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**PART 5 – NATIONAL ANNEX**

**ANNEX ZA - USA**

**KC-135 STRATOTANKER**

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**1ZA Introduction.** The USAF has a large fleet of KC-135 Stratotankers. A small number of KC-135s are fitted with a receptacle to receive fuel from boom equipped tankers.

**2ZA Receiver Types Certified.** Details of receiver technical clearances together with AAR speeds and altitudes are published at Annex ZE. In addition, Annex ZE provides boom operators with receiver information essential to achieving safe AAR operations. For non-US receiver aircraft, the publishing of information in Annex ZE does not constitute an automatic authority to undertake refueling. However, see Annex ZH, paragraph 3ZH for details about authority to conduct AAR.

**3ZA AAR Equipment.** There is one centerline mounted flyable boom for boom-type refueling. The boom can be modified to refuel probe-equipped aircraft by fitting a Boom Drogue Adapter (BDA); the BDA can only be fitted/removed on the ground. Approximately twenty aircraft have the capability to be fitted with two FRL Mk32B-753 wingtip mounted Multi-Point Refueling System (MPRS) AAR pods.

**a. AAR Equipment - Boom**

**(1) Description.** The boom is approximately 28 ft (8.5m) long with an additional 18.5 ft (5.6 m) of inner fuel tube which can be extended or retracted by the boom operator. The boom is equipped with a Boom Interphone System which permits direct communication with suitably equipped receivers.

**(2) Basic Operation**

- (a)** When ready to refuel, the boom is lowered from its stowed position and about 10 ft (3 m) of the retractable portion is extended by the boom operator.
- (b)** When cleared, the receiver moves from a stabilized (zero rate of closure) astern position to a steady boom contact position.
- (c)** Closure to contact will be slow and stable (approximately 1 foot per second) with the receiver stabilizing in the contact position.

- (d) When this is achieved, the boom operator flies the boom to the receiver aircraft's receptacle and extends the boom to make contact. Locking toggles in the receptacle operate to hold the boom nozzle in contact.
- (e) The receiver then maintains its position within the boom operating envelope.

**WARNING**

- The receiver will stabilize in the astern position and attain a zero rate of closure. If the receiver fails to attain a stabilized position, or it becomes apparent that a closure overrun will occur, breakaway procedures will be initiated. Failure to do so could result in a mid-air collision.
- Excessive closure rate could cause the tanker to descend into the path of the receiver. The tanker pilot must be prepared to disconnect the autopilot to prevent altitude deviations. Initiate a breakaway at the first indication of a closure overrun.

- (3) **Automatic Disconnect.** Provided the receiver remains within the envelope, contact is maintained; however, if the receiver moves beyond the limits, a disconnect will automatically occur provided the tankers system is operating in normal.

**CAUTION**

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

**NOTE**

- When the tankers air refueling system is in OVERRIDE, boom limit switches are inactive, the boom operator must initiate disconnects before the receiver exceeds limits.
- (4) **Boom Envelope.** The envelope is defined by automatic limit switches connected to the boom; the envelope permits a limited amount of fore and aft movement and some freedom of maneuver in the pitching, rolling and yawing planes. The envelope limits are set well within the mechanical limitations of the boom; therefore, provided the envelope limits are not exceeded too rapidly, disconnect will occur before the boom is damaged. The full boom envelope is illustrated in Figures ZA-1-1 and 2 in Appendix 1 to this Annex; however, the freedom of maneuver in boom elevation is reduced for some receiver aircraft because of their receptacle characteristics.
  - (5) **Normal Disconnect.** To make a normal disconnect, the receiver releases the receptacle toggles (this may also be effected remotely by the boom operator) and remains stabilized in the contact position until the boom operator confirms a disconnect has been achieved; the receiver then moves to the astern position.
  - (6) **Brute Force Disconnect.** There are two types of brute force disconnect, inadvertent, and controlled tension (coordinated).
    - (a) **Inadvertent Brute Force Disconnect.** An inadvertent brute force disconnect is defined as any unplanned disconnect which is the result of one of the following:
      - (i) The receiver aircraft moves rapidly to the aft limit, causing mechanical tanker/receiver separation.

- (ii) Boom pullout occurs at 38 degrees elevation or below.



- Following an inadvertent brute force disconnect, AAR will be terminated except during fuel emergencies or when continuation of AAR is dictated by operational necessity.
- (b) **Controlled Tension Brute Force Disconnect.** A controlled tension brute force disconnect is defined as an intentional coordinated disconnect occurring above 38 degrees elevation, accomplished by gradual aft movement of the receiver aircraft (approximately 1 foot per second) until the boom is fully extended, and ending with a controlled tension boom pullout. Coordination between the receiver pilot and boom operator is required to ensure as smooth a disconnect as possible. Following a controlled tension disconnect, AAR may be continued with other receivers, provided the results of the following checks are satisfactory:

- (i) Operational check of the boom for binding or uncontrollability.
- (ii) Test of the tanker signal coil.



- A controlled tension brute force disconnect will be accomplished only as a last resort, after all other normal and emergency methods of disconnect have failed.
- AAR for the receiver that required a controlled tension disconnect will be terminated except during fuel emergencies or when continuation of AAR is dictated by operational necessity. If the receiver requires further AAR, the following actions must be accomplished before attempting another contact:
  - (i) Visual inspection of the receiver receptacle area and AAR boom.
  - (ii) Operational check of the boom for binding or uncontrollability.
  - (iii) Test of the tanker signal coil.

## (7) AAR Boom Lighting

- (a) **Description.** Pilot Director Lights (PDL) provide positioning information to receiver pilots during boom type refueling. The PDLs are located on the bottom of the fuselage, aft of the nose landing gear; they consist of 2 panels of lights. The left panel gives boom elevation information and the right panel gives boom telescoping information. See Appendix 1, Figure ZA-1-1.
- (b) **Basic Operation.** The lights are controlled by movement of the boom in elevation and by the in and out movement of the telescoping portion. These lights indicate the position of the boom in relation to the boom operating envelope and command the direction of receiver movement required to bring the boom to the ideal refueling position.

