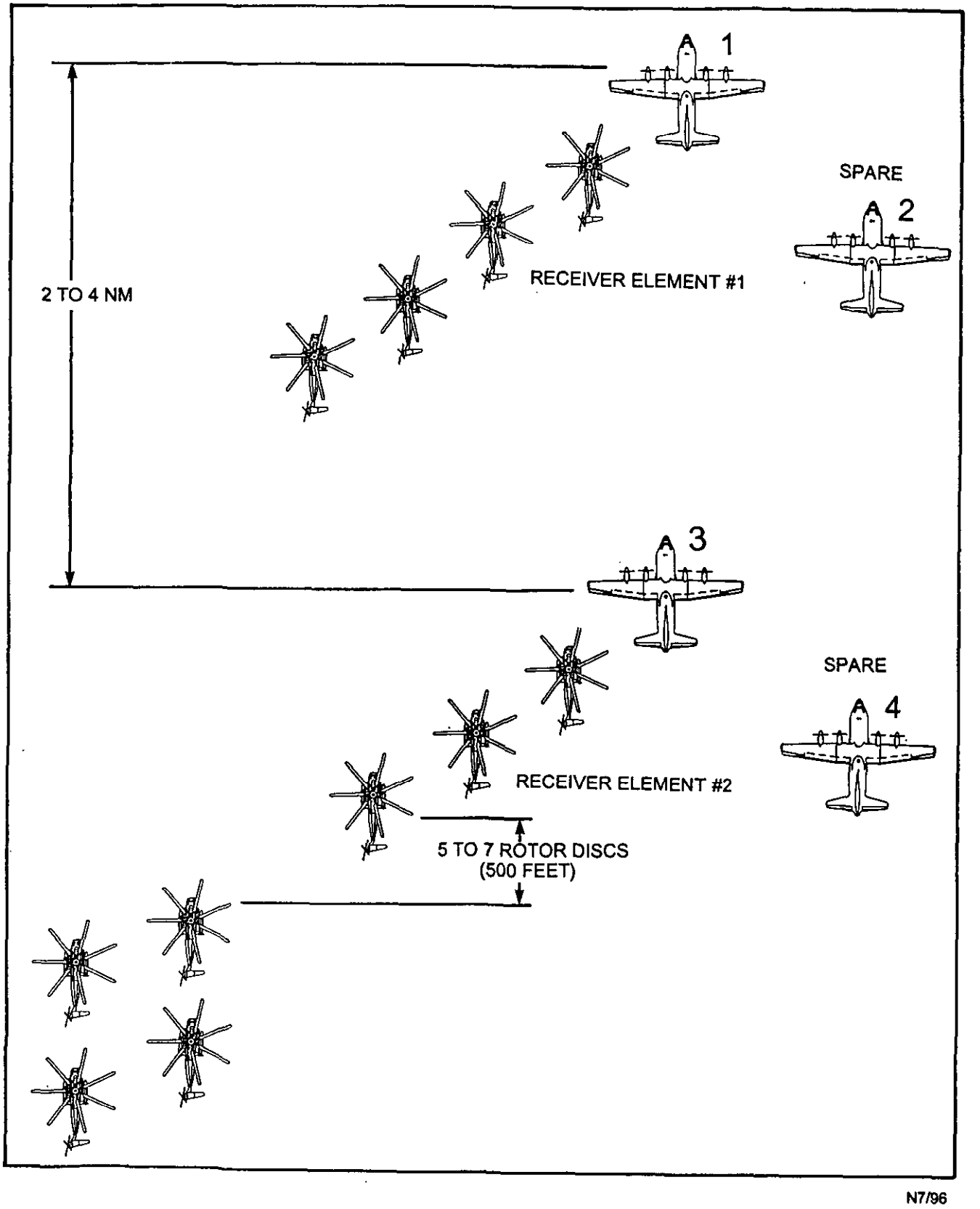

Figure 5-15. Air Refueling Formation Option 2 With Four Tankers

pass fuel offload distance, heading, and ETE to the receiver's next checkpoint/destination,

5.28 ABORT PROCEDURES

Tankers will be prepared to assist receivers in any way in the event of a receiver abort. If navigation/communication assistance is required by the aborting receiver's tanker and wingman will normally accompany the aborting aircraft to the abort base. Except in the critical emergencies or when a tanker spare is not available, aborting tankers will not abandon receivers that require navigation/communication assistance.

5.28.1 Tanker Engine Failure. Under conditions of high altitudes and ambient temperatures, an instantaneous loss of an engine may require the addition of close to full power on the remaining engines to maintain airspeed and altitude. Because three-engine air minimum control speed, out of ground effect, may be close to the helicopter air refueling speed, caution must be exercised when adding power so as not to lose directional control if the failed engine is an outboard. In this situation, direction control can be regained by losing altitude to regain airspeed, apply asymmetrical flight controls, reducing drag (raising flaps, retracting hoses), or by reduction of power of asymmetrical operating engines.