**(c) Receiver Actions**

- (i) **Elevation.** At one end of the elevation panel is the illuminated letter U (for up); at the other end is the illuminated letter D (for down); see Appendix 1 to this Annex. Adjacent to the letters are red arrowheads. If a receiver is in contact with the boom near the upward elevation limit, the red arrowhead next to the D will be illuminated; this indicates a downward movement is required. As the receiver moves down, the red light extinguishes and a green arrowhead illuminates, indicating the boom is approaching the ideal elevation. When the ideal elevation is reached, the green light extinguishes and 2 parallel green bars illuminate.
- (ii) **Longitudinal Position.** Longitudinal position is verified using similar indications to those described above for the vertical position. The right-hand telescoping panel is similar in function, although the display is slightly different. The ends of the panel have the illuminated letters F and A (forward and aft); see Appendix 1 to this Annex. The position information and movement commands are given by illuminated horizontal bars with red leading into green, with the ideal position shown by 2 parallel green bars illuminating. The command indications are separated by illuminated vertical white bars to give contrast. The telescoping part of the boom is in colored segments, which duplicate PDL indications; at night these segments are illuminated by boom marker lights. Lights are not provided for azimuth positioning; however, a fluorescent yellow stripe on the undersurface of the tanker fuselage is provided for centerline reference. See Appendix 5.
- (iii) **Visual References - Heavy Receivers.** Heavy receivers should refer to Appendix 5 for illustrations and descriptions of tanker visual references.
- (d) **Radio Silent Procedures.** During radio silence, the PDLs can be used to give positioning commands to direct a receiver into the boom contact position. A steady red PDLs commands a large movement in the direction indicated, and a flashing red light commands a small correction. The PDLs can also be extinguished to signal a request for disconnect.
- (e) **Failure of PDLs to Illuminate**
  - (i) **PDLs Fail to Illuminate When Making Contact.** If the PDLs do not illuminate when a receiver makes contact, the receiver pilot will inform the boom operator if refueling will continue. If refueling is continued, verbal corrections from the boom operator may be requested.
  - (ii) **PDLs Fail During Contact.** If the PDLs go out during contact, the receiver will initiate a disconnect and return to the astern position. Subsequently, if refueling is continued, verbal corrections from the boom operator may be requested.
- (f) **Flashing PDLs.** Flashing PDLs and the tanker lower strobe light on command a breakaway. Receivers will follow procedures in Part 2, Chapter 4, Para 408.
- (g) **Other Illumination.** During night AAR, the AAR floodlight, and boom nozzle light will also be used to illuminate the boom and receiver receptacle.

**b. AAR Equipment – Boom Drogue Adapter (BDA)**

- (1) **Description.** The BDA is 9 ft (2.74 m) of hose attached to the end of the telescoping part of the boom by a swiveling coupling; the hose terminates in a hard, non-collapsible drogue. The telescoping part of the boom is kept fully extended whilst the BDA is in use. The boom will be trailed at the pre-determined boom elevation and azimuth settings for that particular receiver type.
- (2) **Basic Operation.** The boom operator will hold the boom as motionless as possible, at the proper trail position, from the time the receiver reaches astern until completion of refueling. The ideal astern position for the receiver is to be stabilized 5 ft (1.52 m) behind the drogue. When cleared, the receiver moves forward to make contact; slight oscillations of the drogue are normal, and can be expected in even ideal weather conditions. The boom operator will not move the boom except to avoid striking the receiver airplane (the drogue is never "Locked down"). This movement will be momentary and not meant to follow the receiver throughout the range of movement of the boom. If the receiver cannot maintain the proper trail/contact position, the receiver will disconnect and return to astern position.

**WARNING**

- Simultaneous refueling from the centerline BDA and wingtip mounted MPRS AAR pod(s) is prohibited due to inadequate refueling envelope clearance between receiver aircraft.
- (3) **Receiver Actions** Extreme caution is required when operating on the BDA because, unlike hose drum systems, hose slack is not wound in. Contacts made with closure rates greater than about 2 kts will cause the hose to whip, with a consequently high probability of probe damage. Care must be taken to prevent the hose from looping around the probe, or touching the receiver's fuselage; this can be avoided by the receiver approaching no closer than one half hose length. See Appendix 2.
- (4) **Fuel Transfer** When the receiver has made contact, the tanker will transfer a small quantity of fuel to check the integrity of the system; if there are no fuel leaks, normal fuel transfer will continue. If possible, the tanker air refueling pumps will be switched off 5 seconds before the scheduled disconnect; this is to minimize fuel spray on disconnect.
- (5) **Fuel Transfer Failure** If fuel does not transfer, the receiver will be instructed to disconnect; the receiver should drop back to the astern position and check that the correct fuel system selections have been made. The boom operator will cycle the boom system by retracting the boom to approximately 15 ft (6.5 m) extension and then fully re-extend it. The receiver will then be re-cleared for a further contact.
- (6) **Normal Disconnect** When cleared, the receiver should disconnect by backing, remaining aligned with the boom and aim to separate leaving the drogue aligned to its free trail position. The boom operator does not retract the boom for a normal disconnect. To avoid the drogue striking the aircraft, the receiver pilot must not stray away from the correct lateral alignment.

**NOTE**

- As soon as the receiver is in a safe position, the boom operator will cycle the boom by retracting to approximately 15 ft (6.5 m), then fully extending to signal "Ready for contact". Failure to cycle the boom could prevent subsequent contacts.
- (7) **Emergency Disconnect** In an emergency the boom operator may retract the boom, in which event the drogue will whip violently as contact is broken.
- (8) **AAR Equipment Lighting - BDA**

- (a) **Description.** The elevation background lights and letters (PDLs described above in Para 3ZA a (7)) will be on during BDA AAR, but will not be used to direct receiver positioning; the PDLs do not provide correct positioning information during BDA operations. During night AAR, the AAR floodlight, boom nozzle light, and boom marker lights will also be used to illuminate the boom and BDA.
- (b) **Radio Silent Procedures and Breakaway.** The elevation background lights and letters are used during radio silence to signal a routine disconnect (lights going out), or command a breakaway (flashing lights and tanker lower strobe light on).

**c. AAR Equipment - Wingtip Mounted MPRS AAR Pods**

- (1) **Description.** When installed, the pods trail a 74 ft (22.5 m) retractable hose with MA-4 coupling and collapsible paradrogue. The black hose is marked with a series of 1 ft (0.3 m) long white markings and two 2 ft (0.6 m) wide orange bands. The range between the orange bands corresponds with the green pod status lights indicating the fuel transfer position. Appendix 3 provides a visual description of the pod status lights and relates this to hose position.
- (2) **Basic Operation.** To start fuel flowing, the hose must be pushed in at least 5 ft (1.5 m), indicated by the first orange band, whereupon a green pod status lights coming on.
- (3) **Receiver Actions.** Receiver pilots should remain within the ideal refueling position; this is with the hose extended between the two orange bands. The inner limit is 54 ft (16.4 m) and the outer limit 69 ft (21 m). This provides a fore and aft range of movement of 15 ft (4.6 m). See Appendix 3, Figure ZA-3-2 and Figure ZA-3-3.
- (4) **Receiver Too Close.** If the hose is pushed in too far, the amber pod status lights flash, fuel ceases after the hose is pushed in to less than 50 ft (15.2 m). Fuel flow will start again as the hose is pulled back out past 52 ft (15.8 m). Thus the receiver has a fore and aft range of movement of 19 ft (5.8 m) during which fuel will flow. See Appendix 3.

**WARNING**

- The system can be used to refuel two receivers simultaneously if the receiver wingspan is less than 68 ft. However, the boom operator will only clear one receiver at a time to move from astern to the contact position.
- Simultaneous refueling from the centerline BDA and wingtip mounted MPRS AAR pod(s) is prohibited due to inadequate refueling envelope clearance between receiver aircraft.

**(5) AAR Equipment Lighting - Wingtip Mounted MPRS AAR Pods**

- (a) **Description.** Drogue lighting is provided by lights attached to four drogue ribs. Reflective tape is also affixed to both sides of each drogue rib and the outer ring. In addition to the drogue lighting, the following lights will be set by the boom operator; the receiver pilot can request intensity adjustments to lights as desired.
  - (i) **Day AAR.** For day AAR, the pod status lights and pod floodlights should be turned on full bright.
  - (ii) **Night AAR.** In addition to the day AAR lights, the underbody, underwing, nacelle illumination lights, pod illumination, horizontal stabilizer, and outboard nacelle illumination lights will be set to on/full bright for night AAR; they may be adjusted as requested by the receiver pilot. The AAR floodlight may also be used as desired. (Also see details of aircraft lighting in Para 4ZA d.)

- d. **Pod Status Lights.** Three pairs of the lights (red, amber, and green) are located on opposite sides of the rear fairing of each pod. These lights inform the receiver pilot of the current mode/status of the pod. The lighting sequence is listed in, Appendix 3 Figure 2A-3-3.
- e. **Aircraft Lighting.** Aircraft undersurfaces are illuminated by a comprehensive array of lights, many of which are adjustable for brilliance upon request (see Appendix 4, Figure ZA-4-1). The initial setting for underbody and underwing lights will be on/full bright during all types of refueling day or night. The nacelle lights will be on during all types of refueling, but during night AAR, will be dimmed prior to receivers reaching the observation position.

#### 4ZA Refueling Heights and Speeds

- a. **AAR RV Speed.** The standard KC-135 tanker orbit speed is 275 KIAS or 0.78M, whichever is lower.
  - (1) The tanker will normally adjust to AAR speed when rolled out towards the RVCP.
  - (2) In the case of the A-10, fly orbit at 220 KIAS or the tanker's charted holding speed, whichever is the higher, and plan to roll out ½ NM in front of the receiver.
- b. **Standard Speed Boom and BDA AAR.** At 29,100 feet and below; maximum speed is 335 KIAS. Above 29,100 feet; maximum speed is 0.85 Mach. Minimum speed for all altitudes is based on aircraft weight.
- c. **High Speed Boom and BDA AAR.** From Sea Level to 29,400 feet; maximum speed ranges between 355 KIAS to 373 KIAS. Above 29,400 feet; maximum speed is 0.90 Mach. Minimum speed for all altitudes is based on aircraft weight.
- d. **MPRS AAR.** Wingtip mounted MPRS AAR pods height band for AAR is 5,000 to 35,000 ft; speed range is 225 to 305 KIAS

**5ZA Maximum Transferable Fuel.** Total fuel load is 203,000 lb (92,060 kg). Maximum fuel available for offload on a four hour sortie is approximately 135,000 lb (61,280 kg).

**6ZA Fuel Transfer Rate.** The tanker can transfer fuel at the following rates:

- a. **Boom.** Exceeding 6000 lb/min (2722 kg/min) through the boom.
- b. **BDA.** Exceeding 2800 lb/min (1270 kg/min) through the BDA.
- c. **MPRS.** Exceeding 2680 lb/min (1216 kg/min) through the wingtip mounted MPRS AAR pods.

**7ZA Regulated Fuel Pressure.** Fuel is delivered to the receiver at the regulated pressure of  $50 \pm 5$  psi ( $3.5 \pm 0.35$  bars).

#### 8ZA Fuel Types Available for AAR

- a. **Primary Fuel.** The primary fuel is F34 (JP-8).
- b. **Alternate Fuels.** The alternative fuels are F35 (Jet A-1), F40 (JP-4) and F44 (JP-5).

**9ZA Mark Facilities.** In response to a receiver request to "Mark" the tanker can dump fuel from the boom. "Mark" should only be used if a receiver low fuel state or other similar circumstance requires the rendezvous be expedited. If required, the tanker will dump fuel in 500 to 1000 pound increments until positive visual contact can be maintained.



**10ZA Tanker Dimensions.** The KC-135 is 128 ft (39 m) long with a wingspan of 130 ft (40 m).

**11ZA RV Aids.** The KC-135 has the following radio, navigation and RV aids:

- a. UHF, VHF, HF, and VHF Data Link radios.
- b. VOR, TACAN, INS, GPS, and search/weather radar.
- c. A/A TACAN (DME only), TCAS, IFF.