5.28.2 System Malfunctions. When a system malfunction jeopardizes safety, air refueling should not be accomplished except during fuel emergencies or when continuance of refueling is dictated by operational necessity. When fuel spray is noticed, fuel transfer will be stopped and the receiver notified. The requirements to continue fuel transfer will be at the discretion of the receiver pilot.

Note

A small amount of fuel spray may be present upon drogue engagement/disengagement. No fuel spray should be evident during fuel transfer.

5.28.3 Breakaway Procedures. The tanker will call "Breakaway" preceded by the receiver's call sign when an emergency condition exists that requires an immediate separation of aircraft. This will include but is not limited to excessive rate of closure, engine failure, and excessive fuel leakage at the drogue. The receiver will effect an emergency disengagement and maneuver clear of the tanker. The tanker will simultaneously turn on the lower rotating beacon.

5.28.4 Crash Landing, Ditching, or Bailout. If an emergency occurs that necessitates a crash landing, ditching, or bailout, an aircraft designated by the RAC will accompany the disabled aircraft or will cover personnel at a safe distance above the surface. The designated aircraft will render all assistance possible, orbiting the area until aid arrives or until fuel supply requires leaving the area.

CHAPTER 6

Weather

6.1 PURPOSE

This chapter outlines, in general, the special weather support features required in the execution of long-range flights involving air refueling. The procedures included herein are not intended to restrict the functions of aerological personnel. Task forecasters may augment these procedures with any effort considered advantageous to the operation.

6.2 CONCEPT

All weather support shall be conceived and conducted with the intention of providing all operational and support element commanders with single-source, common data as a basis for their respective operational decisions and plans. It is vital to the success of the operation that a single coordinated forecast be provided simultaneously to the mission controlling agency and to the different operational and support element commanders involved. It is also imperative that a close watch of abort bases, receiver destinations and alternates, and tanker recovery bases be maintained throughout the operation to aid in making recalls, diversions, etc., if unexpected weather conditions critical to the operation occur.

6.3 SPECIAL WEATHER SUPPORT FEATURES

The extensive planning and operational coordination required in air refueling operations dictate that special mission control forecasts be provided to the command and participating agencies.

6.3.1 Forecast Objectivity. The go/no-go effect of forecast weather phenomena will be determined by the commander exercising operational control. All weather forecasts should be entirely objective in nature and should contain no forecaster-applied safety margins in either direction. Completed forecasts should indicate, as nearly as possible, realistic weather that is actually expected. Go/no-go decisions are placed entirely at the command level. The forecaster merely provides a portion of the data to be considered in the go/no-go decision.

6.3.2 Preliminary Mission Control Forecasts. Twelve to eighteen hours prior to receiver launch time, a detailed forecast folder, applicable to the operation, shall be prepared. This forecast shall be termed the preliminary mission control forecast and shall be submitted to the mission controlling agency to assist in arriving at a preliminary go/no-go decision.

6.3.3 Prelaunch Final Mission Control Forecasts. Three hours prior to initial launch time, a detailed forecast folder shall be prepared and submitted to the controlling agency for the final go/no-go decision. Simultaneous distribution shall be made to all task organization elements.

6.3.4 Weather Monitoring. Subsequent to submission of the prelaunch final forecast, a strict surveillance and monitoring system of existing conditions along the route is required. Significant changes and deteriorations shall be immediately brought to the attention of the controlling agency so that recalls, aborts, or diversions may be directed if considered necessary. Specific weather phenomena that will warrant an abort or recall shall be determined jointly by the controlling agency and by the operational and support elements.

6.3.5 Airborne Weather Reconnaissance. A requirement exists for airborne reconnaissance when refueling operations are to be conducted over remote areas where weather has not been reported and also when forecast conditions in the refueling areas are marginal or unknown.

6.3.5.1 Responsibility. The responsibility for providing or arranging for airborne weather reconnaissance rests with the agency having overall control of the operation. Consideration shall be given to the acquisition of long-range, high-altitude, multiplace aircraft.

6.3.5.2 Purpose. Weather reconnaissance shall be flown in order to:

1. Provide the task forecaster with the data required for the evolution of accurate operational forecasts for planning and execution.

2. Reconnoiter alternate refueling areas in the event the primary areas are unsuitable because of weather phenomena.

6.3.5.3 Execution

1. The profile of the weather reconnaissance flight shall duplicate as nearly as possible the planned profile of the receiver aircraft.

2. An aerology man shall be assigned as a crewmember to observe, record, and report the applicable weather conditions.

3. Reports shall be made for every 180 miles of progress. Supplementary reports shall be made in the actual refueling area.

4. Weather reconnaissance flights shall be scheduled so that the observed data can be incorporated into the prelaunch final forecast.

5. Communication methods shall be prescribed in the appropriate communication annex(es).

6. The task forecaster shall advise the controlling agency of any suspicious or significant areas that may warrant investigation.

6.4 SUPPORTING WEATHER SECTION

Weather support for routine air refueling operations will be afforded by the weather section of the base from which operational aircraft are launched. In addition to the previously specified support features, the supporting weather section shall be required to:

1. Have two aerology men become qualified in the pressure chamber and ejection seats for utilization as airborne weather observers.