**12ZA List of Source Documents**

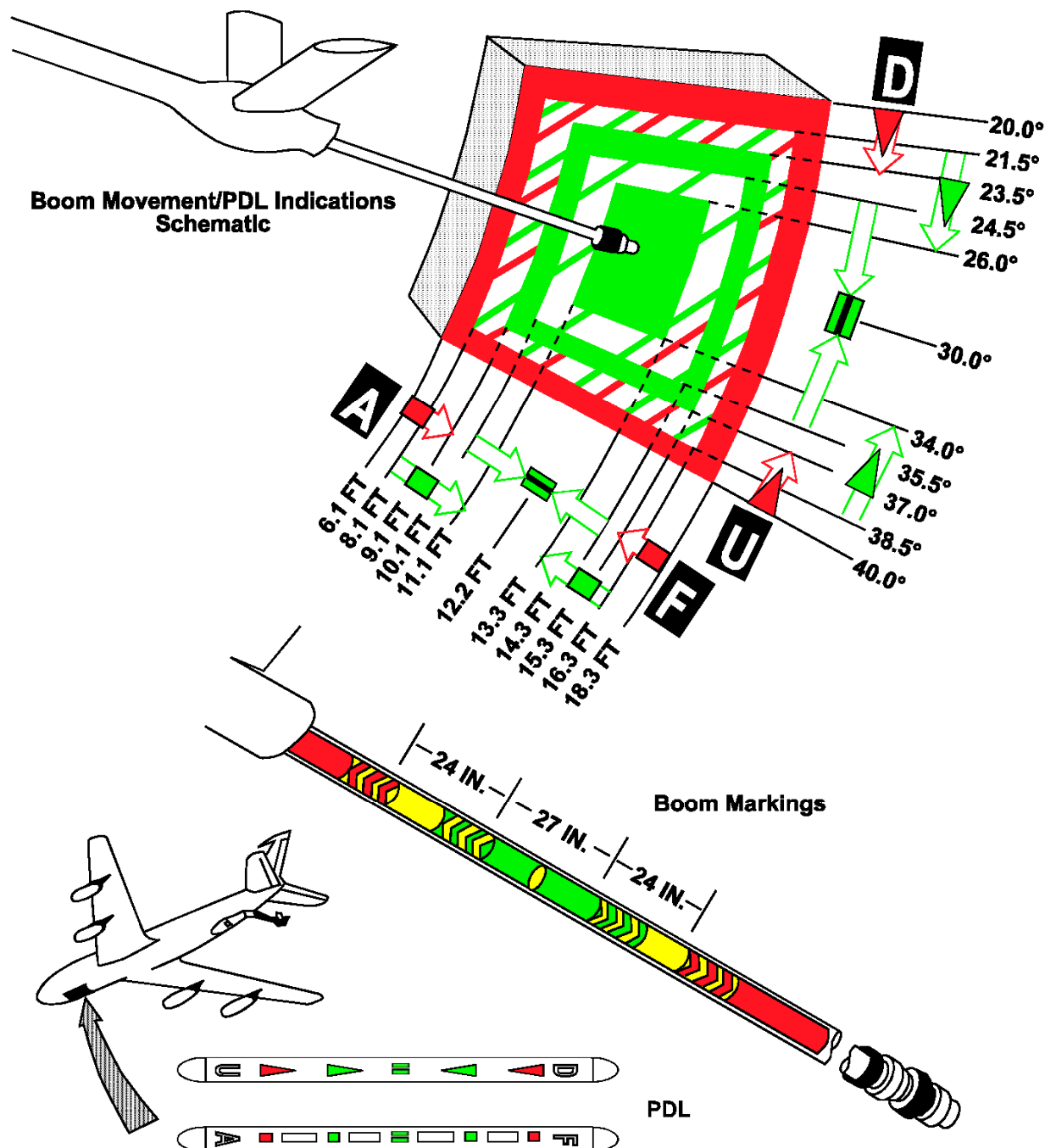
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**List of Appendices**

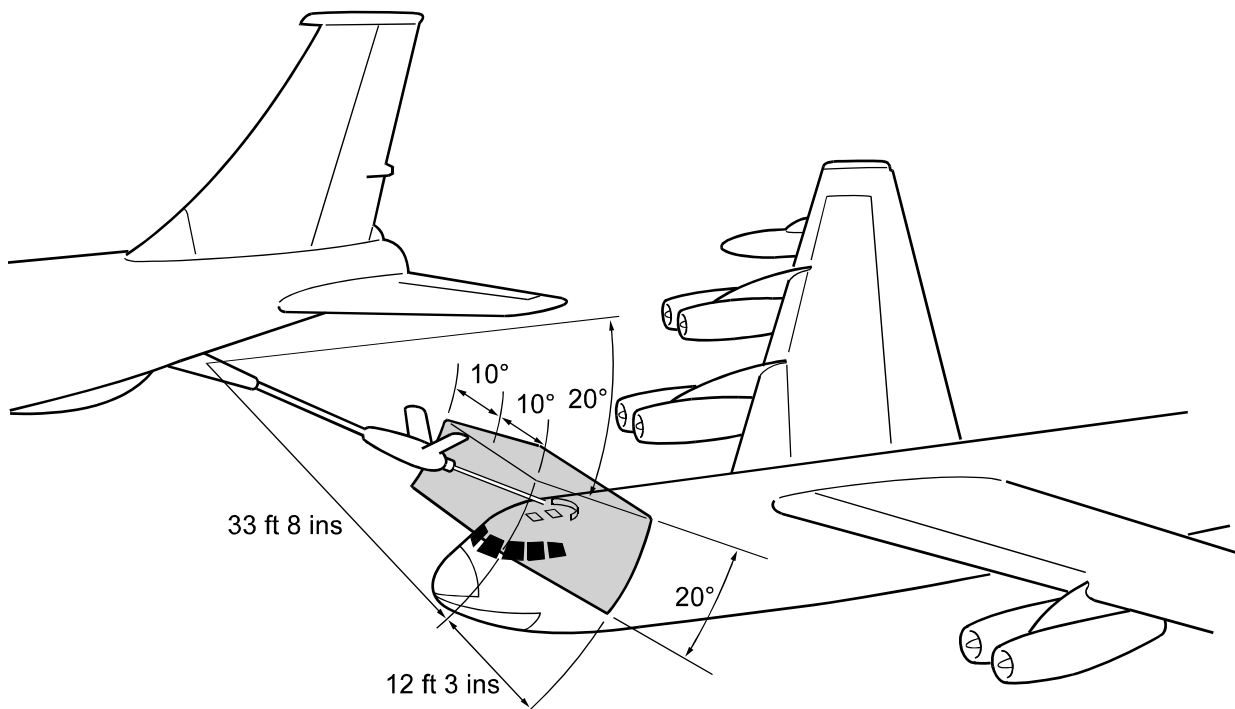
<b><u>Appendix</u></b>	<b><u>Subject</u></b>
<a href="#">Appendix ZA-1</a>	Boom
<a href="#">Appendix ZA-2</a>	BDA
<a href="#">Appendix ZA-3</a>	MPRS
<a href="#">Appendix ZA-4</a>	Exterior Lighting
<a href="#">Appendix ZA-5</a>	Refueling - Visual References

PART 5 – NATIONAL ANNEX  
ANNEX ZA, APPENDIX 1 - USA  
**KC-135 STRATOTANKER - BOOM**

**Figure ZA-1-1 - KC-135 Pilot Director Lights Illumination Profile and Boom Limits**



**Figure ZA-1-2 - KC-135 Boom Limits**



**PART 5 – NATIONAL ANNEX**  
**ANNEX ZA, APPENDIX 2 - USA**

**KC-135 STRATOTANKER - BOOM DROGUE ADAPTER**  
**(BDA)**

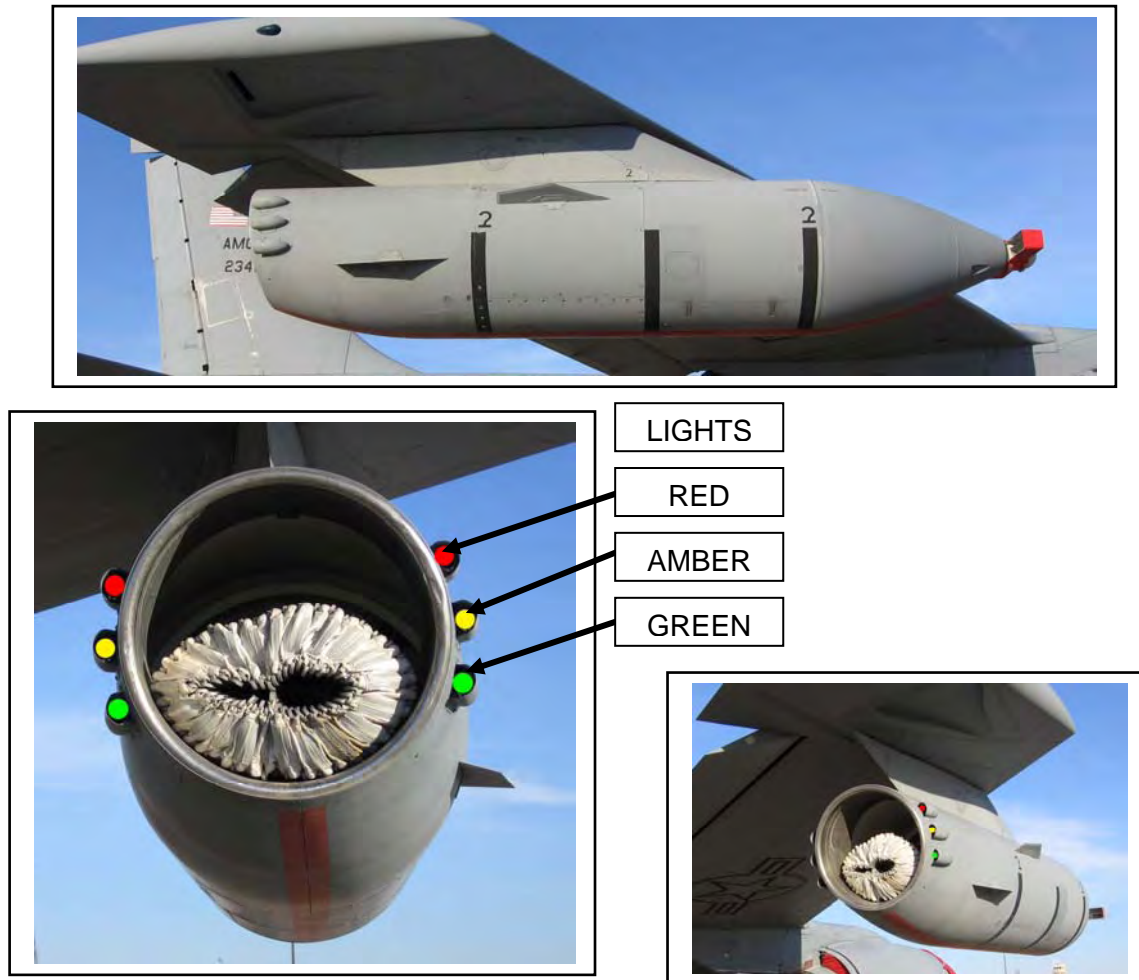
**Figure ZA-2-1 – BDA**



**PART 5 – NATIONAL ANNEX**  
**ANNEX ZA, APPENDIX 3 - USA**

**KC-135 MPRS POD STATUS LIGHTS**

**Figure ZA-3-1 – KC-135 MPRS Pod Status Lights**

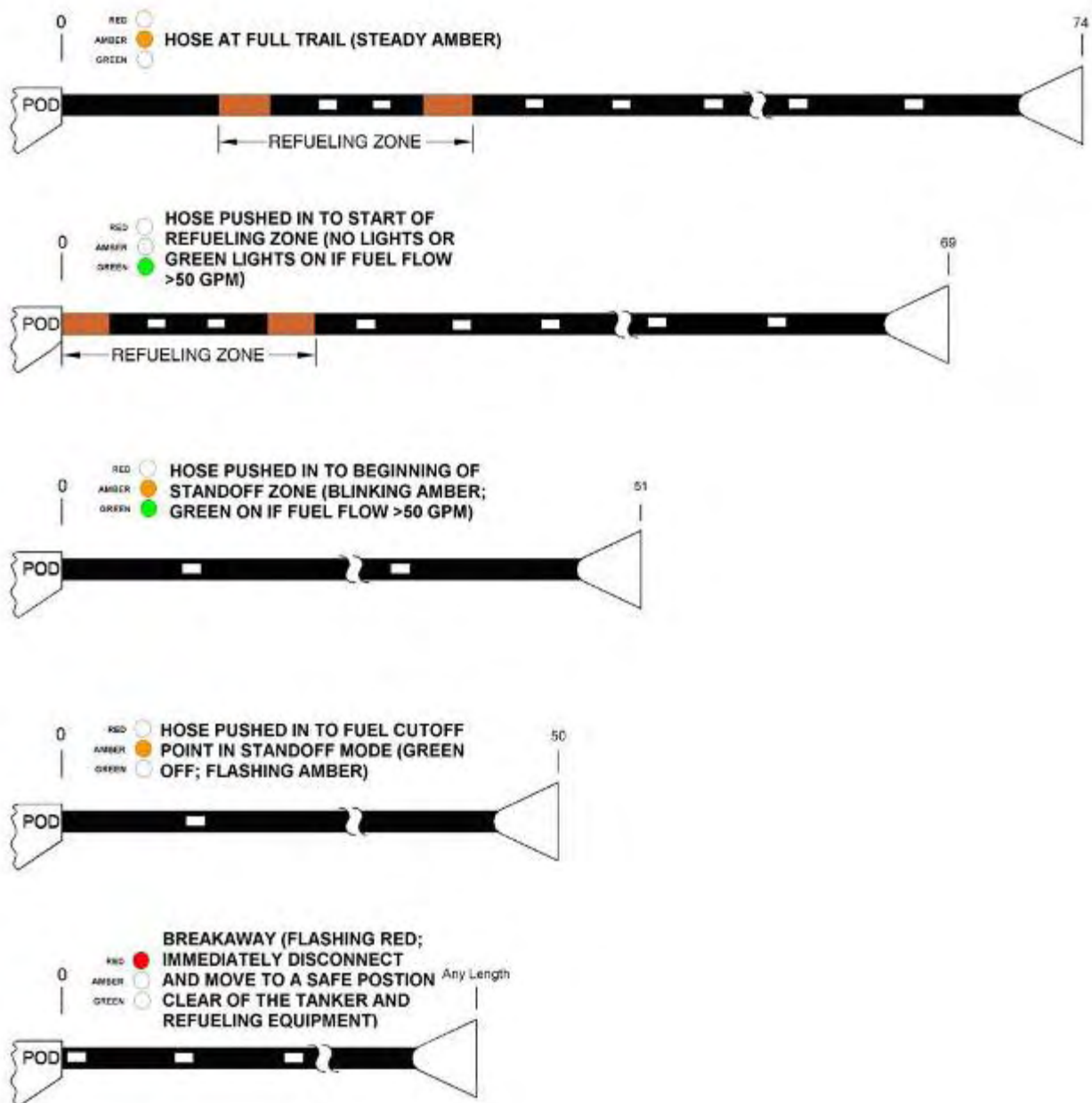


<b><u>LIGHTS</u></b>	<b><u>FUNCTION</u></b>
<b>RED (2)</b>	Light is on steady when power is on and hose is stowed and when the hose is deploying or being rewound using the REWIND/TRAIL switch on the pod control panel. Steady red light indicates to receiver the pod system is not ready to transfer fuel. Flashing indicates the need to immediate disconnect and separation. Comes on flashing when emergency breakaway switch on boom telescope lever is pressed; goes off after approximately 10 seconds or if emergency breakaway switch is pressed while lights are flashing.