2. Assign specific weather personnel to provide services for the mission so that the required support efforts will not interfere with the normal weather section routing and watch changes.

CHAPTER 7

Communications

7.1 GENERAL

Communication operating procedures during air refueling operations shall be in accordance with applicable Allied communication publications (ACPs); Joint Army, Navy, Air Force publications (JANAPs); ICAO instructions; and pertinent regulations. Additional instructions shall be included in the orders and plans governing specific operations.

The procedures for the employment of communication means and channels during air refueling operations shall be as directed in this and preceding chapters and as modified by the applicable operation order.

Communication and electronic personnel shall be thoroughly briefed on the mission to be accomplished, and all communications and electronic equipment shall be at peak operating condition.

7.2 COMMUNICATIONS

The procedures contained herein shall be used for air refueling operations on transoceanic flights. The methods employed during air refueling and tactical operations training should conform as closely as possible to these procedures within the limits imposed by local conditions.

Two UHF frequencies shall be used during the refueling operation: the en route frequency and the refueling frequency. The en route frequency shall be used for the initial contact between tankers and receivers and for control of the air refueling rendezvous. The refueling frequency may be used both during refueling operations and for control of receiver retirement. The change from the en route to the refueling frequency and the return to the en route frequency after refueling shall be made on order from the receiver flight leader.

When required, a separate communication frequency may be assigned for rendezvous control and another for control of the retirement of receivers from the refueling area.

7.2.1 Air-to-Ground Communications. Whenever possible, air-to-ground communications for position reporting shall be conducted through facilities operated by the appropriate air traffic control agency.

By prior arrangement and when receiver aircraft are operating beyond UHF range, tankers shall relay receiver position reports by high frequency (HF) radio.

During transoceanic operations, there shall be a communication system established for tactical control of the movement. Communications between the control center and tanker aircraft shall be conducted directly over HF radio and/or relay through air traffic control agencies. Tanker aircraft or other aircraft, as designated, shall relay for those receivers equipped with UHF only.

Specific instructions shall be contained in the appropriate operation order.

Air refueling reports and weather reconnaissance reports shall be transmitted as prescribed by the appropriate operation order.

7.3 POINT-TO-POINT COMMUNICATIONS

Instructions for the use of a point-to-point communication system for movement control during transoceanic movements shall be contained in the operation order governing the movement. Normally, there is no requirement for point-to-point communications during training operations.

7.4 COMMUNICATION SECURITY

1. All UHF communications shall be in plain language unless specifically directed otherwise.

2. During training operations, emphasis should be placed on radio silence as a preparation for combat operations.

3. Operation orders shall prescribe the use of air/ground codes and the extent of air traffic control reporting for transoceanic operations.

4. Safety is paramount: The use of air/ground codes shall be suspended when an unsafe or emergency condition exists.

7.5 SELECTIVE IDENTIFICATION FEATURE (SIF)/IFF

Aircraft commanders shall be provided with SIF/IFF codes, modes, and procedures.

7.5.1 Authentication. Special procedures for authentication and recognition shall be contained in the appropriate operation order.

Prior to in-flight refueling operations requiring radar as the primary means of rendezvous, IFF/SIF equipment shall be adjusted for optimum performance and capability.

7.6 SEARCH AND RESCUE COMMUNICATIONS

Instructions for search and rescue communications shall be contained in the appropriate operation order.

7.7 COMMUNICATION BRIEFINGS

Communication briefings for all pilots and aircrews shall include but not necessarily be limited to the following:

1. Communication facilities and the procedures to be used in air-to-air and air-to-ground communications

2. Air traffic control reporting requirements, including procedures and facilities, and any additional reporting requirements

3. Search and rescue and emergency or distress communication procedures and facilities and any limitations to their use

4. Navigational aids and sources of weather information and any limitations or special instructions pertaining to their use

5. Conditions or degree of UHF, VHF, HF, radio, radar, or SIF/IFF silence imposed, or any other limitations placed on the use of communication-electronic facilities

6. Any other communication-electronic requirements, procedures, and facilities, such as air-to-air homing and radar rendezvous/control

7. Aircraft call signs

8. Ground station call signs

9. Frequencies

10. Frequency selection data that personnel operating HF equipment can use to establish reliable contact with the control center and airways radio stations

11. VHF/UHF and HF radio set channelization and in-flight frequency rechannelization that may be required

12. HF aeronautical stations

13. Air-to-ground codes to be employed

14. Addressing of in-flight reports, methods of transmission, ground stations, or aircraft to which they are to be transmitted, and whether messages are to be sent in code or in plain language

15. Recognition — Advising the areas concerned to include procedures, signals, and current issues of necessary extracts from applicable publications

16. SIF/IFF instructions

17. Special instructions covering refueling reports.

Radio operators or pilots of those aircraft not carrying radio operators shall be provided with the necessary communication flimsies and the extracts of communication instructions, authentication and recognition procedures, SIF/IFF setting, and air/ground code books, as required.

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