<b>AMBER (2)</b>	When light is on steady, indicates to receiver that hose is fully extended and refueling system is ready for contact. Light flashes when hose is pushed in so deployed hose length is less than 51 feet and goes off when deployed hose length is more than 54 feet, when hose is pulled-out. Light is also on flashing when supplemental hose response is active.
<b>GREEN (2)</b>	Indicates to receiver that fuel transfer (greater than 50 gpm) is occurring. Lights are on when hose is deployed greater than 52 ft (but less than 69 ft), when the hose is pulled out. Lights are off when hose is pushed-in and less than 50 ft of hose is deployed or while supplemental hose response is active.


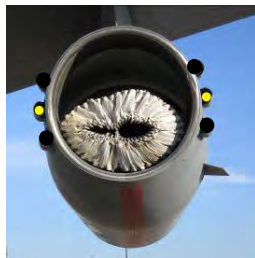
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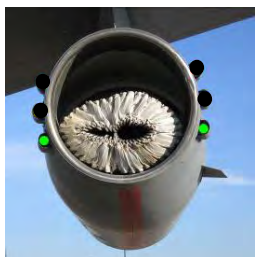
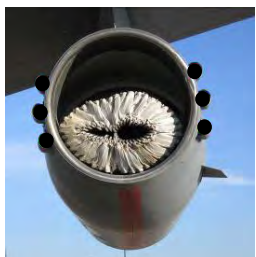
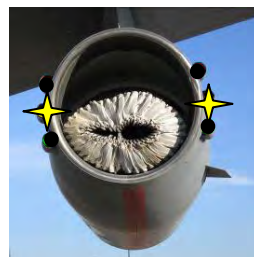
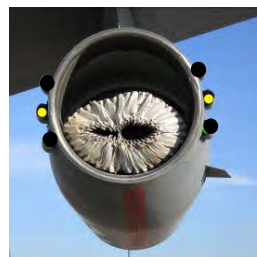
### Part 5, Annex ZA, Appendix 3

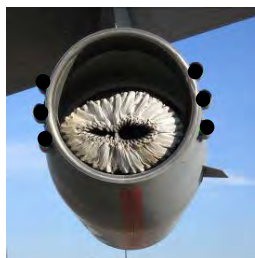

**Figure ZA-3-2 – KC-135 MPRS Hose Markings/Pod Status Lights**



**Figure ZA-3-3 – KC-135 MPRS Pod Status Lights**

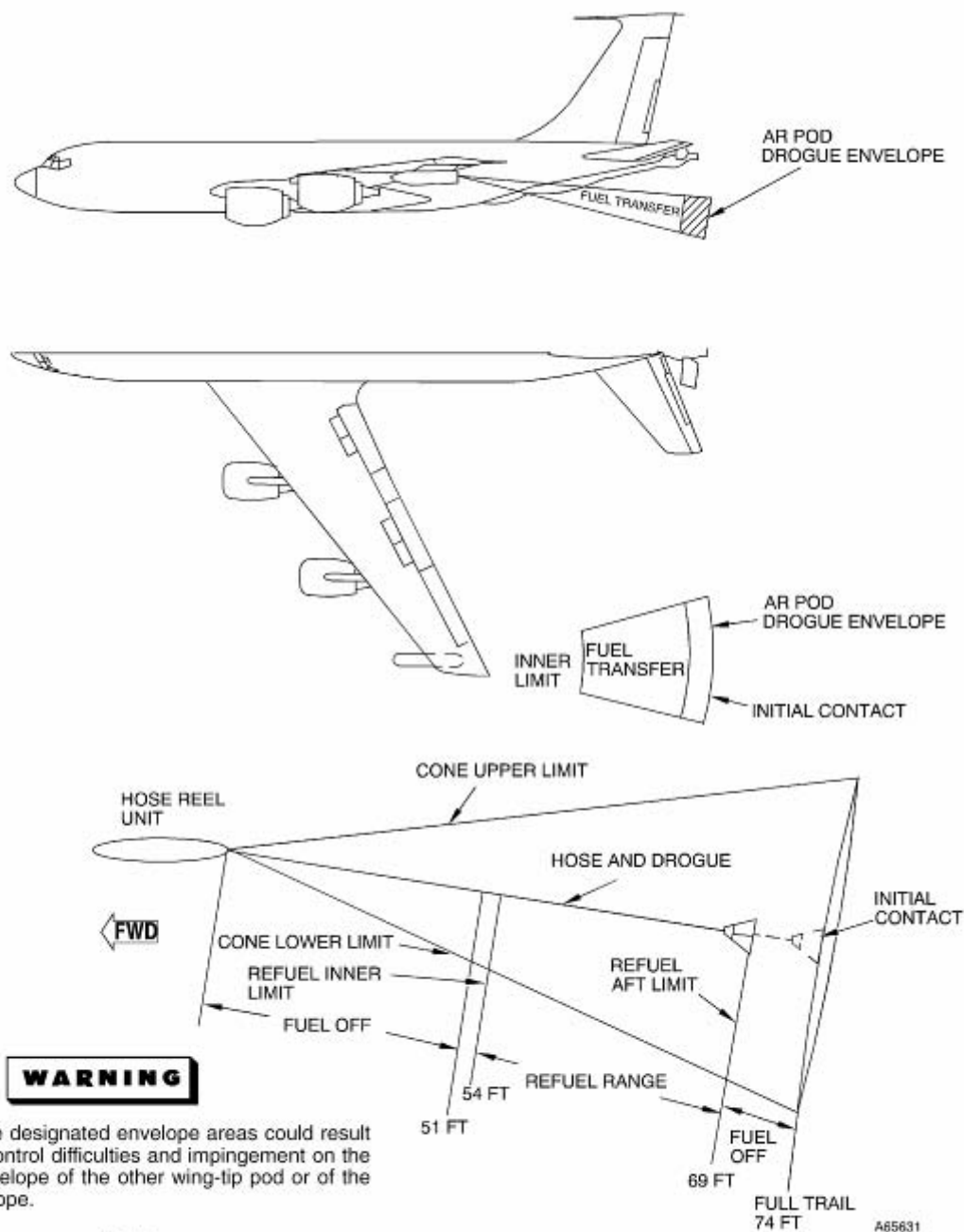
BEFORE CONTACT			
STEADY RED		STEADY AMBER	
Pod <b>NOT</b> ready. Do <b>NOT</b> make contact.		Ready for contact	
			

IN CONTACT			
STEADY GREEN	ALL LIGHTS OUT (Receiver in Fuel Transfer Position)	FLASHING AMBER	STEADY AMBER
Fuel flows	Offload complete/ dry contact	Forward limit, drawback	Aft limit
			

ANYTIME	
ALL 3 LIGHTS OUT	FLASHING RED
Disconnect	<b>BREAKAWAY</b>
	



**Figure ZA-3-4 – KC-135 Hose and Drogue – In-Flight Positioning**



Flight outside designated envelope areas could result in receiver control difficulties and impingement on the refueling envelope of the other wing-tip pod or of the tanker envelope.

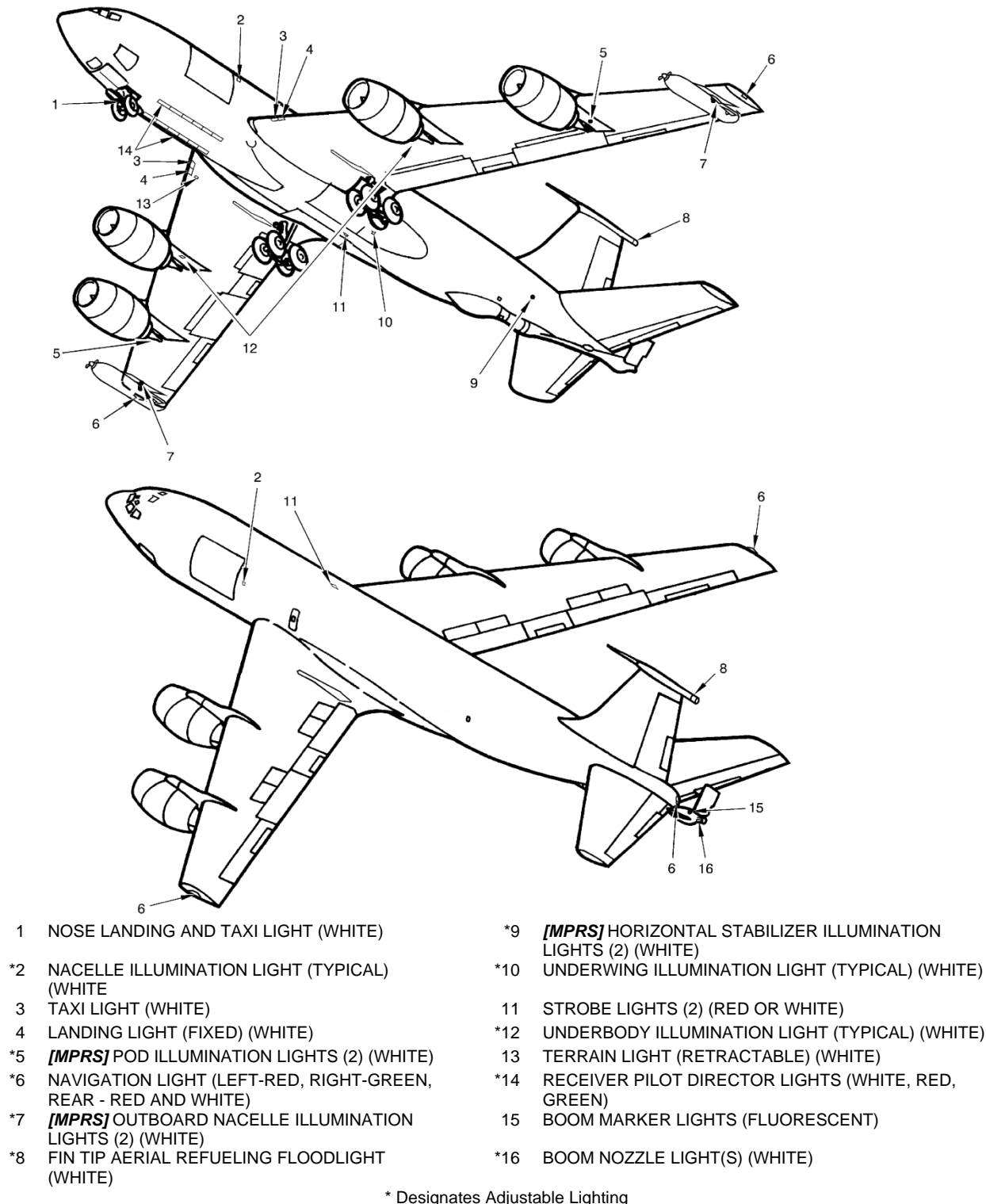
**NOTE**

Depicted hose extensions are based on nominal values and do not account for hysteresis in the fuel-draulics or the effects of receiver closure rate and activation of supplemental hose response mode.



# PART 5 – NATIONAL ANNEX ANNEX ZA, APPENDIX 4 - USA **KC-135 STRATOTANKER - EXTERIOR LIGHTING**

**Figure ZA-4-1 – KC-135 Exterior Lighting**



**PART 5 – NATIONAL ANNEX**  
**ANNEX ZA, APPENDIX 5 - USA**

**KC-135 STRATOTANKER AAR - VISUAL REFERENCES**

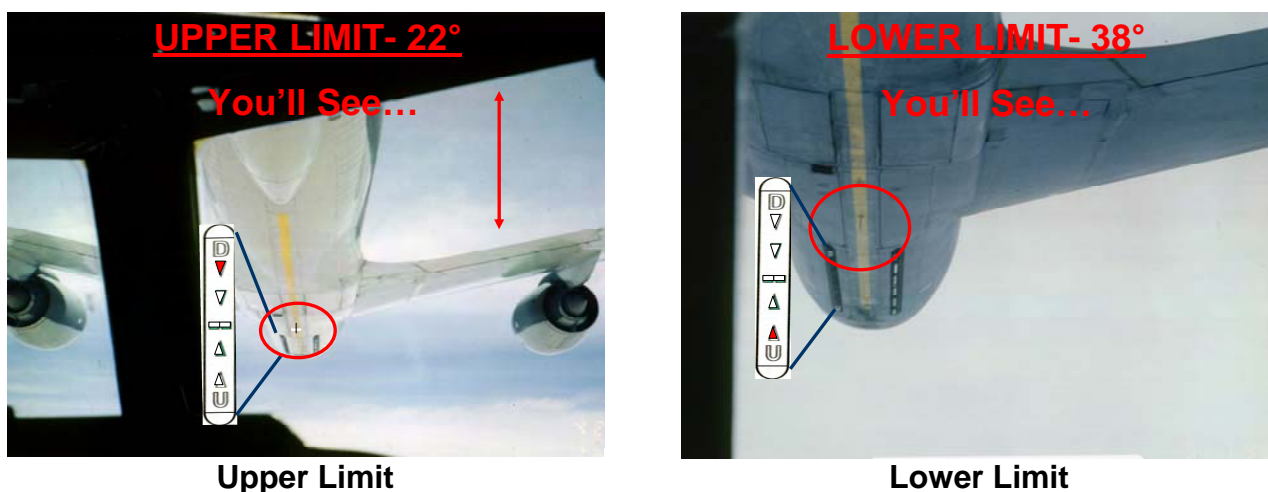
**1ZA-5 Refueling Position - Visual References.** When moving forward from the astern position to the contact position, the visual references used by heavy aircraft receiver pilots permit them to position their aircraft so that they remain within the tanker's AAR envelop. The following paragraphs provide guidance to help pilots achieve the correct position.

**2ZA-5 Position – Elevation.** Determination of correct elevation is best achieved by comparing the alignment of the lower UHF antenna with the white line painted on the lower fuselage of the tanker. This antenna may be hidden by the VHF Data Link (VDL) antenna installed between the UHF antenna and the white line.

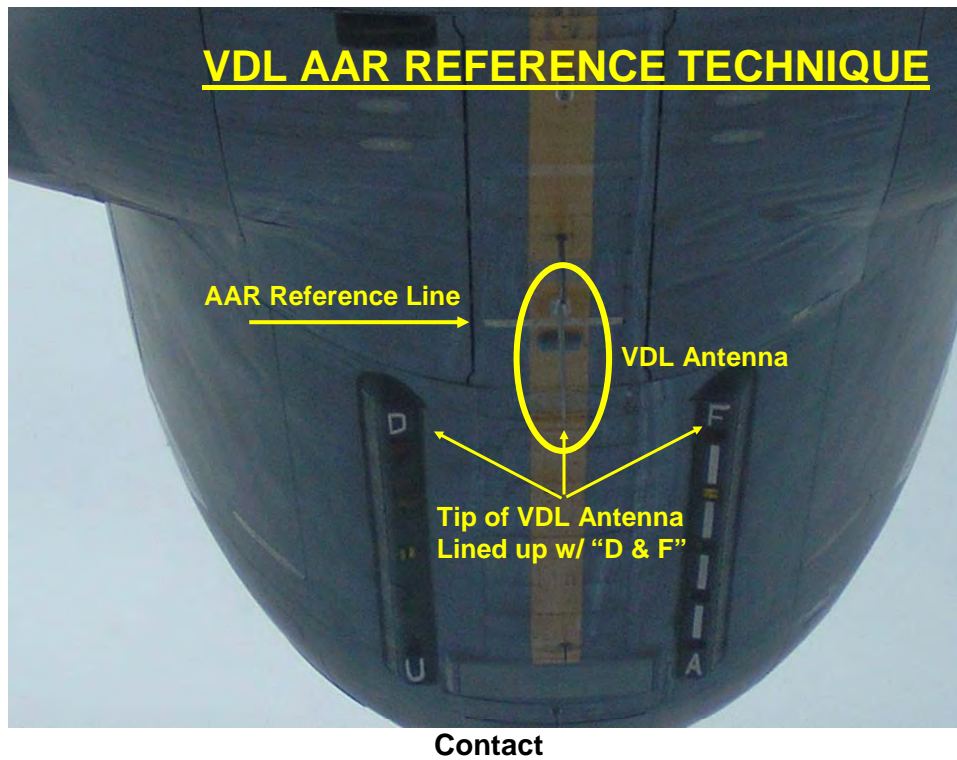
**a. Vertical Visual Reference – Heavy Aircraft Receivers**

- (1) Lower UHF Antenna** When receiving fuel, receiver pilots must exercise caution to ensure that they do not mistakenly attempt to create an inverted “T” using the VDL antenna instead of the UHF antenna. Moving two degrees left or right will allow the receiver pilot to distinguish the lower UHF antenna, and use normal references.
- (2) Alternative Reference – VDL Antenna** When AAR position is determined by reference to the VDL antenna, the correct vertical position is achieved when the receiver pilot aligns the tip of the VDL antenna with an imaginary line drawn between the top of “D” and the top of the “F” of the Pilot Director Lights.

**Figure ZA-5-1. Upper and Lower Limits - Lower UHF Reference**



**Figure ZA-5-3. Vertical Visual Reference**



## **LIST OF EFFECTIVE PAGES TO PART 5, ANNEX ZA, ATP-56(B)**

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ZA-1to ZA-9	Aug 11
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